Manjunath.R

100 People who

Changed History and the world

100 People Who Changed History and the World

"The only true wisdom is in knowing you know nothing."

— Socrates

Edited By

Manjunath.R

#16/1, 8th Main Road, Shivanagar, Rajajinagar, Bangalore560010, Karnataka, India

*Corresponding Author Email: manjunath5496@gmail.com

*Website: http://www.myw3schools.com/

This book takes readers back and forth through achievements of 100 world's most inspirational and influential people (from brainy biologists and clever chemists to magnificent mathematicians and phenomenal physicists) who have shaped our society and how we see the world around us.

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100 Most Influential Scientists Who Shaped World History

[1] **Sir Isaac Newton**

Birth: Dec. 25, 1642 [Jan. 4, 1643, New Style], Woolsthorpe, Lincolnshire, England

Death: March 20 [March 31], 1727, London

Known for: the Newtonian Revolution

Sir Isaac Newton was an English physicist and mathematician and was the culminating figure of the Scientific Revolution of the 17th century. In optics, his discovery of the composition of white light integrated the phenomena of colours into the science of light and laid the foundation for modern physical optics. In mechanics, his three laws of motion, the basic principles of modern physics, resulted in the formulation of the law of universal gravitation. In mathematics, he was the original discoverer of the infinitesimal calculus. Newton's Philosophiae Naturalis Principia Mathematica (Mathematical Principles of Natural Philosophy, 1687) was one of the most important single works in the history of modern science.

[2] **Albert Einstein**

Birth: March 14, 1879, Ulm, Wurttemberg, Germany

Death: April 18, 1955, Princeton, N.J., U.S.

Known for: Twentieth-Century Science

Albert Einstein was a German-born physicist who developed the special and general theories of relativity and won the Nobel Prize for Physics in 1921 for his explanation of the photoelectric effect. Einstein is generally considered the most influential physicist of the 20th century.

[3] **Niels Bohr**

Birth: Oct. 7, 1885, Copenhagen, Denmark

Death: Nov. 18, 1962, Copenhagen

Known for: the Atom

Niels Henrik David Bohr was a Danish physicist who is generally regarded as one of the foremost physicists of the 20th century. He was the first to apply the quantum concept, which restricts the energy of a system to certain discrete values, to the problem of atomic and molecular structure. For that work he received the Nobel Prize for Physics in 1922. His manifold roles in the origins and development of quantum physics may be his most-important contribution, but through his long career his involvements were substantially broader, both inside and outside the world of physics.

[4] **Charles Darwin**

Birth: Feb. 12, 1809, Shrewsbury, Shropshire, England

Death: April 19, 1882, Downe, Kent

Known for: Evolution

Charles Robert Darwin was an English naturalist whose scientific theory of evolution by natural selection became the foundation of modern evolutionary studies. An affable country gentleman, Darwin at first shocked religious Victorian society by suggesting that animals and humans shared a common ancestry. However, his nonreligious biology appealed to the rising class of professional scientists, and by the time of his death evolutionary imagery had spread through all of science, literature, and politics. Darwin, himself an agnostic, was accorded the ultimate British accolade of burial in Westminster Abbey, London.

[5] **Louis Pasteur**

Birth: Dec. 27, 1822, Dole, France

Death: Sept. 28, 1895, Saint-Cloud, near Paris

Known for: the Germ Theory of Disease

Louis Pasteur was a French chemist and microbiologist who was one of the most important founders of medical microbiology. Pasteur's contributions to science, technology, and medicine are nearly without precedent. He pioneered the study of molecular asymmetry; discovered that microorganisms cause fermentation and disease; originated the process of pasteurization; saved the beer, wine, and silk industries in France; and developed vaccines against anthrax and rabies.

[6] **Sigmund Freud**

Birth: May 6, 1856, Freiberg, Moravia, Austrian Empire [now Příbor, Czech Republic]

Death: Sept. 23, 1939, London, England

Known for: Psychology of the Unconscious

Sigmund Freud was an Austrian neurologist and the founder of psychoanalysis, a clinical method for treating psychopathology through dialogue between a patient and a psychoanalyst.

[7] **Galileo Galilei**

Birth: Feb. 15, 1564, Pisa [Italy]

Death: Jan. 8, 1642, Arcetri, near Florence

Known for: the New Science

Galileo was an Italian natural philosopher, astronomer, and mathematician who made fundamental contributions to the sciences of motion, astronomy, and strength of materials and to the development of the scientific method. His formulation of (circular) inertia, the law of falling bodies, and parabolic trajectories marked the beginning of a fundamental change in the study of motion. His insistence that the book of nature was written in the language of mathematics changed natural philosophy from a verbal, qualitative account to a mathematical one in which experimentation became a recognized method for discovering the facts of nature. Finally, his discoveries with the telescope revolutionized astronomy and paved the way for the acceptance of the Copernican heliocentric system, but his advocacy of that system eventually resulted in an Inquisition process against him.

"If I have seen further it is by standing on the shoulders of Giants."

— Isaac Newton

Newton's Three Laws of Motion:

- Every object in a state of rest will remain in that state of rest unless an external force acts on it.
- Force = mass × acceleration.
- For every action there is an equal and opposite reaction.

Newton's law of universal gravitation:

$$F_G = \frac{GMm}{R^2}$$

where F_G denote the gravitational force acting between two objects, M and m the masses of the objects, r the distance between the centers of their masses, and G the gravitational constant.

"Logic will get you from A to Z; imagination will get you everywhere."

— Albert Einstein

Einstein's mass-energy relation

$$\text{Energy} = \text{mass} \times (\text{speed of light})^2$$

Einstein's special relativity equations:

$$\text{Relativistic mass} = \frac{\text{rest mass}}{\sqrt{1 - \frac{(\text{velocity})^2}{(\text{speed of light})^2}}}$$

$$\text{Contracted Length} = \text{original length} \times \sqrt{1 - \frac{(\text{velocity})^2}{(\text{speed of light})^2}}$$

$$\text{Dilated time} = \frac{\text{stationary time}}{\sqrt{1 - \frac{(\text{velocity})^2}{(\text{speed of light})^2}}}$$

Einstein's Photoelectric Equation:

$$\text{Energy of photon} = \boxed{\begin{array}{c}\text{Minimum energy needed}\\ \text{to remove an electron}\end{array}} + \boxed{\begin{array}{c}\text{Maximum kinetic energy}\\ \text{of the emitted electron}\end{array}}$$

Einstein's General Theory of Relativity:

$$\text{Strain} \propto \text{stress}$$

$$\text{Space-time curvature} \propto \text{mass-energy stress}$$

Curvature from stuff in space-time	+	Curvature of space-time itself	=	Mass-energy stress

"Those who are not shocked when they first come across quantum theory cannot possibly have understood it."

— Niels Bohr

In 1911, fresh from completion of his PhD, the young Danish physicist **Niels Bohr** left Denmark on a foreign scholarship headed for the Cavendish Laboratory in Cambridge to work under **J. J. Thomson** on the structure of atomic systems. At the time, Bohr began to put forth the idea that since light could no long be treated as continuously propagating waves, but instead as discrete energy packets (as articulated by **Max Planck** and **Albert Einstein**), why should the classical Newtonian mechanics on which Thomson's model was based hold true? It seemed to Bohr that the atomic model should be modified in a similar way. If electromagnetic energy is quantized, i.e. restricted to take on only integer values of **hυ**, where υ is the frequency of light, then it seemed reasonable that the mechanical energy associated with the energy of atomic electrons is also quantized. However, Bohr's still somewhat vague ideas were not well received by Thomson, and Bohr decided to move from Cambridge after his first year to a place where his concepts about quantization of electronic motion in atoms would meet less opposition. He chose the University of Manchester, where the chair of physics was held by **Ernest Rutherford**. While in Manchester, Bohr learned about the nuclear model of the atom proposed by Rutherford. To overcome the difficulty associated with the classical collapse of the electron into the nucleus, Bohr proposed that the orbiting electron could only exist in certain special states of motion - called stationary states, in which no electromagnetic radiation was emitted. In these states, the angular momentum of the electron L takes on integer values of Planck's constant divided by 2π, denoted by $\hbar = \frac{h}{2\pi}$ (pronounced h-bar). In these stationary states, the electron angular momentum can take on values ħ, 2ħ, 3ħ... but never non-integer values. This is known as quantization of angular momentum, and was one of Bohr's key hypotheses. He imagined the atom as consisting of electron waves of wavelength $\lambda = \frac{h}{mv} = \frac{h}{p}$ endlessly circling atomic nuclei.

In his picture, only orbits with circumferences corresponding to an integral multiple of electron wavelengths could survive without **destructive interference** (i.e., $r = \frac{n\hbar}{mv}$ could survive without destructive interference). For circular orbits, the position vector of the electron r is always perpendicular to its linear momentum p. The angular momentum L has magnitude mvr in this case. Thus Bohr's postulate of quantized angular momentum is equivalent to $mvr = n\hbar$ where n is a positive integer called principal quantum number. It tells us what energy level the electron occupies.

> "You cannot teach a man anything, you can only help him find it within himself."
>
> **— Galileo**

Kinematic Equations:

- Final velocity = Initial velocity + (acceleration × time)
- Displacement = (Initial velocity × time) + $\frac{1}{2}$ [acceleration × $(\text{time})^2$]
- $(\text{Final velocity})^2 = (\text{Initial velocity})^2$ + 2 (acceleration × Displacement)

"In our acquisition of knowledge of the Universe, that which renovates the quest is nothing more nor less than complete innocence. In this state of complete innocence we receive everything from the moment of our birth. Although so often the object of our contempt and private fears, it is always in us. It alone can unite humility with boldness to allow us to penetrate to the heart of things or allow things to enter us and taken possession of us.

This unique power is [not] a privilege [of] exceptional talents – persons of incredible brainpower, better able to manipulate, with dexterity and ease, an enormous mass of ideas and specialized skills. Such gifts are valuable and undoubtedly worthy of envy from those who (like myself) were not so "endowed at birth, far beyond the ordinary."

Yet it is not these gifts, nor the most determined ambition and will-power, that enables one to surmount the invisible yet formidable boundaries" that encircle our universe. Only innocence can surmount them, which mere knowledge doesn't even take into account, in those moments when we find ourselves able to listen to things, intensely absorbed in child's play."

− **Alexander Grothendieck**

A mathematician who was the focal point in the launching of the modern Theory of Algebraic Geometry

James Hillman was an eminent American therapist. He was the principal Director of the Jung Institute in Zurich and established a development toward prototype brain research, which arose out of the Jungian convention.

"No fairer destiny could be allotted to any physical theory than that it should of itself point out the way to the introduction of a more comprehensive theory, in which it lives on as a limiting case."

− **Albert Einstein**

One of the best uncelebrated logical masters ever was the German mathematician and physicist **Amalie Emmy Noether**. Despite the fact that she endured segregation all through her splendid vocation, her associates perceived her extraordinary virtuoso.

It is hard to exaggerate the significance of her commitments to extract variable based math and hypothetical physical science.

Noether's hypothesis, for instance, which states that given a physical system, for every infinitesimal symmetry, there is a corresponding law of symmetry − associates evenness and preservation laws, is a significant foundation of current hypothetical material science.

Additionally, her authority of present day polynomial math drove the mathematician **Irving Kaplansky** to comment:

"It most likely isn't a lot of a misrepresentation to call her the mother of current polynomial math."

"When I speak about computer programming as an art, I am thinking primarily of it as an art form, in an aesthetic sense. The chief goal of my work as an educator and author is to help people learn how to write beautiful programs. [...] My feeling is that when we prepare a program, it can be like composing poetry or music; as [the Soviet computer scientist] **Andrei Ershov** has said, programming can give us both intellectual and emotional satisfaction because it is a real achievement to master complexity and to establish a system of consistent rules."

− Donald Knuth

An American computer scientist, mathematician, and professor emeritus at Stanford University

Letter from **Dutch post-impressionist painter** Vincent Willem van Gogh to his brother Theo

"What am I in the eyes of most people — a nonentity, an eccentric, or an unpleasant person — somebody who has no position in society and will never have; in short, the lowest of the low. All right, then — even if that were absolutely true, then I should one day like to show by my work what such an eccentric, such a nobody, has in his heart. That is my ambition, based less on resentment than on love in spite of everything, based more on a feeling of serenity than on passion. Though I am often in the depths of misery, there is still calmness, pure harmony, and music inside me. I see paintings or drawings in the poorest cottages, in the dirtiest corners. And my mind is driven towards these things with an irresistible momentum."

"You know that I write slowly. This is chiefly because I am never satisfied until I have said as much as possible in a few words, and writing briefly takes far more time than writing at length."

− **Carl Friedrich Gauss**

In a 1929 meeting, **German-born theoretical physicist** Albert Einstein was inquired:

"How could he get his thoughts?"

His answer was:

"I'm sufficient of a craftsman to draw unreservedly on my creative mind. Creative mind is a higher priority than information. Information is restricted. Creative mind encompasses the world."

In the spring of 1955, not well before he passed on (April 18), **German-born theoretical physicist** Albert Einstein entered the medical clinic since his heart was starting to fall flat. His companion **Dutch-American physicist and science historian** Abraham Pais described, "[A few days before Einstein died] on April 15, he called his secretary. He needed his wellspring pen, his glasses, and his most recent piece of notes. What's more, Einstein, obviously, realized that his time was approaching, to go. Yet, he needed a mini-computer. What's more, he plunked down and started to ascertain. That is a story that makes you shiver. It makes me shiver. He realized he would not see whatever would emerge from these figurings via accomplishment. It didn't make a difference to him."

Maria Gaetana Agnesi was an Italian mathematician, philosopher, theologian, and humanitarian. She was the first woman to write a mathematics handbook on both integral and differential calculus and the first woman appointed as a mathematics professor at a university.

[8] **Antoine-Laurent Lavoisier**

Birth: Aug. 26, 1743, Paris, France

Death: May 8, 1794, Paris

Known for: the Revolution in Chemistry

Antoine-Laurent Lavoisier was a prominent French chemist and leading figure in the 18th-century chemical revolution who developed an experimentally based theory of the chemical reactivity of oxygen and coauthored the modern system for naming chemical substances. Having also served as a leading financier and public administrator before the French Revolution, he was executed with other financiers during the revolutionary terror.

[9] **Johannes Kepler**

Birth: Dec. 27, 1571, Weil der Stadt, Wurttemberg [Germany]

Death: Nov. 15, 1630, Regensburg

Known for: Motion of the Planets

Johannes Kepler was a German astronomer who discovered three major laws of planetary motion, conventionally designated as follows: (1) the planets move in elliptical orbits with the Sun at one focus; (2) the time necessary to traverse any arc of a planetary orbit is proportional to the area of the sector between the central body and that arc (the "area law"); and (3) there is an exact relationship between the squares of the planets' periodic times and the cubes of the radii of their orbits (the "harmonic law"). Kepler himself did not call these discoveries "laws," as would become customary after Isaac Newton derived them from a new and quite different set of general physical principles. He regarded them as celestial harmonies that reflected God's design for the universe. Kepler's discoveries turned Nicolaus Copernicus's Sun-centered system into a dynamic universe, with the Sun actively pushing the planets around in noncircular orbits. And it was Kepler's notion of a physical astronomy that fixed a new problematic for other important 17th-century world-system builders, the most famous of whom was Newton.

[10] **Nicolaus Copernicus**

Birth: Feb. 19, 1473, Toruń, Poland

Death: May 24, 1543, Frauenburg, East Prussia [now Frombork, Poland]

Known for: the Heliocentric Universe

Nicolaus Copernicus was an Polish astronomer who proposed that the planets have the Sun as the fixed point to which their motions are to be referred; that Earth is a planet which, besides orbiting the Sun annually, also turns once daily on its own axis; and that very slow long-term changes in the direction of this axis account for the precession of the equinoxes. This representation of the heavens is usually called the heliocentric, or "**Sun-centered**," system—derived from the Greek helios, meaning "Sun." Copernicus's theory had important consequences for later thinkers of the Scientific Revolution, including such major figures as Galileo, Kepler, Descartes, and Newton. Copernicus probably hit upon his main idea sometime between 1508 and 1514, and during those years he wrote a manuscript usually called the Commentariolus ("**Little Commentary**"). However, the book that contains the final version of his theory, De revolutionibus orbium coelestium libri vi ("**Six Books Concerning the Revolutions of the Heavenly Orbs**"), did not appear in print until 1543, the year of his death.

[11] **Michael Faraday**

Birth: Sept. 22, 1791, Newington, Surrey, England

Death: Aug. 25, 1867, Hampton Court

Known for: the Classical Field Theory

Michael Faraday was an English physicist and chemist whose many experiments contributed greatly to the understanding of electromagnetism.

[12] **James Clerk Maxwell**

Birth: June 13, 1831, Edinburgh, Scotland

Death: Nov. 5, 1879, Cambridge, Cambridgeshire, England

Known for: the Electromagnetic Field

James Clerk Maxwell was a Scottish physicist best known for his formulation of electromagnetic theory. He is regarded by most modern physicists as the scientist of the 19th century who had the greatest influence on 20th-century physics, and he is ranked with Sir Isaac Newton and Albert Einstein for the fundamental nature of his contributions. In 1931, on the 100th anniversary of Maxwell's birth, Einstein described the change in the conception of reality in physics that resulted from Maxwell's work as "the most profound and the most fruitful that physics has experienced since the time of Newton."

[13] **Claude Bernard**

Birth: July 12, 1813, Saint-Julien

Death: February. 10, 1878, Paris

Known for: the Founding of Modern Physiology

Claude Bernard was a French physiologist known chiefly for his discoveries concerning the role of the pancreas in digestion, the glycogenic function of the liver, and the regulation of the blood supply by the vasomotor nerves. On a broader stage, Bernard played a role in establishing the principles of experimentation in the life sciences, advancing beyond the vitalism and indeterminism of earlier physiologists to become one of the founders of experimental medicine. His most seminal contribution was his concept of the internal environment of the organism, which led to the present understanding of homeostasis—i.e., the self-regulation of vital processes.

[14] **Franz Boas**

Birth: July 9, 1858, Minden, Westphalia, Germany

Death: December 21, 1942, New York, U.S

Known for: Modern Anthropology

Franz Boas was a German-born American anthropologist of the late 19th and early 20th centuries, the founder of the relativistic, culture-centered school of American anthropology that became dominant in the 20th century. During his tenure at Columbia University in New York City (1899–1942), he developed one of the foremost departments of anthropology in the United States. Boas was a specialist in North American Indian cultures and languages, but he was, in addition, the organizer of a profession and the great teacher of a number of scientists who developed anthropology in the United States, including A.L. Kroeber, Ruth Benedict, Margaret Mead, Melville Herskovits, and Edward Sapir.

[15] **Werner Heisenberg**

Birth: December, 1901, Würzburg, Bavaria, German Empire

Death: 1 February 1976, Munich, Bavaria, West Germany

Known for: Quantum Theory

Werner Karl Heisenberg was a German physicist and philosopher who discovered a way to formulate quantum mechanics in terms of matrices. For that discovery, he was awarded the Nobel Prize for Physics for 1932. In 1927 he published his uncertainty principle, upon which he built his philosophy and for which he is best known. He also made important contributions to the theories of the hydrodynamics of turbulent flows, the atomic nucleus, ferromagnetism, cosmic rays, and subatomic particles, and he was instrumental in planning the first West German nuclear reactor at Karlsruhe, together with a research reactor in Munich, in 1957. Considerable controversy surrounds his work on atomic research during World War II.

[16] **Linus Pauling**

Birth: Feb. 28, 1901, Portland, Ore., U.S.

Death: Aug. 19, 1994, Big Sur, California

Known for: Twentieth-Century Chemistry

Linus Carl Pauling was an American theoretical physical chemist who became the only person to have won two unshared Nobel Prizes. His first prize (1954) was awarded for research into the nature of the chemical bond and its use in elucidating molecular structure; the second (1962) recognized his efforts to ban the testing of nuclear weapons.

[17] **Erwin Schrodinger**

Birth: Aug. 12, 1887, Vienna, Austria

Death: Jan. 4, 1961, Vienna

Known for: Wave Mechanics

Erwin Schrödinger was an Austrian theoretical physicist who contributed to the wave theory of matter and to other fundamentals of quantum mechanics. He shared the 1933 Nobel Prize for Physics with British physicist P.A.M. Dirac.

[18] **John James Audubon**

Birth: April 26, 1785, Les Cayes, Saint-Domingue, West Indies [now in Haiti]

Death: Jan. 27, 1851, New York, N.Y., U.S.

Known for: drawings and paintings of North American birds

John James Audubon was an ornithologist, artist, and naturalist who became particularly well known for his drawings and paintings of North American birds.

[19] **Ernest Rutherford**

Birth: Aug. 30, 1871, Spring Grove, N.Z.

Death: Oct. 19, 1937, Cambridge, Cambridgeshire, England

Known for: the Structure of the Atom

Ernest Rutherford was a New Zealand-born British physicist considered the greatest experimentalist since Michael Faraday (1791–1867). Rutherford was the central figure in the study of radioactivity, and with his concept of the nuclear atom he led the exploration of nuclear physics. He won the Nobel Prize for Chemistry in 1908, was president of the Royal Society (1925–30) and the British Association for the Advancement of Science (1923), was conferred the Order of Merit in 1925, and was raised to the peerage as Lord Rutherford of Nelson in 1931.

[20] **Paul Adrien Maurice Dirac**

Birth: Aug. 8, 1902, Bristol, Gloucestershire, England

Death: Oct. 20, 1984, Tallahassee, Florida, USA

Known for: Quantum Electrodynamics

Paul Adrien Maurice Dirac was an English theoretical physicist who was one of the founders of quantum mechanics and quantum electrodynamics. Dirac is most famous for his 1928 relativistic quantum theory of the electron and his prediction of the existence of antiparticles. In 1933 he shared the Nobel Prize for Physics with the Austrian physicist Erwin Schrödinger.

[21] **Andreas Vesalius**

Birth: Dec. 1514, Brussels [now in Belgium]

Death: June 1564, island of Zacynthus, Republic of Venice [now in Greece]

Known for: the New Anatomy

Andreas Vesalius was a Renaissance physician who revolutionized the study of biology and the practice of medicine by his careful description of the anatomy of the human body. Basing his observations on dissections he made himself, he wrote and illustrated the first comprehensive textbook of anatomy.

"The history of astronomy is a history of receding horizons."

— Edwin Powell Hubble

Hubble's Law:

$$v = \frac{dD}{dt} = HD$$

where:

- v is the observed velocity of the galaxy away from us, usually in km/sec
- H is Hubble's constant, in km/sec/Mpc
- D is the distance to the galaxy in Mpc

"Science cannot solve the ultimate mystery of nature. And that is because, in the last analysis, we ourselves are a part of the mystery that we are trying to solve."

— Max Planck

Planck's Quantum Theory:

$$E = h\upsilon$$

where h denote the Planck's constant ($6.62606957 \times 10^{-34}$ J s), υ the frequency and E the energy of an electromagnetic radiation.

> "Not only is the Universe stranger than we think, it is stranger than we can think."
>
> **— Werner Heisenberg**

Heisenberg's uncertainty principle:

- uncertainty in position × uncertainty of momentum $\geq \frac{\hbar}{4\pi}$
- uncertainty of energy × uncertainty in time $\geq \frac{\hbar}{4\pi}$

> "The history of science shows that the progress of science has constantly been hampered by the tyrannical influence of certain conceptions that finally came to be considered as dogma. For this reason, it is proper to submit periodically to a very searching examination, principles that we have come to assume without any more discussion."
>
> **— Louis de Broglie**

de Broglie Equation:

$$\text{Wavelength} = \frac{\text{Planck's constant}}{\text{momentum}}$$

"There are two possible outcomes: if the result confirms the hypothesis, then you've made a measurement. If the result is contrary to the hypothesis, then you've made a discovery."

— Enrico Fermi

$$\text{Fermi temperature} = \frac{\text{Fermi energy}}{\text{Boltzmann constant}}$$

$$\text{Fermi momentum} = \sqrt{2 \times \text{particle mass} \times \text{Fermi energy}}$$

$$\text{Fermi velocity} = \frac{\text{Fermi momentum}}{\text{particle mass}}$$

$$\text{Fermi momentum} = \frac{\text{Planck's constant}}{2\pi} \times \text{Fermi wavevector}$$

"Nothing takes place in the world whose meaning is not that of some maximum or minimum."

— Leonhard Euler

Euler's Identity:

$$e^{i\pi} + 1 = 0$$

"You have no responsibility to live up to what other people think you ought to accomplish. I have no responsibility to be like they expect me to be. It's their mistake, not my failing.

− Richard P. Feynman

Quite possibly the most strange figures throughout the entire existence of mathematical physics is **George Green**. He was a dough puncher and mill operator who, with little formal education, authored an important treatise on mathematical physics. He was first to attempt to devise a theory of electricity and magnetism. This work proclaimed the start of modern mathematical physics in Great Britain.

Constance Bowman Reid wrote in her superb memoir of **German mathematician** David Hilbert (one of the most influential mathematicians of the 19th and early 20th centuries):

"Hilbert had no tolerance with numerical talks, which filled the understudies with realities however didn't show them how to outline an issue and address it. He regularly used to disclose to them that an ideal definition of an issue is as of now a large portion of its answer."

Two sentences stand out on American theoretical physicist **Richard Feynman's writing board** at his time of death:

"What I cannot make, I don't understand."

"Know how to illuminate each issue that has been solved."

"Julian Schwinger already understands 90% of physics; the remaining 10% should only take a few days."

Feynman could do anything, anything at all. At one time, the most important group in our division was concerned with calculating machines. . . . The two men I had put in charge of these computers just played with them, and they never gave us the answers we wanted. . . . I asked Feynman to take over. As soon as he got in there, we got answers every week—lots of them, and very accurate. He always knew what was needed, and he always knew what had to be done to get it. . . . (I should mention that the computer had arrived in boxes—about ten boxes for each. Feynman and one of the former group leaders put the machines together. . . . Later we got some professionals from IBM who said, "This has never been done before. I have never seen laymen put together one of these machines, and it's perfect! "

− Hans Albrecht Bethe

A German-American nuclear physicist who made important contributions to astrophysics, quantum electrodynamics, and solid-state physics, and who won the 1967 Nobel Prize in Physics for his work on the theory of stellar nucleosynthesis.

The Indian mathematician and hypothetical physicist **Satyendra Nath Bose** (1894-1974), is well-known for his collaboration with German physicist **Albert Einstein** in developing a theory regarding the gas-like qualities of electromagnetic radiation (**Bose-Einstein statistics**). But Bose's judgment skills weren't confined to hypothetical material science. His interface included test material science, science, chemistry, science, mineralogy, reasoning, expressions, writing, and music (he too adored verse, chess, and cats).

"Euler was the most prolific writer of mathematics in history of the subject. He wrote mathematics incessantly with the effortless ease and fluency that a skilled conversationalist exhibits when speaking. It is said that he would dash off a mathematical paper in the scant half-hour between the first and second call to dinner. As soon as Euler finished a paper, he would put it on top of a growing stack that was awaiting the printer. When material was needed to fill the Academy's transactions, the printer would grab a sheaf from the top of the pile... A monumental edition of Euler's complete works was initiated in 1909... and was planned to run into seventy-three... volumes, but the later discovery of overlooked material will considerably increase this number."

– Howard Whitley Eves

An American mathematician, known for his work in geometry and the history of mathematics

When **Paul Adrien Maurice Dirac**, an English theoretical physicist who is regarded as one of the most significant physicists of the 20th century, was creating quantum mechanics (a fundamental theory in physics that provides a description of the physical properties of nature at the scale of atoms and subatomic particles), he presented an unrigorous numerical work: the Dirac delta function. Extreme Dirac recognized that the work was unrigorous, he famous it might be utilized 'as in spite of the fact that it was an appropriate work for all intents and purposes all purposes in quantum mechanics.' Later, he commented that his ponder of designing driven him to it: "I think it was that sort of preparing that gave me the thought of the delta work since once you think of load in building structures, now and then you have got a distributed load, and now and then you've got a concentrated stack at the point. It is [...] the same whether you have got a concentrated stack or a dispersed one, but you employ to some degree distinctive conditions within the two cases. [I]t's as it were to bind together these two things which sort of driven to the delta function."

"I never come across one of Laplace's 'Thus it plainly appears' without feeling that I have hours of hard work before me to fill up the chasm and find out and show how it 'plainly' appears."

− Nathaniel Bowditch

An early American mathematician remembered for his work on ocean navigation

"There are [many] categories of scientists; those of 2nd or 3rd rank [...] never get very far. Then there is the 1st rank, those who make important discoveries [...]. But then there are the geniuses, like Galileo and Newton. Majorana was one of these."

− Enrico Fermi

The creator of the world's first nuclear reactor, the Chicago Pile-1

"My intuition was not strong enough in the field of mathematics in order to differentiate clearly the fundamentally important . . . from the rest of the more or less dispensable erudition. Beyond this, however, my interest in the knowledge of nature was also unqualifiedly stronger. . . . In this field I soon learned to scent out that which was able to lead to fundamentals and to turn aside . . . from the multitude of things which clutter up the mind and divert it from the essential."

−Albert Einstein

(Autobiographical notes)

This brief work is the closest Albert Einstein ever came to composing a personal history. In spite of the fact that an awfully individual account, it is simply concerned with the advancement of his thoughts, saying small approximately his private life or almost the world-shaking occasions through which he lived.

Frank Nelson Cole (September 20, 1861 – May 26, 1926) was an American mathematician, born in Ashland, Massachusetts, and educated at Harvard, where he lectured on mathematics from 1885 to 1887.

Later, he was employed at the University of Michigan and Columbia University. Professor Cole became secretary of the **American Mathematical Society** in 1895 and an editor of its Bulletin in 1897.

Cole published a number of important papers, including The Diurnal Variation of Barometric Pressure (1892). In 1893 in Chicago, his paper On a Certain Simple Group was read (but not by him) at the International Mathematical Congress held in connection with the World's Columbian Exposition.

On October 31, 1903, Cole famously made a presentation to a meeting of the American Mathematical Society where he identified the factors of the Mersenne number $2^{67} - 1$, or M_{67}. **Édouard Lucas** had demonstrated in 1876 that M_{67} must have factors (i.e., is not prime), but he was unable to determine what those factors were. During Cole's so-called "lecture", he approached the chalkboard and in complete silence proceeded to calculate the value of M_{67}, with the result being 147,573,952,589,676,412,927. Cole then moved to the other side of the board and wrote 193,707,721 × 761,838,257,287, and worked through the tedious calculations by hand. Upon completing the multiplication and demonstrating that the result equaled M_{67}, Cole returned to his seat, not having uttered a word during the hour-long presentation. His audience greeted the presentation with a standing ovation. Cole later admitted that finding the factors had taken "three years of Sundays."

Cole died alone in New York City, aged 64. The American Mathematical Society's Cole Prize was named in his honor.

"Though I knew Einstein for two or three decades, it was only in the last decade of his life that we were close colleagues and something of friends. But I thought that it might be useful because I am sure that it is not too soon - and for our generation perhaps almost too late - to start to dispel the clouds of myth and to see the great mountain peak that these clouds hide. As always, the myth has its charms; but the truth is far more beautiful."

− J. Robert Oppenheimer

[22] **Tycho Brahe**

Birth: Dec. 14, 1546, Knudstrup, Scania, Denmark

Death: Oct. 24, 1601, Prague

Known for: the New Astronomy

Tycho Brahe was a Danish astronomer whose work in developing astronomical instruments and in measuring and fixing the positions of stars paved the way for future discoveries. His observations—the most accurate possible before the invention of the telescope—included a comprehensive study of the solar system and accurate positions of more than 777 fixed stars.

[23] **Comte de Buffon**

Birth: September 07, 1707, Montbard, Burgundy, France

Death: April 16, 1788, Paris, France

Known for: l'Histoire Naturelle

Comte de Buffon was a French naturalist, mathematician, cosmologist, and encyclopedist. His works influenced the next two generations of naturalists, including Jean-Baptiste Lamarck and Georges Cuvier. Buffon published thirty-six quarto volumes of his Histoire Naturelle during his lifetime; with additional volumes based on his notes and further research being published in the two decades following his death.

[24] **Ludwig Boltzmann**

Birth: February 20, 1844, Vienna, Austrian Empire (present-day Austria)

Death: September 5, 1906, Tybein near Trieste, Austria-Hungary [present-day Duino, Italy]

Known for: Thermodynamics

Ludwig Eduard Boltzmann was an Austrian physicist whose greatest achievement was in the development of statistical mechanics, which explains and predicts how the properties of atoms (such as mass, charge, and structure) determine the visible properties of matter (such as viscosity, thermal conductivity, and diffusion).

[25] **Max Planck**

Birth: April 23, 1858, Kiel, Schleswig [Germany]

Death: Oct. 4, 1947, Göttingen, West Germany

Known for: the Quanta

Max Karl Ernst Ludwig Planck was a German theoretical physicist who originated quantum theory, which won him the Nobel Prize for Physics in 1918.

[26] **Marie Curie**

Birth: Nov. 7, 1867, Warsaw, Poland, Russian Empire

Death: July 4, 1934, near Sallanches, France

Known for: Radioactivity

Marie Curie was a Polish-born French physicist, famous for her work on radioactivity and twice a winner of the Nobel Prize. With Henri Becquerel and her husband, Pierre Curie, she was awarded the 1903 Nobel Prize for Physics. She was the sole winner of the 1911 Nobel Prize for Chemistry. She was the first woman to win a Nobel Prize, and she is the only woman to win the award in two different fields.

[27] **Sir William Herschel**

Birth: Nov. 15, 1738, Hanover, Germany

Death: Aug. 25, 1822, Slough, Buckinghamshire, England

Known for: Sidereal astronomy

Sir William Frederick Herschel was a German-born British astronomer, the founder of sidereal astronomy for the systematic observation of the heavens. He discovered the planet Uranus, hypothesized that nebulae are composed of stars, and developed a theory of stellar evolution. He was knighted in 1816.

[28] **Charles Lyell**

Birth: Nov. 14, 1797, Kinnordy, Forfarshire, Scotland

Death: Feb. 22, 1875, London, England

Known for: Modern Geology

Sir Charles Lyell, Baronet was a Scottish geologist largely responsible for the general acceptance of the view that all features of the Earth's surface are produced by physical, chemical, and biological processes through long periods of geological time. The concept was called uniformitarianism (initially set forth by James Hutton). Lyell's achievements laid the foundations for evolutionary biology as well as for an understanding of the Earth's development. He was knighted in 1848 and made a baronet in 1864.

[29] **Pierre Simon de Laplace**

Birth: March 23, 1749, Beaumount-en-Auge, Normandy, France

Death: March 5, 1827, Paris

Known for: Black hole, Nebular hypothesis of the origin of the solar system

Pierre-Simon de Laplace was a French scholar and polymath whose work was important to the development of engineering, mathematics, statistics, physics, astronomy, and philosophy. He summarized and extended the work of his predecessors in his five-volume Mécanique Céleste (**Celestial Mechanics**). This work translated the geometric study of classical mechanics to one based on calculus, opening up a broader range of problems. In statistics, the Bayesian interpretation of probability was developed mainly by Laplace. Laplace is remembered as one of the greatest scientists of all time. Sometimes referred to as the French Newton or **Newton of France**, he has been described as possessing a phenomenal natural mathematical faculty superior to that of any of his contemporaries.

[30] **Edwin Powell Hubble**

Birth: Nov. 20, 1889, Marshfield, Mo., U.S.

Death: Sept. 28, 1953, San Marino, California

Known for: Extragalactic astronomy

Edwin Powell Hubble was an American astronomer who played a crucial role in establishing the field of extragalactic astronomy and is generally regarded as the leading observational cosmologist of the 20th century.

[31] **Joseph J. Thomson**

Birth: December 18, 1856, Cheetham Hill, Manchester, Lancashire, England, United Kingdom

Death: August 30, 1940, Cambridge, Cambridgeshire, England, UK

Known for: the Discovery of the Electron

Sir Joseph John Thomson was an English physicist who helped revolutionize the knowledge of atomic structure by his discovery of the electron (1897). He received the Nobel Prize for Physics in 1906 and was knighted in 1908.

[32] **Max Born**

Birth: December 11, 1882, Breslau, German Empire

Death: January 5, 1970, Göttingen, West Germany

Known for: Quantum Mechanics

> **Max Born** was a German physicist who shared the Nobel Prize for Physics in 1954 with Walther Bothe for his probabilistic interpretation of quantum mechanics.

[33] **Francis Harry Compton Crick**

Birth: June 8, 1916, Northampton, Northamptonshire, England

Death: July 28, 2004, San Diego, Calif., U.S.

Known for: Molecular Biology

> **Francis Harry Compton Crick** was a British biophysicist, who, with James Watson and Maurice Wilkins, received the 1962 Nobel Prize for Physiology or Medicine for their determination of the molecular structure of deoxyribonucleic acid (DNA), the chemical substance ultimately responsible for hereditary control of life functions. This accomplishment became a cornerstone of genetics and was widely regarded as one of the most important discoveries of 20th-century biology.

[34] **Enrico Fermi**

Birth: Sept. 29, 1901, Rome, Italy

Death: Nov. 28, 1954, Chicago, Ill., U.S.

Known for: Statistical mechanics

Enrico Fermi was an Italian-born American scientist who was one of the chief architects of the nuclear age. He developed the mathematical statistics required to clarify a large class of subatomic phenomena, explored nuclear transformations caused by neutrons, and directed the first controlled chain reaction involving nuclear fission. He was awarded the 1938 Nobel Prize for Physics, and the Enrico Fermi Award of the U.S. Department of Energy is given in his honour. Fermilab, the National Accelerator Laboratory, in Illinois, is named for him, as is fermium, element number 100.

[35] **Leonhard Euler**

Birth: April 15, 1707, Basel, Switzerland

Death: September 18, 1783, Saint Petersburg, Russian Empire

Known for: Eighteenth-Century Mathematics

Leonhard Euler was a Swiss mathematician and physicist, one of the founders of pure mathematics. He not only made decisive and formative contributions to the subjects of geometry, calculus, mechanics, and number theory but also developed methods for solving problems in observational astronomy and demonstrated useful applications of mathematics in technology and public affairs.

[36] **Justus Liebig**

Birth: May 12, 1803, Darmstadt, Grand Duchy of Hesse

Death: April 18, 1873, Munich, German Empire

Known for: Nineteenth-Century Chemistry

Justus Freiherr von Liebig was a German scientist who made major contributions to agricultural and biological chemistry, and is considered one of the principal founders of organic chemistry. As a professor at the University of Giessen, he devised the modern laboratory-oriented teaching method, and for such innovations, he is regarded as one of the greatest chemistry teachers of all time. He has been described as the "**father of the fertilizer industry**" for his emphasis on nitrogen and trace minerals as essential plant nutrients, and his formulation of the law of the minimum, which described how plant growth relied on the scarcest nutrient resource, rather than the total amount of resources available. He also developed a manufacturing process for beef extracts, and with his consent a company, called Liebig Extract of Meat Company, was founded to exploit the concept; it later introduced the Oxo brand beef bouillon cube. He popularized an earlier invention for condensing vapors, which came to be known as the Liebig condenser.

[37] **Arthur Stanley Eddington**

Birth: December 28, 1882, Kendal, Westmorland, England

Death: November 22, 1944, Cambridge, Cambridgeshire, England

Known for: Modern astronomy

Sir Arthur Stanley Eddington was an English astronomer, physicist, and mathematician who did his greatest work in astrophysics, investigating the motion, internal structure, and evolution of stars. He also was the first expositor of the theory of relativity in the English language.

[38] **William Harvey**

Birth: April 1, 1578, Folkestone, Kent, England

Death: June 3, 1657, London

Known for: Circulation of the Blood

William Harvey was an English physician who was the first to recognize the full circulation of the blood in the human body and to provide experiments and arguments to support this idea.

[39] **Marcello Malpighi**

Birth: 1628

Death: 1694

Known for: Microscopic Anatomy

Marcello Malpighi was an Italian physician and biologist who, in developing experimental methods to study livingthings, founded the science of microscopic anatomy. After Malpighi's researches, microscopic anatomy became aprerequisite for advances in the fields of physiology, embryology, and practical medicine.

[40] **Christiaan Huygens**

Birth: 1629

Death: 1695

Known for: the Wave Theory of Light

Christian Huyghens was a Dutch mathematician, astronomer, and physicist, who founded the wave theory of light, discovered the true shape of the rings of Saturn, and made original contributions to the science of dynamics—the study of the action of forces on bodies.

[41] **Johann Carl Friedrich Gauss**

Birth: April 30, 1777, Brunswick, Duchy of Brunswick-Wolfenbüttel, Holy Roman Empire

Death: February 23, 1855, Göttingen, Kingdom of Hanover

Known for: Number theory, algebra, statistics, analysis, differential geometry, geodesy, geophysics, mechanics, electrostatics, astronomy, matrix theory and optics

Johann Carl Friedrich was a German mathematician and physicist who made significant contributions to many fields in mathematics and science. Sometimes referred to as the Princeps mathematicorum (Latin for "**the foremost of mathematicians**") and "**the greatest mathematician since antiquity**", Gauss had an exceptional influence in many fields of mathematics and science, and is ranked among history's most influential mathematicians.

[42] **Albrecht von Haller**

Birth: October 16, 1708, Bern, Swiss Confederacy

Death: December 12, 1777, Bern, Swiss Confederacy

Known for: Eighteenth-Century Medicine

Albrecht von Haller was a Swiss biologist, the father of experimental physiology, who made prolific contributions to physiology, anatomy, botany, embryology, poetry, and scientific bibliography.

[43] **Friedrich August Kekule von Stradonitz**

Birth: September 7, 1829, Darmstadt, Grand Duchy of Hesse

Death: July 13, 1896, Bonn, German Empire

Known for: Theory of chemical structure, tetravalence of carbon, structure of benzene

Friedrich August Kekule von Stradonitz was a German organic chemist. From the 1850s until his death, Kekulé was one of the most prominent chemists in Europe, especially in theoretical chemistry. He was the principal founder of the theory of chemical structure and in particular the Kekulé structure of benzene.

[44] **Robert Koch**

Birth: Dec. 11, 1843, Clausthal, Hannover [now Clausthal-Zellerfeld, Germany]

Death: May 27, 1910, Baden-Baden, Germany

Known for: Bacteriology

Robert Heinrich Hermann Koch was a German physician and one of the founders of bacteriology. He discovered the anthrax disease cycle (1876) and the bacteria responsible for tuberculosis (1882) and cholera (1883). For his discoveries in regard to tuberculosis, he received the Nobel Prize for Physiology or Medicine in 1905.

[45] **Murray Gell-Mann**

Birth: September 15, 1929, Manhattan, New York City, United States

Known for: Gell-Mann and Low theorem, Elementary particles, quarks, Gell-Mann matrices

Murray Gell-Mann was an American physicist, winner of the Nobel Prize for Physics in 1969 for his work pertaining to the classification of subatomic particles and their interactions.

[46] **Hermann Emil Louis Fischer**

Birth: October 09, 1852, Euskirchen, Rhine Province

Death: July 15, 1919, Berlin, Germany

Known for: Organic Chemistry

Emil Hermann Fischer was a German chemist who was awarded the 1902 Nobel Prize for Chemistry in recognition of his investigations of the sugar and purine groups of substances.

[47] **Dmitri Mendeleev**

Birth: Jan. 27 [Feb. 8, New Style], 1834, Tobolsk, Siberia, Russian Empire

Death: Jan. 20 [Feb. 2], 1907, St. Petersburg, Russia

Known for: the Periodic Table of Elements

Dmitri Mendeleev was a Russian chemist who developed the periodic classification of the elements. Mendeleev found that, when all the known chemical elements were arranged in order of increasing atomic weight, the resulting table displayed a recurring pattern, or periodicity, of properties within groups of elements. In his version of the periodic table of 1871, he left gaps in places where he believed unknown elements would find their place. He even predicted the likely properties of three of the potential elements. The subsequent proof of many of his predictions within his lifetime brought fame to Mendeleev as the founder of the periodic law.

[48] **Sheldon Glashow**

Birth: December 5, 1932, New York City, New York, USA

Known for: Electroweak theory and Georgi–Glashow model

Sheldon Lee Glashow was an American theoretical physicist who, with Steven Weinberg and Abdus Salam, received the Nobel Prize for Physics in 1979 for their complementary efforts in formulating the electroweak theory, which explains the unity of electromagnetism and the weak force.

"We are just an advanced breed of monkeys on a minor planet of a very average star. But we can understand the Universe. That makes us something very special."

— Stephen Hawking

Hawking radiation is black-body radiation that is predicted to be released by black holes, due to quantum effects near the black hole event horizon. It is named after the physicist Stephen Hawking, who provided a theoretical argument for its existence in 1974.

$$\text{Black Hole Temperature} \propto \frac{1}{\text{Black Hole mass}}$$

$$\text{Black Hole Entropy} \propto \text{area of the event horizon}$$

"The highest object at which the natural sciences are constrained to aim, but which they will never reach, is the determination of the forces which are present in nature, and of the state of matter at any given moment—in one word, the reduction of all the phenomena of nature to mechanics."

— Gustav Robert Kirchhoff

Kirchhoff's Junction Rule Formula:

Sum of the currents in and out of a circuit junction = 0

$$\Sigma I = 0$$

- I = current, (Amperes, A)

Kirchhoff's Loop Rule Formula:

Sum of voltage differences around a circuit loop = 0

$$\Sigma V = 0$$

- V = voltage difference, (Volts, V)

"During the first half of the present century we had an Alexander von Humboldt, who was able to scan the scientific knowledge of his time in its details, and to bring it within one vast generalization. At the present juncture, it is obviously very doubtful whether this task could be accomplished in a similar way, even by a mind with gifts so peculiarly suited for the purpose as Humboldt's was, and if all his time and work were devoted to the purpose."

— Hermann von Helmholtz

Helmholtz free energy = internal energy – (absolute temperature × entropy)

"As long as Man continues to be the ruthless destroyer of lower living beings, he will never know health or peace. For as long as men massacre animals, they will kill each other. Indeed, he who sows the seed of murder and pain cannot reap joy and love."

— Pythagoras

Pythagoras Theorem: In a right-angled triangle, the square of the hypotenuse side is equal to the sum of squares of the other two sides

$$\text{Hypotenuse} = \sqrt{(\text{Perpendicular})^2 + (\text{Base})^2}$$

"In the natural sciences, and particularly in chemistry, generalities must come after the detailed knowledge of each fact and not before it."

— Joseph-Louis Gay-Lussac

Gay-Lussac's Law: The pressure of a given mass of gas varies directly with the absolute temperature of the gas, when the volume is kept constant.

"Mathematics reveals its secrets only to those who approach it with pure love, for its own beauty."

— Archimedes

Buoyant force = − fluid density × acceleration due to gravity × fluid volume

"It must ... be admitted that very simple relations ... exist between the volumes of gaseous substances and the numbers of simple or compound molecules which form them. The first hypothesis to present itself in this connection, and apparently even the only admissible one, is the supposition that the number of integral molecules in any gases is always the same for equal volumes, or always proportional to the volumes. Indeed, if we were to suppose that the number of molecules contained in a given volume were different for different gases, it would scarcely be possible to conceive that the law regulating the distance of molecules could give in all cases relations so simple as those which the facts just detailed compel us to acknowledge between the volume and the number of molecules."

— Amedeo Avogadro

Avogadro's law: For a given mass of an ideal gas, the volume and amount (moles) of the gas are directly proportional if the temperature and pressure are constant.

"Ordinarily logic is divided into the examination of ideas, judgments, arguments, and methods. The two latter are generally reduced to judgments, that is, arguments are reduced to apodictic judgments that such and such conclusions follow from such and such premises, and method is reduced to judgments that prescribe the procedure that should be followed in the search for truth."

— André-Marie Ampère

[49] **James Dewey Watson**

Birth: April 6, 1928, Chicago, Illinois, U.S

Known for: the Structure of DNA

James Dewey Watson was an American geneticist and biophysicist who played a crucial role in the discovery of the molecular structure of deoxyribonucleic acid (DNA), the substance that is the basis of heredity. For this accomplishment he was awarded the 1962 Nobel Prize for Physiology or Medicine with Francis Crick and Maurice Wilkins.

[50] **John Bardeen**

Birth: May 23, 1908, Madison, Wisconsin, U.S

Death: Jan. 30, 1991, Boston, Massachusetts, U.S

Known for: Superconductivity and BCS theory

John Bardeen was an American physicist who was cowinner of the Nobel Prize for Physics in both 1956 and 1972. He shared the 1956 prize with William B. Shockley and Walter H. Brattain for their joint invention of the transistor. With Leon N. Cooper and John R. Schrieffer he was awarded the 1972 prize for development of the theory of superconductivity.

[51] **John von Neumann**

Birth: December 28, 1903, Budapest, Austria-Hungary

Death: February 8, 1957, Walter Reed General Hospital Washington, D.C.

Known for: the Modern Computer

"Geometry has two great treasures; one is the Theorem of Pythagoras; the other, the division of a line into extreme and mean ratio. The first we may compare to a measure of gold; the second we may name a precious jewel."

— Johannes Kepler

Kepler's laws of planetary motion:

- Planets orbit on ellipses with the Sun at one focus.
- Planet sweeps out equal areas in equal times.
- The square of a planet's orbital period is proportional to the cube of the orbit's semi-major axis ($P^2 \propto a^3$).

"Nothing is too wonderful to be true if it be consistent with the laws of nature."

— Michael Faraday

Faraday's law of electromagnetic induction:

$$\text{Induced voltage} = -\,\text{number of loops} \times \frac{\text{change in magnetic flux}}{\text{change in time}}$$

Faraday's law of electrolysis:

$$\text{Mass of chemical deposition} \propto \text{quantity of electricity passed}$$

"Thoroughly conscious ignorance is the prelude to every real advance in science."

— James Clerk Maxwell

The ratio of the electric to magnetic fields in an electromagnetic wave in free space is always equal to the speed of light

$$\frac{E}{B} = c$$

where $c = \dfrac{1}{\sqrt{\text{Vacuum permittivity} \times \text{Vacuum permeability}}}$

"I realized that more and more I was saying, 'It seems to me that we have come to the time war ought to be given up. It no longer makes sense to kill 20 million or 40 million people because of a dispute between two nations who are running things, or decisions made by the people who really are running things. It no longer makes sense. Nobody wins. Nobody benefits from destructive war of this sort and there is all of this human suffering.' And Einstein was saying the same thing of course. So that is when we decided — my wife and I — that first, I was pretty effective as a speaker. Second, I better start boning up, studying these other fields so that nobody could stand up and say, 'Well, the authorities say such and such '."

— Linus Pauling

Pauli Exclusion Principle: No two electrons in an atom can occupy the same quantum state simultaneously.

"Consciousness cannot be accounted for in physical terms. For consciousness is absolutely fundamental. It cannot be accounted for in terms of anything else."

— Erwin Schrödinger

$$\hat{H}\psi = E\psi$$

- $\hat{H}$ = Hamiltonian operator
- ψ = wave function
- E = energy

"A good deal of my research in physics has consisted in not setting out to solve some particular problem, but simply examining mathematical quantities of a kind that physicists use and trying to fit them together in an interesting way, regardless of any application that the work may have. It is simply a search for pretty mathematics. It may turn out later to have an application. Then one has good luck. At age 78."

— Paul A. M. Dirac

$$(i\,\gamma_\mu\, d^\mu\; - m\,)\,\psi = 0$$

The Dirac Equation that predicted the existence of antimatter

where:

- i = imaginary number
- γ_μ = Pauli matrices
- d^μ = derivative in 4 dimensions
- m =fermion mass
- ψ = wave function

"Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less."

— Marie Curie

ΔN = number of radioactive decays per unit time Δt then,

$$\frac{\Delta N}{\Delta t} \propto N$$

$$\frac{\Delta N}{\Delta t} = \lambda \times N$$

where: λ = constant of proportionality (or radioactive decay constant or disintegration constant).

"Read Euler, read Euler, he is the master of us all."

— Pierre-Simon Laplace

Laplace's equation:

$$\nabla^2 \phi = 0$$

The symbol ∇^2 is called the Laplacian operator:

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$$

"We have learnt that the exploration of the external world by the methods of physical science leads not to a concrete reality but to a shadow world of symbols, beneath which those methods are unadapted for penetrating. Feeling that there must be more behind, we return to our starting point in human consciousness - the one centre where more might become known. There we find other stirrings, other revelations than those conditioned by the world of symbols... Physics most strongly insists that its methods do not penetrate behind the symbolism. Surely then that mental and spiritual nature of ourselves, known in our minds by an intimate contact transcending the methods of physics, supplies just that... which science is admittedly unable to give."

— Arthur Stanley Eddington

The **Eddington luminosity**

$$L_{Edd} = \frac{4\pi G M m_p c}{\sigma_T}$$

where: σ_T denote the Thomson scattering cross-section for the electron, c the speed of light, G the gravitational constant, M the mass of the star and m_p the mass of a proton.

, also referred to as the Eddington limit, is the maximum luminosity a body (such as a star) can achieve when there is balance between the force of radiation acting outward and the gravitational force acting inward. The state of balance is called hydrostatic equilibrium. When a star exceeds the Eddington luminosity, it will initiate a very intense radiation-driven stellar wind from its outer layers. Since most massive stars have luminosities far below the Eddington luminosity, their winds are mostly driven by the less intense line absorption. The **Eddington limit** is invoked to explain the observed luminosity of accreting black holes such as quasars.

"We may mount from this dull Earth; and viewing it from on high, consider whether Nature has laid out all her cost and finery upon this small speck of Dirt. So, like Travelers into other distant countries, we shall be better able to judge of what's done at home, know how to make a true estimate of, and set its own value upon everything. We shall be less apt to admire what this World calls great, shall nobly despise those Trifles the generality of Men set their Affections on, when we know that there are a multitude of such Earths inhabited and adorned as well as our own."

— Christiaan Huygens

Huygens was the first to derive the formula for the period of an ideal mathematical pendulum (with massless rod and length much longer than its swing), in modern notation:

$$T = 2\pi \sqrt{\frac{l}{g}}$$

with T the period, *l* the length of the pendulum and *g* the gravitational acceleration.

"A great part of its [higher arithmetic] theories derives an additional charm from the peculiarity that important propositions, with the impress of simplicity on them, are often easily discovered by induction, and yet are of so profound a character that we cannot find the demonstrations till after many vain attempts; and even then, when we do succeed, it is often by some tedious and artificial process, while the simple methods may long remain concealed."

— Carl Friedrich Gauss

Gauss Law: The total of the electric flux out of a closed surface is equal to the charge enclosed divided by the Vacuum permittivity.

$$\Phi_{\text{electric}} = \frac{Q}{\varepsilon_0}$$

John von Neumann was a Hungarian-born American mathematician. As an adult, he appended von to his surname; the hereditary title had been granted his father in 1913. Von Neumann grew from child prodigy to one of the world's foremost mathematicians by his mid-twenties. Important work in set theory inaugurated a career that touched nearly every major branch of mathematics. Von Neumann's gift for applied mathematics took his work in directions that influenced quantum theory, automata theory, economics, and defense planning. Von Neumann pioneered game theory and, along with Alan Turing and Claude Shannon, was one of the conceptual inventors of the stored-program digital computer.

[52] **Richard P. Feynman**

Birth: May 11, 1918, New York, N.Y., U.S.

Death: Feb. 15, 1988, Los Angeles, California

Known for: Quantum Electrodynamics

Richard Phillips Feynman was an American theoretical physicist, known for his work in the path integral formulation of quantum mechanics, the theory of quantum electrodynamics, the physics of the superfluidity of super cooled liquid helium, as well as his work in particle physics for which he proposed the parton model. For contributions to the development of quantum electrodynamics, Feynman received the Nobel Prize in Physics in 1965 jointly with Julian Schwinger and Shinichiro Tomonaga.

[53] **Alfred Lothar Wegener**

Birth: Nov. 1, 1880, Berlin, Germany

Death: Nov. 1930, Greenland

Known for: Continental Drift

Alfred Lothar Wegener was a German polar researcher, geophysicist and meteorologist. During his lifetime he was primarily known for his achievements in meteorology and as a pioneer of polar research, but today he is most remembered as the originator of continental drift hypothesis by suggesting in 1912 that the continents are slowly drifting around the Earth. His hypothesis was controversial and widely rejected by mainstream geology until the 1950s, when numerous discoveries such as **palaeomagnetism** provided strong support for continental drift, and thereby a substantial basis for today's model of plate tectonics. Wegener was involved in several expeditions to Greenland to study polar air circulation before the existence of the jet stream was accepted. Expedition participants made many meteorological observations and were the first to overwinter on the inland Greenland ice sheet and the first to bore ice cores on a moving Arctic glacier.

[54] **Stephen W. Hawking**

Birth: Jan. 8, 1942, Oxford, Oxfordshire, England

Known for: Quantum Cosmology

Stephen William Hawking was an English theoretical physicist whose theory of exploding black holes drew upon both relativity theory and quantum mechanics. He also worked with space-time singularities.

[55] **Antonie van Leeuwenhoek**

Birth: Oct. 24, 1632, Delft, Neth.

Death: Aug. 26, 1723, Delft

Known for: the Simple Microscope

Antonie van Leeuwenhoek was a Dutch microscopist who was the first to observe bacteria and protozoa. His researches on lower animals refuted the doctrine of spontaneous generation, and his observations helped lay the foundations for the sciences of bacteriology and protozoology.

[56] **Max von Laue**

Birth: Oct. 09, 1879, Pfaffendorf, Kingdom of Prussia, German Empire

Death: April 24, 1960, West Berlin

Known for: X-ray Crystallography

Max Theodor Felix von Laue was a German recipient of the Nobel Prize for Physics in 1914 for his discovery of the diffraction of X rays in crystals. This enabled scientists to study the structure of crystals and hence marked the origin of solid-state physics, an important field in the development of modern electronics.

[57] **Gustav Kirchhoff**

Birth: March 12, 1824, Königsberg, Kingdom of Prussia [present-day Russia]

Death: October 17, 1887, Berlin, Prussia, German Empire [present-day Germany]

Known for: Kirchhoff's circuit laws, Kirchhoff's laws of spectroscopy, Kirchhoff's law of thermochemistry and Kirchhoff's law of thermal radiation

Gustav Robert Kirchhoff was a German physicist who contributed to the fundamental understanding of electrical circuits, spectroscopy, and the emission of black-body radiation by heated objects. He coined the term black-body radiation in 1862. Several different sets of concepts are named "**Kirchhoff's laws**" after him, concerning such diverse subjects as black-body radiation and spectroscopy, electrical circuits, and thermochemistry. The Bunsen–Kirchhoff Award for spectroscopy is named after him and his colleague, Robert Bunsen.

[58] **Hans Bethe**

Birth: July 2, 1906, Strassburg, Ger. [now Strasbourg, France]

Death: March 6, 2005, Ithaca, N.Y., U.S.

Known for: the Energy of the Sun

Hans Albrecht Bethe was a German-born American theoretical physicist who helped shape quantum physics and increased the understanding of the atomic processes responsible for the properties of matter and of the forces governing the structures of atomic nuclei. He received the Nobel Prize for Physics in 1967 for his work on the production of energy in stars. Moreover, he was a leader in emphasizing the social responsibility of science.

[59] **Euclid**

Known for: the Foundations of Mathematics

Euclid was the most prominent mathematician of Greco-Roman antiquity, best known for his treatise on geometry, the Elements.

[60] **Gregor Mendel**

Birth: July 22, 1822, Heinzendorf, Austria [now Hynčice, Czech Rep.]

Death: Jan. 6, 1884, Brünn, Austria-Hungary [now Brno, Czech Rep.]

Known for: the Laws of Inheritance

Gregor Johann Mendel was a botanist, teacher, and Augustinian prelate, the first person to lay the mathematical foundation of the science of genetics, in what came to be called **Mendelism**.

[61] **Heike Kamerlingh Onnes**

Birth: September 21, 1853, Groningen, Netherlands

Death: February 21, 1926, Leiden, Netherlands

Known for: Superconductivity, Onnes-effect and Virial Equation of State

Professor **Heike Kamerlingh Onnes** was a Dutch physicist and Nobel laureate. He exploited the Hampson–Linde cycle to investigate how materials behave when cooled to nearly absolute zero and later to liquefy helium for the first time, in 1908. He also discovered superconductivity in 1911.

[62] **Thomas Hunt Morgan**

Birth: September 25, 1866, Lexington, Kentucky

Death: December 04, 1945, Pasadena, California

Known for: the Chromosomal Theory of Heredity

Thomas Hunt Morgan was an American zoologist and geneticist, famous for his experimental research with the fruit fly (Drosophila) by which he established the chromosome theory of heredity. He showed that genes are linked in a series on chromosomes and are responsible for identifiable, hereditary traits. Morgan's work played a key role in establishing the field of genetics. He received the Nobel Prize for Physiology or Medicine in 1933.

[63] **Hermann von Helmholtz**

Birth: August 31, 1821, Potsdam, Kingdom of Prussia

Death: September 08, 1894, Charlottenburg, German Empire

Known for: the Rise of German Science

Hermann Ludwig Ferdinand Helmholtz was a German scientist and philosopher who made fundamental contributions to physiology, optics, electrodynamics, mathematics, and meteorology. He is best known for his statement of the law of the conservation of energy. He brought to his laboratory research the ability to analyze the philosophical assumptions on which much of 19th-century science was based, and he did so with clarity and precision.

[64] **Paul Ehrlich**

Birth: March 14, 1854, Strehlen, Lower Silesia, German Kingdom of Prussia

Death: August 20, 1915, Bad Homburg, Hesse, Germany

Known for: Chemotherapy

Paul Ehrlich was a German physician and scientist who worked in the fields of hematology, immunology, and antimicrobial chemotherapy. Among his foremost achievements were finding a cure for syphilis in 1909 and inventing the precursor technique to Gram staining bacteria. The methods he developed for staining tissue made it possible to distinguish between different types of blood cells, which led to the ability to diagnose numerous blood diseases. His laboratory discovered arsphenamine (**Salvarsan**), the first effective medicinal treatment for syphilis, thereby initiating and also naming the concept of chemotherapy. Ehrlich popularized the concept of a magic bullet. He also made a decisive contribution to the development of an antiserum to combat diphtheria and conceived a method for standardizing therapeutic serums. In 1908, he received the Nobel Prize in Physiology or Medicine for his contributions to immunology. He was the founder and first director of what is now known as the Paul Ehrlich Institute, a German research institution and medical regulatory body that is the nation's federal institute for vaccines and biomedicines.

[65] **Ernst Walter Mayr**

Birth: July 05, 1904, Kempten, Germany

Death: February 03, 2005, Bedford, Massachusetts, United States

Known for: Evolutionary Theory

Ernst Walter Mayr was a German-born American biologist known for his work in avian taxonomy, population genetics, and evolution. Considered one of the world's leading evolutionary biologists, he was sometimes referred to as the "Darwin of the 20th century."

[66] **Theodosius Grygorovych Dobzhansky**

Birth: January 25, 1900, Nemyriv, Russian Empire

Death: December 18, 1975, San Jacinto, California, United States

Known for: the Modern Synthesis

Theodosius Grygorovych Dobzhansky was a prominent Ukrainian-American geneticist and evolutionary biologist, and a central figure in the field of evolutionary biology for his work in shaping the modern synthesis. Dobzhansky was born in Ukraine, then part of the Russian Empire, and became an immigrant to the United States in 1927, aged 27. His 1937 work Genetics and the Origin of Species became a major influence on the modern synthesis. He was awarded the US National Medal of Science in 1964 and the Franklin Medal in 1973.

[67] **Max Ludwig Henning Delbrück**

Birth: September 04, 1906, Berlin, German Empire

Death: March 9, 1981, Pasadena, California, United States

Known for: the Bacteriophage

Max Ludwig Henning Delbrück was a German–American biophysicist, who helped launch the molecular biology research program in the late 1930s. He stimulated physical scientists' interest into biology, especially as to basic research to physically explain genes, mysterious at the time. Formed in 1945 and led by Delbrück along with Salvador Luria and Alfred Hershey, the Phage Group made substantial headway unraveling important aspects of genetics. The three shared the 1969 Nobel Prize in Physiology or Medicine "for their discoveries concerning the replication mechanism and the genetic structure of viruses". He was the first physicist to predict what is now called Delbrück scattering.

[68] **Charles Scott Sherrington**

Birth: November 27, 1857, Islington, Middlesex, England

Death: March 04, 1952, Eastbourne, Sussex, England

Known for: Neurophysiology

Sir Charles Scott Sherrington was an English neurophysiologist, histologist, bacteriologist, and a pathologist, Nobel laureate and president of the Royal Society in the early 1920s. He received the Nobel Prize in Physiology or Medicine with Edgar Adrian, 1st Baron Adrian, in 1932 for their work on the functions of neurons. Prior to the work of Sherrington and Adrian, it was widely accepted that reflexes occurred as isolated activity within a reflex arc. Sherrington received the prize for showing that reflexes require integrated activation and demonstrated reciprocal innervation of muscles (**Sherrington's law**). Through his seminal 1906 publication, The Integrative Action of the Nervous System, he had effectively laid to rest the theory that the nervous system, including the brain, can be understood as a single interlinking network. His alternative explanation of synaptic communication between neurons helped shape our understanding of the central nervous system.

[69] **Jean Baptiste Lamarck**

Birth: August 01, 1744, Bazentin, Picardy, France

Death: December 18, 1829, Paris, France

Known for: the Foundations of Biology

Jean-Baptiste Lamarck − a pioneering French biologist who is best known for his idea that acquired characters are inheritable, an idea known as Lamarckism, which is controverted by modern genetics and evolutionary theory.

[70] **William Bayliss**

Birth: May 2, 1860, Wednesbury, Staffordshire, England

Death: August 27, 1924, London, England

Known for: Modern Physiology

Sir William Maddock Bayliss was a British physiologist, co-discoverer (with the British physiologist Ernest Starling) of hormones; he conducted pioneer research in major areas of physiology, biochemistry, and physical chemistry.

[71] **John Dalton**

Birth: Sept. 5 or 6, 1766, Eaglesfield, Cumberland, England

Death: July 27, 1844, Manchester

Known for: the Theory of the Atom

John Dalton was an English chemist, physicist, and meteorologist. He is best known for introducing the atomic theory into chemistry, and for his research into colour blindness, sometimes referred to as Daltonism in his honour.

[72] **Frederick Sanger**

Birth: August 13, 1918, Rendcomb, Gloucestershire, England

Death: November 19, 2013, Cambridge, Cambridgeshire, England

Known for: the Genetic Code

Frederick Sanger was an English biochemist who was twice the recipient of the Nobel Prize for Chemistry. He was awarded the prize in 1958 for his determination of the structure of the insulin molecule. He shared the prize (with Paul Berg and Walter Gilbert) in 1980 for his determination of base sequences in nucleic acids. Sanger was the fourth two-time recipient of the Nobel Prize.

[73] **Louis Victor de Broglie**

Birth: August 15, 1892, Dieppe, France

Death: March 19, 1987, Louveciennes, France

Known for: Wave-Particle Duality

Louis de Broglie was a French physicist best known for his research on quantum theory and for predicting the wave nature of electrons. He was awarded the 1929 Nobel Prize for Physics.

[74] **Carl Linnaeus**

Birth: May 23, 1707, Råshult, Stenbrohult parish (now within Älmhult Municipality), Sweden

Death: January 10, 1778, Hammarby (estate), Danmark parish (outside Uppsala), Sweden

Known for: the Binomial Nomenclature

Carl Linnaeus was a Swedish naturalist and explorer who was the first to frame principles for defining natural genera and species of organisms and to create a uniform system for naming them (binomial nomenclature).

[75] **J. Robert Oppenheimer**

Birth: April 22, 1904, New York, N.Y., U.S.

Death: Feb. 18, 1967, Princeton, N.J.

Known for: the Atomic Era

Julius Robert Oppenheimer was an American theoretical physicist and science administrator, noted as director of the Los Alamos Laboratory (1943–45) during development of the atomic bomb and as director of the Institute for Advanced Study, Princeton (1947–66). Accusations of disloyalty led to a government hearing that resulted in the loss of his security clearance and of his position as adviser to the highest echelons of the U.S. government. The case became a cause popular in the world of science because of its implications concerning political and moral issues relating to the role of scientists in government.

[76] **Sir Alexander Fleming**

Birth: Aug. 6, 1881, Lochfield Farm, Darvel, Ayrshire, Scotland

Death: March 11, 1955, London, England

Known for: Penicillin

Sir Alexander Fleming was a Scottish bacteriologist best known for his discovery of penicillin. Fleming had a genius for technical ingenuity and original observation. His work on wound infection and **lysozyme**, an antibacterial enzyme found in tears and saliva, guaranteed him a place in the history of bacteriology. But it was his discovery of penicillin in 1928, which started the antibiotic revolution that sealed his lasting reputation. Fleming was recognized for that achievement in 1945, when he received the Nobel Prize for Physiology or Medicine, along with Australian pathologist Howard Walter Florey and German-born British biochemist Ernst Boris Chain, both of whom isolated and purified penicillin.

[77] **Jonas Edward Salk**

Birth: October 28, 1914, New York

Death: June 23, 1995, La Jolla, California, United States

Known for: Vaccination

Jonas Edward Salk was an American physician and medical researcher who developed the first safe and effective vaccine for polio.

[78] **Robert Boyle**

Birth: Jan. 25, 1627, Lismore Castle, County Waterford, Ireland

Death: Dec. 31, 1691, London, England

Known for: Boyle's law

Robert Boyle was an Anglo-Irish natural philosopher and theological writer, a preeminent figure of 17th-century intellectual culture. He was best known as a natural philosopher, particularly in the field of chemistry, but his scientific work covered many areas including hydrostatics, physics, medicine, earth sciences, natural history, and alchemy. His prolific output also included Christian devotional and ethical essays and theological tracts on biblical language, the limits of reason, and the role of the natural philosopher as a Christian. He sponsored many religious missions as well as the translation of the Scriptures into several languages. In 1660 he helped found the Royal Society of London.

[79] **Francis Galton**

Birth: Feb. 16, 1822, near Sparkbrook, Birmingham, Warwickshire, England

Death: Jan. 17, 1911, Grayshott House, Haslemere, Surrey

Known for: Eugenics

Sir Francis Galton was an English explorer, anthropologist, and eugenicist known for his pioneering studies of human intelligence. He was knighted in 1909.

[80] **Joseph Priestley**

Birth: March 13, 1733, Birstall Fieldhead, near Leeds, Yorkshire [now West Yorkshire], England

Death: Feb. 6, 1804, Northumberland, Pa., U.S.

Known for: Discovery of oxygen

Joseph Priestley was an English clergyman, political theorist, and physical scientist whose work contributed to advances in liberal political and religious thought and in experimental chemistry. He is best remembered for his contribution to the chemistry of gases.

10 Interesting facts about Aristotle:

- He was an orphaned at a young age and raised by his sister
- He is the founder of zoology
- He was a tutor to royalty and constituted the first comprehensive system of Western philosophy.
- His name in ancient Greek means "**the best purpose**"
- He was the first person to mention Antarctica in his work and has been called the last person to know everything there was to know
- He contributed to the classification of animals and made first observations of natural events
- He established a philosophical school known as the Lyceum in 335 B.C which aided in the production of many of his hundreds of books
- He enrolled in Plato's Academy and spent 20 years of his life span acquiring knowledge.
- He was a misogynist and a supporter of patriarchy and his works had a major impact on medieval Islamic thought
- His views on physical science profoundly shaped medieval scholarship

Time crumbles things; everything grows old under the power of Time and is forgotten through the lapse of Time.

In all things of nature there is something of the marvelous.

Misfortune shows those who are not really friends.

He who has overcome his fears will truly be free.

– Aristotle

Top 11 Contributions of Archimedes:

- Archimedes ' Principle
- The Sand Reckoner
- Evaluation of Pi (π)
- The Claw of Archimedes
- Archimedes ' Screw
- Archimedes ' Death Ray
- The Odometer
- Archimedes ' Catapults
- The Law of the Lever
- Discovery of Infinitesimals
- The Formula for Surface Area and the Area of a Sphere

[81] **Hippocrates**

Known for: Medicine

Hippocrates was an ancient Greek physician who lived during Greece's Classical period and is traditionally regarded as the father of medicine. It is difficult to isolate the facts of Hippocrates' life from the later tales told about him or to assess his medicine accurately in the face of centuries of reverence for him as the ideal physician. About 60 medical writings have survived that bear his name, most of which were not written by him. He has been revered for his ethical standards in medical practice, mainly for the Hippocratic Oath, which, it is suspected, he did not write.

[82] **Pythagoras**

Known for: Pythagorean Theorem

Pythagoras was a Greek philosopher, mathematician, and founder of the Pythagorean brotherhood that, although religious in nature, formulated principles that influenced the thought of Plato and Aristotle and contributed to the development of mathematics and Western rational philosophy.

[83] **Benjamin Franklin**

Birth: January 17, 1706, Boston, Massachusetts Bay, British America

Death: April 17, 1790, Philadelphia, Pennsylvania, U.S.

Known for: Electricity

Benjamin Franklin was an American printer and publisher, author, inventor and scientist, and diplomat. One of the foremost of the Founding Fathers, Franklin helped draft the Declaration of Independence and was one of its signers, represented the United States in France during the American Revolution, and was a delegate to the Constitutional Convention. He made important contributions to science, especially in the understanding of electricity, and is remembered for the wit, wisdom, and elegance of his writing.

[84] **Leonardo da Vinci**

Birth: April 15, 1452, Anchiano, near Vinci, Republic of Florence [now in Italy]

Death: May 2, 1519, Cloux [now Clos-Luce], France

Known for: Mechanics and Cosmology

Leonardo da Vinci was an Italian painter, draftsman, sculptor, architect, and engineer whose genius, perhaps more than that of any other figure, epitomized the Renaissance humanist ideal. His Last Supper (1495–98) and Mona Lisa (c. 1503–19) are among the most widely popular and influential paintings of the Renaissance. His notebooks reveal a spirit of scientific inquiry and a mechanical inventiveness that were centuries ahead of their time.

[85] **Ptolemy**

Known for: Greco-Roman science

Ptolemy was an Egyptian astronomer, mathematician, and geographer of Greek descent who flourished in Alexandria during the 2nd century CE. In several fields his writings represent the culminating achievement of Greco-Roman science, particularly his geocentric (Earth-centered) model of the universe now known as the Ptolemaic system.

[86] **Joseph-Louis Gay-Lussac**

Birth: Dec. 6, 1778, Saint-Léonard-de-Noblat, France

Death: May 9, 1850, Paris

Known for: Behavior of gases

Joseph-Louis Gay-Lussac was a French chemist and physicist who pioneered investigations into the behavior of gases, established new techniques for analysis, and made notable advances in applied chemistry.

6 important discoveries of Stephen Hawking:

- Singularities – 1970
- Laws of Black hole mechanics – (1971−1972)
- Hawking Radiation −1974
- Cosmic Inflation Theory – 1982
- Model on the wave function of the Universe – 1983
- Top-Down Theory on Cosmology – 2006

12 Interesting facts about Professor Stephen Hawking:

- He was born on the 300th anniversary of Galileo's death
- He died on March 14, 2018 on the anniversary of Albert Einstein's birth
- He was an average student in elementary school
- His father wanted him to study medicine but he was always more inclined towards Mathematics
- When he was a teenager, His friends nicknamed him, '**Einstein**'!
- Upon his ALS diagnosis, Hawking was told he only had two-and-a-half years to live
- His book **'A Brief History of Time'** appeared on the British Sunday Times best-seller list for a record-breaking 237 weeks.
- His one of the biggest achievements was coming up with the **Boundless Universe Theory** that the universe is boundless − with partner **Jim Hartle** in 1983.
- He Believed in Possibility of Aliens
- He was once taken by scientists to a zero-gravity shuttle to make him float out from his wheelchair. He experienced a total of four minutes of weightlessness in a plane that dives through the sky to give passengers a taste of zero gravity
- He wrote several children's books with his daughter (**Lucy Hawking**) that combine science and adventure.
- Even after having made various notable discoveries − he was never nominated for a noble prize.

- "God is the name people give to the reason we are here."
- "God may exist, but science can explain the universe without the need for a creator."
- "However difficult life may seem, there is always something you can do and succeed at."
- "I am just a child who has never grown up. I still keep asking these 'how' and 'why' questions. Occasionally, I find an answer."
- "I believe alien life is quite common in the universe, although intelligent life is less so. Some say it has yet to appear on planet Earth."
- "I believe there are no questions that science can't answer about a physical universe."
- "I have found far greater enthusiasm for science in America than here in Britain. There is more enthusiasm for everything in America."
- "I have noticed even people who claim everything is predestined, and that we can do nothing to change it, look before they cross the road."
- "In my opinion, there is no aspect of reality beyond the reach of the human mind."
- "Intelligence is the ability to adapt to change."
- "Life would be tragic if it weren't funny."
- "Many people find the universe confusing -- it's not."
- "People who boast about their IQ are losers."
- "People won't have time for you if you are always angry or complaining."
- "Science can lift people out of poverty and cure disease. That, in turn, will reduce civil unrest."
- "Science is increasingly answering questions that used to be the province of religion."
- "Science is not only a disciple of reason but also one of romance and passion."
- "Scientists have become the bearers of the torch of discovery in our quest for knowledge."
- "The past, like the future, is indefinite and exists only as a spectrum of possibilities."
- "The universe is not indifferent to our existence -- it depends on it."

- "There is no unique picture of reality."
- "There is nothing bigger or older than the universe."
- "We are just an advanced breed of monkeys on a minor planet of a very average star. But we can understand the universe. That makes us something very special."
- "When one's expectations are reduced to zero, one really appreciates everything one does have."
- "Work gives you meaning and purpose, and life is empty without it."

– Stephen Hawking

"There are two kinds of geniuses: the 'ordinary' and the 'magicians'. An ordinary genius is a fellow whom you and I would be just as good as, if we were only many times better. There is no mystery as to how his mind works. Once we understand what they've done, we feel certain that we, too, could have done it. It is different with the magicians. Even after we understand what they have done it is completely dark. **Richard Feynman** is a magician of the highest calibre."

– Mark Kac

[87] **Archimedes**

Known for: the Beginning of Science

Archimedes was the most-famous mathematician and inventor in ancient Greece. Archimedes is especially important for his discovery of the relation between the surface and volume of a sphere and its circumscribing cylinder. He is known for his formulation of a hydrostatic principle (known as **Archimedes' principle**) and a device for raising water, still used in developing countries, known as the Archimedes screw.

[88] **Sir Fred Hoyle**

Birth: June 24, 1915, Bingley, Yorkshire [now West Yorkshire], England

Death: Aug. 20, 2001, Bournemouth, Dorset

Known for: Stellar nucleosynthesis

Sir Fred Hoyle was a British mathematician and astronomer best known as the foremost proponent and defender of the steady-state theory of the universe. This theory holds both that the universe is expanding and that matter is being continuously created to keep the mean density of matter in space constant.

[89] **Norman Ernest Borlaug**

Birth: March 25, 1914, Cresco, Iowa, U.S.

Known for: Green revolution

Norman Ernest Borlaug was an American agricultural scientist, plant pathologist, and winner of the Nobel Prize for Peace in 1970. Known as the "**Father of the Green Revolution**," Borlaug helped lay the groundwork for agricultural technological advances that alleviated world hunger.

[90] **Amedeo Avogadro**

Birth: Aug. 9, 1776, Turin, in the Kingdom of Sardinia and Piedmont

Death: July 9, 1856, Turin, Italy

Known for: Molecular Hypothesis of Combining Gases

Lorenzo Romano Amedeo Carlo Avogadro was an Italian mathematical physicist who showed in what became known as Avogadro's law that, under controlled conditions of temperature and pressure, equal volumes of gases contain an equal number of molecules.

[91] **Luis W. Alvarez**

Birth: June 13, 1911, San Francisco, Calif., U.S.

Death: Sept. 1, 1988, Berkeley, California

Known for: discovery of many resonance particles (subatomic particles having extremely short lifetimes and occurring only in high-energy nuclear collisions)

Luis Walter Alvarez was an American experimental physicist, inventor, and professor who was awarded the Nobel Prize in Physics in 1968 for development of the hydrogen bubble chamber enabling discovery of resonance states in particle physics. The American Journal of Physics commented, "**Luis Alvarez was one of the most brilliant and productive experimental physicists of the twentieth century.**"

[92] **George Gamow**

Birth: March 4, 1904, Odessa, Russian Empire [now in Ukraine]

Death: Aug. 19, 1968, Boulder, Colo., U.S.

Known for: Big Bang Hypothesis

George Gamow was a Russian-born American nuclear physicist and cosmologist who was one of the foremost advocates of the big-bang theory, according to which the universe was formed in a colossal explosion that took place billions of years ago. In addition, his work on deoxyribonucleic acid (DNA) made a basic contribution to modern genetic theory.

[93] **Francis Collins**

Birth: April 14, 1950, Staunton, Va., U.S.

Known for: Human Genome Project

Francis Sellers Collins is an American geneticist who discovered genes causing genetic diseases and who is director of the U.S. National Institutes of Health (NIH) public research consortium in the Human Genome Project (HGP).

[94] **Albert Abraham Michelson**

Birth: Dec. 19, 1852, Strelno, Prussia [now Strzelno, Pol.]

Death: May 9, 1931, Pasadena, Calif., U.S.

Known for: Establishment of the speed of light as a fundamental Constant

Albert Abraham Michelson was a German-born American physicist who established the speed of light as a fundamental constant and pursued other spectroscopic and metrological investigations. He received the 1907 Nobel Prize for Physics.

[95] **Rachel Carson**

Birth: May 27, 1907, Springdale, Pa., U.S.

Death: April 14, 1964, Silver Spring, Md.

Known for: Environmental pollution and the natural history of the sea

Rachel Louise Carson was an American biologist well known for her writings on environmental pollution and the natural history of the sea.

[96] **Joseph Lister**

Birth: April 5, 1827, Upton, Essex, England

Death: Feb. 10, 1912, Walmer, Kent

Known for: antiseptic medicine

Joseph Lister was a British surgeon and medical scientist who was the founder of antiseptic medicine and a pioneer in preventive medicine. While his method, based on the use of antiseptics, is no longer employed, his principle—that bacteria must never gain entry to an operation wound — remains the basis of surgery to this day. He was made a baronet in 1883 and raised to the peerage in 1897.

[97] **Louis Agassiz**

Birth: May 28, 1807, Motier, Switz.

Death: Dec. 14, 1873, Cambridge, Mass., U.S.

Known for: Natural science

Jean Louis Rodolphe Agassiz was a Swiss-born American naturalist, geologist, and teacher who made revolutionary contributions to the study of natural science with landmark work on glacier activity and extinct fishes. He achieved lasting fame through his innovative teaching methods, which altered the character of natural science education in the United States.

[98] **André-Marie Ampère**

Birth: Jan. 22, 1775, Lyon, France

Death: June 10, 1836, Marseille

Known for: Electrodynamics

André-Marie Ampère was a French physicist who founded and named the science of electrodynamics, now known as electromagnetism. His name endures in everyday life in the ampere, the unit for measuring electric current.

[99] **Paracelsus**

Birth: Nov. 11 or Dec. 17, 1493, Einsiedeln, Switzerland

Death: Sept. 24, 1541, Salzburg, Archbishopric of Salzburg [now in Austria]

Known for: Der grossen Wundartzney ("**Great Surgery Book**")

Philippus Aureolus Theophrastus Bombastus von Hohenheim was a German-Swiss physician and alchemist who established the role of chemistry in medicine. He published Der grossen Wundartzney (**Great Surgery Book**) in 1536 and a clinical description of syphilis in 1530.

The **Hardy-Ramanujan number** stems from an anecdote wherein the British mathematician **Godfrey Harold Hardy** had gone to meet Srinivasa Ramanujan in hospital. Hardy said that he came in a taxi having the number '1729', which the British mathematician described "as rather a dull one". But without wasting even a second Ramanujan replied: "No Sir, it is not a dull number. It is the smallest number expressible as the sum of two cubes in two different ways."

$$1729 = 1^3 + 12^3$$

$$1729 = 9^3 + 10^3$$

More than 4700 years ago, the famous Indian mathematician and astronomer **Aryabhata** (b. 2765 BC) gave $\frac{62832}{20000} = \frac{31416}{10000} = 3.1416$ as an approximation of π.

Mahaviracharya was a 9th-century Jain mathematician possibly born in or close to the present day city of Mysore, in southern India. He discovered **Garland or mala product**:

A product of numbers remains the same when read from left to right or vice.

$$139 \times 139 = 15151$$

$$152207 \times 73 = 11111111$$

$$14287143 \times 7 = 100010001$$

$$12345679 \times 9 = 111111111$$

$$142857143 \times 7 = 1000000001$$

$$11011011 \times 91 = 1002002001$$

$$27994681 \times 441 = 12345654321$$

$$333333666667 \times 33 = 11000011000011$$

Dattatreya Ramchandra Kaprekar (1905–1986) was an Indian recreational mathematician who described several classes of natural numbers including the Kaprekar, harshad and self numbers and discovered the Kaprekar's constant, named after him. Despite having no formal postgraduate training and working as a schoolteacher, he published extensively and became well known in recreational mathematics circles.

Kaprekar Numbers:

8426

Ascending order: 2468

Descending order: 8642

Difference: 6174

4671

Ascending order: 1467

Descending order: 7641

Difference: 6174

1, 9, 45, 55, 703, 2223 … are known as **Kaprekar numbers**.

[100] **Edward O. Wilson**

Birth: April 15, 1452, Anchiano, near Vinci, Republic of Florence [now in Italy]

Death: June 10, 1929, Birmingham, Ala., U.S.

Known for: Sociobiology

Edward Osborne Wilson was an American biologist recognized as the world's leading authority on ants. He was also the foremost proponent of sociobiology, the study of the genetic basis of the social behavior of all animals, including humans.

Nikola Tesla

Birth: 10 July 1856, Smiljan, Austrian Empire (modern-day Croatia)
Death: 7 January 1943, New York City, United States

Nikola Tesla was a Serbian American inventor and engineer who discovered and patented the rotating magnetic field, the basis of most alternating-current machinery. He also developed the three-phase system of electric power transmission. He immigrated to the United States in 1884 and sold the patent rights to his system of alternating-current dynamos, transformers, and motors to George Westinghouse. In 1891 he invented the Tesla coil, an induction coil widely used in radio technology.

Yes, we now have to divide up our time like that, between politics and our equations. But to me our equations are far more important, for politics are only a matter of present concern. A mathematical equation stands forever.

−Albert Einstein

"Rather than asking questions, she [**Maryam Mirzakhani**] would start describing elaborate stories or mathematical narratives. And these narratives were very ambitious and speculative. They were almost like science fiction. She could make these very vague speculations about the shape of the unknown mathematical frontier quite elaborate and detailed in imagining how things might fit together. And she was very adept at finding the right question. And I think this came from this sort of speculative intuition that she had. She would sort of think ahead as to what the shape of the theory might be that was yet to be discovered."

− Curtis McMullen

Hawking radiation is black-body radiation that is predicted to be released by black holes, due to quantum effects near the black hole event horizon. It is named after the British cosmologist Stephen Hawking, who provided a theoretical argument for its existence in 1974.

Fermat's Last Theorem:

No three positive integers *a*, *b*, and *c* satisfy the equation

$$a^n + b^n = c^n$$

for any integer value of *n* greater than 2.

Sir Chandrasekhara Venkata Raman was an Indian physicist whose work was influential in the growth of science in India. He was the recipient of the Nobel Prize for Physics in 1930 for the discovery that when light traverses a transparent material, some of the light that is deflected changes in wavelength. This phenomenon is now called Raman scattering and is the result of the Raman Effect.

The awesome German hypothetical physicist and Nobelist Max Planck is popular for finding the vitality quanta, but most individuals don't know almost his melodic capacities. He was a concert-caliber piano player, having nearly committed his career to music. Concurring to the American student of history of science **John Lewis Heilbron**:

"He had the piano strategy of a proficient artist. As a understudy, he had composed songs and a whole operetta for melodic nighttimes in scholarly houses... [too his] sense of pitch was so idealize that he may barely appreciate a concert," for fear that it be ruined by an off-key note.

8 important discoveries of Louis Pasteur:

- He pioneered the study of molecular asymmetry
- He discovered that microorganisms cause fermentation and disease and he originated the process of **pasteurization** (the process of heating and cooling food to kill bacteria)
- He developed vaccines against Fowl Cholera, anthrax and rabies
- He developed methods and techniques for cultivation of microorganisms
- He popularized the germ theory of disease and that introduced the hope that all infectious diseases could be prevented by **prophylactic vaccination**
- He coined the term Microbiology and vaccine
- He disapproved the theory of **spontaneous generation** (the hypothetical process by which living organisms develop from nonliving matter)
- He introduced sterilization techniques and developed the steam sterilizer, hot-air oven and autoclave.

10 Interesting facts about Richard Feynman:

- He pioneered the field of quantum computing and developed the concept of nanotechnology.
- He had an early interest in mathematics and taught himself trigonometry, advanced algebra and analytic geometry before he entered college.
- He used to spend up to 5 hours practicing his lectures in an empty classroom.
- He joined the secret US army project called the Manhattan Project at Los Alamos to develop the atomic bomb.
- He received the Nobel Prize for Physics in 1965 for his contributions to the development of quantum electrodynamics, jointly with **Julian Schwinger** and **Sin-ltiro Tomonaga**.
- He was ranked as one of the ten greatest physicists of all time in 1999 by a poll conducted by the British journal Physics World.
- He and Hans Bethe developed the formula for calculating the yield of a fission bomb.
- He married three times in his life but truly loved only his childhood sweetheart who died at very early age.
- He died on February 15 in the year 1988 and was buried in Mountain View Cemetery and Mausoleum in Altadena.
- He was the curious character who mastered Thinking and Physics.

- The first principle is that you must not fool yourself, and you are the easiest person to fool.
- Our imagination is stretched to the utmost, not, as in fiction, to imagine things which are not really there, but just to comprehend those things which are there.
- I can live with doubt, and uncertainty, and not knowing. I think it's much more interesting to live not knowing than to have answers which might be wrong.
- Philosophers say a great deal about what is absolutely necessary for science, and it is always, so far as one can see, rather naive, and probably wrong.
- I don't know anything, but I do know that everything is interesting if you go into it deeply enough.
- We have a habit in writing articles published in scientific journals to make the work as finished as possible, to cover up all the tracks, to not worry about the blind alleys or describe how you had the wrong idea first, and so on. So there isn't any place to publish, in a dignified manner, what you actually did in order to get to do the work.
- In this age of specialization men who thoroughly know one field are often incompetent to discuss another.
- When playing Russian roulette the fact that the first shot got off safely is little comfort for the next.
- Is no one inspired by our present picture of the universe? Our poets do not write about it; our artists do not try to portray this remarkable thing. The value of science remains unsung by singers: you are reduced to hearing not a song or poem, but an evening lecture about it. This is not yet a scientific age.
- Reality must take precedence over public relations, for nature cannot be fooled.
- I don't know what's the matter with people: they don't learn by understanding, they learn by some other way—by rote or something. Their knowledge is so fragile!
- God was invented to explain mystery. God is always invented to explain those things that you do not understand.
- Poets say science takes away from the beauty of the stars mere globs of gas atoms. I, too, can see the stars on a desert night, and feel them. But do I see less or more?
- Listen, buddy, if I could tell you in a minute what I did, it wouldn't be worth the Nobel Prize.
- What I cannot create, I do not understand.
- I was born not knowing and have only had a little time to change that here and there.

- I believe that a scientist looking at nonscientific problems is just as dumb as the next guy — and when he talks about a nonscientific matter, he will sound as naive as anyone untrained in the matter.
- There is no harm in doubt and skepticism, for it is through these that new discoveries are made.
- A great deal more is known than has been proved.
- Philosophy of science is about as useful to scientists as ornithology is to birds.
- I have approximate answers and possible beliefs and different degrees of certainty about different things, but I'm not absolutely sure of anything, and many things I don't know anything about, such as whether it means anything to ask why we're here, and what the question might mean. I might think about it a little bit, but if I can't figure it out, then I go on to something else. But I don't have to know an answer…. I don't feel frightened by not knowing things, by being lost in the mysterious universe without having any purpose, which is the way it really is, as far as I can tell, possibly. It doesn't frighten me.
- You can know the name of a bird in all the languages of the world, but when you're finished, you'll know absolutely nothing whatever about the bird… So let's look at the bird and see what it's doing — that's what counts. I learned very early the difference between knowing the name of something and knowing something.
- The worthwhile problems are the ones you can really solve or help solve, the ones you can really contribute something to. No problem is too small or too trivial if we can really do something about it.

— Richard Feynman

10 Major Contributions and Achievements of Marie Sklodowska Curie (1867 – 1934):

- Along with her husband (**Pierre Curie**), she coined the term radioactivity
- She made groundbreaking discoveries regarding uranium rays and her notebooks are still radioactive.
- She discovered the radioactive element polonium and developed a portable x-ray to treat soldiers.
- She also discovered and isolated the radioactive element radium and continued to investigate its properties.
- Her work proved that atom was not indivisible and did her most important work in a shed.
- She is the only person to win the Nobel Prize in two different scientific fields
- She invented mobile radiology units during World War I and founded centers for medical research
- Her WWI efforts paved the way for extensive use of x-rays for medical purposes
- Her work on radioactivity paved the way for possible treatments of cancer
- She is one of the most influential scientists in history

Muhammad al-Khwarizmi was a Persian scientist, astronomer and mathematician whose major works introduced Hindu-Arabic numerals and the concepts of algebra into European mathematics. The word algorithm derives from his name. His algebra treatise **Hisab al-jabr w'al-muqabala** gives us the word algebra and can be considered as the first book to be written on algebra.

11 Interesting facts about Charles Darwin:

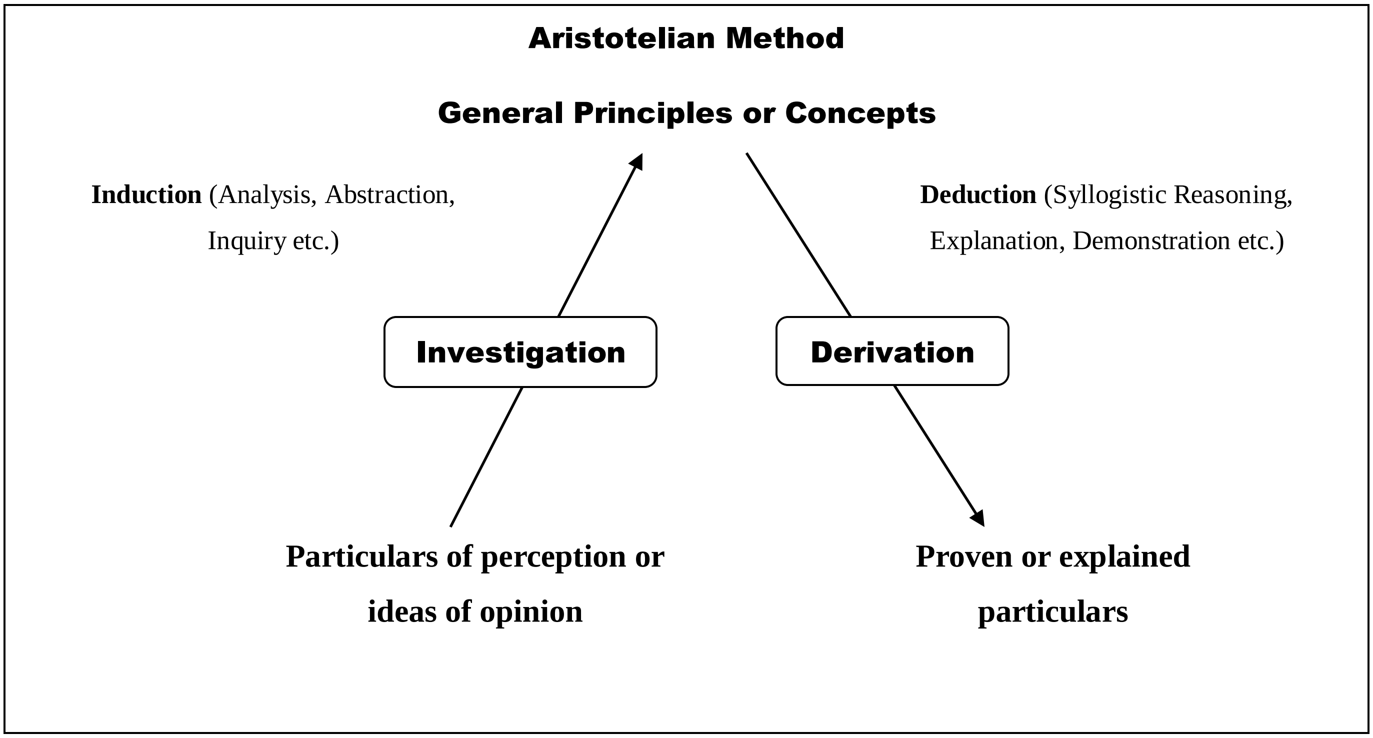
- He was a college drop-out and was born on the same day as Abraham Lincoln.
- He began life as a creationist that led him to his voyage around the world
- He waited more than 20 years to publish his groundbreaking theory on evolution.
- He suffered from chronic illnesses and possessed a unique hunger for knowledge.
- He didn't coin the phrase "survival of the fittest."
- He was a Reluctant Revolutionary and married his first cousin (**Emma**)
- He used to play backgammon with his wife during the time he was ill after his visit to South America
- His 10-year-old daughter died of an illness. This incident had damaging consequences on Darwin 's health
- He maintained a notebook to record his detailed observations of birds and their habits during his studies.
- He has a mountain named after him (**Mount Darwin**)

The love for all living creatures is the most noble attribute of man.

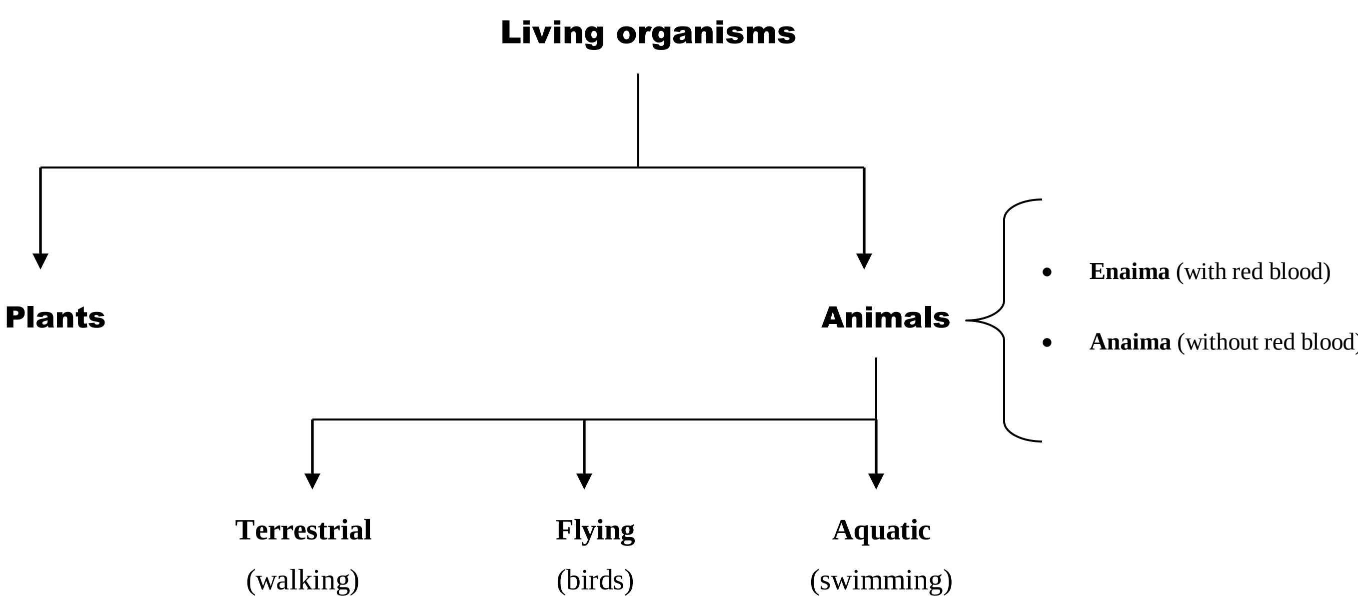
— **Charles Darwin**

Aristotle's Contributions to Science:

- Development of Scientific Method



- He was the first person to firmly suggest that Earth is spherical.
- Classification of Living Things



Nikola Tesla's last letter to his mother

Wednesday, 18.November

Mother, at the thought of you feel somewhat hard and dreary, I do not know how, but I feel that you are not good. I wish I was near you now that you offer water. All these years of my service to humanity are not brought me nothing but insults and humiliation. This morning I got up before dawn, because I heard something again for a long time the dream I hear in my room. I heard the voice of the troughs and pray some Moorish language beautiful dirge or call. This morning I chased the dream with his eyes and confirmed that the voice comes everywhere and cannot be made with the outside or inside. I'm afraid that I did not mind losing. About this I cannot talk because Dr. Layonelu no longer believe him. I heard that he visited Mr. Edison two weeks ago.

Thursday, 19.November

Again, I think of you, Mother. Again I have the anxiety and sorrow in the body. Today I will write in the Patent Office that my public experiment moves to a week earlier, because I have to go home to home, you go. I know now, certainly not good, because that voice, that dirge again I heard quite aware and awake. I'm still reasonable.

Friday, 20.November

I have not written in the Patent Office, came to their agent to bring me confirmation and I told him personally of their intentions. He said he watered, but the term cannot changed Given that the Congressmen from about 20 states hardly comply appointment. I went to the waterfall and told his men to turn turbines and to wait for my call tomorrow ready. I decided that mankind worship what belongs to him and he returned to Europe, you mother. The governments of the same here as at home. I realized now that at the end of humanity is depending on government and that individual cannot I change the world. But that strange voice concerns me. I know it means something that has to do with you, with my experiment with something transcendental.

Saturday, 21.November

Mother, is scheduled tommorow to leave for Yugoslavia. Miss Nora is left to a harbor master's office and provided me a ticket to Lisbon, from there go by train to Zurich, and then directly to the house. I estimate that I need about ten days or two weeks maximum.

Today I walked into the Congress building and the session of the Senate asked for a few minutes of attention. They were not at will, but let me. I asked for the phone to me and together with the laboratory in Niagara Falls. The guys on my account released to drive turbines and Conference Hall is shone on my electric energy, ten times stronger than normal, just as I said.

I am not interested in their reactions to me at all. I went out immediately, because I have this worked for them but for humanity. I was just at the moment when I looked at the lamp and waited to "my" wireless electricity comes from turbines, I felt that I was not the creator of all this.

June 1931 Letter From Albert Einstein To Nikola Tesla

Dear Mr. Tesla,

It is with great joy that I hear you are celebrating your 75th birthday, and as a successful pioneer in the field of high frequency energy you have experienced the miraculous development of this area of technology. Congratulations on the great success of your life’s work.

Albert Einstein.

July 20th, 1901 Letter From Wilhelm Rontgen To Nikola Tesla

Dear Sir!

You have surprised me tremendously with the beautiful photographs of wonderful discharges and I tell you thank you very much for that.

If only I knew how you make such things!

With the expression of special respect I remain yours devoted,

W. C. Röntgen

"Meantime, there is no doubt a certain crudeness in the use of a complex wave function. If it were unavoidable in principle, and not merely a facilitation of the calculation, this would mean that there are in principle two wave functions, which must be used together in order to obtain information on the state of the system."

– **Erwin Schrödinger**

Letter That Albert Einstein Sent to Marie Curie During a Time of Personal Crisis (1911)

Highly esteemed **Mrs. Curie**,

Do not laugh at me for writing you without having anything sensible to say. But I am so enraged by the base manner in which the public is presently daring to concern itself with you that I absolutely must give vent to this feeling. However, I am convinced that you consistently despise this rabble, whether it obsequiously lavishes respect on you or whether it attempts to satiate its lust for sensationalism! I am impelled to tell you how much I have come to admire your intellect, your drive, and your honesty, and that I consider myself lucky to have made your personal acquaintance in Brussels. Anyone who does not number among these reptiles is certainly happy, now as before, that we have such personages among us as you, and Langevin too, real people with whom one feels privileged to be in contact. If the rabble continues to occupy itself with you, then simply don’t read that hogwash, but rather leave it to the reptile for whom it has been fabricated.

With most amicable regards to you, Langevin, and Perrin, yours very truly,

A. Einstein

A letter from Albert Einstein to his daughter, Lieserl on The Universal Force of Love

"When I proposed the theory of relativity, very few understood me, and what I will reveal now to transmit to mankind will also collide with the misunderstanding and prejudice in the world.

I ask you to guard the letters as long as necessary, years, decades, until society is advanced enough to accept what I will explain below.

There is an extremely powerful force that, so far, science has not found a formal explanation to. It is a force that includes and governs all others, and is even behind any phenomenon operating in the universe and has not yet been identified by us. This universal force is LOVE.

When scientists looked for a unified theory of the universe they forgot the most powerful unseen force. Love is Light, that enlightens those who give and receive it. Love is gravity, because it makes some people feel attracted to others. Love is power, because it multiplies the best we have, and allows humanity not to be extinguished in their blind selfishness. Love unfolds and reveals. For love we live and die. Love is God and God is Love.

This force explains everything and gives meaning to life. This is the variable that we have ignored for too long, maybe because we are afraid of love because it is the only energy in the universe that man has not learned to drive at will.

To give visibility to love, I made a simple substitution in my most famous equation. If instead of $\mathbf{E = mc^2}$, we accept that the energy to heal the world can be obtained through love multiplied by the speed of light squared, we arrive at the conclusion that love is the most powerful force there is, because it has no limits.

After the failure of humanity in the use and control of the other forces of the universe that have turned against us, it is urgent that we nourish ourselves with another kind of energy…

If we want our species to survive, if we are to find meaning in life, if we want to save the world and every sentient being that inhabits it, love is the one and only answer.

Perhaps we are not yet ready to make a bomb of love, a device powerful enough to entirely destroy the hate, selfishness and greed that devastate the planet.

However, each individual carries within them a small but powerful generator of love whose energy is waiting to be released.

When we learn to give and receive this universal energy, dear Lieserl, we will have affirmed that love conquers all, is able to transcend everything and anything, because love is the quintessence of life.

I deeply regret not having been able to express what is in my heart, which has quietly beaten for you all my life. Maybe it’s too late to apologize, but as time is relative, I need to tell you that I love you and thanks to you I have reached the ultimate answer!."

Your father,
Albert Einstein

Einstein's Letter to President Roosevelt - 1939

Sir:

Some recent work by **E. Fermi and L. Szilard**, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations.

In the course of the last four months it has been made probable through the work of Joliot in France as well as Fermi and Szilard in America--that it may be possible to set up a nuclear chain reaction in a large mass of uranium, by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable--though much less certain--that extremely powerful bombs of this type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove too heavy for transportation by air.

The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and former Czechoslovakia, while the most important source of uranium is in the Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust the task with a person who has your confidence and who could perhaps serve in an unofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problem of securing a supply of uranium ore for the United States.

b) to speed up the experimental work, which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining co-operation of industrial laboratories which have necessary equipment.

I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, **von Weizsacker**, is attached to the Kaiser-Wilhelm Institute in Berlin, where some of the American work on uranium is now being repeated.

Yours very truly,
Albert Einstein

Letter from Albert Einstein to French mathematician Elie Cartan - 21 June1950

Dear Mr.Cartan:

I felt very strongly with you when I received notice of the great loss you have suffered recently. In these trying situations one feels stronger than ordinarily how difficult it is for a human being to hold fast to the notion - so inescapable to a physicist- that the Now is only an illusion, not something pertaining to reality. Several colleagues have drawn my attention to the fact that - already in the beginning of the twenties - you proposed to introduce non-symmetrical fields to generalize relativity theory. I have found in the last years that it is very natural indeed to find on this basis general equations for the field. It seems, however, extremely difficult to find out if the whole thing is conform to physical reality. One thing I have no doubt about, namely that any scheme of physics based fundamentally on the probability concept will show itself unacceptable eventually.

With my cordial greetings and wishes,
yours sincerely,
Albert Einstein

Letter from Albert Einstein to French physicist Louis de Broglie - 14 April 1953

Dear de Broglie:

I received your kind letter of April 9th and feel glad that you decided to add some remarks of your own to Bohm’s paper. This will be a beautiful occasion for me to see how you think now about the interpretation of the basis of quantum theory. But at the same time I am sorry that indirectly - without my fault - I have caused you to be troubled. You may send your contribution directly to the editor of the Born volume (Dr. Robert Schlapp, The University, Edinburgh, Scotland). No English translation will be needed, for my contribution will also be published in German. I shall also send Bohm's contribution directly to Dr.Schlapp. I do not know, of course, whether he will accept such belated contributions and especially such which are connected with the contribution of somebody else. I am mentioning this so that you may not feel annoyed if it should happen that the editor sees no possibility to print your remarks. It would be cautious, in any case, to ask him before you do the work. But even if your and Bohm's remarks could not appear in the Born volume it seems to me that it would be highly desirable that they should appear together in some place, because I know that the interest for the questions of principle is very vivid in the younger generation of physicists. The whole affair reminds me a little of the biblical tale of the Tower of Babel: "And the Lord said: Now nothing will restrain them to do what they have imagined. Let us go down and there confound their language, that they may not understand one another' s speech!" But in our case the Lord not only confounded the language but also the thoughts. So you see He has since improved his methods.

With cordial regards,

yours,

Albert Einstein.

"The idea comes to me from outside of me - and is like a gift. I then take the idea and make it my own - that is where the skill lies."

– **Johannes Brahms**

10 Major Accomplishments of Leonardo Da Vinci:

- He was a prolific inventor, sculpture, painter, mathematician and architect
- He designed a tank more than 400 years before it became a reality
- He designed a mechanical knight known as Leonardo's robot
- He designed a workable precursor to the modern diving suit
- He conceptualized the parachute, rolling bridge, aerial screws, glider, monster crossbow, armored car, helicopter, self-propelled cart and landing gear
- He described the process governing friction before **Guillaume Amontons**
- He did an unprecedented detailed study of anatomy of humans and animals
- He made several important discoveries in human anatomy and made contributions to the advancement of weapon design
- He is considered one of the greatest painters of all time and studied water and had ideas for canals, steam-powered cannons and waterwheels
- He created the most famous painting in the world (**Mona Lisa and The Last Supper**)

Niels Bohr's 10 Major Contributions to Science:

- He discovered the **Bohr–Van Leeuwen theorem** in 1911
- He introduced the Bohr model of the atom in 1913 and made fundamental contributions to understanding the structure of atoms and to the early development of quantum mechanics
- His application of quantum concept to the atomic model was revolutionary
- He was a Nobel Prize-winning physicist and humanitarian who explained the structure of the periodic table through his atomic theory
- He formulated the Complementarily Principle (**It is impossible to observe both the wave and particle aspects simultaneously**) in 1927
- With Heisenberg and Pauli, He devised the Copenhagen interpretation of quantum theory
- He came up with the compound-nucleus model in 1936
- He explained nuclear fission through his liquid drop model
- His debates with Einstein brought quantum mechanics in focus
- He made an instrumental contribution in the development of quantum mechanics

- The greatest deception men suffer is from their own opinions.
- Tears come from the heart and not from the brain.
- There are three classes of people: those who see. Those who see when they are shown. Those who do not see.
- Beyond a doubt truth bears the same relation to falsehood as light to darkness.
- Simplicity is the ultimate sophistication.
- Marriage is like putting your hand into a bag of snakes in the hope of pulling out an eel.
- Intellectual passion drives out sensuality.
- Every action needs to be prompted by a motive.
- He who loves practice without theory is like the sailor who boards ship without a rudder and compass and never knows where he may cast.
- The noblest pleasure is the joy of understanding.
- Life is pretty simple: You do some stuff. Most fails. Some works. You do more of what works. If it works big, others quickly copy it. Then you do something else. The trick is the doing something else.
- People react to fear, not love - they don't teach that in Sunday School, but it's true.
- Time stays long enough for anyone who will use it.
- Nothing strengthens authority so much as silence.
- Necessity is the mistress and guide of nature.
- Wisdom is the daughter of experience.
- Truth was the only daughter of Time.
- He who possesses most must be most afraid of loss.
- Wherever good fortune enters, envy lays siege to the place and attacks it; and when it departs, sorrow and repentance remain behind.
- It is easier to contend with evil at the first than at the last.
- I have been impressed with the urgency of doing. Knowing is not enough; we must apply. Being willing is not enough; we must do.
- Anyone who conducts an argument by appealing to authority is not using his intelligence; he is just using his memory.
- Art is never finished, only abandoned.

- Where the spirit does not work with the hand there is no art.
- While I thought that I was learning how to live, I have been learning how to die.
- Why does the eye see a thing more clearly in dreams than the imagination when awake?
- Iron rusts from disuse; water loses its purity from stagnation ... even so does inaction sap the vigour of the mind.
- Nature is the source of all true knowledge. She has her own logic, her own laws, she has no effect without cause nor invention without necessity.
- It's easier to resist at the beginning than at the end.
- Learning never exhausts the mind.
- Nature never breaks her own laws.
- The truth of things is the chief nutriment of superior intellects.
- All our knowledge has its origins in our perceptions.
- Blinding ignorance does mislead us. O! Wretched mortals, open your eyes!
- He who loves practice without theory is like the sailor who boards ship without a rudder and compass and never knows where he may cast.
- In rivers, the water that you touch is the last of what has passed and the first of that which comes; so with present time.
- As every divided kingdom falls, so every mind divided between many studies confounds and saps itself. ”
- Human subtlety will never devise an invention more beautiful, more simple or more direct than does nature because in her inventions nothing is lacking, and nothing is superfluous.
- As a well spent day brings happy sleep, so a life well spent brings happy death.
- Learning acquired in youth arrests the evil of old age; and if you understand that old age has wisdom for its food, you will so conduct yourself in youth that your old age will not lack for nourishment.
- Experience does not err. Only your judgments err by expecting from her what is not in her power.

- Although nature commences with reason and ends in experience it is necessary for us to do the opposite, that is to commence with experience and from this to proceed to investigate the reason.
- Nature is the source of all true knowledge. She has her own logic, her own laws, she has no effect without cause nor invention without necessity.
- Where there is shouting, there is no true knowledge.
- For, verily, great love springs from great knowledge of the beloved object, and if you little know it, you will be able to love it only little or not at all.
- Common Sense is that which judges the things given to it by other senses.
- Just as courage imperils life, fear protects it.
- Our body is dependent on Heaven and Heaven on the Spirit.

− Leonardo Da Vinci

James Clerk Maxwell's 10 Major Contributions to Science:

- He gave mathematical form to faraday's work in electromagnetism
- His equations form the basis of classical electromagnetism and completely describe the behavior of electric and magnetic fields and their interrelations
- His unification of electromagnetism and optics is considered a scientific landmark and provided the foundations for our modern western society
- He carried out the first profound unification of nature 's forces and paved the way for major technological innovations
- He accurately described the reason for the stability of rings of Saturn and showed that the rings of Saturn are not solid, liquid or gaseous but instead consist of vast numbers of independent particles
- He made important contributions to colour theory and played a key role in the development of statistical mechanics − paving the way for the development of quantum mechanics
- He produced the world 's first colour photo of a tartan ribbon in 1861
- He was the first to apply probability and statistics to the kinetic theory of gases
- His demon was a factor in the development of information theory
- He wrote the founding paper on the field of cybernetics

"From a long view of the history of mankind, seen from, say, ten thousand years from now, there can be little doubt that the most significant event of the nineteenth century will be judged as Maxwell's discovery of the laws of electrodynamics."

− Richard Feynman

Since Maxwell's time, physical reality has been thought of as represented by continuous fields, and not capable of any mechanical interpretation. This change in the conception of reality is the most profound and the most fruitful that physics has experienced since the time of Newton.

— Albert Einstein

This velocity is so nearly that of light, that it seems we have strong reason to conclude that light itself (including radiant heat, and other radiations if any) is an electromagnetic disturbance in the form of waves propagated through the electromagnetic field according to electromagnetic laws.

− James Clerk Maxwell

Letter from Alan Turing to British mathematician Norman Arthur Routledge

My dear Norman,

I don't think I really do know much about jobs, except the one I had during the war, and that certainly did not involve any travelling. I think they do take on conscripts. It certainly involved a good deal of hard thinking, but whether you'd be interested I don't know. Philip Hall was in the same racket and on the whole, I should say, he didn't care for it. However I am not at present in a state in which I am able to concentrate well, for reasons explained in the next paragraph.

I've now got myself into the kind of trouble that I have always considered to be quite a possibility for me, though I have usually rated it at about 10:1 against. I shall shortly be pleading guilty to a charge of sexual offences with a young man. The story of how it all came to be found out is a long and fascinating one, which I shall have to make into a short story one day, but haven't the time to tell you now. No doubt I shall emerge from it all a different man, but quite who I've not found out.

Glad you enjoyed broadcast. Jefferson certainly was rather disappointing though. I'm afraid that the following syllogism may be used by some in the future.

Turing believes machines think
Turing lies with men
Therefore machines do not think

Yours in distress,

Alan

British Prime Minister Gordon Brown's apology to codebreaker Alan Turing

10 September 2009

This has been a year of deep reflection – a chance for Britain, as a nation, to commemorate the profound debts we owe to those who came before. A unique combination of anniversaries and events have stirred in us that sense of pride and gratitude that characterise the British experience. Earlier this year, I stood with Presidents Sarkozy and Obama to honour the service and the sacrifice of the heroes who stormed the beaches of Normandy 65 years ago. And just last week, we marked the 70 years which have passed since the British government declared its willingness to take up arms against fascism and declared the outbreak of the Second World War.

So I am both pleased and proud that thanks to a coalition of computer scientists, historians and LGBT (lesbian, gay, bisexual and transgender) activists, we have this year a chance to mark and celebrate another contribution to Britain's fight against the darkness of dictatorship: that of code-breaker Alan Turing.

Turing was a quite brilliant mathematician, most famous for his work on the German Enigma codes. It is no exaggeration to say that, without his outstanding contribution, the history of the Second World War could have been very different. He truly was one of those individuals we can point to whose unique contribution helped to turn the tide of war. The debt of gratitude he is owed makes it all the more horrifying, therefore, that he was treated so inhumanely.

In 1952, he was convicted of "gross indecency" – in effect, tried for being gay. His sentence – and he was faced with the miserable choice of this or prison – was chemical castration by a series of injections of female hormones. He took his own life just two years later.

Thousands of people have come together to demand justice for Alan Turing and recognition of the appalling way he was treated. While Turing was dealt with under the law of the time, and we can’t put the clock back, his treatment was of course utterly unfair, and I am pleased to have the chance to say how deeply sorry I am and we all are for what happened to him. Alan and so many thousands of other gay men who were convicted, as he was convicted, under homophobic laws, were treated terribly. Over the years, millions more lived in fear of conviction. I am proud that those days are gone and that in the past 12 years this Government has done so much to make life fairer and more equal for our LGBT community. This recognition of Alan’s status as one of Britain’s most famous victims of homophobia is another step towards equality, and long overdue.

But even more than that, Alan deserves recognition for this contribution to humankind. For those of us born after 1945, into a Europe which is united, democratic and at peace, it is hard to imagine that our continent was once the theatre of mankind’s darkest hour. It is difficult to believe that in living memory, people could become so consumed by hate – by anti-Semitism, by homophobia, by xenophobia and other murderous prejudices – that the gas chambers and crematoria became a piece of the European landscape as surely as the galleries and universities and concert halls which had marked out European civilisation for hundreds of years.

It is thanks to men and women who were totally committed to fighting fascism, people like Alan Turing, that the horrors of the Holocaust and of total war are part of Europe’s history and not Europe’s present. So on behalf of the British government, and all those who live freely thanks to Alan’s work, I am very proud to say: we’re sorry. You deserved so much better.

Gordon Brown

"Perhaps I can best describe my experience of doing mathematics in terms of a journey through a dark unexplored mansion. You enter the first room of the mansion and it's completely dark. You stumble around bumping into the furniture, but gradually you learn where each piece of furniture is. Finally, after six months or so, you find the light switch, you turn it on, and suddenly it's all illuminated. You can see exactly where you were. Then you move into the next room and spend another six months in the dark. So each of these breakthroughs, while sometimes they're momentary, sometimes over a period of a day or two, they are the culmination of—and couldn't exist without—the many months of stumbling around in the dark that proceed them."

– English mathematician Andrew Wiles

Letter from Alan Turing to Morcom's mother, Frances Isobel Morcom

A day before the third anniversary of Morcom's death (13 February 1933)

I expect you will be thinking of Chris when this reaches you. I shall too, and this letter is just to tell you that I shall be thinking of Chris and of you tomorrow. I am sure that he is as happy now as he was when he was here.

Your affectionate Alan

"I have ... a terrible need ... shall I say the word? ... of religion. Then I go out at night and paint the stars."

– Dutch post-impressionist painter Vincent van Gogh

Draft of letter from Bohr to Heisenberg, never sent

In the handwriting of Niels Bohr's assistant, Aage Petersen.

Undated, but written after the first publication, in 1957, of the Danish translation of Robert Jungk, Heller als Tausend Sonnen, the first edition of Jungk's book to contain Heisenberg's letter

Dear Heisenberg,

I have seen a book, "Stærkere end tusind sole" ["Brighter than a thousand suns"] by Robert Jungk, recently published in Danish, and I think that I owe it to you to tell you that I am greatly amazed to see how much your memory has deceived you in your letter to the author of the book, excerpts of which are printed in the Danish edition [1957].

Personally, I remember every word of our conversations, which took place on a background of extreme sorrow and tension for us here in Denmark. In particular, it made a strong impression both on Margrethe and me, and on everyone at the Institute that the two of you spoke to, that you and Weizsäcker expressed your definite conviction that Germany would win and that it was therefore quite foolish for us to maintain the hope of a different outcome of the war and to be reticent as regards all German offers of cooperation. I also remember quite clearly our conversation in my room at the Institute, where in vague terms you spoke in a manner that could only give me the firm impression that, under your leadership, everything was being done in Germany to develop atomic weapons and that you said that there was no need to talk about details since you were completely familiar with them and had spent the past two years working more or less exclusively on such preparations. I listened to this without speaking since [a] great matter for mankind was at issue in which, despite our personal friendship, we had to be regarded as representatives of two sides engaged in mortal combat. That my silence and gravity, as you write in the letter, could be taken as an expression of shock at your reports that it was possible to make an atomic bomb is a quite peculiar misunderstanding, which must be due to the great tension in your own mind. From the day three years earlier when I realized that slow neutrons could only cause fission in Uranium 235 and not 238, it was of course obvious to me that a bomb with certain effect could be produced by separating the uraniums. In June 1939 I had even given a public lecture in Birmingham about uranium fission, where I talked about the effects of such a bomb but of course added that the technical preparations would be so large that one did not know how soon they could be overcome. If anything in my behaviour could be interpreted as shock, it did not derive from such reports but rather from the news, as I had to understand it, that Germany was participating vigorously in a race to be the first with atomic weapons.

Besides, at the time I knew nothing about how far one had already come in England and America, which I learned only the following year when I was able to go to England after being informed that the German occupation force in Denmark had made preparations for my arrest.

All this is of course just a rendition of what I remember clearly from our conversations, which subsequently were naturally the subject of thorough discussions at the Institute and with other trusted friends in Denmark. It is quite another matter that, at that time and ever since, I have always had the definite impression that you and Weizsäcker had arranged the symposium at the German Institute, in which I did not take part myself as a matter of principle, and the visit to us in order to assure yourselves that we suffered no harm and to try in every way to help us in our dangerous situation.

This letter is essentially just between the two of us, but because of the stir the book has already caused in Danish newspapers, I have thought it appropriate to relate the contents of the letter in confidence to the head of the Danish Foreign Office and to Ambassador Duckwitz.

Einstein letter to Professor G. Gamow (in August 4, 1946), with a comment handwritten by Gamow at the bottom

Dear Dr. Gamow

After receiving your manuscript I read it immediately and then forwarded it to Dr. Spitzer. I am convinced that the abundance of elements as function of the atomic weight is a highly important starting point for cosmogonic speculations. The idea that the whole expansion process started with a neutron gas seems to be quite natural too. The explanation of the abundance curve by formation of the heavier elements in making use of the known facts of probability coefficients seems to me pretty convincing. Your remarks concerning the formation of the big units (nebulae) I am not able to judge for lack of special knowledge.

Thanking you for your kindness, I am

yours sincerely,

Albert Einstein

(Of course, the old man agrees with almost anything nowadays.)

– comment handwritten by Gamow

Letter from Linus Pauling to George Gamow. December 9, 1953

Dear Gamow:

I have been interested to see your letter which arrived in Pasadena just about when I was leaving, on a trip to Israel.

The problem of the determination of sequence of amino-acid residues in the protein molecule through complementariness to the nucleic acid molecule is a very interesting one, Corey and I thought about it in connection with our proposed structure for nucleic acid (Proc. Hat. Acad. Sci. Feb., 1953) which stimulated Watson and Crick, who had a copy of the manuscript, to develop their structure, and I know that Watson and Crick have thought it over too. I feel that a decision has to be made through the consideration of the shapes of the molecules as to where the amino-acid residues fit in. The number of possibilities is, as you point out, about enough to explain the selection uniquely of the residues, in position of about 3.5 Angstrom from one another along the polynucleotide molecule.

The comment I would make about your number 20 is that I do not see the 12 that you rule out on the basis that they are D forms. The rhomb is on one side of the nucleic acid molecule, and there is a polar axis along the molecule if a polypeptide chain is being built up because the polypeptide chain itself has a polar axis. Hence, all 32 rhombs are to be considered as different. In fact, I think that the number should still be multiplied by two.

Sincerely yours,
Linus Pauling

"Any list of the three “greatest” mathematicians of all history would include the name of Archimedes. The other two usually associated with him are Newton and Gauss. Some, considering the relative wealth — or poverty — of mathematics and physical science in the respective ages in which these giants lived, and estimating their achievements against the background of their times, would put Archimedes first."

– Scottish-born mathematician Eric Temple Bell

Letter from George Gamow to Francis Crick

Dear Francis,

I include a m.s. which may reduce a 5 times 10^9y. decoding time to ovey (sic!) a few hundred hours. There are also some hopes in making some conclusion by applying Poisson distribution test to Brenner's table. As you must have heard, RNATIE is in production. Soon you will get a chain letter (not branching chain) concerning the selection of one of 20 aa (or "amigos") for tie pin.

Best regards to the jolly old good England and to yourself

Yours Geo.

Letter from Francis Crick to James D. Watson

13th April 1967.

Dear Jim,

The new version of Honest Jim is naturally a little better, but my basic objections to it remain the same as before. They are:

I. The book is not a history of the discovery of DNA, as you claim in the preface. Instead it is a fragment of your autobiography which covers the period when you worked on DNA.

I do not see how anybody can seriously dispute this, for the following reasons:-

a) Important scientific considerations, which concerned you at the time, are omitted. For example the work of Furberg, which established the relative configuration of the sugar and the base. There are many other examples.

b) Such scientific details that are mentioned are referred to rather than described. For example, you do not explain exactly why you got the water content of DNA wrong, nor make it clear that if there had been so little water electrostatic forces were bound to predominate. You do not mention that Pauling worked from an old X-ray picture of Astbury's which had both the A and B pictures on the same photograph. There are many other examples.

c) The thread of the argument is often lost beneath the mass of personal details. For example I asked both Bragg and Doty the following question. "Since we had realized that 1:1 base ratios mean that the bases went together in pairs why did we not immediately use this idea when we started model building the second time?" Neither could give the correct answer.

d) No attempt is made to ask or answer questions which would interest the historian (such as the one above). For example, the advantages or disadvantages of collaboration, or when the structure would have been solved if we had not solved it. Nothing is said about the importance of the MRC, nor why they decided to finance "biophysics" after the war.

e) Gossip is preferred to scientific considerations. For example, you explain how Bragg and I had a misunderstanding but you omit to say what the scientific issue was.

f) Much of the gossip and even some of the science is irrelevant to a history of DNA. For example, your work on TMV and bacterial genetics is only of marginal importance to the main theme. Whole chapters, such as Chapter 15 on your visit to Carradale, are irrelevant as far as DNA is concerned. Even when personal matters should be mentioned they are described in quite unnecessary detail.

g) Absolutely no attempt is made to document your assertions, many of which are not completely accurate because of your faulty memory. You have not troubled to consult documents which you could easily lay your hands on, nor have you made available to others the documents you yourself have, such as the letters you wrote at the time to your mother, which are in fact not even mentioned in the book. Dates are given in the book only very casually.

It is thus absolutely clear that your book is not history as normally understood. However once it is realized that it is not history but a part of your autobiography many of the points made above become irrelevant. Unfortunately you yourself claim it as history, and the misguided but worthy people who are supporting you in publishing it also use this as their major excuse for publication.

Should you persist in regarding your book as history I should add that it shows such a naive and egotistical view of the subject as to be scarcely credible. Anything which concerns you and your reactions, apparently, is historically relevant, and anything else is thought not to matter. In particular the history of scientific discovery is displayed as gossip. Anything with any intellectual content, including matters which were of central importance to us at the time, is skipped over or omitted. Your view of history is that found in the lower class of women's magazines.

The objections to your book considered as an autobiography are not so clear-cut as the objections to it considered as history. The criticisms are naturally more a matter of personal opinion. However it seems to me that some of these are beyond dispute. My second major objection is therefore:

II. Considered as autobiography your book is misleading and in bad taste.

a) Your book is misleading because it does not in fact accurately convey the atmosphere in which the work was done. Most of the time we were engaged in complicated intellectual discussions concerning points in crystallography and biochemistry. The major motivation was to understand. Science is not done merely by gossiping with other scientists, let alone by quarrelling with them. The most important requirements in theoretical work are a combination of accurate thinking and imaginative ideas. To understand these they must be described at the intellectual level involved. I concede that the idea that scientific work is impersonal is ridiculous, but you have gone much too far in the other direction in trying to correct this misconception.

b) Your book is in poor taste because of the style. I select a few examples:

"waited for the day when he could fall flat on his face by botching something important."

"The scuttlebuck about Peter centered on girls and was confused. But now Ava Helen gave me the dope that Peter was an exceptionally fine boy whom everybody would enjoy having around as much as she did".

" . . . Linus' chemistry was screwy".

" . . . he knew that the presence of pospies does not inevitably lead to a scientific future".

The examples show some of the more glaring features, but longer quotations and comments would be needed to bring out the attitude behind much of the writing. For example, the tone used to describe Rosalind's work in the Epilogue is perfectly reasonable, but contrasts ludicrously with the descriptions of her in the text itself.

c) It is not customary to write intimate books about your friends without their permission, at least until they are dead. I would remind you that Betrand Russell delayed the publication of his autobiography till he was over 90, and that Lord Moran's much criticized account of Churchill's health was not published till after the latter's death.

The fact that a man is well-known does not by itself excuse his friends from respecting his privacy while he is alive. Only if a person himself either gives permission or discusses his own personal affairs in public should his friends feel free to write about them. The only exception is when private matters are of prime and direct public concern, as in the case of Mrs. Simpson and King Edward, and even then the British press wrote nothing for many months. It cannot really be said that the way the structure of DNA was discovered is of major public concern.

Next I must deal with miscellaneous points made by various people. I do not concede that pure scientific research lies in the public realm in the same way that politics or military affairs do. People who engage in the latter activities naturally expect to have their behavior written about. But the point of science is what is discovered, not how it was discovered or by whom. It is the results which need to be brought home to the public. It is quite inexcusable to invade someone's privacy to describe how the structure of DNA was discovered to people who don't even know what it is, nor why it is important. I have no objection to a genuine historical description. It is vulgar popularization which is indefensible.

I am also unimpressed by the number of people who favour publication. The fact is that those most intimately concerned, Maurice, Pauling and myself have all protested strongly. Bragg was furious when he first read the book, and, was only subsequently talked round. He still has considerable doubts. I understand that Beadle has advised you not to publish. No doubt a number of people who know nothing about the subject have enjoyed the book, but what is that to me? I very much doubt if any historian of science has thought it worth much. You should realize that the approval of people like Jacques Barzun is not worth having.

Nor can I see any logic in the argument that since 50 people have read it already, it will make no difference if 50,000 now read it. I can assure you that it makes all the difference to me. Nor do I believe that the book is so fascinating that everybody will want to have an underground Xerox copy.

I agree your book is "unprecedented" but that by itself does not make it acceptable. It certainly "provides something which cannot be brought out in any other way", namely a lot of tasteless gossip about the past. It does not illuminate the process of scientific discovery. It grossly distorts it.

Again there is no force in the argument that if the book were only to be published in 40 to 50 years time no one would be alive to set straight the errors. The people actually involved can correct the errors now, using the present manuscript. Wide publication would not make this process any easier.

I must also point out to you, once again, the risks you will run if you publish such a book. The picture which emerges of yourself is not only unfavourable but misleadingly so. Moreover I do not think you realize what others will see in it. One psychiatrist who saw your collection of pictures said it could only have been made by a man who hated women. In a similar way another psychiatrist, who read Honest Jim, said that what emerged most strongly was your love for your sister. This was much discussed by your friends while you were working in Cambridge, but so far they have refrained from writing about it. I doubt if others will show this restraint.

Finally we come to the question, what should you do about the book. I can see only two courses which you can honourably take:

1. Scrap the present book, and write a proper history of the subject. I can understand that you may not wish to do this, especially as Olby is planning to write such a book.

2. Put the book on one side, with instructions that it may be published either when all the major participants agree to it, or after those who object are dead.

There is no reason why your bock, as it stands, should not be made available to selected scholars, provided any documents you may have (such as your letters to your mother) which bear on the subject are also made available at the same time.

My objection, in short, is to the widespread dissemination of a book which grossly invades my privacy, and I have yet to hear an argument which adequately excuses such a violation of friendship. If you publish your book now, in the teeth of my opposition, history will condemn you, for the reasons set out in this letter.

I have written separately to Wilson pointing out several cases of factual errors in your latest draft. I enclose a copy of my letter to him.

Yours sincerely,

F.H.C. Crick.

"Like Nietzsche, Spinoza has not much use for humility; it is either the hypocrisy of a schemer or the timidity of a slave; it implies the absence of power - whereas to Spinoza, all virtues are forms of ability and power. So is remorse a defect rather than a virtue: "he who repents is twice unhappy and doubly weak.

But he does not spend so much time as Nietzsche in inveighing against humility, for 'humility is very rare,' and as Cicero said, even the philosophers who write books in its praise *take care to put their names on the title-page*."

– American writer, historian, and philosopher Will Durant

"Hilbert had no patience with mathematical lectures, which filled the students with facts but did not teach them how to frame a problem and solve it. He often used to tell them that a perfect formulation of a problem is already half its solution."

– Constance Reid

Leonardo da Vinci Letter to Ludovico Sforza

My Most Illustrious Lord,

Having now sufficiently seen and considered the achievements of all those who count themselves masters and artificers of instruments of war, and having noted that the invention and performance of the said instruments is in no way different from that in common usage, I shall endeavour, while intending no discredit to anyone else, to make myself understood to Your Excellency for the purpose of unfolding to you my secrets, and thereafter offering them at your complete disposal, and when the time is right bringing into effective operation all those things which are in part briefly listed below:

- I have plans for very light, strong and easily portable bridges with which to pursue and, on some occasions, flee the enemy, and others, sturdy and indestructible either by fire or in battle, easy and convenient to lift and place in position. Also means of burning and destroying those of the enemy.
- I know how, in the course of the siege of a terrain, to remove water from the moats and how to make an infinite number of bridges, mantlets and scaling ladders and other instruments necessary to such an enterprise.
- Also, if one cannot, when besieging a terrain, proceed by bombardment either because of the height of the glacis or the strength of its situation and location, I have methods for destroying every fortress or other stranglehold unless it has been founded upon a rock or so forth.
- I have also types of cannon, most convenient and easily portable, with which to hurl small stones almost like a hail-storm; and the smoke from the cannon will instil a great fear in the enemy on account of the grave damage and confusion.
- Also, I have means of arriving at a designated spot through mines and secret winding passages constructed completely without noise, even if it should be necessary to pass underneath moats or any river.

- Also, I will make covered vehicles, safe and unassailable, which will penetrate the enemy and their artillery, and there is no host of armed men so great that they would not break through it. And behind these the infantry will be able to follow, quite uninjured and unimpeded.
- Also, should the need arise, I will make cannon, mortar and light ordnance of very beautiful and functional design that are quite out of the ordinary.
- Where the use of cannon is impracticable, I will assemble catapults, mangonels, trebuckets and other instruments of wonderful efficiency not in general use. In short, as the variety of circumstances dictate, I will make an infinite number of items for attack and defence.
- And should a sea battle be occasioned, I have examples of many instruments which are highly suitable either in attack or defence, and craft which will resist the fire of all the heaviest cannon and powder and smoke.
- In time of peace I believe I can give as complete satisfaction as any other in the field of architecture, and the construction of both public and private buildings, and in conducting water from one place to another.

Also I can execute sculpture in marble, bronze and clay. Likewise in painting, I can do everything possible as well as any other, whosoever he may be.

Moreover, work could be undertaken on the bronze horse which will be to the immortal glory and eternal honour of the auspicious memory of His Lordship your father, and of the illustrious house of Sforza.

And if any of the above-mentioned things seem impossible or impracticable to anyone, I am most readily disposed to demonstrate them in your park or in whatsoever place shall please Your Excellency, to whom I commend myself with all possible humility.

Letter from Albert Einstein to the Jewish philosopher Eric B. Gutkind

The word God is for me nothing more than the expression and product of human weaknesses, the Bible a collection of honorable, but still primitive legends which are nevertheless pretty childish. No interpretation no matter how subtle can (for me) change this. These subtilised interpretations are highly manifold according to their nature and have almost nothing to do with the original text. For me the Jewish religion like all other religions is an incarnation of the most childish superstitions. And the Jewish people to whom I gladly belong and with whose mentality I have a deep affinity have no different quality for me than all other people. As far as my experience goes, they are also no better than other human groups, although they are protected from the worst cancers by a lack of power. Otherwise I cannot see anything 'chosen' about them.

In general I find it painful that you claim a privileged position and try to defend it by two walls of pride, an external one as a man and an internal one as a Jew. As a man you claim, so to speak, a dispensation from causality otherwise accepted, as a Jew the privilege of monotheism. But a limited causality is no longer a causality at all, as our wonderful Spinoza recognized with all incision, probably as the first one. And the animistic interpretations of the religions of nature are in principle not annulled by monopolization. With such walls we can only attain a certain self-deception, but our moral efforts are not furthered by them. On the contrary.

Now that I have quite openly stated our differences in intellectual convictions it is still clear to me that we are quite close to each other in essential things, i.e; in our evaluations of human behavior. What separates us are only intellectual 'props' and 'rationalization' in Freud's language. Therefore I think that we would understand each other quite well if we talked about concrete things.

With friendly thanks and best wishes,

Yours, A. Einstein

"Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less. "

— **Marie Curie**

Letter from Isaac Newton to Richard Bentley

As to your first query, it seems to me that if the matter of our sun and planets and all the matter of the universe were evenly scattered throughout all the heavens, and every particle had an innate gravity toward all the rest, and the whole space throughout which this matter was scattered was but finite, the matter on the outside of this space would, by its gravity, tend toward all the matter on the inside and, by consequence, fall down into the middle of the whole space and there compose one great spherical mass. But if the matter was evenly disposed throughout an infinite space, it could never convene into one mass; but some of it would convene into one mass and some into another, so as to make an infinite number of great masses, scattered at great distances from one to another throughout all that infinite space. And thus might the sun and fixed stars be formed, supposing the matter were of a lucid nature.

But how the matter should divide itself into two sorts, and that part of it which is to compose a shining body should fall down into one mass and make a sun and the rest which is t to compose an opaque body should coalesce, not into one great body, like the shining matter, but into many little ones; or if the sun at first were an opaque body like the planets or the planets lucid bodies like the sun, how he alone should be changed into a shining body whilst all they continue opaque, or all they be changed into opaque ones whilst he remains unchanged, I do not think explicable by mere natural causes, but am forced to ascribe it to the counsel and contrivance of a voluntary Agent.

– December 10, 1692

But you argue, in the next paragraph of your letter, that every particle of matter in an infinite space has an infinite quantity of matter on all sides, and, by consequence, an infinite attraction every way, and therefore must rest in equili- brio, because all infinites are equal. Yet you suspect a paralogism in this argument; and I conceive the paralogism lies in the position, that all infinites are equal. The generality of mankind consider infinites no other ways than indefinitely; and in this sense they say all infinites are equal; though they would speak more truly if they should say, they are neither equal nor unequal, nor have any certain difference or proportion one to another. In this sense, therefore, no conclusions can be drawn from them about the equality, proportions, or differences of things; and they that attempt to do it usually fall into paralogisms.

So, when men argue against the infinite divisibility of magnitude, by saying, that if an inch may be divided into an infinite number of parts, the sum of those parts will be an inch; and if a foot may be divided into an infinite number of parts, the sum of those parts must be a foot; and therefore, since all infinites are equal, those sums must be equal, that is, an inch equal to a foot. The falseness of the conclusion shews an error in the premises ; and the error lies in the position, that all infinites are equal.

– January 17, 1693

"If you wish to make an apple pie from scratch, you must first invent the universe."

– **Carl Sagan**

A letter to Charles Darwin from Jerry Coyne

My Dear Mr. Darwin,

Happy 200th birthday! I hope you are as well as can expected for someone who has been dead for nearly 130 years. I suppose that your final book, the one about earthworms, has a special significance for you these days. Are the worms of Westminster Abbey superior to the ones you studied so carefully in the grounds of your home at Downe in Kent? They've certainly mulched some distinguished people over the years!

But enough of the personal questions: let me introduce myself. I am one of thousands – maybe tens of thousands – of professional biologists who work full time on your scientific legacy. You'll be happy to know that Britain remains a powerhouse in what we nowadays call evolutionary biology, and your ideas now have wide currency across the entire planet. I work in Chicago, in the United States of America. But even the French have finally reluctantly relinquished their embrace of Jean-Baptiste Lamarck, whose misguided evolutionary ideas you did so much to discredit.

Your Origin of Species turns 150 this year. I just re-read it in your honour and must say that, though you did not always have the snappiest turn of phrase, it really is a wonderfully comprehensive and insightful work. It is remarkable, considering what you did not know when you wrote it, how robust the book has proved over the years. The findings of modern biology, many of them inconceivable to you as you beavered away in your Down House study, have provided ever more evidence in support of your ideas, and none that contradicts them. We have learned a huge amount in the past 150 years, but nearly all of it still fits comfortably into the framework you outlined in The Origin. Take DNA, for example. This is what we call the hereditary material that is passed down from generation to generation. You knew nothing about it – remember how you wished you understood more about how heredity works? Now we have full DNA sequences from dozens of species, each one a string of billions of the four DNA letters — A, T, G and C — each a different chemical compound. What do we find when we compare these sequences, say between a mouse and a human? We see the DNA equivalent of the anatomical similarities – as mammals – that you noted mice and humans share because they are descended from a common ancestor, an early mammal. Strings of As, Gs, Cs, and Ts tell precisely the same evolutionary story as traits like lactation and warm-bloodedness. It is absolutely marvelous that your 150 year old insight on common ancestry should be so relevant to the very latest discoveries of the new field we call molecular biology.

In The Origin, you gave very little evidence for evolution from the fossil record, wringing your hands instead about the incompleteness of the geological record. But since then, the labors of fossil-hunters throughout the world have turned up plenty of evidence of evolutionary change, and many amazing "transitional" forms that connect major groups of animals, proving your idea of common ancestry. You predicted that these forms would exist; we have found them. These include fossils that show transitions between mammals and reptiles, fish and amphibians, and even dinosaurs with feathers—the ancestors of birds! Just in the past few years, paleontologists have unearthed an astonishing fossil, called Tiktaalik, that is intermediate between fish and amphibians. It has the flat head and neck of an amphibian, but a fishy tail and body, while its fins are sturdy, easily able, with slight modification, to give them a leg up when they left the water. The fossil record has given us a direct glimpse of an event of great moment in the history of the planet: the colonization of land by vertebrates. And we have evidence just as convincing for the recolonization of the sea by mammals: the group that gave rise to whales. In The Origin, you were correct in suggesting that whales arose from land animals, but you got it wrong on one point. You thought they may have come from carnivores like bears, but we now know this is not true. Instead, the ancestral whale came from a small hooved animal rather like a deer. And in the last thirty years we have discovered a whole series of intermediate fossils spanning the gap from those ancient deer to modern whales, showing them losing their hind legs, evolving flippers, and moving their breathing hole to the top of their head. Both Tiktaalik and these ancestral whales put paid to the objection, which you yourself encountered, that no transitional form between land and water could possibly have existed.

Perhaps the most remarkable set of intermediate fossils, however, come from an evolutionary transition rather closer to home. In 1871, you more predicted that, since humans seem most related to African great apes, gorillas and chimpanzees, we would find human fossils on that continent. And now we have them—in profusion! It turns out that our lineage separated from that of chimpanzees, our closest living relatives, nearly 7 million years ago, and we have a superb series of fossils documenting our transition from early apelike creatures to more modern human forms. Our own species has become an exemplar of evolution. And we know even more: evidence from our hereditary DNA material has told us that all modern humans came from a relatively recent migration event—about 100,000 years ago—when our ancestors left Africa and spread throughout the world.

The idea you were proudest of was natural selection. That too has had a good 150 years, holding up well as the main cause of evolution and the only known cause of adaptation. Perhaps the most dramatic modern example involves bacteria that are now known to cause disease, including the scarlet fever that was such a plague upon your family. Chemists have developed drugs to cure diseases like this, but now, as you might well predict, the microbes are becoming resistant to those drugs—precisely in accord with the principles of natural selection—for the most drug-resistant microbes are the ones that survive to breed. There are hundreds of other cases. One that will especially please you is the observation of natural selection in the Galápagos finches you collected in the Beagle voyage—now called "Darwin's finches" in your honor. A few decades ago, zoologists observed a great drought on the islands that reduced the number of small seeds available for the birds to eat. And, just as predicted, natural selection caused the evolution of larger-beaked birds within only a few years. These examples would surely be a centerpiece of The Origin were you to rewrite it today.

All told, the resilience of your ideas is remarkable. But that is not to say that you got everything right. On The Origin of Species was, admit it, a misnomer. You described correctly how a single species changes through time, but you came a cropper trying to explain how one species splits into two. Speciation is a significant problem, because it underpins the branching process that has yielded the tree of life – that extraordinary vision you bequeathed us of the natural world as one vast genealogy. Speciation is the key to understanding how, starting with the very first species on earth, evolution has resulted in the 50 million species that are thought to inhabit our planet today.

You once called speciation the "mystery of mysteries," but it's a lot less mysterious these days. We recognize now that species are separated one from another by barriers to reproduction. That is, we recognize different species, like humans and chimpanzees, because they cannot successfully interbreed. To modern evolutionary biologists, studying "the origin of species" means studying how these barriers to reproduction arise. And now that we have a concrete phenomenon to investigate, we are making remarkable progress in understanding the genetic details of how one species splits into two. This is in fact the problem to which I've devoted my entire career

I wish I could end this letter by telling you that your theory of evolution has achieved universal acceptance. As you well knew, evolution has proved a bitter pill for religious people to swallow. For example, a large proportion of the American public, despite access to education, clings to a belief in the literal truth of Genesis. You will find this hard to believe, but more Americans believe in the existence of heavenly angels than accept the fact of evolution. Unfortunately, I must often put aside my research to fight the attempts of these "creationists" to have their Biblical views taught in the public schools. Humans have evolved extraordinary intellectual abilities, but sadly these are not always given a free rein by their owners. But this probably won't surprise you – remember the Bishop of Oxford and his attempt to put your friend Thomas H. Huxley in his place?

You wrote in your introduction to **The Origin of Species** that

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"No one can feel more sensible than I do of the necessity of hereafter publishing in detail all the facts, with references, on which my conclusions have been grounded; and I hope in a future work to do this."
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It seems that, distracted by other projects, you never got around to it, but my own effort along these lines is represented in a book (which I enclose) called Why Evolution is True. It goes further to describe the evidence supporting you than a letter this size ever could, but it's just one book at just one moment in the history of biology. When I myself am as long gone as you are, somebody else will certainly need to write an update, for the facts supporting your theories continue to roll in, and I wager they will continue to do so.

So, rest in peace, Mr. Darwin, and here's hoping that the next hundred years will see a steady evolution of rationality in a troubled world.

Your most humble servant,

Jerry Coyne

Letter from James Watson to Max DelbrÃžck. March 12, 1953

March 12, 1953

Dear Max

Thank you very much for your recent letters. We were quite interested in your account of the Pauling Seminar. The day following the arrival of your letter, I received a note from Pauling, mentioning that their model had been revised, and indicating interest in our model. We shall thus have to write him in the near future as to what we are doing. Until now we preferred not to write him since we did not want to commit ourselves until we were completely sure that all of the Van der Waals contacts were correct and that all aspects of our structure were stereochemically feasible. I believe now that we have made sure that our structure can be built and today we are laboriously calculating out exact atomic coordinates.

Our model (a joint project of Francis Crick and myself) bears no relationship to either the original or the revised Pauling-Corey-Schomaker models. It is a strange model and embodies several unusual features. However since DNA is an unusual substance, we are not hesitant in being bold. The main features of the model are (1) The basic structure is helical - it consists of two intertwining helices - the core of the helix is occupied by the purine and pyrimidine bases - the phosphates groups are on the outside. (2) The helices are not identical but complementary so that if one helix contains a purine base, the other helix contains a pyrimidine - this feature is a result of our attempt to make the residues equivalent and at the same time put the purines and pyrimidine bases in the center. The pairing of the purine with pyramidines is very exact and dictated by their desire to form hydrogen bonds - Adenine will pair with Thymine while Guanine will always pair with Cytosine. For example [diagrams of base pairing] Thymine with Adenine, Cytosine with Guanine.

While my diagram is crude, in fact these pairs form 2 very nice hydrogen bonds in which all of the angles are exactly right. This pairing is based on the effective existence of only one out of the two possible tautomeric forms - in all cases we prefer the keto form over the enol[,] the amino over the imino. This is definitely an assumption but Jerry Donohue and Bill Cochran tell us that for all organic molecules so far examined, the keto and amino forms are present in preference to the enol and imino possibilities.

The model has been derived almost entirely from stereochemical considerations with the only x-ray consideration being the spacing between the pair of bases 3.4 A which was originally found by Astbury. It tends to build itself with approximately 10 residues per tern in 34 A. The screw is right handed.

The x-ray pattern approximately agreed with the model, but since the photographs available to us are poor and meagre (we have no prototypes of our own and like Pauling must use Astbury's photographs) this agreement in no way constitutes a proof of our model. We are certainly a long way from proving its correctness. To do this we must obtain collaboration from the group at Kings College London who possess very excellent photographs of a crystalline phase in addition to rather good photographs of a paracrystalline phase. Our model has been made in reference to the paracrystalline form, and as yet we have no clear idea as to how these helices pack together to form the crystalline phase.

In the next day or so Crick and I shall send a note to Nature proposing our structure as a possible model, at the same time emphasizing its provisional nature and the lack of proof in its favor. Even if wrong I believe it to be interesting since it promises a concrete example of a structure composed of complementary chains. If by chance, it is right then I suspect we may be making a slight dent into the manner in which DNA can reproduce itself. For these reasons (in addition to many others) I prefer this type of model over Pauling's which if true would tell us next to nothing about [the] manner of DNA reproduction.

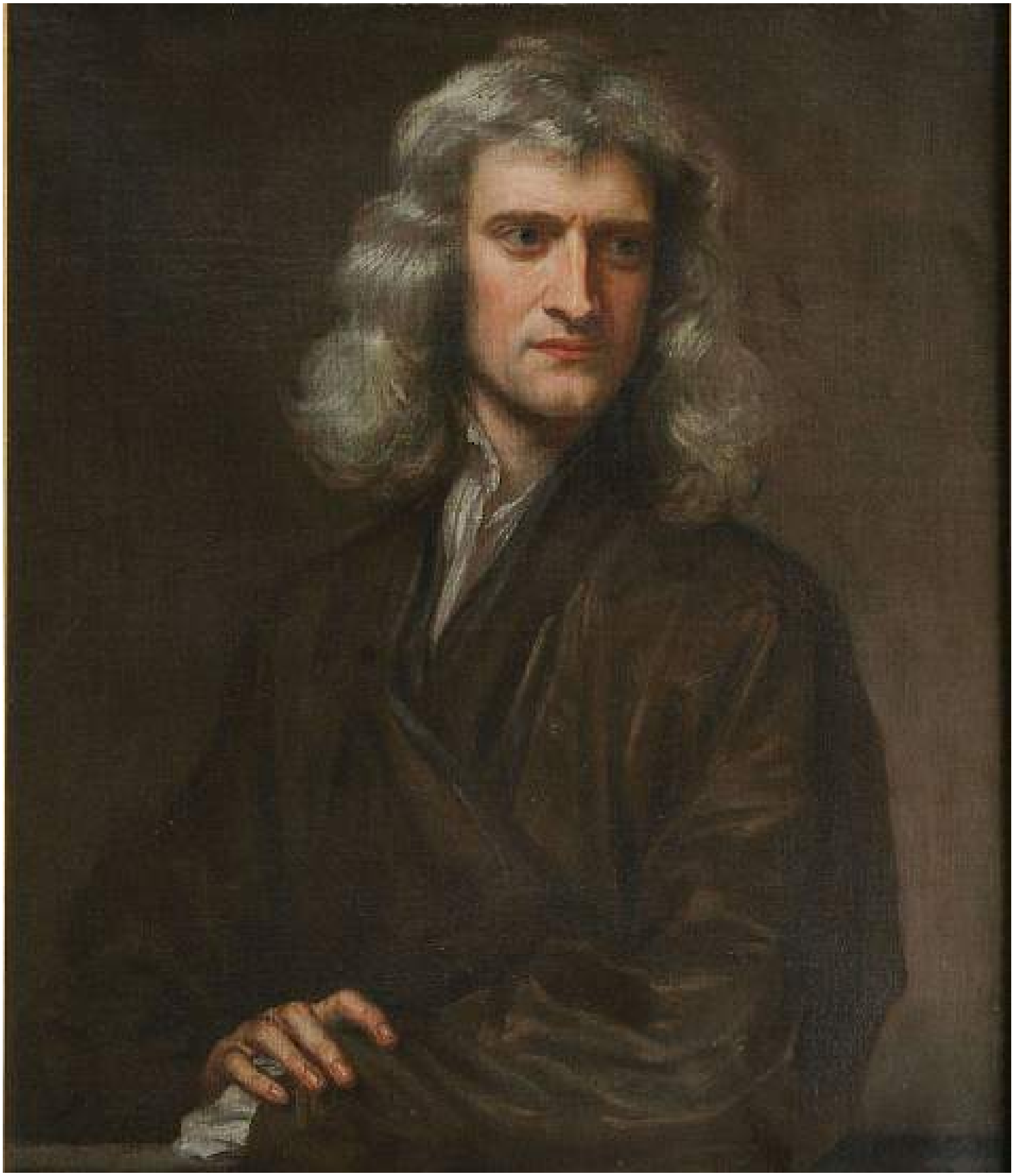
I shall write you in a day or so about the recombination paper. Yesterday I received a very interesting note from Bill Hayes. I believe he is sending you a copy.

I have met Alfred Tissieus recently. He seems very nice. He speaks fondly of Pasadena and I suspect has not yet become accustomed to being a Fellow of Kings.

My regards to Mary

Jim

P.S. We would prefer you're not mentioning this letter to Pauling. When our letter to Nature is completed we shall send him a copy. We should like to send him coordinates.



I can calculate the motion of heavenly bodies, but not the madness of people.

Sir Isaac Newton

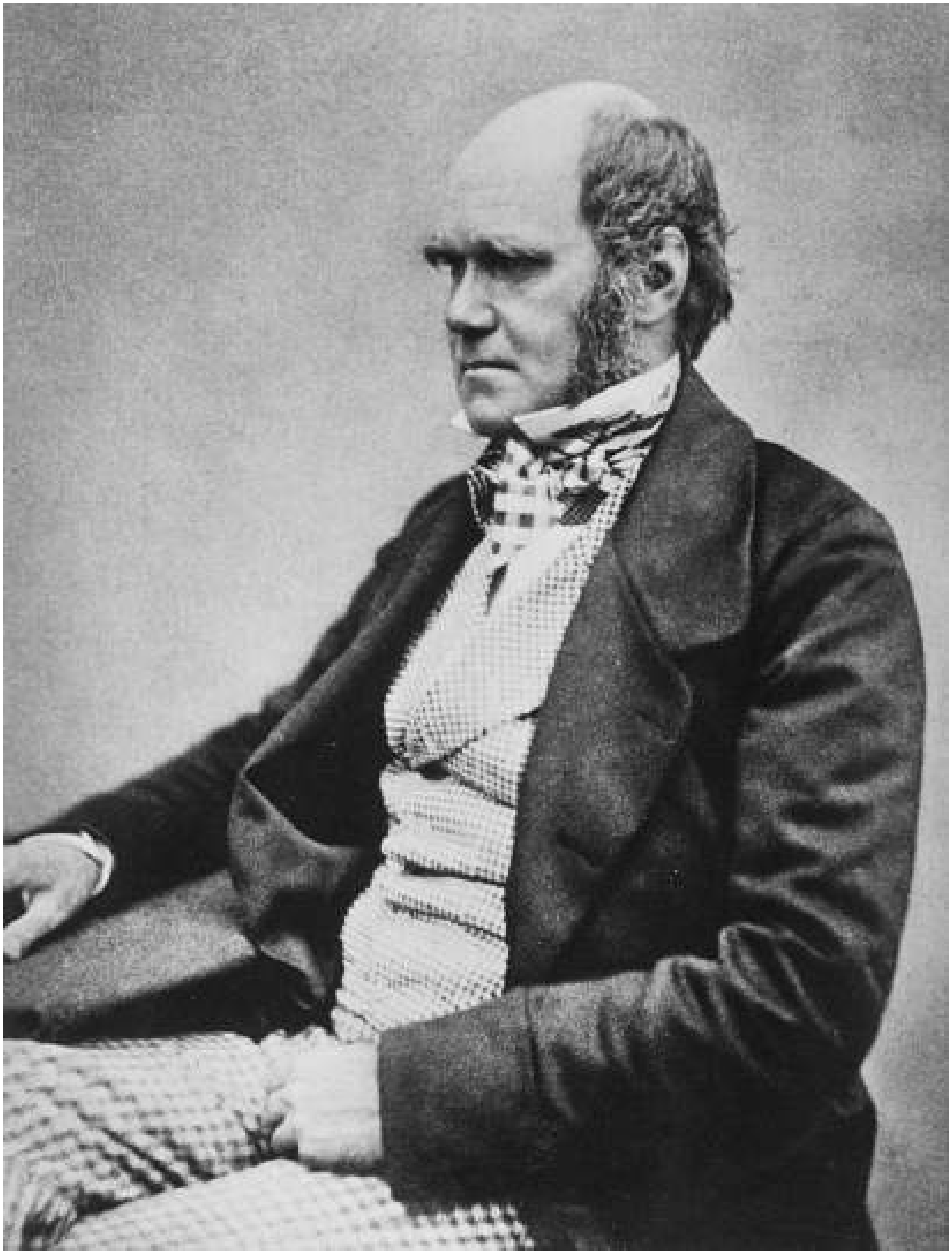
Albert Einstein

Look deep into nature, and then you will understand everything better.

Albert Einstein

Prediction is very difficult, especially if it's about the future.

Niels Bohr

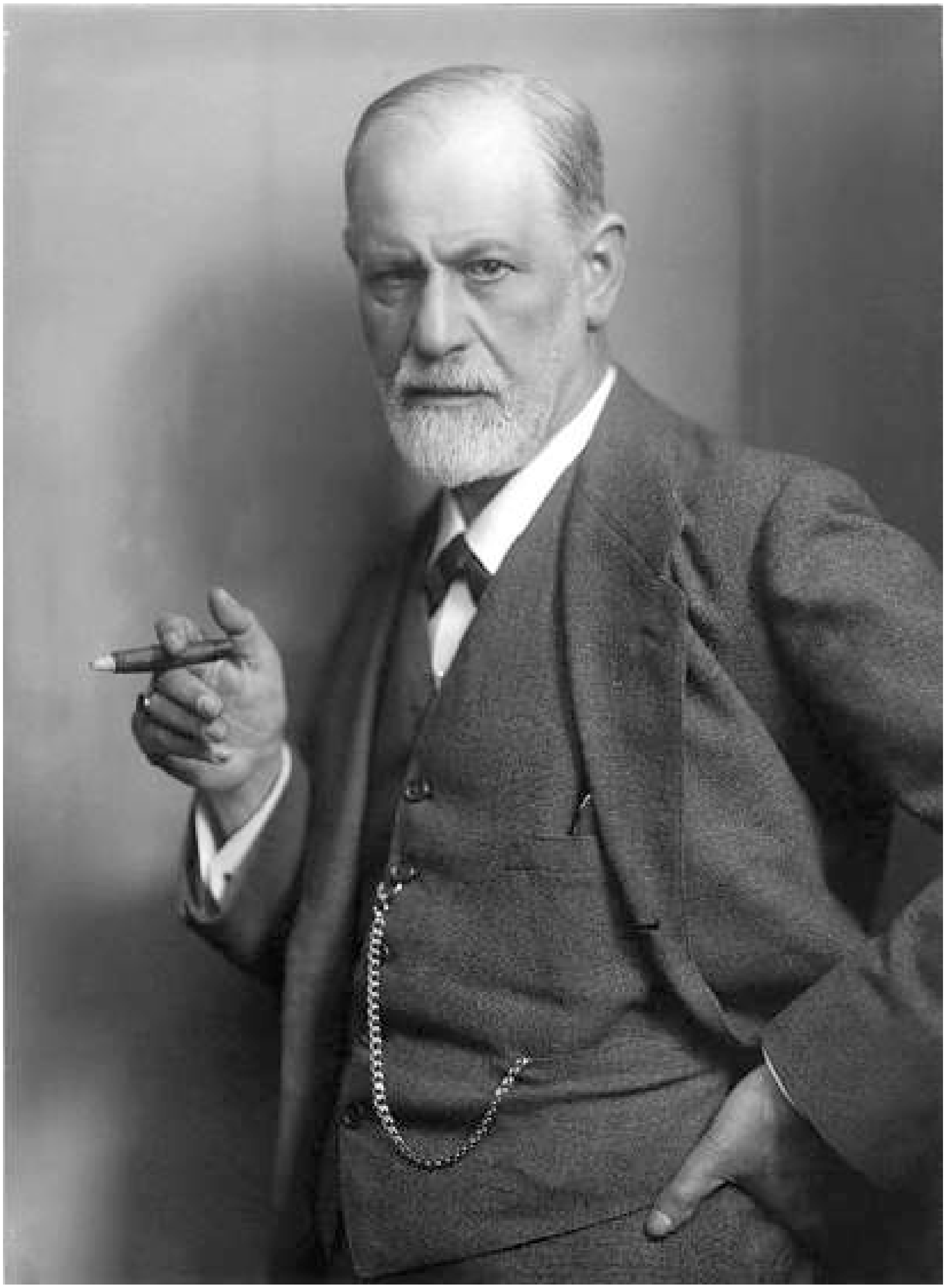


A scientific man ought to have no wishes, no affections, - a mere heart of stone.

Charles Darwin

Science knows no country, because knowledge belongs to humanity, and is the torch which illuminates the world.

Louis Pasteur



Being entirely honest with oneself is a good exercise.

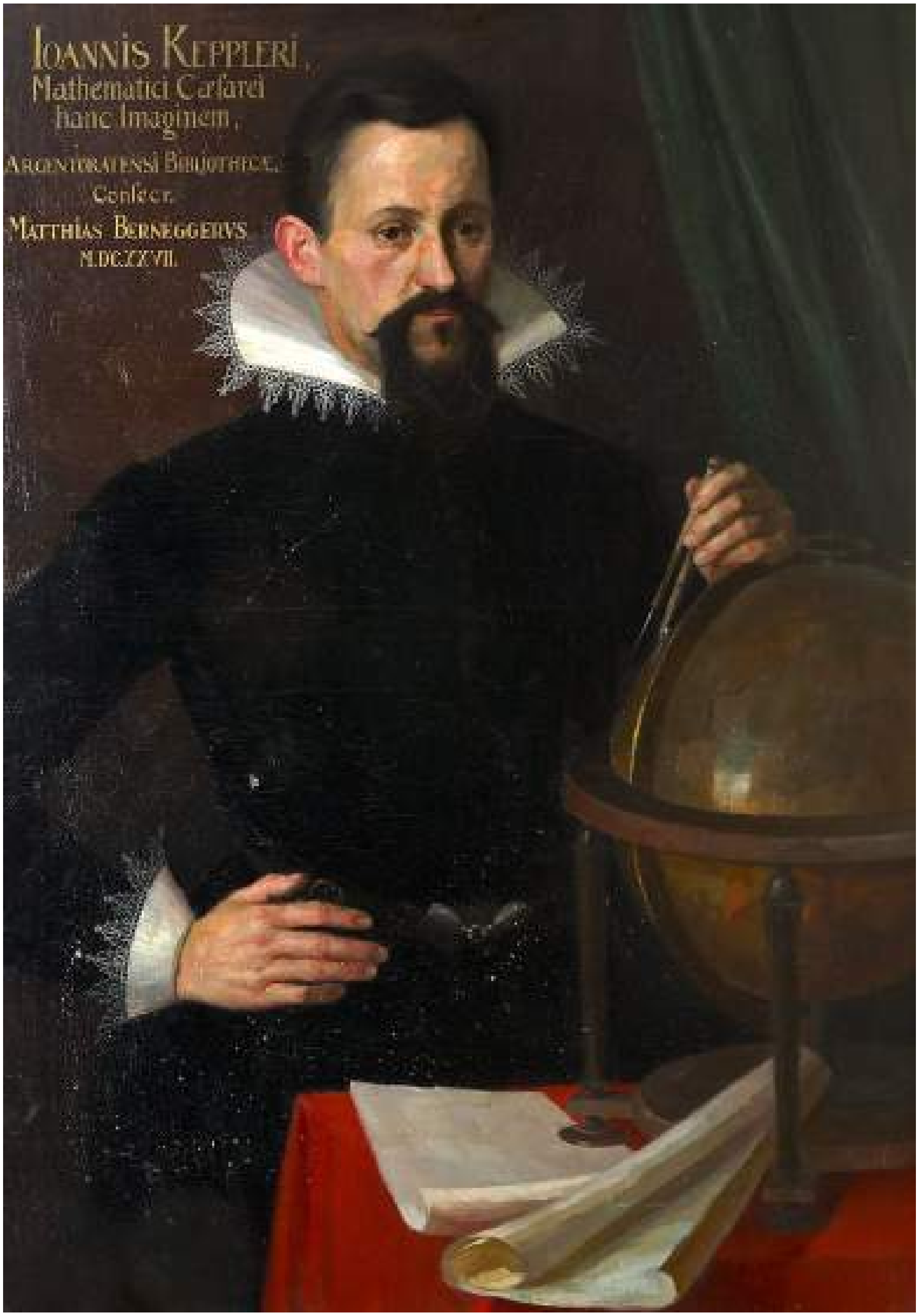
Sigmund Freud

Measure what is measurable, and make measurable what is not so.

Galileo Galilei

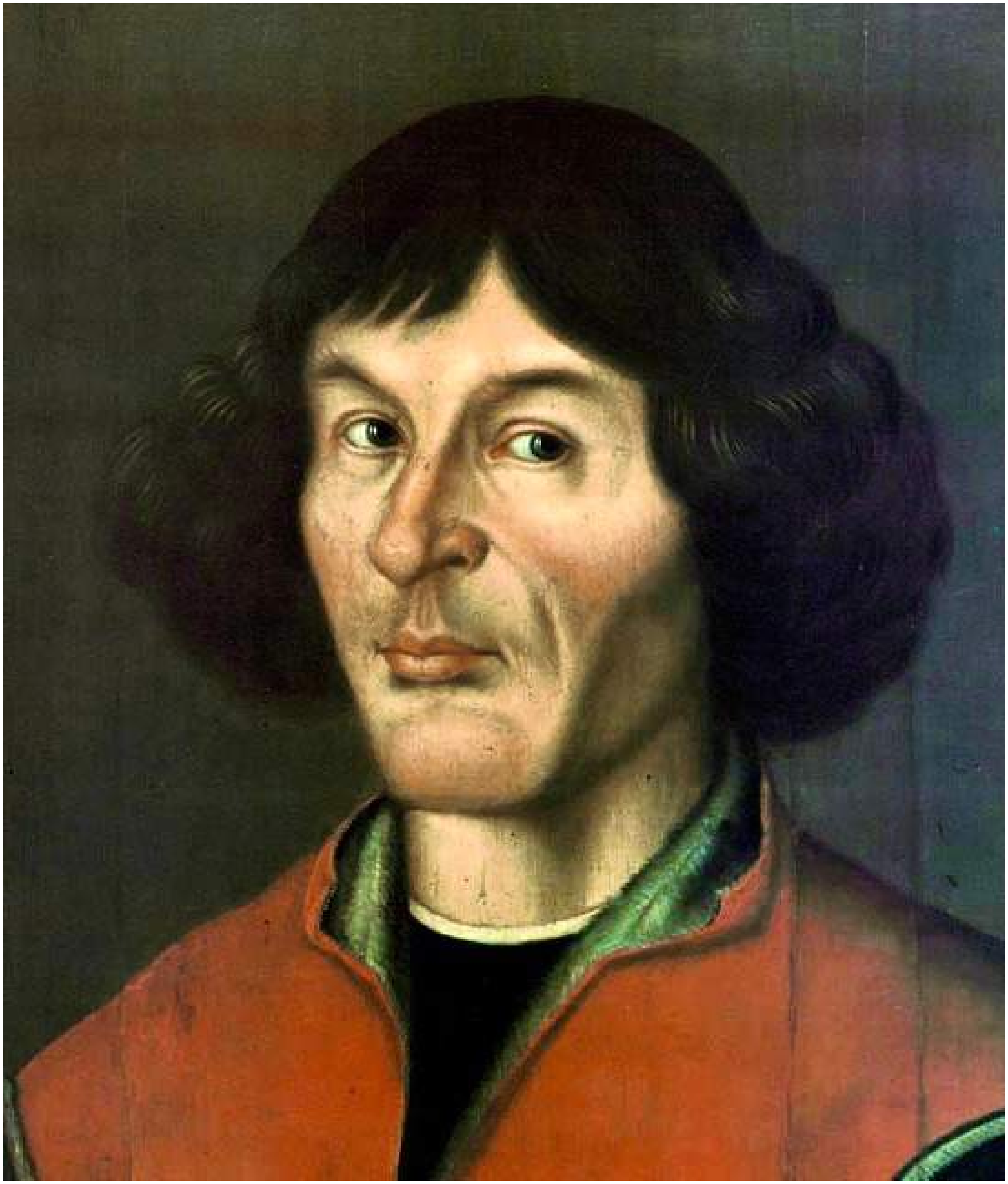
I consider nature a vast chemical laboratory in which all kinds of composition and decompositions are formed.

Antoine Lavoisier



I much prefer the sharpest criticism of a single intelligent man to the thoughtless approval of the masses.

Johannes Kepler

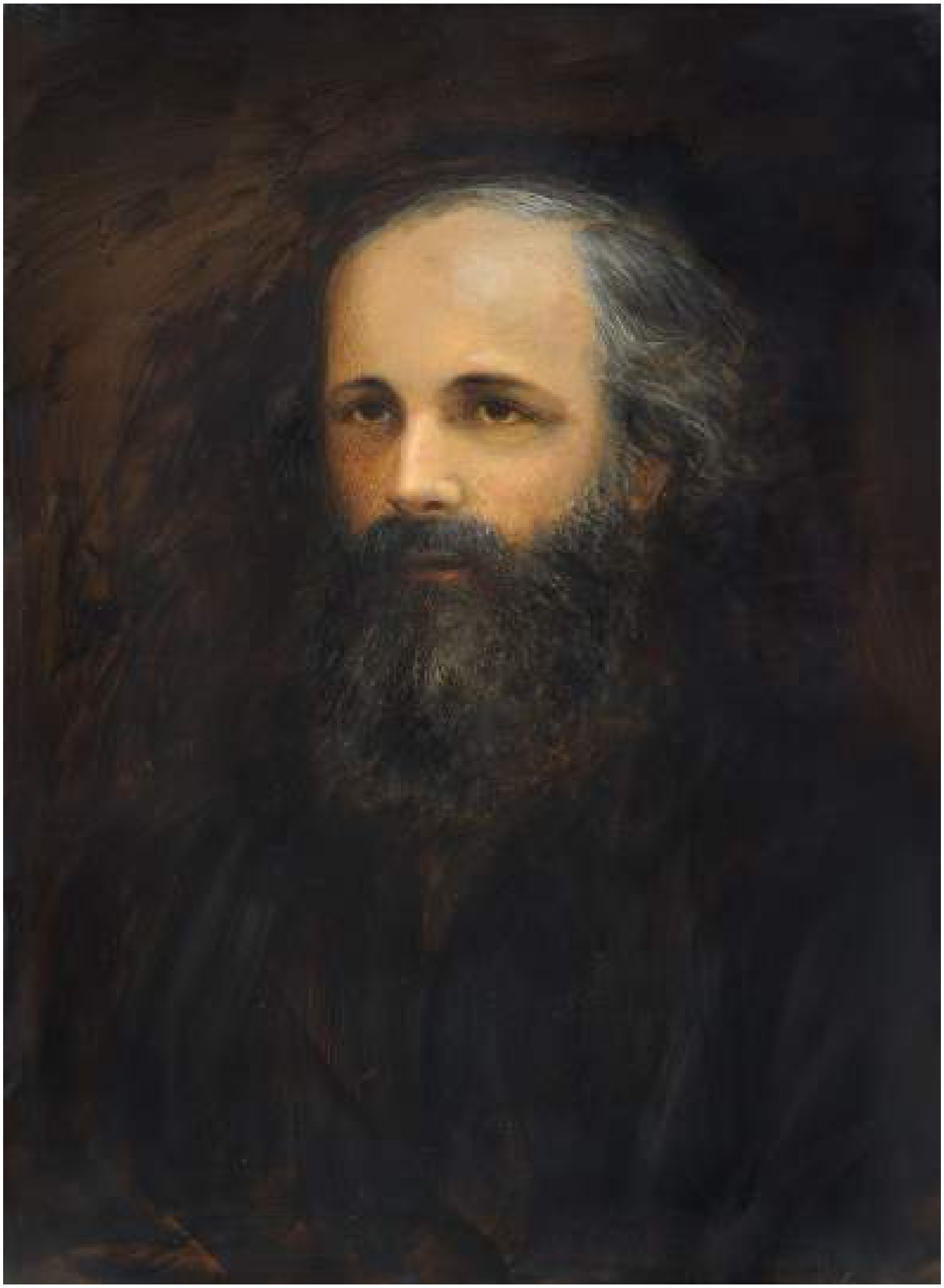


Of all things visible, the highest is the heaven of the fixed stars.

Nicolaus Copernicus

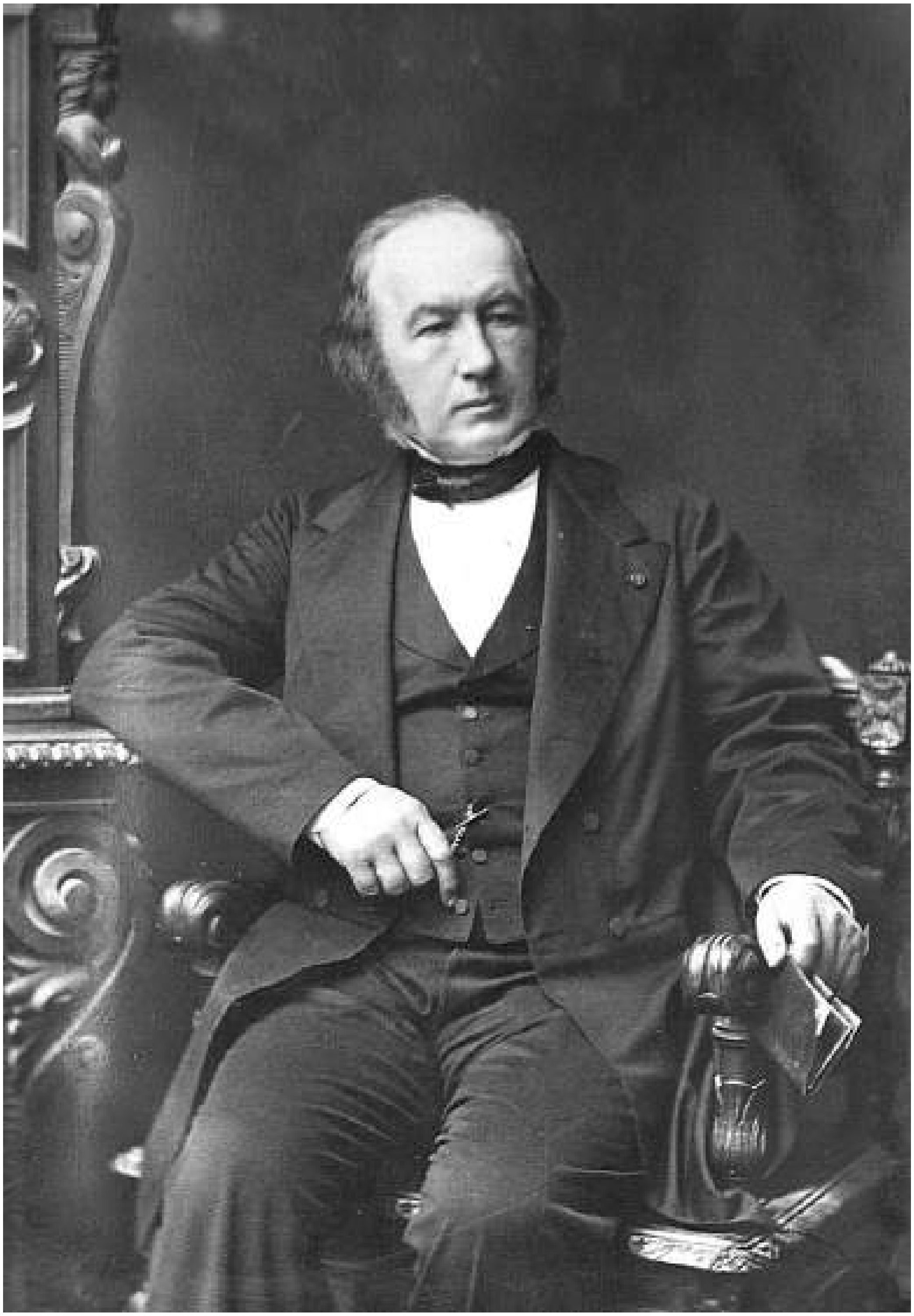
The important thing is to know how to take all things quietly.

Michael Faraday



Thoroughly conscious ignorance is the prelude to every real advance in science.

James Clerk Maxwell



Observation is a passive science, experimentation an active science.

Claude Bernard

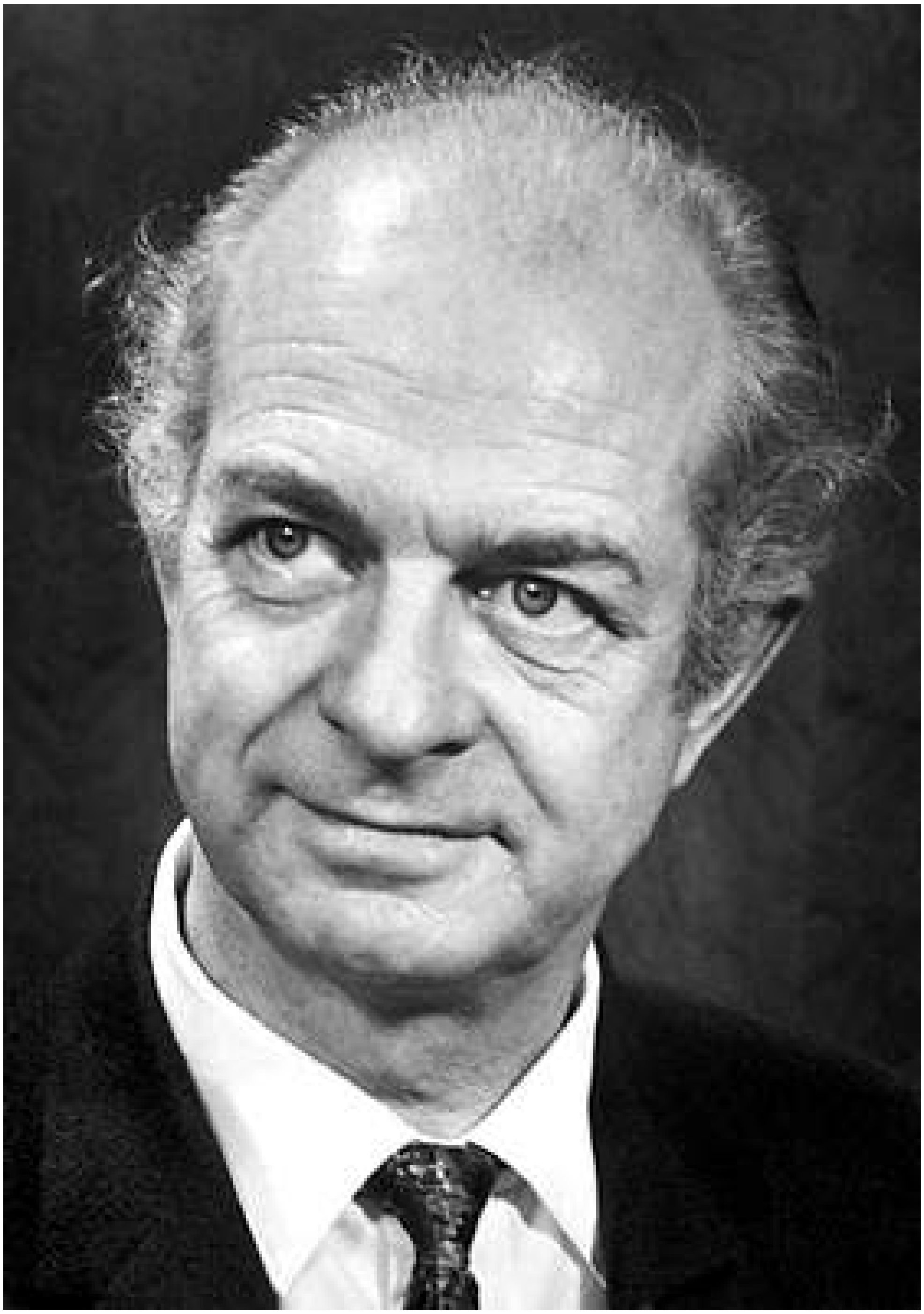
Franz Boas

The disease of mutual distrust among nations is the bane of modern civilization.

Franz Boas

What we observe is not nature itself, but nature exposed to our method of questioning.

Werner Heisenberg

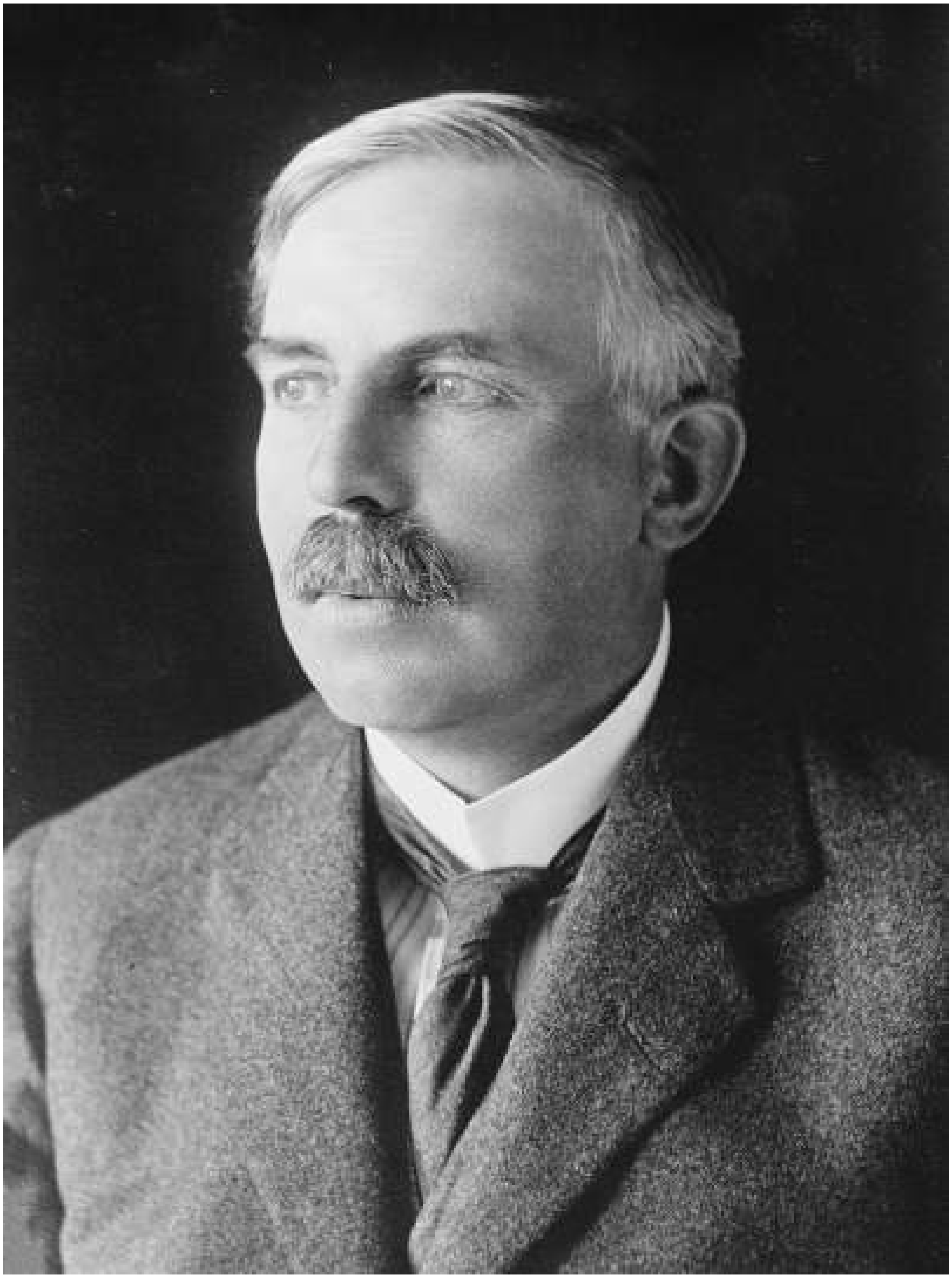


The best way to have a good idea is to have a lot of ideas.

Linus Pauling

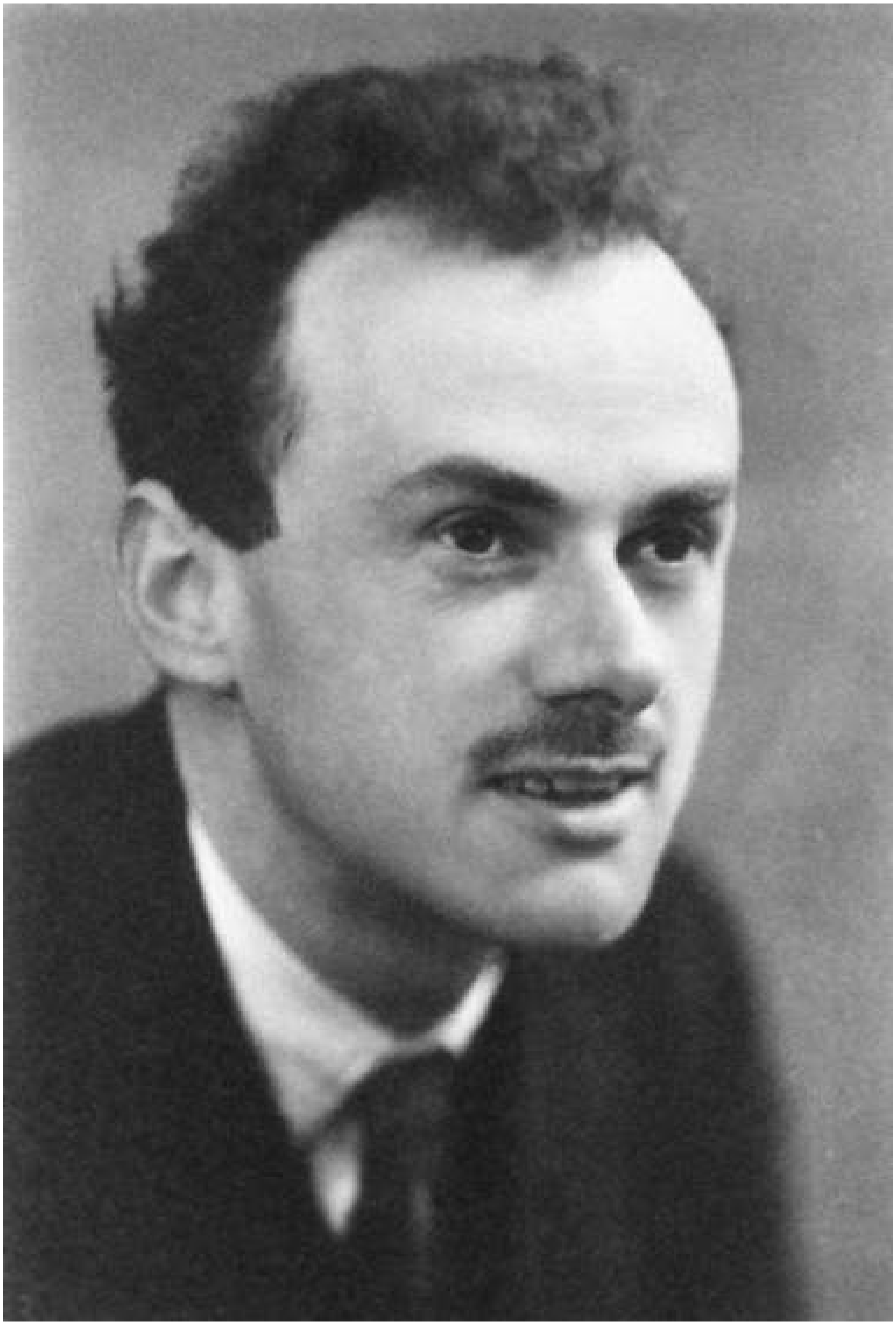
Quantum physics thus reveals a basic oneness of the universe.

Erwin Schrodinger



All science is either physics or stamp collecting.

Ernest Rutherford



God used beautiful mathematics in creating the world.

Paul Dirac

In our age nothing has been so degraded and then wholly restored as anatomy.

Andreas Vesalius

It was not just the Church that resisted the heliocentrism of Copernicus.

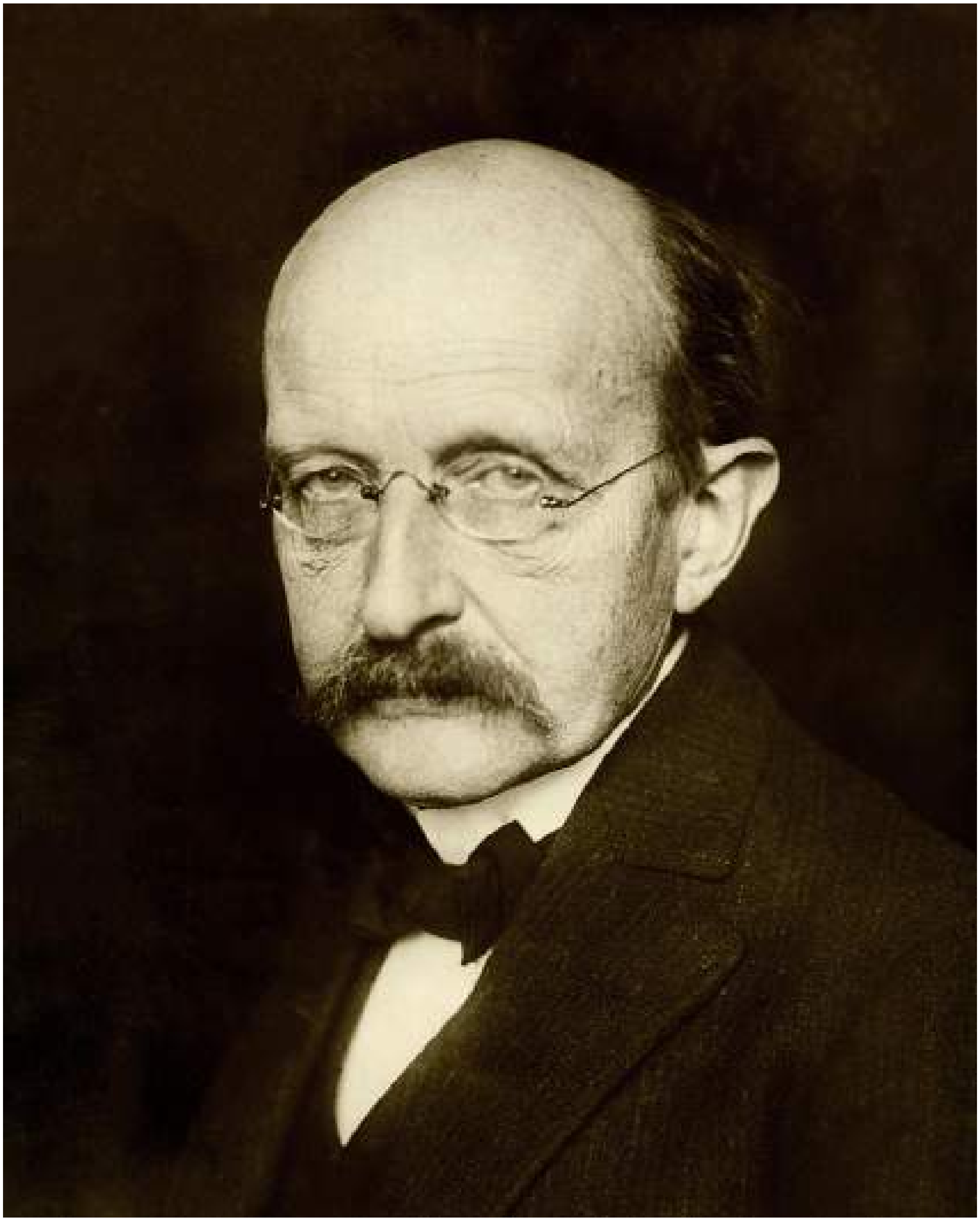
Tycho Brahe

To be and to think are one and the same for us.

Comte de Buffon

Available energy is the main object at stake in the struggle for existence and the evolution of the world.

Ludwig Boltzmann



Ego is the immediate dictate of human consciousness.

Max Planck

Be less curious about people and more curious about ideas.

Marie Curie

We need not hesitate to admit that the Sun is richly stored with inhabitants.

Sir William Herschel

Never call an accountant a credit to his profession; a good accountant is a debit to his profession.

Charles Lyell

What we know is not much. What we don't know is enormous.

Pierre Simon de Laplace

The history of astronomy is a history of receding horizons.

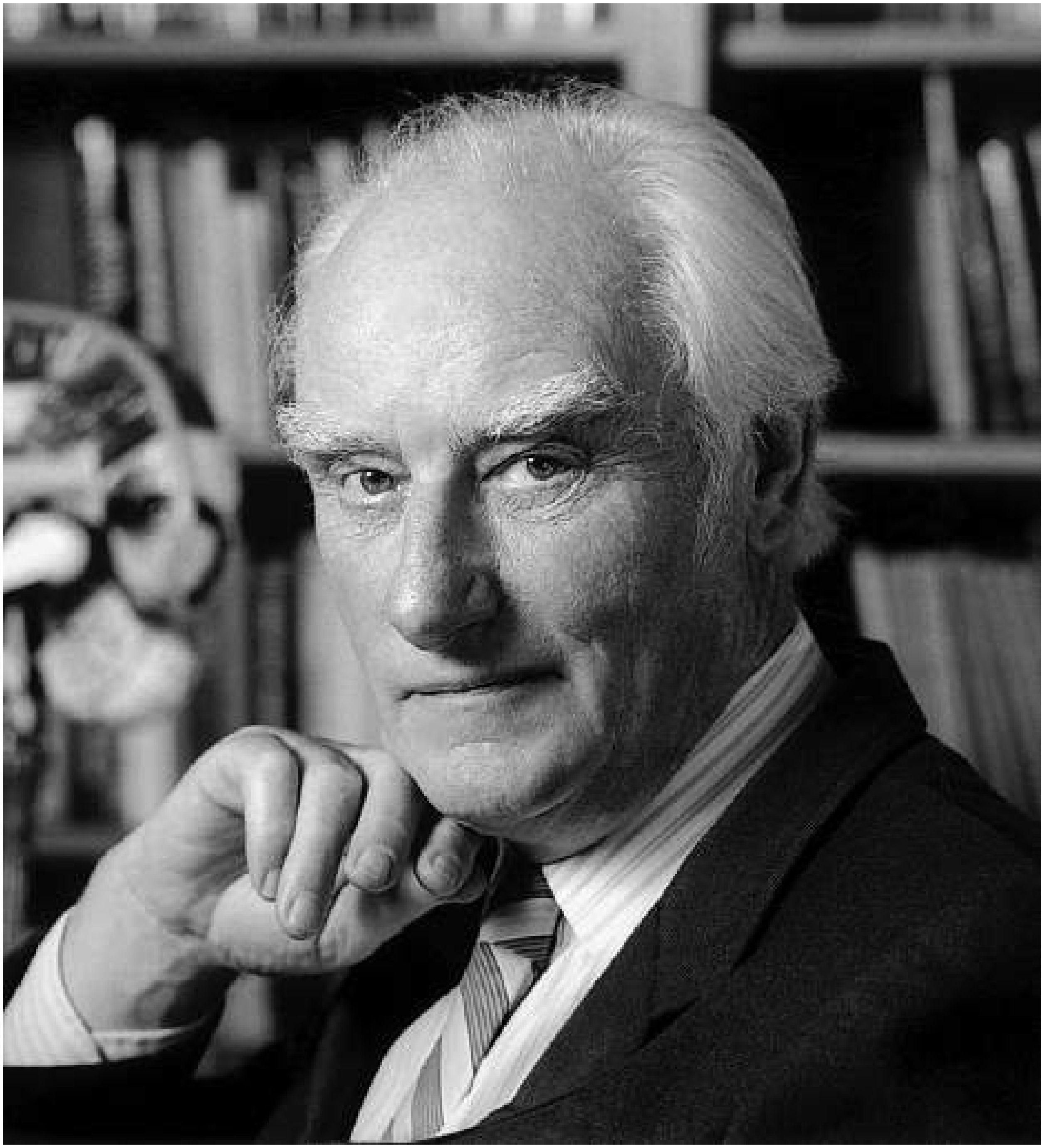
Edwin Powell Hubble

Atoms are not indivisible, for negatively electrified particles can be torn from them by the action of electrical forces.

Joseph J. Thomson

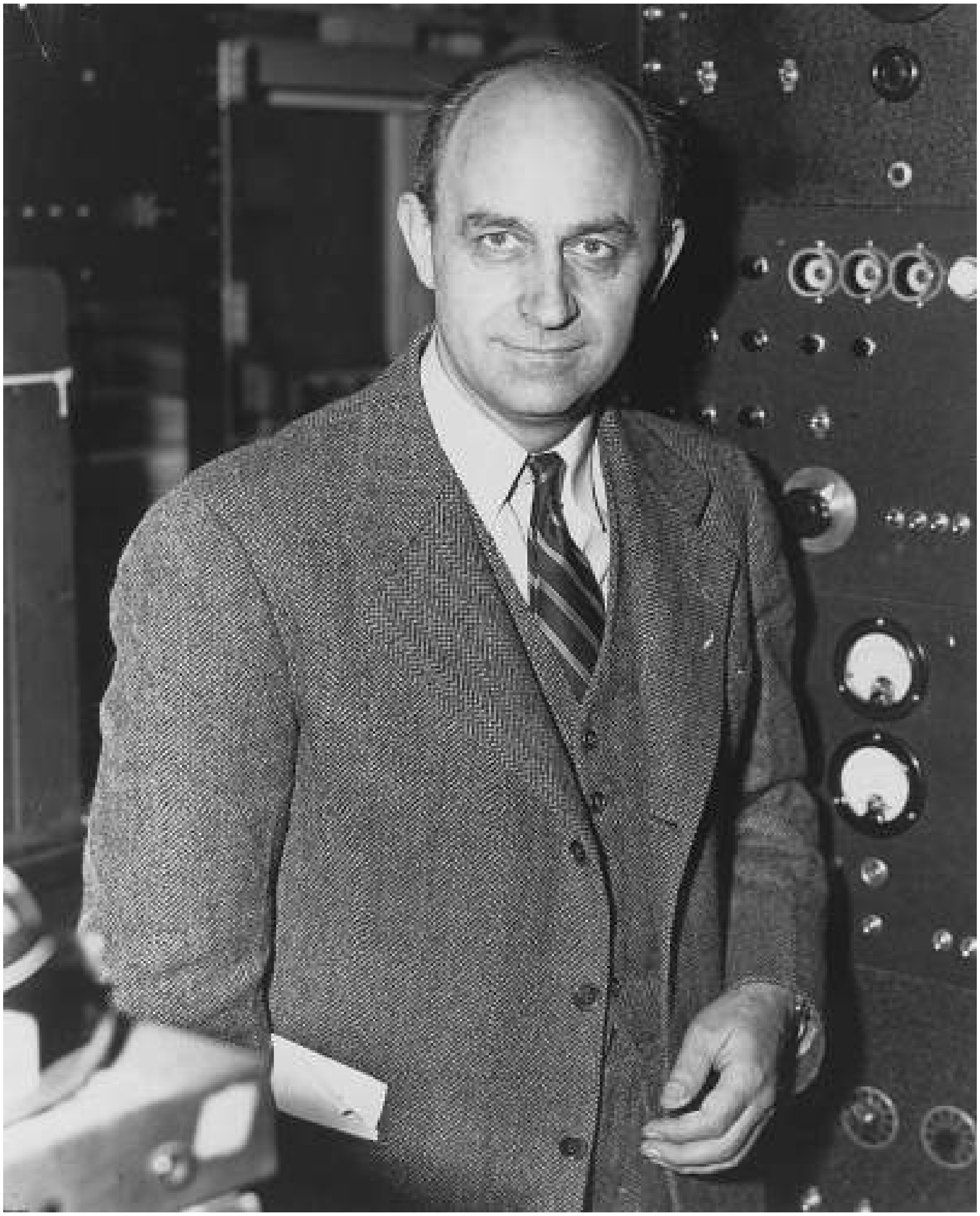
I am now convinced that theoretical physics is actually philosophy.

Max Born



Biologists must constantly keep in mind that what they see was not designed, but rather evolved.

Francis Harry Compton Crick



Ignorance is never better than knowledge.

Enrico Fermi

Logic is the foundation of the certainty of all the knowledge we acquire.

Leonard Euler

The progress of mankind is due exclusively to the progress of natural sciences, not to morals, religion or philosophy.

Justus Liebig

Proof is an idol before whom the pure mathematician tortures himself.

Arthur Stanley Eddington

All we know is still infinitely less than all that remains unknown.

William Harvey

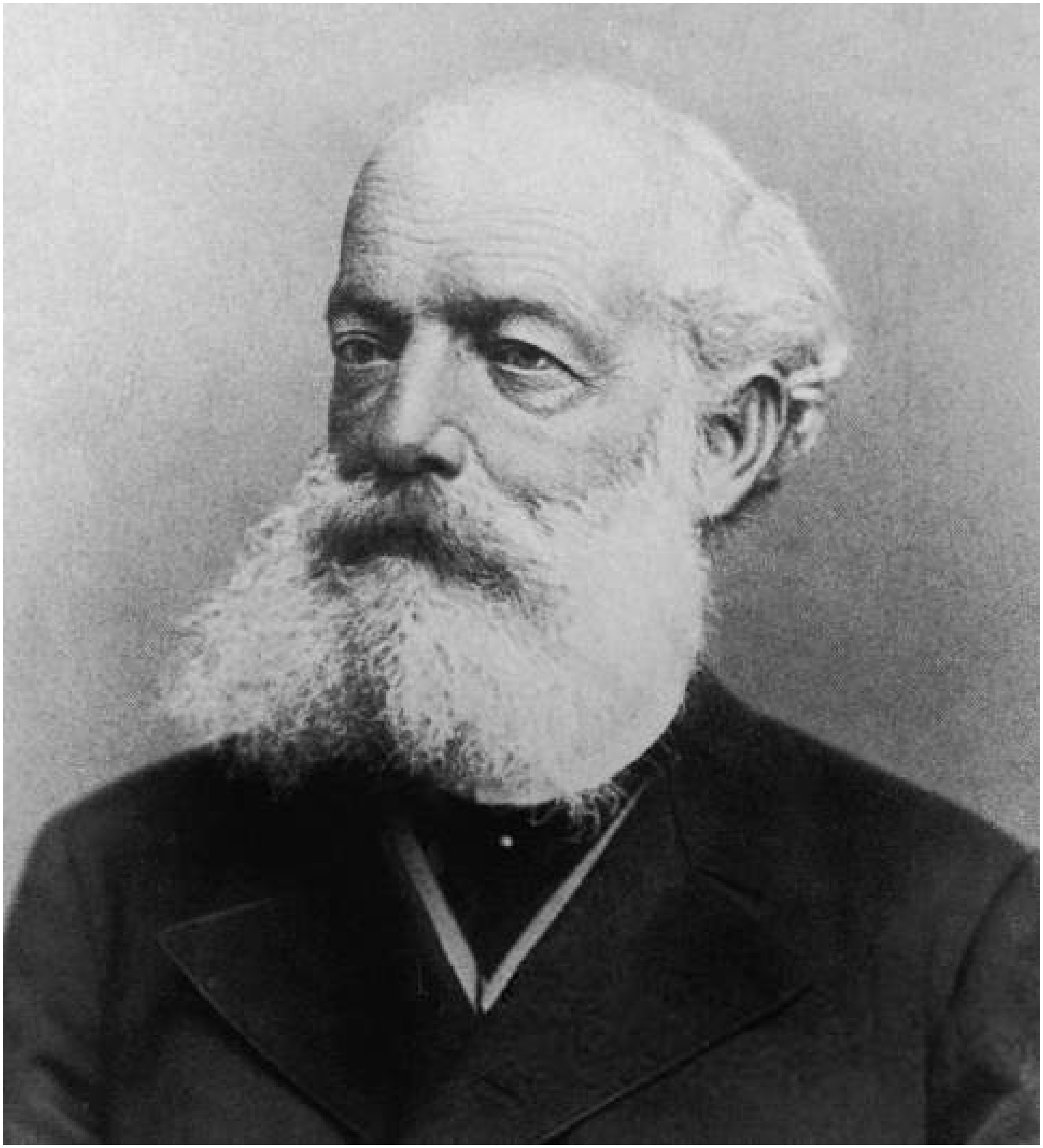
Johann Carl Friedrich Gauss

Mathematicians stand on each other's shoulders.

Johann Carl Friedrich Gauss

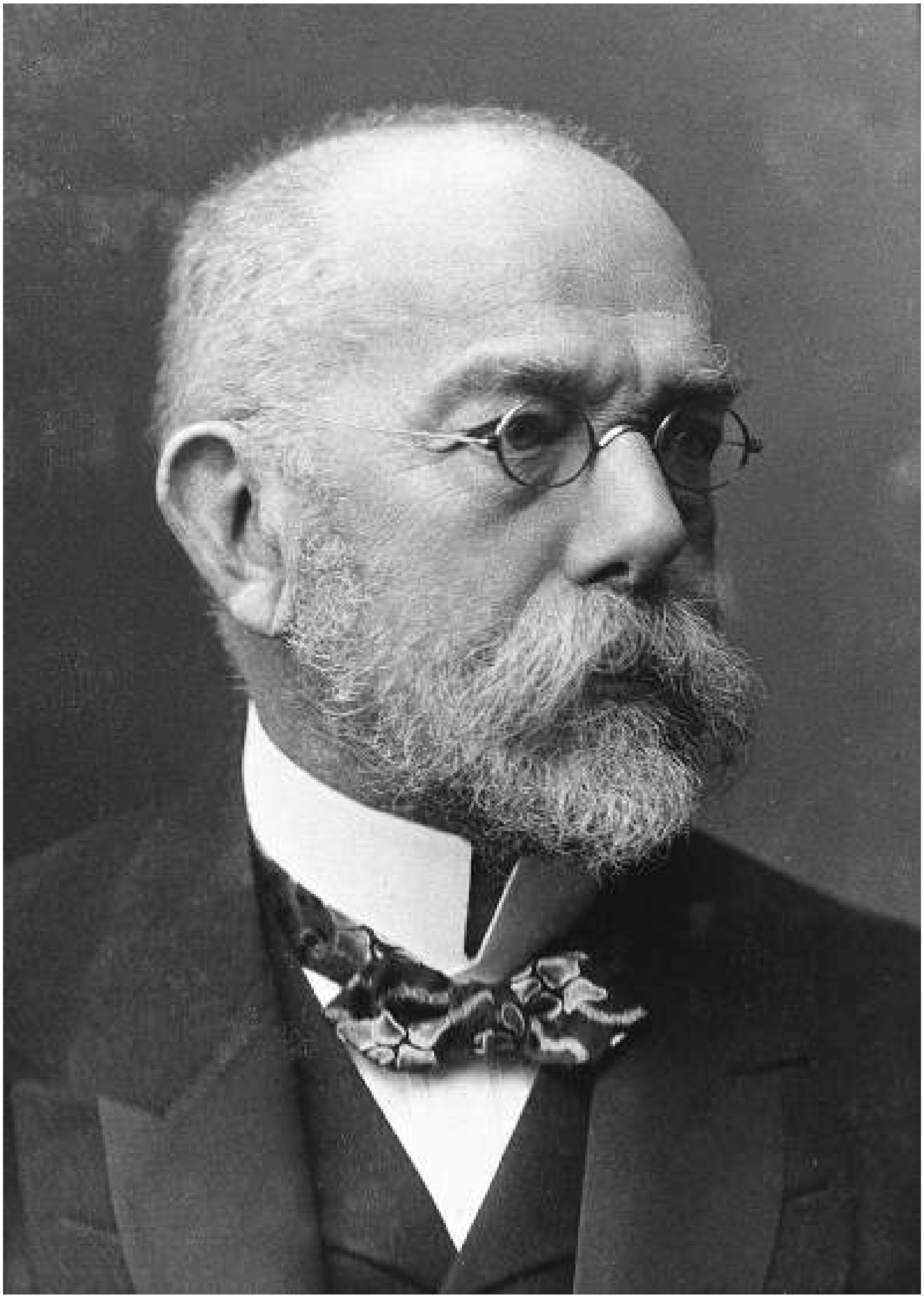
Nature never jests.

Albrecht von Haller



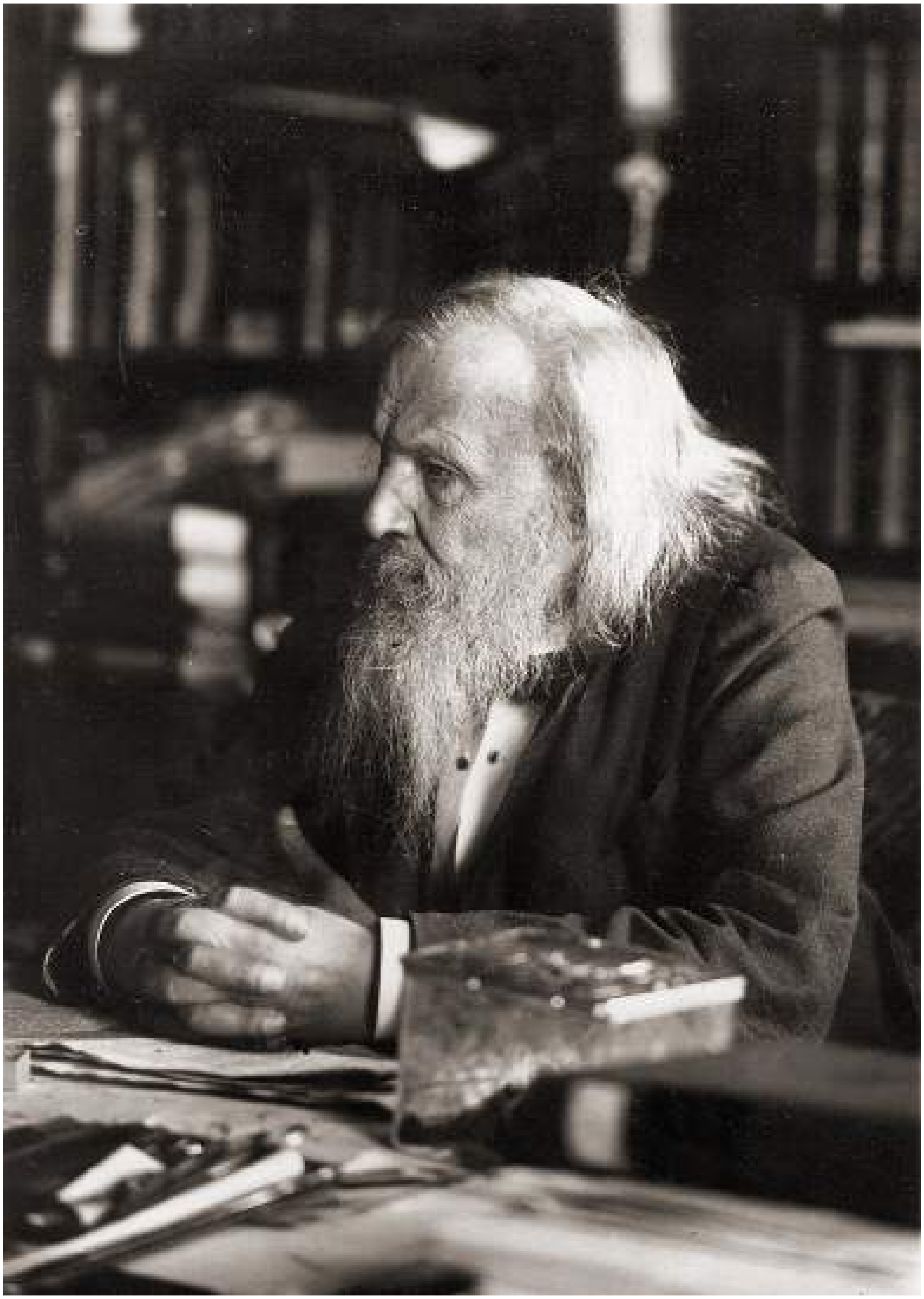
We define organic chemistry as the chemistry of carbon compounds.

Friedrich August Kekule von Stradonitz



The pure culture is the foundation for all research on infectious disease.

Robert Koch



The elements, if arranged according to their atomic weights, exhibit an apparent periodicity of properties.

Dmitri Mendeleev

DNA was my only gold rush. I regarded DNA as worth a gold rush.

James Dewey Watson

Science is a field which grows continuously with ever expanding frontiers.

John Bardeen

Science is a field which grows continuously with ever expanding frontiers.

John Bardeen

The first principle is that you must not fool yourself and you are the easiest person to fool.

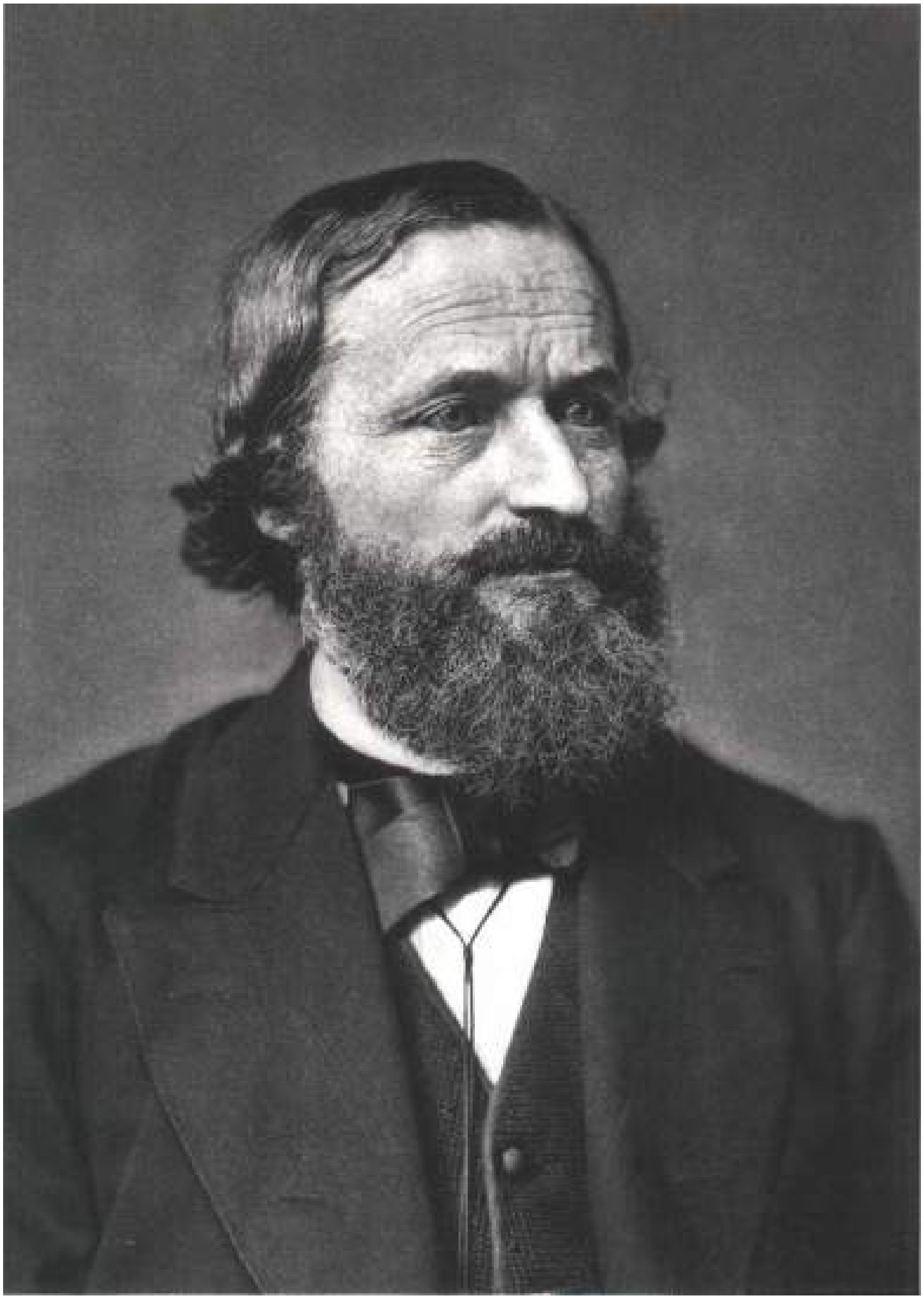
Richard P. Feynman

Knowledge comes, but wisdom lingers.

Alfred Lothar Wegener

Intelligence is the ability to adapt to change.

Stephen W. Hawking



Experience is the collecting of what is similar in different particular perceptions.

Gustav Kirchhoff

"We are so used to doing simple arithmetic that it is easy to believe it MUST bee doable. But in fact, its doability depends fundamentally on the nature of the physical world. For example, would counting make sense to us if there did not exist discrete objects such as coins and sheep?"

"The nature of the laws of physics permits addition and multiplication to be computable [and] we find that among these computable operations [there] are some which describe the laws of physics... Imagine a world in which the laws of physics were [...] so different that discrete objects did not exist. Some of the mathematical operations that are computable in our world would not be in this world..."

– English physicist Paul Davies

"Einstein was a giant. His head was in the clouds, but his feet were on the ground. But those of us who are not that tall have to choose!"

−American engineer Carver A. Mead

Letter from Linus Pauling to President Kennedy

1 March 1962 Night Letters Durham, NC

President John F. Kennedy, White House:

Are you going to give an order that will cause you to go down in history as one of the most immoral men of all time and one of the greatest enemies of the human race? In a letter to the New York Times, I state that nuclear tests duplicating the Soviet 1961 tests would seriously damage over 20 million unborn children, including those caused to have gross physical or mental defect and also the still births and embryonic, neonatal and childhood deaths from the radioactive fission products and carbon 14. Are you going to be guilty of this monstrous immorality, matching that of the Soviet leaders, for the political purpose of increasing the still imposing lead of the United States over the Soviet Union in nuclear weapons technology?

(Signed)
Linus Pauling

Letter from Albert Einstein to Chaim Weizmann

Dear Mr. Weizmann,

I have read with great satisfaction that the Palestinian Jewry has made you head of the new state. This is at least a partial reparation for the ungrateful attitude they have shown towards you and your great accomplishments. One still cannot say that the powerful men of this earth mean well with us. The game the English play with us is miserable, and the American attitude appears ambivalent.

However, I am confident that our people will overcome this last scare and that you will live to experience the satisfaction of having created a happy Jewish community.

With heartfelt greetings and best wishes,

Your A. Einstein

Stephen Wolfram's letter to Richard Feynman (September 26th, 1985)

Dear Feynman,

I thought I would send the enclosed stuff that I have just written. It is not about science (which his what I would prefer to write about), but rather about the organization of science. I am being treated increasingly badly at IAS, and really have to move. I can't see anywhere that would really be nice to go to, and would support the kinds of things I am now interested in. So I am thinking of trying to create my own environment, by starting some kind of institute. It would be so much nicer if such a thing already existed, but it doesn't. There are a few plans afoot to create things perhaps like this, but I think they are rather misguided. You probably think that doing something administrative like this is an awful waste of time, and I am not sure that I can disagree, but I feel that I have little choice, and given that I am going to do it,, I would like to do it as well as possible. Any comments, suggestions, etc., that you might have I would very greatly appreciate.

Best wishes,
Stephen Wolfram

Richard Feynman's Letter to Wolfram (October 14th, 1985)

Dear Wolfram:

1. It is not my opinion that the present organizational structure of science inhibits "complexity research"--I do not believe such an institution is necessary.
2. You say you want to create your own environment--but you will not be doing that: you will create (perhaps!) an environment that you might like to work in--but you will not be working in this environment--you will be administrating it--and the administration

environment is not what you seek--is it? You won't enjoy administrating people because you won't succeed in it.

You don't understand "ordinary people". To you they are "stupid fools"--so you will not tolerate them or treat their foibles with tolerance or patience--but will drive yourself wild (or they will drive you wild) trying to deal with them in an effective way.

Find a way to do you own research with as little contact with non-technical people as possible, with one exception, fall madly in love! That is my advice, my friend.

Sincerely,

Richard P. Feynman

"All the time. It is miraculous. I even have a superstition that has grown on me as a result of invisible hands coming all the time - namely, that if you do follow your bliss, you put yourself on a kind of track that has been there all the while, waiting for you, and the life that you ought to be living is the one you are living. When you can see that, you begin to meet people who are in your field of bliss, and they open doors to you. I say, follow your bliss and don't be afraid, and doors will open where you didn't know they were going to be."

– **American professor of literature Joseph Campbell**

Richard Feynman's Letter to Gerald Freund (April 6th, 1981)

Dear Dr. Freund,

Looking for something else I found this unfinished recommendation for Stephen Wolfram in a drawer.

I did not consciously remember it when the Zweig request came. I see now my desire to revolt against writing these recommendations has an unconscious basis in previous experience. Anyway, for what it is worth I am having my secretary type the Wolfram recommendation and send it to you in the unfinished state I left it.
You asked for information about Stephen Wolfram in connection with the MacArthur Foundation Prize Fellow Award.

Dr. Wolfram has the truly exceptional qualities you are seeking for your award. He has worked energetically and creatively in many fields. Examples of his creative originality are many. For example, he invented an ingenious way to make comparison of high-energy experiments to incomplete theoretical predictions of quantum chromodynamics. As another example he has designed and programmed a new system for computer algebraic and symbolic manipulation starting from scratch and in an entirely original and independent manner. His analysis of baryon production in the early universe pointed out significant errors in the work that came before him.

He has made himself fully aware of all the problems in theoretical physics, from gravitation, cosmology and the new unified field theories, to the detailed problems of hadron physics and the weak interactions. The method he uses in studying each question is not so much to read about it, but to work it all out himself. He works very hard. Such methods and such industry is, of course, the true source of creativity and originality.

There is not a seminar here that proceeds without an important comment, question, or criticism by Wolfram.

I don't know of any others in this field that have the wide range of understanding of Dr. Wolfram. He seems to have worked on everything and has some original or careful judgement on any topic.

Sincerely,

Richard P. Feynman

Observations on the Filth of the Thames a letter to the Editor of the Times of London (July 7, 1855) by Professor Michael Faraday

SIR,

I traversed this day by steam-boat the space between London and Hangerford Bridges between half-past one and two o'clock; it was low water, and I think the tide must have been near the turn. The appearance and the smell of the water forced themselves at once on my attention. The whole of the river was an opaque pale brown fluid. In order to test the degree of opacity, I tore up some white cards into pieces, moistened them so as to make them sink easily below the surface, and then dropped some of these pieces into the water at every pier the boat came to; before they had sunk an inch below the surface they were indistinguishable , though the sun shone brightly at the time; and when the pieces fell edgeways the lower part was hidden from sight before the upper part was under water. This happened at St. Paul's Wharf, Blackfriars Bridge, Temple Wharf, Southwark Bridge, and Hungerford; and I have no doubt would have occurred further up and down the river. Near the bridges the feculence rolled up in clouds so dense that they were visible at the surface, even in water of this kind.

The smell was very bad, and common to the whole of the water; it was the same as that which now comes up from the gully-holes in the streets; the whole river was for the time a real sewer. Having just returned from out of the country air, I was, perhaps, more affected by it than others; but I do not think I could have gone on to Lambeth or Chelsea, and I was glad to enter the streets for an atmosphere which, except near the sink-holes, I found much sweeter than that on the river.

I have thought it a duty to record these facts, that they may be brought to the attention of those who exercise power or have responsibility in relation to the condition of our river; there s nothing figurative in the words I have employed, or any approach to exaggeration;

they are the simple truth. If there be sufficient authority to remove a putrescent pond from the neighbourhood of a few simple dwellings, surely the river which flows for so many miles through London ought not to be allowed to become a fermenting sewer. The condition in which I saw the Thames may perhaps be considered as exceptional, but it ought to be an impossible state, instead of which I fear it is rapidly becoming the general condition. If we neglect this subject, we cannot expect to do so with impunity; nor ought we to be surprised if, ere many years are over, a hot season give us sad proof of the folly of our carelessness.

I am, Sir,

Your obedient servant,

M. FARADAY.

Royal Institution, July 7

S.N. Bose's letter to Einstein

Respected Master,

I have ventured to send you the accompanying article for your perusal and opinion. I am anxious to know what you think of it… I do not know sufficient German to translate the paper. If you think the paper worth publication I shall be grateful if you arrange for its publication in Zeitschrift fur Physik. Though a complete stranger to you, I do not feel any hesitation in making such a request. Because we are all your pupils though profiting only by your teachings through your writings. I do not know whether you still remember that somebody from Calcutta asked your permission to translate your papers on Relativity in English. You acceded to the request. The book has since been published. I was the one who translated your paper on Generalised Relativity.

Yours faithfully

S. N. Bose

Translation of a machine typed copy of a letter that Wolfgang Pauli sent to a group of physicists

Dear radioactive ladies and gentlemen,

… I have hit upon a 'desperate remedy' to save… the law of conservation of energy. Namely the possibility that there exists in the nuclei electrically neutral particles, that I call neutrons… I agree that my remedy could seem incredible… but only the one who dare can win…

Unfortunately I cannot appear in person, since I am indispensable at a ball here in Zurich.

Your humble servant

W. Pauli

(December 4, 1930)

Feynman's letter to an old pupil of his - on the worthwhile of 'humble' research

27 October 1964

Mr. David Eisenman

Harvard University

Adams C-56

Cambridge 38, Massachusetts

Dear Mr. Eisenman:

Thank you for your interesting letter describing that wonderful phenomenon. I guess your "zero" is displaced outward but the inner nerve connections are as usual, so you have to "converge" to see parallel. Half way through your letter, I though, "poor guy", but on reading of the manifold advantages that your singular ability has for your [sic], I am going back to the bathroom mirror and practice harder this time, again and again, to see if I can do it too. Evidently you are a genetically advantageous mutation, and we can guess now where the evolution of the human race is headed.

Sincerely,
[signed]
Richard P. Feynman

Letter, Franklin Roosevelt to Robert Oppenheimer thanking the physicist and his colleagues for their ongoing secret atomic research, 29 June 1943

THE WHITE HOUSE
WASHINGTON
June 29, 1943

SECRET

My dear Dr. Oppenheimer:

I have recently reviewed with Dr. Bush the highly important and secret program of research, development and manufacture with which you are familiar. I was very glad to hear of the excellent work which is being done in a number of places in this country under the immediate supervision of General L.R. Groves and the general direction of the Committee of which Dr. Bush is Chairman. The successful solution of the problem is of the utmost importance to the national safety, and I am confident that the work will be completed in as short a time as possible as the result of the wholehearted cooperation of all concerned.

I am writing to you as the leader of one group which is to play a vital role in the months ahead. I know that you and your colleagues are working on a hazardous matter under unusual circumstances. The fact that the outcome of your labors is of such great significance to the nation requires that this program be even more drastically guarded than other highly secret war development. I have therefore given directions that every precaution be taken to insure the security of your project and feel sure that those in charge will see that these orders are carried out. You are fully aware of the reasons why your endeavors and those of your associates must be circumscribed by very special restrictions. Nevertheless, I wish you would express to the scientists assembled with you my deep appreciation of their willingness to undertake the tasks which lie before them in spite of the dangers and the personal sacrifices. I am sure that we can rely on their continued wholehearted and unselfish labors. Whatever the enemy may be planning, American science will be equal to the challenge. With this thought in mind, I send this note of confidence and appreciation.

Though there are other important groups at work, I am writing only to you as the leader of one which is operating under very special conditions, and to General Groves. While this letter is secret, the contents of it may be disclosed to your associates under pledge of secrecy.

Very Sincerely Yours
Franklin Delano Roosevelt
Dr. J. R. Oppenheimer
Post Office Box 1663
Santa Fe,
New Mexico

Do Scientists Pray? Einstein Answers a Little Girl's Question about Science vs. Religion

The Riverside Church
January 19, 1936

My dear Dr. Einstein,

We have brought up the question: Do scientists pray? in our Sunday school class. It began by asking whether we could believe in both science and religion. We are writing to scientists and other important men, to try and have our own question answered.

We will feel greatly honored if you will answer our question: Do scientists pray, and what do they pray for? We are in the sixth grade, Miss Ellis's class.

Respectfully yours,
Phyllis

Einstein's reply:

January 24, 1936

Dear Phyllis,

I will attempt to reply to your question as simply as I can. Here is my answer:

Scientists believe that every occurrence, including the affairs of human beings, is due to the laws of nature. Therefore a scientist cannot be inclined to believe that the course of events can be influenced by prayer, that is, by a supernaturally manifested wish.

However, we must concede that our actual knowledge of these forces is imperfect, so that in the end the belief in the existence of a final, ultimate spirit rests on a kind of faith. Such belief remains widespread even with the current achievements in science.

But also, everyone who is seriously involved in the pursuit of science becomes convinced that some spirit is manifest in the laws of the universe, one that is vastly superior to that of man. In this way the pursuit of science leads to a religious feeling of a special sort, which is surely quite different from the religiosity of someone more naive.

With cordial greetings,

your A. Einstein

Max Planck Letter to Hitler

"My Führer!

I am most deeply shaken by the message that my son Erwin has been sentenced to death by the People's Court.

The acknowledgement for my achievements in service of our fatherland, which you, my Führer, have expressed towards me in repeated and most honouring way, makes me confident that you will lend your ear to an imploring 87-year old.

As the gratitude of the German people for my life's work, which has become an everlasting intellectual wealth of Germany, I am pleading for my son's life.

Max Planck"

Maxwell Letter to R. B. Litchfield

5 February 1858, from The Life of James Clerk Maxwell, Campbell and Garnett, pp.306-6

With respect to the " material sciences," they appear to me to be the appointed road to all scientific truth, whether metaphysical, mental, or social. The knowledge which exists in these subjects derives a great part of its value from ideas suggested by analogies from the material sciences, and the remaining part, though valuable and important to mankind, is not scientific but aphoristic. The chief philosophical value of physics is that it gives the mind something distinct to lay hold of, which, if you don't, Nature at once tells you you are wrong. Now, every stage of this conquest of truth leaves a more or less presentable trace on the memory, so that materials are furnished here more than anywhere else for investigation of the great question, "How does Knowledge come?"

I have observed that the practical cultivators of science (e.g., Sir J. Herschel, Faraday, Ampere, Oersted, Newton, Young), although differing excessively in turn of mind, have all a distinctness and a freedom from the tyranny of words in dealing with questions of Order, Law, etc., which pure speculators and literary men never attain.

Now, I am going to put down something on my own authority, which you must not take for more than it is worth. There are certain men who write books, who assume that, whatever things are orderly, certain, and capable of being accurately predicted by men of experience, belong to one category; and whatever things are the result of conscious action, whatever are capricious, contingent, and cannot be foreseen, belong to another category.

All the time I have lived and thought, I have seen more and more reason to disagree with this opinion, and to hold that all want of order, caprice, and unaccountableness results from interference with liberty, which would, if unimpeded, result in order, certainty, and trustworthiness (certainty of success of predicting). Remember I do not say that caprice and order are not the result of free will (so called), only I say that there is a liberty which is not disorder, and that this is by no means less free than the other, but more.

In the next place, there are various states of mind, and schools of philosophy corresponding to various stages in the evolution of the idea of liberty.

In one phase, human actions are the resultant (by parallelogram of forces) of the various attractions of surrounding things, modified in some degree by internal states, regarding which all that is to be said is that they are subjectively capricious, objectively the "**RESULT OF LAW**," — that is, the wilfulness of our wills feels to us like liberty, being in reality necessity.

In another phase, the wilfulness is seen to be anything but free will, since it is merely a submission to the strongest attraction, after the fashion of material things. So some say that a man's will is the root of all evil in him, and that he should mortify it out till nothing of himself remains, and the man and his selfishness disappear together. So said Buddha (see Max Muller), and many Christians have and thought nearly the same thing.

Nevertheless there is another phase still, in which appears a possibility of the exact contrary to the first state, namely, an abandonment of wilfulness without extinction of will, but rather by means of a great development of will, whereby, instead of being consciously free and really in subjection to unknown laws, it becomes consciously acting by law, and really free from the interference of unrecognised laws.

There is a screed of metaphysics. I don't suppose that is what you wanted. I have no nostrum that is exactly what you want. Every man must brew his own, or at least fill his own glass for himself, but I greatly desire to hear some more from you, just to get into rapport.

Letter from Winston Churchill to his wife Clementine

Do not grieve for me too much. I am a spirit confident of my rights. Death is only an incident & not the most important which happens to us in this state of being. On the whole, especially since I met you my darling one I have been happy, & you have taught me how noble a woman's heart can be. If there is anywhere else I shall be on the look out for you. Meanwhile look forward, feel free, rejoice in life, cherish the children, guard my memory. God bless you.

Good bye.
W.

Russell-Einstein Manifesto

5 April, 1955.
41, Queen's Road,
Richmond, Surrey.

Dear Einstein,

I have been turning over in my mind, and discussing with various people, the best steps for giving effect to the feeling against war among the great majority of men of science. I think the first step should be a statement by men of the highest eminence, communists and anti-Communists, Western and Eastern, about the disasters to be expected in a war. I enclose a draft of such a statement, and I very much hope that you will be willing to sign it. I enclose also a list of those whom I am asking to sign. If sufficient signatures are obtained, I think the next step should be an international scientific congress which should be invited by the signatories to pass a resolution on the lines of the draft resolution which I enclose. I hope that in this way both Governments and public opinion can be made aware of the seriousness of the situation.

On the whole, I have thought that it was better at this stage to approach only men of science and not men in other fields, such as Arnold Toynbee whom you mentioned. Scientists have, and feel that they have, a special responsibility, since their work has unintentionally caused our present dangers. Moreover, widening the field would make it very much more difficult to steer clear of politics.

Yours sincerely,

(Signed, 'Bertrand Russell')

In response, Einstein was brief:

Dear Bertrand Russell,

Thank you for your letter of April 5. I am gladly willing to sign your excellent statement. I also agree with your choice of the prospective signers.

With kind regards,
A. Einstein.

"Master craftspeople and seers come to science for different reasons. Master craftspeople go into science because they have discovered in school that they're good at it. They are usually the best students in their math and physics classes from junior high school all the way up to graduate school, where they meet their peers. They have always [solved] math problems faster and more accurately than their classmates, so problem-solving is what they tend to value. Seers are very different. They are dreamers. They go into science because they have questions about the nature of existence that schoolbooks don't answer. If they weren't scientists, they might be artists or writers, or might end up in divinity school."

–Physicist Lee Smolin

Letter from Galileo Galilei to Benedetto Castelli

Very Reverend Father and My Most Respectable Sir:

Yesterday Mr. Niccolò Arrighetti came to visit me and told me about you. Thus I took infinite pleasure in hearing about what I did not doubt at all, namely about the great satisfaction you have been giving to the whole University.. However, the seal of my pleasure was to hear him relate the arguments which through the great kindness of their Most Serene Highness, you had the occasion of advancing at their table and then of continuing in the chambers of the Most Serene Ladyship, in the presence also of the Grand Duke and the Most Serene Archduchess, the Most Illustrious and Excellent Don Antonio and Don Paolo Giordano, and some of the very excellent philosophers there. What greater fortune can you wish than to se their Highnesses themselves enjoying discussing with you, putting forth doubts, listening to your solutions, and finally remaining satisfied with your answers?

After Mr. Arrighetti related the details you had mentioned, they gave me the occasion to go back to examine some general questions about he use of the Holy Scripture in disputes involving physical conclusions and some particular other ones about Joshua's passage, which was presented in opposition to the earth's motion and sun's stability by the Grand Duchess Dowager with some support by the Most Serene Archduchess.

In regard to the first general point of the Most Serene Ladyship, it seems to me very prudent of her to propose and of you to concede and to agree that the Holy Scripture can never lie or err, and that its declarations are absolutely and inviolably true. I should have added only that, through the Scripture cannot err, nevertheless some of its interpreters and expositors can sometimes err in various ways. One of these would be very serious and very frequent, namely to want to limit oneself always to the literal meaning of the words; for there would thus emerge not only various contradictions but also serious heresies and blasphemies, and it would be necessary to attribute to God feet, hands and eyes, as well as bodily and human feelings like anger, regret, hate and sometimes even forgetfulness of things past and ignorance of future ones. Thus in the Scripture one finds many propositions which look different from the truth if one goes by the literal meaning of the words, but which are expressed in this manner to accommodate the incapacity of common people; likewise, for the few who deserve to be separated from the masses, it is necessary that wise interpreters produce their true meaning and indicate the particular reasons why they have been expressed by means of such words.

Thus, given that in many places the Scripture is not only capable but necessarily in need of interpretations different from the apparent meaning of the words, it seems to me that in disputes about natural phenomena it should be reserved to the last place. For the Holy Scripture and nature both equally derive from the divine Word, the former as the dictation of the Holy Spirit, the latter as the most obedient executrix of God's commands; moreover, in order to adapt itself to the understanding of all people, it was appropriate for the Scripture to say many things which are different from absolute truth, in appearance and in regard to the meaning of the words; on the other hand, nature is inexorable and immutable, and she does not care at all whether or not her recondite reasons and modes of operations are revealed to human understanding, and so she never transgresses the terms of the laws imposed on her; therefore, whatever sensory experience places before our eyes or necessary demonstrations prove to us concerning natural effects should not in any way be called into question on account of scriptural passages whose words appear to have a different meaning, since not every statement of the Scripture is bound to obligations as severely as each effect of nature. Indeed, because of the aim of adapting itself to the capacity of unrefined and undisciplined peoples, the Scripture has not abstained from somewhat concealing its most basic dogmas, thus attributing to God himself properties contrary to and very far from his essence; so who will categorically maintain that, in speaking even incidentally of the earth of the sun or other creatures, it abandoned this aim and chose to restrict itself rigorously within the limited and narrow meanings of the words: This would have been especially problematic when saying about these creatures things which are very far from the primary function of the Holy Writ, indeed things which, if said and put forth in their naked and unadorned truth, would more likely harm its primary intention and make people more resistant to persuasion about the articles pertaining to salvation.

Given this, and moreover it being obvious that two truths can never contradict each other, the task of wise interpreters is to strive to find the true meanings of scriptural passages agreeing with those physical conclusions of which we are already certain and sure from clear sensory experience or from necessary demonstrations. Furthermore, as I already said, though the Scripture was inspired by the Holy Spirit, because of the mentioned reasons many passages admit of interpretations far removed from the literal meaning, and also we cannot assert with certainty that all interpreters speak by divine inspiration; hence I should think it would be prudent not to allow anyone to oblige scriptural passages to have to maintain the truth of any physical conclusions whose contrary could ever be proved to us by the senses and demonstrative and necessary reasons. Who wants to fix a limit for the human mind? Who wants to assert that everything which is knowable in the world is already known? Because of this, it would be most advisable not to add anything beyond necessity to the articles concerning salvation and the definition of the Faith, which are firm enough that there is no danger of any valid and effective doctrine ever rising against them. If this is so, what greater disorder would result from adding them upon request by persons of whom we do not know whether they speak with celestial inspiration, and of whom also we see clearly that they are completely lacking in the intelligence needed to understand, let alone to criticize, the demonstrations by means of which the most exact sciences proceed in the confirmation of some of their conclusions?

I should believe that the authority of the Holy Write has merely the aim of persuading men of those article and propositions which are necessary for their salvation and surpass all human reason, and so could not become credible through some other science or any other means except the mouth of the Holy Spirit itself. However, I do not think it necessary to believe that the same God who has furnished us with senses, language, and intellect would want to bypass their use and give us by other means the information we can obtain with them. This applies especially to those sciences about which one can read only very small phrases and scattered conclusions in the Scripture, as is particularly the case for astronomy, of which it contains such a small portion that one does not even find in it the names of all the planets; but if the first sacred writers had been thinking of persuading the people about the arrangement and the movements of the heavenly bodies, they would not have treated of them so sparsely, which is to say almost nothing in comparison to the infinity of very lofty and admirable conclusions contained in such a science.

So you see, if I am not mistaken, how disorderly is the procedure of those who in disputes about natural phenomena that do not directly involve the Faith give first place to scriptural passages, which they quite often misunderstand anyway. However, if these people really believe they have grasped the true meaning of a particular scriptural passage, and if they consequently feel sure of possessing the absolute truth on the question they intend to dispute about, then let them sincerely tell me whether they think that someone in a scientific dispute who happens to be right has a great advantage over another who happens to be wrong. I know they will answer Yes, and that the one who supports the true side will be able to provide a thousand experiments and a thousand necessary demonstrations for his side, whereas the other person can have nothing but sophisms, paralogisms, and fallacies. But is they know they have such an advantage over their opponents as long as the discussion is limited to physical questions and only philosophical weapons are used, why is it that when they come to the meeting they immediately introduce an irresistible and terrible weapon, the mere sight of which terrifies even the most skillful and expert champion? If I must tell the truth, I believe it is they who are the most terrified, and that they are trying to find a way of not letting the opponent approach because they feel unable to resist his assaults. However, consider that, as I just said, whoever has truth on his side has a great, indeed the greatest, advantage over the opponent, and that it is impossible for two truths to contradict each other; it follows therefore that we must not fear any assaults launched against us by anyone, as long as we are allowed to speak and to be heard by competent persons who are not excessively upset by their own emotions and interests.

To confirm this I now come to examining the specific passage of Joshua, concerning which you put forth three theses for their Most Serene Highness. I take the third one, which you advanced as mine (as indeed it is), but I add some other consideration that I do not believe I have ever told you.

Let us then assume and concede to the opponent that the words of the sacred text should be taken precisely in their literal meaning, namely that in answer to Joshua's prayers God made the sun stop and lengthened the day, so that as a result he achieved victory; but I request that the same rule should apply to both, so that the opponent should not pretend to tie me and to leave himself free to change or modify the meanings of the words. Given this, I say that this passage shows clearly the falsity and impossibility of the Aristotelian and Ptolemaic world system, and on the other hand agrees very well with the Copernican one.

I first ask the opponent whether he knows with how many motions the sun moves. If he knows, he must answer that is moves with two motions, namely with the annual motion from west to east and with the diurnal motion in the opposite direction from east to west.

Then, secondly, I ask him whether these two motions, so different and almost contrary to each other, belong to the sun and are its own to an equal extent. The answer must be No, but that only one is specifically its own, namely the annual motion, whereas the other is not but belongs to the highest heaven, I mean the Prime Mobile; the latter carries along with it the sun as well as the other planets and the stellar sphere, forcing them to make a revolution around the earth in twenty-four hours, with a motion, as I said, almost contrary to their own natural motion.

Coming to the third question, I ask him with which of these two motions the sun produces night and day, that is, whether with its own motion or else with that of the Prime Mobile. The answer must be that night and day are effects of the motion of the Prime Mobile and that what depends on the sun's own motion is not night or day but the various seasons and the year itself.

Now, if the day derives not from the sun's motion but from that of the Prime Mobile, who does not see that to lengthen the day one must stop the Prime Mobile and not the sun? Indeed, is there anyone who understands these first elements of astronomy and does not know that, if God had stopped the sun's motion, He would have cut and shortened the day instead fo lengthening it? For, the sun's motion being contrary to the diurnal turning, the more the sun moves toward the east the more its progression toward the west is slowed down, whereas by its motion being diminished or annihilated the sun would set that much sooner; this phenomenon is observed in the moon, whose diurnal revolutions are slower than those of the sun inasmuch as is own motion is faster than that of the sun. It follows that it is absolutely impossible to stop the sun and lengthen the day in the system of Ptolemy and Aristotle, and therefore either the motions must not be arranged as Ptolemy says or we must modify the meaning of the words of the Scripture; we would have to claim that, when it says that God stopped the sun, it meant to say that He stopped the Prime Mobile, and that is said the contrary of what it would have said if speaking to educated men in order to adapt itself to the capacity of those who are barely able to understand the rising and setting of the sun.

Add to this that it is not believable that God would stop only the sun, letting the other spheres proceed; for He would have unnecessarily altered and upset all the order, appearances, and arrangements of the other stars in relation to the sun, and would have greatly disturbed the whole system of nature. On the other hand, it is believable that He would stop the whole system of celestial spheres, which could then together return to their operations without any confusion or change after the period of intervening rest.

However, we have already agreed not to change the meaning of the words in the text; therefore it is necessary to resort to another arrangement of the parts of the world, and to see whether the literal meaning of the words flows directly and without obstacle from its point of view. This is in fact what we see happening.

For I have discovered and conclusively demonstrated that the solar globe turns on itself, completing an entire rotation in about one lunar month, in exactly the same direction as all the other heavenly revolutions; moreover, it is very probable and reasonable that, as the chief instrument and minister of nature and almost the heart of the world, the sun gives not only light (as it obviously does) but also motion to all the planets that revolve around it; hence, if in conformity with Copernicus's position the diurnal motion is attributed to the earth, anyone can see that is sufficed stopping the sun to stop the whole system, and thus to lengthen the period of the diurnal illumination without altering in any way the rest of the mutual relationships of the planets; and that is exactly how the words of the sacred text sound. Here then is the manner in which by stopping the sun one can lengthen the day on the earth, without introducing any confusion among the parts of the world and without altering the words of the Scripture.

I have written much more than is appropriate in the view of my slight illness. So I end by reminding you that I am at your service, and I kiss your hands and pray the Lord to give you happy holidays and all you desire.

Florence, December, 21, 1613

To Your Very Reverend Paternity.

Your Most Affectionate Servant, Galileo Galilei

"Any sufficiently advanced technology is indistinguishable from magic."

— Arthur C. Clarke

"If you expect science to give all the answers to the wonderful questions about what we are, where we're going, what the meaning of the universe is... you could easily become disillusioned and look for a mystic answer... [W]e're exploring, trying to find out as much as we can about the world. People [ask], "Are you looking for the ultimate physics laws?" No, I'm not. I'm just looking to find out more about the world. If it turns out there is an ultimate law which explains everything, so be it; that would be very nice to discover. If it turns out it's like an onion, with millions of layers... then that's the way it is. But whatever way it comes out, it's nature, and she's going to come out the way she is! Therefore we shouldn't pre-decide what it is we're going to find, except to try to find out more. If you think that you are going to get an answer to some deep philosophical question, you may be wrong - it may be that you can't get an answer to that particular problem by finding out more about the character of nature. But I don't look at it like that; my interest in science is to find out more about the world, and the more I find out, the better."

−Richard Feynman

General Leslie Groves − James B. Conant Letter to Robert Oppenheimer

Dear Dr. Oppenheimer:

We are addressing this letter to you as the Scientific Director of the special laboratory in New Mexico in order to confirm our many conversations on the matters of organization and responsibility. You are at liberty to show this letter to those with whom you are discussing the desirability of their joining the project with you; they of course realizing their responsibility as to secrecy, including the details of organization and personnel.

I. The laboratory will be concerned with the development and final manufacture of an instrument of war, which we may designate as Projectile S-1-T. To this end, the laboratory will be concerned with:

A. Certain experimental studies in science, engineering and ordnance; and

B. At a later date large-scale experiments involving difficult ordnance procedures and the handling of highly dangerous material.

The work of the laboratory will be divided into two periods in time: one, corresponding to the work mentioned in section A; the other, that mentioned in section B. During the first period, the laboratory will be on a strictly civilian basis, the personnel, procurement and other arrangements being carried on under a contract arranged between the War Department and the University of California. The conditions of this contract will be essentially similar to that of the usual OSRD contract. In such matters as draft deferment, the policy of the War Department and OSRD in regard to the personnel working under this contract will be practically identical. When the second division of the work is entered upon (mentioned in B), which will not be earlier than January 1, 1944, the scientific and engineering staff will be composed of commissioned officers. This is necessary because of the dangerous nature of the work and the need for special conditions of security. It is expected that many of those employed as civilians during the first period (A) will be offered commissions and become members of the commissioned staff during the second period (B), but there is no obligation on the part of anyone employed during period A to accept a commission at the end of that time.

II. The laboratory is part of a larger project which has been placed in a special category and assigned the highest priority by the President of the United States. By his order, the Secretary of War and certain other high officials have arranged that the control of this project shall be in the hands of a Military Policy Committee, composed of Dr. Vannevar Bush, Director of OSRD, as Chairman, Major General W. D. Styer, Chief of Staff, SOS, Rear Admiral W. R. Purnell, Assistant Chief of Staff to Admiral King; Dr. James B. Conant serves as Dr. Bush’s deputy and alternate on this Committee, but attends all meetings and enters into all discussions. Brigadier General L. R. Groves of the Corps of Engineers has been given over-all executive responsibility for this project, working under the direction of the Military Policy Committee. He works in close cooperation with Dr. Conant, who is Chairman of the group of scientists who were in charge of the earlier phases of some aspects of the investigation.

III. Responsibilities of the Scientific Director.

1. He will be responsible for:

A. The conduct of the scientific work so that the desired goals as outlined by the Military Policy Committee are achieved at the earliest possible dates.

B. The maintenance of secrecy by the civilian personnel under his control as well as their families.

2. He will of course be guided in his determination of policies and courses of action by the advice of his scientific staff.

3. He will keep Dr. James B. Conant and General Groves informed to such an extent as is necessary for them to carry on the work which falls in their respective spheres. Dr. Conant will be available at any time for consultation on general scientific problems as well as to assist in the determination of definite scientific policies and research programs. Through Dr. Conant complete access to the scientific world is guaranteed.

IV. Responsibilities of the Commanding Officer.

1. The Commanding Officer will report directly to General Groves.

2. He will be responsible for:

A. The work and conduct of all military personnel.

B. The maintenance of suitable living conditions for civilian personnel.

C. The prevention of trespassing on the site.

D. The performance of duty by such guards as may be established within the reservation for the purpose of maintaining the secrecy precautions deemed necessary by the Scientific Director.

V. Cooperation.

The closest cooperation is of course necessary between the Commanding Officer and the Scientific Director if each is to perform his function to the maximum benefit of the work. Such a cooperative attitude now exists on the part of Dr. Conant and General Groves and has so existed since General Groves first entered the project.

Very sincerely yours,

James B. Conant

Leslie R. Groves

"[T]he reward for harnessing Albert Einstein's general theory of relativity is nothing less than the key to understanding the history of the universe, the origin of time, and the evolution of all the stars and galaxies in the cosmos. General relativity can tell us about what lies at the farthest reaches of the universe and explain how that knowledge affects our existence here and now. Einstein's theory also sheds light on the smallest scales of existence, where the highest-energy particles can come into being out of nothing. It can explain how the fabric of reality, space, and time emerges to become the backbone of nature."

– Portuguese astrophysicist Pedro Ferreira

1899, John Smith Interview with Nikola Tesla

John Smith: Mr. Tesla, you have gained the glory of the man who got involved in the cosmic processes. Who are you, Mr. Tesla?

Nikola Tesla: It is a right question, Mr. Smith, and I will try to give you the right answer to it.

John Smith: Some say you're from the country of Croatia, from the area called Lika, where together with the people are growing trees, rocks and starry sky. They say that your home village is named after the mountain flowers, and that the house, where you were born, is next to the forest and the church.

Nikola Tesla: Really, all it true. I'm proud of my Serbian origin and my Croatian homeland.

John Smith: Futurists say that the Twenty-and Twenty First Century was born in head of Nikola Tesla. They celebrate conversely magnetic field and sing hymns to Inductions engine. Their creator was called the hunter who caught the light in his net from the depths of the earth, and the warrior who captured fire from heaven. Father of alternating current will make the Physics and Chemistry dominate half the world. Industry will proclaim him as their supreme saint, a banker for the largest benefactors. In the laboratory of Nikola Tesla for the first time is broken atom.

There is created a weapon that causes the earthquake vibrations. There are discovered black cosmic rays. Five races will pray to him in the Temple of the future, because they had taught a great secret that Empedocles elements can be watered with the life forces from the ethers.

Nikola Tesla: Yes, these are some of my most important discoveries. I’m a defeated man. I have not accomplished the greatest thing I could.

John Smith: What is it, Mr. Tesla?

Nikola Tesla: I wanted to illuminate the whole earth. There is enough electricity to become a second sun. Light would appear around the equator, as a ring around Saturn.

Mankind is not ready for the great and good. In Colorado Springs I soaked the earth by electricity. Also we can water the other energies, such as positive mental energy. They are in the music of Bach or Mozart, or in the verses of great poets. In the Earth’s interior, there are energy of Joy, Peace and Love. Their expressions are a flower that grows from the Earth, the food we get out of her and everything that makes man’s homeland. I’ve spent years looking for the way that this energy could influence people. The beauty and the scent of roses can be used as a medicine and the sun rays as a food.

Life has an infinite number of forms, and the duty of scientists is to find them in every form of matter. Three things are essential in this. All that I do is a search for them. I know I will not find them, but I will not give up on them.

John Smith: What are these things?

Nikola Tesla: One issue is food. What a stellar or terrestrial energy to feed the hungry on Earth? With what wine watered all thirsty, so that they can cheer in their heart and understand that they are Gods?

Another thing is to destroy the power of evil and suffering in which man’s life passes! They sometimes occur as an epidemic in the depths of space. In this century, the disease had spread from Earth in the Universe.

The third thing is: Is there an excess Light in the Universe? I discovered a star that by all the astronomical and mathematical laws could disappear, and that nothing seems to be modified. This star is in this galaxy. Its light can occur in such density that fits into a sphere smaller than an apple, a heavier than our Solar System. Religions and philosophies teach that man can become the Christ, Buddha and Zoroaster. What I'm trying to prove is wilder, and almost unattainable. This is what to do in the Universe so every being is born as Christ, Buddha or Zoroaster.

I know that gravity is prone to everything you need to fly and my intention is not to make flying devices (aircraft or missiles), but teach individual to regain consciousness on his own wings … Further; I am trying to awake the energy contained in the air. There are the main sources of energy. What is considered as empty space is just a manifestation of matter that is not awakened.

No empty space on this planet, nor in the Universe.. In black holes, what astronomers talk about, are the most powerful sources of energy and life.

John Smith: On the window of your room in hotel "Valdorf-Astoria", on the thirty-third floor, every morning, the birds arrive.

Nikola Tesla: A man must be sentimental towards the birds. This is because of their wings. Human had them once, the real and visible!

John Smith: You have not stopped flying since those distant days in Smiljan!

Nikola Tesla: I wanted to fly from the roof and I fell: Children's calculations could be wrong. Remember, the youth wings have everything in life!

John Smith: Have you ever married? It is not known that you have affection for love or for a woman. Photos from the youth show you were handsome man.

Nikola Tesla: Yes. I did not. There are two views: a lot affection or not at all. The center serves to rejuvenate human race. Women for certain people nurtures and strengthen its vitality and spirit. Being single does the same to other people. I chose that second path.

John Smith: Your admirers are complaining that you attacking relativity. The strange is your assertion that the matter has no energy. Everything is imbued with energy, where it is?

Nikola Tesla: First was energy, then matter.

John Smith: Mr. Tesla, it's like when you said that you were born by your father, and not on you.

Nikola Tesla: Exactly! What about the birth of the Universe? Matter is created from the original and eternal energy that we know as Light .It shone, and there have been appear star, the planets, man, and everything on the Earth and in the Universe. Matter is an expression of infinite forms of Light, because energy is older than it. There are four laws of Creation. The first is that the source of all the baffling, dark plot that the mind cannot conceive, or mathematics measure. In that plot fit the whole Universe.

The second law is spreading a darkness, which is the true nature of Light, from the inexplicable and it's transformed into the Light. The third law is the necessity of the Light to become a matter of Light. The fourth law is: no beginning and no end; three previous laws always take place and the Creation is eternal.

John Smith: In the hostility to the theory of relativity you go so far, that you hold lectures against its Creator at your birthday parties..

Nikola Tesla: Remember, it is not curved space, but the human mind which cannot comprehend infinity and eternity! If relativity has been clearly understood by its Creator, he would gain immortality, even yet physically, if he is pleased.

I am part of a light, and it is the music. The Light fills my six senses: I see it, hear, feel, smell, touch and think. Thinking of it means my sixth sense. Particles of Light are written note. O bolt of lightning can be an entire sonata. A thousand balls of lightening is a concert. For this concert

I have created a Ball Lightning, which can be heard on the icy peaks of the Himalayas. About Pythagoras and mathematics a scientist may not and must not infringe of these two. Numbers and equations are signs that mark the music of the spheres. If Einstein had heard these sounds, he would not create theories of relativity. These sounds are the messages to the mind that life has meaning, that the Universe exists in perfect harmony, and its beauty is the cause and effect of Creation. This music is the eternal cycle of stellar heavens.

The smallest star has completed composition and also, part of the celestial symphony. The man's heartbeats are part of the symphony on the Earth. Newton learned that the secret is in geometric arrangement and motion of celestial bodies. He recognized that the supreme law of harmony exists in the Universe. The curved space is chaos, chaos is not music. Einstein is the messenger of the time of sound and fury.

John Smith: Mr. Tesla, do you hear that music?

Nikola Tesla: I hear it all the time. My spiritual ear is as big as the sky we see above us. My natural ear I increased by the radar. According to the Theory of Relativity, two parallel lines will meet in infinity. By that Einstein's curved will straighten. Once created, the sound lasts forever. For a man it can vanish, but continues to exist in the silence that is man's greatest power.

No, I have nothing against Mr. Einstein. He is a kind person and has done many good things, some of which will become part of the music. I will write to him and try to explain that the ether exists, and that its particles are what keep the Universe in harmony, and the life in eternity.

John Smith: Tell me, please, under what conditions Angel adopt on the Earth?

Nikola Tesla: I have ten of them. Keep good records vigilant.

John Smith: I will document all your words, Dear Mr. Tesla.

Nikola Tesla: The first requirement is a high awareness of its mission and work to be done. It must, if only dimly, exist in the early days. Let us not be falsely modest; Oak knows that it is oak tree, a bush beside him being a bush. When I was twelve, I have been sure I will get to Niagara Falls. For most of my discoveries I knew in my childhood that I will achieve them, although not entirely apparent … The second condition to adapt is determination. All that I might, I finished.

John Smith: What is the third condition of adjustment, Mr. Tesla?

Nikola Tesla: Guidance for all the vital and spiritual energies in labor. Therefore purification of the many effects and needs that man has. I therefore have not lost anything, but just gained.

So I enjoyed every day and night. Write down: Nikola Tesla was a happy man… The fourth requirement is to adjust the physical assembly with a work.

John Smith: What do you mean, Mr. Tesla?

Nikola Tesla: First, the maintenance of the assembly. Man’s body is a perfect machine. I know my circuit and what’s good for him. Food what nearly all people eat, to me it is harmful and dangerous. Sometimes I visualize that chefs in the world are all in conspiracy against me … Touch my hand.

John Smith: It was cold.

Nikola Tesla: Yes. Bloodstream can be controlled, and many processes in and around us. Why are you frightened young man?

John Smith: It’s a story that Mark Twain wrote a mysterious stranger, that wonderful book of Satan, inspired by you.

Nikola Tesla: The word “**Lucifer**” is more charming. Mr. Twain likes to joke. As a child I was healed once by reading his books. When we met here and told him about, he was so touched that he cried. We became friends and he often came to my lab. Once he requested to show him a machine that by vibration provokes a feeling of bliss. It was one of those inventions for entertainment, what I sometimes like to do.

I warned Mr. Twain as not to remain under these vibrations. He did not listen and stayed longer. It ended by being, like a rocket, holding pants, darted into a certain room. It was a diabolically funny, but I kept the seriousness.

But, to adjust the physical circuit, in addition to food, dream is very important . From a long and exhausting work, which required superhuman effort, after one hour of sleep I’d be fully recovered. I gained the ability to manage sleep, to fell asleep and wake up in the time which I have designated. If I do something what I do not understand, I force myself to think about it in my dream, and thus find a solution.

Nikola Tesla: The fifth condition of adjustment is memory. Perhaps in the most people, the brain is keeper of knowledge about the world and the knowledge gained through the life. My brain is engaged in more important things than remembering, it is picking what is required at a given moment. This is all around us. It should only be consumed.

Everything that we once saw, hear, read and learn, accompanies us in the form of light particles. To me, these particles are obedient and faithful.

Goethe’s Faust, my favorite book, I learned by heart in German as a student, and now it can all recite. I held my inventions for years ‘in my head “, and only then I realized them.

John Smith: You often mentioned the power of visualization.

Nikola Tesla: I might have to thank to visualization for all that I invented. The events of my life and my inventions are real in front of my eyes, visible as each occurrence or the item. In my youth I was frightened of not knowing what it is, but later, I learned to use this power as an exceptional talent and gift. I nurtured it, and jealously guarded. I also made corrections by visualization on most of my inventions, and finish them that way, by visualization I mentally solve complex mathematical equations. For that gift I have, I will receive rank High Lama in Tibet.

My eyesight and hearing are perfect and, dare to say, stronger than other people. I hear the thunder of a hundred fifty miles away, and I see colors in the sky that others cannot see. This enlargement of vision and hearing, I had as a child. Later I consciously developed.

John Smith: In youth you have several times been seriously ill. Is it a disease and a requirement to adapt?

Nikola Tesla: Yes. It is often the result of a lack of exhaustion or vital force, but often the purification of mind and body from the toxins that have accumulated. It is necessary that a man suffers from time to time. The source of most disease is in the spirit. Therefore the spirit and can cure most diseases. As a student I got sick of cholera which raged in the region of Lika. I was cured because my father finally allowed me to study technology, which was my life. Illusion for me was not a disease, but the mind’s ability to penetrate beyond the three dimensions of the earth.

I had them all my life, and I have received them as all other phenomena around us. Once, in childhood, I was walking along the river with Uncle and said: “From the water will appear the trout, I’ll throw a stone and it is cut.” That’s what happened. Frightened and amazed, his uncle cried: “Bade retro Satan’s!” He was an educated and he spoke in Latin …

I was in Paris when I saw my mother’s death. In the sky, full of light and music floated are wonderful creatures. One of them had a mother’s character, who was looking at me with infinite love. As the vision disappeared, I knew that my mother died.

John Smith: What is the seventh adjustment, Mr. Tesla?

Nikola Tesla: The knowledge of how the mental and vital energy transform into what we want, and achieve control over all feelings. Hindus call it Kundalini Yoga. This knowledge can be learned, for what they need many years or is acquired by birth. The most of them I acquired by birth. They are in the closest connection with a sexual energy that is after the most widespread in the Universe. The woman is the biggest thief of that energy, and thus the spiritual power.

I’ve always knew that and was alerted. Of myself I created what I wanted: a thoughtful and spiritual machine.

John Smith: A ninth adjustment, Mr. Tesla?

Nikola Tesla: Do everything that any day, any moment, if possible, not to forget who we are and why we are on Earth. Extraordinary people who are struggling with illness, privation, or the society which hurts them with its stupidity, misunderstanding, persecution and other problems which the country is full of a swamps with insects, leaves behind unclaimed until the end of the work. There are many fallen angels on Earth.

John Smith: What is the tenth adaptation?

Nikola Tesla: It is most important. Write that Mr. Tesla played. He played the whole of his life and enjoyed it.

John Smith: Mr. Tesla! Whether it relates to your findings and your work? Is this a game?

Nikola Tesla: Yes, dear boy. I have so loved to play with electricity! I always cringe when I hear about the one also the Greek who stole fire. A terrible story about studding, and eagles peck at his liver. Did Zeus did not have enough lightning and thunder, and was damaged for one fervor? There is some misunderstanding…

Lightning are the most beautiful toys that can be found. Do not forget that in your text stand out: Nikola Tesla was the first man who discovered lightning.

John Smith: Mr. Tesla, you're just talking about angels and their adaptation to the Earth.

Nikola Tesla: Am I? This is the same. You could write this: he dared to take upon himself the prerogatives of Indri, Zeus and Peron. Imagine one of these gods in a black evening suit, with the bowler hat and wearing white cotton gloves prepares lightning, fires and earthquakes to the New York City elite!

John Smith: Readers love the humor of our paper. But you confuse me stating that your findings, which have immense benefits for the people, representing the game. Many will frown on it.

Nikola Tesla: Dear Mr. Smith, the trouble is that people are too serious. If they were not, they would be happier and much longer would have lived. Chinese proverb says that the seriousness reduces life. Visiting the inn Tai Pe guessed that he visits the Imperial Palace.

But that the newspaper readers would not have frowned, let's get back to things which they consider important.

John Smith: They would love to hear what your philosophy is.

Nikola Tesla: Life is a rhythm that must be comprehended. I feel the rhythm and direct on it and pamper in it. It was very grateful and gave me the knowledge I have. Everything that lives is related to a deep and wonderful relationship: man and the stars, amoebas' and the sun, the heart and the circulation of an infinite number of worlds. These ties are unbreakable, but they can be tame and to propitiate and begin to create new and different relationships in the world, and that does not violate the old.

Knowledge comes from space; our vision is its most perfect set. We have two eyes: the earthly and spiritual. It is recommended that it become one eye. Universe is alive in all its manifestations, like a thinking animal.

Stone is a thinking and sentient being, such as plant, beast and a man. A star that shines asked to look at, and if we are not a sizeable self-absorbed we would understand its language and message. His breathing, his eyes and ears of the man must comply with breathing, eyes and ears of the Universe.

John Smith: As you say this, it seems to me like I hear Buddhist texts, words or Taoist Parazulzusa.

Nikola Tesla: That's right! This means that there is general knowledge and truth that man has always possessed. In my feeling and experience, the Universe has only one substance and one supreme energy with an infinite number of manifestations of life. The best thing is that the discovery of a secret nature, reveals the other.

One cannot hide, there are around us, but we are blind and deaf to them. If we emotionally tie ourselves to them, they come to us themselves. There are a lot of apples, but one Newton. He asked for just one apple that fell in front of him.

John Smith: A question that might be set at the beginning of this conversation. What was Electricity for you, Dear Mr. Tesla?

Nikola Tesla: Everything is Electricity. First was the light, endless source from which points out material and distribute it in all forms that represent the Universe and the Earth with all its aspects of life. Black is the true face of Light, only we do not see this. It is remarkable grace to man and other creatures. One of its particles possesses light, thermal, nuclear, radiation, chemical, mechanical and an unidentified energy.

It has the power to run the Earth with its orbit. It is true Archimedean lever.

John Smith: Mr. Tesla, you're too biased towards electricity.

Nikola Tesla: Electricity I am. Or, if you wish, I am the electricity in the human form. You are Electricity; too Mr. Smith, but you do not realize it.

John Smith: Is it thus your ability to allow fails of electricity of one million volts trough your body?

Nikola Tesla: Imagine a gardener who is attacked by herbs. This would indeed be crazy. Man's body and brain are made from a large amount energy; in me there is the majority of electricity. The energy that is different in everyone is what makes the human "I" or "soul". For other creatures to their essence, "soul" of the plant is the "soul" of minerals and animals.

Brain function and death is manifested in light. My eyes in youth were black, now blue, and as time goes on and strain the brain gets stronger, they are closer to white. White is the color of heaven. Through my window one morning, landed a white dove, which I fed. She wanted to bring me a word that she was dying. From her eyes the light jets were coming out. Never in the eyes of any creature had I not seen so much light, as in that pigeon.

John Smith: Personnel in your lab speak about flashes of light, flames and lightning that occur if you are angry or into kind of risk.

Nikola Tesla: It is the psychic discharge or a warning to be alert. The light was always on my side. Do you know how I discovered the rotating magnetic field and induction motor, which made me became famous when I was twenty-six? One summer evening in Budapest, I watched with my friend Sigetijem sunset.

Thousands of fire was turning around in thousands of flaming colors. I remembered Faust and recited his verses and then, as in a fog, I saw spinning magnetic field, and induction motor. I saw them in the sun!

John Smith: Hotel service telling that at the time of lightning you isolate into the room and talk to yourselves.

Nikola Tesla: I talk with lightning and thunder.

John Smith: With them? What language, Mr.Tesla?

Nikola Tesla: Mostly my native language. It has the words and sounds, especially in poetry, what is suitable for it.

John Smith: Readers of our magazine would be very grateful if you would interpret that.

Nikola Tesla: The sound does not exist only in the thunder and lightning, but, in transformation into the brightness and color. A color can be heard. Language is of the words, which means that it is from the sounds and colors. Every thunder and lightning are different and have their names. I call some of them by the names of those who were close in my life, or by those whom I admire.

In the sky brightness and thunder live my mother, sister, brother Daniel, a poet Jovan Jovanovic Zmaj and other persons of Serbian history. Names such AsIsaiah, Ezekiel, Leonardo, Beethoven, Goya, Faraday, Pushkin and all burning fires mark shoals and tangles of lightning and thunder, which does not stop all night bringing to the Earth precious rain and burning trees or villages.

There is lightning and thunder, and they are the brightest and most powerful, that will not vanish. They are coming back and I recognize them among the thousands.

John Smith: For you, science or poetry is the same?

Nikola Tesla: These are the two eyes of one person. William Blake was taught that the Universe was born from the imagination, that it maintains and it will exist as long as there is a last man on the Earth. With it was a wheel to which astronomers can collect the stars of all galaxies. It is the creative energy identical to the light energy.

John Smith: Imagination is more real to you than life itself?

Nikola Tesla: It gives birth to the life. I have fed by my taught; I've learned to control emotions, dreams and visions. I have always cherished, as I nurtured my enthusiasm. All my long life I spent in ecstasy. That was the source of my happiness. It helped me during all these years to bear with work, which was enough for the five lives. The best is to work at night, because the stellar light, and close bond.

John Smith: You said that I am, like every being, the Light. This flatter me, but I confess, I do not quite understand.

Nikola Tesla: Why would you need to understand, Mr. Smith? Suffice it to believe it. Everything is light. In one its ray is the fate of nations, each nation has its own ray in what great light source we see as the sun. And remember: no one who was there did not die. They transformed into the light, and as such exist still. The secret lies in the fact that the light particles restore their original state.

John Smith: This is the resurrection!

Nikola Tesla: I prefer to call it: return to a previous energy. Christ and several others knew the secret. I am searching how to preserve human energy. It is forms of Light, sometimes straight like heavenly light. I have not looked for it for my own sake, but for the good of all. I believe that my discoveries make people's lives easier and more bearable, and channel them to spirituality and morality.

John Smith: Do you think that time can be abolished?

Nikola Tesla: Not quite, because the first feature of the energy is that it transforms. It is in perpetual transformation, as clouds of Taoists. But it is possible to leverage the fact that a man preserves consciousness after the earthly life. In every corner of the universe exist energy of life; one of them is immortality, whose origin is outside of man, waiting for him.

The universe is spiritual; we are only half that way. The Universe is more moral than us, because we do not know his nature and how to harmonize our lives with it. I am not scientist, science is perhaps the most convenient way to find the answer to the question that always haunt me, and which my days and nights turned into fire.

John Smith: What's the matter?

Nikola Tesla: How are your eyes brightened!… What I wanted to know is: what happens to a falling star as the sun goes out? Stars fall like dust or seed in this or in other worlds, and the sun be scattered in our minds, in the lives of many beings, what will be reborn as a new light, or cosmic wind scattered in infinity.

I understand that this is necessary included in the structure of the Universe. The thing is, though, is that one of these stars and one of these suns, even the smallest, preserves.

John Smith: But, Mr. Tesla, you realize that this is necessary and is included in the constitution of the world!

Nikola Tesla: When a man becomes concuss; that his highest goal must be to run for a shooting star, and tries to capture it; shall understand that his life was given to him because of this and will be saved. Stars will eventually be capable to catch!

John Smith: And what will happen then?

Nikola Tesla: The creator will laugh and say: "It fall only that you chase her and grab her."

John Smith: Isn't all of this contrary to the cosmic pain, which so often you mention in your writings? And what is it cosmic pain?

Nikola Tesla: No, because we are on Earth … It is an illness whose existence the vast majority of people are not aware of. Hence, many other illnesses, suffering, evil, misery, wars and everything else what makes human life an absurd and horrible condition. This disease cannot be completely cured, but awareness shall make it less complicated and hazardous. Whenever one of my close and dear people were hurt, I felt physical pain. This is because our bodies are made as of similar material, and our soul related with unbreakable strands. Incomprehensible sadness that overwhelmed us at times means that somewhere, on the other side on this planet, a child or generous man died.

The entire Universe is in certain periods sick of itself, and of us. Disappearance of a star and the appearance of comets affect us more than we can imagine. Relationships among the creatures on the Earth are even stronger, because of our feelings and thoughts the flower will scent even more beautiful or will fall in silence.

These truths we must learn in order to be healed. Remedy is in our hearts and evenly, in the heart of the animals that we call the Universe.

"Though I knew Einstein for two or three decades, it was only in the last decade of his life that we were close colleagues and something of friends. But I thought that it might be useful because I am sure that it is not too soon - and for our generation perhaps almost too late - to start to dispel the clouds of myth and to see the great mountain peak that these clouds hide. As always, the myth has its charms; but the truth is far more beautiful."

– Robert Oppenheimer

"I discovered that programming was one of the purest activities; it was truly architecture with words."

– Emanuel Derman

"I'm enough of an artist to draw freely on my imagination. Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world."

– Albert Einstein

Einstein's Letter to Mathematician David Hilbert

"There was a moment in which something like as irritation came between us, the origin of which I no longer want to analyze. I have fought against the bitterness which it provoked in me, and have succeeded completely in doing so. I again think of you with unclouded friendship, and I ask you to do the same for me. It is really a pity if companions such as we are, who have managed to forge a path aside from the pettiness of this world, could find anything other than joy in each other's company."

Stephen Hawking Letter

TO WHOM IT MAY CONCERN

I, **Dr Stephen W Hawking**, director of research at the Centre for Theoretical Cosmology at the University of Cambridge, author of **A Brief History of Time** and many, other works, am pleased to announce my participation in a research project with Dr Philip Low of Neurovigil and his associates. The research project rims to develop brain interface communication devices for the use of people such as myself, who have lost their natural speaking voice.

As the longest known survivor with amyotropic lateral sclerosis (ALS), it is increasingly a priority for me to participate in research projects in order to shed light on the nature of this condition and provide assistance and support to other sufferers.

Having communicated electronically for over 25 years. I am well aware of the devastating impact of the loss of speech on individuals and their families. I am participating in this project in the hope that I can offer insights and practical advice to **NeuroVigil**. Dr Low and his company have done some outstanding work in this field and I am pleased to be invited to collaborate with him and his colleagues.

In joining this exciting field of scientific study, my aim is to help make communication devices easier to use and more readily available for others who face the challenges that have defined my life. I wish to assist in research, encourage investment in this area and most importantly, to offer some future hope to people diagnosed with ALS and other neurodegenerative conditions.

Niels Bohr Letter to Winston Churchill

Sir,

In accordance with your kind permission, I have the honour to send you a brief report about my impressions of the great Anglo-American enterprise, in the scientific aspects of which I have been given the opportunity to participate together with my British colleagues.

The principles on which the enormous energy stored in the nuclei of atoms may be released for practical purposes were, as a result of international scientific collaboration, already perceived in outline before the war and are, therefore, common knowledge to physicists all over the world. It was, however, by no means certain whether the task would surpass human resources, and it was therefore a revelation to me, on my arrival in England last October, to learn with what courage and foresight the effort had been undertaken and what an advanced stage the work had already reached.

In fact, what until a few years ago might be considered as a fantastic dream is at present being realized within great laboratories and huge production plants secretly erected in some of the most solitary regions of the United States. There a larger group of physicists than ever before collected for a single purpose, working hand in hand with a whole army of engineers and technicians, are preparing new materials capable of an immense energy release, and are developing ingenious devices for the most effective use of these materials.

To everyone who is given the opportunity to see for himself the refined laboratory equipment and the gigantic production machinery, it is an unforgettable experience, of which words can only give a poor impression. Moreover it was to me a special pleasure to witness the most harmonious and enthusiastic cooperation between the British and American colleagues, and on my departure I was expressly asked by the leaders of the American organization to convey their genuine appreciation of the help they are receiving, on an ever increasing scale, from their British collaborators.

I will not tire you with any technical details, but one cannot help comparing the situation with that of the alchemists of former days, groping in the dark in their vain efforts to make gold. To-day physicists and engineers are, on the basis of firmly established knowledge, controlling and directing violent reactions by which new materials far more precious than gold are built up, atom by atom. These processes are in fact similar to those which took place in the early stages of development of the universe and still go on in the turbulent and flaming interior of the stars.

The whole undertaking constitutes, indeed, a far deeper interference with the natural course of events than anything ever before attempted, and it must be realized that the success of the endeavours has created a quite new situation as regards human resources. The revolution in industrial development which may result in coming years cannot at present be surveyed, but the fact of immediate preponderance is, that a weapon of devastating power far beyond any previous possibilities and imagination will soon become available.

The lead in the efforts to master such mighty forces of nature, hitherto beyond human reach, which by good fortune has been achieved by the two great free nations, entails the greatest promises for the future. The responsibility for handling the situation rests, of course, with the statesmen alone. The scientists who are brought into confidence can only offer the statesmen all such information about technical matters as may be of importance for their decisions.

In this connection it is significant that the enterprise, immense as it is, has still proved to demand a much smaller effort than might have been anticipated, and that the development of the work has continually revealed unsuspected possibilities for facilitating the production of the materials and for intensifying their effects.

These circumstances obviously have an important bearing on the question of an eventual competition about the formidable weapon, and on the problem of establishing an effective control, and might therefore perhaps influence the judgment of the statesmen as to how the present favourable situation can best be turned to lasting advantage for the cause of freedom and world security.

I hope you will permit me to say that I am afraid that, at the personal interview with which you honoured me, I may not have given you the right impression of the confidential conversation in Washington on which I reported. It was, indeed, far from my mind to venture any comment about the way in which the great joint enterprise has been so happily arranged by the statesmen; I wished rather to give expression to the profound conviction I have met everywhere on my journey that the hope for the future lies above all in the most brotherly friendship between the British Commonwealth and the United States.

It was just this spirit of co-operation that the President's friend [**Felix Frankfurter**], believing the matter to be of the highest importance for the two countries, and knowing that, at the Chancellor's request, I was coming to England for technical consultations, entrusted me, in strictest confidence, to convey to you, that the President is deeply occupied in his own mind with the stupendous consequences of the project, in which he sees grave dangers, but also unique opportunities, and that he hopes together with you to find ways of handling the situation to the greatest benefit of all mankind.

Most respectfully,

Letter from J. T. Randall to Rosalind Franklin

4th December, 1950

Dear Dr. Franklin,

I am sorry I have taken so long to reply to your letter of November 24th. The real difficulty has been that the X-ray work here is in a somewhat fluid state and the slant on the research has changed rather since you were last here.

After very careful consideration and discussion with the senior people concerned, it now seems that it would be a good deal more important for you to investigate the structure of certain biological fibres in which we are interested, both by low and high angle diffraction, rather than to continue with the original project of work on solutions as the major one.

Dr. Stokes, as I have long inferred, really wishes to concern himself almost entirely with theoretical problems in the future and these will not necessarily be confined to X-ray optics. It will probably involve microscopy in general. This means that as far as the experimental X-ray effort is concerned there will be at the moment only yourself and Gosling, together with the temporary assistance of a graduate from Syracuse, Mrs. Heller. Gosling, working in conjunction with Wilkins, has already found that fibres of desoxyribose nucleic acid derived from material provided by Professor Signer of Bern gives remarkably good fibre diagrams. The fibres are strongly negatively birefringent and become positive on stretching, and are reversible in a moist atmosphere. As you no doubt know, nucleic acid is an extremely important constituent of cells and it seems to us that it would be very valuable if this could be followed up in detail. If you are agreeable to this change of plan it would seem that there is no necessity immediately to design a camera for work on solutions. The camera will, however, be extremely valuable in searching for large spacings from such fibres.

I hope you will understand that I am not in this way suggesting that we should give up all thought of work on solutions, but we do feel that the work on fibres would be more immediately profitable and, perhaps, fundamental.

I think I must leave to you the question as to whether you come over here for a day or two to discuss these matters further. It now seems so near to the time when you will actually be working here that it is perhaps hardly necessary for you to make the special journey. On the other hand there may be things which you could organize on the apparatus side in Paris and you could hardly do this without further discussion with us. The change of program, such as I have suggested, will probably mean that we should obtain the formal consent of the Fellowhip Committee; there is no hurry about this and there is no doubt about the answer.

Dr. Price has just heard from Mr. Heins of the Rockefeller Foundation that orders have now been placed for your apparatus.

Yours sincerely,
J.T. Randall

Letter from Rosalind Franklin to Dorothy Wrinch

26th May, 1955
Dear Dorothy,

Thank you so much for your letter and reprints and for your very kind invitation. I am afraid there is no chance of my getting to America this summer, but I certainly hope to come again sometime, and to visit you in rather less of a rush. This year I shall be going to the Biochemistry conference in Brussels in August, and spending my holiday on the Continent after that.
I enclose the numerical values of the Patterson. The accuracy is, of course considerably lower than for a crystal because of the difficulty of measuring intensities on very small

fibre-diagrams having peaks of various shapes and sizes. (The large, unwieldy numerical scale is simply because it was easier to get the figures copied as they were than to reduce them). The origin peak has been added in, assuming it to be as for a uniform density rod of radius 75A, and using the first two observed equatorial maxima to obtain the scale. I have not worked out the absolute scale, but you can obtain it approximately from the fact that the origin peak is due to a "unit cell" in the form of a disc of radius 75A and height 69A surrounded by water.

I think there is now very little doubt that the principal non-axial periodicity of TMV protein is helical, there being 3n+l units in 3 turns of the helix. This makes a hexagon unit cell impossible. I have no information at present about the 3-dimensional distribution of any reflections, but I believe that the strong 11A reflections on the 2nd and 7th layer-lines are due to structure within the protein subunit, and therefore have rotational 2 symmetry of a higher order.

You have probably seen by now the 3-dimensional Patterson of DNA in Acta. I will ask Gosling to send you a set of reprints of all our DNA papers.

With best wishes,

Yours,

Enrico Fermi's letter about computers

To: Professor Enrico Avanzi

Rector of the University of Pisa

Dear Professor

On the occasion of my stay at the Varenna School, Professors Conversi and Salvini mentioned that the University of Pisa might have at its disposal a large amount of money to use for the development and progress of Italian research.

On being questioned about the various possibilities to use such funds. I thought that the idea of building an electronic computer in Pisa was by far the best.

An electronic computer would constitute a research instruments from which all science and research activities would profit, in such a manner that is currently inestimable.

I know that the Institute for Applications of Computation, headed by Professor Picone, is in the process of buying a machine of the same kind. However, I do not think that this event would reduce the need for such a machine for a centre of study like the University of Pisa. Experience shows that the possibility of executing complex calculations with great speed and accuracy quickly creates such an enormous demand for these services which would soon be beyond the capacity of just one machine. Furthermore, there are the advantages for the students and researchers who will be trained in the use of these new tools for computation.

Yours sincerely

Enrico Fermi

Letter From Oppenheimer To Fermi With AM-Poison Plan

I wanted to report to you on the question of the radioactively poisoned foods, both because there are some steps that I have taken, and because Edward Teller has told me of the difficulties into which you have run.

When I was in Washington I learned that the Chief of Staff had requested from (James Bryant) Conant (former Harvard University president and chairman of the National Defense Research Committee during World War II) a summary report on the military uses of radioactive materials and that Conant was in the process of collecting the material for that report. I therefore, with (Gen. Leslie) Groves' (commander of the Manhattan

Project) knowledge and approval, discussed with him the application which seemed to us so promising, gave him a few points of detail and some orders of magnitude. I raised the question of what steps, offensive and defensive, should be taken in this connection. It is my opinion, and it was also Conant's, that the defensive measures would probably preclude our carrying out the method ourselves effectively, and therefore I asked that in his report the question of policy he raised as to which of these lines we should primarily follow. This report, and you will undoubtedly have heard of it in other connections, is to go directly to Gen. (George C.) Marshall (Army chief of staff) so that it will have authoritative if not expert consideration. I hope to discuss the question further when Conant visits here in 10 days.

I also plan to go into the matter a little more deeply with (Joseph) Hamilton (a physician and associate professor of medicine at the University of California at Berkeley's Radiation Laboratory), although of course only on the physiological side. As you know, he has already made studies of the strontium which appears to offer the highest promise, and he expressed his willingness to look into these questions more fully. I think that I can do this without in any way indicating the nature of our interest, but it will be some time, perhaps three weeks, before I get to see him.

I understand the difficulties that you have had in getting this subject developed without telling anyone about it,and it is hard for me to give very sound advice on what to do. I think that there is at least one quite well defined radiochemical problem, which is the separation of the beta-strontium from other activities. It is my impression after talking it over with (Edward) Teller (known as the father of the hydrogen bomb), that this is not a very major problem except in so far as provision would have to be made for carrying it out by remote control at the actual site of operation. I do not see how this can be done without letting a number of people into the secret of why we want the strontium. I should therefore like to ask you what you think the latest safe date is for the solution of this and other problems. It seems to me that we have a much better chance of keeping your plan quiet if we do not start work on it until it is essential to do so. If, in your opinion, the time for such work is now, I believe that you should discuss it with (Chicago physicist Samuel

K.) Allison and (German-born physicist and Nobel laureate James) Franck (both based in Chicago and doing atomic bomb research) on their advice, if absolutely necessary, with Compton, and that perhaps this group of people will be enough to get the work done without more wide-spread discussion. In a general way I think we have better facilities here for keeping things of that kind within a well defined group, namely, the scientific personnel of the laboratory, than exists in other places. On the other hand, I do not think that we are equipped to tackle the problem with anything like the expedition that you can in Chicago.

To summarize, then, I should recommend delay if that is possible. (In this connection I think that we should not attempt a plan unless we can poison food sufficient to kill a half million men, since there is no doubt that the actual number affected will, because of non-uniform distribution, be much smaller than this.) If you believe that such delay will be serious, I should recommend discussion with a few well-chosen people. Finally, I should postpone this action until I have had an opportunity to reopen the question with Conant and if possible to obtain information on the decision of the General Staff.

Things here are going quite well and we are still remembering with pleasure and profit your fine visit. I hope that you can come again late in June, and that we shall have at that time some less programatic problems to discuss with you.

"The views of space and time which I wish to lay before you have sprung from the soil of experimental physics, and therein lies their strength. They are radical. Henceforth, space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality."

– Hermann Minkowski

Freeman Dyson's Letter Offer Another Glimpse Of Genius

March 8, 1948

Feynman is the young American professor, half genius and half buffoon, who keeps all physicists and their children amused with his effervescent vitality. He has, however, as I have recently learned, a great deal more to him than that, and you may be interested in his story. The part of it with which I am concerned began when he arrived at Los Alamos; there he found and fell in love with a brilliant and beautiful girl, who was tubercular and had been exiled to New Mexico in the hope of stopping the disease. When Feynman arrived, things had got so bad that the doctors gave her only a year to live, but he determined to marry her, and marry her he did; and for a year and a half, while working at full pressure on the project, he nursed her and made her days cheerful. She died just before the end of the war.

I was wrong when I wrote that Feynman found his wife Arlene in New Mexico. He married her first in a city hall on Staten Island and then took her with him to New Mexico. The story is movingly told by Feynman in the book What Do You Care What Other People Think? (1988), the title being a quote from Arlene.

As Feynman says, anyone who has been happily married once cannot long remain single, and so yesterday we were discussing his new problem, this time again a girl in New Mexico with whom he is desperately in love. This time the problem is not tuberculosis, but the girl is a Catholic. You can imagine all the troubles this raises, and if there is one thing Feynman could not do to save his soul, it is to become a Catholic himself. So we talked and talked and sent the sun down the sky and went on talking in the darkness. At the end of it, Feynman was no nearer to the solution of his problems, but it must have done him good to get them off his chest. I think that he will marry the girl and that it will be a success, but far be it from me to give advice to anybody on such a subject.

Email From Elon Musk to Tesla Employees Describes What Great Communication Looks Like

Subject: Communication Within Tesla

There are two schools of thought about how information should flow within companies. By far the most common way is chain of command, which means that you always flow communication through your manager. The problem with this approach is that, while it serves to enhance the power of the manager, it fails to serve the company.

Instead of a problem getting solved quickly, where a person in one dept talks to a person in another dept and makes the right thing happen, people are forced to talk to their manager who talks to their manager who talks to the manager in the other dept who talks to someone on his team. Then the info has to flow back the other way again. This is incredibly dumb. Any manager who allows this to happen, let alone encourages it, will soon find themselves working at another company. No kidding.

Anyone at Tesla can and should email/talk to anyone else according to what they think is the fastest way to solve a problem for the benefit of the whole company. You can talk to your manager's manager without his permission, you can talk directly to a VP in another dept, you can talk to me, you can talk to anyone without anyone else's permission. Moreover, you should consider yourself obligated to do so until the right thing happens. The point here is not random chitchat, but rather ensuring that we execute ultra-fast and well. We obviously cannot compete with the big car companies in size, so we must do so with intelligence and agility.

One final point is that managers should work hard to ensure that they are not creating silos within the company that create an us vs. them mentality or impede communication in any way. This is unfortunately a natural tendency and needs to be actively fought. How can it possibly help Tesla for depts to erect barriers between themselves or see their success as relative within the company instead of collective? We are all in the same boat. Always view yourself as working for the good of the company and never your dept.

Thanks,
Elon

Letter from G.H. Hardy to S. Ramanujan (8 February 1913)

Dear Sir,

I was exceedingly interested by your letter and by the theorems which you state. You will however understand that, before I can judge properly the value of what you have done, it is essential that I should see proofs of some of your assertions.

Your results seem to me to fall into roughly 3 classes:

(1) there are a number of results which are already known, or are easily deducible from known theorems;

(2) there are results which, so far as I know, are new and interesting but interesting rather from their curiosity and apparent difficulty than their importance;

(3) there are results which appear new and important, but in which almost everything depends on the precise rigour of the methods of proof which you have used.

As instances of these 3 classes I may mention

(1) [Hardy next provides examples of results of the first class]

I need not say that, if what you say about your lack of training is to be taken literally, the fact that you should have rediscovered such interesting results is all to your credit. But you must be prepared for a certain amount of disappointment of this kind.

There are also of course known theories of divergent series, fractional orders of differentiation and integration, and so on. I should be extremely interested to compare your theories with these.

In this class also come some of your theorems about numbers. [...] But I would want particularly to see your proofs of your assertions here. You will understand that, in this theory, everything depends on rigorous exactitude of proof.

I should add that theorems of this character are not only interesting, but very difficult and important. If you have some sound and independent proofs of them, it would be, in my opinion, a very remarkable achievement.

(2) [Hardy next provides examples of results of the second class]

(3) In this class I should put (assuming the proofs to be rigerous) some of your theorems about prime numbers-e.g. the expression you say you have for the number of primes < x, which is nearly exact.

It is of course possible that some of the results I have classed under (2) are really important, as examples of general methods. You always state your results in such particular forms that it is difficult to be sure about this.

I hope very much that you will send me as quickly as possible at any rate a few of your proofs, and follow this more at your leisure by a more detailed account of your work on primes and divergent series. It seems to be quite likely that you have done a great deal of work worth publication; and, if you can produce satisfactory demonstrations, I should be very glad to do what I can to secure it.

I have said nothing about some of your results--notably those about elliptic functions. I have not got them to refer to, as I handed them to another mathematician more expert than I in this special subject.

Hoping to hear from you again as soon as possible.

I am

Yours very truly,

G.H. Hardy

[Hardy finally adds "further notes suggested by Mr. Littlewood"]

Letter from S. Ramanujan to G.H. Hardy (16 January 1913)

Dear Sir,

I beg to introduce myself to you as a clerk in the Accounts Department of the Port Trust Office at Madras on a salary of only £20 per annum. I am now about 23 years of age. I have had no University education but I have undergone the ordinary school course. After leaving school I have been employing the spare time at my disposal to work at Mathematics. I have not trodden through the conventional regular course which is followed in a University course, but I am striking out a new path for myself. I have made a special investigation of divergent series in general and the results I get are termed by the local mathematicians as "startling".

Just as in elementary mathematics you give a meaning to a^n when n is negative and fractional to conform to the law which holds when n is a positive integer, similarly the whole of my investigations proceed on giving a meaning to Eulerian Second Integral for all values of n. My friends who have gone through the regular course of University education tell me that [eq. 1] is true only when n is positive. They say that this integral relation is not true when n is negative. Supposing this is true only for positive values of n and also supposing the definition [eq. 2] to be universally true, I have given meanings to these integrals and under the conditions I state the integral is true for all values of n negative and fractional. My whole investigations are based upon this and I have been developing this to a remarkable extent so much so that the local mathematicians are not able to understand me in my higher flights.

Very recently I came across a tract published by you styled Orders of Infinity in page 36 of which I find a statement that no definite expression has been as yet found for the number of prime numbers less than any given number. I have found an expression which very nearly approximates to the real result, the error being negligible. I would request you to go through the enclosed papers. Being poor, if you are convinced that there is anything of value I would like to have my theorems published. I have not given the actual investigations nor the expressions that I get but I have indicated the lines on which I proceed. Being inexperienced I would very highly value any advice you give me. Requesting to be excused for the trouble I give you.

I remain, Dear Sir, Yours truly,

S. Ramanujan

P.S. My address is S. Ramanujan, Clerk Accounts Department, Port Trust, Madras, India

Carl Sagan Letter to 17-Year-Old Neil deGrasse Tyson (1975)

Dear Neil:

Thanks for your letter and most interesting resume. I was especially glad to see that, for a career in astronomy, you intend to do your undergraduate work in physics. In this way, you will acquire the essential tools for a wide range of subsequent astronomical endeavors.

I would guess from your resume that your interests in astronomy are sufficiently deep and your mathematical and physical background sufficiently strong that we could probably engage you in real astronomical research during your undergraduate career here, if the possibility interests you. For example, we hope to be bringing back to Ithaca in late calendar year 1976 an enormous array of Viking data on Mars both from the orbiters and from the landers.

I would be delighted to meet with you when you visit Ithaca. Please try and give as much advance notice of the date as you can because my travel schedule is quite hectic right now and I really would like to be in Ithaca when you drop by.

With all good wishes,
Carl Sagan

Tyson Reply:

Dear Prof. Sagan

Thank you for your offer concerning the Viking Missions. After long thought and decision making I have chosen to attend Harvard University this September. I chose it not simply because of its "valuable" name but because they have a larger astronomy department in addition to the Smithsonian Astrophysical Observatory, so while I am majoring in physics I will have more surrounding me in the way of on-going research in astronomy.

I want to say that I did enjoy meeting you and I am very grateful for your hospitality and the time you spent with me while at Cornell. I will throughout my undergraduate years keep you informed on any noteworthy news concerning astronomy-related work that I'm involved in. I do plan to apply again for the Viking Internship next summer.

Thanks again
Neil D. Tyson

A Horrific Humiliation And Sense Of Betrayal | Eddington And Chandrasekhar

This story dates back to 1930s when India was ruled or administered by the United Kingdom and its predecessor states. Just a few years ago, the Nobel Prize in Physics was awarded to the first Asian Sir **Chandrasekhara Venkata Raman** for his work on the scattering of light and for the discovery of the effect named after him. In this uncertain time when India was suffering under colonial rule of the British Raj, there was one Lahore-born, Presidency College-educated student who was dreaming of bringing the second Nobel Prize to his country and he was none other than Nephew of the Indian physicist Chandrasekhara Venkata Raman: Subrahmanyan Chandrasekhar.

Applied mathematician and astrophysicist Subrahmanyan Chandrasekhar completed his university education at Presidency College [Madras] graduating with a Bachelor of Science degree in physics and to pursue his Master's Chandra went to Britain as he was awarded a Government of India scholarship to study at Cambridge as a member of Trinity College.

While on the voyage to Cambridge in 1930, Chandra worked on one of his most significant discoveries called Chandrasekhar's limit. He applied Albert Einstein's theory of relativity to the processes inside a star. His calculations suggested that once a stellar star had burned up all its energy (exhibiting a corresponding mass m given by its energy E divided by the speed of light squared) it would collapse to a point of infinite density where gravity is so strong that nothing—no particles or even electromagnetic radiation such as light—can escape from it.

Since he was born in an open minded Tamil Iyer family, to Sita Balakrishnan (1891–1931) and Chandrasekhara Subrahmanya Ayyar (1885–1960) who was stationed in Lahore as Deputy Auditor General of the Northwestern Railways at the time of Chandrasekhar's birth, He assumed the community there would welcome him and his contribution to the structure and evolution of stars with open arms. But the reality was far from what he had thought − his theories were overlooked because of his race. The scientific community in Britain ignored him and his work on the white dwarfs and black holes as a result of which he went into a deep mood disorder. He had lost all feeling of trust.

Then came an English astronomer, physicist, and mathematician "Sir Arthur Stanley Eddington". For those who don't know about Eddington, he was the

- Philosopher of science
- Populariser of science

One who conducted an expedition to observe the solar eclipse of 29 May 1919 that provided one of the earliest confirmations of Albert Einstein's general theory of relativity, and he became known for his popular expositions and interpretations of the theory.

The legendary astrophysicist Arthur Stanley Eddington started meeting Chandra frequently. **Chandra and Eddington** were almost in daily contact about their research. Subrahmanyan Chandrasekhar felt motivated that a man of Eddinton's reputation is helping him out. Arthur Eddington was also working on the similar subject and he encouraged Chandrasekhar to pursue the detailed calculations and produce his results at the Royal Astronomical Society meeting on 11 January 1935, in England to which Chandrasekhar agreed.

But, on January 10, he came to know that Eddington too had a lecture after him that too on the same topic. He was puzzled, but thought no more about it. On the day of the conference, all the leading figures in astrophysics were at the Royal Astronomical Society. Chandra delivered his paper, showing a graph that made it transparently clear that the maximum mass at which a star near the end of its life cycle can become a white dwarf and above which the star will collapse to form a neutron star or black hole: a stellar mass equal to about 1.4 solar masses. Triumphantly he sat down, assuming that Eddington would support his conclusions. But to his horror, Eddington − a supercilious man – claimed that there was no such thing as Chandra's relativistic degeneracy; arguing that Chandra's theory was mere mathematical game-playing − with no basis in reality, he used the full force of his famed oratorical skills to demolish the young researcher's calculations and theory. Eddington's arguments were unfounded and highly dubious; but the weight of his reputation was such that no one dared to disagree with him. Chandra was not even given the opportunity to reply to this confrontation. The next speaker was called.

This controversy rumbled and preoccupied scientific journals for several years. Chandra and Eddington came across each other in many conferences and it was Sir Arthur Eddington, who was always favored and at a talk at Harvard, Eddington termed Chandra's notions a "**stellar buffoonery**".

But years later, in one meeting it was proved that it was Chandrasekhar’s calculations that were correct. On that day, they both had a brief meeting. "I am sorry if I hurt you," Eddington said to Chandra. Chandra asked whether he had changed his mind. "No," Eddington responded. "What are you sorry about then?" Chandra replied and brusquely walked away.

Chandrasekhar was awarded the 1983 Nobel Prize for Physics with William A. Fowler for **"... theoretical studies of the physical processes of importance to the structure and evolution of the stars"**. On several occasions he admitted that Eddington's behavior was indeed racially motivated.

Letter from Johannes Kepler to Michael Mästlin

Your Honorable M. Mästlin,
the Most Famous Professor of Mathematics at the Tübingen Academy,
my Most Preceptor,

Due to your continuous silence, great master Mästlin, I have often been forced to be careful in writing to you. It turns out, however, that I despair in war, for the more I write, the less with you. You must have read my work on optics, of which I have already sent, as a gift to Frankfurt, copies (one, together with four others for you, by librarian Célio as your depositary, I beg you to deal with **Doctor Besoldo** who asked for a copy). If you read my conception of the new star, which you have already received, you will not be motivated to write to me; but at least because of S. Majesty Cesar, for which the writings are so pleasant, ask him about various things; write me something. Ask for Rosalino, whose writings now accepts S. Majesty Cesar; this matter is common to mathematicians, and not understanding it represents a crime of desertion.

My efforts are concentrated on comments on the movements of Mars. I believe that you have already said something about it in the things of optics, which I do not doubt; namely, that I rarely find the issue. So, I think, why don't you communicate by letters? I often think of naughty things, which, if fanned by letters, can be known. All my work consists of this, in proposing the genuine causes, both for the correct eccentric equations and for the accumulated distances. But I will always continue to advance by the grace of God, so that I no longer withdraw from one thing or another, and I am sure that I will advance by another hypothesis, and from now on I will not consider that things about the driving forces may be in vain. And, as I have often triumphed over Mars, this, however, is at issue: if the eccentric ratio is distributed among the concentric and the epicycle; know that the center of the epicycle has a different movement than the concentric one; that is, that the concentric moves equally over the other center; because the eccentric also moves over the other center. In this regard, if the movements of both the concentric and the epicycle attract and repel each other equally (that is, if the line drawn from the center of the concentric passes equally through the center of the epicycle, then this indicates the true heyday of the epicycle), thus, in effect, the planet's orbit, which passes through the body, remains in a perfect eccentric circle. However, the observations attest that, at median longitudes, on both sides, the planet enters about 900 parts in 152,500 sideways. And these physical reasons persuade us to say that the movement of the epicycle over the center itself is without uniform ambiguity (that is, that the line of the apogee of the true epicycle passes through the centers of the concentric and the epicycle). However, if you do this, the planet deflects from circular orbit by 1,300 [parts], while it should, according to observations, only be in the order of 900. In addition, as in the median longitudes and in the most distant directions of the perigee, this entrance also happens to the sides, so that in the direction of the apogee it will not be seen as great.It follows that the epicycle itself is not entirely uniform; nor does it match the inequality of movement with the concentric, but it becomes faster both on a planet moving in the vicinity of the epicycle's heyday, and in the vicinity of the epicycle's perigee. (that is, that the line of the true apogee of the epicycle is just below the center of the concentric at the apogee and, above it, at the perigee). Tycho attributes the same to the Moon, that it be fast, **caeteris paribus**, both in relation to Mars and the Earth.

I already got the reasons for the tables. I have the Mars tables, from which in a single day someone diligent makes the ephemeris for every ten days of a single year. Nor are any new corrections of one distance useless: the others are general.

The parallax that is in Optica, one saves all latitudes, without any calculation, nor any exception. I think I have achieved something; and as I sometimes get distressed by my health, I ask you for advice on the work that I am prohibited from publishing and presenting to the Academy, elaborated with Tycho's very abundant and selected observations. If there was a slight hope about Tengnagel, from which something is taken advantage of, no work would require my advice, using Tycho's observations. However, believe me, I am not afraid of it, nor am I lost in the desert. I ask what your opinion is, if you were in Tycho's place, and you discerned these things, would you by any chance also criticize being daring what I do? I've written a lot about eclipses in recent months, as well as about the star Cygni. However, I do not want to force you; waste a quarter of an hour with words, with which you will purify the guilt of the silence of so many years.

Goodbye and wish me well.

"[Projective geometry] was most useful for research… When I had obtained a particular result, I translated it into an analytic form and put down the argument in terms of equations."

PAUL DIRAC

Recollections of an Exciting Era, 1977

"Please do not take these questions as criticisms of your wonderful work… [I] still wonder at the mathematical simplicity with which you have overcome this problem."

WERNER HEISENBERG

Letter to Dirac, December 1, 1925

"At last gleams of light have come, & I am almost convinced (quite contrary to opinion I started with) that species are not (it is like confessing a murder) immutable."

– Charles Darwin to Joseph Dalton Hooker, 11 January 1844

Charles Darwin's letter to Charles Lyell [18 June 1858]

My dear Lyell

Some year or so ago, you recommended me to read a paper by Wallace in the Annals, which had interested you & as I was writing to him, I knew this would please him much, so I told him. He has today sent me the enclosed & asked me to forward it to you. It seems to me well worth reading. Your words have come true with a vengeance that I should be forestalled. You said this when I explained to you here very briefly my views of "Natural Selection" depending on the Struggle for existence. I never saw a more striking coincidence. If Wallace had my M.S. sketch written out in 1842 he could not have made a better short abstract! Even his terms now stand as Heads of my Chapters.

Please return me the M.S. which he does not say he wishes me to publish; but I shall of course at once write & offer to send to any Journal. So all my originality, whatever it may amount to, will be smashed. Though my Book, if it will ever have any value, will not be deteriorated; as all the labour consists in the application of the theory.

I hope you will approve of Wallace's sketch, that I may tell him what you say.

My dear Lyell | Yours most truly | C. Darwin

Charles Darwin's letter to Charles Lyell [25 June 1858]

My dear Lyell

I am very very sorry to trouble you, busy as you are, in so merely personal an affair. But if you will give me your deliberate opinion, you will do me as great a service, as ever man did, for I have entire confidence in your judgment & honour.

I should not have sent off your letter without further reflexion, for I am at present quite upset, but write now to get subject for time out of mind. But I confess it never did occur to me, as it ought, that Wallace could have made any use of your letter.

There is nothing in Wallace's sketch which is not written out much fuller in my sketch copied in 1844, & read by Hooker some dozen years ago. About a year ago I sent a short sketch of which I have copy of my views (owing to correspondence on several points) to Asa Gray, so that I could most truly say & prove that I take nothing from Wallace. I should be extremely glad now to publish a sketch of my general views in about a dozen pages or so. But I cannot persuade myself that I can do so honourably. Wallace says nothing about publication, & I enclose his letter. But as I had not intended to publish any sketch, can I do so honourably because Wallace has sent me an outline of his doctrine? I would far rather burn my whole book than that he or any man should think that I had behaved in a paltry spirit. Do you not think his having sent me this sketch ties my hands? I do not in least believe that that he originated his views from anything which I wrote to him.

If I could honourably publish I would state that I was induced now to publish a sketch (& I should be very glad to be permitted to say to follow your advice long ago given) from Wallace having sent me an outline of my general conclusions. We differ only, that I was led to my views from what artificial selection has done for domestic animals. I could send Wallace a copy of my letter to Asa Gray to show him that I had not stolen his doctrine.

But I cannot tell whether to publish now would not be base & paltry: this was my first impression, & I should have certainly acted on it, had it not been for your letter.

This is a trumpery affair to trouble you with; but you cannot tell how much obliged I should be for your advice.

By the way would you object to send this & your answer to Hooker to be forwarded to me, for then I shall have the opinion of my two best & kindest friends. This letter is miserably written & I write it now, that I may for time banish whole subject. And I am worn out with musing.

I fear we have case of scarlet-fever in House with Baby. Etty is weak but is recovering.

My good dear friend forgive me. This is a trumpery letter influenced by trumpery feelings.

Yours most truly | C. Darwin

I will never trouble you or Hooker on this subject again

"Mathematics, rightly viewed, possesses not only truth, but supreme beauty - a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show. The true spirit of delight, the exaltation, the sense of being more than Man, which is the touchstone of the highest excellence, is to be found in mathematics as surely as poetry."

– Nobelist Bertrand Russell

Bertrand Russell's Artful Letter Stating His Refusal to Debate British Fascist Leader Oswald Mosley (1962)

Dear Sir Oswald,

Thank you for your letter and for your enclosures. I have given some thought to our recent correspondence. It is always difficult to decide on how to respond to people whose ethos is so alien and, in fact, repellent to one’s own. It is not that I take exception to the general points made by you but that every ounce of my energy has been devoted to an active opposition to cruel bigotry, compulsive violence, and the sadistic persecution which has characterized the philosophy and practice of fascism.

I feel obliged to say that the emotional universes we inhabit are so distinct, and in deepest ways opposed, that nothing fruitful or sincere could ever emerge from association between us.

I should like you to understand the intensity of this conviction on my part. It is not out of any attempt to be rude that I say this but because of all that I value in human experience and human achievement.

Yours sincerely,
Bertrand Russell

A letter from Albert Einstein to Sigmund Freud

Dear Professor Freud,...

Is there any way of delivering mankind from the menace of war?

It is common knowledge that, with the advance of modern science, this issue has come to mean a matter of life and death for civilization as we know it; nevertheless, for all the zeal displayed, every attempt at its solution has ended in a lamentable breakdown.

I believe, moreover, that those whose duty it is to tackle the problem professionally and practically are growing only too aware of their impotence to deal with it, and have now a very lively desire to learn the views of men who, absorbed in the pursuit of science, can see world-problems in the perspective distance lends. As for me, the normal objective of my thought affords no insight into the dark places of human will and feeling. Thus, in the enquiry now proposed, I can do little more than seek to clarify the question at issue and, clearing the ground of the more obvious solutions, enable you to bring the light of your far-reaching knowledge of man's instinctive life to bear upon the problem...

...As one immune from nationalist bias, I personally see a simple way of dealing with the superficial (i.e. administrative) aspect of the problem: the setting up, by international consent, of a legislative and judicial body to settle every conflict arising between nations. Each nation would undertake to abide by the orders issued by this legislative body, to invoke its decision in every dispute, to accept its judgments unreservedly and to carry out every measure the tribunal deems necessary for the execution of its decrees. But here, at the outset, I come up against a difficulty; a tribunal is a human institution which, in proportion as the power at its disposal is inadequate to enforce its verdicts, is all the more prone to suffer these to be deflected by extrajudicial pressure. This is a fact with which we have to reckon; law and might inevitably go hand in hand, and juridical decisions approach more nearly the ideal justice demanded by the community (in whose name and interests these verdicts are pronounced) in so far as the community has effective power to compel respect of its juridical ideal. But at present we are far from possessing any supranational organization competent to render verdicts of incontestable authority and enforce absolute submission to the execution of its verdicts. Thus I am led to my first axiom: the quest of international security involves the unconditional surrender by every nation, in a certain measure, of its liberty of action, its sovereignty that is to say, and it is clear beyond all doubt that no other road can lead to such security.

The ill-success, despite their obvious sincerity, of all the efforts made during the last decade to reach this goal leaves us no room to doubt that strong psychological factors are at work, which paralyse these efforts. Some of these factors are not far to seek. The craving for power which characterizes the governing class in every nation is hostile to any limitation of the national sovereignty. This political power-hunger is wont to batten on the activities of another group, whose aspirations are on purely mercenary, economic lines. I have specially in mind that small but determined group, active in every nation, composed of individuals who, indifferent to social considerations and restraints, regard warfare, the manufacture and sale of arms, simply as an occasion to advance their personal interests and enlarge their personal authority.

But recognition of this obvious fact is merely the first step towards an appreciation of the actual state of affairs. Another question follows hard upon it: how is it possible for this small clique to bend the will of the majority, who stand to lose and suffer by a state of war, to the service of their ambitions? (In speaking of the majority, I do not exclude soldiers of every rank who have chosen war as their profession, in the belief that they are serving to defend the highest interests of their race, and that attack is often the best method of defence.) An obvious answer to this question would seem to be that the minority, the ruling class at present, has the schools and press, usually the Church as well, under its thumb. This enables it to organize and sway the emotions of the masses, and make its tool of them.

Yet even this answer does not provide a complete solution. Another question arises from it: How is it these devices succeed so well in rousing men to such wild enthusiasm, even to sacrifice their lives? Only one answer is possible. Because man has within him a lust for hatred and destruction. In normal times this passion exists in a latent state, it emerges only in unusual circumstances; but it is a comparatively easy task to call it into play and raise it to the power of a collective psychosis. Here lies, perhaps, the crux of all the complex of factors we are considering, an enigma that only the expert in the lore of human instincts can resolve.

And so we come to our last question. Is it possible to control man's mental evolution so as to make him proof against the psychoses of hate and destructiveness? Here I am thinking by no means only of the so-called uncultured masses. Experience proves that it is rather the so-called "**Intelligentzia**" that is most apt to yield to these disastrous collective suggestions, since the intellectual has no direct contact with life in the raw, but encounters it in its easiest, synthetic form upon the printed page.

To conclude: I have so far been speaking only of wars between nations; what are known as international conflicts. But I am well aware that the aggressive instinct operates under other forms and in other circumstances. (I am thinking of civil wars, for instance, due in earlier days to religious zeal, but nowadays to social factors; or, again, the persecution of racial minorities). But my insistence on what is the most typical, most cruel and extravagant form of conflict between man and man was deliberate, for here we have the best occasion of discovering ways and means to render all armed conflicts impossible.

Yours very sincerely,

A. Einstein

Richard Feynman's Letter to His Departed Wife

October 17, 1946

D'Arline,

I adore you, sweetheart.

I know how much you like to hear that — but I don't only write it because you like it — I write it because it makes me warm all over inside to write it to you.

It is such a terribly long time since I last wrote to you — almost two years but I know you'll excuse me because you understand how I am, stubborn and realistic; and I thought there was no sense to writing.

But now I know my darling wife that it is right to do what I have delayed in doing, and that I have done so much in the past. I want to tell you I love you. I want to love you. I always will love you.

I find it hard to understand in my mind what it means to love you after you are dead — but I still want to comfort and take care of you — and I want you to love me and care for me. I want to have problems to discuss with you — I want to do little projects with you. I never thought until just now that we can do that. What should we do. We started to learn to make clothes together — or learn Chinese — or getting a movie projector. Can't I do something now? No. I am alone without you and you were the "idea-woman" and general instigator of all our wild adventures.

When you were sick you worried because you could not give me something that you wanted to and thought I needed. You needn't have worried. Just as I told you then there was no real need because I loved you in so many ways so much. And now it is clearly even more true — you can give me nothing now yet I love you so that you stand in my way of loving anyone else — but I want you to stand there. You, dead, are so much better than anyone else alive.

I know you will assure me that I am foolish and that you want me to have full happiness and don't want to be in my way. I'll bet you are surprised that I don't even have a girlfriend (except you, sweetheart) after two years. But you can't help it, darling, nor can I — I don't understand it, for I have met many girls and very nice ones and I don't want to remain alone — but in two or three meetings they all seem ashes. You only are left to me. You are real.

My darling wife, I do adore you.

I love my wife. My wife is dead.

Rich.

PS Please excuse my not mailing this — but I don't know your new address.

Richard Feynman's Letter to his former student Koichi Manom

Dear Koichi,

I was very happy to hear from you, and that you have such a position in the Research Laboratories. Unfortunately your letter made me unhappy for you seem to be truly sad. It seems that the influence of your teacher has been to give you a false idea of what are worthwhile problems. The worthwhile problems are the ones you can really solve or help solve, the ones you can really contribute something to. A problem is grand in science if it lies before us unsolved and we see some way for us to make some headway into it. I would advise you to take even simpler, or as you say, humbler, problems until you find some you can really solve easily, no matter how trivial. You will get the pleasure of success, and of helping your fellow man, even if it is only to answer a question in the mind of a colleague less able than you. You must not take away from yourself these pleasures because you have some erroneous idea of what is worthwhile.

You met me at the peak of my career when I seemed to you to be concerned with problems close to the gods. But at the same time I had another Ph.D. Student (Albert

Hibbs) whose thesis was on how it is that the winds build up waves blowing over water in the sea. I accepted him as a student because he came to me with the problem he wanted to solve. With you I made a mistake, I gave you the problem instead of letting you find your own; and left you with a wrong idea of what is interesting or pleasant or important to work on (namely those problems you see you may do something about). I am sorry, excuse me. I hope by this letter to correct it a little.

I have worked on innumerable problems that you would call humble, but which I enjoyed and felt very good about because I sometimes could partially succeed. For example, experiments on the coefficient of friction on highly polished surfaces, to try to learn something about how friction worked (failure). Or, how elastic properties of crystals depend on the forces between the atoms in them, or how to make electroplated metal stick to plastic objects (like radio knobs). Or, how neutrons diffuse out of Uranium. Or, the reflection of electromagnetic waves from films coating glass. The development of shock waves in explosions. The design of a neutron counter. Why some elements capture electrons from the L-orbits, but not the K-orbits. General theory of how to fold paper to make a certain type of child's toy (called flexagons). The energy levels in the light nuclei. The theory of turbulence (I have spent several years on it without success). Plus all the "grander" problems of quantum theory.

No problem is too small or too trivial if we can really do something about it.

You say you are a nameless man. You are not to your wife and to your child. You will not long remain so to your immediate colleagues if you can answer their simple questions when they come into your office. You are not nameless to me. Do not remain nameless to yourself – it is too sad a way to be. Know your place in the world and evaluate yourself fairly, not in terms of your naïve ideals of your own youth, nor in terms of what you erroneously imagine your teacher's ideals are.

Best of luck and happiness.

Sincerely,

Richard P. Feynman.

Einstein's Letter to His Son Hans Albert

My dear Albert,

Yesterday I received your dear letter and was very happy with it.

I was already afraid you wouldn't write to me at all anymore. You told me when I was in Zurich, that it is awkward for you when I come to Zurich. Therefore I think it is better if we get together in a different place, where nobody will interfere with our comfort.

I will in any case urge that each year we spend a whole month together, so that you see that you have a father who is fond of you and who loves you. You can also learn many good and beautiful things from me, something another cannot as easily offer you.

What I have achieved through such a lot of strenuous work shall not only be there for strangers but especially for my own boys. These days I have completed one of the most beautiful works of my life, when you are bigger, I will tell you about it.

I am very pleased that you find joy with the piano.

This and carpentry are in my opinion for your age the best pursuits, better even than school. Because those are things which fit a young person such as you very well. Mainly play the things on the piano which please you, even if the teacher does not assign those.

That is the way to learn the most, when you are doing something with such enjoyment that you don't notice that the time passes.

I am sometimes so wrapped up in my work that I forget about the noon meal. . . .

Be with Tete kissed by your Papa.

Regards to Mama.

"Three principles — the conformability of nature to herself, the applicability of the criterion of simplicity, and the "unreasonable effectiveness" of certain parts of mathematics in describing physical reality — are thus consequences of the underlying law of the elementary particles and their interactions. Those three principles need not be assumed as separate metaphysical postulates. Instead, they are emergent properties of the fundamental laws of physics."

– **American physicist Murray Gell-Mann**

The Kurt Gödel Letter to John von Neumann

Princeton, 20 March 1956

Dear Mr. von Neumann:

With the greatest sorrow I have learned of your illness. The news came to me as quite unexpected. Morgenstern already last summer told me of a bout of weakness you once had, but at that time he thought that this was not of any greater significance. As I hear, in the last months you have undergone a radical treatment and I am happy that this treatment was successful as desired, and that you are now doing better. I hope and wish for you that your condition will soon improve even more and that the newest medical discoveries, if possible, will lead to a complete recovery.

Since you now, as I hear, are feeling stronger, I would like to allow myself to write you about a mathematical problem, of which your opinion would very much interest me: One can obviously easily construct a Turing machine, which for every formula F in first order predicate logic and every natural number n, allows one to decide if there is a proof of F of length n (length = number of symbols). Let $\psi(F,n)$ be the number of steps the machine requires for this and let $\varphi(n) = \max_F \psi(F,n)$. The question is how fast $\varphi(n)$ grows for an optimal machine. One can show that $\varphi(n) \geq k \cdot n$. If there really were a machine with $\varphi(n) \sim k \cdot n$ (or even $\sim k \cdot n^2$), this would have consequences of the greatest importance. Namely, it would obviously mean that in spite of the undecidability of the Entscheidungsproblem, the mental work of a mathematician concerning Yes-or-No questions could be completely replaced by a machine. After all, one would simply have to choose the natural number n so large that when the machine does not deliver a result, it makes no sense to think more about the problem. Now it seems to me, however, to be completely within the realm of possibility that $\varphi(n)$ grows that slowly. Since it seems that $\varphi(n) \geq k \cdot n$ is the only estimation which one can obtain by a generalization of the proof of the undecidability of the Entscheidungsproblem and after all $\varphi(n) \sim k \cdot n$ (or $\sim k \cdot n^2$) only means that the number of steps as opposed to trial and error can be reduced from N to log N (or $(\log N)^2$). However, such strong reductions appear in other finite problems, for example in the computation of the quadratic residue symbol using repeated application of the law of reciprocity. It would be interesting to know, for instance, the situation concerning the determination of primality of a number and how strongly in general the number of steps in finite combinatorial problems can be reduced with respect to simple exhaustive search.

I do not know if you have heard that "**Post's problem**", whether there are degrees of unsolvability among problems of the form $(\exists\ y)\ \varphi(y,x)$, where φ is recursive, has been solved in the positive sense by a very young man by the name of Richard Friedberg. The solution is very elegant. Unfortunately, Friedberg does not intend to study mathematics, but rather medicine (apparently under the influence of his father). By the way, what do you think of the attempts to build the foundations of analysis on ramified type theory, which have recently gained momentum? You are probably aware that Paul Lorenzen has pushed ahead with this approach to the theory of Lebesgue measure. However, I believe that in important parts of analysis non-eliminable impredicative proof methods do appear.

I would be very happy to hear something from you personally. Please let me know if there is something that I can do for you. With my best greetings and wishes, as well to your wife,

Sincerely yours,

Kurt Gödel

"I then asked Mr. Chandrasekhar, 'I hear you are studying Newton these days. Are you finding him as interesting as you had hoped he would be?'

He replied that somebody else who had heard he was studying Newton had recently asked him, 'How do you feel?' And (Mr. Chandrasekhar continued) he had answered:

'I am like a small boy going to the zoo for the first time and seeing a lion.'"

In the talk "Shakespeare, Newton, and Beethoven" in April 1975 at the University of Chicago, Chandrasekhar made the following remark:

"It is only when we observe the scale of Newton's achievement that comparisons, which have sometimes been made with other men of science, appear altogether inappropriate both with respect to Newton and with respect to the others."

– **George Anastaplo**

Planck Letter to Schrödinger [2 April 1926]

Berlin—Grunewald

2 April 1926

Dear Colleague,

Many thanks for the reprint. I read your article the way an inquisitive child listens in suspense to the solution of a puzzle that he has been bothered about for a long time, and I am delighted with the beauties that are evident to the eye, but I have to study it much more closely and in detail to be able to grasp it completely. Besides, I find it extremely congenial that such a prominent role is played by the action function W. I have always been convinced that its significance in physics was still far from exhausted. There is just one little blemish that I would have been glad to see removed. Old Jacobi would have been a little annoyed, despite all his interest, over the alteration of his name. Can it still be changed?

Yours,

Planck

Schrödinger Letter to Planck [8 April 1926]

Zürich

8 April 1926

My dear Professor,

I was indescribably delighted by your kind card of April 2nd. I am especially happy that the basic idea seems plausible to you, and am now very confident that in the course of time it will be worked out in a way that is useable in all respects, no matter how imperfect it may be at present.

I am very ashamed about the dreadful "k", and immediately wrote to the printers; I hope it can still be changed. Many thanks—the worst of it is the ironclad consistency with which I disfigured this hallowed name in five places; it would have been terribly distressing to me.

Thank you very much for kindly sending me your lecture, which I had already read with the greatest interest several days earlier. I was especially captivated by the dramatic force with which you sketch the status of the theory of relativity and the quantum theory—in the third section—and with the way you pick out the key difficulty and make it comprehensible without formulas. Just this difficulty concerning the energy unfortunately still persists, quite unimpaired.

If I did not answer your card, which gave me so much pleasure, at once, it was because I wanted to send along at least a little something that was new. Enclosed are the results for the Stark Effect in H. It seems that the intensities come out completely right. The assumption on which it is based is that the electrical charge density is given by the square of the wave function, and that the normalization integral has the same value for all the individual proper vibrations that belong to one coarse Balmer level. I cannot yet describe the numbers I am sending you as incontestable because the calculation is very involved and I have not yet checked everything again. In any case Epstein's formula for the splitting comes out completely unaltered (as I already said at the end of my "Second Paper"); also the "Selection Rule for the azimuthal quantum number". Moreover, the "exclusion of zero for the equatorial quantum number" also comes out quite automatically—there is no proper vibration that would correspond to the quantum orbit that collides with the nucleus. It is also very gratifying that although the three unobserved components at relative distances of 5, 6, and 8, are not actually "forbidden" theoretically, they receive an intensity that is 80 to 700 times smaller than that of the weakest observed component, so that their non-appearance becomes very understandable.

I am now calculating H_α, H_β, H_γ. The calculations are unfortunately terribly difficult to see through and I cannot manage to bring them into a simpler form.

With best compliments and greetings I remain, dear Professor, always

Yours faithfully,
E. Schrödinger

Planck Letter to Schrödinger [24 May 1926]

Berlin—Grunewald
24 May 1926

Dear Colleague,

I have owed you my thanks for some time for your kindly having sent me your last Annalen article on quantization. You can imagine the interest and enthusiasm with which I plunge into the study of these epoch making works, although I now make very slow headway penetrating into this peculiar train of thought. In connection with that I have high hopes of the beneficial influence of a certain amount of familiarity which in time facilitates the use of new concepts and ideas, as I have often found already. But what especially delights me, and the reason for my really writing you today, is the joyful hope that we may soon have the opportunity to hear you and to talk to you here. As my colleague Grüneisen tells me, your visit to a meeting of the Physical Society has not been cancelled but only somewhat postponed, and it may even still take place this semester. Let me tell you explicitly how much pleasure all of the physicists here would have in hearing you yourself present your new theory and in coming into contact with your ideas. And don't be afraid that we will make too many demands on you and tire you out. I do not know if you are already familiar with Berlin. But I hope you will find that in certain respects life here is freer and more independent than in a smaller city where everyone checks on everyone else, and there is no possibility of completely withdrawing at some time without anybody noticing it.

I should like to express just one little selfish request. In case you can come in July, please not before the 11th. Because at the beginning of July I have to go to Bonn for a few lectures and I would be sad if I missed your visit here as a result. Above all, however, I wish you the relaxation that you need after your demanding labors, and the complete recovery of your powers. I should be especially grateful if, at your convenience, you would send me a brief card with a word about your travel plans.

In the meantime, with best regards,

Yours sincerely,
M. Planck

Schrödinger Letter to Planck [31 May 1926]

Zürich

31 May 1926

My dear Professor,

Thank you very much for your kind and extremely gracious letter of the 24th, which now has finally decided me to accept the attractive invitation for this semester, however things may go. I have just written to Mr. Grüneisen. It goes without saying that, so far as I am concerned, a date when you are absent from Berlin is out of the question. Now Mr. Grüneisen was kind enough to point out to me that it might also be possible to consider a slight postponement of the date of the meeting, and since a postponement of the July 9th meeting would surely come too near the end of the semester, as he himself thinks, I have allowed myself to suggest that perhaps the June 25th meeting could be put off until July 2nd. Would that still work out with your trip to Bonn? The 25th of June would not be acceptable to me because from the 21st to the 26th a number of foreign physicists (among them Sommerfeld, Langevin, Pauli, Stern, P. Weiss) are meeting here for lectures and discussions. Now the connections work out so badly that I would have to leave here on the afternoon of the 23rd at the latest, if I do not want to travel through the night directly before the Berlin meeting. And I should not like to do that because then I am often completely exhausted and may possibly speak very badly.

I should be very grateful if you would give me some hints, in just a few words, as to how I should plan my lecture. What I mean is, should I think more of the fact that you and Einstein and Laue are in the audience—a thought without which I should feel uneasy—or should I direct myself more to those gentlemen who are further removed from theoretical work; which would of course have as an inevitable result that those named above (and a considerable number of others) will be very bored. In other words: should I recapitulate in a simplified way what has already been published or, passing over that lightly, talk more about perturbation theory, the Stark effect, and general intensity formulas? (Otherwise I could only mention these latter things briefly at the end, or else it would get to be too long; it takes about an hour for a general survey of the fundamentals, for the purpose of orientation and without much calculation, as I know from our colloquium here).

Naturally I can also do both, if there is the opportunity, one in a general meeting and the other in a more restricted colloquium.

Today I received a very kind and very interesting letter of 13 closely written pages from H. A. Lorentz which I still have to study in detail, of course. He raises a good many interesting questions; however, he does not reject it at all, on the whole, but still appears to be very critical. Lorentz sees one of the chief difficulties in reinterpreting classical mechanics as "wave mechanics" to lie in the fact that the "wave packet" which is to replace the “representative point” of classical mechanics in macroscopic problems, (possibly also in the motion of the electron on paths of slight curvature), that, I say, this wave packet will not remain together, but, on the contrary, will gradually spread into larger volumes by “diffraction”, according to general theorems of wave theory. I felt that to be a serious point at first—yet, strange to say, it seems not to be the case, at least not always. For the harmonic oscillator (which always remains the simplest typical example of a mechanical system which one can work with so easily and agreeably), I was able to produce a wave packet, by superposition of a large number of neighboring characteristic oscillations of high order (i.e. high quantum number), which is practically confined to a small spatial region, and which as a matter of fact revolves in precisely the harmonic ellipses described by classical mechanics for an arbitrarily long time without dispersing! I believe that it is only a question of computational skill to accomplish the same thing for the electron in the hydrogen atom. The transition from microscopic characteristic oscillations to the macroscopic “orbits” of classical mechanics will then be clearly visible, and valuable conclusions can be drawn about the phase relations of adjacent oscillations. For the present these phase relations and amplitude relations remain postulates, however; they can naturally also be so arranged that for large quantum numbers a “revolving” mass point does not result: e.g. since the structure is linear it can also be arranged so that two wave groups, revolving independently of one another, result—perhaps the equations are only approximately linear.

A second very delicate question that concerns Lorentz is the energy that is to be assigned to a characteristic oscillation. It is quite certain that the Balmer-Bohr energy value is not to be ascribed to the characteristic oscillation. In general one should not consider the individual characteristic oscillation as the equivalent of the individual Bohr orbit; that is a mistaken parallel, as the above construction shows. The concept “energy” is something that we have derived from macroscopic experience and really only from macroscopic experience. I do not believe that it can be taken over into micro-mechanics just like that, so that one may speak of the energy of a single partial oscillation. The energetic property of the individual partial oscillation is its frequency. Its amplitude must be determined in quite another way—I believe by normalizing the integral of the square of the total excitation to the value of the electronic charge.

Mr. Grüneisen was kind enough to hold out to me the prospect that either you or Mr. von Laue would offer me hospitality. If it doesn't cause too much trouble I am naturally very pleased about it, and in any case I am very grateful for your kind offer. I would strive to give as little inconvenience as possible, and ask that it be so arranged that you are disturbed as little as possible; naturally any improvised lodging you choose is completely adequate for me.

Thank you once again for all the kindness that is always shown me by Berlin in general and by you especially, Professor Planck. With sincere respect, I remain

Yours faithfully,

E. Schrödinger

Planck Letter to Schrödinger [4 June 1926]

Berlin—Grunewald
4 June 1926

Dear Colleague,

I am extremely pleased that you could make up your mind to visit Berlin before the end of this semester, and I know for certain that the rest of the physicists here think the same way.

My colleague Grüneisen informs me that he has some doubts with regard to July 2nd and suggests July 16th instead. I should just like to join him in this. The semester here lasts until the beginning of August so that things are still in full swing in the middle of July and we need not be afraid that many will have already gone away. Grüneisen himself is an exception, to be sure, but he has to set out so early that he would unfortunately miss your visit all the same. But the 16th of July would suit the rest of us very well, and the only question is whether it is suitable for you yourself.

My wife and I would be especially happy if you would stay with us. We hope very much that we will be able to make you comfortable in our house. I shall take care above all that you remain master of your own actions to the greatest possible extent, and especially that, at those times over and above the "official" periods dedicated to the Physical Society, you have the opportunity to withdraw and to occupy yourself as you see fit. I know from experience how pleasant it often is to have a possibility of this kind. Moreover, my house stands at your disposal night and day for as long as you are inclined to stay.

You also talk about the level at which your lecture should best be given, or rather at which it should begin. I would like to propose, in agreement with my colleagues, that you imagine your audience to be students in the upper classes who, therefore, have already had mechanics and geometrical optics, but who have not yet advanced into the higher realms; to whom, therefore, the Hamilton-Jacobi differential equation, if they are acquainted with it at all, signifies a difficult result of profound research, deserving of reverence, and not by any means something to be taken for granted. Under no circumstances, however, should you be afraid that any one of us will consider one sentence of yours to be superfluous. For even if the sentence should not be necessary for an understanding of your train of thought, it would always offer the particular interest of seeing what special paths your thought takes and which particular forms your perception favors. For all of us the main point of your lecture will be what you yourself in your letter designated as a general survey of the fundamentals for the purpose of orientation without much calculation and without many individual problems. Perhaps it would be easier and more natural for you to carry this out, if on the other day, Saturday morning the 17th of July, you were to give a second lecture in our Colloquium, aimed at more special matters with supplements and continuations of the lines of thought you will have described at the more general meeting. I hope that this seems suitable to you, since you already indicated such a possibility yourself. That can very easily be arranged, and I ask you only to let me know so that we can take care of matters.

What a cross-fire of critical, enthusiastic, and questioning acclamations might now besiege you! But still, it is a thing with incredible prospects. I see that you have already energetically taken hold of the big question of whether and under what conditions a wave packet will remain intact. I have such a feeling that for closed systems it is the boundary conditions that take care of the conservation [of the wave packet], whereas a satisfactory solution for phenomena in an unbounded space seems to me to be possible only on the basis of new assumptions. That, however, is a cura posterior.

In the meantime my cordial greetings and the friendly request that you write me the day and hour that you arrive here.

Yours faithfully,
Planck

"He has left mathematicians something to keep them busy for five hundred years."

– French mathematician Charles Hermite said about Niels Henrik Abel

"Unthinking respect for authority is the greatest enemy of truth."

– In a famous Albert Einstein letter to Jost Winteler

	Famous For
Michael Faraday (1791−1867)	Discovery of electromagnetic induction
Ada Lovelace (1815−1852)	Writing code for Analytical Engine
James Maxwell (1831−1879)	Work on the Theory of Electromagnetism and the Kinetic theory of gases
Nikola Tesla (1856−1943)	Created the first Alternating Current system
Max Planck (1858-1947)	Formulation of the quantum theory
Ernest Rutherford (1871−1937)	Work on Radioactivity and discovery of the atomic nucleus
Guglielmo Marconi (1874−1937)	Works Radio and Wireless telegraphy
Alan Turing (1912−1954)	Cracking the Enigma Codes
Richard Feynman (1918−1988)	Collective work on Path integral formulation on quantum mechanics, particle physics, the theory of quantum electrodynamics
Tim Berners-Lee (1955)	Contributions to the birth of the Internet

Nikola Tesla's top ten inventions:

- The Tesla Coil
- The Magnifying Transmitter
- The Tesla Turbine
- The Shadowgraph
- The Radio
- The Neon Lamp
- The Niagara Falls Transformer House
- The Induction Motor
- The Radio Controlled Boat
- Alternating Current

Thomas Alva Edison's top 6 Contributions:

- Electric pen
- Motion Picture Camera
- Gramophone
- Stock ticker
- Light bulb
- Alkaline Batteries

To invent, you need a good imagination and a pile of junk.

Genius is one percent inspiration and ninety-nine percent perspiration.

There are no rules here – we're trying to accomplish something.

Opportunity is missed by most people because it is dressed in overalls and looks like work.

− Thomas Alva Edison

Alan Turing's Inventions:

- Universal Computing Machine
- Turing Test
- CAPTCHA
- Breaking The Enigma Code

Sir Jagadish Chandra Bose was the person who first demonstrated the science behind capturing radio waves

Albert Einstein's Contributions to Science:

- Quantum Theory of Light (**photoelectric effect** that formed the basis of how solar cells work)
- $E=mc^2$
- Brownian Movement
- Special Theory of Relativity
- General Theory of Relativity
- Manhattan Project that led to the development of the atomic bomb in 1945
- Einstein's Refrigerator that used ammonia, water, and butane, and required almost no energy to work
- **The Bose-Einstein Condensate** (a state of matter which is typically formed when a gas of bosons at low densities is cooled to temperatures very close to absolute zero)
- Wave-Particle Duality

A theory is the more impressive the greater the simplicity of its premises is, the more different kinds of things it relates, and the more extended is its area of applicability. Therefore the deep impression which classical thermodynamics made upon me. It is the only physical theory of universal content concerning which I am convinced that within the framework of the applicability of its basic concepts, it will never be overthrown.

— Albert Einstein

A rare letter sent by Louis Pasteur himself to an unknown recipient

"[B]efore anything, and as I mentioned in my last message to you, I ask that you take note of the necessity of performing the heating of the bottles inside the large-scale heating containers; and remember the fact which the professional committee finally agreed upon at the last wine tasting, that the color of the wine that was heated when protected from air was stronger and even somewhat darker than that of the same wine when it remained unchanged and unheated. One can get an idea of the speed of the oxygenation of the wine by looking at the exact experiments appearing in my publications. Do not forget that the wine in bottles or in any other vessel, after it has been sealed a few days before, and after moving it from vessel to vessel to remove the sediment, will, during its decomposition, contain only nitrogen or carbonic acid and no trace of oxygen, but will contain oxygen the very moment it comes into contact with air. Furthermore, bear in mind that the solubility of gases is proportional to pressure.

Finally, it is best to remember that the wine, at the first removal of sediment after the end of fermentation, is saturated with only carbonic acid gas; also on this point refer to my publication "Etudes sur le vin" – the amount of dissolved carbonic acid, at this moment, is so great and so ready to be released that it might resist the intake of air in your device.

I am far from being against cooling after heating. Here again, one must take into account the oxidation process. With the reduction in volume in a barrel, air will penetrate, however it is perfectly clear, from the point of view of preservation principles, that it is safer to fill while heating; but the germs of the wine development process are many and much more active than those created by the air. Through heating, the wine has acquired such features of preservation as to allow, in most cases, even further maneuvering at a later date without great danger to its preservation. In short, with regard to the practice of immediate cooling after heating it will be possible to formulate an opinion after the accumulation of [data from] experiments. In the current state of affairs, I am far from doubting the wisdom of this practice. When heated in a bottle it is clear that the process is more or less natural and certainly not harmful here…"

Sigmund Freud Letter to a worried mother who was seeking treatment for her son's apparent homosexuality

Dear Mrs [Erased],

I gather from your letter that your son is a homosexual. I am most impressed by the fact that you do not mention this term yourself in your information about him. May I question you why you avoid it? Homosexuality is assuredly no advantage, but it is nothing to be ashamed of, no vice, no degradation; it cannot be classified as an illness; we consider it to be a variation of the sexual function, produced by a certain arrest of sexual development. Many highly respectable individuals of ancient and modern times have been homosexuals, several of the greatest men among them. (Plato, Michelangelo, Leonardo da Vinci, etc). It is a great injustice to persecute homosexuality as a crime – and a cruelty, too. If you do not believe me, read the books of Havelock Ellis.

By asking me if I can help, you mean, I suppose, if I can abolish homosexuality and make normal heterosexuality take its place. The answer is, in a general way we cannot promise to achieve it. In a certain number of cases we succeed in developing the blighted germs of heterosexual tendencies, which are present in every homosexual in the majority of cases it is no more possible. It is a question of the quality and the age of the individual. The result of treatment cannot be predicted.

What analysis can do for your son runs on a different line. If he is unhappy, neurotic, torn by conflicts, inhibited in his social life, analysis may bring him harmony, peace of mind, full efficiency, whether he remains a homosexual or gets changed. If you make up your mind he should have analysis with me — I don’t expect you will — he has to come over to Vienna. I have no intention of leaving here. However, don’t neglect to give me your answer.

Sincerely yours with best wishes,

Freud

Letter from Freud to Ludwig Binswanger, April 11, 1929

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Prof. Dr. Freud

Dear Dr. Binswanger,

I do not remember whether it was in 1912 or 1913 that I came to see you and found you so full of courage that you won forever a high place in my esteem. The years since then have, as you know, left me a fairly decrepit old man. I am no longer able to make the trip to come and take your hand.

12 April 1929

My daughter who died would have been thirty-six today. Yesterday I nearly made a serious mistake. I started to read your letter, discovered several kind words I should have been sorry to miss, but was unable to piece together a single sentence, and the further I went the more puzzling your characters became. I considered returning the letter to you with some jocular expression of indignation and the request that you have it copied and sent back to me. Then my sister-in-law came to my aid and told me the shocking news the rest of the letter contained.[2] And I realised why, this time, you had preferred not to dictate it to a typist.

We know that the acute sorrow we feel after such a loss will run its course, but also that we will remain inconsolable, and will never find a substitute. No matter what may come to take its place, even should it fill that place completely, it yet remains something else. And that is how it should be. It is the only way of perpetuating a love that we do not want to abandon.

I would ask you please to remember me kindly to your wife.

In unchanging friendship,
Your old Freud

Physicist Hans Bethe's letter to his teacher Arnold Sommerfeld

20 May 1947

Dear Sommerfeld,

I am very gratified and very honored that you have thought of me as your successor. If everything since 1933 could be undone, I would be very happy to accept this offer. It would be lovely to return to the place where I learned physics from you, and learned to solve problems carefully. And where subsequently as your Assistent and as Privatdozent I had perhaps the most fruitful period of my life as a scientist. It would be lovely to try to continue your work and to teach the Munich students in the same sense as you have always done: With you one was certain to always hear of the latest developments in physics, and simultaneously learn mathematical exactness, which so many theoretical physicists neglect today.

Unfortunately it is not possible to extinguish the last 14 years. . . . For us who were expelled from our positions in Germany, it is not possible to forget.

Perhaps still more important than my negative memories of Germany, is my positive attitude toward America. It occurs to me (already since many years ago) that I am much more at home in America than I ever was in Germany. As if I was born in Germany only by mistake, and only came to my true homeland at 28. Americans (nearly all of them) are friendly, not stiff or reserved, nor have a brusque attitude as most Germans do. It is natural here to approach all other people in a friendly way. Professors and students relate in a comradely way without any artificially erected barrier. Scientific research is mostly cooperative, and one does not see competitive envy between researchers anywhere. Politically most professors and students are liberal and reflect about the world outside—that was a revelation to me, because in Germany it was customary to be reactionary (long before the Nazis) and to parrot the slogans of the German National ["Deutschnationaler"] party. In brief, I find it far more congenial to live with Americans than with my German "Volksgenossen."

On top of that America has treated me very well. I came here under circumstances which did not permit me to be very choosy. In a very short time I had a full professorship, probably more quickly than I would have gotten it in Germany if Hitler had not come. Although a fairly recent immigrant, I was allowed to work and have a prominent position in military laboratories. Now, after the war, Cornell has built a large new nuclear physics laboratory essentially "around me." And two or three of the best American universities have made me tempting offers.

I hardly need mention the material side, insofar as my own salary is concerned and also the equipment for the Institute. And I hope, dear Sommerfeld, that you will understand: Understand what I love in America and that I owe America much gratitude (disregarding the fact that I like it here). Understand, what shadows lie between myself and Germany. And most of all understand, that in spite of my "no" I am very grateful to you for thinking of me.

Yours,

Hans

Benjamin Franklin's letter to Joseph Priestley

To Joseph Priestley

London, September 19, 1772

Dear Sir,

In the Affair of so much Importance to you, wherein you ask my Advice, I cannot for want of sufficient Premises, advice you what to determine, but if you please I will tell you how. When these difficult Cases occur, they are difficult chiefly because while we have them under Consideration all the Reasons pro and con are not present to the Mind at the same time; but sometimes one Set present themselves, and at other times another, the first being out of Sight. Hence the various Purposes or Inclinations that alternately prevail, and the Uncertainty that perplexes us.

To get over this, my Way is, to divide half a Sheet of Paper by a Line into two Columns, writing over the one Pro, and over the other Con. Then during three or four Days Consideration I put down under the different Heads short Hints of the different Motives that at different Times occur to me for or against the Measure. When I have thus got them all together in one View, I endeavour to estimate their respective Weights; and where I find two, one on each side, that seem equal, I strike them both out: If I find a Reason pro equal to some two Reasons con, I strike out the three. If I judge some two Reasons con equal to some three Reasons pro, I strike out the five; and thus proceeding I find at length where the Ballance lies; and if after a Day or two of farther Consideration nothing new that is of Importance occurs on either side, I come to a Determination accordingly.

And tho' the Weight of Reasons cannot be taken with the Precision of Algebraic Quantities, yet when each is thus considered separately and comparatively, and the whole lies before me, I think I can judge better, and am less likely to take a rash Step; and in fact I have found great Advantage from this kind of Equation, in what may be called Moral or Prudential Algebra.

Wishing sincerely that you may determine for the best, I am ever, my dear Friend,

Yours most affectionately

B. Franklin

Letter from Dr. Norman E. Borlaug to Dr. A.H. Boerma

Dr. A.H. Boerma

Food and Agriculture Organization (FAO) of the United Nations

Viale delle Terme di Caracalla

Rome, Italy

Dear Dr. Boerma:

Thank you for your kind telegram of October 23rd.

When the Nobel Committee awarded me the Nobel Peace Prize for 1970 it in effect awarded it to agriculture. The so-called Green Revolution is the result of a team effort involving many. It involved the efforts of a number of organizations, many government officials, scientists, educators and millions of farmers.

In this total effort your organization, FAO, played an important role. I was privileged to have been invited by FAO in March through May, 1960 to make a study of wheat production problems and potentials from Lybia to India. It was while making this survey, accompanying Drs. James Harrington and José Vallega, that it became apparent to me that little progress could be made in improving production without first training more young wheat scientists. Subsequently, the joint FAO-Rockefeller Foundation-CIMMYT practical wheat training program was established in Mexico. This activity trained many of the young scientists who are today playing vital roles in the Green Revolution in a number of countries.

Although considerable progress has been made in expanding food production in a number of hungry nations during the past three years, this is no time for complacency. We must continue to push production aggressively. We must continue to pressure governments of the developing countries to increase their support for agriculture. We must at the same time encourage governments from the developed world to continue to assist the developing countries with both financial and technical assistance. We must try to build a better image for agriculture so that increased numbers of talented young men and women will choose careers in agriculture. We must assist them to obtain fellowships and scholarships so that they can obtain training at the post-graduate University level. This is an enormous responsibility and undertaking, yet we must all collectively accept the continuing challenge and struggle on to produce more. If we hesitate or falter the monster rapid increase in population growth - will destroy the world.

I am convinced that those of us working with food and agriculture also must bring pressure on politicians, government officials, and the general public to face up to and tame the monster of population growth before it is too late.

I want you to know that it has always been a pleasure to work with FAO officials and scientists and we look forward to continued effective collaboration.

Sincerely,

Norman E. Borlaug

Letter from Mark Wilson to Rachel Carson

Dear Rachel Carson,

I should begin by saying thank you. When I was a kid I would have said my “heroes” were Yoda from Star Wars, and perhaps also Indiana Jones. As an adult, you would be at the top of my list.

I first heard of you when I was a master’s student. My supervisor suggested I write about you and your work, and how it was received in Britain.

It was the beginning of a long journey with you, which I have only recently completed, in an academic sense, but which I have yet to finish in a personal one. I have not read all your published work yet, though I was lucky enough to talk about you—on a podcast for an environmental history website.

The environment—or more particularly, the destruction of the environment—affects me greatly. My Facebook wall and my Twitter feed are filled with articles reposted or retweeted about the environment, most of it negative. It is clear that the climate is changing, mostly for the worse, something which you hinted at in your work, but which you did not have the chance to expand on.

I wonder what you would think of the environmental movement today. In the film X-Men: Days of Future Past, the opening reminds me of the opening chapter of your most famous book, Silent Spring. Professor Xavier describes the future as a dark, desolate world, a world of war, suffering, and loss on both sides. In the film, mutants, and the humans who dare to help them, fight an enemy they cannot defeat. It causes me to wonder: Are we destined to follow the same path? Are we destined to destroy ourselves as we have destroyed so many species before us? Or can we evolve fast enough to change ourselves and thus, change our fate? Is the future truly set?

Silent Spring is a warning for the future. But equally it conveys a sense of hope. Your words make me feel that all not lost. Your words are your most powerful weapon. You were an early environmental historian, even before the discipline formally existed. The first chapter of your most famous book is only a page or two long, yet, it sets the scene for the rest of the story, and whilst it is about a mythical town and warns against the perils of uncontrolled and unquestioned science, underneath it, I read a rallying cry to act, and to do more to stop this future from actually coming true.

In researching for my master's dissertation, I read up on your life. You came from relatively humble beginnings, and money was always a problem. There was something of a loner about you. I saw that in myself too. You had an intimate, intense relationship with nature and I only wish I had come upon you sooner. Perhaps I would have stayed on and studied science in university, rather than history.

You also showed me, when I was really struggling with my PhD, that it is possible to be successful without attaining that degree. Through your experience, I realized that a PhD isn't the be-all and the end-all. I know you wanted one but I think not getting one was actually better for you. Had you spent years in college, you might not have had the opportunity to write what you did, when you did.

There is a general sense of hopelessness in much of the environmental literature, news stories, and documentaries that I read and watch. We hear that climate change is getting worse, wildlife are becoming extinct, and pollution is increasing. It can be difficult to find a positive. I think, however, if you were here, you would be projecting a message of hope. You would remind us that we are not all forsaken and that we can act. Even if we go down fighting, we should at least try, as you did.

I read that your favorite work was not your most famous book. The Sense of Wonder is a book about your walks through woods and along the Maine coast with your nephew, and it was written specifically for children. You negate any sense of hopelessness with which the environment might be perceived when you write:

Those who dwell the beauties and mysteries of the earth are never alone or weary of life. Whatever the vexations or concerns of their personal lives, their thoughts can find paths that lead to inner contentment and to renewed excitement in living. Those who contemplate the beauty of the earth find reserves of strength that will endure as long as life lasts.

And so, Rachel Carson, thank you. For opening my eyes to the wonder of nature; for the relationship I have developed with you through scholarly research; and for being so humble and quiet yet being so brave. You never once ran from the fight which you were faced with, whether it was your cancer or the responses to Silent Spring. You are my hero. But, above all, thank you for replacing despair with hope; for your legacy as the "nun of nature" and as a founder of the modern environmental movement; and for your delight at the wonders of the natural world. If we all saw the wonder of the environment, as you did, perhaps we would all take more time to care for it.

Thank you.

The wartime head of the Los Alamos Laboratory and the "father of the atomic bomb", the American theoretical physicist **Robert Oppenheimer**, composed this letter of proposal for Richard Feynman to the chairman of UC Berkeley:

"Dear Professor Birge,

[...] I would like to make one suggestion to you... about which I have... a strong conviction. [...] We have [many] physicists here... Of these, there is one who [...] is so outstanding and so clearly recognized as such, that I think it appropriate to call his name to your attention, with the urgent request that you consider him for a position [...] at the earliest time that that is possible [...]. [I]t is Richard Feynman. He is [...] the most brilliant young physicist here, and everyone knows this.

The reason for telling you [this] is that his excellence is [very] well known [...] to [several] of the "big shots" on the project... I may give you 2 quotations from men with whom he has worked. Bethe said he would rather lose any 2 other men than Feynman from this job, and Wigner said, “He is a 2nd Dirac, only this time human.” [...] I cannot too strongly emphasize Feynman’s personal qualities which have been generally recognized by officers, scientists, and laity in this community."

The talented Norwegian mathematician **Niels Henrik Abel** was born on 5 August 1802. When he died, only 26 years old, he left a large body of work, including the first proof of the general binomial theorem, which had been stated by Newton and Euler. During his short life, he suffered from poverty, starvation, and painful frustration while trying hopelessly to find a university teaching position.

"He [**Niels Henrik Abel**] has left mathematicians something to keep them busy for five hundred years."

− Charles Hermite

A French mathematician who did research concerning number theory, quadratic forms, invariant theory, orthogonal polynomials, elliptic functions and algebra.

Karl Theodor Wilhelm Weierstrass was a German mathematician often cited as the "father of modern analysis". Despite leaving university without a degree, he studied mathematics and trained as a school teacher, eventually teaching mathematics, physics, botany and gymnastics.

"If A is success in life, then A = x + y + z. Work is x, play is y, and z is keeping your mouth shut."

− Albert Einstein

"...there is a pleasure in recognizing old things from a new point of view."

− Richard Feynman

Hideki Yukawa was a Japanese theoretical physicist and the first Japanese Nobel laureate for his prediction of the pi meson, or pion (a particle of mass about 200 times that of an electron).

Well, I come down in the morning and I take up a pencil and

I try to THINK.

Hans Bethe

My scientific studies have afforded me great gratification; and I am convinced that it will not be long before the whole world acknowledges the results of my work.

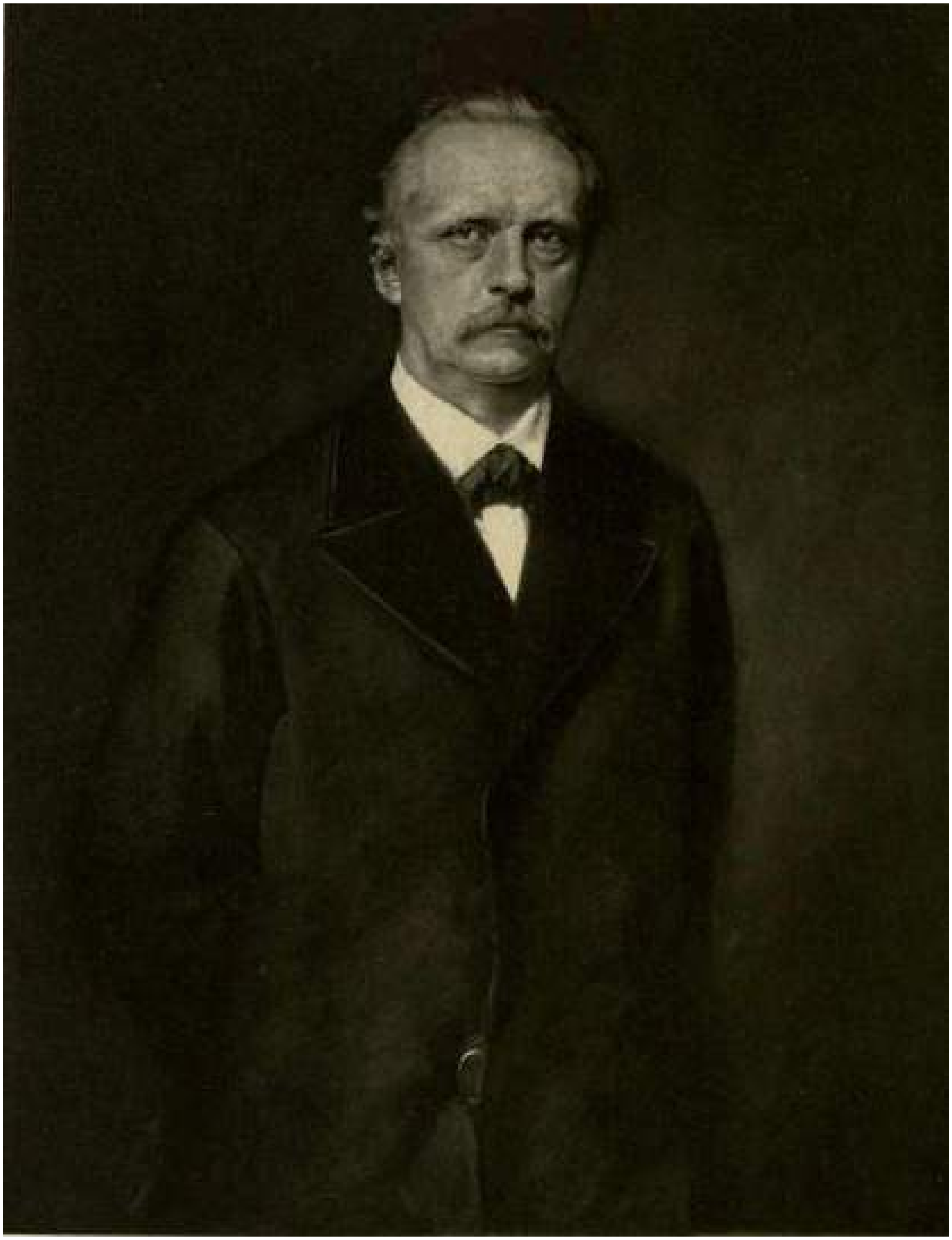
Sir William Herschel

Through measurement to knowledge.

Heike Kamerlingh Onnes

Two years work wasted, I have been breeding those flies for all that time and I've got nothing out of it.

Thomas Hunt Morgan

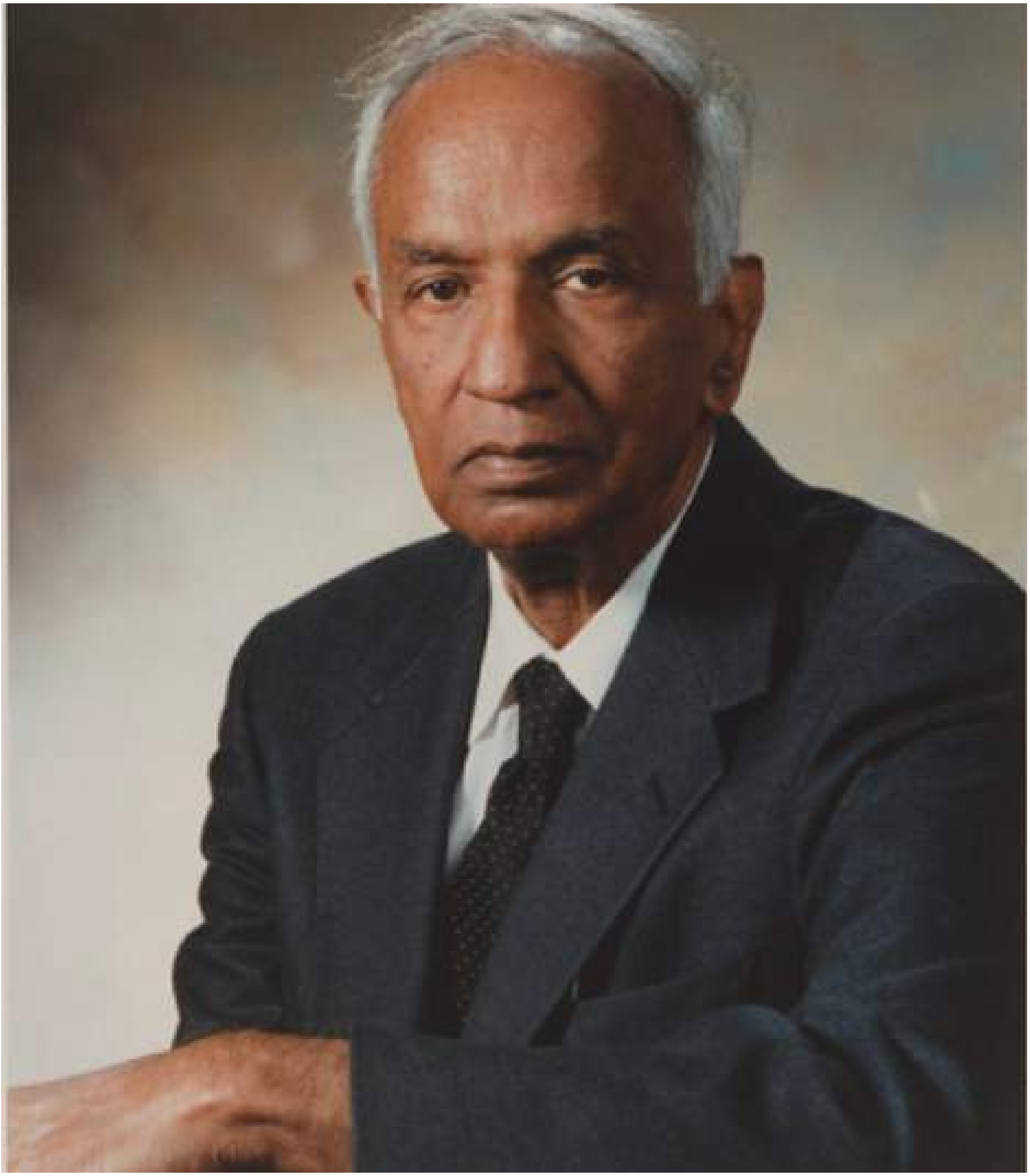


Reason we call that faculty innate in us of discovering laws and applying them with thought.

Hermann von Helmholtz

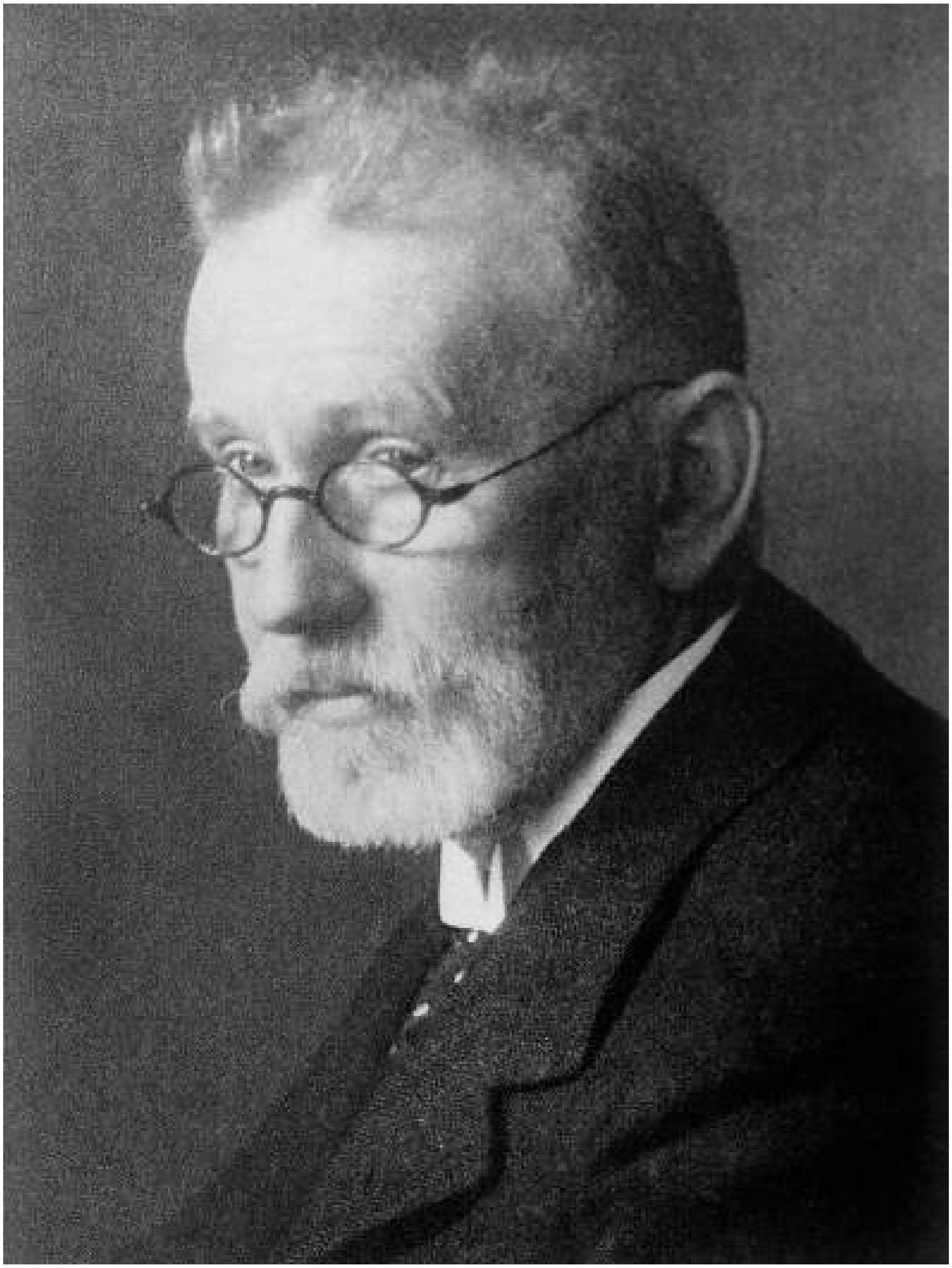
Ask the right questions, and nature will open the doors to her secrets.

Chandrasekhara Venkata Raman



I am aware of the usefulness of science to society and of the benefits society derives from it.

Subrahmanyan Chandrasekhar

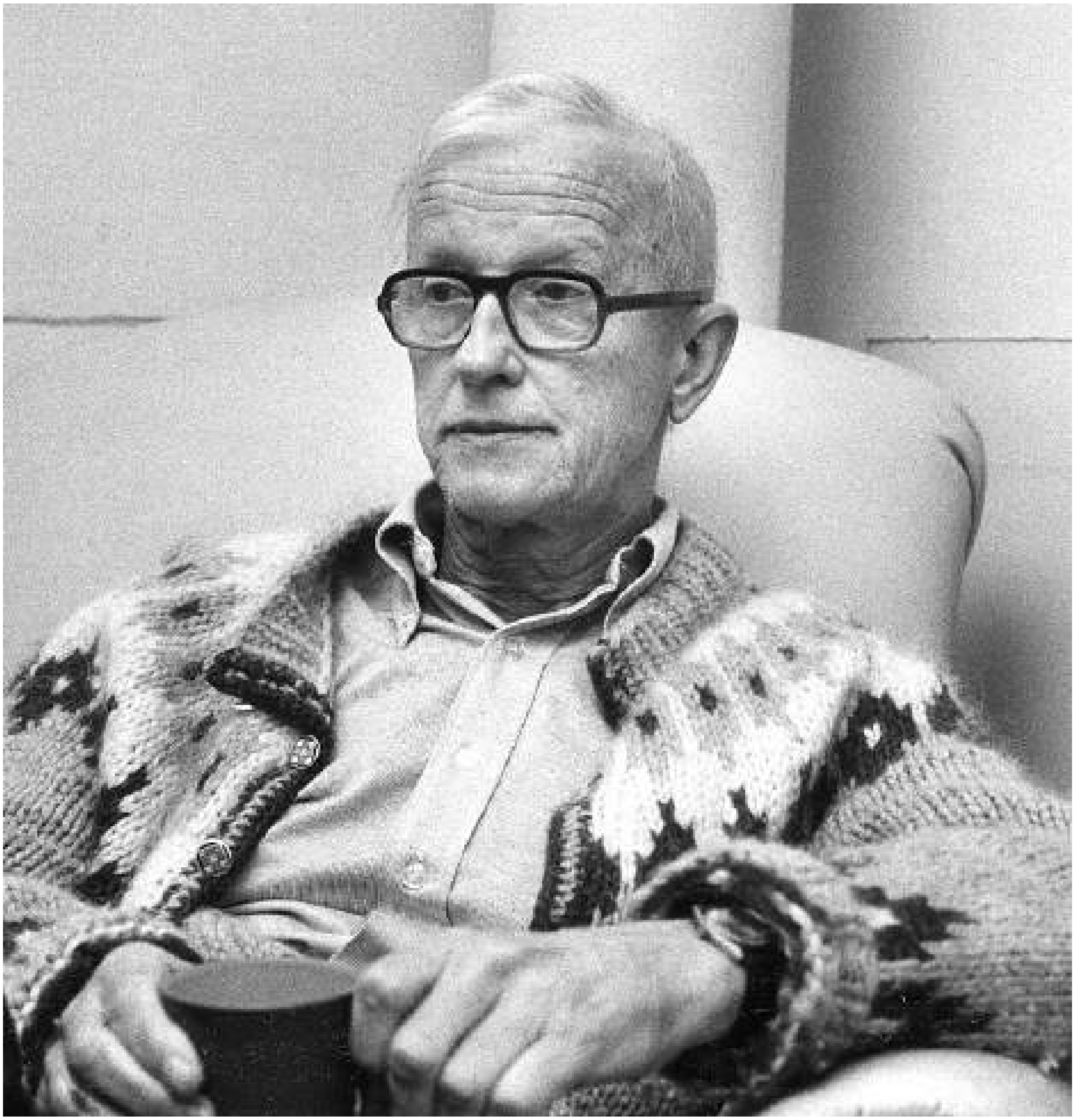


The fluttering of a butterfly's wings can effect climate changes on the other side of the planet.

Paul Ehrlich

According to the concept of transformational evolution, first clearly articulated by Lamarck, evolution consists of the gradual transformation of organisms from one condition of existence to another.

Ernst Walter Mayr

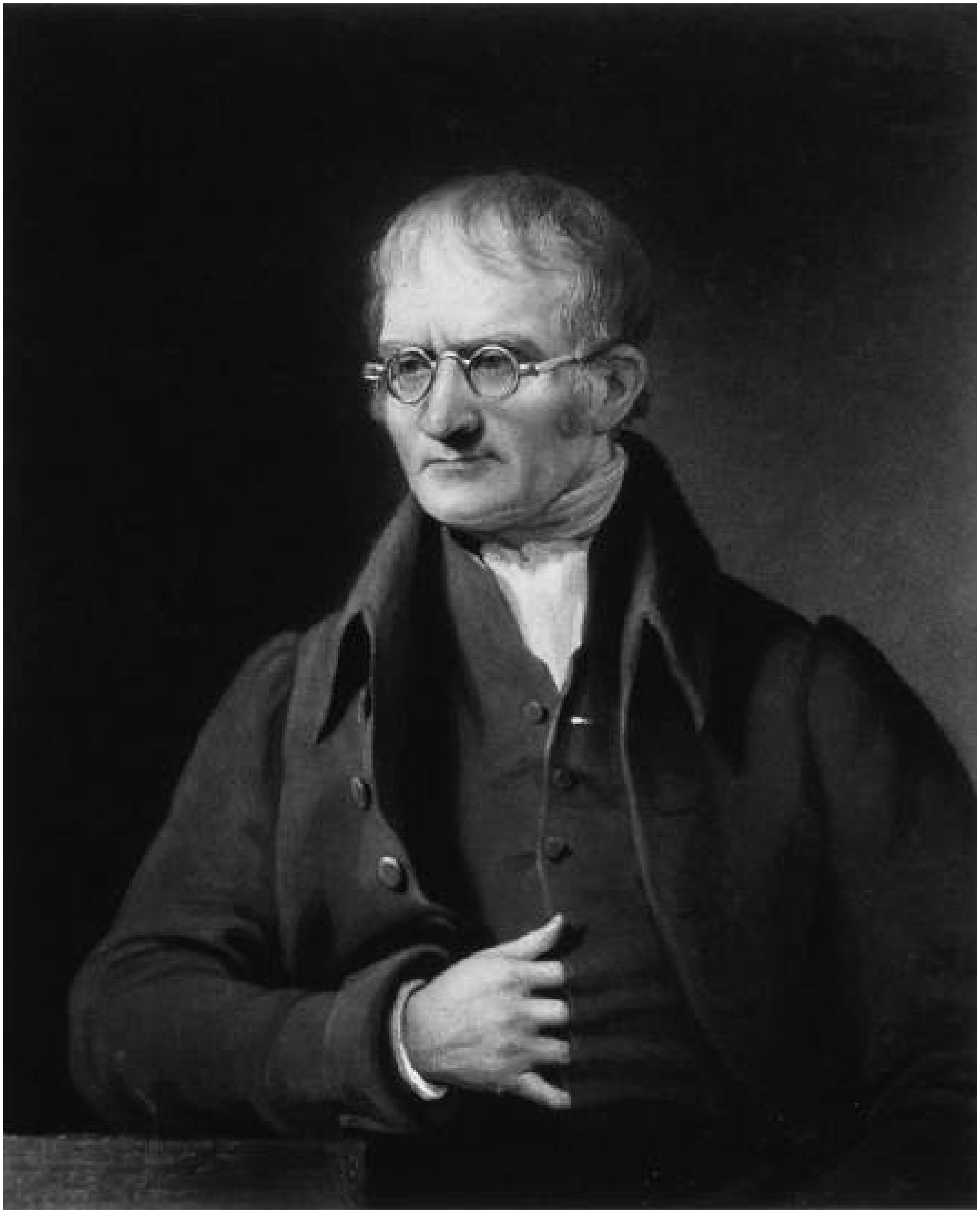


The scientist has in common with the artist only this: that he can find no better retreat from the world than his work and no stronger link with the world than his work.

Max Delbruck

It is not enough to discover and prove a useful truth previously unknown, but that it is necessary also to be able to propagate it and get it recognized.

Jean Baptiste Lamarck



It's the right idea, but not the right time.

John Dalton

Scientific research is one of the most exciting and rewarding of occupations.

Frederick Sanger

The history of science shows that the progress of science has constantly been hampered by the tyrannical influence of certain conceptions that finally came to be considered as dogma. For this reason, it is proper to submit periodically to a very searching examination, principles that we have come to assume without any more discussion.

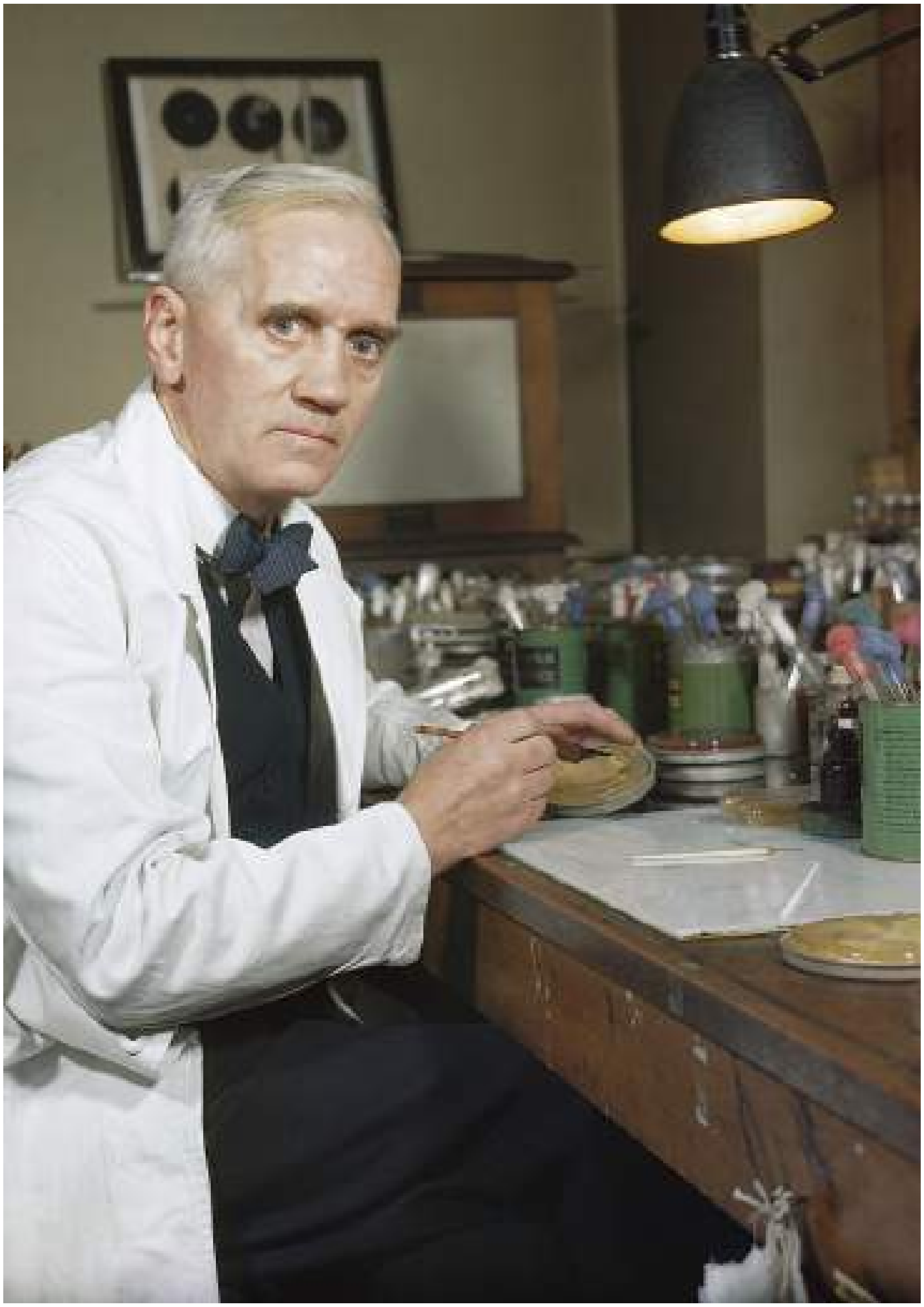
Louis Victor de Broglie

A practical botanist will distinguish at the first glance the plant of the different quarters of the globe and yet will be at a loss to tell by what marks he detects them.

Carl Linnaeus

Both the man of science and the man of action live always at the edge of mystery, surrounded by it.

J. Robert Oppenheimer



One sometimes finds what one is not looking for.

Sir Alexander Fleming

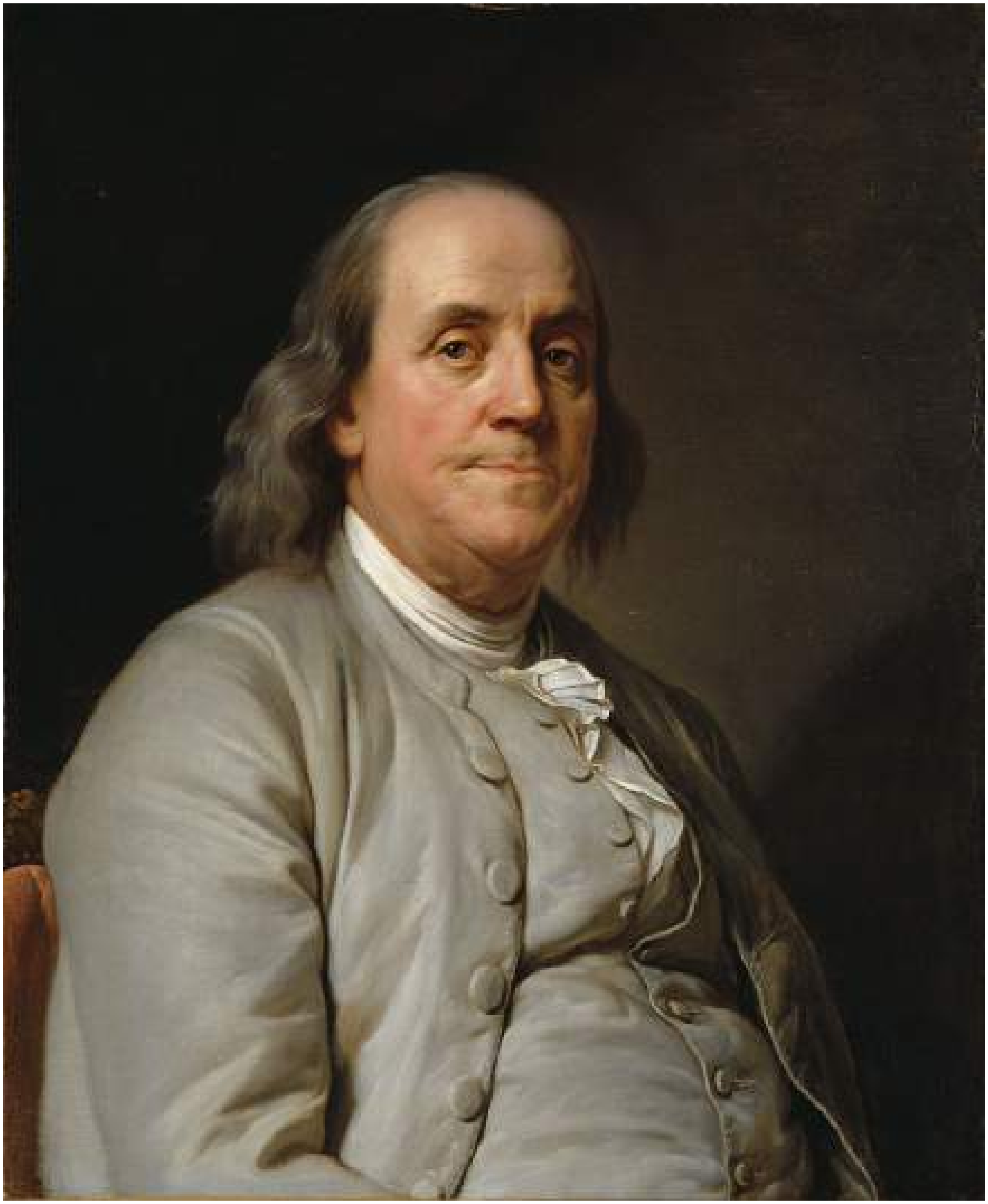
The reward for work well done is the opportunity to do more.

Jonas Edward Salk

A blind man will suffer himself to be led, though by a dog, or a child.

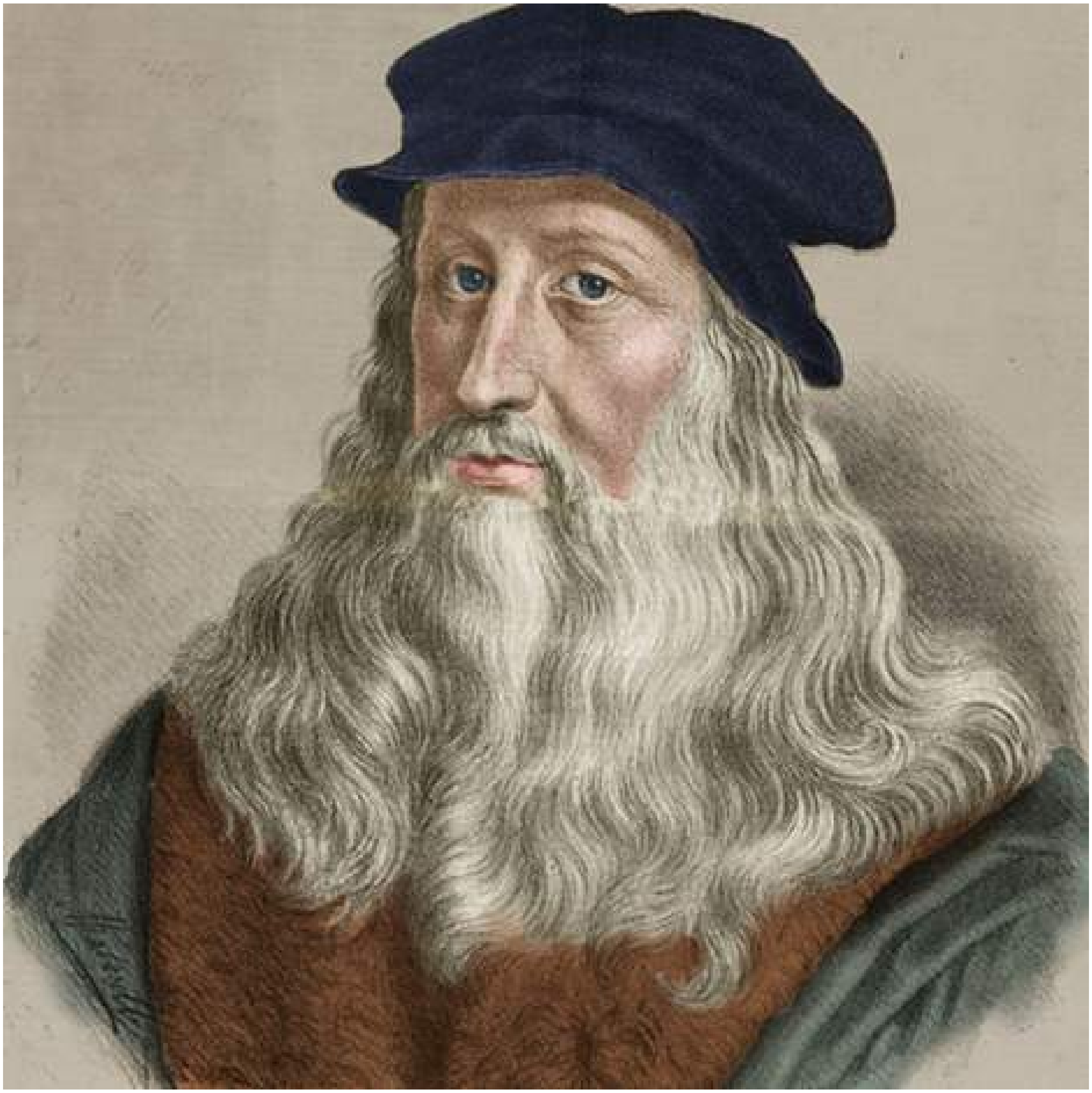
Robert Boyle

Benjamin Franklin



An investment in knowledge pays the best interest.

Benjamin Franklin



Principles for the Development of a Complete Mind: Study the science of art. Study the art of science. Develop your senses- especially learn how to see. Realize that everything connects to everything else.

Leonardo da Vinci

John Archibald Wheeler was an American theoretical physicist, the first American involved in the theoretical development of the atomic bomb. He also originated a novel approach to the unified field theory and popularized the term **black hole**.

Homi Jehangir Bhabha was an Indian nuclear physicist, founding director, and professor of physics at the Tata Institute of Fundamental Research – who explained the absorption features and electron shower production in cosmic rays, performed the first calculation of the cross-section of electron-positron scattering, and is considered the "**father of the Indian nuclear program**."

"Any list of the three "greatest" mathematicians of all history would include the name of Archimedes. The other two usually associated with him are Newton and Gauss. Some, considering the relative wealth - or poverty - of mathematics and physical science in the respective ages in which these giants lived, and estimating their achievements against the background of their times, would put Archimedes first."

− Eric Temple Bell

"The most beautiful and deepest experience a man can have is the sense of the mysterious."

"The Cosmos is all that is or was or ever will be. Our feeblest contemplations of the Cosmos stir us - there is a tingling in the spine, a catch in the voice, a faint sensation, as if a distant memory, of falling from a height. We know we are approaching the greatest of mysteries."

− Carl Sagan

Gottfried Wilhelm Leibniz was a prominent German polymath and one of the most important logicians, mathematicians and natural philosophers of the Enlightenment.

> "There are two broad and antithetical domains of mathematical thought, the continuous and the discrete. Leibniz is the one man in the history of mathematics who possessed both of these qualities of thought to a superlative degree."
>
> **− Howard Eves**

Alan Mathison Turing − English mathematician, logician and philosopher who made important advancements in the field of computer theory and who contributed important logical analyses of computer processes. In an unfortunate end to his prolific career, Turing was arrested in 1952 after British authorities found out he was having a relationship with another man. Under British law, homosexuality was a crime, and it resulted in Turing losing his security clearance to continue his work at Bletchley Park. Rather than face a life in prison, Turing accepted treatment of regular estrogen injections, which were believed to neutralize libido. On 8 June 1954, Turing died of potassium cyanide poisoning while conducting electrolysis experiments. The cyanide was found on a half eaten apple beside him. An inquest concluded that it was self-administered but his mother always maintained that it was an accident. In 2013, a bill was passed offering statutory pardon to Turing for offences under section 11 of the Criminal Law Amendment Act 1885. In 2016, the law (known as **Turing's law**) was widened to retroactively pardon all men who were convicted under the historical legislation of gross indecency.

100 most influential people in the world

- **Muhammad:**

Prophet Muhammad was the founder of Islam and the proclaimer of the Quran. Muhammad is traditionally said to have been born in 570 in Mecca and to have died in 632 in Medina, where he had been forced to emigrate to with his adherents in 622.

- **Isaac Newton**

Sir Isaac Newton was an English physicist and mathematician, who was the culminating figure of the Scientific Revolution of the 17th century. In optics, his discovery of the composition of white light integrated the phenomena of colours into the science of light and laid the foundation for modern physical optics. In mechanics, his three laws of motion, the basic principles of modern physics, resulted in the formulation of the law of universal gravitation. In mathematics, he was the original discoverer of the infinitesimal calculus. **Newton's Philosophiae Naturalis Principia Mathematica** (Mathematical Principles of Natural Philosophy, 1687) was one of the most important single works in the history of modern science.

- **Jesus Christ**

Jesus Christ was a religious leader revered in Christianity, one of the world's major religions. He is regarded by most Christians as the Incarnation of God. The history of Christian reflection on the teachings and nature of Jesus is examined in the article Christology.

- **Buddha**

Buddha was the founder of Buddhism, one of the major religions and philosophical systems of southern and eastern Asia and of the world. Buddha is one of the many epithets of a teacher who lived in northern India sometime between the 6th and the 4th century before the Common Era.

- **Confucius**

Confucius was an influential Chinese philosopher – who taught a philosophy of correct behavior, social interaction and kindness towards others. During his lifetime, he sought to educate his fellow citizens on principles of justice, service and personal integrity. After his death, his precepts and philosophy became the cornerstone of Chinese culture and philosophy – widely known as Confucianism.

- **St. Paul**

St Paul was an influential figure in the early development of Christianity. His writings and epistles form a key section of the New Testament; St Paul helped to codify and unify the direction of the emerging religion of Christianity. In particular, St Paul emphasized the role that salvation is based on faith and not religious customs. St Paul was both Jewish and a Roman citizen; in his early life, he took part in the persecution of Christians. However, on the road to Damascus, he underwent a conversion and became a committed Christian himself.

- **Cai Lun**

Cai Lun was a Chinese court official who is traditionally credited with the invention of paper.

- **Johann Gutenberg**

Johannes Gutenberg was a German craftsman and inventor who originated a method of printing from movable type. Elements of his invention are thought to have included a metal alloy that could melt readily and cool quickly to form durable reusable type, an oil-based ink that could be made sufficiently thick to adhere well to metal type and transfer well to vellum or paper, and a new press, likely adapted from those used in producing wine, oil, or paper, for applying firm even pressure to printing surfaces. None of these features existed in the European technique used up to that time for stamping letters on various surfaces or in woodblock printing.

- **Christopher Columbus**

Christopher Columbus was a master navigator and admiral whose four transatlantic voyages (1492–93, 1493–96, 1498–1500, and 1502–04) opened the way for European exploration, exploitation, and colonization of the Americas. He has long been called the "**discoverer**" of the New World, although Vikings such as Leif Eriksson had visited North America five centuries earlier. Columbus made his transatlantic voyages under the sponsorship of Ferdinand II and Isabella I, the Catholic Monarchs of Aragon, Castile, and Leon in Spain. He was at first full of hope and ambition, an ambition partly gratified by his title “Admiral of the Ocean Sea,” awarded to him in April 1492, and by the grants enrolled in the Book of Privileges (a record of his titles and claims). However, he died a disappointed man.

- **Albert Einstein**

Born in Germany in 1879, **Albert Einstein** is one of the most celebrated scientists of the Twentieth Century. His theories on relativity laid the framework for a new branch of physics, and Einstein's $E = mc^2$ on mass-energy equivalence is one of the most famous formulas in the world. In 1921, he was awarded the Nobel Prize in Physics for his contributions to theoretical physics and the evolution of Quantum Theory.

- **Louis Pasteur**

Louis Pasteur was a French chemist and microbiologist who developed antidotes and cures to many dangerous illnesses such as anthrax and rabies. He also successfully invented a way to pasteurize milk and make it safe from tuberculosis. Pasteur also illustrated how germs grew from contamination and disproved the theory of spontaneous contamination.

- **Galileo Galilei**

Galileo Galilei was an Italian astronomer, scientist and philosopher, who played a leading role in the Scientific Revolution. Galileo improved the telescope and made many significant discoveries in astronomy. His findings encouraged him to speak out for the Copernican view that the earth revolved around the sun. However, his views were considered heretical, and he was placed under house arrest. His greatest scientific works included **Two New Sciences** about kinetics and the strength of materials.

- **Aristotle**

Aristotle was an ancient Greek philosopher and scientist, one of the greatest intellectual figures of Western history. He was the author of a philosophical and scientific system that became the frame work and vehicle for both Christian Scholasticism and medieval Islamic philosophy. Even after the intellectual revolutions of the Renaissance, the Reformation, and the Enlightenment, Aristotelian concepts remained embedded in Western thinking.

- **Euclid**

Euclid was a Greek Mathematician considered the "**Father of Geometry**". His textbook ‘Elements’ remained a highly influential mathematics teaching book until the late 19th Century and is one of the most widely published books in the world. It has had a lasting influence on the sciences, especially in mathematics.

- **Moses**

Moses was an Egyptian prince who became the leader and prophet of the Jewish people – taking them from slavery in Egypt across the Red Sea to Mount Sinai. On Mount Sinai, Moses received the Ten Commandments, which form an important basis of the Old Testament and the Torah.

- **Charles Darwin**

Charles Darwin was an English Natural scientist who laid down a framework for the theory of evolution – showing how Man evolved from lower life forms. At the time, his research and publication led to bitter controversy, but his theory of evolution and natural selection later became accepted within the scientific community.

- **Qin Shi Huang**

Qin Shi Huang was an emperor (reigned 221–210 BCE) of the Qin dynasty (221–207 BCE) and creator of the first unified Chinese empire (which collapsed, however, less than four years after his death).

- **Augustus Caesar**

Augustus Caesar was a first Roman emperor, following the republic, which had been finally destroyed by the dictatorship of Julius Caesar, his great-uncle and adoptive father. His autocratic regime is known as the principate because he was the Princeps, the first citizen, at the head of that array of outwardly revived republican institutions that alone made his autocracy palatable. With unlimited patience, skill, and efficiency, he overhauled every aspect of Roman life and brought durable peace and prosperity to the Greco-Roman world.

- **Nicolaus Copernicus**

Nicolaus Copernicus was a Polish mathematician and astronomer. Copernicus created a model of the universe which placed the sun at the centre of the universe (**heliocentrism**) – challenging the prevailing orthodoxy of the time – which believed the earth at the centre of the universe. His major work **De revolutionibus orbium coelestium** (1543) (On the Revolutions of the Celestial Spheres) was published just before his death and marked an important scientific landmark – it was a key moment in the scientific revolution of the Renaissance period.

- **Antoine Laurent Lavoisier**

Lavoisier was a French chemist who was a key figure in the chemical revolution of the 18th-century. Amongst his pioneering achievements, he recognised and discovered oxygen and hydrogen – discovering the role of oxygen in combustion. Lavoisier helped bring a new scientific rigor to the subject of chemistry, using quantitative methods rather than relying on hypothesis. He constructed a list of elements and helped to construct the metric system. Using the work of other scientists, Lavoisier was able to combine into a new common framework which broke with previous classical beliefs. He ushered in a new era of modern chemistry.

- **Constantine the Great**

Constantine I was the first Roman emperor to profess Christianity. He not only initiated the evolution of the empire into a Christian state but also provided the impulse for a distinctively Christian culture that prepared the way for the growth of Byzantine and Western medieval culture.

- **James Watt**

James Watt was a Scottish instrument maker and inventor whose steam engine contributed substantially to the Industrial Revolution. He was elected fellow of the Royal Society of London in 1785.

- **Michael Faraday**

Michael Faraday was an influential British scientist who, amongst other discoveries, helped turn electricity into a property that could be easily used.

- **James Clerk Maxwell**

James Maxwell was one of the world's most influential physicists. In particular, he made great strides in helping to understand electromagnetism and produced a unified model of electromagnetism. His research in kinetics and electricity laid the foundations for modern Quantum mechanics and special relativity.

- **Martin Luther**

Martin Luther was a German theologian and religious reformer who was the catalyst of the 16th-century Protestant Reformation. Through his words and actions, Luther precipitated a movement that reformulated certain basic tenets of Christian belief and resulted in the division of Western Christendom between Roman Catholicism and the new Protestant traditions, mainly Lutheranism, Calvinism, the Anglican Communion, the Anabaptists, and the Antitrinitarians. He is one of the most influential figures in the history of Christianity.

- **George Washington**

George Washington was Commander in Chief of the Continental Forces during the American Wars of Independence. He also became the first president of the US, serving from 1789-1797. Washington is often referred to as the **'Father of the Nation** ' and symbol of Republican democracy. His image is widely displayed on coins and statues throughout the United States.

- **Karl Marx**

Karl Heinrich Marx was a revolutionary, sociologist, historian, and economist. He published (with Friedrich Engels) **Manifest der Kommunistischen Partei** (1848), commonly known as The Communist Manifesto, the most celebrated pamphlet in the history of the socialist movement. He also was the author of the movement's most important book, **Das Kapital**. These writings and others by Marx and Engels form the basis of the body of thought and belief known as Marxism.

- **Orville and Wilbur Wright Orville**

Wright brothers, American brothers, inventors, and aviation pioneers who achieved the first powered, sustained, and controlled airplane flight (1903). Wilbur Wright (April 16, 1867, near Millville, Indiana, U.S.—May 30, 1912, Dayton, Ohio) and his brother Orville Wright (August 19, 1871, Dayton—January 30, 1948, Dayton) also built and flew the first fully practical airplane (1905).

- **Genghis Kahn**

Genghis Khan was a fierce and brilliant military commander, who achieved unprecedented success in setting up the Mongol Empire which stretched across Europe, China and Asia. His Mongol armies left a trail of fear, death and destruction. But, he also created a vibrant empire with a common language, booming trade, tolerance of religion and some basic customs and laws.

- **Adam Smith**

Adam Smith was a Scottish social philosopher and political economist. After two centuries, Adam Smith remains a towering figure in the history of economic thought. Known primarily for a single work—An Inquiry into the Nature and Causes of the Wealth of Nations (1776), the first comprehensive system of political economy—Smith is more properly regarded as a social philosopher whose economic writings constitute only the capstone to an overarching view of political and social evolution. If his masterwork is viewed in relation to his earlier lectures on moral philosophy and government, as well as to allusions in The Theory of Moral Sentiments (1759) to a work he hoped to write on "the general principles of law and government, and of the different revolutions they have undergone in the different ages and periods of society," then The Wealth of Nations may be seen not merely as a treatise on economics but also as a partial exposition of a much larger scheme of historical evolution.

- **William Shakespeare**

William Shakespeare was an English poet, dramatist, and actor often called the English national poet and considered by many to be the greatest dramatist of all time.

- **John Dalton**

John Dalton was an English meteorologist and chemist, a pioneer in the development of modern atomic theory.

- **Alexander the Great**

Alexander the Great was perhaps the greatest military commander of all time. During one decade, he conquered the entire known world leaving one of the world's most extensive empires.

- **Napoleon Bonaparte**

Napoleon I was the French general, first consul (1799–1804), and emperor of the French (1804 – 1814/15), one of the most celebrated personages in the history of the West. He revolutionized military organization and training; sponsored the Napoleonic Code, the prototype of later civil-law codes; reorganized education; and established the long-lived Concordat with the papacy.

- **Thomas Edison**

Thomas Edison was an American inventor and businessman who developed and made commercially available – many key inventions of modern life. His Edison Electric company was a pioneering company for delivering DC electricity directly into people's homes. He filed over 1,000 patents for a variety of different inventions. Crucially, he used mass-produced techniques to make his inventions available at low cost to households across America. His most important inventions include the electric light bulb, the phonograph, the motion picture camera, an electric car and the electric power station.

- **Antony van Leeuwenhoek**

Antonie Philips van Leeuwenhoek was a Dutch chemist credited with developing the science of microbiology. He was a businessman who made his own revolutionary microscopes. He then used this technological breakthrough to make innumerable discoveries of the world that can only be seen through microscopes. He discovered single-celled organisms, bacteria and revolutionized the way science looked at the living world. Entirely self-taught, he was often criticized for being an amateur with no scientific pedigree. But, he shared his findings freely with the Royal Society, and his findings were widely accepted – leading to a whole new branch of science – microbiology.

- **William T.G. Morton**

William T.G. Morton was an American dentist who is credited with revealing and popularizing the use of aesthetics during operations. Although he was not the first to realise ether had anaesthetic properties, it was Morton who conducted the first public operation – leading to widespread acceptance and use of ether in painful operations. The introduction of anaesthetics revolutionized medical procedures; it overcame the terrible pain that amputees had to face when having a limb cut off. It also enabled a much greater range of operations, which would not have been possible without anaesthesia. Morton never benefitted from his discoveries as he hoped to. He spent his remaining years in rather futile legal proceedings trying to claim sole patent to anaesthesia, and he died aged 48 in New York. He is widely regarded as an instrumental figure in the practical use of anaesthesia.

- **Guglielmo Marconi**

Guglielmo Marconi was an Italian physicist and inventor of a successful wireless telegraph (1896). In 1909 he received the Nobel Prize for Physics, which he shared with German physicist Ferdinand Braun. He later worked on the development of shortwave wireless communication, which constitutes the basis of nearly all modern long-distance radio.

- **Adolf Hitler**

Adolf Hitler was a charismatic leader of the Nazi party, gaining power in 1933 and become dictator of Germany until his death in 1945. He led Germany in an aggressive war of conquest invading Western Europe and then the Soviet Union. Initially successful, his army then suffered a series of reverses, before the eventual complete defeat of his Nazi Germany in 1945. Hitler has become infamous as a personification of human evil. His name is inexorably linked to the Holocaust and extermination of Jews and other 'undesirables'. He is also seen as the principal cause of the Second World War in which over 70 million people died. Yet, in the midst of the Great Depression, he captivated a nation with his mixture of charm, xenophobia, and ability to persuade.

- **Plato**

Plato was a Classical Greek philosopher, mathematician, student of Socrates, writer of philosophical dialogues, and founder of the Academy in Athens – the first institution of higher learning in the Western world. Along with his mentor, Socrates and his student, Aristotle, Plato helped to lay the foundations of Western philosophy and science. Plato influenced a whole range of subjects from philosophy to maths, logic and ethics.

- **Oliver Cromwell**

Oliver Cromwell was an English soldier and statesman, who led parliamentary forces in the English Civil Wars and was lord protector of England, Scotland, and Ireland (1653–1658) during the republican Commonwealth.

- **Alexander Graham Bell**

Alexander Graham Bell was a Scottish inventor, most notably credited with inventing the modern telephone.

- **Alexander Fleming**

Sir Alexander Fleming was born in East Ayrshire, Scotland in 1881. He was a biologist and pharmacologist most famous for his discovery of the antibiotic substance penicillin in 1928. He was awarded a Nobel Prize, jointly with Howard Florey and Ernst Boris Chain for medicine in 1945.

- **John Locke**

John Locke was an English philosopher – instrumental in founding modern philosophical empiricism and political liberalism. Locke developed the concept of individual rights and the social contract – the idea government was based on rights and responsibilities. Locke was an influential figure in the Enlightenment and the American Revolution.

- **Ludwig van Beethoven**

Ludwig van Beethoven was a German composer, the predominant musical figure in the transitional period between the Classical and Romantic eras.

- **Werner Heisenberg**

Werner Heisenberg was a German physicist and influential figure in the development of quantum mechanics. Heisenberg developed new theories for explaining the behavior of sub-atomic particles. Contrasting with the established view of Newtonian mechanics, Heisenberg proved that at the sub-atomic level, there was not the same certainty, but the outcome was uncertain and based on probabilities. Later physicists slightly modified his quantum theories, but essentially kept it the same. For his work, he was awarded the Nobel Prize for physics in 1932.

- **Louis Daguerre**

Louis Daguerre was a French painter and physicist who invented the first practical process of photography, known as the daguerreotype. Though the first permanent photograph from nature was made in 1826/27 by Nicéphore Niépce of France, it was of poor quality and required about eight hours' exposure time. The process that Daguerre developed required only 20 to 30 minutes.

- **Simon Bolivar**

Simon Bolivar was a Venezuelan military and political leader who was instrumental in helping Latin American countries achieve independence from the Spanish Empire. During his lifetime, Bolivar became known as '**El Libertador**' through helping countries such as Venezuela, Colombia, Ecuador, Peru and Bolivia all achieve independence. Bolivar acted as a political dictator, but to some extent helped lay the foundations of democracy in Latin America. From 1819 to 1830 he served as president of the Hispanic-American republic known as Gran Colombia.

- **Rene Descartes**

Rene Descartes was a French philosopher and mathematician. Descartes is considered the founder of modern philosophy for successfully challenging many of the accepted wisdom of the medieval scholastic traditions of Aristotelian philosophy. Descartes promoted the importance of using human reason to deduct the truth. This principle of reason was an important aspect of the Enlightenment and the development of modern thought. His work in mathematics was important for the later work of Isaac Newton.

- **Michelangelo**

Michelangelo was an Italian Renaissance sculptor, painter, architect, and poet who exerted an unparalleled influence on the development of Western art.

- **Pope Urban II**

Pope Urban II was Pope and head of the Roman Catholic Church from 1088 to 1099. In 1096, he gave a speech exhorting Christians to go on a 'Holy Crusade' to regain the Holy Lands from Muslim rulers. Promising the pardon of sins, righteous conduct and the wealth of the Holy Lands, Christian knights from across Europe heeded his call, leading to two centuries of conflict in the Holy Land and radically changing European and middle-eastern history.

- **Umar Ibn Al-Khattab**

The Second Muslim Caliph, **Umar** played a key role in the expansion of Islam following the death of the prophet Muhammad. Umar was considered a pious Muslim who played a role in compiling the first Quran. As Caliph, he oversaw an expansion of Arab conquests which saw a sustained expansion of Arab rule and the new Muslim religion.

- **Ashoka**

Ashoka was the last major emperor of the Mauryan dynasty of India. His vigorous patronage of Buddhism during his reign (c. 265–238 BCE; also given as c. 273–232 BCE) furthered the expansion of that religion throughout India. Following his successful but bloody conquest of the Kalinga country on the east coast, Ashoka renounced armed conquest and adopted a policy that he called “conquest by dharma” (i.e., by principles of right life).

- **St. Augustine**

St. Augustine was the bishop of Hippo from 396 to 430, one of the Latin Fathers of the Church and perhaps the most significant Christian thinker after St. Paul. Augustine’s adaptation of classical thought to Christian teaching created a theological system of great power and lasting influence. His numerous written works, the most important of which are Confessions (c. 400) and The City of God (c. 413–426), shaped the practice of biblical exegesis and helped lay the foundation for much of medieval and modern Christian thought. In Roman Catholicism he is formally recognized as a doctor of the church.

- **William Harvey**

William Harvey was an English Physician who made important discoveries in the circulation of blood within the human body.

- **Ernest Rutherford**

Ernest Rutherford was a New Zealand born British physicist who is considered to be the father of nuclear physics. Through numerous experiments, Rutherford changed our understanding of the atom. Rutherford discovered the atom was mostly space with a nucleus and electrons. Rutherford discovered properties of radiation, half-life and performed the first artificially induced nuclear reaction when he transformed nitrogen atoms into oxygen atoms. His work was a pivotal moment in the development of nuclear energy, radiation and the sub-atomic level of physics. His work was also instrumental in later quantum physics.

- **John Calvin**

John Calvin was a theologian and ecclesiastical statesman. He was the leading French Protestant reformer and the most important figure in the second generation of the Protestant Reformation. His interpretation of Christianity, advanced above all in his **Institutio Christianae religionis** (1536 but elaborated in later editions; Institutes of the Christian Religion), and the institutional and social patterns he worked out for Geneva deeply influenced Protestantism elsewhere in Europe and in North America. The Calvinist form of Protestantism is widely thought to have had a major impact on the formation of the modern world.

- **Gregor Mendel**

Gregor Mendel was an Augustinian Friar and Abbot, who is best known for his pioneering work on genetics and plant breeding. His experiments in breeding different varieties of peas illustrated laws of heredity and genetics, which later proved highly influential in the development of new strains of plants and animals. It was Mendel who was the first to highlight the role of recessive and dominant genes, which explain how certain characteristics, such as colour can skip a generation, but appear at a later date.

- **Max Planck**

Max Planck was a German physicist who is considered the father of Quantum Physics. He discovered that light could be emitted in particles (Quanta) rather than steady waves. This hypothesis over-turned many assumptions of classical physics, paving the way for many future developments in Quantum Physics.

- **Joseph Lister**

Joseph Lister was a surgeon who introduced principles of cleanliness and antiseptic routines, which drastically helped to improve survival rates from surgery. Overcoming opposition from within the medical profession, Lister successfully advocated and popularized the preventative methods until it became standard practise. Lister's work increased the safety of major operations and enabled a greater ranger of surgery to be taken place. He is often referred to as the "**father of modern surgery**."

- **Nikolaus August Otto**

Nikolaus August Otto was a German engineer who developed the four-stroke internal-combustion engine, which offered the first practical alternative to the steam engine as a power source.

- **Francisco Pizarro**

Francisco Pizarro was a Spanish Conquistador who led a small force of Spanish soldiers to conquer the Inca Empire. This improbably and spectacular military victory led to Spanish control over a considerable part of South America radically changing the destiny of these countries. Pizzaro was ruthless, ambitious and cruel in his conquest of the Inca's but was very influential in bringing European culture and religion to the former Inca Empire.

- **Hernando Cortes**

Hernando Cortes was a Spanish conquistador who defeated the Aztec Empire and claimed Mexico for Spain. Cortes was a pioneer for claiming lands in the Americas for European powers. After Cortes, other Spanish conquistadors followed in his footsteps, such as Pizzaro who conquered the Inca Empire. Cortes is a controversial figure for his invasion and conquest of the Aztec Empire, but undoubtedly had tremendous influence in claiming Mexico for the Spanish monarchy – bringing Christianity and European culture to the Americas.

- **Thomas Jefferson**

Thomas Jefferson was a leading Founding Father of the United States, the author of the Declaration of Independence (1776) and he served as the third President of the US (1801–1809). Jefferson was a committed Republican – arguing passionately for liberty, democracy and devolved power. Jefferson also wrote the Statute for Religious Freedom in 1777 – it was adopted by the state of Virginia in 1786. Jefferson was also a noted polymath with wide-ranging interests from architecture to gardening, philosophy, literature and education. Although a slave owner himself, Jefferson sought to introduce a bill

(1800) to end slavery in all Western territories. As President, he signed a bill to ban the importation of slaves into the US (1807).

- **Queen Isabella I**

Queen Isabella I of Castile was an influential monarch who helped to unite the different regions of Spain and make Spain a leading power in Europe and the Americas. Queen Isabella was a strict Catholic and, amongst contemporaries, was noted for her '**virtue and fear of God**'. She was an effective monarch in bringing greater law and order to the country and had a reputation for promoting justice rather than mercy. With her husband King Ferdinand, she set up the Spanish Inquisition, to investigate heretical religious practices.

- **Joseph Stalin**

Joseph Stalin was an absolute ruler of the Soviet Union from 1924 until his death in 1953. Stalin presided over the industrialization of the Soviet economy and was the supreme war leader during the Second World War. In consolidating his absolute power, he ordered many 'purges' in which people in positions of power were executed or sent to gulags. Stalin was also instrumental in the formation of the Cold War and annexation of Eastern European countries after the end of WWII.

- **Julius Caesar**

Julius Caesar was a Roman general who conquered vast areas of land in the region of Gaul. This significantly expanded the Roman Empire and accelerated the diffusion of Roman culture, into Western Europe. Caesar also launched a coup against the failing Senate, and after a civil war set himself up as sole ruler and dictator. Caesar's dictatorship and cult of personality moved Rome from a republic to an autocratic state. He was murdered by senators on the Edes of March. He was succeeded by his adopted son Augustus Caesar who consolidated the gains of his father.

- **William the Conqueror**

William the Conqueror was a Norman King, who successfully invaded England in 1066. He established Norman rule in England, having a large impact on English life and history. The invasion created a close link between the fortunes of France and England. All English kings can trace their lineage to William the Conqueror.

- **Sigmund Freud**

Sigmund Freud was an Austrian neurologist who is credited with developing the field of psychoanalysis. He is considered one of the most influential thinkers of the Twentieth Century, even though many of his ideas have been challenged in recent decades.

- **Edward Jenner**

Edward Jenner was an English doctor who helped create and popularize a vaccination for smallpox. Through his pioneering work, he helped save the lives of countless people, and over time became known as the "**father of immunology**" and later vaccinations.

- **Wilhelm Conrad Roentgen**

Wilhelm Conrad Rontgen − physicist who was a recipient of the first Nobel Prize for Physics, in 1901,for his discovery of X-rays, which heralded the age of modern physics and revolutionized diagnostic medicine.

- **Johann Sebastian Bach**

J.S. Bach was a German composer, organist and violinist. During his lifetime, he worked as a teacher and organist and was a prolific composer of choral works, concertos and preludes. Bach is widely regarded as one of the greatest classical composers of all time.

- **Lao Tzu**

Lao Tzu was a Chinese philosopher, believed to have lived in the 6th century BC. He is considered the author of the Taoist classic – the "**Tao Te Ching**", which offers an iconoclastic spiritual philosophy, based on an underlying unity of the universe. The work of Lao Tzu has a timeless appeal and has been claimed by the religion of Taoism but also co-opted into a range of spiritual philosophies and anti-authoritarian movements and remains relevant today.

- **Voltaire**

Voltaire was a French writer, essayist, and philosopher – he was known for his wit, satire, and defence of civil liberties. He sought to defend freedom of religious and political thought and played a major role in the Enlightenment period of the eighteenth century.

- **Johannes Kepler**

Johannes Kepler was a German astronomer, mathematician and astrologer, who discovered laws of planetary motion. Kepler was a key figure in the Scientific Revolution of the 17th Century – confirming the theories of Copernicus and laying the foundation for Issac Newton to discover the laws of gravity. He also worked on optics, inventing an improved version of the refracting telescope. Kepler sought to show that scientific reason was compatible with religion and belief in an intelligent God – he described his astronomy as "**celestial physics**."

- **Enrico Fermi**

Enrico Fermi was an Italian-American nuclear physicist who created the first self-sustaining nuclear chain reaction in 1942. He played a key role in developing the first atomic bomb and has been described as the architect of the nuclear age. Fermi excelled in both theoretical physics and experimental physics and was awarded the Nobel Prize in physics in 1938, for his work on induced radioactivity. He made contributions to quantum theory, statistical analysis, nuclear physics and particle physics.

- **Leonhard Euler**

Leonhard Euler was a Swiss mathematician and scientist who made a prolific number of discoveries in mathematics. Amongst his many contributions, Euler made discoveries in infinitesimal calculus, graph theory and contributed to topology and analytic number theory. His work was remarkably prolific – running to 70-80 volumes on maths, physics, astronomy and logic. It is estimated Euler wrote a third of all the mathematic works of the 18th Century. Euler also introduced many modern mathematical notations such as π. His work served as a basis for many other mathematicians and he is widely regarded as the greatest mathematician of all time. Born in Switzerland he spent considerable time in Russia and Prussia.

- **Jean-Jacques Rousseau**

Jean Jacques Rousseau was a Swiss-born French philosopher. His most influential political work was the Social Contract (1762) – which promoted the idea of a more egalitarian republicanism. His philosophy had a direct influence on the French and American Revolution. Rousseau was an original thinker and challenged the orthodox religious and political views of the day. For his controversial criticism of established religion, his works were often banned, and he sought exile in different European countries. He was also a musician and lover of nature – because of his freedom of spirit and thought, he is considered an influential figure of the European Enlightenment and a precursor of Romanticism.

- **Nicoli Machiavelli**

Niccolo Machiavelli was an Italian diplomat, politician, philosopher and writer. Machiavelli is best known for his book "The Prince" which offers a realistic guide to those seeking to increase and maintain their power by all means necessary. It is a controversial book as it suggests an amoral approach to keeping power. On the one hand, it is has been viewed as a template for dictators, on the other hand, Machiavelli is seen as an influential philosopher for Republican government and political enlightenment.

Macchiavelian has become a pejorative term meaning one who schemes and plots with underhand methods.

- **Thomas Malthus**

Thomas Malthus was an English cleric and scholar famous for his gloomy predictions about the population growing at a faster rate than food production – causing widespread shortages and famine. Although his worst predictions proved to be completely wrong, he was very influential in shaping attitudes to contraception and future concerns over population growth. His ideas influenced Charles Darwin’s theory of evolution and were also studied by political economists David Ricardo and Karl Marx.

- **John F. Kennedy**

John F. Kennedy was America's second youngest elected president. He oversaw one of the most crucial moments in the Cold War (Cuban Missile Crisis) and sought to affirm America’s beliefs in basic human rights by calling for civil rights legislation and an attempt to reduce poverty. Kennedy was assassinated on November 22, 1963 – a tragic death that shocked America and the world.

- **Gregory Pincus**

Gregory Goodwin Pincus was an American endocrinologist whose work on the antifertility properties of steroids led to the development of the first effective birth-control pill.

- **Mani**

Mani was an Iranian third-century prophet who founded the religion Manichaeism. Originating in the middle-east, the religion had numerous followers and spread as far as China and southern France. However, the religion was gradually purged by stronger monotheistic religions, with Islam and the Catholic Church persecuting its followers. Mani attempted to create a synthesis of former religions, including aspects of Zoroastrianism, Christianity and Buddhism. Mani recognised the prophets Zoroaster, Buddha and Jesus Christ, though he claimed to have received a more powerful revelation and he sought to create a new religious framework which was his own synthesis of previous teachings and his own inner revelations.

- **Lenin**

Lenin was a Russian revolutionary and the leader of the Bolshevik party. He was the first leader of the USSR and the Communist government that took over Russia in 1917. Lenin is also known as the creator of Leninism a version of Communism that he adapted for the Soviet Union.

- **Sui Wen Ti :** Founder of China's Sui Dynasty and reunifying China in 589

- **Vasco da Gama**

Vasco da Gama was a Portuguese navigator whose voyages to India (1497–1499, 1502–03, 1524) opened up the sea route from Western Europe to the East by way of the Cape of Good Hope.

- **Cyrus the Great**

Cyrus the Great was the founder of the Persian (Achaemenid) Empire. Born in Anshan, Persia (modern day Iran) Cyrus conquered the empires of Media, Lydia and Babylonia. In doing so, he created the largest empire the world had seen. Cyrus the Great also ruled with tolerance for the respective cultures and religions of the conquered peoples. He ruled fairly with an efficient administration and was appreciated by those who governed him. His rule became a template for a multi-ethnic state that allowed religious and cultural diversity. His rule was studied and admired by many of the great leaders, such as Alexander the Great, Julius Caesar and Thomas Jefferson.

- **Peter the Great**

Peter the Great was an influential Russian Tsar who pursued a policy of westernization and economic development, transforming Russia from a backward agrarian economy to greater openness and western orientation. Through military success, he also increased the boundaries of Russia, making the Russian Empire an important military power.

- **Mao Zedong:** Leader of the Communist Revolution and dictator of China from 1949-1974.

- **Francis Bacon**

Francis Bacon was an English scientist and lawyer. Bacon was an instrumental figure in the Renaissance and Scientific Enlightenment. In particular, Bacon developed and popularized a scientific method which marked a new scientific rigor based on evidence, results and a methodical approach to science. He is widely considered to be the father of empiricism and the Scientific Revolution of the Renaissance period.

- **Henry Ford**

Henry Ford was an industrialist who changed the face of automobile manufacture in America, becoming the epitome of American Capitalism. He lent his name to '**Fordism**' – efficient mass production.

- **Mencius**

Mencius was a Chinese sage who developed a tradition of Confucianism based around the belief that human nature was essentially good but needed to careful nurturing. Mencius has often been described as "**the second Sage**" and the most important of the orthodox interpreters of Confucianism.

- **Zoroaster**

Zarathustra was a prophet and spiritual teacher who founded the religion of Zoroastrianism. **Zoroaster** was a religious reformer teaching a monotheistic religion based on choosing between light and darkness – truth and falsehood.

- **Queen Elizabeth I**

Queen Elizabeth I was an influential Queen of England reigning during a time of economic, political and religious upheaval. She presided over an era of economic and political expansion, which lay the framework for Britain's later dominance as a world power. It was Queen Elizabeth who also established the supremacy of Protestantism in England.

- **Mikhail Gorbachev**

Mikhail Gorbachev was a Soviet official, the general secretary of the Communist Party of the Soviet Union (CPSU) from 1985 to 1991 and president of the Soviet Union in 1990–91. His efforts to democratize his country's political system and decentralize its economy led to the downfall of communism and the breakup of the Soviet Union in 1991. In part because he ended the Soviet Union's postwar domination of Eastern Europe, Gorbachev was awarded the Nobel Prize for Peace in 1990.

- **Menes**

Menes was a legendary first king of unified Egypt, who, according to tradition, joined Upper and Lower Egypt in a single centralized monarchy. Manetho, a 3rd-century-BCE Egyptian historian, called him Menes, the 5th-century-BCE Greek historian Herodotus referred to him as Min, and two native-king lists of the 19th dynasty (13th century BCE) call him Meni. Modern scholars have inconclusively identified the legendary Menes with one or more of the archaic Egyptian kings bearing the names Scorpion, Narmer, and Aha.

- **Charlemagne**

Charlemagne was the king of the Franks (768–814), king of the Lombards (774–814), and first emperor (800–814) of the Romans and of what was later called the Holy Roman Empire.

- **Homer**

Homer was a Classical Greek poet. Author of the Iliad and the Odyssey. Through his epic poems, Homer has played a hugely influential role in Western Literature. His classics of the Iliad and the Odyssey stand at the forefront of the Western Canon of literature.

- **Justinian I**

Justinian I was a Byzantine emperor (527–565), noted for his administrative reorganization of the imperial government and for his sponsorship of a codification of laws known as the Code of Justinian (Codex Justinianus; 534).

- **Mahavira**

Mahavira was a spiritual teacher and a key figure in the growth of Jainism. He advocated a spiritual path focused on ahimsa (non-violence) and Satya (truth). Mahavira taught that adherence to these basic principles, combined with meditation and the practice of Brahmacharya (chastity) would enable a seeker to attain spiritual liberation. Mahavira was born in India and was a near contemporary of Siddhartha the Buddha. Like the Buddha, he sought to reform existing religious practices and widen spirituality to everyone, without the caste distinction of Hinduism. Jainism is a small but influential religion with just an estimated 3.5 million adherents.

Karl Marx's Letter to Abraham Lincoln

"The workingmen of Europe feel sure that, as the American War of Independence initiated a new era of ascendancy for the middle class, so the American Antislavery War will do for the working classes. They consider it an earnest of the epoch to come that it fell to the lot of Abraham Lincoln, the single-minded son of the working class, to lead his country through the matchless struggle for the rescue of an enchained race and the reconstruction of a social world."

T. A. EDISON.

Menlo Park, N. J., Oct 22 1879

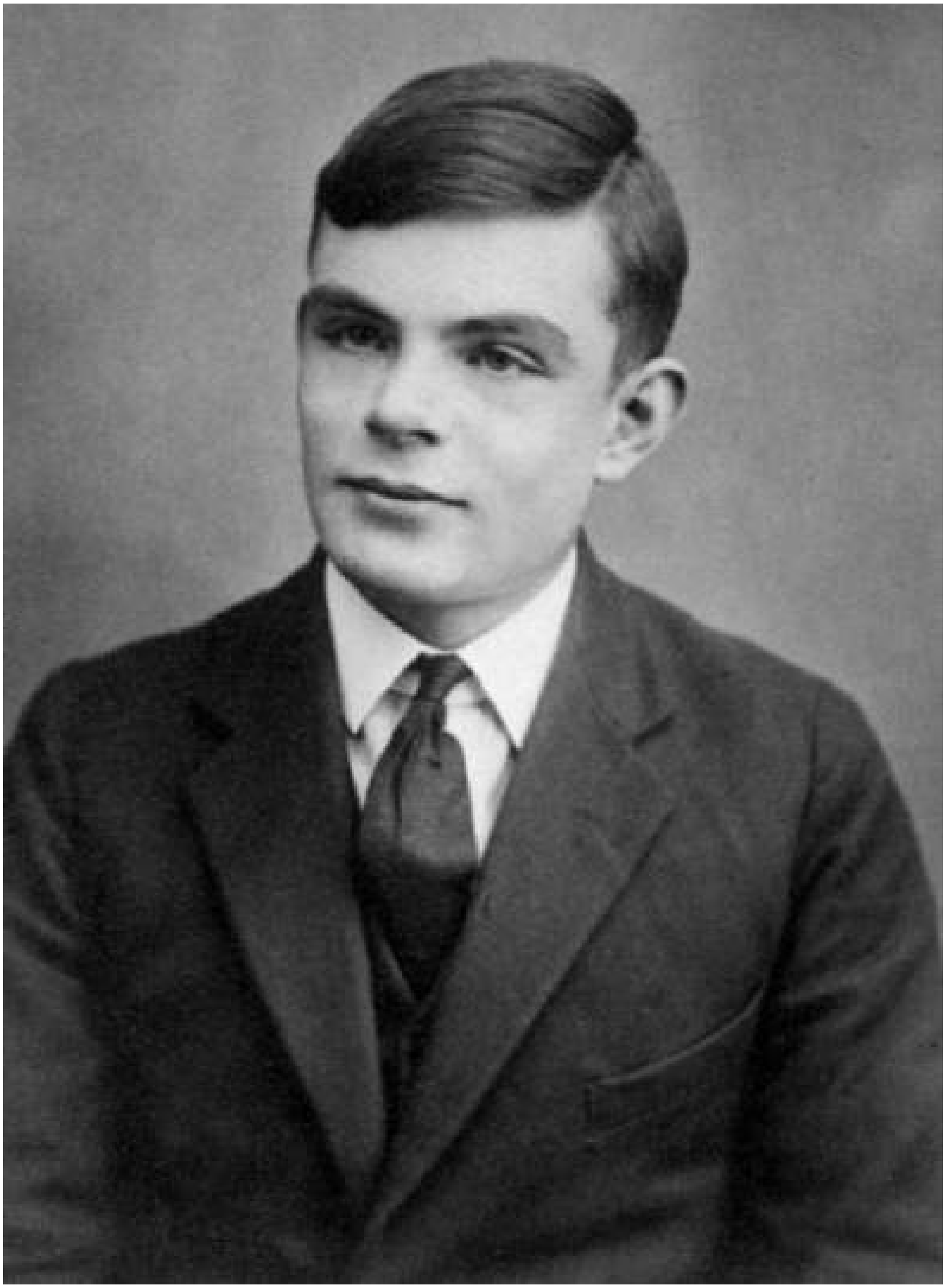
Mrs[.] Stroud

Dear Madame

Your favor of the 19th was duly rec'd - The megaphone is not yet completed and I am quite unable to say when it will be as at present I am busily engaged on the Electric light.

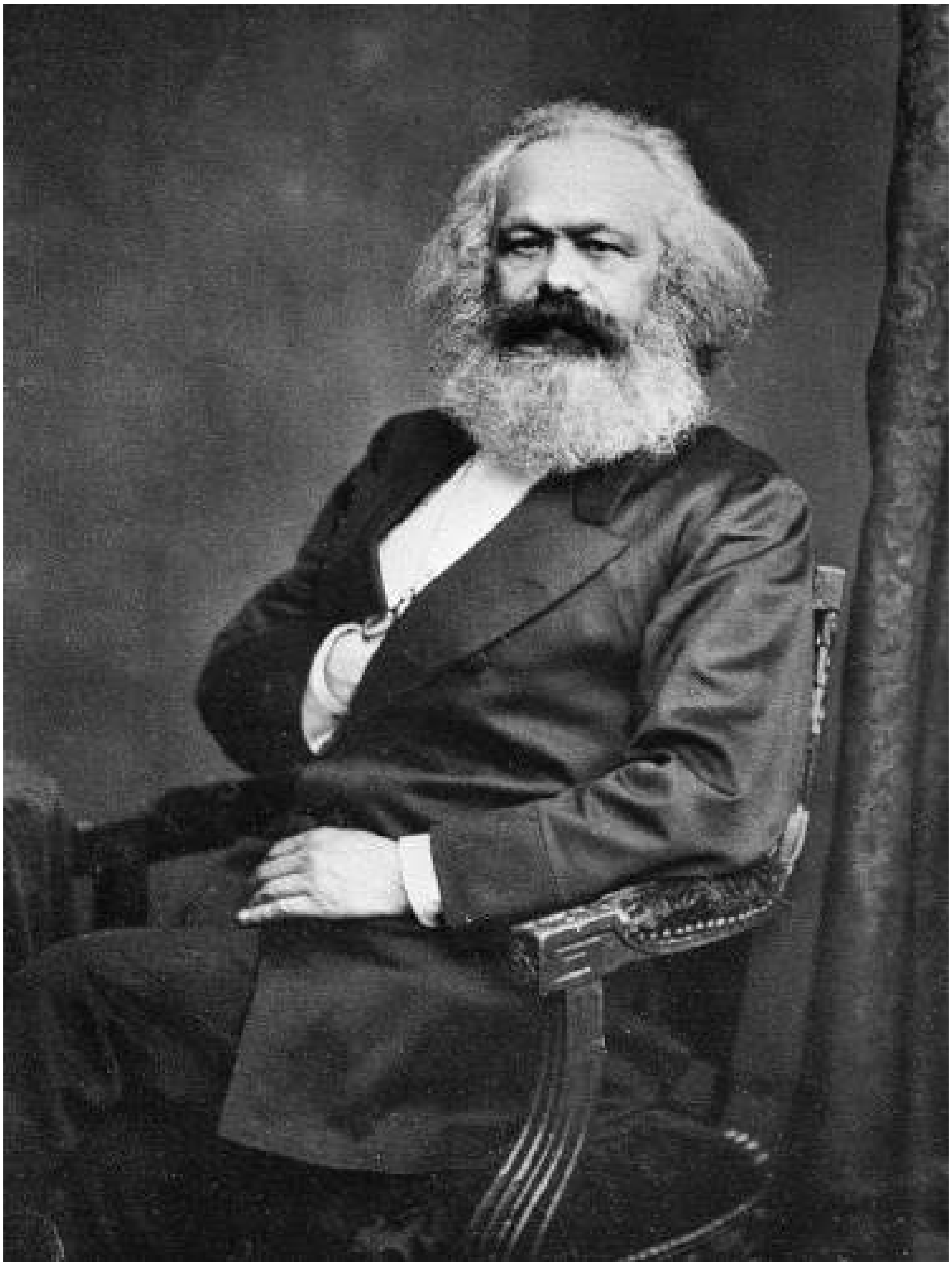
Very Truly

T. A. Edison



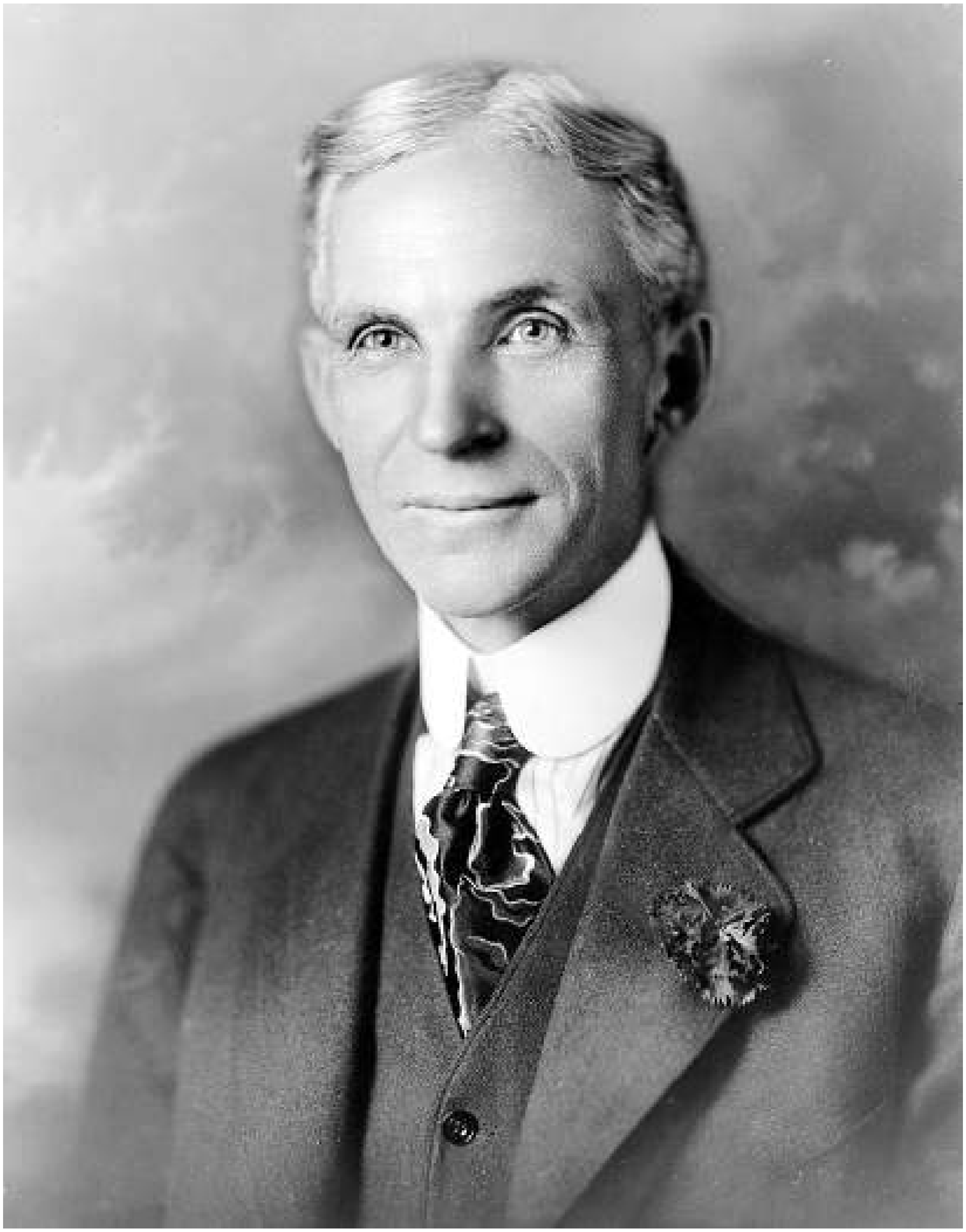
Those who can imagine anything, can create the impossible.

Alan Turing



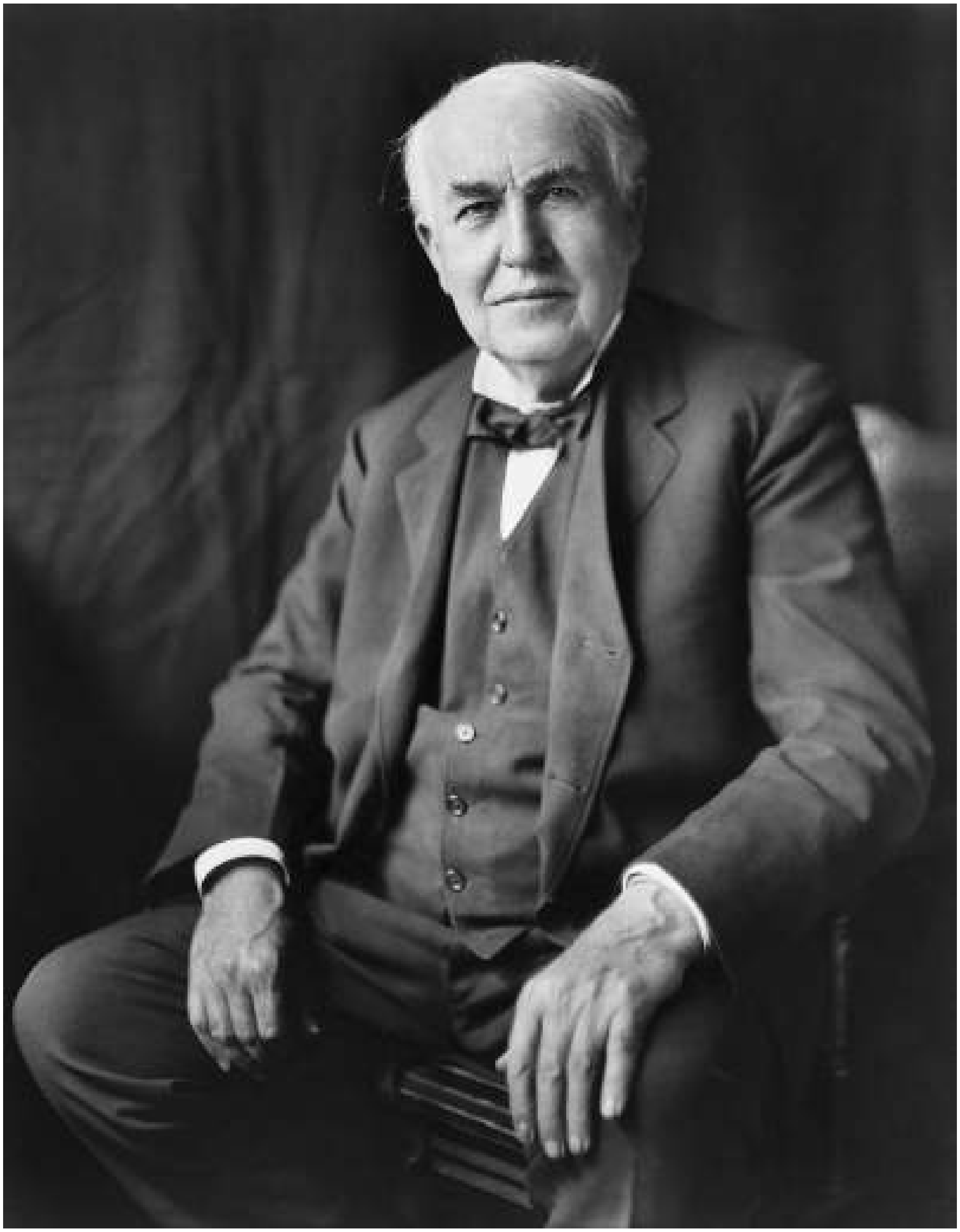
History repeats itself, first as tragedy, second as farce.

Karl Marx



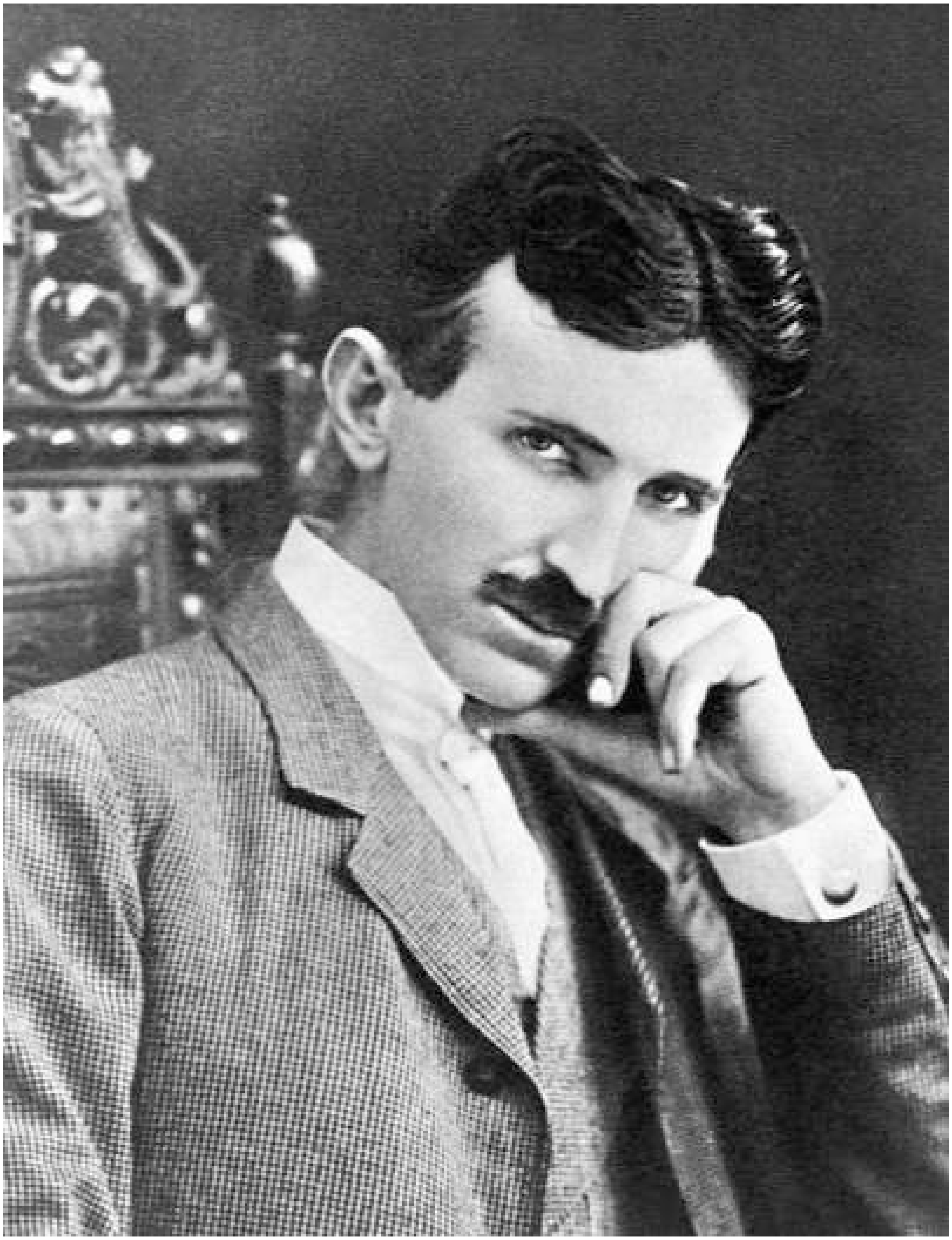
Failure is simply the opportunity to begin again, this time more intelligently.

Henry Ford



I have not failed. I've just found 10,000 ways that won't work.

Thomas Edison

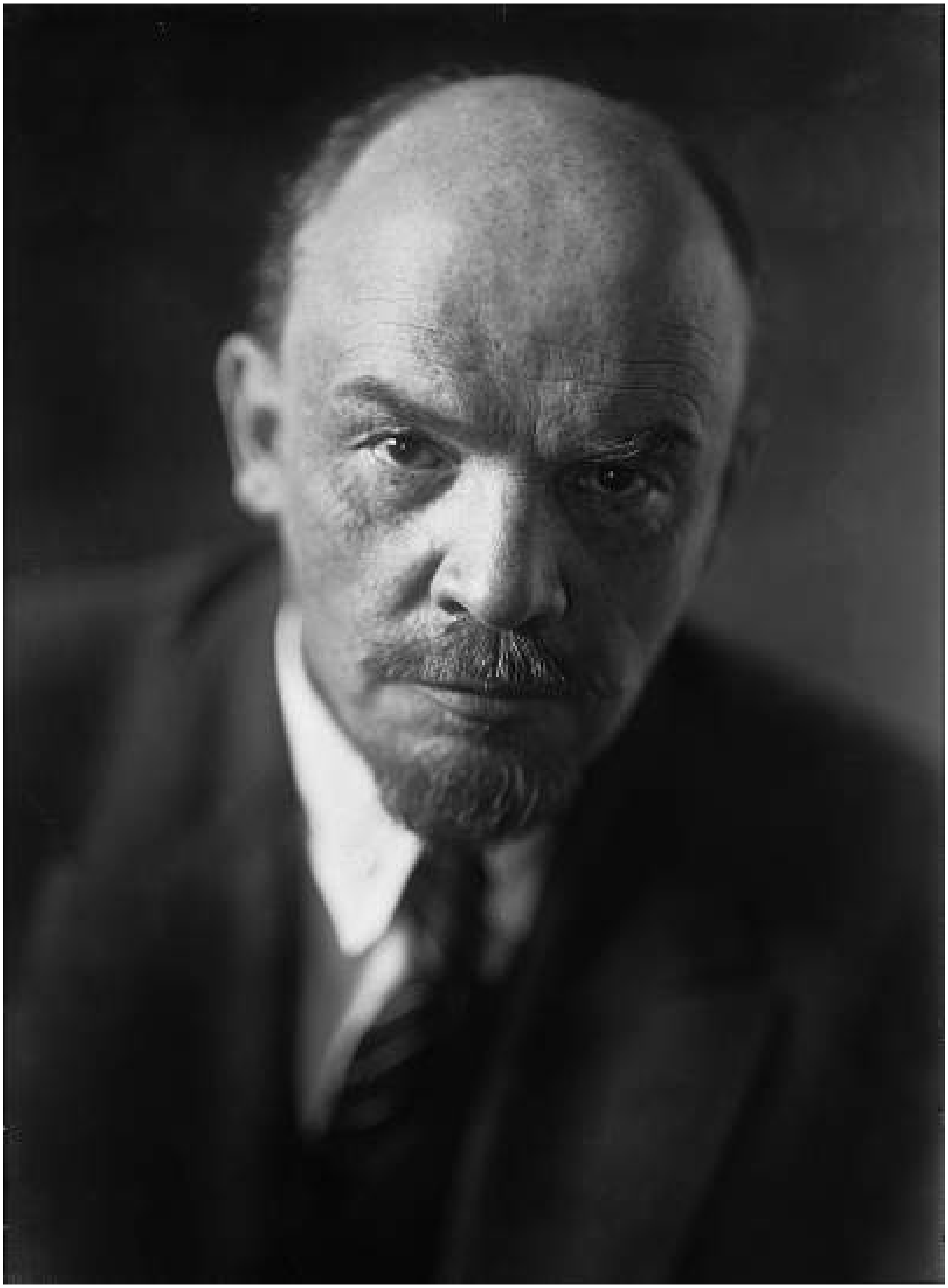


In the twenty-first century, the robot will take the place which slave labor occupied in ancient civilization.

Nikola Tesla

In peace-time the scientist belongs to humanity, in war-time to his fatherland.

Fritz Haber

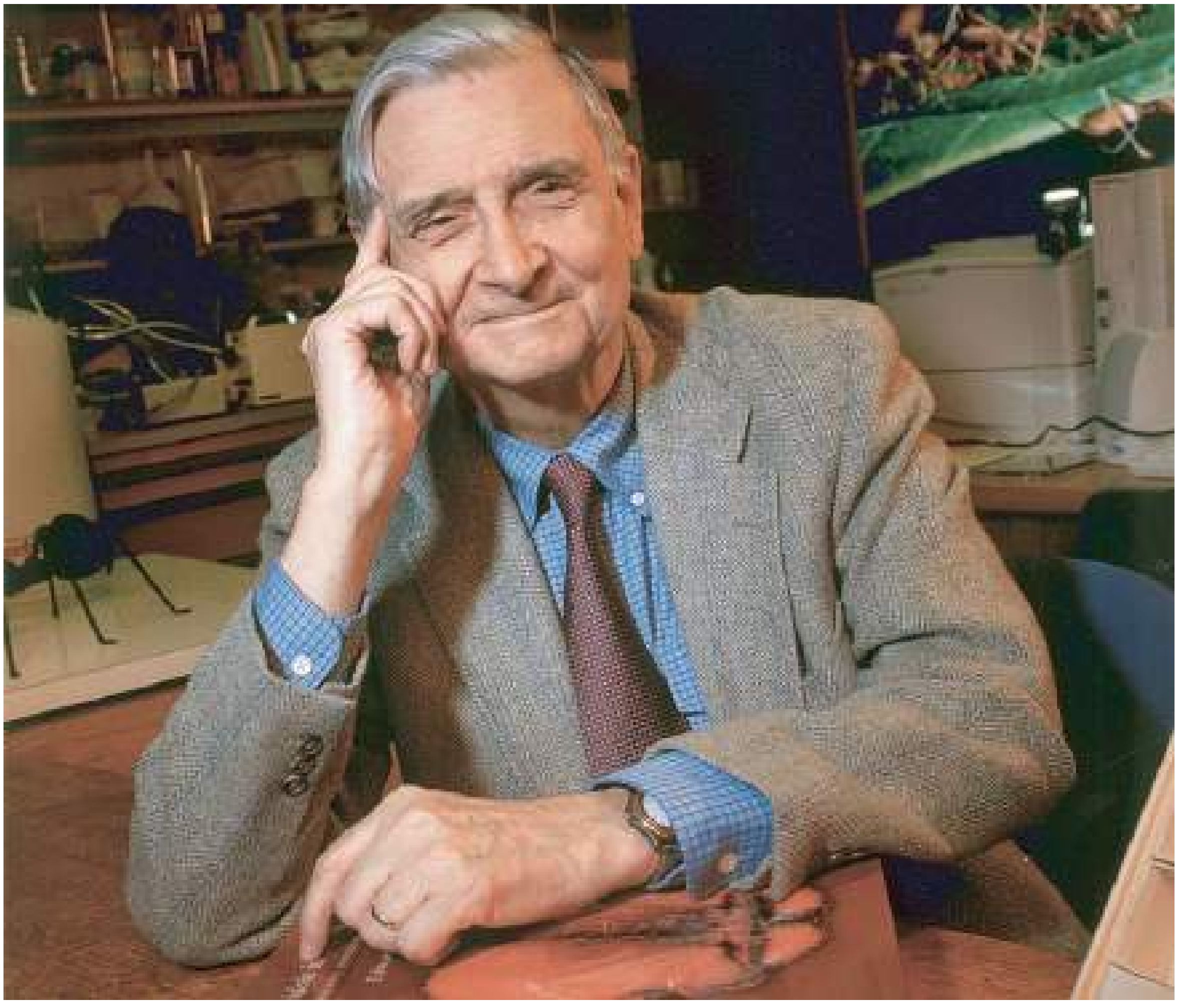


A lie told often enough becomes the truth.

Vladimir Lenin

The physicist in preparing for his work need three things, mathematics, mathematics, and mathematics.

Wilhelm Röntgen



Humanity today is like a waking dreamer, caught between the fantasies of sleep and the chaos of the real world. The mind seeks but cannot find the precise place and hour. We have created a Star Wars civilization, with Stone Age emotions, medieval institutions, and godlike technology. We thrash about. We are terribly confused by the mere fact of our existence, and a danger to ourselves and to the rest of life.

Edward O. Wilson

Year	**Discovery**	**Scientist Name**
1905	Photon	Albert Einstein
1897	Electron	J.J. Thomson
1919	Proton	Ernest Rutherford
1808	Atom	John Dalton
1932	Neutron	James Chadwick
1687	Law of Motion	Isaac Newton
1779	Coulomb	Charles-Augustin de Coulomb
1827	Ohm's Law	Georg Simon Ohm
1831	Electromagnetic Induction	Michael Faraday
1880	Thermionic Emission	Thomas Edison
1896	Radioactivity	Henri Becquerel
1898	Radium	Marie Sklodowska-Curie
1900	Quantum theory	Max Planck
1905	Photoelectric Effect	Heinrich Rudolf Hertz
1895	X-Ray	Röntgen
1905	Relativity	Albert Einstein
1913	Atomic Structure	Neils Bohr and Rutherford
1942	Nuclear Reactor	Enrico Fermi

Aryabhata was an Indian mathematician and the first of the major mathematician-astronomers from the classical age of Indian mathematics and Indian astronomy. His works include the Aryabhatiya and the Arya-siddhanta. He was the first person who gave the general integral solution of linear Diophantine equation ax + by = c in his Aryabhatiya.

Varahamihira was a Hindu astronomer and polymath who lived in Ujjain. His mathematical work included the discovery of the trigonometric formulas. He improved the accuracy of the sine tables of Aryabhata. He defined the algebraic properties of zero as well as of negative numbers.

Brahmagupta was an Indian mathematician and one of the most accomplished of the ancient Indian astronomers. He is the author of two early works on mathematics and astronomy: the **Brāhmasphuṭasiddhānta**, a theoretical treatise, and the **Khaṇḍakhādyaka**, a more practical text. He was the first person who gave the sum formulae:

$$1^2 + 2^2 + 3^2 + \ldots. + n^2 = \frac{n\,(n+1)\,(2n+1)}{6}$$

$$1^3 + 2^3 + 3^3 + \ldots. + n^3 = \left[\frac{n\,(n+1)}{2}\right]^2$$

Shridhara was an Indian mathematician, Sanskrit pundit and philosopher who wrote several treatises on the two major fields of Indian mathematics, pati-ganita ("**mathematics of procedures**," or algorithms) and bija-ganita ("**mathematics of seeds**," or equations). He wrote down rules for Solving Quadratic Equation, hence the most common method of finding the roots of the quadratic equation is recognised as **Sridharacharya rule**.

Thomas Alva Edison

Thomas Alva Edison was an American inventor who, singly or jointly, held a world record 1,093 patents. In addition, he created the world's first industrial research laboratory.

Che Guevara was a theoretician and tactician of guerrilla warfare, prominent communist figure in the Cuban Revolution (1956–59), and guerrilla leader in South America. After his execution by the Bolivian army, he was regarded as a martyred hero by generations of leftists worldwide, and his image became an icon of leftist radicalism and anti-imperialism.

Henry Ford was an American industrialist and business magnate, founder of the Ford Motor Company, and chief developer of the assembly line technique of mass production. By creating the first automobile that middle-class Americans could afford, he converted the automobile from an expensive curiosity into an accessible conveyance that profoundly impacted the landscape of the 20th century, considering him to be a revolutionary in the sector.

Letter from Alexander Graham Bell to his wife Mabel Hubbard Bell

June 26, 1906
Beinn Bhreagh,
Victoria County,
Cape Breton, N.S.

Dear Mabel,

The French Journal L'Aerophile for January 1906 contains some interesting details concerning the flying machine of the Wright Brothers of Dayton Ohio. It seems strange that our enterprising American newspapers have failed to keep tract of the experiments in Dayton Ohio for the machine is so large that it must be visible over a considerable extent of country and an electrical tramway runs right by the field where the experiments were made. Numerous persons residing in the neighborhood of Dayton have witnessed the experiments and yet hardly any details of the apparatus employed have appeared in print in America.

This seems to be due to the desire of secrecy. The Wright Brothers have made their experiments at a time when few people excepting the surrounding farmers have been out. They have declined to give the newspapers any information and when they discovered that the Dayton Daily News contained an article describing their apparatus they made arrangements with the Editor to have the edition suppressed.

It seems however that a French Journal L'Auto sent to Dayton Ohio one of their correspondents, M. Robert Coquelle who interviewed various witnesses and although he could get no details from the Wright Brothers themselves he succeeded in obtaining for a price a copy of the suppressed number of the Dayton Daily News. He sent this to France and a French translation of it has appeared in L'Auto. L'Aerophile also gives extracts from it in the number published January 1906, Pages 18 and 19. Considering the fact that this information was published as long ago as the first of January 1906, it seems strange that no American journal has yet got ahold of the information.

The January number of L'Aerophile also contains a letter from the Wright Brothers to the Editor of the Journal giving such information as they care to make public, but the information has not so far as I am aware yet appeared in the English Language. The same number of L'Aerophile contains a French translation of an interesting letter from a Mr. Weaver (who seems to be an American) addressed to M. Frank S. Lahm, but this letter too has not appeared in English. Mr. Weaver gives a plan sketch of the field where the experiments were made with its surroundings, and the results of interviews with the farmers who witnessed the experiments.

The same number of L'Aerophile contains a French translation of a letter signed by Wilbur and Orville Wright, dated 3rd of January 1906, and addressed to M. Frank S. Lahm relating to the purchase of his machine by the French. The number of L'Aerophile published December 1905, pages 265 to 272 contains an account of the negotiations of the Wright Brothers with the French government, with pictures of the two brothers. Several letters are published from the Wright Brothers to persons in France with the object of inducing the French Government to purchase their machine. The price asked being one million francs. Cablegrams backwards and forwards across the Atlantic are also given.

I do not understand how it is that so little attention has been paid to this matter by the American press. I am now studying carefully the details published. I wonder whether Bert would like me to ask Mr. Largelamb to send him some account of the matter.

Your loving husband,
Alec
Mr. A. Graham Bell
Twin Oaks, Woodley Lane,
Washington, D. C.

U. S. A

Letter from Wilbur Wright to Smithsonian

The Smithsonian Institution, Washington:
Dear Sirs:

"I am an enthusiast, but not a crank in the sense that I have some pet theories as to the proper construction of a flying machine. I wish to avail myself of all that is already known and then if possible add my mite to help on the future worker who will attain final success."

Wilbur Wright

Benjamin Franklin, Advice to a Young Man on the Choice of a Mistress (1745).

June 25, 1745

My dear Friend,

I know of no Medicine fit to diminish the violent natural Inclinations you mention; and if I did, I think I should not communicate it to you. Marriage is the proper Remedy. It is the most natural State of Man, and therefore the State in which you are most likely to find solid Happiness. Your Reasons against entering into it at present, appear to me not well-founded. The circumstantial Advantages you have in View by postponing it, are not only uncertain, but they are small in comparison with that of the Thing itself, the being married and settled. It is the Man and Woman united that make the compleat human Being. Separate, she wants his Force of Body and Strength of Reason; he, her Softness, Sensibility and acute Discernment. Together they are more likely to succeed in the World. A single Man has not nearly the Value he would have in that State of Union. He is an incomplete Animal. He resembles the odd Half of a Pair of Scissars. If you get a prudent healthy Wife, your Industry in your Profession, with her good Economy, will be a Fortune sufficient.

But if you will not take this Counsel, and persist in thinking a Commerce with the Sex inevitable, then I repeat my former Advice, that in all your Amours you should prefer old Women to young ones. You call this a Paradox, and demand my Reasons. They are these:

1. Because as they have more Knowledge of the World and their Minds are better stor'd with Observations, their Conversation is more improving and more lastingly agreable.
2. Because when Women cease to be handsome, they study to be good. To maintain their Influence over Men, they supply the Diminution of Beauty by an Augmentation of Utility. They learn to do a 1000 Services small and great, and are the most tender and useful of all Friends when you are sick. Thus they continue amiable. And hence there is hardly such a thing to be found as an old Woman who is not a good Woman.
3. Because there is no hazard of Children, which irregularly produc'd may be attended with much Inconvenience.
4. Because thro' more Experience, they are more prudent and discreet in conducting an Intrigue to prevent Suspicion. The Commerce with them is therefore safer with regard to your Reputation. And with regard to theirs, if the Affair should happen to be known, considerate People might be rather inclin'd to excuse an old Woman who would kindly take care of a young Man, form his Manners by her good Counsels, and prevent his ruining his Health and Fortune among mercenary Prostitutes.
5. Because in every Animal that walks upright, the Deficiency of the Fluids that fill the Muscles appears first in the highest Part: The Face first grows lank and wrinkled; then the Neck; then the Breast and Arms; the lower Parts continuing to the last as plump as ever: So that covering all above with a Basket, and regarding only what is below the Girdle, it is impossible of two Women to know an old from a young one. And as in the dark all Cats are grey, the Pleasure of corporal Enjoyment with an old Woman is at least equal, and frequently superior, every Knack being by Practice capable of Improvement.

6. Because the Sin is less. The debauching a Virgin may be her Ruin, and make her for Life unhappy.

7. Because the Compunction is less. The having made a young Girl miserable may give you frequent bitter Reflections; none of which can attend the making an old Woman happy.

8thly and Lastly They are so grateful!!

Thus much for my Paradox. But still I advise you to marry directly; being sincerely

Your affectionate Friend.

Letter from Francis Crick to William Shockley

Dr. W. Shockley
Stanford Electronics Laboratories

Stanford, California 94305

U.S.A.

2 April 1969

Thank you for your letter of the 17th March, and the enclosures, all of which I have read. The UPI story about my talk was slightly garbled; but was essentially correct. I certainly think these problems are important and that they should be dealt with objectively. Your experience clearly shows that this is not easy.

At the moment we have a large new extension to our laboratory, and are, taking up research in scientific areas which are new to us. Consequently I have decided not to speak or write on these social problems until our new work is will launched. In a year or so I hope to take up these issues again.

Yours sincerely
F.H.C. Crick

Letter from Nicolaus Copernicus to the Varmia Chapter

Melsac, 22 October 1518

To the Venerable and Worshipful Officers, Canons, and Chapter of the Church of Varmia, most honorable masters

Venerable and worshipful gentlemen, honorable masters:

I learned from his Most Reverend Lordship [the bishop of Varmia] yesterday what your Reverences write about preparing the reception. The arrangements are virtually complete for either [contingency], whether it happens to be a fish day or a meat day.

P[hilip] Greusing's letter impelled me to leave Olsztyn sooner [than I had intended]. At my invitation the burgrave 1eft with me. In Lidzbark he received more complete information, as a result of which Greusing will be unable to complain that he has been denied justice.

His Most Reverend Lordship also commissioned me to advise your Reverences concerning the reply to be given to the Grand Master [of the Teutonic Knights]. If the letter has not been sent, in the copy transmitted [to you] by his Lordship the following clause is to be added: "that holy justice may not be blocked," the better to forestall their perverse and quibbling interpretation.

His Lordship has also received the news that [the Grand Duke ot] Moscow has signed with the king [of Poland] a permanent peace treaty, the provisions of which his Lordship expects to learn at any moment. Thus the complete confidence of our neighbors has accordingly now collapsed.

I commend myself to your Reverences.

Melsac, 22 October 1518

I shall leave from here too as soon as I can.

N. Coppernic

Letter from Nicolaus Copernicus to Bishop Ferber

Frombork, 29 February 1524

To my lord, Most Reverend Father in Christ, Maurice [Ferber], by the grace of God bishop of Varmia, my most honorable and beloved superior

My lord, Most Reverend Father in Christ, my gracious lord. Some time ago, during the war, the venerable Heinrich Snellenberg received from Reinhold Feldstedt 100 marks of the money Feldstedt owed me. Not long afterward Snellenberg paid 90 of those marks. He remained obligated to me for 10 marks. I often asked him for them. Up to the present time I have not been able to recover them. But, putting me off, he always promised to pay up at the next distribution of the proceeds. Several months having passed, then, it happened that in my presence the venerable administrator counted out a certain share of the money to him. I asked him to pay me then out of that money in accordance with his promises, while I proposed to give him a receipt in full in my own handwriting. Then he again imposed on me with a new objection, and he forced me first to obtain his receipt from Reinhold Feldstedt.

Now the venerable administrator arrived yesterday and distributed the bulk of the proceeds. Holding Snellenberg's receipt, I sought him out, and even so I did not succeed. He said that he wanted to keep all the money [coming to him] from the administrator. If he owed me anything, I should claim it in a legal action in the court of a judge.

I therefore see that I cannot act otherwise, and that my reward for affection is to be hated, and to be mocked for my complacency. I am forced to follow his advice, the advice by which he plans to frustrate me or cheat me if he can.

I have recourse to your Most Reverend Lordship, whom I ask and beseech to deign to order on my behalf the withholding of the income from his benefice until he satisfies me, or a kind provision in some other way for me to be able to obtain what is mine.

I pledge my services with the utmost promptness to your Most Reverend Lordship. May divine goodness preserve you in a completely prosperous long life and happy rule.

Frombork, 29 February 1524

Your Most Reverend Lordship's

Nic. Coppernic

Letter from Nicolaus Copernicus to Duke Albrecht of Prussia

Frombork, 21 June 1541

To the serene and honorable prince, Albert, by the grace of God margrave of Brandenburg, duke of Prussia and Wendland, burgrave of Neuenburg, and prince of Rügen, my gracious lord

Serene, honorable Prince, gracious lord:

Just yesterday I received from Jan Benedict [Solfa], the physician of His Majesty the king of Poland, a letter and an answer to my message about the honorable George of Kunheim, commander in Tapiau etc. But since no mention is made therein of any other special or extraneous matters, I have forwarded the original letter to your Princely Grace. From it your Princely Grace will learn this doctor's opinion and advice. If I knew anything better to contribute thereto that would be helpful in restoring that good man, your Princely Grace's officer, to health, no labor, exertion, and trouble would be vexatious to me that would be beneficial to your Princely Grace, to whose service I am devoted.

Frombork, 21 June 1541

Your Princely Grace's obedient servant

Nicholas Copernicus

Ernest Hemingway's Letter to F. Scott Fitzgerald

Key West
28 May 1934

Dear Scott:

I liked it and I didn't. It started off with that marvelous description of Sara and Gerald (goddamn it Dos took it with him so I can't refer to it. So if I make any mistakes—). Then you started fooling with them, making them come from things they didn't come from, changing them into other people and you can't do that, Scott. If you take real people and write about them you cannot give them other parents than they have (they are made by their parents and what happens to them) you cannot make them do anything they would not do. You can take you or me or Zelda or Pauline or Hadley or Sara or Gerald but you have to keep them the same and you can only make them do what they would do. You can't make one be another. Invention is the finest thing but you cannot invent anything that would not actually happen.

That is what we are supposed to do when we are at our best—make it all up—but make it up so truly that later it will happen that way.

Goddamn it you took liberties with peoples' pasts and futures that produced not people but damned marvellously faked case histories. You, who can write better than anybody can, who are so lousy with talent that you have to—the hell with it. Scott for gods sake write and write truly no matter who or what it hurts but do not make these silly compromises. You could write a fine book about Gerald and Sara for instance if you knew enough about them and they would not have any feeling, except passing, if it were true.

There were wonderful places and nobody else nor none of the boys can write a good one half as good reading as one that doesn't come out by you, but you cheated too damned much in this one. And you don't need to.

In the first place I've always claimed that you can't think. All right, we'll admit you can think. But say you couldn't think; then you ought to write, invent, out of what you know and keep the people's antecedants straight. Second place, a long time ago you stopped listening except to the answers to your own questions. You had good stuff in too that it didn't need. That's what dries a writer up (we all dry up. That's no insult to you in person) not listening. That is where it all comes from. Seeing, listening. You see well enough. But you stop listening.

It's a lot better than I say. But it's not as good as you can do.

You can study Clausewitz in the field and economics and psychology and nothing else will do you any bloody good once you are writing. We are like lousy damned acrobats but we make some mighty fine jumps, bo, and they have all these other acrobats that won't jump.

For Christ sake write and don't worry about what the boys will say nor whether it will be a masterpiece nor what. I write one page of masterpiece to ninety one pages of shit. I try to put the shit in the wastebasket. You feel you have to publish crap to make money to live and let live. All write but if you write enough and as well as you can there will be the same amount of masterpiece material (as we say at Yale). You can't think well enough to sit down and write a deliberate masterpiece and if you could get rid of Seldes and those guys that nearly ruined you and turn them out as well as you can and let the spectators yell when it is good and hoot when it is not you would be all right.

Forget your personal tragedy. We are all bitched from the start and you especially have to hurt like hell before you can write seriously. But when you get the damned hurt use it—don't cheat with it. Be as faithful to it as a scientist—but don't think anything is of any importance because it happens to you or anyone belonging to you.

About this time I wouldn't blame you if you gave me a burst. Jesus it's marvellous to tell other people how to write, live, die etc.

I'd like to see you and talk about things with you sober. You were so damned stinking in N.Y. we didn't get anywhere. You see, Bo, you're not a tragic character. Neither am I. All we are is writers and what we should do is write. Of all people on earth you needed discipline in your work and instead you marry someone who is jealous of your work, wants to compete with you and ruins you. It's not as simple as that and I thought Zelda was crazy the first time I met her and you complicated it even more by being in love with her and, of course you're a rummy. But you're no more of a rummy than Joyce is and most good writers are. But Scott, good writers always come back. Always. You are twice as good now as you were at the time you think you were so marvellous. You know I never thought so much of Gatsby at the time. You can write twice as well now as you ever could. All you need to do is write truly and not care about what the fate of it is.

Go on and write.

Anyway I'm damned fond of you and I'd like to have a chance to talk sometimes. We had good times talking. Remember that guy we went out to see dying in Neuilly? He was down here this winter. Damned nice guy Canby Chambers. Saw a lot of Dos. He's in good shape now and he was plenty sick this time last year. How is Scotty and Zelda? Pauline sends her love. We're all fine. She's going up to Piggott for a couple of weeks with Patrick. Then bring Bumby back. We have a fine boat. Am going good on a very long story. Hard one to write.

Always your friend

Ernest

Letter from Pearl S. Buck to Helen Keller

Dear Helen Keller:

I am one of many thousands, I know, who are thinking of you today with especial affection and sympathy. I count meeting your Teacher as one of the great experiences of my life - one was instantly impressed with the sense of greatness in her presence. What a glorious life you and she made together! How much you both achieved for the world, and what immense strength you have given to us all! I know of no human source so full of inspiration to others as the story of your life with her.

Please, then, accept my deepest admiration, my faith in you that you are able, now, as you always have been, to live triumphantly. I know what this means to you - this parting - I know a little of what this must mean, rather- but I have no fears for you. And will you count me among your friends now more than ever, and if ever I can help you, let me know - I shall be so glad. And when you feel able, I should like to come and see you.
Please remember me kindly and warmly to dear Polly Thomson.

Faithfully yours,
Pearl S. Buck
(Mrs. Richard J. Walsh)
480 Park. Ave.
New York City
Wednesday

Letter from John Steinbeck to 20th Century Fox

New York

January 10, 1944

Dear Sirs:

I have just seen the film *Lifeboat*, directed by Alfred Hitchcock and billed as written by me. While in many ways the film is excellent there are one or two complaints I would like to make. While it is certainly true that I wrote a script for *Lifeboat*, it is not true that in that script as in the film there were any slurs against organized labor nor was there a stock comedy Negro. On the contrary there was an intelligent and thoughtful seaman who knew realistically what he was about. And instead of the usual colored travesty of the half comic and half pathetic Negro there was a Negro of dignity, purpose and personality. Since this film occurs over my name, it is painful to me that these strange, sly obliquities should be ascribed to me.

John Steinbeck

Letter from Alfred Nobel toVictor Hugo

Victor Hugo

Paris

Long may the Grand Master live, to charm the world and spread his ideas of universal charity.

A. Nobel

Second law of thermodynamics:

$$\Delta S_{Universe} > 0$$

Entropy (a measure of disorder) always increases.

Euler's Formula for Polyhedra:

$$\boxed{\text{Number of faces} - \text{Number of edges} + \text{Number of vertices} = 2}$$

Boltzmann Equation:

$$S = k_B \log W$$

S is the entropy of the system, W is the number of distinct microstates that can give rise to the overall macro state, and k_B is a constant called Boltzmann's constant, and its value is 1.38×10^{-23} joules per degree Kelvin.

Hermann Minkowski was a German mathematician and professor at Königsberg, Zürich and Göttingen. He created and developed the geometry of numbers and used geometrical methods to solve problems in number theory, mathematical physics, and the theory of relativity.

William B. Shockley was an American engineer and teacher, cowinner (with John Bardeen and Walter H. Brattain) of the Nobel Prize for Physics in 1956 for their development of the transistor, a device that largely replaced the bulkier and less-efficient vacuum tube and ushered in the age of microminiature electronics.

Robert Norton Noyce was an American physicist who co-founded Fairchild Semiconductor in 1957 and Intel Corporation in 1968. He is also credited with the realization of the first monolithic integrated circuit or microchip, which fueled the personal computer revolution and gave Silicon Valley its name.

Top 10 Scientists who Committed Suicide

Alan Turing	Founding father of **artificial intelligence** and of modern cognitive science	**Suicide** by eating an apple laced with cyanide
Wallace Carothers	American chemist who developed **nylon**	**Suicide** by drinking potassium cyanide
George Eastman	The pioneer of popular **photography** and **motion picture film**	**Suicide** by gunshot
Nicolas Leblanc	**French surgeon and chemist** who discovered how to manufacture soda from common salt	**Suicide** by gunshot
Edwin Armstrong	One of the most prolific inventors of the **radio era**	**Suicide** by jumping from his apartment window in New York
Hans Berger	The inventor of **electroencephalography**	**Suicide** by hanging
Valery Legasov	Mainly remembered for his work as Chief	**Suicide** by hanging

	Scientific Advisor of the commission investigating the **Chernobyl disaster**	
Ludwig Boltzmann	Austrian physicist who is known mostly for his work on **statistical mechanics and the field of thermodynamics**	**Suicide** by hanging
David Kelly	**Biological weapons scientist** who was an employee of the United Kingdom Ministry of Defence and a former United Nations weapons inspector in Iraq	**Suicide** by slashing his wrist with a blunt gardening knife
Viktor Meyer	Best known for inventing an apparatus for determining vapor densities and for discovering **thiophene**	**Suicide** by taking cyanide

Ludwig Boltzmann's grave in Vienna's Central Cemetery bears a cryptic epitaph:

$$\mathbf{S = k_B \log W}$$

Letter from Charles Dickens to Michael Faraday

May 28th, 1850

Dear Sir,

It has occurred to me that it would be extremely beneficial to a large class of the public to have some account of your late lectures on the breakfast-table.

. . . I should be exceedingly glad to have . . . them published in my new enterprise. . . .

With great respect and esteem I am Dear Sir,

Your faithful servant,

Charles Dickens

Letter from Albert Einstein to his wife Mileva Marić

Once again a few lazy and dull days flitted past my sleepy eyes, you know, such days on which one gets up late because one cannot think of anything proper to do, then goes out until the room has been made up. . . . Then one hangs around and looks halfheartedly forward to the meal. . . .

However things turn out, we are getting the most delightful life in the world. Beautiful work, and together. . . .

Be cheerful, dear sweetheart. Kissing you tenderly,

Your

Albert

Letter from Otto Hahn to Austrian-Swedish physicist Lise Meitner

Monday evening in the lab

Dear Lise!

. . . There is something about the "radium isotopes" that is so remarkable that for now we are telling only you. . . . Perhaps you can suggest some fantastic explanation. . . . If there is anything you could propose that you could publish, then it would still in a way be work by the three of us!

Otto Hahn

Letter from Otto Hahn to his wife Edith Junghans as he celebrates the New Year during WWI

"**My Darling**, Unlike last year, I did not write two letters to you yesterday. But at least we were able to talk briefly. Actually, I was about to give up, because I had tried to ring Julius' apartment twice before, but nobody picked up. Then I thought you couldn't possibly all be at the hospital that long, and that's when I thought of Sonnenfeld, remembering what you had said in your telegram. Thanks to my terrific [memory] – in this case you have to have the last word – I recalled Sonnenfeld's phone number which I have not jotted down anywhere. And so it did work out in the end. I would have loved to talk with you a little longer, but we were playing Skat in the next room, and that is important. Also, the colonel wanted to talk to you and wish you a Happy New Year, but you were already gone again and Julius was on the line. How is Julius feeling? Really proud? I have not written to Grete yet. Yesterday's best wishes were meant for her as well. Or do you think I should write her expressly? Well, I hope I will hear more details from you soon, including about the Sonnenfelds and the quality of the roasted goose, etc.

Our celebration last night was very cozy. I had a crazy amount of work during the day. In the afternoon, I could not leave my desk from 2 to 7:45. Actually, since Dec. 27 I had not gotten out of the house except for one trip to the train station and my haircut today. So we had the usual meal last night, nothing fancy, with the exception of a kind of chocolate dessert with real whipped cream (we do have a cow in the stable!). For drinks with dinner and after, we had planned for the three of us (colonel, medical director, and myself) two bottles of burgundy mixed with one bottle of champagne. There was supposed to follow a punch at midnight, made of

2 bottles of red wine

½ bottle of rum

1 bottle of tea

cinnamon and sugar

But we never got around to the punch because we prolonged our "Turks' Blood," so that in the end, between 8 p.m. and 3 a.m. we had consumed

3 bottles of champagne

2 bottles of burgundy

½ bottle of red wine,

totaling about 2 bottles of alcohol each. Quite a lot, but spread over seven hours, it was tolerable. At the same time, with only short interruptions around midnight, we played wonderful Skat (for the first time in weeks). At 12, we lit the tree and interrupted the Skat. Rehfeldt and other soldiers who had not gotten leave to go to town also got wine and cigars. Today … returned, and gradually there is less work. On the 3rd, Hehr [?] is returning. Late tomorrow, the colonel is going to Namur for a 10-day course, and things will get calmer. I did not give away the rest of my cookies; I still had 1 box of berry cookies which we had after midnight (very hard!). I (and others) also enjoy the English mustard which arrived yesterday. Ohh for it!

Your sweet letter of the 30th already arrived yesterday. From Mother, too, there was a long one. For some reason Heiner thought I'd come on the 28th. He called early and wanted to come in from Schlossborn. But when he called, I was already in Münster. They are staying in Schlossborn over New Year's. Judging from your mother's letters, they don't appear to be starving in Plötnick, notwithstanding the milk soup every night. Even the hunt dinner seems to be well put together. I am happy that you want to throw the book at the butter and I hope enough of it will stick! When you think of it, you can send along the House on the Market. These days, I haven’t had much time for my own reading. I am still reading about the very exciting theater director, even though I find many characters in it very idealized.

Do you recall that I wrote a card to Bergrat Knochenhauer in Kattnitz before Christmas? I had had goose at his place exactly one year ago, and in my note I asked him about his son who was on the front. Today, by way of an answer, I got an obituary. His son, 21, died of his injuries on Dec. 28. Isn’t that sad?

Yesterday, or the day before, I sent you 100 marks. That includes your gift from Santa. Also, do not forget to buy yourself, not from this money, the taffeta before it gets more expensive. Well, this is it. The bell is ringing, I have to run and eat.

A fond kiss and greetings

From your Otto"

Einstein's 5 Papers That Changed the Face of Physics

1. On the Electrodynamics of Moving Bodies

It reconciles Maxwell's equations for electricity and magnetism with the laws of mechanics by introducing major changes to mechanics close to the speed of light.

2. Does the Inertia of a Body Depend on Its Energy Content?

It sets forth that the energy of a body at rest (E) equals its mass (m) times the speed of light (c) squared, or $E = mc^2$

3. **On a Heuristic Point of View Concerning the Production and Transformation of Light**

In this paper, Albert Einstein challenged the wave theory of light, suggesting that light could also be regarded as a collection of particles. This helped to open the door to a whole new world—that of quantum physics.

4. **On the Movement of Small Particles Suspended in Stationary Liquids Required by the Molecular-Kinetic Theory of Heat**

This paper demonstrated how Brownian motion offered experimentalists the possibility to prove that molecules existed, despite the fact that molecules themselves were too small to be seen directly.

5. **A New Determination of Molecular Dimensions**

It shows how to calculate Avogadro's number and the size of molecules.

Letter from Heinrich Himmler [a leading member of the Nazi Party of Germany**] to Werner Heisenberg**

[From the office of the director of the SS]

Very Esteemed Herr Professor Heisenberg!

Only today can I answer your letter of July 21, 1937, in which you direct yourself to me because of the article of Professor Stark. . . .

Because you were recommended by my family I have had your case investigated with special care and precision. I am glad that I can now inform you that I do not approve of the attack . . . and that I have taken measures against any further attack against you.

I hope I shall see you in Berlin in the fall, in November or December, so that we may talk things over thoroughly man to man.

With friendly greetings,
Heil Hitler!

Yours,
H. Himmler

P.S. I consider it, however, best if in the future you make a distinction for your audience between the results of scientific research and the personal and political attitude of the scientists involved.

> "If you fall towards a black hole feet first, gravity will pull harder on your feet than your head, because they are nearer the black hole. The result is that you will be stretched out lengthwise, and squashed in sideways. If the black hole has a mass of a few times our Sun, you would be torn apart and made into spaghetti before you reached the horizon."
>
> **— Stephen Hawking**

Letter from Har Gobind Khorana to Francis Crick

May 22, 1974

Dear Francis:

Thanks for your letter. I was glad that you were interested in the promoter sequence. I shall briefly bring you up-to-date with the different aspects of the work on the tyr tRNA gene and my other research interest as well.

The enclosed sheets essentially summarize the status of the work.

(1) Synthesis: The DNA corresponding to the transcribed part of the gene (Smith-Altman precursor) has been synthesized. The focus is now on the synthesis of the terminator and promoter regions.
(2) The promoter sequence (sheets 2 and 3) looks very beautiful to me. It could hardly be without significance. Transition from the "regular" DNA to the looped out form could be aided by the enzyme without loss of the essential recognition features and strand selection and site selection could both be accomplished in the process??
(3) The terminator sequence is on sheets 4 and 5. This too is interesting. Whatever the postulates at this stage, I am discontinuing sequencing just now and, instead, we are setting up precise systems (containing the known sequences for the signals and the adjacent parts) for studies of initiation and termination of transcription. After all, we have to prove the significance and lengths of sequences in the start and stop regions by actually carrying out transcription. If necessary, we shall go back to do more sequencing.
The ultimate goal is still to have a gene which is functional in in vitro transcription by virtue of its own signals. This should then provide a powerful approach to systematic alterations of the structural gene. Also, I would like to add our synthetic promoter and terminator to ends of "indifferent" DNA's to really prove what part does what.

Although this work takes up much of my effort just now, I hope that I shall be done with all this in the next year or so. In the last couple of years I have also become very deeply interested in the chemistry of membranes and have had a small group working in this field. Last fall I spent some time with Racker and his group at Cornell and this was most stimulating. I am still running a minor collaboration with him on reconstitution of membrane functions. At least this much I have definitely concluded that this sort of work is a reasonable starting point with my limitations and, especially, my deficient biological background.

I enjoyed your article in the 21st Anniversary issue of the DNA structure. If you have other writings in press, I would love to receive copies.

I hope all goes well in Cambridge researchwise and with your family. My warm regards to them.

With best wishes,

H. Gobind Khorana

P.S. If you had any comments or thoughts on my above DNA work, I should of course be very happy to hear about them.

We both sat down on a tree trunk and started to calculate on scraps of paper... When the two drops separated they would be driven apart by electrical repulsion, about 200 MeV in all. Fortunately Lise Meitner remembered how to compute the masses of nuclei... and worked out that the two nuclei formed... would be lighter by about one-fifth the mass of a proton... according to Einstein's formula $E = mc^2$... the mass was just equivalent to 200 MeV. It all fitted !

– Otto Robert Frisch

Austrian-born British Physicist who with his aunt Lise Meitner, described the division of neutron-bombarded uranium into lighter elements and named the process fission.

“There is nothing new to be discovered in physics now. All that remains is more and more precise measurement.”

– Lord Kelvin, 1900.

"If I am given a rod of proper length and proper place to hook its one end, I can lift the earth with the help of a lever."

– ARCHIMEDES (287B.C – 212 B.C)

Isaac Newton's Contributions to Science:

- Three Laws of Motion
- The Law of Universal Gravitation
- Optics (investigated the refraction of light, demonstrated that the multicolored spectrum produced by a prism could be recomposed into white light by a lens and a second prism)
- **Newton 's Law of Cooling:**

$$\boxed{Q = h \times A \times (T - T_s)}$$

  - Q = rate of heat transfer out of the body
  - h = heat transfer coefficient
  - A = heat transfer surface area
  - T = temperature of the body
  - T_s = temperature of surroundings
- Binomial Theorem
- Calculus
- Reflecting Telescope
- **Newton-Raphson Method** (iterative method of approximation to calculate roots of real-valued functions)

I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.

– Sir Isaac Newton

Galileo's Contributions to Science:

- The Geometric Compass
- **Galileo's** Thermoscope
- Pendulum Clock
- The First Microscopes
- The Law of Falling Bodies
- The Principle of the Pendulum
- The discovery of four moons revolving around the planet Jupiter
- The rings of Saturn
- The phases of Venus
- Sunspots
- The rugged lunar surface

About ten months ago [1609] a report reached my ears that a certain Fleming [**Hans Lippershey**] had constructed a spyglass, by means of which visible objects, though very distant from the eye of the observer, were distinctly seen as if nearby... Of this truly remarkable effect several experiences were related, to which some persons gave credence while others denied them. A few days later the report was confirmed to me in a letter from a noble Frenchman at Paris, Jacques Badovere, which caused me to apply myself wholeheartedly to enquire into the means by which I might arrive at the invention of a similar instrument. This I did shortly afterwards, my basis being the theory of refraction. First I prepared a tube of lead, at the ends of which I fitted two glass lenses, both plane on one side while on the other side one was spherically convex and the other concave.

— Galileo Galilei

8 facts about Galileo Galilei:

- He was a college dropout.
- He didn't invent the telescope.
- His daughters were nuns.
- Galileo was sentenced to life in prison by the Roman Inquisition.
- He spent his final years under house arrest.
- His middle finger is on display in Galileo Museum Florence (Italy).
- NASA named a spacecraft for him.
- The Vatican didn't admit Galileo was right until 1992.

But that which will excite the greatest astonishment by far, and which indeed especially moved me to call the attention of all astronomers and philosophers, is this: namely, that I have observed four planets, neither known nor observed by any one of the astronomers before my time, which have their orbits round a certain bright star [Jupiter], one of those previously known, like Venus or Mercury round the sun, and are sometimes in front of it, sometimes behind it, though they never depart from it beyond certain limits. All of which facts were discovered and observed a few days ago by the help of a telescope devised by me, through God's grace first enlightening my mind.

— Galileo Galilei

10 facts about Johannes Kepler:

- He was born prematurely and was a feeble child with weak vision
- He was introduced to astronomy at an early age by his mother
- He wrote the first defense of the heliocentric model of Copernicus
- He married twice and had a number of children
- He served as imperial mathematician to the holy roman emperor
- He is most famous for his three laws of planetary motion
- He considered his three laws as celestial harmonies that reflected god's design
- His mother was accused and tried for witchcraft
- He had to undergo hardships due to counter reformation measures
- He laid the foundation of modern optics

For it is too bad that there are so few who seek the truth and so few who do not follow a mistaken method in philosophy. This is not, however, the place to lament the misery of our century, but to rejoice with you over such beautiful ideas for proving the truth. So I add only, and I promise, that I shall read your book at leisure; for I am certain that I shall find the noblest things in it. And this I shall do the more gladly, because I accepted the view of Copernicus many years ago, and from this standpoint I have discovered from their origins many natural phenomena, which doubtless cannot be explained on the basis of the more commonly accepted hypothesis.

— Galileo Galilei

8 facts about Nicolaus Copernicus:

- He was a physician with no degree
- He came from a family of merchants and clergy
- He spoke many languages (Polyglot)
- He is credited with **heliocentrism** (the astronomical model in which the Earth and planets revolve around the Sun at the center of the Universe)
- He studied in several universities long before he got a degree
- There's a chemical element named after him (**Copernicium**)
- He made contributions to economics
- He published his work (**On the Revolutions of the Heavenly Spheres**) on his deathbed

I myself consider that gravity is merely a certain natural inclination with which parts are imbued by the architect of all things for gathering themselves together into a unity and completeness by assembling into the form of a globe. It is easy to believe that the Sun, Moon and other luminaries among the wandering stars have this tendency also, so that by its agency they retain the rounded shape in which they reveal themselves, but nevertheless go round their orbits in various ways. If then the Earth also performs other motions, as for example the one about the centre, they must necessarily be like those which are similarly apparent in many external bodies in which we find an annual orbit.

— Nicolaus Copernicus

Thus the last and most successful creation of theoretical physics, namely quantum mechanics (QM), differs fundamentally from both Newton's mechanics, and Maxwell's e-m field. For the quantities which figure in QM's laws make no claim to describe physical reality itself, but only probabilities of the occurrence of a physical reality that we have in view. (Albert Einstein, 1931)

I cannot but confess that I attach only a transitory importance to this interpretation. I still believe in the possibility of a model of reality - that is to say, of a theory which represents things themselves and not merely the probability of their occurrence. On the other hand, it seems to me certain that we must give up the idea of complete localization of the particle in a theoretical model. This seems to me the permanent upshot of Heisenberg's principle of uncertainty. (Albert Einstein, 1934)

The backwards-moving electron when viewed with time moving forwards appears the same as an ordinary electron, except that it is attracted to normal electrons - we say it has a positive charge. For this reason it's called a positron. The positron is a sister particle to the electron, and is an example of an anti-particle. ..This phenomena is general. Every particle in Nature has an amplitude to move backwards in time, and therefore has an anti-particle. (Feynman, 1985)

For many years after Newton, partial reflection by two surfaces was happily explained by a theory of waves,* but when experiments were made with very weak light hitting photomultipliers, the wave theory collapsed: as the light got dimmer and dimmer, the photomultipliers kept making full sized clicks -there were just fewer of them. Light behaves as particles.

* This idea made use of the fact that waves can combine or cancel out, and the calculations based on this model matched the results of Newton's experiments, as well as those done for hundreds of years afterwards. But when experiments were developed that were sensitive enough to detect a single photon, the wave theory predicted that the clicks of a photomultiplier would get softer and

softer, whereas they stayed at full strength -they just occurred less and less often. No reasonable model could explain this fact.

This state of confusion was called the wave -particle duality of light. (Feynman, 1985)

Arthur Holly Compton was an American physicist who won the Nobel Prize in Physics in 1927 for his 1923 discovery of the Compton Effect, which demonstrated the particle nature of electromagnetic radiation.

The Compton wavelength of a particle characterizes the length scale at which the wave property of a given particle starts to show up. In an interaction that is characterized by a length scale larger than the Compton wavelength, particle behaves classically (i.e., no observation of wave nature). For interactions that occur at a length scale comparable than the Compton wavelength, the wave nature of the particle begins to take over from classical physics.

An experiment is a question which science poses to Nature, and a measurement is the recording of Nature's answer.

MAX PLANCK, 1858 TO 1947

Subrahmanyan Chandrasekhar was an Indian-American applied mathematician and astrophysicist who spent his professional life in the United States. He was awarded the 1983 Nobel Prize for Physics with American nuclear physicist and astrophysicist **William Albert Fowler** for "...theoretical studies of the physical processes of importance to the structure and evolution of the stars".

Chandrasekhar Limit (1.4 solar masses ≈ 2.765×10^{30} kg)

If the mass of the star < 1.4 solar masses

- Electrons prevent further collapse.
- The core will thus continue to collapse and form a **white dwarf**.

If the mass of the star > 1.4 solar masses but mass < 3 solar masses

- Electrons + protons combine to form neutrons.
- Neutrons prevent further collapse.
- The core will thus continue to collapse and form a **neutron star**.

If the mass of the star > 3 solar masses

- Gravity wins! Nothing prevents collapse.
- The core will thus continue to collapse and form a black hole.

"The black holes of nature are the most perfect macroscopic objects there are in the universe: the only elements in their construction are our concepts of space and time."

− Subrahmanyan Chandrasekhar

Max Planck had different abilities beyond physics. He was a skilled musician, formed music, preceded as a vocalist and furthermore followed up on the stage. He composed a drama "Love in the Woods" with "energizing and dazzling tunes". His long life had a shocking side. His first spouse died in 1909, following 22 years of marriage, leaving him with two sons and two daughters. The oldest son was killed in action in World War I, and both of his daughters died very youthful in childbirth (1918 and 1919). His home was totally annihilated in World War II; his most youthful child was ensnared in the endeavor made on Hitler's life on July 20, 1944 and was executed in a horrifying way by Hitler's supporters in crime.

Niels Bohr got the Nobel Prize in 1922. In World War II, in the wake of getting away from Denmark, he got associated with the American nuclear bomb project. After the war he got back to Copenhagen, and as a transcending figure in Europe he played a significant part in the foundation of CERN, the European community for particle physics. Indeed he turned into the principal head of the hypothesis division, in the start incidentally situated at his organization in Copenhagen.

Hendrik A. Lorentz is known for his work in the area of relativity. Preceding Einstein he inferred a condition concerning the length compression of a moving rod. Einstein finished this with his hypothesis of relativity, including time dilatation of moving frameworks; today the total arrangement of conditions concerning moving bodies is known as a Lorentz change. Einstein had incredible regard for Lorentz and communicated that more than once. At the day of Lorentz's burial service all streetlights along the memorial service course were hung in dark fabric. The message administration in the Netherlands was suspended for three minutes around early afternoon.

Ernst Carl Gerlach Stueckelberg was a Swiss mathematician and physicist, viewed as quite possibly the most prominent physicists of the twentieth century. Notwithstanding making key advances in hypothetical physics, including the exchange particle model of fundamental forces, causal S-matrix theory, and the renormalization group, his idiosyncratic style and publication in minor journals led to his work being unrecognized until the mid-1990s. He experienced cyclothymie. This prompts hyper burdensome periods, and he had to be hospitalized intermittently. In his later years he was constantly joined by a little dog that was professed to be there to direct him home in the event that he lost his direction.

During World War II **Wolfgang Pauli** was at the Institute in Princeton. He was one of the extremely, hardly any individuals who would not like to take an interest in the nuclear bomb project.

Bruno Pontecorvo, a dedicated socialist, as of now politically dynamic in the thirties, moved to Russia in 1950 of every a fairly outlaw way. He was one of those researchers who were censured for abandoning to Russia bringing nuclear bomb mysteries. For his situation there isn't a lot of substance to that; he was never really engaged with weapons research. He just trusted in socialism.

"Another very good test some readers may want to look up, which we do not have space to describe here, is the Casimir effect, where forces between metal plates in empty space are modified by the presence of virtual particles. Thus virtual particles are indeed real and have observable effects that physicists have devised ways of measuring. Their properties and consequences are well established and well understood consequences of quantum mechanics."

— Gordon L. Kane

Aristotle's law of motion

$$\text{Velocity} \propto \frac{\text{Motive force}}{\text{Resistance}}$$

Isaac Asimov was an American author and biochemist, a highly successful and prolific writer of science fiction and of science books for the layperson. He wrote or edited about 500 volumes, of which the most famous are those in the Foundation and robot series.

"Science is uncertain. Theories are subject to revision; observations are open to a variety of interpretations, and scientists quarrel amongst themselves. This is disillusioning for those untrained in the scientific method, who thus turn to the rigid certainty of the Bible instead. There is something comfortable about a view that allows for no deviation and that spares you the painful necessity of having to think."

− Isaac Asimov

The Unruh temperature, derived by Canadian physicist **William Unruh** in 1976, is the effective temperature experienced by a uniformly accelerating observer in a vacuum field. It is given by:

$$T_U = \frac{\hbar a}{2\pi c k_B},$$

where a is the acceleration of the observer, k_B is the Boltzmann constant, $\hbar$ is the reduced Planck constant, and c is the speed of light in vacuum.

The entire electromagnetic spectrum —from radio waves to gamma rays, most of the light in the universe — resembles nothing but transverse waves of energy $E = hc/\lambda$, which in turn are vibrating Maxwell force fields differing only in their wavelength $\lambda = h/p$.

Science is a game — but a game with reality, a game with sharpened knives … If a man cuts a picture carefully into 1000 pieces, you solve the puzzle when you reassemble the pieces into a picture; in the success or failure, both your intelligences compete. In the presentation of a scientific problem, the other player is the good Lord. He has not only set the problem but also has devised the rules of the game — but they are not completely known, half of them are left for you to discover or to deduce. The experiment is the tempered blade which you wield with success against the spirits of darkness — or which defeats you shamefully. The uncertainty is how many of the rules God himself has permanently ordained, and how many apparently are caused by your own mental inertia, while the solution generally becomes possible only through freedom from its limitations.

— Erwin Schrödinger

The gigantic instrument was constructed by Raymond Davis Jr. and Masatoshi Koshiba to detect neutrinos from the Sun and confirm the prediction that the Sun is powered by nuclear fusion.

"In a scientific sense, earthquakes are unpredictable. But that does not mean that you can't predict things about them."

—PETER SAMMONDS

It is cosmology's most fundamental question: How did the universe begin? : Alexander Vilenkin

"After sleeping through a hundred million centuries we have finally opened our eyes on a sumptuous planet, sparkling with colour, bountiful with life. Within decades we must close our eyes again. Isn't it a noble, an enlightened way of spending our brief time in the sun, to work at understanding the universe and how we have come to wake up in it? This is how I answer when I am asked -- as I am surprisingly often -- why I bother to get up in the mornings. To put it the other way round, isn't it sad to go to your grave without ever wondering why you were born? Who, with such a thought, would not spring from bed, eager to resume discovering the world and rejoicing to be a part of it? "

– Richard Dawkins

(A British ethologist, evolutionary biologist, and author)

"Gravity is the force that rules the Universe. To understand its workings, to the finest degree, is to understand the very nature of our celestial home."

—M. Bartusiak in Einstein's Unfinished Symphony

Frank Donald Drake is an American astronomer and astrophysicist. He is involved in the search for extraterrestrial intelligence, including the founding of SETI, mounting the first observational attempts at detecting extraterrestrial communications in 1960 in Project Ozma, developing the Drake equation, and as the creator of the Arecibo Message, a digital encoding of an astronomical and biological description of the Earth and its life forms for transmission into the cosmos.

The Drake Equation

$$N = R^* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

- R^* = the rate at which stars are born in the galaxy,
- f_p= the fraction of these stars that have planets,
- n_e= the number of planets for each star that have the conditions for life,
- f_l = the fraction of planets that actually develop life,
- f_i= the fraction that develop intelligent life,
- f_c= the fraction that are willing and able to communicate, and
- L = the expected lifetime of a civilization.

"We are storytelling animals, and cannot bear to acknowledge the ordinariness of our daily lives."

– STEPHEN JAY GOULD

Although Nature needs thousands or millions of years to create a new species, man needs only a few dozen years to destroy one.

– VICTOR SCHEFFER, 1906 TO 2011

Hendrik Brugt Gerhard Casimir was a Dutch physicist best known for his research on the two-fluid model of superconductors in 1934 and the Casimir effect in 1948.

When we place two long parallel uncharged plates close to each other, virtual particles outside the plates exerts more pressure than the virtual particles inside the plates, and hence the plates are attracted to each other, which we call the "**Casimir effect."**

In life, everything is relative – except Einstein´s theory: Leonid S. Sukhorukov

Experimental evidence supporting the Watson and Crick model was published in a series of five articles in the same issue of Nature. Of these, **Franklin and Gosling's paper** was the first publication of their own X-ray diffraction data and original analysis method that partially supported the Watson and Crick model; this issue also contained an article on DNA structure by Maurice Wilkins and two of his colleagues, whose analysis supported their double-helix molecular model of DNA. In 1962, after Franklin's death, Watson, Crick, and Wilkins jointly received the Nobel Prize in Physiology or Medicine.

Newton rings is a phenomenon in which an interference pattern is created by the reflection of light between two surfaces—a spherical surface and an adjacent flat surface. It is named after Isaac Newton, who first studied them in 1717.

The physicist **Leo Szilard** once announced to his friend Hans Bethe that he was thinking of keeping a diary: "I don't intend to publish. I am merely going to record the facts for the information of God."
"Don't you think God knows the facts?" Bethe asked.
"Yes," said Szilard.
"He knows the facts, but He does not know this version of the facts."

–Hans Christian von Baeyer, Taming the Atom

Leo Szilard was a Hungarian-American physicist and inventor. He conceived the nuclear chain reaction in 1933, patented the idea of a nuclear fission reactor in 1934, and in late 1939 wrote the letter for Albert Einstein's signature that resulted in the **Manhattan Project** that built the atomic bomb.

Albert Michelson (the first American to receive the Nobel Prize for physics) who disproved the existence of Aether.

"Gravity pulls everything in, but a force called dark energy tries to push it all back together again. And the ultimate fate of the universe relies on which force will win the desire to succeed."

–S.W. Hawking

- **Space:** the potential habitable worlds around ten thousand billion billion stars; ours is just one.
- **Time:** a cosmic history of nearly 14 billion years; life took less than ½ billion years to start here.

"If they not be inhabited, what a waste of space."

: Thomas Carlyle, Scottish Essayist (1795 –1881)

- **Smallpox** was a leading cause of death in 18th-century, and the inexorable spread of the disease reliably recorded the death rate of some hundred thousand people. And the death toll surpassed 5000 people a day. Yet **Edward Jenner**, an English physician, noticed something special occurring in his small village. People who were exposed to cowpox did not get smallpox when they were exposed to the disease. Concluding that cowpox could save people from smallpox, Edward purposely infected a young boy who lived in his village first with cowpox, then with smallpox. Fortunately, Edward's hypothesis worked well. He had successfully demonstrated the world's first vaccine and eradicated the disease.

- In 1930s, **Paul Hermann Müller** a Swiss research chemist at the firm of Geigy in Basel, introduced the first modern insecticide (DDT) and it won him the 1948 Nobel Prize in Physiology and Medicine for its credit of saving thousands of human lives in World War II by killing typhus-carrying lice and malaria-carrying mosquitoes, dramatically reducing Malaria and Yellow Fever around the world.

Fritz Haber was a German chemist who received the Nobel Prize in Chemistry in 1918 for his invention of the Haber–Bosch process, a method used in industry to synthesize ammonia from nitrogen gas and hydrogen gas.

$$N_2 + 3H_2 \leftrightharpoons 2NH_3$$

This invention is of importance for the large-scale synthesis of fertilizers and explosives.

German-born theoretical physicist **Albert Einstein** said Georges Lemaitre's theory is "The most beautiful and satisfactory explanation of creation to which I have ever listened."

$$S = \frac{k_B A c^3}{4\hbar G}$$

"The area formula for the entropy — or number of internal states — of a black hole suggests that information about what falls into a black hole may be stored like that on a record, and played back as the black hole evaporates."

− S.W. Hawking

Daniel Bernoulli was a Swiss mathematician and physicist and was one of the many prominent mathematicians in the Bernoulli family from Basel. He is particularly remembered for his applications of mathematics to mechanics, especially fluid mechanics, and for his pioneering work in probability and statistics.

Bernoulli's Equation:

$$P + \rho \times \frac{1}{2} v^{2} = \text{CONSTANT}$$

P is the absolute pressure, ρ is the fluid density and v is the velocity of the fluid

Fibonacci, also known as **Leonardo Bonacci**, Leonardo of Pisa, or Leonardo Bigollo Pisano, was a medieval Italian mathematician and "**the most talented Western mathematician of the Middle Ages**" who wrote **Liber abaci** (1202; "**Book of the Abacus**"), the first European work on Indian and Arabian mathematics, which introduced Hindu-Arabic numerals to Europe. His name is mainly known because of the Fibonacci sequence.

Fibonacci numbers − 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144...

- Each number is the sum of the previous two.
- The ratio between the numbers = 1.618034 (**golden ratio**).
- From **pinecones to the Hurricane Sandy**, Fibonacci reflects various patterns found in nature.

Karl Schwarzschild was a German physicist and astronomer who investigated the mathematics which eventually led to the prediction of the existence of black holes.

"Any object with a physical radius smaller than its **Schwarzschild radius** will be a black hole."

Prafulla Chandra Ray

Acharya Prafulla Chandra Ray was a notable famous Bengali physicist, educationist, antiquarian, industrialist and one of the principal "current" Indian substance analysts and is viewed as the dad of compound science in India. He found the steady compound mercurous nitrite in 1896 and set up Bengal Chemical and Pharmaceutical Works Ltd, India's first drug organization in 1901.

Baudhayan was the first at any point to show up at a few ideas in Mathematics, which were subsequently rediscovered by the western world. The estimation of pi was first determined by him. As you most likely are aware, pi is valuable in ascertaining the territory and perimeter of a circle. What is known as **Pythagoras theorem** (which states that in a right-angled triangle, the square of the hypotenuse is equal to the sum of the squares of the other two sides) today is now found in Baudhayan's Sulva Sutra, which was composed quite a while before the time of Pythagoras.

Baudhayan theorem:

In a **Deerghchatursh** (triangle), the **chetra** (square) of **rajju** (hypotenuse) is equal to the sum of squares of the **parshvamani** (base) and **triyangmani** (perpendicular line).

Kanad, also known as Kashyapa, Ulūka, Kananda and Kanabhuk, was a 6th century Indian natural scientist and philosopher who founded the **Vaisheshika** school of Indian philosophy that also represents one of the six frameworks of Indian way of thinking. His unique name was Aulukya. He got the name Kanad, on the grounds that even as a kid, he was keen on exact moment particles called "**kana**". His nuclear hypothesis can be a match to any advanced nuclear hypothesis. As per Kanad, material universe is comprised of kanas, (anu/particle) which can't be seen through any human organ. These can't be further partitioned. Consequently, they are indissoluble and indestructible.

Nagarjuna was a 10th century Indian metallurgist and alchemist. The principle point of his trials was to change base components into gold, similar to the chemists in the western world. Despite the fact that he was most certainly not fruitful in his objective, he prevailing with regards to making a component with gold-like sparkle. Till date, this innovation is utilized in making impersonation adornments. In his composition, **Rasaratnakara**, he has talked about strategies for the extraction of metals like gold, silver, tin and copper.

Sushruta was an ancient Indian surgeon who considered surgery as "the highest division of the healing arts and least liable to fallacy" and known for his pioneering operations and techniques and for his influential treatise **Sushruta-samhita**, the main source of knowledge about surgery in ancient India.

Charaka was one of the principal contributors to Ayurveda, a system of medicine and lifestyle developed in Ancient India and is viewed as the father of old Indian study of medication. He was the **Raj Vaidya** (regal specialist) in the court of Kanishka. His **Charaka Samhita** is a wonderful book on medication. It has the depiction of countless illnesses and gives techniques of distinguishing their causes just as the technique for their treatment.

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Meghnad Saha was an Indian astrophysicist who developed the Saha ionization equation, used to describe chemical and physical conditions in stars. His work allowed astronomers to accurately relate the spectral classes of stars to their actual temperatures. He was elected to the Parliament of India in 1952.

For a gas composed of a single atomic species, the **Saha equation** is written:

$$\frac{n_{i+1}\, n_e}{n_i} = \frac{2}{\lambda^3}\frac{g_{i+1}}{g_i} \exp\left[-\frac{\varepsilon_{i+1} - \varepsilon_i}{k_B T}\right]$$

where: n_{i+1} and n_i are the number of atoms in the $(i + 1)^{th}$ and i^{th} ionization states, respectively; ε_{i+1} and ε_i are the energies of the ionization states; n_e is the electron density; and T is the temperature. λ is the thermal de Broglie wavelength of an electron. k_B is the Boltzmann constant. g_{i+1} and g_i describe how energy is partitioned among the $(i + 1)^{th}$ and i^{th} ionization states.

In 1895, Sanskrit scholar and Indian instructor in the Sir JJ School of Art **Shivkur Bapuji Talpade** flew an unmanned aircraft (Marut-sakthi) at Chowpathy beach of Bombay, eight years before Wright Brothers. This aircraft flew to a height of 1500 feet.

Sir Shanti Swaroop Bhatnagar was an Indian colloid chemist, academic and scientific administrator. The first director-general of the Council of Scientific and Industrial Research, he is known as the "**father of research laboratories**" in India.

Vikram Ambalal Sarabhai was an Indian physicist and cosmologist who started space research and created atomic force in India. He was respected with Padma Bhushan in 1966 and the Padma Vibhushan in 1972. He is universally viewed as the **Father of the Indian Space Program**.

Har Gobind Khorana was Indian-born American biochemist who shared the 1968 **Nobel Prize for Physiology or Medicine** with **Marshall W. Nirenberg** and **Robert W. Holley** for research that assisted with showing how the nucleotides in nucleic acids, which convey the hereditary code of the cell, control the cell's union of proteins.

10 Interesting facts of Niels Bohr:

- He was a stellar student but a mediocre writer
- He has an element named after him (**Bohrium** − atomic number 107)
- He won a Nobel Prize at the same time − and in the same field − as Albert Einstein
- His father (**Christian Bohr**) was nominated for Nobel Prize three times in two years.
- He founded the Copenhagen Institute for theoretical physics and aided Jewish scientists in their escape from the Nazis and worked on the Manhattan Project during World War II − which eventually led to the development of the first atomic bomb
- In 1950, He wrote an **Open Letter** to the UN, pressing for peaceful and controlled use of nuclear weapons
- His son **Aage Bohr** also won a Nobel Prize in 1975
- He nailed the true structure of an atom in 1913 and theorized that an electron could move from a higher orbit to a lower one and that in the process energy was emitted.
- The Carlsberg brewery gave him unlimited free beer
- He had six sons with his wife Margrethe, but two of them died during his lifetime

Albert Einstein and Niels Bohr once had an open debate about the **Quantum Theory**. At one point Einstein said "**God does not play dice**" and very famously Bohr had retorted "**Stop telling God what to do, Einstein**"

Niels Bohr's Open Letter to the United Nations:

I address myself to the organization, founded for the purpose to further co-operation between nations on all problems of common concern, with some considerations regarding the adjustment of international relations required by modern development of science and technology. At the same time as this development holds out such great promises for the improvement of human welfare it has, in placing formidable means of destruction in the hands of man, presented our whole civilization with a most serious challenge.

My association with the American-British atomic energy project during the war gave me the opportunity of submitting to the governments concerned views regarding the hopes and the dangers which the accomplishment of the project might imply as to the mutual relations between nations.

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The aim of the present account and considerations is to point to the unique opportunities for furthering understanding and co-operation between nations which have been created by the revolution of human resources brought about by the advance of science, and to stress that despite previous disappointments these opportunities still remain and that all hopes and all efforts must be centered on their realization.

For the modern rapid development of science and in particular for the adventurous exploration of the properties and structure of the atom, international co-operation of an unprecedented extension and intensity has been of decisive importance. The fruitfulness of the exchange of experiences and ideas between scientists from all parts of the world was a great source of encouragement to every participant and strengthened the hope that an ever closer contact between nations would enable them to work together on the progress of civilization in all its aspects.

Yet, no one confronted with the divergent cultural traditions and social organization of the various countries could fail to be deeply impressed by the difficulties in finding a common approach to many human problems. The growing tension preceding the Second World War accentuated these difficulties and created many barriers to free intercourse between nations. Nevertheless, international scientific co-operation continued as a decisive factor in the development which, shortly before the outbreak of the war, raised the prospect of releasing atomic energy on a vast scale.

The fear of being left behind was a strong incentive in various countries to explore, in secrecy, the possibilities of using such energy sources for military purposes. The joint American-British project remained unknown to me until, after my escape from occupied Denmark in the autumn of 1943, I came to England at the invitation of the British government. At that time I was taken into confidence about the great enterprise which had already then reached an advanced stage.

Everyone associated with the atomic energy project was, of course, conscious of the serious problems which would confront humanity once the enterprise was accomplished. Quite apart from the role atomic weapons might come to play in the war, it was clear that permanent grave dangers to world security would ensue unless measures to prevent abuse of the new formidable means of destruction could be universally agreed upon and carried out.

As regards this crucial problem, it appeared to me that the very necessity of a concerted effort to forestall such ominous threats to civilization would offer quite unique opportunities to bridge international divergences. Above all, early consultations between the nations allied in the war about the best ways jointly to obtain future security might contribute decisively to that atmosphere of mutual confidence which would be essential for co-operation on the many other matters of common concern.

In the beginning of 1944, I was given the opportunity to bring such views to the attention of the American and British governments…. [A] memorandum, dated 3 July 1944, contained the following passages regarding the political consequences which the accomplishment of the project might imply: [A] weapon of an unparalleled power is being created which will completely change all future conditions of warfare….[T]his situation raises a number of problems which call for most urgent attention. Unless, indeed, some agreement about the control of the use of the new active materials can be obtained in due time, any temporary advantage, however great, may be outweighed by a perpetual menace to human security…

Many reasons, indeed, would seem to justify the conviction that an approach with the object of establishing common security from ominous menaces without excluding any nation from participating in the promising industrial development which the accomplishment of the project entails will be welcomed, and be met with a loyal co-operation on the enforcement of the necessary far reaching control measures….

The secrecy regarding the project which prevented public knowledge and open discussion of a matter so profoundly affecting international affairs added, of course, to the complexity of the task of the statesmen. With full appreciation of the extraordinary character of the decisions which the proposed initiative involved, it still appeared to me that great opportunities would be lost unless the problems raised by the atomic development were incorporated into the plans of the allied nations for the post-war world.

[M]utual openness, which now was obviously necessary for common security, would in itself promote international understanding and pave the way for enduring co-operation. This memorandum, dated March 24th 1945, contains, besides remarks which have no interest to-day, the following passages:

Above all, it should be appreciated that we are faced only with the beginning of a development and that, probably within the very near future, means will be found to simplify the methods of production of the active substances and intensify their effects to an extent which may permit any nation possessing great industrial resources to command powers of destruction surpassing all previous imagination….

Any arrangement which can offer safety against secret preparations for the mastery of the new means of destruction would, as stressed in the memorandum, demand extraordinary measures. In fact, not only would universal access to full information about scientific discoveries be necessary, but every major technical enterprise, industrial as well as military, would have to be open to international control….

Detailed proposals for the establishment of an effective control would have to be worked out with the assistance of scientists and technologists appointed by the governments concerned, and a standing expert committee, related to an international security organization, might be charged with keeping account of new scientific and technical developments and with recommending appropriate adjustments of the control measures.

On recommendations from the technical committee the organization would be able to judge the conditions under which industrial exploitation of atomic energy sources could be permitted with adequate safeguards to prevent any assembly of active material in an explosive state.

[F]ree access to information, necessary for common security, should have far-reaching effects in removing obstacles barring mutual knowledge about spiritual and material aspects of life in the various countries, without which respect and goodwill between nations can hardly endure….

Indeed, it need hardly be stressed how fortunate in every respect it would be if, at the same time as the world will know of the formidable destructive power which has come into human hands, it could be told that the great scientific and technical advance has been helpful in creating a solid foundation for a future peaceful co-operation between nations.

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Looking back on those days, I find it difficult to convey with sufficient vividness the fervent hopes that the progress of science might initiate a new era of harmonious co-operation between nations, and the anxieties lest any opportunity to promote such a development be forfeited.

Until the end of the war I endeavoured by every way open to a scientist to stress the importance of appreciating the full political implications of the project and to advocate that, before there could be any question of use of atomic weapons, international co-operation be initiated on the elimination of the new menaces to world security.

I left America in June 1945, before the final test of the atomic bomb, and remained in England, until the official announcement in August 1945 that the weapon had been used. Soon thereafter I returned to Denmark and have since had no connection with any secret, military or industrial, project in the field of atomic energy.

When the war ended and the great menaces of oppression to so many peoples had disappeared, an immense relief was felt all over the world. Nevertheless, the political situation was fraught with ominous foreboding. Divergences in outlook between the victorious nations inevitably aggravated controversial matters arising in connection with peace settlements. Contrary to the hopes for future fruitful co-operation, expressed from all sides and embodied in the Charter of the United Nations, the lack of mutual confidence soon became evident.

The creation of new barriers, restricting the free flow of information between countries, further increased distrust and anxiety. In the field of science, especially in the domain of atomic physics, the continued secrecy and restrictions deemed necessary for security reasons hampered international co-operation to an extent which split the world community of scientists into separate camps.

Despite all attempts, the negotiations within the United Nations have so far failed in securing agreement regarding measures to eliminate the dangers of atomic armament. The sterility of these negotiations, perhaps more than anything else, made it evident that a constructive approach to such vital matters of common concern would require an atmosphere of greater confidence.

Without free access to all information of importance for the interrelations between nations, a real improvement of world affairs seemed hardly imaginable. It is true that some degree of mutual openness was envisaged as an integral part of any international arrangement regarding atomic energy, but it grew ever more apparent that, in order to pave the way for agreement about such arrangements, a decisive initial step towards openness had to be made.

The ideal of an open world, with common knowledge about social conditions and technical enterprises, including military preparations, in every country, might seem a far remote possibility in the prevailing world situation. Still, not only will such relationship between nations obviously be required for genuine co-operation on progress of civilization, but even a common declaration of adherence to such a course would create a most favourable background for concerted efforts to promote universal security. Moreover, it appeared to me that the countries which had pioneered in the new technical development might, due to their possibilities of offering valuable information, be in a special position to take the initiative by a direct proposal of full mutual openness.

I thought it appropriate to bring these views to the attention of the American government without raising the delicate matter publicly. On visits to the United States in 1946 and in 1948 to take part in scientific conferences, I therefore availed myself of the opportunity to suggest such an initiative to American statesmen. Even if it involves repetition of arguments already presented, it may serve to give a clearer impression of the ideas under discussion on these occasions to quote a memorandum, dated 17 May 1948, submitted to the Secretary of State as a basis for conversations in Washington in June 1948:

[G]reat scientific and technical developments… have placed formidable means of destruction in the hands of man. Indeed, just as previous technical progress has led to the recognition of need for adjustments within civilized societies, many barriers between nations which hitherto were thought necessary for the defence of national interests would now obviously stand in the way of common security…

In the years which have passed since the war, the divergences in outlook have manifested themselves ever more clearly and a most desperate feature of the present situation is the extent to which the barring of intercourse has led to distortion of facts and motives, resulting in increasing distrust and suspicion between nations and even between groups within many nations. Under these circumstances the hopes embodied in the establishment of the United Nations organization have met with repeated great disappointments and, in particular, it has not been possible to obtain consent as regards control of atomic energy armaments….

Under the circumstances it would appear that most careful consideration should be given to the consequences which might ensue from an offer, extended at a well-timed occasion, of immediate measures towards openness on a mutual basis. Such measures should in some suitable manner grant access to information, of any kind desired, about conditions and developments in the various countries and would thereby allow the partners to form proper judgment of the actual situation confronting them….

The consideration in this memorandum may appear utopian, and the difficulties of surveying complications of non-conventional procedures may explain the hesitations of governments in demonstrating adherence to the course of full mutual openness. Nevertheless, such a course should be in the deepest interest of all nations, irrespective of differences in social and economic organization, and the hopes and aspirations for which it was attempted to give expression in the memorandum are no doubt shared by people all over the world.

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Within the last years, world-wide political developments have increased the tension between nations and at the same time the perspectives that great countries may compete about the possession of means of annihilating populations of large areas and even making parts of the earth temporarily uninhabitable have caused widespread confusion and alarm.

As there can hardly be question for humanity of renouncing the prospects of improving the material conditions for civilization by atomic energy sources, a radical adjustment of international relationship is evidently indispensable if civilization shall survive. Here, the crucial point is that any guarantee that the progress of science is used only to the benefit of mankind presupposes the same attitude as is required for co-operation between nations in all domains of culture.

Also in other fields of science recent progress has confronted us with a situation similar to that created by the development of atomic physics. Even medical science, which holds out such bright promises for the health of people all over the world, has created means of extinguishing life on a terrifying scale which imply grave menaces to civilization, unless universal confidence and responsibility can be firmly established.

The situation calls for the most unprejudiced attitude towards all questions of international relations. Indeed, proper appreciation of the duties and responsibilities implied in world citizenship is in our time more necessary than ever before. On the one hand, the progress of science and technology has tied the fate of all nations inseparably together, on the other hand, it is on a most different cultural background that vigorous endeavours for national self-assertion and social development are being made in the various parts of our globe.

An open world where each nation can assert itself solely by the extent to which it can contribute to the common culture and is able to help others with experience and resources must be the goal to be put above everything else. Still, example in such respects can be effective only if isolation is abandoned and free discussion of cultural and social developments permitted across all boundaries.

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The very fact that knowledge is in itself the basis for civilization points directly to openness as the way to overcome the present crisis. Whatever judicial and administrative international authorities may eventually have to be created in order to stabilize world affairs, it must be realized that full mutual openness, only, can effectively promote confidence and guarantee common security.

Any widening of the borders of our knowledge imposes an increased responsibility on individuals and nations through the possibilities it gives for shaping the conditions of human life. The forceful admonition in this respect which we have received in our time cannot be left unheeded and should hardly fail in resulting in common understanding of the seriousness of the challenge with which our whole civilization is faced. It is just on this background that quite unique opportunities exist to-day for furthering co-operation between nations on the progress of human culture in all its aspects.

I turn to the United Nations with these considerations in the hope that they may contribute to the search for a realistic approach to the grave and urgent problems confronting humanity. The arguments presented suggest that every initiative from any side towards the removal of obstacles for free mutual information and intercourse would be of the greatest importance in breaking the present deadlock and encouraging others to take steps in the same direction. The efforts of all supporters of international co-operation, individuals as well as nations, will be needed to create in all countries an opinion to voice, with ever increasing clarity and strength, the demand for an open world.

Benjamin Franklin's Inventions:

- Lightning Rod
- Bifocals
- Swim Fins
- Franklin Stove
- Urinary Catheter
- Armonica

"Of all my inventions, the glass armonica has given me the greatest personal satisfaction."

– Benjamin Franklin

As regards the co-ordination of all ordinary properties of matter, Rutherford's model of the atom puts before us a task reminiscent of the old dream of philosophers: to reduce the interpretation of the laws of nature to the consideration of pure numbers.

— Niels Bohr

Komaravolu Chandrasekhar was a teacher at ETH Zurich and an establishing employee of School of Mathematics, Tata Institute of Fundamental Research. He is known for his work in number hypothesis and summability.

Gopalasamudram Narayanan Ramachandran was an Indian physicist who was known for his work that prompted his formation of the **Ramachandran plot** for understanding peptide structure. He was the first to propose a **triple-helical model** for the design of collagen.

Harish-Chandra was an Indian American mathematician and physicist who accomplished central work in portrayal hypothesis, particularly symphonious investigation on semi-simple Lie gatherings.

Manali Kallat Vainu Bappu was an Indian stargazer and leader of the International Astronomical Union. Bappu set up a few galactic foundations in India — — including the **Vainu Bappu Observatory** named after him — and furthermore added to the foundation of the advanced Indian Institute of Astrophysics.

We are going to die, and that makes us the lucky ones. Most people are never going to die because they are never going to be born. The potential people who could have been here in my place but who will in fact never see the light of day outnumber the sand grains of Arabia. Certainly those unborn ghosts include greater poets than Keats, scientists greater than Newton. We know this because the set of possible people allowed by our DNA so massively exceeds the set of actual people. In the teeth of these stupefying odds it is you and I, in our ordinariness, that are here. We privileged few, who won the lottery of birth against all odds, how dare we whine at our inevitable return to that prior state from which the vast majority have never stirred?

― **Richard Dawkins**

Source of Information:

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