**Physics**

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*This article is about the field of science. For other uses, see* [*Physics (disambiguation)*](https://en.wikipedia.org/wiki/Physics_(disambiguation))*.*

*Not to be confused with* [*Physical science*](https://en.wikipedia.org/wiki/Physical_science)*.*

[](https://en.wikipedia.org/wiki/File:CollageFisica.jpg)

Various examples of physical phenomena

**Physics** (from [Ancient Greek](https://en.wikipedia.org/wiki/Ancient_Greek): φυσική (ἐπιστήμη) *phusikḗ (epistḗmē)* "knowledge of nature", from φύσις *phúsis* "nature"[[1]](https://en.wikipedia.org/wiki/Physics#cite_note-etymonline-physics-1)[[2]](https://en.wikipedia.org/wiki/Physics#cite_note-etymonline-physic-2)[[3]](https://en.wikipedia.org/wiki/Physics#cite_note-LSJ-3)) is the [natural science](https://en.wikipedia.org/wiki/Natural_science) that involves the study of [matter](https://en.wikipedia.org/wiki/Matter)[[4]](https://en.wikipedia.org/wiki/Physics#cite_note-feynmanleightonsands1963-atomic-4) and its [motion](https://en.wikipedia.org/wiki/Motion_(physics)) and behavior through [space and time](https://en.wikipedia.org/wiki/Spacetime), along with related concepts such as [energy](https://en.wikipedia.org/wiki/Energy) and [force](https://en.wikipedia.org/wiki/Force).[[5]](https://en.wikipedia.org/wiki/Physics#cite_note-maxwell1878-physicalscience-5) One of the most fundamental scientific disciplines, the main goal of physics is to understand how the [universe](https://en.wikipedia.org/wiki/Universe) behaves.[[a]](https://en.wikipedia.org/wiki/Physics#cite_note-6)[[6]](https://en.wikipedia.org/wiki/Physics#cite_note-youngfreedman2014p1-7)[[7]](https://en.wikipedia.org/wiki/Physics#cite_note-youngfreedman2014p2-8)[[8]](https://en.wikipedia.org/wiki/Physics#cite_note-holzner2003-physics-9)

Physics is one of the oldest [academic disciplines](https://en.wikipedia.org/wiki/Academic_discipline), perhaps the oldest through its inclusion of [astronomy](https://en.wikipedia.org/wiki/Astronomy).[[9]](https://en.wikipedia.org/wiki/Physics#cite_note-krupp2003-10) Over the last two millennia, physics was a part of [natural philosophy](https://en.wikipedia.org/wiki/Natural_philosophy) along with [chemistry](https://en.wikipedia.org/wiki/Chemistry), [biology](https://en.wikipedia.org/wiki/Biology), and certain branches of [mathematics](https://en.wikipedia.org/wiki/Mathematics), but during the [scientific revolution](https://en.wikipedia.org/wiki/Scientific_revolution) in the 17th century, the natural sciences emerged as unique [research](https://en.wikipedia.org/wiki/Research) programs in their own right.[[b]](https://en.wikipedia.org/wiki/Physics#cite_note-12) Physics intersects with many [interdisciplinary](https://en.wikipedia.org/wiki/Interdisciplinarity) areas of research, such as [biophysics](https://en.wikipedia.org/wiki/Biophysics) and [quantum chemistry](https://en.wikipedia.org/wiki/Quantum_chemistry), and the boundaries of physics are not [rigidly defined](https://en.wikipedia.org/wiki/Demarcation_problem). New ideas in physics often explain the fundamental mechanisms of other sciences[[6]](https://en.wikipedia.org/wiki/Physics#cite_note-youngfreedman2014p1-7) while opening new avenues of research in areas such as mathematics and [philosophy](https://en.wikipedia.org/wiki/Philosophy).

Physics also makes significant contributions through advances in new [technologies](https://en.wikipedia.org/wiki/Technology) that arise from theoretical breakthroughs. For example, advances in the understanding of [electromagnetism](https://en.wikipedia.org/wiki/Electromagnetism) or [nuclear physics](https://en.wikipedia.org/wiki/Nuclear_physics) led directly to the development of new products that have dramatically transformed modern-day [society](https://en.wikipedia.org/wiki/Society), such as [television](https://en.wikipedia.org/wiki/Television), [computers](https://en.wikipedia.org/wiki/Computer), [domestic appliances](https://en.wikipedia.org/wiki/Domestic_appliance), and [nuclear weapons](https://en.wikipedia.org/wiki/Nuclear_weapon);[[6]](https://en.wikipedia.org/wiki/Physics#cite_note-youngfreedman2014p1-7) advances in [thermodynamics](https://en.wikipedia.org/wiki/Thermodynamics) led to the development of [industrialization](https://en.wikipedia.org/wiki/Industrialization), and advances in [mechanics](https://en.wikipedia.org/wiki/Mechanics) inspired the development of [calculus](https://en.wikipedia.org/wiki/Calculus).

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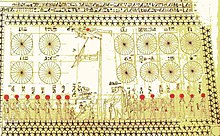
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  + [1.1 Ancient astronomy](https://en.wikipedia.org/wiki/Physics#Ancient_astronomy)
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    - [5.4.2 Atomic, molecular, and optical physics](https://en.wikipedia.org/wiki/Physics#Atomic.2C_molecular.2C_and_optical_physics)
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**History**

*Main article:* [*History of physics*](https://en.wikipedia.org/wiki/History_of_physics)

**Ancient astronomy**

*Main article:* [*History of astronomy*](https://en.wikipedia.org/wiki/History_of_astronomy)

[](https://en.wikipedia.org/wiki/File:Senenmut-Grab.JPG)

Ancient [Egyptian astronomy](https://en.wikipedia.org/wiki/Egyptian_astronomy) is evident in monuments like the [ceiling of Senemut's tomb](https://en.wikipedia.org/wiki/Astronomical_ceiling_of_Senemut_Tomb) from the [Eighteenth Dynasty of Egypt](https://en.wikipedia.org/wiki/Eighteenth_Dynasty_of_Egypt).

[Astronomy](https://en.wikipedia.org/wiki/Astronomy) is the oldest of the [natural sciences](https://en.wikipedia.org/wiki/Natural_science). The earliest civilizations dating back to beyond 3000 BCE, such as the [Sumerians](https://en.wikipedia.org/wiki/Sumer), [ancient Egyptians](https://en.wikipedia.org/wiki/Ancient_Egypt), and the [Indus Valley Civilization](https://en.wikipedia.org/wiki/Indus_Valley_Civilization), all had a predictive knowledge and a basic understanding of the motions of the [Sun](https://en.wikipedia.org/wiki/Sun), [Moon](https://en.wikipedia.org/wiki/Moon), and [stars](https://en.wikipedia.org/wiki/Star). The stars and planets were often a target of worship, believed to represent their gods. While the explanations for these phenomena were often unscientific and lacking in evidence, these early observations laid the foundation for later astronomy.[[9]](https://en.wikipedia.org/wiki/Physics#cite_note-krupp2003-10)

According to [Asger Aaboe](https://en.wikipedia.org/wiki/Asger_Aaboe), the origins of [Western](https://en.wikipedia.org/wiki/Western_world) astronomy can be found in [Mesopotamia](https://en.wikipedia.org/wiki/Mesopotamia), and all Western efforts in the [exact sciences](https://en.wikipedia.org/wiki/Exact_science) are descended from late [Babylonian astronomy](https://en.wikipedia.org/wiki/Babylonian_astronomy).[[11]](https://en.wikipedia.org/wiki/Physics#cite_note-aaboe1991-13) [Egyptian astronomers](https://en.wikipedia.org/wiki/Egyptian_astronomy) left monuments showing knowledge of the constellations and the motions of the celestial bodies,[[12]](https://en.wikipedia.org/wiki/Physics#cite_note-clagett1995-14) while [Greek poet](https://en.wikipedia.org/wiki/Ancient_Greek_poetry) [Homer](https://en.wikipedia.org/wiki/Homer) wrote of various celestial objects in his [*Iliad*](https://en.wikipedia.org/wiki/Iliad) and [*Odyssey*](https://en.wikipedia.org/wiki/Odyssey); later [Greek astronomers](https://en.wikipedia.org/wiki/Greek_astronomy) provided names, which are still used today, for most constellations visible from the [northern hemisphere](https://en.wikipedia.org/wiki/Northern_hemisphere).[[13]](https://en.wikipedia.org/wiki/Physics#cite_note-thurston1994-15)

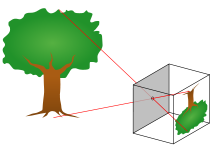
**Natural philosophy**

*Main article:* [*Natural philosophy*](https://en.wikipedia.org/wiki/Natural_philosophy)

[Natural philosophy](https://en.wikipedia.org/wiki/Natural_philosophy) has its origins in [Greece](https://en.wikipedia.org/wiki/Greece) during the [Archaic period](https://en.wikipedia.org/wiki/Archaic_Greece), (650 BCE – 480 BCE), when [pre-Socratic philosophers](https://en.wikipedia.org/wiki/Presocratics) like [Thales](https://en.wikipedia.org/wiki/Thales) rejected [non-naturalistic](https://en.wikipedia.org/wiki/Methodological_naturalism) explanations for natural phenomena and proclaimed that every event had a natural cause.[[14]](https://en.wikipedia.org/wiki/Physics#cite_note-singer2008p35-16) They proposed ideas verified by reason and observation, and many of their hypotheses proved successful in experiment;[[15]](https://en.wikipedia.org/wiki/Physics#cite_note-lloyd1970pp108-109-17) for example, [atomism](https://en.wikipedia.org/wiki/Atomism) was found to be correct approximately 2000 years after it was first proposed by [Leucippus](https://en.wikipedia.org/wiki/Leucippus) and his pupil [Democritus](https://en.wikipedia.org/wiki/Democritus).[[16]](https://en.wikipedia.org/wiki/Physics#cite_note-about-atomism-18)

**Physics in the medieval Islamic world**

*Main article:* [*Physics in the medieval Islamic world*](https://en.wikipedia.org/wiki/Physics_in_the_medieval_Islamic_world)

[](https://en.wikipedia.org/wiki/File:Pinhole-camera.svg)

The basic way a pinhole camera works

[Islamic scholarship](https://en.wikipedia.org/wiki/Science_in_medieval_Islam) had inherited [Aristotelian physics](https://en.wikipedia.org/wiki/Aristotelian_physics) from the Greeks and during the [Islamic Golden Age](https://en.wikipedia.org/wiki/Islamic_Golden_Age) developed it further, especially placing emphasis on observation and *a priori* reasoning, developing early forms of the [scientific method](https://en.wikipedia.org/wiki/Scientific_method).

The most notable innovations were in the field of optics and vision, which came from the works of many scientists like [Ibn Sahl](https://en.wikipedia.org/wiki/Ibn_Sahl), [Al-Kindi](https://en.wikipedia.org/wiki/Al-Kindi), [Ibn al-Haytham](https://en.wikipedia.org/wiki/Ibn_al-Haytham), [Al-Farisi](https://en.wikipedia.org/wiki/Kam%C4%81l_al-D%C4%ABn_al-F%C4%81ris%C4%AB) and [Avicenna](https://en.wikipedia.org/wiki/Avicenna). The most notable work was [*The Book of Optics*](https://en.wikipedia.org/wiki/Book_of_Optics) (also known as Kitāb al-Manāẓir), written by Ibn Al-Haitham, in which he was not only the first to disprove the ancient Greek idea about vision, but also came up with a new theory. In the book, he was also the first to study the phenomenon of the [pinhole camera](https://en.wikipedia.org/wiki/Pinhole_camera) and delved further into the way the eye itself works. Using dissections and the knowledge of previous scholars, he was able to begin to explain how light enters the eye, is focused, and is projected to the back of the eye: and built then the world's first [camera obscura](https://en.wikipedia.org/wiki/Camera_obscura) hundreds of years before the modern development of photography.[[17]](https://en.wikipedia.org/wiki/Physics#cite_note-19)

[](https://en.wikipedia.org/wiki/File:Alhazen,_the_Persian.gif)

Ibn al-Haytham (c. 965 - c. 1040), the pioneer of optics

The seven-volume *Book of Optics* (*Kitab al-Manathir*) hugely influenced thinking across disciplines from the theory of visual perception to the nature of perspective in medieval art, in both the East and the West, for more than 600 years. Many later European scholars and fellow polymaths, from [Robert Grosseteste](https://en.wikipedia.org/wiki/Robert_Grosseteste) and [Leonardo da Vinci](https://en.wikipedia.org/wiki/Leonardo_da_Vinci) to [René Descartes](https://en.wikipedia.org/wiki/Ren%C3%A9_Descartes), [Johannes Kepler](https://en.wikipedia.org/wiki/Johannes_Kepler) and [Isaac Newton](https://en.wikipedia.org/wiki/Isaac_Newton), were in his debt. Indeed, the influence of Ibn al-Haytham's Optics ranks alongside that of Newton's work of the same title, published 700 years later.

The translation of *The Book of Optics* had a huge impact on Europe. From it, later European scholars were able to build the same devices as what Ibn al-Haytham did, and understand the way light works. From this, such important things as eyeglasses, magnifying glasses, telescopes, and cameras were developed.

**Classical physics**

*Main article:* [*Classical physics*](https://en.wikipedia.org/wiki/Classical_physics)

[](https://en.wikipedia.org/wiki/File:GodfreyKneller-IsaacNewton-1689.jpg)

[Sir Isaac Newton](https://en.wikipedia.org/wiki/Sir_Isaac_Newton) (1643–1727), whose [laws of motion](https://en.wikipedia.org/wiki/Newton%27s_laws_of_motion) and [universal gravitation](https://en.wikipedia.org/wiki/Newton%27s_law_of_universal_gravitation) were major milestones in classical physics

Physics became a separate science when [early modern Europeans](https://en.wikipedia.org/wiki/Early_modern_Europe) used experimental and quantitative methods to discover what are now considered to be the [laws of physics](https://en.wikipedia.org/wiki/Laws_of_physics).[[18]](https://en.wikipedia.org/wiki/Physics#cite_note-benchaim2004-20)[[*page needed*](https://en.wikipedia.org/wiki/Wikipedia:Citing_sources)]

Major developments in this period include the replacement of the [geocentric model](https://en.wikipedia.org/wiki/Geocentric_model) of the [solar system](https://en.wikipedia.org/wiki/Solar_system) with the heliocentric [Copernican model](https://en.wikipedia.org/wiki/Copernican_model), the [laws governing the motion of planetary bodies](https://en.wikipedia.org/wiki/Kepler%27s_laws) determined by [Johannes Kepler](https://en.wikipedia.org/wiki/Johannes_Kepler) between 1609 and 1619, pioneering work on [telescopes](https://en.wikipedia.org/wiki/Telescope) and [observational astronomy](https://en.wikipedia.org/wiki/Observational_astronomy) by [Galileo Galilei](https://en.wikipedia.org/wiki/Galileo_Galilei) in the 16th and 17th Centuries, and [Isaac Newton](https://en.wikipedia.org/wiki/Isaac_Newton)'s discovery and unification of the [laws of motion](https://en.wikipedia.org/wiki/Newton%27s_laws_of_motion) and [universal gravitation](https://en.wikipedia.org/wiki/Newton%27s_law_of_universal_gravitation) that would come to bear his name.[[19]](https://en.wikipedia.org/wiki/Physics#cite_note-21) Newton also developed [calculus](https://en.wikipedia.org/wiki/Calculus),[[c]](https://en.wikipedia.org/wiki/Physics#cite_note-22) the mathematical study of change, which provided new mathematical methods for solving physical problems.[[20]](https://en.wikipedia.org/wiki/Physics#cite_note-allen1997-23)

The discovery of new laws in [thermodynamics](https://en.wikipedia.org/wiki/Thermodynamics), [chemistry](https://en.wikipedia.org/wiki/Chemistry), and [electromagnetics](https://en.wikipedia.org/wiki/Electromagnetics) resulted from greater research efforts during the [Industrial Revolution](https://en.wikipedia.org/wiki/Industrial_Revolution) as energy needs increased.[[21]](https://en.wikipedia.org/wiki/Physics#cite_note-schoolscience-industrialrevolution-24) The laws comprising classical physics remain very widely used for objects on everyday scales travelling at non-relativistic speeds, since they provide a very close approximation in such situations, and theories such as [quantum mechanics](https://en.wikipedia.org/wiki/Quantum_mechanics) and the [theory of relativity](https://en.wikipedia.org/wiki/Theory_of_relativity) simplify to their classical equivalents at such scales. However, inaccuracies in classical mechanics for very small objects and very high velocities led to the development of modern physics in the 20th century.

**Modern physics**

*Main article:* [*Modern physics*](https://en.wikipedia.org/wiki/Modern_physics)

*See also:* [*History of special relativity*](https://en.wikipedia.org/wiki/History_of_special_relativity) *and* [*History of quantum mechanics*](https://en.wikipedia.org/wiki/History_of_quantum_mechanics)

[](https://en.wikipedia.org/wiki/File:Einstein1921_by_F_Schmutzer_2.jpg)

[Albert Einstein](https://en.wikipedia.org/wiki/Albert_Einstein) (1879–1955), whose work on the [photoelectric effect](https://en.wikipedia.org/wiki/Photoelectric_effect) and the [theory of relativity](https://en.wikipedia.org/wiki/Theory_of_relativity) led to a revolution in 20th century physics

[](https://en.wikipedia.org/wiki/File:Max_Planck_(Nobel_1918).jpg)

[Max Planck](https://en.wikipedia.org/wiki/Max_Planck) (1858–1947), the originator of the theory of [quantum mechanics](https://en.wikipedia.org/wiki/Quantum_mechanics)

[Modern physics](https://en.wikipedia.org/wiki/Modern_physics) began in the early 20th century with the work of [Max Planck](https://en.wikipedia.org/wiki/Max_Planck) in [quantum theory](https://en.wikipedia.org/wiki/Quantum_mechanics) and [Albert Einstein](https://en.wikipedia.org/wiki/Albert_Einstein)'s [theory of relativity](https://en.wikipedia.org/wiki/Theory_of_relativity). Both of these theories came about due to inaccuracies in classical mechanics in certain situations. [Classical mechanics](https://en.wikipedia.org/wiki/Classical_mechanics) predicted a varying [speed of light](https://en.wikipedia.org/wiki/Speed_of_light), which could not be resolved with the constant speed predicted by [Maxwell's equations](https://en.wikipedia.org/wiki/Maxwell%27s_equations) of electromagnetism; this discrepancy was corrected by Einstein's theory of [special relativity](https://en.wikipedia.org/wiki/Special_relativity), which replaced classical mechanics for fast-moving bodies and allowed for a constant speed of light.[[22]](https://en.wikipedia.org/wiki/Physics#cite_note-oconnorrobertson1996-relativity-25) [Black body radiation](https://en.wikipedia.org/wiki/Black_body_radiation) provided another problem for classical physics, which was corrected when Planck proposed that the excitation of material oscillators is possible only in discrete steps proportional to their frequency; this, along with the [photoelectric effect](https://en.wikipedia.org/wiki/Photoelectric_effect) and a complete theory predicting discrete [energy levels](https://en.wikipedia.org/wiki/Energy_levels) of [electron orbitals](https://en.wikipedia.org/wiki/Atomic_orbital), led to the theory of quantum mechanics taking over from classical physics at very small scales.[[23]](https://en.wikipedia.org/wiki/Physics#cite_note-oconnorrobertson1996-quantum-26)

[Quantum mechanics](https://en.wikipedia.org/wiki/Quantum_mechanics) would come to be pioneered by [Werner Heisenberg](https://en.wikipedia.org/wiki/Werner_Heisenberg), [Erwin Schrödinger](https://en.wikipedia.org/wiki/Erwin_Schr%C3%B6dinger) and [Paul Dirac](https://en.wikipedia.org/wiki/Paul_Dirac).[[23]](https://en.wikipedia.org/wiki/Physics#cite_note-oconnorrobertson1996-quantum-26) From this early work, and work in related fields, the [Standard Model of particle physics](https://en.wikipedia.org/wiki/Standard_Model_of_particle_physics) was derived.[[24]](https://en.wikipedia.org/wiki/Physics#cite_note-donut2001-27) Following the discovery of a particle with properties consistent with the [Higgs boson](https://en.wikipedia.org/wiki/Higgs_boson) at [CERN](https://en.wikipedia.org/wiki/CERN) in 2012,[[25]](https://en.wikipedia.org/wiki/Physics#cite_note-cho2012-28) all [fundamental particles](https://en.wikipedia.org/wiki/Fundamental_particles) predicted by the standard model, and no others, appear to exist; however, [physics beyond the Standard Model](https://en.wikipedia.org/wiki/Physics_beyond_the_Standard_Model), with theories such as [supersymmetry](https://en.wikipedia.org/wiki/Supersymmetry), is an active area of research.[[26]](https://en.wikipedia.org/wiki/Physics#cite_note-29) Areas of [mathematics](https://en.wikipedia.org/wiki/Mathematics) in general are important to this field, such as the study of [probabilities](https://en.wikipedia.org/wiki/Probability_amplitude) and [groups](https://en.wikipedia.org/wiki/Group_theory#Physics).

**Philosophy**

*Main article:* [*Philosophy of physics*](https://en.wikipedia.org/wiki/Philosophy_of_physics)

In many ways, physics stems from [ancient Greek philosophy](https://en.wikipedia.org/wiki/Ancient_Greek_philosophy). From [Thales](https://en.wikipedia.org/wiki/Thales)' first attempt to characterise matter, to [Democritus](https://en.wikipedia.org/wiki/Democritus)' deduction that matter ought to reduce to an invariant state, the [Ptolemaic astronomy](https://en.wikipedia.org/wiki/Ptolemaic_astronomy) of a crystalline [firmament](https://en.wikipedia.org/wiki/Firmament), and Aristotle's book [*Physics*](https://en.wikipedia.org/wiki/Physics_(Aristotle)) (an early book on physics, which attempted to analyze and define motion from a philosophical point of view), various Greek philosophers advanced their own theories of nature. Physics was known as [natural philosophy](https://en.wikipedia.org/wiki/Natural_philosophy) until the late 18th century.[[27]](https://en.wikipedia.org/wiki/Physics#cite_note-30)

By the 19th century, physics was realised as a discipline distinct from philosophy and the other sciences. Physics, as with the rest of science, relies on [philosophy of science](https://en.wikipedia.org/wiki/Philosophy_of_science) and its "scientific method" to advance our knowledge of the physical world.[[28]](https://en.wikipedia.org/wiki/Physics#cite_note-rosenberg2006ch1-31) The scientific method employs [*a priori reasoning*](https://en.wikipedia.org/wiki/A_priori_and_a_posteriori) as well as [*a posteriori*](https://en.wikipedia.org/wiki/Empirical_evidence) reasoning and the use of [Bayesian inference](https://en.wikipedia.org/wiki/Bayesian_inference) to measure the validity of a given theory.[[29]](https://en.wikipedia.org/wiki/Physics#cite_note-godfreysmith2003ch14-32)

The development of physics has answered many questions of early philosophers, but has also raised new questions. Study of the philosophical issues surrounding physics, the philosophy of physics, involves issues such as the nature of [space](https://en.wikipedia.org/wiki/Space) and [time](https://en.wikipedia.org/wiki/Time), [determinism](https://en.wikipedia.org/wiki/Determinism), and metaphysical outlooks such as [empiricism](https://en.wikipedia.org/wiki/Empiricism), [naturalism](https://en.wikipedia.org/wiki/Naturalism_(philosophy)) and [realism](https://en.wikipedia.org/wiki/Philosophical_realism).[[30]](https://en.wikipedia.org/wiki/Physics#cite_note-godfreysmith2003ch15-33)

Many physicists have written about the philosophical implications of their work, for instance [Laplace](https://en.wikipedia.org/wiki/Laplace), who championed [causal determinism](https://en.wikipedia.org/wiki/Causal_determinism),[[31]](https://en.wikipedia.org/wiki/Physics#cite_note-laplace1951-34) and [Erwin Schrödinger](https://en.wikipedia.org/wiki/Erwin_Schr%C3%B6dinger), who wrote on [quantum mechanics](https://en.wikipedia.org/wiki/Quantum_mechanics).[[32]](https://en.wikipedia.org/wiki/Physics#cite_note-schroedinger1983-35)[[33]](https://en.wikipedia.org/wiki/Physics#cite_note-schroedinger1995-36) The mathematical physicist [Roger Penrose](https://en.wikipedia.org/wiki/Roger_Penrose) has been called a [Platonist](https://en.wikipedia.org/wiki/Platonism) by [Stephen Hawking](https://en.wikipedia.org/wiki/Stephen_Hawking),[[34]](https://en.wikipedia.org/wiki/Physics#cite_note-hawkingpenrose1996p4-37) a view Penrose discusses in his book, [*The Road to Reality*](https://en.wikipedia.org/wiki/The_Road_to_Reality).[[35]](https://en.wikipedia.org/wiki/Physics#cite_note-penrose2004-38) Hawking refers to himself as an "unashamed reductionist" and takes issue with Penrose's views.[[36]](https://en.wikipedia.org/wiki/Physics#cite_note-penroseshimonycartwrighthawking1997-39)

**Core theories**

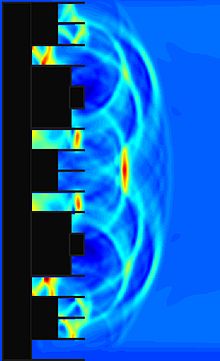
*Further information:* [*Branches of physics*](https://en.wikipedia.org/wiki/Branches_of_physics) *and* [*Outline of physics*](https://en.wikipedia.org/wiki/Outline_of_physics)

Though physics deals with a wide variety of systems, certain theories are used by all physicists. Each of these theories were experimentally tested numerous times and found to be an adequate approximation of nature. For instance, the theory of [classical](https://en.wikipedia.org/wiki/Classical_physics) mechanics accurately describes the motion of objects, provided they are much larger than [atoms](https://en.wikipedia.org/wiki/Atom) and moving at much less than the [speed of light](https://en.wikipedia.org/wiki/Speed_of_light). These theories continue to be areas of active research today. [Chaos theory](https://en.wikipedia.org/wiki/Chaos_theory), a remarkable aspect of classical mechanics was discovered in the 20th century, three centuries after the original formulation of classical mechanics by [Isaac Newton](https://en.wikipedia.org/wiki/Isaac_Newton) (1642–1727).

These central theories are important tools for research into more specialised topics, and any physicist, regardless of their specialisation, is expected to be literate in them. These include [classical mechanics](https://en.wikipedia.org/wiki/Classical_mechanics), [quantum mechanics](https://en.wikipedia.org/wiki/Quantum_mechanics), [thermodynamics](https://en.wikipedia.org/wiki/Thermodynamics) and [statistical mechanics](https://en.wikipedia.org/wiki/Statistical_mechanics), [electromagnetism](https://en.wikipedia.org/wiki/Electromagnetism), and [special relativity](https://en.wikipedia.org/wiki/Special_relativity).

**Classical physics**

*Main article:* [*Classical physics*](https://en.wikipedia.org/wiki/Classical_physics)

[](https://en.wikipedia.org/wiki/File:Prediction_of_sound_scattering_from_Schroeder_Diffuser.jpg)

Classical physics implemented in an [acoustic engineering](https://en.wikipedia.org/wiki/Acoustic_engineering) model of sound reflecting from an acoustic diffuser

[Classical physics](https://en.wikipedia.org/wiki/Classical_physics) includes the traditional branches and topics that were recognised and well-developed before the beginning of the 20th century—[classical mechanics](https://en.wikipedia.org/wiki/Classical_mechanics), [acoustics](https://en.wikipedia.org/wiki/Acoustics), [optics](https://en.wikipedia.org/wiki/Optics), [thermodynamics](https://en.wikipedia.org/wiki/Thermodynamics), and [electromagnetism](https://en.wikipedia.org/wiki/Electromagnetism). [Classical mechanics](https://en.wikipedia.org/wiki/Classical_mechanics) is concerned with bodies acted on by [forces](https://en.wikipedia.org/wiki/Force) and bodies in [motion](https://en.wikipedia.org/wiki/Motion_(physics)) and may be divided into [statics](https://en.wikipedia.org/wiki/Statics) (study of the forces on a body or bodies not subject to an acceleration), [kinematics](https://en.wikipedia.org/wiki/Kinematics) (study of motion without regard to its causes), and [dynamics](https://en.wikipedia.org/wiki/Analytical_dynamics) (study of motion and the forces that affect it); mechanics may also be divided into [solid mechanics](https://en.wikipedia.org/wiki/Solid_mechanics) and [fluid mechanics](https://en.wikipedia.org/wiki/Fluid_mechanics) (known together as [continuum mechanics](https://en.wikipedia.org/wiki/Continuum_mechanics)), the latter include such branches as [hydrostatics](https://en.wikipedia.org/wiki/Fluid_statics), [hydrodynamics](https://en.wikipedia.org/wiki/Fluid_dynamics), [aerodynamics](https://en.wikipedia.org/wiki/Aerodynamics), and [pneumatics](https://en.wikipedia.org/wiki/Pneumatics). [Acoustics](https://en.wikipedia.org/wiki/Acoustics) is the study of how [sound](https://en.wikipedia.org/wiki/Sound) is produced, controlled, transmitted and received.[[37]](https://en.wikipedia.org/wiki/Physics#cite_note-britannica-acoustics-40) Important modern branches of acoustics include [ultrasonics](https://en.wikipedia.org/wiki/Ultrasonics), the study of sound waves of very high frequency beyond the range of human hearing; [bioacoustics](https://en.wikipedia.org/wiki/Bioacoustics), the physics of animal calls and hearing,[[38]](https://en.wikipedia.org/wiki/Physics#cite_note-41) and [electroacoustics](https://en.wikipedia.org/wiki/Electroacoustics), the manipulation of audible sound waves using electronics.[[39]](https://en.wikipedia.org/wiki/Physics#cite_note-42)

[Optics](https://en.wikipedia.org/wiki/Optics), the study of [light](https://en.wikipedia.org/wiki/Light), is concerned not only with [visible light](https://en.wikipedia.org/wiki/Visible_light) but also with [infrared](https://en.wikipedia.org/wiki/Infrared) and [ultraviolet radiation](https://en.wikipedia.org/wiki/Ultraviolet_radiation), which exhibit all of the phenomena of visible light except visibility, e.g., reflection, refraction, interference, diffraction, dispersion, and polarization of light. [Heat](https://en.wikipedia.org/wiki/Heat) is a form of [energy](https://en.wikipedia.org/wiki/Energy), the internal energy possessed by the particles of which a substance is composed; thermodynamics deals with the relationships between heat and other forms of energy. [Electricity](https://en.wikipedia.org/wiki/Electricity) and [magnetism](https://en.wikipedia.org/wiki/Magnetism) have been studied as a single branch of physics since the intimate connection between them was discovered in the early 19th century; an [electric current](https://en.wikipedia.org/wiki/Electric_current) gives rise to a [magnetic field](https://en.wikipedia.org/wiki/Magnetic_field), and a changing magnetic field induces an electric current. [Electrostatics](https://en.wikipedia.org/wiki/Electrostatics) deals with [electric charges](https://en.wikipedia.org/wiki/Electric_charge) at rest, [electrodynamics](https://en.wikipedia.org/wiki/Classical_electromagnetism) with moving charges, and [magnetostatics](https://en.wikipedia.org/wiki/Magnetostatics) with magnetic poles at rest.

**Modern physics**

*Main article:* [*Modern physics*](https://en.wikipedia.org/wiki/Modern_physics)

|  |
| --- |
| **Modern physics** |
| H ^ | ψ n ( t ) ⟩ = i ℏ ∂ ∂ t | ψ n ( t ) ⟩ {\displaystyle {\hat {H}}|\psi \_{n}(t)\rangle =i\hbar {\frac {\partial }{\partial t}}|\psi \_{n}(t)\rangle }  1 c 2 ∂ 2 ϕ n ∂ t 2 − ∇ 2 ϕ n + ( m c ℏ ) 2 ϕ n = 0 {\displaystyle {\frac {1}{{c}^{2}}}{\frac {{\partial }^{2}{\phi }\_{n}}{{\partial t}^{2}}}-{{\nabla }^{2}{\phi }\_{n}}+{\left({\frac {mc}{\hbar }}\right)}^{2}{\phi }\_{n}=0}  [*Manifold dynamics*](https://en.wikipedia.org/wiki/Spacetime_topology#Manifold_topology)*:* [*Schrödinger*](https://en.wikipedia.org/wiki/Schr%C3%B6dinger_equation) *and* [*Klein–Gordon equations*](https://en.wikipedia.org/wiki/Klein%E2%80%93Gordon_equation) |
| Founders  [Max Planck](https://en.wikipedia.org/wiki/Max_Planck)  **·** [Albert Einstein](https://en.wikipedia.org/wiki/Albert_Einstein)  **·** [Niels Bohr](https://en.wikipedia.org/wiki/Niels_Bohr)  **·** [Max Born](https://en.wikipedia.org/wiki/Max_Born)  **·** [Werner Heisenberg](https://en.wikipedia.org/wiki/Werner_Heisenberg)  **·** [Erwin Schrödinger](https://en.wikipedia.org/wiki/Erwin_Schr%C3%B6dinger)  **·** [Pascual Jordan](https://en.wikipedia.org/wiki/Pascual_Jordan)  **·** [Wolfgang Pauli](https://en.wikipedia.org/wiki/Wolfgang_Pauli)  **·** [Paul Dirac](https://en.wikipedia.org/wiki/Paul_Dirac)  **·** [Ernest Rutherford](https://en.wikipedia.org/wiki/Ernest_Rutherford)  **·** [Louis de Broglie](https://en.wikipedia.org/wiki/Louis_de_Broglie)  **·** [Satyendra Nath Bose](https://en.wikipedia.org/wiki/Satyendra_Nath_Bose) |
| Concepts  [Topology](https://en.wikipedia.org/wiki/Spacetime_Topology) **·** [space](https://en.wikipedia.org/wiki/Space) **·** [time](https://en.wikipedia.org/wiki/Time) **·** [energy](https://en.wikipedia.org/wiki/Energy) **·** [matter](https://en.wikipedia.org/wiki/Matter) **·** [work](https://en.wikipedia.org/wiki/Work_(physics)) [randomness](https://en.wikipedia.org/wiki/Randomness) **·** [information](https://en.wikipedia.org/wiki/Information) **·** [entropy](https://en.wikipedia.org/wiki/Entropy) **·** [mind](https://en.wikipedia.org/wiki/Mind) [light](https://en.wikipedia.org/wiki/Light) **·** [particle](https://en.wikipedia.org/wiki/Particle) **·** [wave](https://en.wikipedia.org/wiki/Wave) |
| Branches  [Applied](https://en.wikipedia.org/wiki/Applied_physics) **·** [Experimental](https://en.wikipedia.org/wiki/Experimental_physics) **·** [Theoretical](https://en.wikipedia.org/wiki/Theoretical_physics) [Philosophy of Science](https://en.wikipedia.org/wiki/Philosophy_of_Science) **·** [Philosophy of physics](https://en.wikipedia.org/wiki/Philosophy_of_physics) [Mathematical logic](https://en.wikipedia.org/wiki/Mathematical_logic) **·** [Mathematical physics](https://en.wikipedia.org/wiki/Mathematical_physics) [Supersymmetry](https://en.wikipedia.org/wiki/Supersymmetry) **·** [String theory](https://en.wikipedia.org/wiki/String_theory) **·** [M-theory](https://en.wikipedia.org/wiki/M-theory) [Grand Unified Theory](https://en.wikipedia.org/wiki/Grand_Unified_Theory) **·** [Standard model](https://en.wikipedia.org/wiki/Standard_model) [Quantum mechanics](https://en.wikipedia.org/wiki/Quantum_mechanics) **·** [Quantum field theory](https://en.wikipedia.org/wiki/Quantum_field_theory) [Antiparticle](https://en.wikipedia.org/wiki/Antiparticle) **·** [Antimatter](https://en.wikipedia.org/wiki/Antimatter) [Electromagnetism](https://en.wikipedia.org/wiki/Electromagnetism) **·** [Quantum electrodynamics](https://en.wikipedia.org/wiki/Quantum_electrodynamics) [Weak interaction](https://en.wikipedia.org/wiki/Weak_interaction) **·** [Electroweak interaction](https://en.wikipedia.org/wiki/Electroweak_interaction) [Strong interaction](https://en.wikipedia.org/wiki/Strong_interaction) **·** [Quantum chromodynamics](https://en.wikipedia.org/wiki/Quantum_chromodynamics) [Atomic physics](https://en.wikipedia.org/wiki/Atomic_physics) **·** [Particle physics](https://en.wikipedia.org/wiki/Particle_physics) **·** [Nuclear physics](https://en.wikipedia.org/wiki/Nuclear_physics) [Exotic matter](https://en.wikipedia.org/wiki/Exotic_matter) **·** [Higgs boson](https://en.wikipedia.org/wiki/Higgs_boson) [Atomic, molecular, and optical physics](https://en.wikipedia.org/wiki/Atomic,_molecular,_and_optical_physics) [Condensed matter physics](https://en.wikipedia.org/wiki/Condensed_matter_physics) [Quantum statistical mechanics](https://en.wikipedia.org/wiki/Quantum_statistical_mechanics) [Quantum information](https://en.wikipedia.org/wiki/Quantum_information) **·** [Quantum computation](https://en.wikipedia.org/wiki/Quantum_computation) [Spintronics](https://en.wikipedia.org/wiki/Spintronics) **·** [Superconductivity](https://en.wikipedia.org/wiki/Superconductivity) [Non-linear dynamics](https://en.wikipedia.org/wiki/Non-linear_dynamics) **·** [Photonics](https://en.wikipedia.org/wiki/Photonics) **·** [Biophysics](https://en.wikipedia.org/wiki/Biophysics) [Neurophysics](https://en.wikipedia.org/wiki/Neurophysics) **·** [Quantum mind](https://en.wikipedia.org/wiki/Quantum_mind) [Plasma physics](https://en.wikipedia.org/wiki/Plasma_physics) **·** [Neutrino astronomy](https://en.wikipedia.org/wiki/Neutrino_astronomy) [Special relativity](https://en.wikipedia.org/wiki/Special_relativity) **·** [General relativity](https://en.wikipedia.org/wiki/General_relativity) [Scale relativity](https://en.wikipedia.org/wiki/Scale_relativity) **·** [Spacetime symmetries](https://en.wikipedia.org/wiki/Spacetime_symmetries) [Dark matter](https://en.wikipedia.org/wiki/Dark_matter) **·** [Dark energy](https://en.wikipedia.org/wiki/Dark_energy) [Fractal analysis](https://en.wikipedia.org/wiki/Fractal_analysis) **·** [Quantum chaos](https://en.wikipedia.org/wiki/Quantum_chaos) [Emergence](https://en.wikipedia.org/wiki/Emergence) **·** [Complex systems](https://en.wikipedia.org/wiki/Complex_system) [Black holes](https://en.wikipedia.org/wiki/Black_hole) **·** [Holographic principle](https://en.wikipedia.org/wiki/Holographic_principle) [Astrophysics](https://en.wikipedia.org/wiki/Astrophysics) **·** [Observable universe](https://en.wikipedia.org/wiki/Observable_universe) [Big Bang](https://en.wikipedia.org/wiki/Big_Bang) **·** [Cosmology](https://en.wikipedia.org/wiki/Cosmology) [Theories of gravitation](https://en.wikipedia.org/wiki/Theories_of_gravitation) **·** [Loop quantum gravity](https://en.wikipedia.org/wiki/Loop_quantum_gravity) [Quantum gravity](https://en.wikipedia.org/wiki/Quantum_gravity) **·** [Theory of everything](https://en.wikipedia.org/wiki/Theory_of_everything) [Mathematical universe hypothesis](https://en.wikipedia.org/wiki/Mathematical_universe_hypothesis) **·** [Multiverse](https://en.wikipedia.org/wiki/Multiverse) **·** [Weak gravity conjecture](https://en.wikipedia.org/wiki/Weak_gravity_conjecture) |
| Scientists  [Röntgen](https://en.wikipedia.org/wiki/Wilhelm_R%C3%B6ntgen) **·** [Becquerel](https://en.wikipedia.org/wiki/Henri_Becquerel) **·** [Lorentz](https://en.wikipedia.org/wiki/Hendrik_Lorentz) **·** [Planck](https://en.wikipedia.org/wiki/Max_Planck) **·** [Curie](https://en.wikipedia.org/wiki/Pierre_Curie) **·** [Wien](https://en.wikipedia.org/wiki/Wilhelm_Wien) **·** [Skłodowska-Curie](https://en.wikipedia.org/wiki/Marie_Curie) **·** [Sommerfeld](https://en.wikipedia.org/wiki/Arnold_Sommerfeld) **·** [Rutherford](https://en.wikipedia.org/wiki/Ernest_Rutherford) **·** [Soddy](https://en.wikipedia.org/wiki/Frederick_Soddy) **·** [Onnes](https://en.wikipedia.org/wiki/Heike_Kamerlingh_Onnes) **·** [Einstein](https://en.wikipedia.org/wiki/Albert_Einstein) **·** [Wilczek](https://en.wikipedia.org/wiki/Frank_Wilczek) **·** [Born](https://en.wikipedia.org/wiki/Max_Born) **·** [Weyl](https://en.wikipedia.org/wiki/Hermann_Weyl) **·** [Bohr](https://en.wikipedia.org/wiki/Niels_Bohr) **·** [Schrödinger](https://en.wikipedia.org/wiki/Erwin_Schr%C3%B6dinger) **·** [de Broglie](https://en.wikipedia.org/wiki/Louis_de_Broglie) **·** [Laue](https://en.wikipedia.org/wiki/Max_von_Laue) **·** [Bose](https://en.wikipedia.org/wiki/Satyendra_Nath_Bose) **·** [Compton](https://en.wikipedia.org/wiki/Arthur_Compton) **·** [Pauli](https://en.wikipedia.org/wiki/Wolfgang_Pauli) **·** [Walton](https://en.wikipedia.org/wiki/Ernest_Walton) **·** [Fermi](https://en.wikipedia.org/wiki/Enrico_Fermi) **·** [van der Waals](https://en.wikipedia.org/wiki/Johannes_Diderik_van_der_Waals) **·** [Heisenberg](https://en.wikipedia.org/wiki/Werner_Heisenberg) **·** [Dyson](https://en.wikipedia.org/wiki/Freeman_Dyson) **·** [Zeeman](https://en.wikipedia.org/wiki/Pieter_Zeeman) **·** [Moseley](https://en.wikipedia.org/wiki/Henry_Moseley) **·** [Hilbert](https://en.wikipedia.org/wiki/David_Hilbert) **·** [Gödel](https://en.wikipedia.org/wiki/Kurt_G%C3%B6del) **·** [Jordan](https://en.wikipedia.org/wiki/Pascual_Jordan) **·** [Dirac](https://en.wikipedia.org/wiki/Paul_Dirac) **·** [Wigner](https://en.wikipedia.org/wiki/Eugene_Wigner) **·** [Hawking](https://en.wikipedia.org/wiki/Stephen_Hawking) **·** [P.W Anderson](https://en.wikipedia.org/wiki/Philip_Warren_Anderson) **·** [Lemaître](https://en.wikipedia.org/wiki/Georges_Lema%C3%AEtre) **·** [Thomson](https://en.wikipedia.org/wiki/Sir_George_Paget_Thomson) **·** [Poincaré](https://en.wikipedia.org/wiki/Henri_Poincar%C3%A9) **·** [Wheeler](https://en.wikipedia.org/wiki/John_Archibald_Wheeler) **·** [Penrose](https://en.wikipedia.org/wiki/Roger_Penrose) **·** [Millikan](https://en.wikipedia.org/wiki/Robert_A._Millikan) **·** [Nambu](https://en.wikipedia.org/wiki/Yoichiro_Nambu) **·** [von Neumann](https://en.wikipedia.org/wiki/John_von_Neumann) **·** [Higgs](https://en.wikipedia.org/wiki/Peter_Higgs) **·** [Hahn](https://en.wikipedia.org/wiki/Otto_Hahn) **·** [Feynman](https://en.wikipedia.org/wiki/Richard_Feynman) **·** [Lee](https://en.wikipedia.org/wiki/Tsung-Dao_Lee) **·** [Lenard](https://en.wikipedia.org/wiki/Philipp_Lenard) **·** [Salam](https://en.wikipedia.org/wiki/Abdus_Salam) **·** ['t Hooft](https://en.wikipedia.org/wiki/Gerard_%27t_Hooft) **·** [Bell](https://en.wikipedia.org/wiki/John_Stewart_Bell) **·** [Gell-Mann](https://en.wikipedia.org/wiki/Murray_Gell-Mann) **·** [J. J. Thomson](https://en.wikipedia.org/wiki/J._J._Thomson)  **·** [Raman](https://en.wikipedia.org/wiki/C._V._Raman) **·** [Bragg](https://en.wikipedia.org/wiki/William_Lawrence_Bragg) **·** [Bardeen](https://en.wikipedia.org/wiki/John_Bardeen) **·** [Shockley](https://en.wikipedia.org/wiki/William_Shockley) **·** [Chadwick](https://en.wikipedia.org/wiki/James_Chadwick) **·** [Lawrence](https://en.wikipedia.org/wiki/Ernest_O._Lawrence) **·** [Zeilinger](https://en.wikipedia.org/wiki/Anton_Zeilinger) |
| * [v](https://en.wikipedia.org/wiki/Template:Modern_physics) * [t](https://en.wikipedia.org/wiki/Template_talk:Modern_physics) * [e](https://en.wikipedia.org/w/index.php?title=Template:Modern_physics&action=edit) |

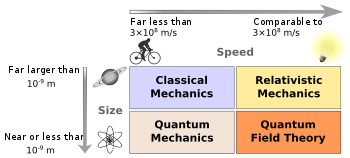
[](https://en.wikipedia.org/wiki/File:Solvay_conference_1927.jpg)

[Solvay Conference](https://en.wikipedia.org/wiki/Solvay_Conference) of 1927, with prominent physicists such as [Albert Einstein](https://en.wikipedia.org/wiki/Albert_Einstein), [Werner Heisenberg](https://en.wikipedia.org/wiki/Werner_Heisenberg), [Max Planck](https://en.wikipedia.org/wiki/Max_Planck), [Hendrik Lorentz](https://en.wikipedia.org/wiki/Hendrik_Lorentz), [Niels Bohr](https://en.wikipedia.org/wiki/Niels_Bohr), [Marie Curie](https://en.wikipedia.org/wiki/Marie_Curie), [Erwin Schrödinger](https://en.wikipedia.org/wiki/Erwin_Schr%C3%B6dinger) and [Paul Dirac](https://en.wikipedia.org/wiki/Paul_Dirac)

Classical physics is generally concerned with matter and energy on the normal scale of observation, while much of modern physics is concerned with the behavior of matter and energy under extreme conditions or on a very large or very small scale. For example, [atomic](https://en.wikipedia.org/wiki/Atomic_physics) and [nuclear physics](https://en.wikipedia.org/wiki/Nuclear_physics) studies matter on the smallest scale at which [chemical elements](https://en.wikipedia.org/wiki/Chemical_element) can be identified. The [physics of elementary particles](https://en.wikipedia.org/wiki/Particle_physics) is on an even smaller scale since it is concerned with the most basic units of matter; this branch of physics is also known as high-energy physics because of the extremely high energies necessary to produce many types of particles in [particle accelerators](https://en.wikipedia.org/wiki/Particle_accelerator). On this scale, ordinary, commonsense notions of space, time, matter, and energy are no longer valid.[[40]](https://en.wikipedia.org/wiki/Physics#cite_note-43)

The two chief theories of modern physics present a different picture of the concepts of space, time, and matter from that presented by classical physics. Classical mechanics approximates nature as continuous, while [quantum theory](https://en.wikipedia.org/wiki/Quantum_mechanics) is concerned with the discrete nature of many phenomena at the atomic and subatomic level and with the complementary aspects of particles and waves in the description of such phenomena. The [theory of relativity](https://en.wikipedia.org/wiki/Theory_of_relativity) is concerned with the description of phenomena that take place in a [frame of reference](https://en.wikipedia.org/wiki/Frame_of_reference) that is in motion with respect to an observer; the [special theory of relativity](https://en.wikipedia.org/wiki/Special_relativity) is concerned with relative uniform motion in a straight line and the [general theory of relativity](https://en.wikipedia.org/wiki/General_relativity) with accelerated motion and its connection with [gravitation](https://en.wikipedia.org/wiki/Gravitation). Both quantum theory and the theory of relativity find applications in all areas of modern physics.[[41]](https://en.wikipedia.org/wiki/Physics#cite_note-44)

**Difference between classical and modern physics**

[](https://en.wikipedia.org/wiki/File:Modernphysicsfields.svg)

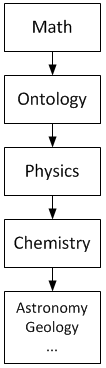
The basic domains of physics

While physics aims to discover universal laws, its theories lie in explicit domains of applicability. Loosely speaking, the laws of [classical physics](https://en.wikipedia.org/wiki/Classical_physics) accurately describe systems whose important length scales are greater than the atomic scale and whose motions are much slower than the speed of light. Outside of this domain, observations do not match predictions provided by classical mechanics. [Albert Einstein](https://en.wikipedia.org/wiki/Albert_Einstein) contributed the framework of [special relativity](https://en.wikipedia.org/wiki/Special_relativity), which replaced notions of [absolute time and space](https://en.wikipedia.org/wiki/Absolute_time_and_space) with [spacetime](https://en.wikipedia.org/wiki/Spacetime) and allowed an accurate description of systems whose components have speeds approaching the speed of light. [Max Planck](https://en.wikipedia.org/wiki/Max_Planck), [Erwin Schrödinger](https://en.wikipedia.org/wiki/Erwin_Schr%C3%B6dinger), and others introduced [quantum mechanics](https://en.wikipedia.org/wiki/Quantum_mechanics), a probabilistic notion of particles and interactions that allowed an accurate description of atomic and subatomic scales. Later, [quantum field theory](https://en.wikipedia.org/wiki/Quantum_field_theory) unified [quantum mechanics](https://en.wikipedia.org/wiki/Quantum_mechanics) and [special relativity](https://en.wikipedia.org/wiki/Special_relativity). [General relativity](https://en.wikipedia.org/wiki/General_relativity) allowed for a dynamical, curved [spacetime](https://en.wikipedia.org/wiki/Spacetime), with which highly massive systems and the large-scale structure of the universe can be well-described. General relativity has not yet been unified with the other fundamental descriptions; several candidate theories of [quantum gravity](https://en.wikipedia.org/wiki/Quantum_gravity) are being developed.

**Relation to other fields**

[](https://en.wikipedia.org/wiki/File:Pahoeoe_fountain_original.jpg)

This [parabola](https://en.wikipedia.org/wiki/Parabola)-shaped [lava flow](https://en.wikipedia.org/wiki/Lava_flow) illustrates the application of mathematics in physics—in this case, [Galileo](https://en.wikipedia.org/wiki/Galileo)'s [law of falling bodies](https://en.wikipedia.org/wiki/Law_of_falling_bodies).

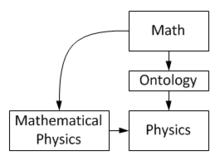
[](https://en.wikipedia.org/wiki/File:Physics_and_other_sciences.png)

Mathematics and ontology are used in physics. Physics is used in chemistry and cosmology.

**Prerequisites**

Mathematics provides a compact and exact language used to describe of the order in nature. This was noted and advocated by [Pythagoras](https://en.wikipedia.org/wiki/Pythagoras),[[42]](https://en.wikipedia.org/wiki/Physics#cite_note-dijksterhuis1986-45) [Plato](https://en.wikipedia.org/wiki/Plato),[[43]](https://en.wikipedia.org/wiki/Physics#cite_note-mastin2010-plato-46) [Galileo](https://en.wikipedia.org/wiki/Galileo_Galilei),[[44]](https://en.wikipedia.org/wiki/Physics#cite_note-toraldodifrancia1976p10-galileo-47) and [Newton](https://en.wikipedia.org/wiki/Isaac_Newton).

Physics uses mathematics[[45]](https://en.wikipedia.org/wiki/Physics#cite_note-applicationsofmathematics-48) to organise and formulate experimental results. From those results, [precise](https://en.wikipedia.org/wiki/Analytic_solution) or [estimated](https://en.wikipedia.org/wiki/Simulation#Computer_simulation) solutions, quantitative results from which new predictions can be made and experimentally confirmed or negated. The results from physics experiments are numerical measurements. Technologies based on mathematics, like [computation](https://en.wikipedia.org/wiki/Scientific_computing) have made [computational physics](https://en.wikipedia.org/wiki/Computational_physics) an active area of research.

[](https://en.wikipedia.org/wiki/File:Mathematical_Physics_and_other_sciences.png)

The distinction between mathematics and physics is clear-cut, but not always obvious, especially in mathematical physics.

[Ontology](https://en.wikipedia.org/wiki/Ontology) is a prerequisite for physics, but not for mathematics. It means physics is ultimately concerned with descriptions of the real world, while mathematics is concerned with abstract patterns, even beyond the real world. Thus physics statements are synthetic, while mathematical statements are analytic. Mathematics contains hypotheses, while physics contains theories. Mathematics statements have to be only logically true, while predictions of physics statements must match observed and experimental data.

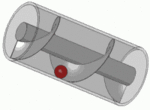
The distinction is clear-cut, but not always obvious. For example, mathematical physics is the application of mathematics in physics. Its methods are mathematical, but its subject is physical.[[46]](https://en.wikipedia.org/wiki/Physics#cite_note-jmp-def-49) The problems in this field start with a "[mathematical model of a physical situation](https://en.wikipedia.org/wiki/Boundary_condition)" (system) and a "mathematical description of a physical law" that will be applied to that system. Every mathematical statement used for solving has a hard-to-find physical meaning. The final mathematical solution has an easier-to-find meaning, because it is what the solver is looking for.[[*clarification needed*](https://en.wikipedia.org/wiki/Wikipedia:Please_clarify)]

Physics is a branch of [fundamental science](https://en.wikipedia.org/wiki/Fundamental_science), not [practical science](https://en.wikipedia.org/wiki/Practical_science). Physics is also called "the fundamental science" because the subject of study of all branches of [natural science](https://en.wikipedia.org/wiki/Natural_science) like chemistry, astronomy, geology, and biology are constrained by laws of physics,[[47]](https://en.wikipedia.org/wiki/Physics#cite_note-feynmanleightonsands1963v1ch3-50) similar to how chemistry is often called [the central science](https://en.wikipedia.org/wiki/The_central_science) because of its role in linking the physical sciences. For example, chemistry studies properties, structures, and [reactions](https://en.wikipedia.org/wiki/Chemical_reaction) of matter (chemistry's focus on the atomic scale [distinguishes it from physics](https://en.wikipedia.org/wiki/Difference_between_chemistry_and_physics)). Structures are formed because particles exert electrical forces on each other, properties include physical characteristics of given substances, and reactions are bound by laws of physics, like conservation of energy, mass, and charge.

Physics is applied in industries like engineering and medicine.

**Application and influence**

*Main article:* [*Applied physics*](https://en.wikipedia.org/wiki/Applied_physics)

[](https://en.wikipedia.org/wiki/File:Archimedes-screw_one-screw-threads_with-ball_3D-view_animated_small.gif)

[Archimedes' screw](https://en.wikipedia.org/wiki/Archimedes%27_screw), a [simple machine](https://en.wikipedia.org/wiki/Simple_machine) for lifting

[](https://en.wikipedia.org/wiki/File:IMG_1729_Gemaal_met_schroef_van_Archimedes_bij_Kinderdijk.JPG)

The application of physical laws in lifting liquids

[Applied physics](https://en.wikipedia.org/wiki/Applied_physics) is a general term for physics research which is intended for a particular [use](https://en.wikipedia.org/wiki/Utility). An applied physics [curriculum](https://en.wikipedia.org/wiki/Curriculum) usually contains a few classes in an applied discipline, like geology or electrical engineering. It usually differs from [engineering](https://en.wikipedia.org/wiki/Engineering) in that an applied physicist may not be designing something in particular, but rather is using physics or conducting physics research with the aim of developing new technologies or solving a problem.

The approach is similar to that of [applied mathematics](https://en.wikipedia.org/wiki/Applied_mathematics). Applied physicists use physics in scientific research. For instance, people working on [accelerator physics](https://en.wikipedia.org/wiki/Accelerator_physics) might seek to build better [particle detectors](https://en.wikipedia.org/wiki/Particle_detector) for research in theoretical physics.

Physics is used heavily in [engineering](https://en.wikipedia.org/wiki/Engineering). For example, [statics](https://en.wikipedia.org/wiki/Statics), a subfield of [mechanics](https://en.wikipedia.org/wiki/Mechanics), is used in the building of [bridges](https://en.wikipedia.org/wiki/Bridge) and other static structures. The understanding and use of [acoustics](https://en.wikipedia.org/wiki/Acoustics) results in sound control and better concert halls; similarly, the use of [optics](https://en.wikipedia.org/wiki/Optics) creates better optical devices. An understanding of physics makes for more realistic [flight simulators](https://en.wikipedia.org/wiki/Flight_simulator), [video games](https://en.wikipedia.org/wiki/Video_game), and [movies](https://en.wikipedia.org/wiki/Film), and is often critical in [forensic](https://en.wikipedia.org/wiki/Forensic) investigations.

With the [standard consensus](https://en.wikipedia.org/wiki/Uniformitarianism_(science)) that the [laws](https://en.wikipedia.org/wiki/Scientific_law) of physics are universal and do not change with time, physics can be used to study things that would ordinarily be mired in [uncertainty](https://en.wikipedia.org/wiki/Uncertainty). For example, in the [study of the origin of the earth](https://en.wikipedia.org/wiki/History_of_Earth#Origin_of_the_Earth.27s_core_and_first_atmosphere), one can reasonably model earth's [mass](https://en.wikipedia.org/wiki/Mass), [temperature](https://en.wikipedia.org/wiki/Temperature), and rate of [rotation](https://en.wikipedia.org/wiki/Rotation), as a function of time allowing one to extrapolate forward or backward in time and so predict future or prior events. It also allows for simulations in engineering which drastically speed up the development of a new technology.

But there is also considerable [interdisciplinarity](https://en.wikipedia.org/wiki/Interdisciplinarity) in the physicist's methods, so many other important fields are influenced by physics (e.g., the fields of [econophysics](https://en.wikipedia.org/wiki/Econophysics) and sociophysics).

**Research**

**Scientific method**

Physicists use [the scientific method](https://en.wikipedia.org/wiki/Scientific_method) to test the validity of a [physical theory](https://en.wikipedia.org/wiki/Physical_theory). By using a methodical approach to compare the implications of a theory with the conclusions drawn from its related [experiments](https://en.wikipedia.org/wiki/Experiment) and observations, physicists are better able to test the validity of a theory in a logical, unbiased, and repeatable way. To that end, experiments are performed and observations are made in order to determine the validity or invalidity of the theory.[[48]](https://en.wikipedia.org/wiki/Physics#cite_note-51)

A [scientific law](https://en.wikipedia.org/wiki/Scientific_law) is a concise verbal or mathematical statement of a relation which expresses a fundamental principle of some theory, such as Newton's law of universal gravitation.[[49]](https://en.wikipedia.org/wiki/Physics#cite_note-honderich1995pp474-476-52)

**Theory and experiment**

*Main articles:* [*Theoretical physics*](https://en.wikipedia.org/wiki/Theoretical_physics) *and* [*Experimental physics*](https://en.wikipedia.org/wiki/Experimental_physics)

[](https://en.wikipedia.org/wiki/File:Astronaut-EVA.jpg)

The [astronaut](https://en.wikipedia.org/wiki/Astronaut) and [Earth](https://en.wikipedia.org/wiki/Earth) are both in [free-fall](https://en.wikipedia.org/wiki/Free-fall)

[](https://en.wikipedia.org/wiki/File:Lightning_in_Arlington.jpg)

[Lightning](https://en.wikipedia.org/wiki/Lightning) is an [electric current](https://en.wikipedia.org/wiki/Electric_current)

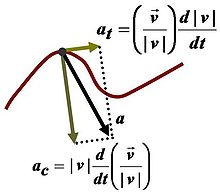
Theorists seek to develop [mathematical models](https://en.wikipedia.org/wiki/Mathematical_model) that both agree with existing experiments and successfully predict future experimental results, while [experimentalists](https://en.wikipedia.org/wiki/Experimentalism) devise and perform experiments to test theoretical predictions and explore new phenomena. Although [theory](https://en.wikipedia.org/wiki/Theory) and [experiment](https://en.wikipedia.org/wiki/Experiment) are developed separately, they are strongly dependent upon each other. Progress in physics frequently comes about when experimentalists make a discovery that existing theories cannot explain, or when new theories generate experimentally testable [predictions](https://en.wikipedia.org/wiki/Prediction), which inspire new experiments.[[50]](https://en.wikipedia.org/wiki/Physics#cite_note-53)

[Physicists](https://en.wikipedia.org/wiki/Physicist) who work at the interplay of [theory](https://en.wikipedia.org/wiki/Theory) and [experiment](https://en.wikipedia.org/wiki/Experiment) are called [phenomenologists](https://en.wikipedia.org/wiki/Phenomenology_(particle_physics)), who study complex phenomena observed in experiment and work to relate them to a [fundamental theory](https://en.wikipedia.org/wiki/Theory_of_everything).[[51]](https://en.wikipedia.org/wiki/Physics#cite_note-54)

Theoretical physics has historically taken inspiration from philosophy; [electromagnetism](https://en.wikipedia.org/wiki/Electromagnetism) was unified this way.[[d]](https://en.wikipedia.org/wiki/Physics#cite_note-55) Beyond the known universe, the field of theoretical physics also deals with hypothetical issues,[[e]](https://en.wikipedia.org/wiki/Physics#cite_note-56) such as [parallel universes](https://en.wikipedia.org/wiki/Many-worlds_interpretation), a [multiverse](https://en.wikipedia.org/wiki/Multiverse), and [higher dimensions](https://en.wikipedia.org/wiki/Higher_dimension). Theorists invoke these ideas in hopes of solving particular problems with existing theories. They then explore the consequences of these ideas and work toward making testable predictions.

[Experimental](https://en.wikipedia.org/wiki/Experiment) physics expands, and is expanded by, [engineering](https://en.wikipedia.org/wiki/Engineering) and [technology](https://en.wikipedia.org/wiki/Technology). Experimental physicists involved in [basic research](https://en.wikipedia.org/wiki/Basic_research) design and perform experiments with equipment such as [particle accelerators](https://en.wikipedia.org/wiki/Particle_accelerator) and [lasers](https://en.wikipedia.org/wiki/Laser), whereas those involved in [applied research](https://en.wikipedia.org/wiki/Applied_research) often work in industry developing technologies such as [magnetic resonance imaging (MRI)](https://en.wikipedia.org/wiki/MRI) and [transistors](https://en.wikipedia.org/wiki/Transistor). [Feynman](https://en.wikipedia.org/wiki/Richard_Feynman) has noted that experimentalists may seek areas which are not well-explored by theorists.[[52]](https://en.wikipedia.org/wiki/Physics#cite_note-feynman1965p157-experiment-57)

**Scope and aims**

[](https://en.wikipedia.org/wiki/File:Acceleration_components.JPG)

Physics involves modeling the natural world with theory, usually quantitative. Here, the path of a particle is modeled with the mathematics of [calculus](https://en.wikipedia.org/wiki/Calculus) to explain its behavior: the purview of the branch of physics known as [mechanics](https://en.wikipedia.org/wiki/Mechanics).

Physics covers a wide range of [phenomena](https://en.wikipedia.org/wiki/Phenomenon), from [elementary particles](https://en.wikipedia.org/wiki/Elementary_particle) (such as quarks, neutrinos, and electrons) to the largest [superclusters](https://en.wikipedia.org/wiki/Superclusters) of galaxies. Included in these phenomena are the most basic objects composing all other things. Therefore, physics is sometimes called the "[fundamental science](https://en.wikipedia.org/wiki/Fundamental_science)".[[47]](https://en.wikipedia.org/wiki/Physics#cite_note-feynmanleightonsands1963v1ch3-50) Physics aims to describe the various phenomena that occur in nature in terms of simpler phenomena. Thus, physics aims to both connect the things observable to humans to [root causes](https://en.wikipedia.org/wiki/Root_cause), and then connect these causes together.

For example, the [ancient Chinese](https://en.wikipedia.org/wiki/History_of_China) observed that certain rocks ([lodestone](https://en.wikipedia.org/wiki/Lodestone) and [magnetite](https://en.wikipedia.org/wiki/Magnetite)) were attracted to one another by an invisible force. This effect was later called [magnetism](https://en.wikipedia.org/wiki/Magnetism), which was first rigorously studied in the 17th century. But even before the Chinese discovered magnetism, the [ancient Greeks](https://en.wikipedia.org/wiki/Ancient_Greece) knew of other objects such as [amber](https://en.wikipedia.org/wiki/Amber), that when rubbed with fur would cause a similar invisible attraction between the two.[[53]](https://en.wikipedia.org/wiki/Physics#cite_note-stewart-58) This was also first studied rigorously in the 17th century and came to be called [electricity](https://en.wikipedia.org/wiki/Electricity). Thus, physics had come to understand two observations of nature in terms of some root cause (electricity and magnetism). However, further work in the 19th century revealed that these two forces were just two different aspects of one force—[electromagnetism](https://en.wikipedia.org/wiki/Electromagnetism). This process of "unifying" forces continues today, and electromagnetism and the [weak nuclear force](https://en.wikipedia.org/wiki/Weak_nuclear_force) are now considered to be two aspects of the [electroweak interaction](https://en.wikipedia.org/wiki/Electroweak_interaction). Physics hopes to find an ultimate reason ([Theory of Everything](https://en.wikipedia.org/wiki/Theory_of_Everything)) for why nature is as it is (see section [*Current research*](https://en.wikipedia.org/wiki/Physics#Current_research) below for more information).[[54]](https://en.wikipedia.org/wiki/Physics#cite_note-59)

**Research fields**

Contemporary research in physics can be broadly divided into [nuclear](https://en.wikipedia.org/wiki/Nuclear_physics) and [particle physics](https://en.wikipedia.org/wiki/Particle_physics); [condensed matter physics](https://en.wikipedia.org/wiki/Condensed_matter_physics); [atomic, molecular, and optical physics](https://en.wikipedia.org/wiki/Atomic,_molecular,_and_optical_physics); [astrophysics](https://en.wikipedia.org/wiki/Astrophysics); and [applied physics](https://en.wikipedia.org/wiki/Applied_physics). Some physics departments also support [physics education research](https://en.wikipedia.org/wiki/Physics_education_research) and [physics outreach](https://en.wikipedia.org/wiki/Physics_outreach).[[55]](https://en.wikipedia.org/wiki/Physics#cite_note-60)

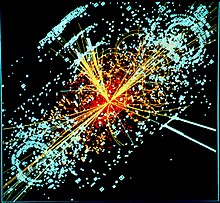
Since the 20th century, the individual fields of physics have become increasingly [specialised](https://en.wikipedia.org/w/index.php?title=Specialisation_of_knowledge&action=edit&redlink=1), and today most physicists work in a single field for their entire careers. "Universalists" such as [Albert Einstein](https://en.wikipedia.org/wiki/Albert_Einstein) (1879–1955) and [Lev Landau](https://en.wikipedia.org/wiki/Lev_Landau) (1908–1968), who worked in multiple fields of physics, are now very rare.[[f]](https://en.wikipedia.org/wiki/Physics#cite_note-61)

The major fields of physics, along with their subfields and the theories and concepts they employ, are shown in the following table.

|  |  |  |  |
| --- | --- | --- | --- |
| **Field** | **Subfields** | **Major theories** | **Concepts** |
| [Nuclear](https://en.wikipedia.org/wiki/Nuclear_physics) and [particle physics](https://en.wikipedia.org/wiki/Particle_physics) | [Nuclear physics](https://en.wikipedia.org/wiki/Nuclear_physics), [Nuclear astrophysics](https://en.wikipedia.org/wiki/Nuclear_astrophysics), [Particle physics](https://en.wikipedia.org/wiki/Particle_physics), [Particle astrophysics](https://en.wikipedia.org/wiki/Particle_astrophysics), [Particle physics phenomenology](https://en.wikipedia.org/wiki/Particle_physics_phenomenology) | [Standard Model](https://en.wikipedia.org/wiki/Standard_Model), [Quantum field theory](https://en.wikipedia.org/wiki/Quantum_field_theory), [Quantum electrodynamics](https://en.wikipedia.org/wiki/Quantum_electrodynamics), [Quantum chromodynamics](https://en.wikipedia.org/wiki/Quantum_chromodynamics), [Electroweak theory](https://en.wikipedia.org/wiki/Electroweak_interaction), [Effective field theory](https://en.wikipedia.org/wiki/Effective_field_theory), [Lattice field theory](https://en.wikipedia.org/wiki/Lattice_field_theory), [Lattice gauge theory](https://en.wikipedia.org/wiki/Lattice_gauge_theory), [Gauge theory](https://en.wikipedia.org/wiki/Gauge_theory), [Supersymmetry](https://en.wikipedia.org/wiki/Supersymmetry), [Grand unification theory](https://en.wikipedia.org/wiki/Grand_unification_theory), [Superstring theory](https://en.wikipedia.org/wiki/Superstring_theory), [M-theory](https://en.wikipedia.org/wiki/M-theory) | [Fundamental force](https://en.wikipedia.org/wiki/Fundamental_force) ([gravitational](https://en.wikipedia.org/wiki/Gravity), [electromagnetic](https://en.wikipedia.org/wiki/Electromagnetism), [weak](https://en.wikipedia.org/wiki/Weak_interaction), [strong](https://en.wikipedia.org/wiki/Strong_interaction)), [Elementary particle](https://en.wikipedia.org/wiki/Elementary_particle), [Spin](https://en.wikipedia.org/wiki/Spin_(physics)), [Antimatter](https://en.wikipedia.org/wiki/Antimatter), [Spontaneous symmetry breaking](https://en.wikipedia.org/wiki/Spontaneous_symmetry_breaking), [Neutrino oscillation](https://en.wikipedia.org/wiki/Neutrino_oscillation), [Seesaw mechanism](https://en.wikipedia.org/wiki/Seesaw_mechanism), [Brane](https://en.wikipedia.org/wiki/Membrane_(M-Theory)), [String](https://en.wikipedia.org/wiki/String_(physics)), [Quantum gravity](https://en.wikipedia.org/wiki/Quantum_gravity), [Theory of everything](https://en.wikipedia.org/wiki/Theory_of_everything), [Vacuum energy](https://en.wikipedia.org/wiki/Vacuum_energy) |
| [Atomic, molecular, and optical physics](https://en.wikipedia.org/wiki/Atomic,_molecular,_and_optical_physics) | [Atomic physics](https://en.wikipedia.org/wiki/Atomic_physics), [Molecular physics](https://en.wikipedia.org/wiki/Molecular_physics), [Atomic and Molecular astrophysics](https://en.wikipedia.org/wiki/Atomic_and_Molecular_astrophysics), [Chemical physics](https://en.wikipedia.org/wiki/Chemical_physics), [Optics](https://en.wikipedia.org/wiki/Optics), [Photonics](https://en.wikipedia.org/wiki/Photonics) | [Quantum optics](https://en.wikipedia.org/wiki/Quantum_optics), [Quantum chemistry](https://en.wikipedia.org/wiki/Quantum_chemistry), [Quantum information science](https://en.wikipedia.org/wiki/Quantum_information_science) | [Photon](https://en.wikipedia.org/wiki/Photon), [Atom](https://en.wikipedia.org/wiki/Atom), [Molecule](https://en.wikipedia.org/wiki/Molecule), [Diffraction](https://en.wikipedia.org/wiki/Diffraction), [Electromagnetic radiation](https://en.wikipedia.org/wiki/Electromagnetic_radiation), [Laser](https://en.wikipedia.org/wiki/Laser), [Polarization (waves)](https://en.wikipedia.org/wiki/Polarization_(waves)), [Spectral line](https://en.wikipedia.org/wiki/Spectral_line), [Casimir effect](https://en.wikipedia.org/wiki/Casimir_effect) |
| [Condensed matter physics](https://en.wikipedia.org/wiki/Condensed_matter_physics) | [Solid state physics](https://en.wikipedia.org/wiki/Solid_state_physics), [High pressure physics](https://en.wikipedia.org/wiki/High_pressure_physics), [Low-temperature physics](https://en.wikipedia.org/wiki/Cryogenics), [Surface Physics](https://en.wikipedia.org/wiki/Surface_science), [Nanoscale and Mesoscopic physics](https://en.wikipedia.org/wiki/Nanotechnology), [Polymer physics](https://en.wikipedia.org/wiki/Polymer_physics) | [BCS theory](https://en.wikipedia.org/wiki/BCS_theory), [Bloch wave](https://en.wikipedia.org/wiki/Bloch_wave), [Density functional theory](https://en.wikipedia.org/wiki/Density_functional_theory), [Fermi gas](https://en.wikipedia.org/wiki/Fermi_gas), [Fermi liquid](https://en.wikipedia.org/wiki/Fermi_liquid), [Many-body theory](https://en.wikipedia.org/wiki/Many-body_theory), [Statistical Mechanics](https://en.wikipedia.org/wiki/Statistical_Mechanics) | [Phases](https://en.wikipedia.org/wiki/Phase_(matter)) ([gas](https://en.wikipedia.org/wiki/Gas), [liquid](https://en.wikipedia.org/wiki/Liquid), [solid](https://en.wikipedia.org/wiki/Solid)), [Bose-Einstein condensate](https://en.wikipedia.org/wiki/Bose-Einstein_condensate), [Electrical conduction](https://en.wikipedia.org/wiki/Electrical_conduction), [Phonon](https://en.wikipedia.org/wiki/Phonon), [Magnetism](https://en.wikipedia.org/wiki/Magnetism), [Self-organization](https://en.wikipedia.org/wiki/Self-organization), [Semiconductor](https://en.wikipedia.org/wiki/Semiconductor), [superconductor](https://en.wikipedia.org/wiki/Superconductivity), [superfluid](https://en.wikipedia.org/wiki/Superfluid), [Spin](https://en.wikipedia.org/wiki/Spin_(physics)), |
| [Astrophysics](https://en.wikipedia.org/wiki/Astrophysics) | [Astronomy](https://en.wikipedia.org/wiki/Astronomy), [Astrometry](https://en.wikipedia.org/wiki/Astrometry), [Cosmology](https://en.wikipedia.org/wiki/Physical_cosmology), [Gravitation physics](https://en.wikipedia.org/wiki/Gravitation), [High-energy astrophysics](https://en.wikipedia.org/wiki/High-energy_astronomy), [Planetary astrophysics](https://en.wikipedia.org/wiki/Planetary_science), [Plasma physics](https://en.wikipedia.org/wiki/Plasma_(physics)), [Solar physics](https://en.wikipedia.org/wiki/Solar_physics), [Space physics](https://en.wikipedia.org/wiki/Space_physics), [Stellar astrophysics](https://en.wikipedia.org/wiki/Astronomy#Stellar_astronomy) | [Big Bang](https://en.wikipedia.org/wiki/Big_Bang), [Cosmic inflation](https://en.wikipedia.org/wiki/Cosmic_inflation), [General relativity](https://en.wikipedia.org/wiki/General_relativity), [Newton's law of universal gravitation](https://en.wikipedia.org/wiki/Newton%27s_law_of_universal_gravitation), [Lambda-CDM model](https://en.wikipedia.org/wiki/Lambda-CDM_model), [Magnetohydrodynamics](https://en.wikipedia.org/wiki/Magnetohydrodynamics) | [Black hole](https://en.wikipedia.org/wiki/Black_hole), [Cosmic background radiation](https://en.wikipedia.org/wiki/Cosmic_background_radiation), [Cosmic string](https://en.wikipedia.org/wiki/Cosmic_string), [Cosmos](https://en.wikipedia.org/wiki/Cosmos), [Dark energy](https://en.wikipedia.org/wiki/Dark_energy), [Dark matter](https://en.wikipedia.org/wiki/Dark_matter), [Galaxy](https://en.wikipedia.org/wiki/Galaxy), [Gravity](https://en.wikipedia.org/wiki/Gravity), [Gravitational radiation](https://en.wikipedia.org/wiki/Gravitational_radiation), [Gravitational singularity](https://en.wikipedia.org/wiki/Gravitational_singularity), [Planet](https://en.wikipedia.org/wiki/Planet), [Solar System](https://en.wikipedia.org/wiki/Solar_System), [Star](https://en.wikipedia.org/wiki/Star), [Supernova](https://en.wikipedia.org/wiki/Supernova), [Universe](https://en.wikipedia.org/wiki/Universe) |
| [Applied Physics](https://en.wikipedia.org/wiki/Applied_Physics) | [Accelerator physics](https://en.wikipedia.org/wiki/Accelerator_physics), [Acoustics](https://en.wikipedia.org/wiki/Acoustics), [Agrophysics](https://en.wikipedia.org/wiki/Agrophysics), [Biophysics](https://en.wikipedia.org/wiki/Biophysics), [Chemical Physics](https://en.wikipedia.org/wiki/Chemical_Physics), [Communication Physics](https://en.wikipedia.org/wiki/Communication_Physics), [Econophysics](https://en.wikipedia.org/wiki/Econophysics), [Engineering physics](https://en.wikipedia.org/wiki/Engineering_physics), [Fluid dynamics](https://en.wikipedia.org/wiki/Fluid_dynamics), [Geophysics](https://en.wikipedia.org/wiki/Geophysics), [Laser Physics](https://en.wikipedia.org/wiki/Laser_Physics), [Materials physics](https://en.wikipedia.org/wiki/Materials_science), [Medical physics](https://en.wikipedia.org/wiki/Medical_physics), [Nanotechnology](https://en.wikipedia.org/wiki/Nanotechnology), [Optics](https://en.wikipedia.org/wiki/Optics), [Optoelectronics](https://en.wikipedia.org/wiki/Optoelectronics), [Photonics](https://en.wikipedia.org/wiki/Photonics), [Photovoltaics](https://en.wikipedia.org/wiki/Photovoltaics), [Physical chemistry](https://en.wikipedia.org/wiki/Physical_chemistry), [Physics of computation](https://en.wikipedia.org/wiki/Physics_of_computation), [Plasma physics](https://en.wikipedia.org/wiki/Plasma_physics), [Solid-state devices](https://en.wikipedia.org/wiki/Solid-state_physics), [Quantum chemistry](https://en.wikipedia.org/wiki/Quantum_chemistry), [Quantum electronics](https://en.wikipedia.org/wiki/Quantum_electronics), [Quantum information science](https://en.wikipedia.org/wiki/Quantum_information_science), [Vehicle dynamics](https://en.wikipedia.org/wiki/Vehicle_dynamics) | | |

**Nuclear and particle physics**

*Main articles:* [*Particle physics*](https://en.wikipedia.org/wiki/Particle_physics) *and* [*Nuclear physics*](https://en.wikipedia.org/wiki/Nuclear_physics)

[](https://en.wikipedia.org/wiki/File:CMS_Higgs-event.jpg)

A simulated event in the CMS detector of the [Large Hadron Collider](https://en.wikipedia.org/wiki/Large_Hadron_Collider), featuring a possible appearance of the [Higgs boson](https://en.wikipedia.org/wiki/Higgs_boson).

[Particle physics](https://en.wikipedia.org/wiki/Particle_physics) is the study of the [elementary](https://en.wikipedia.org/wiki/Elementary_particle) constituents of [matter](https://en.wikipedia.org/wiki/Matter) and [energy](https://en.wikipedia.org/wiki/Energy) and the [interactions](https://en.wikipedia.org/wiki/Fundamental_interaction) between them.[[56]](https://en.wikipedia.org/wiki/Physics#cite_note-aps-dpf-62) In addition, particle physicists design and develop the high energy [accelerators](https://en.wikipedia.org/wiki/Particle_accelerator),[[57]](https://en.wikipedia.org/wiki/Physics#cite_note-halpern2010-63) [detectors](https://en.wikipedia.org/wiki/Particle_detector),[[58]](https://en.wikipedia.org/wiki/Physics#cite_note-grupen1999-64) and [computer programs](https://en.wikipedia.org/wiki/Computational_particle_physics)[[59]](https://en.wikipedia.org/wiki/Physics#cite_note-walsh2012-65) necessary for this research. The field is also called "high-energy physics" because many elementary particles do not occur naturally but are created only during high-energy [collisions](https://en.wikipedia.org/wiki/Collision) of other particles.[[60]](https://en.wikipedia.org/wiki/Physics#cite_note-iop-hepp-66)

Currently, the interactions of elementary particles and [fields](https://en.wikipedia.org/wiki/Field_(physics)) are described by the [Standard Model](https://en.wikipedia.org/wiki/Standard_Model).[[61]](https://en.wikipedia.org/wiki/Physics#cite_note-oerter2006-67) The model accounts for the 12 known particles of matter ([quarks](https://en.wikipedia.org/wiki/Quark) and [leptons](https://en.wikipedia.org/wiki/Lepton)) that interact via the [strong](https://en.wikipedia.org/wiki/Strong_nuclear_force), [weak](https://en.wikipedia.org/wiki/Weak_nuclear_force), and [electromagnetic](https://en.wikipedia.org/wiki/Electromagnetism) [fundamental forces](https://en.wikipedia.org/wiki/Fundamental_force).[[61]](https://en.wikipedia.org/wiki/Physics#cite_note-oerter2006-67) Dynamics are described in terms of matter particles exchanging [gauge bosons](https://en.wikipedia.org/wiki/Gauge_boson) ([gluons](https://en.wikipedia.org/wiki/Gluon), [W and Z bosons](https://en.wikipedia.org/wiki/W_and_Z_bosons), and [photons](https://en.wikipedia.org/wiki/Photon), respectively).[[62]](https://en.wikipedia.org/wiki/Physics#cite_note-gribbin1998-68) The Standard Model also predicts a particle known as the [Higgs boson](https://en.wikipedia.org/wiki/Higgs_boson).[[61]](https://en.wikipedia.org/wiki/Physics#cite_note-oerter2006-67) In July 2012 [CERN](https://en.wikipedia.org/wiki/CERN), the European laboratory for particle physics, announced the detection of a particle consistent with the Higgs boson,[[63]](https://en.wikipedia.org/wiki/Physics#cite_note-eonr-higgs-69) an integral part of a [Higgs mechanism](https://en.wikipedia.org/wiki/Higgs_mechanism).

[Nuclear physics](https://en.wikipedia.org/wiki/Nuclear_physics) is the field of physics that studies the constituents and interactions of [atomic nuclei](https://en.wikipedia.org/wiki/Atomic_nuclei). The most commonly known applications of nuclear physics are [nuclear power](https://en.wikipedia.org/wiki/Nuclear_power) generation and [nuclear weapons](https://en.wikipedia.org/wiki/Nuclear_weapons) technology, but the research has provided application in many fields, including those in [nuclear medicine](https://en.wikipedia.org/wiki/Nuclear_medicine) and [magnetic resonance imaging](https://en.wikipedia.org/wiki/Magnetic_resonance_imaging), [ion implantation](https://en.wikipedia.org/wiki/Ion_implantation) in [materials engineering](https://en.wikipedia.org/wiki/Materials_engineering), and [radiocarbon dating](https://en.wikipedia.org/wiki/Radiocarbon_dating) in [geology](https://en.wikipedia.org/wiki/Geology) and [archaeology](https://en.wikipedia.org/wiki/Archaeology).

**Atomic, molecular, and optical physics**

*Main article:* [*Atomic, molecular, and optical physics*](https://en.wikipedia.org/wiki/Atomic,_molecular,_and_optical_physics)

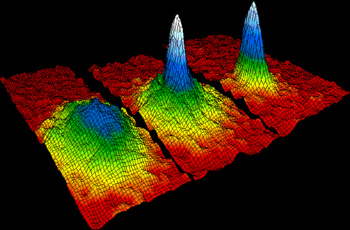
[Atomic](https://en.wikipedia.org/wiki/Atom), [molecular](https://en.wikipedia.org/wiki/Molecule), and [optical](https://en.wikipedia.org/wiki/Optics) physics (AMO) is the study of [matter](https://en.wikipedia.org/wiki/Matter)–matter and [light](https://en.wikipedia.org/wiki/Light)–matter interactions on the scale of single [atoms](https://en.wikipedia.org/wiki/Atom) and molecules. The three areas are grouped together because of their interrelationships, the similarity of methods used, and the commonality of their relevant [energy](https://en.wikipedia.org/wiki/Energy) scales. All three areas include both [classical](https://en.wikipedia.org/wiki/Classical_physics), semi-classical and [quantum](https://en.wikipedia.org/wiki/Quantum_physics) treatments; they can treat their subject from a microscopic view (in contrast to a macroscopic view).

[Atomic physics](https://en.wikipedia.org/wiki/Atomic_physics) studies the [electron](https://en.wikipedia.org/wiki/Electron) shells of [atoms](https://en.wikipedia.org/wiki/Atom). Current research focuses on activities in quantum control, cooling and trapping of atoms and ions,[[64]](https://en.wikipedia.org/wiki/Physics#cite_note-70)[[65]](https://en.wikipedia.org/wiki/Physics#cite_note-71)[[66]](https://en.wikipedia.org/wiki/Physics#cite_note-72) low-temperature collision dynamics and the effects of electron correlation on structure and dynamics. Atomic physics is influenced by the [nucleus](https://en.wikipedia.org/wiki/Atomic_nucleus) (see, e.g., [hyperfine splitting](https://en.wikipedia.org/wiki/Hyperfine_splitting)), but intra-nuclear phenomena such as [fission](https://en.wikipedia.org/wiki/Nuclear_fission) and [fusion](https://en.wikipedia.org/wiki/Nuclear_fusion) are considered part of [nuclear physics](https://en.wikipedia.org/wiki/Nuclear_physics).

[Molecular physics](https://en.wikipedia.org/wiki/Molecular_physics) focuses on multi-atomic structures and their internal and external interactions with matter and light. [Optical physics](https://en.wikipedia.org/wiki/Optical_physics) is distinct from [optics](https://en.wikipedia.org/wiki/Optics) in that it tends to focus not on the control of classical light fields by macroscopic objects but on the fundamental properties of [optical fields](https://en.wikipedia.org/wiki/Optical_field) and their interactions with matter in the microscopic realm.

**Condensed matter physics**

*Main article:* [*Condensed matter physics*](https://en.wikipedia.org/wiki/Condensed_matter_physics)

[](https://en.wikipedia.org/wiki/File:Bose_Einstein_condensate.png)

Velocity-distribution data of a gas of [rubidium](https://en.wikipedia.org/wiki/Rubidium) atoms, confirming the discovery of a new phase of matter, the [Bose–Einstein condensate](https://en.wikipedia.org/wiki/Bose%E2%80%93Einstein_condensate)

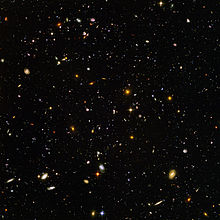
[Condensed matter physics](https://en.wikipedia.org/wiki/Condensed_matter_physics) is the field of physics that deals with the macroscopic physical properties of matter.[[67]](https://en.wikipedia.org/wiki/Physics#cite_note-taylorheinonen2002-73) In particular, it is concerned with the "condensed" [phases](https://en.wikipedia.org/wiki/Phase_(matter)) that appear whenever the number of particles in a system is extremely large and the interactions between them are strong.[[68]](https://en.wikipedia.org/wiki/Physics#cite_note-cohen2008-74)

The most familiar examples of condensed phases are [solids](https://en.wikipedia.org/wiki/Solid-state_physics) and [liquids](https://en.wikipedia.org/wiki/Liquid), which arise from the bonding by way of the [electromagnetic force](https://en.wikipedia.org/wiki/Electromagnetic_force) between [atoms](https://en.wikipedia.org/wiki/Atom).[[69]](https://en.wikipedia.org/wiki/Physics#cite_note-moore2011-75) More exotic condensed phases include the [superfluid](https://en.wikipedia.org/wiki/Superfluid)[[70]](https://en.wikipedia.org/wiki/Physics#cite_note-leggett1999-76) and the [Bose–Einstein condensate](https://en.wikipedia.org/wiki/Bose%E2%80%93Einstein_condensate)[[71]](https://en.wikipedia.org/wiki/Physics#cite_note-levy2001-77) found in certain atomic systems at very low [temperature](https://en.wikipedia.org/wiki/Temperature), the [superconducting](https://en.wikipedia.org/wiki/Superconductivity) phase exhibited by [conduction electrons](https://en.wikipedia.org/wiki/Conduction_electron) in certain materials,[[72]](https://en.wikipedia.org/wiki/Physics#cite_note-stajiccoontzosborne2011-78) and the [ferromagnetic](https://en.wikipedia.org/wiki/Ferromagnet) and [antiferromagnetic](https://en.wikipedia.org/wiki/Antiferromagnet) phases of [spins](https://en.wikipedia.org/wiki/Spin_(physics)) on [atomic lattices](https://en.wikipedia.org/wiki/Crystal_lattice).[[73]](https://en.wikipedia.org/wiki/Physics#cite_note-mattis2006-79)

Condensed matter physics is the largest field of contemporary physics. Historically, condensed matter physics grew out of [solid-state physics](https://en.wikipedia.org/wiki/Solid-state_physics), which is now considered one of its main subfields.[[74]](https://en.wikipedia.org/wiki/Physics#cite_note-aps-dcmp-80) The term *condensed matter physics* was apparently coined by [Philip Anderson](https://en.wikipedia.org/wiki/Philip_Warren_Anderson) when he renamed his research group—previously *solid-state theory*—in 1967.[[75]](https://en.wikipedia.org/wiki/Physics#cite_note-princeton-anderson-81) In 1978, the Division of Solid State Physics of the [American Physical Society](https://en.wikipedia.org/wiki/American_Physical_Society) was renamed as the Division of Condensed Matter Physics.[[74]](https://en.wikipedia.org/wiki/Physics#cite_note-aps-dcmp-80) Condensed matter physics has a large overlap with [chemistry](https://en.wikipedia.org/wiki/Chemistry), [materials science](https://en.wikipedia.org/wiki/Materials_science), [nanotechnology](https://en.wikipedia.org/wiki/Nanotechnology) and [engineering](https://en.wikipedia.org/wiki/Engineering).[[68]](https://en.wikipedia.org/wiki/Physics#cite_note-cohen2008-74)

**Astrophysics**

*Main articles:* [*Astrophysics*](https://en.wikipedia.org/wiki/Astrophysics) *and* [*Physical cosmology*](https://en.wikipedia.org/wiki/Physical_cosmology)

[](https://en.wikipedia.org/wiki/File:Hubble_ultra_deep_field_high_rez_edit1.jpg)

The deepest visible-light image of the [universe](https://en.wikipedia.org/wiki/Universe), the [Hubble Ultra Deep Field](https://en.wikipedia.org/wiki/Hubble_Ultra_Deep_Field)

[Astrophysics](https://en.wikipedia.org/wiki/Astrophysics) and [astronomy](https://en.wikipedia.org/wiki/Astronomy) are the application of the theories and methods of physics to the study of [stellar structure](https://en.wikipedia.org/wiki/Stellar_structure), [stellar evolution](https://en.wikipedia.org/wiki/Stellar_evolution), the origin of the Solar System, and related problems of [cosmology](https://en.wikipedia.org/wiki/Physical_cosmology). Because astrophysics is a broad subject, astrophysicists typically apply many disciplines of physics, including mechanics, electromagnetism, statistical mechanics, thermodynamics, quantum mechanics, relativity, nuclear and particle physics, and atomic and molecular physics.[[76]](https://en.wikipedia.org/wiki/Physics#cite_note-82)

The discovery by [Karl Jansky](https://en.wikipedia.org/wiki/Karl_Jansky) in 1931 that radio signals were emitted by celestial bodies initiated the science of [radio astronomy](https://en.wikipedia.org/wiki/Radio_astronomy). Most recently, the frontiers of astronomy have been expanded by space exploration. Perturbations and interference from the earth's atmosphere make space-based observations necessary for [infrared](https://en.wikipedia.org/wiki/Infrared_astronomy), [ultraviolet](https://en.wikipedia.org/wiki/Ultraviolet_astronomy), [gamma-ray](https://en.wikipedia.org/wiki/Gamma-ray_astronomy), and [X-ray astronomy](https://en.wikipedia.org/wiki/X-ray_astronomy).

[Physical cosmology](https://en.wikipedia.org/wiki/Physical_cosmology) is the study of the formation and evolution of the universe on its largest scales. Albert Einstein's theory of relativity plays a central role in all modern cosmological theories. In the early 20th century, [Hubble](https://en.wikipedia.org/wiki/Edwin_Hubble)'s discovery that the universe is expanding, as shown by the [Hubble diagram](https://en.wikipedia.org/wiki/Hubble_diagram), prompted rival explanations known as the [steady state](https://en.wikipedia.org/wiki/Steady_state_theory) universe and the [Big Bang](https://en.wikipedia.org/wiki/Big_Bang).

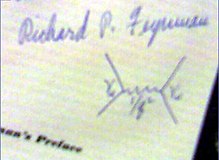
The Big Bang was confirmed by the success of [Big Bang nucleosynthesis](https://en.wikipedia.org/wiki/Big_Bang_nucleosynthesis) and the discovery of the [cosmic microwave background](https://en.wikipedia.org/wiki/Cosmic_microwave_background) in 1964. The Big Bang model rests on two theoretical pillars: Albert Einstein's general relativity and the [cosmological principle](https://en.wikipedia.org/wiki/Cosmological_principle). Cosmologists have recently established the [ΛCDM model](https://en.wikipedia.org/wiki/Lambda-CDM_model) of the evolution of the universe, which includes [cosmic inflation](https://en.wikipedia.org/wiki/Cosmic_inflation), [dark energy](https://en.wikipedia.org/wiki/Dark_energy), and [dark matter](https://en.wikipedia.org/wiki/Dark_matter).

Numerous possibilities and discoveries are anticipated to emerge from new data from the [Fermi Gamma-ray Space Telescope](https://en.wikipedia.org/wiki/Fermi_Gamma-ray_Space_Telescope) over the upcoming decade and vastly revise or clarify existing models of the [universe](https://en.wikipedia.org/wiki/Universe).[[77]](https://en.wikipedia.org/wiki/Physics#cite_note-nasa-glast-83)[[78]](https://en.wikipedia.org/wiki/Physics#cite_note-84) In particular, the potential for a tremendous discovery surrounding dark matter is possible over the next several years.[[79]](https://en.wikipedia.org/wiki/Physics#cite_note-nasa-glast-darkmatter-85) Fermi will search for evidence that dark matter is composed of [weakly interacting massive particles](https://en.wikipedia.org/wiki/Weakly_interacting_massive_particle), complementing similar experiments with the [Large Hadron Collider](https://en.wikipedia.org/wiki/Large_Hadron_Collider) and other underground detectors.

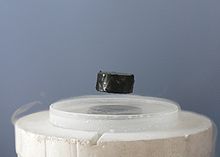
[IBEX](https://en.wikipedia.org/wiki/IBEX) is already yielding new [astrophysical](https://en.wikipedia.org/wiki/Astrophysical) discoveries: "No one knows what is creating the [ENA (energetic neutral atoms)](https://en.wikipedia.org/wiki/Energetic_neutral_atom) ribbon" along the [termination shock](https://en.wikipedia.org/wiki/Termination_shock) of the [solar wind](https://en.wikipedia.org/wiki/Solar_wind), "but everyone agrees that it means the textbook picture of the [heliosphere](https://en.wikipedia.org/wiki/Heliosphere)—in which the Solar System's enveloping pocket filled with the solar wind's charged particles is plowing through the onrushing 'galactic wind' of the interstellar medium in the shape of a comet—is wrong."[[80]](https://en.wikipedia.org/wiki/Physics#cite_note-kerr2009-86)

**Current research**

*Further information:* [*List of unsolved problems in physics*](https://en.wikipedia.org/wiki/List_of_unsolved_problems_in_physics)

[](https://en.wikipedia.org/wiki/File:Feynman%27sDiagram.JPG)

[Feynman diagram](https://en.wikipedia.org/wiki/Feynman_diagram) signed by [R. P. Feynman](https://en.wikipedia.org/wiki/R._P._Feynman).

[](https://en.wikipedia.org/wiki/File:Meissner_effect_p1390048.jpg)

A typical event described by physics: a [magnet](https://en.wikipedia.org/wiki/Magnet) levitating above a [superconductor](https://en.wikipedia.org/wiki/Superconductor) demonstrates the [Meissner effect](https://en.wikipedia.org/wiki/Meissner_effect).

Research in physics is continually progressing on a large number of fronts.

In condensed matter physics, an important unsolved theoretical problem is that of [high-temperature superconductivity](https://en.wikipedia.org/wiki/High-temperature_superconductivity).[[81]](https://en.wikipedia.org/wiki/Physics#cite_note-Legg2006-87) Many condensed matter experiments are aiming to fabricate workable [spintronics](https://en.wikipedia.org/wiki/Spintronics) and [quantum computers](https://en.wikipedia.org/wiki/Quantum_computer).[[68]](https://en.wikipedia.org/wiki/Physics#cite_note-cohen2008-74)[[82]](https://en.wikipedia.org/wiki/Physics#cite_note-88)

In particle physics, the first pieces of experimental evidence for physics beyond the [Standard Model](https://en.wikipedia.org/wiki/Standard_Model) have begun to appear. Foremost among these are indications that [neutrinos](https://en.wikipedia.org/wiki/Neutrino) have non-zero [mass](https://en.wikipedia.org/wiki/Mass). These experimental results appear to have solved the long-standing [solar neutrino problem](https://en.wikipedia.org/wiki/Solar_neutrino_problem), and the physics of massive neutrinos remains an area of active theoretical and experimental research. The [Large Hadron Collider](https://en.wikipedia.org/wiki/Large_Hadron_Collider) has already found the [Higgs Boson](https://en.wikipedia.org/wiki/Higgs_Boson), but future research aims to prove or disprove the [supersymmetry](https://en.wikipedia.org/wiki/Supersymmetry), which extends the Standard Model of particle physics. Research on the nature of the major mysteries of [dark matter](https://en.wikipedia.org/wiki/Dark_matter) and [dark energy](https://en.wikipedia.org/wiki/Dark_energy) is also currently ongoing.[[83]](https://en.wikipedia.org/wiki/Physics#cite_note-89)

Theoretical attempts to unify [quantum mechanics](https://en.wikipedia.org/wiki/Quantum_mechanics) and [general relativity](https://en.wikipedia.org/wiki/General_relativity) into a single theory of [quantum gravity](https://en.wikipedia.org/wiki/Quantum_gravity), a program ongoing for over half a century, have not yet been decisively resolved. The current leading candidates are [M-theory](https://en.wikipedia.org/wiki/M-theory), [superstring theory](https://en.wikipedia.org/wiki/Superstring_theory) and [loop quantum gravity](https://en.wikipedia.org/wiki/Loop_quantum_gravity).

Many [astronomical](https://en.wikipedia.org/wiki/Astronomical) and [cosmological](https://en.wikipedia.org/wiki/Physical_cosmology) phenomena have yet to be satisfactorily explained, including the origin of [ultra-high energy cosmic rays](https://en.wikipedia.org/wiki/GZK_paradox), the [baryon asymmetry](https://en.wikipedia.org/wiki/Baryon_asymmetry), the [acceleration of the universe](https://en.wikipedia.org/wiki/Accelerating_universe) and the [anomalous rotation rates of galaxies](https://en.wikipedia.org/wiki/Galaxy_rotation_problem).

Although much progress has been made in high-energy, [quantum](https://en.wikipedia.org/wiki/Quantum), and astronomical physics, many everyday phenomena involving [complexity](https://en.wikipedia.org/wiki/Complex_systems),[[84]](https://en.wikipedia.org/wiki/Physics#cite_note-nrc1997v9p161-90) [chaos](https://en.wikipedia.org/wiki/Chaos_theory),[[85]](https://en.wikipedia.org/wiki/Physics#cite_note-kellert1993p32-91) or [turbulence](https://en.wikipedia.org/wiki/Turbulence)[[86]](https://en.wikipedia.org/wiki/Physics#cite_note-eames-quoting-feynman-92) are still poorly understood. Complex problems that seem like they could be solved by a clever application of dynamics and mechanics remain unsolved; examples include the formation of sandpiles, nodes in trickling [water](https://en.wikipedia.org/wiki/Water), the shape of water [droplets](https://en.wikipedia.org/wiki/Droplet), mechanisms of [surface tension](https://en.wikipedia.org/wiki/Surface_tension) [catastrophes](https://en.wikipedia.org/wiki/Catastrophe_theory), and self-sorting in shaken heterogeneous collections.[[87]](https://en.wikipedia.org/wiki/Physics#cite_note-93)

These complex phenomena have received growing attention since the 1970s for several reasons, including the availability of modern [mathematical](https://en.wikipedia.org/wiki/Mathematical) methods and [computers](https://en.wikipedia.org/wiki/Computers), which enabled [complex systems](https://en.wikipedia.org/wiki/Complex_systems) to be modeled in new ways. Complex physics has become part of increasingly [interdisciplinary](https://en.wikipedia.org/wiki/Interdisciplinary) research, as exemplified by the study of [turbulence](https://en.wikipedia.org/wiki/Turbulence) in [aerodynamics](https://en.wikipedia.org/wiki/Aerodynamics) and the observation of [pattern formation](https://en.wikipedia.org/wiki/Pattern_formation) in [biological](https://en.wikipedia.org/wiki/Biological) systems. In the 1932 *Annual Review of Fluid Mechanics*, [Horace Lamb](https://en.wikipedia.org/wiki/Horace_Lamb) said:[[88]](https://en.wikipedia.org/wiki/Physics#cite_note-goldstein1969-94)

I am an old man now, and when I die and go to heaven there are two matters on which I hope for enlightenment. One is quantum electrodynamics, and the other is the turbulent motion of fluids. And about the former I am rather optimistic.