# Quantum

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For other uses, see Quantum (disambiguation).

In physics, a **quantum** (pl.: **quanta**) is the minimum amount of any physical entity (physical property) involved in an interaction. Quantum is a discrete quantity of energy proportional in magnitude to the frequency of the radiation it represents. The fundamental notion that a chemical property can be "quantized" is referred to as "the hypothesis of quantization".[1] This means that the magnitude of the physical property can take on only discrete values consisting of integer multiples of one quantum. For example, a photon is a single quantum of light of a specific frequency (or of any other form of electromagnetic radiation). Similarly, the energy of an electron bound within an atom is quantized and can exist only in certain discrete values. (Atoms and matter in general are stable because electrons can exist only at discrete energy levels within an atom.) Quantization is one of the foundations of the much broader physics of quantum mechanics. Quantization of energy and its influence on how energy and matter interact (quantum electrodynamics) is part of the fundamental framework for understanding and describing nature.

## Contents



## Etymology and discovery

The word *quantum* is the neuter singular of the Latin interrogative adjective *quantus*, meaning "how much". "Quanta", the neuter plural, short for "quanta of electricity" (electrons), was used in a 1902 article on the photoelectric effect by Philipp Lenard, who credited Hermann von Helmholtz for using the word in the area of electricity. However, the word *quantum* in general was well known before 1900,[2] e.g. *quantum* was used in E. A. Poe's Loss of Breath. It was often used by physicians, such as in the term *quantum satis*, "the amount which is enough". Both Helmholtz and Julius von Mayer were physicians as well as physicists. Helmholtz used *quantum* with reference to heat in his article[3] on Mayer's work, and the word *quantum* can be found in the formulation of the first law of thermodynamics by Mayer in his letter[4] dated July 24, 1841.

](https://en.wikipedia.org/wiki/File:Max_Planck_(1858-1947).jpg)German Physicist and 1918 Nobel Prize for Physics recipient Max Planck (1858–1947)

In 1901, Max Planck used *quanta* to mean "quanta of matter and electricity",[5] gas, and heat.[6] In 1905, in response to Planck's work and the experimental work of Lenard (who explained his results by using the term *quanta of electricity*), Albert Einstein suggested that radiation existed in spatially localized packets which he called "quanta of light" ("*Lichtquanta*").[7]

The concept of quantization of radiation was discovered in 1900 by Max Planck, who had been trying to understand the emission of radiation from heated objects, known as black-body radiation. By assuming that energy can be absorbed or released only in tiny, differential, discrete packets (which he called "bundles", or "energy elements"),[8] Planck accounted for certain objects changing color when heated.[9] On December 14, 1900, Planck reported his findings to the German Physical Society, and introduced the idea of quantization for the first time as a part of his research on black-body radiation.[10] As a result of his experiments, Planck deduced the numerical value of *h*, known as the Planck constant, and reported more precise values for the unit of electrical charge and the Avogadro–Loschmidt number, the number of real molecules in a mole, to the German Physical Society. After his theory was validated, Planck was awarded the Nobel Prize in Physics for his discovery in 1918.

# Quantization

Main article: Quantization (physics)

While quantization was first discovered in electromagnetic radiation, it describes a fundamental aspect of energy not just restricted to photons.[11] In the attempt to bring theory into agreement with experiment, Max Planck postulated that electromagnetic energy is absorbed or emitted in discrete packets, or quanta.[12]

# See also

- Graviton
- Introduction to quantum mechanics
- Magnetic flux quantum
- Particle
  - Elementary particle
  - Subatomic particle
- Photon polarization
- Qubit
- Quantum cellular automata
- Quantum channel
- Quantum chromodynamics
- Quantum cognition
- Quantum coherence
- Quantum computer
- Quantum cryptography

- Quantum dot
- Quantum electronics
- Quantum entanglement
- Quantum fiction
- Quantum field theory
- Quantum lithography
- Quantum mechanics
- Quantum mind
- Quantum mysticism
- Quantum number
- Quantum optics
- Quantum sensor
- Quantum state
- Quantum suicide and immortality
- Quantum teleportation

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