Topic Page: Particle Physics

Definition: **particle physics** from *The Penguin Dictionary of Science*

The physics of ➤elementary particles and ➤subatomic particles. Particle physics deals with the nature of the particles and interactions between them. The experimental study of particle physics is often known as **high-energy physics**.

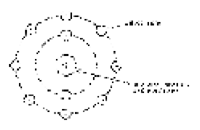

Image from: **Simplified diagram showing the...** in *Newnes Dictionary of Electronics, Newnes*

Summary Article: **particle physics**
From *The Hutchinson Unabridged Encyclopedia with Atlas and Weather Guide*

Study of the particles that make up all atoms, and of their interactions. More than 300 subatomic particles have now been identified by physicists, categorized into several classes according to their mass, electric charge, spin, magnetic moment, and interaction. Subatomic particles include the elementary particles (quarks, leptons, and gauge bosons), which are indivisible, so far as is known, and so may be considered the fundamental units of matter; and the hadrons (baryons, such as the proton and neutron, and mesons), which are composite particles, made up of two or three quarks. Quarks, protons, electrons, and neutrinos are the only stable particles (the neutron being stable only when in the atomic nucleus). The unstable particles decay rapidly into other particles, but can be studied when they are created in experiments with particle accelerators and cosmic radiation. See atomic structure.

Pioneering research took place at the Cavendish Laboratory, Cambridge, England. In 1897 the English physicist J J Thomson discovered that all atoms contain identical, negatively charged particles (electrons), which can relatively easily be freed. By 1911 the New Zealand physicist Ernest Rutherford had shown that the electrons surround a very small, positively charged nucleus. In the case of hydrogen, this was found to consist of a single positively charged particle, a proton. The nuclei of other elements are made up of protons and uncharged particles called neutrons, which were discovered by the English physicist James Chadwick in 1932. The same year saw the discovery of a particle (whose existence had been predicted by the British theoretical physicist Paul Dirac in 1928) with the mass of an electron, but an equal and opposite charge – the positron. This was the first example of antimatter; it is now believed that all particles have corresponding antiparticles. In 1934 the Italian-born US physicist Enrico Fermi argued that a hitherto unsuspected particle, the neutrino, must accompany electrons in beta-emission.

Particles and fundamental forces By the mid-1930s, four types of fundamental force acting between particles had been identified. The electromagnetic force (1) acts between all particles with electric charge, and is related to the exchange between these particles of gauge bosons called photons, packets of electromagnetic radiation. In 1935 the Japanese physicist Hideki Yukawa suggested that the strong nuclear force (2) (binding protons and neutrons together in the nucleus) was transmitted by the exchange of particles with a mass about one-tenth of that of a proton; these particles, called pions (originally pi mesons), were found by the British physicist Cecil Powell in 1946. Yukawa's theory was largely superseded from 1973 by the theory of quantum chromodynamics, which postulates that the strong nuclear force is transmitted by the exchange of gauge bosons called gluons between the quarks and antiquarks making up protons and neutrons. Theoretical work on the weak nuclear force (3) began with Enrico Fermi in the 1930s. The existence of the gauge bosons that carry this force, the W and Z particles, was confirmed in 1983 at CERN, the European nuclear research organization. The fourth fundamental force, gravity (4), is experienced by all matter; the postulated carrier of this force has been named the graviton.

Leptons The electron, muon, tau, and their corresponding neutrinos comprise the leptons – particles with half-integral spin that 'feel' the weak nuclear and electromagnetic force but not the strong force. The muon (found by the US physicist Carl Anderson in cosmic radiation in 1937) produces the muon neutrino when it decays; the tau, a surprise discovery of the 1970s, produces the tau neutrino when it decays.

Mesons and baryons The hadrons (particles that 'feel' the strong nuclear force) are classified into mesons, with whole-number or zero spins, and baryons (which include protons and neutrons), with half-integral spins. It was shown in the early 1960s that if hadrons of the same spin are represented as points on suitable charts, simple patterns are formed. This symmetry enabled a hitherto unknown baryon, the omega-minus, to be predicted from a gap in one of the patterns; it duly turned up in experiments.

Quarks In 1964 the US physicists Murray Gell-Mann and George Zweig suggested that all hadrons were built from three 'flavours' of a new particle with half-integral spin and a charge of magnitude either 1/3 or 2/3 that of an electron; Gell-Mann named the particle the **quark**. Mesons are quark–antiquark pairs (spins either add to one or cancel to zero), and baryons are quark triplets. To account for new mesons such as the J/ψ(J-psi) particle, the number of quark flavours had risen to six by 1985.

In 2003 scientists at the High-Energy Accelerator Research Organization in Tsukuba, Japan, discovered a new particle that could not readily be explained in terms of existing particle theory. The new particle, which the researchers labelled as X(3872), was detected in the decay products of a type of meson called the beauty meson; it weighed as much as a single atom of helium and lasted a billionth of a trillionth of a second (10^{-21} s), an unusually long lifetime for a subatomic particle of this mass. One theory is that the X(3872) is a combination of two mesons, a D and an anti-D*.

It appeared that a new class of subatomic particle made up of five quarks had been created in 2004 at the Hadron–Electron Ring Accelerator in Hamburg, Germany, when beams of electrons and protons were collided. However, by 2010 the consensus was that this 'pentaquark' did not exist.

essays

Antimatter

Neutrino: Discovery

Particle Physics: Future Research

Physics: Neutrinos and Optical Molasses

Quark: The Top Quark at Last

The Top Quark

Understanding the Universe: from Atoms to M Theory

weblinks

European Laboratory for Particle Physics

Particle Physics

APA

Chicago

Harvard

MLA

particle physics. (2018). In Helicon (Ed.), *The Hutchinson unabridged encyclopedia with atlas and weather guide*. Abington, UK: Helicon. Retrieved from https://search.credoreference.com/content/topic/particle_physics

© RM, 2018. All rights reserved.

APA

particle physics. (2018). In Helicon (Ed.), *The Hutchinson unabridged encyclopedia with atlas and weather guide*. Abington, UK: Helicon. Retrieved from https://search.credoreference.com/content/topic/particle_physics

Chicago

"particle physics." In *The Hutchinson Unabridged Encyclopedia with Atlas and Weather Guide*, edited by Helicon. Helicon, 2018. https://search.credoreference.com/content/topic/particle_physics

Harvard

particle physics. (2018). In Helicon (Ed.), *The Hutchinson unabridged encyclopedia with atlas and weather guide*. [Online]. Abington: Helicon. Available from: https://search.credoreference.com/content/topic/particle_physics [Accessed 18 September 2019].

MLA

"particle physics." *The Hutchinson Unabridged Encyclopedia with Atlas and Weather Guide*, edited by Helicon, 2018. *Credo Reference*, https://search.credoreference.com/content/topic/particle_physics. Accessed 18 Sep. 2019.