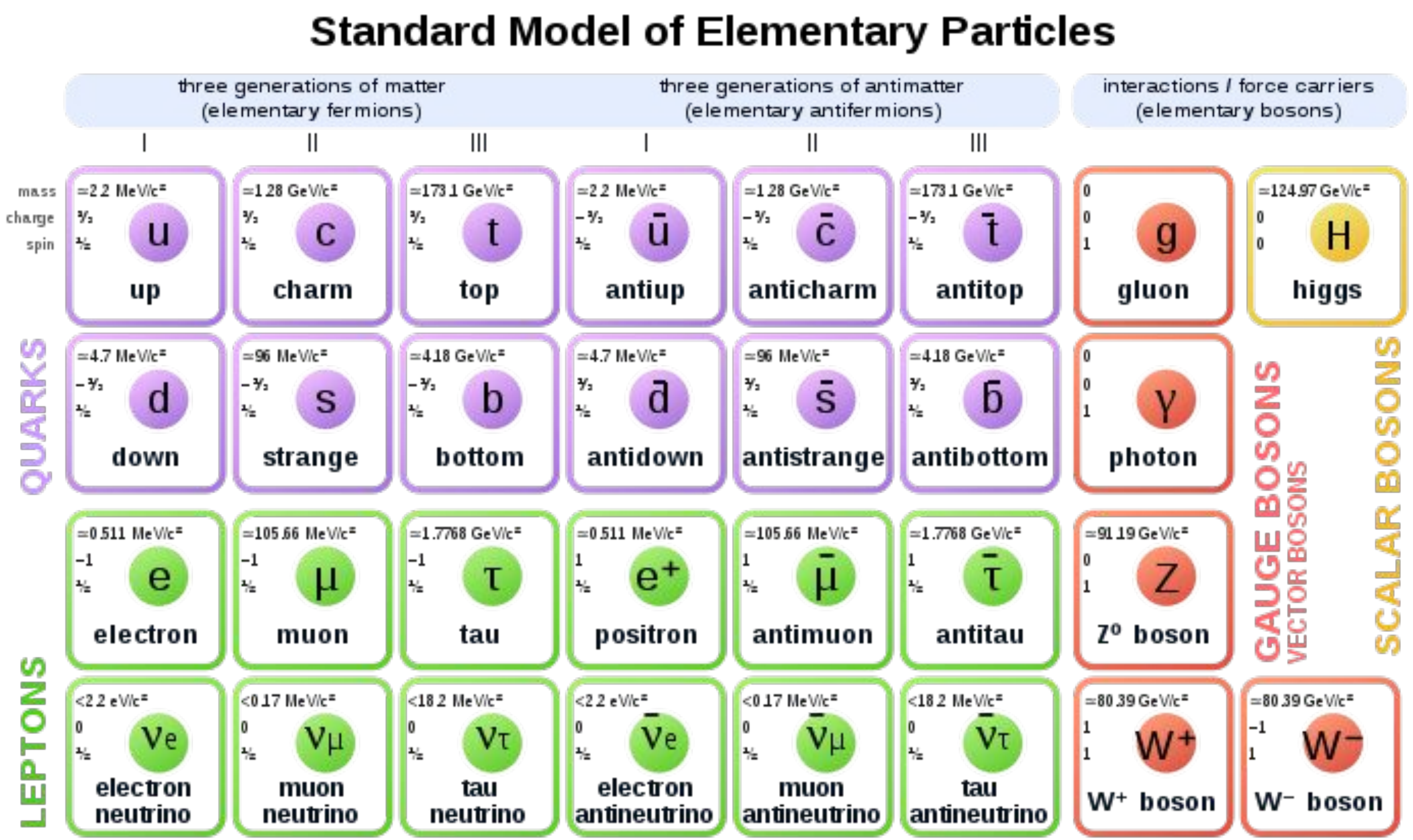
Particle physics

Standard Model

Particles

Standard Model

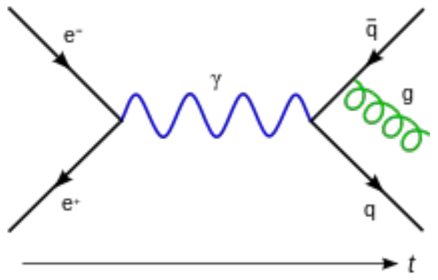
- The current state of the classification of all elementary particles is explained by the Standard Model, gaining widespread acceptance in the mid-1970s after experimental confirmation of the existence of quarks. It describes the strong, weak, and electromagnetic fundamental interactions, using mediating gauge bosons. The species of gauge bosons are eight gluons, W^-, W^+ and Z bosons, and the photon.[4] The Standard Model also contains 24 fundamental fermions (12 particles and their associated anti-particles), which are the constituents of all matter.[8] Finally, the Standard Model also predicted the existence of a type of boson known as the Higgs boson. Early in the morning on 4 July 2012, physicists with the Large Hadron Collider at CERN announced they had found a new particle that behaves similarly to what is expected from the Higgs boson.

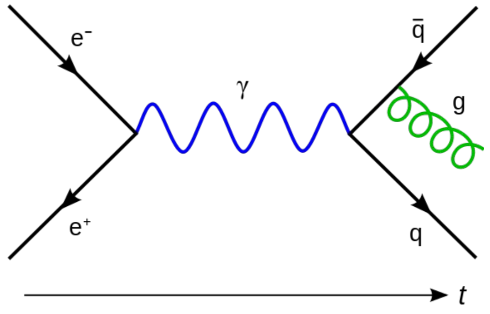


The Standard Model has been found to agree with almost all the experimental tests conducted to date. However, most particle physicists believe that it is an incomplete description of nature and that a more fundamental theory awaits discovery

Theory

Theoretical particle physics attempts to develop the models, theoretical framework, and mathematical tools to understand current experiments and make predictions for future experiments. See also theoretical physics. There are several major interrelated efforts being made in theoretical particle physics today. One important branch attempts to better understand the Standard Model and its tests. By extracting the parameters of the Standard Model, from experiments with less uncertainty, this work probes the limits of the Standard Model and therefore expands our understanding of nature's building blocks. Those efforts are made challenging by the difficulty of calculating quantities in quantum chromodynamics. Some theorists working in this area refer to themselves as phenomenologists and they may use the tools of quantum field theory and effective field theory. Others make use of lattice field theory and call themselves lattice theorists.





Feynman diagrams

Practical applications

In principle, all physics (and practical applications developed therefrom) can be derived from the study of fundamental particles. In practice, even if "particle physics" is taken to mean only "high-energy atom smashers", many technologies have been developed during these pioneering investigations that later find wide uses in society. Particle accelerators are used to produce medical isotopes for research and treatment (for example, isotopes used in PET imaging), or used directly in external beam radiotherapy. The development of superconductors has been pushed forward by their use in particle physics. The World Wide Web and touchscreen technology were initially developed at CERN. Additional applications are found in medicine, national security, industry, computing, science, and workforce development, illustrating a long and growing list of beneficial practical applications with contributions from particle physics.