

Toward a Grand Unified Theory

Ever since Sir Isaac Newton identified the gravitational force, all the forces of nature have come very close to unification in theory. Electricity and magnetism were found to be linked as the same force early in the twentieth century. Then, after gravity and electromagnetism, two more forces were discovered at the beginning of the twentieth century: the “strong” and “weak” nuclear forces of the atomic nucleus.

Whereas the electromagnetic and gravitational forces operate over relatively large distances, the strong and weak nuclear forces operate over distances confined to the diameter of an atom. The strong force holds the individual parts of the nucleus together, and the weak force, through “beta radiation,” is responsible for the decay of the nucleus itself. A subatomic particle called a “neutrino” reacts within the core of the atom and participates in some nuclear reactions. Although neutrinos do not react with mass, they interact with other subnuclear particles through the weak force. Most of the neutrinos that affect Earth are generated in the center of the Sun’s thermonuclear core.



Steven Weinberg. (The Nobel Foundation)

The theory developed by Sheldon Glashow (Born 1932), Abdus Salam (1926-1996), and Steven Weinberg (Born 1933) is called the electroweak theory.

For the first time it precisely detailed the interaction of the electromagnetic (large) force and the weak (small) force. It also stated that the neutrino and the electron are members of the same family of particles; in effect, the neutrino is the electron’s “little brother.” The theory predicted the existence of what are called “neutral currents.” When the electron changes its identity to a neutrino and vice versa, the



Sheldon Glashow. (The Nobel Foundation)

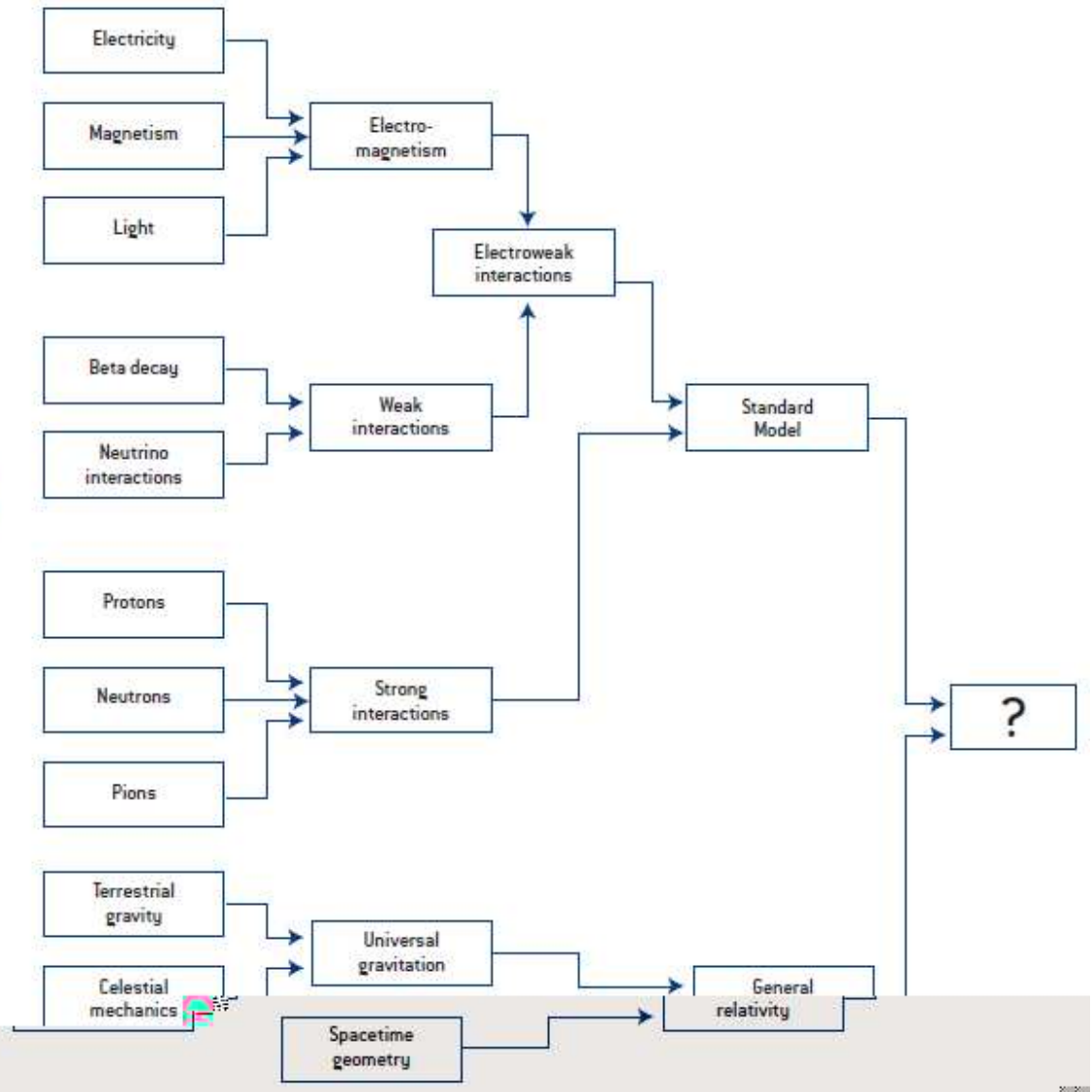


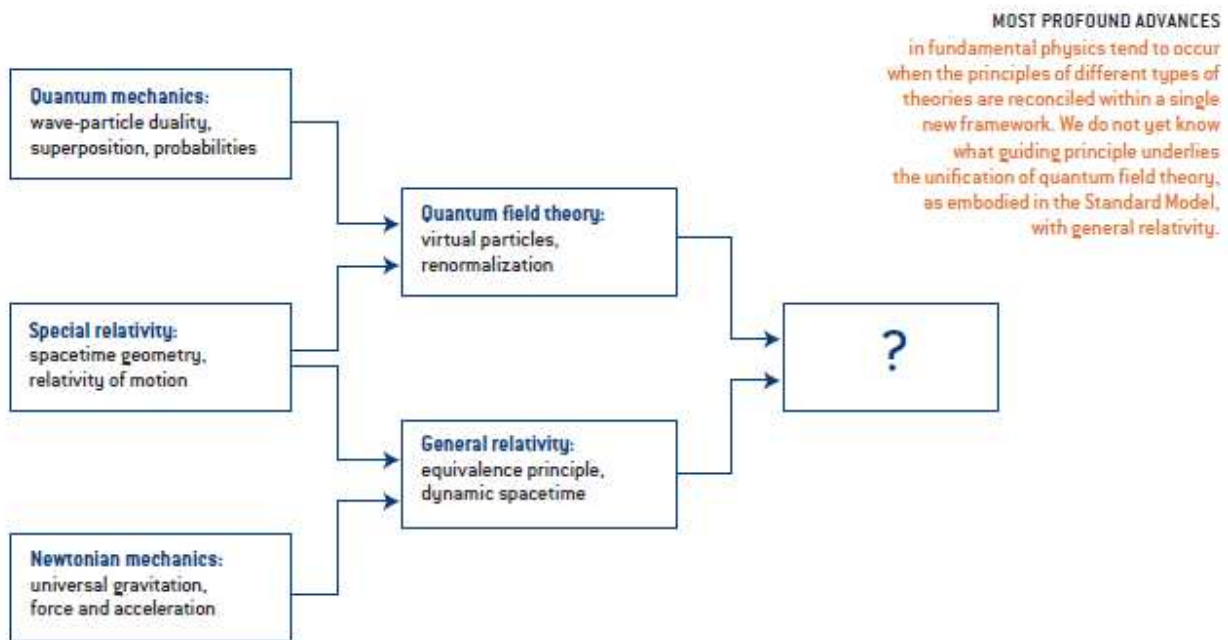
Professor Abdus Salam

theory predicts that a “charged current” will be manifested in advance of the change of charge. Concurrently, a “neutral current” is present as the neutrino “acts without changing identity.”

The unification of all the forces into a single, unified mathematical theory has been a dream of physicists. The development of the electroweak theory brought that “grand unified theory” one step closer to being discovered.

UNIFICATION of disparate phenomena within one theory has long been a central theme of physics. The Standard Model of particle physics successfully describes three (electromagnetism, weak interactions and strong interactions) of the four known forces of nature but remains to be united definitively with general relativity, which governs the force of gravity and the nature of space and time.





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