Contribution ID: **88** Type: **Poster**

New Insights to the Weak Interaction and Quark Model

Tuesday, 5 September 2023 17:30 (2h 10m)

A quark is a subatomic particle, composed of the mass, electric charge, and color charge, the three fundamental elements found in the nature. Among these three fundamental elements, there are four fundamental interactions, which are the gravitational force between masses, the electromagnetic force between electric charges, the strong force between color charges, and the weak force between electric and color charges. Inside a quark, the weak force or interaction between electric and color charges influences and excites the quark, which relaxes and transits from one state to another by emitting a quark-antiquark pair, in analogy to the emission of a photon by an excited electron in an atom. A quark and an antiquark with either the same or different flavors and states combine to form a meson when they couple together via mainly the strong interaction, a charged lepton when they annihilate their color charges and combine their electric charges and masses, a neutrino when they annihilate both their color and electric charges and combine their masses, and a photon or gamma ray when they entirely annihilate all their mass, electric, and color charges. The decay of a particle (e.g. the beta decay of a neutron) with formation of leptons involves one or more quark-antiquark pair emissions and annihilations. This multi-pair quark and antiquark emission and annihilation process establishes a fine structure of the Feynman diagram for the quark decay with lepton formation and indicates the formed leptons as products rather than participants of the weak interaction. This study attempts to fully explain and describe how various possible particles (far more than the discovered so far) are formed, generated, decayed, and interacted via quark excitations, degenerations, pair productions and annihilations. We aim at advancing and developing the standard model of particle physics and quantum chromodynamics in terms of innovatively theorizing the weak interaction as an interaction between electric and color charges and creatively modelling quarks with two flavors and multiple excitations. This quantum science study is partially supported by the IBM-HBCU Quantum Center.

Category

Theory

Collaboration (if applicable)

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Session Classification: Poster Session

Track Classification: New theoretical developments