Why Quarks are Different from Leptons – An Explanation by a Fermionic Substructure of Leptons and Quarks

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To explain the difference between leptons and quarks, it is assumed that electroweak gauge bosons, leptons and quarks are composites of elementary fermionic constituents denoted by partons (not to be identified with quarks) or subfermions, respectively. The dynamical law of these constituents is assumed to be given by a relativistically invariant nonlinear spinor field theory with local interaction, canonical quantization, selfregularization and probability interpretation. According to the general requirements of field operator algebraic theory, this model is formulated in algebraic Schroedinger representation referred to generating functionals in functional state spaces. The derivation of the corresponding effective dynamics for the composite particles is studied by the construction of a map between the spinor field state functionals and the state functionals of the effective theory for gauge bosons, leptons and quarks. A closer examination of this map shows that it is then and then only selfconsistent if certain boundary conditions are satisfied. The latter enforce in the case of electroweak symmetry breaking the difference between lepton and quark states. This difference can be analytically expressed as conditions to be imposed on the wave functions of these composite particles and leads ultimately to the introduction and interpretation of color for quarks, i.e., the characteristic of their strong interaction.

Key words: Substructure of Quarks and Leptons; Effective Dynamics; Difference of Leptons and Quarks.