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Quarks for Hadrons and Leptons

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The simplest, naive, model for a unified description of leptons and hadrons consists in postulating, besides the usual quarks p, n, λ, a fourth quark, with very heavy mass and very high binding to pairs like $\bar{p}n$ and $\bar{p}\lambda$. In a SU(4) scheme the fourth quark has a quantum number charm which may be taken as proportional to the lepton number. Muons would be distinguished from electrons by the occurrence of a λ-quark instead of a n-quark in their structure. The forces among these quarks would have to be such as to give leptons an almost point-like structure at the experimentally known energies as well as absence of strong interactions at these energies. However, one would expect the display of strong interactions by leptons at extremely high energies.

O modelo mais simples, ingênuo, para uma descrição unitária de leptons e hadrons consiste em postular, além dos quarks usuais p, n, λ, um quarto quark l, dotado de massa muito grande e forte ligação a pares do tipo $\bar{p}n$, $\bar{p}\lambda$. Em um esquema SU(4), o quarto quark tem um número quântico "charm" que seria proporcional ao número leptônico. Muons se distinguem de electrons pela ocorrência do quark λ em lugar do quark n. As forças entre os quarks deveriam ser tais a dar aos leptons uma estrutura puntiforme às energias conhecidas bem como ausência de interações fortes entre leptons e entre leptons e hadrons. Contudo, seria de esperar que os leptons apresentassem interações fortes a energias extremamente elevadas.

This paper is a report on an attempt made a few years ago by the author to formulate a unified model of quarks for hadrons and leptons. The model has several difficulties, the most important one being the implication that leptons would be expected to display strong interactions; and that the incorporation of lepton and hadron quarks into a multiplet would lead to a violation of the laws of conservation of baryon and lepton numbers.

These difficulties seem now to be less discouraging than in the past. One finds experimentally that the ratio of the cross section for electron pair annihilation into multihadrons to the cross section for electron pair annihilation into a muon pair increases with the energy[1], which is perhaps an indication that at very high energies electrons have strong interactions. On the other hand, the possible violation of the laws of conservation of lepton number and of baryon has recently been proposed by Salam and Pati[2].