

THE "TOPOLOGICAL" FERMION IN STRONG AND WEAK INTERACTIONS

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In the first lecture we show that there exists limiting mass for the fermion in the chiral σ model at the semiclassical or one fermion loop level. The maximum mass^{1,3}, M_{max}^F , depends exclusively on the vacuum expectation value of the higgs field $\langle\sigma\rangle$. Below a critical value of the Yukawa coupling, g_c , we find the one fermion ground state is Yukawa particle with the mass of the fermion M^F increasing with g . The maximum mass is found to be 782 MeV.

When the fermion is a quark, we find, further, a maximum mass for the colour singlet, three quark composite, the nucleon, $M^N = 1116$ MeV, with a corresponding critical coupling $g_c^N = 4.0$ which is much smaller than $g_c = 8.4$ for a single quark. In the regime $g > g_c^N$ the nucleon is very strongly bound.

For the nucleon composed of three bound quarks ($N_c = 3$), in the neglect of direct QCD interactions, we show, for the first time, how the collective quantization of this quark soliton can be consistently carried out (including Dirac sea effects) and calculate the static properties of the nucleon and find them in reasonable agreement with data².

In the second lecture, we consider the standard electro-weak model for strong Yukawa coupling (higgs-fermion) and weak gauge coupling. We find a similar structure with a maximum mass for the "heavy" quark of 2 TeV and that for the "heavy nucleon" of 3 TeV regardless of the number of generation.

The three quarks colour singlet bound state, the "heavy nucleon" can be very strongly bound in the scheme as opposed to the weak binding mediated by QCD one gluon exchange. As a candidate for new phenomenology at the SSC, we find that the decay of a Δ like excited state of the "heavy nucleon" into "heavy nucleon" and W_L could provide a good observable signature of this scheme.

¹ V. Soni, The Chiral σ Model Fermion - Yukawa or Topological. Proceedings of the 2nd Hellenic School on Elementary Particle Physics, Corfu, Greece (1985)

² V. Soni, Collective Quantization of Quark Solitons with Quarks, Regensburg Preprint, (1985)

³ V. Soni, B. Moussalam and S. Hadjithodoradis, Possible Experimental Signatures of Heavy Quark Physics in the Standard Model, Orsay Preprint 1987, to be submitted for publication.