Impact Of Dynamical Chiral Symmetry Breaking On Meson Struture And Interactions

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Understanding the spectrum of hadrons with masses less than 2 GeV is an essential step toward revealing the essence of light-quark confinement and dynamical chiral symmetry breaking (DCSB) and describing hadron structure in terms of QCD's elementary degrees of freedom. These are basic questions, which define a frontier of contemporary hadron physics, yet there are no reliable Poincaré invariant calculations of this spectrum.

Dynamical chiral symmetry breaking is the most effective mass generating mechanism in the Standard Model of Particle Physics. It is the foundation for a successful application of chiral effective field theories and the origin of constituent-quark masses. Its importance is difficult to over estimate. This presentation will explain the nature and origin of dynamical chiral symmetry breaking, elucidate its consequences, and explain how it can be charted through experiment.

Of particular relevance to this workshop are exciting new developments in the use of Poincaré-covariant Bethe-Salpeter equations in the study of the meson spectrum [1]. An exact form has been derived for the axial-vector Bethe-Salpeter equation, which is valid and usable when the quark-gluon vertex is fully dressed. This has enabled a Ward-Takahashi identity for the Bethe-Salpeter kernel to be derived therefrom and solved for a class of dressed quark-gluon-vertex models. The solution provides a symmetry-preserving closed system of gap and vertex equations. The analysis can be extended to the vector equation and this has enabled a comparison between the responses of pseudoscalar- and scalar meson masses to nonperturbatively dressing the quark-gluon vertex. The result indicates that dynamical chiral symmetry breaking dramatically enhances spin-orbit splitting in the meson spectrum.

Indeed, DCSB *must* have a material impact on the meson spectrum, and especially states with mass greater than 1 GeV, but hitherto there was no way of elucidating that. Now, with this new formulation, that has changed. Indeed, *prima facie* the new formulation has the potential to overcome a longstanding failure of theoretical hadron physics. Namely, no extant hadron spectrum calculation is believable because all symmetry preserving studies produce a splitting between vector and axial-vector mesons that is far too small. We are thus on the verge of realising the first reliable prediction of the meson spectrum.

[1] Lei Chang and Craig D. Roberts, *Sketching the Bethe-Salpeter kernel*, Phys. Rev. Lett. 103 (2009) 081601, arXiv:0903.5461 [nucl-th].

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