Heavy Tetraquark Spectroscopy via Chiral Two-Pion Exchange Potentials

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Abstract

This project proposes developing a theoretical framework for the spectroscopy of fully and doubly heavy tetraquarks (containing c and b quarks) based on effective potentials derived from two-pion exchange in the chiral formalism. The approach leverages the author's expertise in nucleon-nucleon (NN) two-pion exchange potentials, as established in seminal works [1, 2, 3], extending the methodology to the heavy-quark sector via Heavy Quark Spin Symmetry (HQSS) and Heavy Hadron Chiral Perturbation Theory (HHχPT).

The relevance of the theme is underscored by the recent discovery of fully charmed tetraquark candidates by the LHCb, ATLAS, and CMS collaborations [4, 5], which have opened a new window into non-perturbative QCD. The project aims to predict mass spectra, decay widths, and decay channels for tetraquarks with compositions $bbbc$, $cccb$, and $bbcc$, providing theoretical guidance for interpreting current and future LHC data.

The methodology combines: (i) extension of the chiral two-pion exchange NN potentials to the heavy-quark sector using HQSS, (ii) solution of the four-body Schrödinger equation via the correlated Gaussian method [6], and (iii) calculation of decay widths using QCD sum rules. The project envisions the formation of a research group involving undergraduate and graduate students, as well as collaborations with researchers within the INCT-FNA network and possibly international institutions. The expected outcomes include several publications and the consolidation of a new theoretical research line in hadronic spectroscopy at IFSP-SPO.

Keywords: heavy tetraquarks, hadronic spectroscopy, chiral potential, heavy quark spin symmetry, QCD.

References

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