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Neutron to proton mass difference, parton distribution functions and baryon resonances from dynamics on the Lie group u(3)

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Abstract

We present a hamiltonian structure on the Lie group u(3) to describe the baryon spectrum. The ground state is identified with the proton. From this single fit we calculate approximately the relative neutron to proton mass shift to within half a percentage of the experimental value. From the same fit we calculate the nucleon and delta resonance spectrum. For specific spin eigenfunctions we calculate the delta to nucleon mass ratio to within one percent.

We derive parton distribution functions. The distributions are generated by projecting the proton state to space via the exterior derivative on u(3). We predict precise neutron-flavour singlets which should be visible in nuclear diffusion dissociation experiments or in invariant mass spectra of protons and negative pions in B-decays and in photoproduction on neutrons. The presence of such singlets distinguishes experimentally the present model from the standard model as does the prediction of the neutron to proton mass splitting. Conceptually the hamiltonian may describe an effective phenomenology or more radically describe clearer dynamics implying quarks and gluons as projections from u(3) which we then call allopions.

The allospatial hypothesis

It is the hypothesis of the present work, that the eigenstates of the above space and assume the following Hamiltonian

\[ \mathcal{H}_{\text{allospatial}} = \mathcal{H}_{\text{constituent}} + \mathcal{H}_{\text{Coulomb}} \]

\[ \mathcal{H}_{\text{allospatial}} \rightarrow \mathcal{H}_{\text{Coulomb}} - \mathcal{H}_{\text{constituent}} = \mathcal{H}_{\text{allospatial}} \]

We project from a state constructed from spinorial functions to retrace the period doublings implied in the decay to the proton state.

\[ n \rightarrow p \]

Parton distributions

We project from a state constructed from spinorial functions to retrace the period doublings implied in the decay to the proton state.

Conclusions

The allospatial Hamiltonian in (1) or (2) may be seen as an effective phenomenology or interpreted more radically in a conceptual interpretation where we see

Resonances - from space: The impact momentum as strongcoupling operators generate the maximal torus of U(3). Decay, fragmentation, confinement - from allospatial: The momentum form quark on gluon fields.

The model has no fitting parameters except the scale \( \Lambda \).

A quite accurate prediction of the relative neutron to proton mass shift 0.138% follows from approximate solutions to the Schrödinger equation. A projection of states to space is given via the exterior derivatives. This projection has yielded parton distribution functions that compares rather well with those of the proton valence quark distributions already in a first order approximation. A kinematical parametrization for the projection gives a natural transition between a confinement domain where the dynamics unfolds in the global group space and an asymptotic free domain where the allopions approximate the group. A promising ratio between the Q(1320) and F(1520) masses has been calculated based on specific D-functions. We expect the allospatial eigenstructure to project into partial wave amplitude resonances of specific spin and parity via expansions on specific combinations of D-functions. Single neutral flavour resonances are predicted above the free charm threshold of \( m_c \).

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References


Parton distributions

\[ f(x, \nu) = \frac{d^2 \langle P \hat{F}_2(e^+e^-) \rangle}{dx^2 \nu^2} \]

The projection involves the exterior derivative \( d \), operating on \( \mathcal{H}_{\text{allospatial}} \) and allopions.

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Mr. Robert Chang for critical reading of an earlier version of the manuscript. The result we denote as \( \partial \mathcal{H}_{\text{allospatial}} \) (directional derivative)