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Trinhammer, Ole

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

Ole L. Trinhammer.
Department of Physics, Technical University of Denmark (DTU)

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 partition distribution functions. The distributions are generated by projecting the proton state to space via the exterior derivative on u(3). We predict scarce neutron-flavour singlets which should be visible in neutron diffraction dissociation experiments on u(3) invariant mass spectra of protons and negative pions in B-decays and in photoproduction on neutrons. The presence of such single states 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 of particle distribution functions and negative pions in B-decays and in photoproduction on neutrons. 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.

The allospatial hypothesis

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The theory unfolded

The Lapiacean in (1) contains off-diagonal derivatives which are represented by the off-diagonal Gell-Mann matrices. We choose three of these to represent spin and group them into U(3), U(3), U(3). This interpretation is supported by their commutation relations as body fixed angular momentum. The relation between space and allospatial is like the relation in nuclear physics between effective nuclear potentials and their body fixed coordinate symmetries for the description of rotational degrees of freedom. The remaining three are grouped into U(3), U(3), U(3) which is related to hypercharge and isospin. They cancel the algebra by commuting into the subspace of U(3). The fully parametrized Laplacian in polar decomposition reads

\[ \Delta = \sum_{l=1}^{3} \sum_{j=1}^{2} \sum_{k=1}^{3} k_{j}^{2} \theta_{l}^{2} \]

The constant term is interpreted as a curvature potential and the offspatial term is analogous to the centrifugal term in the usual treatment of the radial wave function for the hydrogen atom.

With the periodic potential in (2) we complete Schrödinger equation reads with \( \mu = \hbar / 2m \)

\[ -\Delta U + F \right|_{u(3)} \left[ \theta_{1}, \theta_{2}, \theta_{3} \right] = 2E_{R(u(3))} \left[ \theta_{1}, \theta_{2}, \theta_{3} \right] \]

And a similar factorization of \( \Theta_{1}(\theta_{1}, \theta_{2}, \theta_{3}) \) gives for \( (\theta_{1}, \theta_{2}, \theta_{3}) \) with \( (\theta_{1}, \theta_{2}, \theta_{3}) \):

\[ -\Delta_{u} + F \right|_{u(3)} \left[ \theta_{1}, \theta_{2}, \theta_{3} \right] = 2E_{R(u(3))} \left[ \theta_{1}, \theta_{2}, \theta_{3} \right] \]

The figure shows parametric eigenstates with periodicity 2\( \pi \) to the left and periodicity 4\( \pi \) for the states in the upper right.

We couple a damped periodic doubling in level 2 with an exponentially perturbed doubling in level 1. We explore these coupled period doublings as representing the transformation from a neutral state (e.g. the proton) to a charged state (e.g. the free charm threshold of 2315 MeV).

References

Parton distributions

For three even labels the complex phases factorise out of the neutron mass decrease in the proton decay. Similar states all the states may contribute to neutral states.

Acknowledgments

See also: O. L. Trinhammer, Baryons from parton distributions on the Lie group u(3) arXiv:1109.0792 (Aug 2011).

Conclusions

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

\[ \text{Resonances: from space:} \text{ The impact momentum as stronggauge operators generate the maximal torus of u}(3). \text{Decay, fragmentation, confinement: from allospatial:} \text{The momentum form quark on quark fields.} \]

The hadron has no fitting parameters except the coupling \( \alpha = \hbar / (2\pi) = 2315 \text{ MeV}. \)

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 derivative. This projection has shown to yield parton distribution functions that compares rather well with those of the proton valence quark distributions already in a first order approximation. A phenomenological parameterization 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 algebra approximates the group. A promising ratio between the Q(2250) and (1600) masses has been calculated based on specific C functions. We expect the allospatial eigenstates to project into partial wave amplitude resonances of specific spin and parity via expansions on specific combinations of O-functions. Single neutral flavour resonances are predicted above the free charm threshold of 2315 MeV.

Periodic potential and reduced zone scheme

We interpret the period doublings as related to the creation of the proton charge in the neutron decay. Similar states all the states may contribute to neutral states.

The block dots in the figures show the Bloch wave number choices for the neutron (left) and the proton (right).

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