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

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Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

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Citation (APA):
Trinhammer, O. (2012). Neutron to proton mass difference, parton distribution functions and baryon resonances from dynamics on the Lie group $u(3)$. Poster session presented at Danish Physical Society Annual Meeting 2012, Nyborg, Denmark.
We present a hamiltonian structure on the Lie group $u(3)$ to describe the baryon spectrum. The ground state is identified with the neutron. 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 and parity via expansions on specific combinations of toroidal generators we interpret as resonances.

The Hamiltonian may describe an effective phenomenology or in the domain where the dynamics unfolds in the global group space and an asymptotic free domain where the algebra of the Hamiltonian is described by the exterior derivative. This projection has shown to yield an effective phenomenology or in invariant mass spectra of protons and negative pions in B-decays and in photoproduction on neutrons. The presence of such singlet states distinguishes experimentally the present model from the standard model as does the predictions for the neutron to proton mass splitting. Conceptually the Hamiltonian may describe an effective phenomenology or a medium space with a finite charm threshold of $\mu = 0.15$ TeV.

The theory unfolded

The Laplacian in (1) contains off-diagonal derivatives which are represented by the off-diagonal Gell-Mann matrices. We choose these of three to represent spin and group them into $\bar{u}, u, d, s, c, b$. This interpretation is supported by their commutation relations as body fixed angular momentum. The rotation between space and algebras is like the relation in non-abelian Gell-Mann matrices and complex body fixed coordinate systems for the description of rotational degrees of freedom. The remaining three are grouped into $\bar{u}, u, d, s, c, b$, which is related to hypercharge and isospin. They can be extended by commuting into the subspace of $l$. The fully parametrized Laplacian in polar decomposition reads

$$\Delta = \sum_{k \geq 0} \frac{k^2}{\omega_k^2} \sum_{\ell, j} \mathbf{k}^2 \mathbf{J}_{\ell, j} \mathbf{M}_{\ell, j}$$

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

$$\Delta = \frac{1}{2m} \left( \frac{\partial^2}{\partial r^2} + \frac{1}{r} \frac{\partial}{\partial r} \right)$$

With the periodic potential in (2) we complete Schrödinger equation reads with $E = E/\Lambda$ and $\Lambda = h/\sqrt{2m}$. The result is $\Lambda = 210$ MeV.

$$-\Delta + (2) P_{\text{algebra}}(\theta, \phi) = E \Psi$$

And a similar factorization of $\mathbf{M}_{\ell, j} = \mathbf{M}_{\ell, j} \mathbf{J}_{\ell, j} \mathbf{M}_{\ell, j}$ gives for $\mathbf{M}_{\ell, j} = \mathbf{M}_{\ell, j} \mathbf{J}_{\ell, j} \mathbf{M}_{\ell, j}$

$$-\Delta + (2) P_{\text{algebra}}(\theta, \phi) = 2E \mathbf{R}_{\text{algebra}}(\theta, \phi, \theta, \phi)$$

The figure shows parametric eigenstates with periodicity $2\pi$ to the left and periodicity $4\pi$ for dimensional states in the right column.

We can couple a dimensional periodic doubling in level two with an expanding period doubling in level three. We interpreted these couple periodic doublings as representing the transformation from a neutral state (e.g. the reaction) to a charge state (e.g. the proton).

$$n \rightarrow p$$

We project from a state constructed from parametric functions to return to the original state as discussed in the decay to the proton state.