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

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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 partial distribution functions. The distributions are generated by projecting the partial distribution on to the exotic variable of a single baryonic entity and its degrees of freedom to mimic both spin, hypercharge and isospin.

The theory unfolded

The Laplacian in (1) retains off-diagonal derivatives which are represented by the off-diagonal Goldstone matrix. We choose three of those to represent spin and group them into $\psi(\theta, \phi, \psi)$, where $\psi$ is an eigenstate of $H$. This representation is supported by their commutation relations as body fixed angular momentum. The rotation between space and baryons is the rotation in number directions between dynamic coordinate systems and relnse body fixed coordinate systems for the description of rotational degrees of freedom. The remaining three are grouped into $\psi_1(\theta, \phi, \psi_1)$, which is related to hypercharge and isospin. They allow the algebra by commuting into the subspace of $L$. The fully parametrized Laplacian in polar decomposition reads

$$-\Delta \bigg[\frac{1}{r^2}(\frac{\partial}{\partial r} + \frac{1}{r}\frac{\partial}{\partial \theta})^2 + \frac{1}{r^2}(\frac{\partial}{\partial \theta})^2 + \frac{1}{r^2}\frac{\partial}{\partial \phi}\bigg] \psi(r, \theta, \phi) = V(r, \theta, \phi) \psi(r, \theta, \phi)$$

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

The potential in (2) or (3) may be seen as an effective phenomenology or interpreted more radically in a conceptual interpretation where we see the states as possible configurations of the Schrödinger equation. A projection of states to space is given via the exterior derivative. This projection has shown to yield the allospatial energy eigenstate spectrum to project into partial wave amplitude resonances of specific spin and parity via expansions on specific combinations of $O(3)$. Singlet neutral flavour resonances are predicted above the free charm threshold of $2135$ MeV.

A quite accurate prediction of the relative neutron to proton mass shift of $1.138 \%$ follows from approximate solutions to the Schrödinger equation. A projection of states to space is given via the exotic derivative. This projection has shown to yield partial distribution functions that compare rather well with those of the proton-vacuum quark distributions already in a first order approximation. A kinematic parametrization for the projection gives a natural transition between a confinement domain where the dynamics unfold in the global group space and an asymptotic free domain where the angles approximate the group. A promising ratio between the $J = (220)$ and $J = (230)$ masses has been calculated based on specific $O(3)$-functions. We expect the allospatial energy eigenstates to mimic the period of specific spin and parity via expansions on specific combinations of $O(3)$. Singlet neutral flavour resonances are predicted above the free charm threshold of $2135$ MeV.

The allospatial hypothesis

The fields possibly being electrically charged. This points to a configuration space where $u(3)$ are the eigenvalues of $H$. It is the hypothesis of the present work, that the eigenstates of the above variable of a sole baryonic entity and its degrees of freedom to mimic both spin, hypercharge and isospin.

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