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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 partial 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 singles which should be visible in neutrino diffusion dissociation experiments in or in 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 their prediction on the neutron to proton mass splitting. Conceptually the hamiltonian may describe an effective phenomenology or more radically describe interior dynamics implying quarks and gluons as projections from $u(3)$ which we then call allospase.

The Hamiltonian has no fitting parameters except the scale $\alpha$. A fit to $\alpha$ is performed to the free charm threshold.

A quite accurate prediction of the relative neutron to proton mass shift $1.13847\%$ 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-neutron 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 unravels in the global group space and an asymptotic free domain where the algebra approximates the group. A promising ratio between the $\Delta (1232)$ and $\Delta (1520)$ masses has been calculated based on specific $\Delta$-functions. We expect the allospatial eigenfunctions 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 $1.210 MeV$.

The allosspatial hypothesis

We wish to generate projection fields transforming under the SU(3) algebra with the Schrödinger equation describe the baryon spectrum with $\epsilon_{ji}$ the delta between $e_j$ and $e_i$. We predict scarce neutral flavour singlets which should be visible in neutron diffraction dissociation $\text{np} \rightarrow \text{n} + \text{p}$. 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 theory unfolded

The Laplacian 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 $\lambda_i, i = 1, \ldots, 3$. The interpretation is supported by their commutation relations as body fixed angular momentum. The relation between space and allospase is like the relation in number theory between two sets of number systems and relates body fixed coordinate systems for the description of rotational degrees of freedom. The remaining three are grouped into $\lambda_{i+3}, i = 1, \ldots, 3$, which is related to hypercharge and isospin. They correct the algebra by commuting into the subspace of $k_l$. The fully parametrized Laplacian in polar decomposition reads

$$\Delta = \sum_{i=1}^{3} \frac{\partial^2}{\partial \lambda_i^2} + \sum_{j=1}^{3} \frac{\partial^2}{\partial \lambda_j^2}$$

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

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

With the periodic potential in (2) we complete Schrödinger equation reads with $E = E_i$ and $\lambda_i = \lambda_i / \alpha = 210 MeV$.

$$\left[ -\Delta + E_i \right] \phi_{\lambda_i} (\phi_{\lambda_i} + \lambda_i \phi_{\lambda_i}) = (\phi_{\lambda_i} + \lambda_i \phi_{\lambda_i})$$

And a similar factorization of $\lambda_i + \Delta_i + F_i \phi_{\lambda_i}$ gives for $\lambda_i + \Delta_i + F_i \phi_{\lambda_i}$, with $\lambda_i + \Delta_i + F_i \phi_{\lambda_i} = 0$.

$$-\Delta_i + F_i \phi_{\lambda_i} (\phi_{\lambda_i} + \lambda_i \phi_{\lambda_i}) = 2 E_i \phi_{\lambda_i} (\phi_{\lambda_i} + \lambda_i \phi_{\lambda_i})$$

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

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

For three even labels we interpret as double charge resonances, for three odd labels we interpret as a massless fermion. The black dots in the figures show the Bloch wave number choices for the neutron (left) and the proton state (right).

Periodic potential and reduced zone scheme

We interpret the period doubling as related to the creation of the proton charge in the neutron decay. Similar states all the states may contribute to neutral states. For three even labels gives possibilities of double charge which we interpret as $\Lambda$ resonances.

Conclusions

The allospatial Hamiltonian in (1) or (3) may be seen as an effective phenomenology or interpreted more radically in a conceptual interpretation where we see the resonance - space; The impact momentum as stronglooping operators generate the maximal torus of $u(3)$.

Decay, fragmentation, confinement – from allospase: The moment form induces quark on glaukons.

The Hamiltonian has no fitting parameters except the scale $\alpha$. A fit to $\alpha$ is performed to the free charm threshold. A quite accurate prediction of the relative neutron to proton mass shift $1.13847\%$ 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-neutron 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 unravels in the global group space and an asymptotic free domain where the algebra approximates the group. A promising ratio between the $\Delta (1232)$ and $\Delta (1520)$ masses has been calculated based on specific $\Delta$-functions. We expect the allospatial eigenfunctions 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 $1.210 MeV$.

References

Parton distributions

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

$$f(x, Q^2) \sim f(x_{\Lambda}, Q^2) + f(x_{\Lambda}, Q^2)$$

The projection involves the exterior derivative $d$ on $u(3)$ acting on the $u(3)$ generators. The result we denote as $\text{p} (\text{directional derivative)}$

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