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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 the Lie group. We predict scarce neutral flavour singlets which should be visible in neutron diffraction dissociation of the neutron to 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 and parity via expansions on specific combinations of Clebsch-Gordan coefficients, we interpret the baryon as a projection from the algebra u(3) which we then call allospace.

The allospatial hypothesis
We work to generate projections from transforming under the u(3) algebra on eigenstates of the Pauli principle. We define a group space containing both su(3) and u(1). Thus we choose the Lie group u(3) as configuration space and assume the following Hamiltonian on it

The potential is half the squared geodetic distance from the ‘point’ alleged N-states and approximate solutions for both alleged N-states and their derivatives on u(3). We predict scarce neutral flavour singlets which should be visible in neutron diffraction dissociation of the neutron to 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 and parity via expansions on specific combinations of Clebsch-Gordan coefficients, we interpret the baryon as a projection from the algebra u(3) which we then call allospace.

The theory unfolded
The Laplacian in (1) contains off-diagonal derivatives which are represented by the off-diagonal Goldstone modes. We introduce three of these to represent spin and group them into h, i, e, j. This interpretation is supported by their commutation relations as body fixed angular momentum. The relation between space and allospace is like the relation in number theory between two disjoint number systems and relics of body fixed coordinate systems for the description of rotational degrees of freedom. The remaining three are grouped into N, v(u, v, v) - which is related to hypercharge and isospin. These connect the algebra by commuting into the subspace of u. The fully parametrized Laplacian in polar decompacton reads

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.

The potential in (2) is a complete Schrödinger equation reads with E = E/λ and λ = h/c = 210 MeV

And a similar factorization of \( \mathcal{H}(\theta_1, \theta_2, \theta_3) \) gives for \( \Theta(\Theta) \) with on-shell \( \Theta(\Theta) \) does not change

≈ \( \mathcal{E}_i \mathcal{H}(\theta_1, \theta_2, \theta_3) = 2\mathcal{E} \mathcal{H}(\theta_1, \theta_2, \theta_3) \)

where \( \mathcal{E}_i \) and \( \mathcal{E}_f \) are determined from parametric eigenvalues

The figure shows parametric eigenvalues with periodicity 2π to the left and periodicity π for vanishing states in the right column.

We can couple a dimensionless period doubling in level two with an augmenting period doubling in level one. We interpret these coupled period doublings as representing the transformation from a neutral state (e.g. the proton) to a charged state (e.g. the proton). We project from a state constructed from trigonometric functions to minic the period doublings implied in the decay to the proton state.

Parton distributions
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References

Acknowledgments
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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 the baryon as a projection from the Lie group u(3) which we then call allospace.

Resonances - from space: The impact momentum as strangeness operators generate the maximal torus of u(3) to the weak decay of the neutron. Fragmentation, confinement – from allospace: The momentum form induces quark on gluon fields.

The field has no fitting parameters except the scale, \( A = h/c = 210 \text{MeV} \).

A quite accurate prediction of the relative neutron to proton mass shift of 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 compare 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 unfold in the global group space and an asymptotic free domain where the algebra approximates the group. A promising ratio between the O(320) and H(300) masses has been calculated based on specific D-functions. We expect the allospatial eigenvalues to project into partial wave amplitude resonances of specific spin and parity via expansions on specific combinations of Clebsch-Gordan coefficients. Singlet neutral flavour resonances are predicted above the free charm threshold of \( 1.2 \times 10^{11} \text{MeV} \).

Periodic potential and reduced zone scheme
The black dots in the figures show the Bloch wave number choices for the neutron (left) and the proton (right). For three even labels the complex phases factorize out and the potential.

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, with one even label give the N resonances.

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