Baryon Wave Functions and Form Factors within a Manifestly Covariant Separable Bethe-Salpeter Formalism

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In current experiments at energies and momentum transfers beyond 1 GeV/c, relativistic effects play a crucial role. Their inclusion for bound systems is in general rather complicated due to 4 dynamical generators of the Poincaré group in the instant form, among them the Lorentz boosts, which involve explicitly the interaction among the bound constituents [1]. In this contribution we approach the problem in a covariant, but simplistic way: we study bound systems in the framework of the manifestly covariant Bethe-Salpeter equation [2], but introduce towards practical applications two severe simplifications: we start out from simple phenomenological interaction kernels together with an integration over retardation effects.
Explicitly we address two problems:
- Lorentz boosts for bound baryons: We derive covariant baryon wave functions for arbitrary Lorentz boosts. Modeling baryons as quark-diquark systems, we reduce their manifestly covariant Bethe-Salpeter equation to a covariant 3-dimensional form by projecting on the relative quark-diquark energy. Guided by a phenomenological multigluon exchange representation of a covariant confining kernel, we derive explicit solutions for harmonic confinement and for the MIT Bag Model. Investigated in particular are the interplay of center-of-mass correlations with the quenching of bound states and the admixture of $l \neq 0$ angular momentum components in the nucleon ground state due to the deformation of the nucleon bag [3];
- Covariant Meson-Nucleon Vertices: For given quark-diquark wave functions of basically separable form we construct the strong λNN vertices for different mesons λ in the impulse approximation for a covariant representation of form factors via s,t,u Mandelstam variables. Analytical solutions with increasing order in the momentum transfers are developed upon an appropriate expansion of the scalar products in the denominators, following a Wick-rotation to Euclidean space. The main goal of the investigation is a simple, however, covariant and unifying representation of from factors in different domains of the analytical scattering plane.
We expect to improve the most crucial problems in our approach, the parametrization the confining kernel, from recent progress in QCD [4].

References

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