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An approach to QCD bound states

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Light hadrons are relativistic, strongly bound states with large gluon and sea quark distributions. Interestingly, hadrons also have properties akin to non-relativistic atoms, despite confinement and chiral symmetry breaking. Hadron quantum numbers appear to be determined by the valence quarks only. The quark model is quite successful, especially for quarkonia. The OZI rule and duality provide further clues to hadron dynamics.

The understanding of bound states developed gradually in QED. NRQED provides an efficient expansion in the rest frame, where solutions of the Schr\"odinger equation appear at lowest order. Various forms of the Bethe-Salpeter equation define equivalent, alternative approaches. Bound state perturbation theory is not unique since atomic wave functions are exponential, gauge dependent functions of the coupling α. However, all approaches must give the same perturbative series for the (measurable) binding energies.

The Schr\"odinger equation defines a "bound state Born term" in an $\hbar$ expansion of QED, where the classical fields of the constituents provide the binding. The instantaneous nature of the A^0 gauge field allows a corresponding Born approximation also for relativistic bound states in QCD. Poincar\'e invariance implies a linear confining potential when a non-vanishing boundary condition is imposed on the classical solutions of Gauss' law for A_a^0. The boundary condition defines the \order{\alpha_s^0} dimensionful constant Λ_{QCD}, and a perturbative expansion around the Born term may be envisaged. I describe some results obtained in such an approach to hadrons.

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