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Nucleon structure and spectroscopy from lattice QCD

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One of the great challenges in our quest to understand QCD is to deduce the spectrum of excited hadronic states predicted by QCD and to compare the properties of those states against experimental evidence. Although great progress is being made in the development of sophisticated models which incorporate many of the known properties of QCD, lattice QCD is the only rigorous way known to solve QCD itself. While for ground states lattice QCD has recently achieved great success, the situation is far more complicated for excited states. In particular, on the lattice the eigenstates are stable, whereas in the real world they may decay into multiple hadronic channels. The approach of Luescher relates energy levels measured on the lattice to phase shifts when there is a single open channel but the generalizations to more realistic cases with multiple open channels are highly non-trivial in that treatment. We review recent work based on a Hamiltonian treatment of the resonant state and its coupled channels on the lattice, showing that it appears to provide a very promising and cost effective alternative method for extracting physical properties from lattice simulations.