Hadron wave functions in Lattice QCD

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Theoretical and algorithmic developments as well as availability of faster computers have led, over the last few years, to notable progress, in spectroscopic calculations as well as in the understanding of the QCD phase structure within lattice QCD. Given these developments, there is a need to systematically advance our understanding of the structure of hadrons beyond spectrum calculations. Wave functions encode important information on hadron structure not directly available from the study of one-body observables. Via the study of gauge invariant hadronic two- and three- density correlators we extract information on the spatial distributions of quarks in hadrons, and of the shape and multipole moments of hadrons. Such information can be used to discriminate among various phenomenological models as well as to construct variational wave functions.
In Figs. 1 and 2 we show the square of the wave function for the pion and the rho computed in the quenched approximation with quarks of mass ~ 130 MeV. The spatial lattice size is 1.5 fm. We obtain similar results for the nucleon and the Δ.

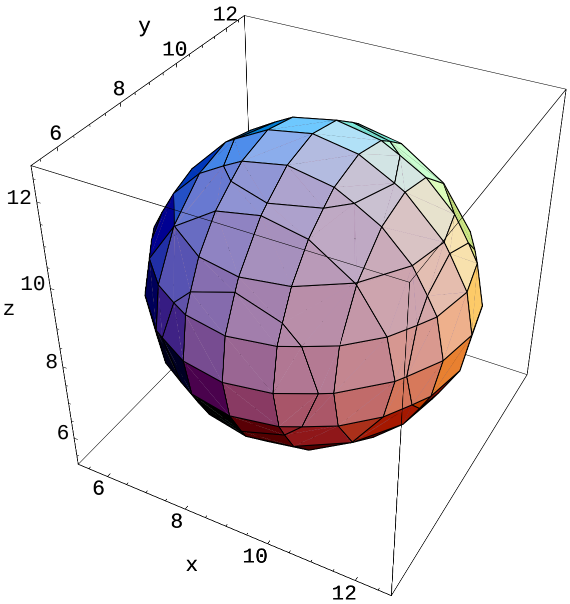

Figure 1: $|\psi(\mathbf{x})|^2$ for the pion

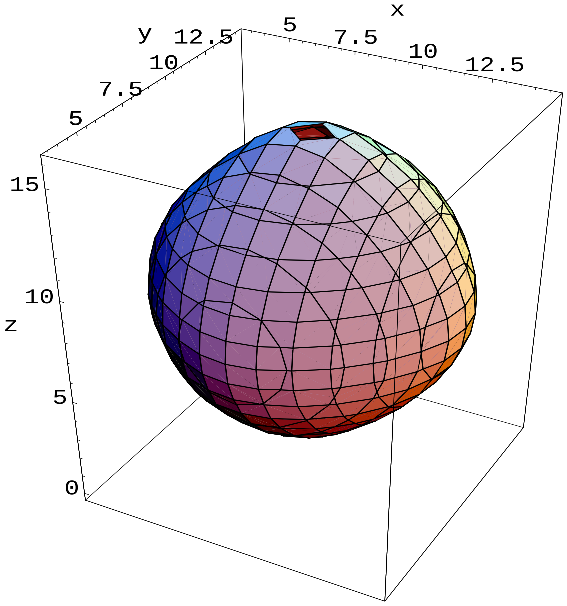

Figure 2: $|\psi(\mathbf{x})|^2$ for the rho