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Lattice QCD sprectrum of excited states of the nucleon[1]

STEPHEN WALLACE, Dept. of Physics, Univ. of Maryland, College Park

Lattice QCD results are presented for the spectrum of excited states of the nucleon. Matrices of correlation functions are calculated using lattice operators that incorporate up to two covariant derivatives in combinations that transform according to SU(2) symmetry restricted to the lattice. Although the lattice has cubic symmetry, identification of continuum SU(2) spins is straightforward using such operators. Overlaps of the operators with the lattice QCD states obtained by diagonalizing matrices of correlation functions provide the link of continuum spins to lattice states. Spins up to 7/2 are identified clearly. Evidence for an approximate realization of rotational symmetry in the spectrum is presented, which helps to explain why the continuum spins can be identified. In lattice simulations with pion mass equal to 392 MeV, the low-lying excited states of lattice QCD are found to have the same spin quantum numbers as the states of SU(6)xO(3) symmetry. The lattice QCD spectra are inconsistent with either a quark-diquark model or parity doubling of states. They suggest that the Roper resonance may have a complex structure consisting of contributions from L=0, 1 and 2.

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