Scattering phase shifts and the spectrum of excited states in lattice QCD using the stochastic LapH method

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ABSTRACT
Our first results for the mass spectrum of excited mesons and light meson scattering phase shifts are presented. Our results are obtained from the temporal correlations of quantum-field operators in quantum chromodynamics (QCD). The correlations are determined using Markov-chain Monte Carlo estimates of QCD path integrals formulated on an anisotropic space-time lattice. To reliably determine the excited states of interest, we use both single-hadron and multi-hadron operators for the first time. A new stochastic method of treating the low-lying modes of quark propagation which exploits a new procedure for spatially-smearing quark fields, known as Laplacian Heaviside smearing, makes such calculations possible for the first time. Our results are obtained using $24^3 \times 128$ and $32^3 \times 256$ anisotropic lattices. The method provides reliable estimates of all needed correlations, even those that are particularly difficult to compute, such as $\eta \eta \to \eta \eta$ in the scalar channel, which involves the subtraction of a large vacuum expectation value. A new glueball operator is introduced, and computing the mixing of this glueball operator with a quark-antiquark operator, $\pi \pi$, and $\eta \eta$ operators is shown to be feasible.

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2. REFERENCES