

# 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  $\eta\eta \rightarrow \eta\eta$  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.

## Categories and Subject Descriptors

J.2 [Physical Sciences and Engineering]: Physics

## General Terms

Algorithms

## Keywords

ACM proceedings, Lattice QCD, Monte Carlo simulations, Hadron Physics

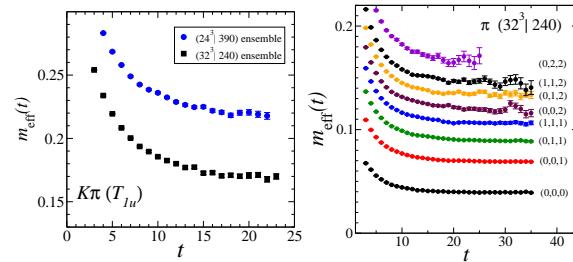


Figure 1: (Left) Effective mass of kaon-pion pair in a  $P$ -wave. (Right) Effective masses of pion with various momenta.

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## 2. REFERENCES

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