Contribution ID: **161** Type: **Parallel contribution**

A new algorithm to estimate quark propagation in Lattice QCD

Friday, August 12, 2011 9:10 AM (20 minutes)

A new algorithm ("stochastic LapH") for computing hadronic correlation functions in Lattice QCD will be presented. Lattice QCD is a framework in which the nonperturbative, first principles computation of hadronic correlation functions is possible. It requires a lattice regulation of QCD in a finite Euclidean space-time where correlation functions are evaluated numerically via Monte-Carlo integration methods. The asymptotic behaviour of correlation functions in Euclidan time is then used to extract the energies of the hadronic states of interest.

This approach of computing correlation functions becomes numerically very challenging as one attempts to evaluate multi-hadron correlators and disconnected diagrams due to the rapid increase in the number of quark propagators involved in the calculation. Each quark propagator is obtained from an inversion of the 4-dimensional Dirac matrix in a finite, but large volume. Disconnected diagrams (quark loop diagrams) are particularly problematic because they require quark propagators from every point on a timeslice to every other point on the same timeslice, for all timeslices of the lattice.

The cost of inverting the Dirac matrix, in terms of CPU cycles, increases as the quark mass being simulated approaches the physical values and the space-time volume is enlarged to reduce the finite size effects. It is not possible to compute these "all-to-all" quark propagators with the current resources available which limits the physics that can be addressed in Lattice QCD.

The standard solution is to stochastically estimate the all-to-all propagators with random noise sources. This method, however, introduces a lot of noise into the calculation which is reduced by performing more and more inversions. The stochastic LapH algorithm for inverting quark propagators solves this "using noise to cancel noise" approach by first reducing the space by cutting out the high frequencies (LapH) and then introducing noise sources in the LapH subspace.

The usual volume scaling problems of all-to-all algorithms are absent in this method and the judicious choice of noise-dilution schemes makes the algorithm practical for real simulations near physical values of the quark masses. The signal for selected correlation functions will be shown to demonstrate the efficacy of the algorithm.

Primary author: Prof. JUGE, Keisuke (University of the Pacific)

Co-authors: Prof. MORNINGSTAR, Colin (Carnegie Mellon Univ.); Mr LENKNER, David (Carnegie Mellon Univ); Dr BULAVA, John (DESY Zeuthen); Dr FOLEY, Justin (University of Utah); Dr PEARDON, Michael (Trinity College Dublin); Mr WONG, Ricky (Carnegie Mellon Univ)

Presenter: Prof. JUGE, Keisuke (University of the Pacific)

Session Classification: Hadron Spectroscopy

Track Classification: Hadron Spectroscopy