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Local Adaptive Refinement on Lattice Gauge Fields

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Adaptive Mesh Refinement (AMR) has been widely used in computational fluid dynamics, shock hydrodynamics, astrophysics, turbulence modeling and combustion to improve the performance of algorithms running large, complex problems. The results are often impressive. However, for various reasons which will be discussed, traditional AMR is not directly applicable to lattice QCD. This talk proposes a new numerical method, Local Adaptive Refinement (LAR), for lattice QCD.
LAR is strongly motivated by AMR, and is designed to work with the aggregation-based algebraic multigrid framework of lattice QCD. The premise behind all adaptive refinement methods is that certain numerical problems have solutions that exhibit local variations, which can be examined more fully at higher resolution (more closely spaced grid or lattice points) than the base level of
resolution used for the simulation. As a result, problems that would normally require very high resolution over a large domain (which is very computationally expensive) could instead be solved at lower resolution over the large domain, with automated local refinement to higher resolution as needed. The scale and nature of the problems commonly found at the leading edge of today's lattice QCD work suggest that the field could be a benefit from adaptive refinement. Among the topics that will be discussed are the need for an algebraic variable-based approach to refinement, as opposed to a geometric grid-based approach, methods of determining the regions in which refinement should occur, and ways to implement LAR in a parallel machine environment.

Title

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