Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Spatial and temporal accuracy of asynchrony-tolerant finite difference schemes for partial differential equations at extreme scales[1] KOMAL KUMARI, DIEGO DONZIS, Texas A&M University — Highly resolved computational simulations on massively parallel machines are critical in understanding the physics of a vast number of complex phenomena in nature governed by partial differential equations. Simulations at extreme levels of parallelism present many challenges with communication between processing elements (PEs) being a major bottleneck. In order to fully exploit the computational power of exascale machines one needs to devise numerical schemes that relax global synchronizations across PEs. This asynchronous computations, however, have a degrading effect on the accuracy of standard numerical schemes.We have developed asynchrony-tolerant (AT) schemes that maintain order of accuracy despite relaxed communications. We show, analytically and numerically, that these schemes retain their numerical properties with multi-step higher order temporal Runge-Kutta schemes. We also show that for a range of optimized parameters,the computation time and error for AT schemes is less than their synchronous counterpart. Stability of the AT schemes which depends upon history and random nature of delays, are also discussed.

[1]Support from NSF is gratefully acknowledged.

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Date submitted: 01 Aug 2017

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