Abstract Submitted
for the DAMOP17 Meeting of
The American Physical Society

Simulation of Quantum Many-Body Dynamics for Generic Strongly-Interacting Systems GREGORY MEYER, FRANCISCO MACHADO, NORMAN YAO, University of California – Berkeley — Recent experimental advances have enabled the bottom-up assembly of complex, strongly interacting quantum many-body systems from individual atoms, ions, molecules and photons. These advances open the door to studying dynamics in isolated quantum systems as well as the possibility of realizing novel out-of-equilibrium phases of matter. Numerical studies provide insight into these systems; however, computational time and memory usage limit common numerical methods such as exact diagonalization to relatively small Hilbert spaces of dimension $\sim 2^{15}$. Here we present progress toward a new software package for dynamical time evolution of large generic quantum systems on massively parallel computing architectures. By projecting large sparse Hamiltonians into a much smaller Krylov subspace, we are able to compute the evolution of strongly interacting systems with Hilbert space dimension nearing 2^{30}. We discuss and benchmark different design implementations, such as matrix-free methods and GPU based calculations, using both pre-thermal time crystals and the Sachdev-Ye-Kitaev model as examples. We also include a simple symbolic language to describe generic Hamiltonians, allowing simulation of diverse quantum systems without any modification of the underlying C and Fortran code.

Gregory Meyer
University of California – Berkeley

Date submitted: 29 Jan 2017 Electronic form version 1.4