MAR14-2013-020618

Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

Recent progress in quantum simulation with trapped ions[1]

JAMES FREERICKS, Georgetown University

Quantum emulation of the transverse field Ising model has made significant progress recently. Ions are placed in a trap and then have an optical spin-dependent force applied to them which generates an effective spin-spin interaction between the different ions. The spin-spin interaction is long range, with a power law that can be continuously adjusted from the uniform case (power law zero) to the dipole-dipole case (power law three). I will begin with a discussion of the experimental results from the Monroe group on examining the antiferromagnetic case in a linear Paul trap with up to 16 spins [1]. Next, I will discuss the progress from the Bollinger group on examining the ferromagnetic spin-spin interactions between about 300 spins in a rotating Penning trap [2]. Both of these experiments show the challenge with scaling up these systems to large sizes, namely that it is difficult to maintain the adiabaticity condition due to experimental limitations on the coherence of the system (primarily from spontaneous emission). The diabatic evolution presents a new opportunity in determining the excitation energies of the spin systems via spectroscopic techniques. Advanced signal processing techniques that employ compressive sensing are needed to efficiently process such data. I will discuss the feasibility of such analyses for future experiments.

[1] R. Islam, et al., Science 340, 583 (2013). Doi: http://dx.doi.org/10.1126/science.1232296
[2] Joseph W. Britton, et al., Nature 484, 489 (2012). Doi: http://dx.doi.org/10.1038/nature10981

[1]We acknowledge support from the NSF under the PIF program and from the ARO with support from the DARPA-OLE program.