DAMOP14-2014-000535

Abstract for an Invited Paper
for the DAMOP14 Meeting of
the American Physical Society

Maria Goeppert Mayer Award Winner: New frontiers in quantum simulation enabled by precision laser spectroscopy[1]

ANA M. REY, JILA, NIST and University of Colorado at Boulder

Ultracold atomic systems have been proposed as ideal quantum simulators of real materials. Major breakthroughs have been achieved using neutral alkali atoms (one-outer-electron atoms) but their inherent "simplicity" introduces important limitations on the physics that can be investigated with them. Systems with more complex interactions and with richer internal structure offer an excellent platform for the exploration of a wider range of many-body phenomena. I will discuss our recent progress on the use of polar molecules, alkaline earth atoms –currently the basis of the most precise atomic clock in the world–, and trapped ions, as quantum simulators of iconic condensed matter Hamiltonians as well as Hamiltonians without solid state analogs. A promising direction under current exploration is the many-body physics that emerges at warmer temperatures (above quantum degeneracy) when there is a decoupling between motional and internal degrees of freedom. Even though in this regime the interaction energy scales can be small ($\sim$ Hz), they can be resolved thanks to the unprecedented level of control offered by modern precision laser spectroscopy.

[1]AFOSR, NSF, ARO and ARO-DARPA-OLE