DAMOP18-2018-020053

Abstract for an Invited Paper
for the DAMOP18 Meeting of
the American Physical Society

2018 Norman F. Ramsey Prize in Atomic, Molecular and Optical Physics, and in Precision Tests of Fundamental Laws and Symmetries Recipient talk: Atomic Quantum Simulation 2.0

PETER ZOLLER, Institute for Theoretical Physics, University of Innsbruck, and IQOQI, Innsbruck, Austria

Atomic physics provides us with the realization of engineered quantum many-body lattice models as quantum simulators. This includes Hubbard models for bosonic and fermionic cold atoms in optical lattices, and spin models with Rydberg atoms and chains of trapped ions. Among the noticeable recent experimental advances are complete quantum control, and single shot measurements in lattice systems of atoms and ions achieving single site resolution, as illustrated by the quantum gas microscope. In this talk we focus from a theory perspective on new opportunities provided by these experimental advances, which blur the the traditional line between 'quantum computing' and 'quantum simulation'. Topics of interest are measurement protocols for Renyi entropies applicable across all atomic platforms, which quantifies entanglement through 'random measurements' on single copies of a quantum system. Furthermore, these developments open the door to implementing Quantum Approximate Optimization Algorithms (QAOA) on various atomic platforms, as a quantum simulator interacting with a classical computer in a feedback loop. We illustrate this approach with finding approximate ground states for high energy models of lattice gauge theories with trapped ions and Rydberg arrays. We conclude with remarks on applying QAOA to quantum metrology, including Ramsey spectroscopy.