MAR10-2009-000860

Abstract for an Invited Paper
for the MAR10 Meeting of
the American Physical Society

Dissipation with Rydberg atoms

HANS PETER BÜCHLER, University of Stuttgart

Following Feynman and as elaborated on by Lloyd, a universal quantum simulator (QS) is a controlled quantum device which efficiently reproduces the dynamics of any other many particle quantum system with short range interactions. This dynamics can refer to both coherent Hamiltonian and dissipative open system evolution. Here we show that laser excited Rydberg atoms in large spacing optical or magnetic lattices provide an efficient implementation of a universal QS for spin models involving (high order) n-body interactions. This includes the simulation of Hamiltonians of exotic spin models involving n-particle constraints such as the Kitaev toric code, color code, and lattice gauge theories with spin liquid phases. In addition, it provides the ingredients for dissipative preparation of entangled states based on engineering n-particle reservoir couplings. The key basic building blocks of our architecture are efficient and high-fidelity n-qubit entangling gates via auxiliary Rydberg atoms, including a possible dissipative time step via optical pumping. This allows to mimic the time evolution of the system by a sequence of fast, parallel and high-fidelity n-particle coherent and dissipative Rydberg gates.