A Rydberg quantum simulator

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Author(s):
H. Weimer, M. Müller, I. Lesanovsky, P. Zoller, H. P. Büchler

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A universal quantum simulator is a controlled quantum device that 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 propose that laser-excited Rydberg atoms in large-spacing optical or magnetic lattices provide an efficient implementation of a universal quantum simulator for spin models involving n-body interactions, including such of higher order. This would allow the simulation of Hamiltonians of exotic spin models involving n-particle constraints, such as the Kitaev toric code, colour code and lattice gauge theories with spin-liquid phases. In addition, our approach provides the ingredients for dissipative preparation of entangled states based on engineering n-particle reservoir couplings. The basic building blocks of our architecture are efficient and high-fidelity n-qubit entangling gates using auxiliary Rydberg atoms, including a possible dissipative time step through optical pumping. This enables mimicking the time evolution of the system by a sequence of fast, parallel and high-fidelity n-particle coherent and dissipative Rydberg gates.

- 12.10.+i Simulations of many-body interactions [2]
- AQUTE [3]
- Quantum Computation [4]
- 12.30.+u Universal quantum simulators with specific systems (e.g. trapped ions, optical lattices, etc.) [5]
- 15.20.Ol Optical lattices [6]

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[2] http://qurope.eu/category/qics/10-quantum-computation/12-simulations/1210i-simulations-many-body-interactions
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