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Open System Quantum Simulations with Cold Atoms, Molecules and Ions[1]

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We discuss concepts and possible implementations of open system quantum simulation with quantum optical systems of cold atoms, molecules and ions. We first explain the general concepts of coherent control in open quantum systems, and we relate these ideas to quantum information and non-equilibirium condensed matter physics. The specific systems to be discussed include cold atoms in optical lattices coupled coupled to a BEC as a phonon reservoir, and an open system Rydberg quantum simulator. We finally discuss theory as well as recent experiments with trapped ions which have demonstrated the basic elements of a such an open system quantum simulator.

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