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An Open-System Quantum Simulator with Trapped Ions JULIO
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F. ROOS, PETER ZOLLER, Universitaet Innsbruck, RAINER BLATT — The control of quantum systems is of fundamental scientific interest and promises powerful
applications and technologies. Impressive progress has been achieved in isolating
the systems from the environment and coherently controlling their dynamics, as
demonstrated by the creation and manipulation of entanglement in various physical systems. However, for open quantum systems, engineering the dynamics of
many particles by a controlled coupling to an environment remains largely unexplored. Here we report the first realization of a toolbox for simulating an open
quantum system with up to five qubits. Using a quantum computing architecture
with trapped ions, we combine multi-qubit gates with optical pumping to implement
coherent operations and dissipative processes. We illustrate this engineering by the
dissipative preparation of entangled states, the simulation of coherent many-body
spin interactions and the quantum non-demolition measurement of multi-qubit observables. By adding controlled dissipation to coherent operations, this work offers
novel prospects for open-system quantum simulation and computation.

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