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Single atom tweezer array platform for open quantum system physics

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Understanding decoherence and dissipation remains a central challenge for quantum information science, particularly in many-body systems where system–environment coupling gives rise to rich and not yet fully understood dynamics. Neutral-atom tweezer arrays offer a promising route toward controlled many-body quantum simulators in which local information spreading through an interacting system can be studied in detail. Such a platform enables exploration of how information flows between a quantum system and its environment, including phenomena such as non-Markovian dynamics, information backflow, partial local recovery, and the encoding of local information into global many-body states. Understanding these processes is essential for clarifying the role of decoherence in quantum information processing and for identifying regimes where environmental coupling can be characterized, mitigated, or potentially exploited.

In this talk, I will describe an experimental platform under development based on individually trapped cesium atoms in optical tweezers with Rydberg interactions. The emphasis will be on the experimental framework, the conceptual questions it enables, and the types of open-system phenomena that such a platform is designed to address, with the goal of enabling studies of decoherence in programmable many-body quantum systems.

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