

Plenary Talk

PV XI Wed 9:00 RW 1

Quantum Processors and Quantum Networks Atom-by-Atom

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Reconfigurable arrays of neutral atoms have emerged as a leading platform for quantum science. Their excellent coherence properties combined with programmable Rydberg interactions have led to intriguing observations such as quantum phase transitions, the discovery of quantum many-body scars, and novel quantum computing architectures.

Here, I will look forward to what is next for atom arrays. In particular, I am going to introduce a dual-species Rydberg array, that naturally lends itself for measurement-based protocols such as quantum error correction, long-range entangled state preparation, and

measurement-altered many-body dynamics. The second atomic species is used as an auxiliary qubit to measure and control the primary species. In a first demonstration of this architecture, we use an array of cesium qubits to correct correlated phase errors on an array of rubidium data qubits. Rydberg interactions between the two species then lead to novel regimes, including greatly enhanced resonant dipole interactions, that we use to demonstrate a two-qubit gate and quantum non-demolition readout. Finally, we realize quantum cellular automaton dynamics with only global control.

An important step for atom arrays will be the scaling beyond a single processing module. I will describe a modular quantum network architecture and will present a node that combines large atom arrays with arrays of photonic interfaces at telecom wavelength.