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# Towards distributed quantum information processing based on Rydberg atoms

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Highly excited Rydberg atoms exhibit strong and long-range interactions, opening new possibilities for scalable quantum information processing. Rydberg atom array is highly programmable and capable of achieving high-fidelity quantum operations, making it an excellent candidate for large-scale quantum computers. Moreover, the interactions between Rydberg atoms provide a new avenue for deterministic control of photonic quantum states. In principle, distributed quantum information processing can be achieved by combining these technologies in Rydberg atomic arrays and Rydberg quantum photonics. We plan to use Rydberg single-atom arrays to realize high-fidelity local quantum computing modules and connecting these modules through Rydberg quantum photonics techniques. In this talk, I will present our recent efforts along this direction. We have demonstrated defect-free, programmable two-dimensional arrays of hundreds of atoms, efficient manipulation of Rydberg states, single qubit gate fidelity of ˜99.9%, and two-qubit gate fidelity of ˜95%. Furthermore, we have achieved on-demand generation of near-optimal Rydberg single photons, with purity and indistinguishability both exceeding 99%, realizing quantum photonic logic gates with 99.8% fidelity. We also implemented Rydberg quantum entanglement filters, extracting high-fidelity quantum entanglement from input states with extremely low fidelity.

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