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Dual-type Dual-element Atom Array for Quantum Computation and Simulation

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Quantum science promises great potential to revolutionize our current technologies. The past few years have witnessed a rapid progress on using arrays of individually trapped atoms as a programmable quantum processor. However, several predominant challenges remain, including reconfigurable individual addressability for qubit/spin operation and non-demolish selective detection, which lead to limited efficiency in implementing quantum algorithm, low experimental repetition rate, and preclude applications of many quantum error correction protocols. Here, we are building a novel architecture that sidesteps these challenges and enable experimental study on frontier topics in quantum information dynamics, with the long-term goal aiming for a fault-tolerant general-purpose quantum computer. This architecture combines an array of individually trapped ytterbium atoms and an array of rubidium atomic ensembles in a bilayer structure, with each layer has its own unique functionality and the interlayer interaction can be tuned with via Förster resonance. Spins/qubits are encoded with the electronic states of Yb atoms, while the Rb atomic ensembles perform ancillary operations on Yb atoms, including rapidly reconfigurable local qubit operation, and fast, non-demolish detection. With these newly developed techniques, this platform can implement previously inaccessible protocols on efficient generation of target quantum states, and is compatible with quantum error correction.

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