Developing a quantum gas microscope with programmable lattices

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Experiments involving ultracold atoms in optical lattices provide powerful ways for engineering and probing strongly correlated quantum matter. The field has advanced significantly in the past few decades, offering exceptional single-site resolution and single-atom addressing. However, current setups are often restricted by rigid lattice configurations and slow cycle times.
In this contribution, I will present our endeavors in building a next-generation quantum gas microscope for fermionic and bosonic lithium atoms. Utilizing auxiliary optical tweezers and direct optical cooling techniques, we aim to assemble small lattice systems atom-by-atom and reach sub-second experimental cycles. We are building tailored optical lattices with dynamically reconfigurable geometries by leveraging holographic projection techniques. Our approach paves the way for multiple research areas, ranging from engineering Hubbard systems with local control to frustrated phases with unconventional geometries.

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