Sub-micron magnetic lattices for ultracold atoms

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Résumé

Lattices of ultracold atoms have been very successful as quantum simulators of many-body Hamiltonians, including Hubbard and spin models. We develop a novel class of such simulators based on magnetic microtrap lattices on atom chips. This approach offers unprecedented flexibility in geometry and length scales, allowing the investigation of new many-body quantum phenomena arising from the increase of interactions in smaller and smaller lattices. We show a plethora of novel designs, including magnetic potentials for atom transport and localization, and (super-)lattices with Kagome and honeycomb structure. We demonstrate the nanofabrication of these structures with a resolution of tens of nm and lattice parameters down to 200 nm. We demonstrate the flexibility of our approach by combining several structures and length scales on a single chip. Lastly, we present the machine that houses our magnetic atom chip.

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