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Can quantum simulators reveal the pairing mechanism in high-Tc superconductors?

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Recent experimental advances of quantum simulators allow unprecedented microscopic studies of the structure of strongly correlated quantum matter. In the Fermi-Hubbard model, believed to underly high-Tc superconductivity and accessible to ultracold atom experiments in optical lattices, this allows to study the origins of unconventional pairing from a new perspective —a long-awaited goal of the cold atom community. In particular, the atomistic structure of the emergent charge carriers can be directly probed by quantum gas microscopes. Here, based on the already obtained insights, we propose a new pairing mechanism in the Hubbard model: It overcomes the large repulsive on-site interactions and yields strong d-wave attraction among the charge carriers at low doping. Our mechanism is closely related to Feshbach resonances occurring in traditional AMO physics —however, the resonances occur between strongly correlated, emergent constituents instead of the underlying atoms or electrons. We present our analytical formalism and report numerical evidence that supports our hypothesis that cuprate superconductors are close to the proposed emergent Feshbach resonance. We close by discussing possible experiments which could provide smoking-gun signatures for the proposed pairing mechanism in the future.

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