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Effective SU(N) multi-body interactions in ultracold fermionic atoms on a lattice[1] MICHAEL A. PERLIN, AKIHISA GOBAN, ROSS B. HUTSON, G. EDWARD MARTI, SARA L. CAMPBELL, JUN YE, ANA MARIA REY, JILA — Ultracold fermionic alkaline-earth atoms featuring SU(N) symmetric interactions and two long-lived electronic states are a promising platform for performing quantum simulation and quantum information processing tasks. A crucial ingredient for realizing this goal is the characterization of interaction parameters which govern low energy atomic collisions. We report recent measurements enabled by the exquisite spectroscopic sensitivity of the 3-D ^{87}Sr optical lattice clock at JILA, resolving interaction-induced density-dependent shifts in the energy spectra of multiply-occupied lattice sites. In order to account for these shifts, we develop a low-energy effective field theory exhibiting SU(N)-symmetric multi-body interactions mediated by virtual occupation of high-energy motional states. Though effective multi-body interactions have previously been observed in ultracold bosonic gasses prepared in a single hyperfine state, our work deals for the first time with collisions between N fermionic atoms in N different nuclear spin states, each with two electronic degrees of freedom. Nonetheless, due to the SU(N) symmetry of collisions we are able to find a simple way to express multi-body Hamiltonians and fully characterize the corresponding many-body eigenstates.

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