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Orbital interactions between strongly confined fermions

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Exchange-antisymmetric pair wavefunctions in fermionic systems hold the promise of new types of quantum simulations, topological quantum gates, and exotic few-body states. However, p-wave and other antisymmetric interactions are weak in naturally occurring systems, and their enhancement via Feshbach resonances in ultracold systems has been limited by three-body loss. Here we revisit p-wave interactions in the presence of strong confinement. In a first scenario, we measure the interaction energy of pairs of atoms isolated in a deep optical lattice. We demonstrate that interactions can be widely tuned, even up to the unitarity, where the p-wave scattering volume diverges. In a second scenario, we study the two-body correlation strength of quasi-one-dimensional (q1D) ensembles of spin-polarized fermionic potassium. Surprisingly, we find a scattering channel that has even particle-exchange parity along the q1D axis. These emergent s-wave collisions are enabled by orbital singlet wave functions in the transverse directions, which also confer high-momentum components to low-energy q1D collisions. I discuss prospects for new combinations of dimensionality and scattering symmetry.

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