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Effective multibody interactions of confined ultracold bosons[1]

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Effective multibody interactions are central to quantum field theories, and play an important role in the dynamics of tightly confined few-body systems. For example, collapse-and-revival oscillations of quenched superfluids in optical lattices show strong signatures of effective three-body interactions. Their effects are also seen in precision measurements of Mott-insulator states of ultracold atoms, and recent studies suggest they can be used to generate exotic quantum phases. These applications require accurate calculations of effective two- and three-body interaction strengths; moreover, effective four-body interactions, which require working to at least third order in perturbation theory, may also yield important corrections and new physics. In this talk, I describe our recent analysis of effective two-, three-, and four-body interactions for confined ultracold bosons. Unexpectedly, comparisons between our numerical simulations and analytic results show that finite-range corrections to the boson-boson interaction potential must also be taken into account. Utilizing an energy-dependent pseudopotential and renormalized perturbation theory, we have constructed a simple yet accurate model of interacting ultracold bosons that captures the combined physics of multibody interactions and finite-range corrections through third order.

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