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Effective renormalized multi-body interactions of harmonically confined ultracold neutral bosons E. TIESINGA, Joint Quantum Institute, P.R. JOHNSON, W.F. FLYNN, American University, D. BLUME, X.Y. YIN, Washington State University — We calculate the renormalized effective two-, three-, and four-body interactions for N neutral ultracold bosons in the ground state of an isotropic harmonic trap, assuming two-body interactions modelled with the combination of a zero-range and energy-dependent pseudopotential, and working to third-order in the free-space scattering length a at zero collision energy. The results account for quantum fluctuations to excited orbitals and finite-range effects. We show that the effective four-body interaction energy is $U_4(\omega) = +(2.43317...)[a/\sigma]^3 + \mathcal{O}(\dashv^{\triangle})$, where ω and σ are the harmonic oscillator frequency and its corresponding length, respectively. After renormalization the effective three-body interaction energy is $U_3(\omega) = -(0.85576...)[a/\sigma]^2 + 2.7921(1)[a/\sigma]^3 + \mathcal{O}(\dashv^{\triangle})$. In addition, we have performed independent numerical simulations for a finite-range boson-boson potential and comparison to the zero-range predictions reveals that finite-range effects must be taken into account. In particular, we show that the energy-dependent pseudopotential captures the finite-range physics and in combination with multi-body effective interactions gives excellent agreement to the numerical simulations.

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