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Do we need more than two-body forces at leading order in chiral effective field theory ? CHIEH-JEN YANG, Chalmers University — We investigate the importance of higher-body forces for describing many-body systems. Based on simple analytical arguments, we show that at least some of the three-body diagrams in chiral effective field theory (χEFT)—which were conventionally regarded as next-to-next-to-leading order (NNLO)—are necessary at leading order (LO) for systems with more than $A \sim 13 - 26$ number of nucleons. We perform numerical calculations with no-core-shell-model (NCSM) and coupled-cluster (CC) methods to verify our assumption. We found that only after the entrance of C_D and C_E terms in the three-body force can a correct ^{16}O pole structure be restored at LO—a feature which has never been achieved previously with an EFT which satisfies the renormalization-group (RG) condition. We also check the importance of four-body force in larger systems by performing ab-initio nuclear matter calculations with two- and three-body forces. The LO results suggest that, without four-body force, RG-invariance and reasonable saturation cannot be achieved at the same time. Our findings serve as a crucial step for developing a model-independent power counting in EFT.

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