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Nuclear forces in a manifestly Lorentz-invariant formulation of chiral EFT

We develop a systematic approach for chiral nuclear forces by applying time-ordered perturbation theory to manifestly Lorentz-ivariant formulation of chiral effective field theory. The effective potential and the scattering equation (Kadyshevsky equation) are obtained within the same framework. Restricting the non-perturbative treatment to the (non-singular) leading order potential and assuming the validity of perturbation theory for higher-order interactions, one can systematically remove all divergences from the amplitude and, therefore, employ arbitrarily large values of the cutoff. Alternatively, the full effective potential can be treated non-perturbatively by taking the cutoff of the order of the hard scale. The milder UV behavior then offers a larger flexibility regarding admissible cutoff values.

Along this line, we have studied chiral two-body force up to next-to-next-to-leading order and achieved a rather good description of phase shifts and deuteron properties, although it is computationally more demanding as compared to its non-relativistic counterpart. We expect that our approach should lead to a better description of systems with larger numbers of nucleons.

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