RENORMALIZING CHIRAL N3LO INTERACTION WITH MULTIPLE SUBTRACTIONS

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The standard procedure for the non-perturbative renormalization of NN interactions in the context of Weinbergs approach to ChEFT can be divided in two steps. In the first step, one has to solve a regularized Lippmann-Schwinger (LS) equation for the scattering amplitude by iterating the effective NN potential truncated at a given order in the chiral expansion, which includes long-range contributions from pion exchange interactions and short-range contribu- tions parametrized by nucleon contact interactions. The most common scheme used to regularize the ultraviolet divergences in the LS equation is to introduce a sharp or smooth momentum cutoff regularizing function that suppresses the contributions from the potential matrix elements for momenta larger than a given momentum cutoff scale (multi-pion exchange interactions also involve UV divergent loop integrals which must be consis- tently regularized and renormalized). In the second step, one has to determine the strengths of the contact interactions, the so-called low- energy constants (LECs), by fitting a set of low-energy scattering data. Once the LECs are fixed at a given momentum cutoff scale, the LS equation can be solved to evaluate other ob- servables. The NN interactions can be considered properly renormalized when the predicted observables are (approximately) independent of the momentum cutoff scale within the range of validity of ChEFT. The state of the art chiral NN potentials available to date, constructed within the framework of Weinbergs approach to ChEFT, are the next-to-next-to-next-to-leading-order (N3LO) potentials of Epelbaum, Glöckle and Meissner (N3LO-EGM) and of Entem and Machlidt (N3LO-EM). Both these potentials provide a very accurate descrip- tion of NN scattering data below laboratory energies $E \sim 300\ MeV$, with a $\chi^2/d.o.f. \sim 1$ comparable to that obtained by high-precision phenomenological potentials such as the Nijmegen II and the Argonne V18, and have been successfully applied in many nuclear structure and reaction calculations. We apply the subtracted kernel method (SKM), a renormalization approach based on recursive multiple subtractions performed in the kernel of the scattering equation, to the chiral N3LO nucleon-nucleon potentials and show a complete analysis for the peripheral waves as well as some waves that require a fitting procedure to obtain the strength of the contact interactions.

[1] V. S. Timóteo et al, Phys.Rev. C83 (2011) 064005 .

[2] S. Szpigel and V. S. Timóteo, J.Phys. G39 (2012) 105102.

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