Nuclear Mean Field from Chiral Pion-Nucleon Dynamics ◇

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Using the two-loop approximation of chiral perturbation theory, we calculate the momentum and density dependent single particle potential of nucleons in isospin-symmetric nuclear matter. The contributions from one- and two-pion exchange diagrams give rise to a potential depth for a nucleon at rest of $U(0, k_{f0}) = -53.2$ MeV at saturation density. The momentum dependence of the real part of the single particle potential $U(p, k_{f0})$ non-monotonic and can be translated into a mean effective nucleon mass of $\bar{M}^* \simeq 0.8$ M. The imaginary part of the single potential $W(p, k_f)$ is generated to that order entirely by iterated one-pion exchange. The resulting half width of a nucleon hole-state at the bottom of the Fermi sea comes out as $W(0, k_{f0}) = 29.7$ MeV. The basic theorems of Hugenholtz-Van-Hove and Luttinger are satisfied in our perturbative two-loop calculation of the nuclear mean field.

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Chiral 2π-Exchange NN-Potentials: Two-Loop Contributions ◇

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We calculate in heavy baryon chiral perturbation theory the local NN-potentials generated by the two-pion exchange diagrams at two-loop order. We give explicit expressions for thhe mass-spectra (or imaginary parts) of the corresponding isoscalar and isovector central, spin-spin and tensor NN-amplitudes. We find from two-loop two-pion exchange a sizeable isoscalar central repulsion which amounts to 62.3 MeV at $r = 1.0$ fm. There is a similarly strong isovector central attraction which however originates mainly from the third order low energy constants $\bar{d}_j$ entering the chiral πN-scattering amplitude. We also evaluate the one-loop 2π-exchange diagram with two second order chiral $\pi\pi NN$-vertices proportional to the low energy constants $c_{1,2,3,4}$ as well as the first relativistic $1/M$-correction to the 2π-exchange diagrams with one such vertex. The diagrammatic results presented here are relevant components of the chiral NN-potential at next-to-next-to-next-to-leading order.

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An Introduction to Few Nucleon Systems in Effective Field Theory ◇

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Progress in the Effective Field Theory of two and three nucleon systems is sketched, concentrating mainly on the low energy version in which pions are integrated out as explicit degrees of freedom. Examples given are: the extraction of nucleon polarizabilities from deuteron Compton scattering at very low energies; the energy dependence of the nucleon polarisabilities; three body forces and the triton; and nd partial waves at momenta below the pion cut.

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