Systematic Calculation of s-Wave Pion and Kaon Self-Energies in Asymmetric Nuclear Matter ◇

N. Kaiser and W. Weise

We calculate the pion self-energies in asymmetric nuclear matter in the two-loop approximation of chiral perturbation theory. We find three types of corrections beyond the well-known linear density approximation. The resulting s-wave potential (or equivalent mass-shift) of a π^- in the center of a heavy nucleus like Pb turns out to be $U_{\pi^-} = \Delta m_{\pi^-} \cong 14$ MeV, about half of what is needed to form the deeply bound and narrow pionic atom-states recently observed at GSI. The potential for a π^+ under the same conditions is $U_{\pi^+} = \Delta m_{\pi^+} \cong -1$ MeV. In the same way we calculate the mass-shifts of K^+-mesons in symmetric nuclear matter and neutron matter and find an increase of the K^+-mass by 9 % and 5 %, respectively. As a further application we give an analytical result for the third order term in the scattering length expansion of the in-medium self-energy of an interacting light-boson/heavy-fermion system.

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Hadrons with Charmed Quarks in the Nuclear Medium ◇

W. Weise

A survey is given on expected changes of charmonium (J/ψ and η_c) as well as charmed meson (D and $\bar{D}$) masses in nuclear matter. The physical implication of such medium effects are discussed.

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The S Wave Pion Deuteron Scattering Length in Effective Field Theory ◇

B. Borasoy and H. W. Grießhammer

The S wave pion deuteron scattering length is presented at NLO in the Effective Field Theory formulation of the two nucleon systems with perturbative pions. At this order, this observable is determined by the iso-scalar S wave pion nucleon scattering length a^+, by pion re-scattering contributions inside the deuteron and by two nucleon two pion contact interactions that involve two unknown parameters which renormalise the appearing divergences. By choosing their values accordingly and in agreement with their natural sizes predicted by the power counting, we are able to accomodate the available experimental data. However, a^+ cannot be determined from pion deuteron scattering directly. An ongoing experiment at PSI aiming to reduce the error bars by an order of magnitude will make it possible to pin down the size of these counter terms more accurately. We compare our findings to an approach in which pions are treated non-perturbatively.

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Quasiparticle Description of Lattice QCD Thermodynamics ◇

R. A. Schneider and W. Weise

We propose a novel quasiparticle interpretation of the equation of state of deconfined QCD at finite temperature. Using appropriate thermal masses, we introduce a phenomenological parametrization of the onset of confinement in the vicinity of the predicted phase transition. Lattice results of the energy density, the pressure and the interaction measure of pure $SU(3)$ gauge theory are excellently reproduced. We find a relationship between the thermal energy density of the Yang-Mills vacuum and the chromomagnetic condensate $\langle B^2 \rangle_T$. Finally, an extension to QCD with dynamical quarks is discussed. Goood agreement with lattice data for 2, $2+1$ and 3 flavour QCD is obtained. We also present the QCD equation of state for realistic quark masses.

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