The Chiral Condensate in Nuclear Matter ◇

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We investigate the density dependence of the chiral order parameter or quark condensate $<\bar{q}q>$ in nuclear matter using relativistic Brueckner-Hartree-Fock theory. While the leading behaviour linear in the density is known to be determined model independently by the pion-nucleon sigma term, we demonstrate that higher order corrections are extremely sensitive to the interpretation of the scalar "σ"-meson and its substructure.

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Hot Symmetric and Asymmetric Nuclear Matter in the Relativistic Hartree-Fock and Brueckner-Hartree-Fock Approximation

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The equation of state of hot symmetric and asymmetric nuclear matter plays a key role in the understanding of high–energy heavy ion reactions and protostars, respectively. So far calculations of the hot matter problem have been performed mainly in the nonrelativistic frame. Relativistic treatments are restricted – with one exception, which uses in the RBHF–approximation the decomposition of the effective scattering amplitude in matter in terms of five Fermi invariants, leading so to non–unique self–energies – to the phenomenological mean field approach, where the couplings are adjusted to the properties of infinite nuclear matter. In our investigation we have solved the coupled system of the Dyson equation, the Bethe–Salpeter equation and the self–energy for matter of finite temperature. The equations were solved in the full Dirac space so avoiding the problem of ambiguous self–energies. For the one–boson–exchange potentials we used modern potentials constructed by Brockmann and Machleidt. In this manner we obtained the equation of state for finite temperatures based on a modern microscopic basis. As expected from the case for $T = O$ the resulting equations of state are stiffer then their nonrelativistic counterparts. Since such calculations in the RBHF–scheme are very cumbersome, we have also performed the calculations in the relativistic Hartree–Fock–scheme, which resembles in its formal structure closely to the RBHF–scheme. The parameters were adjusted to the outcome of the RBHF–treatment.

Relativistic Calculations of Neutron Star Matter

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The microscopic relativistic Brueckner–Hartree–Fock approximation is extended to the treatment of electrically charge neutral neutron star matter in generalized beta equilibrium. In the framework of this self-consistent many–body scheme, we calculate the equation of state, the asymmetry, and the hadron/lepton composition of such matter. For the one–boson–exchange potential we use the Brockmann–Machleidt potentials A and B. Furthermore we appraise the possibility of parametrizing the Brueckner–Hartree–Fock outcome in terms of the relativistic Hartree and Hartree–Fock approximations. Such parametrizations will be very helpful for future studies (e.g., equations of state of proto–neutron stars and supernovae), since much less numerical effort is needed to compute the equation of state within the latter two approximations.

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