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In-Medium Pion Properties in Isospin-Asymmetric Nuclear Matter

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Dynamical symmetry breaking of QCD's chiral symmetry is the mechanism responsible for the bulk of all hadron mass in the universe. One of the order parameters of chiral symmetry breaking is the chiral quark condensate. Theoretical model-independent calculations have shown that the absolute value of this quark condensate is reduced in nuclear medium [1]. This might be an indication of (at least partial) restoration of the chiral symmetry compared to the vacuum. The linear-order density dependence of this process is well known. If we knew higher orders of this density dependence, we might be able to extrapolate to even higher densities, e.g. as they appear in neutron stars. The goal of our work is to investigate the density dependence of certain pion properties in isospin-antisymmetric nuclear matter using in-medium chiral perturbation theory [2] up to the next-to-leading order of the density expansion [3]. To this end, we calculate the pion self-energy and decay constant in proton and neutron matter, where their relative densities can be adjusted. We describe this asymmetry using the ratio ρ_n / ρ_p of their respective densities. Hence for example a ratio of 1.5 corresponds to a neutron-to-proton ratio commonly found in heavy nuclei. References: [1] T.D. Cohen, R.J. Furnstahl, D.K. Griegel, Phys. Rev. C 45, 1881 (1992); E. G. Drukarev and E. M. Levin, Prog. Part. Nucl. Phys. 27, 77 (1991); D. Jido, T. Hatsuda, T. Kunihiro, Phys. Lett. B 670, 109–113 (2008). [2] J. A. Oller, Phys. Rev. C 65, 025204 (2002). [3] S. Goda, D. Jido, PTEP 2014, 033D03 (2014).

Presenter: HUEBSCH, Stephan (東京工業大学)