HK 83: Nuclear Structure and Dynamics II

Time: Friday 11:00–12:45 Location: H-ZO 50

Group Report HK 83.1 Fr 11:00 H-ZO 50

Density Dependent Hadron Field Theory and its Applications — Urnaa Badarch, •Andreas Fedoseew, Walter Heupel, Horst Lenske, and Anika Obermann — Institut für Theoretische Physik, Universität Giessen, Germany

In-medium NN interactions are derived in an ab initio approach by Dirac-Brueckner theory. Within the density dependent relativistic hadron (DDRH) field theory we obtain a fully covariant and thermodynamically consistent density functional theory with interaction vertices described as Lorentz-scalar functionals of the field operators. Nuclear matter results from our ab initio description are compared to calculations with phenomenological input. Employing this model, the properties of isospin asymmetric nuclear matter and neutron stars are studied. The symmetry energy is found to be affected significantly by the $\delta/a_0(980)$ scalar-isovector channel. Landau-Migdal parameters are derived. They enter into quasi-free response functions. Dirac-RPA results for different spin-isospin channels reproduce available data on longitudinal and transverse response functions quite well. As an interesting case we examine the properties of neutron stars, serving also as a test for the high-density behavior of the theory. Neutron star matter in beta-equilibrium including the appearance of hyperons in the core of compact stars is investigated. Results for the mass-to-radius relation show an interesting dependence on the strength of density dependence of the symmetry energy.
This work is supported by the European Graduate School "Complex Systems of Hadrons and Nuclei".

Group Report HK 83.2 Fr 11:30 H-ZO 50

Nuclear Structure Calculations in the UCOM Framework — •Heiko Hergert, Anneke Günther, Panagiota Papakonstantinou, Sabine Reinhardt, and Robert Roth — Institut für Kernphysik, TU Darmstadt

The Unitarity Correlation Operator Method and the Similarity Renormalization Group [1,2] are powerful techniques for the derivation of effective interactions from current realistic NN potentials like Argonne AV18 or the chiral N3LO forces, which are suitable for a wide range of many-body methods, including Hartree-Fock(-Bogoliubov) (HF/HFB), Many-Body Perturbation Theory, RPA & quasi-particle RPA. We discuss nuclear structure calculations based on these interactions, including three-body forces via contact terms or corresponding density-dependent two-body forces.

We primarily focus on open-shell nuclei and the treatment of pairing phenomena in an HFB framework, discussing pairing gaps in isotopic and isotonic chains. The systematic connection to the free NN problem offers new insight into open questions regarding nuclear superfluidity, e.g., the importance of surface vibrations. The impact of pairing correlations on collective excitations is addressed in a QRPA framework, and tentative results are shown, for instance, for the supposed Pygmy dipole resonances in the tin isotopes.

Work supported by the DFG (SFB 634).

[1] R. Roth et al., Phys. Rev. **C73** (2006) 044312
[2] H. Hergert, R. Roth, Phys. Rev. **C75** (2007) 051001(R)

HK 83.3 Fr 12:00 H-ZO 50

Landau parameters with effective nucleon-nucleon interactions — •Haris DJapo[1], Robert Roth[1], Bernd-Jochen Schaefer[2], and Jochen Wambach[1,3] — [1]Institut für Kernphysik, TU Darmstadt, Schloßgartenstr. 9, D-64289 Darmstadt,Germany — [2]Institut für Physik, Karl-Franzens-Universität Graz, Universitätsplatz 5, A-8010 Graz, Austria — [3]Gesellschaft für Schwerionenforschung mbH, Planckstr. 1, D-64291 Darmstadt, Germany

Using recently developed effective nucleon-nucleon interactions we investigate properties of nuclear matter. A comparison of basic properties of effective low momentum potential $V_{\mathrm{low\ k}}$ and a potential constructed with unitary correlation operators V_{UCOM} in uniform nuclear matter is presented. Energy per particle, single-particle potentials, nucleon effective masses and Landau parameters are calculated and analyzed as a function of density for both nuclear and neutron matter. By introducing the density-dependent force we mimic the missing influence of higher order interactions to the properties of nuclear matter.

HK 83.4 Fr 12:15 H-ZO 50

Isospin Dependent Pairing Interactions and BCS-BEC crossover — •J. Margueron[1,2], H. Sagawa[2], and K. Hagino[3] — [1]IPN, Universite Paris-Sud, IN2P3-CNRSF-Orsay Cedex, France — [2]University of Aizu, Aizu-Wakamatsu, Fukushima, Japan — [3]Tohoku University, Sendai, Japan

We propose new types of density dependent contact pairing interaction which reproduce the pairing gaps in symmetric and neutron matters obtained by a microscopic treatment based on the nucleon-nucleon interaction. The BCS-BEC crossover of neutrons pairs in symmetric and asymmetric nuclear matters is studied by using these contact interactions. It is shown that the bare and screened pairing interactions lead to different features of the BCS-BEC crossover in symmetric nuclear matter. We perform Hartree-Fock-Bogoliubov (HFB) calculations for semi-magic Calcium, Nickel, Tin and Lead isotopes and N=20, 28, 50 and 82 isotones using these density-dependent pairing interactions. Our calculations well account for the experimental data for the neutron number dependence of binding energy, two neutrons separation energy, and odd-even mass staggering of these isotopes. Especially the interaction IS+IV Bare without the medium polarization effect gives satisfactory results of all the isotopes.

HK 83.5 Fr 12:30 H-ZO 50

Three-body contributions to the density-dependent NN-interaction — •Abdul Ahad Ataie and Horst Lenske — Institut für Theoretische Physik, Universität Giessen, Germany

We study a non-relativistic energy density functional theory to describe nuclear matter, nuclei and hyper-nuclei. The interaction density functionals are derived from Brueckner G-matrix calculation for the baryon-baryon in-medium forces from which we extract density dependent interaction vertices. The realistic description of the nuclear EOS requires additional density dependent three-body interactions which are shown to act predominantly as additional density dependent vertex corrections. The momentum dependence of self-energies and their modifications by the three-body terms are investigated. Results for the EOS of symmetric and asymmetric nuclear matter are discussed.
Work supported by DFG.