HK 14: Theorie

Zeit: Montag 16:30–19:00 Raum: 2F

Gruppenbericht HK 14.1 Mo 16:30 2F

Relativistic Density Functional Theory for Dynamical Properties of Nuclear Matter — •Urnaa Badarch, Andreas Fedoseew, and Horst Lenske — Institut für Theoretische Physik, Universität Gießen

The relativistic density dependent hadron field theory (DDRH) is a density functional theory with microscopically derived meson exchange interactions. The DDRH approach allows a fully self-consistent calculation of the equation of state and the symmetry energy at any proton-to-neutron fraction on a fully microscopic level. Also we investigate the compressibility and other thermodynamical quantities of nuclear matter over a large density range. The special role of the δ-($a_0(980)$) meson for the effective masses is discussed. A comparison of the DDRH results to those from phenomenological approaches shows significant deviations at very low and high densities relevant for neutron star calculations. The effects on neutron star matter in beta-equilibrium are discussed. Results for the mass-radius relation, i.e. the equation of state of neutron stars are presented. Extensions including hyperons have been tested in investigations of rotating neutron stars. The dynamical properties of nuclear matter are studied in a systematic way by deriving the field theoretical Fermi-Liquid interactions from the DDRH Lagrangian. The Landau-Migdal parameters, obtained as the ground state expectation values of the field theoretical amplitudes, are found to depend in asymmetric matter on the charge ratio of the system. Response functions have been calculated for various modes of excitation.

HK 14.2 Mo 17:00 2F

Kurzreichweitige Korrelationen und die Zustandsgleichung von Λ-Hyperkernmaterie — •Patrick Konrad und Horst Lenske — Institut für Theoretische Physik, Universität Gießen

Wir untersuchen den Einfluß von dynamischen Korrelationen auf die Zustandsgleichung von Λ-Hyperkernmaterie im Beta-Gleichgewicht. In unserem Modell nutzen wir die Beziehungen zwischen den Ein-Teilchen-Spektralfunktionen und Stoßintegralen aus, um die Spektralfunktionen und die 2p1h und 1p2h Selbstenergien selbstkonsistent zu berechnen. Hierzu nehmen wir eine dichteabhängige Punktwechselwirkung mit impuls- und energieunabhängigen Matrixelement an. Wir benutzen eine Skyrme-Parametrisierung als Ausgangspunkt für die Berechung des Mittelfeldes und bestimmen aus der Parametrisierung mit Hilfe der Landau-Migdal Theorie das impuls- und energieunabhängige Matrixelement. Wir zeigen Ergebnisse der Spektralfunktionen und Selbstenergie für Nukleonen und Λ-Hyperonen für verschiedene Dichten. Diese Ergebnisse dienen als Ausgangspunkt zur Berechnung der Zustandsgleichung im Beta-Gleichgewicht. Der Einfluß von Korrelationen auf die Eigenschaften von Neutronensternen wird disktutiert.

Diese Arbeit wird von der DFG durch die European Graduate School “Complex Systems of Hadrons and Nuclei” und der GSI Darmstadt unterstützt.

HK 14.3 Mo 17:15 2F

A statistical model for hot nuclear matter — •Matthias Hempel and Jürgen Schaffner-Bielich — Institut für Theoretische Physik, J. W. Goethe-Universität, Max-von-Laue-Str. 1, 60438 Frankfurt am Main

We study the equation of state and the composition of nuclear matter at finite temperature with a grand canonical model which assumes nuclear statistical equilibrium. Matter is described as a thermodynamic ensemble of nucleons, photons, leptons and all possible nuclei. For the nucleons the relativistic mean field theory is used, the masses of the nuclei are taken from existing nuclear structure calculations, which were corrected for effects of finite temperature and the surrounding medium. The wide range of density, temperature and proton fractions which is present in type II supernovae explosions is analysed. Results for hot neutron stars and supernova explosions are presented, with emphasis on the liquid-gas phase transition region of nuclear matter, which can also be explored by heavy ion experiments.

Gruppenbericht HK 14.4 Mo 17:30 2F

Nuclear structure calculations beyond the relativistic QRPA for astrophysical applications — •Elena Litvinova[1], Peter Ring[2,3], Victor Tselyaev[4], Dario Vretenar[5,2], Karlheinz Langanke[1], Gabriel Martinez-Pinedo[1], and Hans Peter Loens[1] — [1]GSI, Darmstadt, Germany — [2]TUM, Garching, Germany — [3]Universidad Autónoma de Madrid, Madrid, Spain — [4]St. Petersburg State University, St. Petersburg, Russia — [5]University of Zagreb, Zagreb, Croatia

The Relativistic Quasiparticle Time Blocking Approximation (RQTBA) developed recently is presented. The physical content of the RQTBA is the self-consistent Relativistic QRPA supplemented with the quasiparticle-phonon coupling within the quasiparticle time blocking approximation.

The description of electric dipole excitations in the even-even spherical neutron-rich nuclei is performed within the RQTBA. Coupling to collective vibrations generates spectra with a multitude of two quasiparticles-phonon states providing a noticeable fragmentation of the giant dipole resonance and a spreading of the pygmy resonance to lower energies that agrees very well with experimental data. Properties of the low-lying dipole strength below and around the one-nucleon separation energy are investigated within our approach. The influence of the pygmy resonance on (n,γ)-reaction cross sections and reaction rates has been studied within the Hauser-Feshbach model. The (n,γ) cross sections can be strongly enhanced which has a pronounced influence on the r-process abundance distribution.

HK 14.5 Mo 18:00 2F

Relativistische Dichtefunktionaltheorie für quasielastische Elektronstreuung — •Andreas Fedoseew und Horst Lenske — Institut für Theoretische Physik, Universität Gießen

Quasielastische Elektronstreuung an Atomkernen ist als eine der erfolgreichsten Methoden zur Untersuchung von Kernstruktureigenschaften wohl etabliert. Die genauere Analyse dieses Prozesses gibt uns ein besseres Verständnis über die Wechselwirkungen und Vielteilchenphänomene im Kern wieder. Quasielastische Wirkungsquerschnitte werden mit Hilfe von Antwortfunktionen bestimmt, die wiederum stark von dem verwendeten Vielteilchenmodell abhängen. Zur Berechnung dieser Funktionen haben wir die “Random Phase Approximation“ (RPA) für relativistische Dichtefunktionale mit Isospin Asymmetrie verallgemeinert. In unseren Rechnungen gehen wir von der dichteabhängigen relativistischen Funktionaltheorie (DDRH) aus. Hierbei wird die Dichteabhängigkeit der Meson-Austausch Vertices aus mikroskopischen Rechnungen ermittelt. Somit liefert dieser Ansatz einen tieferen Einblick in das Verständnis der Struktur der Antwortfunktionen. Unsere Ergebnisse werden mit Resultaten anderer Modelle verglichen und diskutiert, wobei wir bemerkenswerte Unterschiede feststellen können.

Diese Arbeit wird von der DFG durch die European Graduate School “Complex Systems of Hadrons and Nuclei” und der GSI Darmstadt unterstützt.

HK 14.6 Mo 18:15 2F

Shape transition in Zirconium nuclei — •Kamila Sieja[1] and Frederic Nowacki[2] — [1]GSI, Darmstadt, Germany — [2]IPHC, Strasbourg, France

In the present work the structure of neutron rich Zirconium nuclei is investigated in the framework of Large Scale Shell Model calculations. The valence space suitable for this study is composed of f5p3p1g9 proton and d5s1d3g7h11 neutron orbitals. The corresponding effective interaction is derived by monopole corrections necessary to reproduce the spectroscopic data of the key nuclei between 91Zr and 101Sn. The quality of the monopole-corrected realistic forces used so far provided strong arguments for such a procedure of finding the effective interaction. The agreement of the experiment and theory obtained here in the mass A˜95 region is as well satisfying. The progressive transition from spherical regime to deformation of Zr isotopes is then analysed in terms of shell evolution and of the proton-neutron monopole interaction.

HK 14.7 Mo 18:30 2F

Spectroscopic amplitudes and spectroscopic factors calculated in the Fermionic Molecular Dynamics approach — •Benjamin Hellwig and Thomas Neff — GSI, Darmstadt

Fermionic Molecular Dynamics (FMD) is an ideal approach to describe various properties like clustering and halos of light nuclei. The many-body states in this microscopic model are Slater determinants containing Gaussian wave packets as basis states. The Unitary Correlated Operator Method enables us to include the short-range central and tensor correlations providing an effective interaction derived from the realistic Argonne V18 interaction.

We calculate spectroscopic amplitudes and spectroscopic factors using the FMD many-body wave functions. Center-of-mass and recoil effects are treated properly. Effects of clustering and halos are studied in systems like ^{7}Li, decomposed into ^{6}He 0^{+} and 2^{+} components. The dipole response in ^{11}Be provides information about the neutron halo.

HK 14.8 Mo 18:45 2F

Shell model and RPA study of the $2\nu\beta\beta$ decay using V_{UCOM} — •Christian Möllmann, Karlheinz Langanke, Gabriel Martinez-Pinedo, and Carlo Barbieri — GSI, Planckstr. 1, 64293 Darmstadt

This contribution has been withdrawn by the authors.