HK 3: Struktur und Dynamik von Kernen I

Zeit: Montag 16:30–19:00 Raum: HG II

Gruppenbericht HK 3.1 Mo 16:30 HG II

The symmetry energy in heavy-ion reactions — •Wolfgang Trautmann — GSI Helmholtzzentrum GmbH Darmstadt

The symmetry energy appears in different roles in reaction studies presently performed in many laboratories. Its decreasing strength at sub-saturation densities permits the identification of low-density phenomena at late reaction stages. The less well known behavior at higher-than-normal densities, on the other hand, asks for suitable probes to determine the equation of state of asymmetric nuclear matter.

These two complementary aspects will be illustrated with data from experiments conducted at the GSI laboratory. A systematic study of isotopic effects in spectator fragmentation was performed at the Aladin spectrometer with secondary beams of 600 A MeV [1]. The analysis within the Statistical Fragmentation Model reveals that the symmetry-term coefficient needed for the liquid-drop description of the emerging fragments decreases as the disintegration of the spectator system into fragments and light particles increases.

Higher densities are probed in more central collisions, and isotopic flows have been proposed as observables sensitive to the strength of the symmetry term. The differential elliptic flows, in particular, have appeared as useful probes from a study of ^{197}Au + ^{197}Au collisions at 400 A MeV with the UrQMD model. The preliminary results obtained from a comparison with experimental data of the FOPI/LAND collaboration favor a moderately soft symmetry term with a density dependence of the potential term proportional to $(\rho/\rho_0)^\gamma$ with $\gamma = 0.9 \pm 0.3$.

[1] C. Sfienti et al., Phys. Rev. Lett. 102 (2009) 152701

HK 3.2 Mo 17:00 HG II

Effekte der Symmetrieenergie bei Teilchenproduktion in Schwerionenstößen* — Vaia Prassa[1], Giorgios Lalazissis[1], Theodoros Gaitanos[2], Massimo Di Toro[3], Vincenzo Greco[4] und •Hermann Wolter[5] — [1]Univ. Thessaloniki, Griechenland — [2]Univ. Giessen, — [3]Lab.Naz.del Sud, INFN, Catania, Italien — [4]Univ. di Catania, Italien — [5]Univ. München

Die Suche nach der Dichteabhängigkeit der nuklearen Symmetrieenergie ist von erheblicher Bedeutung für eine Vielzahl von Fragen in der Kern- und Astrophysik. Die Produktion von sekundären Teilchen in relativistischen Schwerionenstößen, insbesondere von Pionen und Kaonen, wird als eine Sonde für die Bestimmung der Symmetrieenergie bei Dichten oberhalb der Sättigungsdichte diskutiert, insbesondere Verhältnisse von Isospinpartnern, wie π^+/π^- und K^0/K^+. Diese Verhältnisse werden einerseits durch das Proton/Neutron-Verhältnis, und damit durch den Isovektoranteil des Mittelfeldes, und andererseits durch Schwelleneffekte, und damit durch die asymmetrieabhängigen effektiven Massen, bestimmt. Wir geben einen Überblick über die (teilweise kontroverse) Situation bzgl. dieser Fragestellungen unter Berücksichtigung unserer eigenen und anderer Arbeiten, und diskutieren die Abhängigkeiten von verschiedenen Eingabegrößen. Wir argumentieren, dass das K^0/K^+ Verhältnis eine aussichtsreiche Observable für die Hochdichte-Symmetrieenergie sein sollte.

* Gefördert z.T. durch durch die I.K.Y. Scholarship Foundation, Greece, und durch das DFG-Exzellenzcluster *Origin and Structure of the Universe*

HK 3.3 Mo 17:15 HG II

ASYEOS: probing symmetry energy term in the nuclear equation of state with neutron and proton flow — •Mladen Kiš and Yvonne Leifels for the ASYEOS-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

Understanding the symmetry term in the nuclear equation of state at supra-saturation densities is of fundamental importance for many aspects of nuclear physics and astrophysics. Neutron and proton elliptic flow in relativistic heavy ion collisions in the energy range between 0.4 and 1.0 AGeV is predicted [1] to provide quantitative information on the symmetry term by various models. Data on simultaneous measurement of neutron and proton flow in Au+Au collisions at various energies have been obtained in a combined experiment of the LAND neutron detector and the forward wall of the FOPI detector at GSI [2] already in the 90's. We will present a re-analysis of these data and a comprehensive comparisons to model predictions, discuss their sensitivity to the symmetry term of the nuclear equation of state and further perspectives.

[1] B.-A. Li et al., Phys.Rep. 464(2008) 113.
[2] Y. Leifels et al., Phys.Rev.Lett. 71(1993) 963.

HK 3.4 Mo 17:30 HG II

Chiral Effective Field Theory for Nuclear Matter — •Andre Lacour[1], Jose Antonio Oller[2], and Ulf-G. Meissner[1,3] — [1]Helmholtz-Institut für Strahlen- und Kernphysik (Theorie) and Bethe Center for Theoretical Physics, Universität Bonn, D-53115 Bonn, Germany — [2]Departamento de Física, Universidad de Murcia, E-30071 Murcia, Spain — [3]Institut für Kernphysik, Institute for Advanced Simulation and Jülich Center for Hadron Physics, Forschungszentrum Jülich, D-52425 Jülich, Germany

Recently a novel chiral power counting for nuclear matter with nucleons and pions as degrees of freedom has been developed. It allows for a systematic expansion taking into account both local and pion-mediated inter-nucleon interactions. It also identifies some non-perturbative strings of diagrams, related to iterated nucleon-nucleon interactions, which have to be re-summed. Unitary chiral perturbation theory has been proven to be a useful tool for taking into account the non-perturbative nature of the nucleon-nucleon interaction. In my talk I will review the most recent progress employing both techniques and will present results of the calculations for the ground state energy density of nuclear matter and the in-medium chiral quark condensate.

HK 3.5 Mo 17:45 HG II

Chiral thermodynamics of nuclear matter — •Salvatore Fiorilla, Norbert Kaiser, and Wolfram Weise — Physik-Department, TU München, D-85747 Garching

We present a calculation of the equation of state of nuclear matter in the frame of in-medium chiral perturbation theory. The calculations are performed up to three-loop order in the free energy density. The contributions to the free energy per particle originate from one- and two-pion exchange diagrams; the effects from two-pion exchange with Δ-isobar excitation are also included, as well as three-body forces. The equation of state and the corresponding phase diagram, displaying the liquid-gas phase transition, is investigated for different proton-to-neutron ratios, from isospin-symmetric nuclear matter to the limiting case of pure neutron matter.

Work supported in part by BMBF, GSI and the DFG Cluster of Excellence "Origin and Structure of the Universe".

HK 3.6 Mo 18:00 HG II

Isospin dependent properties of asymmetric nuclear matter — •Urnaa Badarch and Horst Lenske — Institut für Theoretische Physik, Universität Giessen

The study of the density dependence of the nuclear symmetry energy is very important for understanding many phenomena in both nuclear physics and astrophysics. We study the isospin dependence of in-medium nuclear effective interactions and the equation of state of neutron-rich nuclear matter, i.e., the density dependence of nuclear symmetry energy using the relativistic density-dependent hadron-field theory (DDRH). 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. We present the results of our calculation for the density dependence of nuclear symmetry energy focusing on the features such as an isospin effects in nuclear matter and behavior at low and high density.

HK 3.7 Mo 18:15 HG II

Properties of hot dense asymmetric nuclear matter in the relativistic density functional theory — •Andreas Fedoseew, Horst Lenske, and Joseph Palmer — Institut für Theoretische Physik, Universität Giessen

In recent years there has been increased interest in the study of hot nuclear matter and neutron matter. The properties of dense and finite-temperature asymmetric nuclear matter are of great interest in the studies of the dynamics of heavy-ion collisions, stellar collapse, supernova explosions or neutron stars. We construct the equation of state (EoS) of nuclear matter at finite temperature and density with various proton fractions within the relativistic density-dependent hadron-field theory (DDRH). The particular feature of this theory is a density-dependent description of in-medium NN interactions from an ab initio

approach applying Dirac-Brueckner theory. The properties of nuclear matter with both uniform and non-uniform distributions are studied consistently. We also show results of calculations including hyperons and nuclear matter in β equilibrium. Results for Fermi-Liquid parameters and quasi-elastic response functions are presented.
Supported by HIC for FAIR, GSI, and DAAD.

HK 3.8 Mo 18:30 HG II

Die Gap-Gleichung in unendlicher Kernmaterie — •Michael Strecker und Christian Welzbacher — Institut für Theoretische Physik, Universität Giessen

In unendlicher Kernmaterie ist die Gap-Gleichung durch eine im allgemeinen komplizierte Integralgleichung gegeben. Die Eigenschaften der Bogoljubov-Valatin-Amplituden erlauben die Einführung einer effektiven Kopplungskonstanten, die wir aus der NN-Wechselwirkung selbstkonsistent berechnen. Das Problem wird damit auf eine prinzipiell lösbare Integralgleichung reduziert. Dabei ergibt sich ein divergentes Integral, das durch die Einführung eines Abschneideparameters regularisiert wird. Realistischere Ansätze für das Potential führen zu einem natürlicheren, gleitenden Abschneideverhalten. Ein erweiterter Ansatz für das Nukleon-Nukleon-Potential berücksichtigt den Einfluß von Polarisationswechselwirkungen in asymmetrischer unendlicher Kernmaterie basierend auf Meson-Austausch-Potentialen in der Vierpunktfunktion, zugeschnitten auf die speziellen Anforderungen der Gap-Gleichung.
Gefördert durch HIC for FAIR.

HK 3.9 Mo 18:45 HG II

Breathing mode in an improved transport approach — •Theodoros Gaitanos, Alexei Larionov, Horst Lenske, and Ulrich Mosel — Institut für Theoretische Physik, Universität Giessen

The nuclear breathing-mode giant monopole resonance is studied within an improved relativistic Giessen Boltzmann-Uehling-Uhlenbeck (GiBUU) transport approach. As a new feature, the numerical treatment of ground-state nuclei and their phase-space evolution is realized with the same semiclassical energy-density functional. With this new method a very good stability of ground-state nuclei in BUU simulations is achieved. This is important in extracting clear breathing-mode signals for the excitation energy and, in particular, for the lifetime from transport theoretical studies including mean-field and collisional effects.
Work supported by DFG and BMBF.