HK 25: Struktur und Dynamik von Kernen

Zeit: Dienstag 16:30–19:00 Raum: HZ 5

Gruppenbericht HK 25.1 Di 16:30 HZ 5

Untersuchung der Neutronenhautdicke bei mittleren und schweren Kernen mit mannigfaltigen experimentellen Techniken — •Michaela Thiel für die NeSS-Kollaboration — Institut für Kernphysik, JGU Mainz, Deutschland

Experimente zur Bestimmung der Neutronenhautdicke stellen heutzutage ein immer wichtigeres Bindeglied zwischen Kern- und Astrophysik dar. Dabei nutzt man den Zusammenhang zwischen Neutronenhautdicke und kernphysikalischer Zustandsgleichung zur Aufstellung maßgeblicher Randbedingungen für die Beschreibung von Neutronensternen. Die erste modellunabhängige Bestimmung der Neutronenhautdicke konnte 2010 anhand paritätsverletzender Elektronstreuung an einem Bleitarget im Rahmen des PREX Experiments am Jefferson Laboratory erzielt werden. Für eine Verifizierung dieses Ergebnisses sind zwei Messprogramme innerhalb des Instituts für Kernphysik (Mainz) geplant. Ebenfalls unter Ausnutzung von paritätsverletzender Elektronstreuung sind Experimente sowohl innerhalb der A1-Kollaboration mit dem existierenden Beschleuniger MAMI als auch mit dem zukünftigen Beschleuniger MESA im Rahmen der P2-Kollaboration geplant. Ziel ist die Bestimmung der paritätsverletzenden Asymmetrie mit einer Genauigkeit von 1%. Eine alternative Messmethode zur Bestimmung der Neutronenhautdicke stellt die kohärente Pion-Photoproduktion dar. Bei einem im Rahmen der A2-Kollaboration durchgeführten Experiment war die systematische Bestimmung der Neutronenhautdicke von drei Kernen aus der Zinn-Isotopenreihe von besonderem Interesse. Status und Perspektiven der drei Messprogramme werden vorgestellt.

Gruppenbericht HK 25.2 Di 17:00 HZ 5

Status of the R^{3}B Experiment — •Haik Simon for the R3B-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstr. 1, D-64291 Darmstadt

The R^{3}B experiment aims at reaction studies using relativistic secondary beams, with a versatile setup, including a large target spectrometer (CALIFA), surounded by a silicon tracking system, a very efficient neutron time-of-flight spectrometer (NeuLAND) a superconducting dipole magnet (GLAD) and a high-rate capaple tracking system for heavy ions through the entire setup. The R^{3}B experiment, in it's precursor form, will be set up next year at Cave-C at the existing GSI facility and being used for tests of prototypes of the detectors around the newly to be installed GLAD magnet.

In this presentation I'd like to survey the progress and new developments being made for the different components of the setup.

Supported by LOEWE (HIC for FAIR), EMMI, and the BMBF

HK 25.3 Di 17:30 HZ 5

Microscopic calculations and energy expansions for neutron-rich matter — •Christian Drischler[1,2], Vittorio Somà[1,2], and Achim Schwenk[2,1] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH

We investigate the properties of asymmetric nuclear matter with two- and three-nucleon interactions based on chiral effective field theory. Focusing on neutron-rich matter, we calculate the energy for different proton fractions and include estimates of the theoretical uncertainty. We use our ab-initio results to test the quadratic expansion around symmetric matter with the symmetry energy term, and confirm its validity for highly asymmetric systems. Our calculated energy densities are in remarkable agreement with an empirical parameterization, developed to interpolate between pure neutron and symmetric nuclear matter. These findings are very useful for astrophysical applications and for developing new equations of state.

*This work was supported by the DFG through Grant SFB 634, the Helmholtz Alliance HA216/EMMI and the ERC Grant No. 307986 STRONGINT.

HK 25.4 Di 17:45 HZ 5

Four-Body Forces in Ab Initio Nuclear Structure — •Stefan Schulz, Angelo Calci, and Robert Roth — Institut für Kernphysik, Technische Universität Darmstadt

Nucleon-nucleon (NN) and three-nucleon (3N) interactions derived from chiral effective field theory, transformed using the similarity renormalization group (SRG), have been successful in the ab initio description of nuclear-structure. Previous investigations have shown strong indications for sizable effects originating by SRG-induced four-nucleon (4N) contributions.

To obtain reliable results, the 4N contributions can either be suppressed or included in nuclear-structure calculations. We present an efficient scheme to take induced as well as initial 4N forces into account by performing the SRG transformation in four-body space and extending the importance-truncated no-core shell model (IT-NCSM) for their explicit inclusion. We investigate the effect of induced forces beyond the three-body level in ab intio nuclear-structure calculations and present results for p-shell nuclei up to ^{16}O.

* Supported by DFG (SFB 634), HIC for FAIR, and BMBF (06DA7047I)

HK 25.5 Di 18:00 HZ 5

Erstes EXL-Experiment mit radioaktiven Strahlen am ESR: Protonstreuung an ^{56}Ni — •Mirko von Schmid für die EXL E105-Kollaboration — Institut für Kernphysik, TU Darmstadt

EXL, „**EX**otic nuclei studied in **L**ight-ion induced reactions at the NESR storage-ring“, ist ein Projekt innerhalb von NUSTAR bei FAIR. Der Detektor für targetähnliche, leichte Rückstoßionen soll am zukünftigen NESR („**N**ew **E**xperimental **S**torage **R**ing“) eingesetzt werden, um dort direkte Reaktionsexperimente mit radioaktiven Strahlen an einem internen Target in inverser Kinematik durchzuführen.

2012 wurde am existierenden ESR („**E**xperimental **S**torage **R**ing“, GSI) im Rahmen des laufenden EXL-Experimentierprogramms (E105) mit der Reaktion ^{56}Ni(p,p)^{56}Ni zum ersten Mal erfolgreich eine Kernreaktion mit gespeicherten, exotischen Schwerionen untersucht. Im Rahmen der Auswertung wurde der differentielle Wirkungsquerschnitt für die Reaktion ermittelt, um die radiale Dichteverteilung der Kernmaterie von ^{56}Ni zu bestimmen. Der Vortrag wird den aktuellen Stand der Analyse diskutieren und erste, vorläufige Ergebnisse präsentieren.

Gefördert durch BMBF (06DA9040I und 05P12RDFN8) und HIC for FAIR.

HK 25.6 Di 18:15 HZ 5

The neutron-rich oxygen isotopes ^{25,26}O — •Christoph Caesar for the R3B-Collaboration — TU Darmstadt, Institut für Kernphysik, Germany

The R3B-collaboration has studied the neutron-rich oxygen isotopes ^{25,26}O by utilizing a kinematically complete measurement at relativistic beam energies with the R3B-LAND-setup[1]. The isotopes of interest have been populated via proton removal from ^{26,27}F, respectively. The ground-state masses of both isotopes have been extracted: $E_r(^{25}\mathrm{O(gs)}) = 725^{+54}_{-29}$ keV; $E_r(^{26}\mathrm{O(gs)}) \leqslant 40/120$ (68%/95% c.l.) keV. Furthermore, limits on the lifetime of both ground-states have been extracted for the first time: $\tau(^{25}\mathrm{O(gs)}) \geq 8.2 \times 10^{-12}$ ns; $\tau(^{26}\mathrm{O(gs)}) \leqslant 5.7$ ns.

The determined ground-state energies have been compared to theoretical shell-model calculations based on chiral effective field theory potentials using chiral NN and 3N forces. In addition residual three-valence-neutron forces, which become more important with increasing neutron number along isotopic chains are included. This work is supported by 'BMBF project 06 DA 7047 l', 'GSI TU Darmstadt Cooperation Contract', 'HIC for FAIR' and 'NAVI'.

[1] C.Caesar *et al.* Phys. Rev. C **88** (2013) 034313

HK 25.7 Di 18:30 HZ 5

***Ab Initio* Study of Neutron Drops with Chiral NN+3N Interactions** — •Sebastian Fischer, Robert Roth, Angelo Calci, and Joachim Langhammer — Institut für Kernphysik, Technische Universität Darmstadt

Neutron drops provide a simple test system of neutron-rich matter. Hence, *ab initio* calculations of these pure neutron systems may be used to constrain the large isospin properties of energy-density functionals and equations of state that are used for the description of very neutron-rich systems as they occur in astrophysical environments, e.g., neutron stars.

For the first time, we calculate properties of neutron drops interacting via realistic two- and three-nucleon forces derived from chiral effective field theory using the *ab initio* importance-truncated no-core

shell model (IT-NCSM). In contrast to nuclei, systems consisting of only neutrons are not self-bound and, therefore, need to be confined in an external potential well. Variations of the external potential, typically a harmonic oscillator potential, can be used to explore different density regimes.

With this input, we compute a range of different properties of neutron drops, such as ground-state energies, radial densities and excitation energies, and compare our IT-NCSM results to previous calculations performed by using phenomenological interactions.

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HK 25.8 Di 18:45 HZ 5

Ground-state deformation of Cs isotopes — •Dinko Atanasov for the ISOLTRAP-Collaboration — Max Planck Institute for Nuclear Physics, Heidelberg, Germany

We have performed precision mass measurements of several Cs ($Z = 55$) isotopes using a four-trap mass spectrometer ISOLTRAP, situated at ISOLDE/CERN. The experimental setup consists of an RFQ buncher and cooler, a multi-reflection time-of-flight mass separator and two Penning traps. This scheme allows routinely performing precision mass measurements on short-lived nuclides with a relative mass uncertainty of typically 1E-8. The mass of the neutron-rich ^{148}Cs nuclide was measured for the first time. In addition, the masses of ^{132,147}Cs isotopes were re-measured and found to deviate from the latest atomic-mass evaluation (AME2012). Nuclides found in transitional regions between spherical and deformed nuclear shapes are of particular importance for developing theoretical models. One such example of odd-Z mid-shell nuclei are neutron-rich Cs isotopes. The isotope ^{148}Cs is located in a region of the nuclear chart where the emergence of complex intrinsic shapes are expected such as a negative value for the hexadecapole deformation parameter of nuclear ground-state. For the interpretation of the data we investigated the systematics of ground-state properties such as charge radii or two-neutron separation energies and made an extensive comparison to theoretical predictions. Details of the measurements as well as the new results will be presented.