HK 10: Struktur und Dynamik von Kernen

Zeit: Montag 16:30–19:00 Raum: HZ 4

Gruppenbericht HK 10.1 Mo 16:30 HZ 4

Dipole Polarizability and Neutron Skin in ^{68}Ni — Dominic Rossi[1,2,3], Thomas Aumann[4], and •Konstanze Boretzky[1] for the R3B-Collaboration — [1]GSI Darmstadt, Germany — [2]Univ. Mainz, Germany — [3]NSCL, MSU, USA — [4]TU Darmstadt, Germany

The symmetry energy term E_{sym} of the nuclear equation-of-state describes fundamental phenomena both in nuclear physics and in astrophysics. The electric dipole (E1) response of nuclei as a function of the isospin asymmetry is driven by E_{sym}. Studies of the Pygmy Dipole Resonance (PDR) in exotic nuclei have been used to constrain E_{sym} or the neutron skin thickness $\Delta R_{n,p}$. The electric dipole polarizability α_D, being very sensitive to the low-lying E1 strength, is correlated to $\Delta R_{n,p}$ in a robust and only moderately model-dependent manner [PRC 81, 051303 (2010)]. Here, a first experimental determination of α_D in an unstable nucleus and the derivation of its $\Delta R_{n,p}$ will be reported [PRL 111, 242503 (2013)]. From the E1 strength distribution in ^{68}Ni measured using the R3B-LAND setup at GSI, the resonance parameters for the observed PDR at 9.55(17) MeV and the giant dipole resonance at 17.1(2) MeV are determined. In combination with results from Wieland et al. [PRL 102, 092502 (2009)] an unexpectedly large direct photon-decay branching ratio of 7(2)% is observed for the PDR. The measured α_D of 3.40(23) fm^3 is compared to relativistic RPA calculations yielding $\Delta R_{n,p}$ of 0.17(2) fm for ^{68}Ni. This work was supported by HIC for FAIR, EMMI, the GSI-TU Darmstadt cooperation agreement, the Helmholtz-CAS Joint Research Group HCJRG-108 and BMBF grants 06MZ222I, 05P12RDFN8 and 06MT9156.

Gruppenbericht HK 10.2 Mo 17:00 HZ 4

Nuclear deformation and neutron excess as competing effects for the pygmy dipole strength — •Ralph Massarczyk[1,2], Ronald Schwengner[1], Friedrich Dönau[1], and Stefan Frauendorf[3] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany — [3]University of Notre Dame, Notre Dame, Indiana 46556, USA

The electromagnetic dipole strength below the neutron-separation energy has been studied for the xenon isotopes with mass numbers A = 124, 128, 132, and 134 in nuclear resonance fluorescence experiments using the γELBE bremsstrahlung facility at Helmholtz-Zentrum Dresden-Rossendorf and the HIγS facility at Triangle Universities Nuclear Laboratory Durham. The systematic study gained new information about the influence of the neutron excess as well as of nuclear deformation on the strength in the region of the pygmy dipole resonance. The results are compared with those obtained for the chain of molybdenum isotopes and with predictions of a random-phase approximation in a deformed basis. It turned out that the effect of nuclear deformation plays a minor role compared with the one caused by neutron excess. A global parametrization of the strength in terms of neutron and proton numbers allowed us to derive a formula capable of predicting the summed $E1$ strengths in the pygmy region for a wide mass range of nuclides.

HK 10.3 Mo 17:30 HZ 4

Cluster correlations on the surface of nuclei and the neutron skin thickness — •Stefan Typel — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

Correlations are an essential feature in nuclear many-body systems. The attractive nucleon-nucleon interaction, in particular, causes the formation of clusters in matter below nuclear saturation density. Adapting a generalized relativistic density functional approach with explicit cluster degrees of freedom, which is used in the description of the nuclear matter equation of state [1,2], the appearance of α particles on the surface of nuclei can be studied. It affects the neutron and proton radii and thus the neutron skin thickness of nuclei. A tight correlation between this quantity and the density dependence of the nuclear symmetry, which is important for the prediction of the equation of state of neutron rich matter in compact stars, has been observed in conventional mean-field models. The formation of α particles in the nuclear skin systematically modifies this correlation and has to be considered when conclusions on the slope of the symmetry energy are drawn from the measurement of the neutron skin thickness of neutron-rich heavy nuclei.

[1] S. Typel, G. Röpke, T. Klähn, D. Blaschke, H.H. Wolter, Phys. Rev. C 81 (2010) 015803

[2] S. Typel, H.H. Wolter, G. Röpke, D. Blaschke, accepted for publication in Eur. Phys. J. A

HK 10.4 Mo 17:45 HZ 4

Reactions of neutron-rich Sn isotopes investigated at relativistic energies at R^{3}B — •Fabia Schindler for the R3B-Collaboration — TU-Darmstadt, IKP

Reactions of neutron-rich Sn isotopes have been measured in inverse kinematics at the R^{3}B setup at GSI in Darmstadt in 2012. Due to the neutron excess, which results also in a weaker binding of the valence neutrons, such isotopes are expected to form a very neutron-rich surface, which is called the neutron skin. The investigation of this phenomenon is one of the main goals of the experiment. The reaction products of the isotopes ^{124}Sn to ^{134}Sn have been measured at beam energies of 300 AMeV to 600 AMeV in a kinematically complete way. Different reaction channels will be analyzed, therefore information about the neutron skin can be obtained from different methods. These are in particular the neutron removal cross sections and the dipole polarizability of the nucleus, which are both sensitive to the neutron-skin thickness. The latter will be obtained from the differential cross section of electromagnetic excitation measured in a wide excitation-energy range including the Pygmy and Giant Dipole Resonances.

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HK 10.5 Mo 18:00 HZ 4

Chiral four-body interactions in nuclear matter — •Kaiser Norbert — Physik-Department, Technische Universität München

The effects of chiral four-nucleon interactions in nuclear and neutron matter are studied. The leading-order terms arising from pion-exchange in combination with the chiral 4π-vertex and the chiral NN3π-vertex are found to be very small. The contributions of reducible four-nucleon interactions generated by the method of unitary transformations are included as well. We consider also the four-nucleon interaction induced by pion-exchange and twofold Δ-isobar excitation of nucleons. For most of the closed four-loop diagrams the occurring integrals over four Fermi spheres can either be solved analytically or reduced to one- or two-parameter integrals. After summing the individually large contributions from 3-ring, 2-ring and 1-ring diagrams of alternating signs, one obtains at nuclear matter saturation density $\rho_0 = 0.16\,\mathrm{fm}^{-3}$ a moderate contribution of about 2 MeV to the energy per particle. The curve $\bar{E}(\rho)$ rises rapidly with density, approximately as ρ^3. In pure neutron matter the chiral four-body interactions lead to a repulsive contribution that is about half as strong.

HK 10.6 Mo 18:15 HZ 4

Are the pygmy resonances important for astrophysics? — •Nadia Tsoneva and Horst Lenske — Institut für Theoretische Physik, Universität Giessen

The precise knowledge of nuclear response functions plays a key role in the determination of n-capture reaction rates of importance for the nucleosynthesis of heavier elements. In this connection information on low-energy excitations located around the neutron threshold is needed. Recently, new low-energy modes called pygmy resonances which reveal new aspects on the isospin dynamics of the nucleus have been observed. Their distinct feature is the close connection to nuclear skin oscillations which become visible in transition densities and currents. A successful description of the pygmy resonances could be achieved in our microscopic theoretical approach [1-6]. The method incorporates the density functional theory and QRPA formalism extended with multiphonon degrees of freedom which are found of crucial importance for the understanding of the fine structure of nuclear electric [1-5] and magnetic excitations at low energies [6]. Corresponding theoretical response functions are implemented in the studies of n-capture reaction rates of astrophysical importance [7]. Supported by BMBF project 06GI9109. [1] N. Tsoneva et al., PLB 586 (2004) 213. [2] N. Tsoneva et al. PRC 77, 024321 (2008). [3] N. Tsoneva et al., PLB 695 (2011) 174180. [4] A. Tonchev et al., PRL 104 (2010) 072501. [5] R. Schwengner et al., PRC 87, 024306 (2013). [6] G. Rusev et al., PRL 110, 022503 (2013). [7] R. Raut et al., PRL 111, 112501 (2013).

HK 10.7 Mo 18:30 HZ 4

Investigation of low-lying dipole strength in ^{124}Sn — •D. Symochko[1], T. Aumann[1], M. Bhike[2], V. Derya.[3], M. Duchêne[1], J. Isaak[4], J. Kelley[2], M. Knörzer[1], B. Löher[4], N. Pietralla[1], D. Savran[4], H. Scheit[1], A. Tonchev[5], W. Tornow[2], V. Werner[1,6], and A. Zilges[3] — [1]Institut für Kernphysik, Technische Universität Darmstadt, Germany — [2]Department for Physics, Duke University, USA — [3]Institut für Kernphysik, Universität zu Köln, Germany — [4]ExtreMe Matter Institute EMMI and Research Division, Darmstadt, Germany — [5]Lawrence Livermore National Laboratory, USA — [6]WNSL, Yale University, USA

Dipole excitations in the semi-magic ^{124}Sn nucleus were studied in (γ,γ') reactions using the γ^3 - high-efficiency detector setup [1]. The experiment was carried out with quasimonoenergetic photon beams provided by the HIγS facility at the TUNL in the energy range from 5.2 to 8.6 MeV at 15 different energies. Measurements allowed to identify near 80 new transitions to the ground state, obtain reduced transition probabilities and assign parity quantum numbers to the observed excited states. Besides, the γ-γ coincidence technique gave access to the γ-decay pattern of the Pygmy Dipole Resonance, e.g. it was possible to analyse the branching ratios to the first excited 2+ state. Investigations were made as a part of the experimental campaign aimed to obtain a complete picture of dipole strength function evolution in Sn isotopes - from stable ^{112}Sn to short-lived ^{134}Sn.

Supported by DFG (SFB 634 and ZI 510/4-2).

1. B. Löher et al. Nucl. Instr. Meth. 723, P. 136 (2013).

HK 10.8 Mo 18:45 HZ 4

Relative Selbstabsorptionsmessung an ^{140}Ce zur modellunabhängigen Bestimmung von Übergangsbreiten in den Grundzustand* — •Christopher Romig[1], Jacob Beller[1], Jan Glorius[2], Johann Isaak[3,4], Norbert Pietralla[1], Anne Sauerwein[2], Deniz Savran[3,4], Marcus Scheck[1,5,6], Kerstin Sonnabend[2] und Markus Zweidinger[1] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]Institut für angewandte Physik, Goethe-Universität Frankfurt — [3]ExtreMe Matter Institute EMMI and Research Divison, GSI, Darmstadt — [4]Frankfurt Institute for Advanced Studies FIAS, Goethe-Universität Frankfurt — [5]School of Engineering, University of the West of Scotland, Paisley, UK — [6]SUPA, Scottish Universities Physics Alliance, Glasgow, UK

Am Darmstädter S-DALINAC wurde erstmals eine relative Selbstabsorptionsmessung am Nuklid ^{140}Ce durchgeführt. Die Methode der Selbstabsorption erlaubt es, Übergangsbreiten Γ_0 angeregter Zustände in den Grundzustand modellunabhängig zu bestimmen. In Kombination mit Kernresonanzfluoreszenzmessungen (KRF) ist es darüber hinaus möglich, auch das Verzweigungsverhältnis Γ_0/Γ in den Grundzustand zu extrahieren. Letzteres stellt eine wesentliche Unsicherheit bei der Analyse von KRF-Messungen dar und kann somit überprüft werden. Die Methode und gewonnenen Ergebnisse werden vorgestellt und diskutiert. Das Verzweigungsverhältnis Γ_0/Γ wird mit entsprechenden Ergebnissen aus Simulationen im statistischen Modell verglichen.

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