HK 9: Struktur und Dynamik von Kernen II

Time: Monday 16:30–19:00 Location: O-1

Group Report HK 9.1 Mon 16:30 O-1

Octupole Vibrations in Rare-earth Nuclei — •Michael Elvers[1,2], Carolin Küppersbusch[1], Janis Endres[1], Deniz Savran[2,3,4], Volker Werner[2], and Andreas Zilges[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Wright Nuclear Structure Laboratory, Yale University — [3]ExtreMe Matter Institute EMMI and Research Division, GSI, Darmstadt — [4]Frankfurt Institute for Advanced Studies FIAS

In rare-earth nuclei with nucleon numbers close to the neutron and proton shell closure, low-lying excitations can be described in terms of phonon excitations. The easiest excitations are quadrupole and octupole vibrations carrying spin $J^\pi = 2^+$ and $J^\pi = 3^-$, respectively, which can couple to two-phonon states with spin $(1-5)^-$. With an increasing number of both valence protons and neutrons, the nuclei show a deformed axially symmetric shape which leads to a new quantum number K. Now octupole vibrations built on rational states are observed and a band structure is established. It is identified by the K quantum number which is, in general, not a good quantum number [1]. Several nuclei in both regions have been investigated via fusion-evaporation reactions and inelastic particle scattering. The results on octupole vibrational states, their decay properties, and the mixing of the K quantum number will be discussed.
Supported by the DFG (ZI 510/4-1), U.S. DOE grant DE-FG02-01ER40609, Alliance Program of the Helmholtz Association (HA216/EMMI), and Bonn-Cologne Graduate School of Physics and Astronomy. [1] A. Bäcklin *et. al*, Nucl. Phys. **A380** (1982) 189.

HK 9.2 Mon 17:00 O-1

Investigation of Octupole Vibrational States in ^{146}Sm — •Carolin Küppersbusch, Michael Elvers, Janis Endres, and Andreas Zilges — Institut für Kernphysik, Universität zu Köln

The even-even nucleus ^{146}Sm has spherical shape because of its proximity to the neutron shell closure at N=82. The lowest energy levels in those nuclei are usually interpreted to be collective vibrational excitations. However, it is still unresolved to what extent energy levels with higher spin can be described as a coupling of vibrational phonons in consideration of multipole-multipole interactions.
The fusion evaporation reaction ^{144}Nd(α,2nγ)^{146}Sm was performed at the tandem accelerator of the IFIN HH in Bucharest-Magurele, Rumania. The γ rays were detected using a detector array consisting of 8 high-purity germanium detectors. By means of the coincidence technique and complemented by the data of an early experiment at the tandem accelerator at the IKP in Cologne the level scheme could be extended. Experimental results and their physical interpretation will be presented.
Supported by the DFG (ZI 510/4-1) and by the Bonn-Cologne Graduate School of Physics and Astronomy.

HK 9.3 Mon 17:15 O-1

Vollständige Lösung eines Quadrupol-Oktupol-Modells — •Michael Strecker[1], Nikolay Minkov[2] und Horst Lenske[1] — [1]Institut für Theoretische Physik, Universität Giessen — [2]Institute of Nuclear Research and Nuclear Energy, Sofia, Bulgaria

Wir untersuchen ein kollektives Modell, dessen Hamiltonoperator einen Vibrations- und einen Rotationsanteil in den Quadrupol- (β_2) und Oktupolfreiheitsgraden (β_3) besitzt. Unter gewissen Einschränkungen, welche insbesondere gleiche Oszillatorfrequenzen ω_2 und ω_3 implizieren, konnten analytische Lösungen für die Energien und Wellenfunktionen angegeben werden.

Die vollständige Lösung dieses Modells wird numerisch durch Diagonalisation gewonnen, wobei die bekannten Wellenfunktionen als Basis dienen. Erste Rechnungen für ^{152}Sm zeigen, dass die Energieniveaus und Übergangswahrscheinlichkeiten deutlich besser beschrieben werden können. Wie bei der analytischen Lösung werden dabei Modellparameter angepasst. Auf diese Weise konnte die Standardabweichung zum Experiment um mehr als einen Faktor 2 verbessert werden.

Gefördert durch HIC for FAIR.

HK 9.4 Mon 17:30 O-1

Quadrupole and other multipole excitations in skin nuclei. — •Nadia Tsoneva and Horst Lenske — Institut für Theoretische Physik, Universität Giessen

Quadrupole excitations are investigated theoretically in Sn nuclei at energies up to 35 MeV. A method incorporating the density functional theory (DFT) and quasiparticle-phonon model (QPM) is applied [1]. A question of a special interest is to what extent the presence of a neutron or proton skin will affect low-energy 2^+ states located above the 2^+_1 state and below the neutron threshold, particularly exploring their connection to the thickness of the neutron or proton skin, respectively. By analyzing of the structure and transition densities of the quadrupole states, a new quadrupole mode at excitation energies E*≈ 2-4 MeV is identified and related to pygmy quadrupole resonance (PQR)[2].

Furthermore, the unique character of the PQR states is confirmed in QPM calculations of M1 and E2 transitions indicating that these states are different from the known scissors mode [3] which are typically located in similar energy domain.

Investigations of electric and magnetic dipole strength distributions in skin nuclei at different mass regions are discussed and compared to experimental data [4] . The results reveal interesting aspects of the nuclear isospin dynamics. Supported by BMBF project 06GI9109.

[1] N. Tsoneva, H. Lenske, Phys. Rev. **C 77**, 024321 (2008).
[2] N. Tsoneva and H. Lenske, PLB, in press, doi:10.1016/j.phys.letb.2010.11.002.
[3] N. Pietralla, et al., Prog. Part. Nucl. Phys. **60** (2008) 225.
[4] A. Tonchev et al., Phys. Rev. Lett. **104** (2010) 072501.

HK 9.5 Mon 17:45 O-1

E2 ratios and transition radii differences for one-phonon states of spherical nuclei from electron scattering at low momentum transfer — •Abdulrahman Scheikh Obeid, Oleksiy Burda, Maksym Chernykh, Andreas Krugmann, Peter von Neumann-Cosel, Norbert Pietralla, Iryna Poltoratska, Vladimir Ponomarev, and Christopher Walz — IKP, TU Darmstadt, 64289 Darmstadt, Germany

In order to extract the E2 excitation strength of isospin-polarized one-phonon states from electron scattering spectra we measure their scattering cross section. In a model-independent way the ratio of the E2 strengths of the symmetric and mixed-symmetric 2^+ states in a spherical nucleus is directly proportional to the ratio of the peak areas of the states observed in inclusive electron scattering reactions at low momentum transfer. This procedure reduces the systematic errors included in the absolute cross sections. For data on ^{92}Zr this ratio which is related to the strength of the proton-neutron interaction is about 2 times more precise than the one extracted from lifetime informations [1]. From sufficiently precise data we can deduce the difference of the E2 transition radii for the two one-phonon states. This is demonstrated on the data for the N=52 isotone ^{94}Mo [2].

Support By the DFG under Grant No. SFB 634, By the Helmholtz International Center for FAIR.

[1] C. Fransen *et al.*,Phys. Rev. C **71** 054304 (2005).
[2] O. Burda *et al.,* Phys. Rev. Lett. **99** 029503 (2007).

HK 9.6 Mon 18:00 O-1

Eine neue Methode zur Identifikation eines gemischt-symmetrischen Quadrupol-Zustands — •C. Walz, A. Krugmann, P. von Neumann-Cosel, N. Pietralla, V. Yu. Ponomarev, A. Scheikh-Obeid und J. Wambach — Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany

Symmetrische (FSS) und gemischt-symmetrische (MSS) Quadrupol-Zustände als Grundbausteine von kollektiven, niederenergetischen Strukturen in sphärischen Kernen sind ein etabliertes Konzept. Die Kenntnis ihrer Eigenschaften liefert einen wichtigen Beitrag zum Verständnis der Proton-Neutron Restwechselwirkung und dem Formationsmechanismus von kollektiven Anregungsmoden.

Bisher diente zur experimentellen Identifikation des MSS ein großes M1-Matrixelement zum FSS von $\sim 1\mu_N$. Dieser Beitrag stellt zum ersten Mal eine weitere Signatur zur Identifikation eines MSS vor. Die neue Signatur basiert auf der Messung von Masse- und Ladungsübergangsradien in Proton- und Elektronstreuexperimenten. Am Beispiel von ^{92}Zr und ^{94}Mo wird gezeigt, dass der Masseübergangsradius des MSS im Vergleich zu anderen 2^+ Zuständen in der relevanten Energieregion am kleinsten ist. Die Ladungsübergangsradien sind am Rahmen experimenteller Fehler gleich. Durch Analyse von Übergangsdichten des Quasi-Particle Phonon Models wird gezeigt, dass der kleine Mas-

seübergangsradius des MSS eine direkte Konsquenz seines gemischtsymmetrischen Charakters ist.

*Supported by DFG (SFB 634).

HK 9.7 Mon 18:15 O-1

β-delayed γ-ray spectroscopy of 196Hg — •C. Bernards[1,2], M. Elvers[1,2], D. Radeck[1,2], J. Jolie[1], T. Thomas[1], K.O. Zell[1], T. Ahn[2], A. Heinz[2], G. Ilie[2], D. Savran[2], V. Werner[2], T. Ahmed[3], C. Deng[3], E. Jiang[3], R. Lee[3], and N. Shenkov[3] — [1]IKP, University of Cologne, Germany — [2]WNSL, Yale University, USA — [3]University of Richmond, USA

Recent experimental results on the nucleus 196Hg – especially newly determined level spins and multipole mixing ratios of γ-transitions between low-energy states – show a good agreement with supersymmetrical predictions, describing 196Hg as the two-fermion, five-boson member of the supermultiplet around 194Pt. To complete the data of a previous 194Pt$(\alpha, 2n)$ experiment and to search for further low-lying low-spin states that might not be populated by that reaction, we chose to perform a new experiment on 196Hg. This time we approach 196Hg via β-decay. We used a 35 MeV proton beam at the Wright Nuclear Structure Laboratory to induce the reaction 198Hg$(p, 3n)$196Tl. Our target consisted of highly enriched 198Hgs. One β-decay branch populates preferably the low-spin states we are interested in. The 196Hg γ-transitions were detected with the highly efficient YRAST Ball γ-spectrometer. We present results of the experiment and discuss the description of the even-even mercury isotopes in the context of the nuclear structure supersymmetry. Supported by DFG grants Jo391/2-3, Jo391/3-2, and by U.S. DOE grant DE-FG02-91ER40609.

HK 9.8 Mon 18:30 O-1

Betrachtung der Hf-Hg Region um A=190 mit dem IBM — •Claudia Hafeneger, Linus Bettermann und Jan Jolie — Institut für Kernphysik, Universität zu Köln, Zülpicherstr. 77, 50937 Köln

Auf Grund abrupter Änderungen strukturrelevanter Ordnungsparameter und Analogien zur Landau-Theorie, wird an der O(6) Symmetrie des Interacting Boson Model (IBM) ein Phasenübergang erster Ordnung mit Übergang vom prolatem zu oblatem Rotor erwartet. Kürzlich wurde mit der Oszillation des Ordnungsparameters $\Delta K_3 = K_3(0_2^+) - K_3(0_1^+)$ erstmals eine wichtige charakteristische Signatur für einen Phasenübergang erster Ordnung gezeigt. Bereits in Ref. [2] wurden Kerne der Hf-Hg Region um A=190 im IBM mit einem freien Parameter beschrieben.

Die selben Kerne wurden nun an zwei freie Parameter mit besonderer Berücksichtigung des 0_2^+ Zustandes angepasst. Die berechneten Übergangsstärken wurden genutzt, um die Forminvarianten $K_3(0_1^+)$ und $K_3(0_2^+)$ für die einzelnen Kerne zu bestimmen, da experimentelle Daten zur Bestimmung der Forminvarianten K_3 für den 0_2^+ Zustand für sämtliche Kerne der Übergangsregion nicht zur Verfügung stehen. Die Übergangsregion wird anhand der Ergebnisse diskutiert.

[1] L. Bettermann *et al.*, Phys. Rev. C 81, 021303(R), 2010
[2] J.Jolie und A. Linnemann, Phys. Rev. C 68, 031301(R), 2003

HK 9.9 Mon 18:45 O-1

Search for one-phonon mixed-symmetry states in the radioactive nucleus ^{140}Nd — •Georgi Rainovski[1,2], Kalin Gladnishki[2], Pavel Petkov[3,4], Jan Jolie[3], Norbert Pietralla[1], Andrey Blazhev[3], Antoaneta Damyanova[2], Miroslav Danchev[2], Alfred Dewald[3], Christoph Fransen[3], Matthias Hackstein[3], Doycho Karagyozov[2], Oliver Möller[1], Thomas Pissulla[3], Michael Reese[1], Wolfram Rother[3], and Rositsa Topchiyska[2] — [1]Institut für Kernphysik, Technische Universität Darmstadt, D-64289 Darmstadt, Germany — [2]Faculty of Physics, St. Kliment Ohridski University of Sofia, 1164 Sofia, Bulgaria — [3]Institut für Kernphysik, Universität zu Köln, D-50937 Köln, Germany — [4]Bulgarian Academy of Sciences, Institute for Nuclear Research and Nuclear Energy, 1784 Sofia, Bulgaria

Low-spin excited states of ^{140}Nd have been studied via the ^{140}Ce(^{3}He,3n)^{140}Nd reaction. The data show that one of the candidates for the one-phonon mixed symmetry state of ^{140}Nd, namely the 2_3^+ state at 2140 keV with an effective lifetime of 220(90) fs, exhibits a fast $M1$ decay to the 2_1^+ state. Thus this state can be considered, at least, as a fragment of the one-phonon MSS of ^{140}Nd. This is the first example where mixed symmetry character is tentatively assigned to a state of an unstable nucleus from the mass $A \approx 140$ region based on the data on absolute $M1$ transition rates. However, the data are not conclusive on whether this decay exhausts the total $M1$ strength or whether the one-phonon mixed symmetry state of ^{140}Nd is fragmented.