HK 65: Structure and Dynamics of Nuclei XII

Time: Thursday 15:45–17:15 Location: HBR 19: C 5a

Group Report HK 65.1 Thu 15:45 HBR 19: C 5a

Precision ab initio nuclear structure and implications for fundamental physics — •Matthias Heinz[1,2,3], Kai Hebeler[1,2,3], Jan Hoppe[1,2], Takayuki Miyagi[1,2,3], Achim Schwenk[1,2,3], S. Ragnar Stroberg[4], and Alexander Tichai[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg — [4]Department of Physics and Astronomy, University of Notre Dame

Ab initio nuclear structure theory aims to predict the structure of atomic nuclei from “first principles,” employing systematically improvable approximations in the determination of nuclear forces and in the solution of the many-body Schrödinger equation. Over the past two decades, this ab initio paradigm has been successfully established as a consistent, precise framework for predicting the structure of medium-mass nuclei (closed- and open-shell) and can now also reach heavy systems. Recent developments have extended ab initio calculations on two frontiers: towards higher precision and towards heavier nuclei. I discuss improvements in the treatment of three-body forces to allow converged calculations of ^{208}Pb and high-precision calculations improving the description of calcium isotopes. The precise many-body treatment will be important to understand nuclear structure effects in new physics searches in nuclei.

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HK 65.2 Thu 16:15 HBR 19: C 5a

Evolution of the quadrupole moment of Cd and Sn nuclei — •Pawan Kumar[1,2], Gabriel Martinez-Pinedo[2,1], and Paul-Gerhard Reinhard[3] — [1]Institut für Kernphysik (Theoriezentrum), Fachbereich Physik, Technische Universität Darmstadt, Darmstadt 64298, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt 64291, Germany — [3]Institut für Theoretische Physik II, Universität Erlangen, Erlangen 91058, Germany

The nuclear quadrupole moment is one of the important properties of nuclei. It is taken as a measure of the deviation of nuclear shape from sphericity. While extensive studies by both theorists and experimentalists have been conducted on the nuclear quadrupole moment over the years, its understanding at one aspect has remained elusive: why does the value of the quadrupole moment change in an isotopic chain while the number of protons remains constant? To address this question, we have conducted a theoretical investigation based on the shell model and nuclear density functional theory. Applying these complementary models to the $11/2^-$ and $3/2^+$ states of neutron-rich Cd and Sn nuclei, our investigation reveals that the evolution of the nuclear quadrupole moment in these isotopic chains is a consequence of neutron-induced polarization, which varies with neutron number.

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HK 65.3 Thu 16:30 HBR 19: C 5a

Probing the doubly magic shell closure at ^{132}Sn by Coulomb excitation of neutron-rich ^{130}Sn — •Maximilian Droste[1], Peter Reiter[1], and Thorsten Kröll[2] for the MINIBALL IS702-Collaboration — [1]IKP, Universität zu Köln, Germany — [2]IKP, Technische Universität Darmstadt, Germany

Excited states of ^{130}Sn, the even-even neighbour of the doubly-magic nucleus ^{132}Sn, were populated via safe Coulomb excitation employing the recently commissioned, highly efficient MINIBALL array. The ^{130}Sn ions were accelerated by the HIE-ISOLDE accelerator to an energy of 4.4 MeV/u and impinged onto a ^{206}Pb target. Deexciting γ rays have been recorded in coincidence with scattered particles. Besides γ rays from the first 2^+ state, deexcitation from higher-lying states was observed. The latter is caused by an isomeric $^{130}\mathrm{Sn}_{7^-}$ beam component. Reduced transition strengths for the $0^+_{g.s.} \rightarrow 2^+_1$ ^{130}Sn will illucidate the evolution of collectivity and nuclear structure around the magic shell closure at N=82, Z=50 tin isotopes. Advanced shell model calculations predict enhanced collectivity in the neighbouring isotopes of ^{132}Sn [1]. Moreover, a puzzling discrepancy between previous measurements in ^{130}Sn and latest theoretical results [2] awaits to be resolved.

[1] D. Rosiak et al. Phys. Rev. Lett. 121, 252501 (2018)
[2] T. Togashi et al. Phys. Rev. Lett. 121, 062501 (2018)

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HK 65.4 Thu 16:45 HBR 19: C 5a

Two-body currents at finite momentum transfer — •Catharina Brase[1,2,3], Takayuki Miyagi[1,2,3], Javier Menéndez[4,5], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg — [4]Departament de Física Quántica i Astrofísica, Universitat de Barcelona, 08028 Barcelona, Spain — [5]Institut de Ciències del Cosmos, Universitat de Barcelona, 08028 Barcelona, Spain

Two-body currents (2BCs) at zero momentum transfer are essential for understanding observables of electroweak interactions with nuclei, such as helping to solve the long-standing quenching problem. For other processes, e.g., weakly-interacting massive particles scattering off nuclei, 2BCs need to be evaluated at finite momentum transfer and are currently only approximately included. We derived a multipole decomposition of 2BCs to include 2BCs at finite momentum transfer in calculations for processes with medium-mass nuclei, without approximating the 2BCs. To validate the derived multipole decomposition of the 2BCs we compare matrix elements of 2BCs from chiral effective field theory in a harmonic oscillator basis evaluated with the multipole decomposition and with brute force, i.e., Monte Carlo integration to numerically evaluate the diagrams.

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HK 65.5 Thu 17:00 HBR 19: C 5a

Shell model investigations along the $N = 31$ and $Z = 28$ chains — •Ramona Burggraf, Peter Reiter, Konrad Arnswald, Andrey Blazhev, Maximilian Droste, Christoph Fransen, and Hannah Kleis — IKP, Universität zu Köln

Lifetime measurements of excited states along the $N = 31$ chain were performed in order to investigate the $N = 32$ sub-shell closure at higher masses near proton magic number $Z = 28$. Precise lifetime values for excited states were determined in ^{59}Ni and ^{57}Fe, which were populated in ^{51}V(^{12}C, $p3n$) and ^{51}V(^{12}C, $pn\alpha$) fusion-evaporation reactions at a beam energy of 55 MeV at the FN tandem accelerator of the University of Cologne. The Cologne plunger device, surrounded by an efficient γ-ray detector array was used to determine lifetimes with the recoil-distance Doppler-shift method. The newly determined values differ significantly from previous experimental results. New shell-model calculations employing the GXPF1A interaction were performed for nuclei along the $N = 31$ and $Z = 28$ chains. The evaluated previous experimental B(E2; $9/2^- \rightarrow 5/2^-$) values for the $N = 31$ isotone chain do not show reduced lower values at the $Z = 28$ shell closure which is in contrast to the results of the shell model calculations. However, the newly determined lifetime values are consistent with the latest theoretical findings.