HK 18: Structure and Dynamics of Nuclei IV

Time: Monday 16:00–17:45 Location: HK-H7

Group Report HK 18.1 Mon 16:00 HK-H7

The search for the tetraneutron — •Meytal Duer[1] and Thomas Aumann[1,2] for the NeuLAND-SAMURAI-Collaboration — [1]TU Darmstadt — [2]GSI Helmholtzzentrum

Whether multi-neutron systems can exist as weakly bound states or very short-lived unbound resonant states has been a long-standing quest. The discovery of such a system would have far-reaching implications for many aspects of nuclear physics, from the nature of the force itself up to the way it builds nuclei, and also for the modeling of neutron stars.

The experimental search for isolated multi-neutron systems has been going for six decades, with a particular focus on the four-neutron system called tetraneutron, resulting in up to date only few indications for its existence, leaving it an elusive nuclear system.

In this talk I will present our most recent result from an experiment performed at the RIKEN Nishina Center located in Japan. The measurement was conducted at the SAMURAI setup, there using a new experimental approach based on a knockout reaction at large momentum transfer with radioactive high-energy ^{8}He beam we were able to investigate the four-neutron system.

This work is supported by the DFG through grant no. SFB 1245, the GSI-TU Darmstadt cooperation and the BMBF project 05P15RDFN1.

HK 18.2 Mon 16:30 HK-H7

Precise and Accurate Measurement of the Neutron-Neutron Scattering Length — •Marco Knösel[1] and Thomas Aumann[1,2,3] for the NeuLAND-SAMURAI-Collaboration — [1]Technische Universität Darmstadt — [2]GSI Helmholtz-Zentrum für Schwerionenforschung — [3]Helmholtz Forschungsakademie Hessen für FAIR

In this contribution, a new experimental approach is presented to determine the neutron-neutron scattering length using the knockout reactions ^{6}He$(p,p\alpha)2n$ and $t(p,2p)2n$ as well as the charge-exchange reaction $d(^{7}\mathrm{Li},^{7}\mathrm{Be})2n$. In order to coincidently detect the two neutrons in the final states of these reactions with sufficient time and position accuracy, a new high-resolution neutron detector has to be developed. This is done at Technische Universität Darmstadt in cooperation with the SAMURAI collaboration at RIKEN in Japan, where the experiment will take place. The value of the neutron-neutron scattering length can be inferred from the comparison of the experimentally determined $2n$ relative-energy spectrum to halo EFT calculations.

This work is supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245, the BMBF under contract number 05P21RDFN2 and the GSI-TU Darmstadt cooperation agreement.

HK 18.3 Mon 16:45 HK-H7

Ground and dipole excited states of the ^{8}He halo nucleus from ab initio coupled-cluster theory —

•Francesca Bonaiti[1], Sonia Bacca[1,2], and Gaute Hagen[3,4] — [1]Institut für Kernphysik and PRISMA+ Cluster of Excellence, Johannes Gutenberg-Universität, 55128 Mainz, Germany — [2]Helmholtz-Institut Mainz, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany — [3]Physics Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA — [4]Department of Physics and Astronomy, University of Tennessee, Knoxville, TN 37996, USA

We perform coupled-cluster calculations of ground- and dipole excited-state properties of the ^{8}He halo nucleus with nucleon-nucleon and three-nucleon interactions from chiral effective field theory, both with and without explicit delta degrees of freedom. By increasing the precision in our coupled-cluster calculations from inclusion of leading order three-particle three-hole excitations in the cluster operator, we are able to reproduce (within uncertainties) the available experimental data for the ground-state energy and the charge radius. We also investigate the excited states induced by the electric dipole operator and present a discussion on the Thomas-Reiche-Kuhn and cluster sum rules. Finally, we compute the electric dipole polarizability, providing a theoretical benchmark for future experimental determinations that will study this exotic nucleus.

HK 18.4 Mon 17:00 HK-H7

E1 strength distribution of ^{11}Li in Halo EFT — •Matthias Göbel[1], Daniel R. Phillips[2], and Hans-Werner Hammer[1,3] — [1]Technische Universität Darmstadt, 64289 Darmstadt, Germany — [2]Ohio University, Athens, Ohio 45701, USA — [3]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

Low-energy enhancements of E1 strength distributions are a characteristic property of halo nuclei. We use Halo EFT with a ^{9}Li core and the two halo neutrons as degrees of freedom to calculate this observable for the two-neutron halo nucleus ^{11}Li.

The E1 strength distribution is significantly influenced by final-state interactions. We investigate their role and test different approximation schemes. The comparison of the leading-order results with experimental data from RIKEN [T. Nakamura et al., Phys. Rev. Lett. 96, 252502 (2006)] shows reasonable agreement.

This work was supported Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245 and by the U.S. Department of Energy (Contract No. DE-FG02-93ER40756).

HK 18.5 Mon 17:15 HK-H7

Three-body resonances in pionless effective field theory — •Sebastian Dietz[1], Hans-Werner Hammer[1,2], Sebastian König[3,1], and Achim Schwenk[1,2,4] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI and Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Darmstadt — [3]Department of Physics, North Carolina State University, Raleigh — [4]Max-Planck-Institut für Kernphysik, Heidelberg

We investigate the appearance of resonances in three-body systems using pionless effective field theory at leading order. The Faddeev equation is analytically continued to the unphysical sheet adjacent to the positive real energy axis using a contour rotation. We consider both the three-boson system and the three-neutron system. For the former, we calculate the trajectory of Borromean three-body Efimov states turning into resonances as they cross the three-body threshold. For the latter, we find no sign of three-body resonances or virtual states at leading order.

* This work was supported in part by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Projektnummer 279384907 - SFB 1245 and by the National Science Foundation under Grant No. PHY-2044632. This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, under the FRIB Theory Alliance award DE-SC0013617. Computational resources have been provided by the Jülich Supercomputing Center.

HK 18.6 Mon 17:30 HK-H7

Investigating Short-Range Correlations in exotic nuclei at R3B using inverse kinematics — •Enis Lorenz[1], Thomas Aumann[1,2], Anna Corsi[3], Aldric Revel[3], Meytal Duer[1,2], Or Hen[4], and Julian Kahlbow[4,5] for the R3B-Collaboration — [1]TU Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung Darmstadt, Germany — [3]CEA-Saclay, France — [4]Massachusetts Institute of Technology, Cambridge, USA — [5]Tel Aviv University, Tel Aviv, Israel

Short-Range Correlations (SRC) are two-body components of the nuclear wave function with high relative momentum and low center-of-mass momentum relative to the Fermi momentum, k_F. These high-momentum nucleons, which are absent in a simple Fermi gas model, are formed as temporary closed-proximity nucleon pairs with high density, several times the nuclear saturation density. Studying the characteristics of SRC-pairs gives an unique opportunity to explore the interaction of cold dense nuclear matter as in neutron stars.

The first kinematically complete measurement of SRC in exotic nuclei will be performed at the R3B setup as part of the FAIR Phase-0 experimental program in Spring 2022 by scattering a ^{16}C beam off a liquid hydrogen target in inverse kinematics at energy of 1.25 GeV/nucleon.

This work is supported by the State of Hesse within the Research Cluster ELEMENTS project 500/10.006 and by the German Federal Ministry for Education and Research (BMBF) under contract number 05P21RDFN2.