# HK 12: Structure and Dynamics of Nuclei II

Zeit: Montag 16:30–18:30 Raum: HS 14

HK 12.1 Mo 16:30 HS 14

**Investigation of the Dineutron System via Quasi-Free $^4$He-Knockout Reactions at $^6$He** — •Marco Knösel[1], Thomas Aumann[1,2], Christopher Lehr[1], and Vadim Wagner[1] for the NeuLAND-SAMURAI-Collaboration — [1]Technische Universität Darmstadt — [2]GSI Helmholtz-Zentrum für Schwerionenforschung

In this contribution, a status update on the analysis of a $^6$He$(p, p\alpha)^2n$ experiment in inverse kinematics is given. In order to study the neutron-neutron interaction, a high-energy radioactive $^6$He beam has been directed to a thick liquid hydrogen target, where the alpha particle is removed in a fast quasi-free knockout reaction. The shape of the two-neutron relative energy spectrum thereby is sensitive to the neutron-neutron scattering length. To calculate the distribution of relative energies, the invariant mass of the two-neutron system is measured. The experiment was performed at the SAMURAI setup at RIKEN using the NeuLAND demonstrator (of the R$^3$B setup at GSI/FAIR) and NEBULA as neutron detectors.

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HK 12.2 Mo 16:45 HS 14

**Determining the Neutron-Neutron scattering length with a high resolution relative energy measurement** — •Vadim Wagner, Thomas Aumann, and Heiko Scheit — TU Darmstadt, Darmstadt, Deutschland

In this contribution a short overview about a proposed experiment at Riken (Japan) for a high precision measurement of neutron-neutron relative energies produced in $^6$He(p,p$\alpha$)$^2$n reactions to determine the neutron-neutron scattering length will be presented. Previous measurements with two different methods do not agree well, therefore this experiment was proposed with the goal to achieve a total uncertainty of $\pm 0.2$ fm. The sensitivity of this method lies in the shape of the relative energy spectrum, therefore it is crucial that the shape of spectrum is not changed due to acceptance and cross talk rejection. This was investigated with a simulation of the response of the neutron detector HIME.

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HK 12.3 Mo 17:00 HS 14

**Structure of $^6$He in Halo EFT** — •Matthias Göbel[1], Daniel R. Phillips[2,3], and Hans-Werner Hammer[1,3] — [1]Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany — [2]Institute of Nuclear and Particle Physics and Department of Physics and Astronomy, Ohio University, Athens, Ohio 45701, USA — [3]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

The Borromean two-neutron halo $^6$He with its scale separations is well suited to a treatment in Halo EFT with the neutrons (n) and the $\alpha$ core as degrees of freedom. The $s$-wave $nn$ interaction and the $^2P_{3/2}$ $\alpha n$ interaction as well as a three-body force are employed in our leading order analysis.

Using the Faddeev equations, the leading order results of Ji, Elster and Phillips (see Phys. Rev. C **90** (2014) 044004) for the Faddeev amplitudes are reproduced. Based on these amplitudes, we study the structure of $^6$He by calculating the momentum space probability density as seen with different spectator particles. Moreover, the results for the $nn$ relative energy distribution will be presented.

HK 12.4 Mo 17:15 HS 14

**Resonances and virtual states in few-body systems** — •Sebastian Dietz[1], Hans-Werner Hammer[1,2], Sebastian König[1,2], and Joel E. Lynn[1,2] — [1]IKP, TU Darmstadt — [2]EMMI, GSI Darmstadt

We present an investigation of the analytic structure of the $S$-matrix for three-body systems using the framework of pionless effective field theory. The three-body Faddeev equation in momentum space is rewritten using the dimer formalism and analytically continued onto the unphysical sheet below the positive real energy axis. This formalism is applied to the three-boson system with large scattering length. The investigation is performed as a function of the two-body scattering length and the range of validity is examined. As a further application, the position of the triton virtual state is calculated.

HK 12.5 Mo 17:30 HS 14

**Elastic NN-Scattering with Coupled N$\Delta$-Channels in Chiral Effective Field Theory** — •Susanne Strohmeier and Norbert Kaiser — Technische Universität München

We study the elastic nucleon-nucleon scattering ($T_{\rm lab} \leq 300\,$MeV) by employing the dynamics of the coupled channels. The potentials arising from one- and two-pion exchange, with iterative contributions properly subtracted, are derived from chiral effective field theory at next-to-leading order. The peripheral phase shifts and mixing angles are compared with the Nijmegen partial wave analysis up to I-waves. The short-range contact interaction in the coupled (NN, N$\Delta$, $\Delta$N, $\Delta\Delta$)-channels is constructed up to next-to-leading order (i.e. quadratic in momenta) and the associated low energy constants are determined in fits to empirical NN-scattering phase shifts. We compare solutions of the Kadyshevsky equation with iterative treatments and identify the subset of short-distance parameters with physical significance.
Work supported in part by DFG and NSFC (CRC110).

HK 12.6 Mo 17:45 HS 14

**Exploring alternative SRG generators in one dimension** — •Matthias Heinz[1,2], Kai Hebeler[1,2], and Achim Schwenk[1,2,3] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Planck-Institut für Kernphysik, Heidelberg

The Similarity Renormalization Group (SRG) is used in nuclear theory to decouple high- and low-momentum components of nuclear interactions to improve convergence and thus reduce the computational requirements of many-body calculations. The SRG evolution is characterized by the generator, which determines toward what form the Hamiltonian is transformed. Currently, the standard choice for the generator is the kinetic energy, which evolves the Hamiltonian towards a diagonal form. However, it has been shown that significant contributions from four- and higher-body forces can be induced during the evolution, which limits the application of evolved potentials to many-body problems. Alternative generators may generate weaker many-body forces while offering the same improvements of the many-body convergence. In this talk, I will discuss the use of 1-D systems of two, three and four bosons to investigate alternative generator choices and to study the many-body convergence and the size of the induced many-body forces.

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HK 12.7 Mo 18:00 HS 14

**Single-particle potentials of hyperons in nuclear and neutron matter: Role of 3-baryon forces** — •Dominik Gerstung, Norbert Kaiser, and Wolfram Weise — Technische Universität München

The Brueckner G-matrix formalism is employed to calculate the single-particle potentials of nucleons and hyperons in isospin-symmetric nuclear matter and pure neutron matter. The underlying two-body interactions consist of NLO chiral two-baryon potentials and effective density-dependent baryon-baryon interactions derived from the leading order chiral three-baryon forces. We compute the chemical potentials of neutrons and $\Lambda(1116)$-hyperons in order to investigate the critical density for the onset of $\Lambda$-formation in neutron-star matter.

The contact and one-pion exchange components of the NN$\Lambda$ 3-body force depend on two yet undetermined short-distance parameters $H_1$ and $H_2$, whose ranges are explored by imposing empirical constraints from $\Lambda$-hypernuclei and nuclear matter.

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HK 12.8 Mo 18:15 HS 14

**Structure of three-body hypernuclei** — •Fabian Hildenbrand and Hans-Werner Hammer — Institut für Kernphysik, TU Darmstadt, 64289 Darmstadt, Germany

We construct a short-range effective field theory with contact inter-

actions for three-body hypernuclei in the strangeness S=-1 sector. Renormalization is achieved with a one-parameter three-body force. We present universal correlations between observables in the Isospin $I = 1$ and $I = 0$ sector. Furthermore, predictions for the matter radii in both channels are presented. Finally, we discuss the possibility of a Λnn bound state in this effective theory.

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