HK 20: Struktur und Dynamik von Kernen IV

Zeit: Dienstag 14:00–16:00 Raum: HG VII

Gruppenbericht HK 20.1 Di 14:00 HG VII

Density-dependent effective nucleon-nucleon interaction from chiral three-nucleon forces — •Jeremy Holt, Norbert Kaiser, and Wolfram Weise — Technische Universität München, Garching, Germany

We derive density-dependent corrections to the in-medium nucleon-nucleon interaction from the leading-order chiral three-nucleon force arising at next-to-next to leading order (N^2LO) in the chiral expansion. We consider first a medium of isospin symmetric nuclear matter with density ρ and subsequently generalize to a medium with a small isospin asymmetry. At leading order there are six distinct one-loop diagrams contributing to the in-medium nucleon-nucleon interaction, which we combine with the low-momentum potential $V_{\mathrm{low-k}}$ to obtain an effective density-dependent interaction. We suggest that these results should be useful for nuclear structure calculations of medium- and heavy-mass nuclei, where a direct implementation of the three-nucleon force is computationally prohibitive. We apply these results also to a study of the Fermi liquid parameters of symmetric nuclear matter that characterize the interaction of quasi-particles on the Fermi surface. Work supported in part by BMBF, GSI and by the DFG cluster of excellence: Origin and Structure of the Universe.

HK 20.2 Di 14:30 HG VII

Coulomb effects in pionless effective field theory — •Sebastian König[1,2] and Hans-Werner Hammer[1,2] — [1]Helmholtz-Institut für Strahlen- und Kernphysik (Theorie), Universität Bonn — [2]Bethe Center for Theoretical Physics, Universität Bonn

At very low energies, nuclear interactions can be considered purely short-ranged and even pion exchanges can be integrated out. The resulting pionless effective field theory has been successfully applied to the low-energy neutron-deuteron system. Moreover, it has been shown that Coulomb effects can be included to describe proton-deuteron scattering in the quartet channel using the same methods. We show how to improve the numerical convergence in the p-d system at very low-momenta. Furthermore, we present the extension to the doublet channel, where the Triton and He-3 bound states show up.

HK 20.3 Di 14:45 HG VII

Three-body bound states in finite volume with EFT — •Simon Kreuzer[1,2] and Hans-Werner Hammer[1,2] — [1]Helmholtz-Institut für Strahlen- und Kernphysik (Theorie), Universität Bonn — [2]Bethe Center for Theoretical Physics, Universität Bonn

Three particles with large scattering length display a universal spectrum of three-body bound states called "Efimov trimers". We calculate the modification of the Efimov trimers of three identical bosons in a finite cubic box and compute the dependence of their energies on the box size using effective field theory. The renormalization of the effective field theory in the finite volume is explicitly verified. We investigate the effects of partial wave mixing and study the behavior of shallow trimers near the dimer energy. Finally, we will present first results for the triton in a finite volume.

HK 20.4 Di 15:00 HG VII

Nuclear electromagnetic currents from chiral EFT — •Stefan Kölling[1,2], Evgeny Epelbaum[1,2], Hermann Krebs[2], and Ulf-G. Meissner[1,2] — [1]Forschungszentrum Jülich, Institut für Kernphysik (IKP-3) und Jülich Center for Hadron Physics, Jülich, Deutschland — [2]Helmholtz-Institut für Strahlen- und Kernphysik (Theorie) und Bethe Center for Theoretical Physics, Bonn, Deutschland

Using the method of unitary transformation in combination with chiral effective field theory we derive the pion exchange contributions to the two-nucleon electromagnetic current. A formal definition of the current operator in this scheme and the power counting is presented. We discuss the implications of additional unitary transformations that have to be present to ensure the renormalizability of the one-pion exchange current. Further, we give explicit and compact results for the current in coordinate-space.

HK 20.5 Di 15:15 HG VII

Modified effective range expansion for nucleon-nucleon scattering — •David Minossi[1,2], Evgeny Epelbaum[1,2], Manolo Pavon Valderrama[1], and Andreas Nogga[1] — [1]Institut für Kernphysik and Jülich Center for Hadron Physics, Forschungszentrum Jülich, DE-52425, Jülich, Germany — [2]Helmholtz-Institut für Strahlen- und Kernphysik, DE-53115, Bonn, Germany

The technique of the effective range expansion is commonly used in nucleon-nucleon scattering to encode the properties of the nuclear force in a small set of parameters. However, the applicability of the effective range expansion is limited by the longest-range part of the nuclear potential, i.e. by the one pion exchange, to the domain of momenta below half the pion mass. In the 1960s the formalism of the modified effective range expansion was developed. It was first used to remove the effects of the Coulomb force to study proton-proton scattering. We apply this formulation to the nucleon-nucleon interaction to separate the known long-range interactions from the rest to be able to go beyond the momentum region described above. To show the effectiveness of this technique, we consider a toy model with a two-range potential and study the behaviour of the parameters of the effective and modified effective range expansion in this two-scale problem.

HK 20.6 Di 15:30 HG VII

Dynamical compression of the ^{16}O nucleus by a moving antiproton — •A.B. Larionov[1,2,3], I.N. Mishustin[1,2], L.M. Satarov[1,2], and W. Greiner[1] — [1]Frankfurt Institute for Advanced Studies, J.W. Goethe-Universität, D-60438 Frankfurt am Main, Germany — [2]Russian Research Center Kurchatov Institute, 123182 Moscow, Russia — [3]Institut für Theoretische Physik, Universität Giessen

The Giessen Boltzmann-Uehling-Uhlenbeck (GiBUU) transport model with relativistic mean fields is adjusted and applied to antiproton-nucleus interactions in a wide beam-momentum range [1]. Using the antiproton-meson coupling constants determined from the analysis of $\bar{p}$-absorption cross sections on nuclei at low beam momenta [1], we perform the GiBUU calculations of the dynamical response of the ^{16}O nucleus to the moving antiproton [2]. It is shown that a slow antiproton ($p \leq 300$ MeV/c) propagating through the nuclear interior induces the local nucleon density growth up to $\sim 2\rho_0$ caused by a strongly attractive $\bar{p}N$ potential. We evaluate the probability of antibaryon annihilation at enhanced nucleon density, which is $\sim 10^{-5}$ at the beam momenta or $3-10$ GeV/c relevant for FAIR.

Supported by HIC for FAIR.

[1] A.B. Larionov, I.A. Pshenichnov, I.N. Mishustin, and W. Greiner, Phys. Rev. C **80**, 021601(R) (2009).
[2] A.B. Larionov, I.N. Mishustin, L.M. Satarov, and W. Greiner, arXiv:0912.1794

HK 20.7 Di 15:45 HG VII

Three-body correlations as a key to the structure of light unbound nuclei — •Yuliya Aksyutina for the LAND-R3B-Collaboration — ExtreMe Matter Institute EMMI, GSI Darmstadt

The neutron dripline as being defined by the heaviest, proton-deficient, bound isotopes, determines the limit of nuclear stability at the neutron-rich side of the nuclear chart. Neutron or proton knockout from light dripline nuclei leads to the formation of unbound nuclear systems with extreme A/Z ratios, followed by their immediate decay. An experiment of this kind has been performed at GSI (Darmstadt). A relativistic beam consisting of the halo nuclei ^{11}Li and ^{14}Be with energies of 280 and 305 MeV/nucleon, respectively, impinged on a liquid hydrogen target. The experimental setup, consisting of the neutron detector LAND, the dipole spectrometer ALADIN and different types of tracking detectors, allows the reconstruction of the momentum vectors of all reaction products measured in coincidence.

The properties of unbound nuclei were investigated by reconstructing the relative-energy spectra as well as by studying the energy and angular correlations between their decay products. The relative energy spectra were reconstructed for unbound nuclei ^{9,10}He and ^{10,12,13}Li. In addition, three-body ^{8}He + n + n and ^{11}Li + n + n energy and angular correlations in ^{10}He and ^{13}Li were studied using the hyperspherical harmonics formalism, providing information about their structure. The talk is devoted to a discussion of the obtained results for these unbound isotopes and a physics interpretation of the data.

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