HK 13: Structure and Dynamics of Nuclei II

Zeit: Dienstag 11:00–12:30 Raum: F 2

Gruppenbericht HK 13.1 Di 11:00 F 2

Nuclear Physics Around the Unitarity Limit — •Sebastian König — Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany

In the unitarity (or unitary) limit, where the two-nucleon S-wave channels have infinite scattering lengths and zero-energy bound states, only one dimensionful parameter is left and set by the triton binding energy. While the proximity of the real world to this idealized scenario has been discussed qualitatively for a long time, it has traditionally not played any special role in constructing nuclear forces.

Here it is argued that at least light nuclei may reside in a sweet spot: bound weakly enough to be insensitive to the details of the interaction, but dense enough to be insensitive to the exact values of the large two-body scattering lengths as well, so that a systematic expansion around the unitarity limit converges. With this, the gross features of states in the nuclear chart are determined by a very simple leading-order interaction, whereas—much like the fine structure of atomic spectra—observables are moved to their physical values by small *perturbative* corrections. Explicit evidence in favor of this conjecture is shown for the binding energies of three and four nucleons.

Reference: SK, H.W. Grießhammer, H.-W. Hammer, U. van Kolck, arXiv:1607.04623 [nucl-th]

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HK 13.2 Di 11:30 F 2

Partial wave analysis of nucleon-nucleon scattering with a chiral potential at fifth order — •Patrick Reinert, Evgeny Epelbaum, and Hermann Krebs — Institut für Theoretische Physik II, Ruhr-Universität Bochum, D-44780 Bochum, Germany

We use neutron-proton and proton-proton scattering data to determine the low-energy constants of the novel semilocal two-nucleon potentials up to fifth order in chiral effective field theory. To minimize the sensitivity to the chosen energy range, the novel approach to estimate the theoretical uncertainty from the truncation of the chiral expansion is incorporated in the fit procedure. The resulting phase shifts and mixing angles are in a good agreement with the partial wave analyses by the Nijmegen and Granada groups within the estimated theoretical uncertainties. We give χ^2 per datum values and effective range parameters for different ultraviolet cutoffs and chiral orders. Furthermore, we discuss the uncertainty stemming from F-waves which are still free of adjustable parameters at fifth order in the chiral expansion.

HK 13.3 Di 11:45 F 2

Two-pion exchange corrections to the nucleon-nucleon scattering amplitude in the modified Weinberg approach — •Jens Behrendt — Ruhr-Universität Bochum

We consider the two-pion exchange corrections to the potential and calculate the scattering amplitude in the modified, renormalizable Weinberg approach to the nucleon-nucleon scattering problem in chiral effective field theory. This approach uses time-ordered perturbation theory applied to the manifestly Lorentz invariant form of the effective Lagrangian and does not rely on the heavy baryon expansion. In this framework the leading order amplitude is obtained by solving the Kadyshevsky equation and the corrections are calculated perturbatively.

HK 13.4 Di 12:00 F 2

Weinberg eigenvalue analysis based on chiral forces — •Jan Hoppe[1,2], Christian Drischler[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

We apply the Weinberg eigenvalue analysis as a powerful tool to investigate and quantify the perturbativeness of recent local and semilocal chiral nucleon-nucleon potentials. This check is of particular interest in the framework of (many-body) perturbation theory. We study the impact of cutoff variations on non-perturbative sources, such as the repulsive core in terms of the so-called Weinberg eigenvalues. We show results in different partial waves, in free-space and in-medium, where we distinguish repulsive and attractive eigenvalues to diagnose the impact of the different non-perturbative sources. Due to recent advances in normal-ordering, we are able to include 3N contributions up to N^{3}LO and present results for more traditional chiral potentials.

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HK 13.5 Di 12:15 F 2

Charge Symmetry Breaking in the $dd \to {}^4\mathrm{He}\pi^0$ Reaction with WASA-at-COSY — •Maria Zurek — Forschungszentrum Jülich, Jülich, Germany

If protons and neutrons were treated equally by all types of interactions, isospin symmetry would be conserved. Since up and down quarks, which are the constituent quarks of the proton and the neutron, have different charges and masses, isospin symmetry is not an exact one. It is broken both by electromagnetic and strong interactions.

Investigations of the charge symmetry breaking $dd \to {}^4\mathrm{He}\pi^0$ reaction is one of the primary goals for the WASA-at-COSY experiment. The aim is to provide experimental results for comparison with Chiral Perturbation Theory (χ_{PT}) predictions gaining information on the proton-neutron mass difference induced by the strong interaction.

First steps towards a theoretical understanding of the $dd \to {}^4\mathrm{He}\pi^0$ reaction have found that the existing data are not sufficient for a precise determination of the parameters of χ_{PT}, and further data are required at sufficiently high energy where the p-wave contribution becomes important.

Results from a first measurement with the WASA detector setup at a beam momentum of 1.2 GeV/c had been already published, but the limited statistics did not allow a decisive interpretation. Thus, a second measurement using an improved detector setup aiming at higher statistics has been performed in spring 2014. The new results will be presented.