HK 62: Structure and Dynamics of Nuclei XI

Time: Thursday 14:00–15:30 Location: HK-H7

Group Report HK 62.1 Thu 14:00 HK-H7

Extension and acceleration of the in-medium similarity renormalization group — •Matthias Heinz[1,2,3], Jan Hoppe[1,2], Alexander Tichai[1,2,3], Kai Hebeler[1,2,3], 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-Plank Institut für Kernphysik, Heidelberg

The ab initio solution of the nuclear many-body problem for theoretical predictions of nuclear structure observables is a computationally challenging endeavor. Over the past decade, the in-medium similarity renormalization group (IMSRG) has been established as an important method capable of describing a broad range of nuclei up to mass numbers around 100 and beyond, including open-shell systems via different extensions of the method.

A key (as of yet unrealized) milestone in the IMSRG is the relaxation of the many-body truncation of the method, currently restricted to the normal-ordered two-body level, the IMSRG(2). We discuss studies of the next truncation, the IMSRG(3), in small systems and restricted model spaces. We additionally highlight recent developments to accelerate IMSRG calculations that might make the IMSRG(3) more feasible, including basis optimization via natural orbitals and importance truncation applied to the IMSRG.

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HK 62.2 Thu 14:30 HK-H7

Single-particle strength & nucleon correlations of the Ca isotopic chain. — •Luke Rose[1], Stefanos Paschalis[1], Marina Petri[1], Ryo Taniuchi[1], Thomas Aumann[2], Carlo Barbieri[3], Carlos Bertulani[4], Dolores Cortina-Gil[5], Heather Crawford[6], Roman Gernhäuser[7], Marc Labiche[8], Augusto Macchiavelli[6], Alexandre Obertelli[2], Heiko Scheit[2], Daniel Severin[9], Haik Simon[9], Helmut Weick[9], and Christian Sürder[2] for the R3B-Collaboration — [1]The University of York, York, UK — [2]Technical University of Darmstadt, Darmstadt, Germany — [3]University of Surrey, Guildford, UK — [4]Texas A&M University-Commerce, Commerce, USA — [5]Universidade de Santiago de Compostela, Santiago de Compostela, Spain — [6]Lawrence Berkeley National Lab, Berkeley, USA — [7]Technical University of Munich, Munich,Germany — [8]STFC Daresbury, Daresbury, UK — [9]GSI, Darmstdat, Germany

The unique shell structure of Ca isotopes provides an understanding of the evolution of the shell structure and an in-depth exploration of three-body forces used in microscopic shell-model interactions and ab-initio calculations. By extracting the spectroscopic factors of the ground state configuration along the neutron-rich component of the Ca isotopic chain, one can gain insight into the degree of weakening of the N=28 gap. The experiment was performed in 2020 at R3B as part of the Phase-0 program of FAIR probed proton and neutron configurations using (p,pn) and (p,2p) quasi-free scattering reactions.

HK 62.3 Thu 14:45 HK-H7

Density-dependent in-medium NN-potential from chiral four-nucleon force — •Maurus Geiger and Norbert Kaiser — Physik-Department T39, Technische Universität München, D-85747 Garching, Germany

Density-dependent in-medium NN-potentials are calculated analytically from the five classes of reducible four-nucleon forces (4NF) as derived in chiral effective field theory by Epelbaum (Eur. Phys. J. A34: 197-214 (2007)). An overview is given over the pertinent two-loop diagrams that are obtained by closing two nucleon lines. A fortunate feature of the chiral 4N forces is that due to their spin- and isospin dependence the selfclosing of a nucleon line gives a vanishing spin or isospin trace in nuclear matter. The current status of the evaluation of the remaining 42 diagrams for each class is presented together with results for the double Fermi-sphere integrals. Since the leading order chiral 4NF does not introduce any unkown parameters, this in-medium NN-potential can provide an interesting testing ground for the ability of chiral EFT to describe nuclear many-body systems.

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HK 62.4 Thu 15:00 HK-H7

An alternative scheme for effective range corrections in pionless EFT — •Martin Ebert[1], Hans-Werner Hammer[1,2], and Akaki Rusetsky[3,4] — [1]IKP, TU Darmstadt — [2]EMMI, GSI Darmstadt — [3]HISKP and BCTP, Universität Bonn — [4]Tbilisi State University

We discuss an alternative scheme for including effective range corrections in pionless effective field theory. The standard approach treats range terms as perturbative insertions in the T-matrix. In a finite volume this scheme can lead to singular behavior close to the unperturbed energies. We consider an alternative scheme that resums the effective range but expands the spurious pole of the T-matrix created by this resummation. We test this alternative expansion for several model potentials and observe good convergence.

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HK 62.5 Thu 15:15 HK-H7

Lifetime measurements of excited states in ^{55}Cr — •Hannah Kleis[1], Michael Seidlitz[1], Andrey Blazhev[1], Levent Kaya[1], Peter Reiter[1], Konrad Arnswald[1], Alfred Dewald[1], Maximilian Droste[1], Christoph Fransen[1], Oliver Möller[1,2], Noritaka Shimizu[3], Yusuke Tsunoda[3], Yutaka Utsuno[3,4], Peter von Brentano[1], and Karl-Oskar Zell[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Institut für Kernphysik, Technische Universität Darmstadt — [3]Center for Nuclear Study, The University of Tokyo — [4]Advanced Science Research Center, Japan Atomic Energy Agency

Lifetime measurements in neutron-rich Cr nuclei provide key observables to study the $N = 32$ sub-shell closure. Following an earlier measurement in ^{56}Cr [1], excited states in the neighboring $N = 31$ isotope ^{55}Cr have been populated in a ^{48}Ca(^{11}B, $p3n$) ^{55}Cr fusion-evaporation reaction at a beam energy of 32 MeV at the FN tandem accelerator of the University of Cologne. The recoil-distance Doppler-shift method combined with the differential decay-curve method are utilized for $\gamma\gamma$-coincidence analyses in order to determine precise lifetimes for the first $5/2^-$ and $9/2^-$ states of $\tau = 5.61(28)$ ps and $\tau = 6.33(46)$ ps, respectively [2]. In addition, the experimentally determined transition probabilities were confronted with results from the KB3G, FPD6, GXPF1A and GXPF1Br shell-model interactions. In particular, the $B(E2)$ and $B(M1)$ strengths are discussed with respect to the calculated wave functions configurations.

[1] M. Seidlitz et al., Phys. Rev. C 84, 034318 (2011)
[2] H. Kleis et al., Phys. Rev. C 104, 034310 (2021)