HK 54: Nukleare Astrophysik

Zeit: Freitag 11:00–12:45 Raum: HZ 4

Gruppenbericht HK 54.1 Fr 11:00 HZ 4

Quantum Monte Carlo Calculations with Chiral Effective Field Theory Interactions* — •Ingo Tews[1,2], Kai Hebeler[1,2], Achim Schwenk[2,1], Alexandros Gezerlis[3], and Evgeny Epelbaum[4] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Department of Physics, University of Guelph — [4]Institut für Theoretische Physik II, Ruhr-Universität Bochum

We present first quantum Monte Carlo (QMC) calculations with chiral effective field theory (EFT) interactions. To achieve this, we remove all sources of nonlocality, which hamper the inclusion in QMC calculations, in nuclear forces to next-to-next-to-leading order. We perform auxiliary-field diffusion Monte Carlo (AFDMC) calculations for the neutron matter energy up to saturation density based on these local nucleon-nucleon interactions. Our results provide nonperturbative benchmarks with theoretical uncertainties. For the softer interactions, perturbative calculations are in excellent agreement with the AFDMC results. This work paves the way for QMC calculations with systematic chiral EFT interactions for nuclei and nuclear matter, for testing the perturbativeness of different orders, and allows for matching to lattice QCD results by varying the pion mass.

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HK 54.2 Fr 11:30 HZ 4

Study of the 17Ne Coulomb Dissociation process and its role for the rp process of nucleosynthesis. — •Justyna Marganiec[1,2], Felix Wamers[2,1,3,5], Thomas Aumann[1,3], Irina Egorova[6], Leonid Grigorenko[7,8], Michael Heil[3], Yuliya Perfenova[7,9], and Ralf Plag[3,4] for the R3B-Collaboration — [1]TU Darmstadt, Germany — [2]EMMI, GSI Darmstadt, Germany — [3]GSI Darmstadt, Germany — [4]Goethe-Universitaet, Frankfurt am Main, Germany — [5]FIAS, Frankfurt am Main, Germany — [6]BLTP JINR Dubna, Russia — [7]FLNR JINR Dubna, Russia — [8]RRC KI, Moscow, Russia — [9]INP, Moscow, Russia

The study of 17Ne Coulomb dissociation process gives us a possibility to study the time-reversed reaction 15O(2p,gamma)17Ne, with the detailed balance theorem. This reaction could serve as a bypass of 15O waiting point during the rp process, and move the initial CNO material towards heavier nuclei.

The two-proton capture can proceed sequentially or directly from the three-body continuum. And the reaction rate can be enhanced by a few orders of magnitude by taking the three-body continuum into account. The Coulomb dissociation method is the one way to experimentally determine the three-body radiative capture cross section, which is needed to verify theoretical calculations, and which was not experimentally determined yet. The experiment has been performed at the LAND/R3B setup at GSI.

This project is supported by NAVI, GSI-TU Darmstadt cooperation, HIC for FAIR, EMMI and BMBF.

HK 54.3 Fr 11:45 HZ 4

Background intercomparison with escape-suppressed germanium detectors in underground mines — •Tamás Szücs and Daniel Bemmerer — Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden

A key requirement for underground nuclear astrophysics experiments is the very low background level in germanium detectors underground. The reference for these purposes is the world's so far only underground accelerator laboratory for nuclear astrophysics, LUNA. LUNA is located deep underground in the Gran Sasso laboratory in Italy, shielded from cosmic rays by 1400 m of rock. The background at LUNA was studied in detail using an escape-suppressed Clover-type HPGe detector [1]. Exactly the same detector was subsequently transported to the Felsenkeller underground laboratory in Dresden, shielded by 45 m of rock, and the background was shown to be only a factor of three higher than at LUNA when comparing the escape-suppressed spectra, with interesting consequences for underground nuclear astrophysics [2]. As the next step of a systematic study of the effects of a combination of active and passive shielding on the cosmic ray induced background, this detector is now being brought to the "Reiche Zeche" mine in Freiberg/Sachsen, shielded by 150 m of rock. The data from the Freiberg measurement will be shown and discussed. – Supported by the Helmholtz Association (HGF) through the Nuclear Astrophysics Virtual Institute (HGF VH-VI-417).

[1] T. Szücs et al., Eur. Phys. J. A 44, 513 (2010)
[2] T. Szücs et al., Eur. Phys. J. A 48, 8 (2012)

HK 54.4 Fr 12:00 HZ 4

Erzeugung von ^{91}Nb zur Untersuchung der Reaktion ^{91}Nb(p, γ) an FRANZ — •Benedikt Thomas, Jan Glorius, Rene Reifarth, Anne Sauerwein, Stefan Schmidt und Kerstin Sonnabend — Goethe Universität, Frankfurt, Germany

Die hohen Protonenströme, die FRANZ liefern wird, werden es möglich machen (p, γ) und (n, γ)-Messungen an Targets mit geringer Targetkernzahl durchzuführen, wie es bei der Untersuchung von Reaktionen an radioaktiven Kernen, die nicht natürlich auf der Erde vorkommen, der Fall ist. Ein Beispiel ist das Isotop ^{91}Nb, für das der Wirkungsquerschnitt der Reaktion ^{91}Nb(p, γ)^{92}Mo bei 2 MeV Protonenenergie und damit im astrophysikalisch relevanten Bereich für den p-Prozess bestimmt werden soll. Dafür muss ^{91}Nb in ausreichender Zahl hergestellt werden. Eine mögliche Methode zur Erzeugung von ^{91}Nb ist die Aktivierung von ^{92}Mo mit Protonen bei Energien zwischen 15 MeV bis 30 MeV. Die dominanten Reaktionskanäle (p, 2n), (p, pn) und (p, 2p) mit den anschließenden β-Zerfällen können eine ausreichende Anzahl ^{91}Nb bereit stellen, um nach einer chemischen Aufbereitung ein Target für Experimente an FRANZ zu erhalten.

Dieses Projekt wird durch die DFG (SO907/2-1) und HIC for FAIR unterstützt.

HK 54.5 Fr 12:15 HZ 4

Determining cross sections of the ^{187}Re(α,n) reaction at astrophysically relevant energies — •Philipp Scholz[1], Janis Endres[1], Jan Mayer[1], Lars Netterdon[1], Anne Sauerwein[2], and Andreas Zilges[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]Institute for Applied Physics, Goethe University Frankfurt

Network calculations of the γ process rely almost completely on theoretically predicted reaction rates in the scope of the Hauser-Feshbach statistical model. But especially the prediction of cross sections for (γ,α)-reactions at energies within or close to the astrophysically relevant energy window remains a problem due to the uncertainties in the basic α+nucleus optical-model potentials. Although experimental values far above the Coulomb-barrier are well reproduced, commonly used α-optical potentials often fail to describe the trend at center-of-mass energies comparable to those in astrophysical sites of the γ process. Improvements of the adopted optical-model potentials are hampered by the lack of experimental values at low energies. For the improvement of the experimental situation an α-induced reaction on the very heavy nucleus ^{187}Re was investigated via the activation technique using the Cologne Clover Counting Setup. Cross sections at five energies close to the astrophysically relevant energy region could be measured amongst others applying the $\gamma\gamma$-coincidence method. The experimental setup as well as recent results will be presented.

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HK 54.6 Fr 12:30 HZ 4

Prompt fission γ-ray emission from thermal- and fast-neutron induced fission — •Stephan Oberstedt[1], Robert Billnert[1,2], Matthieu Lebois[3], Andreas Oberstedt[2], and Jon Wilson[3] — [1]European Commission, Joint Research Centre IRMM — [2]Fundamental Fysik, CTH, S-41296 Göteborg — [3]Institut de Physique Nucléaire Orsay, F- 91406 Orsay

In recent years we conducted a systematic investigation of fission-fragment de-excitation through prompt neutron and γ-ray emission. For the latter we were able to obtain spectral data for thermal-neutron induced fission on ^{235}U [1] and ^{241}Pu [2] with unprecedented accuracy. The recently installed neutron source LICORNE [3], where neutrons are produced in inverse kinematics, enables us to explore prompt de-excitation also for fast-neutron induced fission. A first experiment campaign on ^{235,238}U and ^{232}Th was performed at LICORNE. From our experimental data we established a systematic trend up to incident neutron energies of 20 MeV that compares well with modern theoretical calculations.

[1] A. Oberstedt et al., Phys. Rev C87, 051602(R), 2013

[2] R. Billnert et al., to be published in Phys. Rev C

[3] M. Lebois et al., Nucl. Instr. Meth. A735 (2014) 145-151