HK 4: Nuclear Astrophysics I

Zeit: Montag 14:00–16:00 Raum: HZO 100

Gruppenbericht HK 4.1 Mo 14:00 HZO 100

Experimental Nuclear Astrophysics in Cologne — •Philipp Scholz, Felix Heim, Elena Hoemann, Marvin Körschgen, Jan Mayer, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

Nuclear reaction cross sections are one of the main ingredients for the understanding of nucleosynthesis processes in stellar environments. For isotopes heavier than those in the iron-peak region, reaction rates are often calculated using the Hauser-Feshbach statistical model (HF). The accuracy of these reaction rates crucially depend on the uncertainties of nuclear-physics input-parameters like γ-strength functions, optical-model potentials, and level densities.

The combination of the 10 MV FN-Tandem accelerator and the high-efficiency γ-ray spectrometer HORUS at the University of Cologne enables the investigation of γ-strength functions and level-densities via radiative proton-capture reactions.

This talk will introduce the in-beam technique with HPGe detectors as well as the method of two-step γ-ray cascades to the recently performed experiments on the ^{63}Cu(p,γ) and ^{65}Cu(p,γ) reactions. In addition, an overview about investigations of optical-model potentials and half-lives of long lived-isotopes via the activation technique will be given.

Supported by the DFG (ZI 510/8-1) and the ULDETIS project within the UoC Excellence Initiative institutional strategy. PS and JM are supported by the Bonn-Cologne Graduate School of Physics and Astronomy.

HK 4.2 Mo 14:30 HZO 100

Astrophysics with storage rings: ^{124}Xe beam at ESR — •Zuzana Slavkovská[1,2], Jan Glorius[1,2], Christoph Langer[1,2], René Reifarth[1,2], and Yuri Litvinov[2] for the E108B-Collaboration — [1]Goethe Universität Frankfurt — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

The astrophysically motivated reaction ^{124}Xe(p,γ) was investigated at the Experimentier-Speicherring (ESR) at the GSI in Darmstadt in June 2016.

For the first time it was possible to measure proton capture cross sections down to the Gamow window of the p-process using a storage ring. A ^{124}Xe beam reacted with a hydrogen gas jet target at five different energies between 5.5 AMeV and 8 AMeV. A newly designed double-sided silicon strip detector (DSSSD) placed directly into the ultrahigh vacuum of the ESR was used to detect the reaction products.

In this talk the experimental set-up and method as well as the challenges and results of the experiment will be presented.

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HK 4.3 Mo 14:45 HZO 100

Felsenkeller 5 MV underground ion accelerator for nuclear astrophysics — •Daniel Bemmerer[1], Thomas E. Cowan[1,2], Marcel Grieger[1,2], Thomas Hensel[1,2], Arnd R. Junghans[1], Martina Koppitz[1,2], Felix Ludwig[1,2], Bernd Rimarzig[1], Stefan Reinicke[1,2], Ronald Schwengner[1], Klaus Stöckel[1,2], Tamás Szücs[1,3], Marcell P. Takács[1,2], Steffen Turkat[2,1], Andreas Wagner[1], Louis Wagner[1,2], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany — [2]TU Dresden, Germany — [3]MTA ATOMKI, Hungary

A 5 MV Pelletron accelerator with both an internal and an external ion source providing for intensive ^{1}H$^+$, ^{4}He$^+$, and ^{12}C$^+$ beams is being installed in the Felsenkeller underground site in Dresden, shielded from cosmic rays by 45 m rock overburden. Civil construction has recently been completed. The technical features of the new laboratory, test results, and the scientific program will be summarized. In addition to in-house research by HZDR and TU Dresden, the new accelerator will be open for outside users, both from Germany and worldwide.

HK 4.4 Mo 15:00 HZO 100

Big Bang Cosmology in the Lab: The ^{2}H$(p,\gamma)^3$He reaction studied at LUNA — Daniel Bemmerer[1], •Klaus Stöckel[1,2], and Tamás Szücs[1,3] for the LUNA-Collaboration — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany — [2]TU Dresden, Germany — [3]MTA ATOMKI, Debrecen, Hungary

Recent high-precision measurements of the primordial ^{2}H abundance have opened the path to use Big Bang nucleosynthesis to constrain the primordial baryon to photon ratio with similar precision as the cosmic microwave background. This would provide an independent cross-check on current Big Bang models. However, the interpretation of the abundance is limited by the lack of precise nuclear data, in particular on the main ^{2}H destruction channel, the ^{2}H$(p,\gamma)^3$He reaction. A new experiment to study the ^{2}H$(p,\gamma)^3$He cross section directly in the Big Bang energy window is underway at the LUNA 400 kV accelerator, deep underground in the Gran Sasso laboratory, Italy. The progress of experiment and analysis will be summarized. – Supported by DFG (BE 4100/4-1).

HK 4.5 Mo 15:15 HZO 100

Study of the Big Bang nuclear reactions ^{2}H$(p,\gamma)^3$He and ^{3}He$(\alpha,\gamma)^7$Be at high energy — •Steffen Turkat[1], Shavkat Akhmadaliev[2], Daniel Bemmerer[2], Felix Ludwig[1,2], Klaus Stöckel[1,2], Tamás Szücs[1,2], Louis Wagner[1,2], and Kai Zuber[1] — [1]Institut für Kern- und Teilchenphysik, TU Dresden, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany

The improved precision of Big Bang nuclidic abundance determinations calls for more precise nuclear data to improve the models. Currently, the Big Bang abundance predictions for ^{2}H and ^{7}Li are limited in precision by the ^{2}H$(p,\gamma)^3$He and ^{3}He$(\alpha,\gamma)^7$Be reactions, respectively. In order to address this problem, a re-study of these cross sections is underway. Complementing low-energy data from LUNA, these cross sections are being measured in the 0.3-2 MeV center of mass energy range at the HZDR 3 MV Tandetron. The activated ^{7}Be samples from the latter reaction shall be counted at the new Felsenkeller underground facility. The status of the two experiments will be summarized. — Supported by DFG (ZU 123/21-1 and BE 4100/4-1).

HK 4.6 Mo 15:30 HZO 100

Investigating total and partial cross sections of the ^{107}Ag(p,γ)^{108}Cd reaction — •Felix Heim[1], Elena Hoemann[1], Jan Mayer[1], Philipp Scholz[1], Mark Spieker[1,2], and Andreas Zilges[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]NSCL, Michigan State University, MI 48824, USA

The γ process plays an important role in the nucleosynthesis of the majority of the p nuclei. Since the network of the γ process includes so many different reactions and - mainly unstable - nuclei, cross-section values are predominantly calculated in the scope of the Hauser-Feshbach statistical model. The values depend heavily on the nuclear physics input-parameters like the nuclear level density (NLD), the γ-ray strength function (γ-ray SF) and nucleon+nucleus optical model potentials (OMPs). Total and partial cross-section measurements can improve the accuracy of the theoretical calculations. To extend the experimental database the ^{107}Ag(p,γ)^{108}Cd reaction was studied via the in-beam method at the high-efficiency HPGe γ-ray spectrometer HORUS at the University of Cologne. Proton beams with energies between 3.5 and 5.0 MeV were provided by the 10 MV FN-Tandem accelerator. The comparison of the experimental results to Hauser-Feshbach calculations allowed to find adjusted microscopic models for the NLD and γ-ray SF, which very nicely reproduce the results of total and partial cross sections.

Supported by the DFG (ZI 510/8-1) and the ULDETIS project within the UoC Excellence Initiative institutional strategy.

HK 4.7 Mo 15:45 HZO 100

Characterization of the cesium sputter ion source for the new Felsenkeller 5 MV underground accelerator — •Felix Ludwig[1,2], Martina Koppitz[1,2], Daniel Bemmerer[1], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden — [2]Technische Universität Dresden

In order to determine the cross section of the ^{12}C$(\alpha,\gamma)^{16}$O reaction at astrophysically relevant energies, an accelerator with a stable and intensive ^{12}C ion beam in an ultra low background environment is needed. For this purpose a 134-MC-SNICS cesium sputter ion source is going to be part of the Felsenkeller shallow underground accelerator facility. To determine the characteristics of this ion source overground tests were undertaken at HZDR. The contribution will report on long time measurements of the ion current and the beam emittance.