HK 11: Nuclear Astrophysics I

Time: Monday 14:00–15:30 Location: HK-H10

Group Report HK 11.1 Mon 14:00 HK-H10

The explosive nucleosynthesis of proton-rich nuclei mimicked in the laboratory — •Felix Heim, Martin Müller, Svenja Wilden, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics

The universe was born with just hydrogen, helium and small traces of lithium. Most of the heavy nuclei beyond the iron-peak region are created by neutron-capture processes. A group of 30 to 35 proton-rich stable isotopes however, is shielded against these processes. These p nuclei are most likely produced in explosive stellar scenarios by the astrophysical γ process, which is a complex network of thousands of nuclear - mostly photodisintegration - reactions on stable and unstable nuclei. At present, most of the reactions rates involved are taken from theory in the framework of the Hauser-Feshbach model. Therefore, the extension of the experimental database of measured cross sections is one of the tasks of nuclear laboratories. Also, experimental data are required to constrain the nuclear physics parameters entering the theoretical calculations and to test their predictive power. In this contribution, details of the experimental setup and techniques will be presented that are used to measure nuclear reactions relevant for the nucleosynthesis of the p nuclei. In addition, emphasis will be put on studies of the underlying nuclear physics properties.
Supported by the DFG (ZI 510/8-2).

HK 11.2 Mon 14:30 HK-H10

Investigation of ^{170,172}Yb$(\alpha,n)^{173,175}$Hf cross sections in a stacked target experiment — •Martin Müller, Felix Heim, Yanzhao Wang, Svenja Wilden, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

In spite of decades of research, many observed nuclear abundances remain that can not be reproduced by p-process nucleosynthesis calculations [1]. This is mainly due to the lack of constraints for the involved nuclear physics models. Previous studies have shown that key reactions affecting the abundance of the p-nucleus ^{168}Yb are the ^{164,166}Yb(α,γ) reactions and that these are mostly sensitive to the α-optical-model-potential (α-OMP) [2,3]. To study the α-OMP in the Yb chain and its dependence on the proton-to-neutron ratio, a stacked target activation experiment was performed at the University of Cologne's *Cologne Clover Counting* setup investigating the ^{170,172}Yb$(\alpha,n)^{173,175}$Hf reaction cross sections. The results were validated by simultaneous measurements of the well established ^{55}Mn$(\alpha,(2)n)^{57,58}$Co and ^{54}Fe$(\alpha,n)^{57}$Ni reaction cross sections. All measurements were compared to statistical model calculations performed using the TALYS-1.95 code [4].
Supported by the DFG (ZI 510/8-2).

[1] M. Arnould and S. Goriely, Phys. Rep. **384**, 1 (2003)
[2] T. Rauscher *et al.*, Mon. Not. R. Astron. Soc. **463**, 4153 (2016)
[3] T. Rauscher *et al.*, Astrophys. J. Suppl. Ser. **201**, 26 (2012)
[4] A. J. Koning *et al.*, Nucl. Data Sheets **113**, 2841 (2012)

HK 11.3 Mon 14:45 HK-H10

First results of total and partial cross-section measurements of the ^{87}Rb$(p,\gamma)^{88}$Sr reaction — •Svenja Wilden, Felix Heim, Martin Müller, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The existence of most of thestable very neutron deficient nuclei - the p nuclei - cannot be explained via neutron-capture reactions. Therefore, at least one other process has to exist in order to describe their origin, the γ process. Since most photodisintegration reactions involved in the process are not directly accessible, reliable statistical model calculations are needed to predict cross sections and reaction rates. To improve the calculations the nuclear input parameters need to be constrained and a large experimental database is needed. Via comparison of experimental data to theoretical predictions different models can be excluded or constrained. In order to study the ^{87}Rb$(p,\gamma)^{88}$Sr reaction, for the first time an in-beam experiment at the high-efficiency HPGe γ-ray spectrometer HORUS at the University of Cologne was performed. Proton beams with energies between $E_p = 2.0 - 5.0$ MeV inside the Gamow window were provided by the 10 MV FN Tandem accelerator.
Supported by the DFG (ZI 510/8-2).

HK 11.4 Mon 15:00 HK-H10

Investigation of the 3He(α,γ)7Be reaction at the Felsenkeller shallow underground facility — •Steffen Turkat[1], Daniel Bemmerer[2], Axel Boeltzig[2], Fabia Dietrich[2], Armin Freimann[2], Thomas Hensel[1], Jonas Koch[2], Till Lossin[2], Felix Ludwig[2], Jannis Michaelis[2], Max Osswald[2], Simon Rümmler[2], Konrad Schmidt[2], Julian Schwengfelder[2], and Kai Zuber[1] — [1]Institut für Kern- und Teilchenphysik, TU Dresden, Dresden, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The ^{3}He$(\alpha,\gamma)^{7}$Be reaction plays a significant role in Big Bang nucleosynthesis, as well as in solar fusion processes. It affects the predicted solar ^{7}Be and ^{8}B neutrino fluxes as well as the nucleosynthesis of primordial ^{7}Li.
A measurement of the γ-ray angular distribution is currently underway in order to enable a better comparison between several experimental data sets at E = 0.7 - 1.3 MeV and a unique data set from the LUNA collaboration at E = 0.09 MeV - 0.13 MeV. A setup using 21 HPGe detectors and implanted 3He targets is used at the 5 MV Felsenkeller underground accelerator. In addition to the angular distribution study, the activated samples are counted offline. First results of this ongoing campaign will be summarized. - Supported by DFG (ZU123/21-1)
The use of GAMMAPOOL resources is gratefully acknowledged.

HK 11.5 Mon 15:15 HK-H10

Energy calibration of the 5MV accelerator at the Felsenkeller shallow-underground laboratory — •Simon Rümmler[1], Daniel Bemmerer[1], Axel Boeltzig[1], Fabia Dietrich[1], Armin Freimann[1], Jonas Koch[1], Till Lossin[1], Felix Ludwig[1], Max Osswald[1], Konrad Schmidt[1], Julian Schwengfelder[1], Steffen Turkat[2], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiation Physics — [2]TU Dresden, Institute of Nuclear and Particle Physics

Astrophysical radiative capture reactions occur at low energies, resulting in low cross sections and hence low counting rates in the γ-detectors. This calls for accelerator facilities that are located underground, shielded from cosmic rays. The shallow-underground laboratory at Felsenkeller in Dresden provides 45 meters of rock overburden for the installed 5MV Pelletron accelerator. In addition to a low-background setting, an energy calibration of the accelerator is needed to perform precise measurements.

During the commisioning of the accelerator and its two ion sources, as well as during first astrophysically relevant experiments, measurements for different methods of an energy calibration were recorded. The results of the individual methods were obtained independently and provide consistent results, even at different accelerator voltages. The overall result of the completed energy calibration and a comparison of the methods will be presented.