HK 52: Nukleare Astrophysik III

Time: Thursday 14:00–16:00 Location: C-2

Group Report HK 52.1 Thu 14:00 C-2

Experimental Methods for the Astrophysical *p* Process — •Anne Sauerwein, Janis Endres, Michael Elvers, Jens Hasper, Andreas Hennig, Lars Netterdon, and Andreas Zilges — Institut für Kernphysik, Universität zu Köln

The 10 MV ion tandem accelerator of the University of Cologne provides unique opportunities to improve the experimental situation for proton- and α-induced reactions relevant for the p process. This facility allows to perform both in-beam experiments using the highly-efficient HPGe detector array HORUS and activation experiments using a low-background counting setup which employs two clover-type HPGe detectors. In addition, a new 6 MV tandetron accelerator for Accelerator Mass Spectrometry (AMS) is available at the institute which can be used to detect long-lived radionuclides down to concentrations of 10^{-15} to 10^{-16} compared to stable isotopes [1]. The combination of this variety of experimental approaches gives access to a large number of astrophysically relevant reactions and allows detailed investigations of some key reactions within the p-process network [2,3]. In this contribution we will present first results of recent measurements and report on experiments planned in the near future.

Supported by the DFG (ZI 510/5-1 and ME 1169/19-1), by the BMBF under contract 06 KY 9136, by the University of Cologne and by the Bonn-Cologne Graduate School of Physics and Astronomy.

[1] A. Dewald *et al.*, Nuclear Physics News **18** (2008) 26.
[2] W. Rapp *et al.*, Astrophysical Journal **653** (2006) 474.
[3] T. Rauscher, Physical Review C **73** (2006) 01580.

HK 52.2 Thu 14:30 C-2

Activation Measurement of the Reaction ^{141}Pr(α,n)^{144}Pm for the Astrophysical *p* Process — •Andreas Hennig, Lars Netterdon, Anne Sauerwein, and Andreas Zilges — Institut für Kernphysik, Universität zu Köln

About 30-35 proton-rich nuclei, referred to as the p nuclei, are bypassed by the s and r process [1]. One of the processes assumed to produce the p nuclei is the photodisintegration of heavy seed-nuclei. Since experimental data on the reaction rates involved in this process are very rare, the network calculations are almost completely based on theoretically predicted reaction rates. To improve the nuclear models that enter the theoretical calculations, the reaction ^{141}Pr(α,n)^{144}Pm was studied in an activation experiment at energies inside and just above the Gamow window at the cyclotron facility of the "Physikalisch-Technische Bundesanstalt" (PTB) in Braunschweig. Since in this energy region the cross section is predominantly sensitive to the α-nucleus optical-model potential, this reaction is well suited to constrain the optical-model potential in this mass region [2]. Preliminary results will be presented.
Supported by the DFG (ZI 510/5-1), by the BMBF under contract 06 KY 9136 and by the Bonn-Cologne Graduate School of Physics and Anstronomy.

[1] M. Arnould and S. Goriely, Phys. Rep. **384** (2003) 1.
[2] A. Sauerwein *et al.*, Prog. Part. Nucl. Phys, in press.

HK 52.3 Thu 14:45 C-2

Cross section measurements of ^{103}Rh(p,γ)^{104}Pd with the Karlsruhe 4πBaF$_2$ detector — Mario Weigand[1,2], •Stephan Walter[3], Franz Käppeler[3], Ralf Plag[1,2], and Rene Reifarth[1,2] — [1]GSI Helmholtzzentrum für Schwerionenforschung — [2]J.W. Goethe Universität, Frankfurt a.M., 60438, Germany — [3]Karlsruhe Institute of Technology (KIT), Campus Nord, Institut für Kernphysik, Postfach 3640, 76021 Karlsruhe, Germany

The cosmic abundance distribution of elements and isotopes is related to the reaction rates of the different synthesis processes. Most of the elements heavier than iron have been and still are synthesized in neutron-induced in stars of different stages. However, some isotopes are primarily formed in the so-called p-process because they are shielded from the much more effective neutron-induced reactions. The qualitative description of the p-process requires large reaction networks. The most important components here are the proton-, alpha- and gamma-induced reactions and the associated β^+-decays.

At the Karlsruhe Institute of Technology (KIT) ^{103}Rh(p,γ) capture events have been observed with the Karlsruhe 4π-BaF$_2$-detector, which consists of up to 42 spherically arranged BaF$_2$-crystals. The protons were accelerated with a pulsed 3.7 MV Van de Graaff accelerator to an energy of 3 MeV and fired on a metallic Rhodium target.

An overview of the experimental setup and the progresses that have been made with the data processing will be presented. The experiment was supported by the HGF young investigator project VH-NG-327.

HK 52.4 Thu 15:00 C-2

Lifetime measurements of astrophysical interest via the Doppler Shift Attenuation Method — •Clemens Herlitzius and Shawn Bishop — TU München, Garching, Deutschland

Resonant (p,γ) capture reactions on seed nuclei play a key role in the production of intermediate mass elements in classical nova events. The rates of these reactions are often very uncertain. Network calculations use those rates to model the abundance of synthesized nuclei in the ejecta. Since direct rate measurements are not always possible because of small cross sections, indirect methods can be used to determine the reaction rates. The spins of the involved particles, as well as the energies and lifetimes of the excited states of the compound nucleus must be known. Lifetimes in a range of fs up to ps can be measured with the Doppler Shift Attenuation Method (DSAM). A DSAM facility has been designed and installed in 2010 at the tandem accellerator in the Maier-Leibnitz-Laboratorium of LMU and TU Muenchen. This talk will highlight the experimental technique and show data of the commissioning beam time in August 2010 and February 2011.

HK 52.5 Thu 15:15 C-2

p*-Prozess Nukleosynthese und Optische Potentiale — •Jan Glorius[1], K. Sonnabend[1,3,4], A. Sauerwein[2,4], M. Wiescher[4], J. Görres[4] und N. Pietralla[1] — [1]Institut für Kernphysik, TU Darmstadt — [2]Institut für Kernphysik, Universität zu Köln — [3]Institut für Angewandte Physik, Goethe Universität Frankfurt — [4]Physics Department, University of Notre Dame, U.S.A.

Um die Nukleosynthese im astrophysikalischen p-Prozess zu verstehen, gilt es ein komplexes Reaktionsnetzwerk zu lösen. Hierfür werden mehr als 10.000 Reaktionsraten unter stellaren Bedingungen benötigt. Theoretische Vorhersagen dieser Raten im Rahmen des Statistischen Modells zeigen teilweise noch große Abweichungen zum Experiment für Reaktionen mit leichten geladenen Teilchen. Wichtige Parameter, die in die Berechnungen eingehen, sind Optische Potentiale. Um diese Beschreibung der Wechselwirkung zwischen Kern und geladenen Teilchen zu verbessern, wurden die Reaktionen ^{166}Er(α,n), ^{165}Ho(α,n), ^{175}Lu(p,n) sowie ^{169}Tm(p,n) mit der Aktivierungsmethode am FN Tandem der University of Notre Dame gemessen. Bei diesen Messungen liegt eine exklusive Sensitivität auf das Optische α-Teilchen- bzw. Protonenpotential vor. Die Daten können folglich als weiterer Test für die Vorhersagen des Statistischen Modells sowie als Grundlage zur Verbesserung globaler Optischer Potentiale dienen. Die einzelnen Messungen und vorläufige Ergebnisse werden vorgestellt.

*gefördert durch DFG (SFB 634), LOEWE (HIC for FAIR), DAAD und JINA (NSF,USA)

HK 52.6 Thu 15:30 C-2

Entfaltung von (γ,n)-Wirkungsquerschnitten aus Experimenten mit Bremsstrahlungsphotonen* — •Ingo Tews[1], Jan Glorius[1], Jens Hasper[3], Norbert Pietralla[1], Linda Schnorrenberger[1] und Kerstin Sonnabend[1,2] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]Institut für Angewandte Physik, Goethe-Universität Frankfurt am Main — [3]Institut für Kernphysik, Universität zu Köln

Am Darmstadt High Intensity Photon Setup (DHIPS) des Darmstädter Elektronenbeschleunigers S-DALINAC können Photoaktivierungsexperimente mit hochenergetischen und hochintensiven Bremsstrahlungsphotonen durchgeführt werden. Ziel solcher Aktivierungsexperimente ist unter Anderem die Bestimmung von (γ,n)-Wirkungsquerschnitten. Um diese Wirkungsquerschnitte aus den Messdaten zu extrahieren, wurden Entfaltungsmethoden entwickelt und zur Bestimmung des Wirkungsquerschnittes der Reaktion ^{100}Mo(γ,n)^{99}Mo verwendet. Grundlage dieser Methoden ist dabei eine intervallweise konstante Näherung des Wirkungsquerschnittes.

*gefördert durch die DFG (SFB 634), das BMBF (06DA9040I) und LOEWE (HIC for FAIR)

HK 52.7 Thu 15:45 C-2

Proton-induced reactions of astrophysical relevance at FRANZ — •Kerstin Sonnabend[1], Michael Heil[2], Oliver Meusel[1], Ralf Plag[1,2], and Rene Reifarth[1] — [1]Institut für Angewandte Physik, Goethe-Universität Frankfurt, Max-von-Laue-Str. 1, 60438 Frankfurt — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstr. 1, 64291 Darmstadt

The Frankfurt Neutron Source (FRANZ) is driven by a high-intense proton beam of several mA current with energies of about 2 MeV. These energies are well suited to investigate also proton-induced reactions of astrophysical relevance. (p,γ) and (p,n) reactions are important in very different stellar environments and nuclear mass regions. They occur on light nuclei below the iron region in advanced stellar burning stages – like oxygen and silicon burning – at temperatures below 1 GK. Furthermore, (p,γ) and (p,n) reactions contribute to the production of the neutron-deficient *p* nuclei in an explosive scenario reaching temperatures of several GK. Therefore, the proton energies provided at FRANZ will allow measurements near or in the corresponding Gamow energy windows of these different sites of nucleosynthesis.

The current status of the accelerator and the required amendments to use the proton beam directly for cross section studies are presented. In addition, the proposed experimental programme on proton-induced reactions of astrophysical interest will be summarized.

This project is supported by the HGF Young Investigator Project VH-NG-327.