HK 30: Nuclear Astrophysics III

Time: Wednesday 14:00–15:30 Location: SCH/A419

Group Report HK 30.1 Wed 14:00 SCH/A419
Science highlights from the shallow underground laboratory Felsenkeller Dresden — •Konrad Schmidt and Daniel Bemmerer — Helmholtz-Zentrum Dresden-Rossendorf

Underground accelerator laboratories are important instruments to measure nuclear reactions with low cross sections in experimental nuclear astrophysics. The reduced detector background due the shielding from cosmic rays allows the study of astronuclear reactions at energies relevant to Big Bang nucleosynthesis and stellar burning. The reactions 3He(a,g)7Be and 12C(p,g)13N have recently been studied at the shallow underground laboratory Felsenkeller Dresden, where a 5 MV accelerator provides several high intensity ion beams and an ultra-low background counting setup for activation measurements. In the talk, the latest scientific results from the Felsenkeller laboratory, its current capabilities and upcoming enhancements will be summarized.

HK 30.2 Wed 14:30 SCH/A419
The ^{58}Fe(p,n)^{58}Co activation experiment at the University of Cologne — •Pina Wüstenberg, Felix Heim, Martin Müller, Svenja Wilden, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics

The γ-process describes a large network of reactions that leads to the synthesis of proton-rich nuclei, the p nuclei. Not all of these reactions can be measured in the laboratory, therefore theoretical predictions are needed. These models can be tested and improved by comparing them to experimental data. This contribution deals with the determination of cross sections of the ^{58}Fe(p,n)^{58}Co reaction. The cross section of (p,n) reactions is mainly sensitive to the optical model potential that describes the interaction between a proton and a nucleus. For this purpose, highly-enriched ^{58}Fe targets were irradiated with protons with seven different energies in the energy range between 3.3 MeV and 5 MeV. The proton beam was delivered by the 10 MV FN Tandem accelerator of the Institute for Nuclear Physics at the University of Cologne. The total cross sections were derived by analyzing the emitted γ-rays during the decay of ^{58}Fe using a dedicated counting setup. The γ-ray spectra were recorded using two clover-type HPGe detectors in a face-to-face geometry. The resulting cross sections were compared to predictions from theoretical models.
Supported by the DFG (ZI 510/8-2)

HK 30.3 Wed 14:45 SCH/A419
Results of total and partial cross-section measurements of the ^{87}Rb(p,γ)^{88}Sr reaction — •Svenja Wilden, Felix Heim, Martin Müller, Pina Wüstenberg, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics

The existence of most of the proton rich stable 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. The cross sections include total cross sections describing the probability of the reaction itself and partial cross sections describing the decay to certain discrete states in the final nucleus. To improve the calculations the nuclear input parameters need to be constrained. This requires a large experimental database. Via comparison of experimental data to theoretical predictions different models can be excluded or constrained. In order to study the ^{87}Rb(p,γ)^{88}Sr reaction 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 were provided by the 10 MV FN Tandem accelerator. Final results on absolute cross sections and first results on partial cross sections will be presented as well as comparisons to theoretical model calculations.
Supported by the DFG (ZI 510/8-2).

HK 30.4 Wed 15:00 SCH/A419
The ^{205}Pb/^{205}Tl s-process chronometry and pp neutrino flux — •Riccardo Mancino[1,2], Rui Jiu Chen[2], Iris Dillman[3], Chris Griffin[3], Guy Leckenby[4], Yuri Litvinov[2], Gabriel Martínez-Pinedo[2,1], Shahab Sanjari[2,5], and Ragandeep Singh Sidhu[2,6] — [1]Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, DE — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, DE — [3]TRIUMF, Vancouver, CA — [4]University of British Columbia, Vancouver, CA — [5]Aachen University of Applied Sciences, Aachen, DE — [6]University of Edinburgh, Edinburgh, UK

The bound-state beta decay of fully ionized ^{205}Tl has been measured at GSI. Combining this new experimental information and the known electron capture decay of ^{205}Tl we can compute the weak processes connecting these two nuclei. This includes electron capture and beta decay operating during the age phase of intermediate-mass stars. These processes determine the ^{205}Pb/^{205}Tl ratio produced by the s-process. The new experimental information favors a larger production of ^{205}Pb that may be observable in the early Solar System. Another important weak process is the conversion of ^{205}Tl to ^{205}Pb by solar neutrinos capture. This reaction has such a low Q-value that probes the pp solar neutrino flux. Using the new experimental data together with shell-model calculations we provide an update to the neutrino absorption cross section for solar neutrinos on ^{205}Tl. We highlight the necessity of a measurement of the Gamow-Teller strength by charge exchange reactions. This work is funded by SFB 1245 "Nuclei: From Fundamental Interactions to Structure and Stars".

HK 30.5 Wed 15:15 SCH/A419
Linearity and dark rate of SiPMs for large scintillator bars — •Thomas Hensel[1,2], Daniel Bemmerer[2], Konstanze Boretzky[3], Igor Gašparić[5,3,4], Daniel Stach[2], Andreas Wagner[2], and Kai Zuber[1] — [1]Technische Universität Dresden, Institut für Kern- und Teilchenphysik, 01062 Dresden, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), 01328 Dresden, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany — [4]Technische Universität Darmstadt, Fachbereich Physik, Institut für Kernphysik, 64289 Darmstadt, Germany — [5]Ruđer Bošković Institute, Zagreb, Croatia

The NeuLAND (New Large-Area Neutron Detector) plastic scintillator based time of flight detector for neutrons is currently under construction at FAIR. NeuLAND will consist of 3,000 2.7 m long bars that are read out by photomultipliers. Here, data from a comprehensive study of an alternative light readout scheme using silicon photomultipliers (SiPM) are presented. For this purpose, a typical NeuLAND bar was instrumented on each end with a prototype of the same geometry as a 1" photomultiplier tube, including four 6×6mm* SiPMs, amplifiers, high voltage supply, and micro-controller. Using fast digitizers, time resolution and saturation tests were carried out at the 35 MeV electron beam from the ELBE superconducting linac with its ps-level time jitter with 1-60 electrons per bunch. It is found that the SiPM-instrumented NeuLAND bar shows $\leq$ 10% nonlinearity over a range of 10-300 MeV deposited energy. The dark rate due to random coincident triggers of SiPMs is lower than the cosmic ray induced rate in the NeuLAND bar.