HK 60: Nuclear Astrophysics V

Zeit: Freitag 14:00–15:30 Raum: HS 16

Gruppenbericht HK 60.1 Fr 14:00 HS 16

Radiative charged-particle induced reaction studies for the nucleosynthesis of heavy isotopes — •P. Scholz, F. Heim, M. Körschgen, J. Mayer, M. Müller, and A. 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 synthesized in the p- or r process [1,2], reaction rates on exotic nuclei are often calculated in the scope of the Hauser-Feshbach statistical model [3]. The accuracy of these reaction rates crucially depend on the uncertainties of nuclear-physics input-parameters like γ-ray strength functions, optical-model potentials, and level densities. The way to improve the reliability of statistical model calculations is to extend the available database for charged-particle induced reaction cross sections at low energies as well as using these data to study the underlying nuclear physics properties.

This talk will summarize the different projects of our group, measuring proton and α-particle induced reactions in different mass regions and studying the γ-ray strength functions and α+nucleus optical-model potential.

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[1] M. Arnould and S. Goriely, Phys. Rep. **384** (2003) 1.
[2] M. Arnould *et al.*, Phys. Rep. **450** (2007) 97.
[3] W. Hauser and H. Feshbach, Phys. Rev. **87**, 366 (1952).

HK 60.2 Fr 14:30 HS 16

NICE -Neutron Induced Charged particle Emission — •Kafa Khasawneh[1], Benjamin Bruckner[1], Philipp Erbacher[1], Stefan Fiebiger[1], Roman Gernhäuser[2], Kathrin Göbel[1], Deniz Kurtulgil[1], Christoph Langer[1], René Reifarth[1], Benedikt Thomas[1], Meiko Volknandt[1], and Mario Weigand[1] — [1]Goethe University Frankfurt — [2]Technical University Munich

Neutron-induced nuclear reactions with the charged particle in the exit channel play an essential role in the s-process nucleosynthesis, but are also important for medical and nuclear reactor technologies. Despite this importance, cross-section data for such reactions are still scarce because of the short range of charged particles (μ m), which hampers their detection. Only very thin samples in the range of micrometers can therefore be used. New approaches are required in particular for the time-of-flight technique to overcome the low reaction rates.

A new detector setup (NICE-detector) based on an organic plastic scintillator was proposed and tested at the Goethe University Frankfurt. One of the test cases was the capture cross-section of ^{209}Bi at different astrophysically important energies. In this talk, the performance of the adapted detector setup as well as the results of calculated cross-section values will be presented. This project is supported by the DFG project NICE (RE 3461/3-1).

HK 60.3 Fr 14:45 HS 16

Towards background-free studies of capture reactions in a heavy-ion storage ring — •L. Varga, J. Glorius, Yu. A. Litvinov, Z. Slavkovska, and Y. M. Xing — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

In 2016, the first measurement of the 124Xe(p,γ)125Cs reaction was performed at the Experimental Storage Ring (ESR) at GSI. Using Double Sided Silicon Strip Detectors (DSSSD) the 125Cs reaction products have been successfully detected [1]. In order to increase the sensitivity of this method, the signal-to-background ratio has to be improved. In addition to the spatial distribution of the measured ion-hits, using the energy information of the Si detector the particle identification technique for highly charged ions can be optimized.

In this talk, a clear assignment of each events to a p- and n-side strip pair of the DSSSD is introduced. Then, the intrinsic calibration of the detector is presented by performing gain-matching for all individual segments. At last, the deposited energy of the detected ions is reconstructed considering the inter-strip effects for each side of the Si detector. MonteCarlo simulations show, by combining the energy resolution and an additional slit system at ESR, background-free measurements of the p-capture products can be accomplished. This method could provide an unrivaled opportunity for precision (p,g) reaction studies in the Gamow-window using stored and cooled, highly charged, radioactive ions.

[1] J.Glorius et. al., J. Phys: Conf Ser 875(2017)092015

HK 60.4 Fr 15:00 HS 16

Preparation for the measurement of the bound-state beta-decay of bare ^{205}Tl ions at the ESR — •Ragandeep S. Sidhu, Rui Jiu Chen, and Yuri A. Litvinov — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

In bound-state beta-decay [1,2], a neutron inside a nucleus transforms into a proton, an anti-neutrino (produced in a free state), and an electron which is created in a bound atomic state. The determination of the bound-state beta-decay rate of fully-ionized ^{205}Tl is needed to determine the matrix element for the electron capture decay of the 2.3 keV excited state in ^{205}Pb to the ground state of ^{205}Tl [3]. The latter is important for the determination of the neutrino-capture probability on ^{205}Tl and, in turn, within the LOREX project the solar pp neutrino flux for over 4.3 Ma. The Experimental Storage Ring (ESR) at GSI, Darmstadt provides an unrivaled opportunity to allow for the corresponding decay studies. The report on the preparations for the bound-state beta-decay for bare ^{205}Tl ions will be given. [1] R. Daudel, M. Jean and M. Lecoin, J. Phys. Radium 8, 238 (1947). [2] J. N. Bahcall, Phys. Rev. 124, 495 (1961). [3] M.K. Pevicevic et al., Nucl. Instr. and Meth. A 621, 282 (2010).

HK 60.5 Fr 15:15 HS 16

The Measurement of Long Lived Alpha Decay for Cosmochronometry — •Heinrich Wilsenach[1], Kai Zuber[1], Ulli Köster[2], and Mihály Braun[3] — [1]Institut für Kern- und Teilchenphysik TU-Dresden, Dresden, Germany — [2]Institut Laue Langevin, Grenoble, France — [3]Institute for Nuclear Research of the Hungarian Academy of Sciences, Debrecen, Hungary

Due to the mechanism of alpha decay, it has the largest span of half-lives of any decay. The large range of half-lives allows alpha decay to be used as a tool to probe many different fields of physics. A field of recent interest is dating the formation of the Solar System using isotopic ratios. This dating technique relies on isotopes with half-lives in the range of megayears. One of the weaknesses of this technique is the reliability of the half-lives. Measuring this quantity is challenging as the material does not usually exist in nature. This means that the isotopes of interest will have to be made accurately in quantities that give a sufficiently detectable signal. To produce these rare materials the ISOLDE facility at CERN was used. A ultrapure beam of the isotope of interest was implanted into aluminium foil. The foils were then measured with an ultra-low background ionisation chamber. The chamber was specially designed and built to measure low signal rates and has a background in the region of interest of around 0.27 counts per day per MeV. The design and operation of this alpha detector will be discussed, as well as some preliminary results of the new implantation technique.