# HK 54: Nuclear Astrophysics III

Time: Wednesday 16:00–17:30 Location: HK-H10

**Group Report** HK 54.1 Wed 16:00 HK-H10

**Neutronen-induzierte Reaktionen für die Astrophysik** — •Mario Weigand, Ernest Ademi, Marcel Bennedik, Lukas Bott, Benjamin Brückner, Sophia Florence Dellmann, Philipp Erbacher, Madeleine Gail, Nicolai Gimbel, Kathrin Göbel, Alexandra Härth, Tanja Heftrich, Svenja Heil, Benedict Heybeck, Alexander Huhn, Sabina Kasilovskaja, Deniz Kurtulgil, Tabea Kuttner, Rim Mourad, Markus Reich, René Reifarth, Tom Staab, Janina Strahl, Diego Vescovi und Meiko Volknandt — Goethe-Universität, Frankfurt a.M., Germany

Für das Verständnis der Häufigkeiten der meisten Elemente schwerer als Eisen spielen Neutroneneinfangreaktionen eine entscheidende Rolle, da die Synthese dieser Elemente durch sukzessive Neutroneneinfänge und Betazerfälle in Sternen verschiedener Stadien erfolgt. Entsprechende Nukleosynthese-Modelle bedürfen experimenteller Daten zu den beteiligten Reaktionsraten. Die Forschungsgruppe "Experimentelle Astrophysik" an der Goethe-Universität Frankfurt hat daher einen Schwerpunkt auf die Messung von Neutroneneinfangwirkungsquerschnitten im astrophysikalisch relevanten Energiebereich gelegt und nutzt dazu die etablierte Aktivierungsmethode. Dabei werden neue Ansätze verfolgt, um Wirkungsquerschnitte für quasistellare Neutronenspektren von T = 5 bis 90 keV zu bestimmen. In diesem Vortrag werden aktuelle Projekte und die neuesten Ergebnisse der letzten Messkampagnen vorgestellt und ein Ausblick über künftige Vorhaben gegeben. Diese Forschungsarbeiten werden gefördert durch das Helmholtz International Center for FAIR.

HK 54.2 Wed 16:30 HK-H10

**Proton capture on stored radioactive ions** — •Sophia Florence Dellmann[1], Jan Glorius[2], Yuri Litvinov[2], René Reifarth[1], Thomas Stöhlker[2,3], Laszlo Varga[2], and Mario Weigand[1] for the E127-Collaboration — [1]Goethe University Frankfurt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung Darmstadt, Germany — [3]Helmholtz-Institut Jena, Germany

By combining two unique facilities at GSI (Helmholtz Centre for Heavy Ion Research), the fragment separator FRS and the experimental storage ring ESR, the first direct measurement of a proton capture reaction of a stored radioactive isotope has been accomplished. The cross section of the $^{118}$Te(p,$\gamma$) reaction was measured at energies of astrophysical interest.

The ions were stored with energies of 6 and 7 MeV/nucleon and interacted with a hydrogen jet target. The produced $^{119}$I ions were detected with double-sided silicon strip detectors. The radiative recombination process of the fully stripped $^{118}$Te ions and electrons from the hydrogen target was used as a luminosity monitor. The proof-of-principle experiment had been performed in 2016 with the stable isotope $^{124}$Xe [1]. An overview of the experimental method and preliminary results from the ongoing analysis will be presented.

[1]J. Glorius et al., Phys. Rev. Lett. 122, 092701 (2019)

HK 54.3 Wed 16:45 HK-H10

**Nearly background-free measurement of proton-capture reactions using the Experimental Storage Ring** — •Laszlo Varga[1], Sophia Florence Dellmann[2], Jan Glorius[1], Yuri A. Litvinov[1], René Reifahrt[2], and Thomas Stöhlker[1,3] for the E127-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung Darmstadt, Germany — [2]Goethe University Frankfurt, Germany — [3]Helmholtz-Institut Jena, Germany

After the successful campaign for proton-capture measurements on stored stable beams at the Experimental Storage Ring at GSI in 2009 and 2016 [1-2], new experiments have been carried out in 2020 and 2021 using a radioactive ion beam. The complex spatial ion hit distributions on the employed UHV-compatible double sided silicon strip detectors (DSSSD) have been modeled through Monte-Carlo based ion-optical simulations using the MOCADI code [3]. To improve the sensitivity of the experimental method the "Elimination of the Rutherford elAstic ScattEring" (ERASE) technique has been developed. With the application of ERASE the sensitivity for the ions of interest is dramatically increased. The suitability of the method was demonstrated in 2020 and in 2021. In this talk, the measured ion-hit spectra of the DSSSD will be introduced focusing on the effects of the ERASE technique. The newly developed method is a powerful tool to study the proton-capture efficiently on nuclei hardly accessible in large quantities.

[1] - Mei B et al 2015 Phys. Rev. C92 035803
[2] - Glorius J et al 2019 Phys. Rev. Lett. 122 092701
[3] - Iwasa N et al 1997 NIM B 126 284-289

HK 54.4 Wed 17:00 HK-H10

**Analysis of the 3$\alpha$-decay of the $0_2^+$ state in $^{12}$C** — •David Werner[1], Madalina Ravar[1,3], Peter Reiter[1], Konrad Arnswald[1], Maximilian Droste[1], Pavel Golubev[2], Rouven Hirsch[1], Hannah Kleis[1], Nikolas Königstein[1], Dirk Rudolph[2], Alessandro Salice[1], and Luis Sarmiento[2] — [1]University of Cologne, Institute for Nuclear Physics, Cologne — [2]Lund University, Department of Physics, Lund, Sweden — [3]TU Darmstadt, Institute of Nuclear Physics, Darmstadt

The branching ratios of the three-particle decay of the Hoyle state, the $0_2^+$ excited state in $^{12}$C, are an important probe for the inner structure of $^{12}$C and relevant to the topic of stellar nucleosynthesis. A $^{12}$C($\alpha$,$\alpha'$) reaction at 27 MeV beam energy was utilized to populate the state of interest. Two high-statistics experiments were performed at the 10 MV FN-tandem accelerator of the Institute for Nuclear Physics of the University of Cologne. The Lund-York-Cologne-Calorimeter (LYCCA) was used to study the three-particle decay branches of the Hoyle state. The 18 highly-segmented double-sided silicon strip detectors allowed individual detection of the reaction's four $\alpha$ particles with very high angular precision. Results from particle spectra are compared with Geant4 Monte-Carlo simulations. Preliminary results of the analysis, in particular Dalitz plots, will be presented.

HK 54.5 Wed 17:15 HK-H10

**Measurement of the inelastic cross sections of antinuclei with ALICE and the implications for indirect dark matter searches** — •Stephan Koenigstorfer for the ALICE-Collaboration — Technische Universität München

Antinuclei in cosmic rays are considered a unique probe for signals from exotic physics, such as WIMP Dark Matter annihilations. Indeed, these channels are characterised by a very low astrophysical background, which comes from antinuclei produced by high energy cosmic ray interaction with ordinary matter. In order to make quantitative predictions for antinuclei fluxes near earth, both the production and annihilation cross sections of antinuclei need to be accurately known down to low energies.

In ultra relativistic pp and Pb-Pb collisions at the CERN LHC, matter and antimatter are abundantly produced in almost equal amounts, allowing us to study the production of antinuclei and measure their absorption in the detector material. The antinuclei absorption cross section is evaluated on the average ALICE material. Using this result, we then predict the transparency of our galaxy to anti-3He from both dark matter annihilations and high energy cosmic ray collisions. In this talk we present the first measurements of the anti-3He and anti-3H absorption cross section with ALICE and we discuss the implications of these results for indirect Dark Matter searches using cosmic antinuclei.