HK 37: Nuclear Astrophysics III

Time: Wednesday 15:45–17:15 Location: HBR 14: HS 1

Group Report HK 37.1 Wed 15:45 HBR 14: HS 1
Cross-section measurements at the HORUS γ-ray spectrometer and the Cologne Clover Counting setup — •Martin Müller, Felix Heim, Benedikt Machliner, Svenja Wilden, Pina Wüstenberg, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, Germany

The detailed modeling of nucleosynthesis networks requires a vast amount of information on nuclear properties that is not available from experiments. Instead, theoretical calculations are required to predict quantities like masses, lifetimes, and reaction cross sections far away from stability [1]. To make these calculations reliable, theoretical models have to be thoroughly tested and adjusted to experimental data. In order to provide high precision data, especially on the proton rich side of the nuclear chart relevant to the astrophysical γ process, the University of Cologne operates the HORUS γ-ray spectrometer for in-beam spectroscopy and the Cologne Clover Counting setup for activation experiments [2]. While the latter method is limited by the lifetime of the reaction products, a technique using decay chains can be applied. Time resolved decay curves enable the disentanglement of cross sections associated with the production of a nucleus in its ground state and a metastable state. Combining in-beam and activation experiments opens up a broad range of reactions to investigation through which theoretical models can be constrained. Supported by the DFG (ZI 510/8-2).
[1] M. Arnould *et al.*, Prog. Part. Nucl. Phys. **112** (2020) 103766.
[2] F. Heim *et al.*, Nucl. Instrum. Methods A **966** (2020) 163854.

HK 37.2 Wed 16:15 HBR 14: HS 1
Target tests for ^{12}C + ^{12}C fusion studies underground — •Annika Willer[1,2], Daniel Bemmerer[1], Axel Boeltzig[1], Federico Ferraro[3], Matthias Junker[3], Eliana Masha[1], Denise Piatti[4], Konrad Schmidt[1], Steffen Turkat[2], Anup Yadav[1,2], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR) — [2]TU Dresden — [3]INFN Laboratori Nazionali del Gran Sasso, Italy — [4]Università degli studi di Padova and INFN Sezione di Padova, Italy

The ^{12}C(^{12}C,p)^{23}Na and ^{12}C(^{12}C,α)^{20}Ne fusion reactions play an important role in explosive carbon burning, including in cosmologically important supernovae of type Ia. The cross section of these reactions is poorly constrained at energies of astrophysical interest. Their precise measurement is a major aim of the LUNA-MV 3.5 MV underground accelerator in Gran Sasso, Italy that was officially opened for scientific use in 2023. Here, we report on data from a test irradiation carried out at the Felsenkeller 5 MV underground ion accelerator in Dresden. We test the stability of solid carbon targets under intensive carbon ion beam in a dedicated, watercooled setup and check for beam-induced γ-ray background.

HK 37.3 Wed 16:30 HBR 14: HS 1
Advanced data analysis techniques for the $^{12}C(\alpha,\alpha')$ reaction — •Alessandro Salice[1], David Werner[1], Peter Reiter[1], Konrad Arnswald[1], Maximilian Droste[1], Pavel Golubev[2], Rouven Hirsch[1], Hannah Kleis[1], Nikolas Königstein[1], Dirk Rudolph[2], Timo Biesenbach[1], Joe Roob[1], Madalina Ravar[1,3], 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

In order to resolve and understand the inner structure of ^{12}C and its production during stellar nucleosynthesis, the decay properties of ^{12}C's excited 0_2^+ state, the so called Hoyle state, are studied. Excited states in ^{12}C are populated via ^{12}C(α,α') reactions at 27 MeV beam energy at the FN-tandem accelerator at the University of Cologne. A set of 18 highly-segmented Double Sided Silicon Strip Detectors (DSSSD) of the Lund-York-Cologne-Calorimeter enabled a huge solid angle coverage with high angular resolution. Data analysis of a high statistics experiment required best center-of-mass energy resolution and high angular resolution for momentum reconstruction. For this purpose in-beam calibrations of the DSSSDs were performed on a pixel level. Beamspot tracking, dead layer corrections and a precise detector position determination of individual DSSSDs were mandatory for best detector performance. Examples for improvements concerning Q value, position of the reaction plane, angular correlations and the final Dalitz plot of three α decay will be presented.

HK 37.4 Wed 16:45 HBR 14: HS 1
Jet thickness measurements at the Felsenkeller windowless gas target system — •Maxim Hilz[1,2], Daniel Bemmerer[1], Axel Boeltzig[1], Sören Göhler[1], Eliana Masha[1], Konrad Schmidt[1], Steffen Turkat[2], Anup Yadav[1,2], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR) — [2]TU Dresden

For low-energy nuclear astrophysics cross section measurements, in addition to low background and high ion beam intensity, stable and high-purity target assemblies are needed. A windowless gas target including a wall-like gas jet is currently undergoing *ex situ* commissioning for the Felsenkeller underground ion accelerator. The contribution will report on gas thickness measurements using the α energy loss technique for various gas nozzles and nozzle inlet pressures. De Laval type nozzles gave wall thicknesses of a few times 10^{17} cm^{-2}. Tests using interferometric techniques will be reported on, as well.

HK 37.5 Wed 17:00 HBR 14: HS 1
Towards high resolution simulations of the ejecta of neutron star mergers — •Christian Schwebler[1,2], Gabriel Martínez-Pinedo[1,2,3], Andreas Bauswein[1], and Oliver Just[1] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64289 Darmstadt, Germany — [2]Institut für Kernphysik (Theoriezentrum), Fachbereich Physik, Technische Universität Darmstadt, Schlossgartenstraße 2, 64289 Darmstadt, Germany — [3]Helmholtz Forschungsakademie Hessen für FAIR, GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt, Germany

Binary neutron star mergers (BNS) are currently the most promising sites for r-process nucleosynthesis. To determine the nucleosynthesis yields and confront simulations to kilonova observations it is fundamental to have an accurate description of the ejecta properties. Typical hydrodynamical simulations cover the timescales tens of milliseconds after merger and suffer from limited resolution particularly in the ejecta. In order to evolve the ejecta for a longer time and improve their resolution, we have implemented in our smoothed-particle hydrodynamics code (SPH) an equation of state extended to low densities and a particle splitting technique that increases the effective resolution in the ejecta. Several tests of the implementation will be presented.

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