HK 58: Nuclear Astrophysics 4

Time: Thursday 17:00–18:45 Location: K/HS2

HK 58.1 Thu 17:00 K/HS2

Alpha-Induced Production Cross Sections of ^{77,79}Kr and ^{77}Br — •Zuzana Slavkovská[1], Stefan Fiebiger[1], Ulrich Giesen[2], Tanja Heftrich[1], René Reifarth[1], Stefan Schmidt[1], Benedikt Thomas[1], and Mario Weigand[1] — [1]Goethe-Universität Frankfurt — [2]Physikalisch-Technische Bundesanstalt, Braunschweig

Measurements of reaction cross sections help to constrain models predicting stellar reaction rates and can therefore improve our understanding of the stellar nucleosynthesis. The production cross sections of ^{77,79}Kr and ^{77}Br following the α-irradiation of natural selenium were determined between the α-energies of 11 MeV and 15 MeV using the activation technique.

The irradiation of $^{\mathrm{nat}}$Se targets with doubly-charged He^{2+} ions extracted from a cyclotron was conducted at Physikalisch-Technische Bundesanstalt in Braunschweig. The spectroscopic analysis of the reaction products was performed using a HPGe detector. As the α-beam was stopped inside the targets, the thick target yields were determined. The corresponding energy-dependent cross sections were calculated from the difference of the thick target yields at various beam energies. The determined values were compared to theoretical predictions based on the TALYS code.

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HK 58.2 Thu 17:15 K/HS2

Gogny-HFB calculation for r-process nucleosynthesis: towards a fully-converged microscopic mass table. — •Alexander Arzhanov[1,2], Tomás R. Rodríguez[1,3], and Gabriel Martínez-Pinedo[1,2] — [1]Institut für Kernphysik, Technische Universität Darmstadt, D-64289 Darmstadt, Germany. — [2]GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, D-64291 Darmstadt, Germany. — [3]Departamento de Física Teórica, Universidad Autónoma de Madrid, E-28049 Madrid, Spain.

Any realistic model of r-process nucleosynthesis requires accurate predictions of nuclear masses for isotopes beyond the reach of currently available experimental facilities, thus one has to rely on theoretical nuclear masses. In recent years there has been a lot of progress in developing microscopic mass models based on energy density functional techniques. We have performed a large-scale calculation of nuclear masses based on Hartree-Fock-Bogolyubov (HFB) approach with Gogny-type functionals. We analyze in detail the convergence properties of the computed masses, which are related to the finite size of the working basis used in the self-consistent HFB calculations. We find a lack of convergence in the previously published results, and perform a systematic study of recently proposed extrapolation techniques to an infinite working basis size. We also discuss its applicability to global calculations of nuclear masses.

HK 58.3 Thu 17:30 K/HS2

Neutrino oscillations and nucleosynthesis of elements — •Meng-Ru Wu[1], Gabriel Martínez-Pinedo[1,2], Yong-Zhong Qian[3], and Maximilian Enders[1] — [1]Technische Universität Darmstadt, Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerioneneforschung, Darmstadt, Germany — [3]School of Physics and Astronomy, University of Minnesota, Minneapolis, U.S.A.

Neutrinos play an essential role in determining the outcome of formation of nuclei in core-collapse supernovae or in the neutrino-driven winds of neutron star mergers. It has been shown in recent years that neutrino oscillations among active flavors or between the active and a possible sterile state may happen in these astrophysical environments to influence the result of nucleosynthesis. We have examined in detail the effect of neutrino oscillations on different nucleosynthesis processes in these astrophysical environments and the results will be discussed.

This work was partly supported by the Helmholtz Association (HGF) through the Nuclear Astrophysics Virtual Institute (VH-VI-417).

HK 58.4 Thu 17:45 K/HS2

Impact of (α,n) reactions on the nucleosynthesis in neutrino-driven winds — •Julia Bliss[1], Almudena Arcones[1,2], Fernando Montes[3,4], and Jorge Pereira[3,4] — [1]Institut für Kernphysik, TU Darmstadt — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]National Superconducting Cyclotron Laboratory, Michigan State University, USA — [4]Joint Institute for Nuclear Astrophysics, http://www.jinaweb.org

Neutrino-driven winds that follow core-collapse supernova explosions are an exciting astrophysical site for the synthesis of heavy elements. Although recent hydrodynamical simulations show that the conditions in the wind are not extreme enough for a r-process up to uranium, neutrino-driven winds may be the astrophysical site where lighter heavy elements between Sr and Ag are produced. However, it is still not clear if the conditions in the wind are slightly neutron-rich, proton-rich or turn proton-rich for some time. In neutron-rich winds, (α,n) reactions are key to move matter beyond the Fe-group towards heavier elements. Due to the deficit of experimental information, the relevant reaction rates have mostly been calculated with codes based on Hauser-Feshbach models. Although these codes have been cross-checked with experimental data in regions close to stability, their accuracy is questionable as one moves towards more exotic regions. We present the impact of (α,n) reactions on the nucleosynthesis of elements between Sr and Ag in neutrino-driven winds.

HK 58.5 Thu 18:00 K/HS2

Nucleosynthesis in Neutrino-driven Winds after Neutron Star Mergers* — •Dirk Martin[1], Albino Perego[1], and Almudena Arcones[1,2] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

Neutron star mergers (NSMs) are a unique site in astrophysics. They are the most promising scenario for the origin of heavy elements via the rapid neutron capture process (r-process). Moreover, coalescing neutron stars represent also a major source of gravitational waves and are the best candidates to explain short gamma-ray bursts.

NSMs comprise three kinds of neutron-rich ejecta: dynamic ejecta due to tidal torques, neutrino-driven winds and evaporating matter from the accretion disc by viscous heating as well as recombination.

We carried out nucleosynthesis calculations based on a recent simulation of the neutrino-driven wind from a NSM [1]. We find that elements up to the second r-process peak ($A \lesssim 130$) are created in the disk ejecta [2]. These yields complement the robust formation of heavy elements including the third r-process peak ($A \sim 195$) in the dynamic ejecta. Our results also reveal dependencies on the observation angle and the black hole formation time.

[1] A. Perego et al., 2014, MNRAS, 443, 3134.
[2] D. Martin et al., in preparation.

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HK 58.6 Thu 18:15 K/HS2

Cross-section measurement of the ^{130}Ba(p,γ)^{131}La reaction for γ process nucleosynthesis — •Jan Mayer, Lars Netterdon, Philipp Scholz, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

The γ process is an important nucleosynthesis mechanism to explain the abundances of the majority of p nuclei, which are bypassed by neutron capture processes. To improve the accuracy of reaction rates predicted by theoretical models, precise experimental data is required.

Total reaction cross-section values of the ^{130}Ba(p,γ)^{131}La reaction were measured by means of the activation method [1]. Proton beams with energies between 3.6 MeV and 5 MeV were provided by the 10 MV FN-Tandem accelerator at the University of Cologne. After the irradiation, the reaction yield was determined by use of γ-ray spectroscopy using two clover-type high-purity germanium detectors.

The measured cross-section values are compared to Hauser-Feshbach calculations using the Statistical Model codes TALYS and SMARAGD with different proton+nucleus optical model potentials. In addition, an experimentally supported recommendation for the stellar proton-capture reactivity is given. Supported by the DFG (INST 216/544-1).

[1] L. Netterdon *et al.*, Phys. Rev. C **90** (2014) 035806

HK 58.7 Thu 18:30 K/HS2

Neutrino Nucleosynthesis in Core-Collapse Supernoava explosions — •Andre Sieverding[1], Lutz Huther[1], Gabriel

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We study influence of an extensive set of neutrino induced reactions on nucleosynthesis calculations for the outer layers of supernovae. We use cross sections calculated for almost the whole nuclear chart including multi-particle evaporation.

^{7}Li, ^{11}B and ^{19}F are produced by neutrino processes. Furthermore, we have explored the impact of ν-nucleosynthesis on the production of long-lived radioactive nuclei. Our calculations are based on modern simulations of neutrino spectra that turn out to predict substantially lower average neutrino energies than used in previous ν-nucleosynthesis studies. We explore the sensitivity to the neutrino spectra for a large set of solar metallicity progenitor models. Despite the lower neutrino energies we find significant contributions of neutrino-nucleosynthesis for the production of ^{26}Al and ^{22}Na.

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