HK 5: Nuclear Astrophysics I

Zeit: Montag 16:45–19:00 Raum: F 33

Gruppenbericht HK 5.1 Mo 16:45 F 33

Nuclear Astrophysics Experiments in Cologne — •Philipp Scholz, Julia Becker, Felix Heim, Jan Mayer, Mark Spieker, and Andreas 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 heavier than those in the iron-peak region, reaction rates are often calculated using the Hauser-Feshbach statistical model. The accuracy of the predicted cross sections strongly depend on the uncertainties of the nuclear-physics input-parameters. These are nuclear-level densities, γ-strength functions, and particle+nucleus optical-model potentials.

The precise measurement of total and partial reaction cross sections at sub-Coulomb energies and their comparison to statistical model calculations are used to constrain or exclude different nuclear-physics models.

This talk is going to introduce experimental methods and present recent experiments performed at the Cologne 10 MV FN-Tandem accelerator and the high-efficiency HORUS γ-ray spectrometer.

Supported by the DFG (ZI 510/8-1) and the "ULDETIS" project within the UoC Excellence Initiative institutional strategy. P.S. and J.M. are supported by the Bonn-Cologne Graduate School of Physics and Astronomy.

HK 5.2 Mo 17:15 F 33

Recent Progress on hydrogen and helium burning at the LUNA underground accelerator — •Daniel Bemmerer[1] and Klaus Stöckel[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany — [2]TU Dresden, Germany

In-beam radiative-capture experiments at low astrophysical energies require experiments in ultra-low background conditions. The Laboratory for Underground Nuclear Astrophysics (LUNA) 0.4 MV accelerator at INFN Gran Sasso, Italy, is so far the only underground ion accelerator in the world. Recent progress at LUNA regarding the ^{22}Ne(p,γ)^{23}Na [1,2], ^{22}Ne(α,γ)^{26}Mg, and ^{17}O(p,α)^{14}N [3] reactions will be reviewed. The project for the new, 3.5 MV LUNA-MV accelerator is on track and will be summarized.

[1] F. Cavanna *et al.*, Phys. Rev. Lett. 115, 252501 (2015)
[2] R. Depalo *et al.*, Phys. Rev. C 94, 055804 (2016)
[3] C.G. Bruno *et al.*, Phys. Rev. Lett. 117, 142502 (2016)

HK 5.3 Mo 17:30 F 33

Studien zur Nukleosynthesereaktion $^{12}C(\alpha,\gamma)^{16}O$ in inverser Kinematik am MAGIX-Experiment bei MESA — •Stefan Lunkenheimer für die MAGIX-Kollaboration — Institut für Kernphysik der Universiät Mainz

MAGIX ist ein vielseitig einsetzbares Fixed-Target Experiment, welches am neuen Beschleuniger MESA (Mainz Energy-Recovering Superconducting Accelerator) in Mainz eingesetzt werden soll. Dieser wird in wenigen Jahren in Betrieb genommen und ermöglicht es, mit Hilfe der Energierückgewinnung einen sehr hohen Teilchenstrom ($\sim 1\,$mA) im Bereich von ein paar wenigen MEV bis zu 105 MeV zu erreichen. In Kombination mit dem internen Gas-Target von MAGIX kann so eine Luminosität von $\mathcal{O}(10^{35}\,\mathrm{cm}^{-2}\mathrm{s}^{-1})$ erreicht werden. Dies erlaubt es Experimente mit kleinen Impulsüberträgen durchzuführen und eröffnet somit ein reiches physikalisches Programm.

In diesem Vortrag wollen wir auf die geplanten Messungen der Nukleosynthese $^{12}C(\alpha,\gamma)^{16}O$ in inverser Kinematik zur Bestimmung des zugehörigen S-Faktors eingehen. Im Experiment werden Elektronen bei kleinen Impulsüberträgen an Sauerstoff gestreut. Anschließend können über die Detektion des gestreuten Elektrons und des emittierten α-Teilchens der Wirkungsquerschnitt in Abhängigkeit der Schwerpunktsenergie gemessen werden, um den S-Faktor bestimmen zu können. Erste Simulationen geben einen Eindruck über den möglichen Parameterbereich dieser Messung bei MAGIX. In diesem Beitrag werden neben den physikalischen Prozessen die Methoden der Simulation dargestellt und die Ergebnisse diskutiert.

HK 5.4 Mo 17:45 F 33

Explosive Nucleosynthesis in 2D Core-Collapse Supernovae and the Origin of the p-Nuclei ^{92,94}Mo and ^{96,98}Ru — •Marius Eichler — Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Deutschland

Core-collapse supernovae (CCSNe) are the first polluters of heavy elements in the galactic history. As such, it is important to study the nuclear compositions of their ejecta, and understand their dependence on the progenitor structure (e.g., mass, compactness, metallicity). Here, we present a detailed nucleosynthesis study based on two long-term 2D CCSN simulations of a 11.2 M$_\odot$ and a 17.0 M$_\odot$ star. We find that in both models nuclei well beyond the iron group nuclei can be produced, and discuss in detail the nucleosynthesis of the p-nuclei ^{92,94}Mo and ^{96,98}Ru. While we observe the production of ^{92}Mo and ^{94}Mo in slightly neutron-rich conditions in both simulations, ^{96,98}Ru can only be produced efficiently via the νp-process. This disentanglement of production mechanisms has interesting consequences when comparing to the abundance ratios between these isotopes in the solar system and in presolar grains.

HK 5.5 Mo 18:00 F 33

Bypassing ^{56}Ni: a new ^{55}Ni(p,γ) rate and its implications on the rp-process — •Christoph Langer[1,2], Wei Jia Ong[2], Fernando Montes[2], and Hendrik Schatz[2] for the e11024-Collaboration — [1]Goethe University Frankfurt a. M. — [2]NSCL, Michigan State University

The observed light curve emitted during an X-Ray burst is predominantly shaped by details of the rapid proton capture process (rp process). A major waiting point is ^{56}Ni. Processing beyond this important isotope is very sensitive to the temperature and density conditions during the burst. In this work we present a possibility to efficiently bypass ^{56}Ni by processing along the $N = 27$ isotones up to the dripline. Here, the ^{55}Ni(p,γ)^{56}Cu reaction rate is important. The rate is dominantly determined by proton capture into states just above the proton separation threshold of ^{56}Cu. For the first time, we reconstructed the low-lying level scheme of ^{56}Cu using the powerful next-generation γ-ray array GRETINA in conjunction with the S800 spectrograph at the NSCL at MSU. This talk will present the results and discuss the impact on the rp process using detailed network calculations for realistic burst conditions.

This work benefited from support by the National Science Foundation under Grant No. PHY-1430152 (JINA Center for the Evolution of the Elements).

HK 5.6 Mo 18:15 F 33

Constraining the rp-process by measuring ^{23}Al(d,n)^{24}Si with GRETINA and LENDA at NSCL — •Clemens Wolf[1], Christoph Langer[1], Fernando Montes[2], and Jorge Pereira[2] for the e15226-Collaboration — [1]Goethe University Frankfurt — [2]NSCL

The ^{23}Al(p,γ)^{24}Si stellar reaction rate has a significant effect on the light-curve emitted in X-Ray bursts. The reaction rate is mainly determined by the properties of the direct capture as well as low-lying 2^+ states and a possible 4^+ state. Up to now the properties of these states have not been determined precisely enough. Our new approach was to study the surrogate reaction ^{23}Al(d,n) at 47 AMeV at NSCL. We used the GRETINA array to detect the γ-rays following the de-excitation of the reaction products in conjunction with the LENDA array to detect the recoiling neutrons and the S800. These information will be used to determine the urgently needed properties of the ^{24}Si.

This work benefited from support by the National Science Foundation under Grant No. PHY-1430152 (JINA Center for the Evolution of the Elements). The research leading to these results has received funding from the European Research Council under the European Unions's Seventh Framework Programme (FP/2007-2013) / ERC Grant Agreement n. 615126.

HK 5.7 Mo 18:30 F 33

Astrophysics with storage rings: ^{124}Xe beam at ESR — •Zuzana Slavkovská[1,2], Jan Glorius[1,2], and Christoph Langer[1,2] for the E108B-Collaboration — [1]Goethe University Frankfurt — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

The astrophysically motivated reaction ^{124}Xe(p,γ) was examined at the Experimentier-Speicherring (ESR) at the GSI in Darmstadt in June 2016.

For the first time it was possible to measure proton capture cross sections down to the Gamow window of the p-process using a storage ring. A ^{124}Xe beam reacted with a hydrogen gas jet target at five different energies between 5.5 AMeV and 8 AMeV. A newly designed double-sided silicon strip detector (DSSSD) placed directly into the ultrahigh vacuum of the ESR was used to detect the reaction products.

In this talk the experimental set-up and method as well as the first results of the beamtime will be presented.

This project is supported by BMBF-CRYRING, HGS-HIRe, HIC for FAIR and GSI-F&E.

HK 5.8 Mo 18:45 F 33

First results of total and partial cross-section measurements of the ^{107}Ag(p,γ)^{108}Cd reaction. — •Felix Heim, Julia Becker, Jan Mayer, Philipp Scholz, Mark Spieker, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

The γ process is assumed to play an important role in the nucleosynthesis of the majority of the *p* nuclei. Since the network of the γ process includes so many different reactions and - mainly unstable - nuclei, cross-section values are predominantly calculated in the scope of the Hauser-Feshbach statistical model. The values heavily depend on the nuclear physics input-parameters. The results of total and partial cross-section measurements are used to improve the accuracy of the theoretical calculations. In order to extend the experimental database the ^{107}Ag(p,γ)^{108}Cd reaction was studied via the in-beam method at the high-efficiency HPGe γ-ray spectrometer HORUS at the University of Cologne. Proton beams with energies between 3.5 and 5.0 MeV were provided by the 10 MV FN-Tandem accelerator. In this talk, first results on total and partial cross sections will be presented.

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