HK 49: Nukleare Astrophysik

Zeit: Donnerstag 16:30–18:30 Raum: HZ 5

Gruppenbericht HK 49.1 Do 16:30 HZ 5

Underground nuclear astrophysics in Europe: a status update

— •Daniel Bemmerer — Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden

The cross sections of nuclear reactions taking place in stars and in the Big Bang are generally so low that they can only be measured in the low-background environment of an underground accelerator. The talk will report about progress achieved in the past year at the world's only such machine, the LUNA 0.4 MV accelerator in Gran Sasso/Italy. The ^{2}H(α,γ)^{6}Li cross section has been measured for the first time directly in the Big Bang energy region, pinning down the amount of primordial ^{6}Li. Measurements of the ^{17}O(p,α)^{14}N and ^{22}Ne(p,γ)^{23}Na cross sections important for nucleosynthesis in an astrophysical nova are underway at LUNA, and preliminary data at unprecedented low energies are already available. An activation study of the ^{40}Ca(α,γ)^{44}Ti reaction using offline counting in the Felsenkeller underground laboratory in Dresden has yielded new and more precise resonance strengths. In order to apply the method of underground nuclear astrophysics to topics such as helium and carbon burning and the neutron sources for the astrophysical s-process, it is necessary to install a higher-energy accelerator underground. The status of the relevant new accelerator projects at Gran Sasso and at Felsenkeller will be reported. – Supported by DFG (BE 4100/2-1) and NAVI (HGF VH-VI-417).

HK 49.2 Do 17:00 HZ 5

(n,γ)-Wirkungsquerschnitte von ^{69,71}Ga und ^{63,65}Cu bei 25 und 90 keV

— •Clemens Beinrucker[1], Michael Berger[1], Stefan Fiebiger[1], Micaela Fonseca[5], Tanja Heftrich[1], Franz Kaeppeler[4], Antonin Krasa[2], Claudia Lederer[1], Ralf Plag[1], Arjan Plompen[3], Rene Reifarth[1], Stefan Schmidt[1] und Kerstin Sonnabend[1] — [1]Goethe Universität, Frankfurt — [2]SCK-CEN, Mol — [3]Institute for Reference Materials and Measurements, Geel — [4]Karlsruhe Institute of Technology, Karlsruhe — [5]Centro de Fisica Nuclear da Universidade de Lisboa, Portugal

Etwa die Hälfte der beobachteten Isotopenhäufigkeit mit $A > 56$ wird im s-Prozess produziert. Die wichtigsten Reaktionen sind Neutroneneinfänge und β-Zerfälle. Zum besseren Verständnis des s-Prozesses sind die (n,γ)-Querschnitte bei stellaren Energien von Bedeutung.

Neutroneneinfangquerschnitte können u.a. in einem Aktivierungsexperiment bestimmt werden. Dabei werden die Photonen aus dem radioaktiven Zerfall einer durch Neutronenbestrahlung aktivierten Probe mit Hilfe von hochreinen Germanium-Detektoren nachgewiesen. Der Neutronenfluss wird dabei relativ zu ^{197}Au(n,γ) gemessen.

Dieser Beitrag stellt Ergebnisse eines solchen Experiments mit Proben aus natürlichem Gallium und Kupfer vor. Dabei wurden Protonen von einem Van-de-Graaff-Generator beschleunigt, um mittels der ^{7}Li(p,n)-Reaktion ein der Boltzmannverteilung bei $kT = 25$ keV ähnliches Spektrum und eine breite Verteilung um 90 keV zu erhalten.

Dieses Projekt wurde durch EFNUDAT, ERINDA und das EuroGENESIS Projekt MASCHE unterstützt.

HK 49.3 Do 17:15 HZ 5

Gamma-ray width measurements in ^{15}N at the ELBE nuclear resonance fluorescence setup

— •Tamás Szücs[1,2], Daniel Bemmerer[1], Ralph Massarczyk[1,3], Ronald Schwengner[1], Marcell Takács[1,3], and Louis Wagner[1,3] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden — [2]MTA ATOMKI, Debrecen/Hungary — [3]TU Dresden

The stable nucleus ^{15}N is the mirror of the astrophysically important ^{15}O, compound nucleus of the leading reaction of the Bethe-Weizsäcker cycle of hydrogen burning. Most of the ^{15}N level widths below the neutron and proton emission thresholds are known from just one nuclear resonance fluorescence (NRF) measurement published more than 30 years ago, with unsatisfactory precision on some cases [1]. A recent experiment with the AGATA demonstrator array aimed to determine level widths with the Doppler Shift Attenuation Method (DSAM) in ^{15}O and ^{15}N populated in ^{14}N + ^{2}H reaction. In order to set a benchmark value for the upcoming AGATA demonstrator data, the widths of several ^{15}N levels are being studied using the bremsstrahlung facility γELBE at the electron accelerator of Helmholtz-Zentrum Dresden-Rossendorf (HZDR). The γELBE experiment and its preliminary results will be presented. – Supported by the Helmholtz Association (HGF) through the Nuclear Astrophysics Virtual Institute (HGF VH-VI-417).

[1] R. Moreh et al., Physical Review C 23, 988 (1981)

HK 49.4 Do 17:30 HZ 5

Sensitivity studies for the p process

— •Kathrin Göbel[1], Jan Glorius[1], Alexander Koloczek[1,2], Marco Pignatari[3], René Reifarth[1], René Schach[1], and Kerstin Sonnabend[1] for the NuGrid-Collaboration — [1]Goethe-Universität Frankfurt am Main — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [3]Universität Basel

Sequences of photo dissociations and β-decays during explosive conditions produce most of the p nuclei between ^{74}Se and ^{196}Hg (γ process). Some of the light p nuclei, e.g. the neutron magic isotope ^{92}Mo, may also be synthesized by proton capture reactions, especially in thermonuclear supernovae.

Nucleosynthesis simulations require stellar models and a complete reaction network. The NuGrid collaboration has developed routines to post-process the nucleosynthesis depending on temperature and density profiles derived from stellar models. Seed distributions serve as input parameters to the simulations.

We show the influence of rate variations on the abundances of the light p nuclei in a 25 solar mass Supernova model and the effect of different seed distributions. Furthermore, we present the current status of our nucleosynthesis studies of the p process in thermonuclear supernovae.

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HK 49.5 Do 17:45 HZ 5

Nuclear Structure input for Nuclear Astrophysics

— •Andrea Idini and Gabriel Martinez-Pinedo — Institut für Kernphysik, Schlossgartenstraße 2, 64289 Darmstadt

Nuclear Structure calculations can provide important input to Nuclear Astrophysics and detector physics.

Shell-Model calculations are a good tool to constrain high-energy neutrino cross sections that will play an important role in the next generation supernova neutrino detectors.

Moreover high-precision nuclear structure calculations can help to shed light on exotic nuclei that occur in some astrophysical scenarios like the accreting matter onto a Neutron Star.

HK 49.6 Do 18:00 HZ 5

Neutrino interactions with supernova matter*

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Neutrino pair bremsstrahlung and absorption ($NN \leftrightarrow NN\nu\bar{\nu}$) and inelastic scattering of neutrinos ($NN\nu \leftrightarrow \nu NN$) are of great relevance for the generation of and energy transport by neutrinos in core-collapse supernovae. In this talk, we will show that in mixtures of protons and neutrons the interaction rates are enhanced at subnuclear densities due to the large scattering lengths. As a result, the rate for neutrino pair bremsstrahlung and absorption is significantly larger below $10^{13}\,\mathrm{g\,cm^{-3}}$ compared to rates currently used in supernova simulations, which are based on the one-pion-exchange approximation. We will also show further results for neutrino interaction rates up to nuclear densities obtained in the framework of chiral effective field theory.

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HK 49.7 Do 18:15 HZ 5

New time-of-flight data for the neutron capture cross-section of ^{63}Cu

— •M. Weigand[1], T.A. Bredeweg[2], A. Couture[2], M. Jandel[2], J.M. O'Donnell[2], R. Reifarth[1] und J.L. Ullmann[2] —

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One of the important questions in nuclear astrophysics is how the observed abundances of elements came to be. Nearly all of the elements beyond the iron peak are either formed by the s- or the r-process in almost equal shares. The precise s-process path depends on stellar parameters like temperature and neutron density, and on nuclear parameters like half-lifes and neutron capture cross-sections (NCS). Thus, there is a big need for experimental data on the involved reactions to calculate their stellar rates to understand s-process nucleosynthesis.

The NCS of the copper isotopes influences the isotopic ratios of Zn. Former experiments concerning the NCS of ^{63}Cu showed large discrepancies. In order to determine the ^{63}Cu(n,γ) cross-section in the astrophysical energy region, an experiment has been performed using the calorimetric 4π-BaF_2 array DANCE at the Los Alamos National Lab (LANL). The results of the experiment will be presented.

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