HK 50: Nuclear Astrophysics IV

Zeit: Donnerstag 14:00–16:00 Raum: S1/01 A04

Gruppenbericht HK 50.1 Do 14:00 S1/01 A04

The role of nuclear inputs in *r*-process nucleosynthesis — •Samuel Andrea Giuliani, Alexander Arzhanov, Stephen Friess, Gabriel Martínez-Pinedo, Heiko Möller, Andre Sieverding, and Meng-Ru Wu — TU Darmstadt

We have studied the sensitivity of the *r*-process abundances produced in dynamical ejecta from neutron star mergers to different nuclear mass models. For each mass model, the resulting abundances are almost independent of the astrophysical conditions and reproduce the general features of the observed *r*-process abundance. We find that the second peak around $A \sim 130$ is produced by the fission yields of the material that piles up in nuclei with $A \gtrsim 250$. We also find distinct differences in the predictions at and just above the third peak ($A \sim 195$) for different mass models, due to different neutron separation energies at $N = 130$.

Due to the crucial role that fission plays in *r*-process nucleosynthesis, we have computed the fission properties of superheavy nuclei using the BCPM energy density functional. We found that certain combinations of neutron and proton number lead to an enhanced stability against the spontaneous fission process, related with the existence of magic numbers in the superheavy region. However, the systematic of the fission properties is strongly affected by the choice of the collective degree of freedom when the fission path is obtained by minimizing the action integral. Finally, a comparison with other theoretical models and the consequences for *r*-process nucleosynthesis are discussed.

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

Gruppenbericht HK 50.2 Do 14:30 S1/01 A04

Recent progress at the LUNA 400 kV underground accelerator — •Daniel Bemmerer for the LUNA-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden

The experimental study of radiative capture reactions directly at the energies of relevance for astrophysics requires long experiments with low counting rate. This type of study has greatly benefited in recent years from the ultra-low γ-ray background level underground, in the INFN Gran Sasso laboratory, Italy. There, the LUNA 400 kV accelerator has enabled a rich research program. The ^{2}H(α,γ)^{6}Li reaction has been studied for the first time in the Big Bang energy region [1]. Very recently, three resonances have been observed for the first time in the ^{22}Ne(p,γ)^{23}Na reaction, directly at energies relevant for the hot-bottom burning process in asymptotic giant branch stars [2]. Studies on other hydrogen burning reactions on ^{17,18}O and ^{23}Na are ongoing, with promising preliminary results. The group report will show an overview of recent progress and discuss future perspectives, in particular on the future LUNA experiment on the Big Bang ^{2}H(p,γ)^{3}He reaction. — Supported by NAVI (HGF VH-VI-417).

[1] M. Anders *et al.*, Phys. Rev. Lett. 113, 042501 (2014).
[2] F. Cavanna *et al.*, Phys. Rev. Lett. in press, arXiv:1511.05329

HK 50.3 Do 15:00 S1/01 A04

Low-energy resonances in the ^{22}Ne(p,γ)^{23}Na reaction addressed with a 4π BGO summing detector — •Marcell Takács for the LUNA-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden — TU Dresden

The ^{22}Ne(p,γ)^{23}Na reaction takes part in the neon-sodium cycle of hydrogen burning. This cycle is active in asymptotic giant branch (AGB) stars as well as in novae, and contributes to the nucleosythesis of neon and sodium isotopes. In order to reduce the uncertainties in the predicted nucleosynthesis yields, new experimental efforts to measure the ^{22}Ne(p,γ)^{23}Na cross section directly at the astrophysically relevant energies are needed.

In the first phase of the LUNA ^{22}Ne(p,γ)^{23}Na experiment, three new resonances have been discovered at 156-260 keV [1]. In the present talk, the results from the second experimental phase are reported. In this campaign, a 4π bismuth germanate summing detector has been used to address the lowest-energy resonances at 71 and 105 keV as well as direct capture. — Supported by NAVI (HGF VH-VI-417).

[1] F. Cavanna *et al.*, Phys. Rev. Lett. in press, arXiv:1511.05329

HK 50.4 Do 15:15 S1/01 A04

Investigation of the s-process branch-point nucleus ^{86}Rb at HIγS* — •Philipp Erbacher[1], Jan Glorius[1], Johann Isaak[2], Bastian Loeher[2], Rene Reifarth[1], Deniz Savran[2], Kerstin Sonnabend[1], and Werner Tornow[3] — [1]Goethe Universität Frankfurt am Main, Germany — [2]GSI Helmholzzentrum für Schwerionenforschung, Germany — [3]Duke University, USA

The branch-point nucleus ^{86}Rb determines the isotopic abundance ratio ^{86}Sr/^{87}Sr in s-process nucleosynthesis. Thus, stellar parameters such as temperature and neutron density and their evolution in time as simulated by modern s-process network calculations can be constrained by a comparison of the calculated isotopic ratio with the one observed in SiC meteoritic grains. To this end, the radiative neutron-capture cross section of the unstable isotope ^{86}Rb has to be known with sufficient accuracy.
Since the short half-life of ^{86}Rb prohibits the direct measurement, the nuclear-physics input to a calculation of the cross section has to be measured. For this reason, the γ-ray strength function of ^{87}Rb was measured using the γ^3 setup at the High Intensity γ-ray Source facility at TUNL in Durham, USA. First experimental results will be presented.
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HK 50.5 Do 15:30 S1/01 A04

Bestimmung der Halbwertszeit am langlebigen Isoptop 129-Iod — •Lukas Bott[1], Tanja Heftrich[1], Mario Weigand[1], Jan Glorius[1,2] und René Reifarth[1] — [1]Goethe-Universität Frankfurt am Main, 60438 Frankfurt am Main — [2]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt

Bei der Nukleosynthese im s- und r- Prozess spielen unter anderen (n,γ)-Reaktionen eine wichtige Rolle. Zur Bestimmung des Neutroneneinfangquerschnitts zum Beispiel bei ^{129}I(n,γ) ist eine genaue Kenntnis der vorhandenen Probenmenge nötig. Dazu wurde bei vorangegangenen Messungen auf verschiedene Möglichkeiten der Aktivitätsbestimmung zurückgegriffen. Die auf dieser Basis erhaltenen Querschnitte differieren allerdings um einen Faktor drei [1]. Um diesen Widerspruch zu klären soll eine neue Halbwertszeitbestimmung des ^{129}I, mit Hilfe von Niederenergie-Germaniumdetektoren stattfinden. Hierzu wurde stabiles ^{128}Te im Forschungsreaktor TRIGA an der Johannes Gutenberg Universität Mainz aktiviert und eine genaue Bestimmung der Teilchenzahl des produzierten ^{129}Te durchgeführt [2]. Erste Ergebnisse der Messung an ^{129}I werden in diesem Vortrag vorgestellt.

[1] R. Reifarth: Die Verzweigung des Nukleosynthesepfades am ^{128}I - ein stellares Thermometer, Dissertation, Eberhard-Karls-Universität zu Tübingen, 2002.

[2] M. Ziegler-Himmelreich: Produktion der radioaktiven Probe ^{129}I, Bachelorarbeit, Goethe-Universität Frankfurt am Main, 2014 (unveröffentlicht).

HK 50.6 Do 15:45 S1/01 A04

Relativistic mean-field model with energy-dependent self-energies for finite nuclei — •Sofija Antić[1,2] and Stefan Typel[1] — [1]GSI Helmholtzzentrum fur Schwerionenforschung GmbH, Darmstadt, Germany — [2]Technische Universitt Darmstadt, Germany

Following previous applications to infinite nuclear matter and neutron stars, a relativistic mean-field (RMF) model that includes higher-order derivative (NLD) couplings and density dependent (DD) couplings of nucleons to the meson fields is extended to describe finite nuclei. For that purpose, it is necessary to determine a new parametrization of the DD-NLD RMF model. Experimental binding energies, charge and diffraction radii, surface thicknesses and other observables of a set of nuclei ($^{16}O,^{24}O,^{40}Ca,...^{208}Pb$) are used as constraints. The results are studied for different energy dependencies of the regulator functions in order to find the most suitable one that is consistent with the optical potential constraint for nucleons in nuclear matter.

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