HK 4: Nuclear Astrophysics I

Zeit: Montag 14:00–15:30 Raum: S1/01 A02

Gruppenbericht HK 4.1 Mo 14:00 S1/01 A02

Nucleosynthesis in Neutron Star Mergers: insights from astrophysical conditions and nuclear physics input* — •Dirk Martin[1] and Almudena Arcones[1,2] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

Half of the elements heavier than iron are created by the rapid neutron capture process (r-process). Neutron star mergers present the most promising astrophysical site for the r-process, being both an explosive and extremely neutron-rich scenario.

We investigate the nucleosynthesis of matter ejected in different channels [1]. Furthermore, we study the impact of nuclear masses on the yields. Using masses obtained with six Skyrme energy density functionals [2], we determine systematic uncertainty bands for r-process abundances and discuss how details of the underlying microphysics can lead to abundance peaks and troughs [3].

[1] D. Martin et al., ApJ **813** (2015) 2.
[2] J. Erler et al., Nature **486** (2012) 509.
[3] D. Martin et al., submitted to PRL (2015).

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HK 4.2 Mo 14:30 S1/01 A02

Sensitivity studies for Supernovae Type Ia — •Thien Tam Nguyen[1], Alan Calder[2,6], Kathrin Göbel[1,2], Marco Pignatari[2,3], René Reifarth[1,2], Dean Townsley[2,4], and Claudia Travaglio[2,5] — [1]Goethe University Frankfurt am Main, Germany — [2]NuGrid collaboration, http://www.nugridstars.org — [3]Konkoly Observatory of the Hungarian Academy of Sciences, Hungary — [4]The University of Alabama, USA — [5]INAF - Astrophysical Observatory Turin, Italy — [6]SUNY - Department of Physics and Astronomy New York, USA

The NuGrid research platform provides a simulation framework to study the nucleosynthesis in multi-dimensional Supernovae Type Ia models. We use a large network of over 5,000 isotopes and more than 60,000 reactions. The nucleosynthesis is investigated in post-processing simulations with temperature and density profiles, initial abundance distributions and a set of reaction rates as input. The sensitivity of the isotopic abundances to α-, proton-, and neutron-capture reaction, their inverse reactions, as well as fusion reactions were investigated. First results have been achieved for different mass coordinates of the exploding star.

This project was supported by the Helmholtz International Center for FAIR.

HK 4.3 Mo 14:45 S1/01 A02

Time-Resolved Two Million Year Old Supernova Activity Discovered in the Earth's Microfossil Record — •Shawn Bishop[1], Peter Ludwig[1], Ramon Egli[2], Valentina Chernenko[1], Boyana Deveva[1], Thomas Faestermann[1], Nicolai Famulok[1], Leticia Fimiani[1], Jose Gomez[1], Karin Hain[1], Gunther Korschinek[1], Marianne Hanzlik[3], Silke Merchel[4], and Georg Rugel[4] — [1]Physik Department, Technische Universität München, 85748 Garching, Germany — [2]Geomagnetism and Gravimetry, Central Institute for Metrology and Geodynamics, 1190 Vienna, Austria — [3]Chemie Department, FG Elektronmikroskopie, Technische Universität München, 85748 Garching, Germany — [4]Helmholtz-Zentrum Dresden-Rossendorf, Helmholtz Institute Freiburg for Resource Technology, 01328 Dresden, Germany

Using accelerator mass spectrometry, we have conducted a search for live, supernova-produced, ^{60}Fe atoms within biogenically produced magnetite (Fe_3O_4) crystals contained in two Pacific Ocean sediment cores. We have found a time-resolved ^{60}Fe signal in both sediment cores, above background, centered at approximately 2.1 Myr ago and spanning approximately 800 kyr duration (full width half maximum). The onset of this signal coincides with a known marine extinction event at the Pleiocene/Pleistocene boundary, and its shape will require eventual astrophysical interpretation to understand.

HK 4.4 Mo 15:00 S1/01 A02

Role of Nuclear Reactions for the Evolution of Degenerate ONeMg Cores — •Heiko Möller[1], Samuel Jones[2], and Gabriel Martínez-Pinedo[1] — [1]TU Darmstadt — [2]HITS Heidelberg

Degenerate electron cores composed of oxygen, neon & magnesium (ONeMg cores) appear primarily in the context of the late stellar evolution stages of super asymptotic giant branch (SAGB) stars with masses between 8 - 10 $M_\odot$. They can become white dwarfs, they can undergo gravitational collapse or they might even proceed towards explosive oxygen-burning and a subsequent thermonuclear explosion.

We show that an accurate description of nuclear reactions is crucial for the determination of the pre-supernova structure of these stars and point out that weak rates involving sd-shell nuclei are especially important. This concerns in particular the ^{20}Ne electron capture, taking into account the 2$^{\text{nd}}$ forbidden transition to the ^{20}F ground state, where experimental and theoretical advances in the rate determination are currently being made. We perform stellar evolution calculations of accreting ONeMg cores to study the behavior of the core prior to the ignition of oxygen and show that the development of convection is highly sensitive to the nuclear reactions being considered. Some of our models develop an oxygen-deflagration requiring a hydrodynamic description coupled with a nuclear reaction network with $\sim$ 200 nuclear species including all relevant electron captures and beta-decays. We present results of hydrodynamic simulations that capture the onset of the oxygen-flame ignition based on recent SAGB star models.

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HK 4.5 Mo 15:15 S1/01 A02

Impact of (α, n)-reaction rate uncertainties 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 GmbH — [3]National Superconducting Cyclotron Laboratory, Michigan State University, USA — [4]Joint Institute for Nuclear Astrophysics

In neutrino-driven winds from nascent neutron stars, matter moves towards heavier nuclei, mainly via alpha capture reactions, especially (α, n)-reactions. In the absence of experimental information, the reaction rates are usually calculated with statistical Hauser-Feshbach models [1]. The predictive power of these models is uncertain, especially as one moves away from stability. Therefore, it is important to study the sensitivity of the nucleosynthesis to the theoretical uncertainty of those rates.

We will show that under some astrophysical conditions the reaction rate uncertainties can be critical for the nucleosynthesis.

[1] W. Hauser and H. Feshbach, Physical Review, 87: 366-373, 1952.

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