HK 62: Nukleare Astrophysik

Zeit: Freitag 14:00–15:45 Raum: HZ 5

Gruppenbericht HK 62.1 Fr 14:00 HZ 5

Charged-particle induced reaction studies for the astrophysical γ process — •Lars Netterdon[1], Martin Baldenhofer[1], Jan Mayer[1], Anne Sauerwein[2], Philipp Scholz[1], and Andreas Zilges[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]Institute for Applied Physics, Goethe University Frankfurt am Main

About 35 neutron-deficient nuclei, referred to as *p* nuclei, are bypassed by the *s* and *r* process. The majority of these nuclei is believed to be produced by photodisintegration reactions and subsequent β decays during the γ process. Reaction rates for the γ-process reaction network are mainly predicted by statistical model calculations as experimental data are scarce. In order to reduce the uncertainties in these calculations from the nuclear physics side, the input parameters entering the calculations, such as optical-model potentials and the γ-strength function, must be constrained experimentally. In this talk, an overview of experiments aiming at these input parameters performed at the Institute for Nuclear Physics in Cologne will be given. This includes α-induced reactions on ^{168}Yb [1] and the ^{130}Ba(p,γ) reaction using the activation technique. Moreover, a dedicated setup for in-beam nuclear astrophysics experiments utilizing the high-efficiency HPGe-detector array HORUS will be presented in detail. Total and partial cross-section results of the ^{89}Y(p,γ) reaction and first results of experiments on the ^{85}Rb(p,γ) and ^{112}Sn(α,γ) reactions are shown.
Partly supported by the DFG (ZI 510/5-1 and INST 216/544-1).
[1] L. Netterdon *et al.*, Nucl. Phys. A **916** (2013) 149

HK 62.2 Fr 14:30 HZ 5

Effects of the nuclear symmetry energy in core-collapse supernovae — •Matthias Hempel[1], Tobias Fischer[2], Matthias Liebendörfer[1], Jürgen Schaffner-Bielich[3], and Friedrich-Karl Thielemann[1] — [1]Universität Basel, Schweiz — [2]University of Wroclaw, Poland — [3]Universität Frankfurt

The nuclear symmetry energy is known to be an important quantity of the equation of state (EOS) of dense matter. In this presentation we analyze its effect in core-collapse supernovae by means of hydrodynamical simulations with detailed neutrino transport. We consider a representative selection of supernova EOS which we have developed recently, and compare their characteristic properties with experimental constraints. Besides effects on the supernova dynamics, we study implications on nucleosynthesis conditions in the so-called wind phase. Regarding the latter, we can conclude that the current constraints seem to allow only slightly neutron-rich conditions which would not result in a full r-process.

HK 62.3 Fr 14:45 HZ 5

Neutron-Capture Reactions with the R^{3}B-CaveC Setup — •Marcel Heine — IKP, TU Darmstadt

Recent research has shown that the (n,γ) transition-rates on light nuclei can have an influence on the neutron-balance during the r-process. Especially neutron rich carbon isotopes play an important role in r-process nucleo synthesis network calculations which include light nuclei, since these nuclei are aligned along major flow-paths. In particular ^{18}C is of interest, because it can be interpreted as a waiting point. The ^{17}C(n,γ)^{18}C rate could so far only be estimated theoretically and has an uncertainty of a factor of ten [1]. At the R^{3}B-CaveC setup at GSI we have measured the (n,γ) time reversed reaction, i.e. ^{18}C(γ,n)^{17}C for the above mentioned nucleus, via the Coulomb-breakup of ^{18}C beam. The kinematically complete measurement allows extracting energy dependent neutron-capture cross section with respect to the excitation energy by using the invariant-mass method. Experimental results will be presented in comparison to theoretical calculations. This work is supported by BMBF, HIC for FAIR and NAVI
[1] T. Sasaqui et al., APJ 634 (2005) 1173

HK 62.4 Fr 15:00 HZ 5

Broken Superfluid in Dense Quark Matter — •Denis Parganlija[1], Andreas Schmitt[1], and Mark Alford[2] — [1]Institut für Theoretische Physik, Technische Universität Wien, 1040 Vienna, Austria — [2]Department of Physics, Washington University St Louis, MO, 63130, USA

Quark matter at high densities is a superfluid. Properties of the superfluid become highly non-trivial if the effects of strange-quark mass and the weak interactions are considered. These properties are relevant for a microspic description of compact stars.
We discuss the effect of a (small) explicitly symmetry-breaking term on the properties of a zero-temperature superfluid in a relativistic ϕ^4 theory. If the U(1) symmetry is exact, chemical potential and superflow can be equivalently introduced either via (1) a background gauge field or (2) a topologically nontrivial mode. However, in the case of the explicitly broken symmetry, we demonstrate that the scenarios (1) and (2) lead to quantitatively different results for the mass of the pseudo-Goldstone mode and the critical velocity for superfluidity.

HK 62.5 Fr 15:15 HZ 5

Important measurements using reactor technique in order to constrain the s-Process path — •Tanja Heftrich[1], Sebastian Altstadt[1], Jan Glorius[1], Kathrin Göbel[1], Michael Heftrich[1], Franz Käppeler[2], Claudia Lederer[1], Marcus Mikorski[1], Ralf Plag[1], Rene Reifarth[1], Stefan Schmidt[1], Zuzana Slavkovska[1], Kerstin Sonnabend[1], Christian Stieghorst[3], Mario Weigand[1], Norbert Wiehl[3], and Stephan Zauner[3] — [1]Goethe University Frankfurt, Germany — [2]KIT, Germany — [3]University of Mainz, Germany

About half of the heavy elements from iron to bismuth are synthesized during s process (slow neutron capture process) by a sequence of neutron captures and β-decays. The involved β-decay times are usually shorter than the competitive neutron capture times. The resulting s process path runs along the neutron-rich side of the valley of stability in the nuclear chart. An experimental determination of the involved neutron capture cross sections and half-lives is highly desired to reproduce the elemental abundances. Long-lived radioactive isotopes can be produced in reactor activation experiments to determine the β-decay half-lives. As shown at the example of ^{60}Fe, the half-lives times of such isotopes might be more uncertain than currently estimated. An independent investigation is therefore highly desirable. We will present first measurements, and future opportunities for half-live measurements in reactor activation experiments. This project was supported by the HGS-HIRe, the HIC for FAIR, the HGF Young Investigator Project VH-NG-327 and the DFG SO907/2-1.

HK 62.6 Fr 15:30 HZ 5

Simulations of Electron Capture Supernovae with Approximate Neutrino Transport — •Heiko Möller[1], Tobias Fischer[2], Sam Jones[3], and Gabriel Martínez-Pinedo[1,4] — [1]TU Darmstadt — [2]University of Wrocław — [3]Keele University — [4]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

We have performed simulations of electron capture supernovae in a spherically symmetric general relativistic radiation hydrodynamics model with approximate neutrino treatment. We base our study on an $8.8M_\odot$ O-Ne-Mg core progenitor (Nomoto, 1984, 1987). We successfully obtain an explosion and compare our results with a reference run performed with an state-of-the-art three-flavor Boltzmann neutrino transport scheme implemented into the same hydrodynamic code. In general, we find good agreement in the the electron-flavor neutrino spectra. However, we find shorter explosion timescales and also significantly lower explosion energies of only $1.4 \cdot 10^{48}$ erg. This result is in agreement with the explosion energy of SN 2008S as derived by Tominaga et al. (2013) based on light curve studies.

Currently we are extending our simulations to the recently published super-AGB star progenitor models by Jones et al. (2013) with regard to their evolution towards an electron capture supernova.

Our study also explores the role of weak interaction rates in determining the evolution and shaping the spectra of the emitted neutrinos.

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