HK 24: Kern- und Teilchen-Astrophysik

Zeit: Dienstag 11:00–13:30 Raum: 2B

Gruppenbericht HK 24.1 Di 11:00 2B

Experimentelle Untersuchungen zur nuklearen Astrophysik am S-DALINAC* — •Jens Hasper[1], Sebastian Müller[1], Norbert Pietralla[1], Deniz Savran[1], Linda Schnorrenberger[1], Kerstin Sonnabend[1] und Andreas Zilges[2] — [1]Institut für Kernphysik, TU Darmstadt — [2]Institut für Kernphysik, Universität zu Köln

In den vergangenen Jahren wurden am supraleitenden Darmstädter Elektronenbeschleuniger S-DALINAC zahlreiche Photoaktivierungsexperimente im astrophysikalisch relevanten Energiebereich knapp oberhalb der Teilchenschwelle durchgeführt. Die experimentellen Ergebnisse dienen der Überprüfung und Verbesserung von theoretischen Modellen zur Berechnung von stellaren Netzwerken im *p*-Prozess. Vor kurzem wurden am S-DALINAC mehrere Isotope in der Massenregion der Seltenen Erden vermessen. Diese eignen sich auf Grund der genauen Kenntnis ihrer solaren Häufigkeitsverteilung hervorragend zur Untersuchung der Nukleosyntheseprozesse schwerer Elemente und stehen deshalb bereits seit mehreren Jahren im Fokus aktueller astrophysikalischer Experimente. In diesem Zusammenhang präsentieren wir Ergebnisse verschiedener Photodisintegrationsreaktionen in dieser Massenregion [1]. Seit kurzem steht mit dem Photonentagger NEPTUN ein weiterer Messplatz am S-DALINAC zur Verfügung. Hierzu werden wir experimentelle Möglichkeiten der Verwendung getaggter Photonen im Hinblick auf astrophysikalische Untersuchungen diskutieren.
*Gefördert durch die DFG (SFB 634)
[1] J. Hasper et al., Phys. Rev. C, accepted, [arXiv:0711.2603]

Gruppenbericht HK 24.2 Di 11:30 2B

Low-energy cross sections of the BBN reaction d(α,γ)^{6}Li by Coulomb dissociation of ^{6}Li — •Michael Heil[1], Klaus Suemmerer[1], Fairouz Hammache[2], Daniel Galaviz[3], Stefan Typel[4], and S246 collaboration[1] — [1]GSI Darmstadt,Germany — [2]IPN Orsay, France — [3]TU Darmstadt, Germany — [4]GANIL Caen, France

The primordial abundances of D, (^{3}He), ^{4}He, and ^{7}Li can be used to infer the baryon density of the Universe based on the framework of Big-Bang Nucleosynthesis (BBN). By precision measurements of the cosmic microwave background (CMB) an independent method became available recently. This lead to a renewed interest for BBN. Together with the recent observation of ^{6}Li in old stars and the problems to reconcile calculated primordial ^{7}Li abundances with those predicted on the basis of CMB results, the production of both, ^{6}Li and ^{7}Li in BBN has been reinvestigated. One important ingredient is the low-energy S-factor of the d-alpha radiative-capture reaction. Up to now, the only available experimental result by Kiener et al. (1991) introduced an uncertainty of about a factor of 20 in the ^{6}Li yield. We have therefore reinvestigated the d-alpha reaction with the help of Coulomb dissociation (CD) of ^{6}Li at 150 MeV/nucleon at GSI. CD is the only practical way to study the low-energy S-factor (which involves l=2 multipolarity) due to the large number of E2 photons contained in the equivalent-photon flux. Preliminary results indicate a drop of the S-factor as predicted by theory, contrary to the constant low-energy S-factor resulting from the previous study.

HK 24.3 Di 12:00 2B

Color superconducting quark matter in compact stars — David Blaschke[1], •Thomas Klaehn[2], Fredrik Sandin[3], Christian Fuchs[4], Amand Faessler[4], Gerd Roepke[5], Joachim Truemper[6], and Stefan Typel[7] — [1]Uni Wroclaw, Polen — [2]ANL, USA — [3]Lulea UT, Sweden — [4]Uni Tuebingen, Germany — [5]Uni Rostock, Germany — [6]MPE Garching, Germany — [7]GANIL, France

Recent indications for high neutron star masses ($M \sim 2\ M_{\odot}$) and large radii ($R > 12$ km) could rule out soft equations of state and have provoked a debate whether the occurence of quark matter in compact stars can be excluded as well. We show that modern quantum field theoretical approaches to quark matter including color superconductivity and a vector meanfield allow a microscopic description of hybrid stars which fulfill the new, strong constraints. For these objects color superconductivity turns out to be essential for a successful description of the cooling phenomenology in accordance with recently developed tests. We discuss QCD phase diagrams for various conditions thus providing a basis for a synopsis for quark matter searches in astrophysics and in future generations of nucleus-nucleus collision experiments such as low-energy RHIC and CBM @ FAIR.

HK 24.4 Di 12:15 2B

Influence of Mass Uncertainties of Exotic Nuclei on the *rp*- and *νp*-Process — •Timo Fleckenstein[1], Hans Geissel[1], Wolfgang Plass[1,2], Christoph Scheidenberger[1,2], Hendrik Schatz[3], and Gabriel Martinez-Pinedo[2] — [1]Justus-Liebig-Universität Gießen — [2]GSI Darmstadt — [3]Michigan State University

The impact of mass uncertainties of proton-rich nuclei with A=80-105 on astrophysical observables, e.g. x-ray burst light-curves, production path and final chemical abundance produced in nucleosynthesis (*rp*- and *νp*-) processes has been investigated. A database of mass measurements in the mass region A=80-135 since the last atomic-mass evaluation AME 2003 has been created. In addition, extrapolations have been done to hitherto experimentally unknown masses close to the proton dripline. In order to investigate the dependence of nucleosynthesis processes on mass uncertainties, a network-code for nucleosynthesis processes in a type II x-ray burst and for the nucleosynthesis processes in neutrino-driven proton rich winds of a supernova explosion have been applied. New waiting point nuclei have been found in the *rp*-process, and important key nuclei have been discovered for the *νp*-process.

HK 24.5 Di 12:30 2B

Einfluss von Spaltungsprozessen auf die Isotopenverteilung im r-Prozess — •Ilka Petermann[1,2], Aleksandra Kelic[2], Karlheinz Langanke[2,1], Gabriel Martínez-Pinedo[2], Igor Panov[3], Thomas Rauscher[3], Karl-Heinz Schmidt[2], Friedrich-Karl Thielemann[3] und Nikolaj Zinner[4] — [1]IKP, TU Darmstadt, Germany — [2]GSI, Darmstadt, Germany — [3]Department für Physik und Astronomie, Universität Basel, Switzerland — [4]Institute for Physics and Astronomy, University of Århus, Denmark

Die Entstehung der Elemente jenseits von Eisen ist etwa zur Hälfte auf den r-Prozess zurückzuführen, einer Abfolge schneller Neutronen-Einfangreaktionen und Betazerfälle in explosiven Szenarien mit hohen Neutronendichten. Reaktionsnetzwerke zur Nukleosynthese, die die zeitliche Entwicklung von Isotopenhäufigkeiten beschreiben, setzen die Kenntnis einer großen Anzahl von -teilweise ausschließlich theoretisch bestimmten- Wirkungsquerschnitten und Reaktionsraten voraus, die die Produktion und Vernichtung der einzelnen Isotope festlegen. Wegen stark unterschiedlicher Zeitskalen der Reaktionsraten liegt mit den Netzwerkgleichungen ein System steifer Differentialgleichungen vor, in dessen Lösungsansätzen die schwache Besetztheit der zugrundeliegenden Matrix ausgenutzt wird. Der Netzwerkcode wird hier um neutroneninduzierte und betaverzögerte Spaltung ergänzt, wobei für einen weiten Isotopenbereich auch auf verbesserte Reaktionsraten zurückgegriffen werden kann. Der Einfluss von Spaltungsprozessen auf die Isotopenverteilung im r-Prozess kann somit diskutiert und mit vorhergehenden Ergebnissen verglichen werden.

HK 24.6 Di 12:45 2B

shell-model half-lives for N=82 nuclei and their implications for the r-process — •Jose Cuenca-Garcia[1], Gabriel Martinez-Pinedo[1], Karl-Heinz Langanke[1,2], Ivan Borzov[1], and Frederic Nowacki[3] — [1]Geselschaft für Schwerionenforschung Plankstr. 1 64259 Darmstadt — [2]Institut für Kernphysik TU-Darmstadt Schlossgartenstr. 9 64289 — [3]Institut de Rechernes Subatomiques, Université Louis Pasteur 67097 Strasbourg, France

We have performed shell-model calculations of the half-lives and neutron-branching probabilties of the r-process waiting point nuclei at the magic neutron number N = 82. These new calculations use a larger model space than previous shell model studies and an improved residual interaction which is adjusted to recent spectroscopic data around A = 130. Our shell-model results give a good account of all experimentally known half-lives and Q-values for the N = 82 r-process waiting point nuclei. Our half-life predictions for the N = 82 nuclei with Z = 42*46 agree well with recent estimates based in the energy-density functional method.

HK 24.7 Di 13:00 2B

The stellar neutron capture cross section of 60Fe — •Rene Reifarth[1], Michael Heil[1], Dorothea Schumann[2], Iris Dillmann[3],

Cesar Domingo-Pardo[3], Franz Käppeler[3], Justyna Maganiec[3], Fritz Voss[3], Stefan Walter[3], Ethan Uberseder[4], Joachim Görres[4], and Michael Wiescher[4] — [1]GSI, Planckstr. 1, 64291 Darmstadt, Germany — [2]PSI, 5313 Villigen, Switzerland — [3]FZK, P.O. Box 3640, 76021 Karlsruhe, Germany — [4]University of Notre Dame, Physics Department, Notre Dame, IN 46556, USA

60Fe is one of the most interesting radioisotopes found on earth. With an halflife of 1.5 Myr it is sensitive to the younger history of the universe (seen as 60Co decays) and the earth (seen as 60Fe in deep see manganese crusts), but contains basically no pre-solar information. In order to use the observational information in a quantitative manner, production and destruction mechanisms of 60Fe have to be understood.

Therefore we measured the neutron capture cross section of 60Fe in the astrophysically interesting energy region applying the activation technique at the Forschungszentrum Karlsruhe (FZK). The sample material of 1.1*10**16 atoms has been retrieved from a cupper beam stop, which has been irradiated with protons at the Paul Scherrer Institute (PSI).

HK 24.8 Di 13:15 2B

Stellar (n,γ) cross section of proton-rich nuclei — •Justyna Marganiec[1,2], Iris Dillmann[2], Cesar Domingo Pardo[2], Peter Grabmayr[3], and Franz Käppeler[2] — [1]Institute of Physics, University of Lodz, 90-236 Lodz, Poland — [2]Institut für Kernphysik, Forschungszentrum Karlsruhe, 76344 Eggenstein-Leopoldshafen, Germany — [3]Physikalisches Institut der Universität Tübingen, D-72076 Tübingen, Germany

The neutron capture cross sections of proton-rich nuclei are needed for nucleosynthesis studies of the heavy elements in the p process. In this process, (n,γ) reactions compete with (γ,n) reactions and play a secondary role in the freeze-out phase. So far, the neutron capture cross sections for several of these isotopes were not yet experimentally determined.

The present measurements were based on the activation technique. Neutrons were produced at the Karlsruhe Van de Graaff accelerator via the ^{7}Li(p,n)^{7}Be reaction. For proton energies just above threshold, one obtains a neutron spectrum similar to a Maxwellian distribution for kT = 25 keV. A set of samples was irradiated in this quasi-stellar neutron spectrum together with gold foils for normalization of the neutron flux. Results will be reported for isotopes of ^{168}Yb, ^{180}W, ^{190}Pt and ^{196}Hg. These values were obtained at kT = 25 keV and are extrapolated to lower and higher thermal energies.