# HK 15: Kern- und Teilchen-Astrophysik

Zeit: Dienstag 14:15–16:30 Raum: E

HK 15.1 Di 14:15 E

**The $^3$He($\alpha$,$\gamma$)$^7$Be reaction studied at LUNA** — •Daniel Bemmerer[1,2], Ralf Kunz[3], Michele Marta[1,4], Claus Rolfs[3], Frank Strieder[3], and Hanns-Peter Trautvetter[3] for the LUNA-Collaboration — [1]Institut für Strahlenphysik, Forschungszentrum Dresden-Rossendorf — [2]INFN Padua — [3]Institut für Experimentalphysik III, Ruhr-Universität Bochum — [4]INFN Milano

The nuclear physics input from the $^3$He($\alpha,\gamma$)$^7$Be cross section is a major uncertainty in the fluxes of $^7$Be and $^8$B neutrinos from the Sun predicted by solar models and in the $^7$Li abundance obtained in big-bang nucleosynthesis calculations. Here we report on a precision cross section measurement performed by the LUNA collaboration at Gran Sasso (Italy). At energies directly relevant to big-bang nucleosynthesis, the cross section has been studied by both the activation [1] and the prompt-$\gamma$ technique. Using a windowless gas target, high beam intensity, a low background in beam $\gamma$-detector and low background $\gamma$-counting facilities, the $^3$He($\alpha,\gamma$)$^7$Be cross section has been determined at 90–170 keV center-of-mass energy with a total uncertainty as low as 4 %. The new data can be used in big-bang nucleosynthesis calculations and to constrain the extrapolation of the $^3$He($\alpha,\gamma$)$^7$Be astrophysical S-factor to solar energies.

[1] D. Bemmerer et al., Phys. Rev. Lett. 97, 122502 (2006)

HK 15.2 Di 14:30 E

**$^{14}$N(p,$\gamma$)$^{15}$O ground state capture studied above the 259 keV resonance at LUNA** — •Michele Marta[1], Daniel Bemmerer[1], Ralf Kunz[2], Claus Rolfs[2], Frank Strieder[2], and Hanns-Peter Trautvetter[2] for the LUNA-Collaboration — [1]Institut für Strahlenphysik, Forschungszentrum Dresden-Rossendorf — [2]Institut für Experimentalphysik III, Ruhr-Universität Bochum

The cross section of the $^{14}$N(p,$\gamma$)$^{15}$O reaction directly influences the rate of the CNO cycle of hydrogen burning. In order to reliably extrapolate the cross section to the solar Gamow peak, in a previous LUNA experiment capture to the ground state and several excited states in $^{15}$O has been measured and used in an R-matrix fit [1,2]. The data on the ground state capture had been affected by the true coincidence summing effect in a large volume HPGe detector placed in close geometry [1], limiting the precision of the extrapolation.

A new measurement of the cross section for capture to the ground state in $^{15}$O is running at LUNA in Gran Sasso (Italy). A clover HPGe detector is used to reduce the summing correction and its consequent uncertainty. We concentrate on energies above the $E_{\rm CM} = 259$ keV resonance, where the R-matrix fit can be constrained by precision data.

[1] A. Formicola et al., Phys. Lett B 591, 61 (2004)
[2] G. Imbriani et al., Eur. Phys. J. A 25, 455 (2005)

HK 15.3 Di 14:45 E

**Measurement of** $^3$He($\alpha,\gamma$)$^7$Be **with ERNA Recoil Separator** — •Antonino Di Leva for the ERNA-Collaboration — Experimentalphysik III, Ruhr Universität Bochum

The $^3$He($\alpha,\gamma$)$^7$Be reaction plays an important role in the interpretation of the results of the solar neutrino experiments, since the estimate of the oscillation parameters relies on the solar neutrino spectrum, calculated by solar models. The high energy component in this spectrum is mainly produced by the decay of $^7$Be and $^8$B. The uncertainty in the $^3$He($\alpha,\gamma$)$^7$Be cross section is also one of the largest contributions to the uncertainty on the predicted primordial $^7$Li abundance in Big Bang Nucleosynthesis calculations.

Previous measurements of the $^3$He($\alpha,\gamma$)$^7$Be cross section have been performed detecting the capture $\gamma$-rays or, alternatively, measuring the activity of the synthesized $^7$Be. While the results of the two different approaches agree on the energy dependence of the astrophysical $S$ factor, they disagree in the extrapolated $S_{34}(0)$ value at a 3$\sigma$ level.

A novel approach uses the European Recoil separator for Nuclear Astrophysics (ERNA) to detect directly the $^7$Be ions produced in the reaction and, additionally, the coincident detection of the capture $\gamma$-rays. Experiment and results are presented.

Supported by DFG(Ro 429/35-3) and INFN

HK 15.4 Di 15:00 E

**Study of the $^{12}$C+$^{12}$C fusion reactions near the Gamow energy** — •Frank Strieder[1], Timothy Spillane[2], Francesco Raiola[1], Hans-Werner Becker[1], Cristina Bordeanu[3], Lucio Gialanella[4], Claus Rolfs[1], Daniel Schürmann[1], and Jeff Schweitzer[2] — [1]Institut für Physik mit Ionenstrahlen, Ruhr-Universität Bochum, Germany — [2]University of Connecticut, Storrs, CT, USA — [3]HH-NIPNE, Bukarest, Romania — [4]INFN, Napoli, Italy

The fusion reactions $^{12}$C($^{12}$C,$\alpha$)$^{20}$Ne and $^{12}$C($^{12}$C,p)$^{23}$Na have been studied from $E = 2.10$ to 4.75 MeV by $\gamma$-ray spectroscopy using a C target with ultra-low hydrogen contamination. The deduced astrophysical $S(E)^*$ factor exhibits new resonances at $E \leq 3.0$ MeV, in particular a strong resonance at $E = 2.14$ MeV, which lies at the high-energy tail of the Gamow peak. The resonance increases the present non-resonant reaction rate of the $\alpha$ channel by a factor of 5 near $T = 8\times10^8$ K. Due to the resonance structure, extrapolation to the Gamow energy $E_G = 1.5$ MeV is quite uncertain. An experimental approach based on particle spectroscopy is under preparation at the Dynamitron-Tandem Laboratory of the Ruhr-Universität Bochum. Prospects for a measurement of these reactions at an underground accelerator placed in a salt mine in combination with a high efficiency detection setup, which could provide data over the full $E_G$ energy range, will be discussed.

HK 15.5 Di 15:15 E

**Isotopic Production Cross Sections in Proton-Nucleus** — •H. Machner[1,2], D. Aschman[6], K. Baruth-Ram[3,4], J. Carter[2], A. Cowley[5], F. Goldenbaum[6], B. Nangu[7], J. Pilcher[4], E. Sideras-Hadad[2], J. P. Sellschop[2], F. Smit[4], B. Spoelstra[7], and D. Steyn[6] — [1]Institut für Kernphysik, FZ Jülich, 52425 Jülich, Germany — [2]Dept. of Physics, University of the Witwatersrand, Johannesburg, South Africa — [3]Dept. of Physics, University of Durban-Westville, South Africa — [4]iThemba Labs, Faure, South Africa — [5]Dept. of Physics, University of Stellenbosch, Stellenbosch, South Africa — [6]Dept. of Physics, University of Cape Town, Cape Town, South Africa — [7]Dept. of Physics, University of Zululand, Kwa-Dlangezwa, South Africa

Studies of spallation processes, both experimental and theoretical, are numerous. One reason for this may be the importance of knowledge of cross sections and reaction mechanisms for our understanding of cosmic rays and the production of cosmogenic radionuclides, and the process of neutron production in spallation sources.

Intermediate mass fragments (IMF) from the interaction of $^{27}$Al, $^{59}$Co and $^{197}$Au with 200 MeV protons were measured in an angular range from 20 degree to 120 degree in the laboratory system. The fragments, ranging from isotopes of helium up to isotopes of carbon, were isotopically resolved. Double differential cross sections, energy differential cross sections and total cross sections were extracted.

Nuclear reaction mechanism as well as relations to nuclear astrophysics are discussed.

HK 15.6 Di 15:30 E

**Neutron capture cross section of** $^{76}$Ge — •Justyna Marganiec[1], Iris Dillmann[1], Cesar Domingo Pardo[1], Peter Grabmayr[2], and Franz Käppeler[1] — [1]Institut für Kernphysik, Forschungszentrum Karlsruhe, 76344 Eggenstein-Leopoldshafen, Germany — [2]Physikalisches Institut der Universität Tübingen, Morgenstelle 14, D-72076 Tübingen, Germany

The $(n,\gamma)$ cross section of $^{76}$Ge is important for s-process nucleosynthesis in Red Giant Stars as well as for obtaining reliable background estimates in double beta decay experiments. So far, this reaction has been described only by theoretical data. The present measurement was 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. The results obtained at $kT = 25$ keV are presented and an extrapolation to lower and higher thermal energies is suggested.

HK 15.7 Di 15:45 E

**Photoactivation of $^{92}$Mo and investigation of the short-lived isomer in $^{91}$Mo with the new pneumatic delivery system at ELBE** — •Martin Erhard[1], Daniel Bemmerer[1], Roland Beyer[1], Paulo Crespo[1], Michael Fauth[1], Eckart Grosse[1,2], Arnd Junghans[1], Joakim Klug[1], Krasimir Kosev[1], Gencho Rusev[1], Klaus-Dieter Schilling[1], Ronald Schwengner[1], and Andreas Wagner[1] — [1]Institut für Strahlenphysik, Forschungszentrum Dresden-Rossendorf, 01314 Dresden, Germany — [2]Institut für Kern- und Teilchenphysik, Tech. Univ. Dresden, 01062 Dresden, Germany

The photodisintegration cross section of the nucleus $^{92}$Mo is important for p-process nucleosynthesis. The superconducting electron accelerator ELBE at Forschungszentrum Dresden-Rossendorf provides the possibility to investigate photodisintegration with bremsstrahlung using the photoactivation technique.

The reaction $^{92}\mathrm{Mo}(\gamma,\mathrm{p})^{91}\mathrm{Nb}$ was studied using the decay of $^{91\mathrm{m}}$Nb with a 60.9 d half-life at ELBE [1]. Now the reaction $^{92}\mathrm{Mo}(\gamma,\mathrm{n})^{91}\mathrm{Mo}$ has been probed using the new pneumatic delivery system to determine the activity of $^{91\mathrm{m}}$Mo (half-life: 65 s). Since the isomer $^{91\mathrm{m}}$Mo decays also into $^{91\mathrm{m}}$Nb it was necessary to measure this process to separate the $(\gamma,\mathrm{n})$ from $(\gamma,\mathrm{p})$ contributions.

[1] Erhard, M., Nair, C. *et al.*, PoS (NIC-IX) 056 (2006)

HK 15.8 Di 16:00 E

**Erste astrophysikalische Experimente zum *p*-Prozess am FRS/LAND-Aufbau*** — •Linda Kern für die FRS-LAND-S295-Kollaboration — Institut für Kernphysik, TU Darmstadt, Schlossgartenstr. 9, 64289 Darmstadt

Unter den stabilen Isotopen gibt es 35 schwere Kerne, die nicht in Neutroneneinfangsreaktionen erzeugt werden können. Um die Synthese dieser sogenannten *p*-Kerne zu verstehen, werden Netzwerkrechnungen durchgeführt, die als Input Photodissoziationswirkungsquerschnitte benutzen.

Um in Zukunft auch instabile *p*-Kerne experimentell untersuchen zu können, wurden am FRS/LAND-Aufbau der GSI Experimente in inverser Kinematik durchgeführt. Die Anregung erfolgt durch virtuelle Photonen im Coulombfeld schwerer Kerne.

Dabei wurden zunächst ($\gamma$,n)-Reaktionen der Kerne $^{100}$Mo, $^{94}$Mo, $^{93}$Mo und $^{92}$Mo vermessen. Hier existieren teilweise bereits Vergleichsdaten aus Experimenten mit reellen Photonen.

* Gefördert durch die DFG (SFB 634) und das BMBF (06 DA 129 I)

HK 15.9 Di 16:15 E

**Messung der Neutroneinfangquerschnitte von Blei und Wismuth Isotopen** — •Cesar Domingo-Pardo für die nTOF-Kollaboration — Forschungszentrum Karlsruhe GmbH (FZK), Institut für Kernphysik, Germany

Die Neutroneinfangquerschnitte von $^{204,206,207}$Pb und $^{209}$Bi wurden am CERN Flugzeitspektrometer n_TOF im Energiebereich von 1 eV bis 1 MeV gemessen. Einfangereignisse wurden mittels zwei $C_6D_6$ Szintillatoren nachgewiesen, die sich durch eine extrem niedrige Neutronempfindlichkeit auszeichnen. Andere Beiträge zum Untergrund wurden durch zusätzliche Kontrollmessungen untersucht. Die gemessenen Wirkungsquerschnitte werden benötigt, um die Nukleosynthese am Ende des *s*-Prozess Pfads zuverlässig zu beschreiben. Die mit Hilfe von detallierten Sternmodellen gewonnenen Ergebnisse werden vorgestellt und diskutiert.