HK 6: Nuclear Astrophysics I

Zeit: Montag 14:00–16:00 Raum: HS 16

Gruppenbericht HK 6.1 Mo 14:00 HS 16

Recent progress at the LUNA deep underground accelerator: The ^{22}Ne$(p,\gamma)^{23}$Na, ^{22}Ne$(\alpha,\gamma)^{26}$Mg, and ^{2}H$(p,\gamma)^{3}$He reactions — •Daniel Bemmerer[1], Klaus Stöckel[1,2], and Tamás Szücs[1] for the LUNA-Collaboration — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany — [2]TU Dresden, Germany

New data from the LUNA 0.4 MV accelerator in Italy's Gran Sasso lab will be reviewed. After the discovery of three new ^{22}Ne$(p,\gamma)^{23}$Na resonances, very recently the study of this nuclear reaction has been completed with stringent upper limits on two hypothetical resonances at ultra-low energy (Phys. Rev. Lett. 121, 172701 (2018)). A key uncertainty has been removed from the so-called hot-bottom burning process in asymptotic giant branch stars, enabling studies of the anticorrelated Na and O abundances in globular cluster stars. – The ^{22}Ne$(\alpha,\gamma)^{26}$Mg reaction competes against one of the main neutron source reactions of the astrophysical s-process. One of several poorly known resonances is in the LUNA 0.4 MV energy range and under study there. – Measurements of the primordial ^{2}H abundance have rekindled hope to decisively improve the precision of Big Bang nucleosynthesis constraints on the primordial baryon to photon ratio. However, the interpretation of the ^{2}H abundance data is limited by the imprecise knowledge on ^{2}H destruction by the ^{2}H$(p,\gamma)^{3}$He reaction. A study of this reaction directly in the Big Bang energy window is underway at LUNA. – Finally, an update will be given on the progress of the construction of the new, 3.5 MV underground ion accelerator LUNA-MV in Gran Sasso hall B. – Supported by DFG (BE 4100/4-1).

Gruppenbericht HK 6.2 Mo 14:30 HS 16

Status of the Felsenkeller underground accelerator for nuclear astrophysics — •Daniel Bemmerer[1], Thomas E. Cowan[1,2], Marcel Grieger[1,2], Sebastian Hammer[1,2], Thomas Hensel[1,2], Arnd R. Junghans[1], Felix Ludwig[1,2], Conrad Möckel[1,2], Bernd Rimarzig[1], Stefan Reinicke[1,2], Simon Rümmler[1,2], Franziska Schoger[1,2], Ronald Schwengner[1], Julia Steckling[1,2], Klaus Stöckel[1,2], Tamás Szücs[1], Steffen Turkat[2,1], Andreas Wagner[1], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany — [2]TU Dresden, Germany

At the Felsenkeller underground site in Dresden, shielded from cosmic rays by 45 m rock overburden, a 5 MV Pelletron accelerator has been installed. This machine has an internal ion source providing intensive ^{1}H^{+} and ^{4}He^{+} beams and an external sputter ion source for high-current ^{12}C^{+} beams. Both ion sources have already been successfully tested underground, and the commissioning of the accelerator is underway. A survey of the muon, neutron, and γ-ray background of the new lab has recently been completed. The scientific program will start with studies of solar fusion and stellar helium burning. In addition to in-house research by HZDR and TU Dresden, the new accelerator will be open for outside users, both from Germany and worldwide.

HK 6.3 Mo 15:00 HS 16

Study of the ^{2}H(p,γ)^{3}He cross section at $E_p = 400$ - 800 keV — •Sebastian Hammer[1,2], Eliana Mascha[3], S. Akhmadaliev[1], D. Bemmerer[1], F. Cavanna[4], P. Corvisiero[4], R. Depalo[5], F. Ferraro[4], M. Grieger[1,2], A. Guglielmetti[3], C. Gustavino[6], T. Hensel[1,2], M. Koppitz[1,2], F. Ludwig[1,2], V. Mossa[7], R. Schwengner[1], K. Stöckel[1,2], T. Szücs[1], S. Turkat[2], L. Wagner[1], and K. Zuber[2] — [1]Helmholtz - Zentrum Dresden - Rossendorf (HZDR) — [2]Technische Universität Dresden — [3]INFN Sezione di Milano and Università degli Studi di Milano — [4]INFN Sezione di Genova and Università degli Studi di Genova — [5]Sezione di Padova and Università degli Studi di Padova — [6]INFN Sezione di Roma — [7]INFN Sezione di Bari and Università degli Studi di Bari

The production of deuterium during Big Bang Nucleosynthesis (BBN) marks a crucial step for the nucleosynthesis of light elements. Presently, the precision of the Big Bang abundance prediction of ^{2}H is limited by the uncertainty of ^{2}H destruction by the ^{2}H(p,γ)^{3}He reaction. The poor knowledge of the ^{2}H(p,γ)^{3}He cross - section in the BBN energy window is limiting further cosmological conclusions from highly accurate deuterium abundance. The present contribution reports on an experimental study of the ^{2}H(p,γ)^{3}He cross - section at energies of $E_p = 400$ - 800 keV, complementary to an ongoing study of the same reaction deep underground at LUNA at lower energy, $E_p = 50$ - 400 keV. The data have been taken at the 3 MV Tandetron accelerator of HZDR with deuterated titanium targets. Supported by DFG (BE 4100/4-1 and ZU 123/21-1)

HK 6.4 Mo 15:15 HS 16

Measurement of the ^{3}He$(\alpha,\gamma)^{7}$Be γ-ray angular distribution — •Steffen Turkat[1], Shavkat Akhmadaliev[2], Daniel Bemmerer[2], Antonio Caciolli[3], Marcel Grieger[1,2], Sebastian Hammer[1,2], Thomas Hensel[1,2], Lisa Hübinger[1,2], Felix Ludwig[1,2], Stefan Reinicke[1,2], Konrad Schmidt[1], Klaus Stöckel[1,2], Tamás Szücs[2], Louis Wagner[1,2], and Kai Zuber[1] — [1]Institut für Kern- und Teilchenphysik, TU Dresden — [2]Helmholtz-Zentrum Dresden-Rossendorf — [3]University of Padova, Italy

The improved precision regarding abundance determinations of Big Bang nuclides as well as an increased sensitivity for measuring solar neutrinos call for more precise nuclear data to improve the models. Therefore the ^{3}He$(\alpha,\gamma)^{7}$Be reaction is being studied at the 3MV Tandetron accelerator at Helmholtz-Zentrum Dresden-Rossendorf, with a focus on the measurement of the γ-ray angular distribution at $E \approx 1$ MeV.

This reaction affects the nucleosynthesis of ^{7}Li as well as the predicted solar ^{7}Be and ^{8}B neutrino fluxes. A measurement of the angular distribution of the prompt γ-rays may enable a better comparison between precise experimental data sets at $E = 0.7$ - 1.3 MeV and a unique data set from the LUNA collaboration at $E = 0.09$ MeV - 0.13 MeV.

The activated ^{7}Be samples are counted at the new Felsenkeller underground facility in Dresden, where a HPGe detector with a relative detection efficiency of 150% was recently installed. The results of the first campaign will be summarized. — Supported by DFG (ZU 123/21-1 and BE 4100/4-1) and the Konrad-Adenauer-Stiftung.

HK 6.5 Mo 15:30 HS 16

Muon flux measurement in the shallow-underground laboratory Felsenkeller — •Felix Ludwig[1,2], Louis Wagner[1,2], Tariq Al-Abdullah[1,3], Gergely Gábor Barnaföldi[4], Daniel Bemmerer[1], Detlev Degering[5], Gergely Surányi[6], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden — [2]Technische Universität Dresden — [3]Physics Department, Hashemite University, Zarqa, Jordan — [4]Wigner Research Centre for Physics of the Hungarian Academy of Sciences (MTA Wigner), H-1525 Budapest, Hungary — [5]VKTA – Strahlenschutz, Analytik & Entsorgung Rossendorf e.V., 01328 Dresden, Germany — [6]Eötvös Loránd University, H-1117 Budapest, Hungary

Muons, which are produced by cosmic rays in the atmosphere, are highly penetrating and are mitigated by the 45 m of rock above the shallow underground laboratory Felsenkeller in Dresden, Germany. In order to determine the precise flux and angular distribution of muons reaching the tunnels of Felsenkeller, a portable muon detector, developed and built by the REGARD group in Hungary, was employed. Data has been taken at four positions in the Felsenkeller tunnels VIII and IX, where the new 5 MV accelerator will be placed. At each position, seven different orientations of the detector were used to compile a map of the upper hemisphere. The measured muon flux data are matched by a calculation and a simulation using the known shape and density of the local rock cover.

HK 6.6 Mo 15:45 HS 16

Pulse shape discrimination with ^{3}He proportional counters for neutron flux measurements in low background environments — •Thomas Hensel[1,2], Daniel Bemmerer[1], Marcel Grieger[1,2], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden

Pulse shape discrimination methods to discriminate neutrons from background events, offer a new possibility for analyzing neutron flux measurements with a low signal to noise ratio. Neutron flux measurements with moderated ^{3}He proportional counters have been performed at the site of the new Felsenkeller underground accelerator in Dresden and analyzed with different pulse shape discrimination techniques. This method is then applied for the determination of the neutron flux and spectrum in the new laboratory in Felsenkeller. The data show an ambient neutron flux that is approximately 170 times lower than at the surface of the earth.