HK 50: Nuclear Astrophysics

Time: Wednesday 14:00–16:00 Location: H-ZO 60

Group Report HK 50.1 We 14:00 H-ZO 60

The ^{12}C+^{12}C fusion reactions at astrophysical energies — •Frank Strieder[1], Hans-Werner Becker[1], Nicola DeCesare[2], Antonino Di Leva[1,2], Antonio D'Onofrio[2], Lucio Gialanella[2], Benedetta Limata[2], Claus Rolfs[1], Jeff Schweitzer[3], Tim Spillane[3], Oscar Straniero[4], Filippo Terrasi[2], and Jim Zickefoose[3] — [1]Ruhr-Universität Bochum, Germany — [2]INFN Napoli, Italy — [3]University of Connecticut, USA — [4]Osservatorio Astronomico di Teramo, Italy

The fusion reactions $^{12}C(^{12}C,\alpha)^{20}Ne$ and $^{12}C(^{12}C,p)^{23}Na$ are referred to as carbon burning in stars. In massive stars the ashes produced during helium burning become the fuel for further nuclear-burning processes, leading to the synthesis of most elements with mass numbers larger than 20. Consequently, these fusion reactions represent key processes since they influence not only the nucleosynthesis but also the subsequent evolution of a star. However, at the astrophysical relevant energies the reaction rate of these fusion reactions is not very well known and provided only by extrapolations of high energy data. The reactions have now been studied from $E = 1.5$ to 4.75 MeV by γ-ray and particle spectroscopy using thick carbon targets. The data reveal new resonances, in particular strong resonances at $E < 2.3$ MeV, which lie in the range of the Gamow peak for carbon burning in massive stars, which takes place at temperatures $T \approx (5-10) \times 10^8$ K. These resonances increase the present reaction rate significantly in this temperature range. The impact of the results on various astrophysical sites, e.g. supernovae progenitor stars, will be discussed.

HK 50.2 We 14:30 H-ZO 60

Elastic Scattering of ^{7}Be and ^{8}B on Pb and Liquid H_2 and He Targets — •Shawn Bishop for the RIKEN-Collaboration — Institute of Physical and Chemical Research, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan

Elastic angular distributions from scattering of ^{7}Be and ^{8}B beams on Pb, liquid hydrogen and liquid helium targets have been acquired at 60.8 A MeV and 72.8 A MeV, respectively. These distributions have been analyzed within the framework of Woods-Saxon optical potential models yielding complete optical model parameter sets; additionally, the proton scattering distributions have also been analyzed using microscopic folding models employing various ground state density distributions for ^{7}Be and ^{8}B. Using a two-body model for ^{8}B consisting of a ^{7}Be core plus valence proton, our Woods-Saxon ^{7}Be + H and ^{7}Be + Pb optical potentials have been employed in folding calculations for the problem of ^{8}B elastic scattering on H and Pb. We find good agreement between these folding models and our ^{8}B elastic data and marked improvement over that obtained using global nucleon-nucleus optical parameter sets from the literature. A dissociation calculation using this two-body model for ^{8}B and employing our ^{7}Be + Pb potential is shown to reproduce the elastic reaction channel, demonstrating that these potentials can be directly employed for ^{8}B dissociation studies. These results will be shown, and a summary of their application for the analysis of a recent ^{8}B Coulomb Dissociation experiment will be outlined.

HK 50.3 We 14:45 H-ZO 60

Strength, decay branching ratios, and angular distribution of the 0.987 MeV resonance in the ^{14}N(p,γ)^{15}O reaction — •Michele Marta[1], Daniel Bemmerer[1], Roland Beyer[1], Carlo Broggini[2], Antonio Caciolli[2], Martin Erhard[1], Zsolt Fülöp[3], Eckart Grosse[1], György Gyürky[3], Roland Hannaske[1], Arnd Rudolf Junghans[1], Roberto Menegazzo[2], Chithra Nair[1], Roland Schwengner[1], Tamas Szücs[3], Erik Trompler[1], Andreas Wagner[1], and Dmitry Yakorev[1] — [1]Forschungszentrum Dresden-Rossendorf (FZD), Dresden, Germany — [2]INFN Sezione di Padova, Padova, Italy — [3]ATOMKI, Debrecen, Hungary

The ^{14}N(p,γ)^{15}O reaction controls the rate of the hydrogen burning CNO cycle. This reaction has recently been re-studied at $E < 500$ keV at different facilities, including LUNA. However, also data at higher energy play a role in determining the extrapolated cross section in the R-matrix framework. Here we report on a new measurement of the absolute strength, decay branching ratio, and angular distribution of the $E = 0.987$ MeV ($E_x = 8.284$ MeV) resonance carried out at the high-current FZD Tandetron. — This work has been supported in part by the European Union (FP6 AIM RITA 025646).

HK 50.4 We 15:00 H-ZO 60

Temperature dependence of β^- and β^+/ε decay branching ratio of embedded ^{74}As — •Janos Farkas[1], Gyorgy Gyurky[1], Caner Yalcin[1,2], Zoltan Elekes[1], Gabor G. Kiss[1], Zsolt Fulop[1], Endre Somorjai[1], Kalman Vad[1], Jozsef Hakl[1], and Sandor Meszaros[1] — [1]Institute of Nuclear Research (ATOMKI), H-4001 Debrecen, POB. 51, Hungary — [2]Kocaeli University, Dept. of Physics, TR-41380 Umuttepe, Kocaeli, Turkey

The branching ratio between the β^- and β^+/ε decays of ^{74}As has been measured recently in different environments at room temperature [1]. We extended the measurement to the temperature range of 250 mK – 300 K using Ge and Ta host materials. The performed experiment represents the first decay branching ratio measurement down to the millikelvin range. No significant dependence on the temperature or on the host materials has been found.

[1] Gy. Gyürky *et al.*, Europhys. Lett. **83**, 42001 (2008)

HK 50.5 We 15:15 H-ZO 60

Efficiency calibration of the ELBE nuclear resonance fluorescence setup using a proton beam — •Erik Trompler[1], Daniel Bemmerer[1], Roland Beyer[1], Carlo Broggini[2], Antonio Caciolli[2], Martin Erhard[1], Zsolt Fülöp[3], Eckart Grosse[1], György Gyürky[3], Roland Hannaske[1], Arnd Rudolf Junghans[1], Michele Marta[1], Roberto Menegazzo[2], Chithra Nair[1], Roland Schwengner[1], Tamas Szücs[3], Andreas Wagner[1], and Dmitry Yakorev[1] — [1]Forschungszentrum Dresden-Rossendorf (FZD), Dresden, Germany — [2]INFN Sezione di Padova, Padova, Italy — [3]ATOMKI, Debrecen, Hungary

The nuclear resonance fluorescence (NRF) setup at ELBE uses bremsstrahlung with endpoint energies up to 20 MeV. The setup consists of four 100% high-purity germanium detectors, each surrounded by a BGO escape-suppression shield and a lead collimator. The detection efficiency up to $E_\gamma = 12$ MeV has been determined using the proton beam from the FZD Tandetron and well-known resonances in the ^{11}B(p,γ)^{12}C, ^{14}N(p,γ)^{15}O, and ^{27}Al(p,γ)^{28}Si reactions. The deduced efficiency curve allows to check efficiency curves calculated with GEANT. Future photon-scattering work can be carried out with improved precision at high energy. — This work has been supported in part by the European Union (FP6 AIM RITA 025646).

HK 50.6 We 15:30 H-ZO 60

Measurement of the total cross section of ^{3}He(α,γ)^{7}Be with the recoil separator ERNA — •Antonino Di Leva for the ERNA-Collaboration — Institut für Experimentalphysik III Ruhr-Universität Bochum, Bochum, Germany — INFN Sezione di Napoli, Naples, Italy

The rate of ^{3}He(α,γ)^{7}Be plays a key role in the production of ^{7}Li during the Big Bang Nucleosynthesis as well as in stellar hydrogen burning, where it has a strong influence on the high energy component of the solar neutrino spectrum.

In the last decades several experiments exploited either the detection of the prompt γ-rays or the off-line determination of the number of ^{7}Be atoms collected in the target, in few cases both. The results of such experiments show some inconsistency, which hampers a determination of the ^{3}He(α,γ)^{7}Be cross section with the necessary precision and accuracy.

A new approach uses the recoil mass separator ERNA (European Recoil separator for Nuclear Astrophysics) for direct detection of the produced ^{7}Be recoils. The total cross section has been measured in the energy region $E_{\rm cm}$= 0.7 to 3.2 MeV. This approach is completely independent from previous techniques leading to substantially different systematic dependencies and, thus, independent information. In addition, off-beam activation and coincidence γ-ray measurements were performed at selected energies.

The experiment and its results, as well as the astrophysical consequences, are discussed.

HK 50.7 We 15:45 H-ZO 60

Direct Measurements of low energy resonances in ^{25}Mg(p,γ)^{26}Al — •Benedetta Limata for the LUNA-Collaboration — INFN Napoli, Italy

The direct observation of the 1.809 MeV γ-ray line following the β^+ and EC of ^{26}Al from COMPTEL and INTEGRAL instruments provides an evidence that ^{26}Al production is still active on a large scale. Stellar nucleosynthesis studies have not yet identified which one of the possible ^{26}Al sources could explain the observed evidences. Hence, solving the controversy for different astrophysical production sites of ^{26}Al demands a better understanding of the rates for the nuclear reaction ^{25}Mg(p,γ) ^{26}Al, which in turn is the slowest reaction of the Mg-Al cycle. The ^{25}Mg(p,γ) ^{26}Al reaction has been investigated down to the astrophysical relevant low energy resonances at E_R = 93, 130, and 189 keV at the 400 kV accelerator of the LUNA facility at the Laboratori Nazionali del Gran Sasso, Italy taking advantage of the strong suppression of cosmic-ray background in the underground lab. As a γ-ray detection system a six fold segmented 4π BGO detector was used. In addition to the high efficiency the segmented detector allows for detecting a full sum spectrum as well as single spectra from each of the six crystals which provides additional information on the decay scheme. The low energy resonance at E_R = 93 keV of the reaction ^{25}Mg(p,γ) ^{26}Al could be detected for the first time in a direct experiment. The results of the project will be presented and astrophysical consequences will be discussed as well as the potential of this experimental approach for future measurements in an underground lab.