HK 42: Nuclear Astrophysics III

Zeit: Donnerstag 14:00–16:00 Raum: F 33

Gruppenbericht HK 42.1 Do 14:00 F 33

Felsenkeller 5 MV underground ion accelerator: muon, neutron, and γ background and project status — •Daniel Bemmerer[1], Francesca Cavanna[1], Thomas E. Cowan[1,2], Marcel Grieger[1,2], Thomas Hensel[1,2], Arnd R. Junghans[1], Felix Ludwig[1,2], Stefan E. Müller[1], Bernd Rimarzig[1], Stefan Reinicke[1,2], Stefan Schulz[1,2], Ronald Schwengner[1], Klaus Stöckel[1,2], Tamás Szücs[1,3], Marcell P. Takács[1,2], Andreas Wagner[1], Louis Wagner[1,2], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany — [2]TU Dresden, Germany — [3]MTA ATOMKI, Debrecen, Hungary

Motivated by the success of the world's only underground ion accelerator, LUNA 0.4 MV in Italy, a project for a higher-energy underground accelerator is underway in Dresden. A 5 MV Pelletron accelerator with double charging chains and provision for intensive $^{1}H^{+}$, $^{4}He^{+}$, and $^{12}C^{+}$ beams based on external and internal ion sources is currently being installed in the Felsenkeller underground site in Dresden. Civil construction work in Felsenkeller will be completed in August 2017. The nine Felsenkeller tunnels are shielded from cosmic rays by 45 m rock overburden, attenuating the background in radiation detectors. New data on the muon, neutron, and γ background in Felsenkeller will be shown, and used for a discussion on the feasibility of low-background experiments there. The new accelerator will be open for outside users, and its most important experimental capabilities will be summarized.

HK 42.2 Do 14:30 F 33

Bestimmung des ^{10}Be(n,γ)-Wirkungsquerschnitts — •Daniel Veltum[1], Klaus Eberhardt[2], Stephan Heinitz[3], Arndt Junghans[4], René Reifarth[1], Benedikt Thomas[1], Meiko Volknandt[1], Mario Weigand[1], Norbert Wiehl[2] und Clemens Wolf[1] — [1]Goethe Universität, Frankfurt, Deutschland — [2]Johannes Gutenberg Universität, Mainz, Deutschland — [3]Paul Scherrer Institut, Villigan, Schweiz — [4]Helmholtz Zentrum Dresden-Rossendorf, Deutschland

Zu den grundlegenden Aufgabe der experimentellen nuklearen Astrophysik zählt der Versuch die primordiale und stellare Nukleosynthese besser zu verstehen und die beobachtete solare Häufigkeitsverteilung der Elemente zu erklären. Hierzu ist die Untersuchung von Kernreaktionen unter stellaren Bedingungen unerlässlich. Im September 2016 erfolgte eine Aktivierung von ^{10}Be mit Neutronen am Forschungsreaktor TRIGA in Mainz, um den Neutroneneinfangsquerschnitt genauer zu bestimmen. Mit Hilfe zweier $LaBr_3$ Szintiallationsdetektoren wurde die Aktivität der erzeugten ^{11}Be-Kerne gemessen. Es wurden der thermische und der epithermische Wirkungsquerschnitt von ^{10}Be(n,γ) bestimmt.

HK 42.3 Do 14:45 F 33

Untersuchung der ^{135}I(n,γ) - Reaktion — •Meiko Volknandt[1], René Reifarth[1], Michael Heil[2] und Alexander Koloczek[1] für die R3B-Kollaboration — [1]Goethe Universität, Frankfurt am Main, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

Um die beobachtete solare Elementhäufigkeitsverteilung mit theoretischen Modellen rekonstruieren zu können, ist eine genaue Kenntnis der Reaktionsraten der einzelnen Nuklide notwendig.

Für das Verständnis der neutroneninduzierten Nukleosynthese sind Einfangswirkungsquerschnitte von instablien Isotopen unabdinglich.

Der kürzlich postulierte i-Prozess, ein Neutroneneinfangsprozess, der zwischen dem r- und dem s-Prozess angesiedelt ist, ist sehr stark von der ^{135}I(n,γ) - Rate abhängig.

Am R3B-Aufbau ist im Rahmen FAIR Projekts ein Coulomb-Aufbruch-Experiment an ^{136}I geplant. Mit Hilfe der Theorie der virtuellen Photonen kann daraus auf die Reaktion ^{136}I(γ,n) geschlossen werden, was wiederum wertvolle Informationen zur gesuchten, zeitumgekehrten Reaktion ^{135}I(n,γ) liefert.

HK 42.4 Do 15:00 F 33

Screening effects for nuclear reactions of astrophysical interest in laser-generated plasmas — •Yuanbin Wu and Adriana Pálffy — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg, Germany

Due to screening effects, nuclear reactions in astrophysical plasmas may behave differently than in the laboratory. At the upcoming ELI-NP facility with 10 PW lasers, an experimental setup where two laser beams generate two colliding plasmas is envisaged [1]. In this experimental setup, a laser pulse interacting on a solid target produces a plasma through the Target Normal Sheath Acceleration scheme, and then this rapidly streaming plasma (ion flow) interacts on a secondary plasma created by the interaction of a second laser pulse on a gas jet target. We model here this scenario and calculate the reaction events for the reaction ^{13}C(^{4}He,n)^{16}O which is one of the main neutron sources for the s-process. We find that, with this experimental setup, it is possible to determine the plasma screening enhancement factor for fusion reactions, by detecting the difference of the reaction events between the two scenarios of ion flow interacting with the plasma target and the gas target. This will provide a tool to explore the nuclear reactions in stellar environments which could strongly contribute to the field of nuclear astrophysics.

[1] M. Roth et al. (eds.), Laser driven nuclear physics at ELI-NP – technical design report, 2015.

HK 42.5 Do 15:15 F 33

Implementation of isomeric states into stellar nucleosynthesis codes — •Deniz Kurtulgil, Kathrin Göbel, René Reifarth, and Benedikt Thomas — Goethe University Frankfurt

The existence of indirect transitions between ground and long-lived isomeric states through thermal excitation into higher lying states was implemented into a stellar nucleosynthesis code.

Gaining information about the inner workings of stellar burning and thermonuclear explosion phases through direct observation is difficult. Therefore, nuclear astrophysics has to rely on stellar modelling and nucleosynthesis codes to produce those results, which can then be compared to the observable data, like elemental abundances from astronomical spectroscopy or isotopic ratios in presolar grains. One process of interest is the effect that high temperatures have on the lifetime of long-lived isomeric states (e.g. ^{26}Al, ^{85}Kr), where thermal excitations and subsequent decay processes into different states can significantly alter the abundance distribution and availability for further nucleosynthesis reactions of the isotope.

This talk will outline the implementation of isomeric states, first tests on well-studied cases like ^{26}Al and its application to the s-process branchpoint ^{85}Kr.

HK 42.6 Do 15:30 F 33

Determination of the ^{129}I Half-Life Using Research Reactors — •Kafa Khasawneh[1], Lukas Bott[1], Alexander Domula[2], Klaus Eberhardt[3], Jan Glorius[4], Kathrin Göbel[1], Tanja Heftrich[1], René Reifarth[1], Stefan Schmidt[1], Kerstin Sonnabend[1], Mario Weigand[1], Norbert Wiehl[3], Mathilde Ziegler-Himmelreich[1], Stephan Zauner[3], and Kai Zuber[2] — [1]Goethe University Frankfurt — [2]Technical University Dresden — [3]Johannes Gutenberg University Mainz — [4]GSI-Helmholtzzentrum für Schwerionenforschung

A new methodology was adopted in order to determine the half-life of ^{129}I. Half-life measurements in the range of a few million years rely on the determination of the number of radioactive atoms and the activity. In this work the number of atoms was determined from the activity of the short-lived isotope ^{129}Te, which decays into the desired isotope. ^{129}Te was produced at TRIGA MARK II Reactor irradiating ^{128}Te. The long-lived activity was investigated above and under ground at the Felsenkeller Dresden. We will present the method, the current status of analysis as well as future options.

HK 42.7 Do 15:45 F 33

The Measurement of Long Lived Alpha Decay for Cosmochronometry — •Heinrich Wilsenach[1], Kai Zuber[1], Réne Heller[2], Volker Neu[3], Yordan Georgiev[4], and Tommy Schönherr[4] — [1]IKTP TU-Dresden, Dresden, Germany — [2]Institute of Ion Beam Physics and Materials Research, Dresden-Rossendorf, Germany — [3]Institute for Metallic Materials, Dresden, Germany — [4]Transport Phenomena in Nanostructures, Dresden-Rossendorf, Germany

Long lived alpha decaying isotopes (about $T_{1/2} = 10^{8-10}$ a) can be used as a powerful tool to date the formation of astronomical objects in the Solar System. This is due to their extremely long half-lives. This technique is however very vulnerable to the accuracy of the half-life. This means that improved half-life measurements are important, though they pose a significant technical obstacle.

To measure the half-lives of this magnitude special care needs to be taken with background and signal efficiency. To overcome these obstacles the design of the twin Frisch-Grid ionisation chamber was chosen. This design combines excellent energy resolution with a high detector efficiency to measure decay rates in the region of a few counts per day. Pulse shape analysis was used to improved signal to background discrimination.

This presentation will give an overview of the detection aspects of the twin Frisch-Grid ionisation chamber, as well as new measurements of the half-lives of ^{147}Sm and ^{190}Pt.