HK 62: Nuclear Astrophysics V

Time: Thursday 15:45–17:15 Location: HBR 14: HS 4

Group Report HK 62.1 Thu 15:45 HBR 14: HS 4

Fully calibrated lanthanide atomic data for 3D kilonova modeling — •Andreas Flörs[1], Ricardo Fereirra da Silva[2,3], Luke Shingles[1], Christine Collins[1], Jorge Sampaio[2,3], José Manuel Pires Marques[2,3], and Gabriel Martínez-Pinedo[1,4] — [1]GSI, Darmstadt, Germany — [2]LIP, Lisboa, Portugal — [3]Universidade de Lisboa, Lisboa, Portugal — [4]TU Darmstadt, Darmstadt, Germany

With the detection of multiple neutron-star merger events in the last few years, the need for a more comprehensive understanding of nuclear and atomic properties has become increasingly important. Despite our current understanding, there are still large discrepancies in the opacities obtained from different codes and methods. These discrepancies lead to variations in the location and strength or absorption and emission features in radiative transfer models and prevent a firm identification of r-process products. To address this issue, we developed an optimisation technique for energy levels and oscillator strengths consistent with available experimental data. With this novel method, we can increase the accuracy of calculations while reducing the computational cost, finally making it possible to apply the method to all lanthanides instead of focusing on single ions.

In this talk, we will report on converged large-scale atomic structure calculations of all singly and doubly ionised lanthanides with greatly improved transition wavelength accuracy compared to previous works. The impact of our new atomic data set on realistic 3D radiative transfer calculations and prospects of r-process signature identification will be investigated.

HK 62.2 Thu 16:15 HBR 14: HS 4

Mass measurements of neutron-rich nuclides at the N=126 shell closure with the FRS Ion Catcher — •Kriti Mahajan for the S468 experiment-Collaboration — Justus-Liebig-Universität Gießen, Germany — HFHF, Gießen Campus

At GSI Darmstadt experiments with exotic nuclides can be performed, enabling the study of nuclei far from stability. These nuclei can be produced at relativistic energies by projectile fragmentation or fission and separated in the fragment separator FRS.

An experiment was performed in the region "south" of the doubly magic nucleus ^{208}Pb close to the N=126 line, which is of key importance for nuclear structure and nuclear astrophysics studies and can help us to better understand the r-process, in particular the third abundance peak. The experiment aimed to identify new neutron rich isotopes and to measure their production cross sections, masses and half lives. Mean range bunching was used to efficiently stop the beam further in an active stopper for half-life measurements and in the FRS Ion Catcher (FRS-IC) for precise mass measurements.

At FRS-IC, the beam is thermalized inside the cryogenic stopping cell and transmitted to the multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS), which features a high resolving power of up to 1,000,000, short cycle times of a few ten milliseconds and mass accuracies down to a few 1E-8. The preliminary results of these mass measurements will be presented, including the first mass measurements of ^{204}Au, ^{205}Au and ^{200}Ir.

HK 62.3 Thu 16:30 HBR 14: HS 4

γ-ray angular distribution of the ^{3}He$(\alpha,\gamma)^{7}$Be reaction — •Peter Hempel[1,2], Daniel Bemmerer[1], Axel Boeltzig[1], Till Lossin[1,2], Eliana Masha[1], Konrad Schmidt[1], Steffen Turkat[2], Anup Yadav[1,2], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR) — [2]TU Dresden

The ^{3}He$(\alpha,\gamma)^{7}$Be reaction plays two roles in astrophysics: It is responsible for ^{7}Li production during Big Bang nucleosynthesis, and it controls the branching between the pp-1 and pp-2 chains in solar hydrogen burning. Here, we report on the final data from a measurement of the γ-ray angular distribution of this reaction in the energy range $E_{\rm CM} = 450\,\text{-}\,1220\,$keV. The experiment has been carried out at the Felsenkeller 5MV shallow-underground accelerator lab in Dresden. For the angular study more than 20 HPGe detectors were arranged at angles between $\theta = 25\,\text{-}\,140\,^{\circ}$ with respect to the beam direction. – The use of GAMMAPOOL resources is gratefully acknowledged.

HK 62.4 Thu 16:45 HBR 14: HS 4

Results of total and partial cross-section measurements of the ^{87}Rb$(p,\gamma)^{88}$Sr reaction — •Svenja Wilden, Felix Heim, Benedikt Machliner, Martin Müller, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, Germany

The existence of the p nuclei – a set of stable proton-rich nuclei – cannot be explained by neutron-capture processes [1]. Therefore, another mechanism must come into play, namely photodisintegration reactions, giving rise to the γ process. Since many photodisintegration reactions are not accessible trough experiments, statistical model calculations play a crucial role in predicting reaction rates and cross sections.

To study the ^{87}Rb$(p,\gamma)^{88}$Sr reaction, an in-beam experiment was performed at the high-efficiency HPGe γ-ray spectrometer HORUS at the University of Cologne. The 10 MV FN Tandem accelerator provided proton beams between $E_p = 2$ and 5 MeV. For six proton-beam energies cross-sections values were determined. These first experimental cross-section values for the ^{87}Rb$(p,\gamma)^{88}$Sr reaction help to constrain the nuclear physics input for statistical model calculations.

[1] T. Rauscher *et al.*, Rep. Prog. Phys. **76** (2013) 066201.

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HK 62.5 Thu 17:00 HBR 14: HS 4

Transition frequency measurements in $^{46-50}$Ti^{+} of astrophysical interest at COALA — •Julien Spahn, Kristian König, Tim Lellinger, Wilfried Nörtershäuser, and Tim Ratajczyk — Institut für Kernphysik, TU Darmstadt, 64289 Darmstadt, Germany

A long standing question of cosmology is if fundamental physical constants, like the fine structure constant α, are in fact constant or vary with time, as proposed by different theories expanding the standard model [1]. To investigate this behavior, the study of the fine-structure splitting of atomic levels ($\propto \alpha^2$), within the absorption lines caused by gas clouds in the light emitted by quasars, has been proposed [2]. Especially transition metals lighter than Fe and hence produced through fusion, like Ti, are of particular interest, since they are produced in first generation stars and thus give access to the very early state of the universe 12 billion years ago.

Such studies require a precise knowledge of absolute transition frequencies at an accuracy better than 10^{-4} Å, which can be achieved using collinear laser spectroscopy, as demonstrated on numerous stable and short-lived isotopes. Three transitions in $^{46-50}$Ti from the $3d^2(^3\mathrm{F})4s\ ^4\mathrm{F}$ ground state to the $3d^2(^3\mathrm{F})4p\ ^4\mathrm{G}$ state have been investigated at COALA at TU Darmstadt. This contribution will present our latest results obtained using a versatile laser ablation source, which will allow us to investigate other transitions of interest in the future.

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[1] J.-P. Uzan, *Reviews of Modern Physics*, vol. 75, 2003.
[2] D. J. Mortlock et al., *Nature*, vol. 474, 2011.