INPC 2025
May 25-30, 2025
DCC, Daejeon, Korea

Contribution ID: **591** Type: **Contributed Oral Presentation**

Impact of newly measured beta-delayed neutron data for nuclei close to 78Ni on light-element nucleosynthesis in neutron star mergers

Tuesday, 27 May 2025 08:30 (15 minutes)

How different astrophysical events contribute to the synthesis of elements heavier than iron and in particular the role of the rapid (r) neutron capture process, remains an actively debated topic [1]. The r-process was recently observed in the kilonova emission accompanying the unique detection of gravitational waves from the neutron star merger event GW170817 [2]. The EM early emission is dominated by the presence of freshly produced light r-process elements and there is evidence for the observation of Sr [3]. A promising approach to investigating the r-process is to study elemental abundances in the atmosphere of old ultra metal-poor (UMP) stars, which likely collected elements from only one or a few nucleosynthesis events. This can be then compared to calculations based on models of different astrophysical events which together with the nuclear data input are able to predict abundances. A difficulty here is the blurring effect induced by nuclear data uncertainties. In particular in the case of the r-process that runs far away from beta-stability, decay data is obtained from theoretical models with modest predictive power [4].

In this contribution, we present new experimental values of decay half-lives and neutron emission probabilities of 37 very neutron-rich nuclei ranging from 75Ni to 92Br, measured at the RIKEN Nishina Center in Japan, including 11 one-neutron and 13 two-neutron emission probabilities and 6 half-lives determined for the first time [5].

We further investigate the impact of our data on the final abundances produced by a weak r-process, which synthesizes first-peak r-process elements. This process occurs in neutrino-driven winds following a neutron star merger. To do that, we use a comprehensive set of simulated thermodynamical trajectories that describe the evolution of matter properties in the merger outflows [6]. We find a sizable increase in the calculated abundances of Y, Zr, Nb and Mo using our data, significantly larger than the spread on relative abundances observed in UMP stars [7]. This emphasizes the necessity of using reliable experimental decay data for very neutron-rich beta-delayed neutron emitters in r-process models to ensure meaningful comparisons with observational data.

[1] A. Arcones et al., Astron. & Astroph. Review 31, 1 (2023)
[2] D. Kasen et al. Nature 551, 80 (2017)
[3] D. Watson et al., Nature 574, 497 (2019); N. Vieira et al., Astroph. J. 944, 123 (2023)
[4] P. Moeller et al., At. Data and Nucl. Data Tables 125, 1 (2019)
[5] A. Tolosa-Delgado, PhD Thesis, University of Valencia (Spain), 2020
[6] D. Martin et al., Astroph. J. 813, 2 (2015)
[7] I. U. Roederer et al., Astroph. J. 936, 84 (2022)

Primary authors: ARCONES, Almudena (T. U. Darmstadt); TOLOSA-DELGADO, Alvaro (CERN); RASCO, B. C. (ORNL); DILLMANN, Iris (TRIUMF); TAIN, Jose L. (IFIC, CSIC-U.Valencia); RYKACZEWSKI, K.P (ORNL); REICHERT, Moritz (U. Valencia); HALL, O. (U. Edinburgh); YOKOYAMA, R. (Center for Nuclear Study, the University of Tokyo); GRZYWACZ, Robert. K (University of Tennessee, Knoxville, ORNL); NISHIMURA, Shunji (RIKEN); DAVINSON, T. (Univ. Edinburgh); PHONG, V. H. (RIKEN Nishina Center); BRIKEN COLLABORATION, and the

Presenter: TAIN, Jose L. (IFIC, CSIC-U.Valencia)

Session Classification: Parallel Session

Track Classification: Nuclear Astrophysics