Contribution ID: **41** Type: **Submitted oral (In person)**

The Oslo method at ISOLDE - The Nuclear Level Density and γ-ray Strength Function of 67Ni

Friday, 2 December 2022 14:45 (12 minutes)

Nucleosynthesis of the elements beyond Fe/Ni is mainly due to neutron capture processes, with most elements created either through the rapid neutron capture process (r-process) or the slow neutron capture process (s-process) [1]. More recent astronomical observations calls for a third, intermediate neutron capture process (i-process) to explain the elemental composition of certain metal-poor stars [2].
Both the r- and i-process involves mainly unstable nuclei and relies on theoretical predictions of the neutron capture rates, calculated within the Hauser-Feshbach model. The main nuclear data input for these calculations are the nuclear level density (NLD), the γ-ray strength function (γSF) and the optical model potential. Current models of the NLD and γSF are well constrained within the valley of stabillity, but vary siginificantly for unstable neutron rich nuclei. This leads to large uncertanties in the calculated neutron capture rates, usually on the order of one or more magnitudes. To reduce these uncertanties, the NLD and γSF needs be measured in key nuclei such that model parameters can be constrained. One such key nucleus is ^{67}Ni as the $^{66}\mathrm{Ni}(n,\gamma)^{67}$Ni reaction has been identified as a significant bottleneck for the weak i-process, affecting the overall rate of the weak i-process [3].

The Oslo Method is a unique tool for investigating NLDs and γSFs of nuclei as it is the only experimental method able to measure both quantities simultaniously [4]. The method relies on excitation energy versus γ-ray energy matrices, typically obtained from particle-γ coincidences measured in light ion beam experiments. More recently, inverse kinematics have been demonstrated as an effective tool to measure such matrices [5]. The NLD and γSF of neutron rich nuclei can therefore be probed with the Oslo Method at radioactive ion beam facilities such as ISOLDE.

In experiment IS559 a $4.47(1)$ MeV/u beam of ^{66}Ni impinged on a deuterated polyethylene target and proton-γ coincidences were measured in C-REX and Miniball, suplemented with six large volume $LaBr_3$:Ce detectors. From the measured coincidences, the NLD and γSF of ^{67}Ni were extracted, and the neutron capture cross section of ^{66}Ni was constrained. Our result show a relativly high capture rate, suggesting that ^{66}Ni is not a bottleneck for the weak i-process.

[1] E. M. Burbidge *et al.*, Synthesis of the elements in stars, Reviews of Modern Physics **29**, 547 (1957).
[2] I. U. Roederer *et al.*, The diverse origins of neutron-capture elements in the metal-poor star hd 94028: Possible detection of products of i -process nucleosynthesis, The Astrophysical Journal **821**, 37 (2016).
[3] J. E. McKay *et al.*, The impact of (n,γ) reaction rate un- certainties on the predicted abundances of i-process ele- ments with 32 ≤ z ≤ 48 in the metal-poor star hd94028, Monthly Notices of the Royal Astronomical Society **491**, 5179 (2020).
[4] A. C. Larsen *et al.*, Novel techniques for constraining neutron-capture rates relevant for r-process heavy-element nucleosynthesis, Progress in Particle and Nuclear Physics **107**, 69 (2019).
[5] V. W. Ingeberg *et al.*, First application of the oslo method in inverse kinematics, European Physical Journal A **56**, 68 (2020).

Primary author: INGEBERG, Vetle Wegner (University of Oslo (NO))

Presenter: INGEBERG, Vetle Wegner (University of Oslo (NO))

Session Classification: Nuclear Astrophysics and Exotic Decays