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Statistical properties of 180,181,182Ta and their implications for 180Ta nucleosynthesis

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Most stable and extremely low abundance proton-rich nuclei with A>110 are thought to be produced by the photodisintegration of s- and r- process seed nuclei. However, this so-called p-process is insufficient to explain the observed low abundance (0.012%) of the 180Ta isotope. Hence combinations of several processes are considered to reproduce the observed abundance of 180Ta in the cosmos, provoking debates and making it a unique case study. Significant uncertainties in the predicted reaction rates in p-nuclei arise due to large uncertainties in nuclear properties such as the nuclear level densities (NLD) and gamma-ray strength functions (γSF) (S. Goriely et al., 2001), as well as the actual astrophysical environments. An experiment was performed in October 2014 to extract the NLD and γSF below the neutron threshold (Sn) in 180,181,182Ta isotopes which provide important input parameters for nuclear reaction models. In the present case study, these parameters were measured using the 181Ta(3He,3He'γ) and 181Ta(3He,4Heγ) reactions with 34MeV beam, 181Ta(d,d'γ) and 181Ta(3He,tγ) reactions with 15 MeV beam , and 181Ta(d,d'γ) and 181Ta(d,pγ) reactions with 12.5 MeV beam at the Oslo Cyclotron Laboratory (OCL). Using the SiRi array at backward angles (64 silicon particle telescopes) and the CACTUS array (26 NaI(Tl) detectors), the NLD and γSF were simultaneously extracted below Sn from particle-γ coincidence matrices through iterative procedures using the Oslo method (A. Schiller et al., 2000). The experimental results have been used to determine the corresponding neutron capture cross sections, which in turn were utilized to extract Maxwellian averaged cross sections. The latter were further used in astrophysical s- and p-process network calculations to investigate the galactic production mechanism of 180Ta. In this talk I will present final results on the statistical properties of 180,181,182Ta and their implications for the nucleosynthesis of 180Ta.

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