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Nuclear level densities and gamma-ray strength functions of 180;181;182Ta and neutron capture cross sections

Most stable and extremely low abundance proton-rich nuclei with <i>A</i»110 are thought to be produced by the photodisintegration of <i>s</i>- and <i>r</i>- process seed nuclei. However, this so-called <i>p</i>-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 <sub>p</sup>-nuclei arise due to large uncertainties in nuclear properties such as the nuclear level densities (NLD) and gamma-ray strength functions (gamma;SF) [1], as well as the actual astrophysical environments. An experiment was performed in October 2014 to extract the NLD and gamma;SF below the neutron threshold in ^{180,181,182}Ta isotopes which provide important input parameters for nuclear reaction models. In the present case study, these parameters were measured using the ¹⁸¹Ta(³He, ³He') and ¹⁸¹Ta(³He, ⁴He) reactions with 34 MeV beam, ¹⁸¹Ta(d, d') and ¹⁸¹Ta(³He, t) reactions with 15 MeV beam , and ¹⁸¹Ta(d, d') and ¹⁸¹Ta(d, p) reactions with 12.5 MeV beam at the Oslo Cyclotron Laboratory. Using the SiRi array at backward angles (64 silicon particle telescopes) and the CACTUS array (26 NaI(Tl) detectors), the NLD and gamma;SF were simultaneously extracted below the neutron separation energy from particle-gamma; coincidence matrices through iterative procedures using the Oslo method [2]. 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 can be used in astrophysical network calculations to investigate the galactic production mechanism of 180Ta. In this talk I will present results of this investigation of statistical properties for ^{180,181,182}Ta and the corresponding (n, gamma;) cross sections.

[1] S. Goriely et al., A&A J. 375, L35 (2001).
[2] A. Schiller et al., Nucl. Instrum. Methods Phys. Res. A 447, 498 (2000).

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