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Experimental cross-section measurement of ^{144}Sm(p,γ) reaction relevant to astrophysical p-process

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One of the primary aims of experimental nuclear astrophysics is to determine the rates of nuclear reactions taking place in stars under various astrophysical conditions. The reaction rates are determined from the cross sections, which need to be measured at energies as close as possible to the astrophysically relevant ones (near the Gamow window). In many cases, the final nucleus of an important astrophysical reaction is radioactive, which allows the cross-section to be determined based on the offline measurement of the number of produced isotopes. This technique is called the Activation Method. Beyond Fe, there is a class of 35 proton-rich nuclides, between ^{74}Se and ^{196}Hg, called p-nuclei. They are bypassed by the s and r neutron capture processes and are typically 10−1000 times less abundant than the sand/or r-isotopes in the solar system. There is a typical abundance of ~1% for lighter nuclei with 34 ≤ Z ≤ 50 and 0.01-0.3% for medium and heavier nuclei with an atomic number >50. Generally, the abundance of p-nuclei decreases with an increase in atomic number, but for neutron magic p-nuclei ^{92}Mo and ^{144}Sm, it is 14.52% and 3.08%, respectively. Therefore, the study of these nuclei is important to understand why they are more abundant! For this reason, more detailed and precise information on the reaction cross-section in the astrophysical energy region is extremely important. With information on its production and destruction, the final abundance of any nuclei in nucleosynthesis can be estimated. We chose to investigate the ^{144}Sm(p,γ) reaction, which is the destructive pathway of ^{144}Sm nuclei, in this case. The molecular deposition technique has been used to prepare $^{144}Sm_2O_3$ (67% pure) targets on pure aluminium (99.45%) backing. A proton beam was used to activate these targets, yielding a ^{144}Sm(p,γ) ^{145}Eu ($T_{1/2}$ = 5.93 days) reaction cross-section between 4 and 7 MeV. A HPGe detector is used to count the gamma rays, and a Hauser-Feshbach code, TALYS 1.95, is used for theoretical calculations.

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