Implications of the $^{151}Sm(n,\gamma)$ Cross Section measurement at n_TOF*

Stefano Marrone[1] for the n_TOF Collaboration
[1]INFN-Sez. Bari, and Dipartimento di Fisica I-70126 Bari, Italy

The accurate knowledge of the $^{151}Sm(n,\gamma)$ cross section has important implications for nuclear technology developments as well as in fundamental nuclear physics. The $^{151}Sm(n,\gamma)$ reaction rate has a great relevance in nuclear astrophysics as ^{151}Sm is an important branching-point isotope in the *slow* process (*s* process) path, in the Sm-Eu-Gd region. Reaching ^{151}Sm, the *s*-process flow has the possibility of undergoing neutron capture or, alternatively, β-decay. Since the relative probability of the two processes depends on the stellar thermodynamic conditions, in particular on the temperature as well as on the capture rate, from the accurate determination of the capture cross section crucial information on the stellar conditions during the *s*-process nucleosynthesis in this mass region can be derived [1].

From the point of view of fundamental nuclear physics, the study of the ^{152}Sm (the composite system n+^{151}Sm) levels provides important information on the nuclear structure in the rare earth region. In fact, due its position in between the neutron magic ^{144}Sm and the permanently deformed rotators ^{154}Sm isotopes, ^{152}Sm exhibits a high neutron binding energy (8.25 MeV), a large multiplicity (>4) of the de-excitation cascade and a soft γ-ray spectrum. These features strongly characterize nuclear parameters such as the neutron strength function, the nuclear level density and the γ-ray strength function.

^{151}Sm is a radioactive isotope produced abundantly during nuclear reactor operation. Although its half-life ($T_{1/2}$ = 93 yr) is relatively short compared to other long-lived fission products, this isotope is often included in advanced incineration schemes. For this purpose and for the development of new concepts for safe nuclear reactors (such as the Accelerator Driven Systems (ADS) [2]), its capture cross section is needed and a specific request in this sense exists at the Nuclear Energy Agency (NEA) [3].

In this contribution we will report the results of the high-resolution measurement of the $^{151}Sm(n,\gamma)$ cross section with the time-of-flight technique from 0.6 eV up to 1 MeV. Neutrons are produced by spallation at the innovative n_TOF facility at CERN while the γ-rays from capture events are detected with liquid organic scintillators (C_6D_6)-based detectors. A detailed description of the experimental setup and of the data analysis procedures will be presented. Due to the natural radioactivity of the sample, the ^{151}Sm neutron capture measurement represented a challenge for the performance of the n_TOF facility and of the experimental apparatus. In fact, up to date the only experimental data available on this isotope were derived from the transmission measurement performed by Kirouac and Eiland at Renesslaer Polytechnic Institute several years ago [4].

To conclude, we will present the main implications that the results of this measurement may have in the fields of the nuclear astrophysics, nuclear structure and of advanced nuclear technologies.

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