Measurement of the ^{139}La(n,γ) Cross Section at n_TOF*

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

Isotopes with closed neutron shells such as ^{139}La (N=82 and Z=57) are known as neutron magic isotopes and are of special importance in nuclear physics. Their nuclear structure is characterized by low level density and small strength in the reaction channels, determining a low total neutron cross that is dominated by the elastic channel. For these reasons, the experimental information on cross sections of such nuclei is very useful both for fundamental aspects (microscopic calculation of quantum many-body systems and nuclear astrophysics) as well as for applications.

Lanthanum assumes a relevant role in nuclear astrophysics. In fact, the low capture cross sections of neutron magic nuclei like Ba, La and Ce act as bottlenecks for the reaction flow from light (Sr, Zr and Y) towards heavy elements (Sm, Eu and Gd) giving rise to a large slow neutron capture process (*s* process) contribution to the abundances. Therefore, the abundances of the neutron magic isotopes of these elements can be used for monitoring the *s*-process production while other elements (e.g. europium); characterize the *r*-process component of the neutron capture nucleosynthesis. Moreover, lanthanum is particularly suitable as an *s*-process indicator since it is essentially monoisotopic (99.9% of the natural abundance is ^{139}La) and it is easy to observe in the stellar spectra.

Up to date, the ^{139}La(n,γ) cross section has been measured at Oak Ridge [1] and JAERI [2]. As indicated in the reference [3], several activation measurements have been also performed in the recent years with results which are in substantial disagreement (up to 40%) with the previous prompt γ-ray capture measurements. The large discrepancies between different kinds of data and the strong implications of the relative results motivated a new capture measurement at the innovative neutron time-of-flight facility (n_TOF) at CERN. In fact, the unique features of n_TOF such as the high resolution, the extremely high instantaneous neutron flux and background conditions, allow to accurately measure in a wide energy range both radioactive samples as well as isotopes with low capture cross section such as ^{139}La.

In this contribution we will report the results of the measurement of the ^{139}La(n,γ) cross section measured with the time-of-flight technique from 0.6 eV up to 9 keV. At n_TOF, neutrons are produced by spallation 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. The extracted resonance parameters allow to derive the capture cross section and other nuclear quantities up to 9 keV. The implications of the obtained Maxwellian-Averaged cross sections for a wide range of temperatures, together with the most recent spectroscopic observations in low-metallicity stars, will be presented within the framework of the new scenarios for the nucleosynthesis and the chemical evolution of heavy nuclei in the Galaxy.

* This work has been partially supported by the EC (contract FIKW-CT-200000107) and by the National Institutions partners in the n_TOF Collaboration.

[1] L. Musgrove, B.J. Allen, and R.L. Macklin, Australian Journal of Physics **30**, 599 (1977).
[2] Y. Nakajima *et al.*, Journal of Nuclear Science and Technology **20**, 183 (1983).
[3] Z.Y. Bao *et al.*, Atomic Data Table **76**, 70 (2000).