Measurement of $^{139}La(n,\gamma)$ Cross Section at n_TOF

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HTML ABSTRACT + LINKS

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Abstract. The capture cross section of the 139La has been measured relative to 197Au standard at n_TOF. We provide here a short description of the experimental apparatus and of the data analysis procedures. The extracted resonance parameters allow to calculate the fundamental nuclear quantities such as average spacing <D>l=0 = 268 ± 22 eV, <D>l=1 < 250 eV neutron strength functions S0 = (0.79 ± 0.03)×10-4, and S1 = (0.73 ± 0.05)×10-4 and the Maxwellian-averaged capture cross section (MACS). The MACS is particularly useful for the determination of the abundance synthesized by the main component of the s process [3].

Keywords: ^{139}La, neutron capture, level density, neutron strength function, MACS
PACS: 25.40.Lw, 26.20.+f, 27.60.+j, 97.10.Cv

OUTLOOK

The neutron magic isotopes like ^{139}La (N=82) are of special importance in Nuclear Physics. The experimental information on their neutron induced reaction cross sections result very useful both for fundamental physics aspects as well as for the applications in nuclear technologies. In particular, the large discrepancies, amongst the previous determinations of ^{139}La(n,γ) cross section [1-3], suggested to perform a new capture measurement at neutron time-of-flight facility (n_TOF). In fact, the innovative features of n_TOF (high neutron flux and long flight path 187.5 m) are suitable to accurately measure the cross sections of radioactive samples as well as isotopes having low capture cross section like ^{139}La.

In this experiment, the γ rays are detected with two C6D6 positioned symmetrically to the sample exchanger which in turn hosts five samples (natLa, Al-can, natC, 208Pb and 197Au) useful to perform periodically background and reference measurements. Because their low efficiency, the C6D6 detectors are able to detect only a single γ-ray of the capture de-excitation cascade and therefore have to be corrected with the Pulse Height Weighting Function technique [4]. The next steps, in data analysis, consist of the determination and subtraction of different background components (environmental, in-beam γ-ray and neutron scattered), see left panel of Figure 1, and of the neutron flux normalization by the ^{197}Au sample measurement. Finally, the capture cross section is represented in terms of R-matrix resonance parameters [4].

The statistical analysis of the nuclear levels has indicated that all s-wave resonances are detected while the sequence of p-wave levels seems complete up to 2 keV (see right panel of Figure 1). The main nuclear quantities, calculated in this work, are the average spacing of the s-wave <D>l=0 = 268 ± 22 eV, of the p-wave <D>l=1 < 250 eV, and the relative neutron strength functions S0 = (0.79 ± 0.03)×10-4 and S1 = (0.73 ± 0.05)×10-4. With extracted capture data, we have also estimated the MACS which combined with the accurate observations of lanthanum in stellar spectra, assumes a relevant role to study the chemical evolution of the Galaxy.

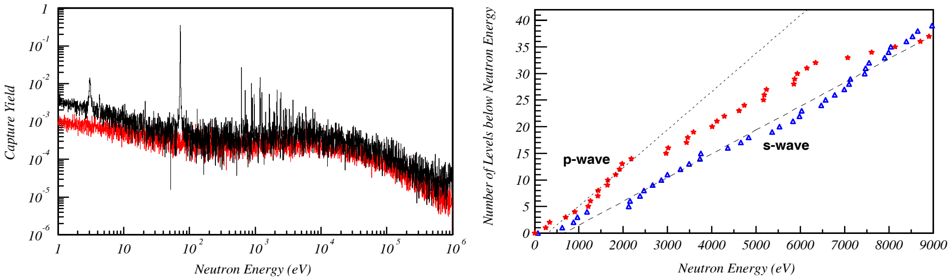

FIGURE 1. In left panel, the raw capture yield of the lanthanum sample (black) is drawn together with the total background (grey). In right panel, the cumulative number of s-wave and p-wave levels is illustrated. Dashed and dotted lines represent the best fit with a straight line.

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