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The neutron capture cross section measurement of the thallium isotopes 203Tl, 204Tl and 205Tl at the n TOF facility at CERN

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About half of the elemental abundances between Fe and Bi are produced by the so-called s (slow) process of neutron capture reactions in AGB stars. Of particular importance are some nuclides produced during the s-process which are radioactive, with half-lives from years to Gy, so its decay process competes with the neutron capture chain: these nuclides are known as branching points. The measurement of the neutron capture cross section of these elements is crucial to determine the local abundance pattern around the branching point, which yields information of the s-process stellar environment, such as temperature, neutron density or pressure. 204Tl (T1/2 = 2.78 y) is a very interesting branching point. In the recurrent He-flashes of AGB stars, 204Tl can either β-decay to the s-only nuclide 204Pb or capture another neutron, thus producing 205Tl, which in some stellar environments can decay to 205Pb. On the other hand, neutron capture on 204Pb also yields 205Pb (T1/2 = 1.5 × 10^7 y). Therefore, the value of the capture cross sections of 204Tl, and also of 205Tl, are necessary to determine precisely the primordial 205Pb/204Pb abundances ratio, which could allow one to estimate the time span since the last s-process events that contributed to the elemental composition of the Solar System.

In the year 2015, the cross section of the 204Tl (n,γ) reaction was measured for the first time ever employing four C6D6 scintillation detectors in the neutron time-of-flight facility n TOF at CERN. The sample was a 203Tl oxide pellet enriched to 4% in 204Tl.

The 204Tl total mass was 9 mg, with a total activity of 160 GBq. Due to the amount of 203Tl in the sample an ancillary measurement of the 203Tl (n,γ) was also necessary in order to improve the accuracy of this reaction cross section. Concerning the 205Tl (n,γ)reaction, its cross section will be measured this year also at n TOF.

In this talk we will cover the different aspects of these capture cross section measurements, from the experimental methods to the extraction of the cross section and other important capture reaction parameters, to finally conclude with the application of the results on s-process nucleosynthesis.

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