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Studies of (n,gamma) and (n,cp) reactions for Nuclear Astrophysics at the n_TOF neutron beam (CERN)

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Neutron-induced cross sections are a key nuclear physics input for the comprehension of stellar nucleosynthesis of heavy elements, as well as for modeling of light element production in Big Bang Nucleosynthesis. In stars, neutron capture reactions are responsible for the production of the majority of elements heavier than Fe, with two processes contributing more or less equally to the overall abundance pattern: the s- and r-process. The first one involves low neutron densities and stable or radioactive isotopes with relatively long half-life. In this context, accurate neutron capture cross sections are needed for heavy elements, as well as for a few light elements acting as neutron poisons, or involved in stellar neutron sources. In Big Bang nucleosynthesis, one of the most intriguing problems surviving since more than 40 years regards the large overestimate of the primordial abundance of Lithium by theoretical models.

Neutron-induced reactions of relevance for Nuclear Astrophysics are being studied since many decades at neutron facilities worldwide. To address the still open issues in stellar and primordial nucleosynthesis, the n TOF Collaboration has been carrying out since several years an ambitious experimental program on nuclear capture reactions with the aim of reducing the uncertainty on cross sections relevant to s-process nucleosynthesis, and improve the reliability of astrophysical models. Several high quality results have been obtained thanks to the innovative features of the neutron beam of the n TOF facility at CERN, in particular the very high instantaneous neutron flux and the high resolution in the first experimental area at 200 m flight path, very convenient in particular for measurements of radioactive isotopes. More recently, the construction of a second experimental area at shorter flight path (20 m) opened the way to very challenging measurements of (n,γ) and (n,charged particle) reactions on isotopes of short half-life, or reactions with very low cross sections, or for isotopes available in a small amount. A first, successful example in this sense is the measurement of the 7Be(n,p) and (n,α) reactions of interest for the Cosmological Lithium problem.

After a brief description of the facility and of the detection systems employed in the mea- surements, the program of the n TOF Collaboration in Nuclear Astrophysics will be presented in this talk, with particular emphasis on the recent results relevant for stellar nucleosynthesis, stellar neutron sources and primordial nucleosynthesis.

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