Stars in a Bottle: The PANDORA Facility

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Nuclear astrophysics is a fascinating discipline which aims to explain – quantitatively and qualitatively – the observed abundance of elements in the cosmos. Current nucleosynthesis models indicate that light elements until the iron peak are produced through progressive stellar burning, while those beyond are mainly generated by neutron capture processes. Depending on the neutron density, these reactions can be classified as slow (*s*-) or rapid (*r*-) processes. The corresponding network models are sensitive to specific inputs associated with atomic/nuclear properties of the isotopes and the underlying astrophysical conditions. Since nucleosynthesis primarily occurs in stars which are high energy density plasmas, it is necessary to factor in the effect of the plasma on these inputs for accurate reconstruction of elemental abundances.

The PANDORA (**P**lasmas for **A**strophysics, **N**uclear **D**ecay **O**bservation and **R**adiation for **A**rchaeometry) facility, currently under realisation at INFN-LNS, aims to investigate the variation of certain nuclear and atomic properties inside a laboratory magnetoplasma emulating some aspects of the stellar interior [1]. In particular, the main goals of the facility are to measure β-decay rates and optical opacities of isotopes in a hot plasma for application to *s*- and *r*-process nucleosynthesis, respectively. The measurements will serve as a crucial benchmark of model-predictions [2, 3], which can then be extrapolated to the appropriate astrophysical conditions. In this seminar, we will provide an overview of the physics and technology behind PANDORA. We will discuss the interplay between nuclear and atomic data, and the resultant plasma-induced variation in decay rates and opacities. The experimental results obtained by PANDORA will help address discrepancies between calculated and observed elemental abundances of several isotopes.

[1] Mascali, D., Palmerini, S., Torrisi, G., De Angelis, G., Santonocito, D., Kratz, K.-L., eds. (2023*). Nuclear Physics and Astrophysics in Plasma Traps*. **Special Issue in Frontiers in Physics**, Lausanne: Frontiers Media SA. DOI: 10.3389/978-2-83251-062-9

[2] Mishra, B., Pidatella, A., Mascali, D., Taioli, S, Simonucci, S. *Electron Captures and Bound-State β-Decays in Ions and Plasma*. **Physical Review C** (under publication)

[3] Pidatella, A. et al. *Experimental and numerical investigation of magneto-plasma optical properties towards measurements of opacity relevant for compact binary objects.* **Frontiers in Space Science and Astronomy**. DOI: 10.3389/fspas.2022.931744