High-resolution Optical Emission Spectroscopy characterization of hydrogen and argon laboratory magneto-plasmas of astrophysical interest

G. Emma[1,2], M. Bezmalinovich[4,5], G. Finocchiaro[1,2,3] , G. S. Mauro[2], M. Mazzaglia[2], B. Mishra[1,2], E. Naselli[2], A. Pidatella[2], D. Santonocito[2], G. Torrisi[2], R. Reitano[1,2] and D. Mascali[2]

[1] Università degli studi di Catania, Catania, Italy

[2] INFN - LNS, Catania, Italy

[3] CSFNSM, Catania, Italy

[4] Università degli studi di Camerino, Camerino, Italy

[5] INFN - Sezione di Perugia, Perugia, Italy

In the last decades there has been a growing interest in the nuclear astrophysics' community to investigate the origin of elements heavier than iron in the Universe produced via r-process nucleosynthesis. Merging of compact binary objects, leading both to high-neutron flux and gravitational wave (GW) events, are among the most favorable astrophysical loci for this production [1]. In this context, it is relevant the study of kilonovae (KN). These are electromagnetic transients powered by freshly synthesized elements and radioactivity and can be used as spectral signatures of nucleosynthetic yields inside the expanding post-merging plasma ejecta [2]. To this aim, in the framework of the PANDORA project [3] we are developing a new plasma trap where it will be attempted the emulation of kilonovae ejecta properties at a specific stage of their evolution. This setup will allow measurements of plasma opacity providing new insights about the most relevant species produced via r-process nucleosynthesis [4]. In order to verify the feasibility of this kind of measurements in terms of required temperature and density (order of eV and 10^{12} cm^{-3}, respectively), we are using the flexible plasma trap (FPT), operative at INFN-LNS, as testbench for PANDORA, characterizing gaseous plasma (H_2, Ar) discharge, stability, and parameters by Optical Emission Spectroscopy. In this work, we will present the experimental results, concerning estimates of plasma density and temperature, deduced by means of the line-ratio method [5], from the analysis of the spectra measured in the visible range under different conditions, i.e., by tuning microwave frequency and power, pressure and magnetic field profile.

[1] Korobkin O. *et al*., Mon. Not. R. Astron. Soc., **426** (2012) 3-1940:1949.

[2] D. Watson *et al*., Nature **574**, pages 497-500 (2019)

[3] D. Mascali *et al*., Universe **8** (2022) 2, 80

[4] A. Pidatella *et al*, Il Nuovo Cimento, **44 C** (2021) 65

[5] U. Fantz, Plasma Source Sci. Technol **15**, S137S147 (2006).