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Photoionization of Low- and Highly-Charged Atomic Ions Using Synchrotron and Free-Electron Lasers

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1- Introduction

New instruments have been employed for spectroscopic studies of gaseous astrophysical environments using synchrotron photoabsorption in the soft X-ray range (0.1–2 keV) at the Elettra Laboratory in Trieste, Italy. The first instrument used in this study is the Electron Beam Ion Trap (EBIT) [1]. The second is a newly developed setup called the OctoIonGuide (OIG), which was designed and characterized at the CNR laboratory in Trieste. The primary purpose of this apparatus is the investigation of low- and highly-charged atomic ions. Preliminary results obtained from the EBIT will be presented for different charge states of oxygen and nitrogen. In addition, the characterization of the OIG instrument will be discussed, including mass spectra of various noble gases and the quantification of ion counts. These measurements are expected to provide valuable insights for upcoming astrophysical observations, facilitating the physical diagnostics of weakly ionized gas distributed throughout the universe [1–3].

2- Results

The Electron Beam Ion Trap (EBIT) has been utilized for high-resolution measurements, as shown in Fig. 1. The photoionization of N^{3+} ions were measured using the EBIT, which served both to produce and confine the ions. The photoion yield of N^{3+} was recorded for the transition process: $1s^2\ 2s\ 2p\ {}^3P^\circ \longrightarrow 1s\ 2s\ 2p^2\ [{}^4P]\ {}^3P$. In contrast, Fig. 2 presents the first results of the photoionization of Xe^+ ions generated in the OIG. The extracted and mass-selected Xe^+ ion beam was merged with the synchrotron photon beam. The resulting photoions were separated from the primary beam, mass-analyzed, and detected using a channeltron optimized for positive-ion detection.

Fig.1 Photoionization of N^(3+): 1s2 2s2p 3 P◦ ⟶ 1s2s2p2 [4 P] 3P Fig2. Photoionization of Xe+ from OIG setup.
From EBIT setup.

3- References

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[2] Nicastro, F., et al., 2018, Nature 558, 406, DOI: 10.1038/s41586-018-0204-1.
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