7th Asia-Pacific Conference on Plasma Physics, 12-17 Nov, 2023 at Port Messe Nagoya

Laboratory measurement of FeX MIT effect for coronal magnetic field diagnosis and very high accuracy calibration of visible light wavelengths in an EBIT

YANG Yang[1], XU Guoqin[1], LI Wenxian[2], SI Ran[1], CHEN Chongyang[1], BAI Xianyong[2], TIAN Hui[3], LI Yajing[1], YAO Ke[1], XIAO Jun[1], Roger HUTTON[1], ZOU Yaming[1]

[1] Shanghai EBIT Laboratory, Key Laboratory of Nuclear Physics and Ion-Beam Application (MOE), Institute of Modern Physics, Fudan University, [2] Key Laboratory of Solar Activity, National Astronomical Observatories, CAS, [3] School of Astronomy and Space Science, CAS

e-mail (speaker):yangyang@fudan.edu.cn

The magnetic field is extremely important for understanding the properties of the solar corona. However, there are still difficulties in the direct measurement of coronal magnetic fields. The discovery of the magnetic-field-induced transition (MIT) in Fe X, which was also observed in the coronal spectra, opened up a new method for measuring the coronal magnetic field.

In this work, we obtained the Fe X extreme ultraviolet (EUV) spectra in the wavelength range of 174–267 Å in Shanghai high-temperature superconducting electron beam ion trap, and for the first time, verified the effect of MIT in Fe X by measuring the line ratios between 257.262 Å and reference line of 226.31 Å (257/226) at different magnetic field strengths. The plasma electron density that may affect the 257/226 value was also obtained experimentally and then verified by comparing the density-sensitive line ratios with the theoretical prediction, and there was good agreement between them. By comparing the simulated line ratios of 257/226 with the experimental values at given electron densities and magnetic fields, the critical energy splitting of the fine-structure levels, one of the most critical parameters to determine the MIT transition rate, was obtained. Possible reasons which may lead to the difference between the obtained energy splitting and the recommended value in previous work are discussed. Magnetic field response curves for the 257/226 value were calculated and compared to the experimental results, which is necessary for future MIT diagnostics.[1]

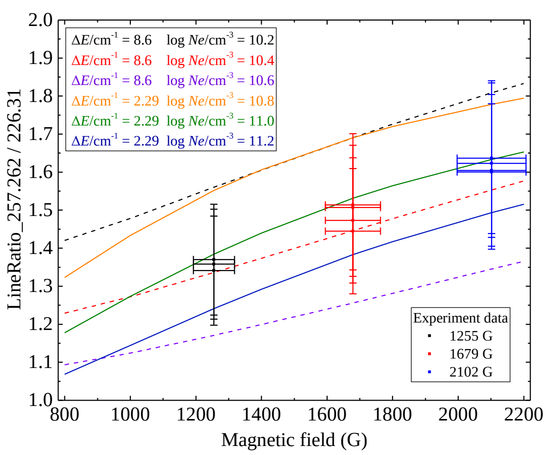

Figure 1. Theoretical and experimental values of line ratios of 257.262 Å and 226.31 Å versus the magnetic field.

The $4s^24p\ ^2P_{3/2} - {}^2P_{1/2}$ magnetic dipole transition in Ga-like ions is interested in developing of high precise highly charged ion clock. we present direct observations of the transition in Mo^{11+} and Ru^{13+} ions at an electron beam ion trap. Internal and external calibration methods are used for determining the wavelength of the Mo^{11+} and Ru^{13+} lines, respectively. Both measurements reach precision levels of a few ppm. Compared with the available values, the current results significantly improve the experimental uncertainty.[2]

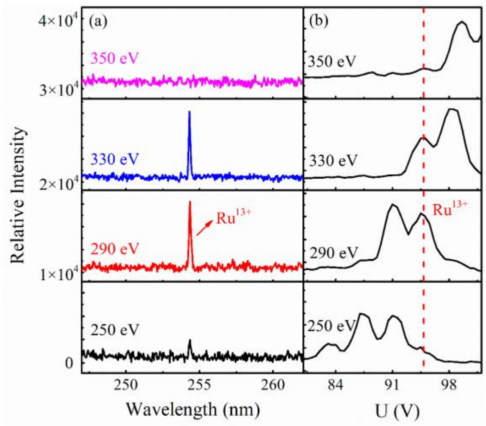

Figure 2. (a) Electron beam energy dependence of the Ru13+ spectra, and (b) the corresponding charge state distributions of ruthenium ions.

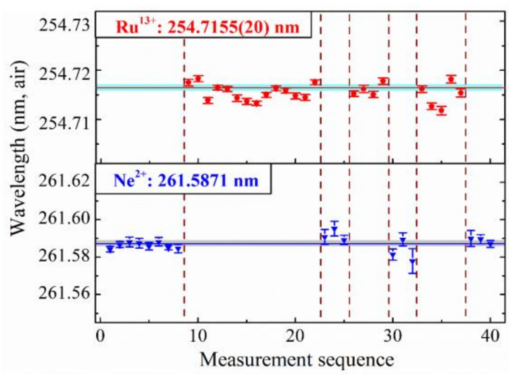

Figure 3. The experimental wavelength (in air) of the Ru^{13+} and Ne^{2+} lines. The two lines are measured alternately.

References

[1] G.Xu, *et al,* Astro. Phys. J. **937,** 48 (2022)

[2] Y. Li *et al,* J. Phys. B: At. Mol. Opt. Phys. **54,** 235001 (2021)