

Hydrogenic Lamb Shift in Iron, Revisited, with Lessons for the future; and Current Status on the hydrogenic and helium-like investigations of titanium and vanadium at NIST and Oxford

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The Hydrogenic Lamb Shift in Iron, Fe 25+ and fine structure Lamb shift 1s-2p Lyman α transitions in hydrogenic iron, Fe25+, have been observed from a beam-foil source in fourth order diffraction off ADP 101 and PET 002 crystals, simultaneously with the n=2 to n=4 Balmer β transitions diffracted in first order [1]. Calibration of the local dispersion relation of the spectrometer using Balmer β lines provides measurements of Lyman wavelengths. The novel approach of fitting the full two-dimensional dispersion relation, including other members of Balmer and Lyman series, limits random and systematic correlation of parameters. The development of a theory of X-ray diffraction from mosaic crystals was necessary for the accurate interpretation of the experimental data.

Several systematics are quantified for the first time for these medium-Z QED comparisons. 2s-1s and 4f-2p satellites are explicitly investigated. A dominant systematic is due to the variable location of spectral emission downstream of the beam-foil target [2]. 1s-2p_{3/2}, 1s-2p_{1/2} iron Lamb shifts are measured to be $35376 \pm 1900 \text{ cm}^{-1}$ and $35953 \pm 1800 \text{ cm}^{-1}$. These agree with but lie higher than theory. This represents a 5.7% measurement of the hydrogenic 1s-2p_{1/2} Lamb shift in iron. The technique also reports iron 2p_{3/2}-2p_{1/2} fine structure as $171108 \text{ cm}^{-1} \pm 180 \text{ cm}^{-1}$, representing a 51% measurement of the hydrogenic iron fine structure Lamb shift, and reports measurements of secondary lines.

I will particularly discuss the need for careful consideration of experimental systematics, the future for EBIT sources, and continuing investigations of the hydrogenic and helium-like tests of QED in medium-Z systems especially including titanium and vanadium.

[1] C. T. Chantler, J. M. Laming, D. D. Dietrich, W. A. Hallett, R. McDonald, J. D. Silver, *Phys. Rev.* **A76** (2007) 042116.

[2] C. T. Chantler, *Can. J. Phys.* **86** (2008) 331-350.