Improved VUV Spectroscopy of Doubly-Ionized Atoms

Peter L. Smith
Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138

Juliet C. Pickering
Blackett Laboratory, Imperial College, London SW7-2BZ, U.K.

State-of-the-art UV and VUV astronomy with the GHRS, and now the STIS, on HST requires wavelengths accurate to a few parts in 10^7 (Morton 1992; Carpenter 1993; Leckrone *et al.* 1997). Smith *et al.* (1998) give a quantitative justification for this value. Fourier transform (FT) spectrometry in the laboratory has provided wavelengths of this accuracy for singly-charged ions, but application of this method to doubly-charged ions (*i.e.*, to so called "third spectra") has been hindered by the lack of a suitable light source. Third spectra, particularly of the iron group, are of great interest to observers of chemically peculiar and other hot stars.

The goal of this project was to apply a new light source (Heise *et al.* 1994) to FT spectrometry of multiply charged ions, in particular, Fe III (Fe^{2+}). The previous recent measurements of Fe III wavelengths were those of Ekberg (1993), who used a photographic grating spectrometer. The resulting wavelengths had an accuracy of, at best, between 5 mÅ and 10 mÅ, *i.e.*, only several parts in 10^6. Literature wavelengths for most other third spectra are less accurate.

The quality of the new Fe III spectra we obtained is unprecedented; the new wavelengths that we have derived are at least an order of magnitude more accurate that those currently used by astronomers. Thus, this project has shown that the urgently needed improvements in accuracy of the laboratory atomic data for doubly ionized species are now possible. An extensive study of Fe III is in progress; branching ratio measurements and studies of other doubly charged ions will follow.

References:

Carpenter, K G, 1993, Physica Scripta **T47**, 139

Ekberg, J O, 1993, A&AS **101**, 1

Heise, C, J. Hollandt, R Kling, M Kock & M Kühne 1994, Appl. Opt. **33**, 5111

Leckrone, D S, S Johansson, G M Wahlgren, C R Proffitt & T Brage, 1998, in *The Scientific Impact of the GHRS*, ASP Conf. Ser., in press.

Morton, D C, 1992 in *Atomic & Molecular Data for Space Astronomy*, Springer Lecture Notes in Physics **407**, p.51

Smith, P L, A P Thorne, R C M Learner, J C Pickering, W A Syed R Kling, W Mende & M Kock, 1998, in *The Scientific Impact of the GHRS*, ASP Conf. Ser., in press.

Acknowledgments: This work was supported by NASA Grant NAGW-4888 to Harvard University, by the Paul Instrument Fund of the Royal Society, and by a NATO grant for International Collaboration in Research. The authors gratefully acknowledge the advice and assistance of G. Cox, C. Heise, R. Kling, R. C. M. Learner, W. Mende, W. H. Parkinson, and A. P. Thorne, and particularly, D. S. Leckrone.