Comprehensive Analysis of the Spectrum of Singly-Ionized Iron (Fe II)

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Abstract. In 1978, Sveneric Johansson published a comprehensive analysis of the spectrum of Fe II, consisting of about 3300 lines from 576 energy levels and covering the region 90 nm to 1120 nm. This analysis has been incorporated in many databases used in astronomical spectroscopy, including the NIST Atomic Spectra Database, the Vienna Atomic Line Database, and the synthetic spectrum codes of Kurucz. Since its publication, high resolution grating and Fourier transform (FT) spectrometers have increased the number of lines by a factor of over 4, extended the wavelength region up to 5500 nm, and reduced the uncertainty of the wavelengths by an order of magnitude. These spectra have been used in an analysis of the spectrum of Fe I, in the discovery of astrophysical lasers in Eta Carinae, and for the identification of very high-excitation spectral lines in HR 6000. However, although Prof. Johansson continued work on the analysis of Fe II, resulting in over 1000 known energy levels, this work remained uncompleted at the time of his death. Hence there has been no new comprehensive analysis of Fe II since 1978 and the majority of these data remain unpublished.

This poster presents the completion of the analysis of the Fe II spectrum. The spectrum has been recorded using high-resolution FT and grating spectroscopy over the wavelength range 90 nm to 5500 nm. The spectra were observed in high-current continuous and pulsed hollow cathode discharges using FT spectrometers at the Kitt Peak National Observatory, Tucson, AZ and Imperial College, London and with the 10.7-m Normal Incidence Spectrograph at the National Institute of Standards and Technology. Over 13 600 lines were classified using 1028 energy levels of Fe II that were optimized to the measured wavenumbers. The uncertainties of lines in the FT spectra range from 10^{-4} cm^{-1} (1.6×10^{-4} nm) for strong lines around 4000 nm to 0.05 cm^{-1} (1.1×10^{-4} nm) for weaker lines around 150 nm. The wavelength uncertainty of lines in the grating spectra is 0.0002 nm for moderately strong lines that do not saturate the photographic plate. The ionization energy of 130 655.4±0.4 cm^{-1} was estimated from the $3d^6(^5D)5g$ and $3d^6(^5D)6h$ levels.

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