Laboratory Astrophysics and High Resolution Atomic Spectroscopy with the Imperial College Fourier Transform Spectrometer

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The Imperial College (IC) Fourier Transform Spectroscopy Group has been focusing on improvements in the laboratory atomic data base for astrophysics. In recent years the group has made enormous improvements in the atomic data for neutral and singly ionised Fe, Co, Cr, V, Mn & Ti. Most of this work has been published, and some is still in progress. Our work on doubly ionised spectra is described in another poster at this meeting. We report examples of recent measurements at IC which impact on a variety of astrophysical problems:

Oscillator strengths: as part of the FERRUM project we are involved in an international effort to improve atomic data for Fe II, in particular by measuring accurate f-values. The Imperial College VUV Fourier Transform spectrometer and a Penning discharge lamp have been used to measure the relative intensities of about 100 emission lines of Fe II between 160 and 350 nm (62168 - 28564 cm^{-1}) from 7 levels. These relative intensities have been combined with level lifetimes measured at Lund University to give absolute oscillator strengths for around 100 lines; typical uncertainties in f-values being less than 12% for strong lines and better than 20% for the majority of weaker lines. We have also completed our extensive measurements of Ti II f-values: using our measured branching ratios we determined f-values for 328 lines using measured lifetimes, and for 335 lines using calculated lifetimes.

Our projects on large scale term analyses of Mn I, V I & V II, and Cr I continue, and are leading to at least order-of- magnitude improvements in accuracy of wavelengths and energy levels, and data for transition probabilities and hyperfine structure. Our projects investigating hyperfine structure continue, and we have completed a study of hfs in Ta II.

We have made highly accurate wavenumber measurements of particular lines of Cr II, Mg I & Mg II, Ni II and Zn II for use in studies investigating a possible time variation in the fine structure constant α. High resolution spectroscopy of gas clouds seen against distant quasars can provide valuable constraints on space-time variations in the fundamental 'constants'. The relative wavelength separation between multiplet components depends on the value of the fine-structure constant α, so high redshift spectroscopic observations of quasars provide tight constraints on space-time variations. However, laboratory wavenumbers are needed to an accuracy of a few parts in 10^8. Our measurements, carried out using water-cooled hollow cathode lamps and our FT spectrometer, used in conjunction with high quality observations from ground-based telescopes, appear to indicate a time variation. If confirmed, this would have far reaching implications for cosmology.

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