Laboratory Measurement of a Fe II FUSE Band Oscillator Strength

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A laboratory absorption experiment has been developed for measuring oscillator strengths of atomic/ionic lines in the FUSE band. This experiment is designed around the U1 undulator beamline with the 4 meter Normal Incidence Monochromator (U1 4m-NIM) at the Synchrotron Radiation Center in Stoughton WI. The very high spectral radiance of synchrotron radiation can be used to overwhelm the spontaneous emission from intense discharge plasmas. The U1 4m-NIM beamline is optimized for work at wavelengths in 25 to 250 nm range. In our experiment a high current (> 1 Amp) hollow cathode discharge was used to produce a gas phase sample of ionized iron. The Fe II line at 114.49 nm in the FUSE Band was observed in absorption and its strength was compared to the Fe II lines at 160.85 nm and 234.42 nm. All three of these lines are true resonance lines connected to the ground fine structure state of ionized iron. These three resonance lines are important for Fe abundance determinations along many lines of sight through the ISM of our Galaxy using orbiting telescopes such as HST and FUSE. These resonance lines are also useful for studying the Fe abundance, dust formation, and related properties of high red shift objects using large ground based telescopes. The oscillator strength of the 234.42 nm line was determined using the combination of a radiative lifetime measured using time-resolved laser-induced-fluorescence with emission branching fractions from Fourier transform spectra [1]. This method has become the standard laboratory approach for oscillator strength measurements from the UV to the near IR [2]. Unfortunately this method is less suited for work at shorter VUV wavelengths due to increasing difficulties of measuring shorter lifetimes and to difficulties in establishing spectroradiometric calibrations for emission branching fraction measurements in the VUV. In earlier work on Fe II, Co II, Ni II, and Ti II [2-6] we have demonstrated the utility of absorption spectroscopy on atomic ions for measuring oscillator strengths of VUV lines. This new experiment has enabled us to reach even shorter wavelengths in the FUSE band. The absorption oscillator strength of the 114.49 nm Fe II line 0.083 +or- 0.006 [7]. This result is 20 to 30 % smaller the earlier determinations from astrophysical observations. The small uncertainty is the result of extensive work to understand and control systematic errors such as scattered or leakage radiation in the spectrometer, curve-of-growth corrections, and other smaller effects.

References:

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