SPECTROSCOPIC MODELING FOR THE INVESTIGATION OF MAGNETIC FUSION PLASMAS AND STARS WITH MAGNETIC FIELD

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Abstract. In this work, we report on a selection of issues present in the elaboration of spectroscopic models for magnetized plasma diagnostic. A focus is put on tokamak edge and white dwarf atmosphere plasma conditions. In both cases, the spectrum exhibits clean lines, either in absorption or in emission, denoting the presence of neutral species (atoms). An analysis of the line shape and intensity yields information on the plasma parameters provided a suitable physical model is used. We examine the broadening of the spectral lines due to the plasma microfield (Stark effect) and due to collisions with the atoms (resonant and van der Waals broadening). A computer simulation method accounting for the microfield dynamics during the radiation time of interest is applied to the calculation of the first lines in the Balmer series. Comparisons to observed spectra are performed. We also address the Zeeman line splitting due to the presence of magnetic fields. While the normal linear Zeeman effect formula can safely be applied to hydrogen in tokamak plasma conditions (B has a value of the order of several teslas), it is strongly inaccurate for white dwarfs that are subject to an extremely strong magnetic field. Observations have indicated that B attains values up to 10 kT in several white dwarfs; at such conditions, the Zeeman splitting becomes comparable to the atomic energy level separation and can no longer be treated as a linear perturbation. This issue is examined in details through dedicated calculations.