Charge Exchange Recombination Spectroscopy modeling challenges on MST

M. D. Nornberg

University of Wisconsin-Madison, Madison WI, USA

Modeling Charge Exchange Recombination Spectroscopy (CHERS) measurements on MST has addressed a number of unique challenges. For typical discharges, the emission from electron-impact excitation is comparable to the charge-exchange emission induced by our 5 Amp, 50 kV diagnostic neutral beam. As such, isolating the charge exchange emission entails modeling both a view intersecting the beam and a view of the background plasma. This modeling requires detailed calculations using the Atomic Data and Analysis Structure (ADAS) database since the Doppler broadening of common emission lines, like C VI at 343.4 nm, is comparable to broadening due to spin-orbit coupling effects which separate the fine-structure components of the otherwise degenerate states for the n=7 to n=6 transition. A final complicating factor in the analysis is the competition of emission strength from different impurities with similar atomic structure. The atomic structure of C^{+5} with its single electron in a highly-excited state looks very similar to O^{+5} with an electron in a highly-excited state resulting in emission at nearly identical wavelengths. Since the cross section for O VI emission at 343.4 nm is much larger than that for C VI, the background emission tends to be dominated by oxygen which has a different fine-structure distribution than carbon. Hence, the fine-structure populations for both species are calculated in ADAS and incorporated into the fitting model used to analyze CHERS data on MST to determine core ion temperature and flow velocity.

References

[1] *Modeling fast charge exchange recombination spectroscopy measurements from the Madison Symmetric Torus*, S. Gangadhara, D. Craig, D.A. Ennis, D.J. Den Hartog, Rev. Sci. Instrum. **77**, (2006).

[2] *Toroidal charge exchange recombination spectroscopy measurements on MST*, R. M. Magee, D. J. Den Hartog, G. Fiksel, S. T. A. Kumar, and D. Craig, Rev. Sci. Instrum. **81**, 10D716 (2010).