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Collisional-radiative analysis of neutral beam spectra in fusion plasmas

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Powerful beams of neutral particles are extensively used in fusion devices, such as tokamaks and stellarators, to heat and diagnose magnetically confined plasmas. The spectral lines originating from the excited states of a neutral beam provide valuable information on plasma fields, particle temperatures and densities, and other parameters. I will present the recently developed collisional-radiative (CR) model for m-resolved parabolic states of hydrogen which has been successfully used to explain motional Stark effect (MSE) spectra from tokamak plasmas.[1] [2] A new method for calculation of collisional cross sections between parabolic states is developed and used to compute the required atomic data. It is shown that the σ- and π-component intensities under typical magnetic fusion conditions cannot be described by statistical (Boltzmann) distribution and therefore require a complete CR analysis. I will also discuss non-statistical behavior of parabolic state populations in a wide range of parameters including those of the ITER tokamak. The field-induced ionization of the high excited states is shown to be a strong uncompensated depopulation channel responsible for deviations from the Boltzmann distribution.

[1]O. Marchuk et al., J. Phys. B 43, 011002 (2010).
[2]E. Delabie et al., PPCF 52, 125008 (2010).