Hybrid time dependent/independent solution for the He I line ratio temperature and density diagnostic for a thermal helium beam with applications in the SOL-edge regions in tokamaks

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(Dated: 15 August 2011)

Spectroscopic studies of line emission intensities and ratios offer an attractive option in the development of non-invasive plasma diagnostics. Evaluating ratios of selected He I line emission profiles from the singlet and triplet neutral helium spin systems allows for simultaneous measurement of electron density (n_e) and temperature (T_e) profiles. Typically this powerful diagnostic tool is greatly limited by the relatively long relaxation times of the ^3S metastable term of helium that populates the triplet system, and on which electron temperature sensitive lines are based. By developing a time dependent analytical solution we model the time evolution of the two spin systems. We present a hybrid time dependent/independent line ratio solution that greatly improves the range of application of this diagnostic technique in the scrape-off layer (SOL) and edge plasma regions when comparing it against the current equilibrium line ratio helium model used at TEXTOR. We explore the application of this diagnostic technique in the SOL region for H-mode plasmas in DIII-D.

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