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Single Emission-Line-Ratio Techniques for Correlating Reduced Electric Field, Electron Energy Distribution, and Metastable-Atom Density in a Pulsed Argon Discharge

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Argon emission lines, particularly those in the near-infrared region (700-900nm), are used to determine plasma properties in low-temperature, partially ionized plasmas to determine effective electron temperature and argon excited state density using appropriately assumed electron energy distributions. While the effect of radiation trapping is included in the interpretation of plasma properties from emission-line ratio analysis, eliminating the need to account for these effects by directly observing the 3px-to-1sy transitions is preferable in most cases as this simplifies the analysis. The extended coronal model is used to acquire an expression for 420.1-419.8nm emission-line ratio, which is sensitive to direct electron-impact excitation of argon excited states as well as stepwise electron-impact excitation of argon excited states for the purpose of inferring plasma quantities from experimental measurements. Initial inspection of the 420.1-419.8nm emission-line ratio suggests the pulse may be empirically divided into three distinct stages. Using equilibrium electron energy distributions from simulation to deduce excitation rates in the extended coronal model affords agreement between predicted and observed metastable density. Applying this diagnostic technique to lower-resolution spectroscopic systems is not straightforward, however, as the 419.8nm and 420.1nm emission-line profiles are convolved and become insufficiently resolved for treating the convolution as two separate emission-lines. To remedy this, the argon 425.9nm emission-line is evaluated as a proxy for the 419.8nm emission-line as they are both attributed to direct excitation from the argon ground state. The intensity of the 425.9nm emission-line is compared to the intensity of the 419.8nm emission-line over a range of plasma conditions to infer the same plasma quantities from similar experimental measurements. Discrepancies between the observed intensities of the emission-lines are explained by electron-impact cross-sections of their parent states and the electron energy distribution.