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Systematic Effects in Laser-Induced Fluorescence Measurments of Ion Density and Temperature Caused by Optical Pumping[1] THOMAS LANGIN, TREVOR STRICKLER, PATRICK MCQUILLEN, THOMAS KILLIAN, Rice University — Ultracold neutral plasmas of strontium are generated by photoionizing laser-cooled atoms. The plasma evolution is probed by laser induced fluorescence (LIF) via the $5s^2S_{1/2}$-$5p^2P_{1/2}$ ion transition. Spectra are obtained by recording LIF intensity at varying laser detunings. The ion temperature, T, is then measured by fitting a Voigt profile to obtain the Doppler width. However, for linearly (circularly) polarized light, $5p^2P_{1/2}$ ions have a 7% (33%) chance of decaying to the dark metastable 5d $^2D_{3/2}$ state (dark opposite spin state). Near resonance, where ions are more likely to scatter multiple photons during the LIF process, the observed signal will be depressed due to optical pumping. This causes an artificial broadening in the spectra and thus artificially high T measurements. Moreover, the loss of ions throughout the excitation process, if not corrected for, will result in artificially low density measurements. We have developed, and experimentally verified, a method for simulating the LIF process in order to determine the LIF-probe durations and intensities for which these effects becomes significant.

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