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Simulations of Flourescence Imaging of an Ultracold Neutral Plasma Including Dark State Pumping[1] THOMAS LANGIN, PATRICK MCQUILLEN, TREVOR STRICKLER, THOMAS KILLIAN, Rice Univ — Ultracold neutral plasmas of strontium are generated by photoionizing laser-cooled atoms. The plasma evolution is probed by imaging light scattered via the $5s^2S_{1/2}$-$5p^2P_{1/2}$ ion transition. Spectra are obtained by taking a series of images at varying laser detunings. The ion temperature, T, is then measured by fitting a Voigt profile to obtain the Doppler width. However, $5p^2P_{1/2}$ ions have a 7% chance of decaying to the metastable 5d $^2D_{3/2}$ state. Thus, close to resonance, where it's more likely for an ion to scatter multiple photons during the imaging process, the observed signal will be depressed due to optical pumping to the dark $^2D_{3/2}$ state. This causes an artificial broadening in the spectra and thus artificially high T measurements. We have developed a method for simulating the imaging process in order to determine the imaging durations, t, and light intensities, I, for which this effect becomes significant. This is both to determine the regime for which Voigt profile fitting yields an accurate T measurement and to develop a new spectra fitting tool which provides accurate T measurements in the high I and t (and thus high signal) regimes.

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Thomas Langin
Rice Univ

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