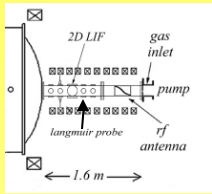


Neutral density profiles in a helicon source

Amy M. Keesee, Earl E. Scime, Department of Physics, West Virginia University Annemie Bogaerts, University of Antwerp

Hot hELIXon eXperiment



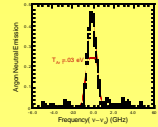
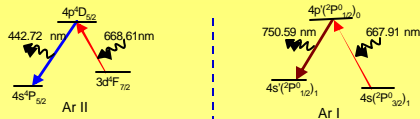
Langmuir probe measurements

Laser-induced fluorescence (LIF)

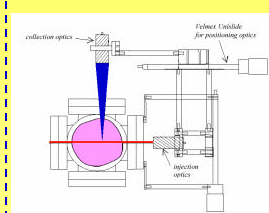
$$f(u) = n \sqrt{\frac{m}{2\pi kT}} \exp\left(-\frac{mu^2}{kT}\right)$$

Amplitude

$$n = (\text{Amplitude}) \sqrt{\frac{2\pi kT}{m}}$$



Passive emission spectroscopy



$$\int I_{\text{em}}(I) dI = \frac{2\pi pc^2 h a_f}{\lambda^5} \int_{S_{\text{em}}} \frac{g_u}{g_m} N dV$$

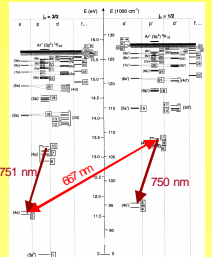
Spectral line area

$$f(r) = -\frac{1}{r} \int_0^{\infty} \frac{dH}{dy} y^2 e^{-y^2/r^2} dy$$

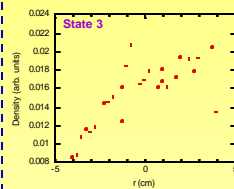
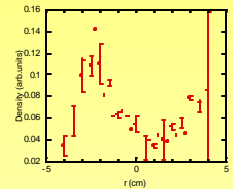
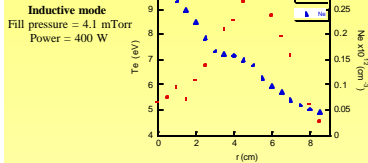
Abel inversion

Collisional-radiative model

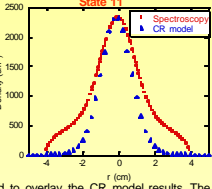
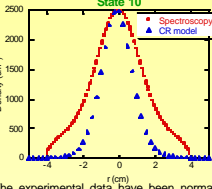
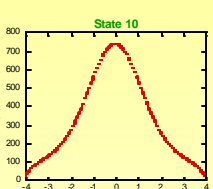
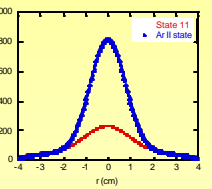
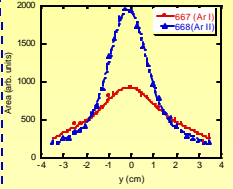
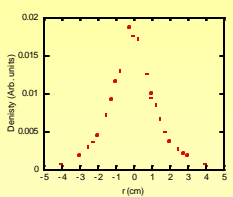
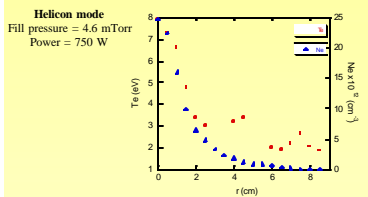
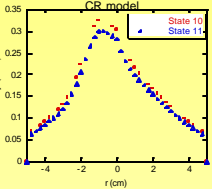
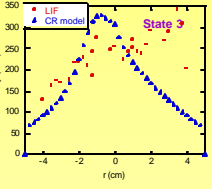
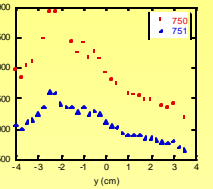
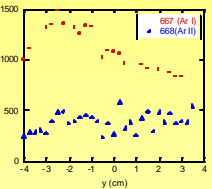
LIF and spectroscopy measurements give the density of the probed state, not the total neutral density. A collisional-radiative (CR) model is needed to relate these state densities to the ground state density. The total neutral density is approximated by the ground state density. Our LIF scheme probes state 3 and states 10 and 11 are probed by spectroscopy using lines at 667, 750, and 751 nm. (The 667 and 750 nm lines are also the pump and fluorescence lines, respectively, in the LIF scheme).



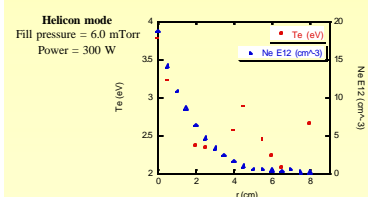
Plots shown assume flat (constant) neutral profile.



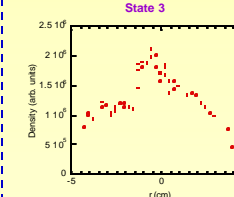
These figures show the non-Abel inverted spectroscopy data for the 667 nm (state 11), Ar II state, 750 nm (state 10) and 751 nm (state 11) lines. The values shown are the area under the curve at the respective line, giving a measure of the density of the respective state. The asymmetry of this data prevents use of a simple Abel inversion.



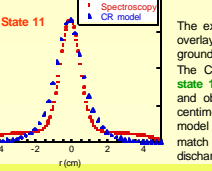
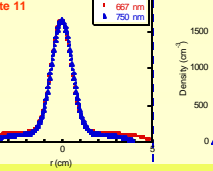
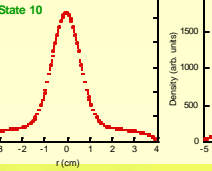
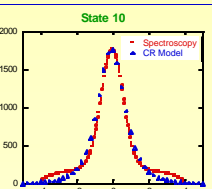
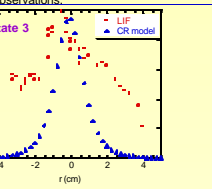
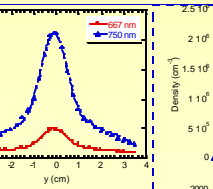
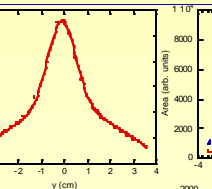
The experimental data have been normalized to overlay the CR model results. The assumed ground state neutral profile was flat (constant). The observed widths of the density of state 10 and state 11 are broader than those of the CR model. The next step will be to adjust the CR model parameters (neutral profile and eedf) to match the observations.



These argon ion LIF measurements show a distinct difference in the radial ion profile between helicon and inductive mode. Based on previous observations, we expect these measurements to be proportional to $N_e \sqrt{T_e}$.



The top figures show the non-Abel inverted data for the 751 nm (left) and 667 nm and 750 nm lines (right) with the fits used for the inversion. The lower graphs show the Abel inverted profiles. Both the 667 nm and 750 nm lines yield the density of state 11. It can be seen in the Abel inverted results that the excited state neutral profiles obtained from the two different emission lines are nearly identical.



The experimental data have been normalized to overlay the CR model results. The assumed ground state neutral profile was flat (constant). The CR and observed widths of the density of state 10 and state 11 are consistent. The model and observations diverge beyond the inner few centimeters. The next step will be to adjust the CR model parameters (neutral profile and eedf) to match the state 3 observations across the whole discharge.

