Title: Argon, neon, and nitrogen impurity transport in the edge and SOL regions of a tokamak

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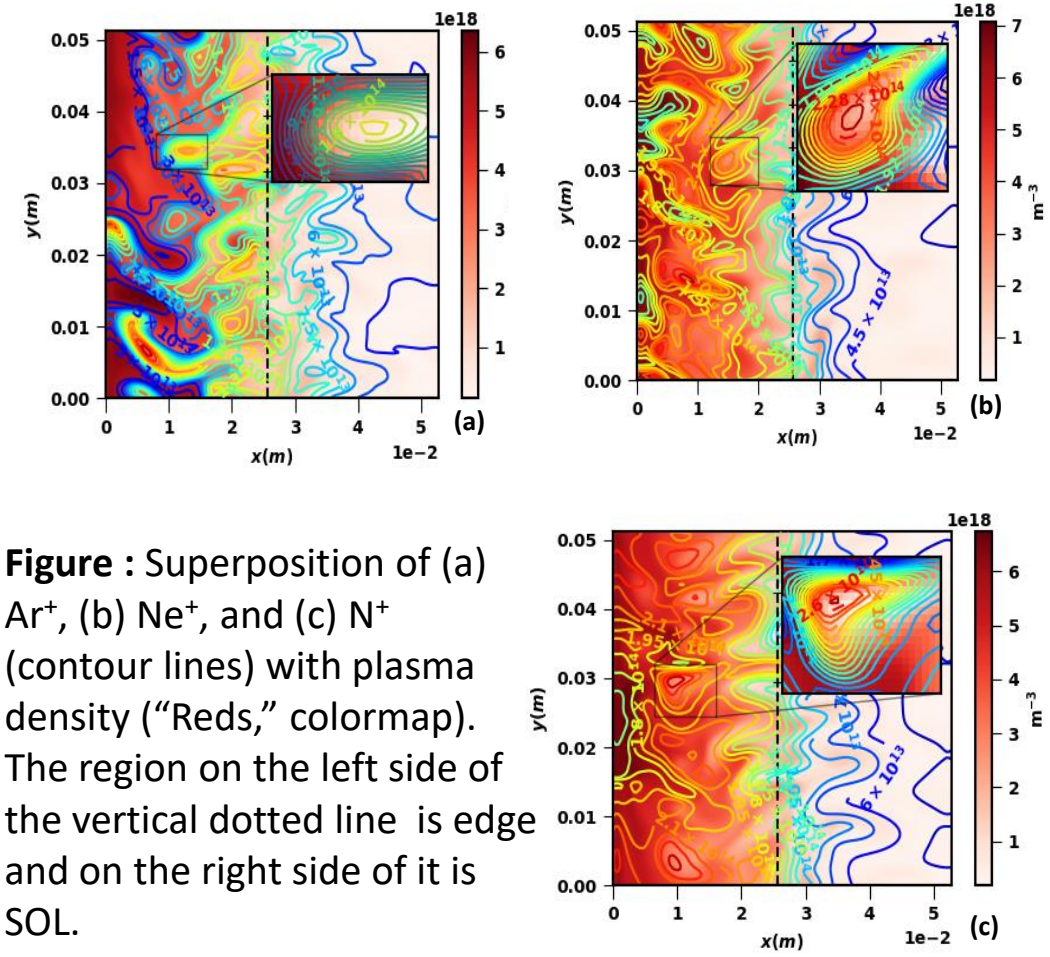

Figure : Superposition of (a) Ar^+, (b) Ne^+, and (c) N^+ (contour lines) with plasma density ("Reds," colormap). The region on the left side of the vertical dotted line is edge and on the right side of it is SOL.

We have explored how impurity ions transport takes place when plasma interacts with medium-Z impurity gases like N_2, Ne, and Ar in the edge and SOL (Scrape-off-layer) regions of a tokamak. We found that the movements of these impurity ions are mainly governed by plasma vortex structures which are formed because of the interchange-plasma turbulence in these regions. These vorticities are further associated with "blobs" and "holes" – blobs(holes) with negative(positive) vorticity. Impurity moves inward by $\vec{E}_y \times \vec{B} \sim 0.02\vec{c}_s$ drift as negative potential at the hole center traps positive impurity ions shown in (a)-(c). c_s is the acoustic velocity.

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Fig.A

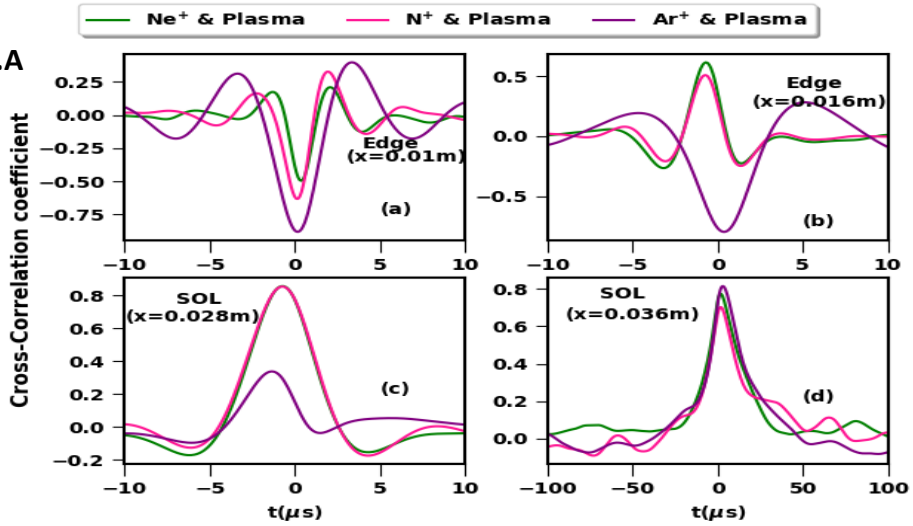

Fig.B

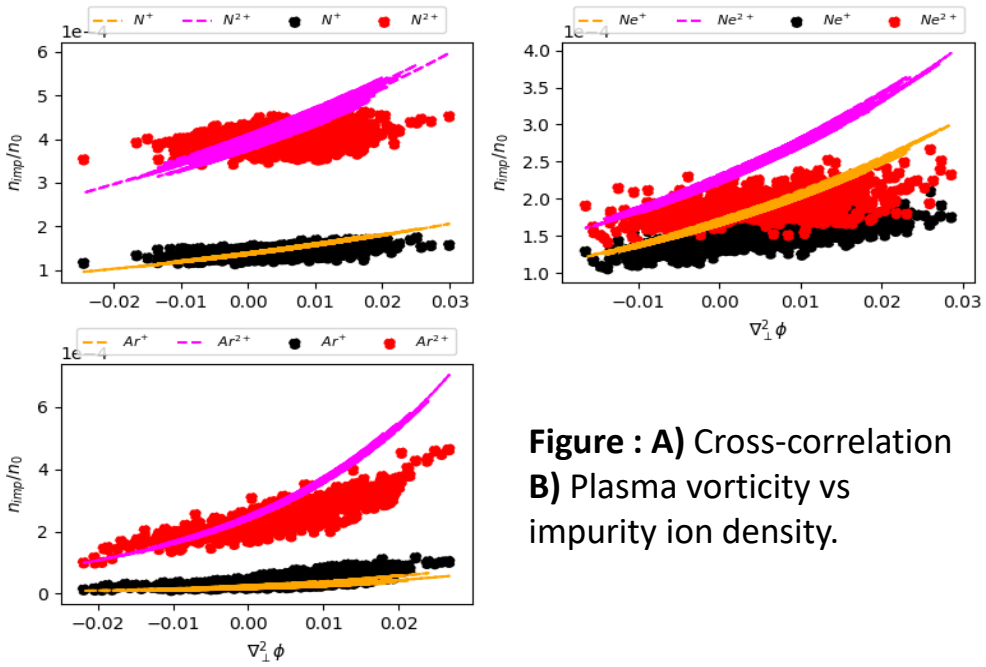

Figure : A) Cross-correlation **B)** Plasma vorticity vs impurity ion density.

To show the simultaneous occurrence of impurity ion density maxima and plasma density holes for a large number of cases. The cross-correlations between the two time series obtained from numerical simulation are shown in Fig.A. We have derived an analytical relation for the impurity ion density with the plasma vorticity using sources, sinks, and mass-to-charge ratio. The remarkable agreement between our theoretical predictions and the observed numerical results is distinctly evident in Fig. B. Both appear to match each other. The (red-black) are simulation data and (orange-magenta) represent theoretical predictions.

The nonlinear simulations were conducted utilizing the BOUT++ suite of code using the drift-reduced Braginskii fluid equations. The simulations are performed on the Antya cluster at the Institute for Plasma Research (IPR), India.

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