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Investigation of Nonlinear Dynamics Between Density Gradient and Low Frequency Fluctuation in a Linear Magnetized Plasma

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The nonlinear dynamics of fluctuations in magnetized plasmas play a crucial role in determining confinement properties and overall plasma behavior [1]. To explore the physical mechanisms underlying such fluctuation of drift wave, a new aperture system was installed in the linear plasma device PANTA, allowing for controlled variation of plasma diameter [2]. This enabled systematic investigation of the relationship between the plasma density gradient and associated fluctuations.

In this study, plasma diameters (D) were adjusted to 18 cm and 16.5 cm by changing the plasma diameter . The five-channel Langmuir probe array was used to measure electron density profiles across the radius under identical discharge conditions. As shown in Figure. 1, the electron density clearly decreases beyond the radial position marked by the purple solid lines, indicating the plasma edge defined by the aperture. This confirms effective control of the plasma diameter. The red curve dotted lines represent the normalized magnitude of the radial density gradient.

To identify the presence and localization of turbulent fluctuations, ion saturation currents were subjected to power spectral density (PSD) analysis. The results revealed prominent fluctuations approximately 5.5 ~ 6.5 kHz. When comparing the normalized fluctuations by PSD with the density gradient in Fig. 1 (a) at D = 18.0 cm, it was found that the strongest fluctuations occurred in regions where the density gradient is largest. A similar pattern can also be seen in Fig. 1 (b) at D = 16.5 cm, which suggests that the link between fluctuation strength and density gradient is consistent in different cases. This indicates that the observed fluctuation is likely driven by the density gradient of the plasma, therefore it is considered a drift wave.

Finally, I considered that changing the diameter of the plasma would cause the density gradient to become steep, however the strength of the gradient did not change much. In the future, I would like to investigate this in detail, as well as the changes in the gradient by changing plasma diameter is changed in relation to plasma temperature and spatial potential.

References

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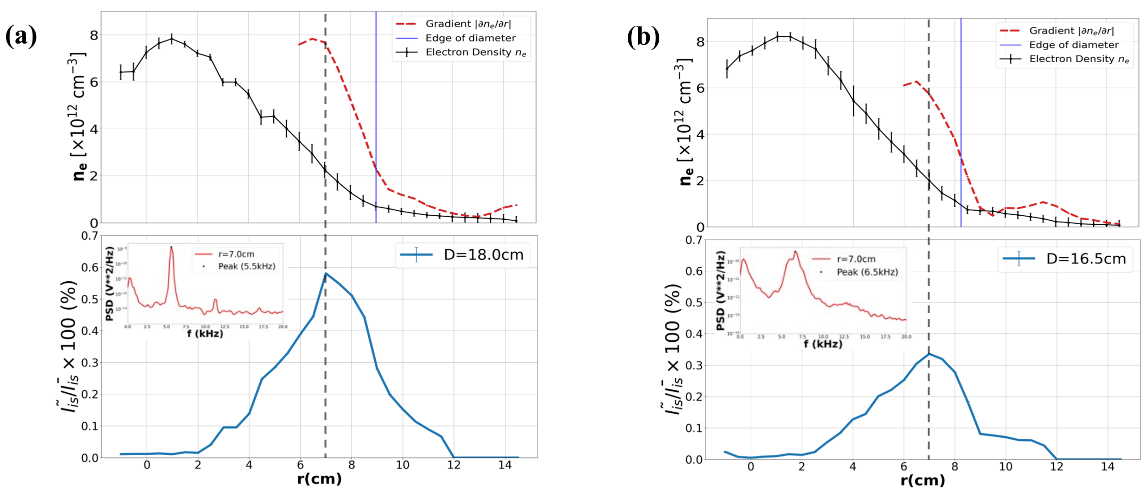

Figure. 1 Radial profile of electron density and its gradients, with the plasma edge indicated by purple solid lines (top). Normalized fluctuations amplitudes at approximately 6 kHz, with the location of the maximum density gradient marked by black dotted lines (bottom). (a) corresponds to a plasma diameter of D = 18.0 cm, and (b) to D = 16.5 cm.