Study of Electrode Biasing in the Edge and SOL regions of a Tokamak

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A theoretical study is made of the effect of edge biasing on the dynamics of the interchange turbulence [1,2,3] in the edge and scrape-off layer (SOL) regions. A linear analysis of a set of model fluid equations shows that biasing stabilizes the small k_y modes. The model equations are next solved numerically, using the BOUT++ framework, to explore the nonlinear dynamics in the presence of positive or negative bias. Positive biasing is found to lead to a larger increment in plasma density and temperature as compared to negative biasing. It is observed that cross-correlation between density and poloidal electric field at different radial positions decreases for positive biasing and in the case of negative biasing it is almost similar to that of no biasing. Plasma density and poloidal electric field fluctuations have been investigated which show that the density fluctuations increase (decrease) for positive (negative) biasing but the radially outward flux for these biasing cases always decreases mainly due to the decrease of cross-correlation between density and poloidal electric field fluctuations. The edge electrode biasing also affects the power spectral density (PSD) in the edge and SOL regions. PSD in the edge region before the position of electrode is higher for the positive bias in the 5-70kHz frequency range. In the SOL region, PSD for both the biasing is lower in comparison to no biasing. Analysis of the k_y spectrum for both the bias cases shows a reduction of k_y in the edge and SOL regions in comparison to the case of no bias. Edge biasing is also shown to impact the heat and particle loads on the plasma-facing components by decreasing the SOL width as a function of the applied voltage.

References:

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