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Dynamics of Fluctuations, Flows and Global Stability Under Electrode Biasing in a Linear Plasma Device

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Various bias electrodes have been inserted into the Helicon-Cathode (HelCat) device at the University of New Mexico, in order to affect intrinsic drift-wave turbulence and flows. The goal of the experiments was to suppress and effect the intrinsic turbulence and with detailed measurements, understand the changes that occur during biasing. The drift-mode in HelCat varies from coherent at low magnetic field (<1kG) to broad-band turbulent at high magnetic fields (>1kG). The first electrode consists of 6 concentric rings set in a ceramic substrate; these rings act as a boundary condition, sitting at the end of the plasma column 2-m away from the source. A negative bias has been found to have no effect on the fluctuations, but a positive bias (Vr>5Te) is required in order to suppress the drift-mode. Two molybdenum grids can also be inserted into the plasma and sit close to the source. Floating or grounding a grid results in suppressing the drift-mode of the system. A negative bias (>-5Te) is found to return the drift-mode, and it is possible to drive a once coherent mode into a broad-band turbulent one. From a bias voltage of -5Te<Vg<5Te, the plasma is found to be quiescent. A positive bias greater the 5Te is found to excite a new mode, which is identified as a parallel-driven Kelvin-Helmholtz mode. At high positive bias, Vg>10Te, a new large-scale global mode is excited. This mode exhibits fluctuations in the ion saturation current, as well as in the potential, with a magnitude >50%. This mode has been identified as the potential relaxation instability (PRI). In order to better understand the modes and changes observed in the plasma, a linear stability code, LSS, was employed. As well, a 1D3V-PIC code utilizing Braginskii's equations was also utilized to understand the high-bias instability.