Multi-scale experiments on the asymmetric response of plasmas to inhomogeneous flows

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The role of spatially inhomogeneous (sheared) flows in the stability, or instability, of plasmas has been a subject of intense study for over two decades. In the space plasma environment, sharp gradients in plasma parameters are correlated to the presence of low frequency waves. Data from FAST [Ergun, et al., Phys Plasmas, 2002] showing the effects of density gradients and data from Freja [Hamrin, et al., J. Geophys. Res., 2001] showing the effects of flow gradients are a few examples of these observations. By contrast, the presence of spatially inhomogeneous flows is believed to be critical for achieving conditions of high density and temperature in fusion plasmas [Burell, Phys. Plasmas, 1997]. Thus, under very different plasma conditions, a range of plasma responses can arise from the same underlying physical mechanism of sheared flows.

Despite this commonality, many studies of sheared plasma flows tend to focus on phenomena in a single type of plasma device (e.g., tokamak vs. stellarator vs. plasma column) or plasma environment (e.g., ionosphere vs. magnetosphere vs. solar corona). This approach can mask common physical processes that are relevant across many different scale sizes. We seek to directly address this issue by performing a multi-scale investigation of the fundamental physics of the stability of plasmas with spatially localized, sheared flows in three different plasma devices: a space plasma simulation experiment (SPSC, NRL), a laboratory experiment (ALEXIS, Auburn), and a fusion experiment (CTH, Auburn). The response of the plasma to sheared flows across these different devices will be parameterized using the ratio of ion gyro-radius to electric field gradient scale length as the key physical parameter.

This presentation will discuss the preliminary results of this coordinated study. Here, results will focus on initial observations of asymmetric plasma responses that are correlated with variations in the electric or magnetic fields. Additionally, this presentation will discuss changes in plasma wave activity in response to changes in the flow.