Software and diagnostics for the study of instabilities in partially magnetized plasmas

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This talk overviews the ongoing development of two exploratory tools whose goal is to aid researchers characterize dispersion relations in plasma discharges. The first is the Plasma Rocket Instability Characterizer (PRINCE), a versatile software tool that numerically characterizes linear plasma waves and their dependence on operational parameters by solving for the zeros of relevant dispersion relations. PRINCE combines a root-bracketing algorithm based on Cauchy's Argument Principle to find the zeros of a user-selected dispersion relation with an iterative root-tracking algorithm to characterize the zeros in frequency-wavenumber $(\omega, \mathbf{k})$ space. The software is wrapped as a stand-alone application with an intuitive graphical user interface for specifying input data numerically and governing dispersion relations analytically. We describe the structure of Prince and illustrate its use with examples that are relevant to waves in Hall thruster plasmas.

The second tool is an active wave injection (AWI) experimental diagnostic which excites plasma waves in order to conduct interferometric measurements of the waves' dispersion relation in a plasma discharge. Through spectral analysis of time-varying ion saturation currents, the AWI diagnostic can be used to carry out experimental plasma wave studies with high signal-to-noise measurements and direct control over the harmonic content of the probing wave modes.

We also describe an experiment designed to validate both tools using, for reference, laser induced fluorescence (LIF) measurements of the dispersion relation of excited electrostatic ion cyclotron (EIC) waves in an RF argon plasma source.