Non-Invasive Impedance Measurements in a Complex Plasma

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A plasma discharge can be modeled electrically as a combination of capacitors, resistors, and inductors. The plasma, much like an RLC circuit, will have resonances at particular frequencies. The location in frequency space of these resonances provides information about the plasma parameters. These resonances can be detected using impedance measurements, where the AC impedance of the plasma is measured by sweeping the frequency of an AC voltage applied to a sensor and determining the magnitude and phase of the measured current.

Dust grains often charge up negatively, owing to the high mobility of electrons. Experimental evidence suggests that, as a result of the high electron mobility, complex plasmas often contain a largely depleted free electron population. Diagnostic measurements in a dusty plasma present a significant challenge due to dust grain interaction with the physical probe or non-invasive probing mechanism. The novelty of this method is that insertion of a physical probe that perturbs the charged dust grains is not necessary. In this work, an electrode used to sustain a dusty glow discharge is also used as an impedance probe.

This non-invasive impedance probing method is used to measure the electron density in a complex plasma discharge. Comparison of non-dusty and dusty plasma experimental results will be presented. Potential applications of this diagnostic method and regimes over which this measurement method is valid will be discussed.

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