EXPERIMENTS AND SIMULATIONS OF ANTENNA COUPLING IN SPACE PLASMAS*

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An ongoing problem in the plasma physics community is the understanding of wave excitation and near field antenna coupling in a magnetized plasma. The anisotropy of the plasma index of refraction, the nonuiniform current distribution on the antenna, and the presence of the plasma sheath surrounding the antenna makes it difficult to determine a framework for building efficient exciters, as it is not immediately apparent which parts of the physics are most important. This is evident in looking at the body of experimental work in the literature, where one can find a broad range of antenna designs in use, but very rarely is a rigorous quantitative theory combined with the experimental results. With an eye toward better understanding antenna plasma coupling, we present new experimental and theoretical results related to excitation of waves in a magnetized plasma across a large plasma parameter space. The antenna is a simple monopole which can be oriented parallel or perpendicular to the magnetic field, and can also be biased to control the width of the sheath interface with the plasma. The amplitude and phase of the transmitted and reflected power are measured to compare the antenna radiation resistance with the actual waves being detected at a distance. The experimental results will be augmented by rigorous numerical modeling to form a more complete picture of the physical process by which waves are excited. The experiments were performed in the Space Physics Simulation Chamber at NRL. The chamber is 2-m diameter, 5-m long vacuum vessel surrounded by five 3-m diameter water-cooled magnet coils capable of producing a wide variety of magnetic field profiles of up to 250 Gauss. The plasma is created in a pressure of $p \approx 10^{-4}$ Torr Argon with a 1-square-meter array of glowing, biased tungsten filaments. The electron density can be set over a very broad range ($10^6 < n < 10^{12} cm^{-3}$) while electron and ion temperatures are typically $T_e \approx 0.5$ eV and $T_i \approx 0.05$ eV.

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