Microwave Measurements on a Well-Collimated Dusty Plasma Sheet for Communications Blackout Applications

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Vehicles traveling at hypersonic velocities within the Earth's atmosphere, such as spacecraft during reentry and weapons systems, are enveloped by a dense plasma layer. This plasma layer reflects and significantly attenuates GPS and S-band signals for vehicle navigation, telemetry, and voice communications, resulting in radio blackout. In these studies, a linear hollow cathode produces an electron beam that is accelerated into a low pressure (50 to 150 mTorr) background of Argon gas, producing an electron beam discharge. A relatively constant 170 Gauss axial magnetic field is produced by two electromagnet coils arranged in a Helmholtz configuration. This results in a well-collimated electron beam, producing a 2-dimensional Argon plasma discharge in a sheet configuration. This discharge sheet is approximately 40 cm long by 30 cm wide by 1 cm thick, and can produce electron densities as high as 1012 cm-3. The plasma sheet is intended to mimic the intense plasma layer produced and experienced by vehicles traveling at hypersonic velocities. The electron beam is accelerated vertically towards a grounded beam dump electrode. This electrode is modified to include an array of six piezo buzzers modified and filled with alumina powder. When supplied with a modest voltage, the piezoelectric shakers uniformly drop dust particles into the plasma sheet discharge directly below at a constant rate, creating a dusty plasma. A transmitting microwave horn is oriented normal to the dense plasma sheet while the receiving horn is mounted on a stage that can be rotated up to 180 degrees azimuthally. Microwave cutoff, transmission, reflection, and scattering measurements of the plasma sheet are made in the S-band and X-band range. These measurements are relevant for applications related to communications blackout and over-the-horizon communications.