ELECTROMAGNETIC SCATTERING FROM METEOR-GENERATED SPHERICAL PLASMAS WITH FINITE PRESSURE: PLASMA WAVE RESONANCES AND PLASMA GRADIENT EFFECTS

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The plasmas that are created at the heads of meteors descending into the upper atmosphere present clear RCS signatures for determining the speed and mass of the projectile. In particular, the size of the critical layer where the incident wave frequency is equal to the plasma frequency, coupled with the knowledge of the mean free path for ionization, can be used to infer the mass. However, both geometric and dielectric properties of the plasma can affect the RCS, and these must be taken into account when interpreting the scattered radiation. Although scattering from spherical reflecting layers is well understood (i.e. Mie scattering) even in the presence of plasma inhomogeneities, the potential for exciting electron plasma waves in the underdense region of the plasma can radically affect the RCS. These electrostatic, longitudinal waves are coupled to the incident transverse waves through the density gradient and the resulting resonances, known as Tonks-Dattner resonances, and give rise to new bands of absorption not present in a cold plasma. The full scattering cross-section is developed as a series of spherical harmonics where the surface impedance of the plasma plays a crucial role in determining the scattering. For the general case, this impedance is found by a numerical integration of the wave equations, but for many cases of practical interest, WKB analysis is adequate. We present the analysis of the warm plasma boundary value problem and derive an expression for the RCS. The implications for the interpretation of RCS data for meteor head echoes will be given.

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