

## Radio sounding within Z-mode propagation “cavities” by the RPI instrument on the IMAGE satellite

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When the Radio Plasma Imager (RPI) on the IMAGE satellite operates in the inner plasmasphere and at moderate to low altitudes over the polar regions, pulses emitted at the low end of its 3 kHz to 3 MHz sounding frequency range can propagate in the Z mode as well as the whistler mode. The Z mode is efficiently excited during almost all soundings in which all or part of its locally allowed frequency range falls within the band of transmitted frequencies. At medium altitudes within the plasmasphere, where the condition  $f_{pe} > f_{ce}$  usually obtains, discrete Z-mode echoes are observed, analogous to the regular and oblique Z-mode echoes found on topside sounder records. Z-mode echoes from RPI can provide diagnostic plasma density information that is complementary to the information acquired by RPI from passive measurements of local plasma resonances and cutoffs and by inversion of O- and X-mode echoes. Within certain low to medium altitude regions, we find a Z-mode “cavity” within which discrete Z-mode echoes can be trapped as they propagate along field-line paths between upper and lower altitude reflection points. The echoes present unique forms, depending upon whether IMAGE is located above or below a minimum in the altitude profile of the Z-mode cutoff frequency. Through an inversion process, such echoes make possible remote determination of the field-line electron density profile in regions where that profile is poorly known. In an example, the electron density distribution along the field lines was determined to a distance of about 10,000 km above the location of IMAGE, all on the basis of echo delay information within a frequency band only ~ 40 kHz wide.