

Polarization Measurements of H⁺ Ion Cyclotron Whistlers Observed by ePOP- RRI

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In this work, we present the polarization measurements made by the Radio Receiver Instrument (RRI) on the Enhanced Polar Outflow Probe (ePOP) on the CASSIOPE satellite. The RRI consists of two crossed dipole antennas which can operate as a polarimeter. This polarimeter configuration was used for this study in which we have made proton whistler observations when the satellite was travelling parallel to the geomagnetic field. These are the first direct polarization measurements of proton whistlers using a radio receiver on a satellite platform.

H⁺ Ion Cyclotron whistlers or proton whistlers were identified in the 1960s. Ion cyclotron whistlers are triggered by fractional-hop electron cyclotron whistlers. H⁺ ion cyclotron whistlers present at a frequency known as the crossover frequency, and then asymptotically reach the H⁺ ion gyro-frequency. The crossover frequency is where a right hand circularly polarized electron cyclotron whistler overlaps with a left hand circularly polarized ion cyclotron whistler. The superposition of the two types of whistlers results in a linearly polarized wave. This process is known as mode conversion.

Since they were first observed, the scientific community has been interested in H⁺ ion cyclotron whistlers, as they may be used to determine ion compositions, magnetic field strength, and plasma temperatures. By knowing the dispersion, polarization and crossover frequencies of ion cyclotron whistlers, the plasma properties of the near Earth space environment may be determined.

All RRI observations presented were made at an altitude of ~1200 km. The latitudinal extent of the observations was from -60° to +60°. Polarization spectrograms of the ellipticity angle were produced and H⁺ ion gyro-frequencies and crossover frequencies were extracted from number of satellite passes.

Our observed H⁺ ion or proton gyro-frequencies agreed well with our modelling calculations obtained using the IGRF magnetic field model. Observed crossover frequencies also showed close agreement with previous observation results from the literature. These are the first radio instrument observations, operating as a polarimeter, of H⁺ ion cyclotron whistlers and their associated crossover frequencies observed from the top-side ionosphere. They also have a larger latitudinal extent than the previous studies.