WHISTLER INTERACTIONS WITH DENSITY GRADIENTS IN THE MAGNETOSPHERE

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Naturally occurring density variations of a few to tens of percent from the background are a ubiquitous feature of the magnetospheric plasma. Very-low frequency (VLF) whistler mode waves (whistlers), which have wavelengths in the middle of this range, are particularly affected by the presence of these density variations. At sub-wavelength scales, these variations are responsible for localized enhancements of wave magnetic and/or electric fields and mode conversion to electrostatic lower hybrid waves. At scales much larger than the wavelength, these variations can be responsible for guiding whistlers along the ambient magnetic field. Recently, large-amplitude whistlers have been observed in the Earth's radiation belts. Unlike the more frequently observed whistler-mode chorus, which propagates primarily parallel to the background magnetic field, these waves were found to propagate at highly oblique angles.

We present results from numerical simulations of the conversion/switching between two whistler-mode waves with the same frequency and the parallel wavelength but different perpendicular wavenumbers. Both whistler-mode waves can co-exist in the magnetospheric plasma and switching occurs when the wave with a smaller perpendicular wavenumber hit the transverse inhomogeneity of the background plasma in the direction of the gradient of this inhomogeneity. In this case the reflected whistler has the larger perpendicular wavenumber than the original signal.

The identification of the whistler mode switching mechanism provides a new tool for the interpretation of whistler phenomena in both laboratory and space plasmas. We have argued that this effect explains some laboratory observations as may also explain magnetospheric observations of highly oblique whistlers. Future research will consider how this mechanism contributes to the energization of electrons by large-amplitude whistlers and the self-consistent generation of additional whistler phenomena including banded chorus and hiss.