DUCTING OF THE WHISTLER-MODE WAVES BY MAGNETIC FIELD-ALIGNED DENSITY ENHANCEMENTS IN THE MAGNETOSPHERE

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Whistler-mode waves (whistlers) are right hand polarized electromagnetic waves with a frequency above the lower hybrid frequency and below the electron cyclotron frequency, which correspond, approximately to 0.1–10 kHz frequency range in the magnetosphere. Whistlers can efficiently interact through the cyclotron resonances with energetic (relativistic) electrons, change their pitch angle and remediate them out of the magnetosphere/radiation belt making the space environment there safer for satellites and humans. Because energetic particles present real danger for next generations of commercial electronics with high degree of miniaturization and integration, various physical mechanisms of remediation of these particles from the magnetosphere had been proposed recently including several quite complex and expensive space- and ground-based experiments.

Some of these experiments involve injection of whistlers into the magnetosphere from powerful HF ground transmitters (like the HAARP transmitter, Alaska, USA) or from satellites (like DSX). The main problem with these experiments is that the resonance interactions between whistlers and energetic particles occur in the equatorial magnetosphere and depends on the wave amplitude. Therefor to succeed with these experiments it is necessary to deliver the electromagnetic power from the transmitter to the interaction region without significant losses. The main physical mechanism which can solve this problem is ducting/guiding of whistlers by magnetic field-aligned density inhomogeneities or ducts.

We present results from a modeling of whistler-mode waves observed by the NASA Van Allen Probes satellites in the magnetospheric ducts formed by density enhancements (also known as, high-density ducts or HDD). Our previous studies suggest that these ducts can only confine waves with some particular frequency, perpendicular and parallel wavelength and all other waves should leak from them. Numerical results confirm that 1) the high-density ducts with amplitudes and perpendicular sizes observed by the RBSP satellites can indeed guide VLF waves over significant distances along the ambient magnetic field with small leakage, and 2) the quality of the ducting indeed depends on the wave perpendicular and parallel wavelengths and, therefore, the fact that the wave is ducted by HDD can be used to determine parameters of the wave.