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Full-wave modeling of ULF wave propagation in the Earth's magnetosphere

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Recent full-wave simulation results using a 2D full-wave code (FW2D) for ultra-low frequency (ULF) waves in Earth's magnetosphere are presented. The FW2D code, which is a two-dimensional finite element code, has been recently developed. This code solves the cold plasma wave equations using unstructured mesh. The wave code has been successfully applied to describe low frequency waves in planetary multi-ion magnetospheres (dipole geometry) [1-4] and radio frequency waves in the scape-off layer (SOL) of tokamaks (tokamak geometry) [4, 5]. The results for space plasmas include ion cyclotron range of frequency waves, which are often detected in the planetary magnetospheres. Generation and propagation of externally driven ULF waves via mode conversion at the ion-ion hybrid resonance at Mercury [1,2] and Earth [4] have been simulated using FW2D code. It has been shown that the mode-converted waves are strongly guided by the ambient magnetic field and have linearly polarization; thus the IIH resonance has been suggested to be the field-line resonance at Mercury and to be generation mechanism of linearly polarized electromagnetic ion cyclotron (EMIC) waves at Earth. The FW2D code also examined mode coupling, refraction and reflection of internally driven field-aligned propagating left-handed EMIC waves and the results emphasized that wave propagation angle from the magnetic equator is crucial to EMIC wave propagation. In this presentation, by adopting empirical magnetospheric model, such as the global core plasma model (GCPM, http://plasmasphere.nasa.gov/models/), we particularly examine the role of heavy ions, such as oxygen on ULF wave generation and propagation at Earth. Since GCPM model provides electron and heavy ion densities as a function of geomagnetic and solar conditions throughout the inner magnetosphere, the results will present wave properties in various geomagnetic conditions as well.

References

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