A computer simulation study on the mode conversion process from Upper-Hybrid wave to LO-mode wave by using the Akebono observation

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A large variety of plasma waves exist in space plasmas depending on the plasma parameters of the medium. The refractive index of plasma medium is determined by the plasma parameters such as plasma density, magnetic field strength, temperature and energetic plasma .Therefore, in an inhomogeneous plasma where these parameters vary as a function of position, the local refractive index is a function of position(Stix,1992). The mode conversion of upper-hybrid mode waves to Z-mode and LO-mode waves has been investigated by previous studies for the purpose of understanding the origin of planetary radio emission [Oya,1974], [Benson, 1975] and [Jones, 1980,1987], observation and theories are summarized by Hashimoto(2005) and Boardsen(2008). However, in the region where the spatial scale of the inhomogeneity is the order of the wave length, there remains unverified physical problems in the conversion process because the previous studies assumed the WKB approximation. Also there arises difficulty in theoretical treatment when the wave encounter to resonance layer as has been discussed by Takano et al (2005). For the discussion of mode conversion process under such environment, a numerical experiment can be a highly useful tool for guiding theory, in the previous study we discussed properties of mode conversion process by performing numerical experiments with different wave normal angle and different incident wave frequency under the same plasma conditions, such as plasma frequency and steepness of the density gradient, also effect of steepness of the density gradient on the mode conversion efficiency. Based on the simulation results, we discussed the parameter dependence of conversion efficiently on the direction of propagation vector [Kalaee, 2008]. In the present study, in order to establish a realistic model, we use Akebono satellite observation of plasmasphere, we choose three case where the mode conversion can be occurred. We estimate the angle between path of satellite and magnetic field vector and also the angle between density gradient and magnetic field vector for use in the simulation model. We discuss about the plasma waves are generated as electrostatic waves via the resonance with electrons at UHR branches in various energy range as the source of UHR-mode waves. Finally, we compare the results of simulation with the Akebono observation. We use Electron Hybrid code which is originally developed by Katoh (2003). We assume two-dimensional simulation system where the uniform magnetic field B_0 is assumed to be in x-y plane. The wave vector was introduced to be aligned the x-axis direction making an oblique propagating to the external magnetic field. The plasma density gradient was set perpendicular (depend on each case) to external magnetic field B_0 within the present study. Several simulations with different wave normal angle have been performed, with the same conditions such as, plasma frequency, steepness of density gradient and angular frequency. The size of the simulation box used in the present study was determined depend on the wave normal angle. Based on the simulation results, we discussed how the wave coupling occurs in magnetized cold plasma by performing FFT analyses on wave electric field to examine spatial distribution of frequency/wavenumber spectra and by considering the polarization of wave modes propagating in the simulation system. Thus, the simulation results showed the generation of electromagnetic LO-mode wave through the mode conversion process from Upper Hybrid wave into LO-mode wave quantitatively. We also evaluated the efficiency of mode conversion depending on the wave normal angle.