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A computer simulation study on the mode conversion process with different length scale of density gradient

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The mode conversion occurs where one propagating mode is linearly coupled to other propagation mode in an inhomogeneous plasma medium. Consequently, plasma waves often change their propagation modes due to the inhomogeneity of space.

Since mode conversion is often associated with singularity in solutions, usually this subject of plasma wave coupling has difficulties in both analytical and numerical aspects. The spatial scale of the inhomogeneity is sometimes in the order of the wavelength, there remain unverified physical problems in the proposed generation mechanism assuming the WKB approximation. To solve this problem, a computer simulation can be a highly useful tool for guiding theory. As a theoretical work Speziale & Catto(1977) indicated in the unmagnetized case, the conversion coefficient is a function of the single parameter q=$(wL/c)^{2/3}\sin^2$a, and Mjolhus(1983) considered the density gradient parallel to the magnetic field and reported that a conversion coefficient is a function of the parameter P=$(1/2piwL/c(Y/(1+Y))^{1/2})\sin^2$a, where L is length scale, w, a and Y are the wave frequency, the propagation direction referring the magnetic field and ratio of cyclotron frequency respect to wave frequency, respectively.

In this study, we investigate mode conversion from UHR-mode wave to LO-mode wave with different length scale by using a computer simulation technique based on the electron Hybrid Code which is originally developed by Katoh(2003). We assume two-dimensional simulation system where the uniform magnetic field B0 is assumed to be in x-y plane. The wave vector was introduced to be aligned the x-axis direction making an oblique perpendicular to external magnetic field B0 within the present study. We generated plasma waves by oscillating E_x and $E_z$components in the generation region assumed in the simulation model. Several simulations with different wave normal angle have been performed. In order to investigate an efficiency of the mode conversion depending on the inhomogeneity, for any wave normal angle, we consider different steepness of density gradient. The size of simulation box used in the present study was determined depending 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 in time and space considering the polarization of plasma waves propagating in the simulation system. We also evaluated the efficiency of mode conversion depending on the wave normal angle and steepness of density gradient.