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Evaluation of the O-X mode conversion rate of the finite width wave in two dimensional systems

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For ECRH in the "over-dense" region where the electron density is more than the cutoff density, the electrostatic electron Bernstein wave (EBW) should be excited via the mode conversion process from the slow X (SX) mode at the upper hybrid resonance (UHR). Waves launched from the low magnetic field side transmit the evanescent region to couple with the SX mode. The previous linear mode conversion theory [1] gives the transmission rate from the incident O-mode to the SX-mode i.e. the O-X mode conversion rate T_{OX} with assuming the plane wave propagation. However, in the real experiment, electromagnetic waves are launched with a finite width from the waveguide antenna, quasi-optical antenna, and so on. The wave optical full wave analysis is required to analyze the characteristics of the mode conversion process with taking into account the beam broadening.
We evaluate T_{OX} numerically for finite width waves in two dimensional systems with using TASK/WF2D code. The cold dielectric tensor is used for solving the Maxwell equation by finite element method and the resonance absorption model in the cold plasma is adopted. The uniform magnetic field where the cyclotron frequency normalized by the wave frequency Ω_e/ω is 0.4, and the linear density profile whose scale length normalized by the vacuum wavelength L_n/λ_0 is 7.5 are adopted. For each case of the propagation angle θ, the incident Gaussian like beams is focused at the plasma cutoff. Two cases of the beam waist size normalized by the vacuum wavelength w_0/λ_0 =3.48 and 1.59 are calculated. We found that T_{OX} is less than one at the optimum propagation angle which the previous linear theory indicates. On the other hand, T_{OX} is more than that given by the linear theory when the propagation angle deviates from the optimum. For the case of narrower beam waist size, these tendencies are enhanced.

Reference

[1] E Mjølhus, Journal of Plasma Physics **31**, pp. 7-28 (1984)

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