NON-GAUSSIAN EC BEAM TRACING IN INHOMOGENEOUS ANISOTROPIC PLASMAS

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The propagation of non-Gaussian electron-cyclotron (EC) beams in inhomogeneous anisotropic plasmas is considered in the framework of the paraxial-WKB beam-tracing theory [1,2]. In the majority of fusion applications concerning EC wave propagation, the launched beams have a Gaussian power profile which is assumed to be maintained during the propagation and absorption (see e.g. [3, 4]). However, the beam that enters the plasma might not always be Gaussian owed e.g. to generation of spurious modes in the launching system, to mirror deformation due to heat load, or intentionally in order to reduce the energy density on the window. Also, it might be the case that the beam undergoes important changes in the shape due to localized absorption or vivid focusing in the plasma. In such cases, the description of arbitrary beams is the first step for a more realistic model for EC absorption, including effects of localization, asymmetry and inhomogeneity. In the paraxial WKB technique, the beam profile is described in terms of superposition of Gaussian modes. A generalized definition for the beam width is considered and, based on the beam-tracing approximation for the wave field, a relation for the width of arbitrary beams is derived. Moreover, we discuss in detail the evolution of the phase shift between different modes due to their different wave vectors. As an application, we study the case of a non-Gaussian beam, formed by the superposition of a pure Gaussian and one higher-order mode, propagating in a simplified plasma geometry perpendicularly to the static magnetic field. Our first results show that, in general, the beam profile is constantly broader than that of the Gaussian mode. There are a few cases, defined by the order of the non-Gaussian mode, where the width depends on the phase difference of the modes and thus varies along the propagation. Also, the effect of EC absorption on the characteristic parameters on the generalized width is found to be very small. The difference in the wave-vectors of the modes may be large enough to cause significant deformation of the beam profile with respect to the Gaussian pattern during the propagation, but is small for introducing different absorption rates of the different modes.

References

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