GRAY: A QUASI-OPTICAL BEAM TRACING CODE FOR EC ABSORPTION AND CURRENT DRIVE

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The propagation of electron cyclotron (EC) waves in tokamaks and the relevant power absorption and current drive have been widely investigated in the literature since long. Usually, the issue of wave propagation is addressed within the geometric optics approximation, by means of ray-tracing techniques in which the wave beam is modeled by an array of independent rays. In some cases, this approach may be inadequate as, e.g., in the case of focused beams or general astigmatic beams, and a description that takes into account diffraction effects is necessary. These effects can be described by beam tracing techniques, which have been theoretically investigated in plasmas by many authors (see, e.g., [1-4]). The new code GRAY has been written for the quasi-optical (QO) propagation of a Gaussian beam of EC waves and the relevant absorbed power and driven current in a general tokamak equilibrium [5]. The problem of beam propagation is addressed in the framework of the complex eikonal approach [1], in which the beam is modeled by a set of quasi-optical rays, which obey to the QO ray-tracing equations, coupled together through an additional constraint in the form of a partial differential equation. A quite fast, and "enough" accurate numerical algorithm for the solution of the imaginary part of the QO dispersion relation has been implemented. On each QO ray, the EC power absorption is computed solving either the weakly or the fully relativistic dispersion relation for EC waves (up to any order in Larmor radius expansion) [6], and the EC driven current is calculated using a linear adjoint model, taking into account trapped particle effects and the full wave polarization [7]. The code has been benchmarked against other existing codes [8], and used for calculations of EC driven current in ITER plasma. Applications to ITER will be presented and discussed.

References

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