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PhD Thesis Abstract

Beyond standard geometrical optics: Paraxial WKB treatment of lower-hybrid wave propagation in Tokamaks

Lower hybrid current drive (LHCD) is a well-established means for non-inductive current drive in tokamak plasmas, and has been successfully used in a large number of tokamaks (e.g., TORE SUPRA , JET, JT60 or HT7), being foreseen to be used in later stages of ITER operation and having recently been installed in tokamaks such as EAST and KSTAR. Despite its success, a long-standing issue remains for LHCD: the so-called spectral-gap problem, which relates to the fact that the LH wave needs to be significantly slowed down before being damped on the bulk electrons, thus generating the large amounts of current seen in the experiments. In this context, geometrical optics and ray tracing have been widely used tools to describe LH wave propagation. In spite of their success in partially explaining the bridging of the spectral gap, geometrical optics faces validity problems, for instance, when rays go back and forth inside the plasma, crossing cut-offs and caustics. In order to overcome these limitations new techniques have been developed such as paraxial WKB (p-WKB) methods, which stand somewhere between geometrical optics and full-wave methods, both in terms of computational cost and completeness of physics description. Indeed, within the p-WKB framework geometrical optics is used along the ray direction, whereas wave characteristics such as beam width and wave-front curvature are described perpendicularly to the ray direction. In this thesis proposal, the main objective is precisely to develop a p-WKB code for LH wave propagation in tokamaks and address the spectral problem, with a secondment year passed at IRFM/CEA (Cadarache), where it is expected to integrate and compare the p-WKB code with state-of-the-art LHCD modelling codes based on ray tracing plus Fokker-Planck, the latter for computing the power-deposition profiles.