Diffraction of radio-frequency waves by plasma turbulence in the edge of a tokamak (*)

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The full-wave theory of radio-frequency (RF) wave scattering by filamentary structures in the edge of a tokamak plasma has been established in prior publications [1-4]. The results from the analytical model, based on the Mie-Lorenz-Debye theory of scattering, have been verified, and extended, by a series of computations [5]. The theory and computations show that RF waves can be reflected, refracted, and diffracted by turbulence. Furthermore, the filamentary structures lead to side scattering of waves and excitation of wave modes different from the launched RF wave. The efficiency of heating and current drive by RF waves depends upon the wave characteristics. A reduction in the efficiency by changes in the wave properties is not desirable. Thus, it is important to quantify the overall effect of turbulence on the propagation of RF waves. The RF waves commonly used range from the low frequency ion-cyclotron waves, to medium frequency lower-hybrid waves, to high-frequency electron cyclotron waves. The relative wave length of these different frequency ranges is, respectively, large, comparable, or smaller than the radial dimensions of the filaments. Each frequency range requires careful modelling of the scattering process. Currently, we discuss the scattering of different RF waves by a variety of turbulent structures in the edge plasma. In Maxwell's equations we use the anisotropic plasma permittivity for a magnetized, cold plasma. The study is applicable to ITER-like plasmas, as well as to plasmas in medium sized tokamaks such as TCV, ASDEX-U and DIII-D. (*) KH, ADP, SIV and PP are partially supported by the Complementary Research Programme of the National Thermonuclear Fusion Research at NTUA. AKR is supported by US DoE Grants DE-FG02-91ER54109 and DE-SC0018090

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