Simulations of probing wave propagation in turbulent plasmas in the case of reflectometry or wave scattering diagnostics

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Different kinds of reflectometers are used on fusion plasmas and are considered as key diagnostics in ITER using both O-mode and X-mode. On ITER long probing wave paths, more than one thousand vacuum wavelengths, are encountered. So the turbulence can modify the amplitude of the probing wave, and as the probing electric field deviates from the unperturbed one, as the result of which, the scattered wave is different from those given by Born approximation models. Assuming that the scattered field is mainly determined by the intensity of the probing electric field, we focus our studies on the computation of the intensity to determine the behavior of probing electric field in turbulent plasma for different parameters as the amplitude of the turbulence, the wavenumber spectrum and plasma parameters.

Different regimes can be identified: the first one at low density fluctuations level described by a Born approximation model, the second one for intermediated density fluctuation level where the average intensity of the probing electric field is very close to the intensity computed without density fluctuation and the last one corresponds to the case where the Bragg backscattering wins over the resonances, that is to say the Bragg backscattering reflects the probing wave before the cut-off or the end of the plasma. So in this last regime, a wrong interpretation of the reflectometry data can arise if the reflection of Bragg scattering region is seen as a cut-off layer.

The modeling of intermediate regime has been analyzed in the framework of weak turbulence theory approach utilizing a more realistic random density fluctuation model\([1]\). A discussion on the role of the resonances and the statistical properties of the resonance occurrence, following a power law, will be shown. The different difficulties encountered during the comparison theory-simulations on the scattered power will be also presented as the requirements for such comparisons in some cases with and without cut-off.

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