Spectrum broadening and degradation of the O-X mode coupling efficiency due scattering of a microwave beam on plasma density fluctuations

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We discuss the tunnelling of quasi-optical wave beams through the evanescent region near the plasma cut-off in magnetized plasmas with density fluctuations: so called ordinary(O) and extraordinary(X) mode coupling. The primary influence of density fluctuations on the O-X mode coupling efficiency is due to a small-angle scattering of a microwave beam along the whole trace of its propagation, while the influence of the fluctuations inside the localised coupling region may be neglected [1]. In this paper model is proposed that describes the effect of a random modulation of a wave phase induced by the fluctuations along the propagation path on the efficiency of linear O-X mode coupling in a two-dimensional geometry that suits well the toroidal magnetic conditions [2]. An analytical formula is derived that relates the mean coupling efficiency and the phase correlation function of a random wave beam. Thresholds are found for the correlation length of the random phase and the length of the beam path, above which the density fluctuations become the dominant effect. The peculiar effects of two-dimensional geometry of mode coupling region [3], including the magnetic field-line curvature [4] and the magnetic surface curvature [5] are shown to be important even in the presents of fluctuations. The results of the analytical study are verified with full-wave numerical simulations.

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