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P2.1087 Scattering of radio frequency waves by plasma turbulence

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The scrape-off layer and the edge region in fusion plasmas are replete with turbulence induced incoherent fluctuations, and coherent fluctuations, such as blobs and filaments. Radio frequency (RF) electromagnetic waves, excited by antenna structures placed near the wall of a fusion device, encounter this turbulent region as they propagate towards the core. In order to optimize the heating of plasmas, or the generation of non-inductive plasma currents, it is necessary to properly assess the effect of this turbulence on RF waves. We have undertaken a set of theoretical and computational studies that model the propagation of RF waves through turbulent plasma. The theoretical models are mathematically tractable, and provide physical and intuitive insight into the effect of turbulence on RF waves. The computational studies provide support for these theoretical models. We use two complementary theoretical approaches ≠ geometrical optics and physical optics ≠ for magnetized plasmas with a tensor permittivity. The former, an approximation to the latter full-wave approach, is useful for incoherent fluctuations and leads to Snell's law and the Fresnel equations in plasmas. This is the basis for the Kirchhoff's approximation for scattering off density fluctuations [1]. The physical optics method is appropriate for studying scattering from coherent fluctuations [2, 3]. The two complementary analyses reveal important physical insights into the scattering processes. Besides refraction and reflection, the spatial uniformity of power flow into the plasma is affected by side-scattering, diffraction, shadowing, and interference. In addition, the incident RF wave power can couple to other plasma waves when interacting with density fluctuations. Within the framework of the COMSOL software, we have built a numerical code to study scattering of RF waves by fluctuations [4]. The code has been benchmarked against theoretical results, and is being used to study scattering from complex representations of fluctuations.

References

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