Contribution ID: **598** Type: **Poster**

TH/P6-29: Scattering of Radio Frequency Waves by Edge Density Blobs and Fluctuations in Tokamak Plasmas

Thursday 11 October 2012 14:00 (4h 45m)

The density fluctuations and blobs present in the edge region of magnetic fusion devices can scatter radio frequency (RF) waves through refraction, reflection, and diffraction. This paper is on two complementary theories that study the effect of fluctuations and blobs on the propagation of RF waves. The first study is on refractive scattering using geometric optics description of wave propagation. A Fokker-Planck description of scattering from a random spatial distribution of blobs of random sizes is formulated. A detailed analysis shows that refractive scattering can diffuse geometric optics rays in configuration space and in wave-vector space. The diffusion in space can make the rays miss their intended target region, while the diffusion in wave-vector space can broaden the wave spectrum. The latter effect modifies the current profile and reduces the current drive efficiency. The second study uses a full wave scattering theory which, besides refraction, includes reflection, diffraction, shadowing, and, quite significantly, coupling to different plasma waves. For example, an externally launched electron cyclotron ordinary mode can couple power to the extraordinary mode due to scattering. The full-wave theoretical model is completely new, first of its kind, study on scattering of RF waves by density blobs. The full-wave model is not limited by the geometric optics approximation of weak density fluctuations; consistent with experimental observations, the ratio of the blob density to the background density can be arbitrary. The scattering of both electron cyclotron waves and lower hybrid waves shows interesting features that are being studied theoretically and computationally. There appear to be effects that have important consequences for ITER –the electron cyclotron waves can be sufficiently deflected by the edge fluctuations so as to miss their intended target region where current is needed to control the neoclassical tearing mode.

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Session Classification: Poster: P6

Track Classification: THW - Magnetic Confinement Theory and Modelling: Wave–plasma interactions; current drive; heating; energetic particles