Contribution ID: **3440** Type: **not specified**

P4.1064 Studies of two plasmon decay and wave trapping at the 2nd harmonic upper hybrid layer in magnetically confined fusion plasmas using particle-in-cell simulations

Thursday, 11 July 2019 14:00 (2 hours)

See full abstract here
http://ocs.ciemat.es/EPS2019ABS/pdf/P4.1064.pdf

Microwave gyrotron beams play an important role in magnetically confined fusion plasmas due, in particular, to the electron cyclotron (EC) frequency typically being in that range. EC resonance heating (ECRH) is a popular method of heating the plasma to thermonuclear temperatures, especially for non-inductively driven reactors such as stellarators. Several heating schemes involving microwaves have been devised; placing the 2nd harmonic EC resonance (ECR) inside an optically thick region of the plasma allows for X-mode heating while bypassing the R cutoff.
Propagating through a plasma, the X-mode beam may decay through parametric decay processes and near the 2nd harmonic upper hybrid (UH) layer, two plasmon decay (TPD) may excite two daughter UH waves at around half the frequency. In a non-monotonic density profile, the UH daughter waves can find themselves trapped between two UH layers, allowing for waves to build up in what may be thought of as optical cavities in the plasma. This way, the trapped waves may eventually exceed parametric decay instability (PDI) amplitude thresholds, thereby exciting other waves. The energy contained in the trapped waves has been estimated to be around 18% [1] of the ECRH energy meant for absorption at the 2nd harmonic ECR. This significant portion might be trapped in the edge region and could be considered lost altogether.
The particle-in-cell (PIC) code EPOCH [2] is used to simulate X-mode gyrotron beams passing a density bump with a 2nd harmonic UH layer found on both sides of the it. Density and magnetic field are loosely based on experimental parameters during shots where observed strong scattering is expected to be related to wave trapping. TPD and further PDIs are investigated in terms of timescales and implicated modes in frequency and wavenumber.
References
[1] E Z Gusakov et al, Physics of Plasmas 23, 082503 (2016) [2] T D Arber et al, Plasma Phys. Control. Fusion 57, 113001 (2015)

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Session Classification: Poster P4

Track Classification: MCF