Electron Bernstein Waves in Spherical Torus Plasmas

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Problems of propagation and absorption of the electron Bernstein waves (EBWs) in small aspect ratio tokamaks have been intensively discussed in recent years because the EBWs coupled with an externally launched electromagnetic beam seems to be the only opportunity for microwave plasma heating and current drive in these tokamaks in the electron cyclotron (EC) frequency range. The whole EBWH&CD problem is naturally divided into three major parts: coupling of incident electromagnetic waves (EMWs) to the EBWs near the upper hybrid resonance (UHR) surface, propagation and absorption of the EBWs in plasma interior and generation of noninductive current driven by the EBWs. Each of the problems has been studied in a number of papers and this talk is an overview of the most important theoretical and numerical results in these fields. Brief outline of the main results is as follows:
Most attractive method of solution of the EMW-EBW coupling problem in a plasma slab has been given in [1] where the mode conversion process is associated with the singularity of the cold plasma wave equation in the UHR. The singularity results in linear interaction of cold plasma EMWs and hot plasma EBWs. This method is applicable to a variety of plasma slab configurations practically without limitations on the plasma inhomogeneity scale-length. The only drawback of the method is its one-dimensionality. An important example of a two-dimensional theory of linear conversion is given in [2] where for moderate scale-length of plasma inhomogeneity an analytical formula for the conversion coefficient between ordinary and extraordinary EM modes near the surface of critical plasma density has been obtained.
A serious possible problem for application of the EBWH&CD in spherical tori has been pointed out in paper [3] where feasibility of an absolute parametric decay instability accompanying the EBWH&CD is estimated. It is found in [3] that a threshold of parametric decay of the incident UH wave into reflected UH wave and lower hybrid wave may be small enough to prevent penetration of incident microwave beam deep into plasma even for moderate beam powers.
In papers [4-7] various aspects of propagation and absorption of the EBWs are discussed. Among them there are a specific behaviour of the EBWs near the plasma mid-plane [4], a modification of the EBW propagation in the EC resonance vicinity in the presence of magnetic wells [5] and useful simplifications [6,7] of very formidable relativistic dispersion relation for the EBWs. Paper [8] describes a code intended for modelling EBWH on MAST tokamak.
Current drive by the EBWs in spherical tori has been studied in papers [9-11] in the framework of the most popular O-X-B experimental scheme for NSTX plasma configurations. Feasibility and perspectives of the EBWH&CD in NSTX spherical tokamak have been discussed there.

References

[1] A.D.Piliya and E.N.Tregubova *Plasma Phys. Control. Fusion* **47** (2005) 143-154
[2] A.Yu.Popov and A.D.Piliya *accepted for presentation at* http://ec14.conferences.gr/
[3] E.Z.Gusakov and A.Surkov *2004 Proc. 12th International Congress on Plasma Physics, Nice* http://hal.ccsd.cnrs.fr/ccsd-00001866/en/, and http://crpppc42.epfl.ch/Tarragona/pdf/P5_103.pdf
[4] A.D.Piliya, A.Yu.Popov, E.N.Tregubova *Plasma Phys. Control. Fusion* **47** (2005) 379-394
[5] A.D.Piliya, A.Yu.Popov, E.N.Tregubova *Plasma Phys. Control. Fusion* **47** (2005) 2029-2040
[6] A.D.Piliya, A.Yu.Popov, E.N.Tregubova *Plasma Phys. Control. Fusion* **45** (2003) 1309-1321
[7] A.N.Saveliev *Plasma Phys. Control. Fusion* **47** (2005) 2003-2017
[8] A.Piliya, A.Saveliev, E.Tregubova http://crpppc42.epfl.ch/StPetersburg/PDF/P3_203.PDF
[9] A.K.Ram et al. http://202.127.204.35/conference/IAEA/IAEA-20/TH_P4-33.pdf
[10] G.Taylor et al. *Phys. Plasmas* **11** (2004) 4733-4739
[11] G.Taylor et al. http://www.pppl.gov/pub_report//2005/PPPL-4066.pdf