INFLUENCE OF ECCD/ECRH-PRODUCED SUPERTHERMAL ELECTRONS ON TRANSPORT OF PLASMA'S ELECTRON CYCLOTRON RADIATION IN TOKAMAK-REACTOR

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Numerical studies are reported for the contribution of superthermal electrons, produced under the condition of ECR heating and EC current drive, to the transport of the electron cyclotron radiation (ECR) emitted by the plasma in an ITER-like tokamak. The results are obtained with the help of successive use of the numerical codes TORBEAM, RELAX and CYNEQ. The motivation comes from

(a) increase in the role of plasma's ECR in the (local and even total) energy balance in tokamak ITER [1,2] because of strong dependence of the profile of the net ECR power loss, $P_{EC}(r)$, on T_e and magnetic field,

(b) sensitivity of $P_{EC}(r)$ in the plasma core [1] to the presence of superthermal electrons.

Calculations with the code CYNEQ [1], which is based on the approach [3], are carried out for *given* electron distribution function (EDF) in velocities and magnetic surfaces, which is calculated in [4] with the help of the combined numerical code TORBEAM+RELAX. The results obtained show how the distortions of EDF caused by the absorption of external intense ECR, *injected* into the plasma at low harmonics of the cyclotron frequency (n=1,2) for ECRH and ECCD, influence the transport of ECR, emitted by the plasma itself at all other harmonics ($2<n<15$) responsible for formation of $P_{EC}(r)$ in hot plasmas ($\langle T_e \rangle > 10$ keV) in a strong toroidal magnetic field ($B_T \geq 5$ T). For conditions, close to the ITER reference scenario 2 ($T_e(0) \sim 25$ keV), we found the following dependence of $P_{EC}(r)$ on the geometry of ECRH/ECCD, for a 20 MW beam with its focusing in the core and full absorption in the plasma.

(1) For perpendicular launch, the change of the profile of $P_{EC}(r)$ is small (~ few percents in the core). The scale of this effect is similar to that in the case [1(A)] when EDF's distortions are caused by the ECR emitted by the plasma (total power of this ECR inside the tokamak chamber with the wall reflection coefficient R_w=0.6 amounts to ~15 MW).

(2) For oblique launch (toroidal injection angle $\beta \sim 20°$) the relative rise of $P_{EC}(r)$ in the core attains ~20%, because in this case the EC power is absorbed by electrons with larger velocity (and, respectively, smaller rate of relaxation to a Maxwellian due to the pair Coulomb collisions).

References

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