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ANALYSIS OF THE MICROWAVES ABSORPTION IN TOKAMAKS AND STELLERATORS USING THE CANONICAL PROFILES TRANSPORT MODEL *)

[1]Dnestrovskij Yu.N., [1]Melnikov A.V., [1]Andreev V.F., [1]Lysenko S.E., [1]Nurgaliev M.R., [2]Shalashov A.G.

[1]*NRC 'Kurchatov Institute', Moscow, Russia, Dnestrovskiy_YN@nrcki.ru*
[2]*Institute of Applied Physics, Russian Academy of Sciences, Nizhni Novgorod, Russia*

On the T-10 tokamak, the electron temperature during microwave heating at the second harmonic of the extraordinary wave (electron cyclotron (EC) mode X2) at a low plasma density ($n < 3\times10^{19}$ m^{-3}) turns out to be significantly lower than at the first harmonic of the ordinary wave (O1), Fig. 1. This may be caused by incomplete absorption at the second harmonic of microwaves. Analysis of experimental data from the T-10 tokamak, and TJ-II and L-2M stellarators, using the canonical profiles transport model, have shown that the fraction of absorbed power $\eta = Q_{ab}/Q_{EC}$ at $n < n_{cr}$ increases linearly with density. Here Q_{ab} and Q_{EC} are correspond to the absorbed and input microwave power; the critical density n_{cr} depends on the magnetic field as $n_{cr} = 1.2\cdot B$, [10^{19} m^{-3}, T]. Theory [2] predicts that in the case of the X2 mode, the fraction of absorbed power η depends on the plasma optical thickness τ as

$$\eta = 1-\exp(-\tau),\ \text{где}\ \tau \approx 5.6\left(nT_eR/1.5B\right). \qquad (1)$$

Figure 2 shows the dependence of heating efficiency on the plasma density for the T-15MD tokamak at B=2 T. The saturated curves correspond to theoretical formulas (1). The dotted broken lines correspond to the empirical formulas [1]. We can see that the discrepancies between the classical and empirical formulas lie in the density range $n < 2.4 \times 10^{19}$ m^{-3}. To overcome the region of incomplete absorption in the T-15MD, we propose to use additional heating by the ion cyclotron waves or by neutral beam injection, or to start the discharge with $n > n_{cr}$, then decrease the density with simultaneous heating.

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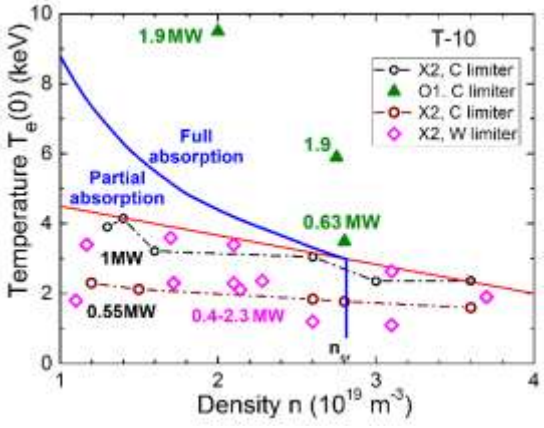

Fig. 1. Comparison of heating at the first (O1) and second (X2) EC harmonics in the T-10 tokamak.

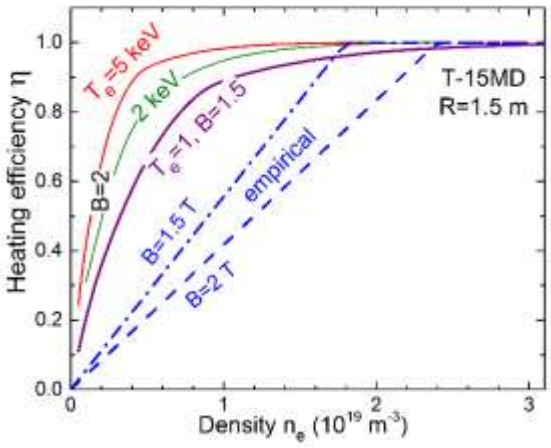

Fig. 2. Theoretical (solid) and empirical (dashed lines) dependences of the of EC heating efficiency in the T-15MD.

References

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