transport model with different canonical profiles for ions and electrons

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The canonical profiles transport model was described in [1]. It was supposed there that the canonical profiles for electron *Te* and ion *Ti* temperatures are the same. However, in recent years, it has been possible to conduct systematic measurements of the ion temperature profiles and to compare the temperature profiles in different discharges [2]. Analysis of experimental data for ohmic and ECR-heated discharges have shown that normalized temperature profiles for ions, , are much flatter than the ones for electrons, , Fig. 1. For a quantitative estimation of the profile shape, we introduce the peaking factor of temperature profile: *pT*=*T*(0)/*T*(*a*/2), where *T*(0) and *T*(*a*/2) are temperatures in the centre and at mid-radius of plasma column. As an example, we consider shot No. 73197 (current *I*=0.23 MA, magnetic field *B*=2.2 T, density *n*=1.3   
1019 m–3). The ECR heating is performed by three gyrotrons, two of which (A and C with a total power of 1.7 MW) deposit the power at = *a*/2, while the gyrotron B with a power of 0.5 MW  at = *a*/6. In the ohmic phase (OH), *pTe*=1.67, *pTi*=1.33, λ = *pTe*/*pTi* = 1.26. Similar values of  are typical for the ECR heating phase. So, we may unambiguously conclude that in our transport model, the canonical profiles for *Ti* should be flatter than ones for *Te*. In the model [1], the boundary condition at =0 for the function μ(ρ)=1/*q*() is as follows: . Usually, in calculations, 0=1, and for flatter profiles, 0<1. Figure 2 shows the canonical profiles of temperature with 0=1 and 0.5. Figure 3 compares the calculation results (solid curves) and experiment (dashed lines) for the electron and ion temperatures in shot No. 73197 with heating by all three gyrotrons ABC. Here, 0*e*= 0.6, 0*i*= 0.55, although  = 1.14 > 1. For the ohmic stage, the calculation gives μ0*e*=1 and μ0*i*=0.55. The *Te* profile after transition from OH to ABC phase is strongly flattened due to sawtooth oscillations and non-central heating by the A and C gyrotrons. Figure 3 shows that the model reasonably describes discharges with strong ECR heating (errors *d*2*T* < 8%) that allows us to use it for prediction the plasma parameters in future devices.

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fig2.tiffig1.tiffig3.tif

Fig. 1. Fig. 2. Fig.3.

References

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2. Krupin V.A. et al., Plasma Phys Rep. 2013, 39, 632.