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# NUMERICAL MODELLING OF HIGH-TEMPERATURE PLASMA IN A STRONG MAGNETIC FIELD AT RFNC-VNIITF

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**Abstract**

Review of code development at RFNC-VNIITF for numerical modelling of high-temperature plasma in a strong magnetic field is presented. Three codes are described: 1D MHD ERA code and 2D MHD codes: MAG and TIGR-M.

ERA is 1D two-temperature Radiation Lagrangian MHD Code. ERA includes magnetic field diffusion; electron and ion heat conduction with heat flux inhibition; superthermal particles creation mechanism and transport equations for particles. Radiation effects can be treated in different cases: three temperature model; multigroup diffusion model; multigroup nonstationary kinetic model; multigroup nonstationary kinetic model with quasidiffusion approximation. A detailed configuration atomic model has been employed to calculate the line opacity, Doppler effect and ionic state variation. The state populations are calculated using a set of time-dependent atomic rate equations for electron collisional excitation and de-excitation, dielectronic and radiative recombination, photoexcitation and others processes. The ionization state of plasma is calculated self-consistently with line and continuum radiation transport. There are a number of tables which contain the characteristics of elements: state equations and different kinetic transport coefficients. Equations of state taking into account the energy of ionization are used for electron and ion pressure and internal energy calculations. In the Code the relevant Braginskii magnetized transport coefficients are used. The microturbulence effects due to current-drive microinstabilities are also included into the Code.

2D resistive MHD Code MAG for plasma modelling in arbitrary moving coordinate system is developed for the case of three components of velocity and three components of magnetic field. The Code is build on the basis of TVD scheme in Lagrangian form. This approach allows to simulate flows with large deformations inside the flow region, conserving the correct description of conditions on its weakly deformed boundaries. The code is modified to include Hall term in the equation for magnetic field evolution. The Code is using the same set of equations of state and magnetized transport coefficients as ERA code excluding radiation effects and superthermal particles transport.

In TIGR-M Code the Eulerian-Lagrangian description of motion with special velocity vector decomposition in moving coordinate basis is used. There are two particular cases of magnetic fields configuration in the Code: 1) two components of velocity and two components of magnetic field lying in the same plane as velocity vector does; 2) two components of velocity and one component of magnetic field which is normal to velocity vector. One coordinate lines family coinciding with interface is Lagrangian one, the other is an Eulerian one (that is a set of straight lines). For realization of implicit finite difference technique the method of splitting according to physical processes and space variables is taken. The following types of problems can be solved with the Codes:

- a set of magnetically related problems which fall in the dynamics of flow of heat-conducting gases in complex systems, taking into account stratified structures consisting from different materials;
- inertial confinement fusion investigations, particularly to study effects in plasma liner implosion and laser-fusion target;
- MHD instabilities development in Z-pinch and its suppression by an axial magnetic field.
- plasma-wall interaction in the tokamak ITER and others.

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