Description of mutual diffusion of rarefied heavy impurities in plasma

Bobrova N.A., \*Sasorov P.V., and \*,\*\*Fomin I.V.

A.I. Alikhanov Institute for Theoretical and Experimental physics, Russian Federation,
 nabobrova@gmail.com
\*Keldysh Institute of Applied Mathematics, Moscow, Russian Federation,
 pavel.sasorov@gmail.com
\*\*Moscow institute of physics and technology, Dolgoprudny, Russian Federation,
 fominalsha@gmail.com

We will present a system of magnetic hydrodynamics (MHD) equations, which are able to describe multi component fully ionized plasma, composed of a basic element and arbitrary number of heavy impurities with sufficiently low total concentration. The total impurities concentration is assumed to be so low that collisions between heavy impurities can be neglected.

A system of MHD equations for plasma, that is a mixture of ions of two kinds (and electrons) with strongly different masses, was obtained in Refs. [1-3]. Concentration of the impurity in these works was not assumed low. Hence only two kinds of ions were taken into account to avoid very complicated expressions for the kinetic coefficients. In the preset work, this approach was generalized on an arbitrary number of impurities kinds with additional restriction concerning total concentration of the impurities.

The new system of MHD equations differs from the usual one in two points. The first point is that an additional system of equation arise that describes transport of separate impurities. The second one is that expressions for Ohmic electric field and thermal fluxes contain additional cross terms, caused inhomogeneities of chemical composition of plasma. Explicit expressions for all kinetic coefficients are obtained. They depend on electron and ion temperatures of plasma, its density, on impurity concentrations, and on their mass numbers and mean ionizations.

References

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