Vibrations in electron plasma featuring an arbitrary degree of degeneracy

© N.M. Gordeeva

Bauman Moscow State Technical University, Moscow, 105005, Russia

The paper analyses a solution to the boundary value problem of plasma responding to an external electric field. We consider vibrations of degenerate electron plasma over a layer of finite thickness. We used the Boltzmann—Vlasov kinetic equation with the Bhatnagar—Gross—Krook collision operator and Maxwell's electric field equation to develop the mathematical simulation. We describe the case of specular electron reflection from the plasma surface. The general solution to the boundary value problem, that is, the electric field intensity, is a linear combination of discrete solutions with constant coefficients and an integral over a continuous spectrum. The discrete solutions prove to be the Drude and Debye solutions known previously, while the continuous spectrum matches the van Kampen waves. We show that the existence of the Debye mode depends on the external electric field frequency and the following plasma parameters: chemical potential and collision frequency. Existence of a complex root of the dispersion function determines the domain of the solution corresponding to the Debye mode. This root may be found by employing the argument principle.

Keywords*: eigenfunctions, Drude mode, Debye mode, van Kampen mode, electron plasma, collisional plasma*

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Gordeeva N.M., Assist. Professor, Department of Higher Mathematics, Bauman Moscow State Technical University. Specialises in mathematical simulation.
e-mail: nmgordeeva@bmstu.ru