Thermodynamic stability of multicomponent nonideal plasma

Filippov A V[1,2], Reshetniak O B[2,@] and Reshetniak V V[2]

[1] Joint Institute for High Temperatures of the Russian Academy of Sciences, Izhorskaya 13 Bldg 2, Moscow 125412, Russia
[2] State Research Center of the Russian Federation—Troitsk Institute for Innovation and Fusion Research, Pushkovykh Street 12, Troitsk, Moscow 108840, Russia

[@] obr@triniti.ru

In this work, the thermodynamic stability of a multicomponent nonideal plasma is studied. To find pair correlation functions and partial static structure factors, the Ornstein-Zernike integral equations for a multicomponent fluid were used, which were closed with the hypernetted chain approximation. A procedure has been developed for the transition to the one-component approximation for the most nonideal plasma subsystem for the case of any number of plasma components. In this procedure, to determine the pair correlation function in the chosen subsystem, an effective pseudopotential is introduced, which is a function of the remaining direct correlation functions. After a solution for the most nonideal subsystem has been found, the remaining pair correlation functions are determined by the iteration method. Then, the thermodynamic potentials of a multicomponent plasma were determined: internal energy, pressure, free energy, chemical potentials and their derivatives. To find the partial chemical potentials of the plasma components, the method proposed by Hansen [1] was used, which is close to the method of thermodynamic integration. To find the derivatives of chemical potentials, the Kirkwood-Buff approach [2] was used. The data obtained in numerical calculations were used to determine the region of thermodynamic stability of a three-component nonideal dusty plasma.

[1] Hansen J P, Torrie G M and Vieillefosse P 1977 *Phys. Rev. A* **16** 2153–2168
[2] Kirkwood J G and Buff F P 1951 *J. Chem. Phys.* **19** 774–777