Pressure fluctuations in nonideal plasma: precursor of the plasma phase transition

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An assumption about the plasma phase transition (PPT) is advanced in [1, 2] by analogy with the Van der Waals equation where the phase transition origin is a result of the balance between long-range attraction and short-range repulsion. Coulomb interaction between charges is a long-range and effectively attractive one because of the plasma polarization. An effective repulsion at short distances even for an electron-proton pair is of the quantum nature. However contrary to real gases there are excited atoms in low temperature plasmas. The restriction of the discrete spectrum in the atomic partition function depends on the charge number density. Gryaznov and Iosilevskiy[3, 4] noted that this dependence results in the appearance of a new term in the equation of state. The term is equivalent to the effective repulsion. Therefore this factor is able to suppress or influence the PPT.

The chemical plasma model is used in [3, 4]. We guess that it is more logical to apply the fluctuation approach [5] which provides the self-consistent joint description of free and weakly bound electron states without their separation. The molecular dynamics method is used. The electron-ion interaction is described by the density and temperature-independent cutoff Coulomb potential. Fluctuations of pressure of singly ionized nonideal plasma are studied. The fully ionized plasma region is found where pressure fluctuation distribution can be approximated by the superposition of two Gauss distribution functions. It should be noted that this region of plasma parameters lies out of the area of the abovementioned stabilized factor action. The result could be considered as a precursor of the PPT.

G.E.Norman, A.N.Starostin, High Temperature 6, 394 (1968)
G.E.Norman, A.N.Starostin, High Temperature 8, 381 (1970)
V. K. Gryaznov, I. L. Iosilevskiy, V. E. Fortov, *Entsiklopediya Nizkotemperaturnoi Plazmy. Seria B. Tom III-I (ed by V. E. Fortov)* (Fizmatlit, Moscow, 2004)
A. S. Kaklyugin, G. E. Norman, *Entsiklopediya Nizkotemperaturnoi Plazmy. Seria B. Tom III-I (ed by V. E. Fortov)* (Fizmatlit, Moscow, 2004)
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