The theory of phase transitions in the system of charged fermi-particles above liquid dielectric surface

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A consistent theory of equilibrium states of same sign charges above the surface of liquid dielectric film located on solid substrate in the presence of external attracting constant electric field is proposed. The approach to the development of the theory is based on the Thomas-Fermi model generalized to the systems under consideration and on the variational principle. The using of self-consistent field model allows formulating a theory containing no adjustable constants. In the framework of the variational principle we obtain the self-consistency equations for the parameters describing the system: the distribution function of charges above the liquid dielectric surface, the electrostatic field potentials in all regions of the system and the surface profile of the liquid dielectric. The self-consistency equations are used to describe the phase transition associated with the formation of spatially periodic structures in the system of charges on liquid dielectric surface. Assuming the non-degeneracy of the gas of charges above the surface of liquid dielectric film the solutions of the self-consistency equations near the critical point are obtained. In the case of the symmetric phase we obtain the expressions for the potentials and electric fields in all regions of the studied system. The distribution of the charges above the surface of liquid dielectric film for the symmetric phase is derived. The system parameters of the phase transition to nonsymmetric phase - the states with a spatially periodic ordering are obtained. We derive the expression determining the period of two-dimensional lattice as a function of physical parameters of the problem - the temperature, the external attractive electric field, the number of electrons per unit of the flat surface area of the liquid dielectric, the density of the dielectric, its surface tension and permittivity and the permittivity of the solid substrate. The possibility of generalizing the developed theory in the case of degenerate gas of like-charged particles above the liquid dielectric surface is discussed.