Thermodynamics of nonideal plasma in the SAHA model

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The central problem of the quasi-chemical description of the thermodynamics of a strongly coupled plasma (SCP), i.e., of the chemical plasma model (CPM) is the problem of correct and self-consistent accounting for the contribution of quantum bound states of many-electron complexes (atoms, molecules, atomic and molecular ions, etc) in a dense plasma environment. The idea of searching for a thermodynamically self-consistent combination of a quasi-classical description of the Coulomb non-ideality of "free" charges and a correct quantum-mechanical calculation of the contribution of substantially "constrained" bound states was initiated by V E Fortov in the 70s. This idea was the basis for the implementation of the so-called the "confined atom" model, where the total effect of plasma coupling was described in frames of the variational procedure and the concept of two "effective" potentials—external and internal (the calculation was carried out by the Hartree–Fock method). This model was applied to the thermodynamics of SCP of inert gases (neon, argon, xenon). Another example of a modern application of the CPM is the precise description of weakly non-ideal and weakly degenerate plasma of the Sun, where the data of long-term helioseismology observations provide extremely accurate knowledge of the effective hydrogen-helium plasma adiabatic exponent with small abundance of numerous elements. The report discusses the history and current state of both aspects of this problem.