Development of the Chemical-Picture-Based Model of Dense Multielectron-Ion Plasmas Using the Superconfiguration Approach

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In the context of the further development of the chemical-picture-based model of plasmas [1,2], a consistent description of ionization balance, modified partition functions, and thermodynamics of dense multielectron-ion plasmas was formulated. To characterize Coulomb coupling in the broad range of plasma nonideality parameters, the relevant model uses multi-ionic mixture generalization of an analytic fit for excess free energy of one-component plasma allowing for the degeneracy and exchange effects [3]. Finite-volume effects of plasma ions are represented by using the hard-sphere model [4] with the effective ion sizes corresponding to the sufficiently occupied orbitals of superconfigurations yielding the greatest contribution to modified partition functions. Those incorporate occupation probabilities of one-electron ion states in the presence of plasma electric microfields [1] and are calculated on the base of the superconfiguration approach [5].

We present the calculated data for average ionization, Gruneisen coefficient, and specific heat of aluminum and iron plasmas in the broad range of plasma temperatures and densities. Calculated thermodynamic functions and shock Hugoniots are compared with other theoretical and experimental data. Further refinements and extensions of the model are also discussed.

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