

Consistency of quantum-statistical and ionization equilibrium models

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The TEFIS database is developed for calculations of physical properties of matter in extreme conditions. Thermodynamic functions in this database are calculated with two models: the Quantum-Statistical model (the Thomas-Fermi model with quantum and exchange corrections) for matter with high density and the model of Ionization Equilibrium for matter with lower density. (Similar models are used in the known SESAME library (Los Alamos).) The possibility of applying these models in wide range of densities is studied in this paper. This is critical for the wide-range state equation achievement.

In previous works the boundary between these two models is a constant line related to a fixed density value. Apparently, this is so because their Ionization Equilibrium model uses traditional corrections for collisional plasma, that can't be used for high densities. At the same time, our calculations demonstrate that on this boundary line the Ionization Equilibrium model contains significant hull effects, while the Quantum-Statistical model doesn't have them. So the models are significantly inconsistent at the boundary (some thermodynamic functions differ by more than 10%). This makes impossible to achieve an accurate state equation.

In our Ionization Equilibrium model a special correction for collisional plasma is found that can be used for matter of huge densities. In addition, electronic component of plasma is taken with respect to degeneration. Therefore the model can be used while the plasma can be treated as gas (it is required that total volume of ionic residuals is negligible). The boundary line between two models becomes not a vertical line (related to some fixed density value as in SESAME) but a function of density and temperature.

For some matters examples of the boundary line is demonstrated and discussed.

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