THERMODYNAMICS OF METALLIC HELIUM

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S u m m a r y

The internal and free energies of liquid metallic helium were calculated in wide ranges of density and temperature, and the corresponding equation of state was obtained in the framework of the perturbation theory. The potential of electron-ion interaction was selected as a small parameter, and the calculations were carried out to the third order of smallness inclusive. Conduction electrons were considered in the random phase approximation and taking into account exchange interaction and correlations in the local field approximation. The hard-sphere model was used for the nuclear subsystem, with the sphere diameter being the only parameter of the theory. The sphere diameter and the system density at which helium transforms from the single- into the double-ionized state were evaluated by analyzing the effective pair interaction between the helium nuclei, also in the third order of perturbation theory. The case of double-ionized helium atoms was considered. The third-order correction turned out substantial in all examined cases. The values obtained for thermodynamic parameters–density, temperature, and pressure–fall within the ranges typical of the central regions in giant planets, which allows us to suppose the existence of metallic helium in the solar system.