THERMODYNAMIC PROPERTIES OF METALLIC HYDROGEN

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S u m m a r y

The internal energy, free energy, and pressure as functions of density and temperature have been calculated for metallic hydrogen. The regions of temperatures and pressure correspond to the conditions of experiments on the formation of metallic hydrogen, as well as to those observed in the cores of giant planets of the Solar system, such as Jupiter and Saturn. Hydrogen is assumed to be in an atomic state, and all its electrons are itinerant. To calculate the thermodynamic potentials of metallic hydrogen, the perturbation expansion in the electron-proton interaction is used. The electron subsystem is considered within the random phase approximation with regard for the exchange interaction and electron correlations within the local field approximation. A proton-proton interaction is taken into account within the rigid sphere approximation. Since the electron-proton interaction for metallic hydrogen is known precisely, the only parameter of the theory is a sphere diameter. For its determination, the effective pairwise proton-proton interaction is used. The zeroth-, second-, and third-order terms of the perturbation expansion are taken into account to perform the numerical calculations of thermodynamic characteristics. The third-order term is found to be important, although it is far smaller than the second-order one over the whole regions of temperature and pressure under consideration. The thermodynamic potentials of metallic hydrogen are the monotonically increasing functions of density and temperature. The pressure values, calculated for the temperatures and densities characteristic of the conditions of obtaining of metallic hydrogen under terrestrial conditions, coincide to a high accuracy with the corresponding values reported by the authors of the discovery of metallic hydrogen.