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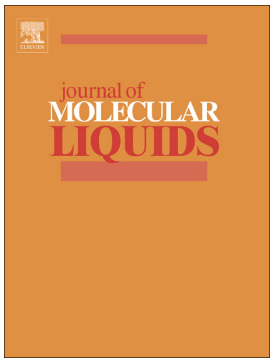

Three-state mesoscopic model of a heterophase fluid in application to the gas-liquid and dielectric-semiconductor-metal transformations in expanded mercury

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Three-state mesoscopic model of a heterophase fluid in application to the gas-liquid and dielectric-semiconductor-metal transformations in expanded mercury

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Abstract

The fluid states of mercury are described in the framework of a mesoscopic theory of a 3-phase random mixture of mutually transforming fluctuons. Fluctuons represent the mesoscopic liquid-like-metallic, liquid-like-nonmetallic, and gas-like species of the fluid. Formulated free energy of the system of interacting fluctuons produces a thermodynamic equation of state. It is found that for an appropriate set of parameters both the vapor-liquid transformation and the metal-nonmetal transformation in the liquid phase of mercury are accurately described. The solutions of the equation of state explain the nonlinearity and asymmetry of the diameter of the liquid-vapor coexistence curve and reveal the physics of metal-nonmetal transition. It is shown that the observed dielectric anomaly in mercury is induced by an excitonic transition at the percolation threshold of the nonmetallic liquid fraction. The partial conductivities and dielectric permittivities of gas phase, as well as metallic and nonmetallic liquid phases are determined. The phase diagram of mercury with its continuous and discontinuous transformation lines is reproduced.

Keywords: heterophase fluctuations, mesoscopic equation of state, mercury, metal-nonmetal transformation, dielectric anomaly, phase diagram.

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