Heterophase nature of mercury and its manifestation at the gas-liquid and metal-nonmetal transitions

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Landau and Zeldovich have proposed a phase diagram of mercury with two critical points belonging to the metal-nonmetal and gas-liquid coexistence curves. In both cases the Ornstein-Zernike (OZ) equation as an approximant of the Bogolyubov chain could be applied. It was revealed experimentally that the gas-liquid transition in mercury (which is a complex fluid) is accompanied by continuous dielectric-semiconductor-metal transformations. In this case applicability of Kadanoff's block spin transformation within fluctuation domain, R1, around the critical point, as well as determination of OZ equation, is questionable. This problem is solved considering mercury as a random mixture of short-living mutually transforming mesoscopic species (fluctuons) of different structure and properties. The latter represent the liquid-like-metallic, liquid-like-nonmetallic, and gas-like species. Free energy of the interacting fluctuons is formulated. A pseudo-renormalized solution within R_1 and OZ-equation for domains beyond is deduced. It is found that for an appropriate set of the fluctuonic parameters both the vapor-liquid and the metal-nonmetal transformations in the mercury are accurately described. The physics of metal-nonmetal transition is clarified. It is shown that the observed dielectric anomaly (Marburg effect) in mercury is induced by excitonic transition at the percolation threshold of the nonmetallic liquid fraction.