The thermal and "cold" ionization mechanism for conductivity of metal vapors in near-critical region

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The coexistence of vapor–liquid and dielectric–metal transitions has been discussed for many decades: it is not clear whether these are separate transitions or they coexist together. We proposed a new model [1] for calculating the metal vapor equation of state and conductivity in near-critical region. This method is based on the hypothesis of the existence of an electron jellium as an origin of the conduction band in metal-vapor gaseous phase. The jellium of the gaseous phase consists of the wave function tails of bound electrons lying outside the Wigner–Seitz cell (WS). The emergence of jellium leads to the appearance of cohesion—the quantum, collective binding energy of atoms. According to our hypothesis, the ion cores together with the jellium form a "gaseous metal" that exists at any density. In this work, the main properties of gaseous metal are considered. The temperature–density phase diagram shows the region of the "gaseous metal" state existence—the region where jellium electrons dominate thermally ionized electrons. The main properties of gaseous metal are discussed: the region of the gaseous metal existence near binodal; conductivity behavior at supercritical isotherms—the existence of minimum and asymptotics. The physical meaning of the conductivity "asymptotics" with density increase is the conductivity along the vapor–liquid coexistence curve. Our results are in good agreement with experimental and quantum molecular dynamics results [2, 3].

[1] Khomkin A L and Shumikhin A S 2017 *J. Exp. Theor. Phys.* **124** 1001–1009
[2] Franz G, Freyland W and Hensel F 1980 *J. Phys., Colloq.* **41**(C8) 70–73
[3] Li D *et al* 2014 *Sci. Rep.* **4** 5898–5904