The line of unit compressibility factor in low-temperature plasmas [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.121

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The similarity laws are one of approaches to the investigations of gases and liquids phase diagrams for more than a century [1]. The principle of corresponding states or the law of the rectilinear diameter of binodals are well-known examples since 19 century [1,2], although they have a limited area of applicability. Another kind of similarity, concerning the line of the unit compressibility factor, has a wider applicability area [3]. This line presents a contour at the phase plane, along which the pressure of a system coincides with the pressure of an ideal gas. I. e. along this contour the compressibility factor Z=1 for any one-component system (as usual Z=P/(nT),where P is the pressure, n is the particle concentration, T is the temperature in energy units). Such a contour can be considered in various coordinates - Такой контур может быть рассмотрен в различных координатах - n-P, n-T, T-P- but, nameli within n-T coordinates the line Z=1 appears to be a straight line for all densities from zero to the melting line. Initially this univeral form was obtained for van der Waals equation. But later it was fount that it is kept for substances, which are described by completely different equation of states (EOS). Now in the NIST database there collected the data and constructed corresponding EOS for ~ 150 веществ. Only for ten of them line Z=1 is not straight [3].Such universality allows one to find new similarity relations for many gases and liquids and the meals in liquid phase [5].

All this properties refer to the systems without charged components under relatively low temperatures. Thus it is interesting to study this contour Z=1 for low-temperature plasma of metals. Previously for this state of metals there were developed a number of chemical models by us and by other authors, which reliably describes their thermodynamics at T10-100 kK and densities lower than the critical one (see [6,7] and references therein). In present study we have applied the chemical models developed earlier to construct the contours Z=1 in the mentioned region for a number of metals. We found that there is no a universal form of the contour in this region, but some general regularities, following from the expansion over the coupling constant for coulomb component [8], are still kept.

Refernces

1. Balescu R., Equilibrium and non-equilibrium statistical mechanics. John Wiley & Sons, Chichester, New York, Sydney, Toronto 1975
2. Smirnov B. M., Phys.-Usp. 2001, V. 44. P. 1229
3. Apfelbaum E. M., Vorob'ev V. S., Int J Thermophys 2020, V.41:8.
4. Lemmon, E. W.; Bell, I. H.; Huber, M. L.; McLinden, M. O. NIST standard reference database 23: Reference fluid thermodynamic and transport properties-REFPROP, Version 10.0 National Institute of Standards and Technology, 2018.
5. Apfelbaum E. M., J. Phys Chem B, 2022, V. 126, P. 2912.
6. Apfelbaum E. M., Phys. Plasmas, 2020, V. 27, 042706.
7. Apfelbaum E. M., Физика Плазмы, 2022, Т. 48, С. 937.
8. Vedenov. A. A., Larkin A. I., JETP, 1959, V. 36. P.1133
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Lt/ru/EA-Apfelbaum.docx) [↑](#footnote-ref-1)