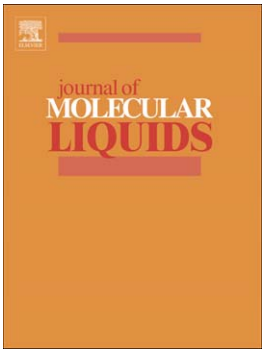

Statistical theory of condensation — Advances and challenges

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Statistical theory of condensation – advances and challenges

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Abstract

The statistical theory of condensation remains an open interdisciplinary problem for more than a century. There are only an extremely limited number of specific theoretical examples for the gas-liquid phase transition, and all the conventional general and rigorous statistical approaches unfortunately have failed in the condensation region. This Review first presents an overall and consistent description of a recent promising approach to the exact evaluation of Mayer's cluster expansion for the system partition function, including its derivation and various applications. On the basis of this approach, the theoretical condition of condensation has finally been established, and a particular attention in the paper is paid to the strong statistical substantiation of this condition. The newest data on the high-order virial coefficients for some realistic models of intermolecular interaction have made the theoretical isotherms qualitatively similar to the experimental ones near the condensation point. However, at high-density regimes (liquid and solid states), the exact cluster expansion has demonstrated a non-physical behavior, and origins of this inadequacy are clearly stated in the Review.

Keywords: Statistical theory of condensation, Gibbs statistics, equation of state, cluster expansion, cluster irreducible integral, Lennard-Jones

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