

Kac, M.; Uhlenbeck, G. E.; Hemmer, P. C.

On the van der Waals theory of the vapor-liquid equilibrium. I: Discussion of a one-dimensional model. (English) [Zbl 0938.82517](#)

J. Math. Phys. 4, 216-228 (1963).

Summary: For a one-dimensional fluid model where the pair interaction potential between the molecules consists of a hard core and an exponential attraction, Kac has shown that the partition function can be determined exactly in the thermodynamic limit. In section II this calculation is reviewed and further discussed. In section III, we show that in the so-called van der Waals limit when the range of the attractive force goes to infinity while its strength becomes proportionally weaker, a phase transition appears which is described exactly by the van der Waals equation plus the Maxwell equal-area rule. In section IV the approach to the van der Waals limit is discussed by an appropriate perturbation method applied to the basic integral equation. The perturbation parameter is the ratio of the size of the hard core to the range of the attractive force. It is seen that the phase transition persists in any order of the perturbation. The two-phase equilibrium is characterized by the fact that in this range of density, the maximum eigenvalue of the integral equation is doubly degenerate and that the corresponding two eigenfunctions do not overlap. In section V we comment on the relevance of our results for the three-dimensional problem.

MSC:

[82D15](#) Statistical mechanical studies of liquids

Cited in **3** Reviews
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[one-dimensional fluid model](#); [pair interaction potential](#); [van der Waals limit](#); [phase transition](#); [perturbation method](#); [integral equation](#)

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