

Kinetic model for the phase transition of the van der Waals fluid

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Abstract

A simple (presumably minimum) kinetic model for the phase transition of the van der Waals fluid is presented. In the model, intermolecular collisions for a dense gas has not been treated faithfully. Instead, the expected interactions as the non-ideal gas effect are confined in a self-consistent force term. Collision term plays just a role of thermal bath. Accordingly, it conserves neither momentum nor energy, even globally. It is demonstrated that (i) by a natural separation of the mean-field self-consistent potential, the potential for the non-ideal gas effect is determined from the equation of state for the van der Waals fluid, with the aid of the balance equation of momentum, (ii) a monotonically decreasing function in time is found from the H theorem and turns out to have a close relation to the Helmholtz free energy in thermodynamics, and (iii) the Cahn–Hilliard type equation is obtained in the continuum limit of the proposed kinetic model. Numerical simulations based on the Cahn–Hilliard type equation are also performed. This is a join work with Takashi Noguchi.