On a way of calculation of the equation of state for a simple fluid near the critical point

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The presently existing equations of state describe the behavior of simple fluids with high accuracy in the wide ranges of both temperature and density. However, their applicability in the vicinity of the critical point is often restricted. In describing the critical region, two kinds of approximation are usually applied. First, the phenomenological parameters are introduced, based on physical reasoning. Second, the approximations of mathematical sort are used which do not allow one to properly take into account non-Gaussian fluctuations of the order parameter. Though the latter are the essential part of the modern, renormalization-group approaches to the investigations of criticality.

We propose a new approach to the description of the critical behavior for simple fluids in the framework of which any phenomenological parameters should not be used. As parameters of the theory, there are only coefficients of interaction potentials that are repulsive at short range and attractive at long range.

The allowance for taking into account non-Gaussian distributions of fluctuations near the critical point is an advantage of a presented approach. This makes it possible to find explicit expression for the pressure and to obtain the dependence of it on temperature and density in ρ^4-approximation. The proposed approach can also be applied to the investigation of the critical behavior of n–component many-body systems.