Critical Neutron and Light Opalescence in Liquids

A.V. Chalyi
Department of Physics
National Medical University
13, Shevchenko Blvd.
252004 Kiev, Ukraine

L.A. Bulavin and K.A. Chalyi
Physics Faculty
Kiev University
6,Glushkov Pr
252022 Kiev, Ukraine

L.M. Chernenko and L.G. Grechko
The Institute of Surface Chemistry
National Academy of Sciences
31 Pr. Nauki
252028 Kiev, Ukraine

Elastic coherent scattering of neutrons has been investigated in a liquid near the critical point with allowance for the gravitational effect and various approximations for the pair correlation function of density fluctuations. Double differential (by a solid angle and height interval) cross sections of neutron scattering are obtained in such a system. The important problem of the experimental study in the critical region, including experiments on the neutron scattering, is to determine the exact (theoretical) critical exponents. There are some factors which give the reason for considerable differences in the results of a real experiment compared with the idealized theoretical models. The problem of relationships between theoretical and experimental (effective) critical exponents is studied.

Finite-size effects on the light critical opalescence are examined. Physical properties in finite-size systems conserve singular behaviour only for the directions in which the system still has infinite size. The verification of these theoretical results needs experimental studies of light scattering at small angles under conditions when the incident and scattered beams propagate almost parallel to boundary surfaces of a plane layer or the cylinder axis. The peculiarities of light critical opalescence are investigated for a single-component liquid with above mentioned geometries. It is shown that the integrated intensity has a finite value even for small scattering angles and at the bulk critical temperature. However, as the new critical temperature for finite-size systems is approached, the correlation of fluctuations along the infinite directions ceases to decay. Thus, the anomalous growth of the correlation length and the integrated light intensity has to be observed in these directions. The specific features of relaxation processes are also studied for liquids in small volumes near the critical point.