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STUDY OF DENSITY DISTRIBUTION IN A NEAR-CRITICAL SIMPLE FLUID (19-IML-1)

Teun Michels
Van der Waals Laboratory
Amsterdam, The Netherlands

This 60 hour experiment uses visual observation, interferometry, and light scattering techniques to observe and analyze the density distribution in SF_6 above and below the critical temperture. Below the critical temperature (T_c = 45.6 °C) the fluid system is split up into two coexisting phases, liquid and vapour. The spatial separation of these phases on earth - liquid below and vapour above - is not an intrinsic property of the fluid system; it is merely an effect of the action of the gravity field. At a fixed temperature the density of each of the coexisting phases is in principle fixed. However, near T_c, where the fluid is strongly compressible, gravity induced hydrostatic forces will result in a gradual decrease in density with increasing height in the sample container. This hydrostatic density profile is even more pronounced in the one-phase fluid at tempertures slightly above T_c.

The gravity-induced density distributions can be visualized and analyzed using an interference technique. This is shown in the three photographic recordings: density profiles are characterized by the horizontal shift of the essentially straight fringes; the density value can be calculated from the distance between these fringes.

It can hence be seen that the gravity induced gradient predominates the intrinsic density distribution of the critical sample. It will be understood that it also largely determines the rate at which, after a change in temperature, the near- critical system evolves towards its equilibrium density distribution.

The proposed experiment is set up to investigate the intrinsic density distributions and equilibration rates of a critical sample in a small container. Within this scope it will also be of interest to analyse in the absence of strong gravitational forces, the influence of the much weaker adhesive surface forces near the container walls as well as of those at the interface between coexisting phases. Interferometer patterns will be used to determine local density and thickness of surface and interface layers. The light scattering data will reveal the size of the density fluctuations on a microscopic scale, which play a fundamental role in the theoretical understanding of critical behaviour. The visual observation system is used to keep track of the sample behaviour, so as to optimize the timeline of the experiment during execution.

In the experiment timeline the sample is first to be homogenized at a temperature well above T_c. Next it will undergo a sequence of temperature steps covering a range of a few degrees around T_c. Since the critical properties of the system depend exponentially on $T-T_c$, the temperature distance to T_c, the stepsizes range from above 1 °C at $T-T_c = 5$ °C to 1 millidegree very close to T_c; waiting times required to study the equilibration rate will, accordingly, vary from 20 min. well away from T_c to as much as six hours within millidegrees from this temperature. In order to observe "memory" effects three runs have to be executed: one cooling down from 3 °C above the critical temperature to about 1 °C below, one heating up over the same range and a third cooling down again.