Establishment of the shadowgraphy-setup for the measurements of non-equilibrium fluctuations

Daniel Zapf, Werner Köhler*

Experimentalphysik IV, Universität Bayreuth, Bayreuth, Germany
*werner.koehler@uni-bayreuth.de

As part of the ESA project "NEUF-DIX" we want to investigate the thermodynamic relaxations of non-equilibrium fluctuations (NEF). For this we planned a completely new shadowgraphy-setup, from the arrangement of the necessary components (like the light source or the Camera) up to the construction of a new fluid cell. We oriented ourselves to the well-known similar constructions from F. Croccolo, in Aglet [1] and A. Valati, in Milan [2]. Form the necessary temperature gradient, which needs to be parallel to the gravitational axes, we constructed the cell completely out of teflon and on a table with a leveling mechanism. The temperature gradient is generated by two peltiers (AMS TB-109-1,4-1,5CH with a 13mm hole) placed horizontally above and below the fluid cell. In addition to an intense and incoherent light source (Superlum SLD), we need a high-resolution, fast camera, to which we chose the Hamamatsu Orca Flash V2 and in the future the Hamamatsu Orca Fusion. The complete setup is seen in Figure 1.

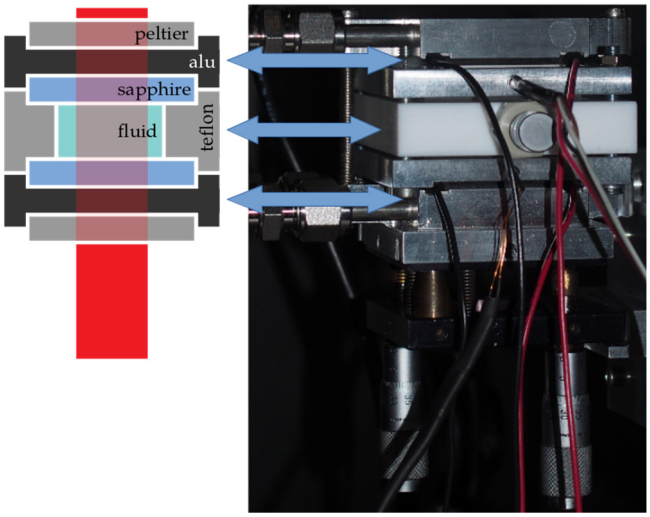

Figure 1: Sketch (left) and real image (right) of the thermally regulated fluid cell.

The considered solutions will be ternary mixtures of toluene, cyclohexane and polystyrene (4700 g/mol). The main interest is in the slowing down processes of the fluctuation-relaxations by high polymer concentrations. Due to the neighborhood to the glass transition temperature T_g, the diffusion D and thermodiffusion D_T are several decades smaller and therefor more available. Experimentally, the external temperature gradient induces an concentration gradient in the opposite direction due to the Soret effect. The fluctuations couple to these gradients and express themselves for small scattering vectors q in a strong q^{-4} dependency.

References

[1] F. Croccolo, H. Bataller, F. Scheffold: *A light scattering study of non equilibrium fluctuations in liquid mixtures to measure the Soret and mass diffusion coefficient*. The Journal of Chemical Physics **137**(23), 234202 (2012).

[2] A. Vailati, M. Giglio: *q Divergence of nonequilibrium fluctuations and its gravity-induced frustration in a temperature stressed liquid mixture*. Physical Review Letters **77**(8), 1484-1487 (1996).