Nematic fluctuations and semi-soft elasticity in liquid crystal elastomers

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In liquid crystal elastomers the nematic director is coupled to the strain of the polymer network. This leads to some interesting properites of the LC elastomers like very large length change with temperature, potentially useful as artificial muscles, and soft elasticity. With light scattering we measured the relaxation rate of the orientational fluctuations which is finite at zero wave vector due to the internal strain frozen in the sample at the time of preparation. We observe a weak, fast signal above the nematic-isotropic transition showing that there is a residual nematic order also in the high temperature phase, in agreement with other experiments showing that due to the internal strain field the system is super-critical. In the geometry of semi-soft elastic response, the director becomes unstable at a critical strain and starts to rotate. This phenomenon is analogous to the well-known Freederickz transition. We show that the director fluctuations are the soft mode of this instability. The data are in good agreement with the theory of semisoft elasticity and allow us to determine all the important parameters of the phenomenological theory of LC elastomers.