Research Highlight:

Memory in an Aging Molecular Glass[1]

Dielectric susceptibility experiments of the molecular liquid sorbitol below its calorimetric glass transition demonstrate the dramatic property of memory in the liquid. During a temporary stop in cooling, the susceptibility changes with time due to aging, and upon reheating the susceptibility retraces these changes. This memory, which is illustrated most clearly by plotting the susceptibility measured during a cooling cycle that includes a stop by that which is measured with no stop (Fig. 1), appears strikingly similar to the memory observed in a variety of disorder systems including spin glasses. We have investigated the out-of-equilibrium state of the liquid as it displays this memory by interrupting the heating stage of this cycle and tracking the subsequent aging. We find that at temperatures above that of the original cooling stop, the liquid enters a state on heating with an effective age that is proportional to the duration of the stop, while at lower temperatures no effective age can be assigned and subtler behavior emerges. These results contrast with properties of memory displayed by spin glasses, and can be understood in the context of the liquid's energy landscape.

[1]H. Yardimci and R. L. Leheny, Europhysics Letters, 2003.

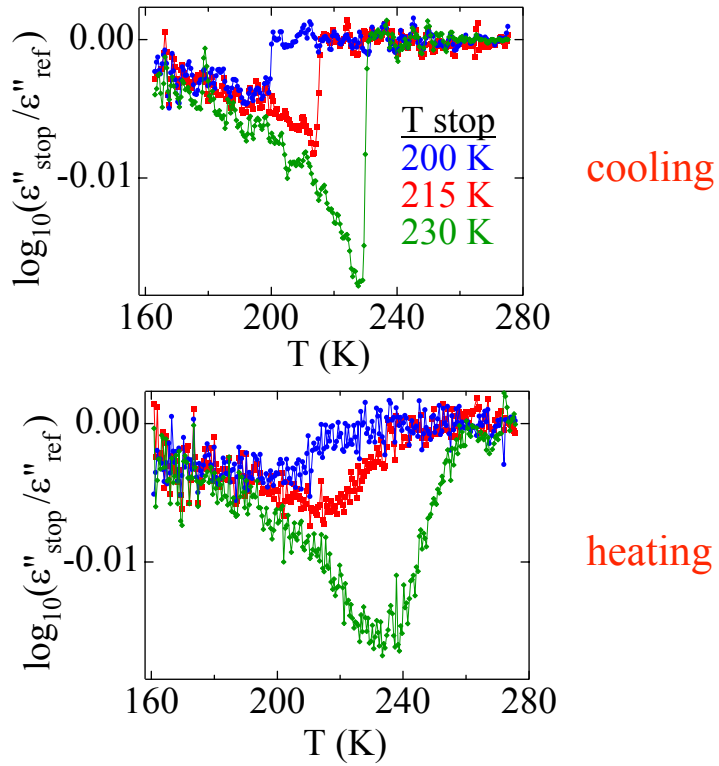

FIG 1: (a) Ratio of the dielectric susceptibility of sorbitol (at 0.79 Hz) measured on cooling below the glass transition with a 12 hour stop to its value measured without a stop. (b) The ratio of the susceptibilities measured on reheating. The ratio on reheating duplicates the shape of that on cooling with a minimum near the temperature of the cooling stop.

Education and Outreach Highlight:

Optical Evidence for a New Phase in Liquid Crystals in Gels

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Calorimetry studies of nematic liquid crystals confined by colloidal silica gels (Fig.2) show two thermodynamic features separated by ~0.2 C at the isotropic to nematic transition (Iannachione et al., PRE **58**, 5966 (1998). Sara Small, high school intern during summer 2003, performed polarization microscopy studies on these materials to characterize the optical properties of the transition. Applying controlled temperature gradients and viewing the samples through crossed polarizers, Sara compared directly the birefringence of the material across the transition (Fig. 3). Between the high temperature isotropic phase with zero transmission and the highly-disordered low temperature nematic phase with modest transmission, she observed a region of strong transmission ~0.2 C wide. A speculative explanation for this optical signature involves a new, intermediate phase with unique nematic correlations that forms in the liquid crystal in the presence of the gel-induced random disorder.

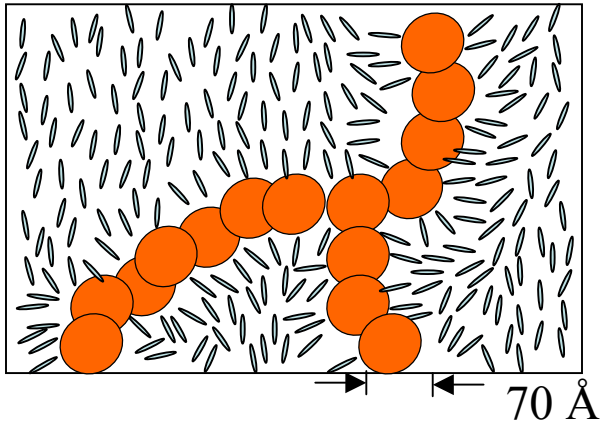

FIG 2: Cartoon of nematic in gel.

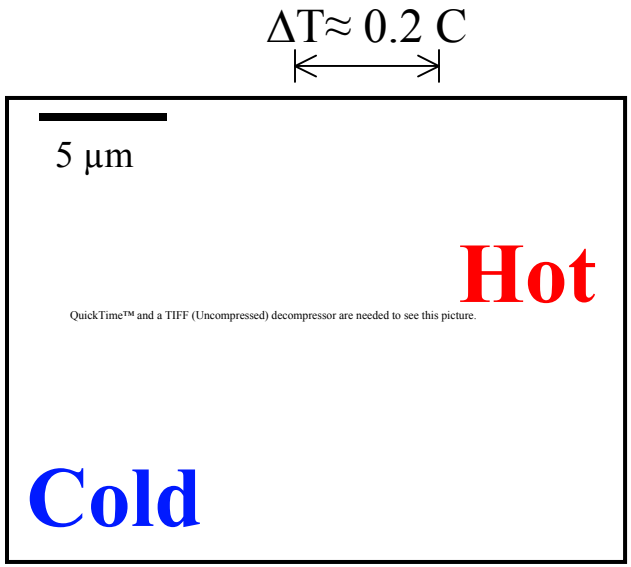

FIG 3: Optical micrograph of nematic in gel.