High Field Magneto-Optical Studies of Liquid Crystals and Complex Fluids

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Introduction

High magnetic fields are a particularly powerful technique for the study of ordered, fluid materials, such as liquid crystals. This technique can give insight into the propensity of these materials to spontaneously break their symmetry. Furthermore, high fields give the experimenter a powerful tool to control the principal axes within inherently anisotropic fluid materials. During 2014, we examined the magneto-optical response of two new classes of liquid crystal materials, the twist-bend nematic phase, and the twist-bend cholesteric phase.

Experimental .

Using the unique capabilities of the split-helix magnet, we measured the magnetic field induced birefringence of these materials in two geometries: Faraday, in which the direction of light propagation is parallel to the field, and Voigt, in which it is perpendicular. For both cases we have devised specialized temperature-controlled magnet inserts and beam recovery optics with appropriate optical access. Additionally, we performed, for the first time, angularly resolved photon-correlation spectroscopy in the split helix, taking advantage of both directions of angular access (horizontal and vertical).

Results and Discussion

Photon correlation spectroscopy results revealed that a high magnetic field stiffens fluctuations in the direction of ordering, this shows up as a decrease in characteristic decay time for the autocorrelation between photon arrival times at the detector. The stiffening is a result of the coupling between the magnetic field and the elastic distortions of the ordering axis in the liquid crystal, and reveals important details, not otherwise obtainable, about the normal modes of this material. Since this is a new category of material, finding the normal modes is a critical step in establishing its basic symmetry properties.

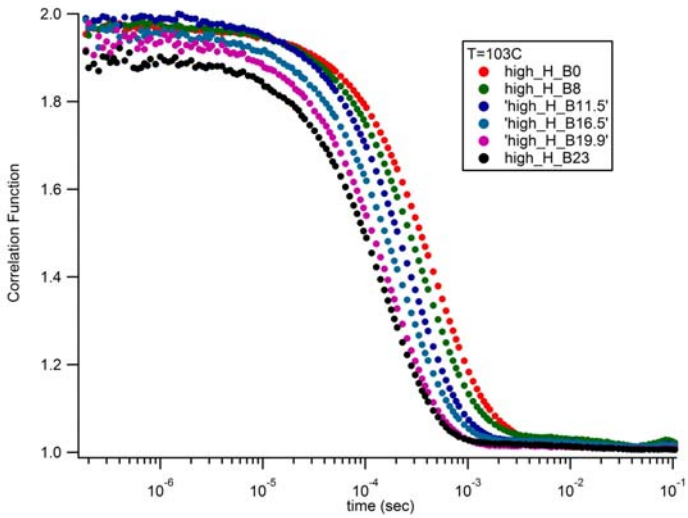

Figure 1 Typical autocorrelation functions at 20 degree scattering angle and a variety of magnetic fields.

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