NANO HIGHLIGHT
Modified Sagnac interferometer for high-sensitivity magneto-optic measurements at cryogenic temperatures

PI: Aharon Kapitulnik
NSF NSEC Grant PHY-0425897

Center for Probing the Nanoscale and
Departments of Applied Physics and Physics, Stanford University, Stanford, CA 94305

A linearly polarized light that interacts with magnetized media can exhibit both ellipticity and a rotation of the polarization state. These effects are generally divided into two primary phenomena, the Faraday Effect, which occurs when electro-magnetic radiation is transmitted through a magnetized medium, and the Magneto-Optic Kerr Effect (MOKE) which describes the state of the light reflected from a magnetized medium. The ability to measure Kerr rotation with high sensitivity at small optical power is especially important in near field MOKE microscope where reflected intensity is very weak, and also in low temperature experiments where cooling power is very limited.

We describe a technique based on Sagnac geometry with a zero-area Sagnac loop for measuring magneto-optic Kerr effect (MOKE) at cryogenic temperatures. The apparatus is capable of measuring absolute polar Kerr rotation at 1550 nm wavelength without any modulation of the magnetic state of the sample, and is intrinsically immune to reciprocal effects such as linear birefringence and thermal fluctuation.

A single strand of Polarization-Maintaining fiber is fed into a liquid helium probe, eliminating the need for optical viewports. With an optical power of only 10mW, we demonstrate static Kerr measurements with a shot-noise limited sensitivity of $1 \times 10^{-7} \text{rad/Hz}^{1/2}$ from room temperature down to 0.7K. Typical bias drift was measured to be $<3 \times 10^{-7} \text{rad/hour}$.