Measurements of nonreciprocal optical effects on magnetic and superconducting materials using a fiber-optic gyroscope (abstract)[a]

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We have modifed a fiber-optic gyroscope based on the Sagnac interferometer to measure nonreciprocal phase shifts. The instrument has a sensitivity of better than 1 μrad and is insensitive to any reciprocal phase shifts. Thin films of high-temperature superconductors (HTSC) have been measured in search for nonreciprocal effects below T_c due to "Anyon superconductivity" ground state. No nonreciprocal phase shift was observed in any of the measured samples.[1] The Faraday effect in various magnetic thin films (e.g., EuO) have been measured using the instrument showing a great sensitivity to submonolayers of the materials.

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[1] S. Spielman, K. Fesler, C. B. Eom, T. H. Geballe, M. M. Fejer, and A. Kapitulnik, Phys. Rev. Lett. (to be published).

New optical magnetic field sensor with optional white light source (abstract)

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A new type of magnetic field sensor which measures ac electric current utilizing Faraday rotation is proposed. On a Faraday element a stabilized dc bias magnetic field H^b is applied. Output signal is given by the ratio $R = I_{2\omega}/I_{\omega}$, where I_{ω} and $I_{2\omega}$ are fundamental and second harmonic signals generated by the field H^x which the ac current induces. Since R is calculated as $R = H^x/4H^b$, we can measure H^x independent not only of light intensity but also of the Verdet constant (and therefore its temperature dependence) of the Faraday element. This was supported by experiments performed at 20–100 °C for HeNe laser ($\lambda = 0.633$ and 1.15 μm) light on Faraday elements of FR-5 paramagnetic glass and Bi-substituted YIG crystal. The bias field H^b was generated by a stabilized dc current in a coil and using a SmGdCo plastic magnet with very weak temperature dependence of remanent magnetization ($< 1\%$ at $T = 20$–120 °C). According to theory the equation holds even when broad spectrum polychromatic light is used. This was confirmed by experiments performed with a halogen-lamp white light transmitted through an optical fiber. Calculated signal-to-noise ratio of the sensor with a polychromatic light agreed with experiments.

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