Verdet Constant of N,N-Diethylaniline

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N,N-Diethylaniline

Introduction

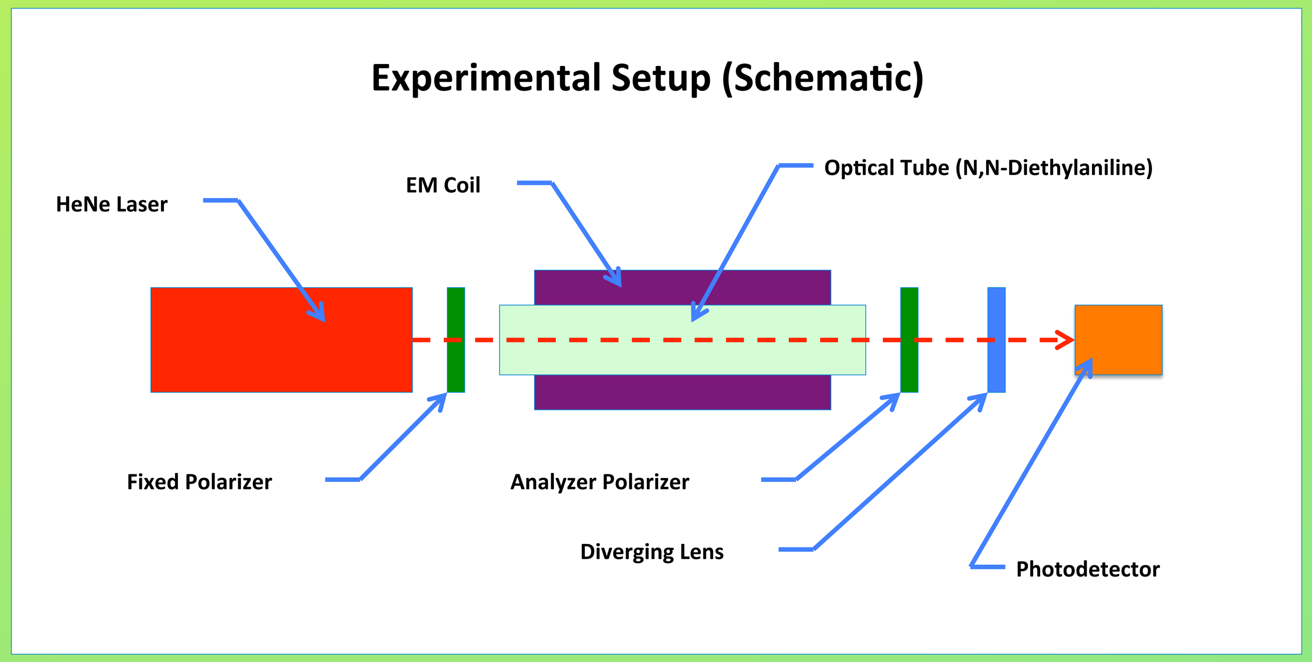
When light enters optical material in the presence of a parallel magnetic field, the light's index of refraction for left and right components of polarization differ. Therefore linear polarization rotates throughout the length of the material. Rotation is measured via minimum beam intensity through crossed polarizers to determine the Verdet constant.

The Verdet constant is an intrinsic property of optical material that is dependent upon temperature and the wavelength of the laser.

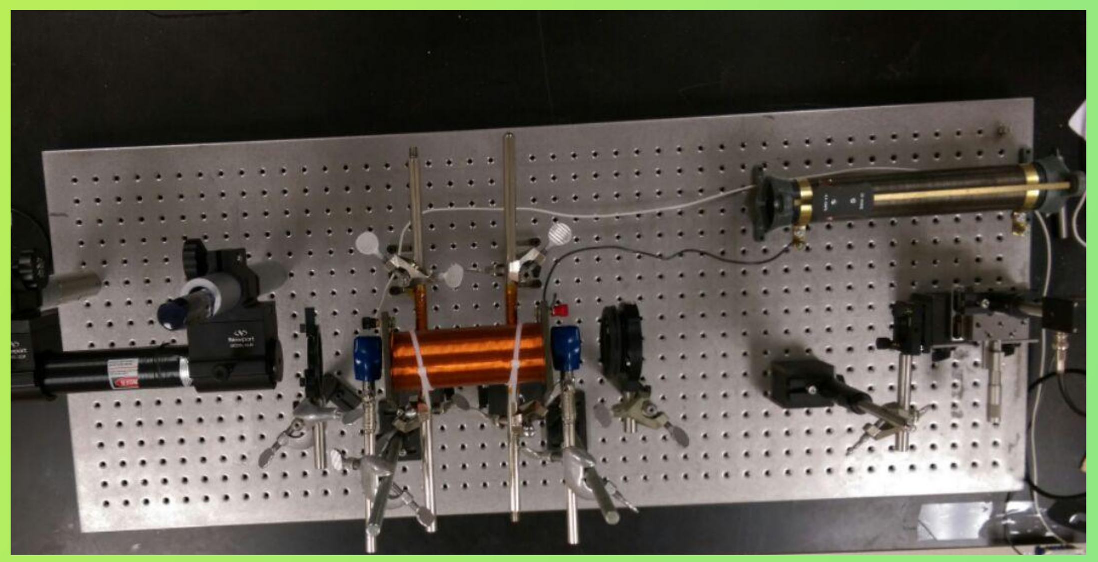
Source: K. Padmaraju; Faraday Rotation; Univ. Rochester, NY; 2008.

Experimental Method

A Helium-Neon laser beam (λ=632.8 nm) is polarized, passed through an optical tube filled with N,N-diethylaniline while subject to a parallel magnetic field (of about 0.264 mT) at room temperature (about 20° C). The magnetic field is created with a 550-turn electro-magnetic coil energized with approximately 5.0 Amperes DC current.



Optical Tube



Experimental Setup (Actual). From left to right: HeNe laser, fixed polarizer, electromagnet coil, analyzer polarizer, diverging lens, and photodetector.

An analyzer polarizer is aligned at the opposite side of the optical tube to find the rotated polarization angle at minimum beam intensity. A photodetector is used to find a relative change in the minimum intensity (crossed analyzer angle) to indicate a rotation in polarization.

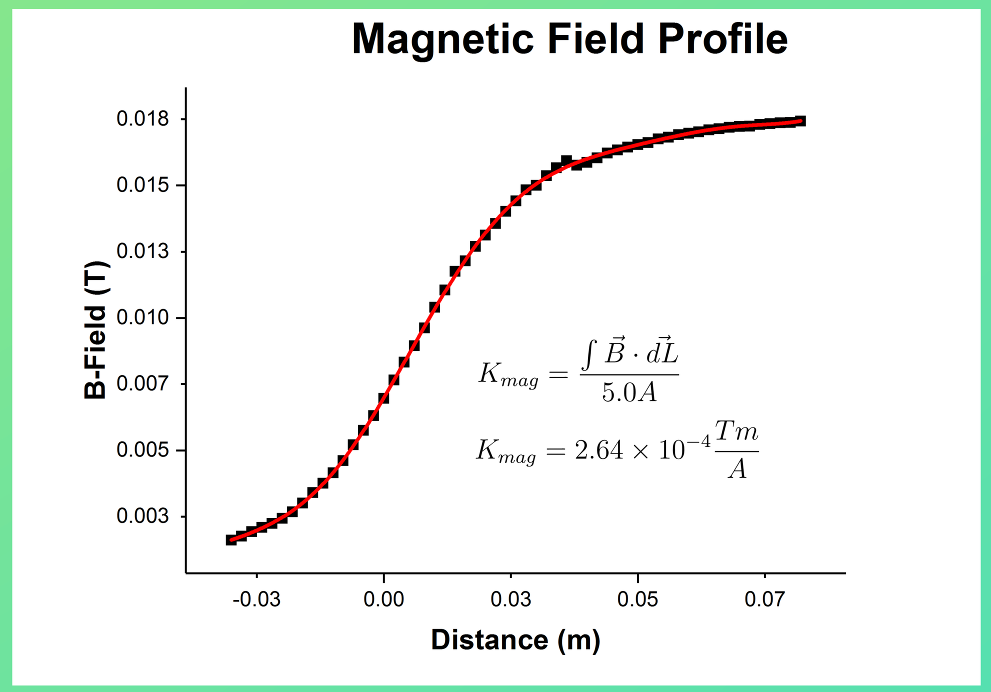
It was discovered that N,N-diethylaniline is sensitive to small increases in temperature caused by electromagnetic coil heating. This resulted in beam drift downward and off the photodetector. The diverging lens was added to disperse the beam in order to lengthen time on detector. Cause of deflection requires further investigation.

Equation

The Verdet constant is calculated with the following equation:

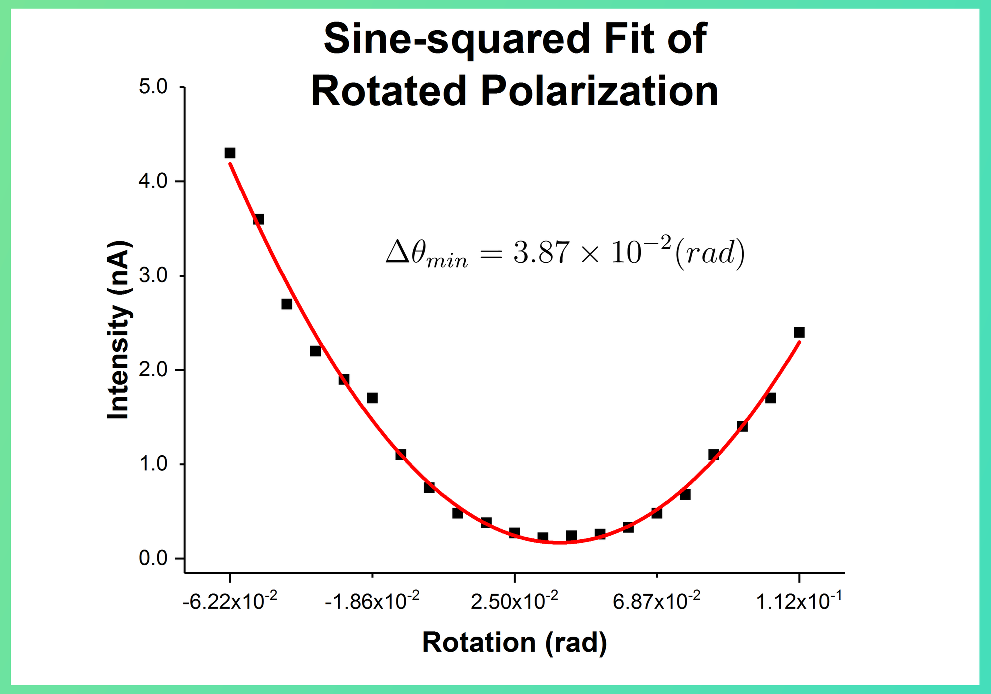
$$\Delta\theta = V \cdot I \cdot K_{mag}$$

Where Δθ is the rotation angle (rad), V is the Verdet constant (rad/(T m)), I is the current (A) that powered the electromagnetic coil, and K_{mag} is the magnetic field profile.



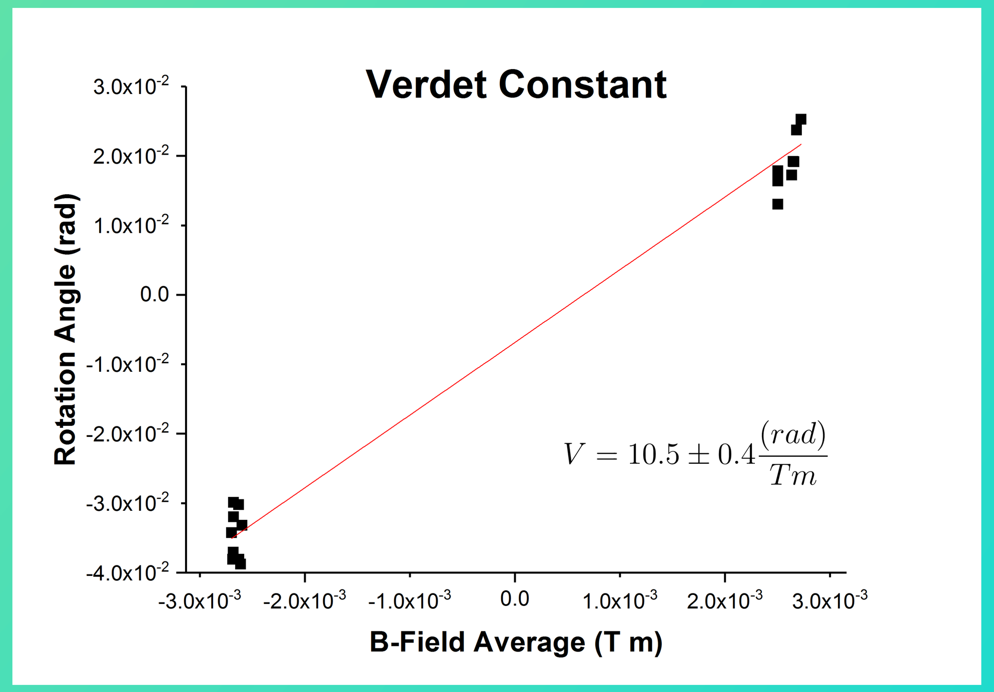
Data and Results

Nine data sets were collected for two states: a negative rotation (coil powered at about -5.0 A), and a positive rotation (coil powered at about +5.0 A). Polarizers operate on the Law of Malus, an equation that is based on a cosine-squared function. Therefore each data set was fit using a sine-squared function with the rotated angle taken at the minimum point.



A linear fit was conducted with the Verdet constant calculated to 10.5 ±0.4 (rad/(T m)) at λ=632.8 nm. This measurement is comparable to the reported value for N,N-diethylaniline: 10.9 (rad/(T m)) at λ=589 nm (presumed sodium lamp) at 15.3° C temperature.

Source: CRC Handbook of Laser Science and Technology, Supplement 2, 1995.



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