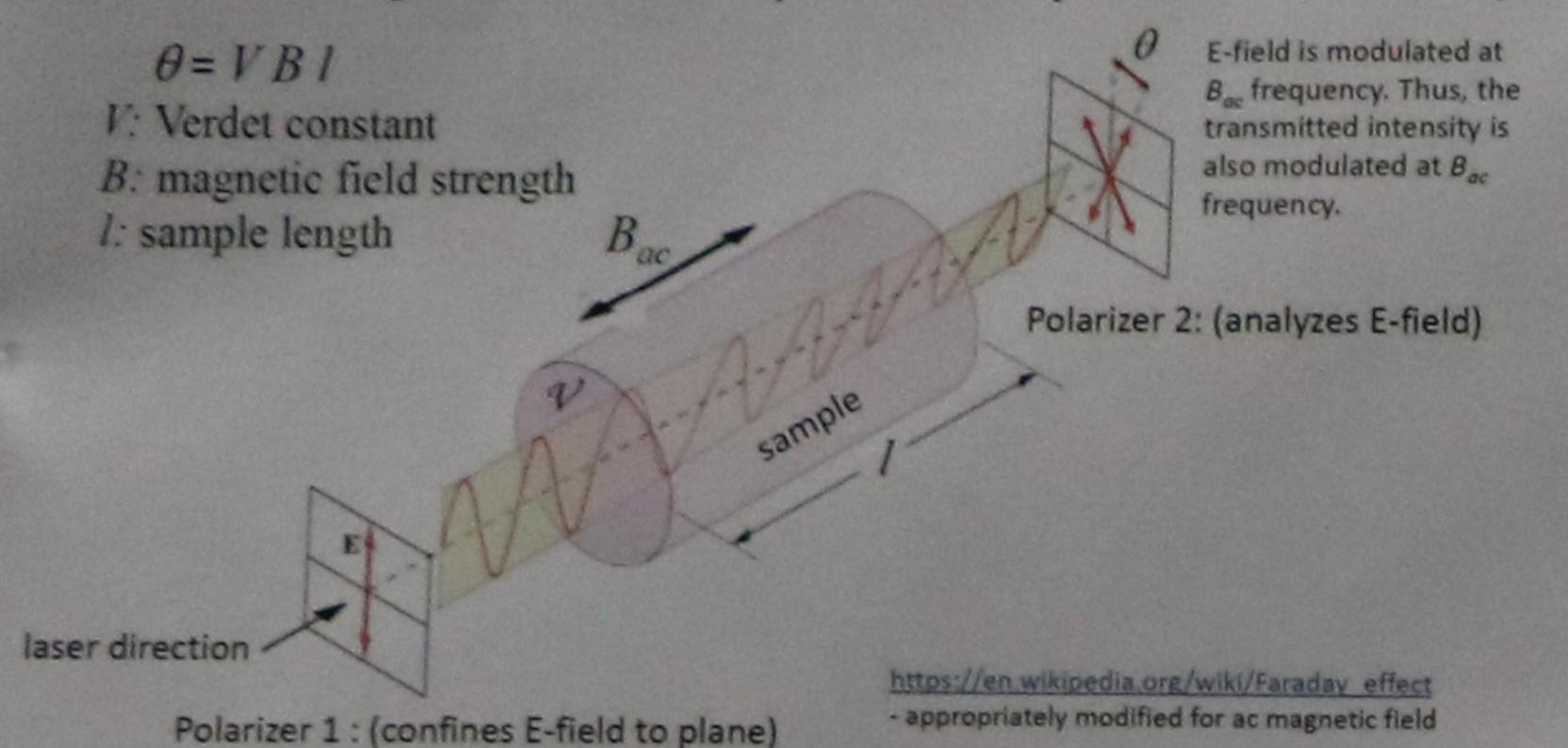
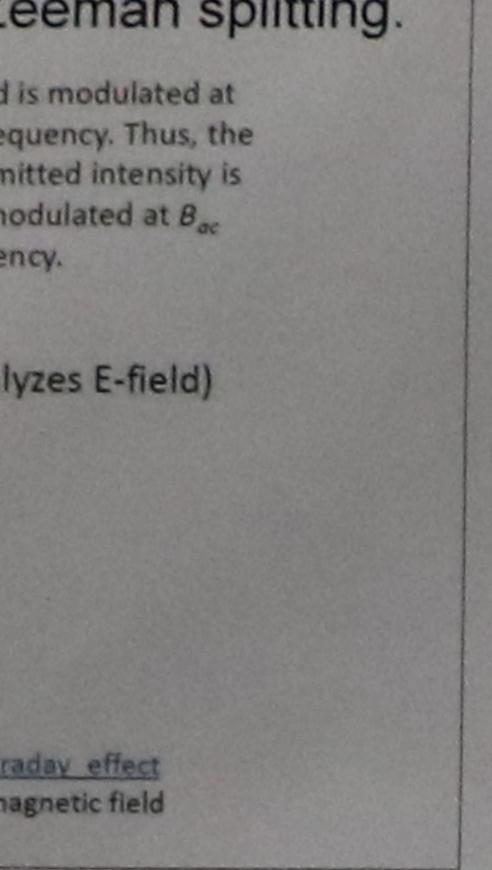
## Introduction to the UNCP Magneto-Optical Facility

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The FARADAY EFFECT, named for physicist Michael Faraday, is a magneto-optical phenomenon characterizing the rotation of the plane of polarization of light - a form of optical activity due to Zeeman splitting.

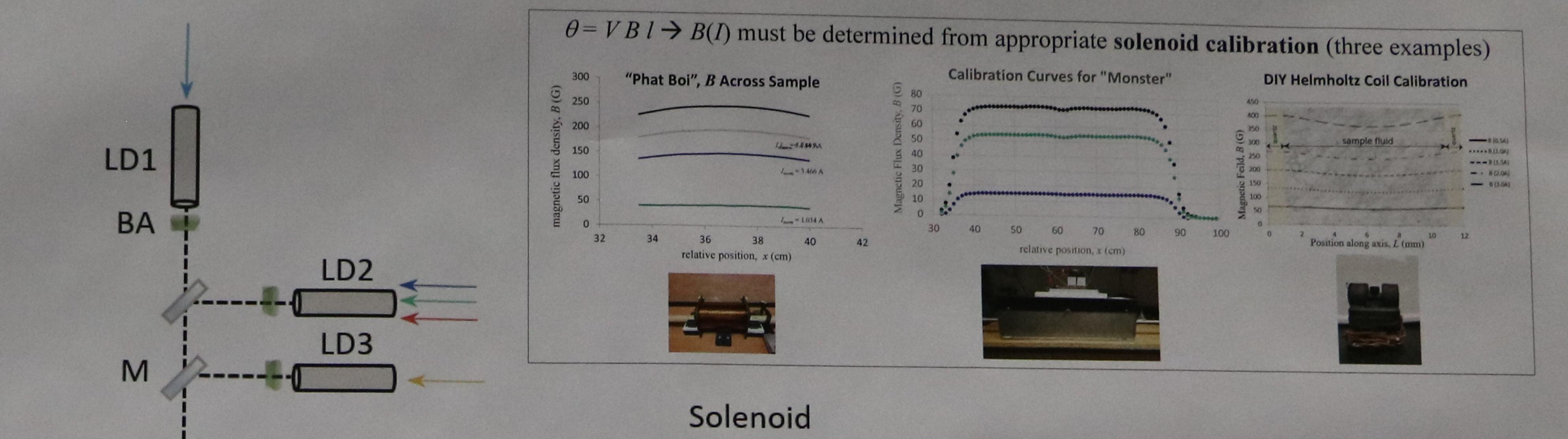




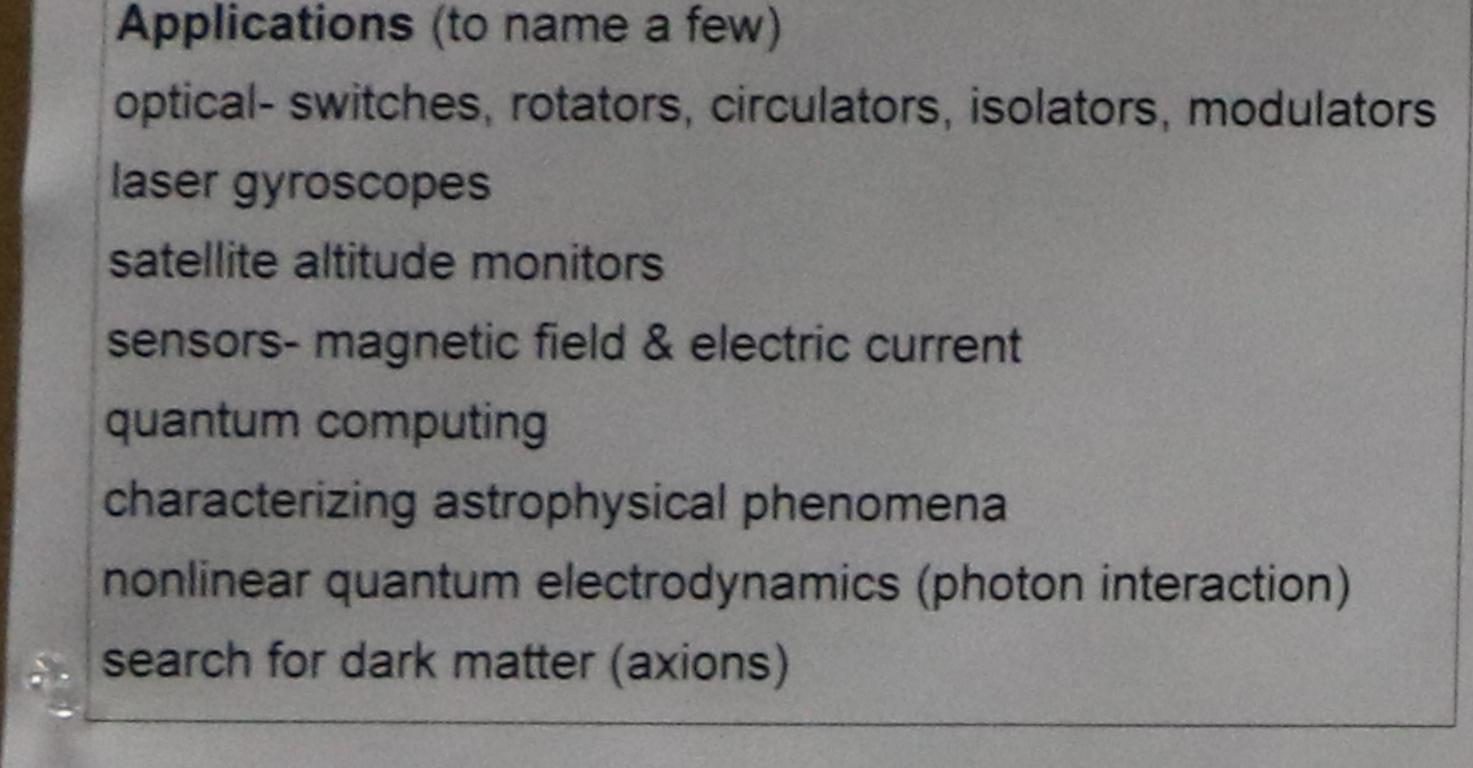
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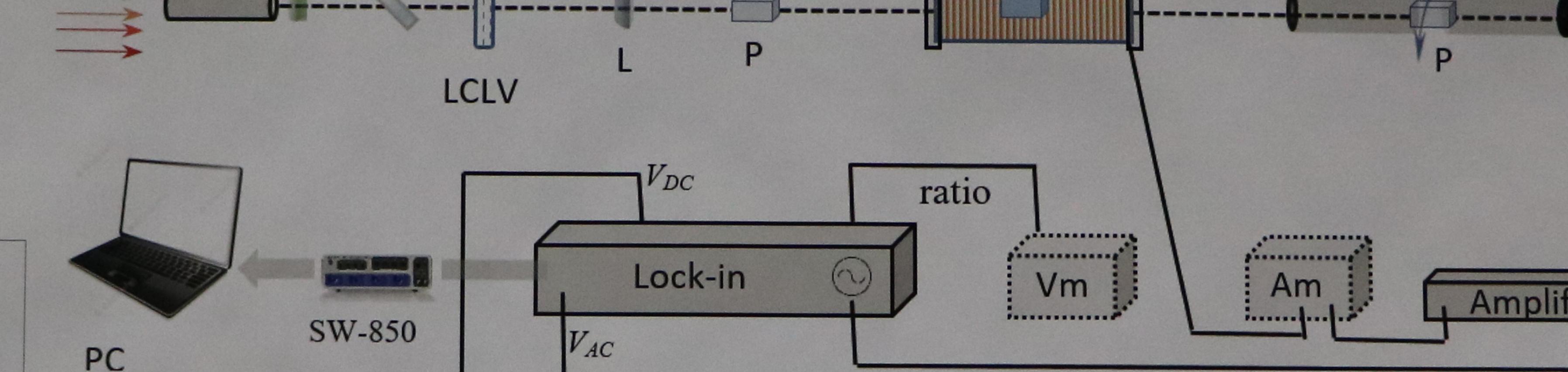
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LD4



with Sample



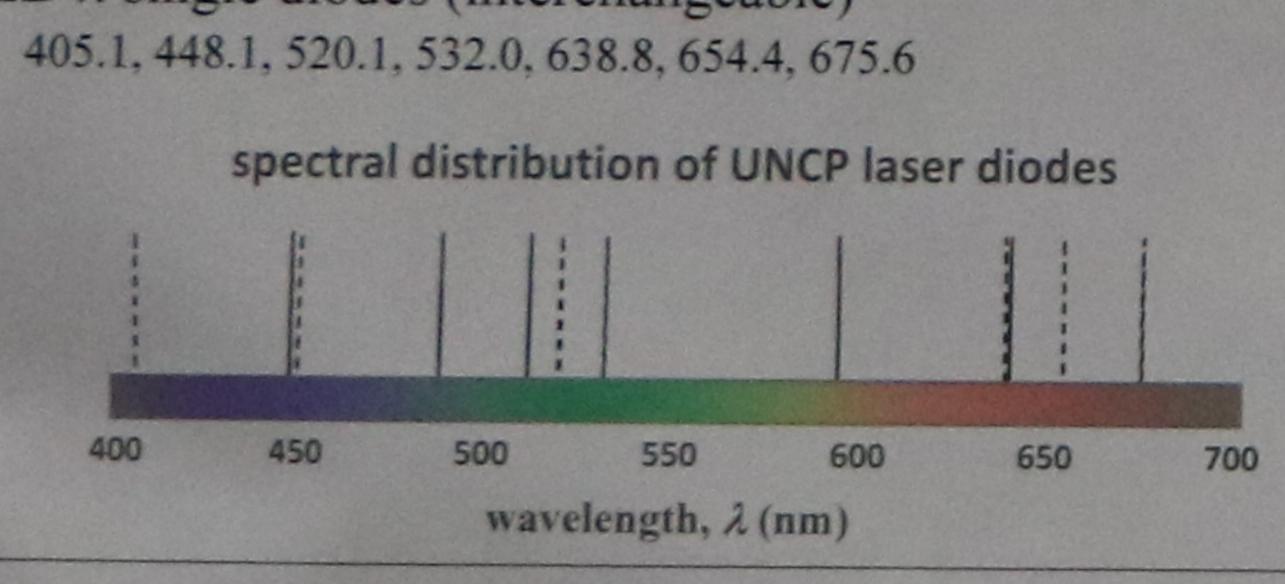


## $\theta = VBI \rightarrow V(\lambda)$ : spectral capabilities

Laser Diodes (LD) – wavelengths shown in nm = 10-9 m LD1: single diode (fixed) LD2: triple diode (switch selectable)

448.0, 511.7, 640.3 LD3: single diode (fixed)

LD4: single diodes (interchangeable)



UNCP-MO Apparatus - Experimental Arrangement (above figure): LD-laser diodes with BA-beam attenuators, M-turning mirrors, LCLVliquid crystal light valve, L-lens, P-crystal polarizer, A&B-aperture and baffle arrangement, PD-photodetector, Am-ammeter, Vm-voltmeter.

signal processing 1: Lock-in amplifier: SRS830-LIA [inputs: Aux- $V_{dc}$  (avg. sig.), R-  $V_{AC}$  (PSD sig.), outputs:  $\bigcirc$ - AC voltage & ref frequency, ratio = R/Aux =  $V_{AC}/V_{dc}$ ,  $\theta$  - phase], - signal outputs for further processing - 2

signal processing 2: SW-850-Science Workshop 850 interface and PC with Capstone software

## $\theta = VBl \rightarrow$ Faraday rotation, $\theta$ measurement using lock-in detection (PSD)

Lock-in amplifiers (LIAs) record an input signal as RMS volts. It can be shown that the rotation, in radians, induced by a modulating magnetic field, follows from the relations 1,2,3

$$\theta = \frac{1}{2} \sin^{-1} \left( \frac{V_{AC}}{V_{DC}} \right) \sim \frac{V_{AC}}{2V_{DC}},$$

which are valid for the small rotations occurring in the UNCP-MO apparatus. The Verdet constant is extracted using measured quantities defined by a measured AC voltage signal,  $V_{AC}$ , a measured DC voltage signal,  $V_{DC}$ ; both of these utilizing a lock-in amplifier. The magnetic flux density B, which is a function of the suppled current, I is obtained from the appropriate solenoid calibration along the sample of interest.

Data Analysis Utilizing Various Theories, via nonlinear curve fitting, characterizes the dispersion of the Verdet constant for samples of interest.

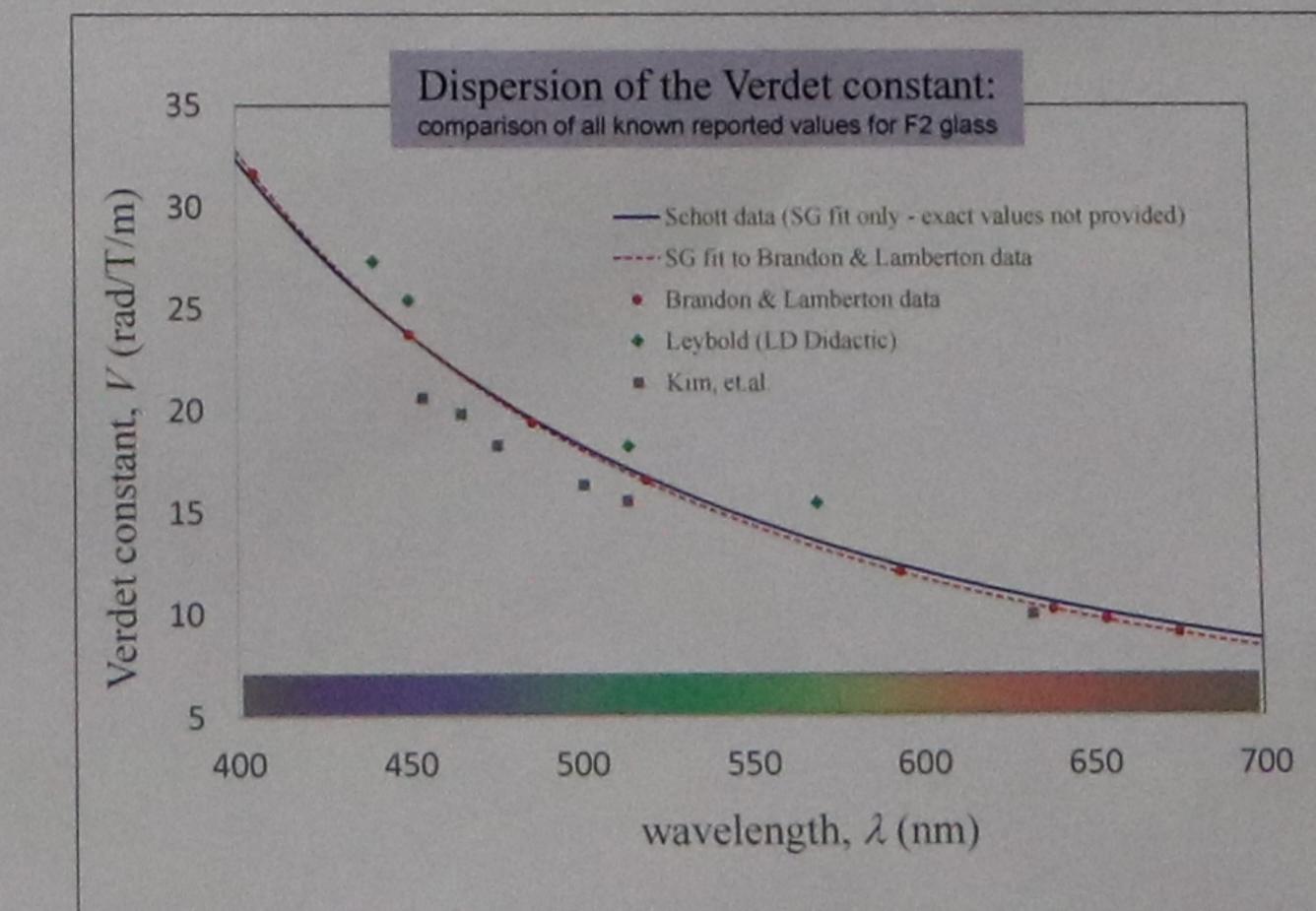
$$SG^{4} \rightarrow V = \frac{\pi}{\lambda} \left( a + \frac{b}{\lambda^{2} - \lambda_{0}^{2}} \right)$$

$$BHL^{5} \rightarrow nV = a \left\{ \frac{1}{b} \left[ (1 - b)^{-\frac{1}{2}} - (1 + b)^{-\frac{1}{2}} \right] - 1 \right\}$$

$$KLN^{6} \rightarrow nV = a \left\{ \frac{1}{b} \left[ (1 - b)^{-\frac{1}{2}} - (1 + b)^{-\frac{1}{2}} \right] - \frac{4}{b^{2}} \left[ 2 - (1 - b)^{\frac{1}{2}} - (1 + b)^{-\frac{1}{2}} \right] \right\}$$

 $SG^4 \rightarrow a,b$  are fitting parameters, and  $\lambda_0$  is the "mean resonance wavelength" obtained from the dispersion of the refractive index of the sample of interest. BHL<sup>5</sup>  $\rightarrow a,b$  are fitting parameters  $(b = \lambda_o/\lambda)$ , n is the refractive index

KLN<sup>6</sup>  $\rightarrow a,b$  are fitting parameters ( $b = \lambda_o/\lambda$ ), n is the refractive index Interestingly, an energy gap can be calculated from the fitting parameter,  $b = \lambda_o / \lambda$  using the BHL and KLN theories according to  $E_o = hc/\lambda_o$  (units: eV)



A & B

Initial Testing (Figure to the left).

Verdet constant of F2 glass reported by four different sources. Our data (red circles), shown with SG fit (red line), is in excellent agreement with the Schott Glaswerke4 group (blue line). The exact values for the Verdet constant were not reported by that group - only the fitting parameters were provided, from which the blue curve was generated. It appears that the Verdet constants reported by Leybold7 are too high, whereas those reported by Kim, et.al.8 are, for the most part, too low.

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Amplifier

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