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Development of Low-Cost Scanning Fabry-Perot Interferometers to Characterize High-resolution Laser Systems

Scanning Fabry-Perot Interferometers (SFPI's) are a very useful tool for characterizing high-resolution laser systems. SFPI's use optical interference effects to probe the frequency spectrum of the laser light, requiring special components that are specific to the wavelength (color) of the laser. Consequently, it is necessary to have multiple SFPI's to characterize the wide variety of lasers used in an optical spectroscopy research lab; this can be prohibitively expensive if one uses standard commercially available SFPI's. With this motivation, we investigated a low-cost modular design using standard optical components to span the entire visible and near-infrared spectrum. An initial SFPI was built and tested for use with a new tunable external cavity diode laser system operating at a wavelength of 690 nm for the study of Cr^{3+} ions in ruby and alexandrite optical crystals. Our new SFPI enabled the diode laser system to be evaluated and optimized by observing the effects of the laser cavity alignment and tuning on the laser's frequency spectrum revealed by the SFPI. The performance and properties of our prototype SFPI have led to optimization of the design and construction. The finesse (spectral resolution) and frequency stability of the SFPI compares favorably to the performance of more expensive commercial interferometers. Additionally, the effects of environmental acoustic noise on the SFPI were studied, demonstrating that the cavity design is robust and stable. Guided by our results on this system, we are currently constructing several additional SFPI's at wavelengths of 405 nm and 980 nm for use with other new laser systems in the laboratory.