Exploring Samarium Spectrum with Dual-Comb Absorption and Faraday Rotation Spectroscopy

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The invention of the frequency comb has revolutionized metrology [1], becoming a cornerstone technology in diverse fields such as astronomy [2], optical communications [3], and beyond. Additionally, it has found significant application in spectroscopy, serving as both a precise reference and a powerful tool for sample interrogation [4]. One of the most advanced techniques leveraging this technology is Dual-Comb Spectroscopy (DCS), which enables high-resolution spectral analysis across a wide range of frequencies with unmatched accuracy and speed [5]. DCS is particularly well-suited for filling gaps in atomic data, which play a crucial role in various branches of physics, especially in efforts to explore phenomena beyond the Standard Model. Such data provide fundamental insights into atomic interactions and are essential for designing experiments that probe new, uncharted scientific domains.

Our project focuses on developing and applying the DCS technique for broadband spectroscopy of rare-earth Elements in a strong magnetic field. We will present the current progress in developing our DCS system and compare different approaches for investigating atomic spectra, including direct absorption spectroscopy and Faraday rotation spectroscopy using crossed polarizers. We have developed and integrated a technique based on an Avalanche Photodiode (APD) array, which enables broadband, light-noise-limited measurements. In addition, we have implemented a data acquisition system that we used in our previous work [6] capable of performing gapless averaging of power spectral density spectra with a 125 MHz bandwidth and better than 1 Hz resolution.

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