Calibration of the Wavelength Scale of a Czerny-Turner Monochromator

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1 Abstract

The wavelength scale of a Czerny-Turner monochrometer was calibrated by comparing the nominal wavelengths of mercury to the transmitted wavelengths of a mercury-argon gas mixture. The linear relationship found was $\lambda_c = 0.9968\lambda - 2.841$, where λ_c is the corrected wavelength and λ is the wavelength setting on the monochromator.

2 Calibration

An experiment was conducted on a HeNe laser to observe the emission spectrum of neon gas. The experiment involved reflecting the image of the HeNe gas discharge tube into a monochromator. A monochromator is an instrument that isolates a narrow wavelength interval of a spectrum. The wavelength setting is selected with a mechanical knob, which turns a grating. There is a linear relationship (a calibration factor and offset) between the setting and the actual wavelengths being transmitted. Thus, it was important to calibrate the instrument so that the detected wavelengths could be corrected for analysis.

The monochromator was calibrated using a mercury-argon gas mixture for which the nominal wavelengths were known. The output of the monochromator was connected to a photomultiplier, from which a voltage reading was obtained. The wavelength selector knob was turned by hand from 300 to 600 nm and the wavelength readings corresponding to peak intensities were recorded. The transmitted wavelengths were then compared to the nominal wavelengths and the following linear relationship was found:

$$\lambda_c = 0.9968\lambda - 2.841, \tag{1}$$

where λ_c is the corrected wavelength and λ is the wavelength setting on the monochromator.

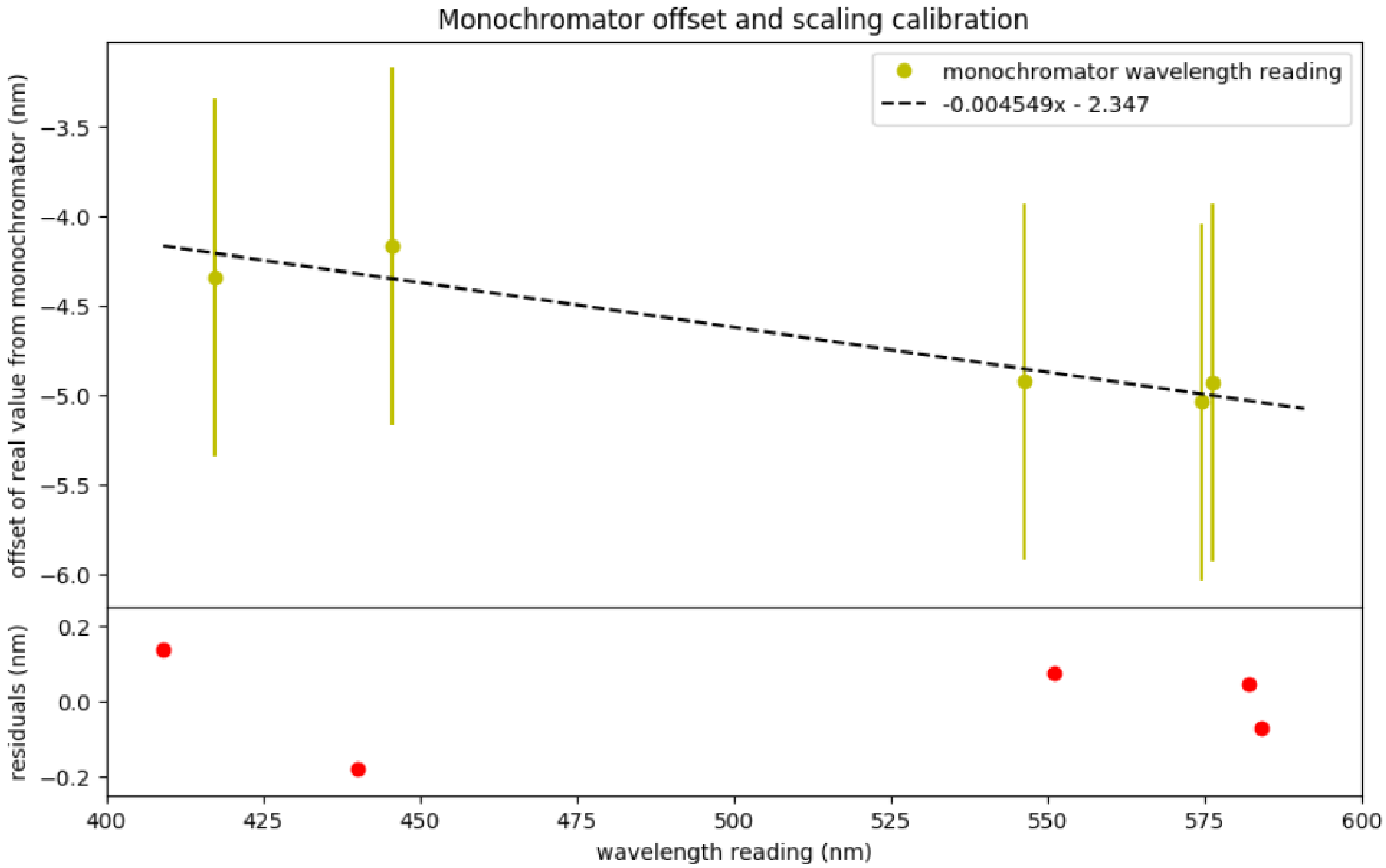

Figure 1: This graph shows the error correction that should be used for our monochromator. It was generated by measuring 5 spectral lines of a mercury-argon lamp using the monochromator, a photomultiplier, and a multimeter. The measured lines were then compared to the well known expected values. The error bars on the monochromator readings are so large since the measurements are in near-discrete increments of 1nm. The residuals in the bottom section show the difference between the correction function and the individual corrections for each emission line. In the dotted line equation, x is the measured value, and the result should be added to the measured value in order to get the real value. Our correction is always negative, so our monochromator gives readings that are too large.