# Calibration of the wavelength scale of a Jarell Ash monochrometer using a Hg Geisler tube.


The wavelength scale of a new drive mechanism fitted to a Jarell Ash Monochrometer was calibrated by comparing known Hg wavelengths of seven optical lines to the readings of intensity peaks found by hand. The resulting calibration os that $\lambda = 1.0043(31)X - 56.77(31)$ nm where $X$ is the micrometer reading and the numbers within parentheses are $1\sigma$ uncertainties in the trailing digits..


In an experiment to study population inversion in the gas of a HeNe laser, side light from the laser discharge tube is focussed onto the input slit of a small monochrometer. In this monochrometer, a knob turns a threaded shaft which in turn pushes on a mechanism which rotates a grating at the core of the instrument. This shaft includes a custom counter which displays a number roughly corresponding to the wavelength of light allowed through the monochrometer at each particular shaft position. Several of these custom shafts have broken after perhaps 50 years of use, and we have replaced them with a simpler system in which a stock micrometer head is mounted on the outside wall of the optical cavity. The correspondence between micrometer readings and transmitted wavelengths in the repaired systems must be determined for the instrument to be useful.

To calibrate readings with the repaired monochrometers, a Geissler tube filled with Hg gas is focussed on the input slit of the monochrometer with an ordinary camera lens and the output is coupled to a photomultiplier tube. The monochrometer is scanned slowly by hand and the micrometer readings at the locations of peak intensity of seven bright Mercury emission lines between 350 and 700 nm is recorded. Scanning up and down in wavelength is was found that the repeatability of line locations is approximately 0.2 divisions. Each division corresponds to a shaft motion of 0.001". These data are plotted in Fig 1. At first glance, a linear relation between shaft position and transmitted wavelength seems supported by the data.

The best fit linear relation between micrometer reading and wavelength is shown in Fig. 1 and so are residuals from the fit. The *rms* deviation of measurements from the fit is 0.7 nm, well above the per-reading scatter. Half of this scatter comes from a single measurement at $\lambda = 405$ nm. The shape of the residuals does not support exploring higher order fits. When the fit is expressed as wavelength in terms of micrometer reading,

$$\lambda = 1.0042(\pm.0031)\ X_m - 56.77(\pm 0.31)\ \ \text{nm}, \tag{1}$$

the slope and offset constitute calibration coefficients for the instrument. Because the best fit slope is so close to 1, It is tempting to believe that the original engineers always envisioned using imperial measurements to infer metric wavelengths. The slope is stable, but the offset in the best fit depends on the details of placement of the lens and Geissler tube.

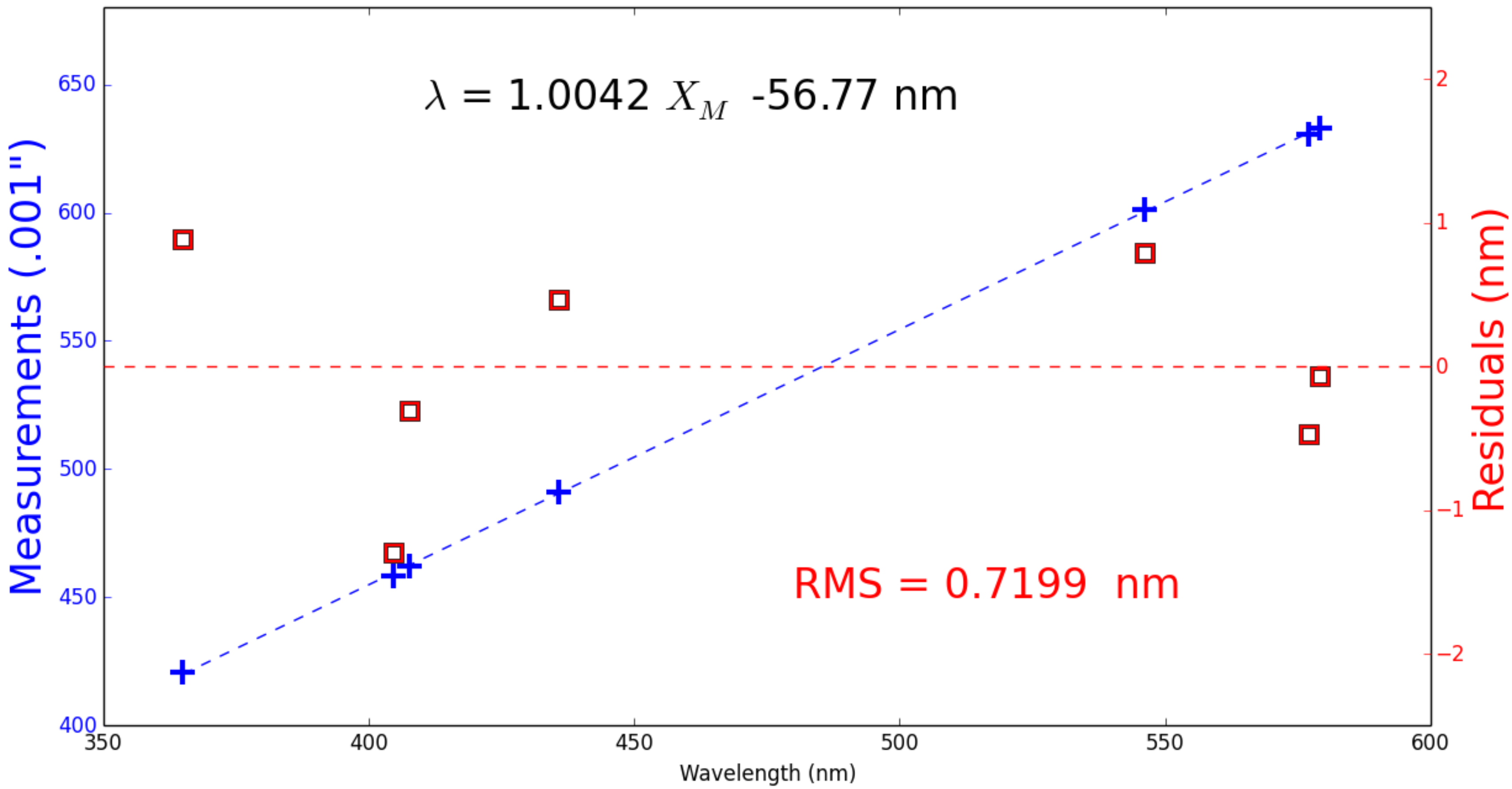


Figure 1: The micrometer reading associated with peak intensity found by hand is plotted for each of seven bright lines observed when an Hg Geissler tube is imaged on the entrance slit of an Jarell Ash monochrometer. The best linear fit of setting to known wavelength is shown as a blue dashed line, and constitutes the calibration of the instrument. Differences between measurements and the fit are shown in red (scale at right). The *rms* scatter of these points is 0.7 nm, which is larger than the scatter of making repeated measurements. These data do not appear to warrant higher order than linear fits.