Draft version September 29, 2016
Preprint typeset using LaTeX style AASTeX6 v. 1.0

LAB 04: SPECTROSCOPY

Bryan Yamashiro[1] and Terry Salaga[2]
University of Hawaii at Manoa
2500 Campus Road
Honolulu, HI 96822

1. INTRODUCTION

- CCD
- Spectral lines
- Emission lines
- Intensity
- Flux, continuum
- Halogen gas absorption lines
- Bias, dark, flat
- Calibration, sensitivity, doppler

1.1. *Equations*

Atomic emission lines

$$E_n = \frac{-2\pi^2 m e^4 Z^2}{n^2 h^2} \tag{1}$$

Hydrogen emission lines

$$E_\gamma = 13.6eV\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \tag{2}$$

Planck Function

$$B_\lambda(\lambda, T) = \frac{2hc^2}{\lambda^5}\left(e^{\frac{hc}{\lambda k_B T}} - 1\right)^{-1} \tag{3}$$

Rayleigh-Jeans law

$$B_\lambda(\lambda, T) = \frac{2ck_B T}{\lambda^4} \tag{4}$$

Wien's approximation

$$B_\lambda(\lambda, T) = \frac{2hc^2}{\lambda^5} e^{-\frac{hc}{\lambda k_B T}} \tag{5}$$

Peak wavelength

$$\lambda_{peak} = \frac{\sum \lambda \times flux}{\sum flux} \tag{6}$$

Uncertainty of the peak

$$\sigma^2_{\lambda_{peak}} = \frac{\sum(\lambda - \lambda_{peak})^2 \times flux}{\sum flux} \tag{7}$$

2. OBSERVATIONS

- Tools -Ocean optics spectrometer, collects in 0.01 second to 4 second time intervals for this study. Shows wavelength versus counts in ascii format.
- Raw data, Background and Darks -Require the sampling time interval. Wavelength versus counts.
- Object X (bkgd, dark, raw), halogen lamps (known spectra), hotdog (100 V and 140 V), known lamp (raw and known spectra) -Contains the samples and their respective known sample. The known samples will lead to a sensitivity factor that will be added to the object X fixed data. Sensitivity calibration will be first done on the "hotdog" lamp to determine if the method is sufficient.
- Fixed data = Raw data - (background - dark) - dark -Darks: Instrument noise, Background-Darks: Ambient noise, Fixed data: Raw with ambient and instrument noise removed.
- Uncertainties from each step -Subtraction of each data set including possible Poisson errors for counts. Uncertainty for peak measurements will be derived using the "uncertainty of the peak" equation mentioned in the introduction.

3. RESULT

Characterize the emission lines and find the continuum peak of the observations using above equations.

3.1. *Preliminary Plots*

- See below.

4. DISCUSSION

The sensitivity measurements need to be redone for the respective time intervals, 1 s and 4 s. Although not needed, measurements for the "hotdog" lamp could be redone to include corrected time intervals.

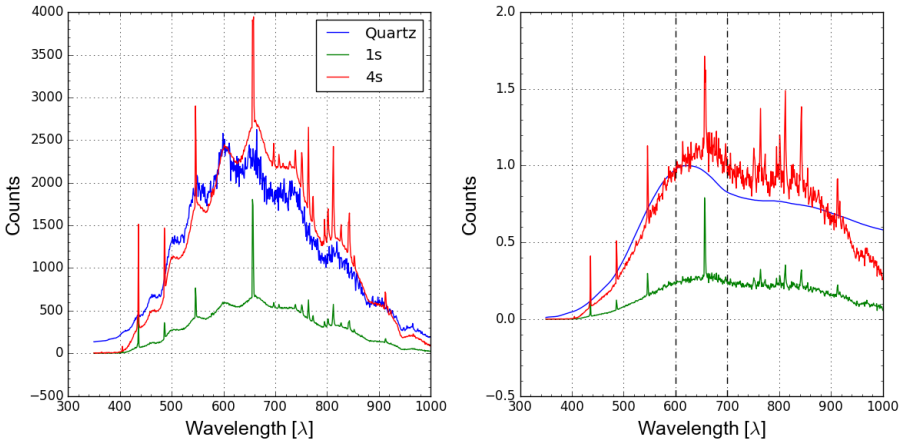

Figure 1. Data from the object X lamps along with the quartz known. Red and green lines are 4 seconds and 1 second time integration, respectively. Dashed lines are drawn between the 600 nm and 700 nm wavelengths.

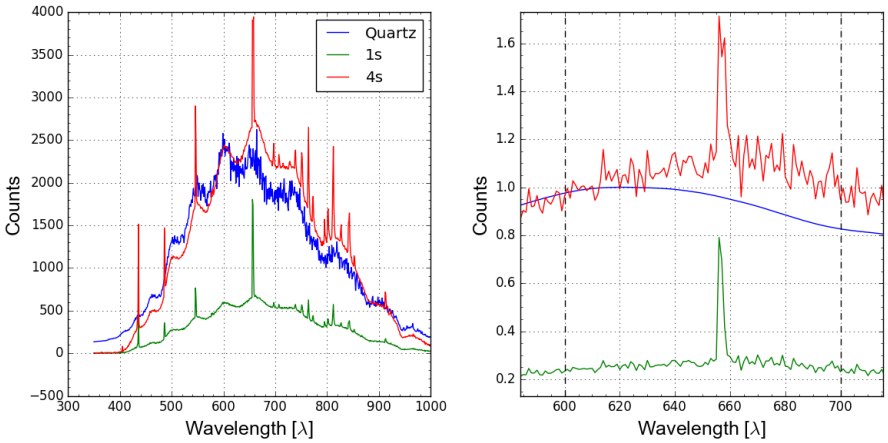

Figure 2. Zoomed of above plot to show the emission line that lies within the wavelength range, optimize this plot.

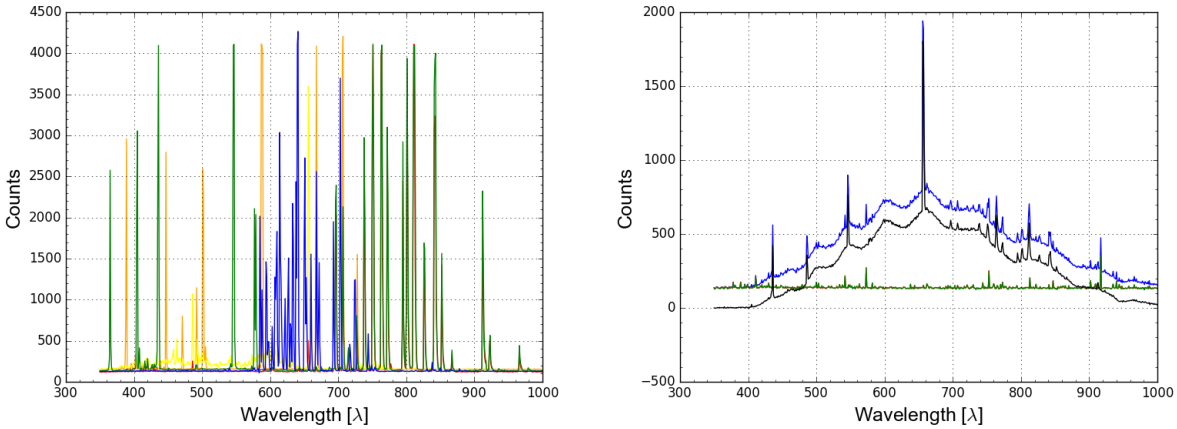

Figure 3. Different spectra (left) for 5 gas lamps. Argon (red), helium (orange), hydrogen (yellow), mercury (green), neon (blue). Also included is the 1 second data for the object X (right). Fixed data (black), raw data (blue), background and dark (red).