Astronomical Spectroscopy

Ayushi Singh, Anita Bahmanyar, Carly Berard

ayushi.singh@mail.utoronto.ca

Astronomy and Physics, University of Toronto, ON

4 November, 2013

Abstract

??????

1 Introduction

???????

2 Equipment

???????

3 Data Summary

The data collected from PMT using PMT Python Module was represented in python array of counts per sample and saved in a file. These files were then later used to manipulate the data. Multiple data was collected with different time interval and number of samples using the method explained in Section 2. For each combination number of samples and time interval, 6 or 10 data set was collected.

Table 1: Data from the CCD in the lab

Data Number	Source	Integration Time (ms)	Number of Samples	Comments
1	Neon	100	1000	pick this
2	Neon	100	6	or this
2	Table Lamp	50	10	
2	Table Lamp	100	1000	
2	Table Lamp	200	10	
2	Table Lamp	1000	10	
3	Mercury Light	100	6	
4	Sun	100	6	
5	Dark	50	10	
5	Dark	100	10	
5	Dark	200	10	
5	Dark	1000	10	

For all the data took from telescope, corresponding dark count data is was also collected. This was then used to reduce noise from the Data.

Table 2: Data from the campus Telescope

Data Number	Source	Integration Time (ms)	Comments
1	Vega		
2	Vega		
3	Vega		
4	Enif		
5	Enif		
6	Albero1		one star from the binary system
7	Albero2		second star from the binary system
8	Halogen		used to correct for flatfield
9	Neon		give us pixel to wavelength relationship

4 Data Reduction and Method

5 Calculation and Modeling

5.1 Noise and Gain in CCD data

Taking the mean and variance of each pixel in all all of the data using equations

$$\bar{x} = \frac{\sum x_i}{N}, \tag{1}$$

where $\bar{x}$ is the mean and N is number of samples. This is the average value of the data x [?].

$$s_{ADU}^2 = \frac{\sum x_i - \bar{x}}{N - 1}, \tag{2}$$

where s_{ADU}^2 is the variance. This value represents the standard deviation (uncertainty in the measurement) squared for that data set [?].

5.2 Pixel calibration in Telescope Data

Flatfield...P_i is the calibrated intensity for each pixel using following equations [?]

$$s_{ADU}^2 = s_0^2 + k\bar{x}_{ADU}, \tag{3}$$

s_0^2 values give us the read noice and k is $\frac{1}{gain}$.

$$P_i = \frac{R_i - D_{Ri}}{L_i - D_{Li}} B(\nu_i, T), \tag{4}$$

where R_i is the raw signal, L_i is the Lamp, D_{Ri} and D_{Li} is the dark count for raw signal and halogen lamp, respectivaly. $B_\nu(T)$ is the Planck fucntion.

$$B(\nu, T) = \frac{2h\nu^3}{c^2} \frac{1}{exp(h\nu/kT) - 1}, \tag{5}$$

where $\nu_i = c/\lambda_i$, λ_i being the corresponding wavelength for each pixel. The value for T for halogen lamp is approxmitaly 3200 K.

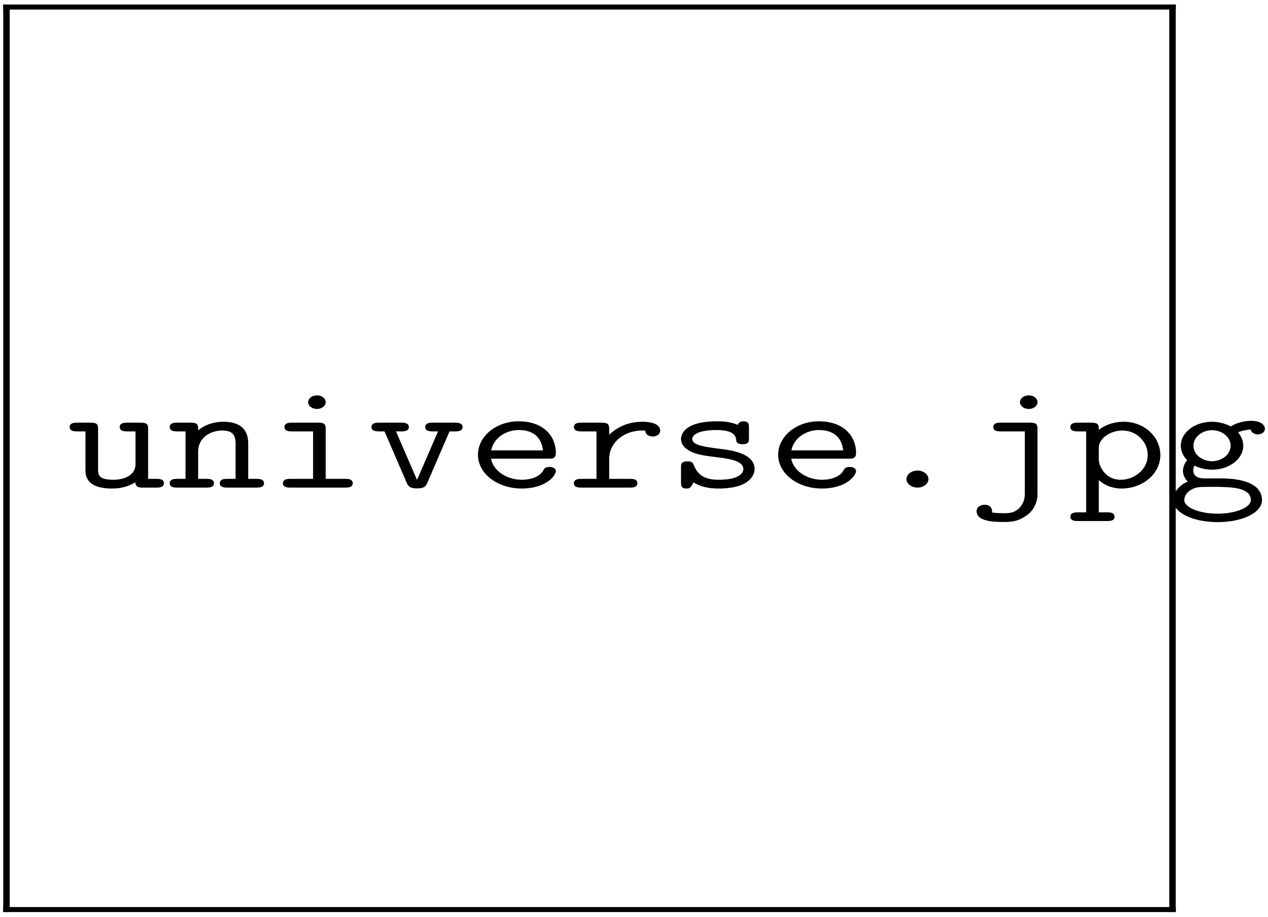

Figure 1: Time vs. count per sample graph for data number 1 from Table 2. There are six sets of data, where time interval of each sample is 0.001s for 100 samples.

6 Discussion

6.1 CCD

6.2 Telescope

7 Conclusion

??????