

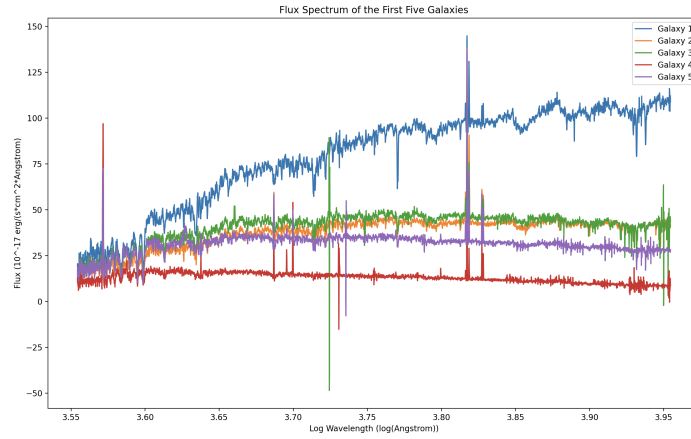
PHYS-UA 210 Computational Physics

Problem Set 06

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November 3, 2023

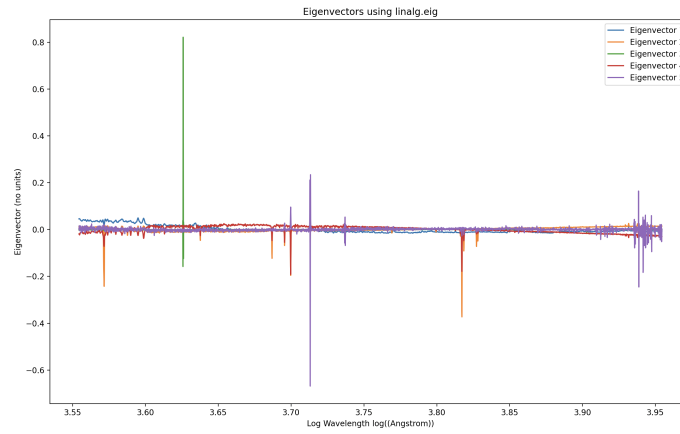
Plotting the First Five Galaxies Spectrum



Particular features: There is a notable spike at 3.82 which corresponds to 6606 Angstroms which is very close to the red line emission in Hydrogen which is about 6500 Angstroms.

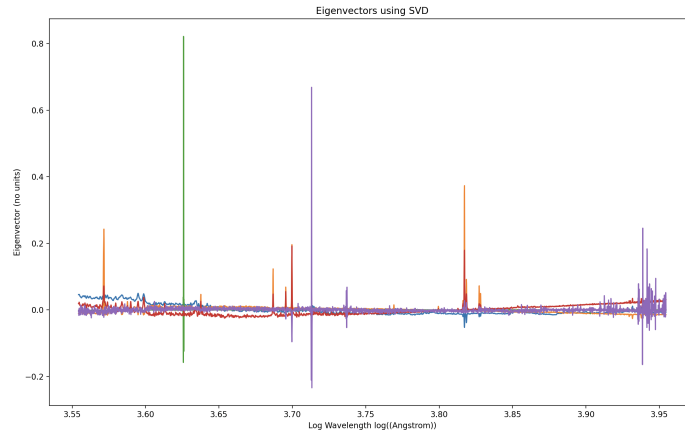
Finding Eigenvectors using Covariance Matrix

Plotting first five eigenvectors using Covariance Matrix:



Finding Eigenvectors using SVD

Plotting first five eigenvectors using SVD:



Comparing the Methods to Find Eigenvectors

The eigenvectors given by two methods are same in magnitude however some (not all) eigenvectors differ in sign only. This is because SVD is unique up to a change in sign in pairs of left and right singular vectors.

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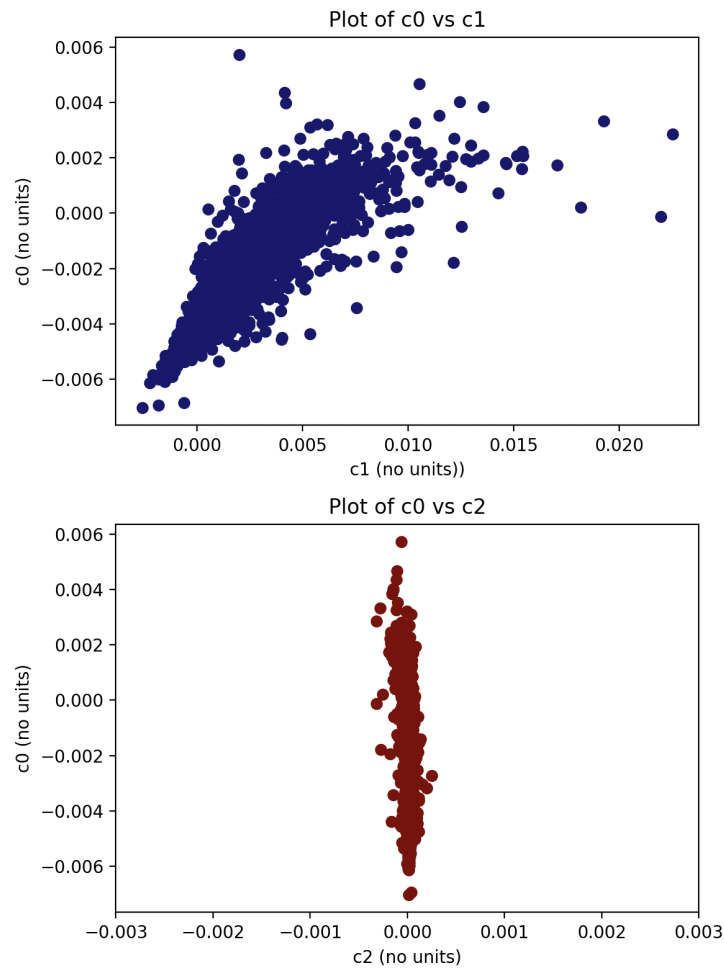
Comparing runtimes of each method:
Runtime for calculating the eigenvectors using linalg.eig: 60.34300574986264
Runtime for calculating the eigenvectors using SVD: 92.32261825003661

Comparing condition numbers of each method:
Condition number of R = 6561841.5
Condition number of C = 17410599000.0

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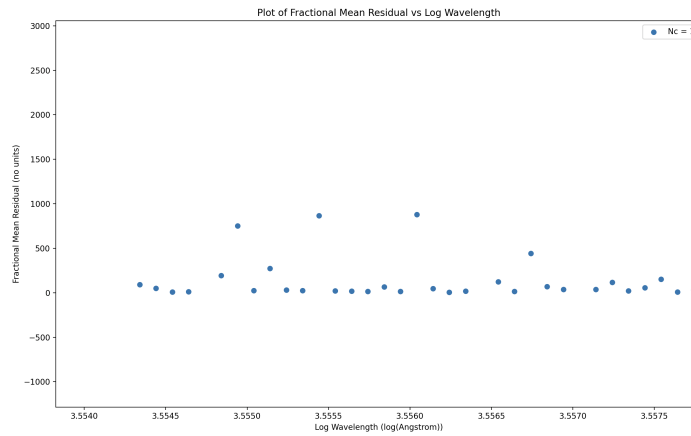
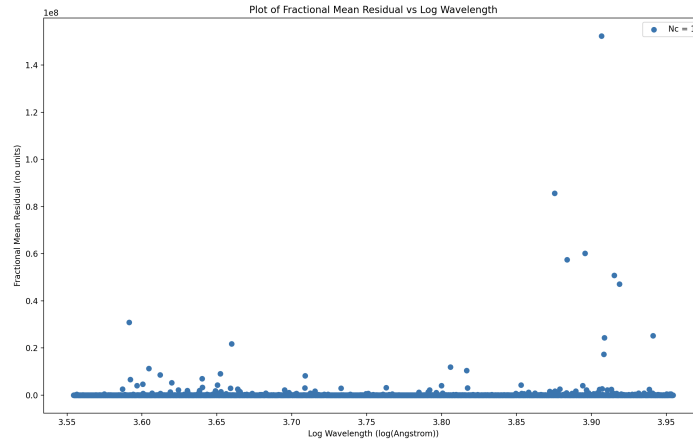
Here, the run times are given in seconds. Given that the condition number of R is much lesser than that of C, the eigenvector matrix given by SVD is much more stable than that given by linalg.eig. Even though the run time for SVD is comparatively more, they are comparable in this context.

Plot of c_0 vs c_1 and c_0 vs c_2

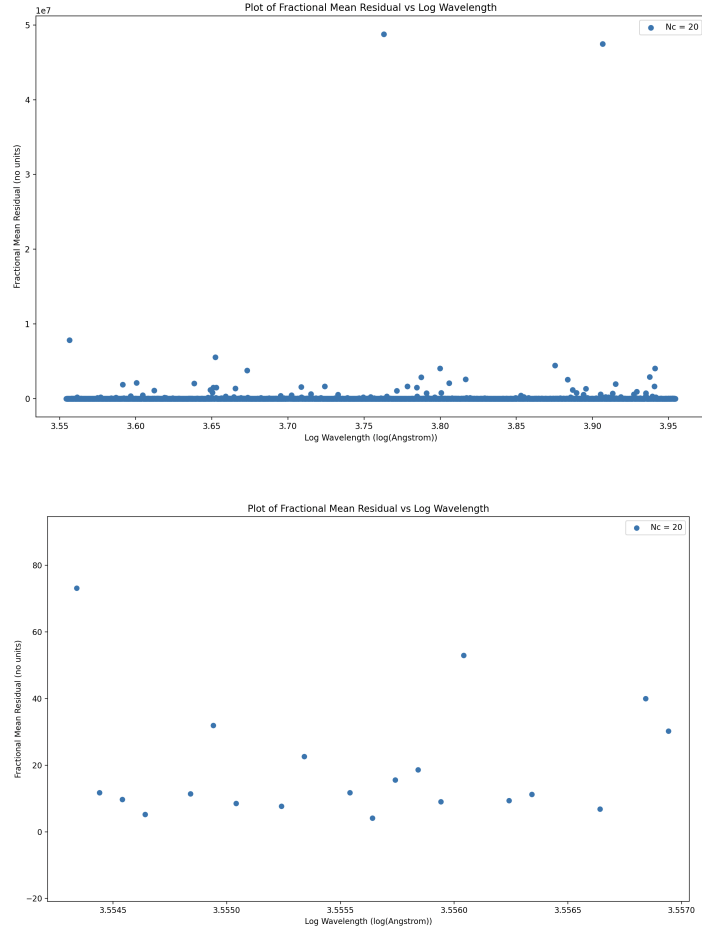


Plotting Squared Fractional Residuals

Residual Plots for $N_c = 1$

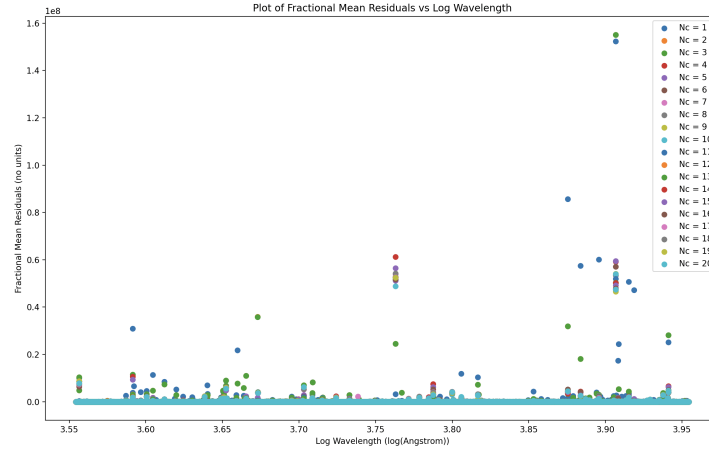


Residual Plots for $N_c = 20$



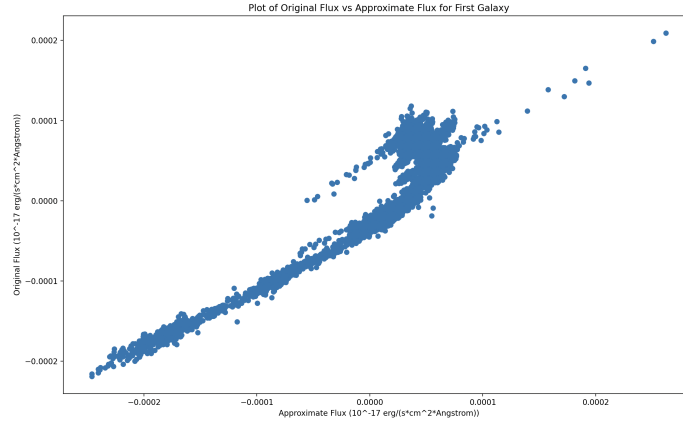
Here, the squared residuals do decline as N_c increases from 1 to 20. Most of the residuals are centered near zero except a few outliers, that's why a scaled in version of the graphs are attached above along with the full spectrum of residuals.

The residuals for all values from N_c ranging from 0 to 20 are as follows:



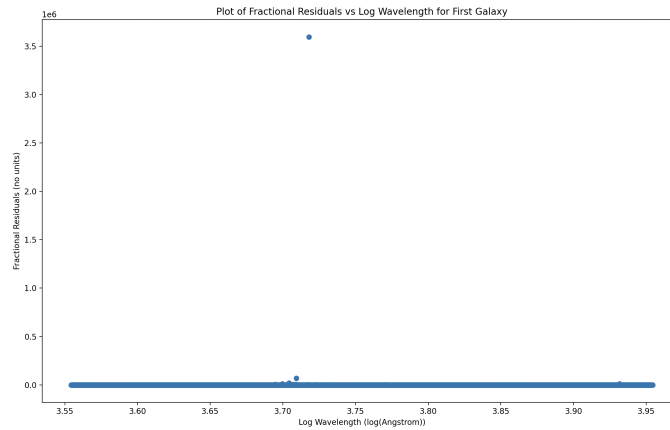
Understanding Outliers

Plot of Original Spectra vs Eigenspectra



Here, the eigenspectra and original spectra of fluxes have a positive correlation to a certain degree. They are not completely identical due to dimension reductionality however, they correlate.

Plot of Fractional Residuals of the First Galaxy



Here, few fractional residuals of the first galaxy are way off from the expected value near zero which is surmised to happen due to extremely small values for the original flux value after normalization and subtracting mean. If the outliers are not taken into account, the rest of the fractional residuals do make sense given their closeness to zero. These outliers are also causing the mean fractional residuals to be extremely high which does not reflect the true mean of the data set.

Please find my GitHub repository through this: [link](#).