



# Characterizing Gas Flow Using Multiply-lensed Quasars

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# Gas Flow and Galaxy Evolution

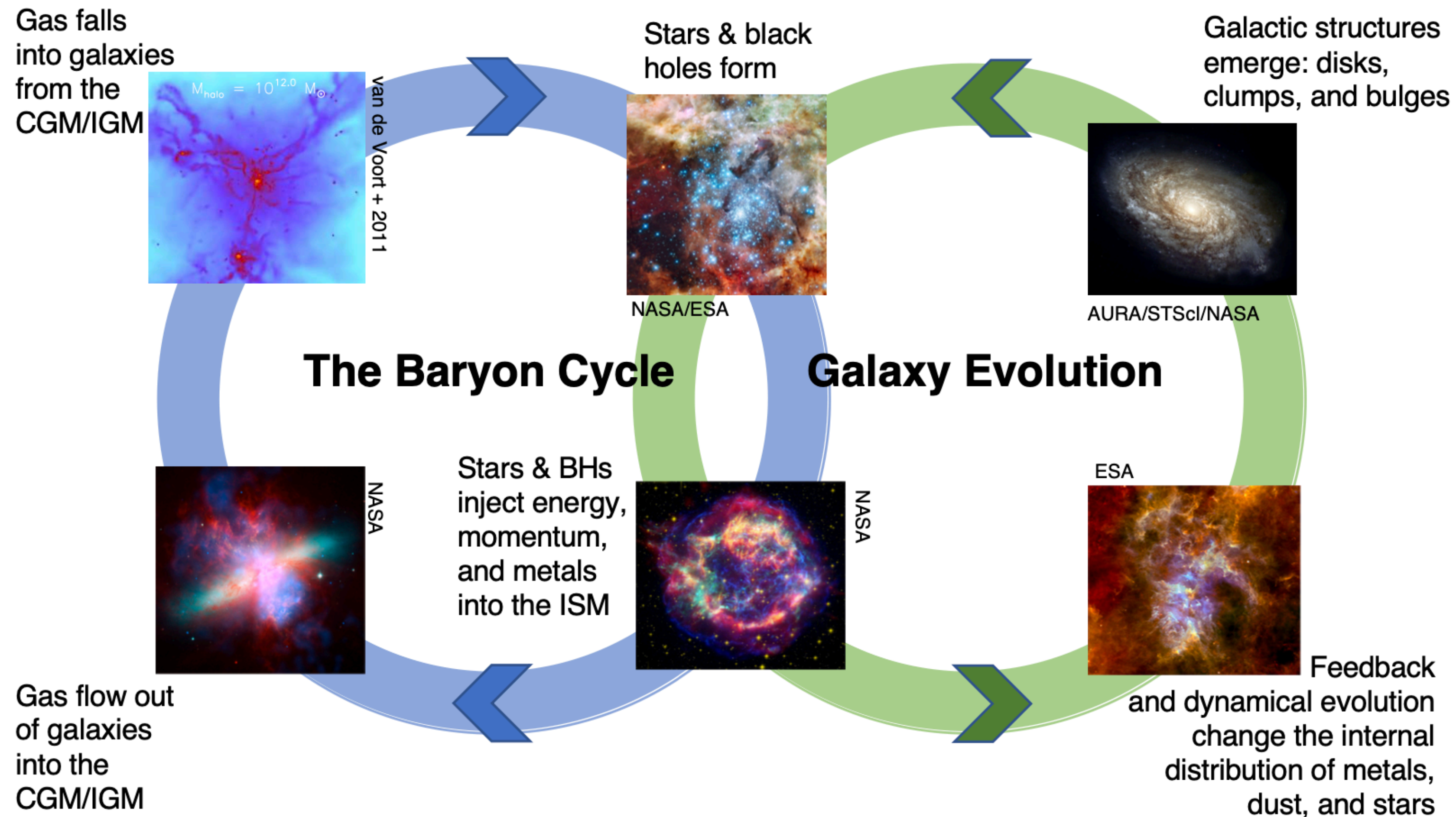
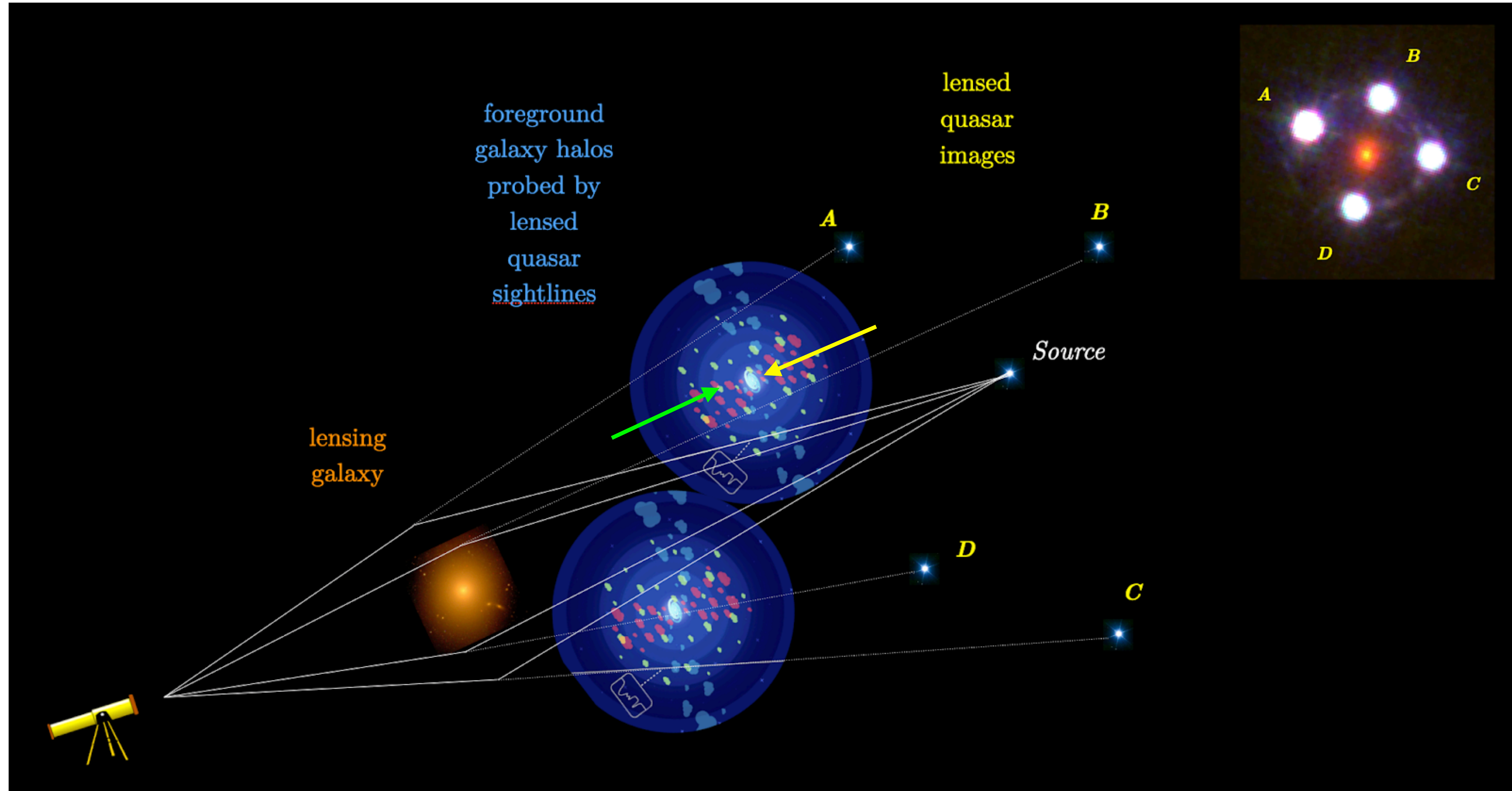


Figure: Newman/Carnegie Institute of Science, 2020

# Gravitational Lensing Illuminates Otherwise Undetectable Gas



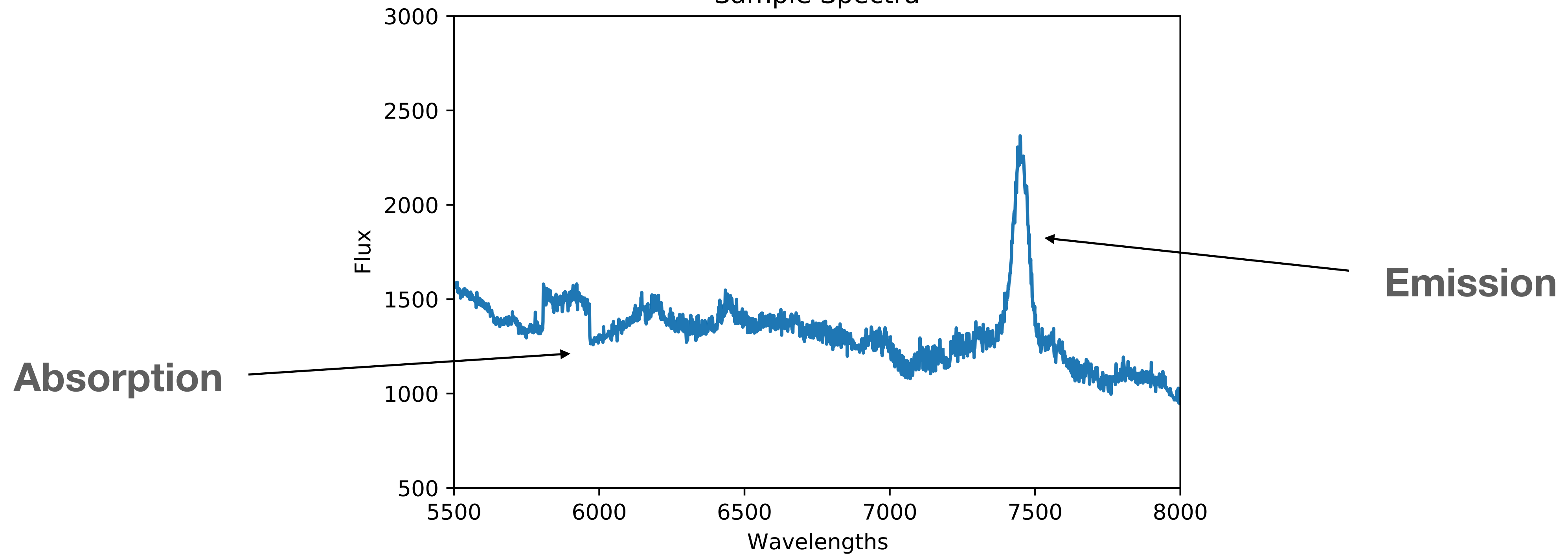
# Absorption Spectroscopy



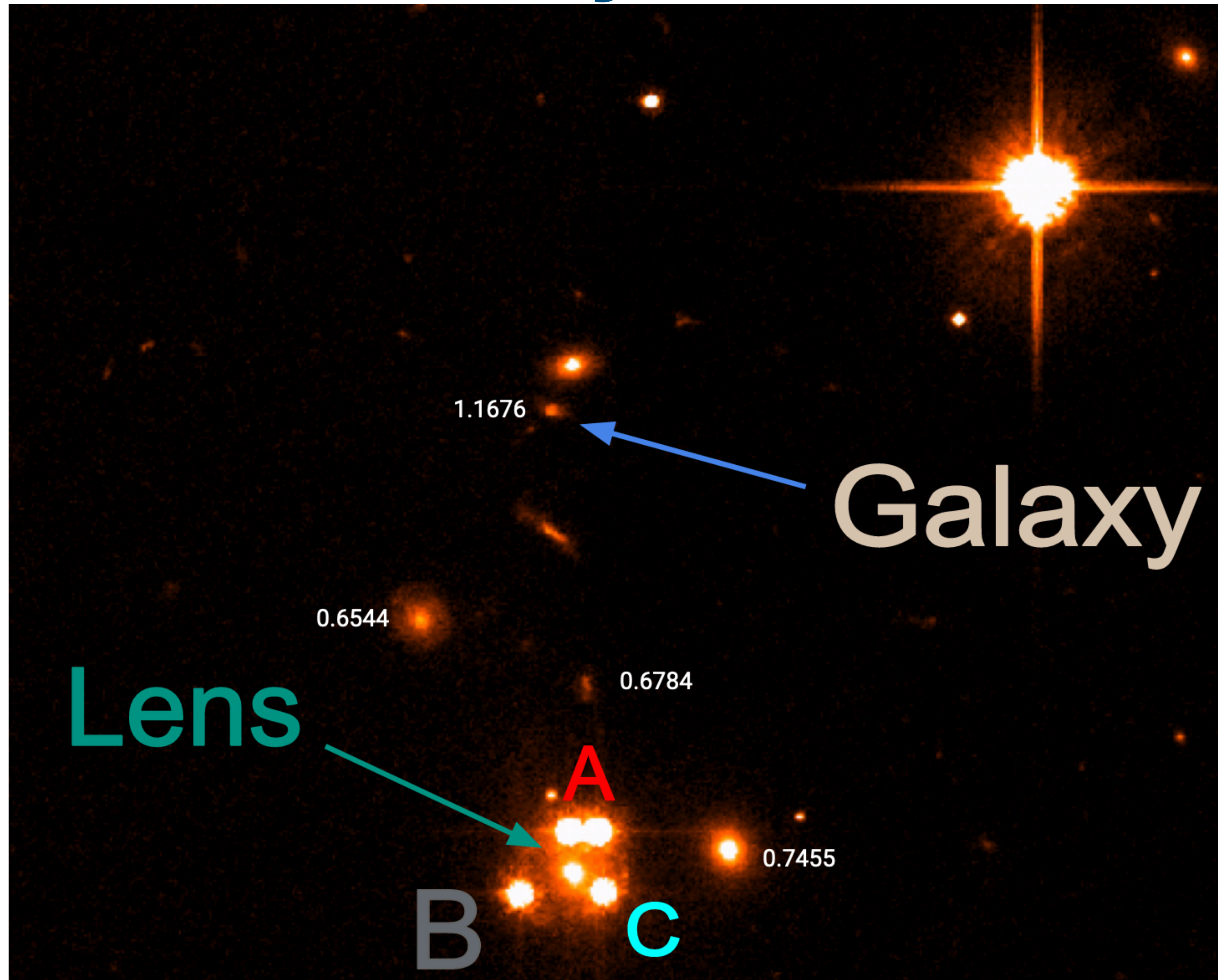
Absorption line spectrum

Absorbing material

Sample Spectra



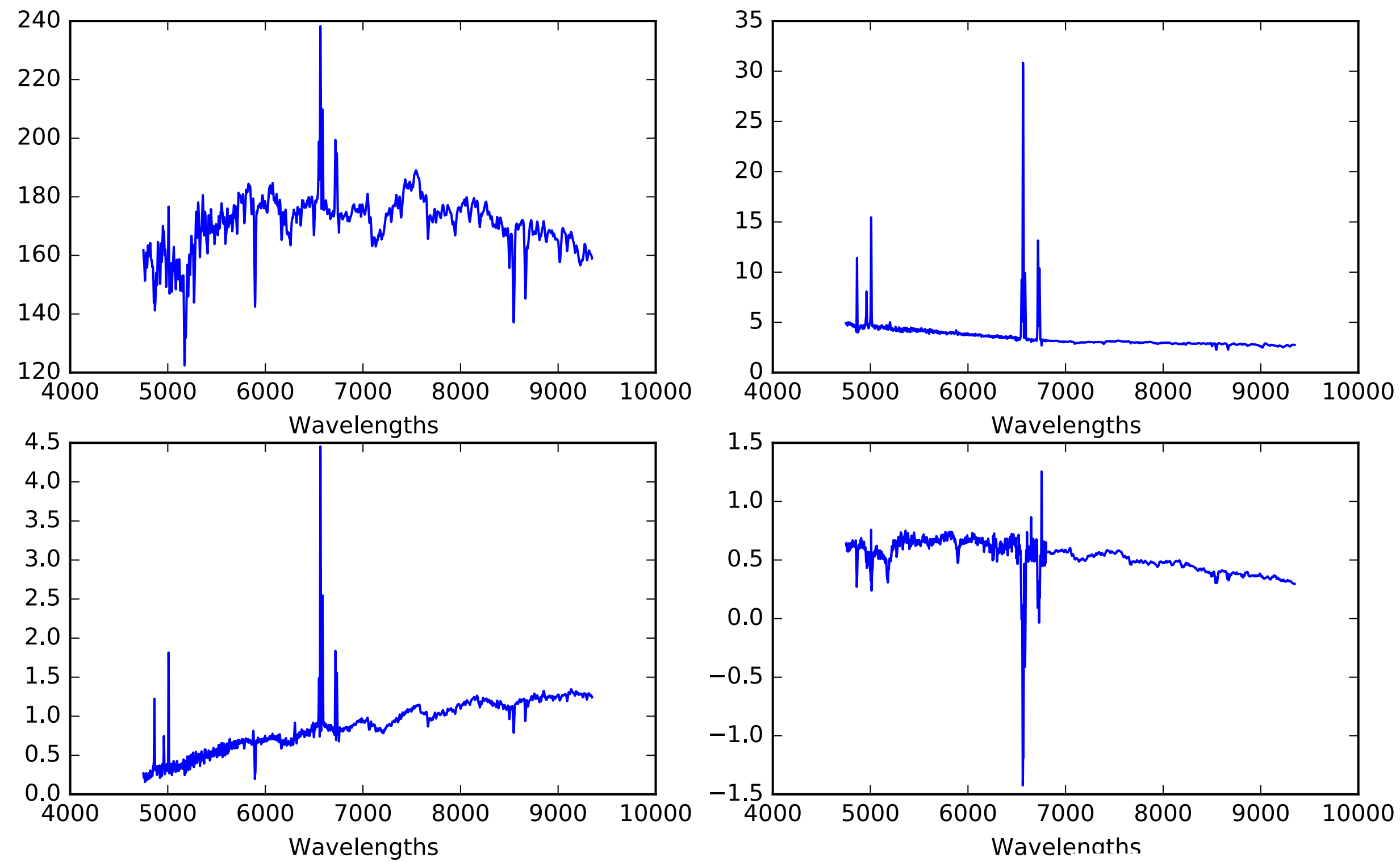
# WFI-2033 and Galaxy of Interest



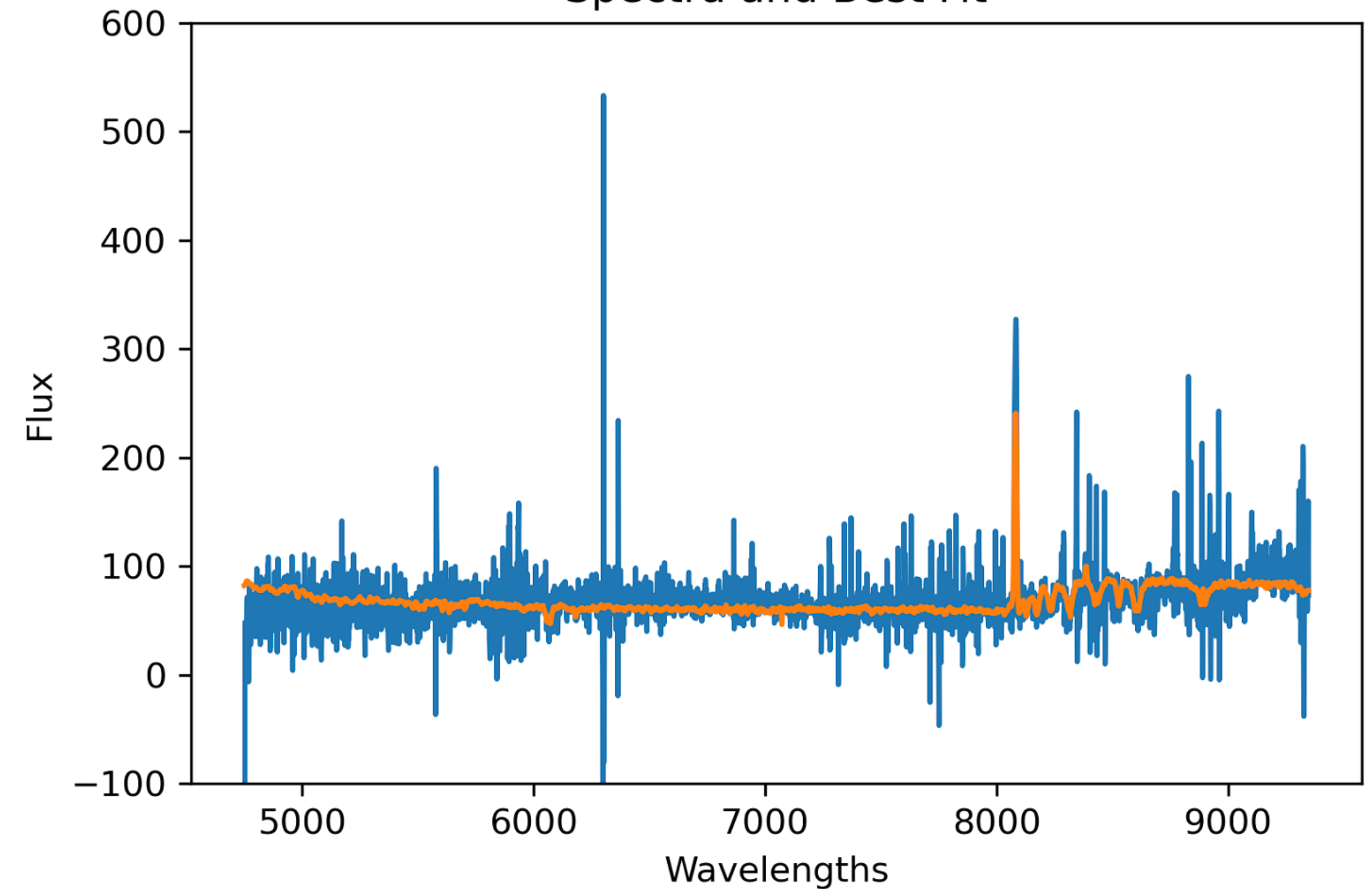
# Chi-Squared Minimized Model

Systemic Redshift,  $z = 1.1676$

Eigenspectra Templates



Spectra and Best Fit



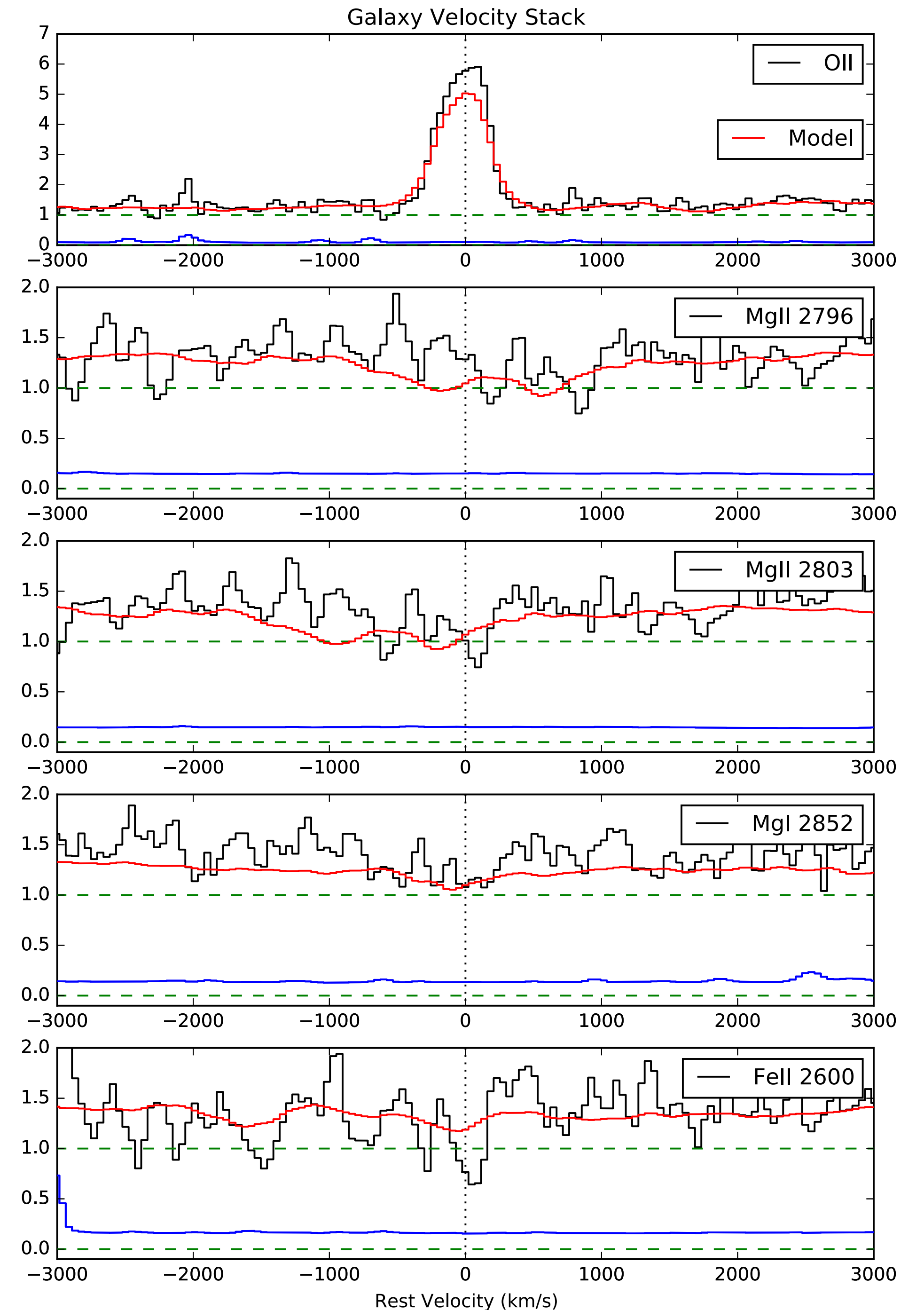
$$Model(\lambda) = \sum_0^i A_i E_i(\lambda)$$

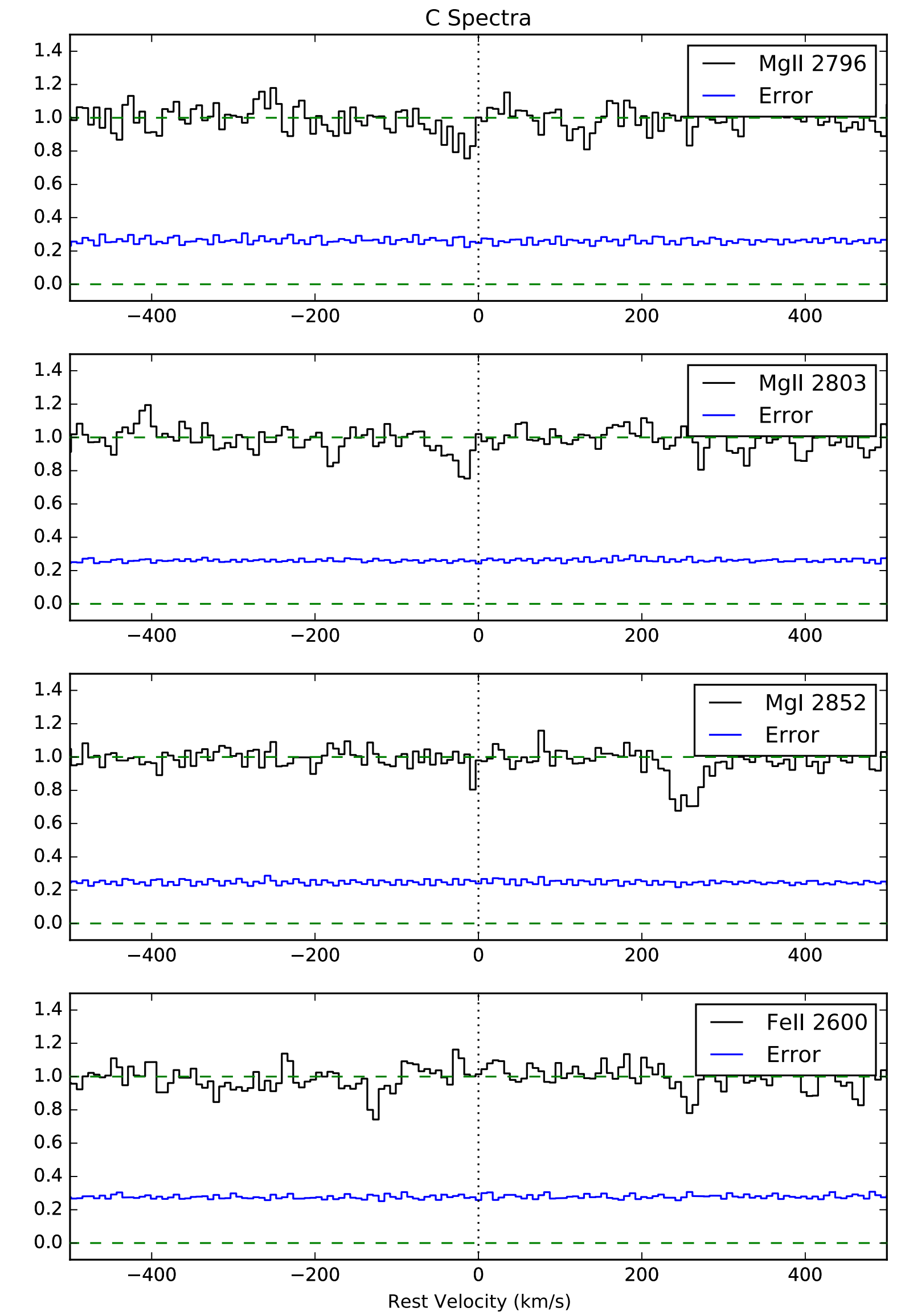
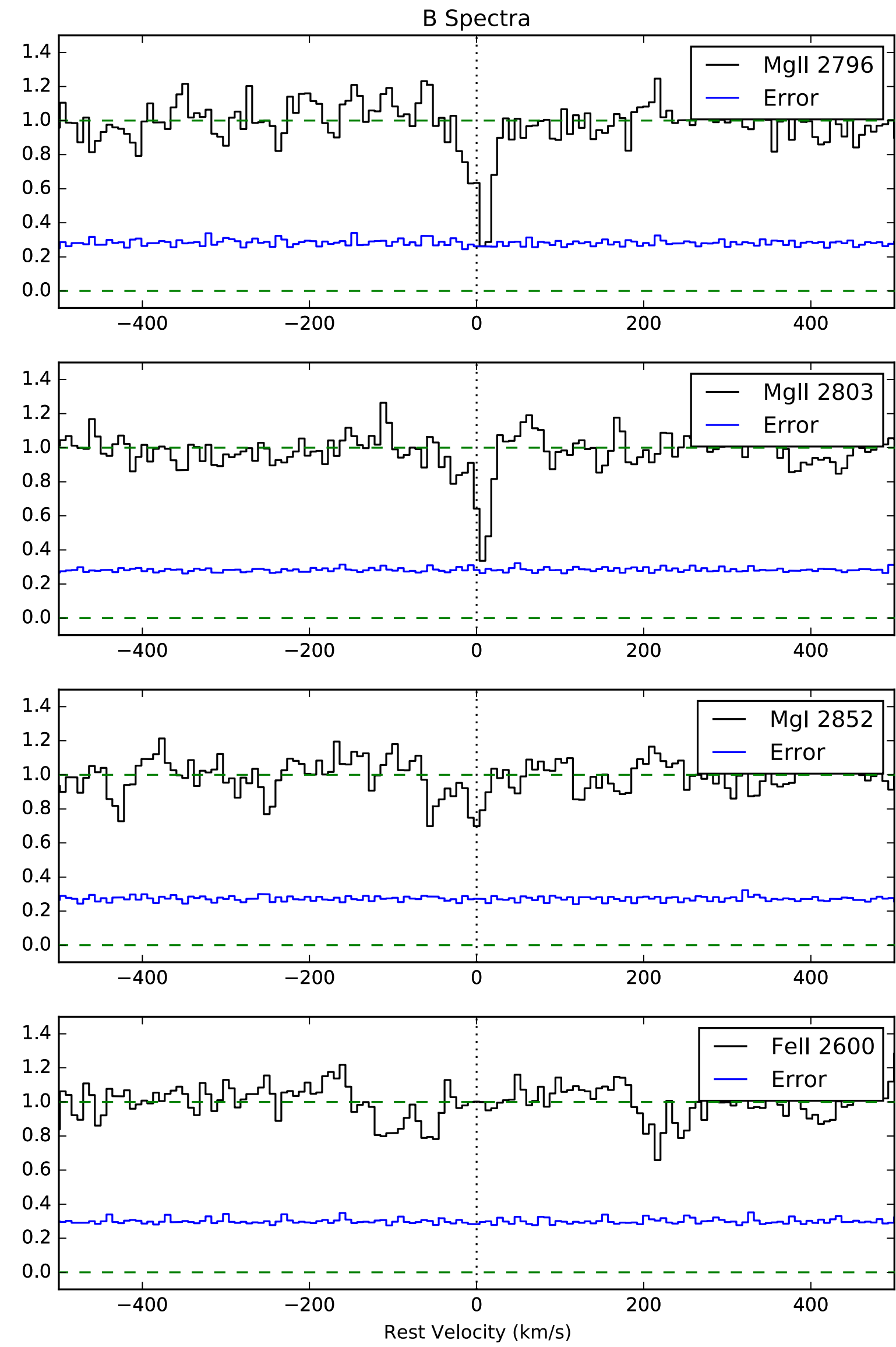
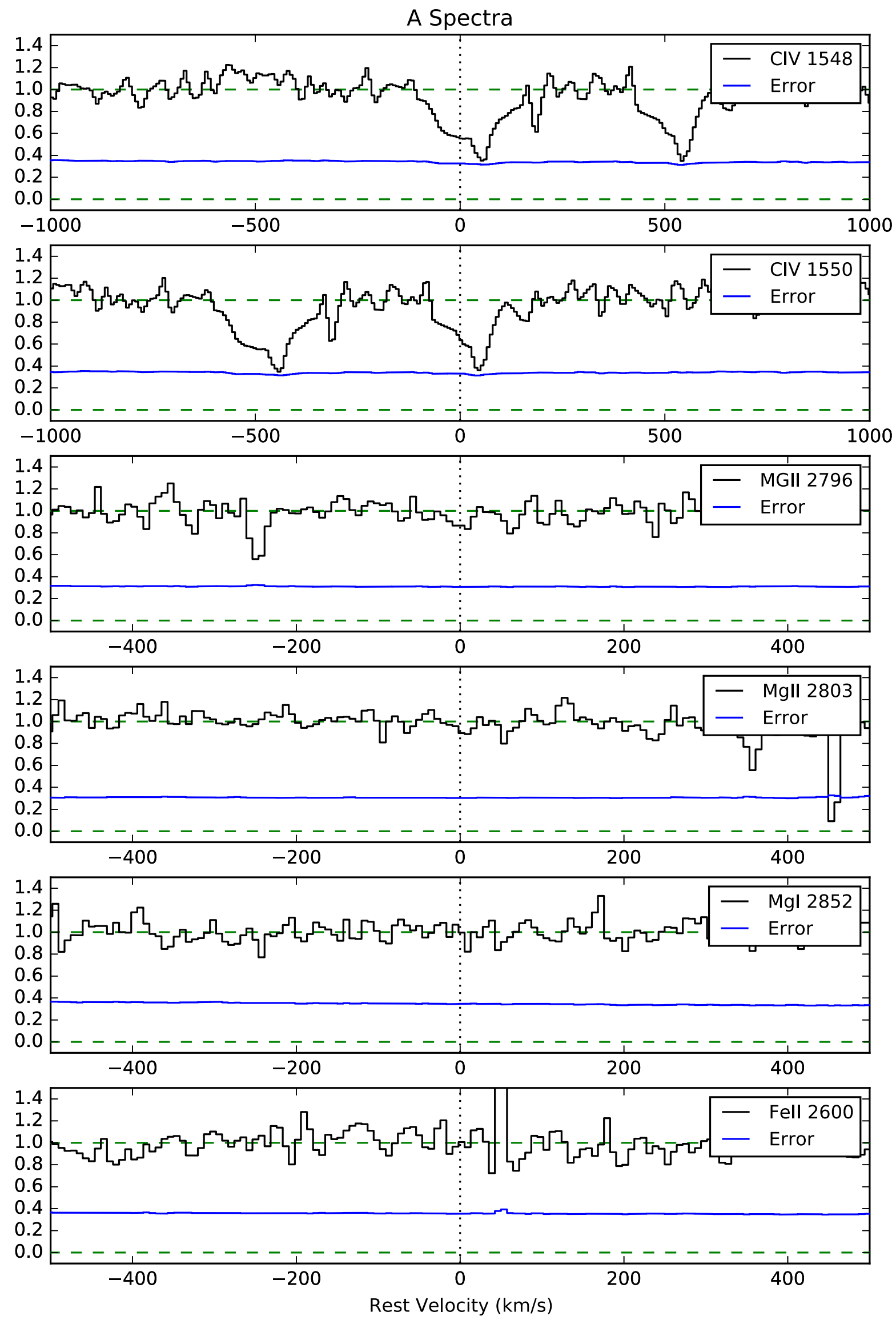
# Local Redshift of Key Gases in the Galaxy

These plots show how far specific gases are redshifted from the systemic redshift of the galaxy.

Peaks and valleys centered at 0 indicate no local redshift.

We find no significant redshifts of MgI, FeII, but slight redshifting at MgII 2796







# Summary

- There is ionized gas present in the halos surrounding the galaxy
- Majority of gas is not significantly redshifted from the systemic velocity of the galaxy

# Future Outlook

- Mapping the motion of gas between the galaxy and its surroundings

# Acknowledgements

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