

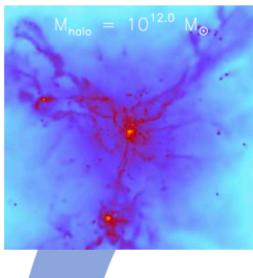
Characterizing Gas Flow Using Multiply-lensed Quasars Carlos Carrillo-Gallegos Dr. Hsiao-Wen Chen

The University of Chicago



Gas Flow and Galaxy Evolution

Gas falls into galaxies from the CGM/IGM



+ 100

201

NASA/ESA

The Baryon Cycle



Stars & BHs inject energy, momentum, and metals into the ISM

Gas flow out of galaxies into the CGM/IGM

Figure: Newman/Carnegie Institute of Science, 2020

Stars & black holes form

Galactic structures emerge: disks, clumps, and bulges



AURA/STScl/NASA

Galaxy Evolution

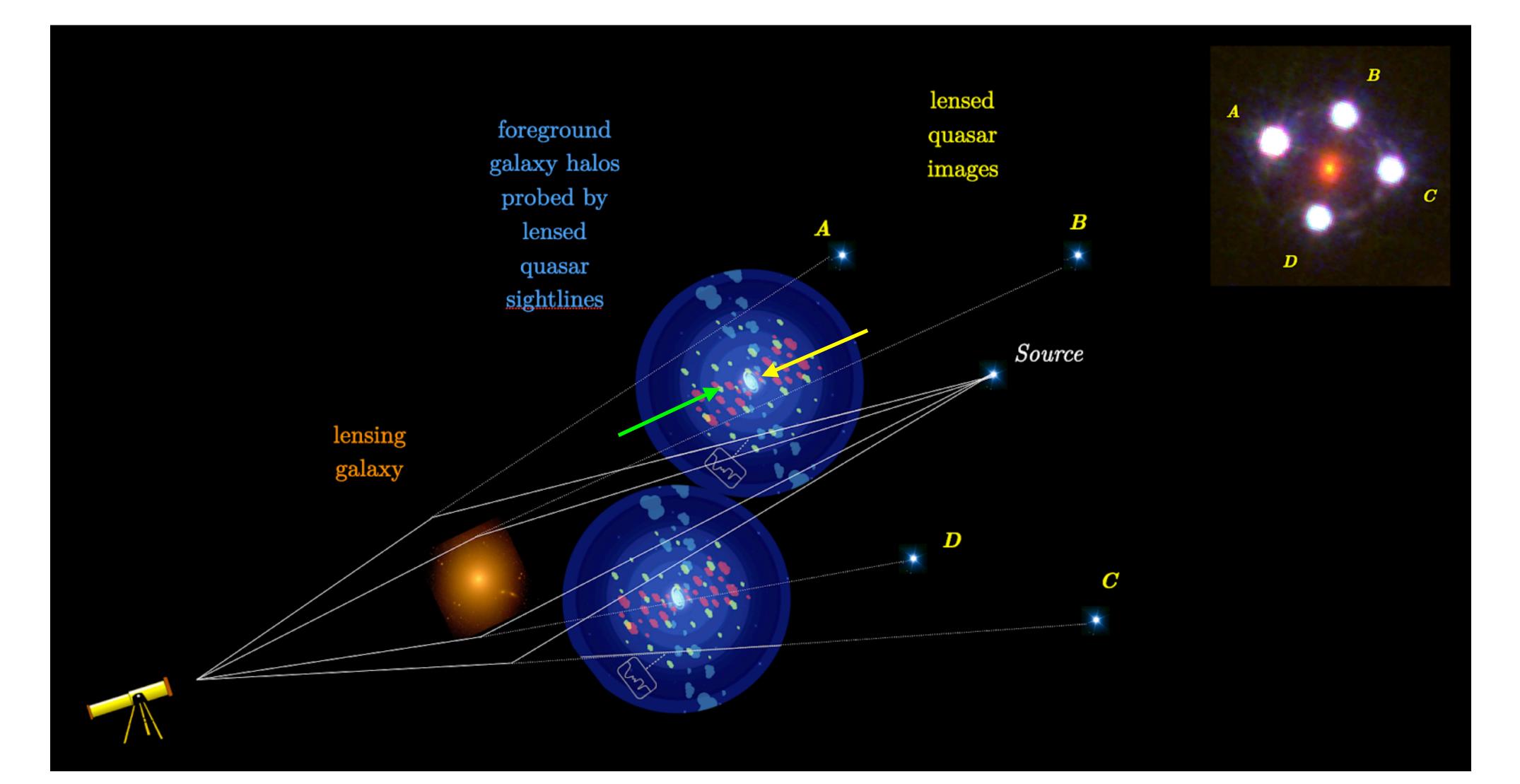
NASA

ESA

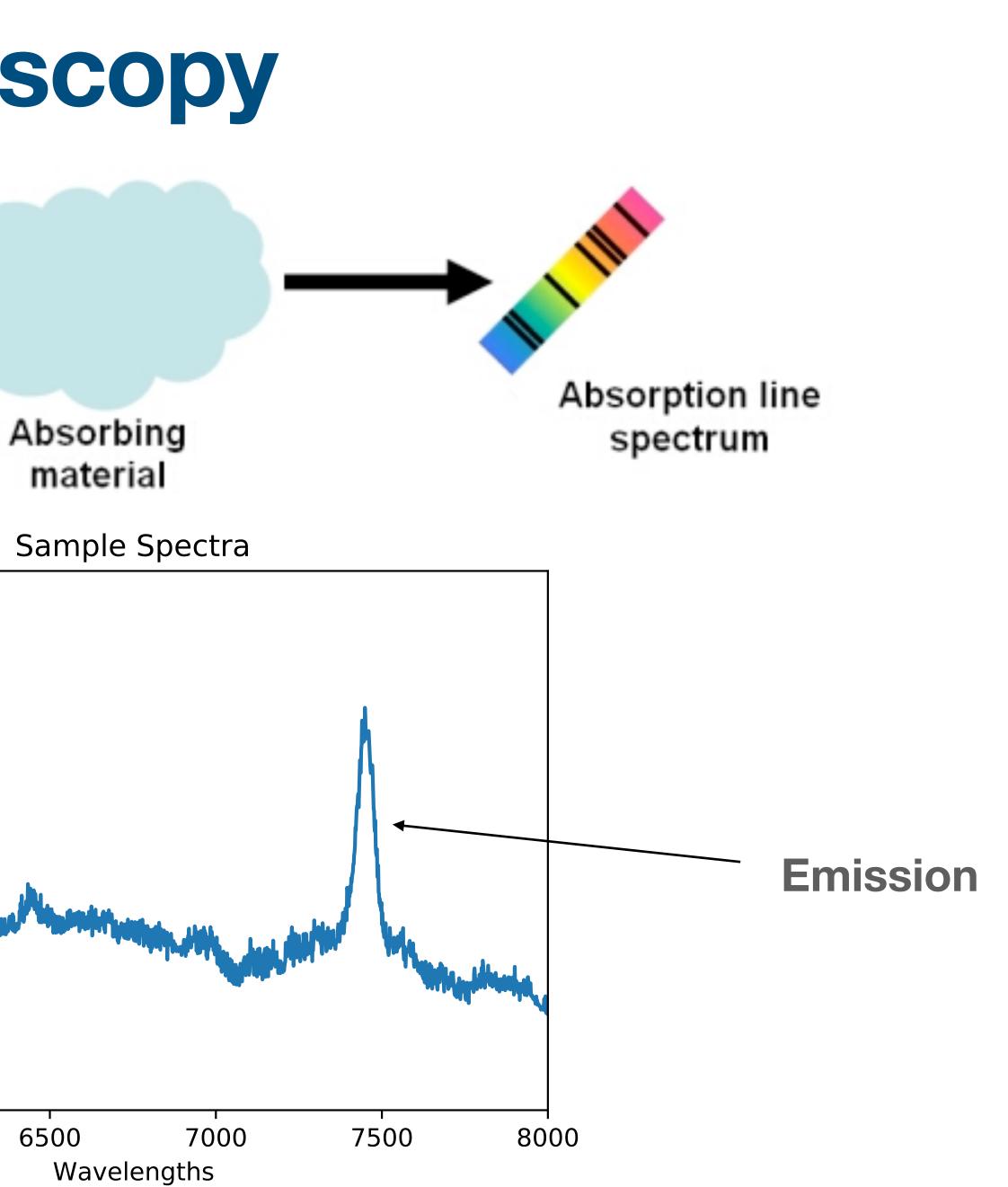


Feedback and dynamical evolution change the internal distribution of metals, dust, and stars

Gravitational Lensing Illuminates Otherwise Undetectable Gas



Absorption Spectroscopy 3000 2500 2000 Flux 1500 Absorption 1000 -500 + 6000 5500



WFI-2033 and Galaxy of Interest

1.1676

0.6544

Lens

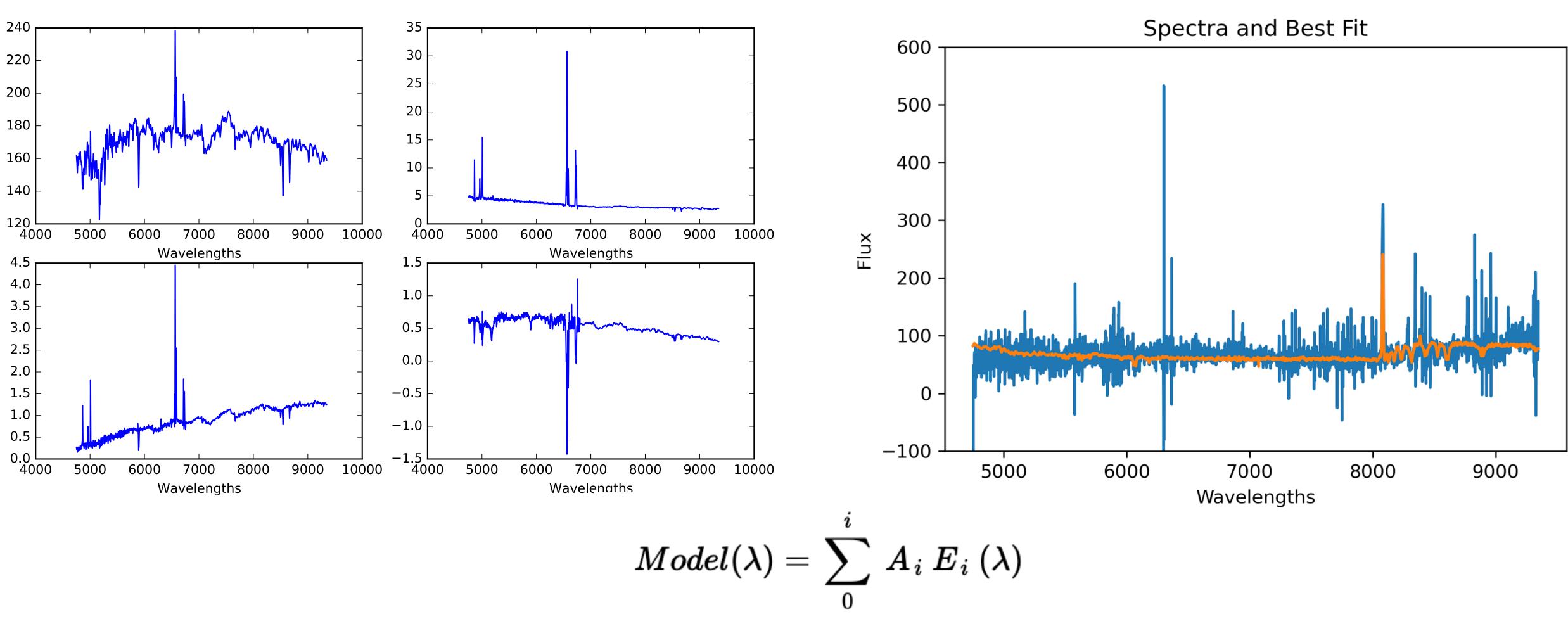
Galaxy

0.6784





Chi-Squared Minimized Model Systemic Redshift, z = 1.1676



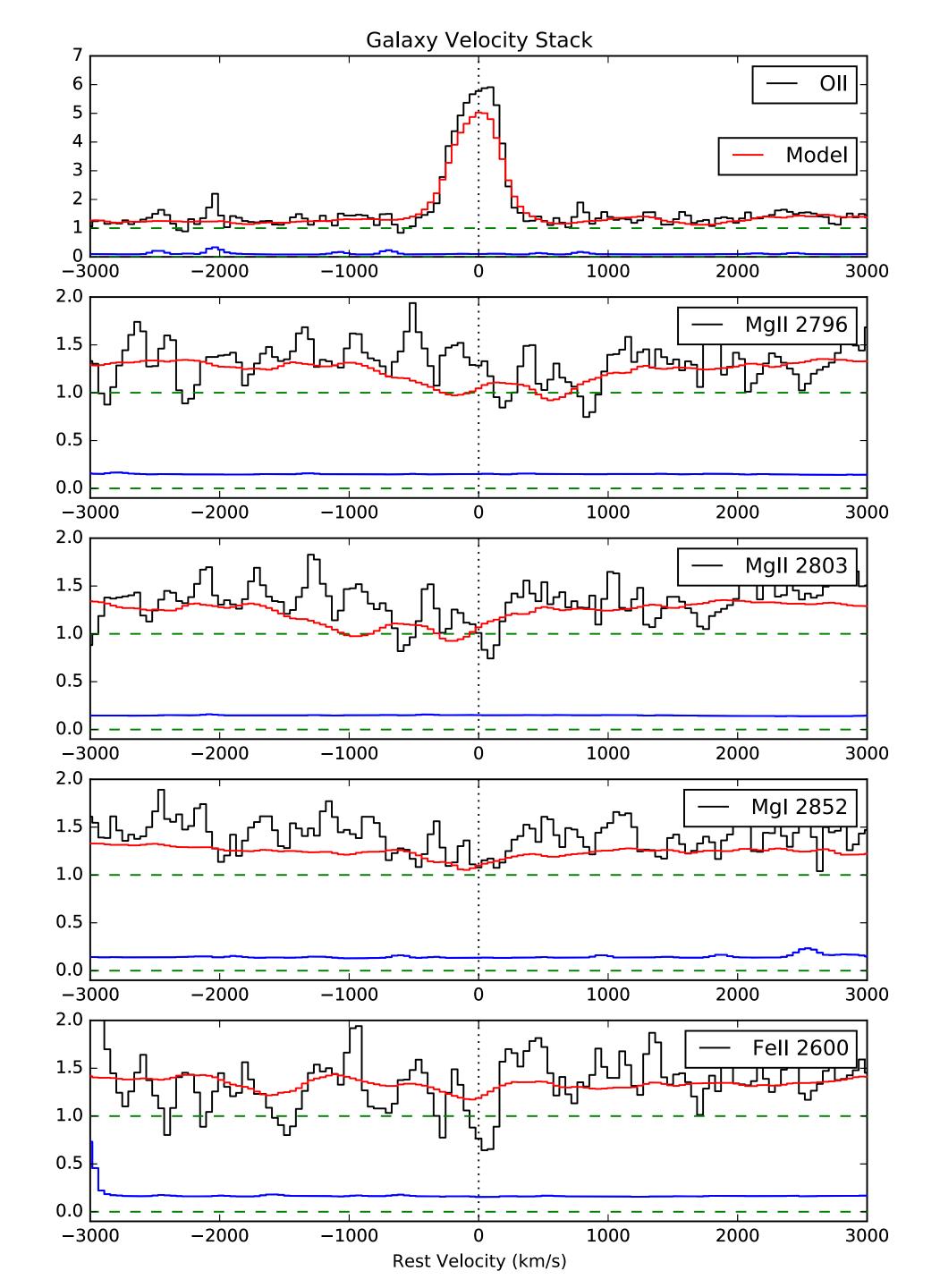
Eigenspectra Templates

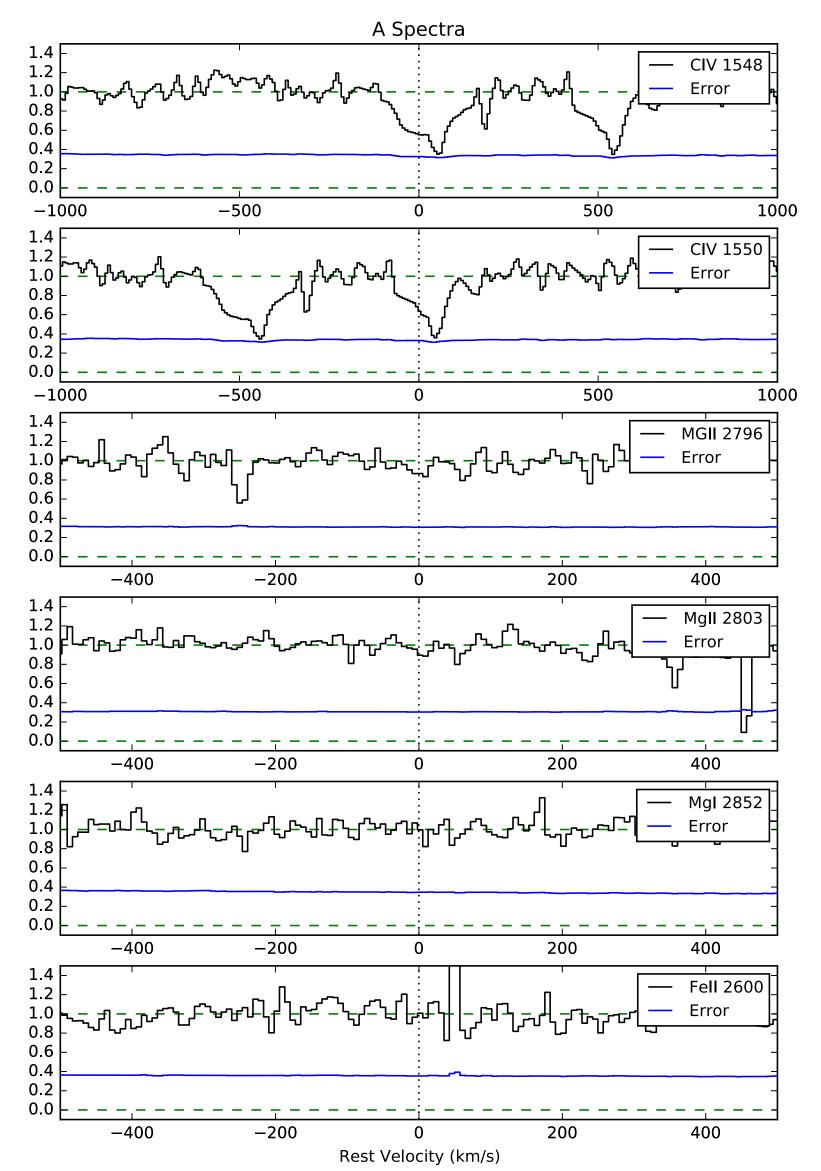
Local Redshift of Key Gases in the Galaxy

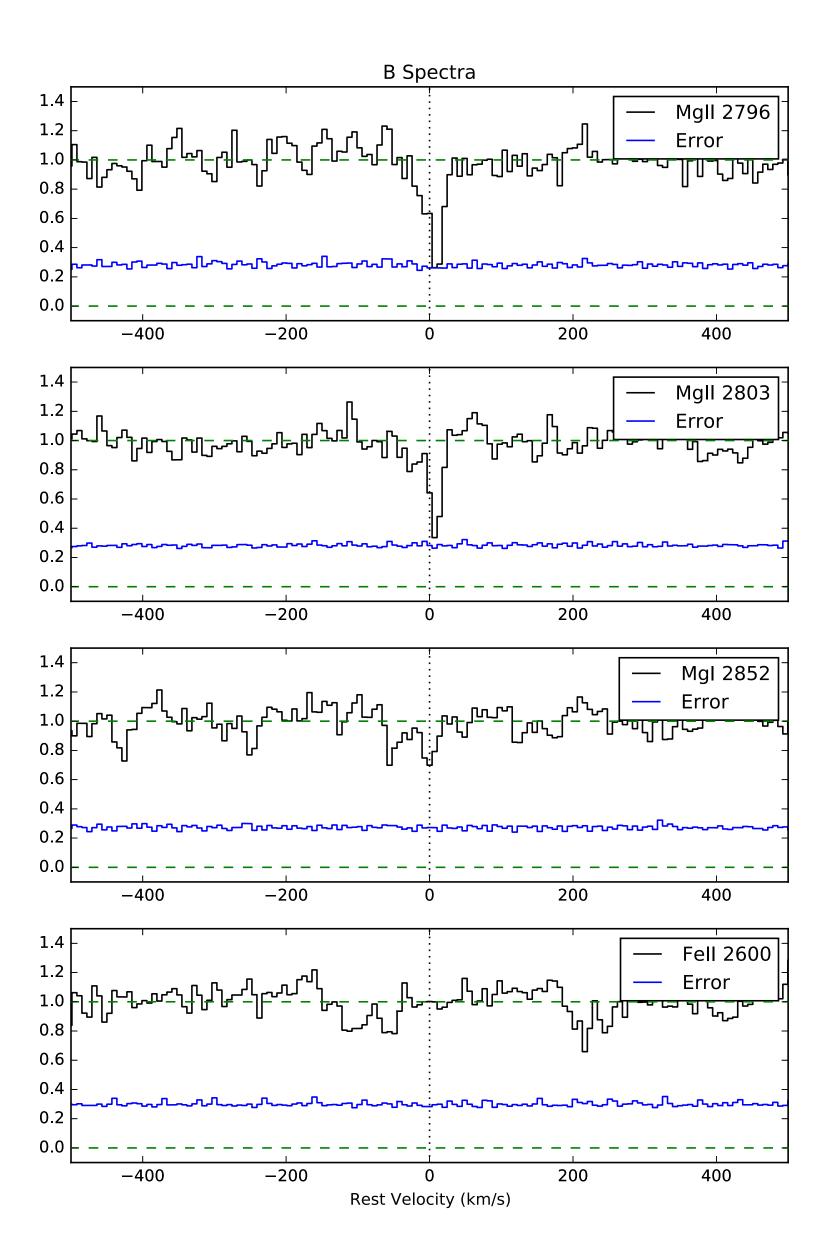
These plots show how far specific gases are redshifted from the systemic redshift of the galaxy.

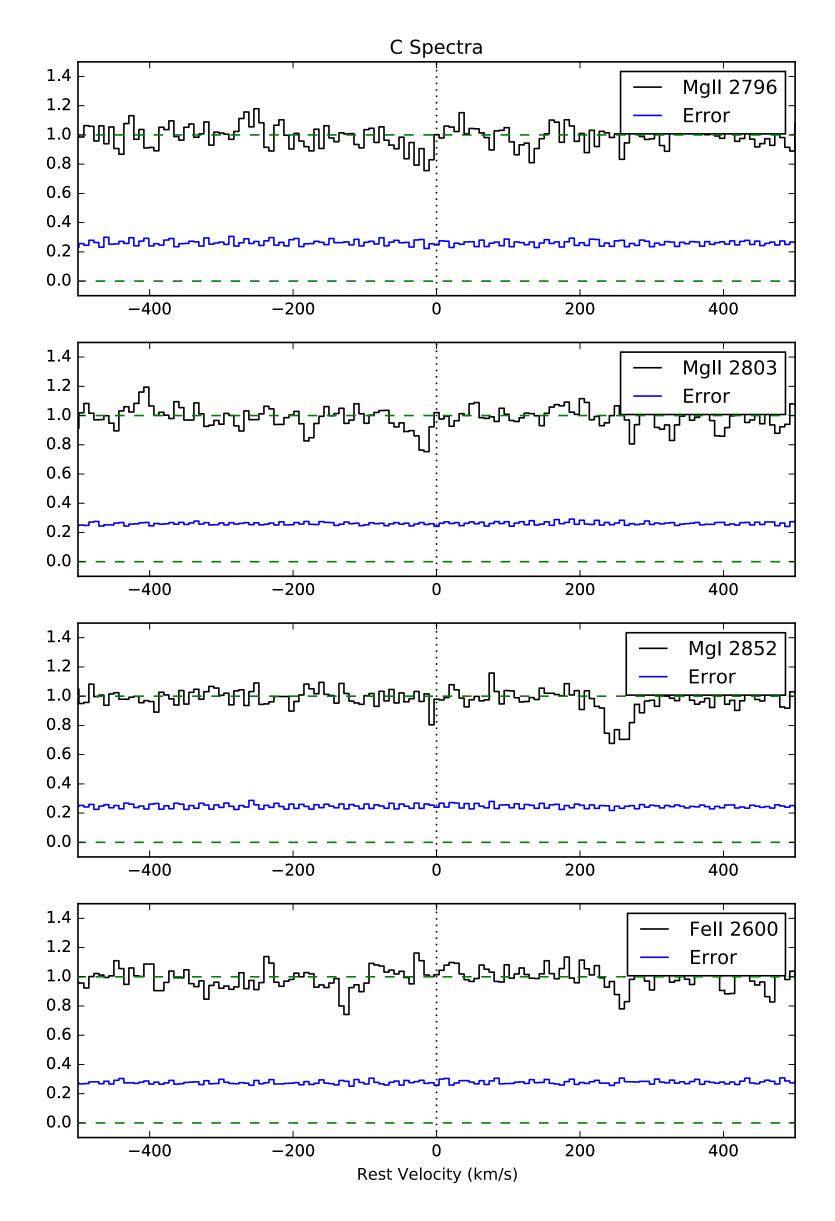
Peaks and valleys centered at 0 indicate no local redshift.

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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