

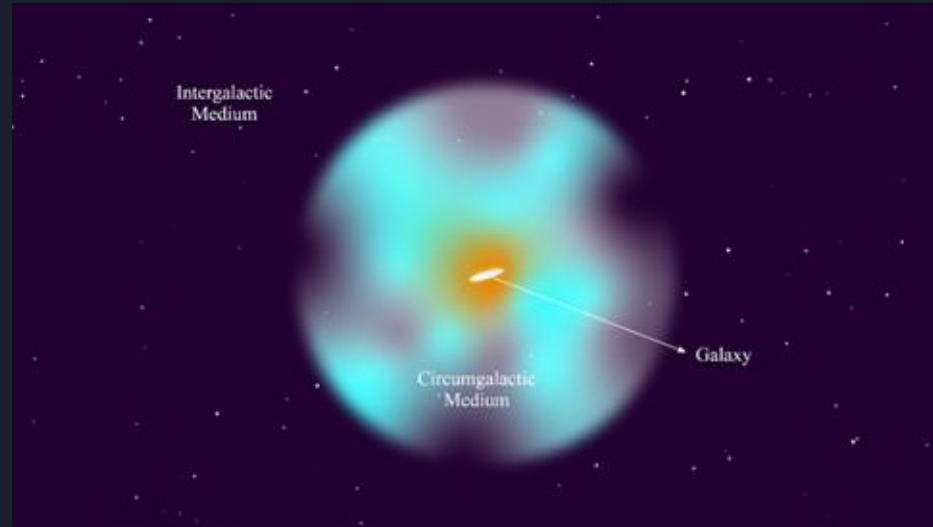


CGM & KCWI Data Cubes

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OU REU 2026

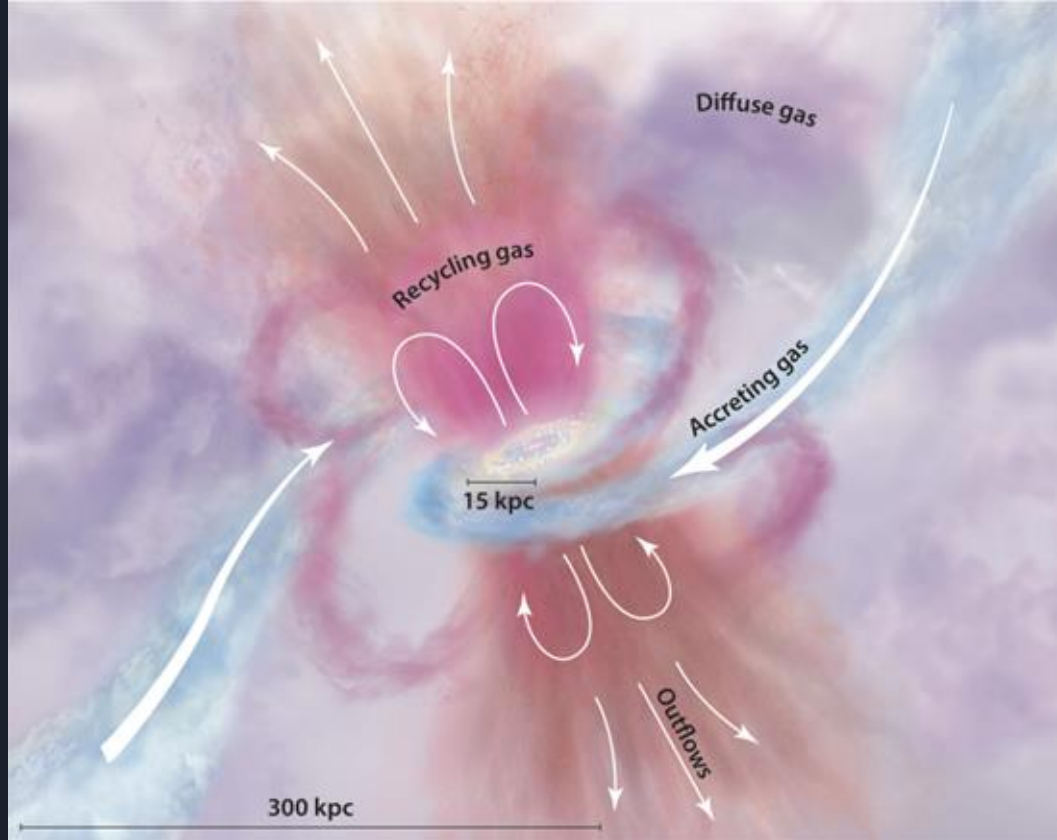
What is the CGM?

- Circumgalactic medium
- Giant atmosphere surrounding a galaxy
 - CGM often is thousands of times more volume than the stellar disk of a galaxy
- Mainly comprised of diffuse gas
 - Ranging from 10^4 - 10^7 K
- Recycles gas through the galaxy
- Fuels star formation in the galaxy



Gas Cycle in CGM

1. Cool gas falls into galaxy from CGM or IGM
2. Gas is used to fuel star formation
3. Stars explode as supernovae and eject heated “metals” back into CGM
 - i. Black holes also eject heated “metals” with jets and winds
4. Gas cools in CGM

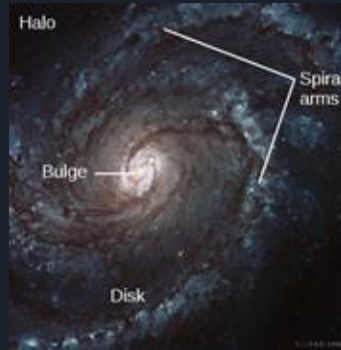


Observation Target

- Redshift $z = 1.01655$
- It's got strong Mg II / Fe II absorption
- Blue in color which suggests it's star-forming.
- Stellar mass $10^{10.9} M_{\text{sun}}$
- Halo mass $10^{12.6} M_{\text{sun}}$
- Face-on



$$z = \frac{\lambda_{\text{obs}} - \lambda_{\text{rest}}}{\lambda_{\text{rest}}}$$



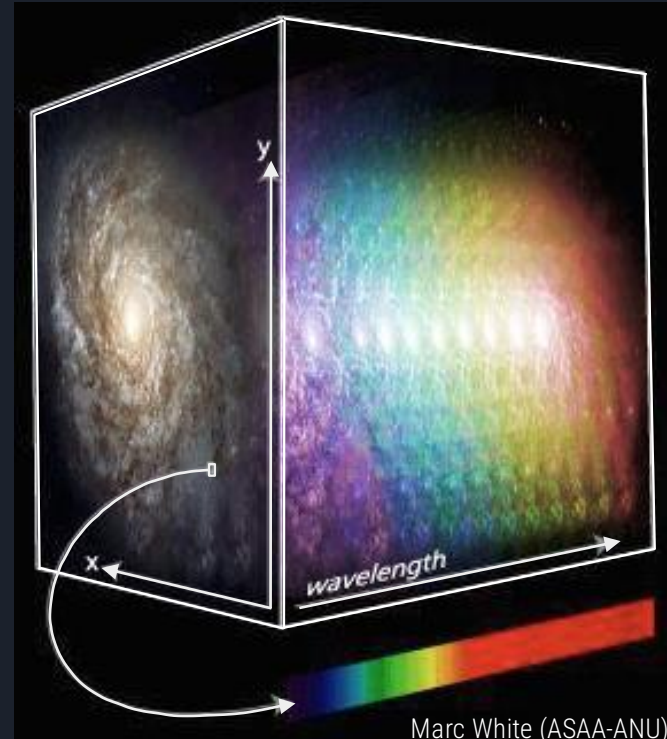
What is KCWI?

- Keck Cosmic Web Imager
 - Keck Observatory in Hawaii
- Integral field spectroscopy
 - produces a spectrum at every point across an image
 - Creates data cubes
- These spectra help astronomers study faint gas across galaxies and the cosmic web



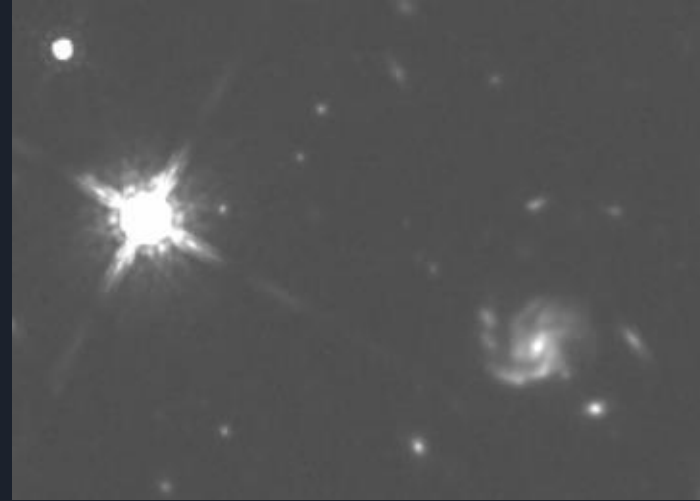
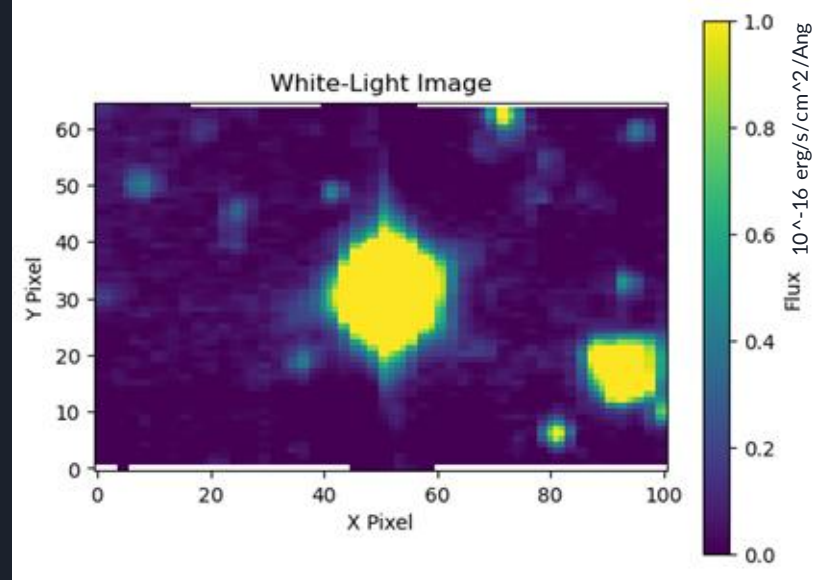
What are Data Cubes (from KCWI)?

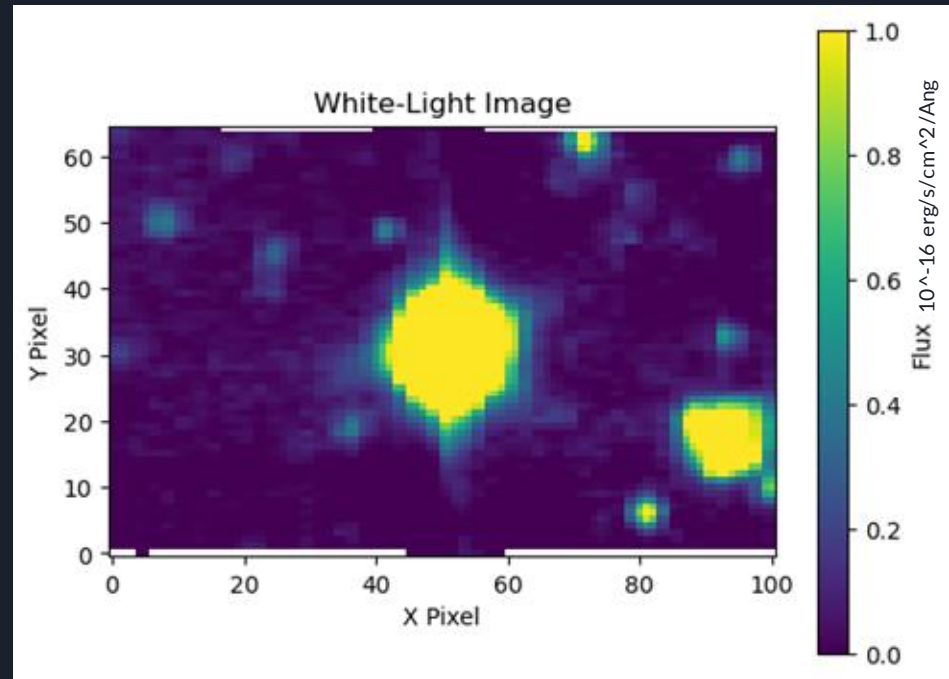
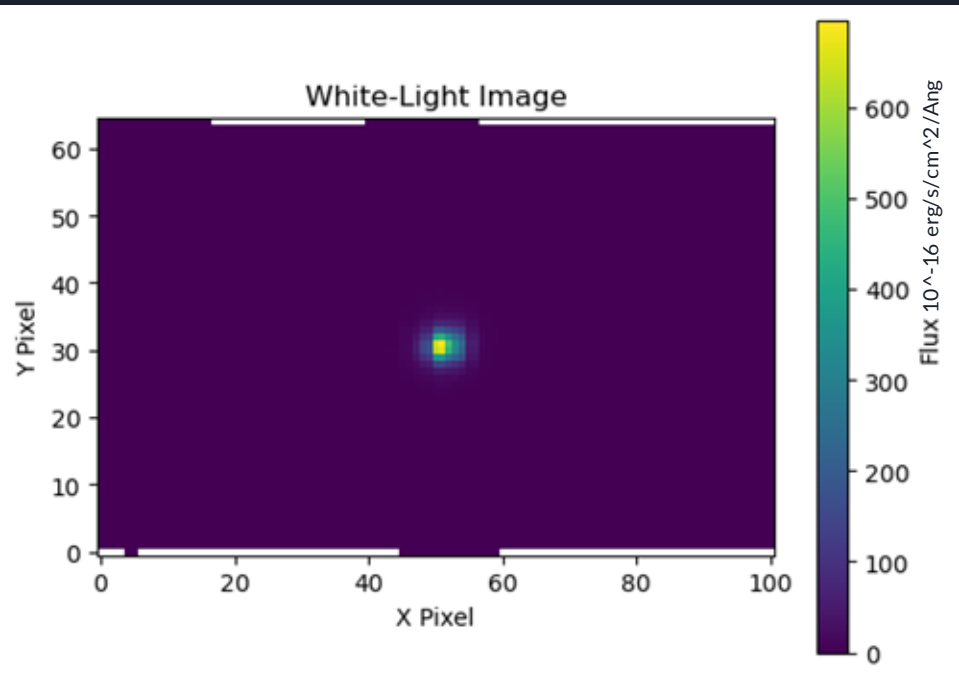
- Data in the dimensions of two spatial dimensions and one spectral dimension (x, y, wavelength)
- Provides a full spectrum for every position in an image
- Can find emission and absorption lines of elements
- Can measure inflows and outflows of the CGM



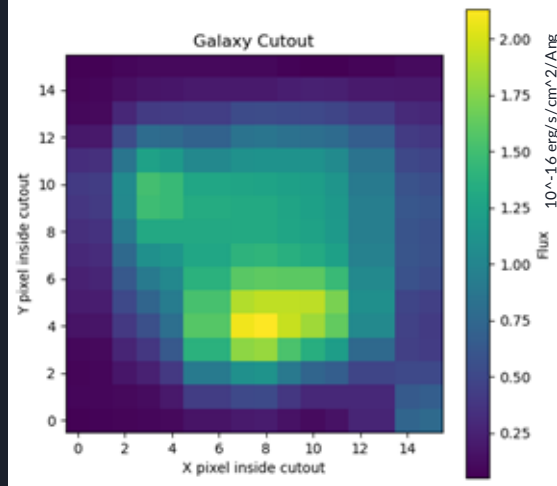
Imaging

- White light imaging from KCWI
- Sums up all wavelengths across a pixel
- Returns flux: how much light/energy reaches the telescope
- Setting a Flux limit
- HST (Hubble Space Telescope)

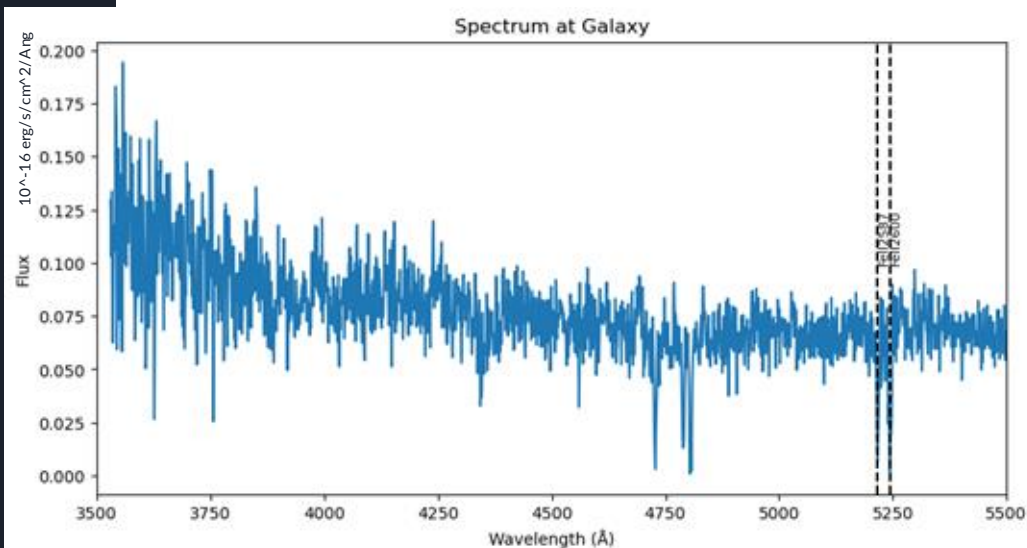
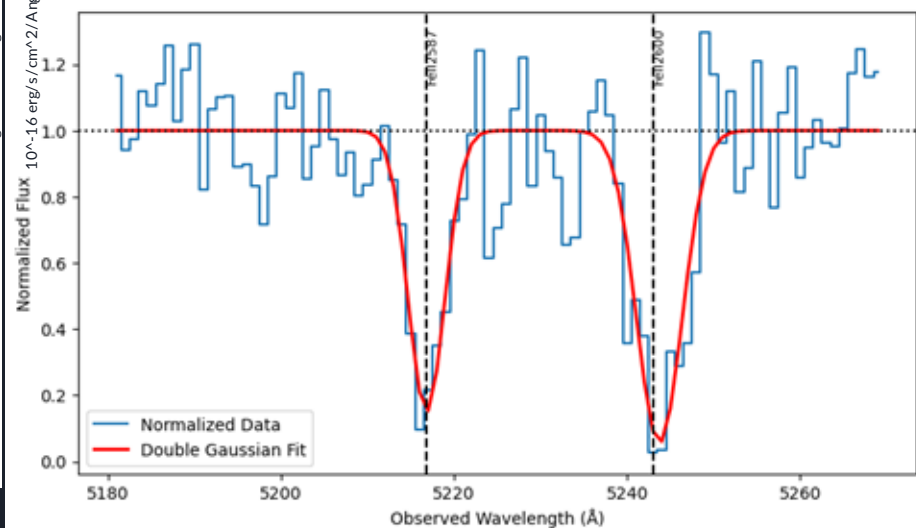




Galaxy

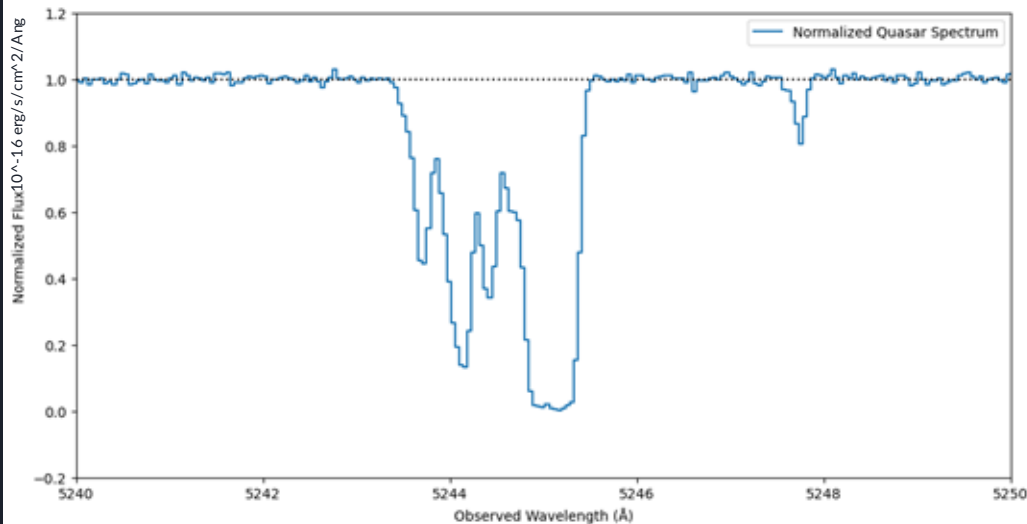
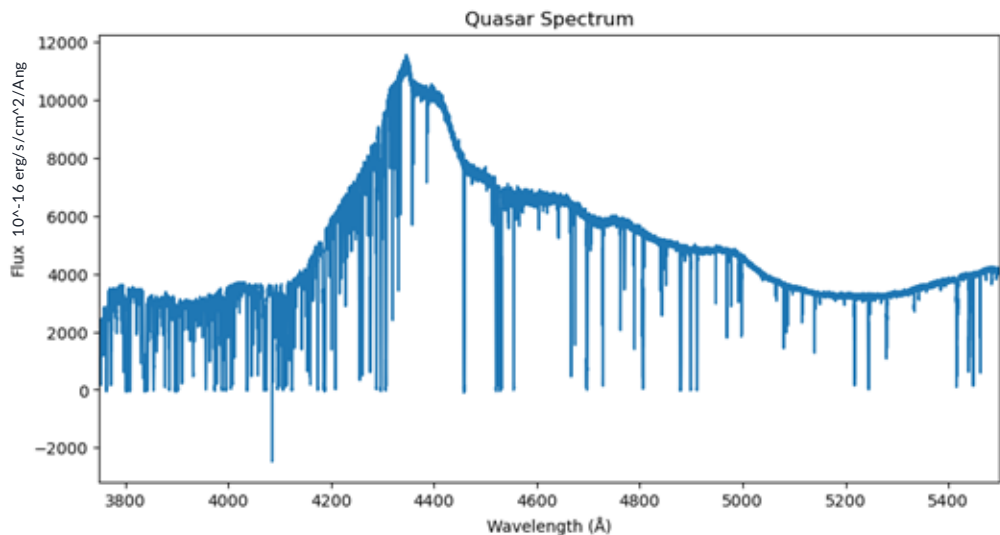


- Cutout for the galaxy
- Spectrum has negative slope/blue galaxy
- Galaxy could have many hot young stars
- These stars produce blue/UV light
- This shows galaxy is still producing new stars
- Plotted Fe II 2600 and 2583 absorption line

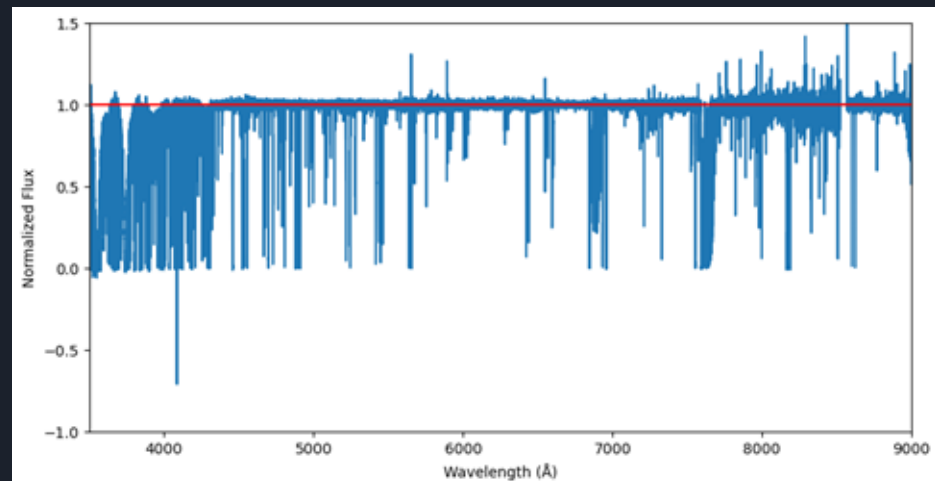
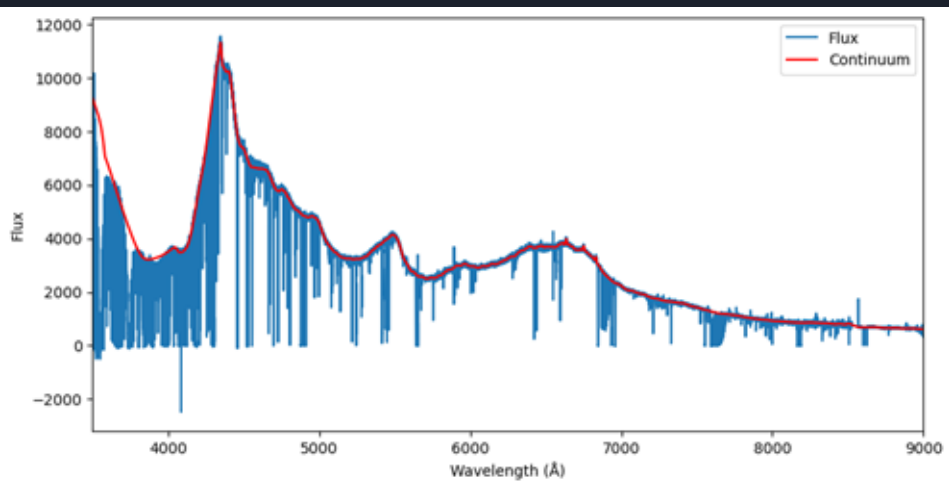


Quasar

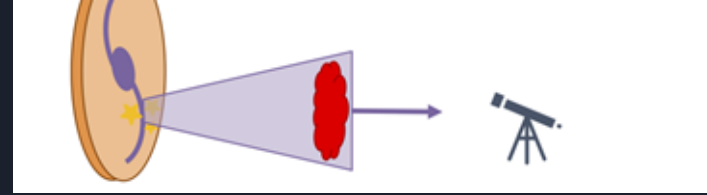
- Fe II 2600
- Absorption lines possibly from other galaxies from other redshifts and Lyman Alpha
- Broad emission lines
- Data from UVES from VLT
- Taken from UVES for better resolution
- 104 kpc away from galaxy, not sure if gas is behind or in front of galaxy from quasar



Normalizing Data



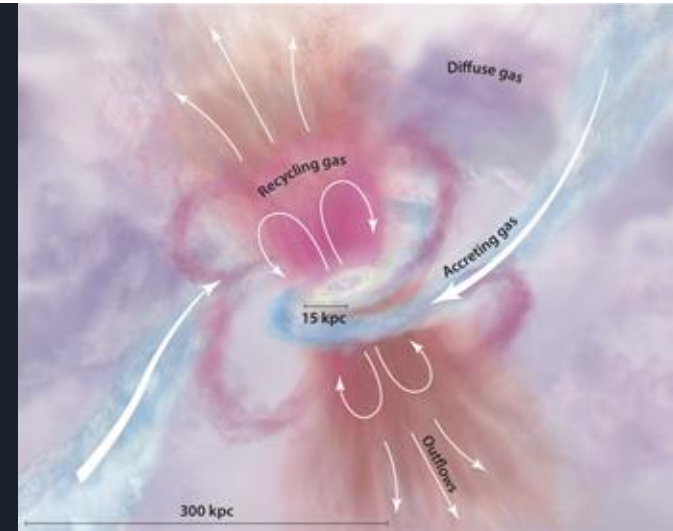
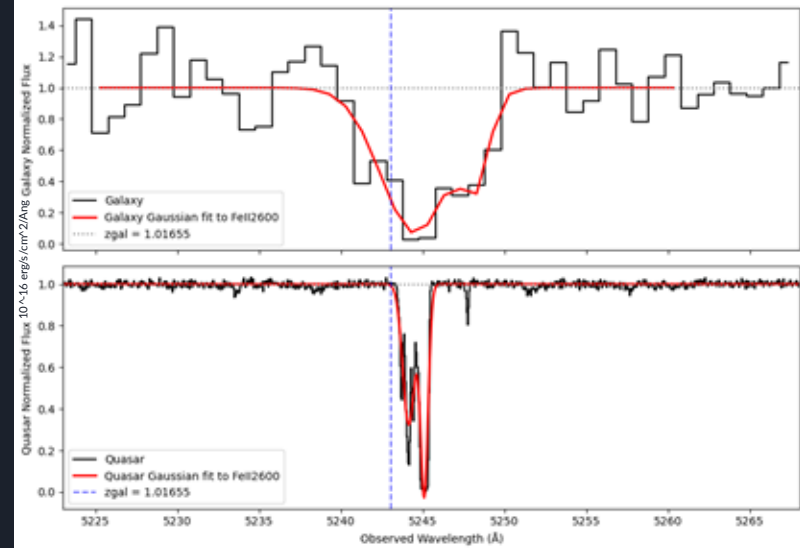
Down the barrel absorption



- Originally we used Quasar to light up CGM gas
- This shows us absorption lines as the CGM blocked light from the quasar
- Down the barrel absorption uses the galaxy's own light
- This focuses on gas in front the galaxy
- These different methods are used to compare gas in front and around the galaxy

Comparison

- Observing same gas in two different sightlines
- Galaxy spectrum shows gas in front galaxy
- Quasar spectrum, shows gas outside galaxy
- Comparing their velocity structure can tell us if the gas inside and outside the galaxy is physically connected
- Redshifted, moving away from us, uncommon with current CGM understanding





Future Goals

- Study inflows and outflows of gas for both QSO and Galaxy
- Measure elemental components, velocities, and flow rates of the gas
- Why is the galaxy so massive and still producing stars?

Questions?

