

Does the gas in the IGM care about galaxies?

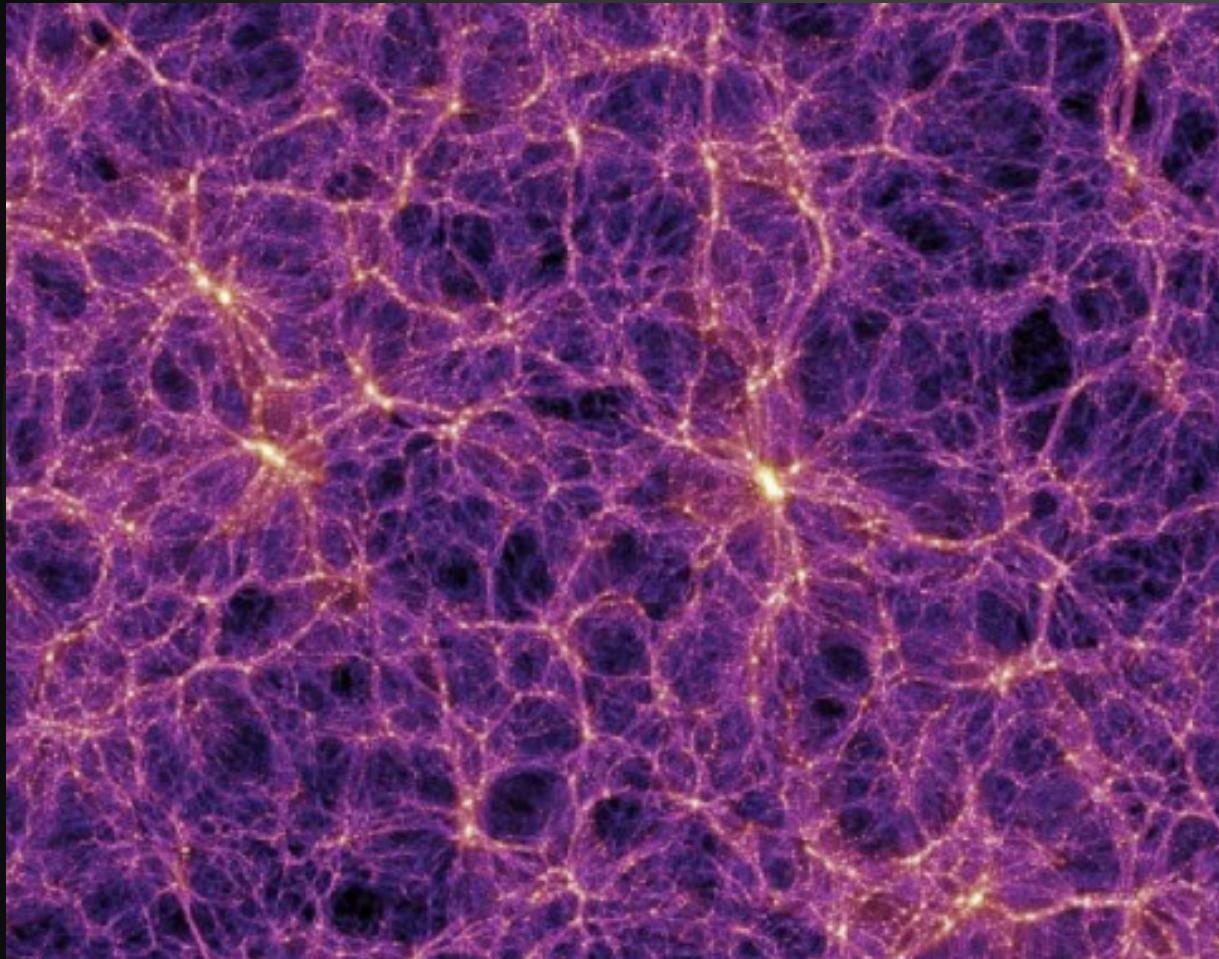
Tracing the Circumgalactic Medium in Ly α with COS

David M. French

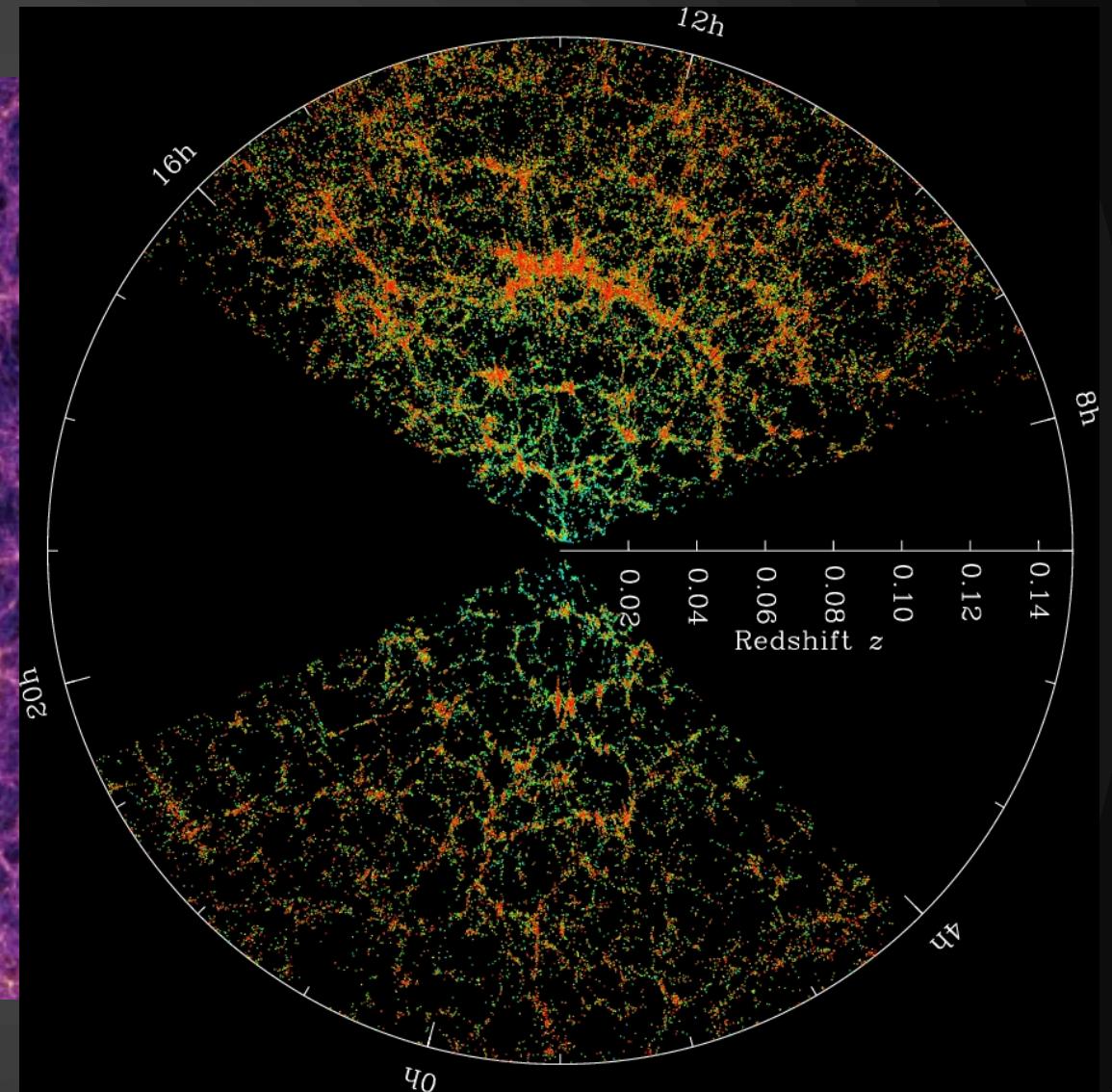
Thesis Advisor: Bart Wakker
University of Wisconsin - Madison

Jan 11, 2018

Gas + galaxies trace the same potential



The Millenium Simulation



SDSS Collaboration

Does the gas care about the galaxies?

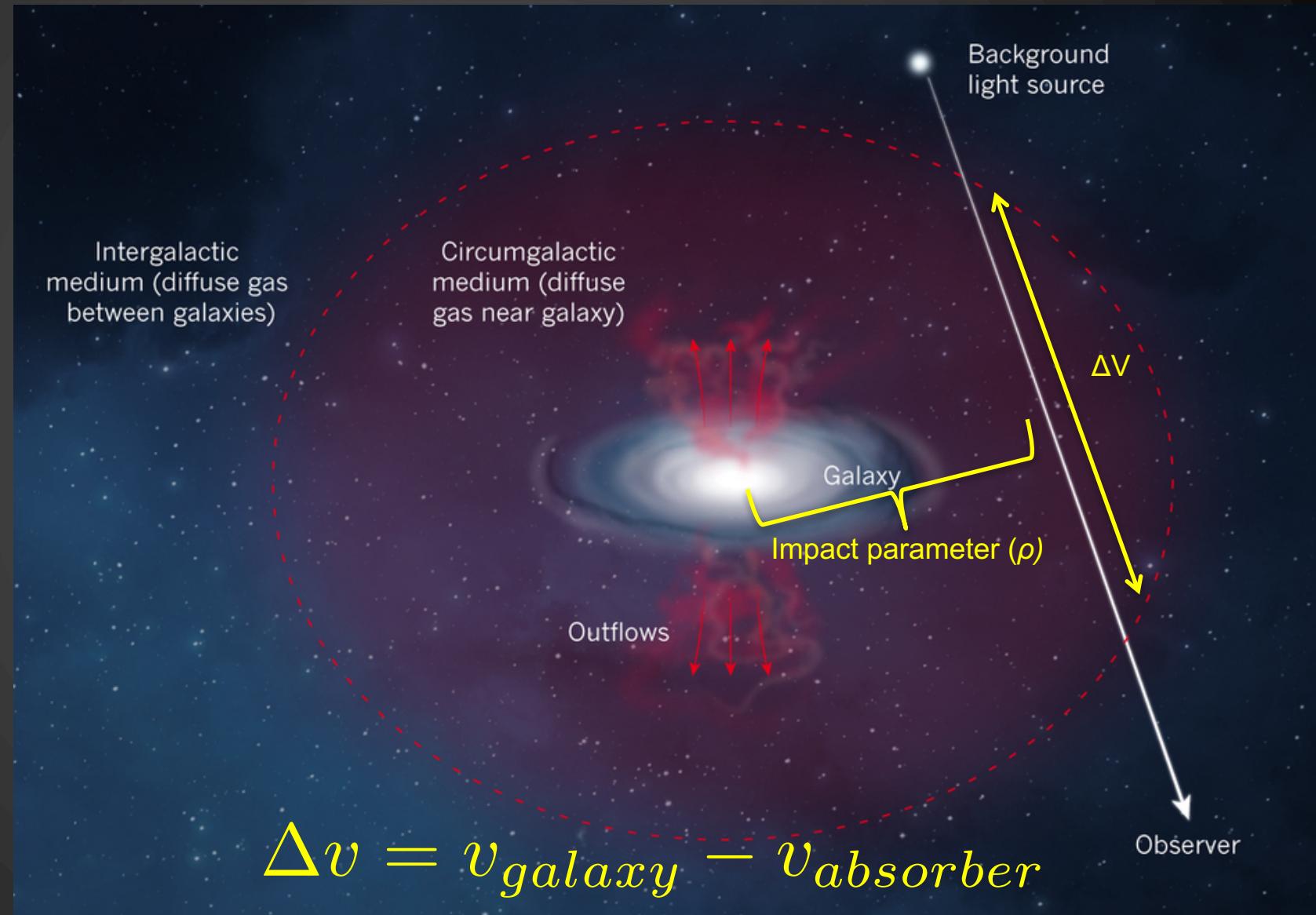
- Gas and galaxies follow the same DM potential
- Galaxies need to continue accreting gas over cosmic time to match observations
- Feedback kicks gas out of galaxies



★ How do the properties of halo gas correlate with nearby galaxy properties?

Probing the CGM with QSO absorption

- Relying on serendipitous QSO locations
- Build a sample of single galaxy-QSO pairs
- Impact parameter and ΔV give absorber position



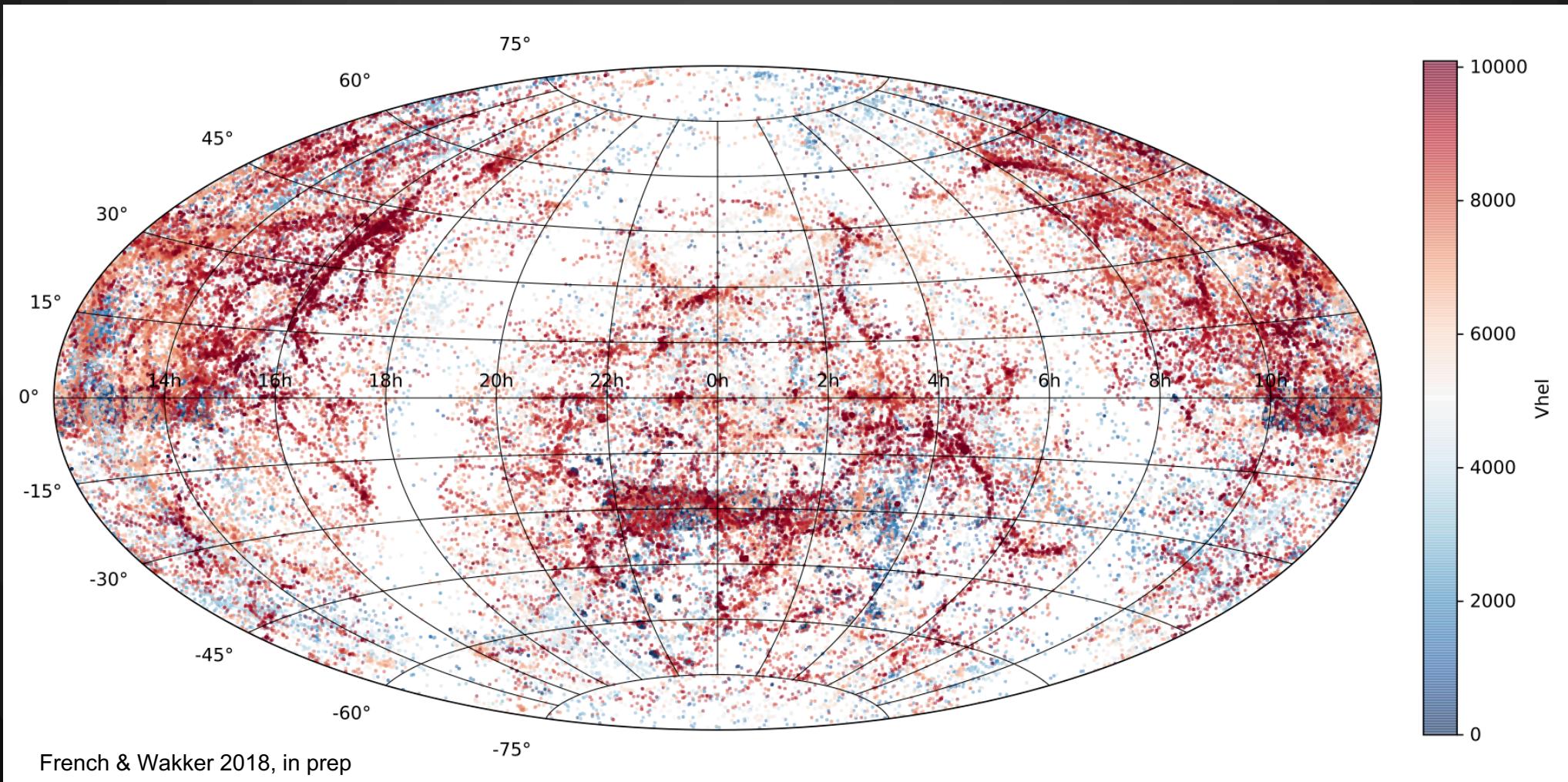
Science Outline

- Use archival COS sightlines (~700)
 - Concentrating on Ly-alpha lines
- Correlate with galaxy environment
 - Limit search to $cz < 10,000 \text{ km/s}$
- Ask
 - absorber(EW, velocity) vs galaxy properties (size, proximity, orientation)

First – New Nearby Galaxy Catalog

Gather and homogenize existing galaxy data

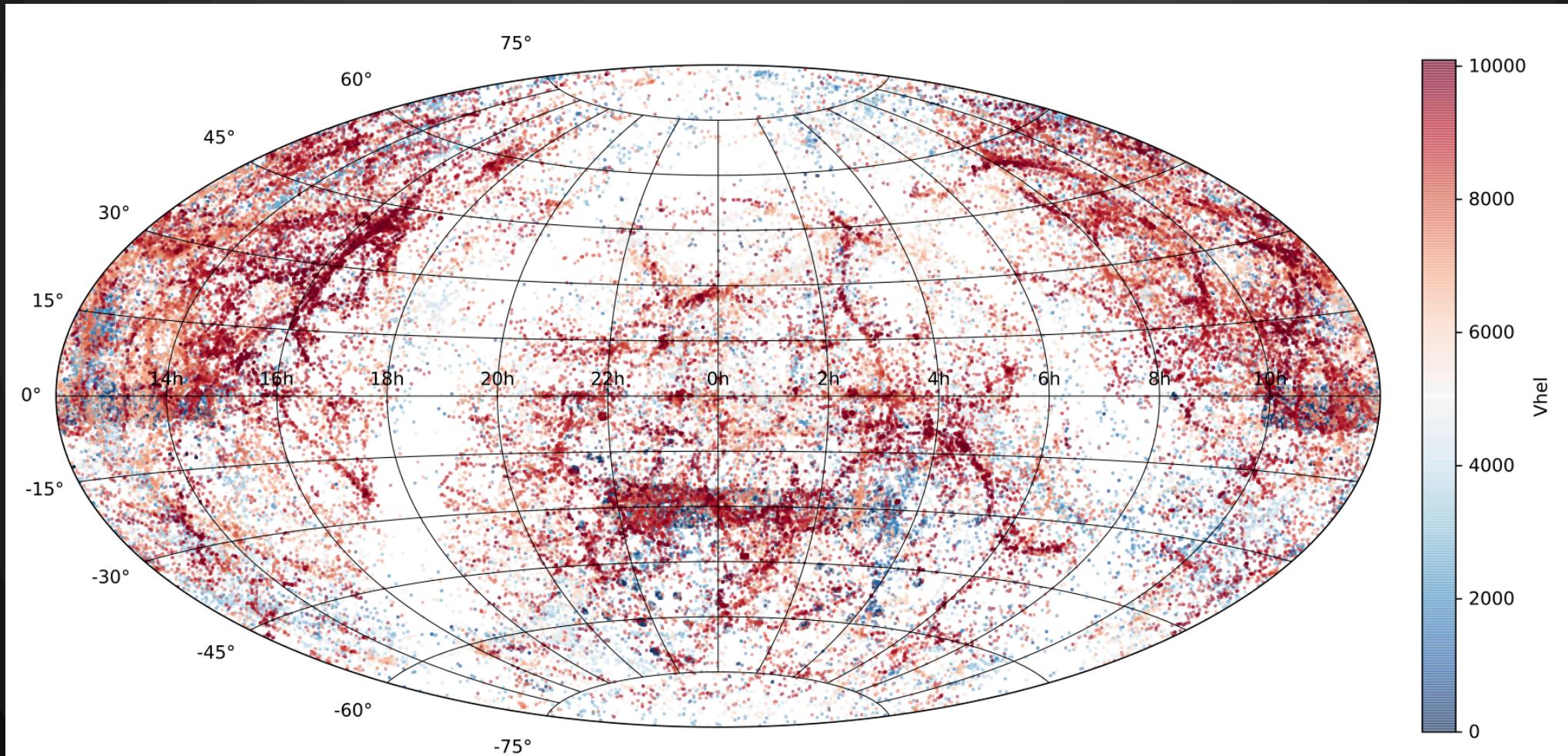
- NED + IRSA
- 130,000+ galaxies with $cz < 10,000$ km/s



New Nearby Galaxy Catalog

Homogenize existing data

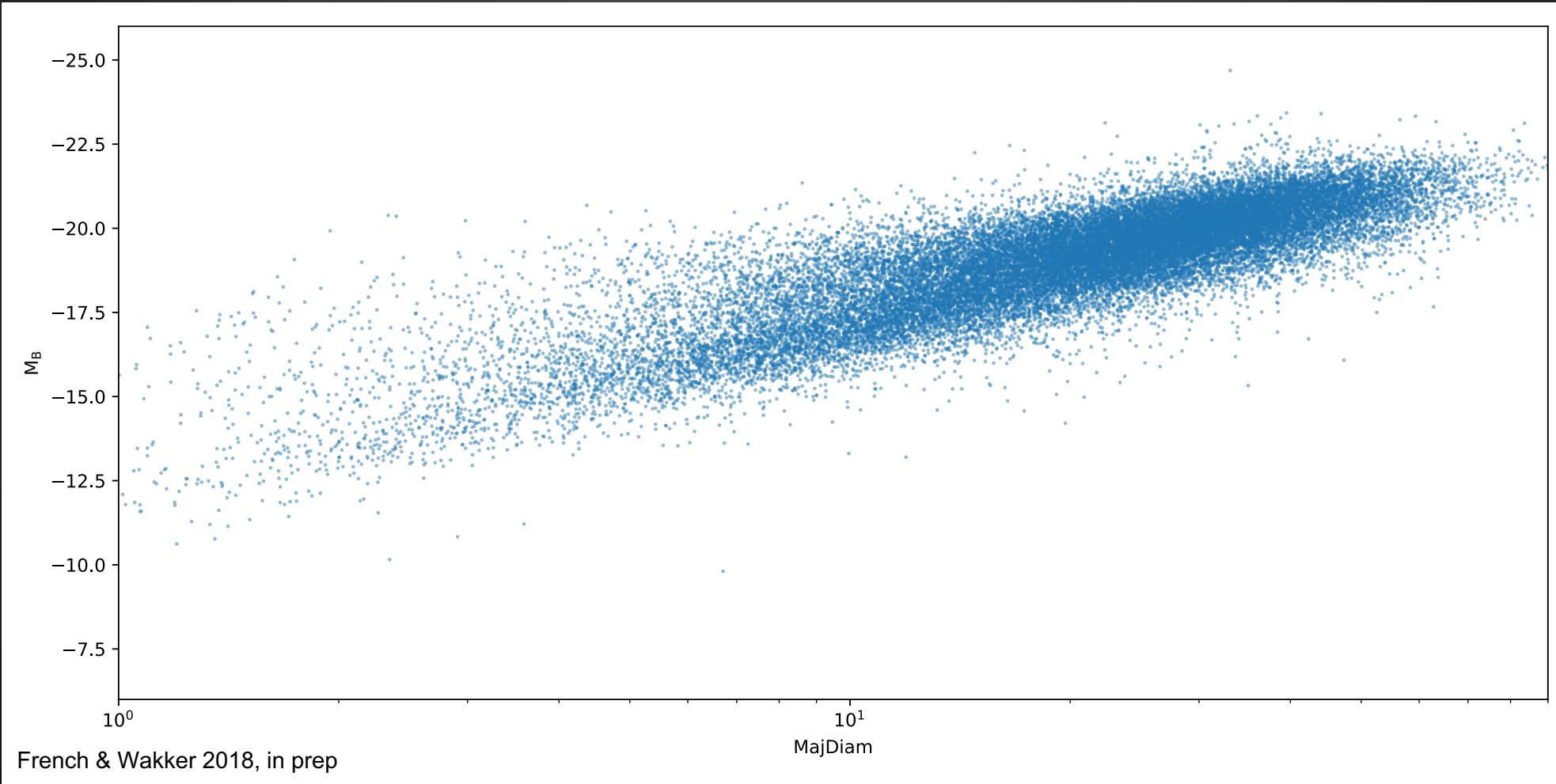
- Normalize diameters, inclination, PA to 2MASS values
- Choose magnitudes, calculate (L^* , R_{vir})



New Nearby Galaxy Catalog

Homogenize existing data

- Normalize diameters, inclination, PA to 2MASS values
- Choose magnitudes, calculate (L^* , R_{vir})

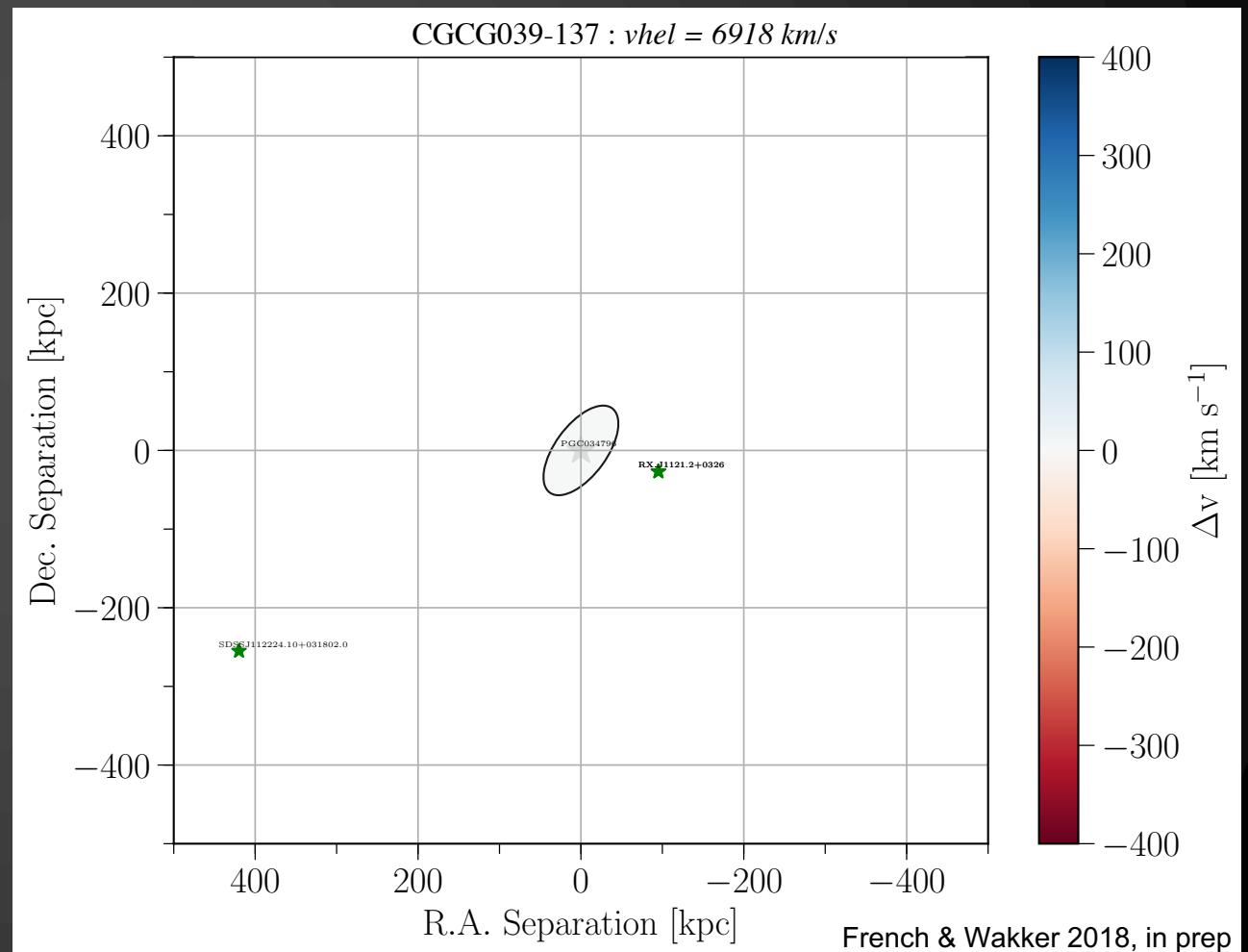


Step 2

Model the velocity structure probed by a QSO sightline

Model sightline velocity structure

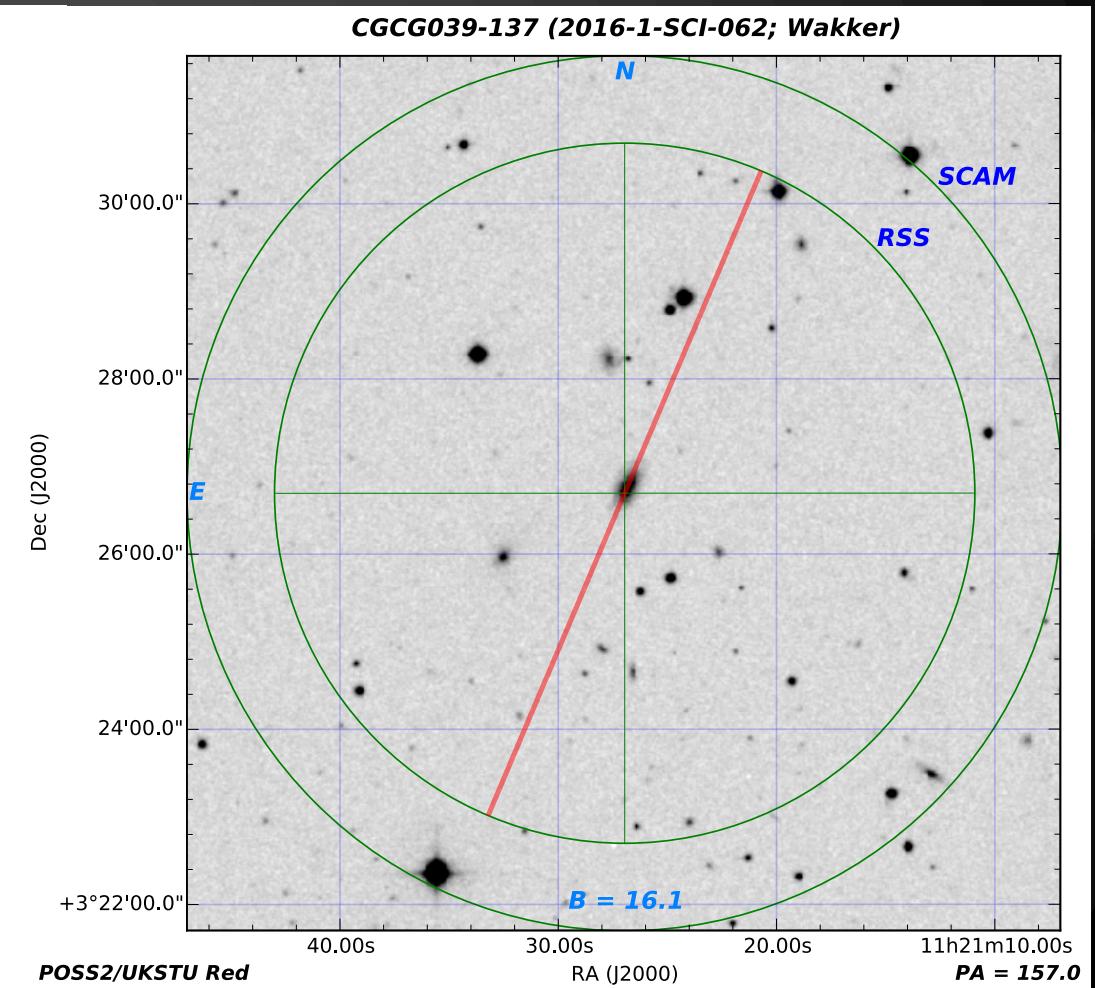
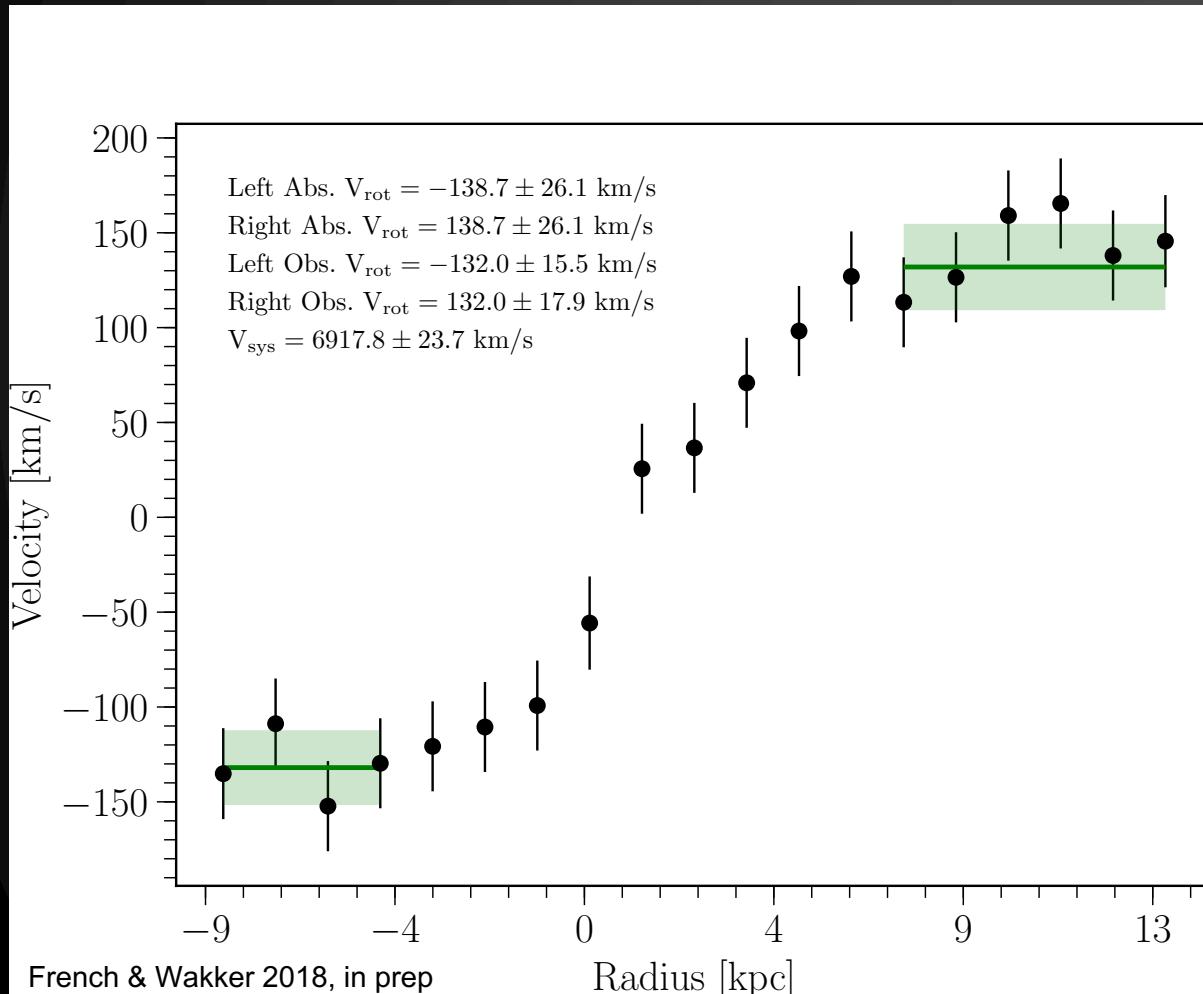
- Is there Halo – disk kinematic connection?



Model sightline velocity structure

The halo – disk kinematic connection

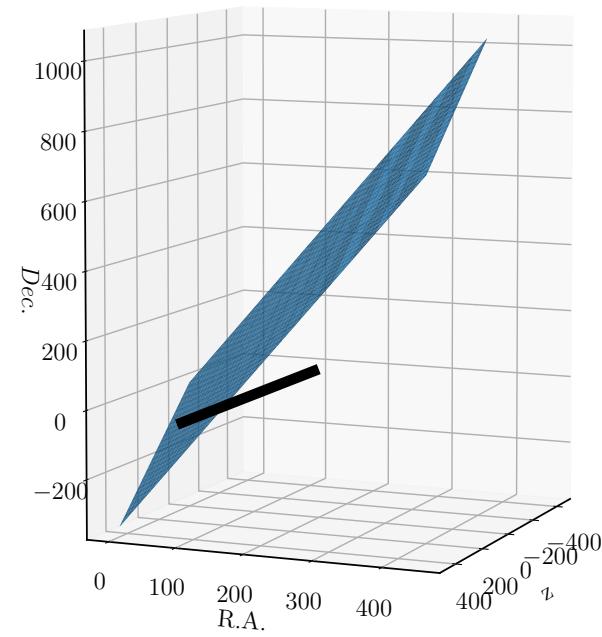
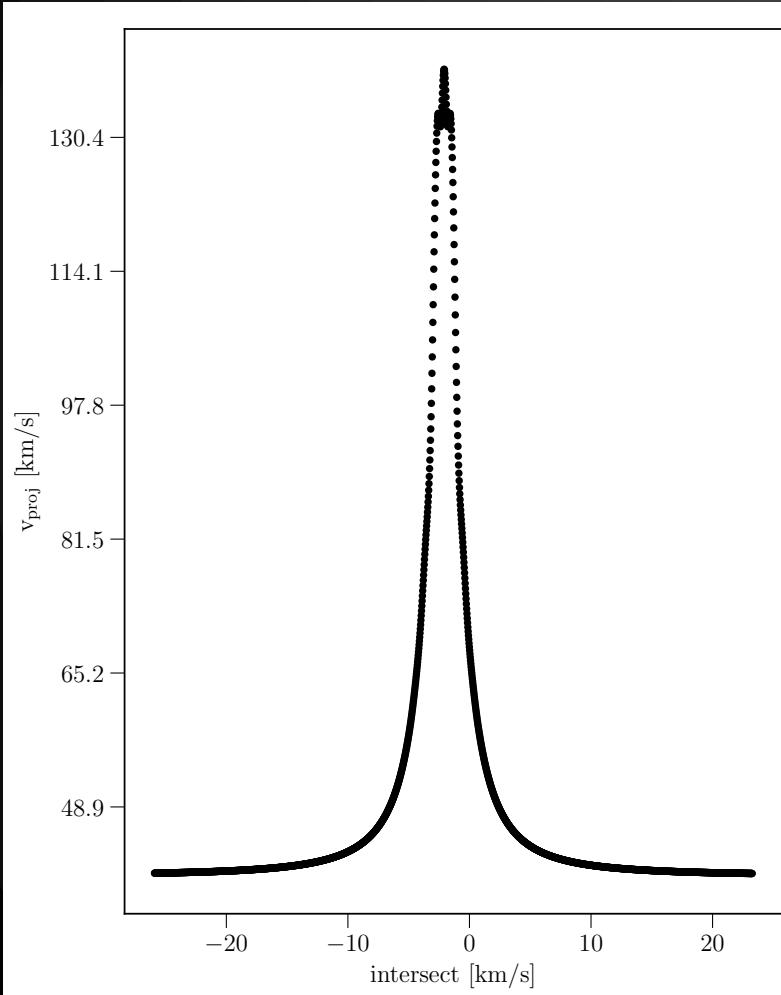
- Rotation curves from SALT



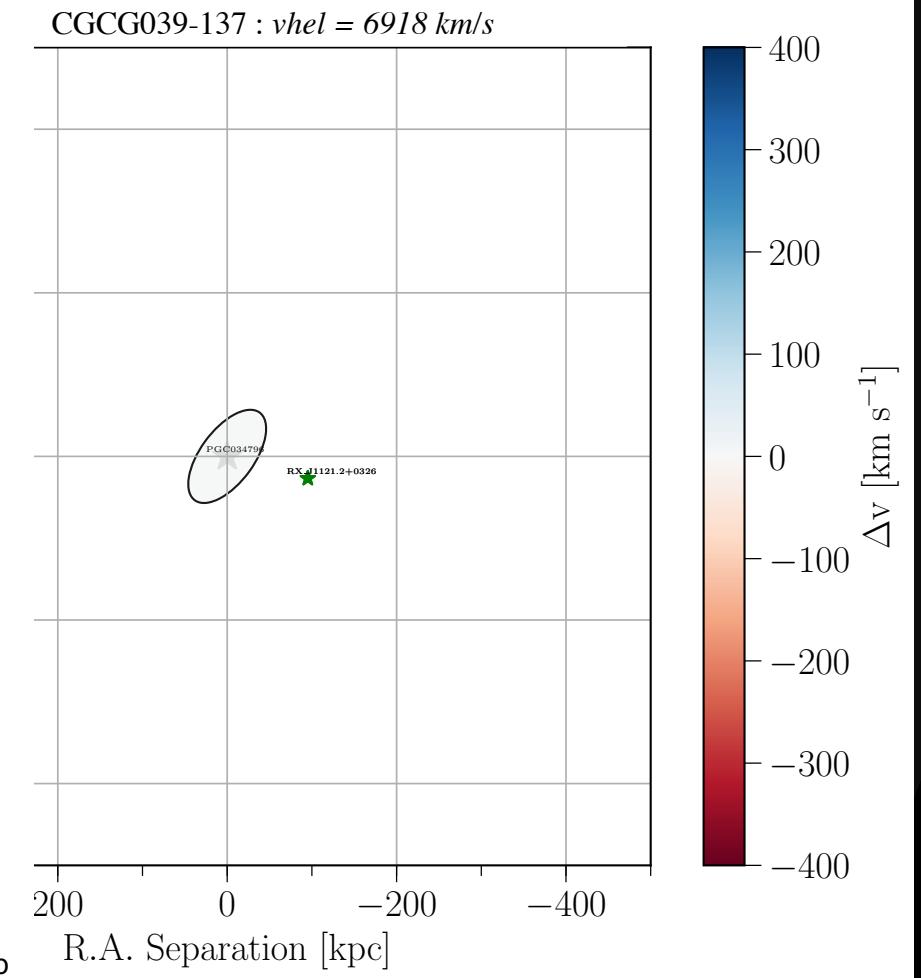
Model sightline velocity structure

The halo – disk kinematic connection

- Model the sightline velocity



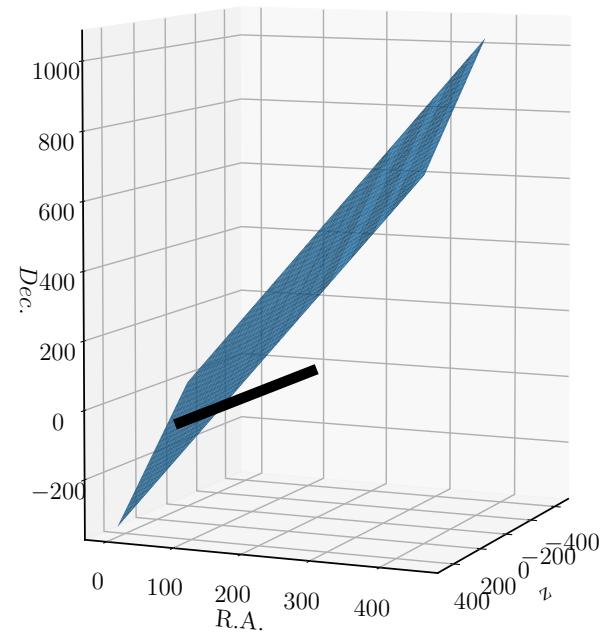
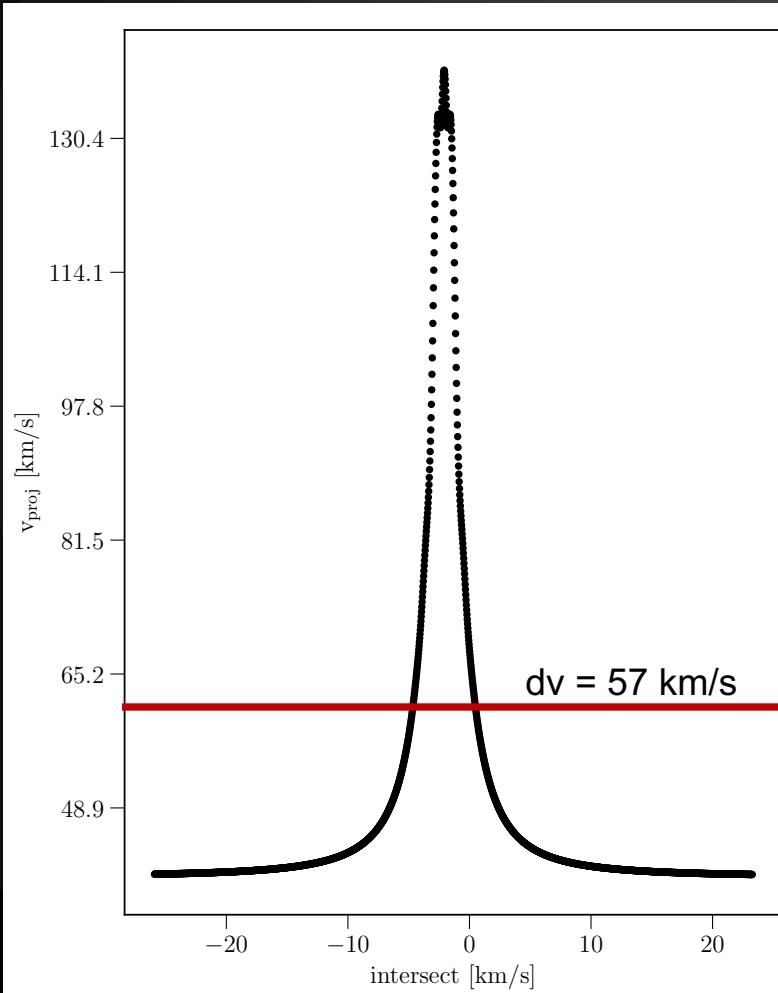
French & Wakker 2018, in prep



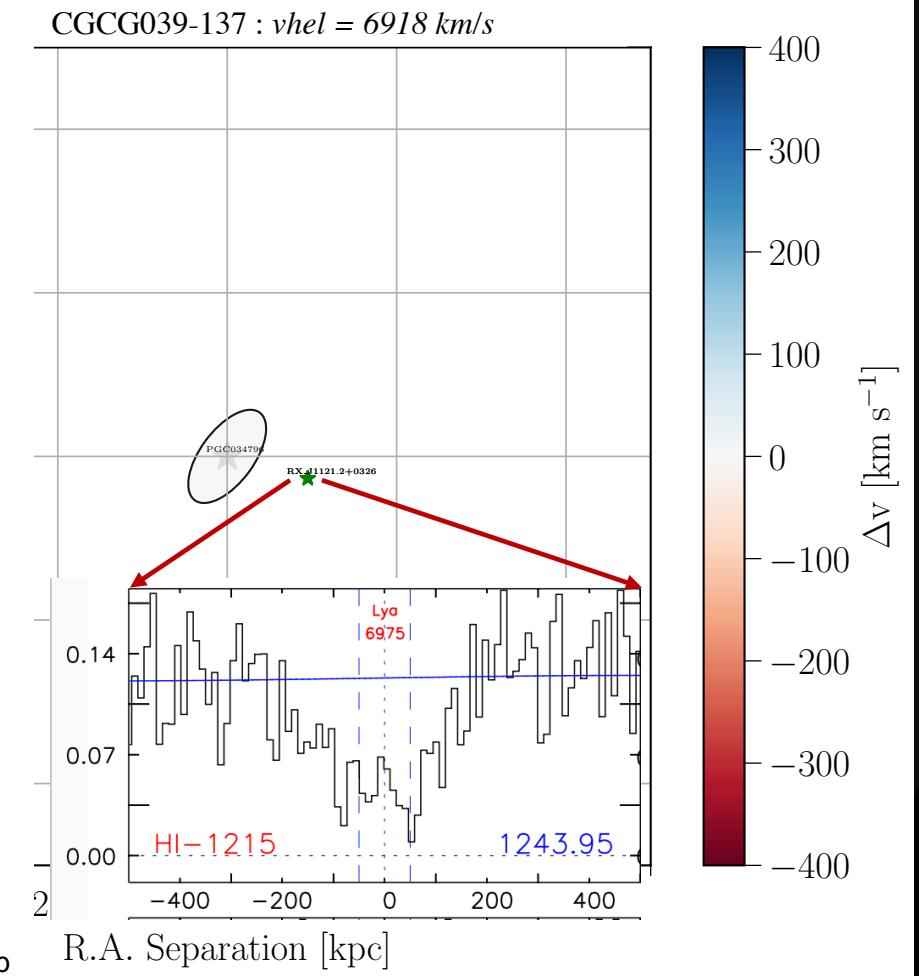
Model sightline velocity structure

The halo – disk kinematic connection

- Model the sightline velocity

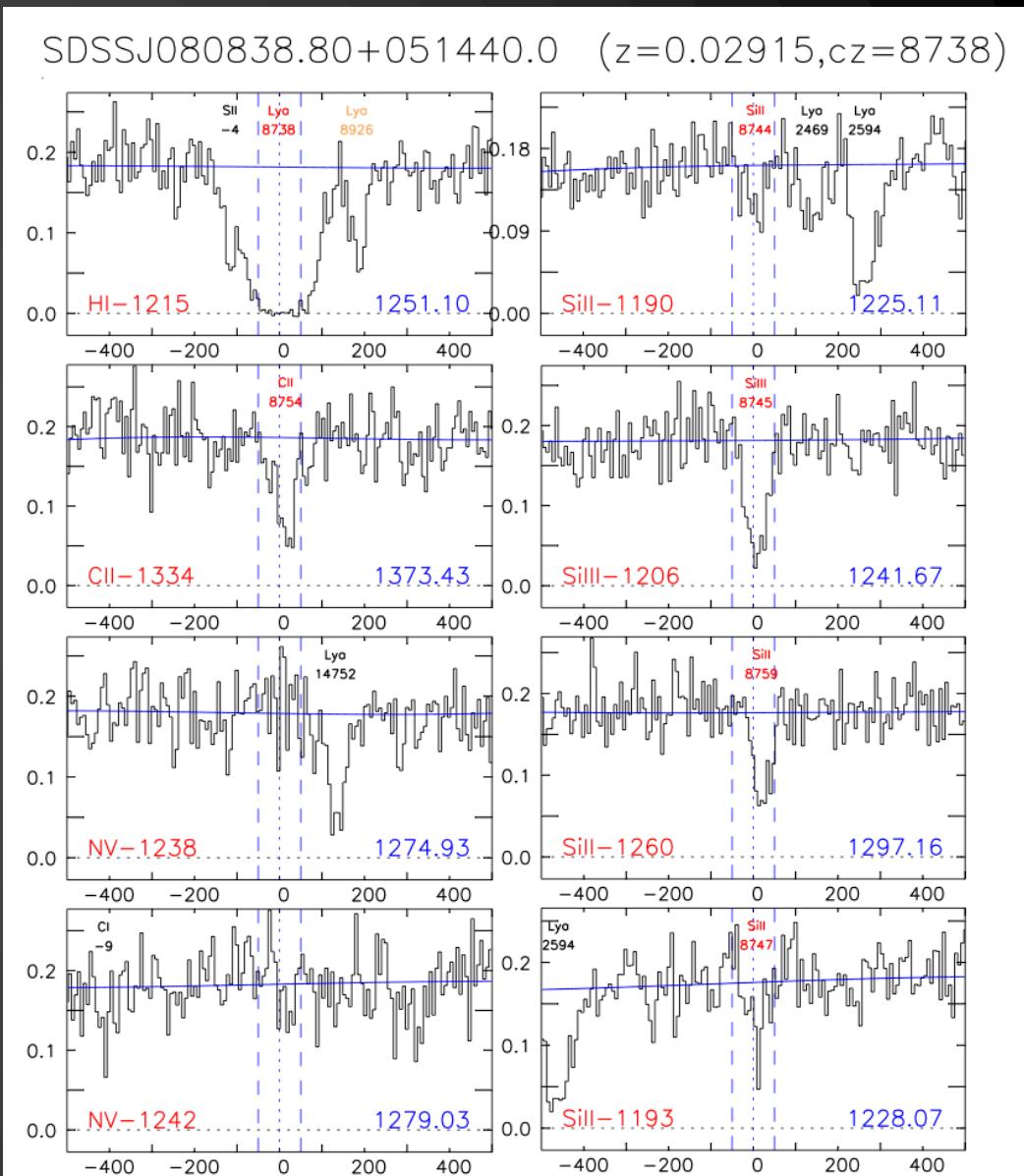


French & Wakker 2018, in prep



Catalog the absorbers

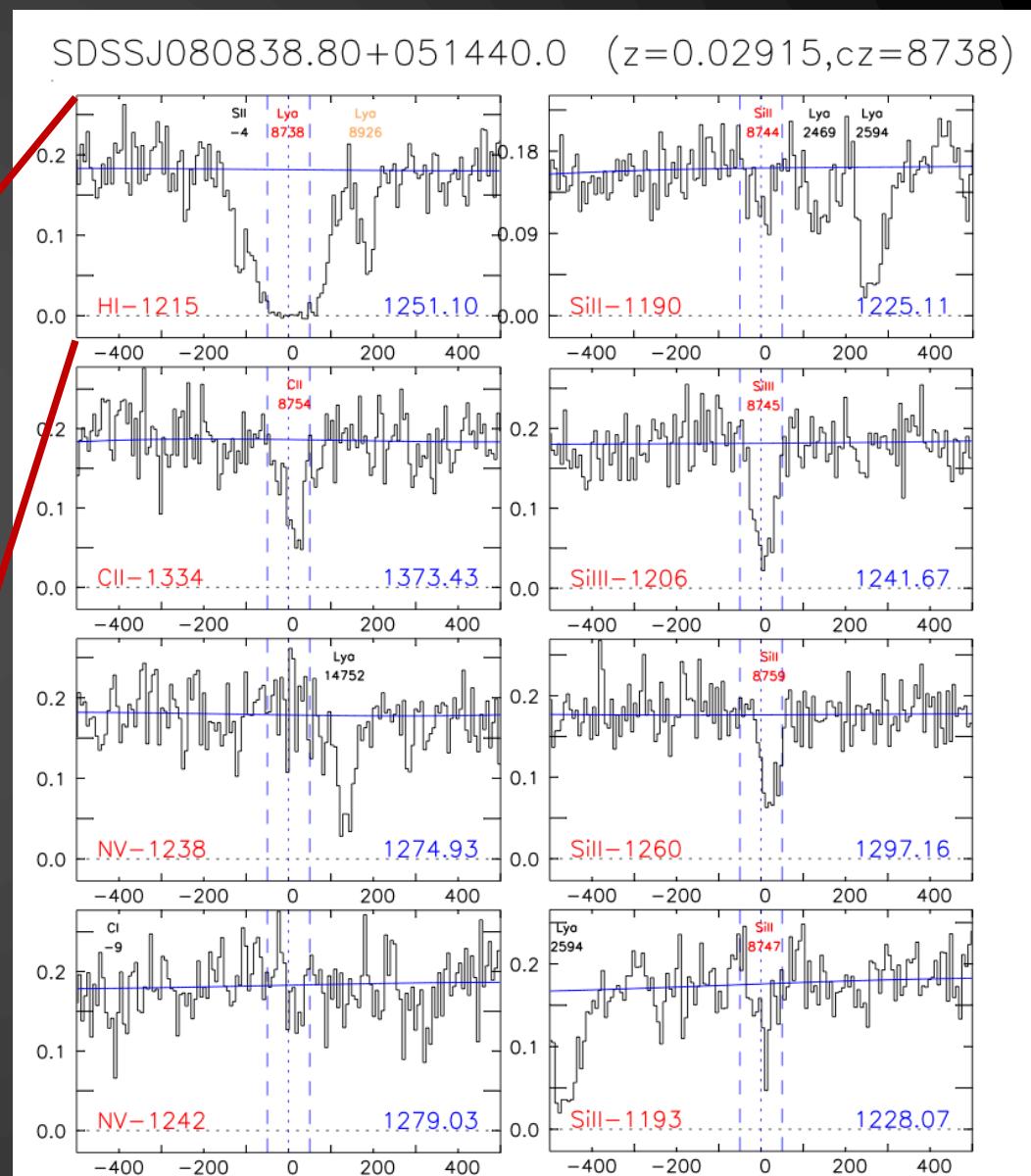
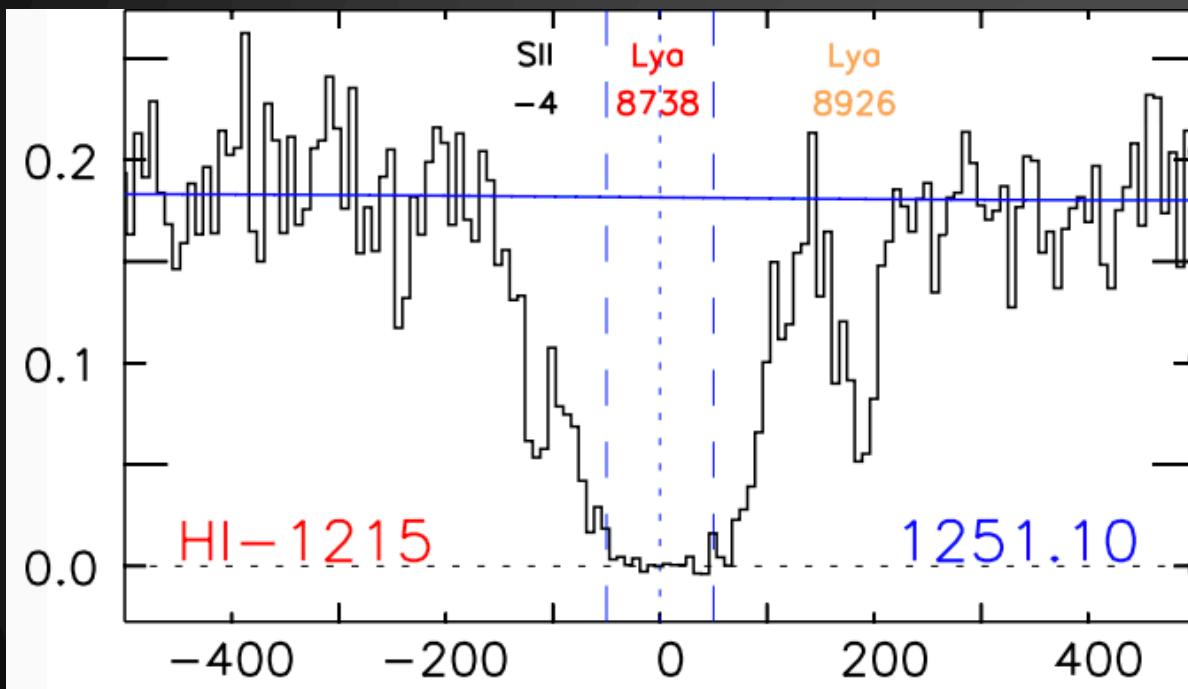
- 700+ G130M COS targets
 - Align, identify and measure all lines



Catalog the absorbers

- Connecting with galaxies

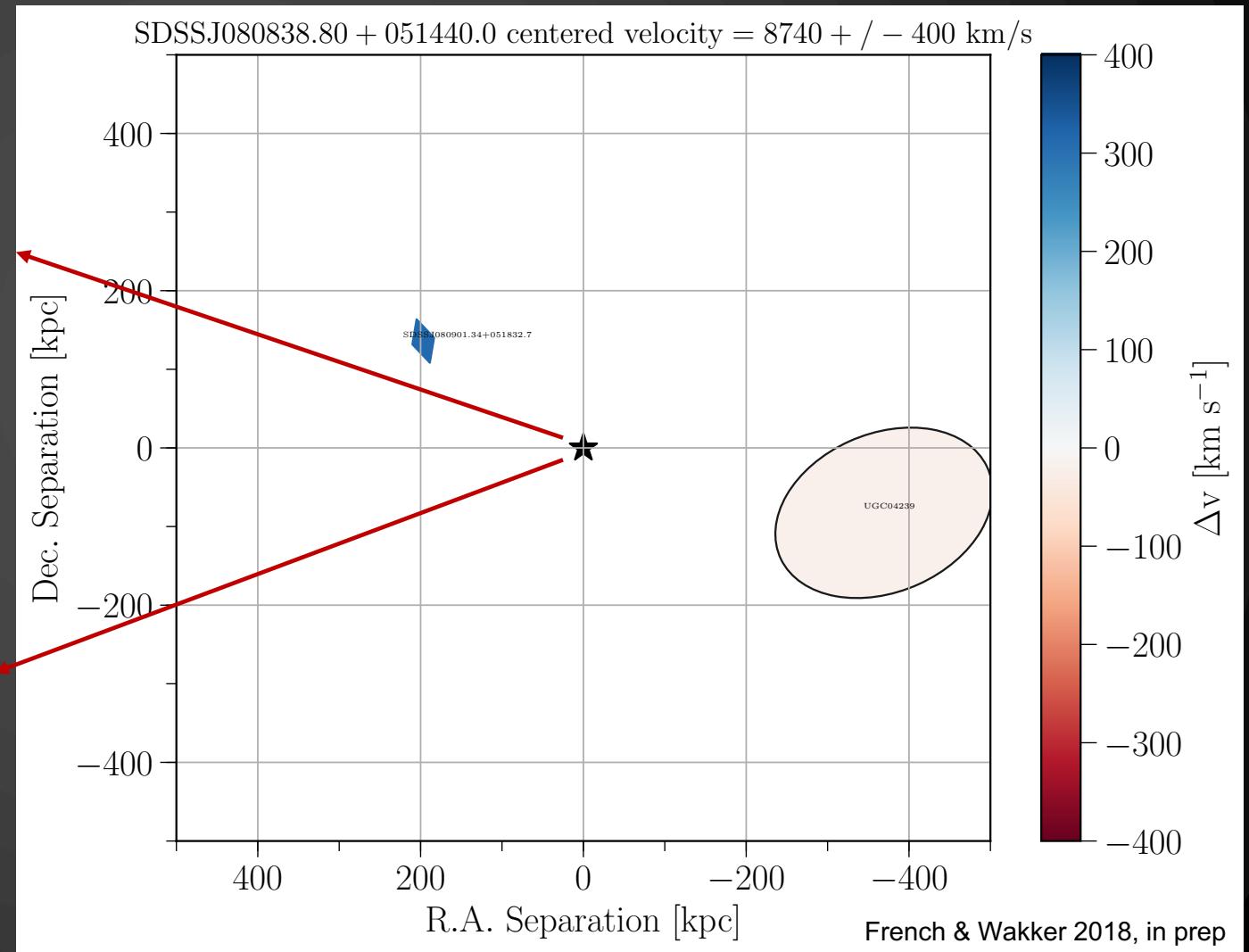
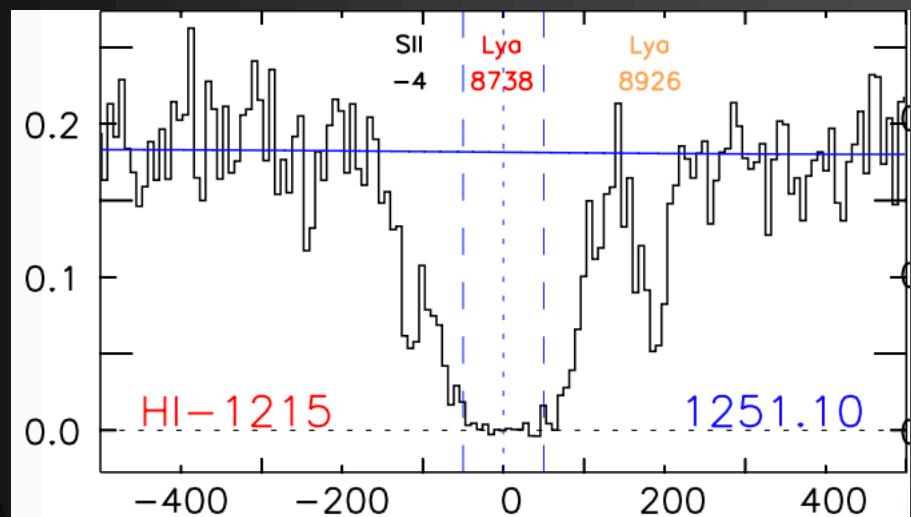
- How?



Catalog the absorbers

Connecting with galaxies – using our galaxy catalog

- Which one?



Matching absorbers with galaxies

Define an objective likelihood parameter

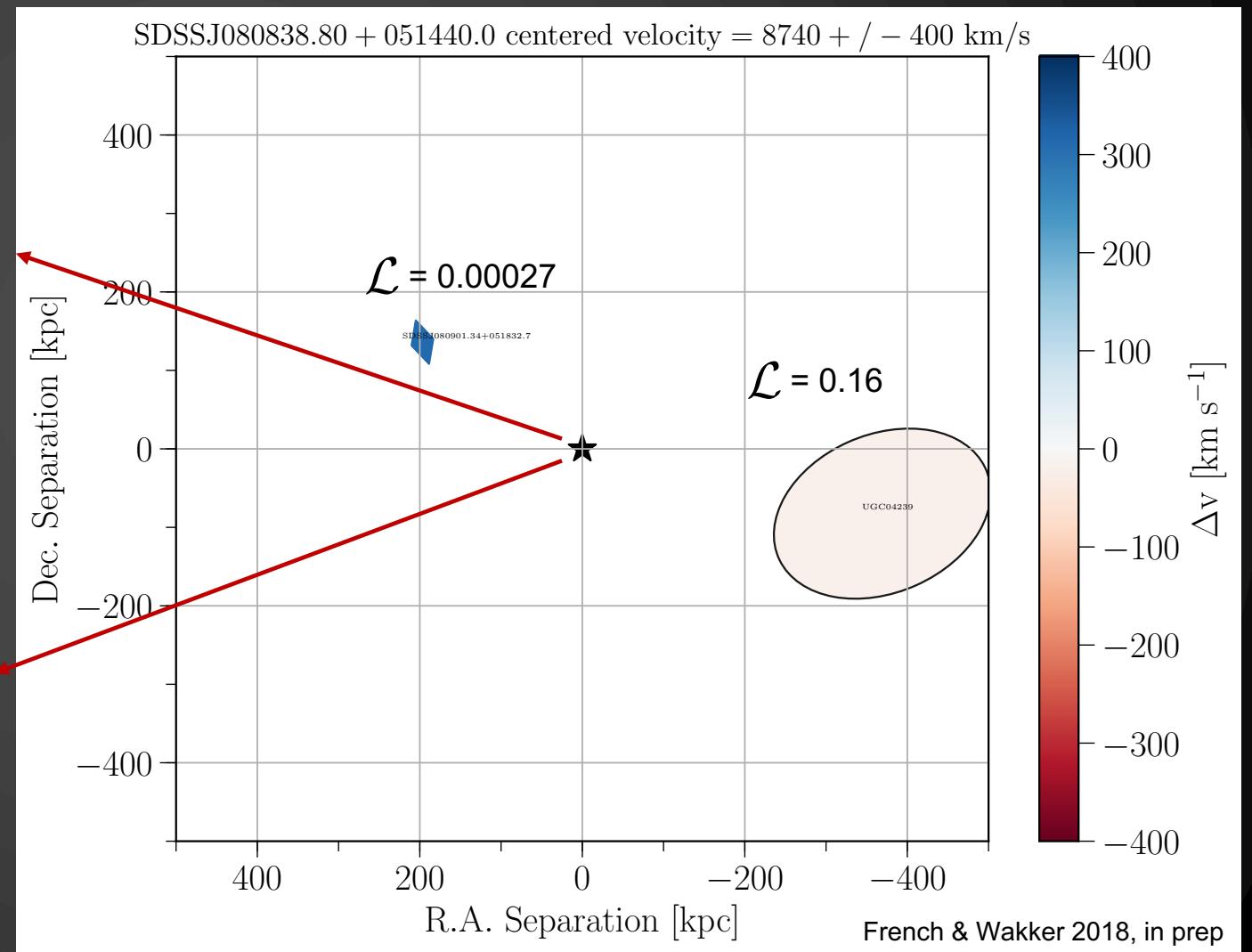
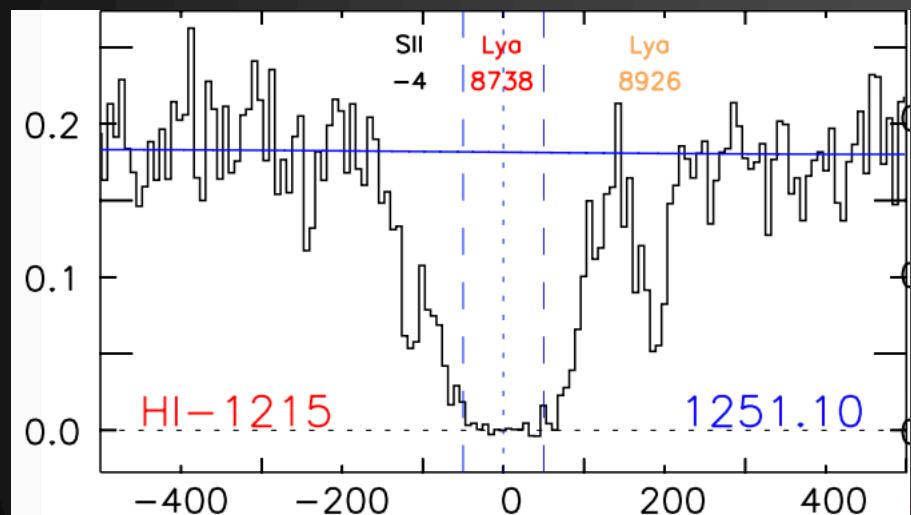
- Define a likelihood:

$$\mathcal{L} = e^{-\left(\frac{\rho}{R_{vir}}\right)^2} e^{-\left(\frac{\Delta v}{200}\right)^2}$$

- ρ = impact parameter
- $\Delta v = v_{galaxy} - v_{absorber}$
- R_{vir} = viral radius of the galaxy

Matching absorbers with galaxies

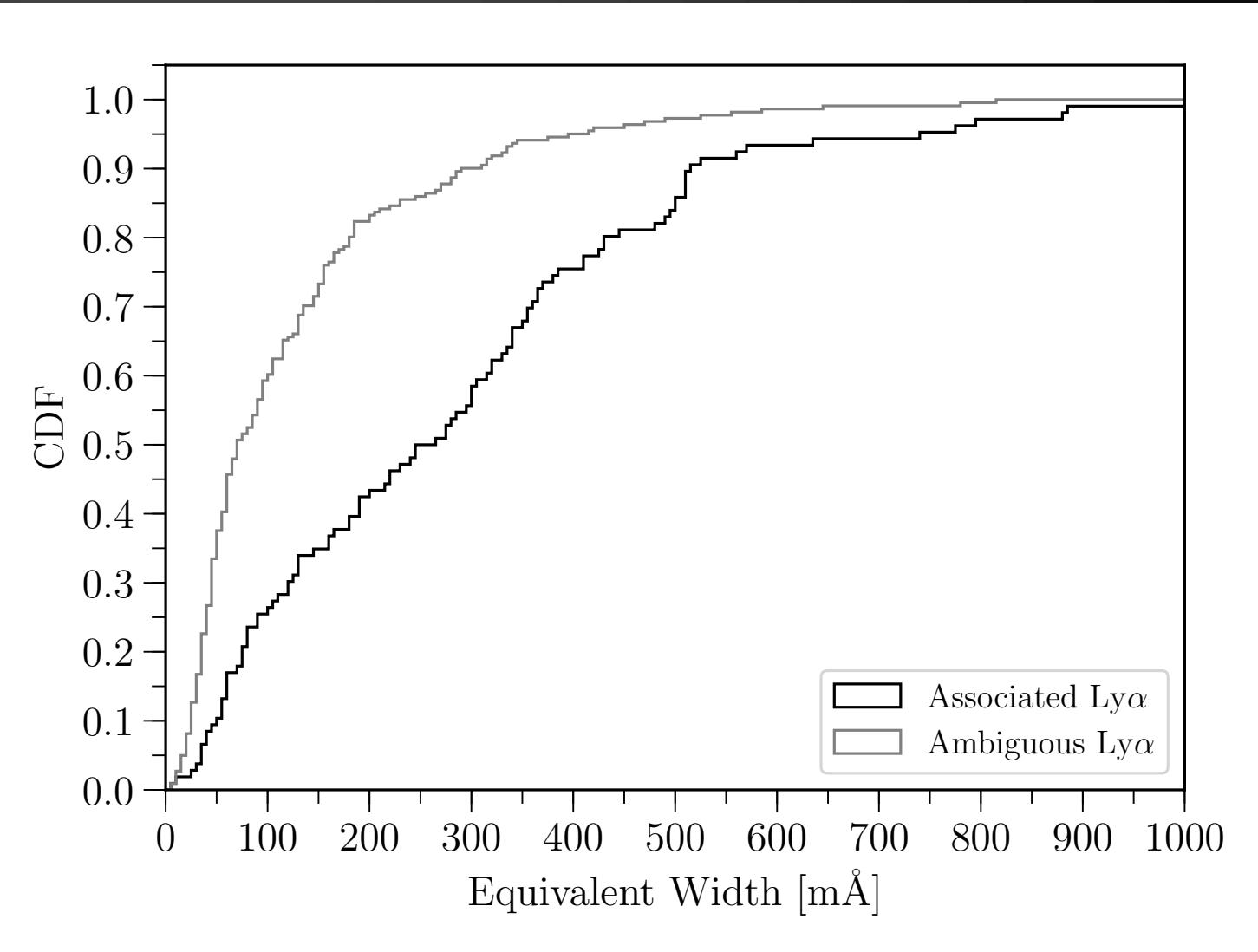
Applying the likelihood method



Preliminary Results

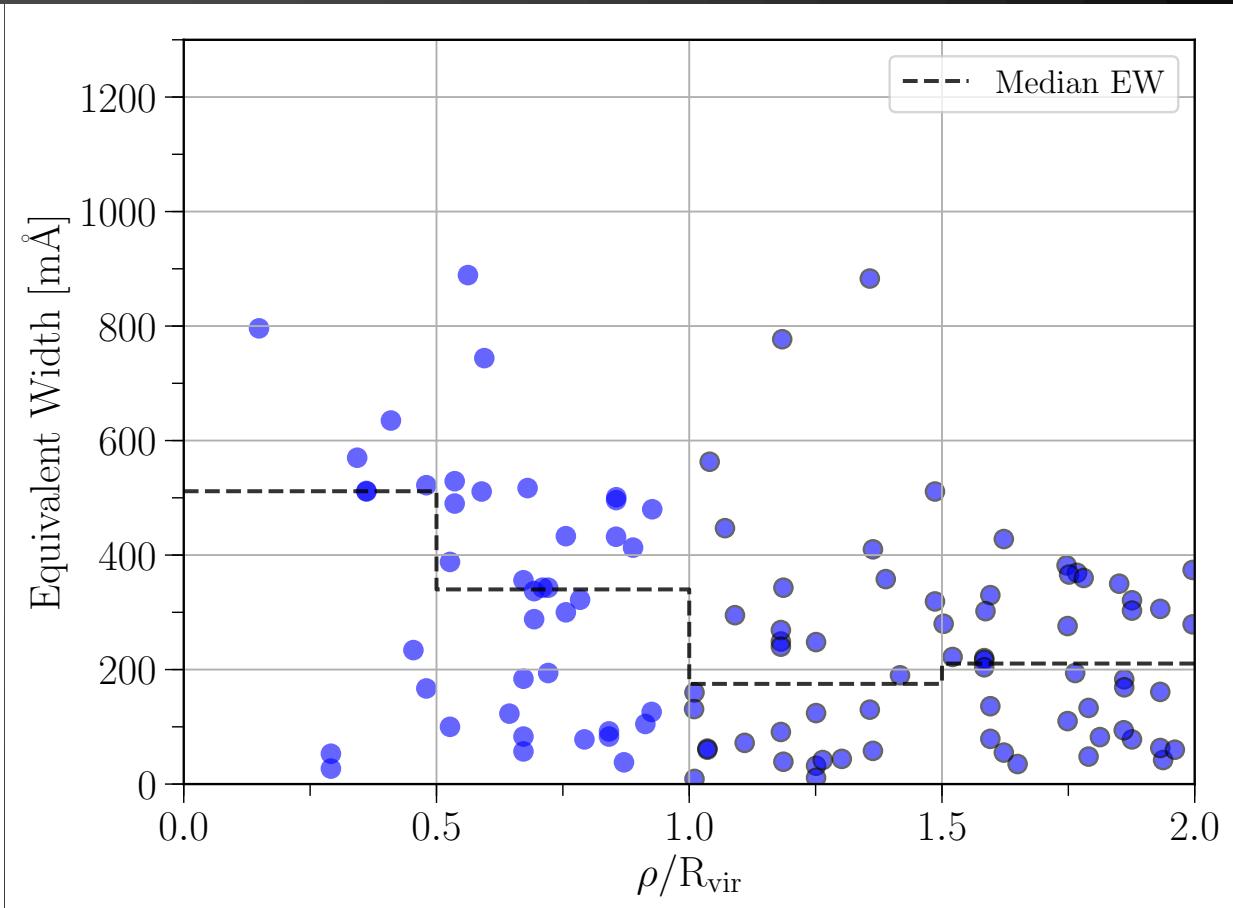
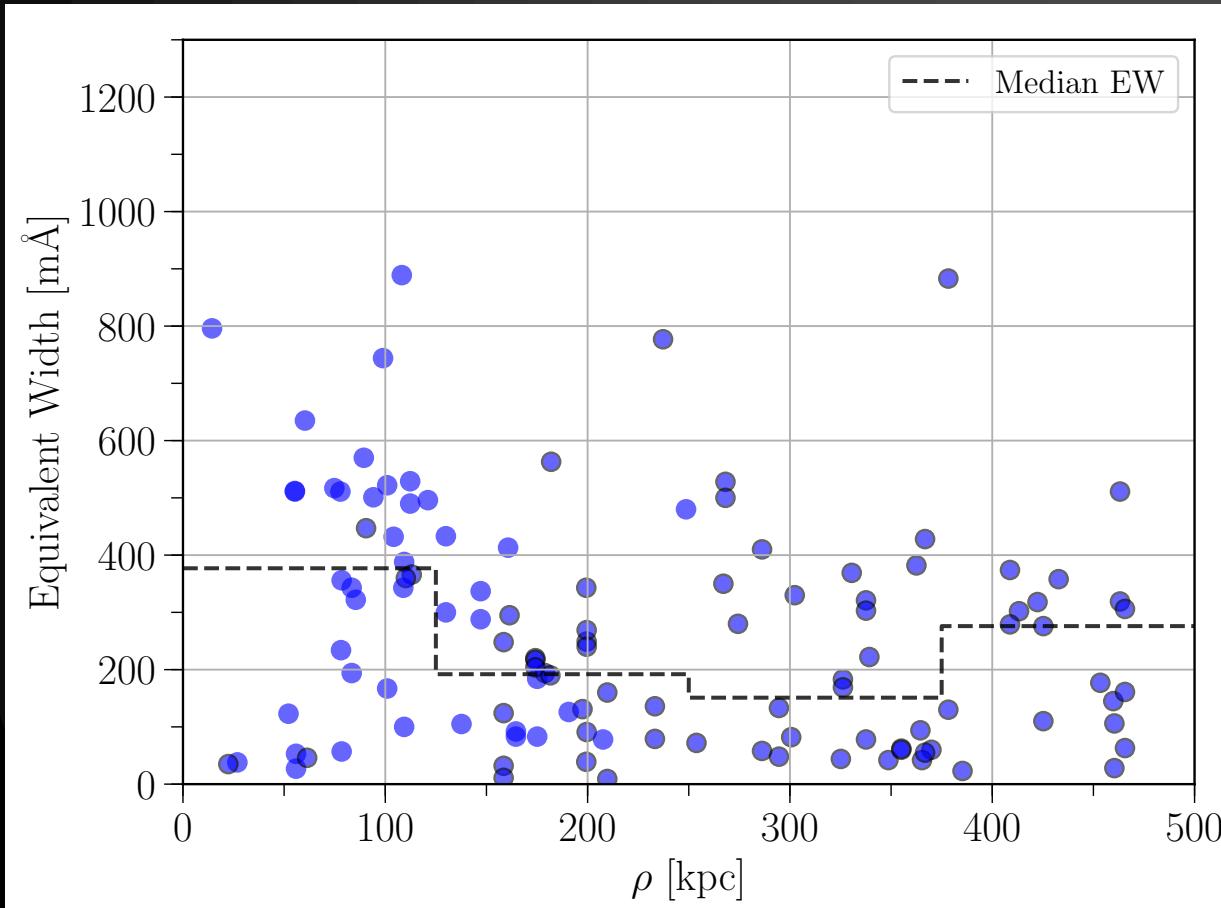
Status:

- **237 spectra aligned and identified**
 - 1067 Ly-alpha absorbers
 - 331 measured
 - 116 "associated" with a single galaxy



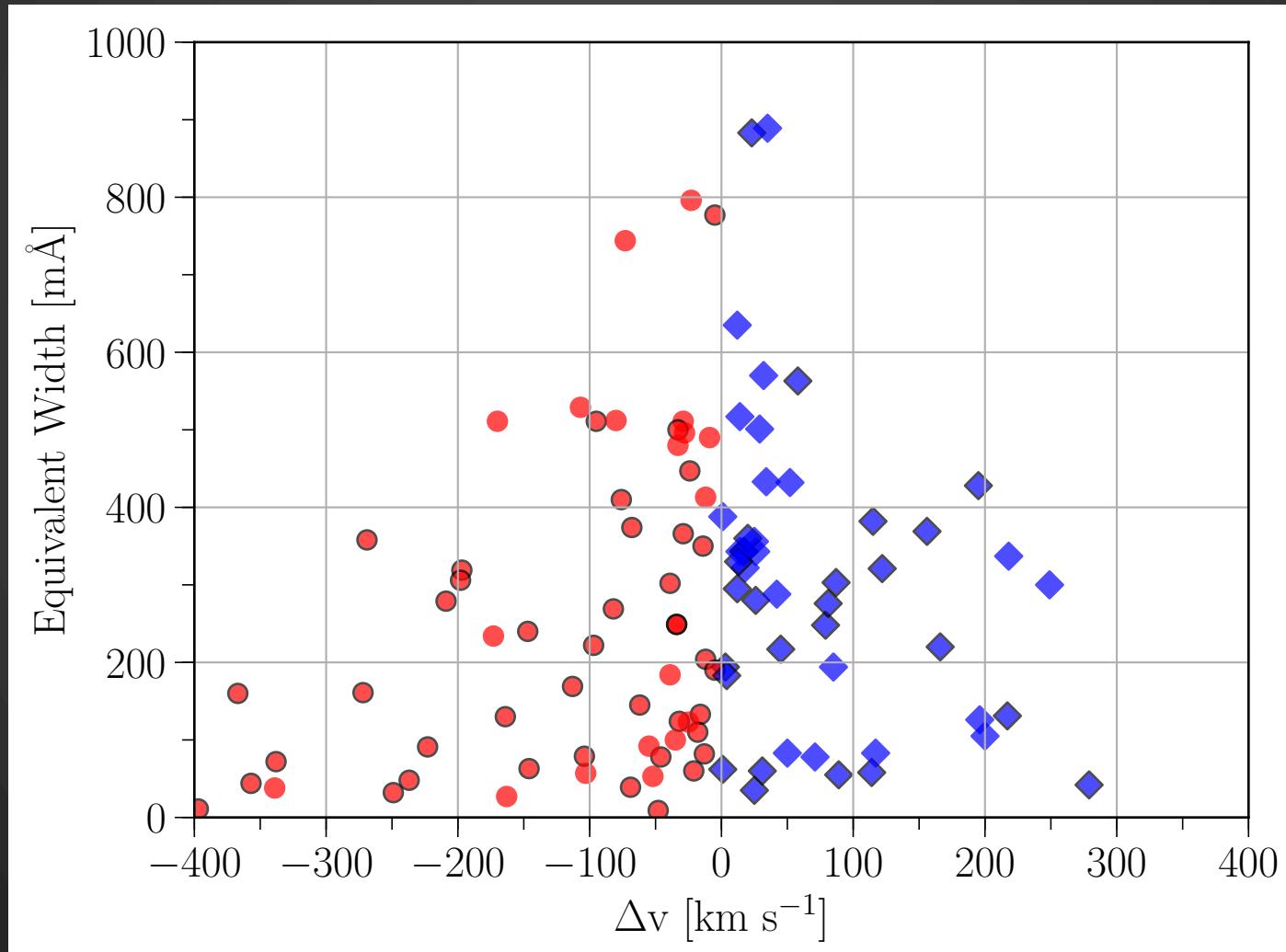
Preliminary Results

EW vs impact parameter:



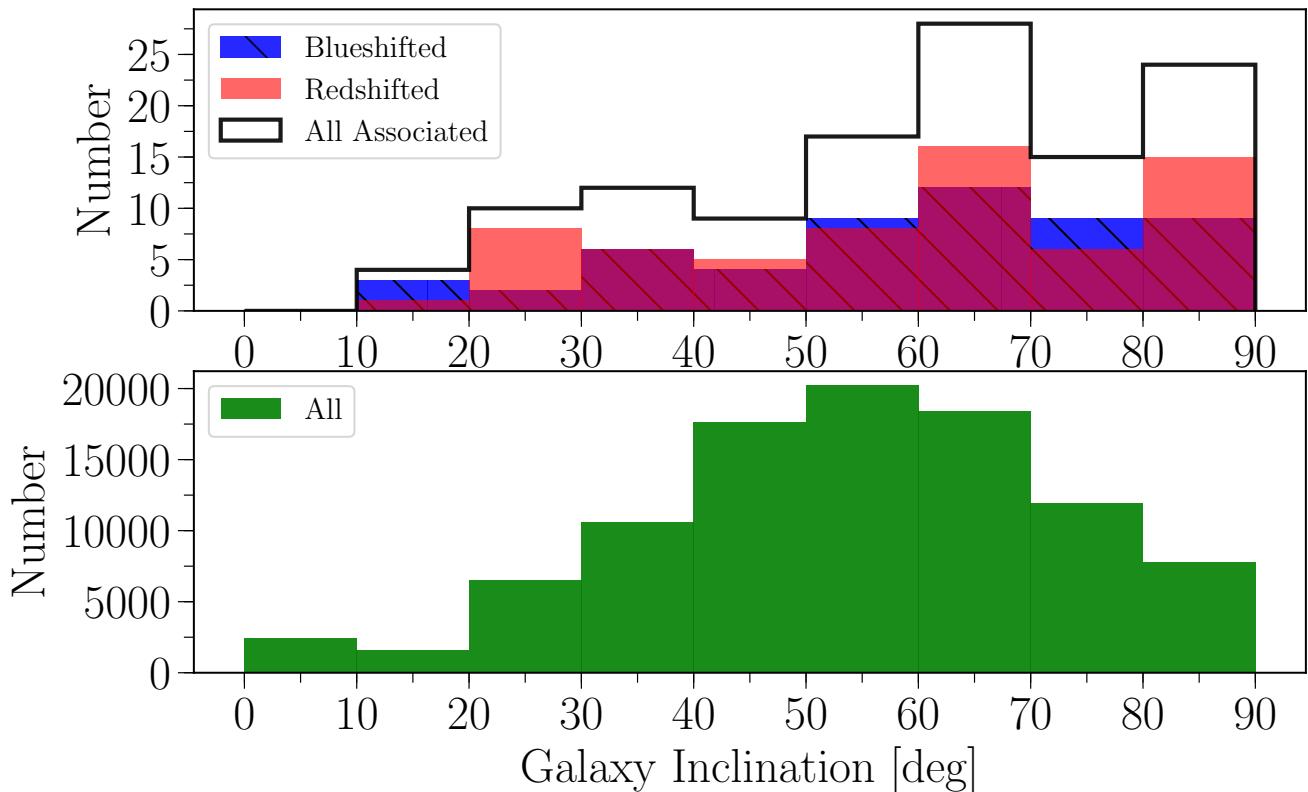
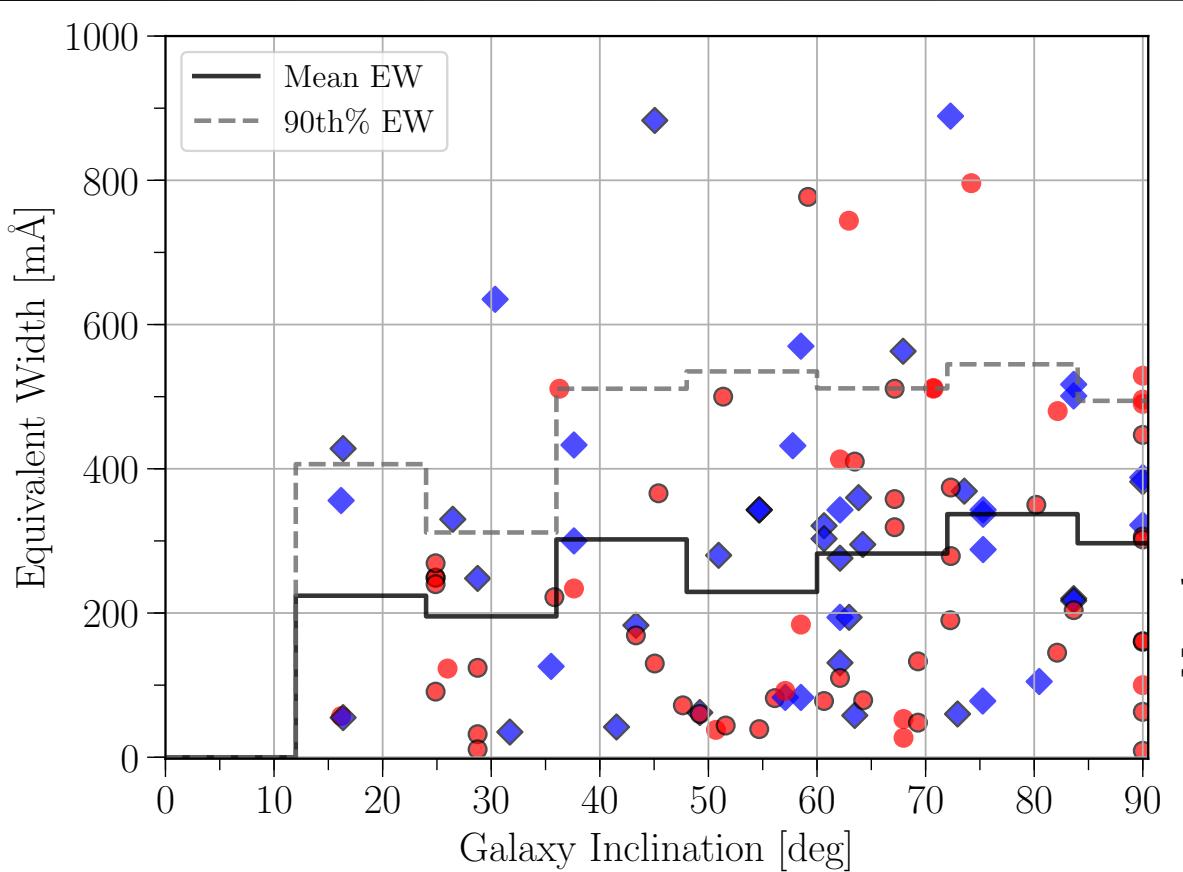
Preliminary Results

EW vs velocity separation:



Preliminary Results

Inclinations:



Summary:

- **700+ COS spectra correlated with 130,000+ galaxies**
 - Expect ~3000 Ly-alpha absorbers
 - ~1000 absorber-galaxy pairs using likelihood method
 - Strong EW – ΔV correlation
 - Overabundance around highly inclined galaxies
- **Disk-halo kinematic connection?**
 - Probably not very far reaching
- **Does CGM gas care about galaxies?**
 - It seems like it might! Stay tuned.

