Abstract

FeLoBAL quasars occupy less than 2% of the quasar population, but because their outflows can be more powerful than HiBAL or LoBAL quasars, studying them can provide valuable information about the effect of quasar outflows on galaxy evolution. In this presentation, I discuss a sample of ten high-redshift, high-luminosity FeLoBAL quasars, doing in in-depth analysis of the physical absorption properties for five objects. I outline the fitting process, which uses the novel spectral synthesis code SimBAL, and describe in detail the six absorption parameters used to model the broad absorption lines of the objects. Each final model is discussed in terms of its physical parameters. We find a wide range of ionization parameters and densities among our objects and no apparent correlation between outflow strength and these two parameters. We note that objects with low densities tend to have low ionization parameters and that objects with high densities tend to have high ionization parameters. We note a similarly diverse spread of column densities, though our objects may lie closer to the hydrogen ionization line than others previously studied. A further analysis of the remaining 21 objects will be conducted in the future, and further study of physical parameter correlations can be done once all objects have been modeled.

Analysis of Physical Properties of High-Redshift High-Luminosity FeLoBAL Quasars

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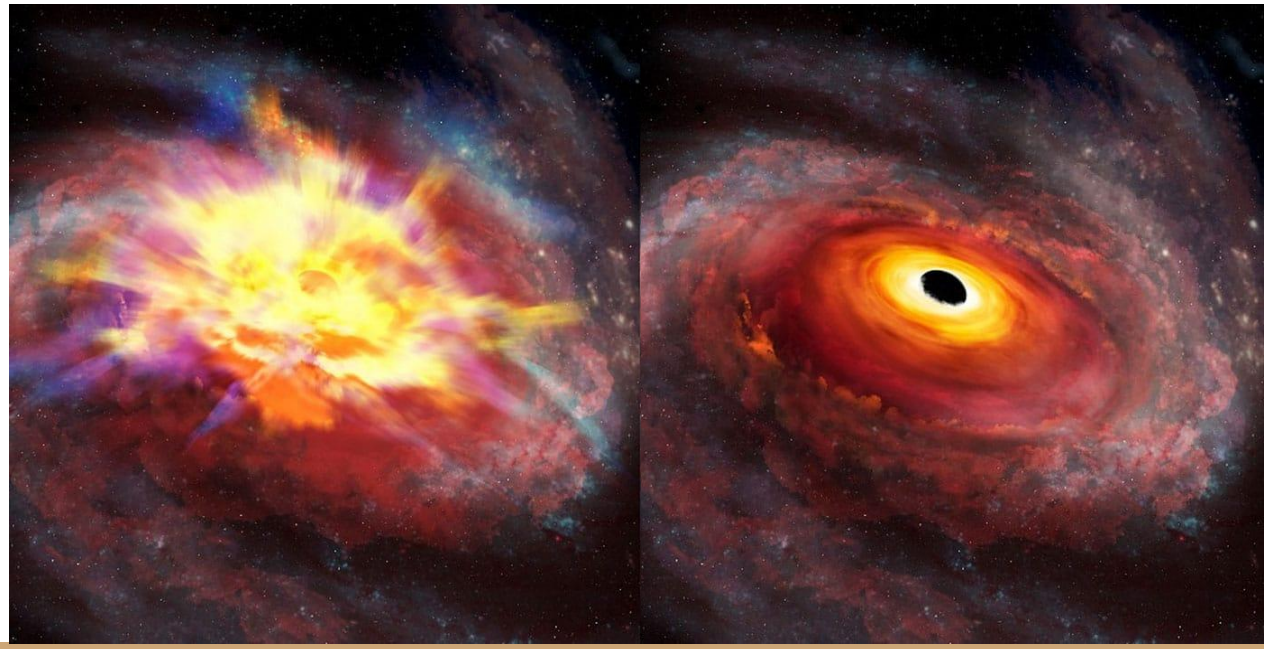
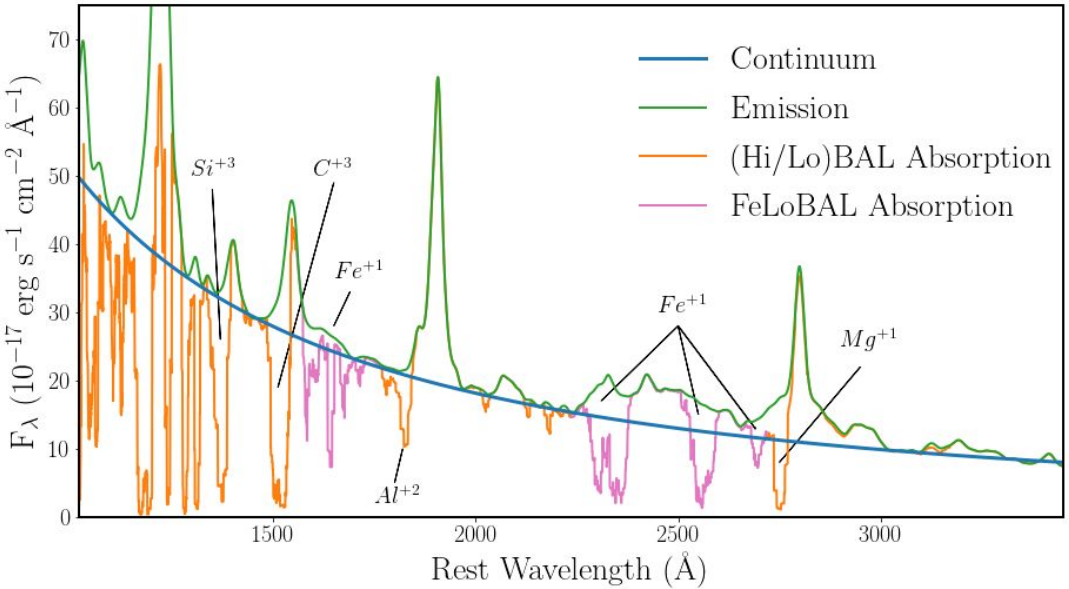
What are Quasars?

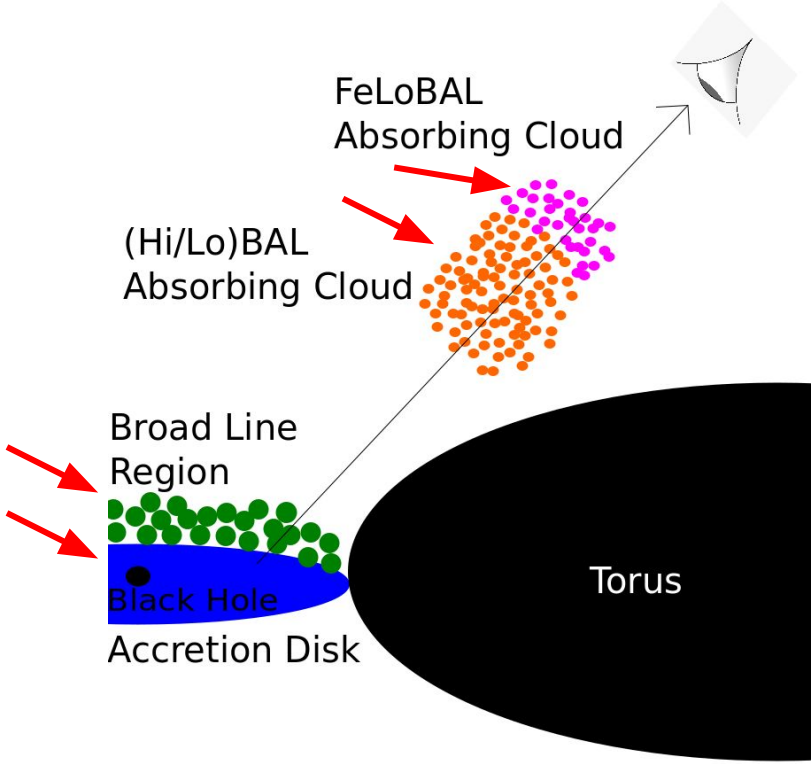
- Brightest class of active galactic nuclei (AGNs)
  - Actively accreting central supermassive black holes



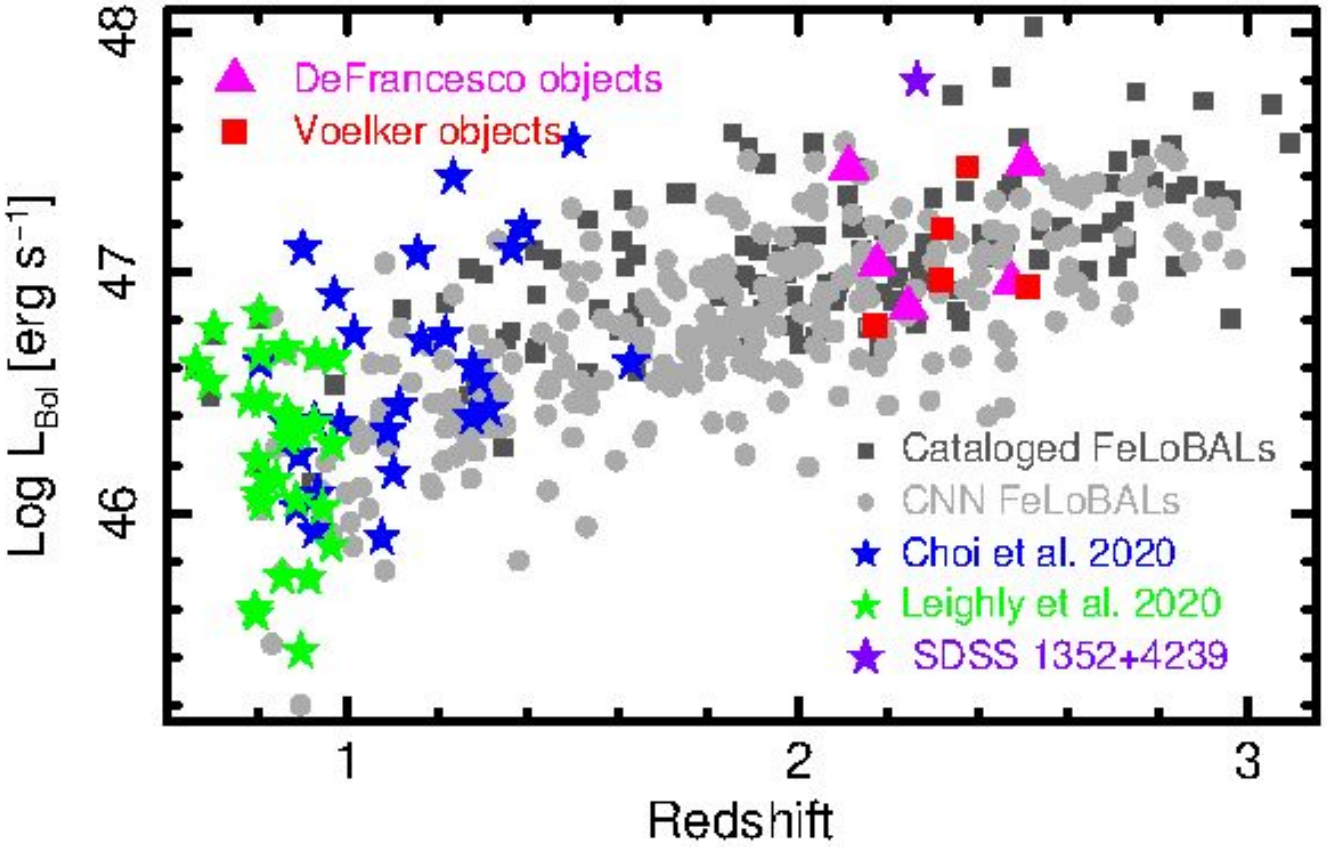
FeLoBAL Quasars

- BAL quasars and FeLoBAL quasars
  - Spectra components





My Objects

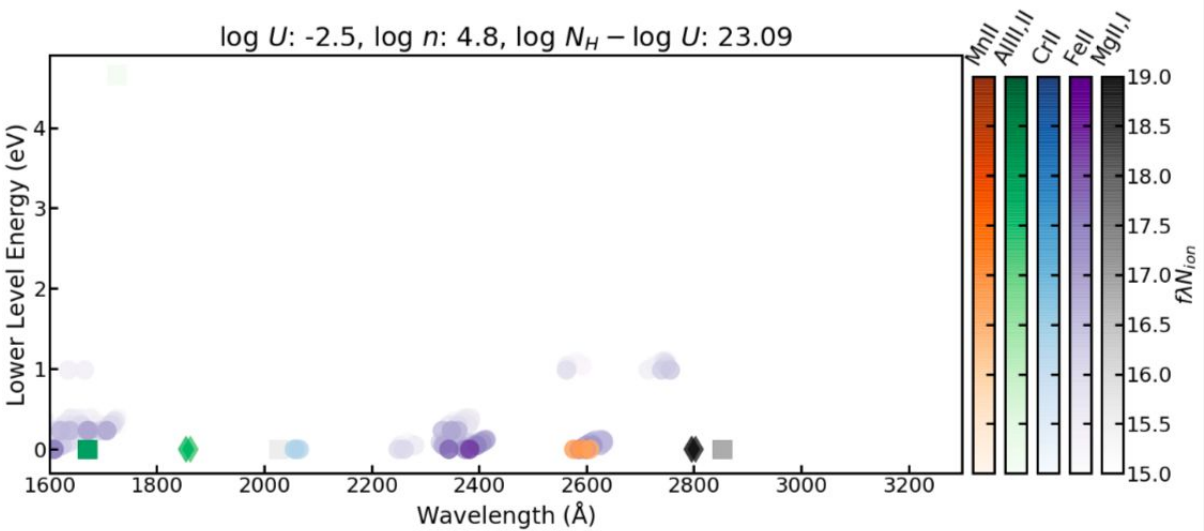

DeFrancesco objects
Voelker objects
Cataloged FeLoBALs
CNN FeLoBALs
Choi et al. 2020
Leighly et al. 2020
SDSS 1352+4239
Log L_{Bol} [erg s^{-1}]
48
47
46
1
2
3
Redshift

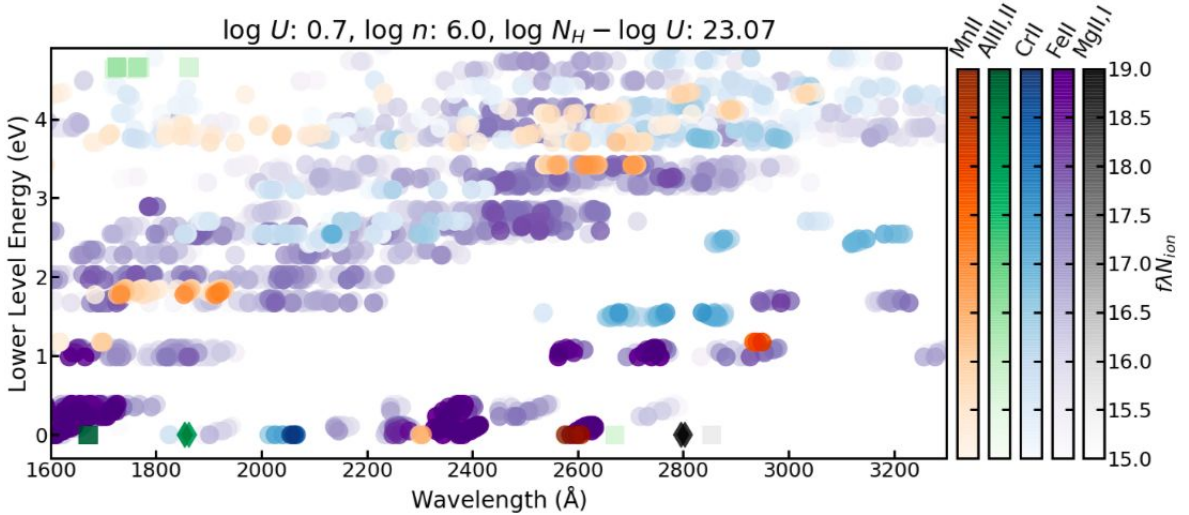
Modeling Spectra with SimBAL

- A novel spectral synthesis code that uses forward modeling to analyze BAL outflows
  - Advantages over the standard model
- Physical absorption parameters
  - Density, Ionization, Column Density, Covering Fraction, Outflow Velocity, Velocity Width

1. Density

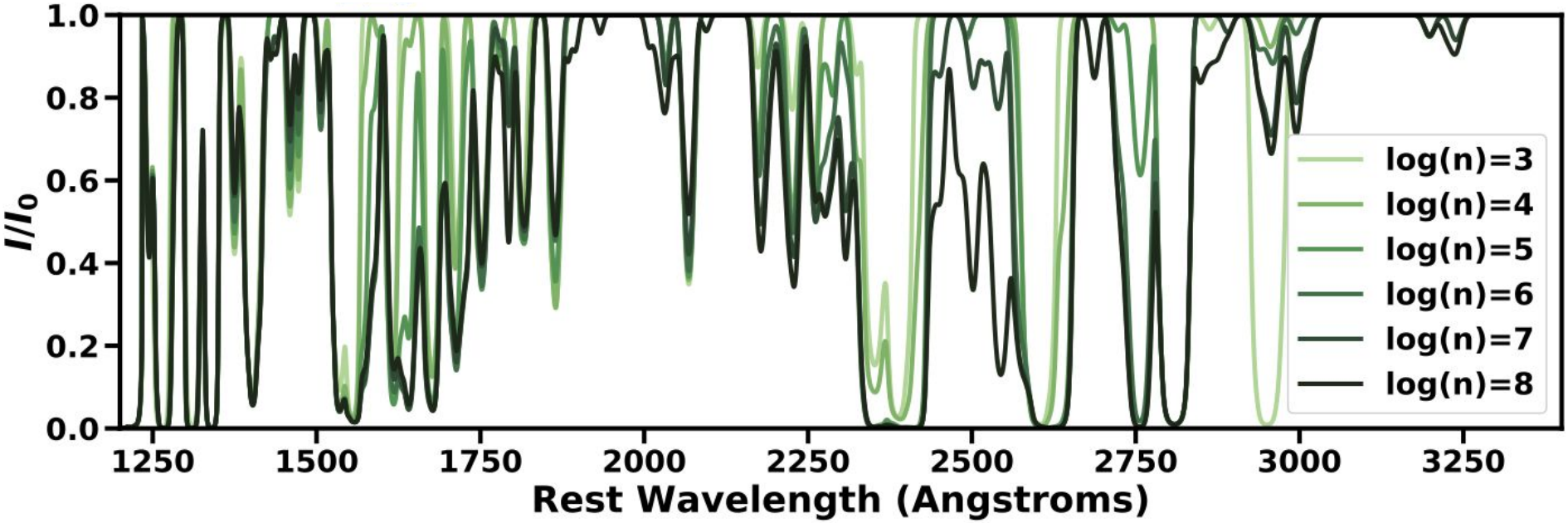
- Gas density, given by log n [cm^{-3}]
- High vs. low density





Source: Choi AAS poster

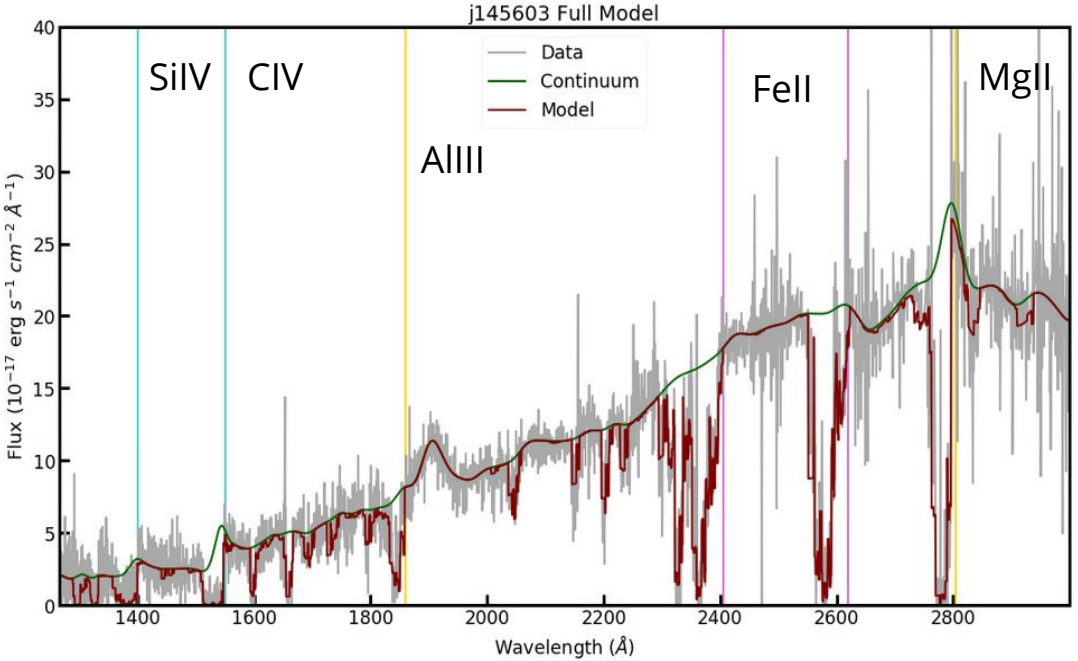
Density



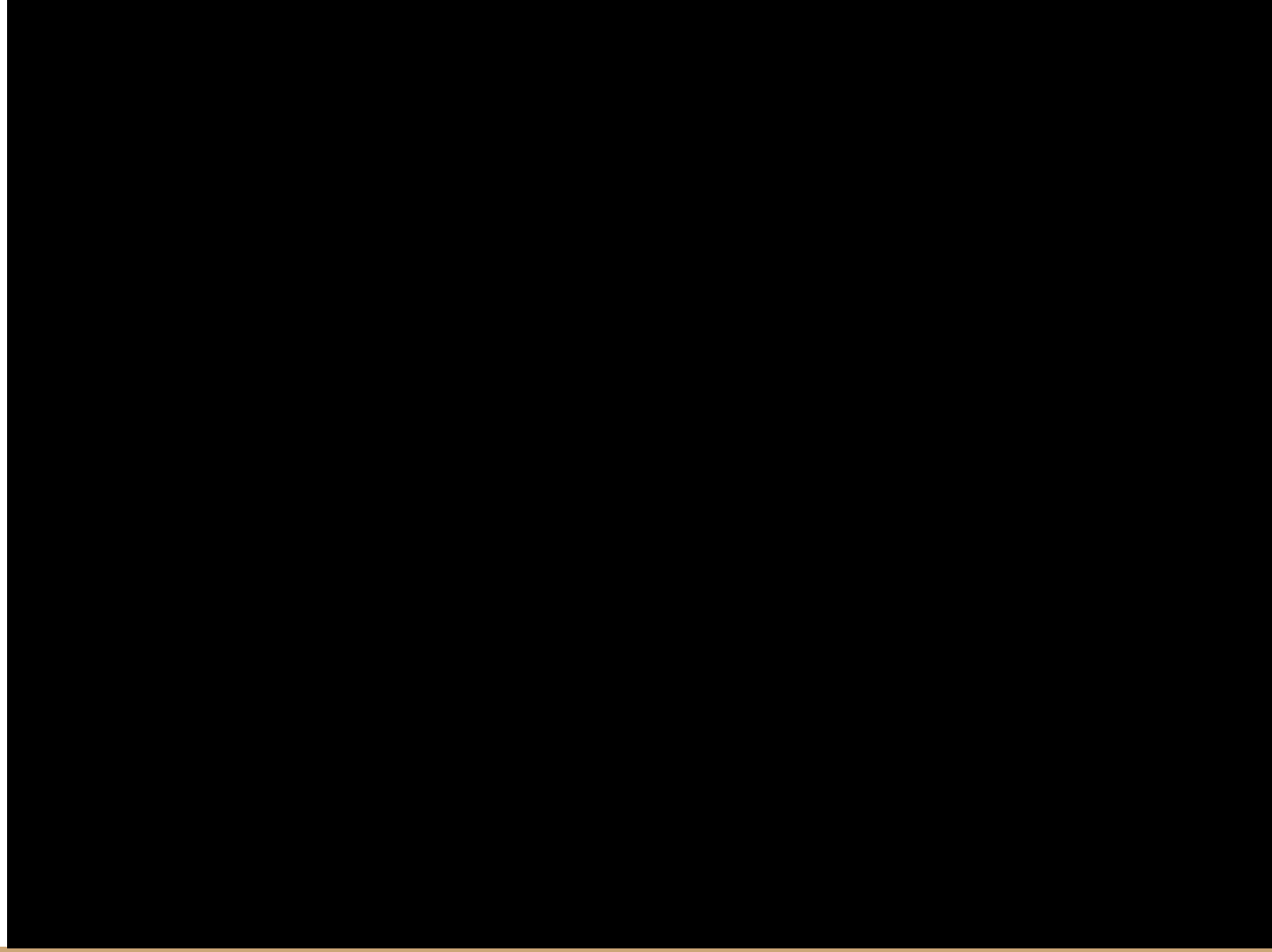
Source: Leighly, private communication

2. Ionization

- Dimensionless ionization parameter log$U$
- Determines what ions are present in our spectrum



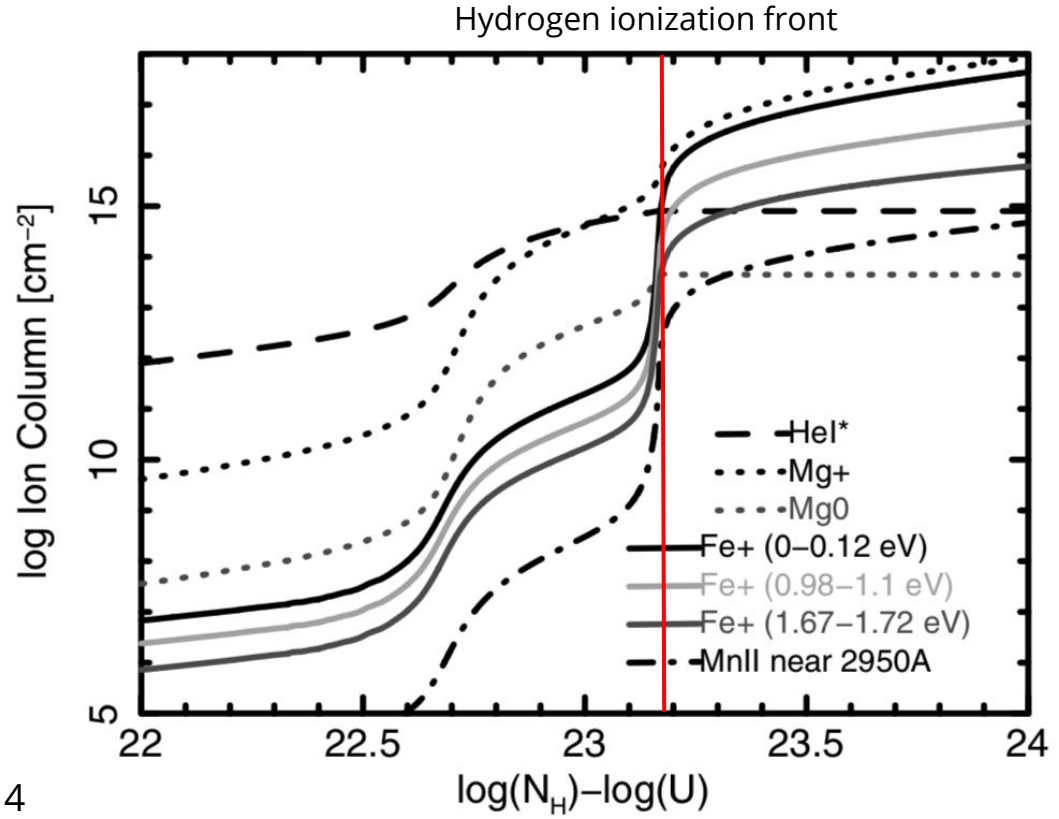
Ionization



Source: Leighly et al 2018

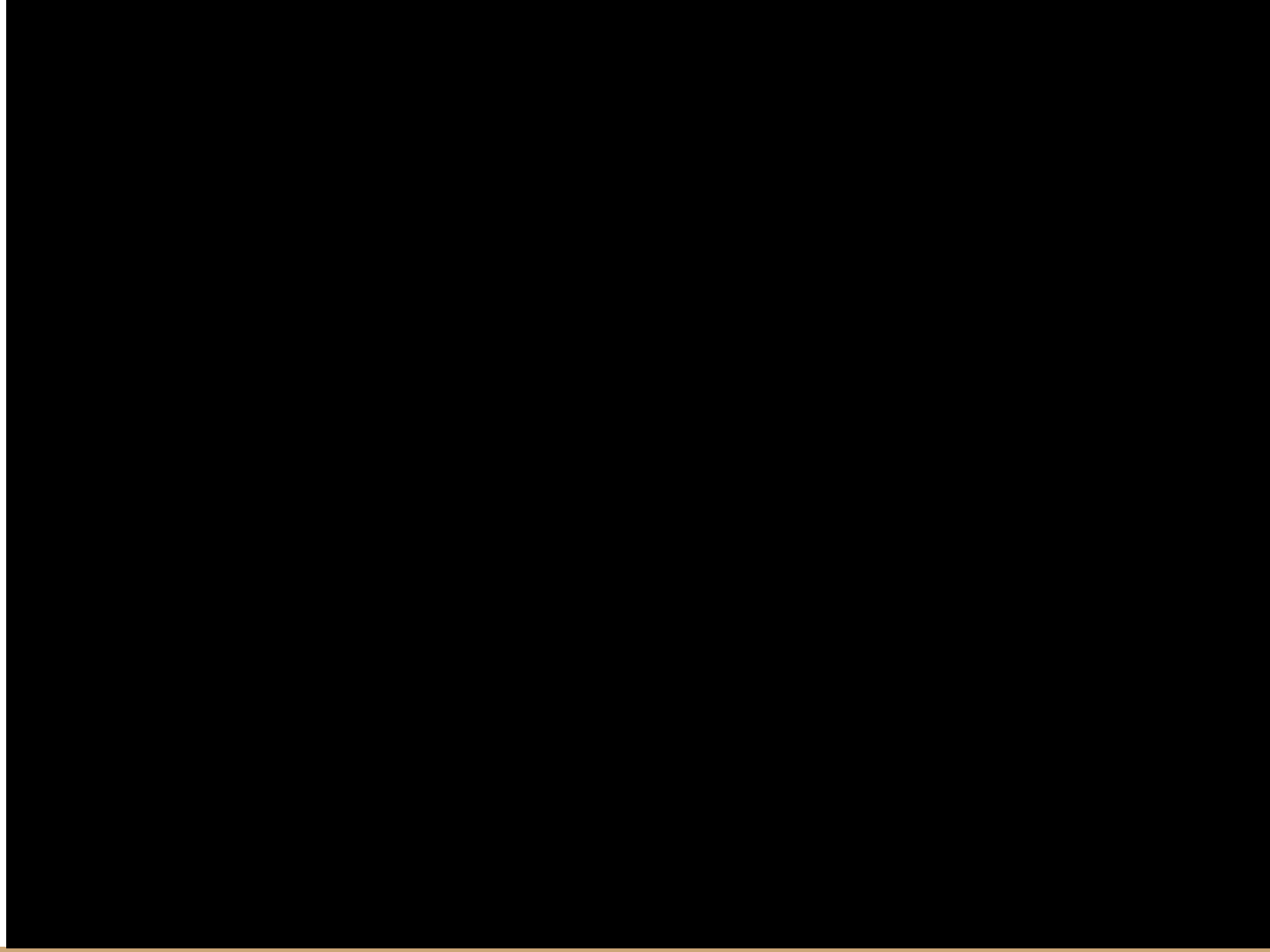
3. Column Density

- Number of particles in a cylindrical cross section along the line of sight
- Hydrogen ionization front



Source: Lucy et al 2014

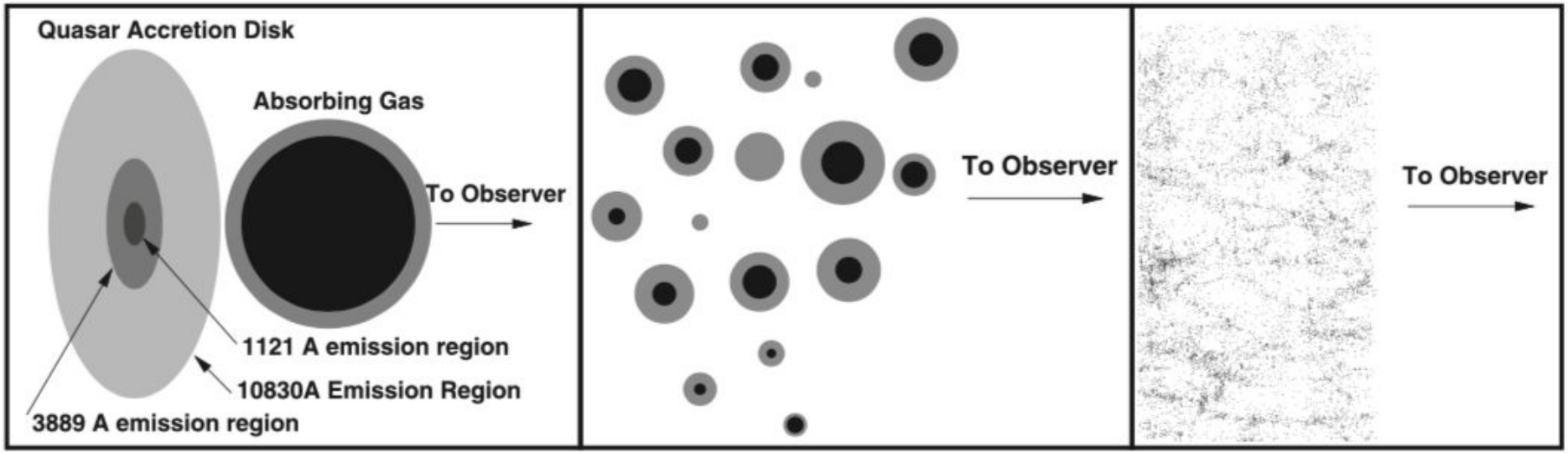
Column Density



Source: Leighly et al 2018

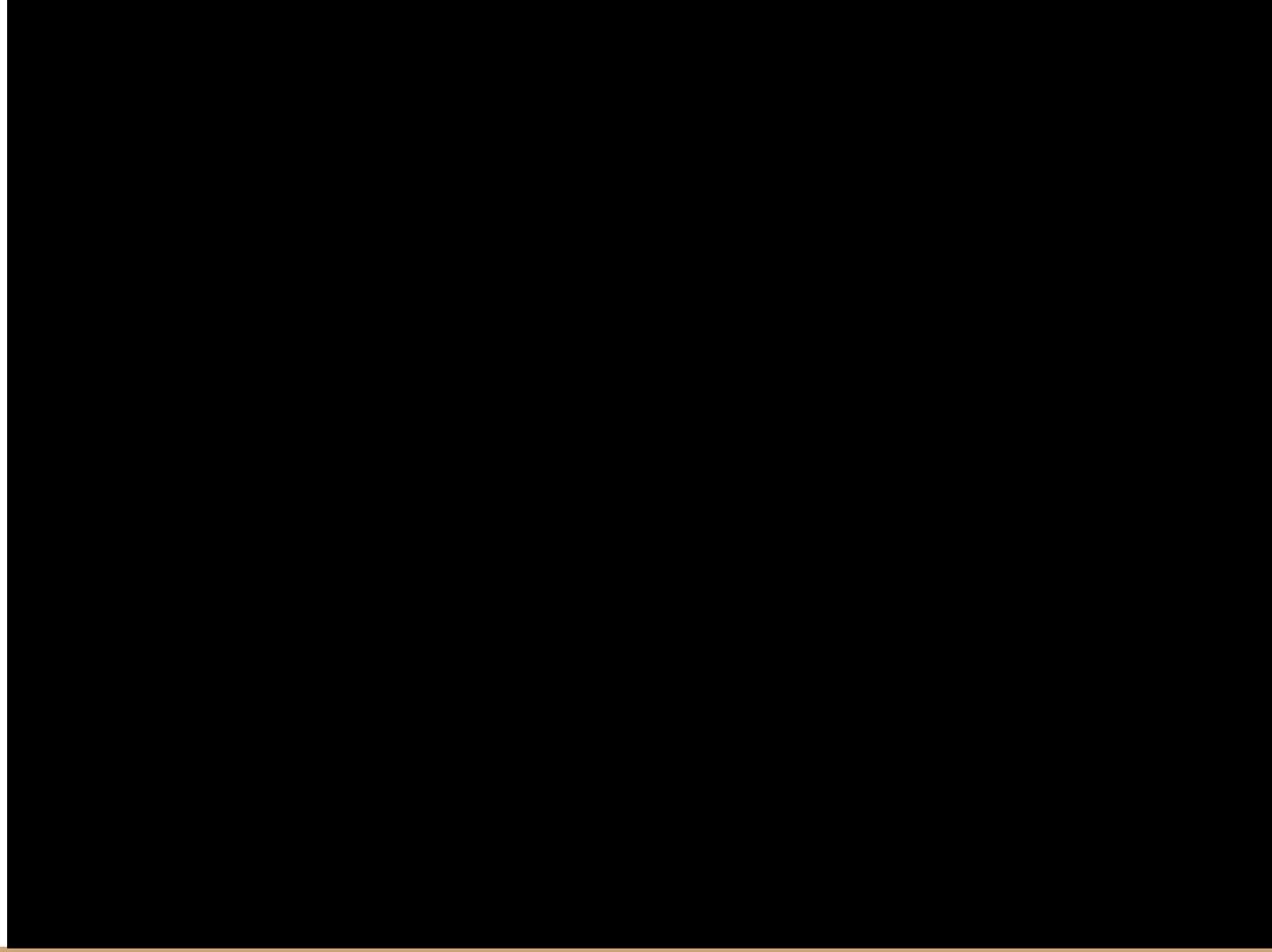
4. Covering Fraction

- Fraction of the continuum source covered by the absorbing medium, log*a*
- Smaller log a = more covering, larger log a = less covering



Source: Leighly et al 2019

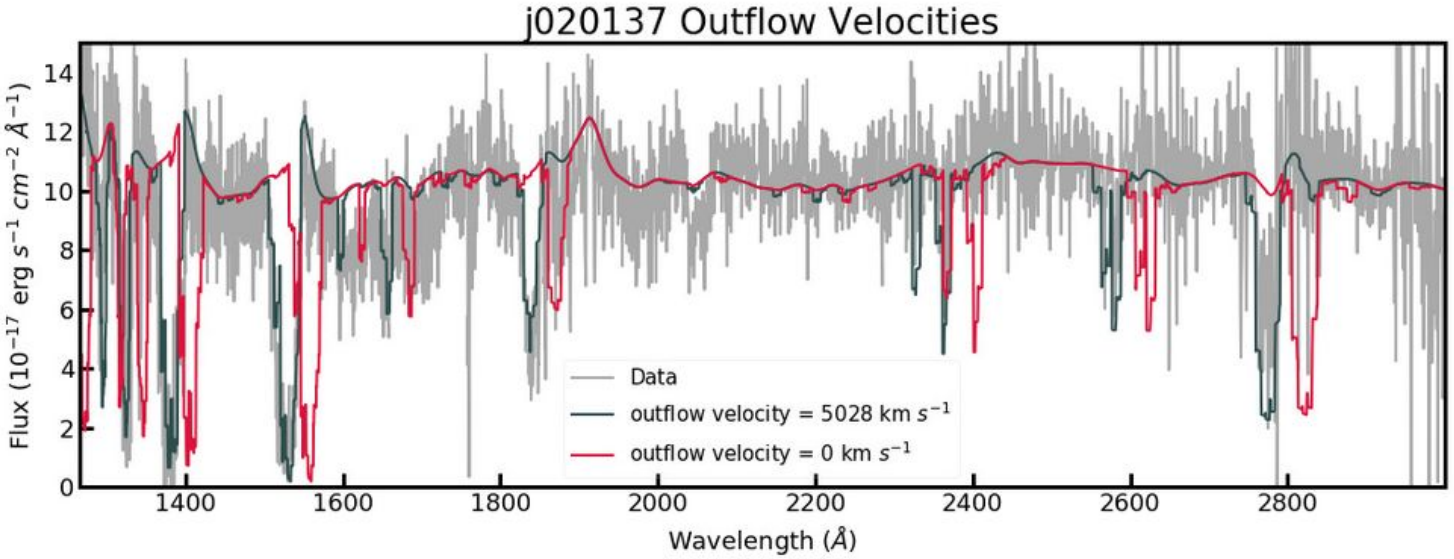
Covering Fraction



Source: Leighly et al 2018

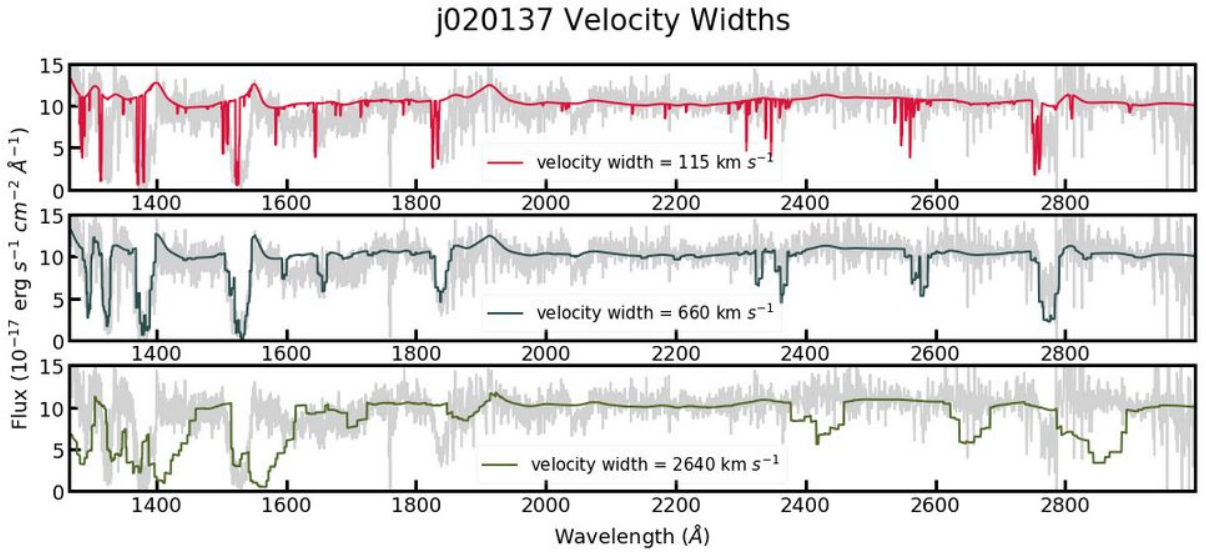
5. Outflow Velocity

- Blueshifted absorption lines
- Range from ~100-50,000 km/s

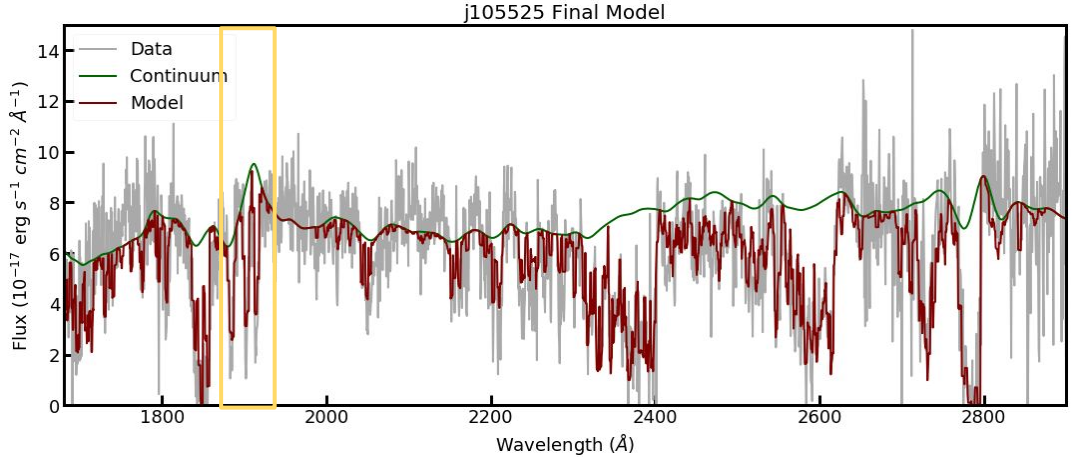


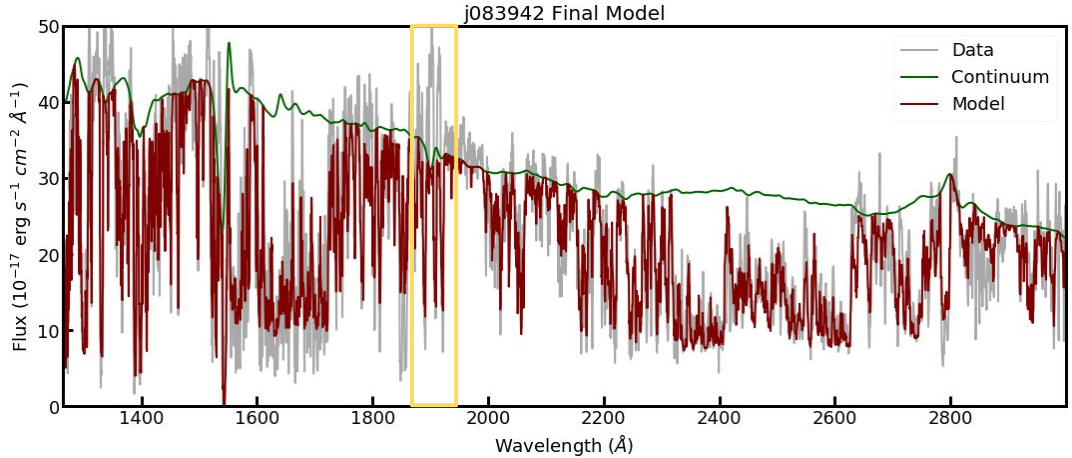
6. Velocity Width

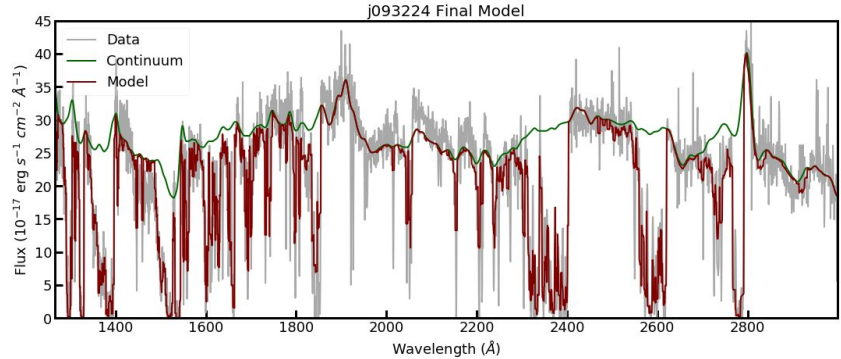
- Width of the absorption lines
- Characteristic width: ~1000 km/s
  - Causes considerable line blending

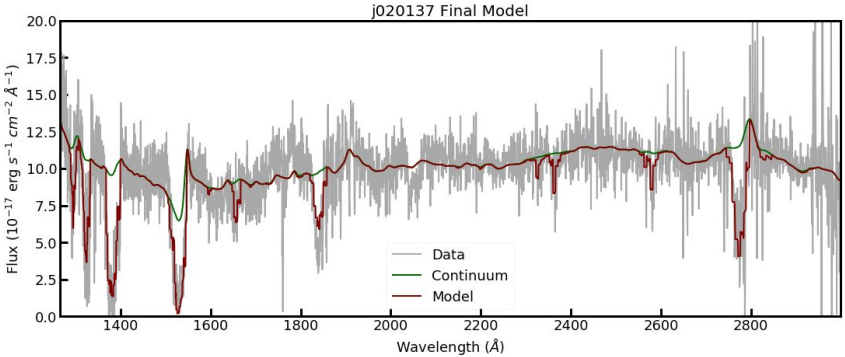


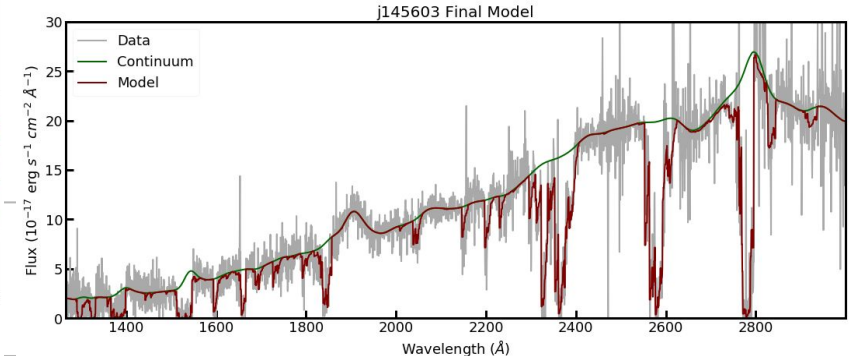
Final Model Fits





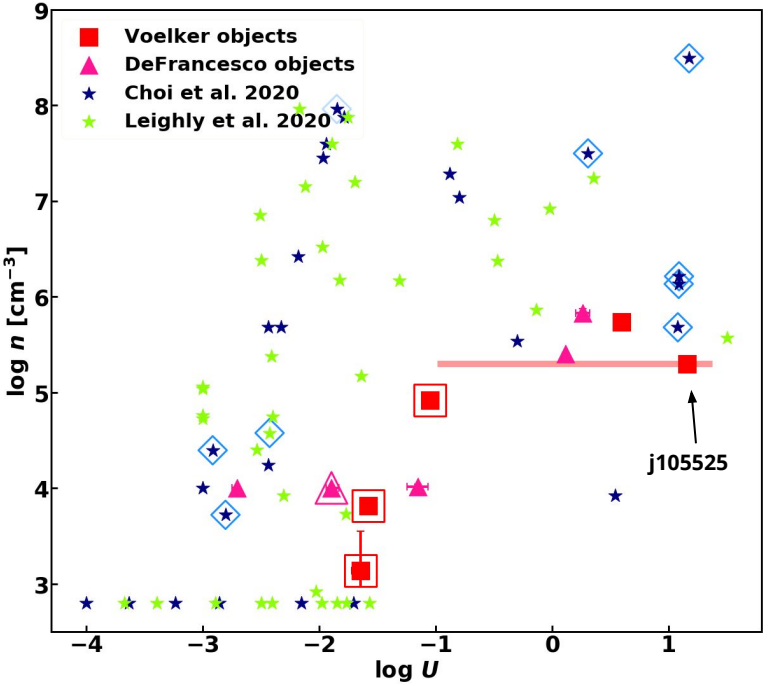


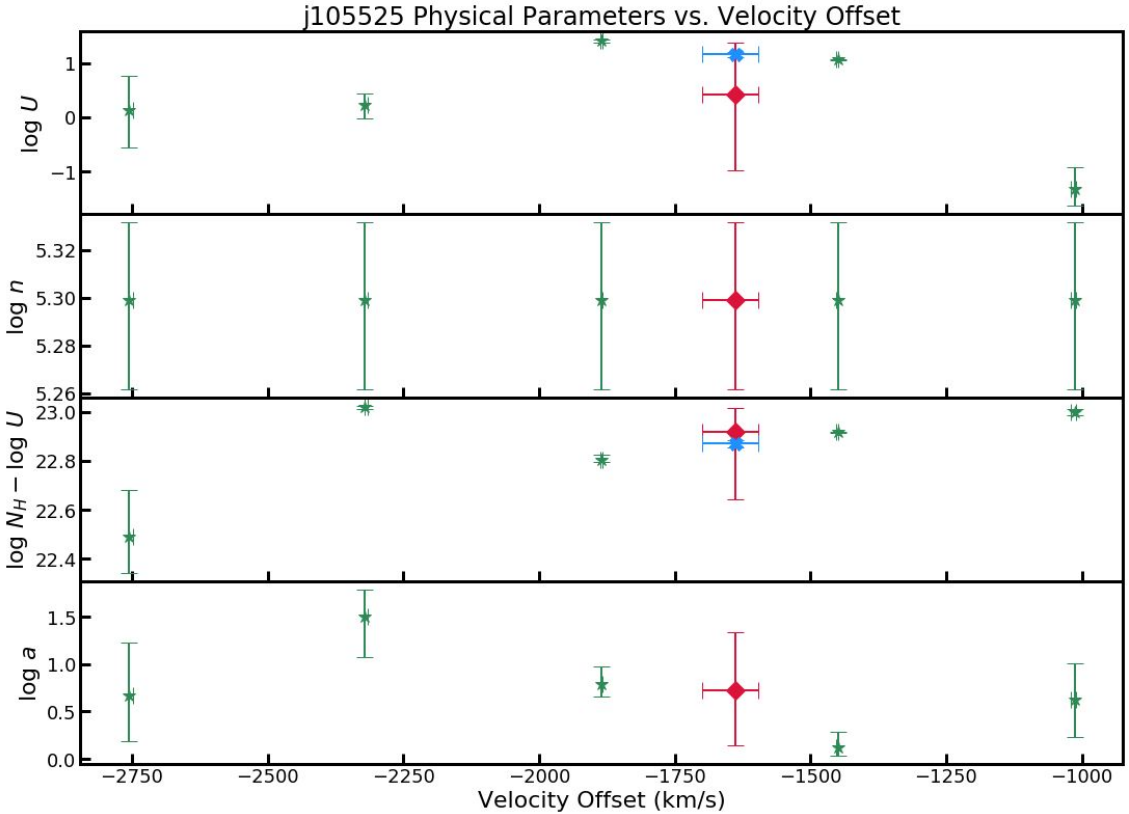




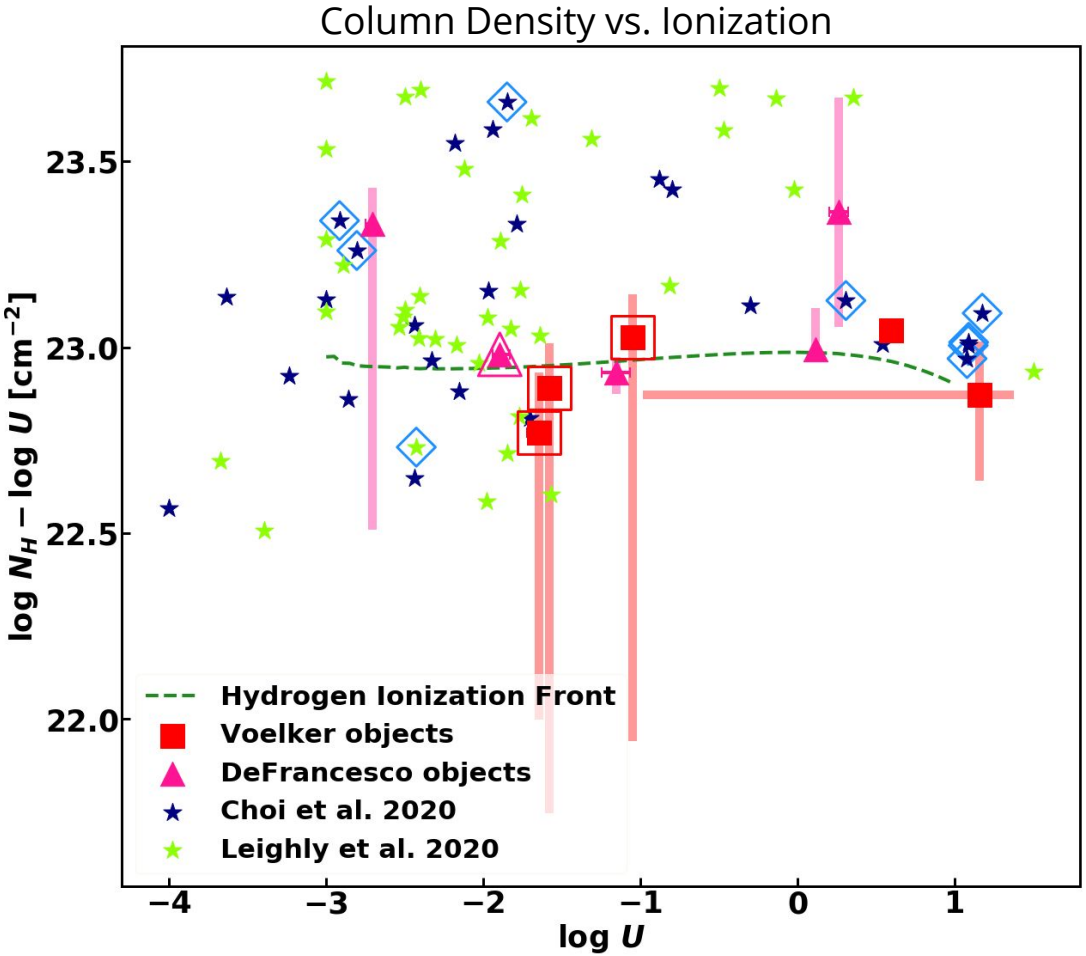
Results

Ionization vs. Density





Results


Column Density vs. Ionization
log N_H − log U [cm^{-2}]
log U
23.5
23.0
22.5
22.0
−4
−3
−2
−1
0
1
Hydrogen Ionization Front
Voelker objects
DeFrancesco objects
Choi et al. 2020
Leighly et al. 2020

References

Arav, N. 2006, Outflows from Active Galactic Nuclei

Choi, H., Leighly, K. M., Terndrup, D. M., Gallagher, S. C., & Richards, G. T. 2020, ApJ, 891, 53

Choi, H., Leighly, K., Dabbieri, C., Terndrup, D., Gallagher, S., Richards, G. 2020, The Physical Properties and Energetics of FeLoBAL Quasar Outflows

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Leighly, K. M., Terndrup, D. M., Gallagher, S. C., Richards, G. T., & Dietrich, M. 2018, ApJ, 866, 7

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Lucy, A. B., Leighly, K. M., Terndrup, D. M., Dietrich, M., & Gallagher, S. C. 2014, ApJ, 783, 58

Questions?