Abstract

We analyzed a subset of a sample of high redshift ($z>2$), high luminosity FeLoBAL quasars. We describe the location of the outflows with respect to the size scale of a host galaxy. We find a large difference in outflow radius R spanning 4 dex. We confirm the inverse proportionality of R with the ionization parameter and gas density. Furthermore, we calculate the outflow strength and find that more objects show outflows greater than 0.5% of quasar luminosity than in previous samples. This is most likely due to a luminosity selection effect. Further analysis of the complete sample will provide more information on outflow strength and the possibility of high redshift, high luminosity quasars supporting feedback.

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Scale and Properties of the Accretion Disk in High Redshift FeLoBAL Quasars

Cora Ann DeFrancesco, Julianna Voelker
Mentor: Dr. Karen Leighly
REU Final Presentation, 30 July 2020

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Motivation

What is the distance of the outflows from the central source?

Origin and Acceleration Mechanisms of the Outflows

Influence of the Outflow on the Origin and Evolution of the Host Galaxy

Relationship Between Mass Accretion and Mass Ejection

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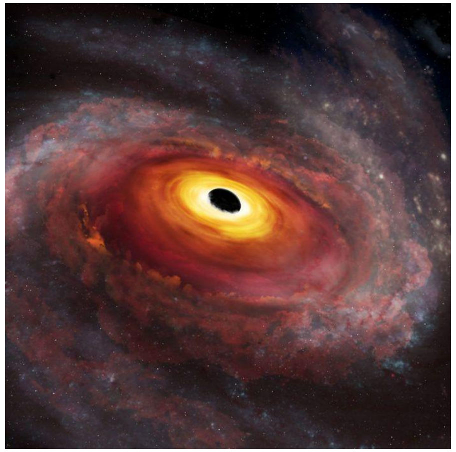

International Gemini Observatory/ NOIRLab/ NSF/ AURA/ P. Marenfeld

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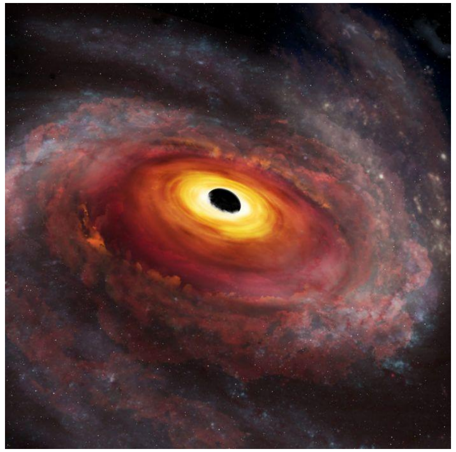

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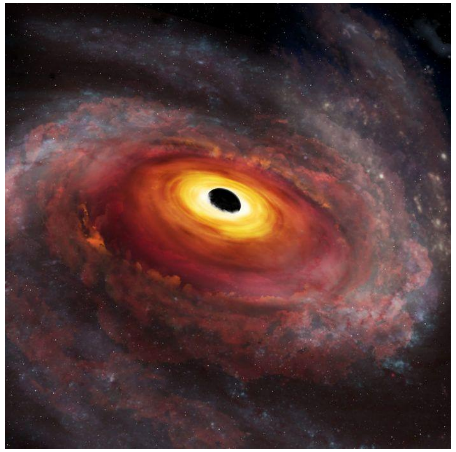

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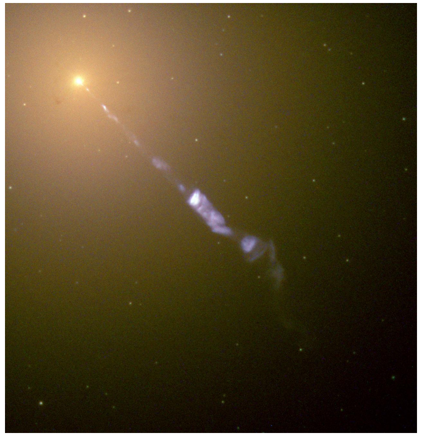

NASA/Hubble/ESA

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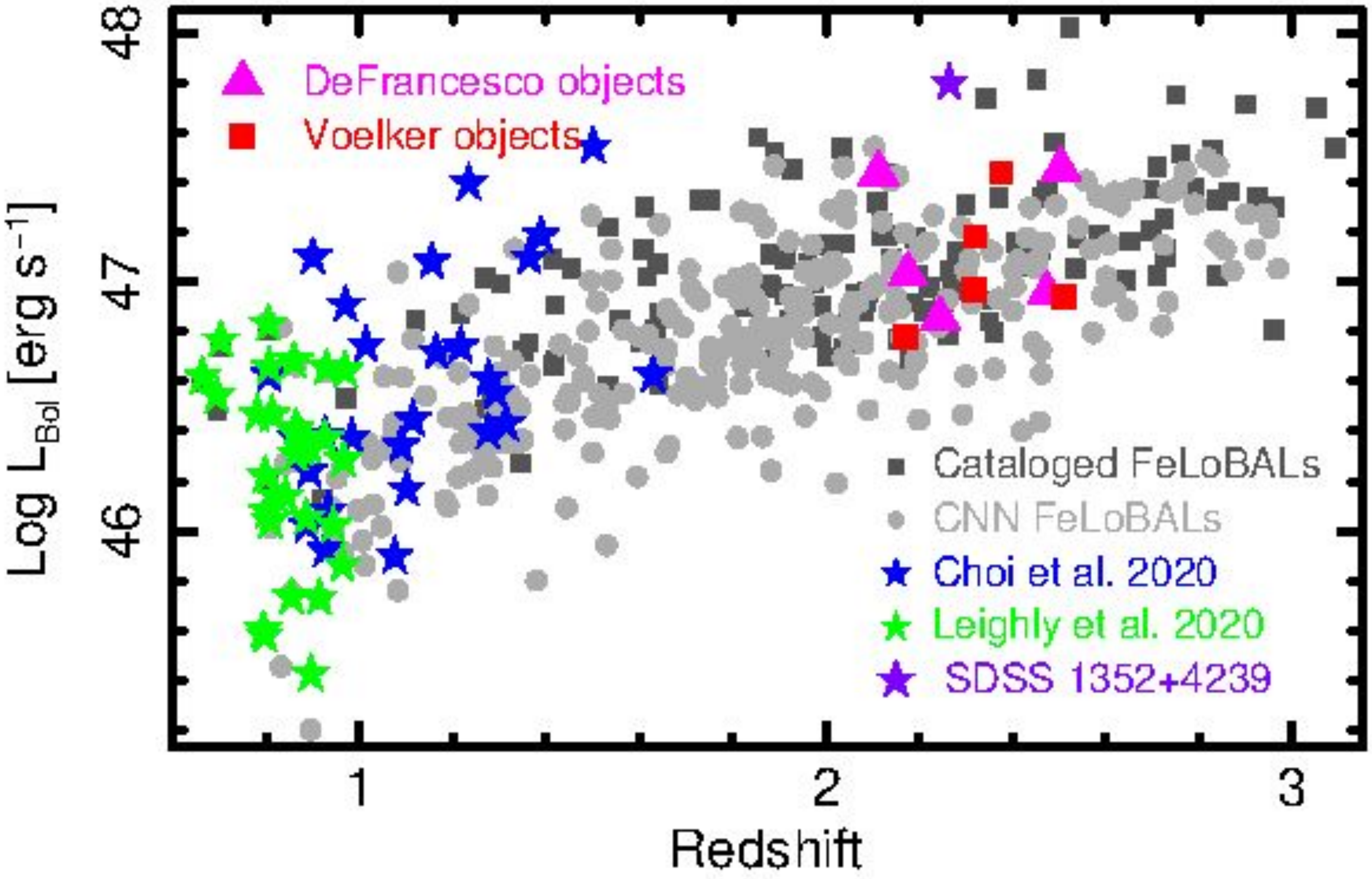

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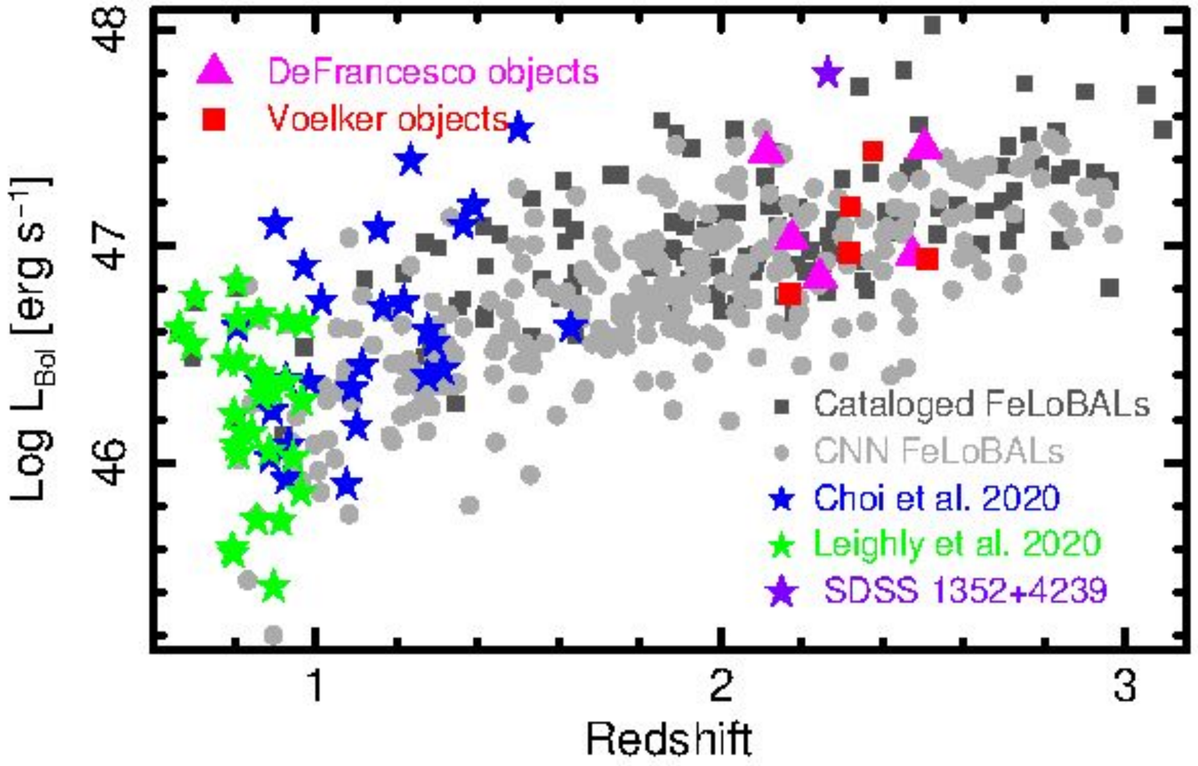
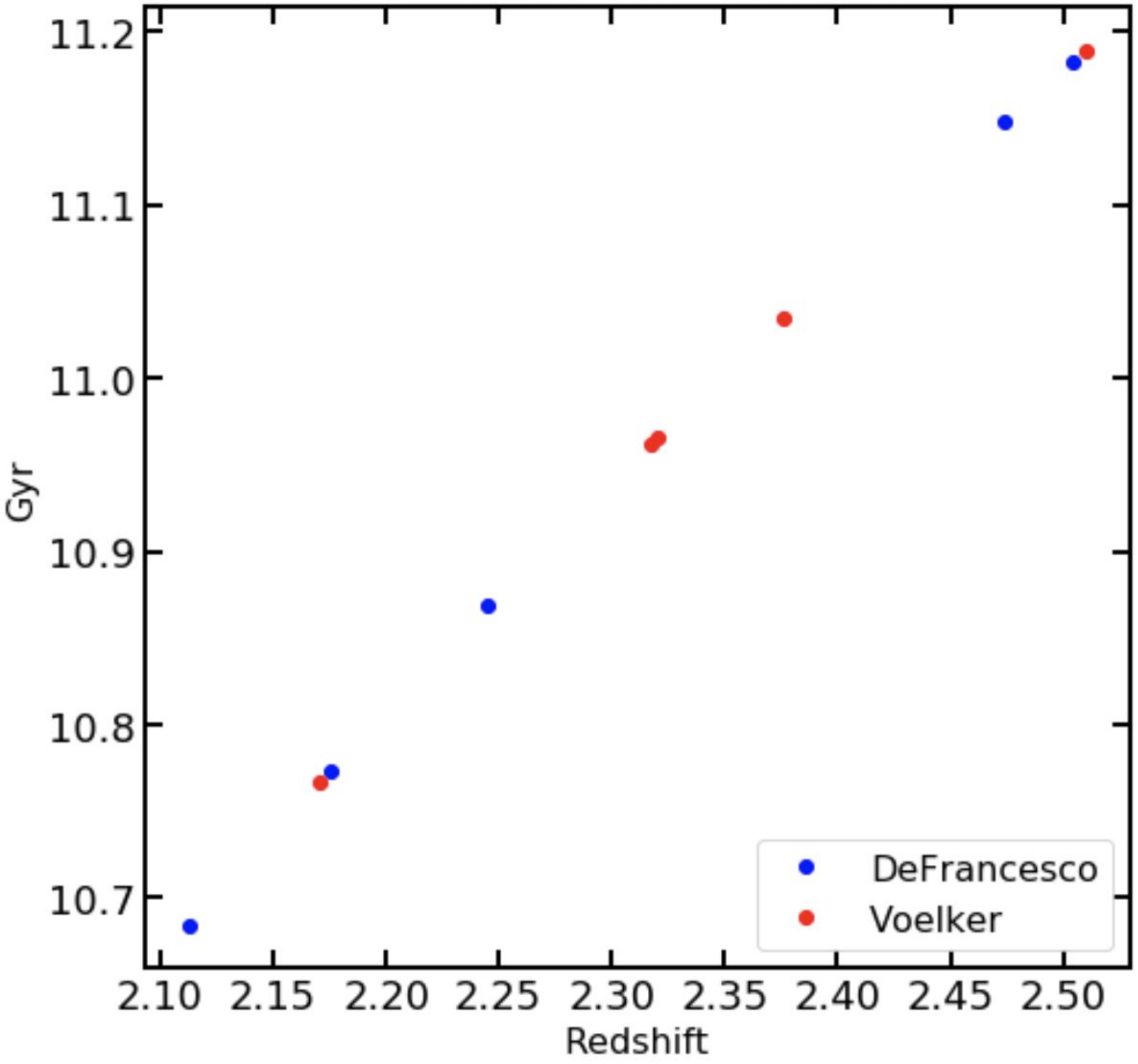
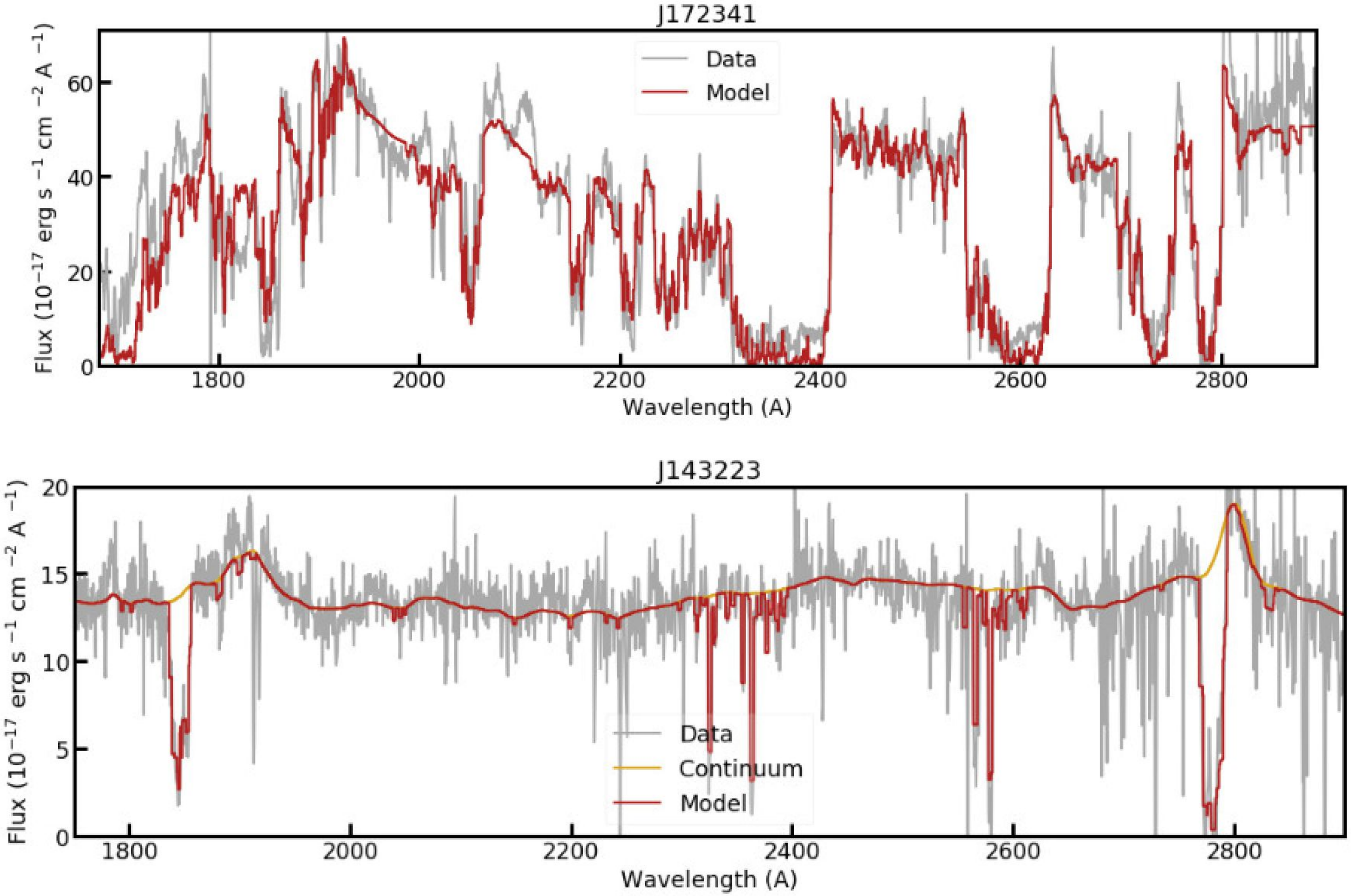
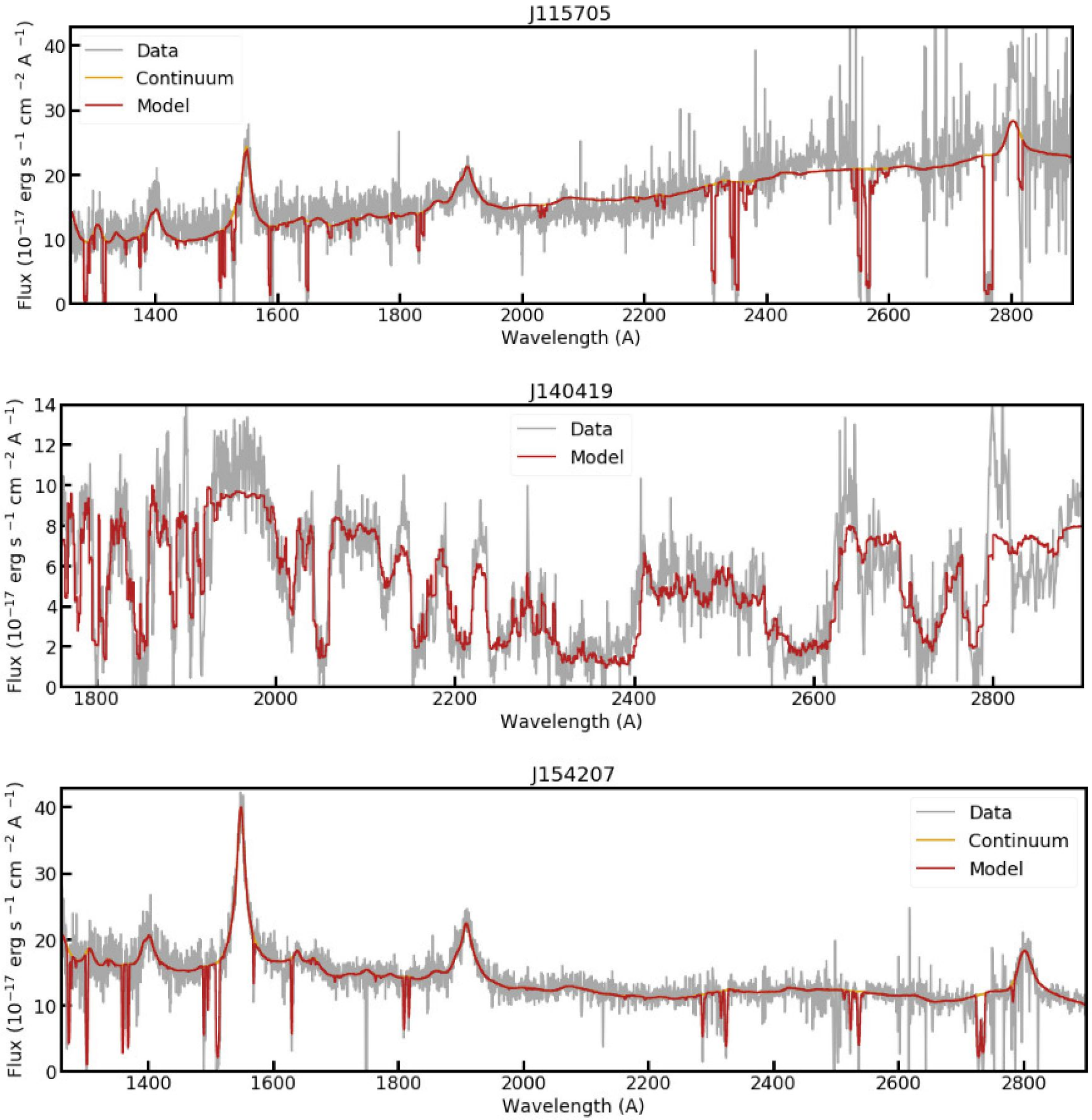


Lookback Times

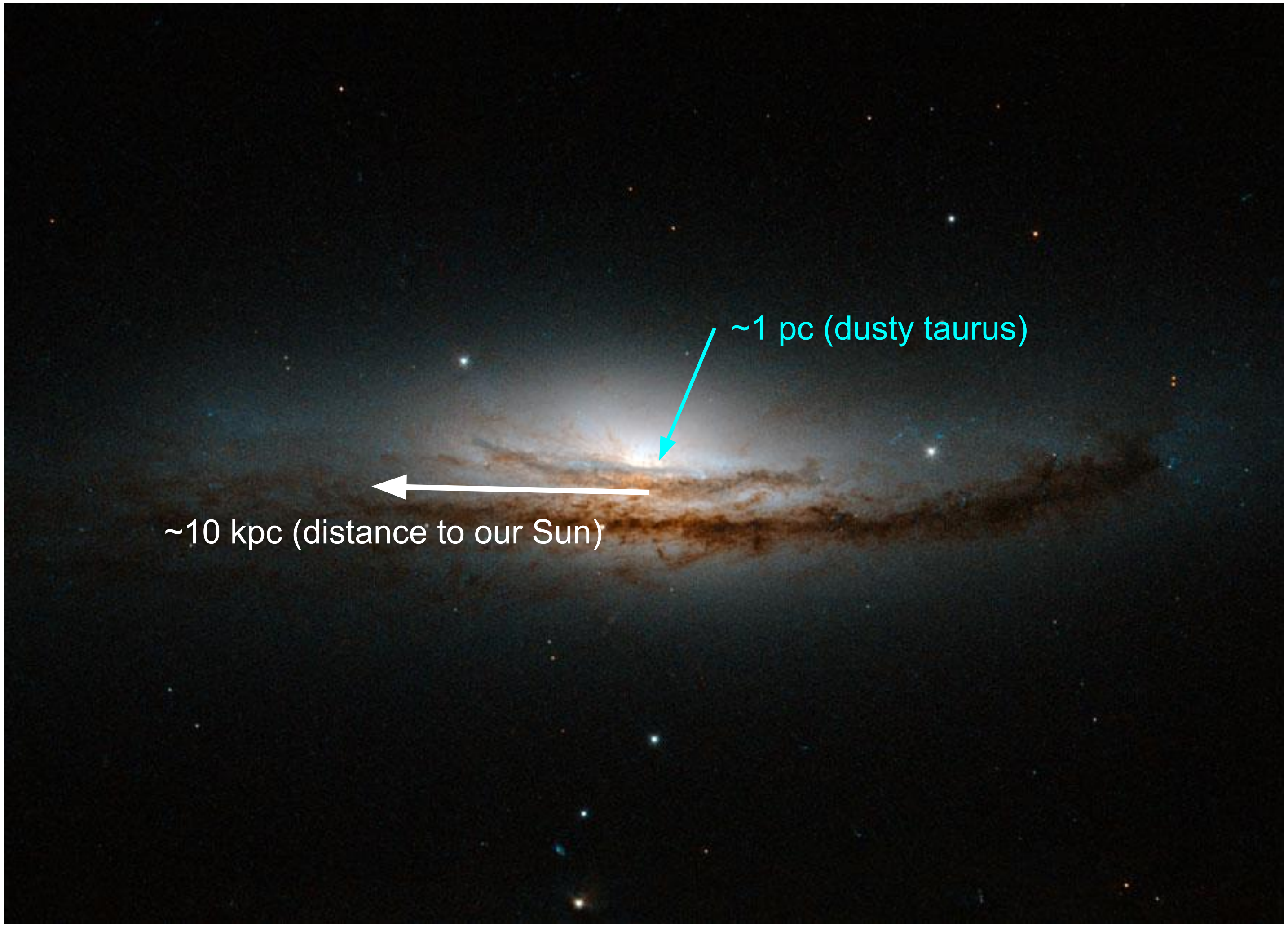


Final Model Fits




J115705
Data
Continuum
Model
Flux (10^{-17} erg s^{-1} cm^{-2} A^{-1})
Wavelength (A)
J140419
Data
Model
Flux (10^{-17} erg s^{-1} cm^{-2} A^{-1})
Wavelength (A)
J154207
Data
Continuum
Model
Flux (10^{-17} erg s^{-1} cm^{-2} A^{-1})
Wavelength (A)

Scale



NASA, ESA, and E. Perlman (Florida Institute of Technology)

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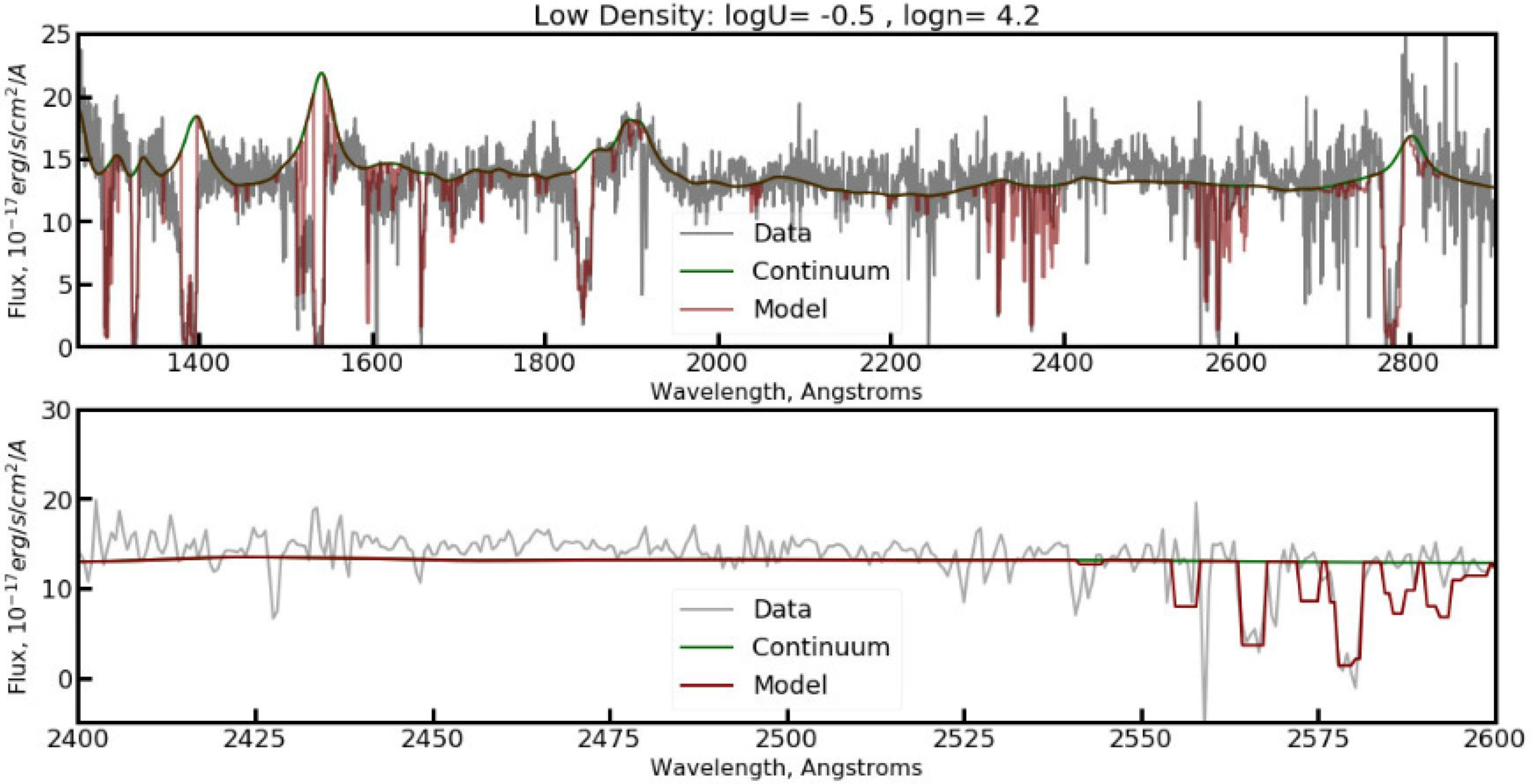
Where are the winds?

- **Large differences** in theoretical models and observational results
  - Outflows are accretion disk winds, seen in acceleration phase at **~ R = 0.01 pc** (Murray et al. 1995)
  - Measuring troughs of excited states of various ions: **R = a few pc to several kpc** (de Kool 2001, Lucy 2014)
  - Ground based observations using CIII*: **10 pc < R < 300 pc** (Borguet et al. 2013)

Density, n [cm^{-3}]



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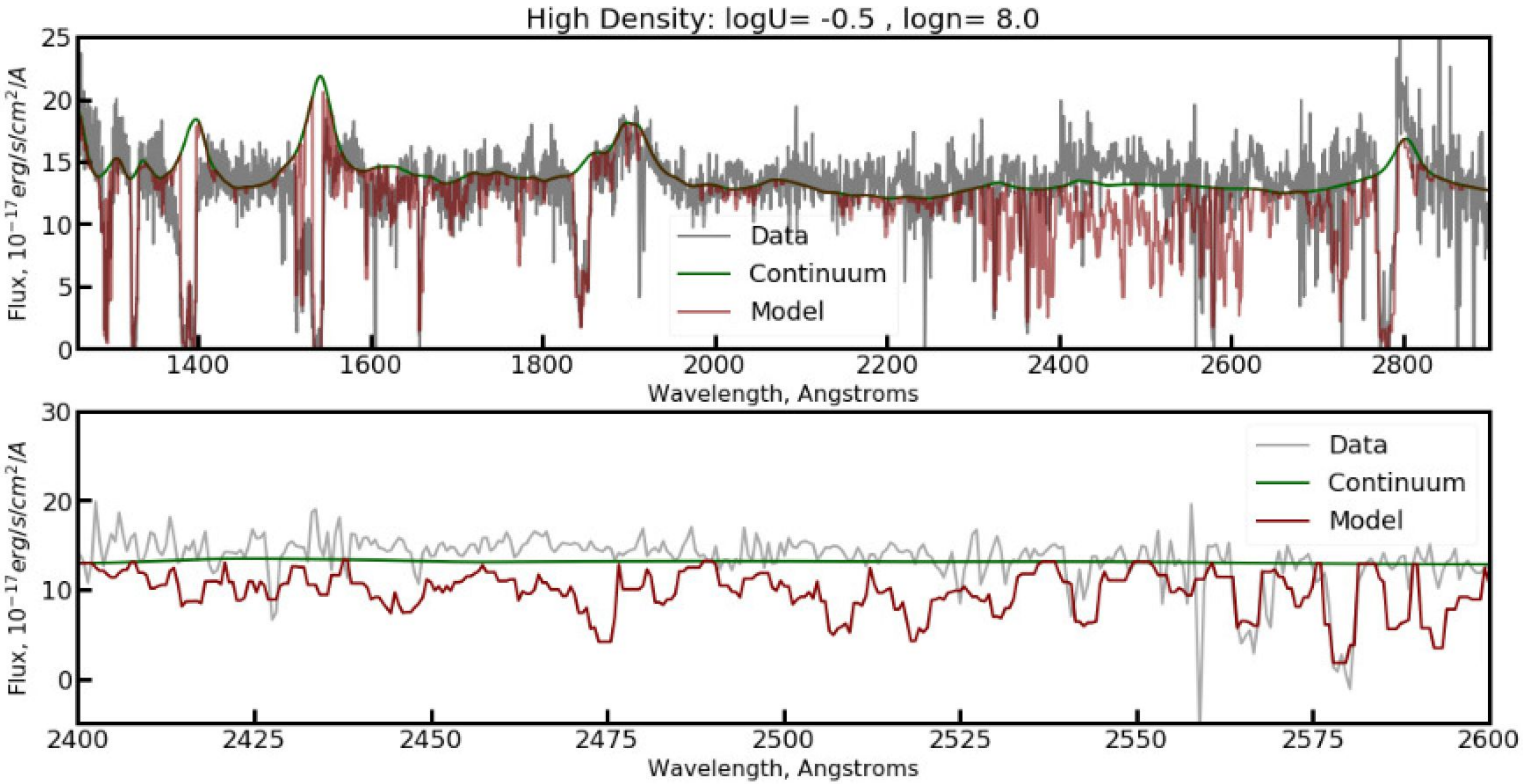

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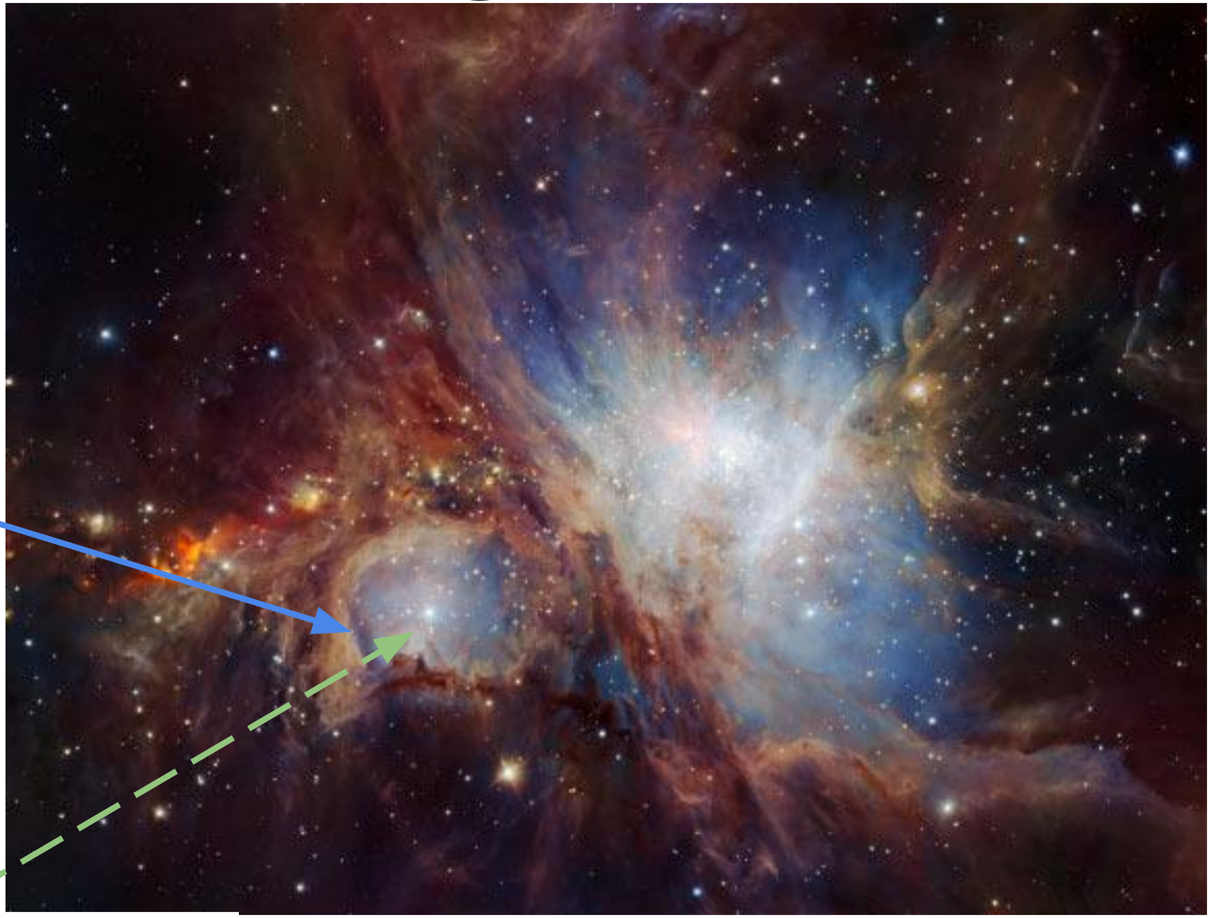
Ionization in HII Regions

Boundary of the HII region

Energetic source.
Here, a star. For quasars, the SMBH.



H. Drass et al / ESO

To expand the HII region by **dr**, the energetic source must ionize $\mathbf{4\pi r^2 n_H dr}$ atoms.

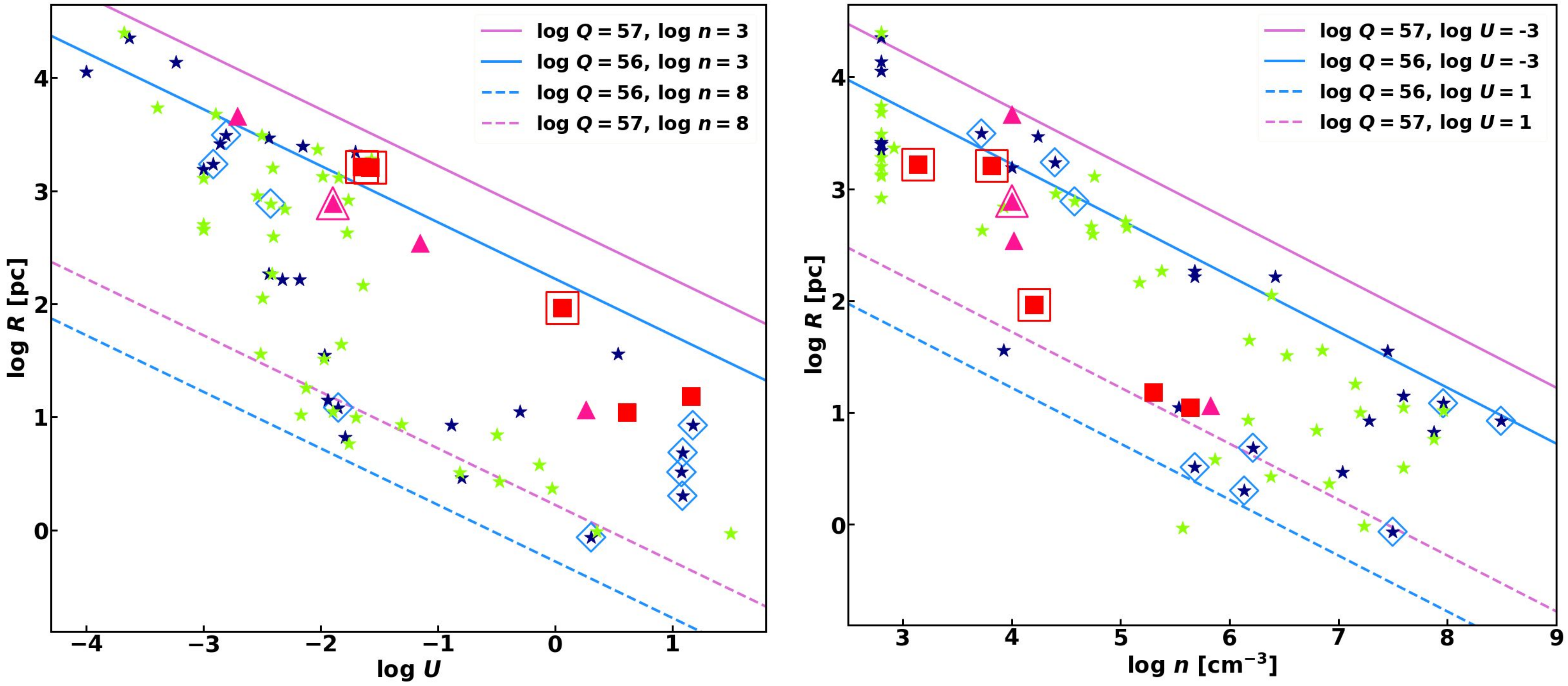
Calculating R

- Use ionization parameter and density measurements
- ϕ: photoionizing flux (number of ionizing photons emitted per second over the area of the spherical surface of the HII region)
- Estimate **Q**: the number of ionizing photons emitted per second from the accretion disk

$$U = \frac{\phi}{nc} = \frac{Q}{4\pi R^2 nc}$$

Results

- Ionization parameter and density as a function of R
- Calculation of outflow rate
- Comparison of outflow strength to lower limits needed to support feedback



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Outflow Rate and Kinetic Luminosity

- Can calculate change in mass from the radius, the global covering fraction, and two SimBAL parameters (N_H and *v*)

$$\dot{M} = 8\pi\mu m_p \Omega R N_{\rm H} v.$$

- Kinetic luminosity corresponds to outflow strength
- Quantify if a quasar has enough energy in the outflow to produce feedback
  - Scaling relations between host galaxy and SMBH
  - Regulate star formation
- Wind energy greater than **0.5% - 5%** of quasar luminosity

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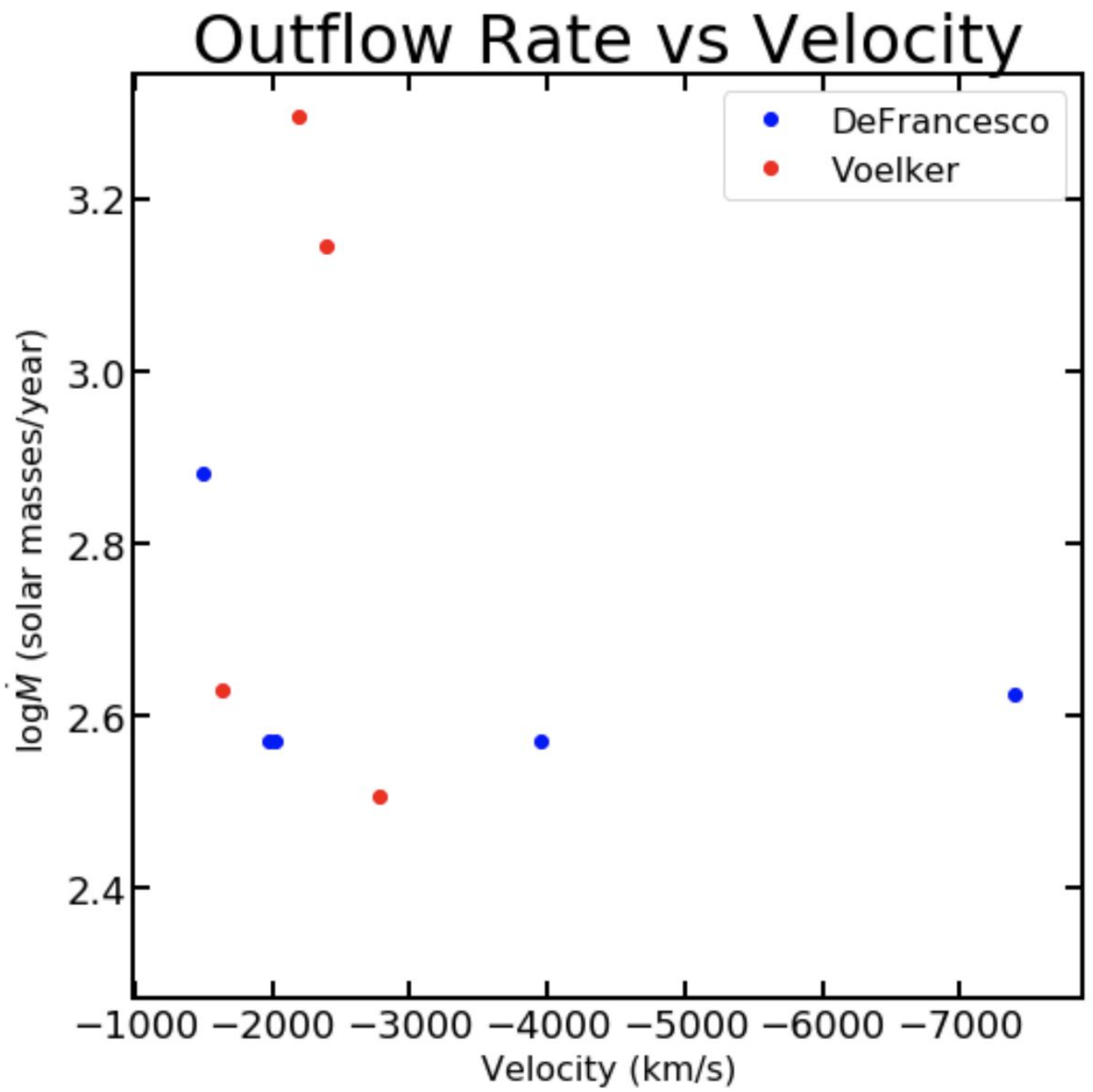

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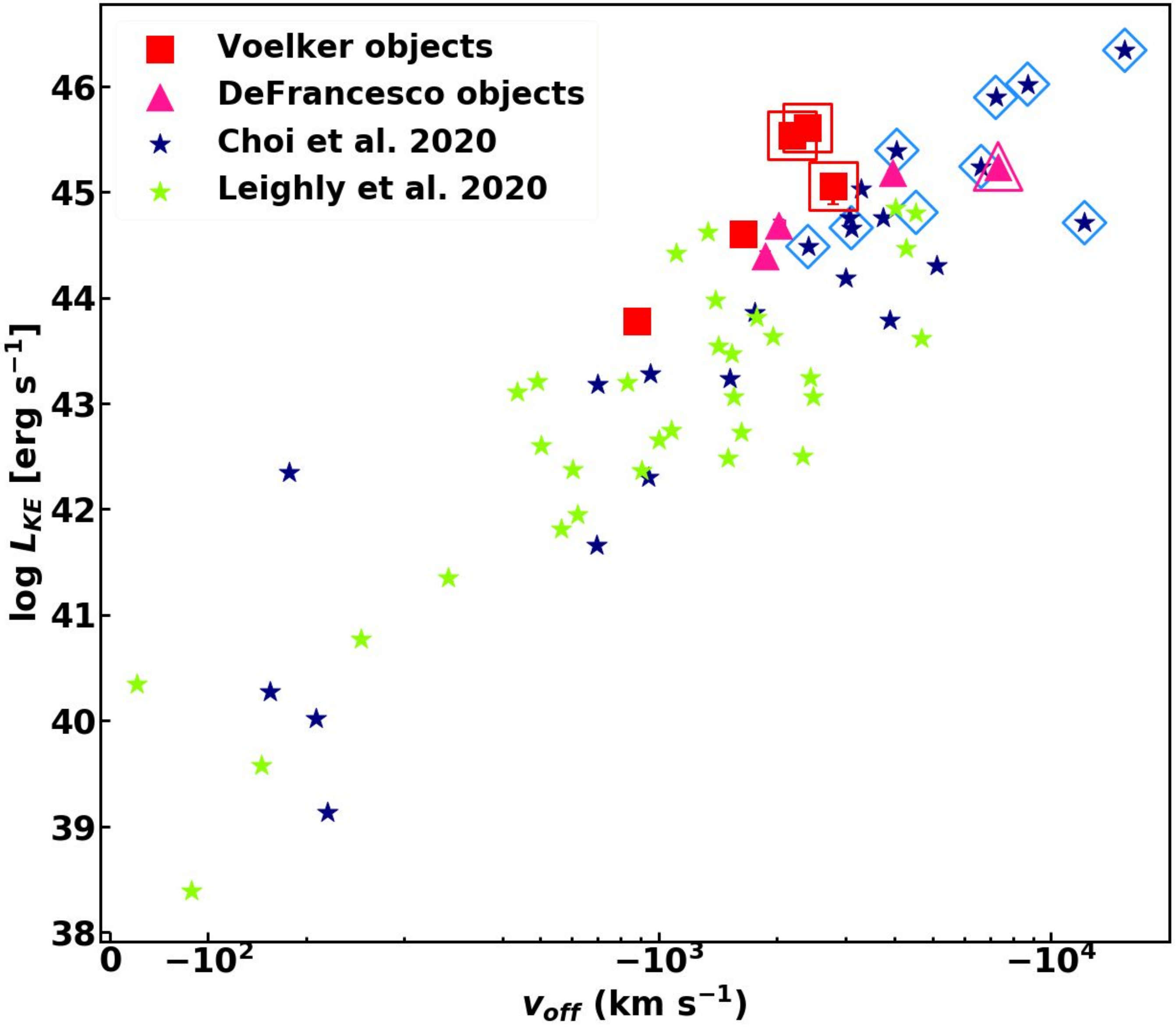
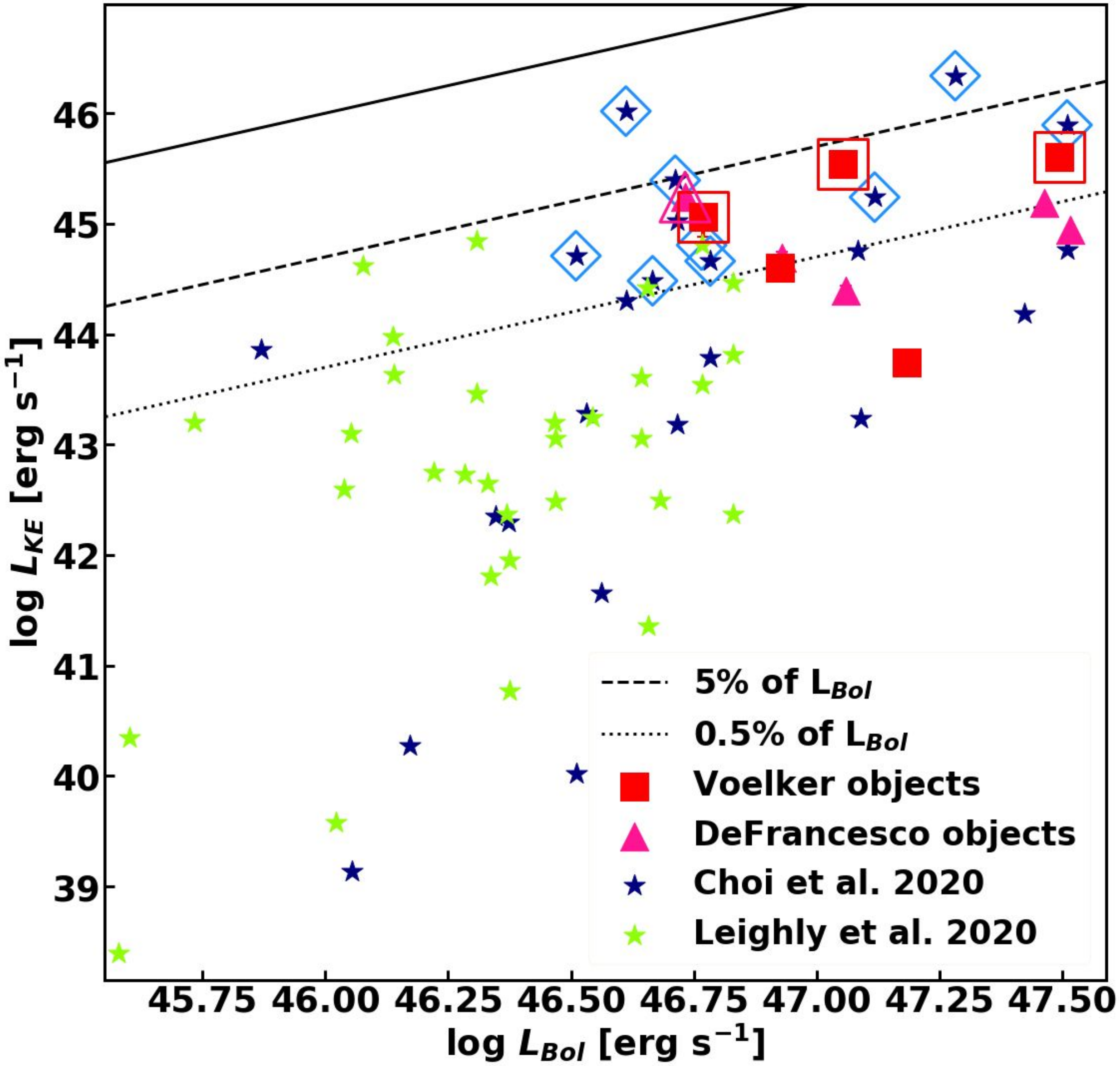
L_{KE} vs Velocity



Outflow Strength



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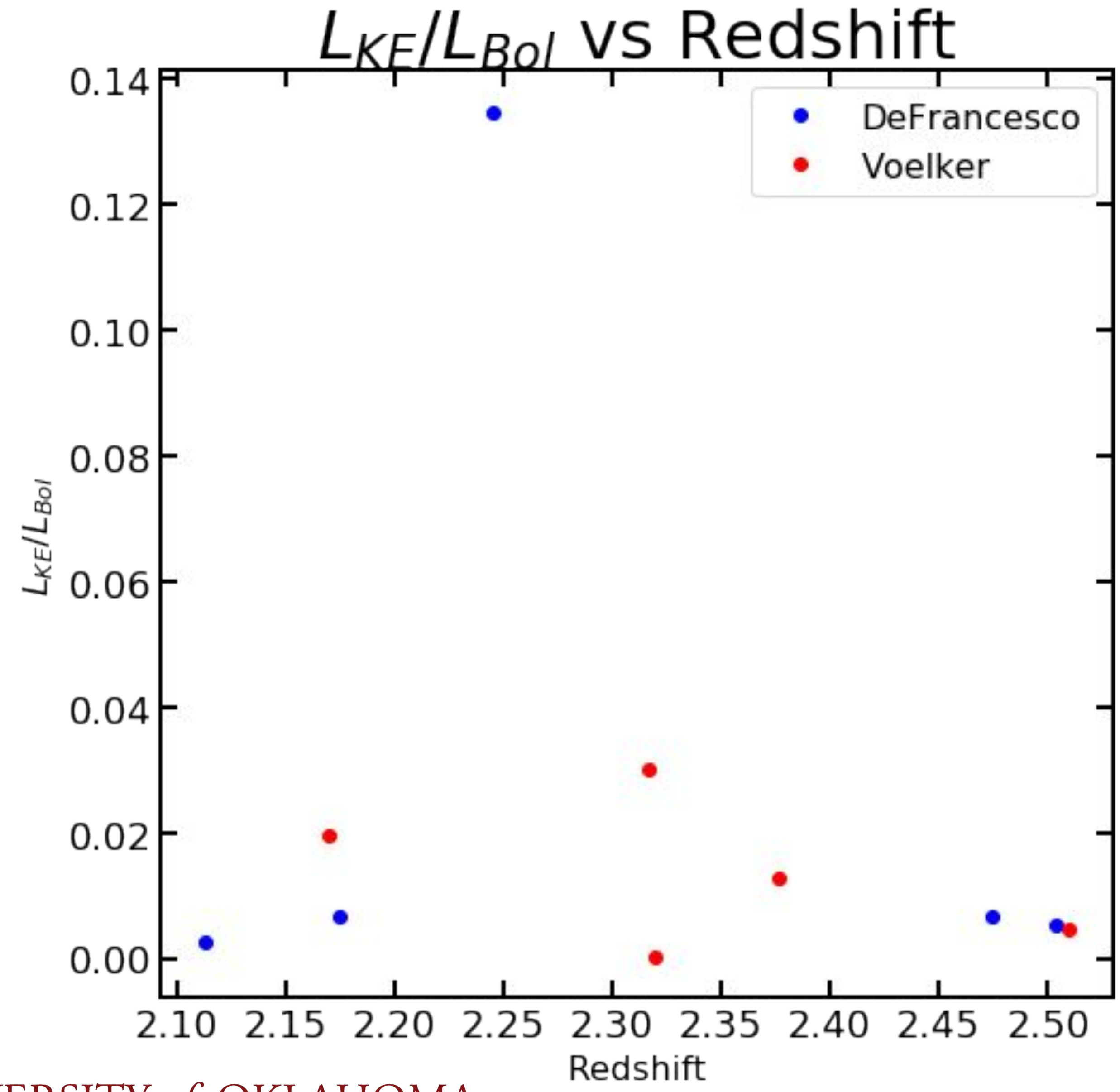
Luminosity Selection Effect



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Summary

- Wind distances are distributed over a large scale compared to the size of the host galaxy.
- We find $1 < \log R$ [pc] < 3.5
- In our high redshift sample, more objects show outflow greater than 0.5% of quasar luminosity than in previous low redshift samples. However, this is most likely due to a luminosity selection effect.

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