Studying Mg II absorption within quasar halos to improve our understanding of quasar fueling and feedback

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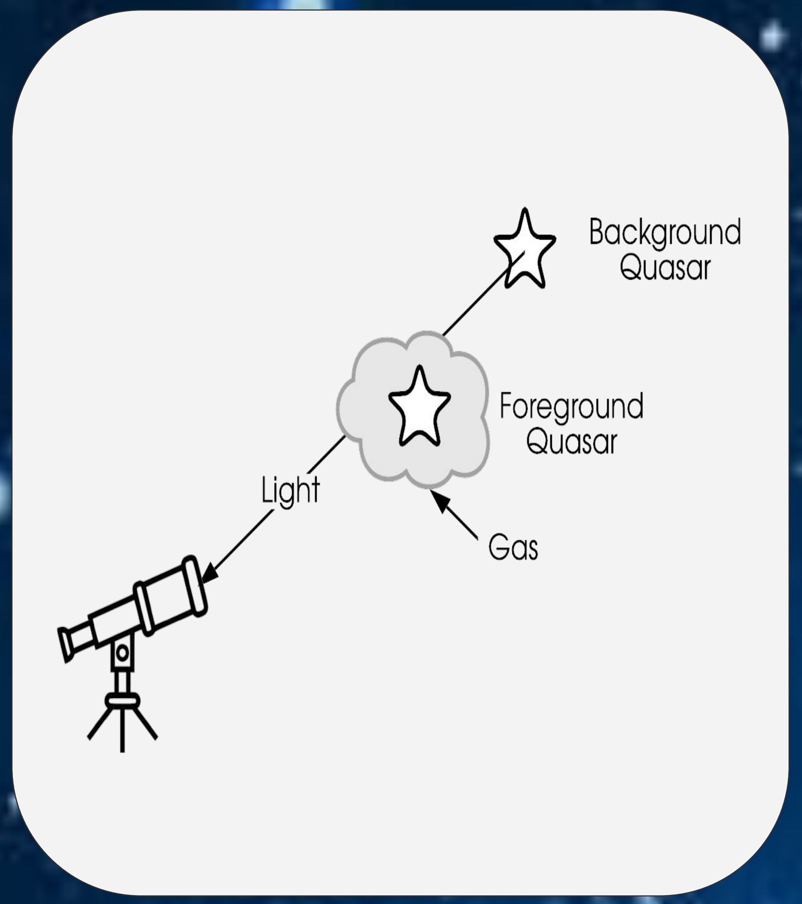
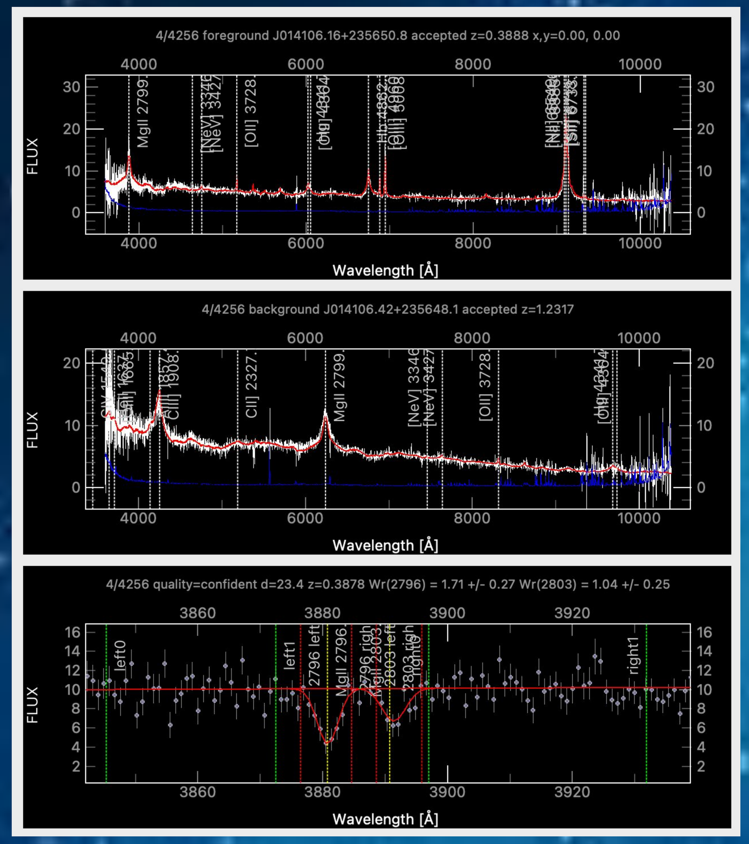
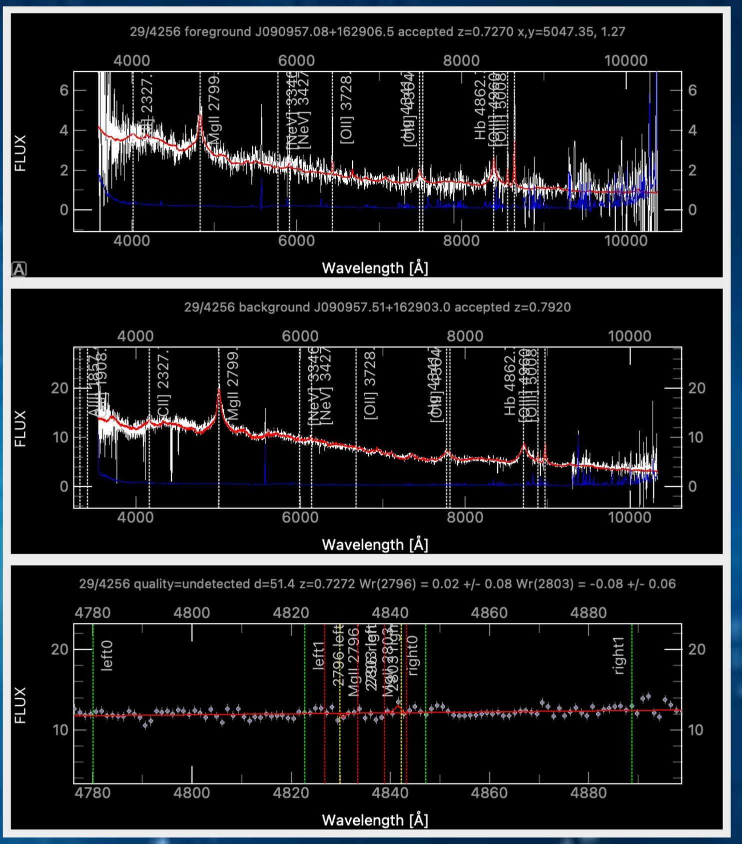
Abstract

Although quasar fueling has been extensively studied in the past, this research was restricted primarily to focusing on signs of recent mergers in star light. However, quasars are fueled by gas reservoirs, not stars. For this project, we used Mg II absorption in 4256 foreground/background quasar pairs from the Sloan Digital Sky Survey (SDSS) to study gas in the halos of the foreground quasars. The light from a background quasar reaches us by passing nearby the foreground quasar, and if there is a cool (10,000 K), metal-enriched cloud along the line-of-sight, a Mg II absorption spectrum is produced. For each pair, we inspected the quasar spectra to visually verify if they were actually quasars, and verified the SDSS redshift measurement. Using Python graphical user interfaces, we zoomed in on the background quasar spectrum at the observed wavelength of Mg II at the foreground quasar redshift. We then fit the continuum and searched for Mg II absorption, which we classified as either confident, single-line, or non-detection. For confident and single-line detections, we fit a Gaussian profile and measured the line strength (equivalent width). Two of us made independent measurements for each pair and then compared them, resulting in a final confirmed sample of 300 confident absorbers, 155 single-line absorbers, and 3590 non-detections. We measured the covering fraction (total number of confident absorbers over sample size) and plotted it against projected distance between the foreground and background quasars. This provided us with a measurement of how common Mg II is at different distances. We found that as projected distance increases, covering fraction decreases. Our next steps involve stratifying our sample by redshift and luminosity, and observing whether these divisions produce changes in the covering fraction vs. distance trends.

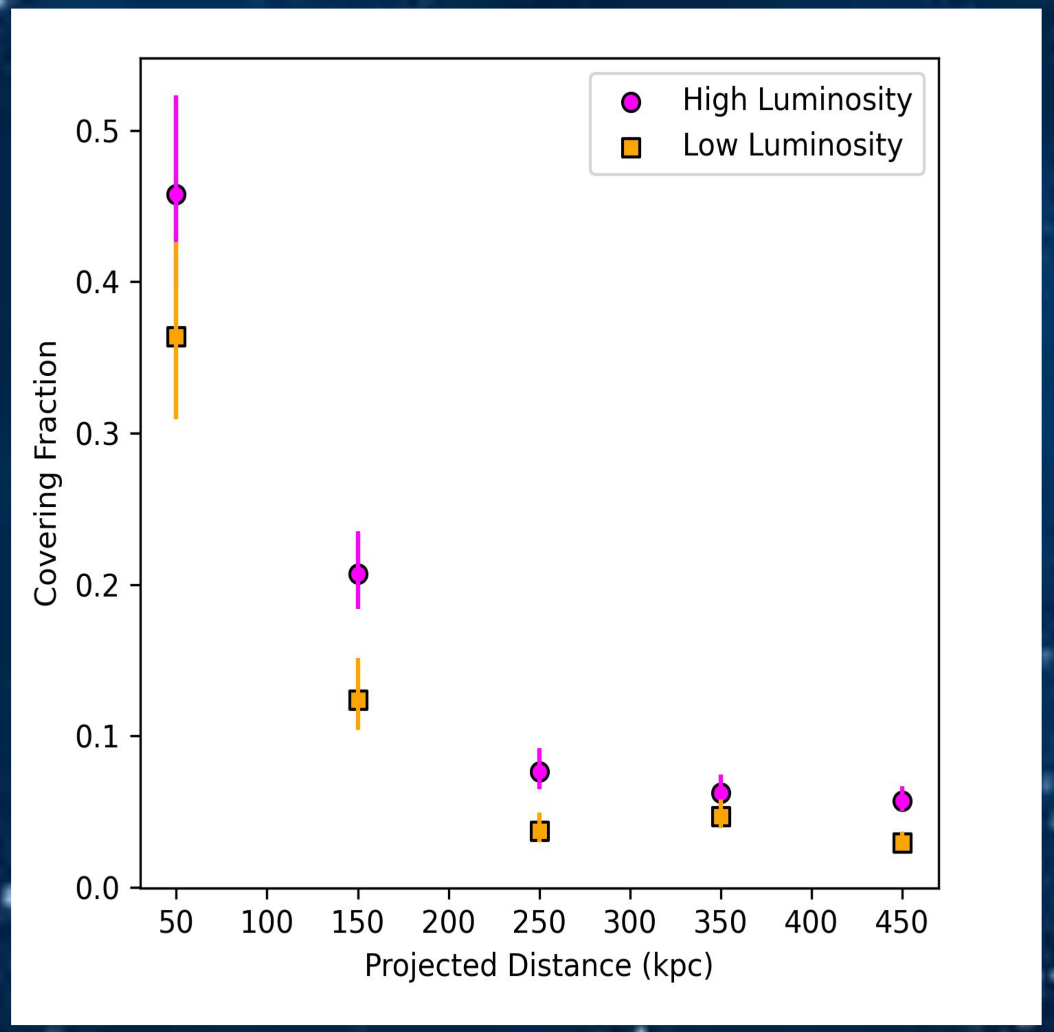


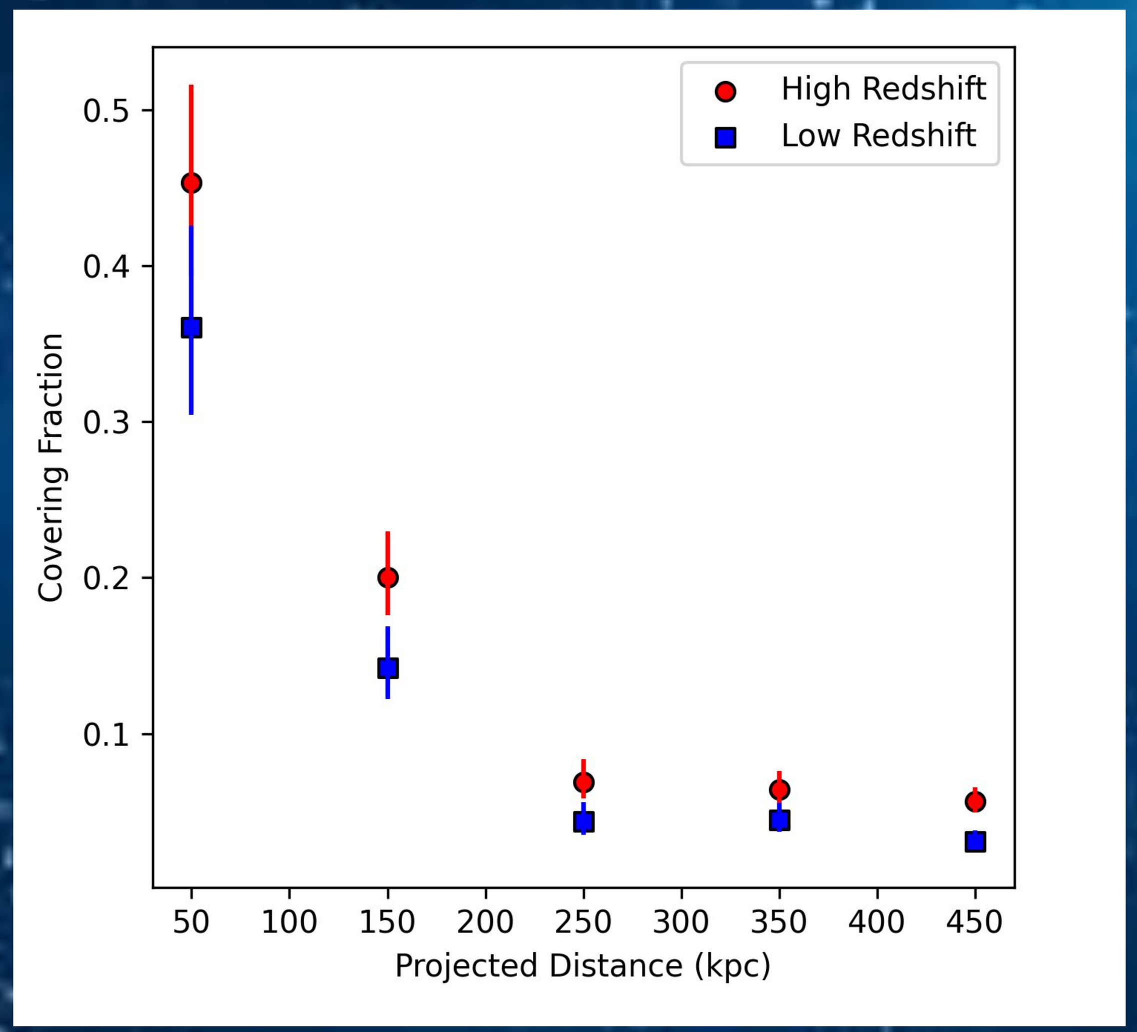


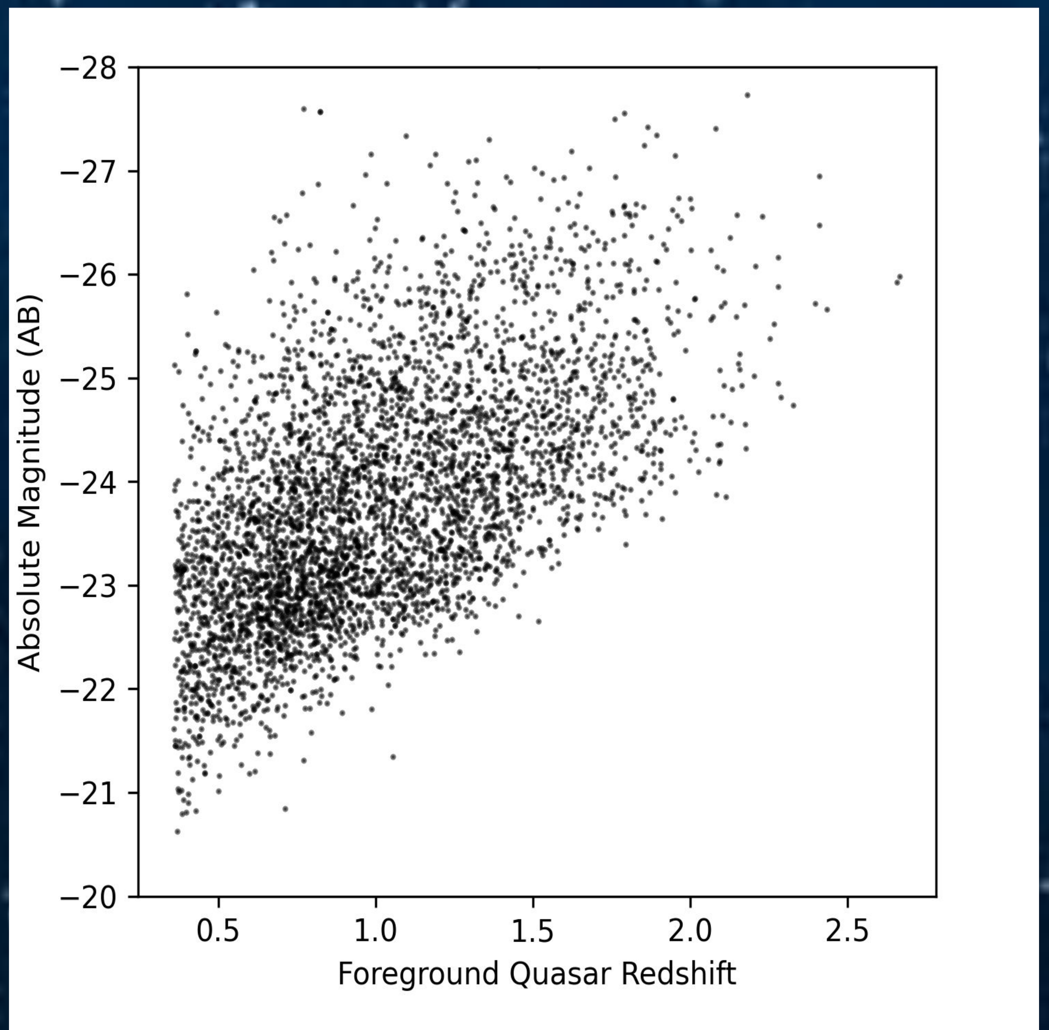


Methods

- Started with a catalog of pairs compiled from the SDSS
- Verified that each spectrum of the sample belonged to a quasar, and not another object such as a galaxy or star
- Measured the continuum and absorption properties of the spectra using Python graphical user interfaces
- Compared each of the measurements from the 4256-pair catalog to refine our final sample
- Plotted covering fraction (the number of confident detections divided by the total number of confident, single-line, and non detections from the sample) as a function of distance
- Repeated this process, split by quasar redshift and luminosity







Results

- 20x more Mg II constraints around quasars than previous studies
  - 300 confident detections from the sample
  - 155 single-line detections
  - 3950 non detections
- Covering fraction decreases as projected distance increases
- Covering fraction is greater for quasars of high luminosity ($M_B < -23.7$) compared to low luminosity
- Covering fraction is greater for quasars of high redshift ($z \geq 0.94$) compared to low redshift

Conclusions & Future Work

- We found clear trends of Mg II absorption among stratifications by redshift and luminosity
- Covering fraction is greater for quasars of higher redshift
  - This could be due to the general evolution of the universe
- Covering fraction is greater for quasars of higher luminosity
  - This could be because luminous quasars drive more outflows
  - It could also be the result of mergers or interactions that may fuel luminous quasars
- In our sample, quasar redshift and luminosity are correlated, so in order to determine which is primarily responsible for the trend, our future plans involve dividing the sample by redshift while controlling luminosity, and dividing the sample by luminosity while controlling redshift

References

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