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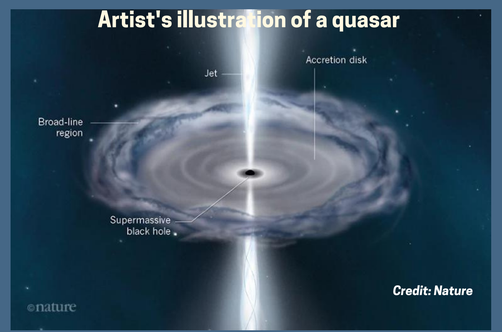
CONNECTION BETWEEN EMISSION AND ABSORPTION OUTFLOWS THROUGH THE STUDY OF QUASARS WITH EXTREMELY-HIGH VELOCITY OUTFLOWS (EHVO)

IMPORTANCE

EHVOs are one of the most intriguing phenomena associated with quasars and have yet to be extensively studied. Understanding the connection between absorption and emission in EHVOs, the most powerful class of outflows in terms of mass energy, can shed light on the mechanism driving the outflows and may be key to understanding the feedback process.

What are Quasars?

- Quasars are a subclass of **active galactic nuclei (AGNs)** -- extremely luminous galactic cores where gas and dust fall into a supermassive black hole and emit light across the entire electromagnetic spectrum.
- A quasar comprises a supermassive black hole at the center with an accretion disk, surrounded by hot gas and dust and , sometimes, they show two perpendicular jets.



Quasar is a short name for "quasi-stellar radio sources". Even the dimmest quasars are still many times more luminous than any normal galaxy. The luminosities of the most powerful quasars are thousands of times greater than that of the Milky Way.

The Sloan Digital Sky Survey or SDSS is a major multi-spectral imaging and spectroscopic redshift survey using a dedicated 2.5-m wide-angle optical telescope at Apache Point Observatory in New Mexico
Quasar spectra used in this study are from various data releases of SDSS.

References

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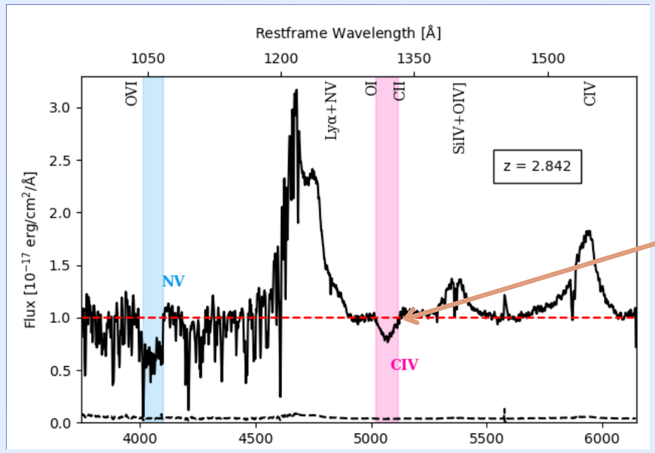
EHVO

What are EHVOs?

*Some quasars show **Extremely High-Velocity Outflows** (EHVOs), which consist of gas propelled away from the supermassive black holes at the centers of quasars at speeds greater than 0.1c.*

What is "blueshift"?

*Blueshift describes the increase in frequency (and **decrease in wavelength**) of a light wave **emitted or absorbed** by an object that is moving toward us as a result of the Doppler Effect.*



*A **spectrum** not only shows the chemical composition but also the **velocity** of the outflow*

How Are EHVOs Identified Using Blueshift?

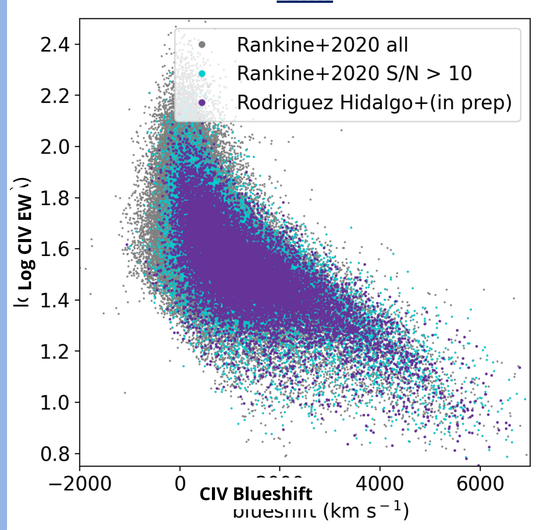
- *EHVOs are identified by measuring the **Carbon IV** (**CIV;** Carbon ionized 3 times) **absorption** feature.*
- *A **broad** CIV absorption trough with **wavelength blueshifted to the 1250-1400 Å** region in the restframe indicates an outflow speed between 0.1c and 0.2c.*
- *Our group identified **98 EHVOs** from a parent sample of 18165 quasar spectra in the SDSS Data Release 16 Quasar (DR16Q) catalog*

Emission Properties of EHVOs

Do EHVOs also show distinct emission features?

- ***Our study finds that EHVOs are more predominant in quasars with large blueshifts of the CIV emission line, suggesting a connection between emission and absorption outflowing signatures for these extreme outflows.***
- *This project is an extension of a previous study (Rodríguez Hidalgo & Rankine, 2022) by using a larger sample of 98 EHVOs.*

Data

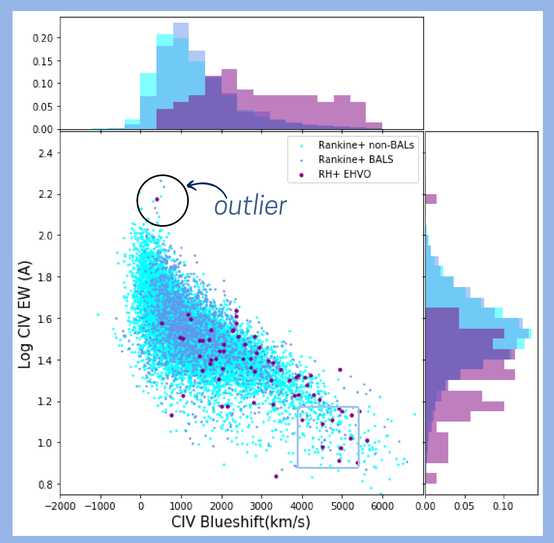


We found that after applying the S/N>10 cutoff, the Rankine+ sample (aqua), and the Rodríguez Hidalgo+ sample (purple) mostly overlap, which indicates that our sample of EHVOs has no selection bias.

*The **parent sample** (**grey dots**) is from a 2020 study by Rankine et al., which calculated the CIV emission line blueshift, among other values, for 144,000 quasars spectra in the SDSS DR14Q catelog.*

*A criteria of Signal-to-Noise Ratio (S/N>10) is applied and the sample size is reduced to 41,535 quasars (**aqua dots**).*

*The **purple dots** are a sample of 18165 quasar spectra from the SSDS DR16Q catalog. Our group previously identified 98 EHVOs from this sample. (Rodríguez Hidalgo et al. in prep)*



- *The parent sample of quasars is divided into **BALs** (blue) and **Non-BALs**(aqua);*
- *BALs are defined as quasar spectra with broad absorption at speeds up to 25,000 km /s.*
- *The **purple** dots are **EHVOs** from the Rodríguez Hidalgo (in prep) study.*

This plot shows that EHVOs appear clearly in quasar spectra with larger values of CIV emission blueshift than the other two populations. We found an outlier EHVO (circle) at the upper left corner. After a closer examination of its spectra, we determined that it is actually misidentified as an EHVO. More EHVOs might be found in the bottom right corner.