

# Data Analysis for Low Signal to Noise Ratio Quasars

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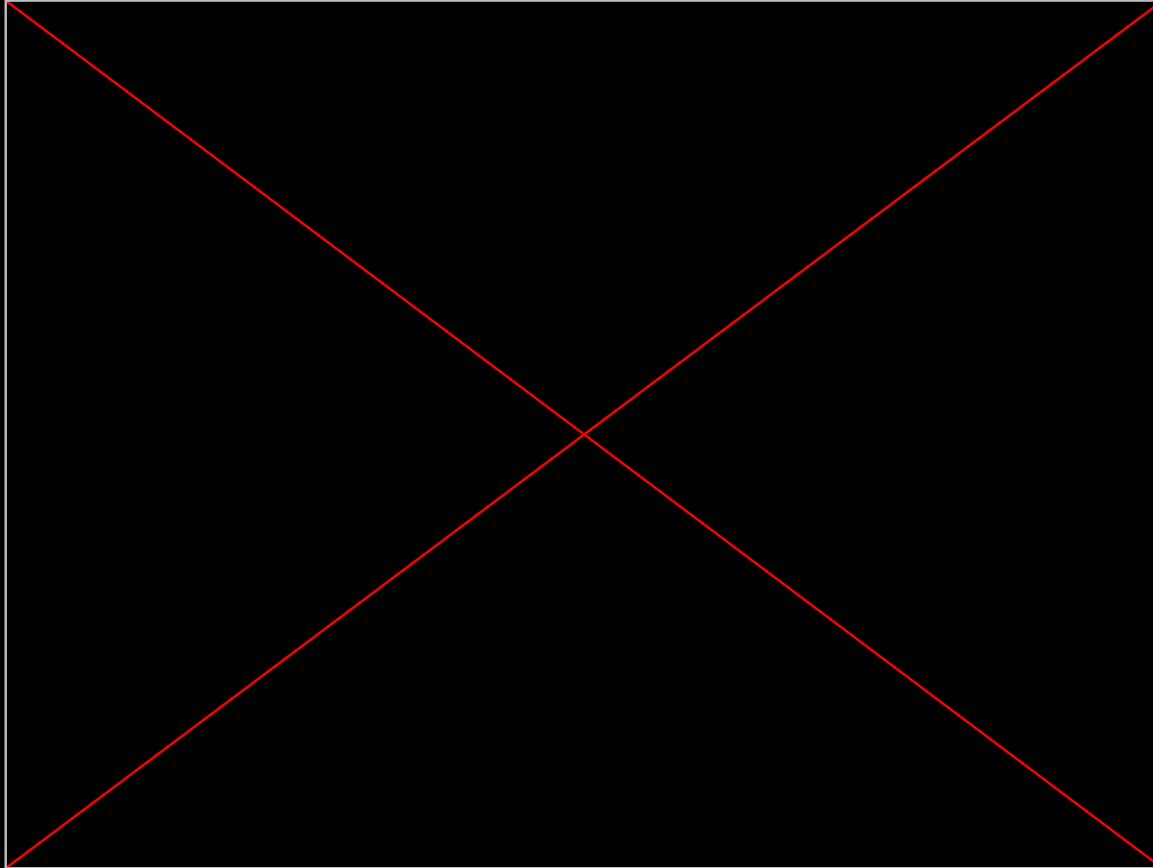
# Crash Course : Quasars

- ★ One type of Active Galactic Nuclei (AGN) that's currently "eating" powered by a supermassive black hole (SMBH).
- ★ Friction from gas clouds makes it extremely bright.
- ★ Some material funneled away from black hole.
- ★ Important time capsules.
- ★ Have strange spectra.



Credit: National Radio Astronomy Observatory, 2021.

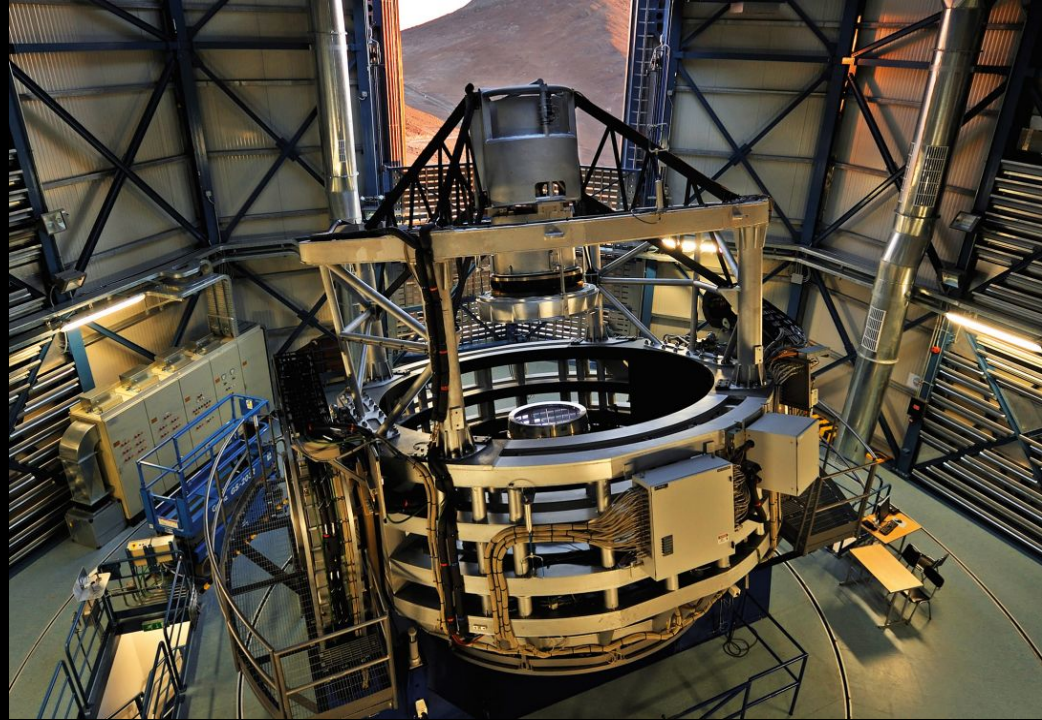
# Lyman Alpha Forest



[https://www.pontzen.co.uk/media/dla\\_credited.mov](https://www.pontzen.co.uk/media/dla_credited.mov)

# Purpose

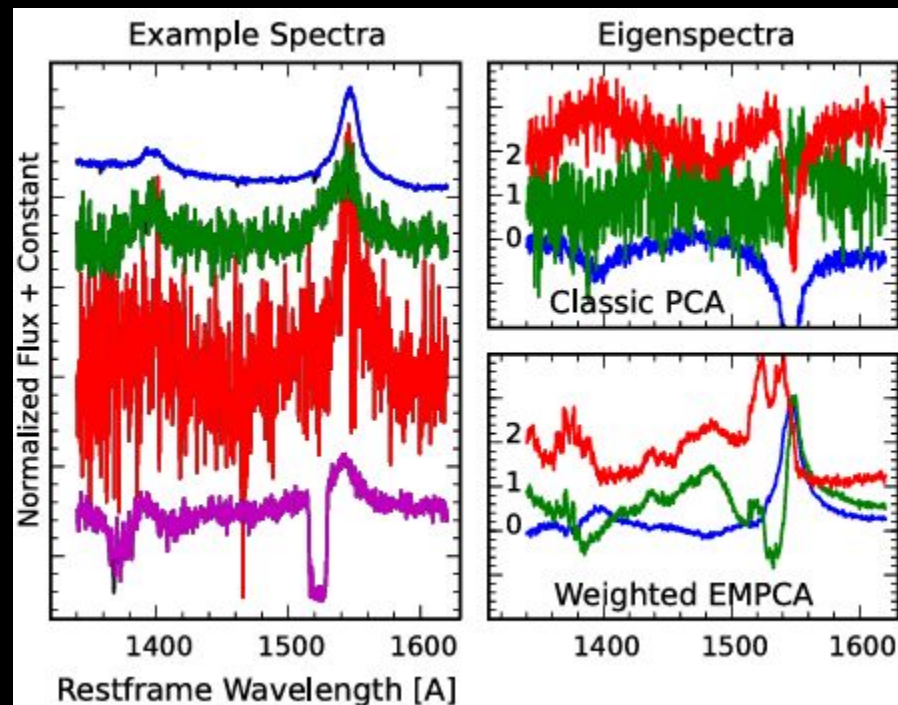
- ★ Analysis of high signal to noise ratio (SNR) quasar data is being worked.
- ★  $\text{SNR} = \text{mean} / \sqrt{\sigma^2}$
- ★ Low SNR = dim object.
- ★ 4MOST Gaia survey will be installed on Vista telescope.
- ★ Need an understanding of the limits of low SNR data to compare.



Credit: Krogager, J.K. et al., The 4MOST-Gaia Purely Astrometric Quasar Survey, *Astronomical Science*, 2023. DOI: 10.18727/0722-6691/5310.

# Method

- ★ Expectation maximization principal component analysis (EMPCA) is a method to analyze by forming eigenvectors.
- ★ Transformation that optimizes eigenvectors to describe true signal variations (99%) without being affected by noise.
- ★ Ranging between wavelengths, normalization, reddening and sigma clipping.



Credit: Bailey, Stephen. Principal Component Analysis with Noisy and/or Missing Data. *Astronomical Society of the Pacific*, 124:1015-1023, 2012.

# Results (So Far)...

- ★ Try to get  $\chi^2$  close to 1 as possible.
- ★ Try to cut out as much non-quasar signal as possible.
- ★ Make sure eigenvectors and model fit appropriately.

