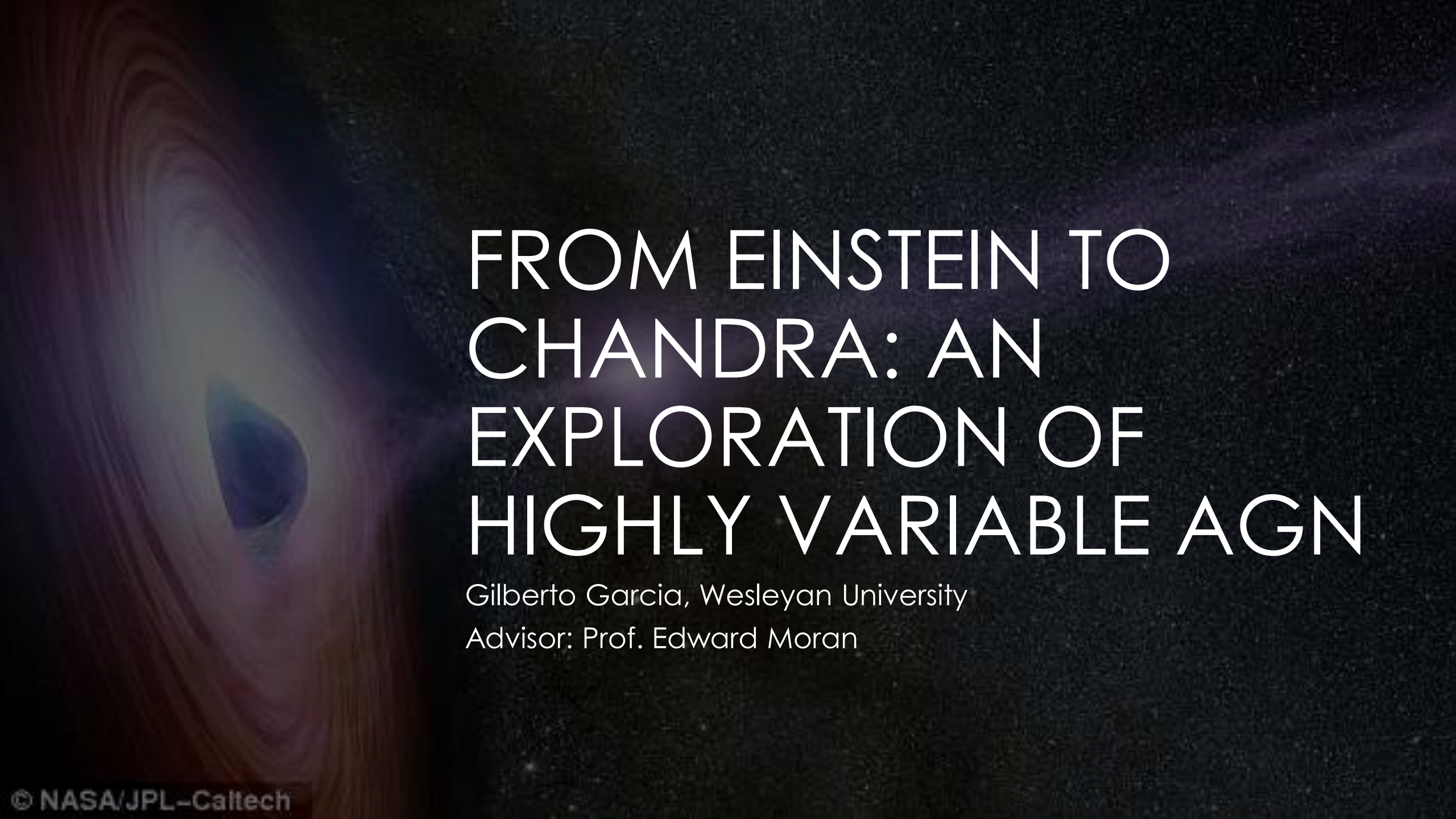

FROM EINSTEIN TO CHANDRA: AN EXPLORATION OF HIGHLY VARIABLE AGN

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INTRODUCTION

- Most (and perhaps all) galaxies host a supermassive black hole (SMBH) at their centers.
- But fully-formed SMBHs have also been observed in really distant quasars during the early stages of the universe.
- So how did SMBHs at the centers of galaxies form?
- How have they evolved over time?

BACKGROUND

- Many SMBHs continue to grow by accreting material, which produces radiation. These SMBHs are called active galactic nuclei (AGN).
- Radiation from the black hole accretion is directly linked to X-ray emission.
- Therefore, observing dramatic, long term changes in an AGN's X-ray luminosity could reflect a change in the way the black hole is being fueled.
- We can study X-ray emission with orbiting X- ray telescopes.

ORBITING X-RAY TELESCOPES

- Einstein Observatory (launched 1978)
- ROSAT Observatory (launched 1990)
- XMM-Newton Observatory (launched 1999)
- Chandra Observatory (launched 1999)




METHODS

- We cross-correlated catalogs of sources detected by Einstein (Einstein Two-Sigma catalog), ROSAT (ROSAT All Sky Survey), and Chandra (Chandra Source Catalog 2.0).

- We examine each source's light curve (i.e., its flux versus time).

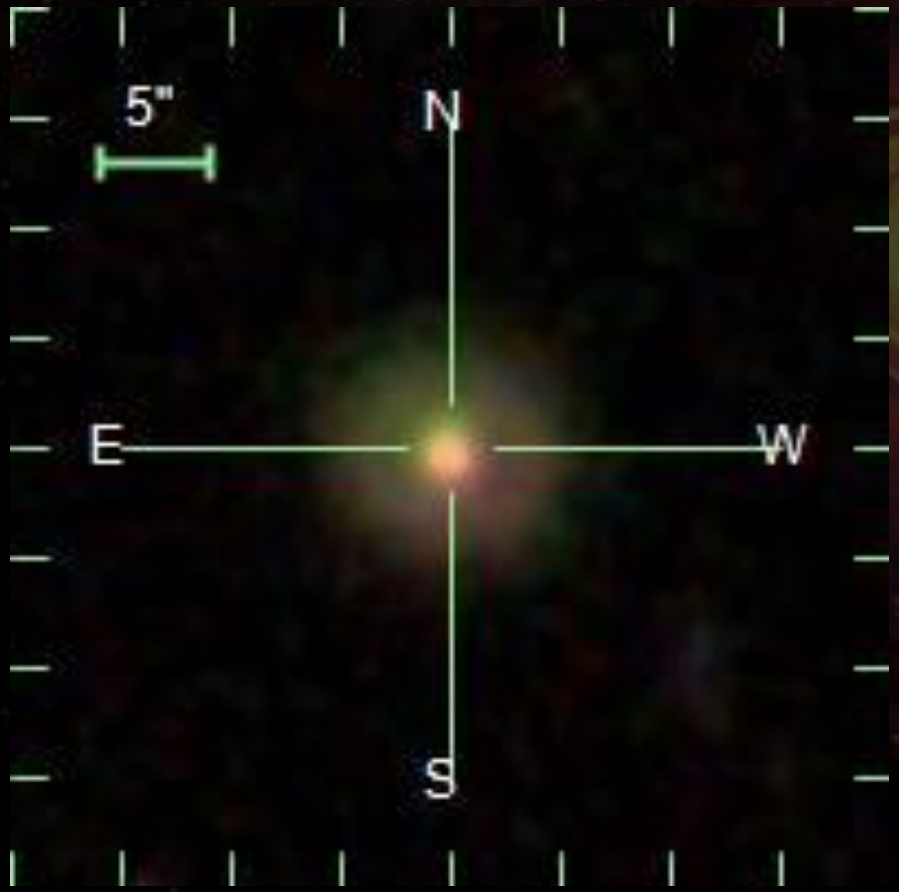
- If a source varied significantly (by a factor of > 6), additional data such as optical images and spectra are obtained.

METHODS (CONTINUED)

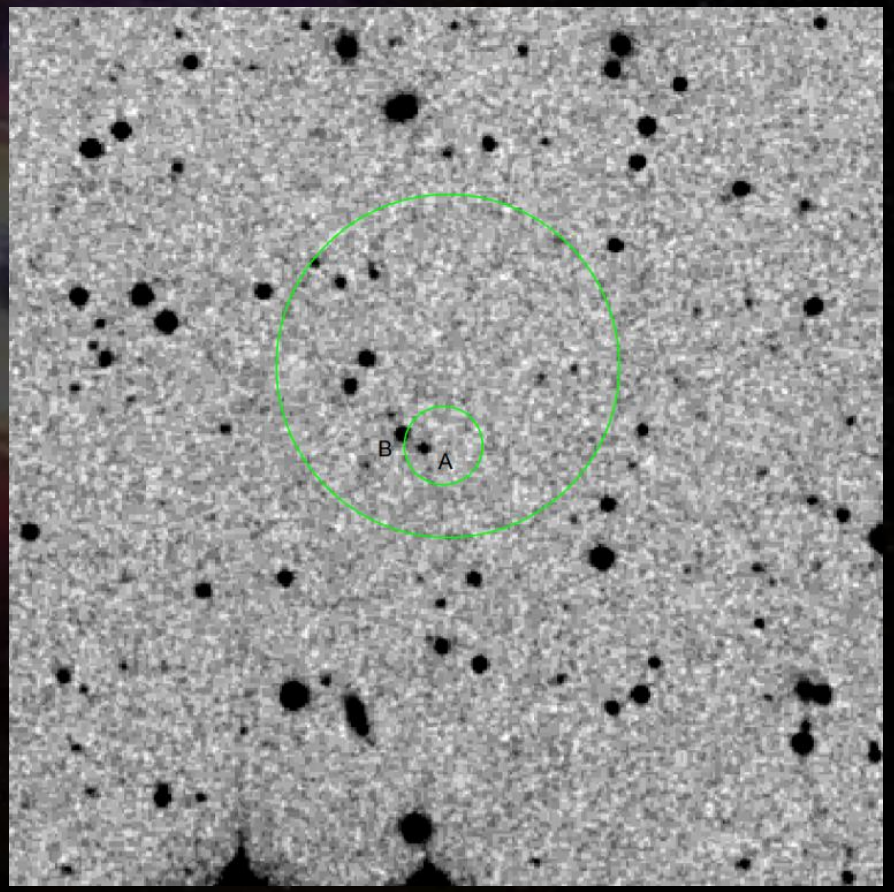
- We continue by working with a subset of Einstein sources that varied dramatically between ~1980 and ~1990.
- We compare this subset to the Chandra Source Catalog 2.0 to extend our investigation of their variability.
- So far, we find 2 highly variable AGN that were also detected by Chandra.
- We have acquired additional X-ray and optical data to characterize these objects further.

OPTICAL IMAGES

J111521.2+404322

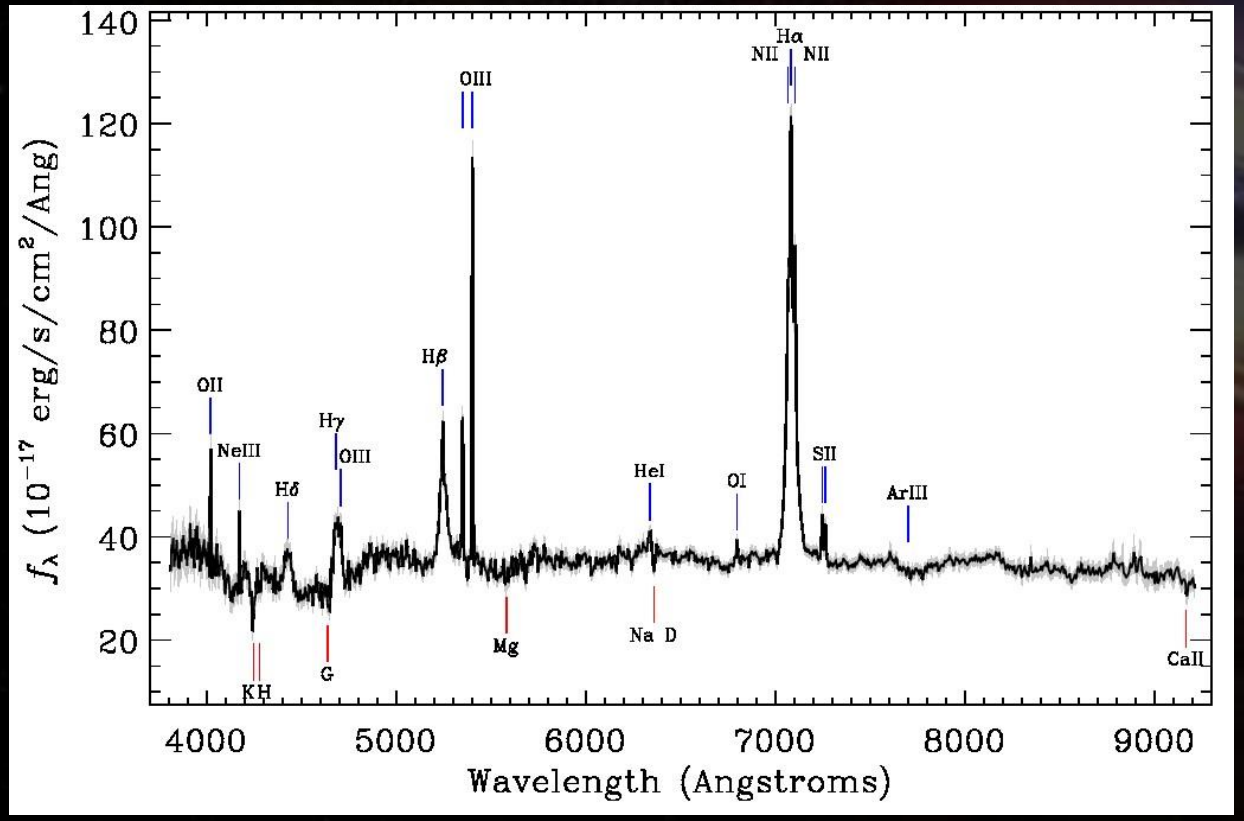


J180115.2+662401



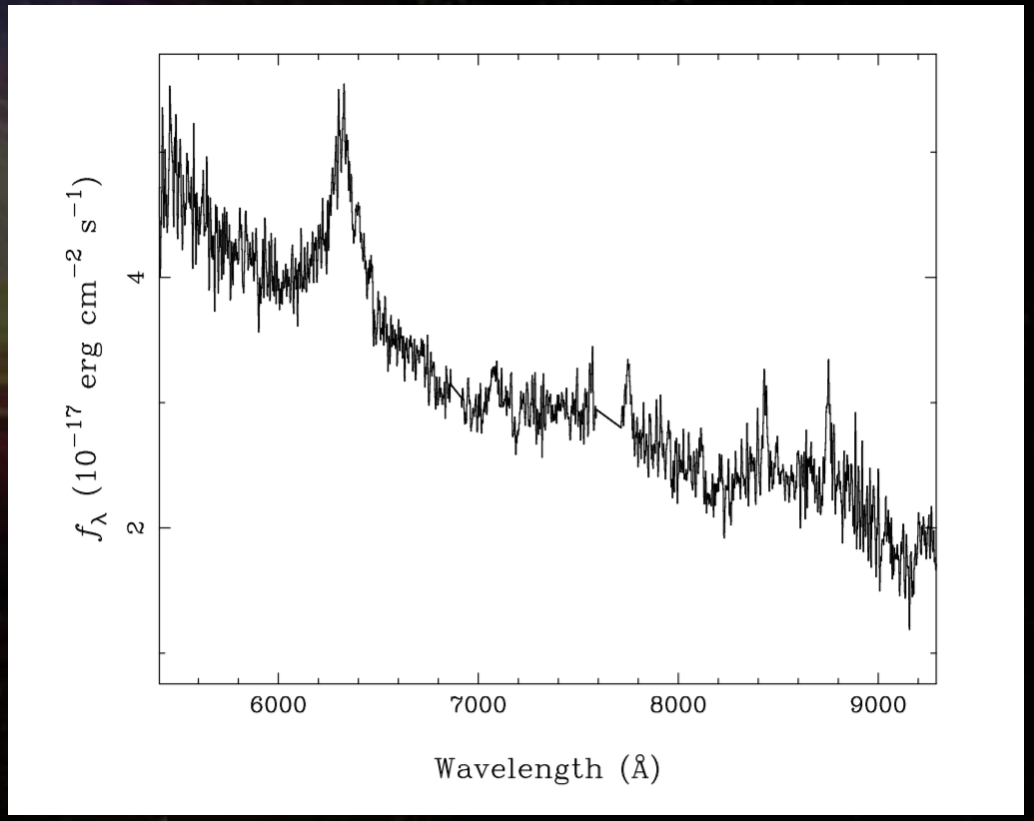
OPTICAL SPECTRA

J111521.2+404322



z = 0.079

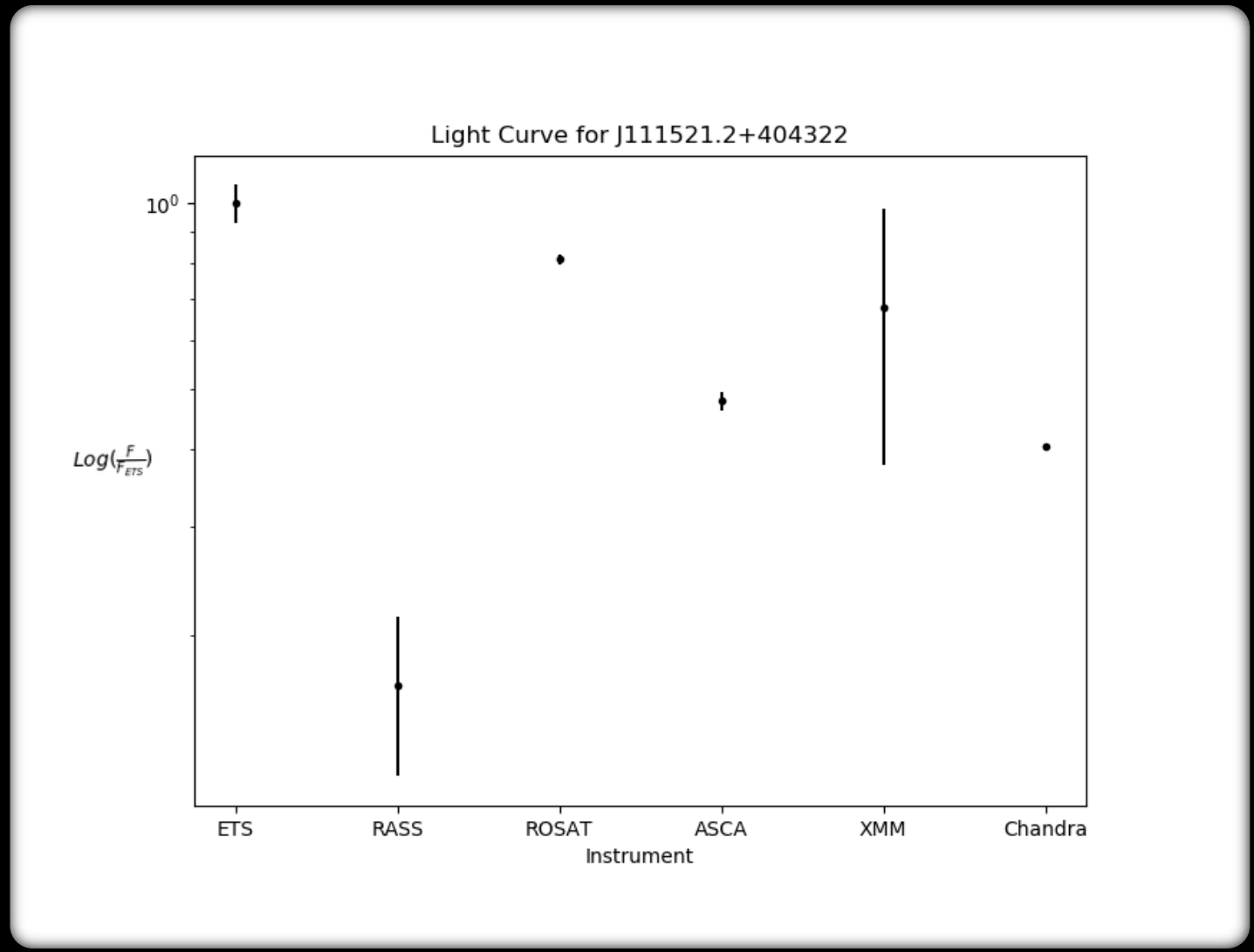
J180115.2+662401



z = 1.25

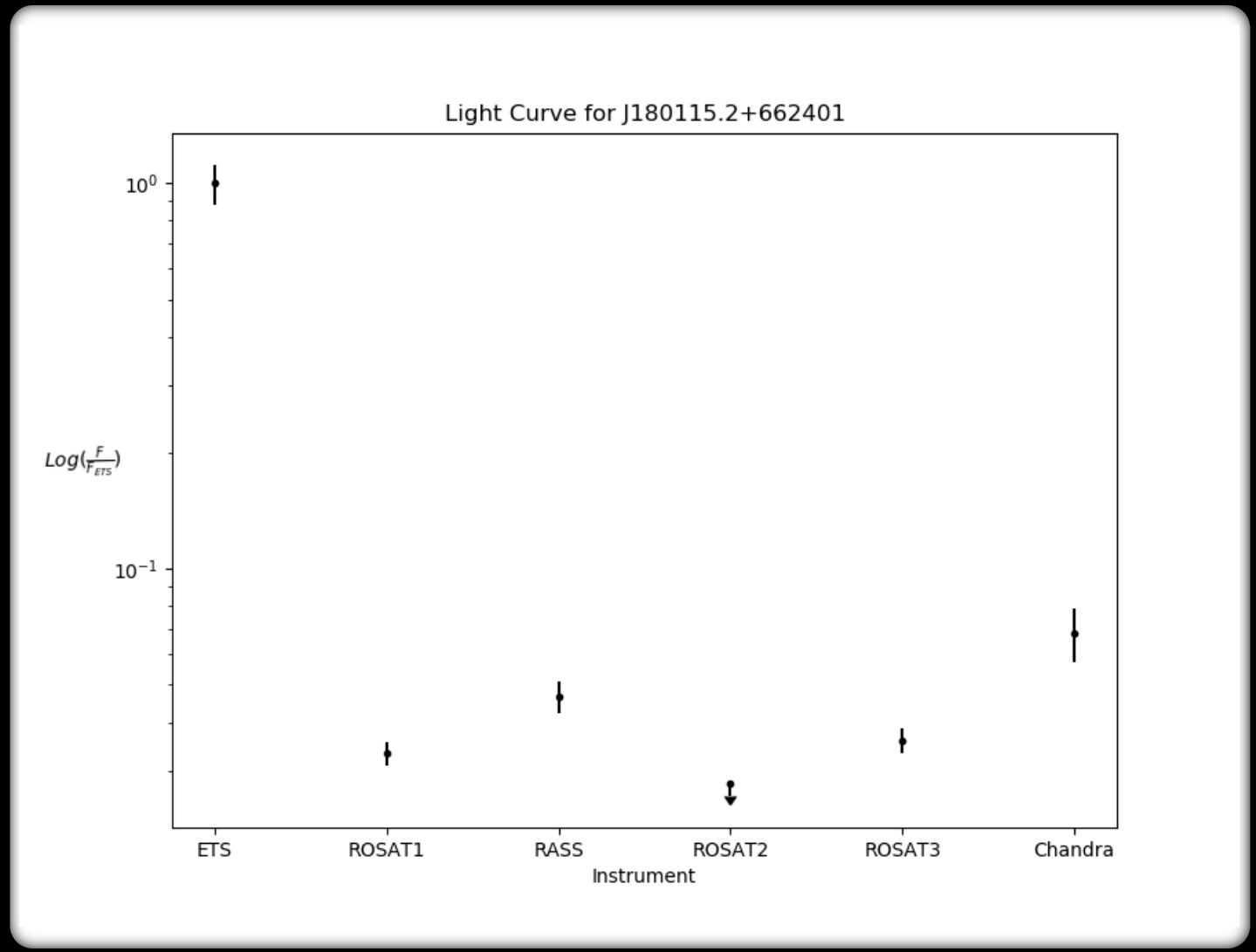
J1115+4043'S LIGHT CURVE

- Initial drastic decrease from ETS to RASS as expected.
- X-ray flux continues to vary throughout detections, but we start to see a generally decreasing trend.



J1801+6624'S LIGHT CURVE

- After the initial decrease from ETS to the first ROSAT pointed observation, J1801+6624 has had a more constant X-ray flux.
- This is suggestive of a dramatic, long term decrease in the accretion rate.



FUTURE WORK

- Continue to work with Chandra Observatory's data to expand the list of highly variable AGN by cross-correlating its newest release to older X-ray catalogs.
- Perform analysis similar to that which was done for J1115+4043 and J1801+6624: obtain spectra, optical images, and light curves for new candidates.
- Conduct up-to-date optical and X-ray observations to establish the connection between variability and the accretion histories of AGN.

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