Optical Variability of Quasar 1308+326

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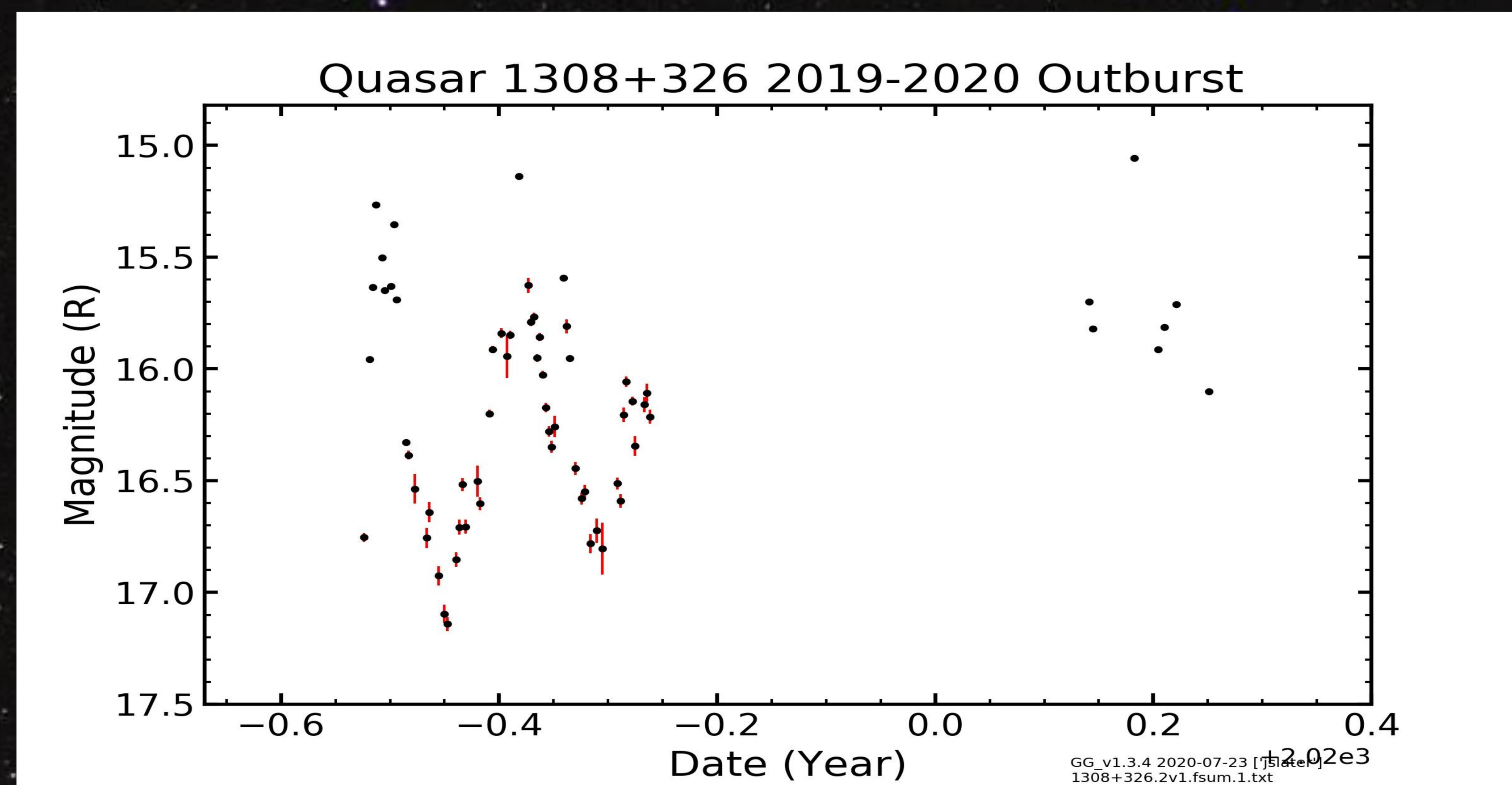
What are quasars/blazars?

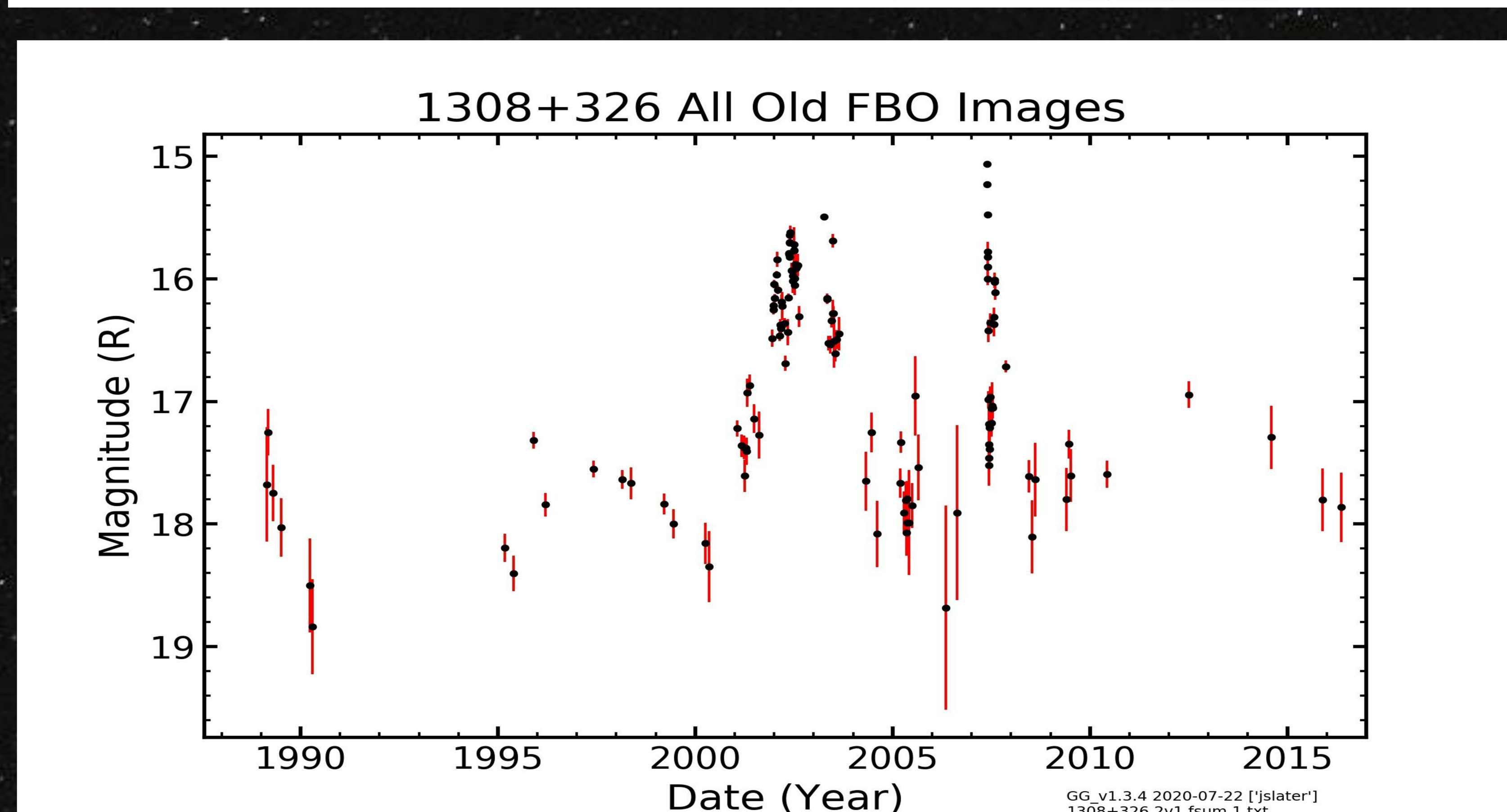
- The word "quasar" comes from a contraction of "quasi-stellar radio source"
- Named from their similarities in optical and radio emission with stars
- Their large redshift and strange emission spectra differentiated them from stars, and quasars were identified as something distinct
- Quasars are supermassive black holes in the center of active galaxies spewing jets of relativistic plasma that emit electromagnetic radiation
  - The jets come from an unknown process that utilizes both the strong magnetic field and the high kinetic energy of the accretion disk
  - This is the light that we usually see
- Blazars are quasars whose jet lines up with the line of sight of the observer[1].

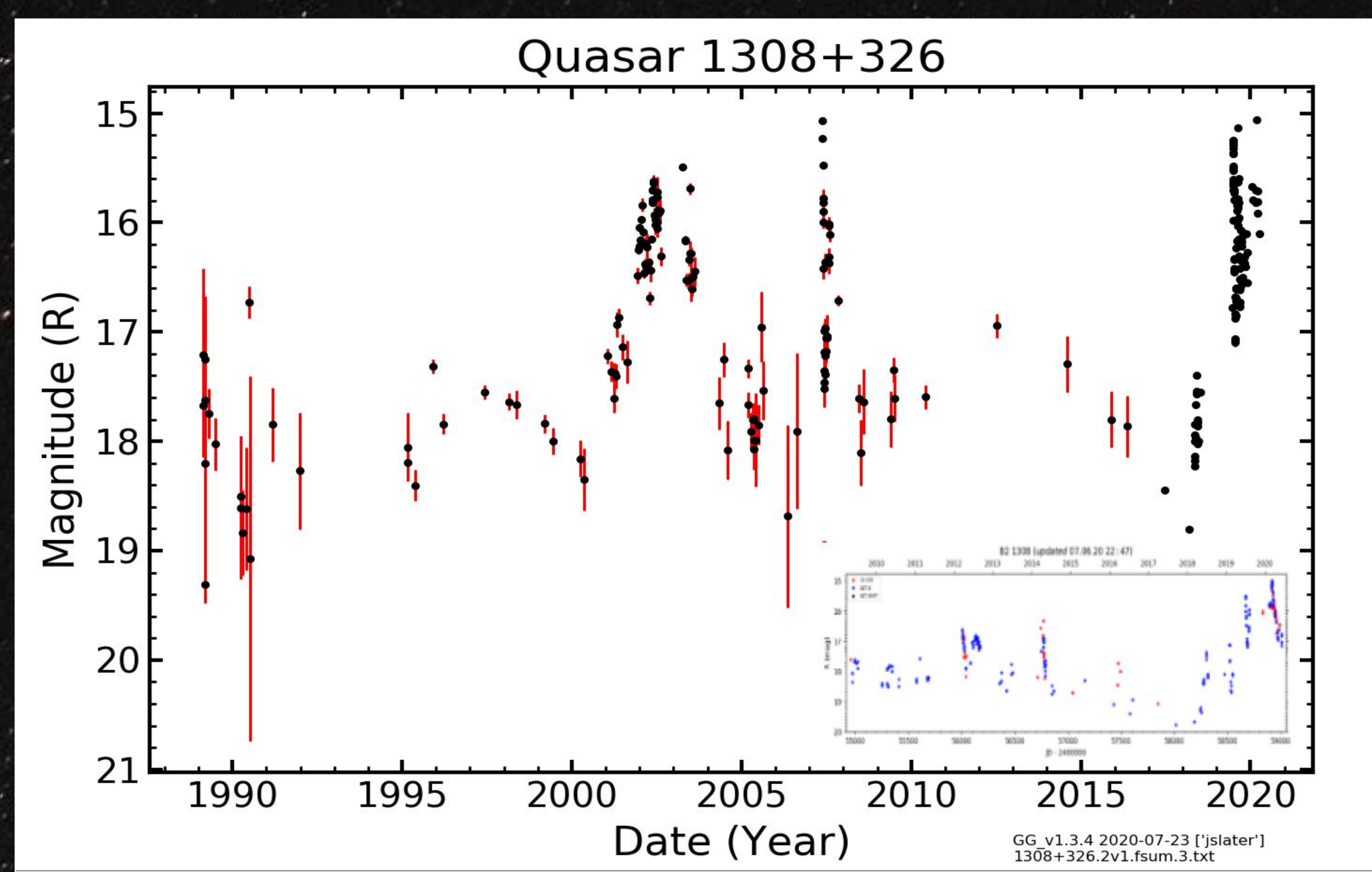
The Process

- To measure magnitude, we used a comparison star with a known constant magnitude and template that places stars
- We could measure the difference in magnitude in the image taken and find the quasar's magnitude using relative fluxes
- For a processed image, we subtracted the dark current image and divided by the flat field image (processed already with the bias).
- From there, we simply used AstroImageJ to measure the brightness over time.
- We did something similar to process the older images (past CCD) using IRAF
- Utilizing Unix, we ran each image through three programs: superproc, superphot, and superflux
- Superproc processes the images using their corresponding flats and darks
- Superphot takes the .fit file and determines the photometry of the image
- Superflux then calculates flux and magnitude of every object identified in the template along with other important timing measurements
- We use Professor Balonek's "GoodGraph" python program to graph

1. Robson, 78 .
2. St. Petersburg St. Univeristy .
3. Britzen et al.

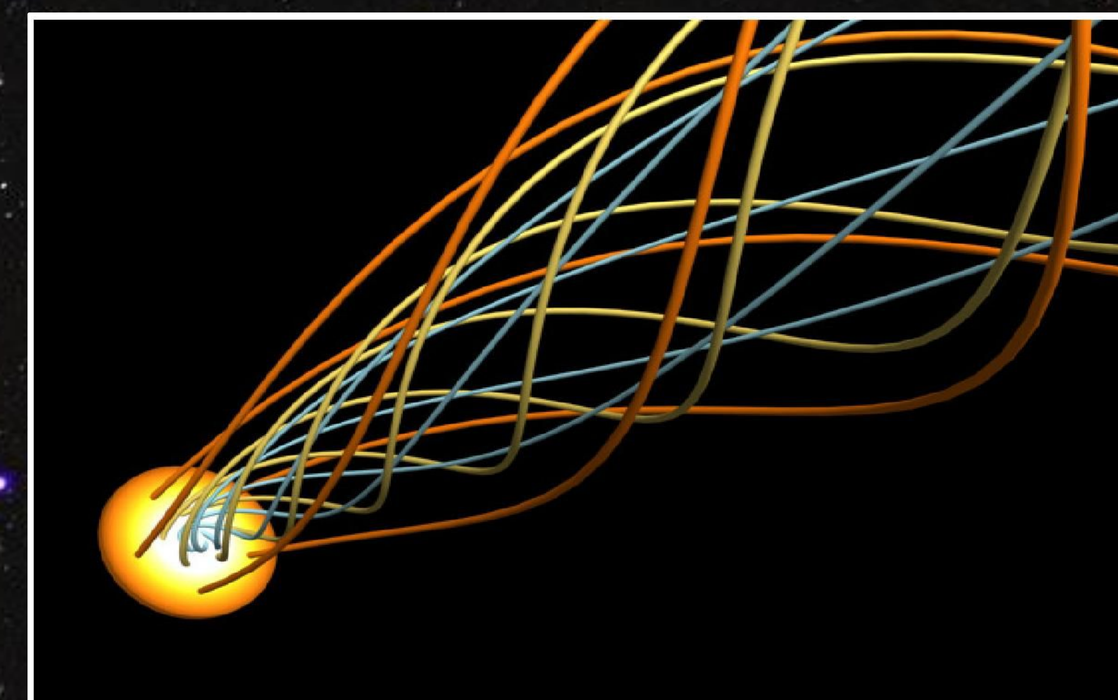






Observed Data

- 1308+326 began to flare on June 24,2019
  - Since, Colgate's Foggy Bottom Observatory has been collecting data when possible
- Other than this flare, those at FBO have been collecting data since 1989
  - Nearly 2000 images during this time period
- All data prior to midway through 2016 is accessed using Unix and the newer data only through some desktop maneuvering
- For every night, we have multiple images to minimize errors with corresponding biases and dark images



Periodicity of the Outbursts

- This quasar has had similar outbursts from, roughly, 1983-1985 and 2002-2004
- A paper by Britzen et al suggests a jet angle precession of 16.9 years
- Does this period exist in the optical wavelengths?
  - Our data, combined with Professor Balonek's past data, suggests an optical period of somewhere between 17-19 years with small flares in between
- Britzen's model of a precessing helical jet could make sense of this
  - Every period, the jet precesses and we receive certain amounts of photons on a semi-consistent basis
  - A helical, not-completely-consistent jet could explain short-term variability
- Much more data is needed to confirm

References:
Britzen, S. et al. (2017). A swirling jet in the quasar 1308+326. *Astronomy & Astrophysics,602*, 27.
Robson, Ian. *Active Galactic Nuclei*. Chichester, West Sussex: White House, 1996

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