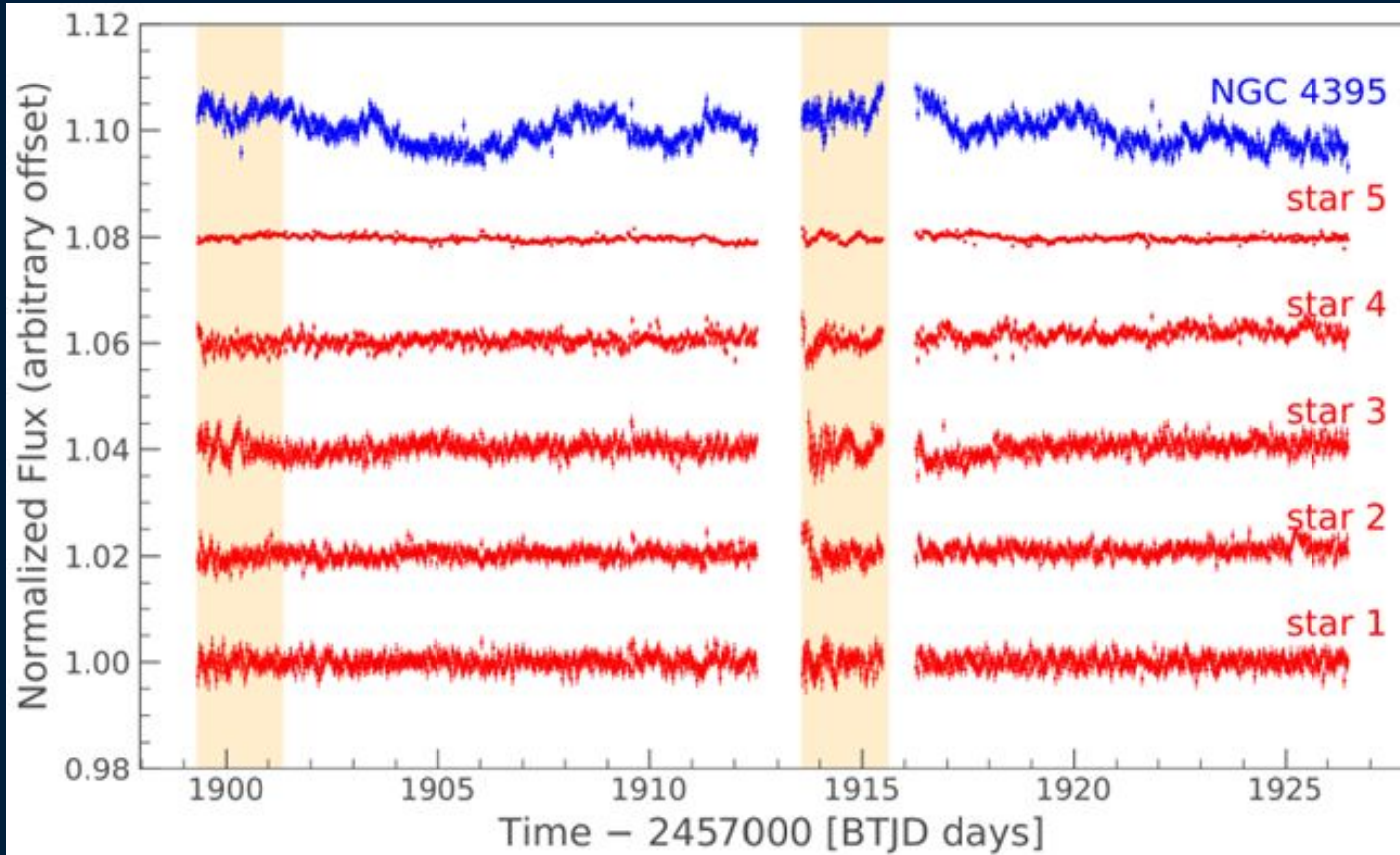




A High-Resolution Study of AGN Variability with TESS



Sophie Clark (University of Florida),
Matthew Graham (Caltech), Szymon Nakoneczny (Caltech)



(Burke et al., 2020)



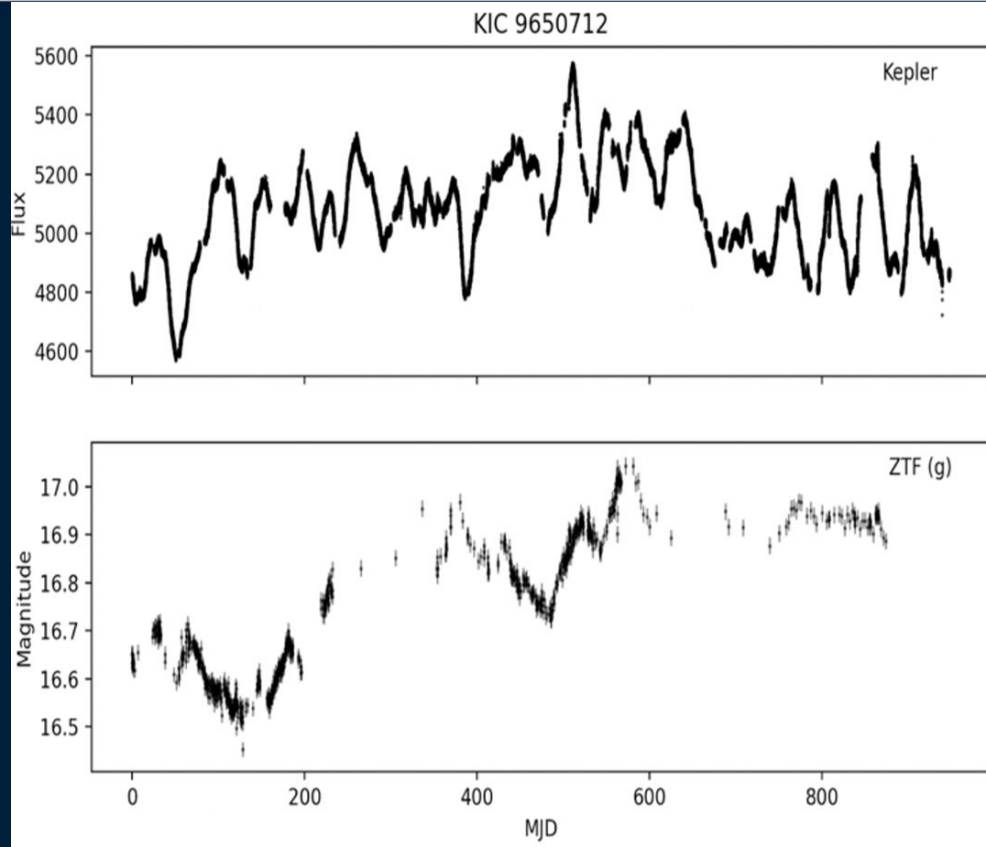
Scans entire Northern
hemisphere every two nights

Characterizes AGN variability on
month to year timescales



Observes $24^\circ \times 96^\circ$ sectors every
30 minutes for one month

Can we characterize variability
on **day to month timescales** ?



A light curve from ZTF (bottom), compared to a light curve from Kepler (top), an exoplanet telescope retired in 2018 (Smith et al. 2011)

Rapid Optical Flares in the Blazar OJ 287 on Intraday Timescales with TESS

SHUBHAM KISHORE,^{1,2} ALOK C. GUPTA,^{1,3} AND PAUL J. WIITA⁴

¹*Aryabhata Research Institute of Observational Sciences (ARIES), Manora Peak, Nainital 263001, India*

²*Department of Physics, DDU Gorakhpur University, Gorakhpur - 273009, India*

³*Key Laboratory for Research in Galaxies and Cosmology,*

Shanghai Astronomical Observatory, Chinese Academy of Sciences, Shanghai 200030, People's Republic of China

⁴*Department of Physics, The College of New Jersey, 2000 Pennington Rd., Ewing, NJ 08628-0718, USA*

Optical Quasi-periodic Oscillations in the TESS light curves of three blazars

Ashutosh Tripathi,^{1,2}★ Krista Lynne Smith,^{1,2} Paul J. Wiita,³ and Robert V. Wagoner⁴

¹*Department of Physics, Southern Methodist University, 3215 Daniel Avenue, Dallas, Texas 75205, USA*

²*George P. and Cynthia Woods Mitchell Institute for Fundamental Physics and Astronomy, Texas A&M University, College Station, TX 77843-4242, USA*

³*Department of Physics, The College of New Jersey, 2000 Pennington Rd., Ewing, New Jersey 08628-0718, USA*

⁴*Department of Physics and KIPAC, Stanford University, Stanford, California 94305, USA*

Detection of Quasi-Periodic Oscillations in the Blazar S4 0954+658 with TESS

SHUBHAM KISHORE,^{1,2} ALOK C. GUPTA,^{1,3} AND PAUL J. WIITA⁴

¹*Aryabhata Research Institute of observational sciencES (ARIES), Manora Peak, Nainital 263001, India*

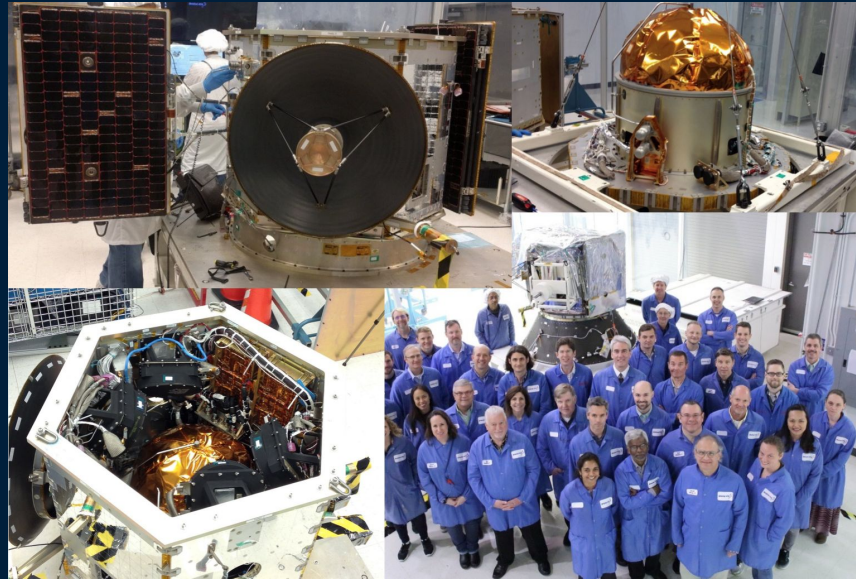
²*Department of Physics, DDU Gorakhpur University, Gorakhpur - 273009, India*

³*Shanghai Frontiers Science Center of Gravitational Wave Detection, 800 Dongchuan Road, Minhang, Shanghai 200240, People's Republic of China*

⁴*Department of Physics, The College of New Jersey, 2000 Pennington Rd., Ewing, NJ 08628-0718, USA*

Challenges of Using TESS

- Short timescale means it's difficult to perform quality checks
- Large pixels -- $21'' \times 21''$
- Systematic errors
 - Pointing jitter
 - Scattered light
 - Metallic straps
 - Asteroids
 - Nearby bright stars



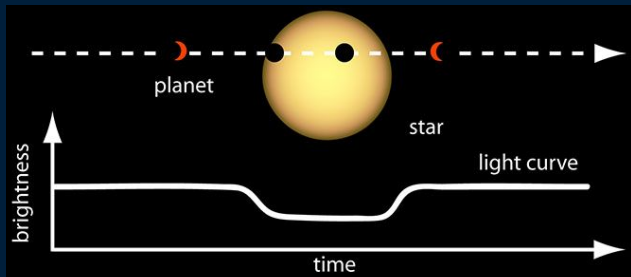
Northrop Grumman Innovation Systems

Quaver

Created by Krista Lynne Smith (Texas A&M)

Quaver is "an interactive, tunable pipeline designed to handle TESS data of stochastically varying sources, especially AGN."

Most TESS pipelines are ill-suited for stochastic variability



Quaver attempts to distinguish between systematic errors from TESS itself and legitimate stochastic variability from an astrophysical source

SearchResult

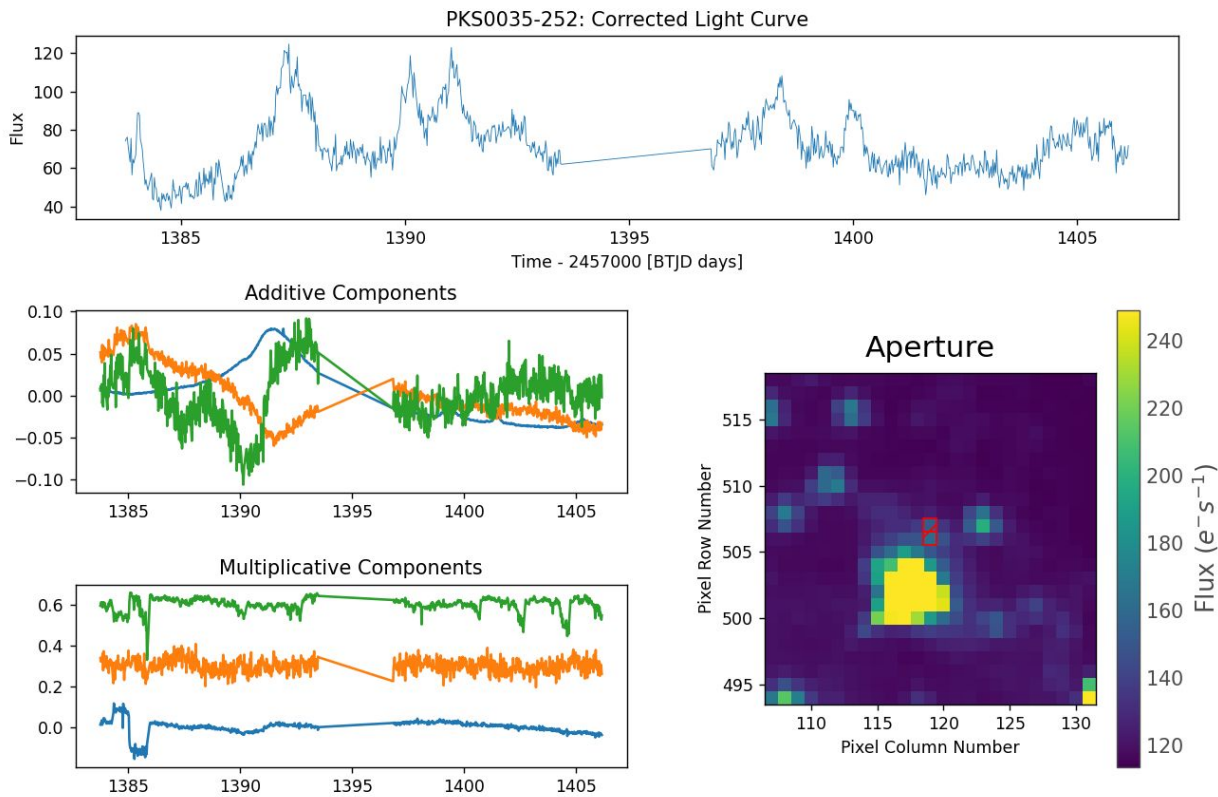
miss

0 TESS Se
1 TESS Se

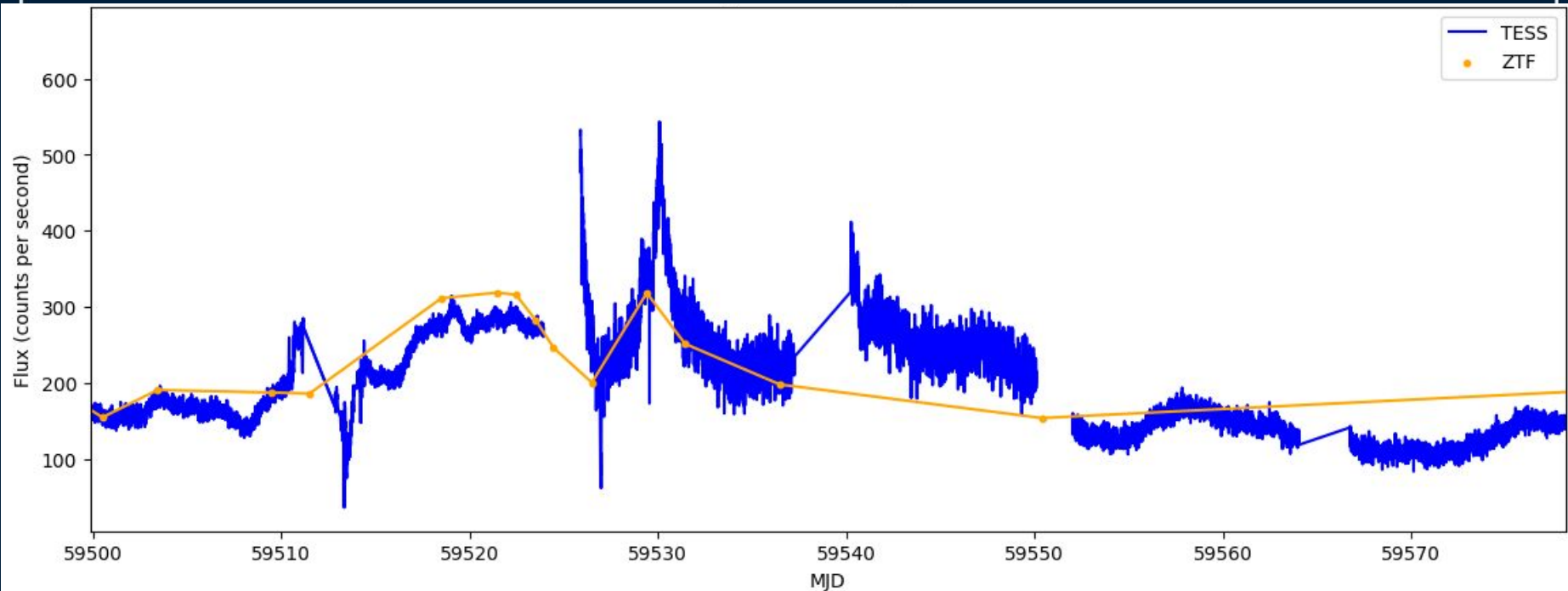
Table of Cy
Cycle 1: Se
Cycle 2: Se
Cycle 3: Se
Cycle 4: Se
Cycle 5: Se
Enter Cycle
Generating

adding(12,
adding(12,
Additive tr
-33
23
0.239643530
Systematics
0.239643530
1017
1092
Systematics
0.232576443
463
578
Systematics
0.201942964
444
466
Saving to f

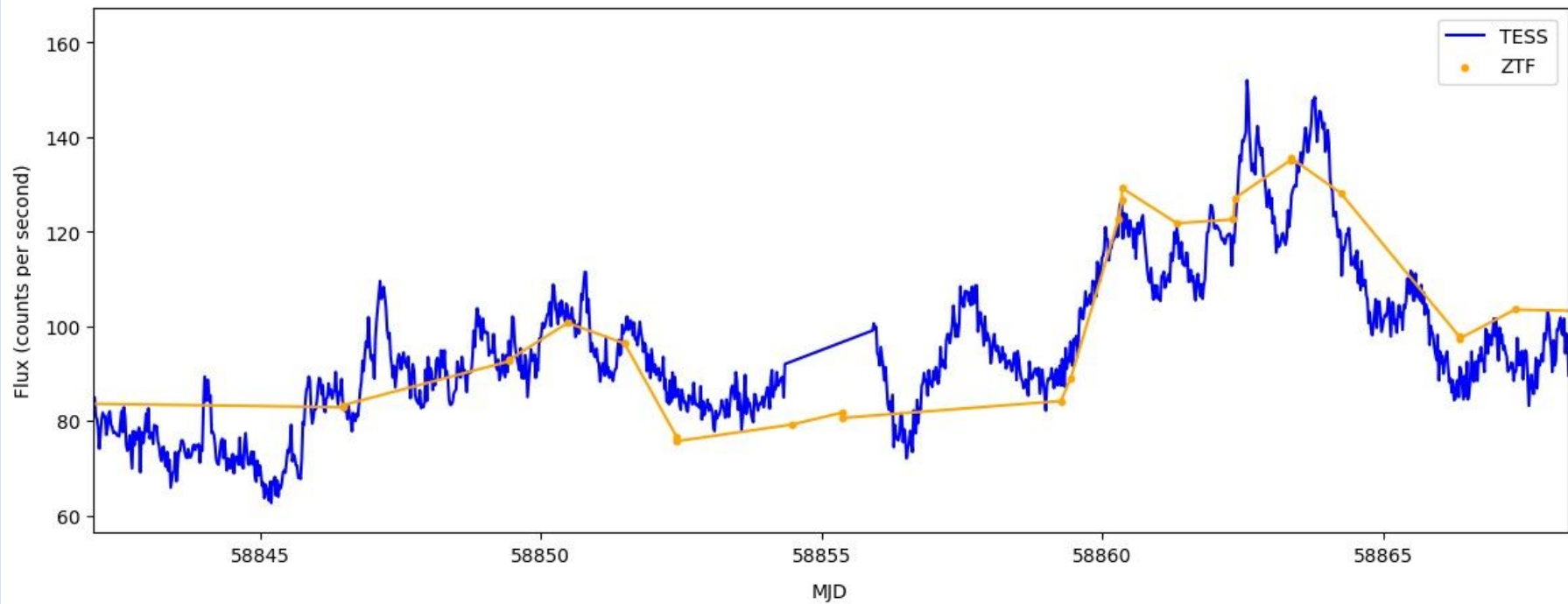
Figure 1



Light Curve for OJ287 (BL Lac object with magnitude 15)



Light Curve for S4 0954+658 (Blazar with magnitude 15.45)

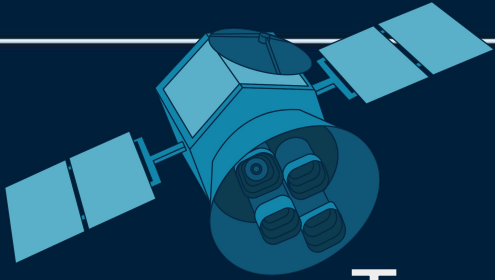


Conclusion

- ZTF is an incredibly beneficial sanity check for AGN light curves extracted from TESS
- Objects from 15th to 17th magnitude appear most likely to agree with ZTF data
 - Bulk run of Quaver may better reveal the limiting magnitude range
- TESS is a continuing mission and we expect to find out more as more data comes in

Thank you for listening!

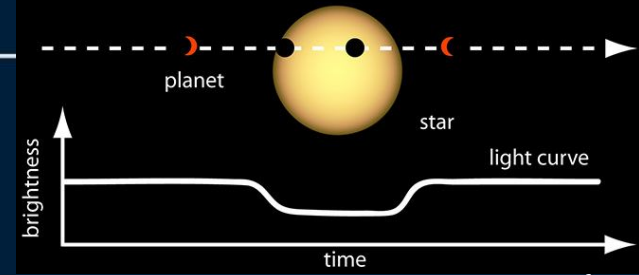
sophieclark@ufl.edu



TESS

Transiting Exoplanet Survey Satellite

- Launched in April 2018
- Designed to observe exoplanet transits in F5-M5 stars
- 4 silicon CCD lenses with $24^\circ \times 24^\circ$ views
- Bandpass of 600-1000 nm
- Elliptical orbit with period of 13.7 days
- All sky survey completed in 2 years (1 per hemisphere)
- Returns full-frame images (FFIs) with 30-minute exposure times



Acknowledgements

My Caltech mentors, Dr. Matthew Graham & Dr. Szymon Nakoneczny, who have guided me through this project

Dr. Kayla Smith, who wrote the original Quaver pipeline and was an incredible resource for learning more about studying AGN with TESS

My mentors at the University of Florida, Dr. Elizabeth Lada & Dr. Paul Sell, who supported me in my efforts to pursue a fellowship at Caltech