Adam Friedman Stellar Results

As a 2020 summer intern at NASA's Goddard Space Flight Center, Friedman was given the mammoth task of sorting through the millions of stars observed by the TESS mission.

Using machine learning and the 129,000-core Discover supercomputer at NASA's Center for Climate Simulation (NCCS), Friedman was able to sort through and classify over 70 million stars! Machine learning works by training a computer system to identify certain classes of variable stars using a well sampled set of initial light curves. Then, the computer learns from this sample set and tries to classify other data based on them.

Eclipsing quadruple systems!

During his investigation, Friedman made a remarkable discovery. Initially, his work focused on identifying eclipsing binaries: pairs of stars that alternately pass in front of each other, or transit, and as such, cause a dip in the light curve of every orbit. However, in this search, he also found systems in which there were multiple dimming events (as shown below), thought to be due to the passage of multiple stars. To date, Friedman has identified eight of these eclipsing quadruple systems.

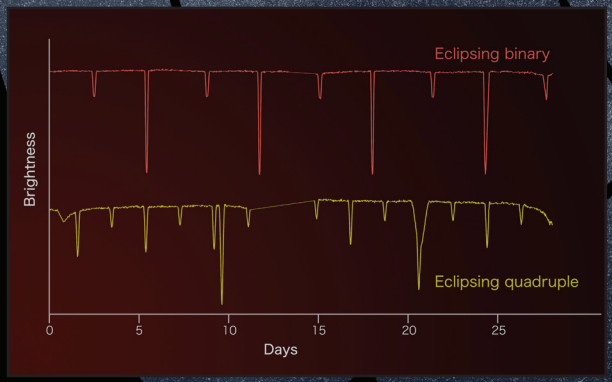


Image credits: NASA's Goddard Space Flight Center

TESS Guest Investigator Program Statistics

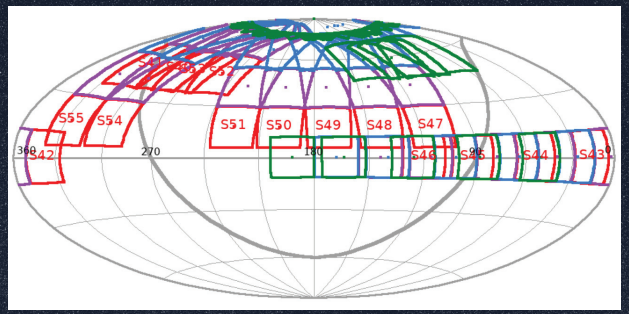
During the Cycle 4 call for proposals, 146 were submitted.

These 146 proposals were sorted into one of four fields: Exoplanet (33), Stellar Astrophysics (62), Accretion and Extragalactic (19), and Ground-based programs (32). Each proposal was assessed by one of seven panels.

Proposals were accepted with the following breakdown:

- **Exoplanet**: 24%
- **Stellar Astrophysics:** 48%
- **Accretion and Extragalactic:** 11%
- **Ground-based Focused:** 16%

Of the successful proposals, 44% were submitted by early career scientists.



Cycle 4 fields in Ecliptic coordinates
Image credits: MIT

National Aeronautics and Space Administration

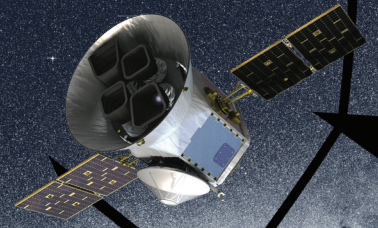
Goddard Space Flight Center
8800 Greenbelt Rd
Greenbelt, MD 20771
www.nasa.gov/tess

www.nasa.gov

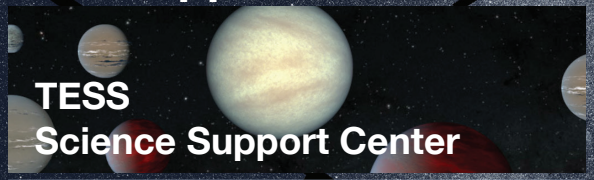
NP-2021-10-700-GSFC

National Aeronautics and Space Administration

TESS SCIENCE HIGHLIGHTS BY EARLY CAREER SCIENTISTS



TESS Guest Investigator Opportunities



TESS Science Support Center

The **Transiting Exoplanet Survey Satellite (TESS)** is a NASA-sponsored Astrophysics Explorer-class mission, operated by MIT that is performing a near all-sky survey to search for planets transiting nearby stars.

Launched on April 18, 2018, TESS successfully completed its prime mission on July 4th, 2020. Since then, TESS has entered its extended mission, during which it continues to scan the sky for exoplanets and transient events.

In the extended mission, TESS is more community-focused, with a much larger guest investigator (GI) program. This program enables teams to propose for the collection of new targets, provides funding to US investigators to analyze these new data, and provides funding for US investigators to collect ground-based data that supports TESS science. All proposals are managed by the GI office.

All scientists at all stages of their career can work with TESS data.

There is no exclusive-use data rights to observations collected by TESS. **Anyone can use TESS data!**

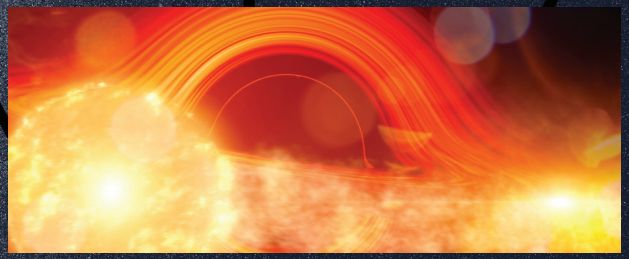
Useful resources for applying for or using TESS data are listed below:

- **TESS science support center website:** Here you can find all things TESS related including instructions on how and when to apply for TESS time - *https://heasarc.gsfc.nasa.gov/docs/tess/proposing-investigations.html*
- **Lightkurve:** A user friendly way to analyze time series data - *https://docs.lightkurve.org*
- **Proposal templates:** A list of templates you can use - *https://heasarc.gsfc.nasa.gov/docs/tess/proposal-templates.html*
- **Viewing tool:** How to determine if your object of interest has been or will be viewed by TESS - *https://heasarc.gsfc.nasa.gov/cgi-bin/tess/webtess/wtv.py*

This pamphlet highlights some of the amazing science achieved by early career astronomers using TESS data.

Image credits: NASA's JPL-Caltech

Anna Payne Discovering a TDE



As a NASA Graduate Fellow at the University of Hawai'i at Mānoa, Anna's research focuses on studying Active Galactic Nuclei, and Tidal Disruption Events (TDEs).

In 2014, an explosive event was observed in an active galaxy known as ESO 253-3, located 570 million light years away in the southern constellation of Pictor. Detected by the All-Sky Automated Survey for Supernovae (ASAS-SN), the event was thought to be a supernova and classified as ASASSN-14ko.

Six years later, Payne was examining the ASAS-SN data for her thesis, looking at active galaxies such as ESO 253-3. On examination of the data, Payne noticed that a flare event occurred within the galaxy nearly every 114 days, with each flare reaching its peak brightness within about five days. Could ASASSN-14ko actually be this flare like event?

A star ripped apart by a black hole!

By combining data from TESS, Swift, NuSTAR, XMM-Newton, ASAS-SN, and other facilities, Payne and her collaborators gained a better insight into this unusual event and ruled out the possibility of a supernova. Instead, she and her colleagues believe that the flare is likely caused by a partial Tidal Disruption Event. In this scenario, a giant star is partially disrupted by a black hole about the mass of our own Sun. Since the star is not in a circular orbit, each time it passes close to the black hole it sheds mass, which then feeds onto the accretion disc of the black hole causing the flare - a unique and remarkable event.

Image credits: NASA's Goddard Space Flight Center

Ward Howard Examining Super Flares

Utilizing data from TESS and the UNC-Chapel Hill Evryscope telescope, Howard (at the time a doctoral student in the Department of Physics and Astronomy at UNC-Chapel Hill), and his colleagues simultaneously observed super flares. The team's work led to the creation of the largest sample of super flares observed at high cadence, with multi-facility, multi-wavelength monitoring, to date.

Energetic stellar events!

Super flares are extremely large bursts of energy from a star, 10 - 1000 times larger than the biggest flares the Earth sees from our Sun. These flares can bathe a planet in high-energy ultra-violet rays and therefore have a significant impact on the ability of a planet to form life.

Using Howard's data, scientists can place limits on the habitability of planets that are targeted by future missions such as the extended TESS mission and the James Webb Space Telescope.

Howard is continuing his research into super flares, now using TESS's 20-second cadence data.

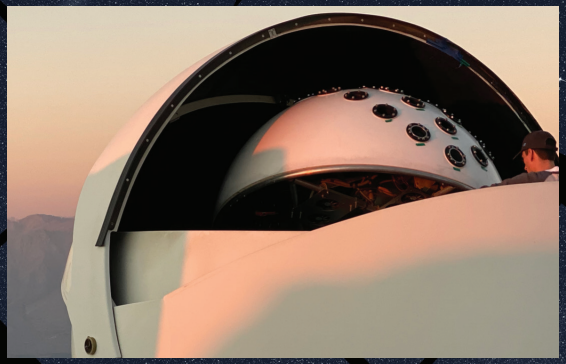


Image credits: NASA's Goddard Space Flight Center & UNC News