

Present and future optical space missions: TESS & PLATO

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Solar Focus – Solar-Stellar Connections: Present and Future Missions
Boulder, May 8th, 2020

Previous missions

CoRoT

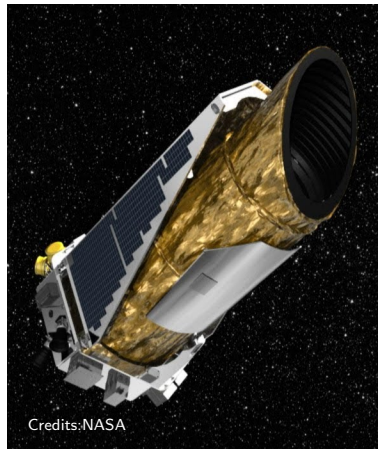
Convection, Rotation et Transits
planétaires (CEA-France & ESA)



Credits:ESA

Kepler & K2

(NASA)



Credits:NASA

CoRoT &
Kepler

TESS

orbit
observations
science
extension

PLATO

orbit
observations
science

Summary

TESS: Transiting Exoplanet Survey Satellite



- * two-year all-sky survey
- * **main goal:** discover hundreds of Earths & super-Earths
- * bright stars in the solar neighborhood
- * NASA's mission; PI: George R. Ricker (MIT)

CoRoT &
Kepler

TESS

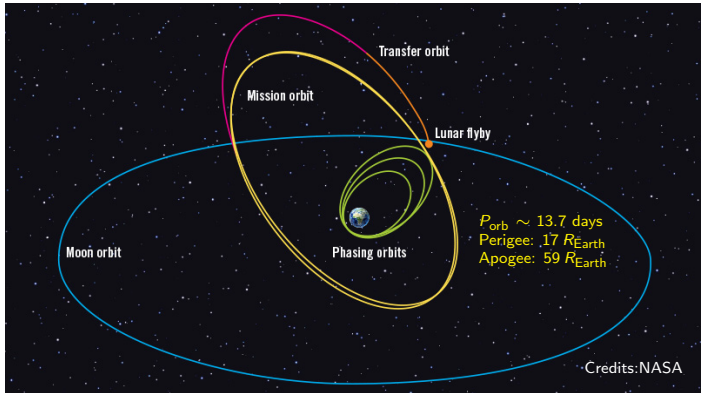
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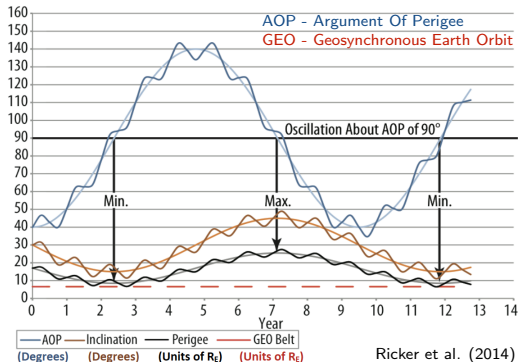
Summary

TESS Orbit



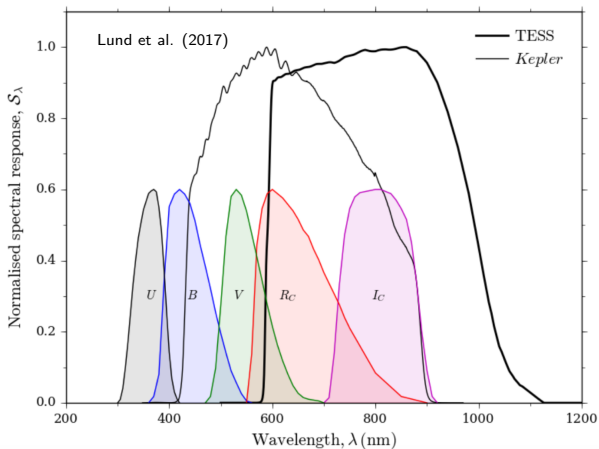
- * low radiation – prevent degradation
- * facilitate data transfer – downlink every ~ 13.7 days at perigee
- * 2:1 resonance with the Moon's orbit
- * inclined orbit – avoid eclipses by the Earth and Moon

TESS Orbit



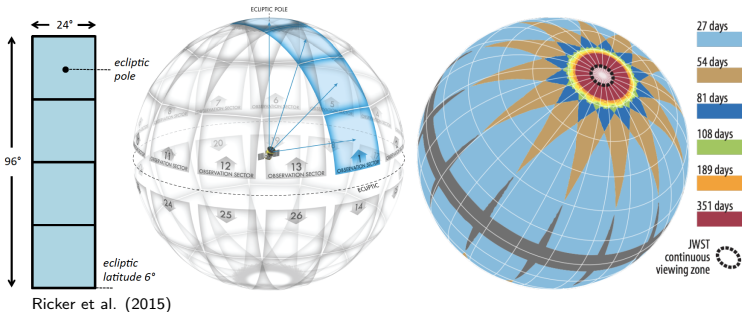
- * Kozai cycles – three-body system: 10-month and 10-year cycles
- * TESS orbital period varies between 12.8 to 14.6 days
- * the orbit is stable on the time scale of decades or more

TESS observations



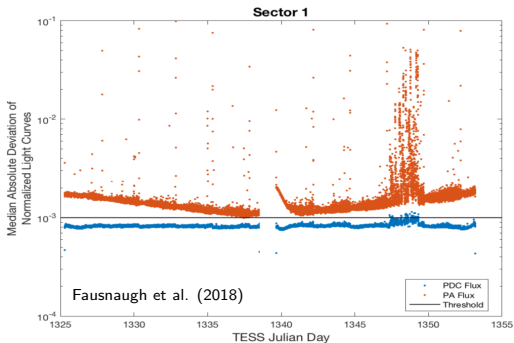
- * TESS band: 600-1000 nm
- * interest in M dwarfs, which are cool and red

TESS observations



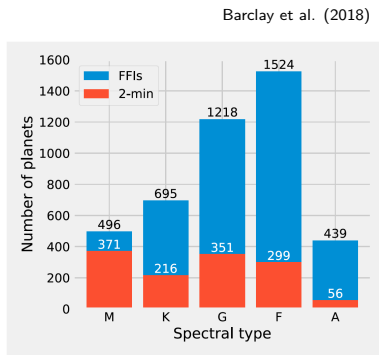
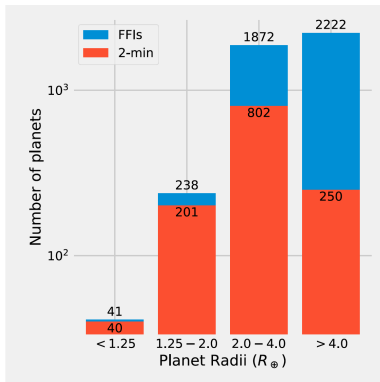
- * observation length from ~ 27 days to ~ 1 year
- * 13 partially overlapping sectors
- * 2-min cadence (main-sequence FGKM)
- * Full Frame Images with cadence of 30 min

TESS observations



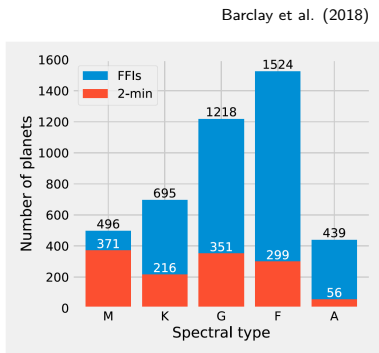
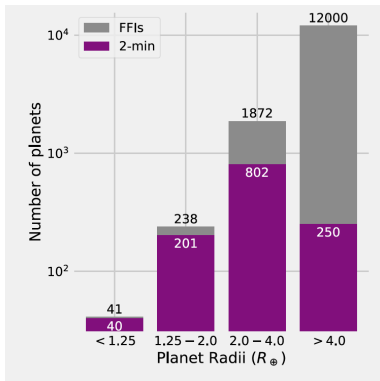
- * ~ 1 day gaps during downlink (perigee)
- * TESS momentum dump every 2.5 days (decrease in flux + modulation)
- * times of large scatter in flux due “anomalously high pointing jitter”
- * long-term systematics
- * large pixels: photometric pollution

Exoplanets with TESS



- * Expected exoplanet yield: more than 14,000 planets
- * 280 planets smaller than $2R_{\text{Earth}}$
- * 500 planets around M dwarfs
- * ground-based follow-up observations: masses and composition

Exoplanets with TESS



Barclay et al. (2018)

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Exoplanets with TESS

Credits: NASA

Transiting Exoplanet Survey Satellite (TESS)

Status

Last update: May 7, 2020

45

CONFIRMED

1,799

TESS CANDIDATES

2:20:11:26:14

TIME IN ORBIT

CoRoT &
Kepler

TESS

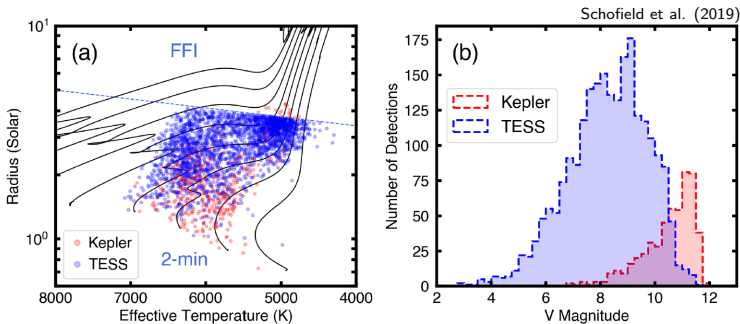
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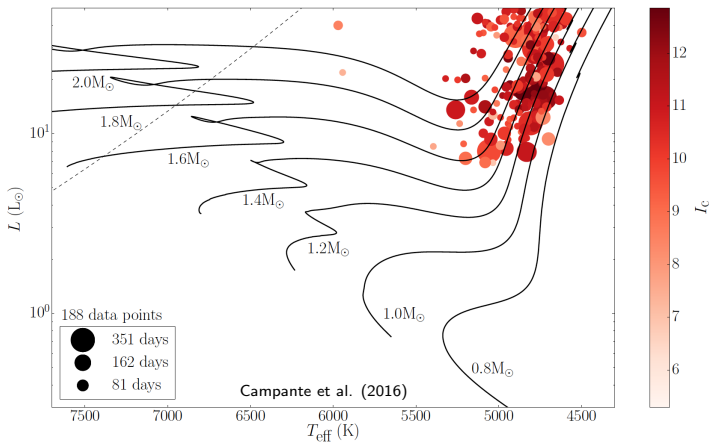
Summary

Asteroseismology with TESS



- * 2-min cadence from 2-yr TESS main-mission
- * Expected p-mode detection for 5000 main-sequence and subgiant stars
- * Asteroseismic Target List: 25,000 stars with p-mode detection probability $> 5\%$

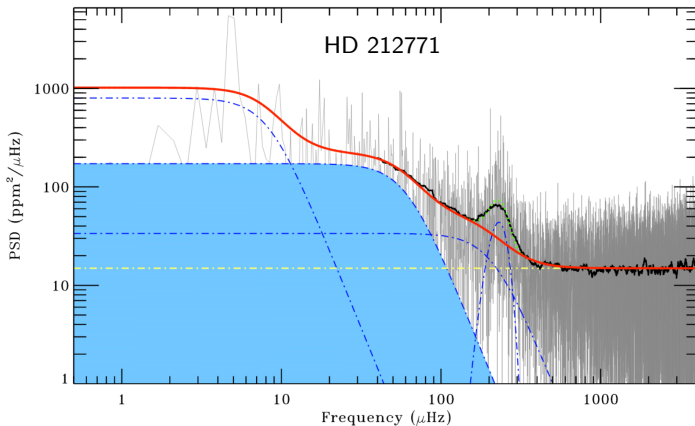
Asteroseismology with TESS



- * 30-min cadence from 2-yr TESS main-mission
- * expected p-mode detection for evolved planet hosts

Asteroseismology with TESS

Campante et al. (2019)



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TESS

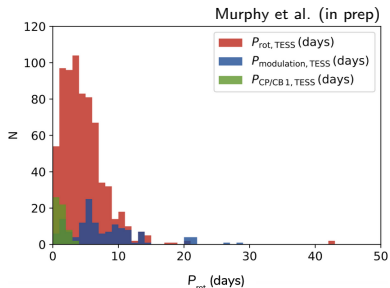
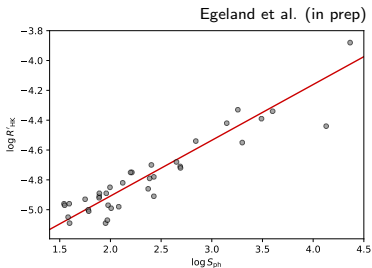
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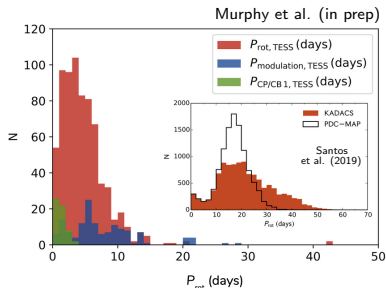
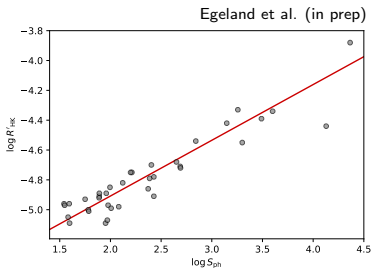
Summary

Rotation and Activity with TESS



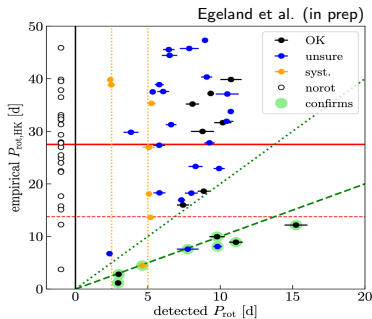
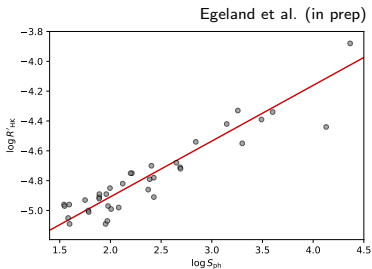
- * TESS targets are **bright stars** in the solar neighborhood (*Kepler* targets are typically faint)
 - Ground-based observations: independent constraints
- * TESS main-mission provides **short-term observations**
 - inadequate for temporal variability (e.g. activity cycles)
 - biased P_{rot} distribution; detection of the harmonics

Rotation and Activity with TESS



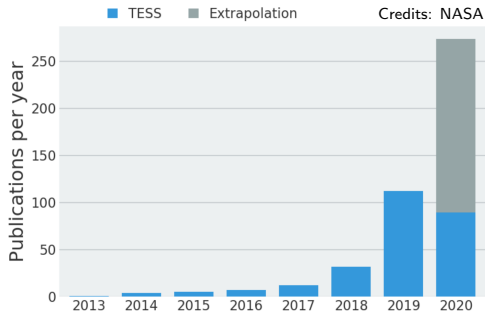
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Rotation and Activity with TESS

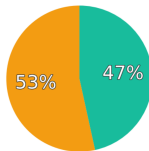


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TESS publications



Exoplanets Astrophysics



CoRoT &
Kepler

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Summary

TESS extension



- * NASA approved 2-year extension
- * short-cadence: from 1 min to 20 sec cadence
- * FFI cadence: from 30 min to 10 min

CoRoT &
Kepler

TESS

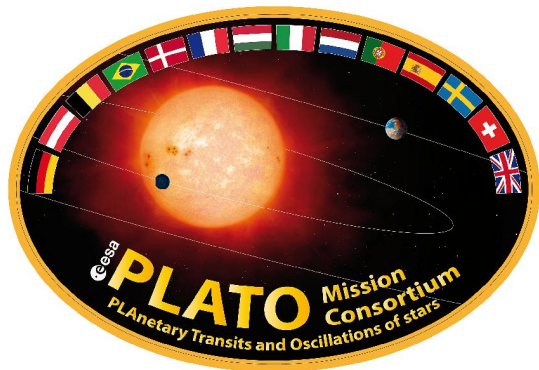
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Summary

PLanetary Transits and Oscillations of stars



- * ultra-precision, long-term, continuous photometry
- * **main goal:** Detect and characterize terrestrial exoplanets around bright solar-type stars
- * under development; launch in **2026**
- * ESA's mission; PI: DLR, Germany

CoRoT &
Kepler

TESS

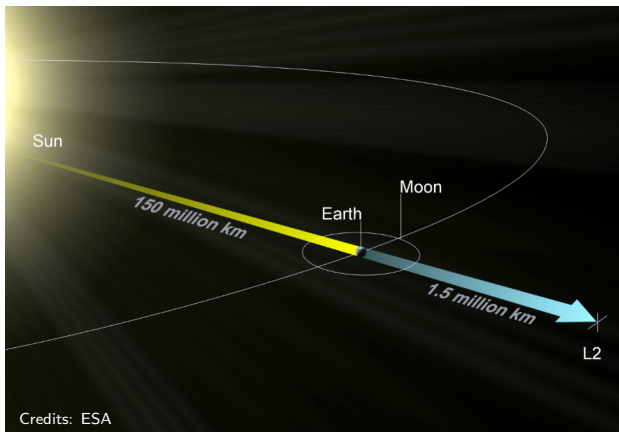
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Summary

PLATO's orbit



- * Lagrangian point L2 of the Sun-Earth system

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TESS

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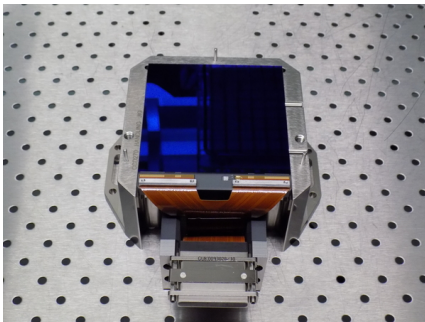
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Summary

PLATO's observations

first CCD – Credits: ESA



- * visible band with cadence of 25 seconds
- * 26 cameras – largest digital combined camera flown in space
- * extremely wide field of views: 2250 square degrees
- * lifetime: 8.5 years (current plan for nominal mission: 4.5 years)

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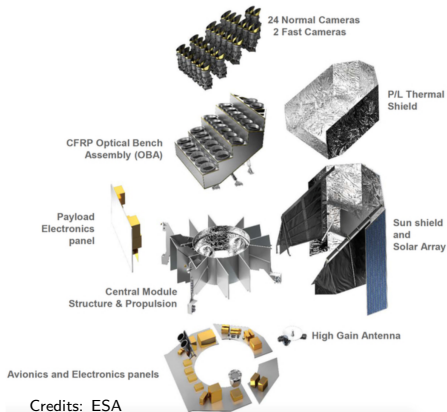
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Summary

PLATO's observations



- * groups of cameras – point into different directions
- * ultra-precision, long-term (up to 3-yr), continuous photometry
- * short-term observations of different fields (2-3 months)

PLATO's science



- * bright stars in the solar neighborhood
- * rocky planets (habitable zone), but also ice and giant planets
- * ground-based follow-up observations: mass and composition
- * understand the formation and evolution of planetary systems
- * asteroseismology: probing stellar structure and evolution

CoRoT &
Kepler

TESS

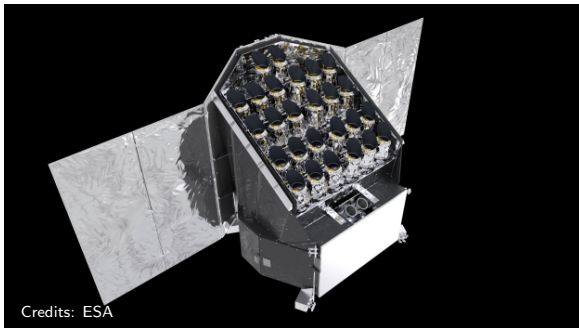
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Summary

PLATO's science



- * planetary radii: $\sim 3\%$ accuracy
- * planetary masses (ground-based follow-up): $\sim 10\%$ accuracy
- * Asteroseismic stellar masses, radii, and ages: $< 10\%$ accuracy
- * Identification of bright targets to study planetary atmospheres
- * Star-planet interactions

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Summary

Present and Future Optical Space Missions

TESS:



- * Nominal mission in progress
- * First extension: 2-years (2020-2022)
- * bright stars in the solar neighborhood
- * large number of targets with short-term observations
- * follow-up observations

PLATO:



- * Planing in progress; launch in 2026
- * bright stars in the solar neighborhood
- * large number of targets with long-term and short-term observations
- * focus on exoplanet research and asteroseismology
- * follow-up observations

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