PLAnetary Transits and Oscillations of stars (PLATO)

plato

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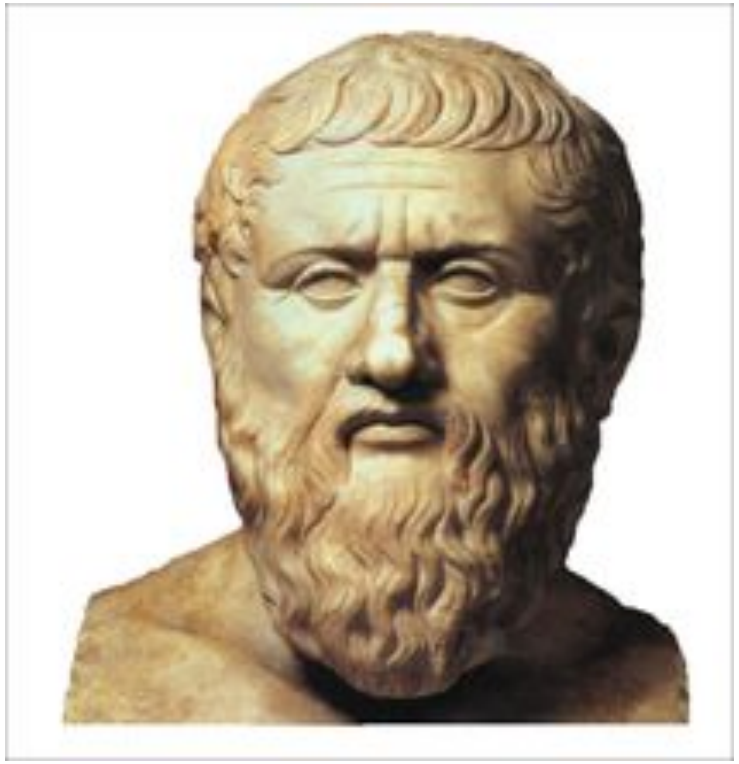
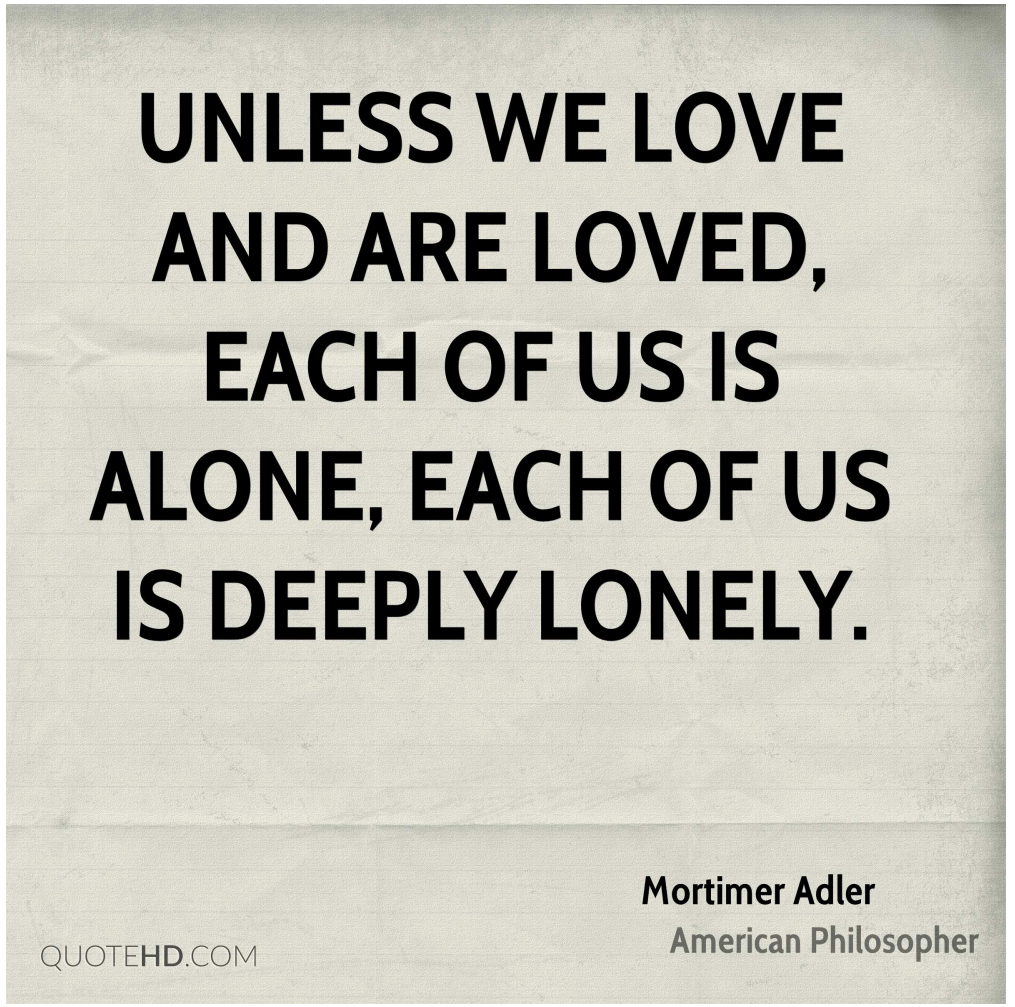
Outline

- **Are we alone?**
- What is PLATO?
- What can PLATO do?
- How to do?

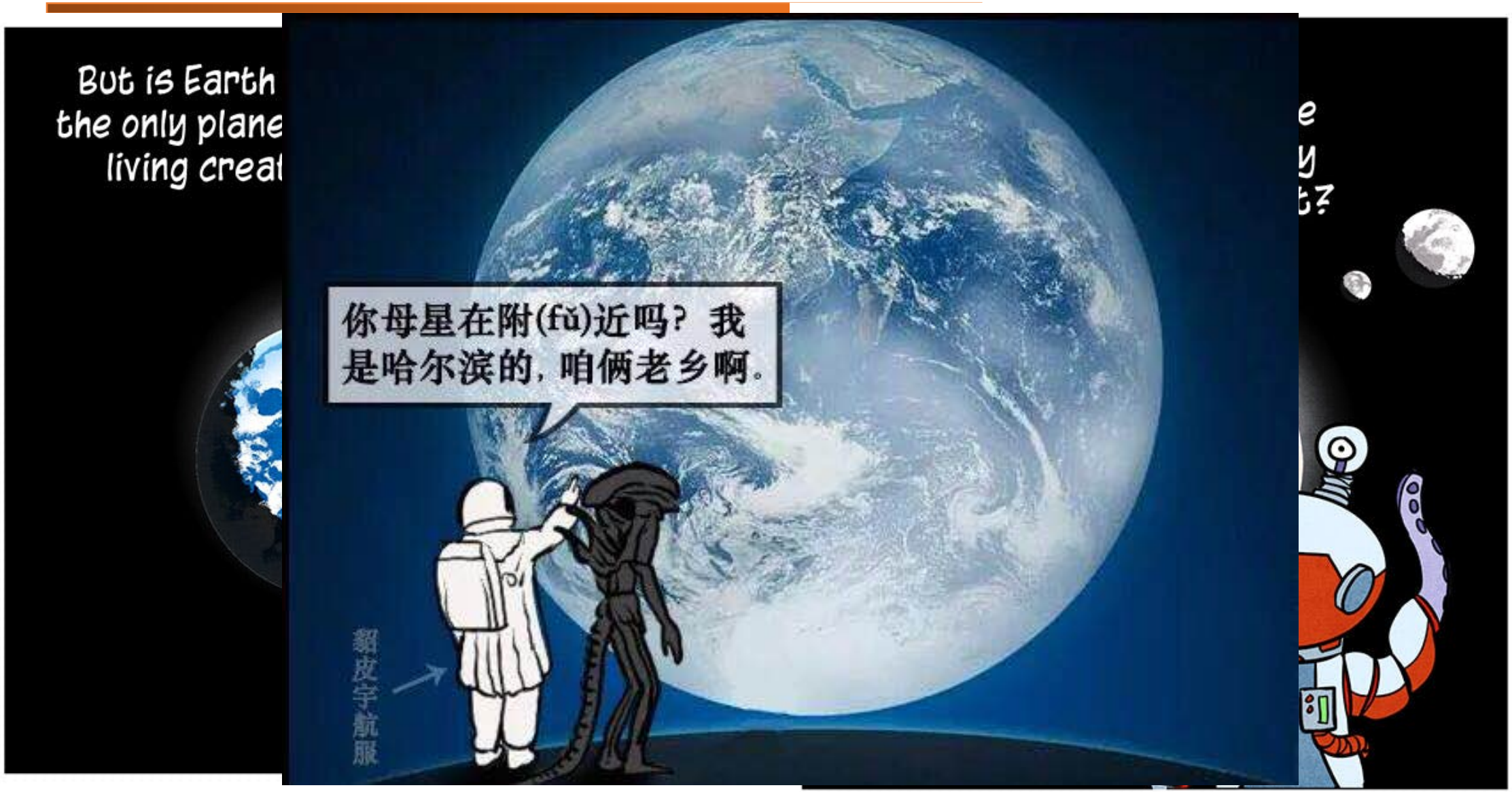
Are we alone?



Ancient Greek Philosopher: Plato



Are we alone?


But is Earth
the only plane
living creat
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是哈尔滨的，咱俩老乡啊。
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Am I alone?

Answer could be given by PLATO !

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- Are we alone?
- **What is PLATO?**
- What can PLATO do?
- How to do?

PLATO PLAnetary Transits and Oscillations of stars	
Theme	What are the conditions for planet formation and the emergence of life?
Primary Goal	Detection and characterisation of terrestrial exoplanets around bright solar-type stars, with emphasis on planets orbiting in the habitable zone.
Measurements	▪ Photometric monitoring of a large number of bright stars for the detection of planetary transits and the determination of the planetary radii (around 3% accuracy) ▪ Ground-based radial velocity follow-up observations for the determination of the planetary masses (around 10% accuracy) ▪ Asteroseismology for the determination of stellar masses, radii, and ages (up to 10% of the main sequence lifetime) ▪ Identification of bright targets for spectroscopic follow-up observations of planetary atmospheres with other ground and space facilities
Wavelength	Optical
Telescope	A number of small, optically fast, wide-field telescopes
Orbit	Large amplitude libration orbit around Sun-Earth Lagrangian point, L2
Lifetime	4 years of nominal science operations; satellite built and verified for an in-orbit lifetime of 6.5 years, accommodating consumables for 8.5 years
Type	M-class Mission

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- Proposed: 2007
- Launch: 2026?

Ground-based observatories

First discoveries of exoplanets in the 1990s opened up the field of exoplanet research. New innovations and discoveries continue to this day

Pioneering stellar seismology and exoplanet hunting mission

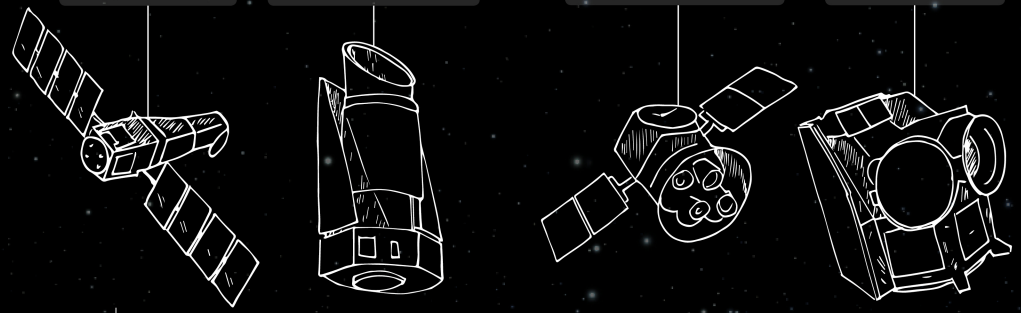
A targeted search for terrestrial and larger planets in or near the habitable zone of a wide variety of stars

First all-sky transit survey satellite

First step characterisation of known Earth-to-Neptune size exoplanets

Studying terrestrial planets in orbits up to the habitable zone of Sun-like stars, and characterising these stars

Performing a chemical census of a large and diverse sample of exoplanets by analysing their atmospheres



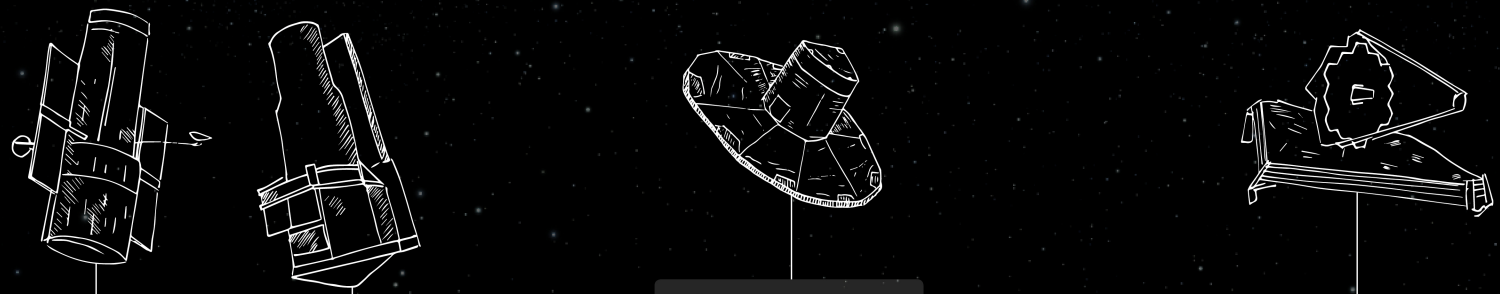
Launch 1990 2003 2006 2009 2013 2018

Dedicated exoplanet missions

Exoplanet-sensitive missions

Corot (cnes, esa) **Kepler/K2** (NASA) **Tess** (NASA) **Cheops** (esa) **Plato** (esa) **Ariel** (esa)

Hubble (NASA, esa) **Spitzer** (NASA) **Gaia** (esa) **Webb** (NASA, esa, CSA)



Probing the composition of exoplanet atmospheres

Studying exoplanet signatures in infrared light

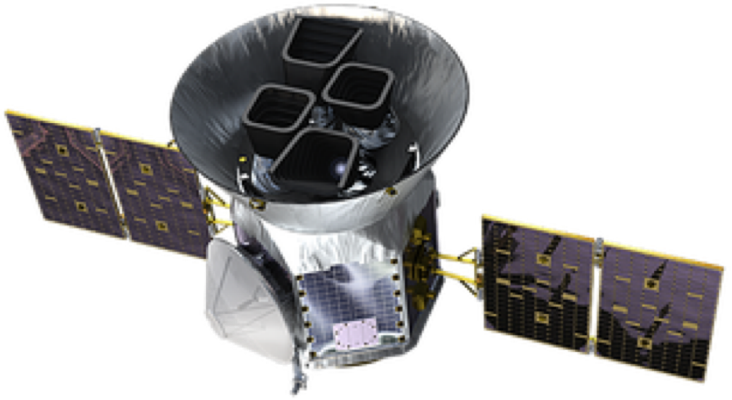
Revealing exoplanets through its all-sky survey of the position, brightness and motion of over one billion stars

Detailed characterisation of exoplanet atmospheres through transit studies and direct imaging

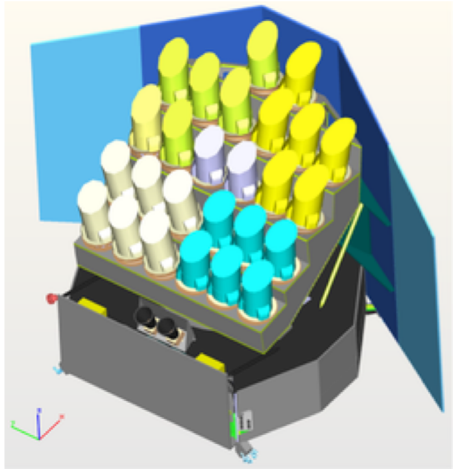
Credit: ESA

PLATO IS NOT ALONE!

	PLATO	TESS
Telescope aperture	12cm	10cm
Telescope field of view	1037 deg^2	576 deg^2
Number of telescopes	24	4
Telescope arrangement	Four groups of six. Each group points together. Groups have overlapping fields-of-view.	Adjacent pointing to give strip-like field-of-view
Total field of view (per pointing)	2232 deg^2	2304 deg^2
Time per pointing	2+ years	27 days
Number of pointings	2	30
Pixel size	15 arcseconds	21 arcseconds
Wavelength range	500-1000nm	600-1000nm
Cadence	25s (for main sample, M-dwarfs, brightest stars) 600s (for statistical sample of ≥245,000 stars)	60s (for brightest 200,000 stars) 1800s (full frame images)
Main targets	Bright, Sun-like stars	Bright, M-dwarf stars
Main objective	Earth-sized planets in the habitable zone	Rocky planets
Number of stars	≥265,000	≥500,000
Noise	≤34ppm in 1hr (for main sample) ≤800ppm in 1hr (for M-dwarfs)	≤200ppm in 1hr
Predicted yield	>4,000 planets 2-120 small planets in habitable zone of solar-like stars	~1,700 planets 640-1340 planets around M-dwarfs 1-4 small planets in the habitable zones around M dwarfs
Nominal mission duration	4 years	2 years
Location	L2 (1.5 Million Km from Earth)	Orbiting between Earth and the Moon's orbit (384,000 Km from the Earth)



TESS, 2018 Cost: 200M USD



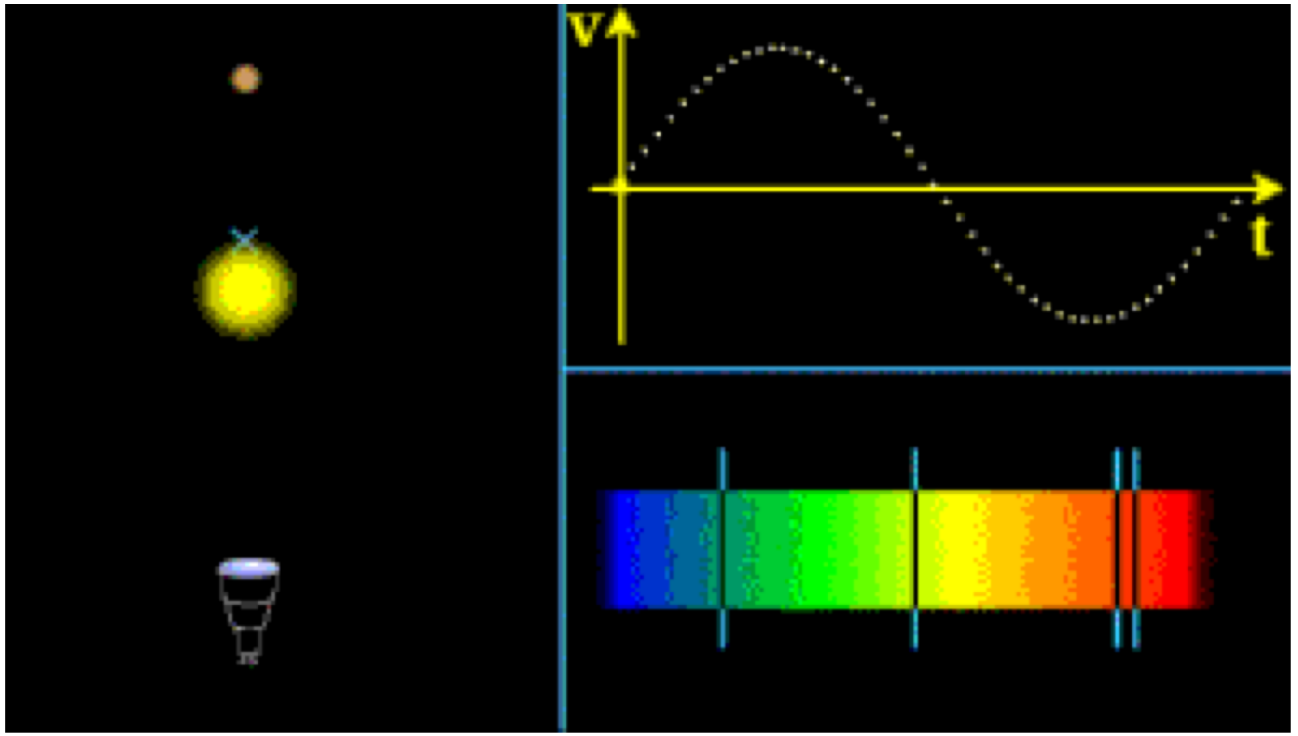
PLATO, 2026? Cost: ??? EUR

NEED HELP: Radial velocity

VLT 2017:

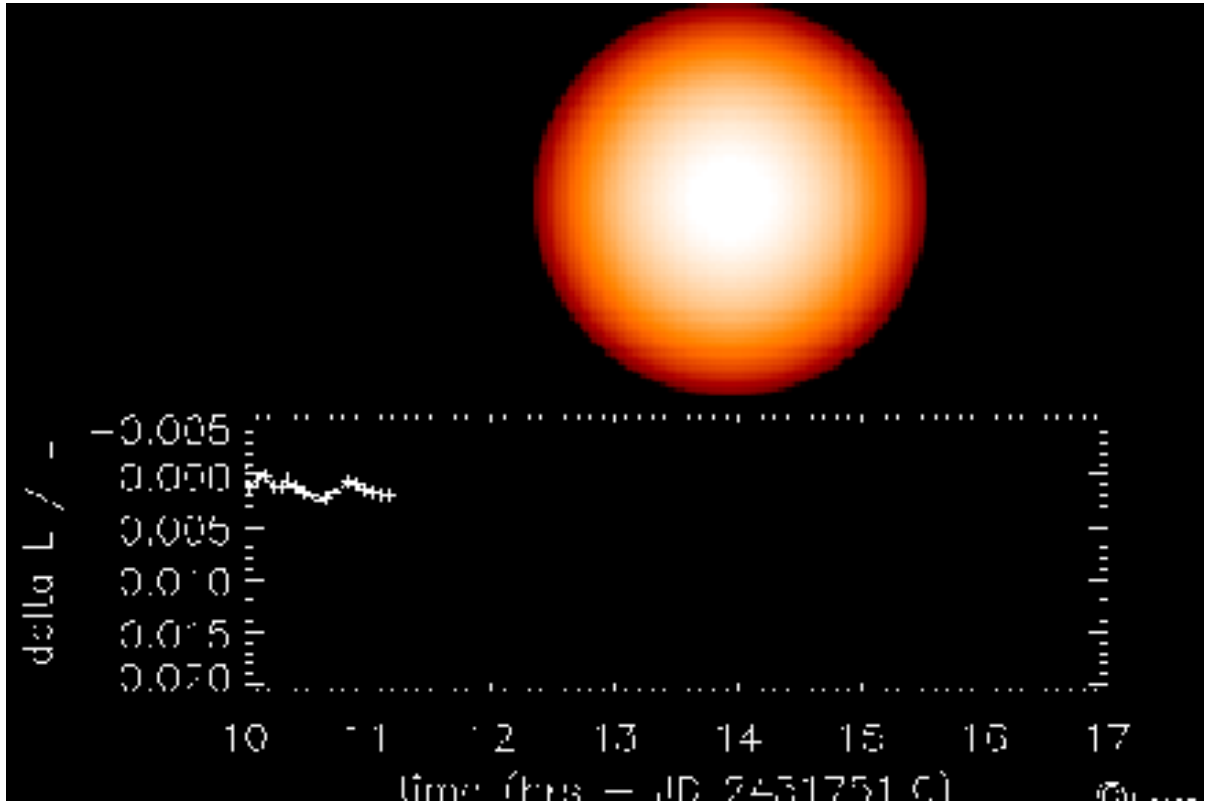
10 cm/s in 15 min for a *V*= 8 star

20 cm/s in 1 hour for a *V*= 11 star.



PLATO: Transit Mission

- Orbit: Period, semi-major axis, orbital inclination, eccentricity, spin-orbit aliment
- Planet parameters:
  - radius, mass, density,
  - effective temperature, *albedo*, atmospheric composition, surface heat distribution,
  - exomoons, planetary rings, et al.

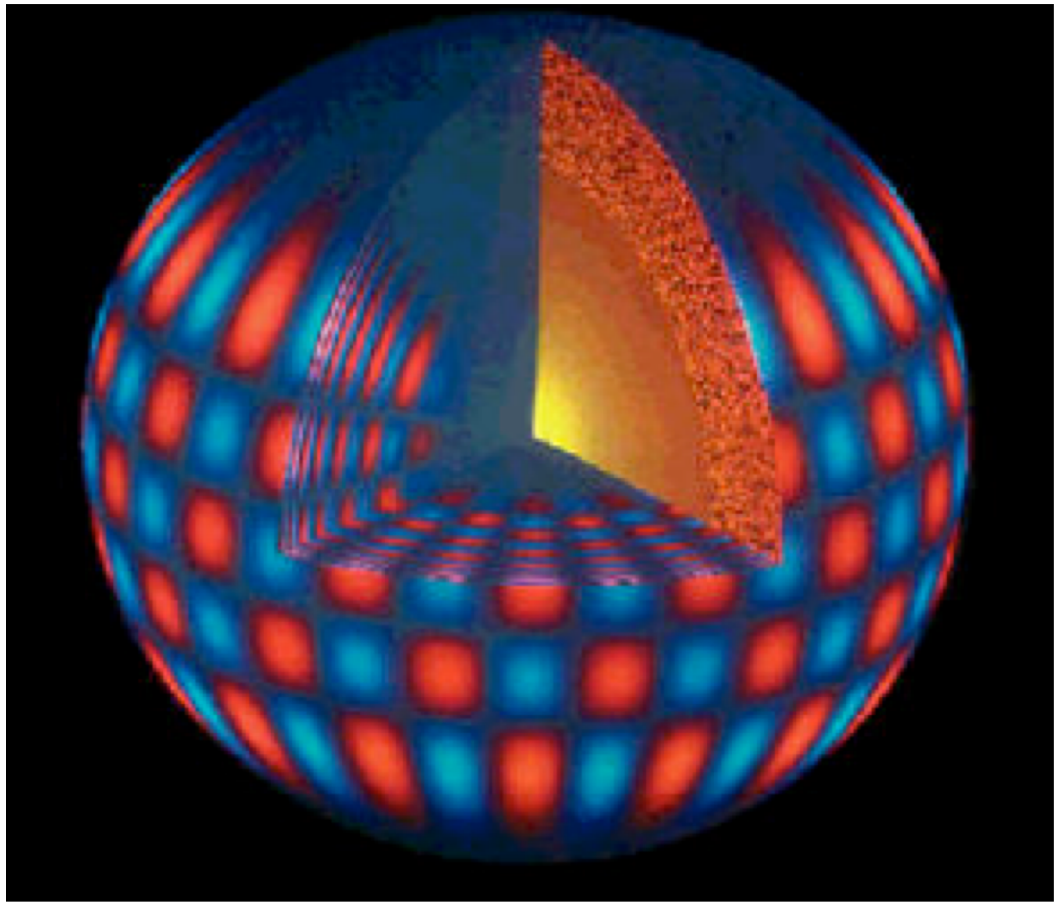


PLATO: Oscillations

Asteroseismology: intrinsic Oscillations of stars.

Accurate stellar masses, radii, and ages from asteroseismology.

Oscillation frequencies of 15,000 dwarf and subgiant stars with *V*>11.



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- **What can PLATO do?**
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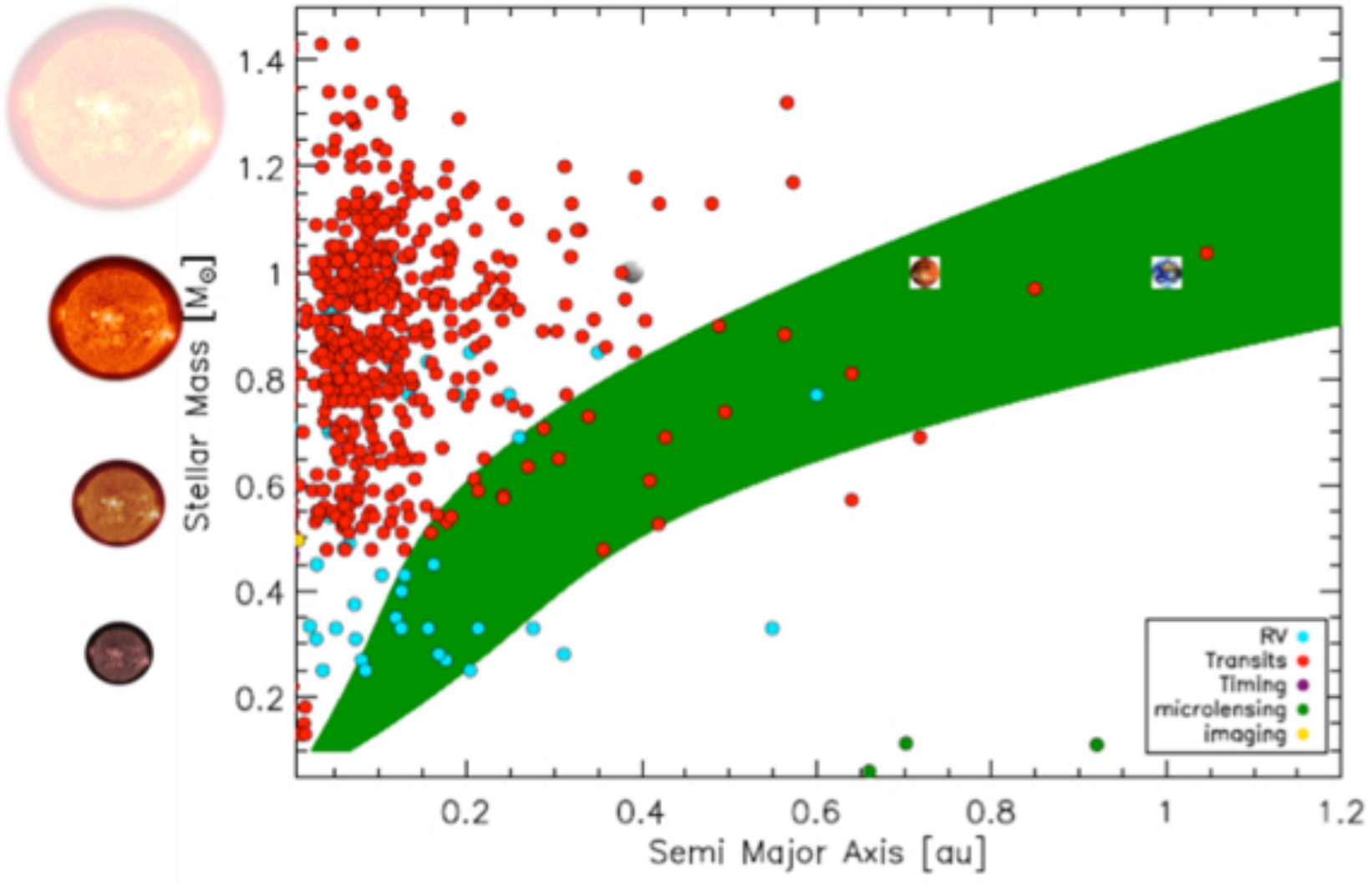
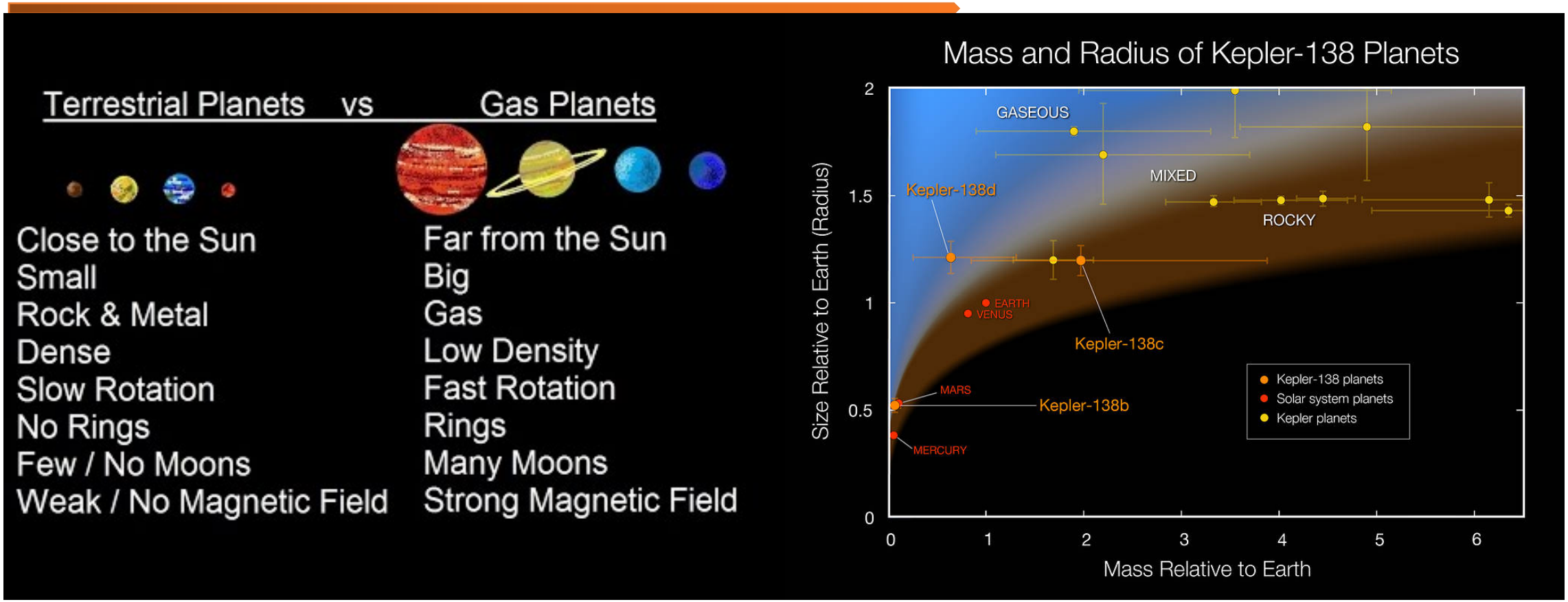
The unique of our solar system



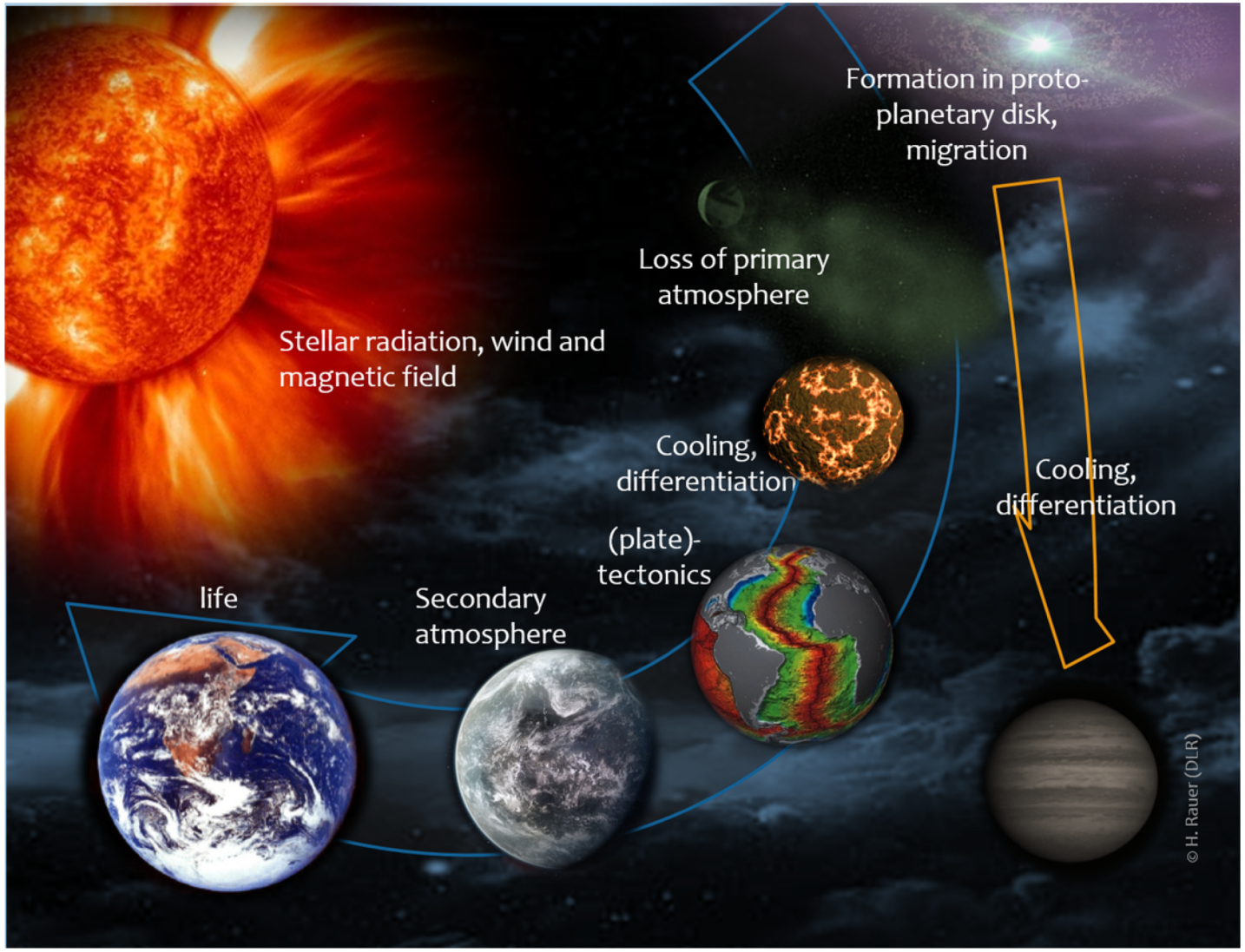
Credit: DLR - H. Rauer, 2016

Interiors of terrestrial and gas planets



PLATO will be unique in providing vital constraints for planetary interior models.

Evolution of planetary systems



Complementary science

- Observe many directions
  - Time-variable phenomena
- Asteroseismic characterisation
  - Stellar and galactic physics
- Photometric measurements
  - Various additional subjects

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gaia

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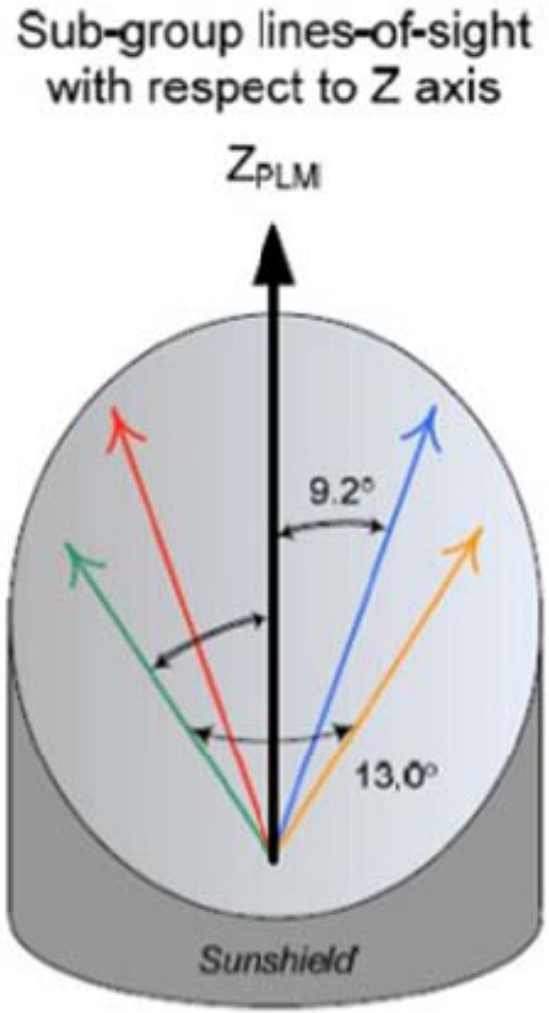
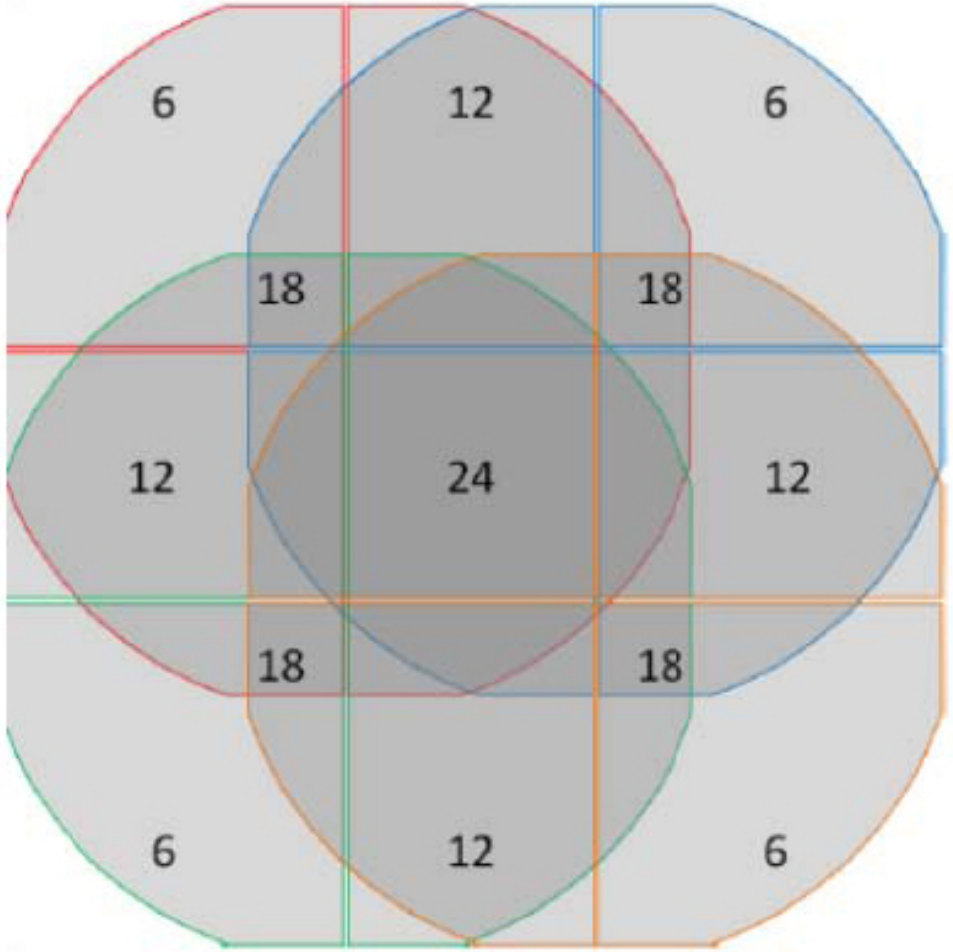
Payload: Cameras

- 24 ‘normal’ camera:
  - Stars fainter than mV = 8,
  - Cadence: 25 s
- 2 ‘fast’ camera:
  - Stars in the magnitude range mV 4~8,
  - Cadence: 2.5 s.
  - The red or blue part of the optical spectrum, respectively

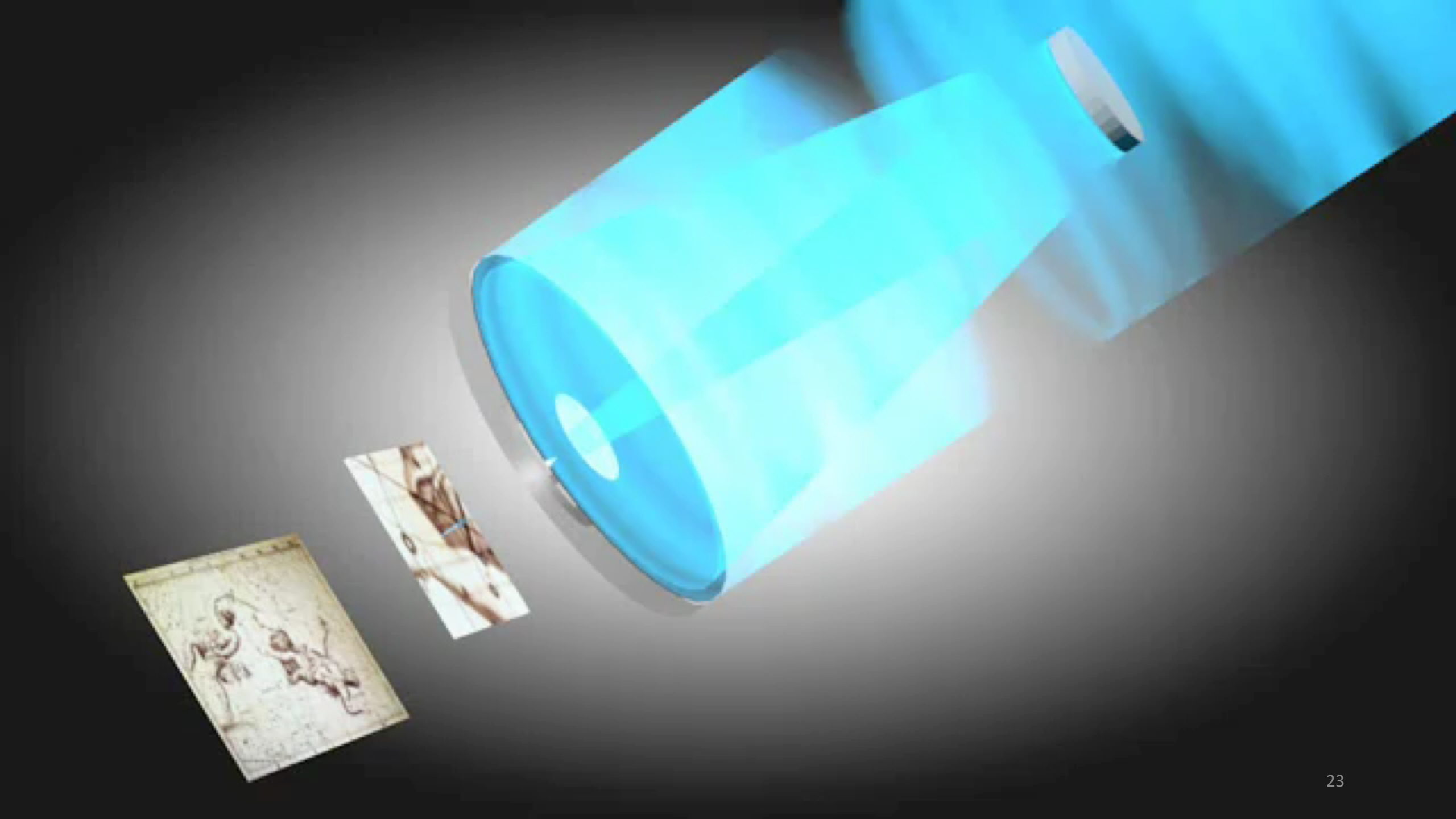
Payload Module





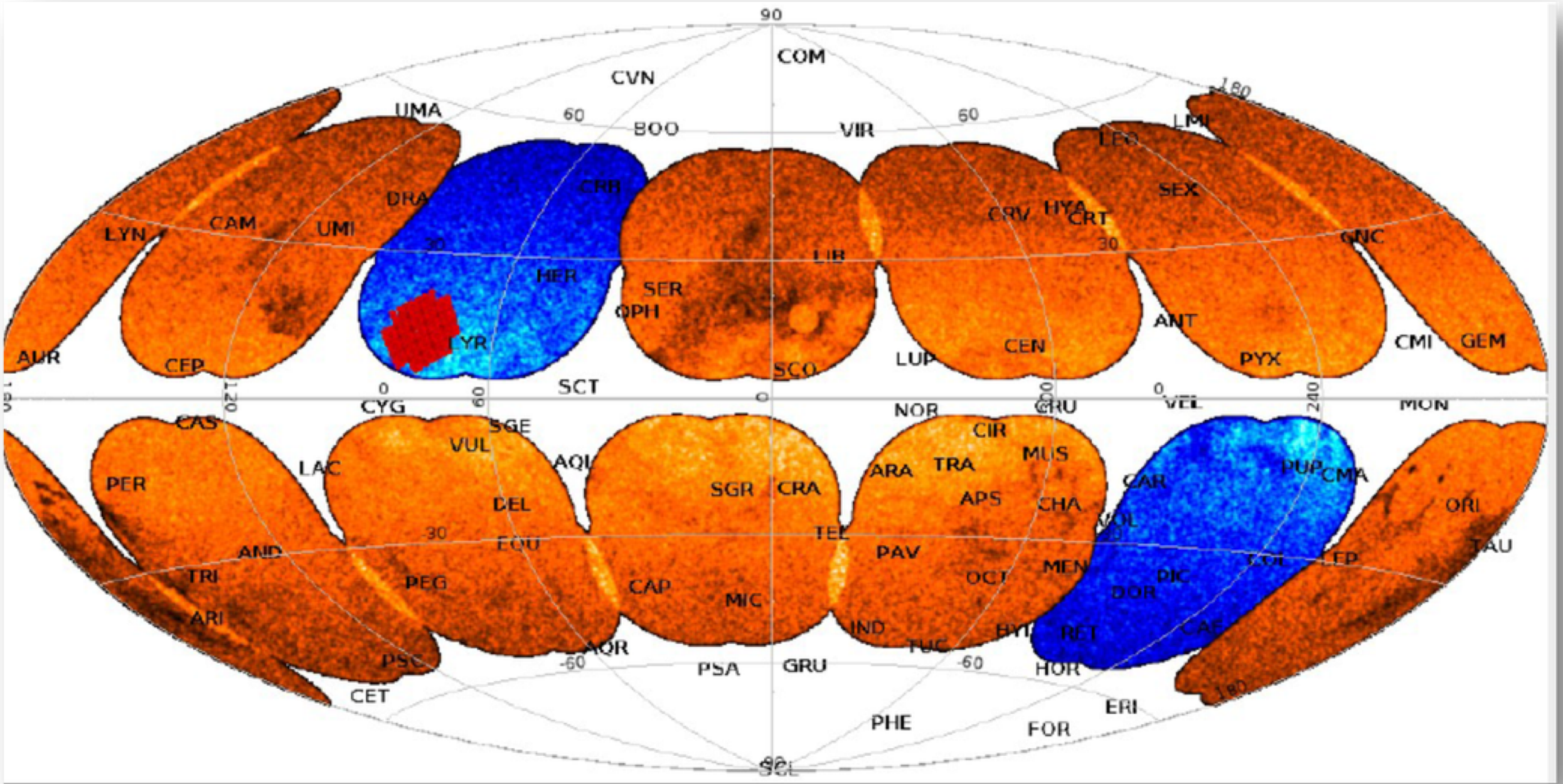
Why so many cameras?

- Science requirements call for a very large field of view coupled with a sensitivity of a 1 m-class telescope.
- Total field of about 2232 deg^2 per pointing, with various parts of the field monitored by 24, 18, 12 or 6 cameras.
- This strategy optimizes both the number of targets observed at a given noise level and their brightness.



The PLATO sky

- Long-duration Observation Phase (LOP) :
  - Small planets out to the Habitable Zone of solar-like stars.
  - Continuous observations of two sky fields, lasting 2 years each.
- Step-and-stare Observation Phase (SOP):
  - Shorter-period planet detections
  - Different science cases such as galactic exploration.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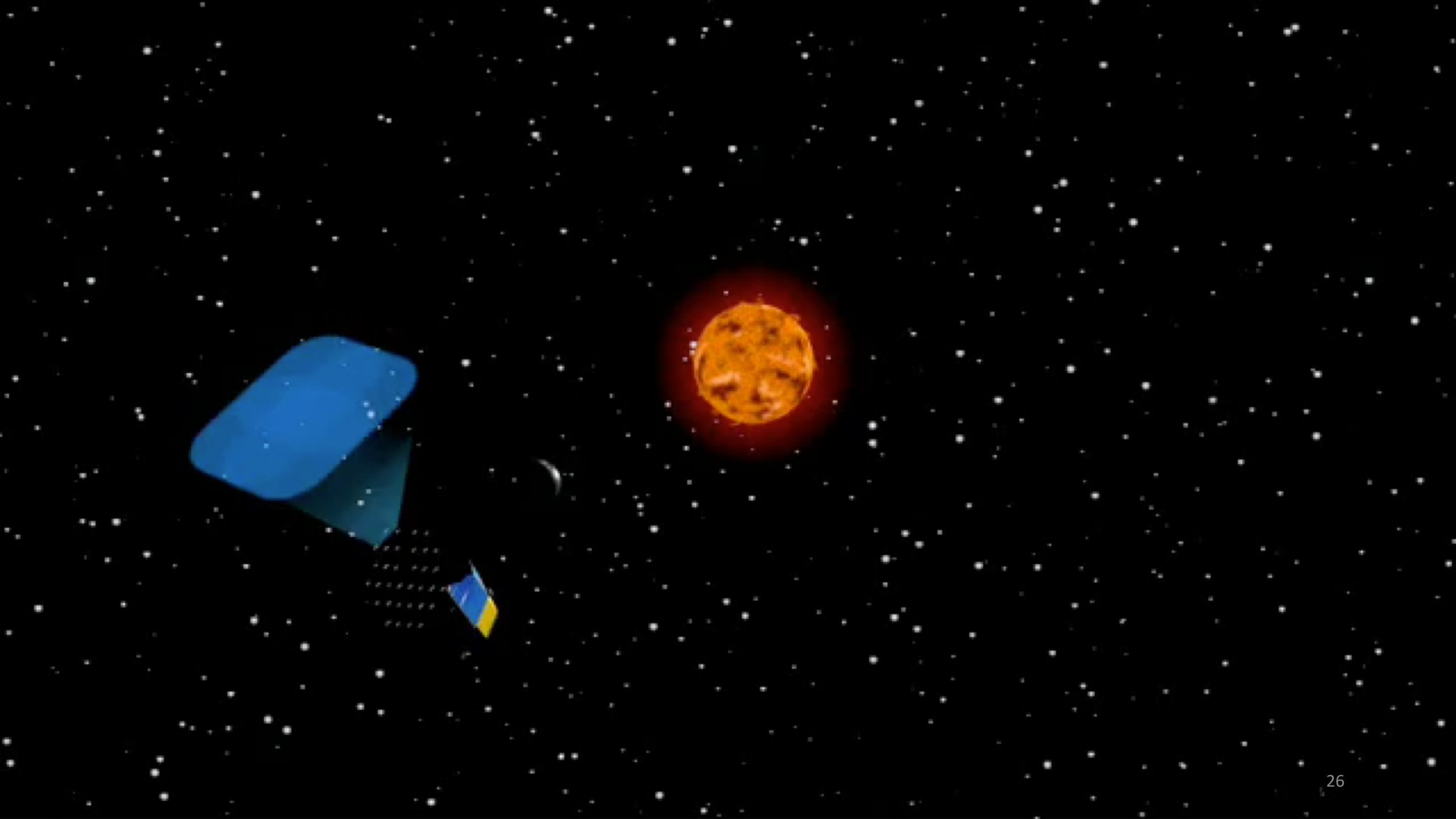

Take home message!

- PLATO: Transits and Oscillations
- Detect terrestrial exoPLAnets
- Character bulk properties
- Habitability of other planets(Are we alone?)