PLATO

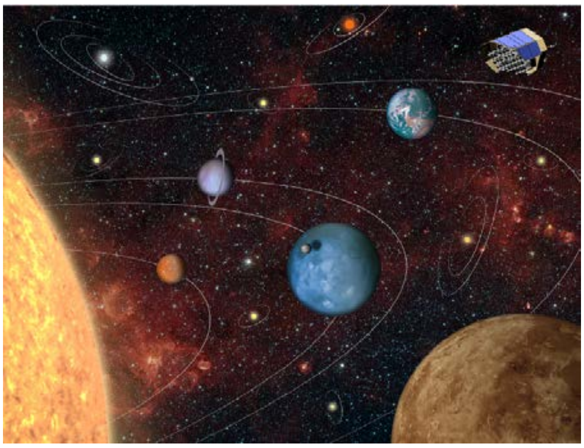
Mission Objectives

Scheduled for launch in 2026 ESA's space science mission PLATO (PLAnetary Transits and Oscillations of stars) will search for exoplanets down to the size of the Earth and below, and characterize their physical parameters like masses, diameters and mean mass densities. As the third of the medium-sized science missions (M3) in ESA's Cosmic-Vision 2015 – 2025 programme PLATO pursues the following main objectives:

(1) Detection of terrestrial exoplanets in the habitable zones of solar-type stars, and characterization of their bulk properties like orbital parameters, diameters, masses, mean densities and ages needed to evaluate their habitability. The habitable zone is defined as the distance interval around a star in which the physical conditions are suitable for planets to bear life.

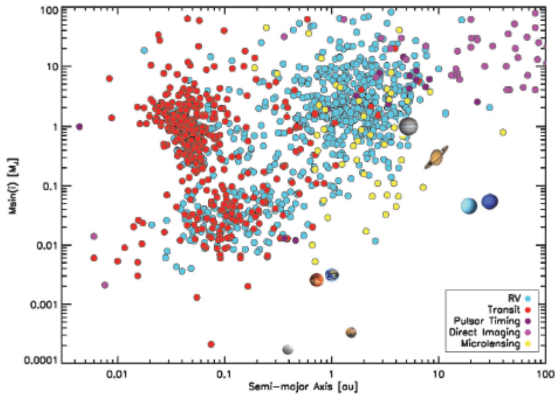
(2) Characterization of a large number of rocky, icy and giant planets, including the architecture of their planetary systems, to fundamentally enhance our understanding of the formation and evolution of these systems. This may also lead to the detection of possible twins of the Earth.

(3) Implementation of an observational programme in asteroseismology with the goal to determine stellar masses, radii, and ages from models of stellar oscillations of the bright stars exhibiting exoplanets.



In order to achieve these goals PLATO will exploit the method of photometric transits of planets passing in front of their stars. This technique was already used by PLATO's predecessors, CoRoT (CNES, France) and Kepler (NASA), as well as by ground-based exoplanet surveys. The method allows to detect planets with their orbital planes oriented such that, when viewed from the Earth or a satellite, they pass in front of their stars causing a shallow eclipse. If at least two consecutive transits are observed the orbital parameters of the planets (orbital periods and distances to the stars), and their diameters can be directly inferred from the time interval between the transits and the dip in brightness. If, in addition, the small gravitational influence of the planet exerted on the star is known from highly sensitive radial velocity measurements acquired by ground-based telescopes the mass of the planet and its (mean) mass density can, finally, be determined.

Eventually, precise photometric observations of the tiny brightness variations of the stars allow modeling their oscillation modes by means of computer models. Besides other parameters the age of the star, and, with it also the age of the planets can be deduced. Thus, the physical characterization of the respective planets by PLATO and dedicated ground-based observations after detection will be complete.



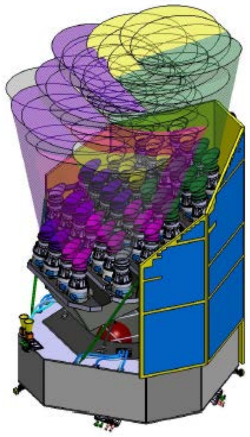
The radii of the newly-found exoplanets will be determined with an accuracy of about 3% from the photometric transits, and their masses deduced with uncertainties of less than 10% from the measurements of stellar radial velocities with ground-based telescopes. These follow-up observations from the ground are an integral part of the mission, and will require coordination with astronomical observatories and institutions worldwide like the European Southern Observatory (ESO). Moreover, stellar masses, radii, and ages shall be deduced with an accuracy of approximately 10% with the help of astroseismology. Finally, promising targets for (ground-based) spectroscopic follow-up observations of exoplanet atmospheres shall be identified.

PLATO will continuously monitor a large number of more than 245,000 bright (< 13 mag), and therefore nearby stars over a period of up to several years, and record their light variations with the highest possible precision. Moreover, up to one million fainter stars (< 16 mag) shall be observed to cover the largest possible range of stellar and planetary variants. In addition to sun-like main sequence stars, a number of more exotic stellar systems will be captured, for example, many low-luminosity red dwarfs, evolved red giants, white dwarfs, and also a few short-living, massive stars of the upper main sequence. It is expected that many thousands of rocky, icy, and giant planets, planets in binary systems, and around white dwarfs will be found. Under favorable circumstances it might even be possible to detect planetary rings, moons, and comets. Finally, a fundamental motivation of PLATO is the search for Earth-like (rocky) planets in the habitable zones of their stars. Within the habitable zones, with their physical conditions depending on the mass and surface temperature of the star, liquid water can exist on the planetary (or lunar) surfaces, and, thus, life as we know it from Earth may form and survive. Moreover, the large number of exoplanets completely characterized will, together with model calculations, finally lead to statistical conclusions about the formation and evolution of different types of planets.

The long-term observations of PLATO will probably comprise two phases of two years each which may result in the detection of planets with orbital periods of up to about one year, and perhaps find twins of the Earth. Subsequently, during a possible mission extension so-called „step-and-stare observations" shall be performed that will monitor selected fields in the sky for two to four months each. In this way, nearly half of the entire sky can be covered during the mission lifetime planned to last for at least eight years.

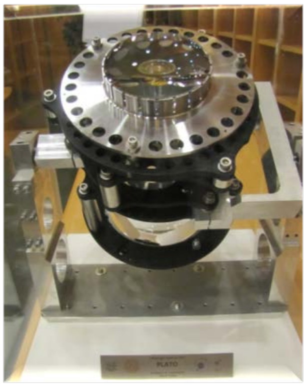
The PLATO Mission and its scientific Payload

The payload concept of PLATO includes 24 cameras mounted into a common optical bench, with fields-of-view overlapping each other so that there is no need to change the pointing of the satellite during observation. In this way, about 5% of the whole sky can be covered in one single shot. In addition, two more “fast cameras” equipped with color filters will observe the brightest stars (< 8 mag) in the field with a much shorter exposure time. These cameras will also support the accurate tracking and navigation of the satellite in its halo orbit around the Sun-Earth Lagrangian Point L2, about 1.5 Million km from Earth outside its orbit.



Each of the 26 cameras is equipped with a wide-field optics (field-of-view about 38°) with a free aperture of 120 mm, and an f-number of 2.1. The focal planes consist of four large-area CCDs with 4510 x 4510 picture elements (pixels) each which are butted together, and operated in full-frame- („normal cameras“) and frame-transfer-mode („fast cameras“) respectively. The combined field-of-view of all cameras in the sky amounts to about 2,250 square degrees. Owing to the mutual orientation of the cameras relative to each other a multiple coverage of their fields-of-view of up to 24-fold is achieved which guarantees a high photometric accuracy. The “fast cameras” exhibit only half the field-of-view compared to the “normal” ones, and utilize a tenfold shorter exposure time in order to avoid overexposures.

A comprehensive sensor and data processing electronics on-board the PLATO satellite will read out the image data of the CCDs, and then extract a small image („imagette“) around each of the observed stars. Together with the light curves which are also produced on-board, and further data, these images are finally compressed, packed, and linked down to Earth where they are further processed. Thus, the data volume produced during the nominal science operation of PLATO will be reduced to an extent that the maximum downlink rate of the mission of about 400 Gbit per day will not be exceeded.



The PLATO ground segment consists of the usual mission operations center (MOC) operated by ESA including up- and downlink stations, and a science operations center (SOC) which is responsible for mission planning, the processing of the science data on ground, and the production of all PLATO data products. These products are finally provided to the science community and the public. A PLATO data center (PDC) distributed over several European locations is responsible for validating and providing all necessary algorithms and tools for data processing, the archiving, the general assessment of, and access to the data products.

The responsibility of the development and manufacture of the PLATO payload lies with an international payload consortium from many European and non-European countries each of which will deliver a contribution to its hardware and/or software (i.e. from Germany, Great Britain, Italy, France, Spain, Switzerland, Belgium, Hungary, Portugal, the Netherlands, Austria, Sweden, Denmark and Brazil). The consortium is led by the DLR Institute of Planetary Research in Berlin, Germany (Prof. H. Rauer) while the responsibility for the overall mission, i.e. the satellite, the launch, the ground segment, and the satellite operations is taken by ESA. Finally, the implementation and operations of the PDC are headed by the Max Planck Institute for Solar System Research in Göttingen, Germany (Prof. L. Gizon). Parts of the payload development, the data center, and the science operations are funded by the DLR Space Management from funds made available by the Federal Ministry for Economic Affairs and Energy of Germany (BMWi).

PLATO Technical Parameters

- Begin of development: 2008
- Begin of mission: 2026
- Launcher: Soyuz-Fregat 2-1b
- Launch site: Kourou / French-Guayana
- Nominal mission duration: min. 4 years (4 years of nominal operations and extension)
- Orbit: halo orbit / libration around L2 (about 1.5 million km from Earth)
- Operations centers: ESOC (Darmstadt; mission) ESAC (Madrid; science op.)
- Mass of spacecraft: 2150 kg
- Dimensions of spacecraft: c. ∅ 2.5 m x 5 m
- Mass of payload: 540 kg (without optical bench)
- El. power consumption (spacecraft with payload): 1650 W (full payload operations)
- Telemetry rate: 36 Mbit/s (K band, downlink)

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