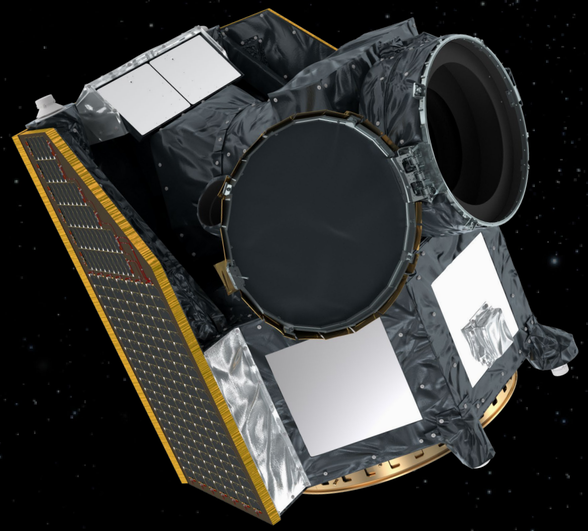
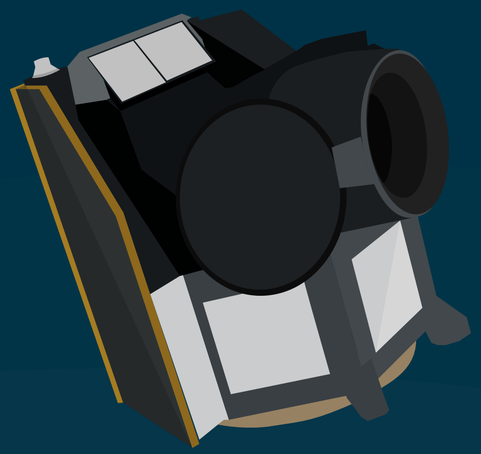


cheops

→ LAUNCH MEDIA KIT

#cheops

→ CONTENTS



→ INTRODUCTION

Cheops, the CHaracterising ExOPlanet Satellite, is scheduled to launch on a Soyuz-Fregat rocket from Europe's Spaceport in Kourou, French Guiana at 09:54 CET on 17 December 2019.

Note: Cheops was launched on 18 December 2019.

Cheops is ESA's first mission dedicated to the study of extrasolar planets, or **exoplanets**. It will observe bright stars that are already known to host planets, measuring minuscule brightness changes due to the planet's transit across the star's disc.

Characterising exoplanets

The mission will target stars hosting planets in the **Earth- to Neptune-size** range, yielding precise measurements of the planet sizes. This, together with independent information about the planet masses, will allow scientists to determine their density, enabling a **first-step characterisation** of these extrasolar worlds. A planet's density provides vital clues about its composition and structure, indicating for example if it is predominantly rocky or gassy, or perhaps harbours significant oceans.

Unlike previous exoplanet satellites, such as the CNES-led CoRoT (Convection, Rotation and planetary Transits) or NASA's Kepler and Tess missions, Cheops is not a 'discovery machine' but rather a **follow-up mission**, focusing on individual stars that are already known to host one or more planets. The exquisite precision with which Cheops is able to measure planetary transits, together with the stability of the telescope, will enable astronomers to determine **planet sizes** both accurately and precisely.

By knowing when and where to point in order to catch planetary transits, Cheops will maximise the time it spends monitoring actual transit events. It will point at stars over most of the sky, returning to the same stars to observe multiple transits over the course of the mission, thus building up the **accuracy** of measurement of planet sizes.

Cheops will not only follow up on previously discovered exoplanets, but it will also identify the **best candidates** for detailed study by future missions and observatories. For example, it will provide targets for the NASA/ESA/CSA James Webb Space Telescope, which will be used to search for the signatures of water and methane, important elements in our quest for habitable words.

Eighty percent of the **science observing time** on Cheops is dedicated to the Guaranteed Time Observing (GTO) programme, defined by the Cheops Science Team. The remaining twenty percent is made available to the astronomical community in the form of an ESA-run Guest Observers' (GO) programme, with proposals selected via a competitive peer-review selection process.

Cheops paves the way for the **next generation** of ESA's exoplanet satellites, with two further missions – Plato and Ariel – planned for the next decade to tackle different aspects of the evolving field of exoplanet science. Together, these missions will keep the European scientific community at the forefront of exoplanet research well beyond the next decade, and will build on answering the fundamental question: what are the conditions for planet formation and the emergence of life?

Launch

Cheops will lift off as a secondary passenger, hitching a ride on the **Soyuz-Fregat** that will deliver the first satellite of the Italian Space Agency's Cosmo-SkyMed Second Generation constellation into space. The launcher will also carry three 'CubeSats', small satellites based on standardised 10 cm cubic units, including ESA's OPS-SAT, the world's first free-for-use, in-orbit testbed for new software, applications and techniques in satellite control.

Partners

- Cheops is a small, or S-class, mission in ESA's science programme. It is a partnership between ESA and Switzerland, with a dedicated consortium led by the University of Bern, and with important contributions from Austria, Belgium, France, Germany, Hungary, Italy, Portugal, Spain, Sweden and the UK.
- ESA is the Cheops mission architect, responsible for procurement and testing of the satellite, launch, the launch and early operations phase, in-orbit commissioning, as well as the Guest Observers' Programme. The consortium of 11 ESA Member States led by Switzerland provided essential elements of the mission.
- The prime contractor for the design and construction of the spacecraft is Airbus Defence and Space in Spain.
- The Cheops mission consortium runs the Mission Operations Centre located at INTA, in Torrejón de Ardoz, Spain, and the Science Operations Centre, located at the University of Geneva, Switzerland.

About this media kit

This is an interactive media kit. Navigate between pages from the contents page or with the arrows at the bottom of each page. Explore scientific and technological themes of the Cheops mission through the series of infographics. Roll over the graphic elements to discover hyperlinks to more information on related webpages. Click on the symbol ⬇ to directly access the infographic download page. Links to recommended images, videos and animations are provided towards the end of this media kit. An internet connection is required to access the external webpages.

→ EVENT PROGRAMME

Provisional schedule at ESA's astronomy centre (ESAC) near Madrid, Spain, 17 December (all times in local CET)

08:30 Doors open

09:15 Programme begins

Experts present the mission, with live transmissions from Kourou including the moment of lift-off at 09:54 CET.
This will be followed by Q&A sessions and individual interview opportunities ahead of the Cheops separation, expected around 12:20, and announcement of acquisition of signal from the Mission Operations Centre located at INTA, in Torrejón de Ardoz, Spain.

14:00 End of event – media invited to join lunch with representatives of ESA, industry and the scientific community.

How to get to ESAC

→ LIVE UPDATES

Webstreaming

ESA will cover the launch live from 09:30 CET at esawebtv.esa.int

Twitter

For live updates throughout the launch period, follow @ESA_CHEOPS and @esascience on Twitter.

The official hashtag is *#cheops*

Information for general public: esa.int/cheops
In-depth information: sci.esa.int/cheops

Facebook.com/EuropeanSpaceAgency

Youtube.com/ESA

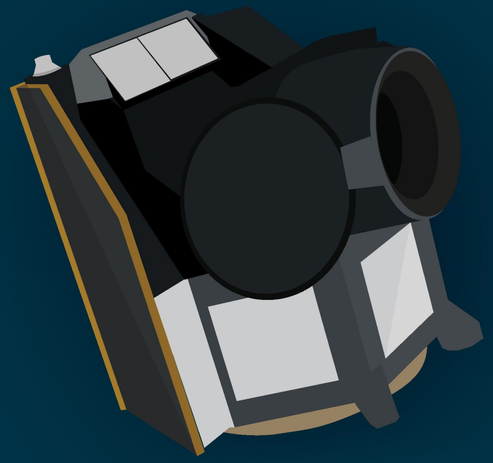
Instagram.com/europeanspaceagency

CONTENTS

→ CHEOPS: KEY MESSAGES

First step characterisation of **super Earth- to Neptune-sized planets**

Piecing together the puzzle of what **small planets** are made of, and how they form and evolve



Measuring the **size** of **known planets**

A **small**, flexible and **fast track** science mission

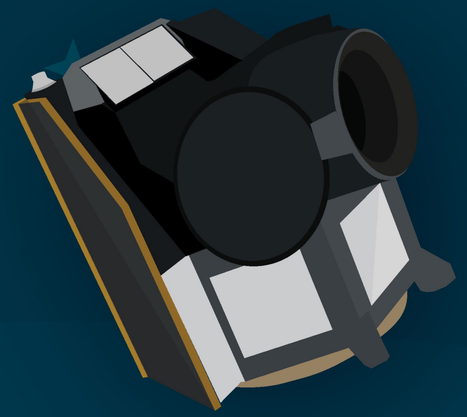
Identifying the **best targets** for future in-depth observations

Tailor-made, with a **high scientific** return on a small investment

→ CHEOPS: SCIENCE THEMES

Using **ultra-high precision photometry** to measure **accurate sizes** of a large sample of Earth- to Neptune-sized planets

Targeting primarily **bright stars** known to host exoplanets **smaller than Saturn**



Combining the Cheops **size** measurements with existing planet masses to constrain their **compositions and internal structures**

Measuring light curves of **hot Jupiters** to see how energy is transported in **planetary atmospheres**

Identifying prime **targets** to search for the **fingerprints** of key molecules in the planets' **atmospheres** using future observatories on Earth and in space

→ CHEOPS: AN EXOPLANET FOLLOW-UP MISSION

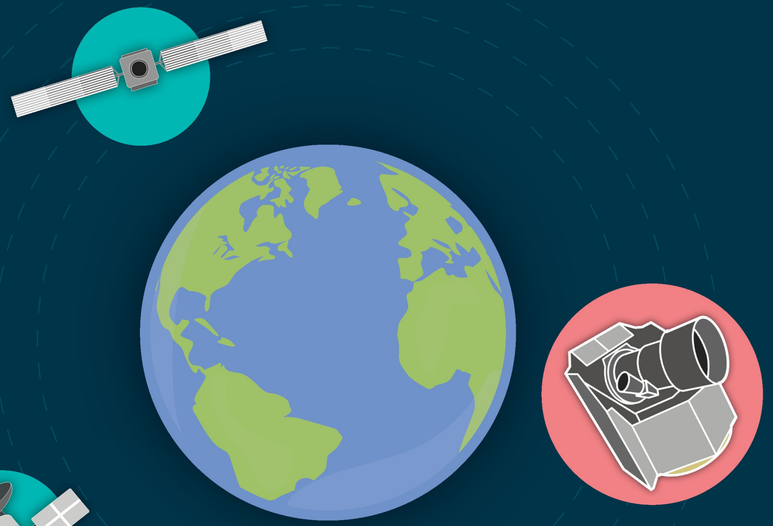
DISCOVERY MISSIONS

These space missions are dedicated to **finding new exoplanets**

Corot:
Operations: 2006–2013
Planets discovered: 33

Kepler/K2:
Operations: 2009–2018
Planets discovered:
2345 (Kepler) + 385 (K2)

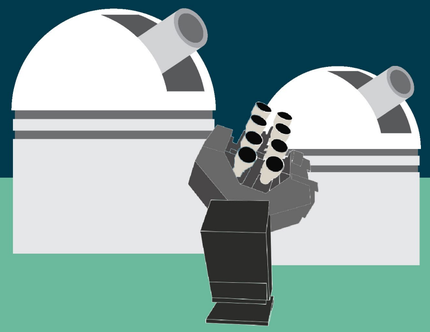
Tess:
Operations: 2018–present
Planets discovered:
37 confirmed; 1516 candidates
(as of 6/12/2019)

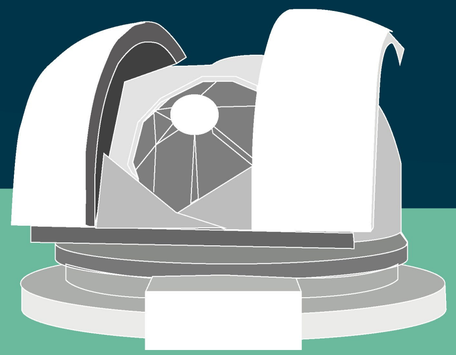


FOLLOW-UP MISSION

Cheops will observe **individual stars already known to host exoplanets** rather than carry out sky surveys to find new ones

Cheops:
Launch 2019



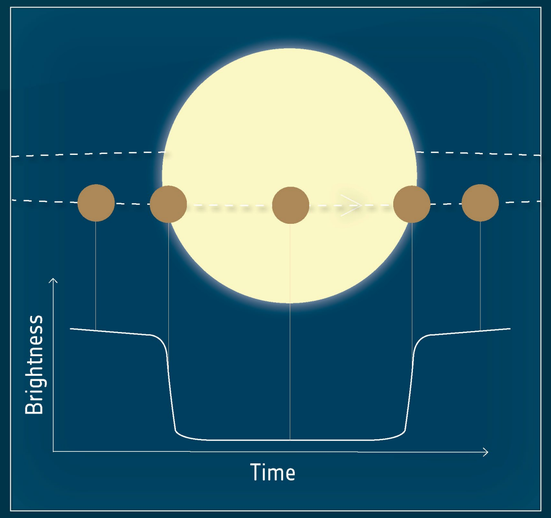


The **first discoveries of exoplanets** were made with ground-based telescopes in the 1990s, opening the field of **exoplanet research.** Dedicated ground-based surveys to find exoplanets included the Wide Angle Search for Planets (WASP) and the Hungarian Automated Telescope Network (HAT) in the 2000s.

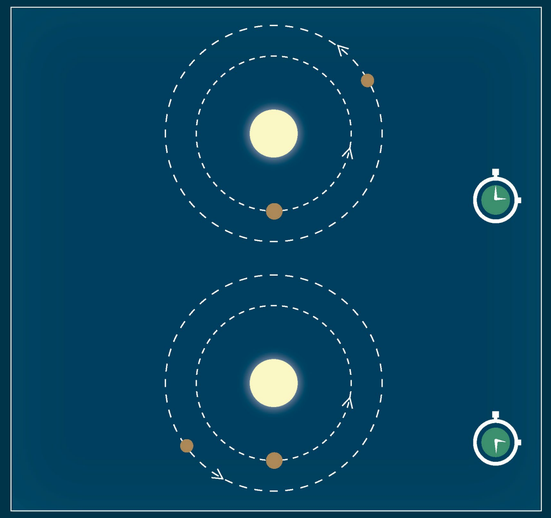
The 2019 **Nobel Prize in Physics** was awarded to Michel Mayor and Didier Queloz for the **discovery of the first exoplanet** around a Sun-like star in 1995. **New innovations and discoveries** continue to this day.

→ EXOPLANET DETECTION METHODS

Transit photometry



Transit-timing variation

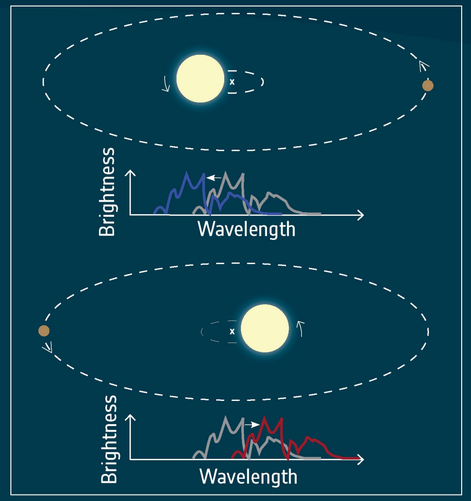


Transit photometry is one of the main techniques used to **discover** exoplanets. Cheops will use this technique to **measure the sizes** of known exoplanets and to start to **characterise** them.

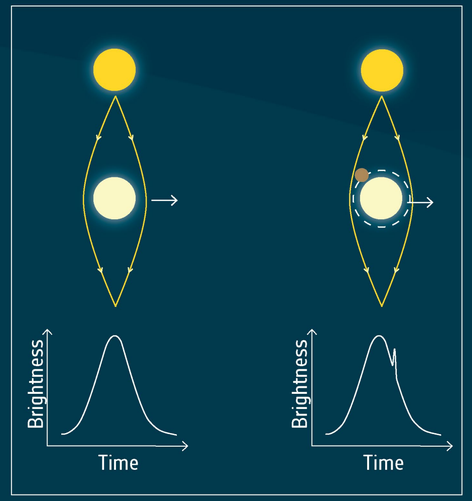
By using the **transit-timing variation** technique, Cheops will be able to **discover** additional, previously unknown planets around some stars, and also determine the planet **masses**.

Other techniques used to discover new exoplanets (not employed by Cheops) are: radial velocity, microlensing, astrometry and direct imaging.

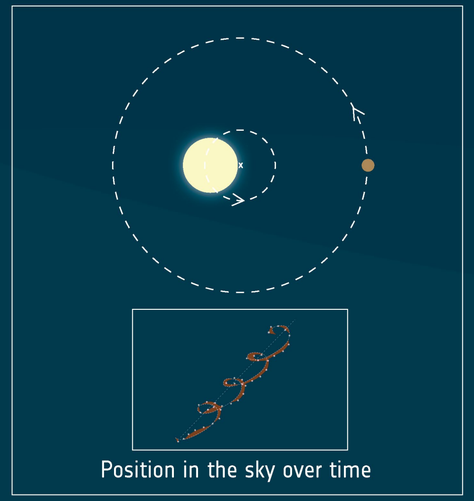
Radial velocity



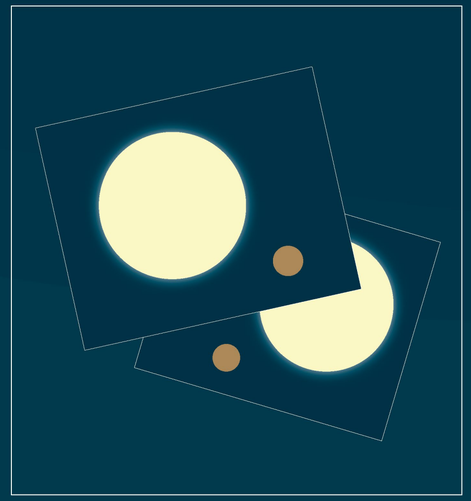
Microlensing



Astrometry



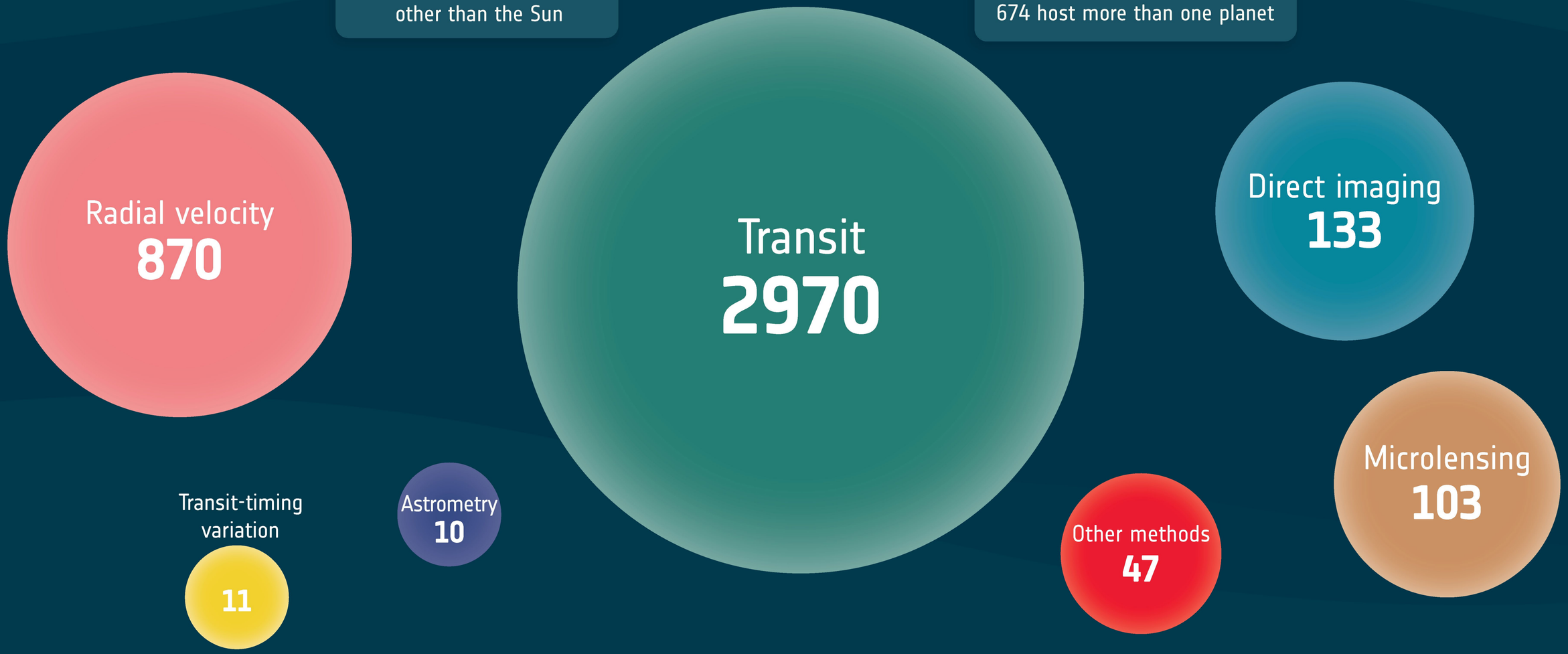
Direct imaging



→ EXOPLANETS DISCOVERIES

To date, **4143** planets have been discovered around stars other than the Sun

These planets belong to **3077 planetary systems,** of which 674 host more than one planet

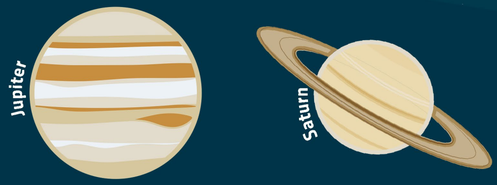


Information based on exoplanet.eu (as of 6 December 2019)

→ EXAMPLES OF PLANETARY SYSTEMS

Solar System

Sun



51 Pegasi

Planet: **51 Pegasi b**
Type: Hot Jupiter
Orbital period: 4.2 days
Discovery method: Radial velocity (1995)

First exoplanet discovered around a Sun-like star

COROT-7

COROT-7 b
Terrestrial planet
0.8 days
Transit (2009)

COROT-7 c
Super Earth
3.7 days
Radial velocity (2009)

COROT-7d
Candidate, to be confirmed
Radial velocity (2010)

First discovery of a terrestrial exoplanet

TOI-270

TOI-270 c
Mini Neptune
5.7 days
Transit (2019)

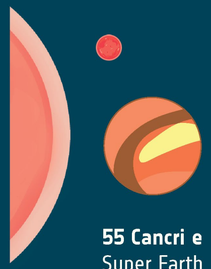
TOI-270 b
Super Earth
3.4 days
Transit (2019)

TOI-270 d
Mini Neptune
11.4 days
Transit (2019)

System with super Earth and mini Neptune exoplanets

55 Cancri

Double star system



55 Cancri e
Super Earth
0.7 days
Transit (2004)

55 Cancri b
Warm Jupiter
14 days
Radial velocity (1996)

First discovery of a super Earth exoplanet

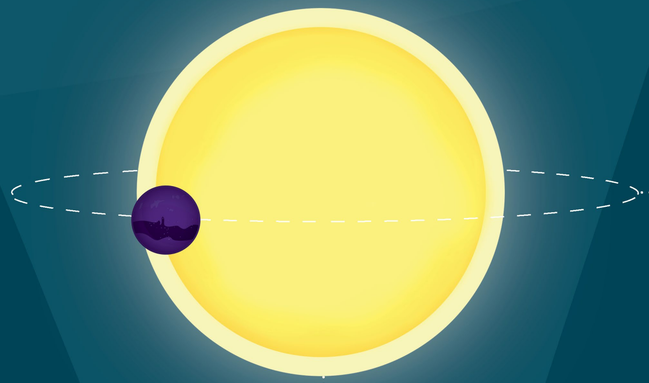
55 Cancri c
Super Neptune
44 days
Radial velocity (2002)

55 Cancri f
Super Neptune
260 days
Radial velocity (2007)

55 Cancri d
Super Jupiter
4867 days
Radial velocity (2002)

Relative sizes and distances are not to scale

→ CHARACTERISING EXOPLANETS WITH CHEOPS



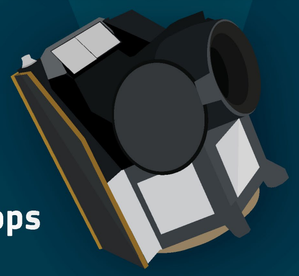
Radial velocity

Minimum **mass** of the planet (depending on orbit inclination)

Transit photometry

Size (radius) of the planet and **orbital parameters**

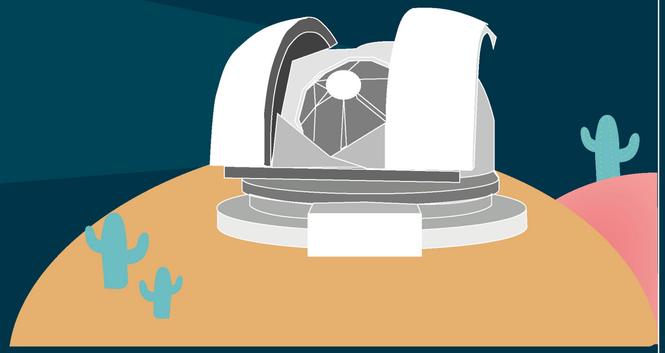
By combining **radius (R) and mass (M)** measurements, it is possible to estimate a planet's bulk **density (density = M / R^3)**

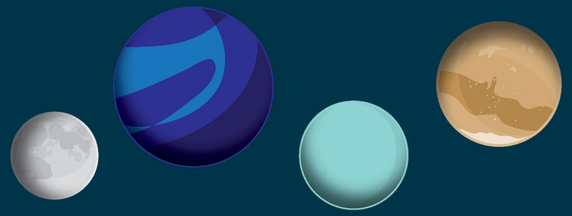


Cheops

Density enables scientists to distinguish between dense **rocky** worlds, **gas** planets, **water**-worlds and **ice-rich** planets

Ground-based telescopes



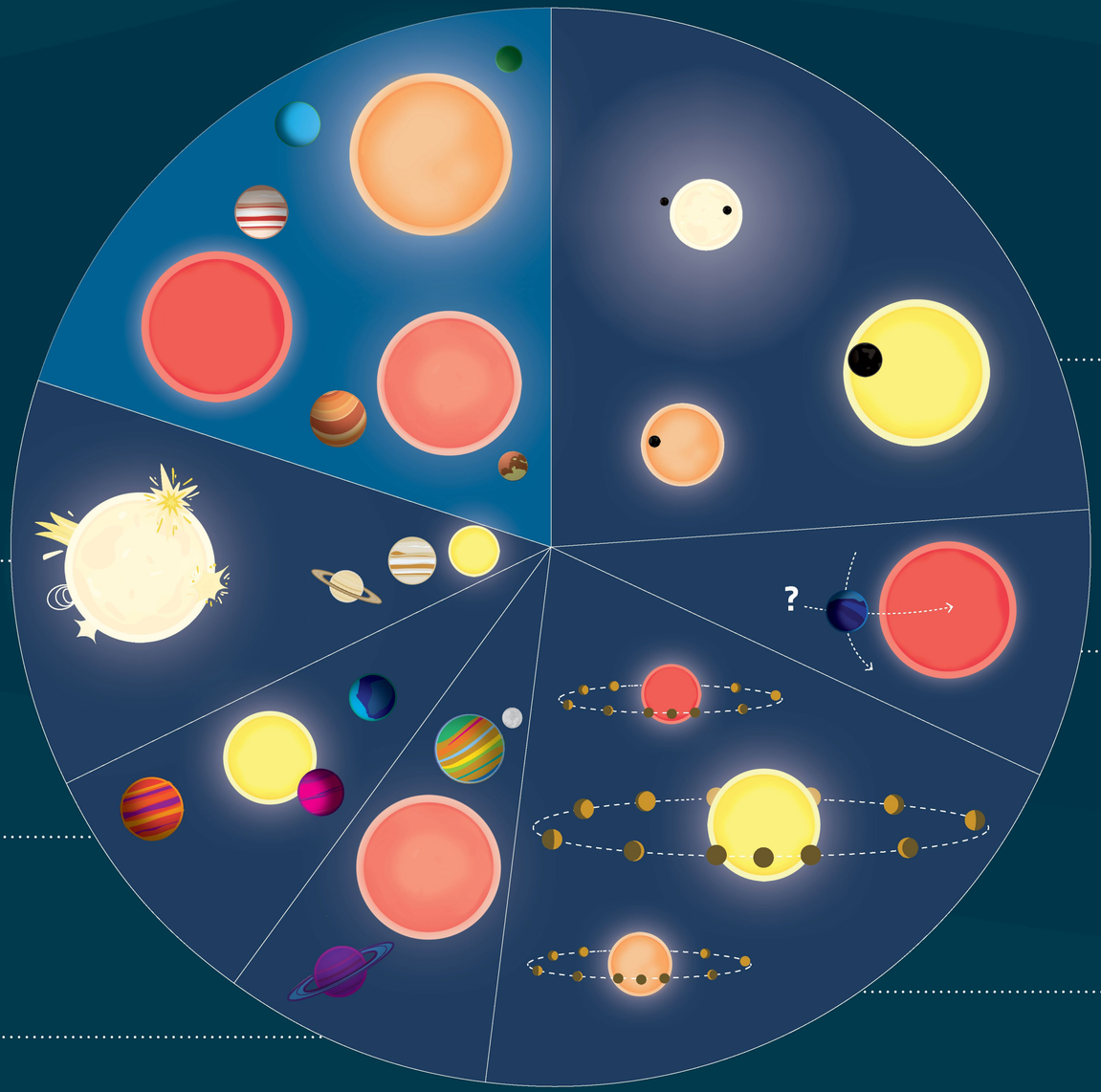


*Cheops will also discover previously unknown planets by measuring **transit-timing variations,** and study planet atmospheres using the **phase curve method** (studying the reflected light as a planet orbits its parent star)*

→ CHEOPS OBSERVING PROGRAMMES

GUEST OBSERVERS' PROGRAMME, proposed by the scientific community worldwide

GUARANTEED TIME OBSERVING PROGRAMME, compiled by the Cheops science team



Improving the **size measurements** of planets for which transit and **radial velocity** measurements are already available, to provide better estimates of their **density**

Ancillary science: non-time critical observations from other research areas such as **stellar physics and planetary science**

Searching for transits of planets that were discovered via the radial velocity method

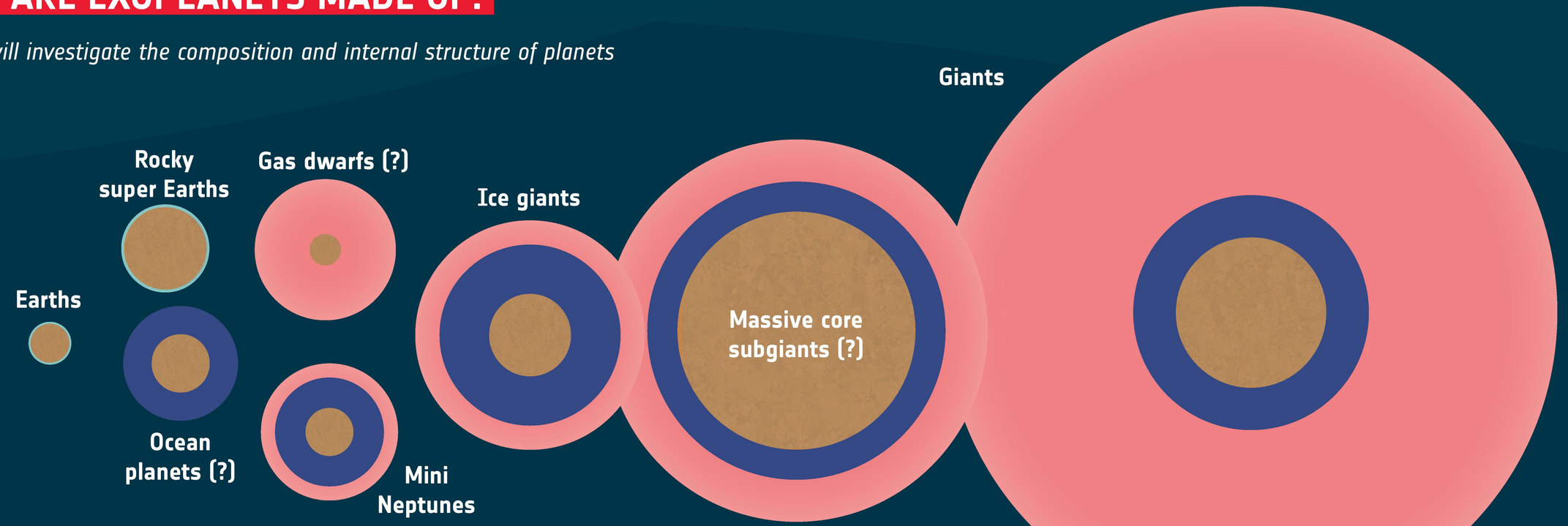
Searching for new planets around bright stars that are already known to host one or more planets

Characterising the **atmosphere** of planets using the **phase curve method**

Searching **for special features** of particular planets (moons, rings, tidal stretching)

→ WHAT ARE EXOPLANETS MADE OF?

How Cheops will investigate the composition and internal structure of planets



** Planetary scientists call **volatiles** all chemical elements and compounds with low boiling points that are associated with a planet's or moon's crust or atmosphere. These include: nitrogen, water, carbon dioxide, ammonia, hydrogen, methane and sulphur dioxide.*

Super Earths | **Neptunes** | **Jupiters**

1 M_{Earth} — 10 M_{Earth} — 100 M_{Earth} — 300 M_{Earth} ~ 1 $M_{Jupiter}$ — 1000 M_{Earth} (M=mass)

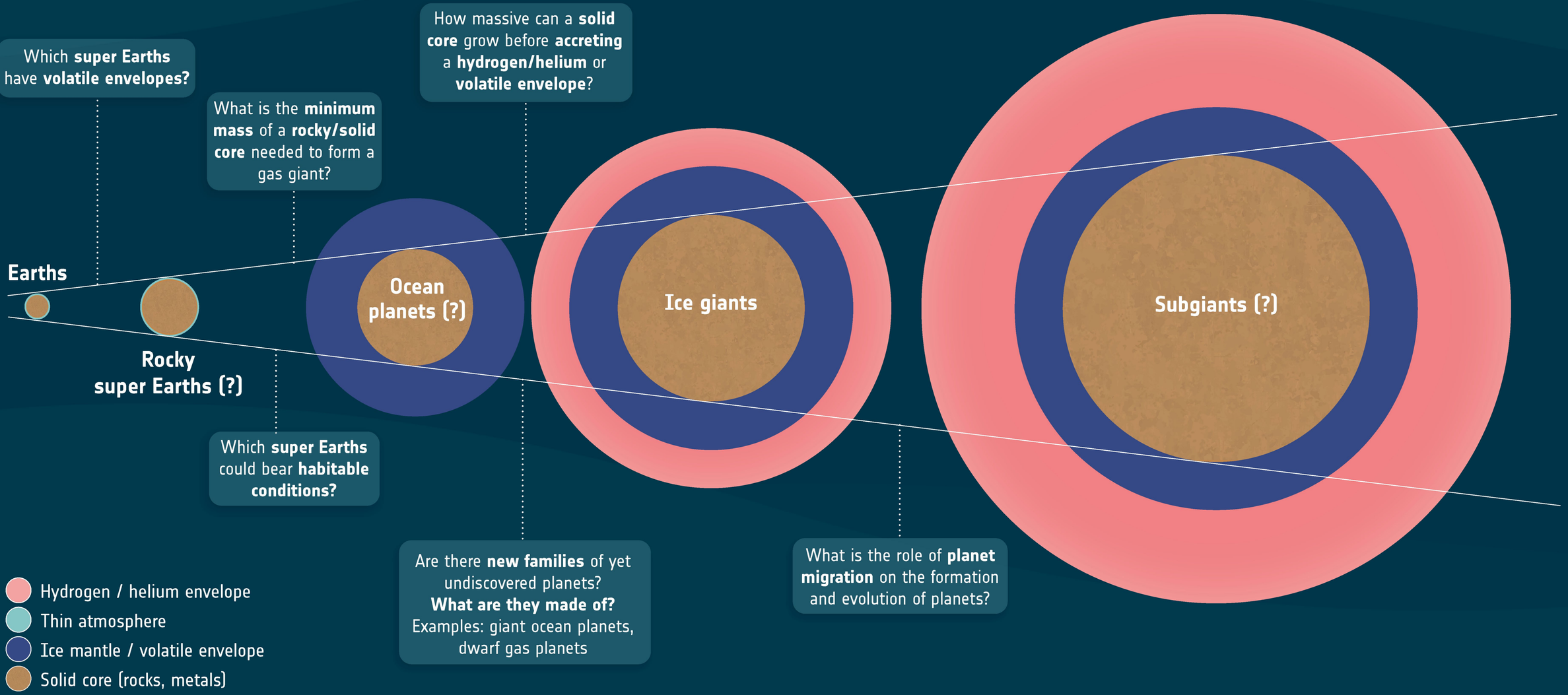
Cheops will measure the sizes of Earth- to Neptune-sized planets. Combining size and mass measurements, it is possible to determine the bulk density of the planets and constrain their composition

Cheops will also measure the light curves of hot Jupiters to study how energy is transported in planetary atmospheres

CONTENTS

→ HOW DO PLANETS FORM?

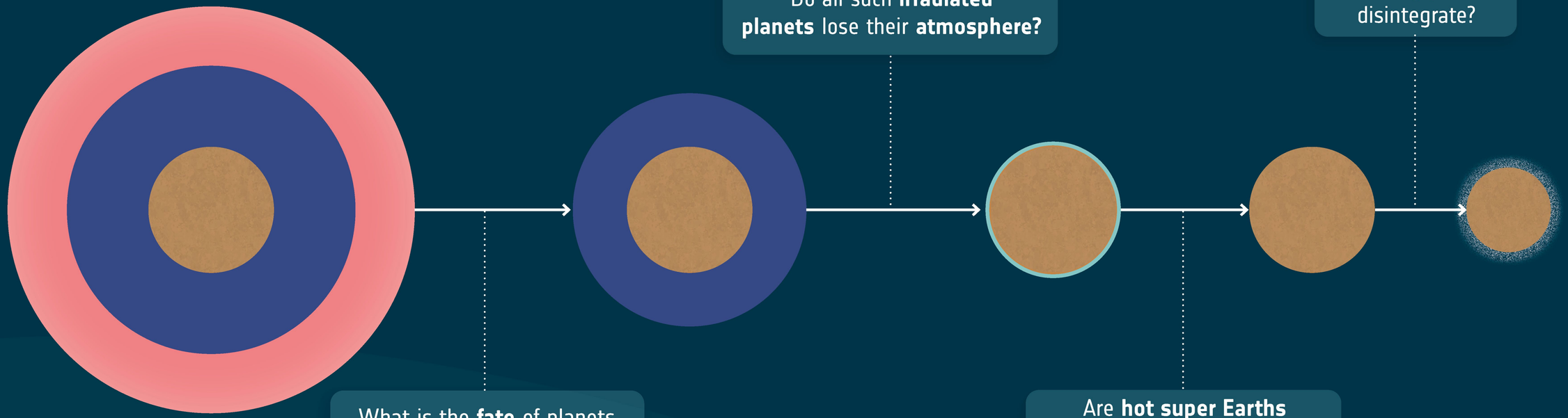
Some of the open questions Cheops will address



CONTENTS

→ HOW DO PLANETS EVOLVE?

Some of the open questions Cheops will address



- Hydrogen / helium envelope
- Thin atmosphere
- Ice mantle / volatile envelope
- Solid core (rocks, metals)

→ HIGH PHOTOMETRIC STABILITY AND PRECISION

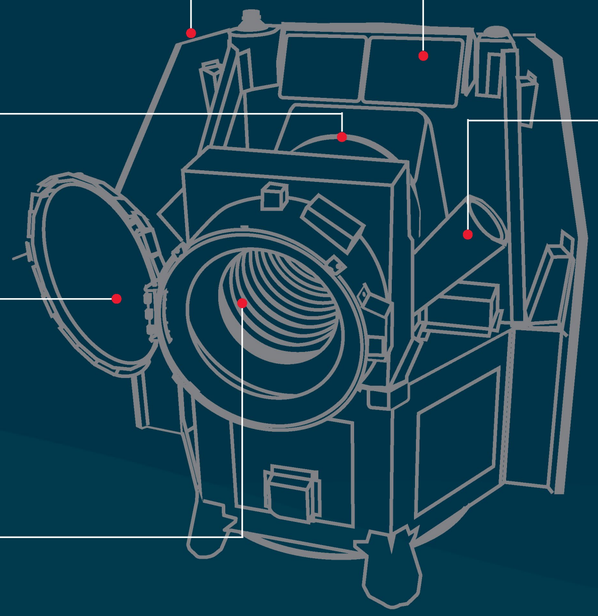
The **signal** of an exoplanet transit can be extremely tiny for the smallest planets, and **noise** from the instrument itself can potentially obscure the transit, so the instrument is designed to be as **stable** as possible

Sunshield: to keep the instrument shaded; it also carries the solar panels

Telescope tube: housing the primary and secondary mirrors

Baffle cover: to protect the optics from contamination up until and during launch; it will be opened once Cheops is in Earth orbit

Baffle: to keep stray light (e.g. from the Earth and Moon) from entering the telescope



Radiators: to provide cooling to the detector and electronics

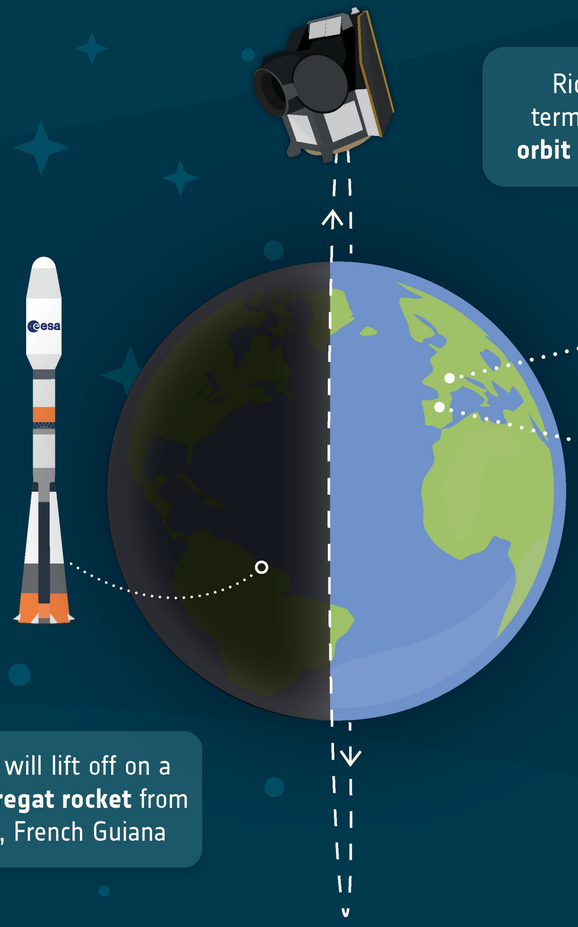
Star tracker: mounted directly onto the instrument to improve pointing stability and minimise misalignment effects

Spacecraft attitude and orbit control system: to control the satellite pointing in order to minimise the pointing error, the instrument provides information on the actual position of the target star that is being measured to the platform attitude control system

One instrument: a high precision photometer

- 300 mm effective aperture telescope
- single charge-coupled device (CCD) detector
- covering wavelengths between 330 and 1100 nm

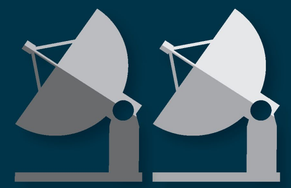
→ WHERE IS CHEOPS?



Riding on the day-night terminator in a **dawn/dusk orbit** at an altitude of **700 km**

Cheops will lift off on a **Soyuz-Fregat rocket** from Kourou, French Guiana

In contact with **ground stations** once or twice per day, downloading data at a rate of **1.2 Gbit/day**



Command uplink and data downlink via **two ground station antennas** at Villafranca & Torrejón, Spain

The ESA ground station at Kiruna, Sweden will also be used during **early mission operations**

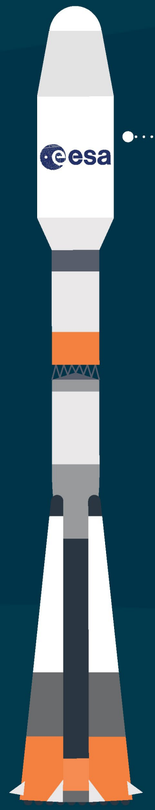
Science Operations Centre (SOC)
Geneva, Switzerland

Planning of observations; processing, archiving and distribution of science data

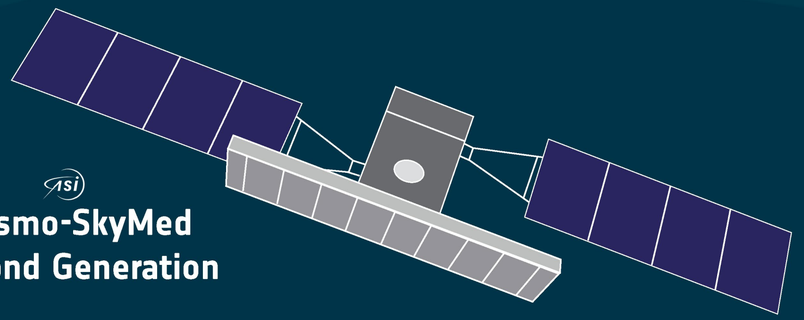
Mission Operations Centre (MOC)
Torrejón, Spain

Spacecraft commanding sequences uplink; telemetry downlink

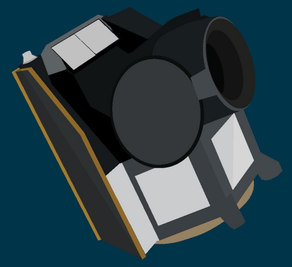
→ LAUNCH DETAILS AND TIMELINE



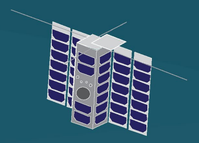
Lift-off with **Arianespace Soyuz-Fregat rocket**
18 December 2019
05:54 GFT (French Guyana Time)
08:54 GMT (Greenwich Mean Time)
09:54 CET (Central European Time)



Cosmo-SkyMed Second Generation



Cheops

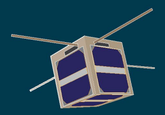


OPS-SAT

Height: 30 cm
The world's first free-for-use, **in-orbit testbed** for new software, applications and techniques in **satellite control.**
It carries a **computer 10 times more powerful** than on any preceding ESA mission, and enables innovative new software to be tested in orbit.

ANGELS

EYE-SAT



CubeSats are small satellites based on **standardised** 10 cm cubic units

Lift-off (L) + 2 mins
First stage separation

L + 3 mins
Fairing jettison

L + 5 mins
Second stage separation

L + 9 mins
Third stage separation

L + 23 mins
Cosmo-SkyMed separation

L + 145 mins
Cheops separation

L + 174 mins
First acquisition of Cheops signal expected (L + 169–179 mins)

L + 251 mins
OPS-SAT separation

L + 257 mins
All CubeSats are separated

→ CHEOPS TEAM AND CONSORTIUM

CHEOPS TEAM

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University of Geneva

UK
University of Cambridge
Keele University
University of St. Andrews
University of Warwick

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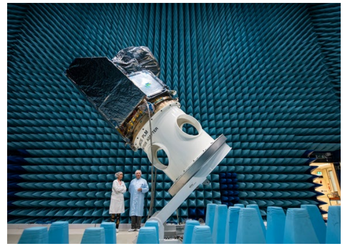
PHOTOS

CHEOPS AT ESA'S TECHNICAL CENTRE

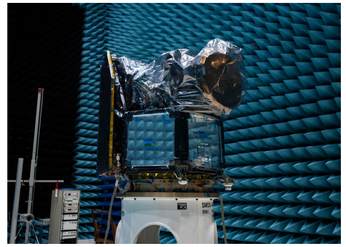
CHEOPS AT ESA'S TECHNICAL CENTRE

CHEOPS AT ESA'S LARGE EUROPEAN ACOUSTIC FACILITY

CHEOPS AT ESA'S LARGE EUROPEAN ACOUSTIC FACILITY



CHEOPS AT ESA'S MAXWELL TEST FACILITY



CHEOPS AT ESA'S MAXWELL TEST FACILITY

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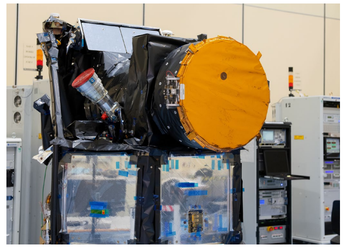

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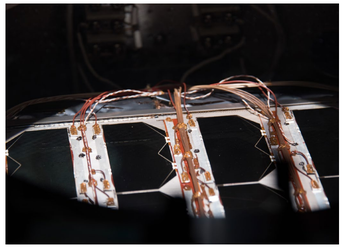
CHEOPS CLOSE UP

CHEOPS TELESCOPE



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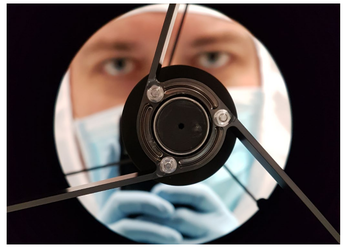

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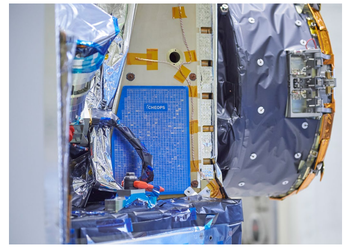

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CHEOPS ARRIVES IN KOUROU

CHEOPS ARRIVES IN KOUROU

CHEOPS INSTALLATION ON TROLLEY IN KOUROU

CHEOPS MISSION OPERATIONS CENTRE

CHEOPS MISSION CONTROL ROOM

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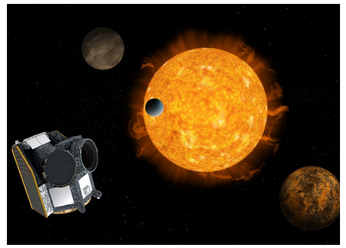
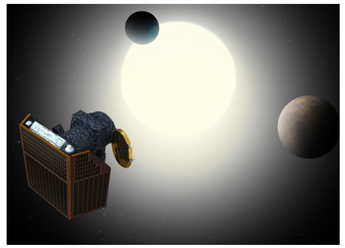


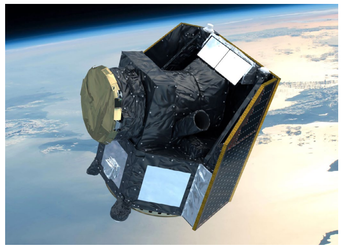
CHEOPS OBSERVING EXOPLANETS



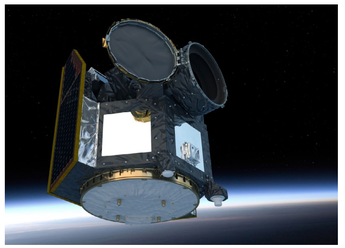
CHEOPS OBSERVING EXOPLANETS

THE CHEOPS SATELLITE

THE CHEOPS SATELLITE



CHEOPS IN SPACE (BAFFLE COVER CLOSED)



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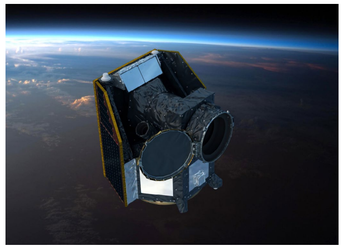
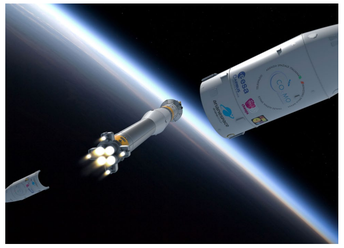


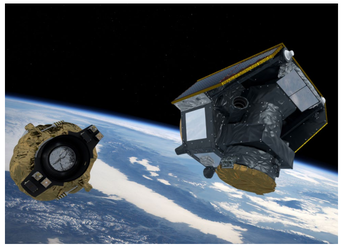
CHEOPS IN SPACE (BAFFLE COVER OPEN)

CHEOPS LAUNCH

CHEOPS LAUNCH



CHEOPS LAUNCH – FAIRING SEPARATION



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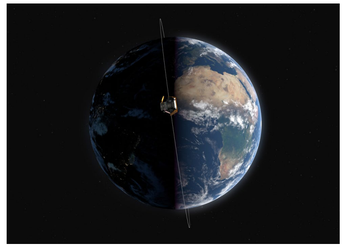

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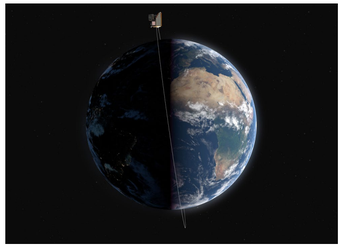

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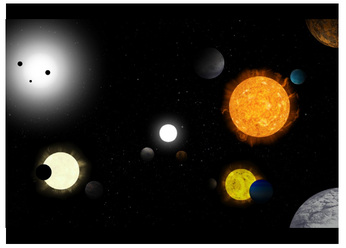
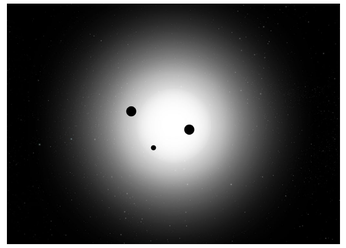


EXOPLANET IMAGINARIUM



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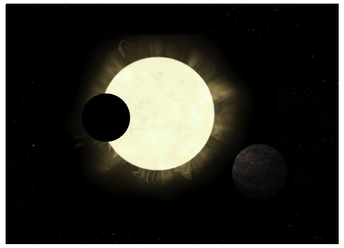
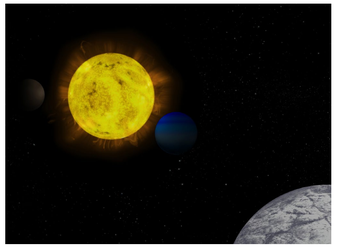


EXOPLANET SYSTEM



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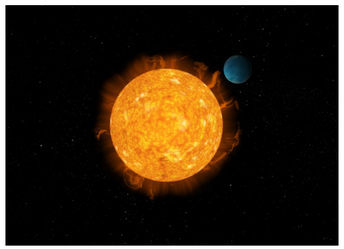

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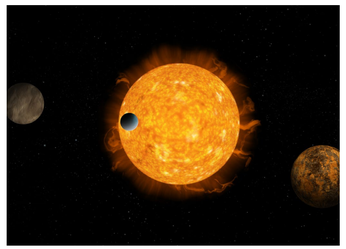

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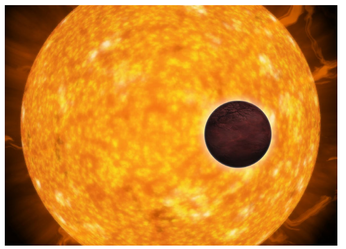

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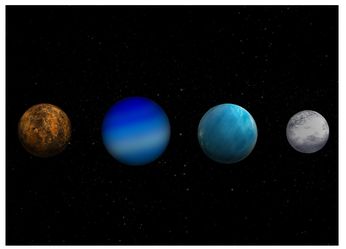

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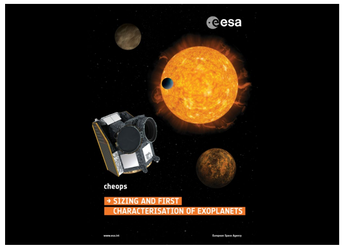

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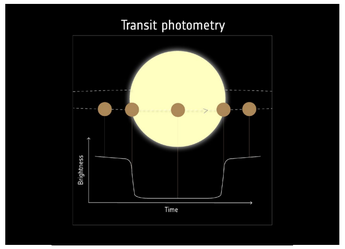

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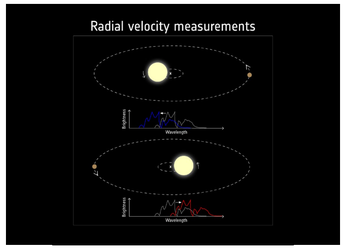

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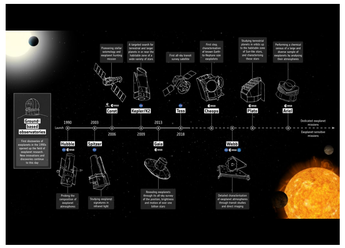

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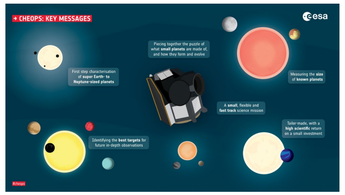
COUNTRIES CONTRIBUTING TO CHEOPS

FAIRING STICKER COMPETITION WINNING



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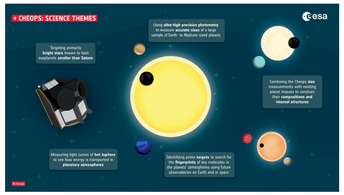

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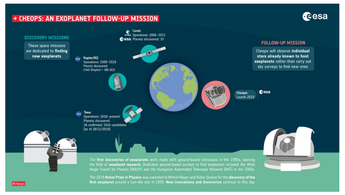

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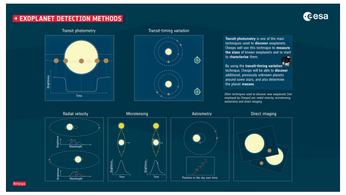

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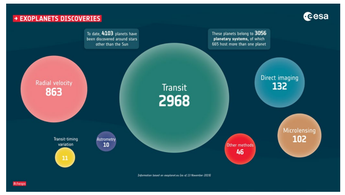

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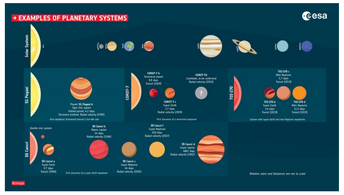

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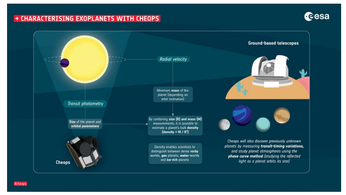
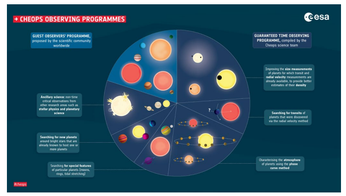


CHARATERISING EXOPLANETS WITH CHEOPS



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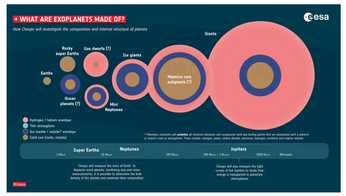

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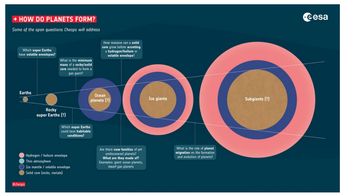

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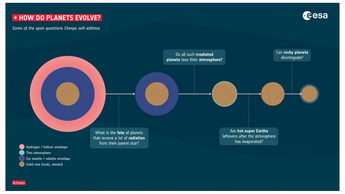

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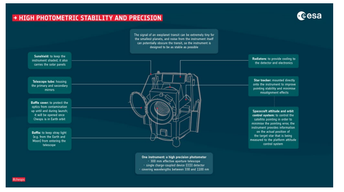

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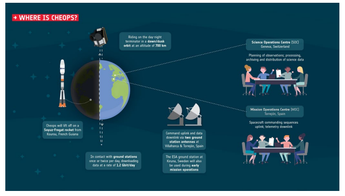

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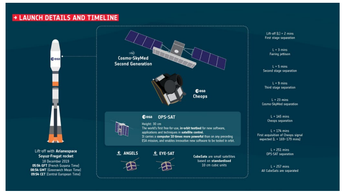

LAUNCH DETAILS AND TIMELINE

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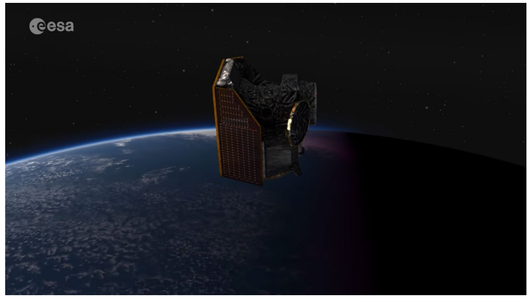

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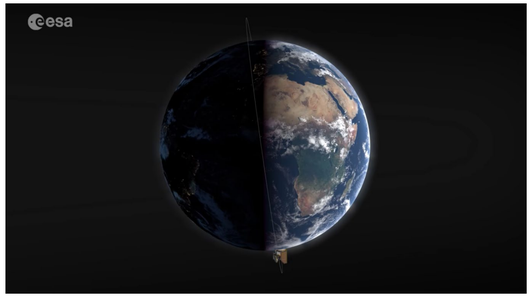

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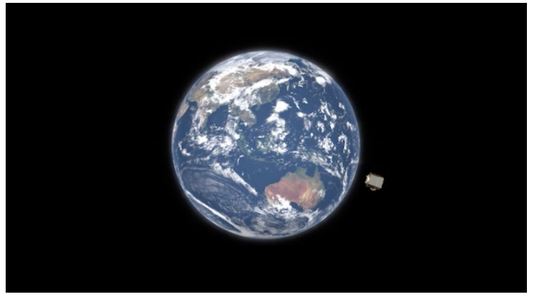
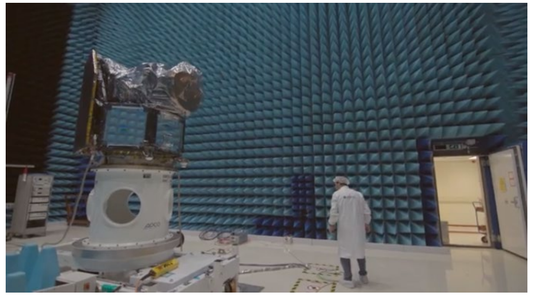


THE ORBIT OF CHEOPS

THE CHEOPS SATELLITE IN THE LARGE EUROPEAN ACOUSTIC FACILITY



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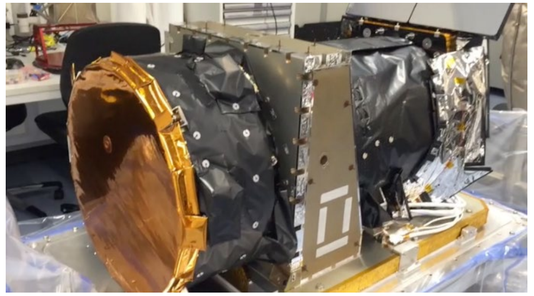
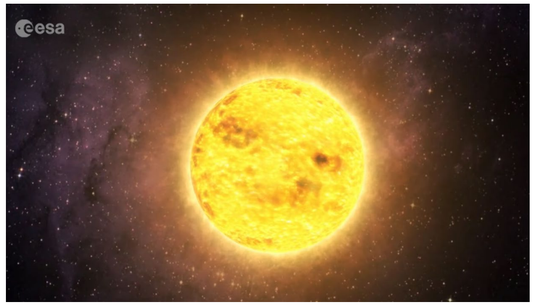


WALKING AROUND THE SCIENCE INSTRUMENT



CHEOPS: SCIENCE IN ACTION

CHEOPS: PLANNING A PERFECT MISSION

CHEOPS - CHARACTERISING EXOPLANETS

PREPARING CHEOPS

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→ HOW TO FOLLOW THE LAUNCH

Livestream
ESA will cover the launch of Cheops at esawebtv.esa.int on 17 December, TIME 09:30 CET.
It will cover the liftoff at 09:54 CET, the Cheops separation approximately 2.5 hours later and the acquisition of signal approximately 3 hours later.

ESA TV productions
ESA TV productions are available at esa.int/esatv/Videos_for_Professionals

Cheops online
Information for general public: esa.int/cheops
In-depth information: sci.esa.int/cheops

Cheops on social media
Twitter: @ESA_CHEOPS
Official hashtag: #cheops

Facebook: Facebook.com/EuropeanSpaceAgency
Youtube: Youtube.com/ESA
Instagram: Instagram.com/europeanspaceagency

Multimedia
A variety of photographs, illustrations, graphics and animations are available via:
- ESA Space in Images
- ESA Space in Videos
- ESA's Photo Library for Professionals
- ESA's Video Library for Professionals

See also pages 21-23 in this media kit for recommended multimedia products


esa
THANK YOU FOR JOINING US FOR THE LAUNCH
OF THE CHEOPS EXOPLANET SATELLITE!
#cheops
European Space Agency