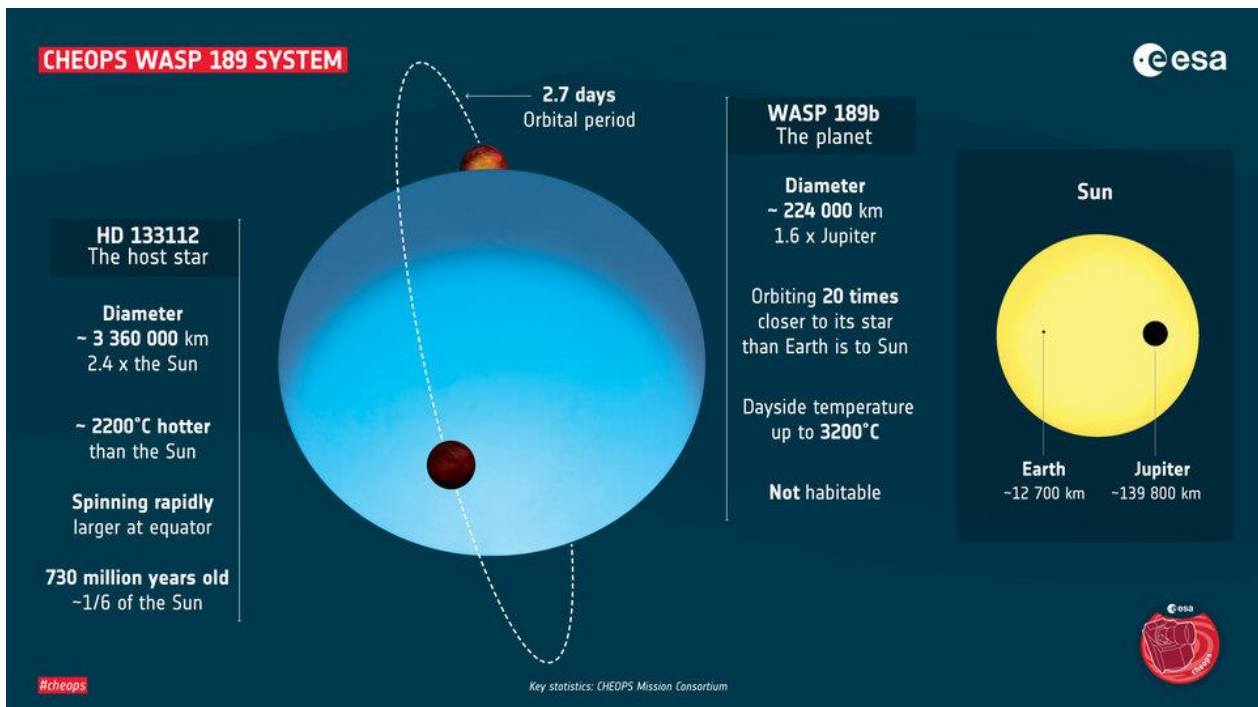




**British Astronomical Association**  
Supporting amateur astronomers since 1890

# Infinite Worlds



First discovery of an exoplanet by CHEOPS

Credit ESA

The e-magazine of the  
Exoplanets Division  
Of the  
Asteroids and Remote Planets Section

Issue 8

2020 October

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## Section officers

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## News

### **If we can't go to exoplanets then perhaps we can investigate what they 'send' to us**

Two extrasolar objects, [1I/Oumuamua](#), [2I/Borisov](#), have passed through our Solar System in the last three years. Such interstellar objects provide a previously unforeseen chance to directly sample physical material from other stellar systems. By analysing these interlopers, we can acquire data and deduce information about their planetary system of origin, planetary formation, galactic evolution and possibly even molecular biosignatures or even clues about panspermia. See <https://arxiv.org/abs/2008.07647> a paper by the [Initiative for Interstellar Studies](#) for the [2023-2032 Planetary Science and Astrobiology Decadal Survey](#)



Artists concept of 1I/2017 U1 ('Oumuamua) Credit ESA/M. Kornmesser

### **New Zooniverse project – Planet Patrol**

Automated methods of processing data from the TESS planet-finding mission sometimes fail to catch imposters that look like exoplanets. The human eye, however, is extremely good at

spotting such imposters. Citizen scientists are needed to help us distinguish between genuine planets and false positives - [https://www.zooniverse.org/projects/marckuchner/planet-patrol?utm\\_source=Newsletter&utm\\_medium=Email&utm\\_campaign=announce29sep2020](https://www.zooniverse.org/projects/marckuchner/planet-patrol?utm_source=Newsletter&utm_medium=Email&utm_campaign=announce29sep2020)

### **Retention of data - ExoClock**

There was some concern expressed as to the longevity of observations submitted to the ARIEL ExoClock project by BAA members. Fear not it will, as explained below by Anastasia Kokori, outlive most of us.

‘All the data are indeed stored in the ExoClock database and will be there for a long time -at least until the end of the mission.

At the same time we also have several backups which are expected to last for a quite longer time. Essentially, there is no expiration date and after the publications the data will be publicly available. Of course, any time BAA asks for a copy, you will get a copy and have access to them.

Note also that at some point all data will be transferred to the OSF (Open Science Framework) which is a platform to store all open scientific data. This can be considered as another backup which it is expected to last for at least 50 years.

In general, there is no reason to worry about data storage and access since we try to have all these alternative ways’.

### **Retention of data - Exoplanet-talks.org (From the ExoPlanet News)**

We are going to try something different, and set up a web-based scientific presentation platform for the field of extrasolar planets. Anybody registered can upload a presentation to the system, e.g. when they have published a paper, a thesis, or at any time. The presentation is stored in the system with a range of keywords to make the database easily searchable - no frills, no likes, no number of views. Anybody can view a presentation until the presenter removes it again from the database. Registered scientists can ask questions either publicly or privately via a discussion console - even months after a talk has been uploaded. You will need to be a scientist affiliated with a recognised institute to register and be able to post a video or place comments. The public at large can only watch the videos.

### **Exoplanet Transit Database (ETD)**

Version 3.0.0 of HOPS (currently under test) produces data that can be input to the ETD (via TRESKA). A tutorial will be added as an appendix to the [ARIEL ExoClock pro-am project web page](#) In addition Appendix B, Running HOPS will be updated to reflect the new version.

### **JWST launch date now 2021 October**

NASA has announced the decision, based on a recently completed schedule risk assessment of the remaining integration and test activities before launch, accounting for impacts from the COVID-19 pandemic and technical challenges. Previously, Webb was targeted to launch in March 2021.

[https://www.esa.int/Science\\_Exploration/Space\\_Science/James\\_Webb\\_Space\\_Telescope\\_to\\_launch\\_in\\_October\\_2021](https://www.esa.int/Science_Exploration/Space_Science/James_Webb_Space_Telescope_to_launch_in_October_2021)

### **WFIRST renamed the Nancy Grace Roman Space telescope**

<https://roman.gsfc.nasa.gov/>

The Roman Space Telescope is a NASA observatory designed to settle essential questions in

the areas of dark energy, exoplanets, and infrared astrophysics. The telescope has a primary mirror that is 2.4 meters in diameter (7.9 feet), and is the same size as the Hubble Space Telescope's primary mirror. The Roman Space Telescope will have two instruments, the Wide Field Instrument, and the Coronagraph Instrument. The Wide Field Instrument will have a field of view that is 100 times greater than the Hubble infrared instrument, capturing more of the sky with less observing time. As the primary instrument, the Wide Field Instrument will measure light from a billion galaxies over the course of the mission lifetime. It will perform a microlensing survey of the inner Milky Way to find around 2,600 exoplanets - <https://roman.gsfc.nasa.gov/exoplanets.html> The Coronagraph Instrument will perform high contrast imaging and spectroscopy of individual nearby exoplanets.

Predictions of the Nancy Grace Roman Space Telescope Galactic Exoplanet Survey II: Free-Floating Planet Detection Rates - <https://arxiv.org/abs/2006.10760>

### **Exoplanet watch**

<https://exoplanets.nasa.gov/exoplanet-watch/about-exoplanet-watch/>

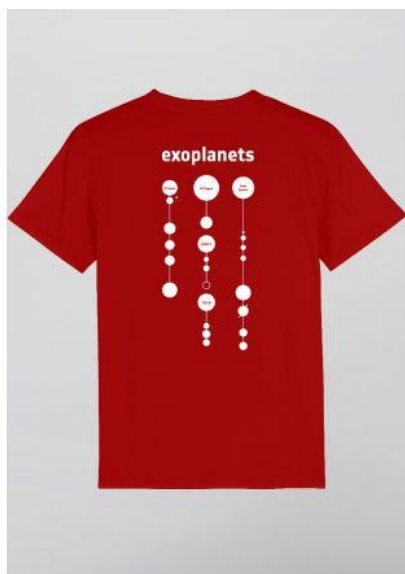
Exoplanet Watch is a citizen science project to observe transiting exoplanets with small telescopes. Exoplanet Watch will help increase the efficiency of exoplanet studies by large telescopes, e.g. HAT, JWST and ARIEL, to characterize exoplanet atmospheres by reducing uncertainty about the predicted timing of transit events.

Note. I feel we have enough on our plate with ARIEL, PLATO and possibly Twinkle. I mention it here but do not intend to pursue it any further. Of course, members are free to observe whatever they wish and are at liberty to join this project or not as the case may be. Note that any data submitted to the ExoClock project will automatically be passed to Exoplanet Watch

### **Want to look the part?**

ESA exoplanets collection -

<https://www.esaspacehop.com/eu/collections/collections/exoplanets.html>



## **Conferences/Meetings/Seminars/Webinars – Reports**

**EuroPlanet Science Congress 21 Sep – 9 Oct** - <https://www.epsc2020.eu/> This was a virtual meeting and Mark Salisbury and Martin Crow participated in the main conference and Splinter sessions wrt the ARIEL mission and ExoClock project.

Mark Salisbury's presentation - Citizen Scientist Participation in Transiting Exoplanet Science – can be viewed by accessing the [Session ODAA3 page](#), scrolling down and clicking on the video link adjacent to the title.

Other presentations of interest which can also be linked to from the Session ODAA3 page are;

- 'Importance of citizen Czech Astronomical Society for variable star and exoplanet research' by Katerina Honkova and Filip Walter
- 'On an Empirical Mathematical Approach to the Densities of Small Transiting Exoplanet' by Yiannis Mantanikas

## **ExoClock and ARIEL splinter meeting – EPSC2020**

An introduction to the ARIEL ExoClock project can be found at [https://www.exoclock.space/epsc2020\\_splinter](https://www.exoclock.space/epsc2020_splinter) A video of the meeting can be viewed at <https://www.youtube.com/watch?v=2LVpcjjj6oE> with Martin Crow's presentation 'Amateur Participation in the ExoClock Project' starting at 61 minutes

## **Conferences/Meetings/Seminars/Webinars - Scheduled**

**PLATO Week 11 meeting** (probably October, date tba but now unlikely to take place). Steve Futcher will be our representative for the Amateur Observing Program

**Exoplanet Demographics Conference** November 9-12

- <https://nexsci.caltech.edu/conferences/exodem/>

**Threats from the surroundings:** an e-workshop on the importance of environment for the evolution of protoplanetary discs and formation of planets, on-line 2020 November 10-12 <https://www.eso.org/sci/meetings/2020/tfts2020.html>

**AGU Fall Meeting**, San Francisco, California, USA, 2020 December 7-11. DI001 - Accretion and differentiation of rocky planets: perspectives from geophysics, geochemistry, & astronomy <https://agu.confex.com/agu/fm20/prelim.cgi/Session/101356>

**AAS Topical Conference:** Habitable Worlds; on-line 2021 February 22-26 <https://aas.org/meetings/aastcs8/habitable>

## **Recent discoveries**

### **WD 1856b. First possible 'Survivor' planet orbiting close to a White Dwarf**

An international team of astronomers has reported what may be the first example of an intact planet closely orbiting a white dwarf, a dense leftover of a Sun-like star that's only 40% bigger than Earth. The detection of the Jupiter-size body was made using data from NASA's Transiting Exoplanet Survey Satellite (TESS) and retired Spitzer Space Telescope. The object, called WD 1856 b, is about seven times larger than the white dwarf.

<https://exoplanets.nasa.gov/news/1657/nasa-missions-spy-first-possible-survivor-planet-hugging-a-white-dwarf-star/>

### **Saturn-sized planet orbiting star TVLM 513–46546**

This exoplanet was discovered using the Very Long Baseline Array, the first by a radio telescope, coupled with previous observations dating back to 2010 -

[https://astronomynow.com/2020/08/04/radio-astronomers-measure-stars-wobble-find-saturn-size-exoplanet/?utm\\_source=Astronomy+Now+Newsletter&utm\\_campaign=fc29014638-151098305&utm\\_medium=email&utm\\_term=0\\_e789188a36-fc29014638-151098305&mc\\_cid=fc29014638&mc\\_eid=789a337ae4](https://astronomynow.com/2020/08/04/radio-astronomers-measure-stars-wobble-find-saturn-size-exoplanet/?utm_source=Astronomy+Now+Newsletter&utm_campaign=fc29014638-151098305&utm_medium=email&utm_term=0_e789188a36-fc29014638-151098305&mc_cid=fc29014638&mc_eid=789a337ae4)

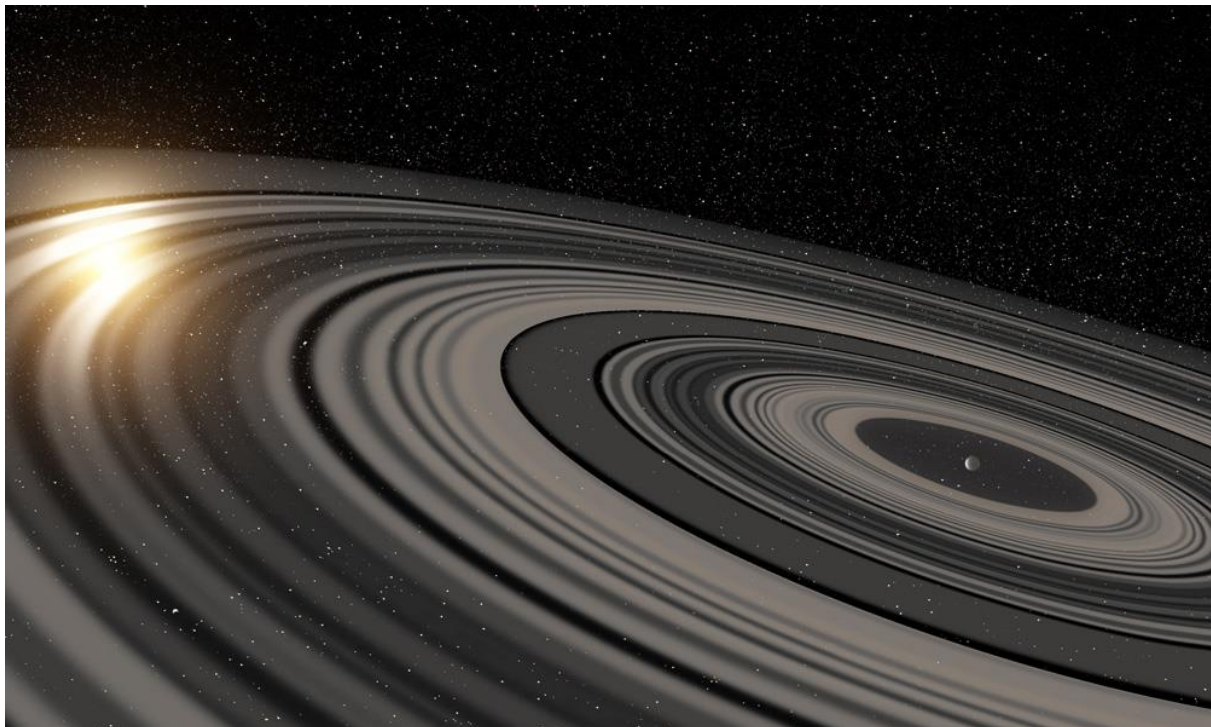
### **Astronomers have for the first time used artificial intelligence to discover exoplanets**

Fifty potential planets have had their existence confirmed by a new machine learning

algorithm developed by University of Warwick scientists - <https://arxiv.org/abs/2008.10516>

### **Gigantic ring system around J1407b**

Astronomer Eric Mamajek at the University of Rochester and his co-author from the Leiden Observatory, The Netherlands, have discovered that the ring system that they see eclipse the very young Sun-like star J1407 is of enormous proportions, much larger and heavier than the ring system of Saturn - <https://www.rochester.edu/newscenter/gigantic-ring-system-around-j1407/>



Artist's conception of the extrasolar ring system circling the young giant planet or brown dwarf J1407b. The rings are shown eclipsing the young sun-like star J1407, as they would have appeared in early 2007. Credit: Ron Miller

### **Latest count**

The [NASA Exoplanet Archive](#) lists 4292 confirmed planets as of 2020 August 10. The 100<sup>th</sup> exoplanet discovered by Microlensing was added on 2020 October 8. Details of recent discoveries are listed at

[https://exoplanetarchive.ipac.caltech.edu/docs/exonews\\_archive.html#24June20](https://exoplanetarchive.ipac.caltech.edu/docs/exonews_archive.html#24June20)

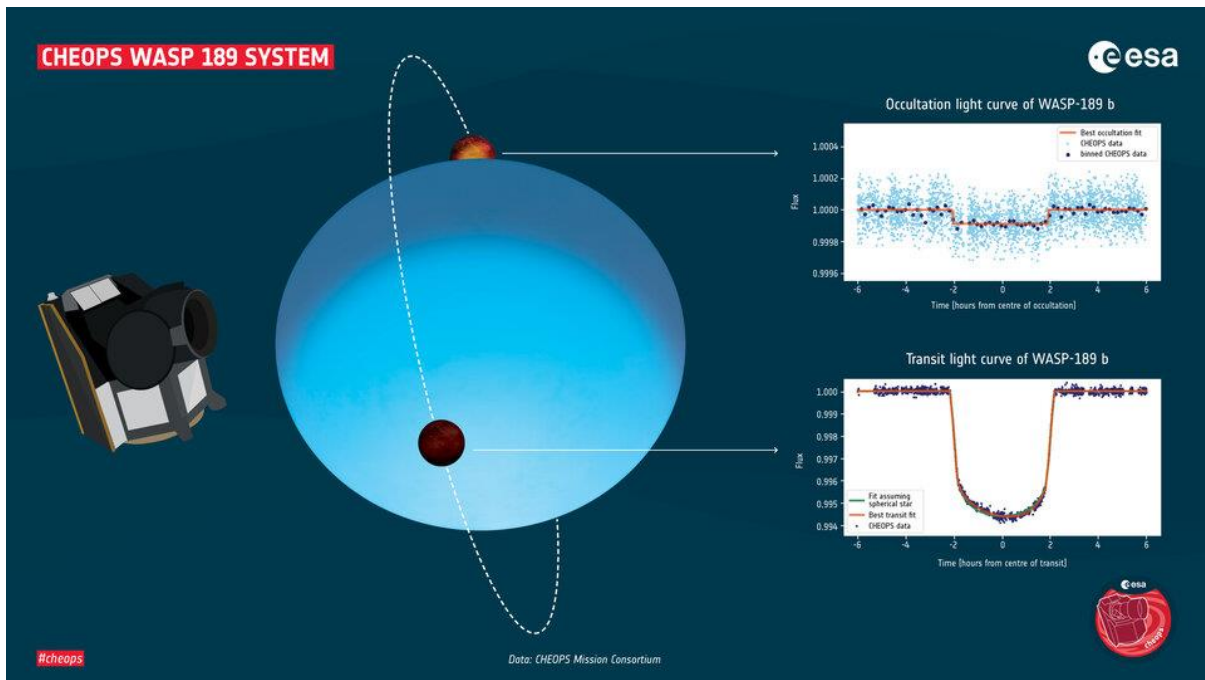
### **The Habitable Exoplanet Hunting Project**

The Habitable Exoplanet Hunting Project is the first international program coordinated by

amateur astronomers to search for habitable exoplanets. The Group includes more than 30 amateur and professional observatories located in more than 10 countries across the five continents. The first amateur discovery of an exoplanet, by this group, is described in the paper at <https://arxiv.org/ftp/arxiv/papers/2007/2007.07373.pdf>

### First results from CHEOPS

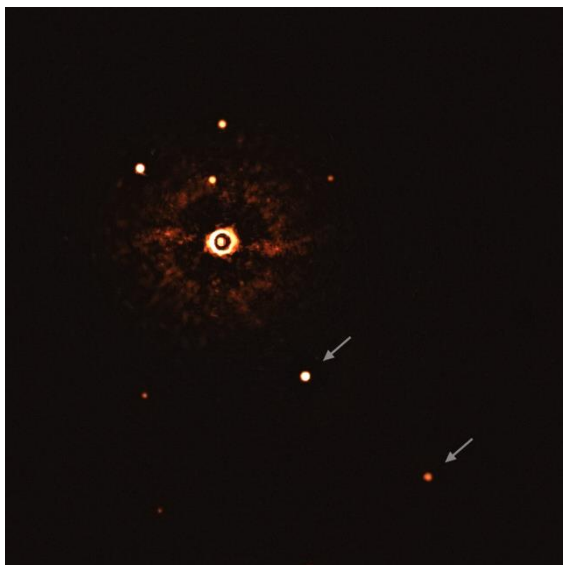
ESA's new exoplanet mission, [CHEOPS](#), has found a nearby planetary system to contain one of the hottest and most extreme extra-solar planets known to date: WASP-189 b. The finding, the very first from the mission, demonstrates Cheops' unique ability to shed light on the Universe around us by revealing the secrets of these alien worlds.



WASP-189b

Credit ESA

### TYC 8998-760-1



The European Southern Observatory's Very Large Telescope has taken the first ever image of a young, Sun-like star accompanied by two giant exoplanets. Images of systems with multiple exoplanets are extremely rare, and, until now, astronomers had never directly observed more than one planet orbiting a star similar to the Sun -

<https://www.eso.org/public/news/eso2011/?lang>

The image on the left, credit ESO, shows two stars orbiting TYC 8998-760-1

## **Exomoons**

Moons around a giant planet in the habitable zone may host life but nothing confirmed as far as I can see.

A number of possibilities are listed at;

<https://en.wikipedia.org/wiki/Exomoon#:~:text=In%20a%20later%20study%2C%20Kipping,become%20the%20first%20exomoons%20discovered.>

Recent, potential, discoveries are mentioned at <https://earthsky.org/space/astronomers-discover-6-possible-new-exomoons>

## **Stellar Activity and its effects on Small Planet Detection**

This was the title of a ZOOM talk by Professor Don Pollacco to Hampshire Astronomy Group on 2020 July 24.

He comments "As we search for smaller Earth-like planets stellar activity assumes a greater importance. For example, convection currents can produce blue and red shifts in a spectrum as the granules rise and fall on the stars surface -

[https://www.youtube.com/watch?v=W\\_Scoj4HqCQ](https://www.youtube.com/watch?v=W_Scoj4HqCQ)

Star spots can simulate a planetary transit as the host star rotates. A transit of Mercury, as seen from Earth, would give a similar signal to that of an Earth sized exoplanet transiting its host star.

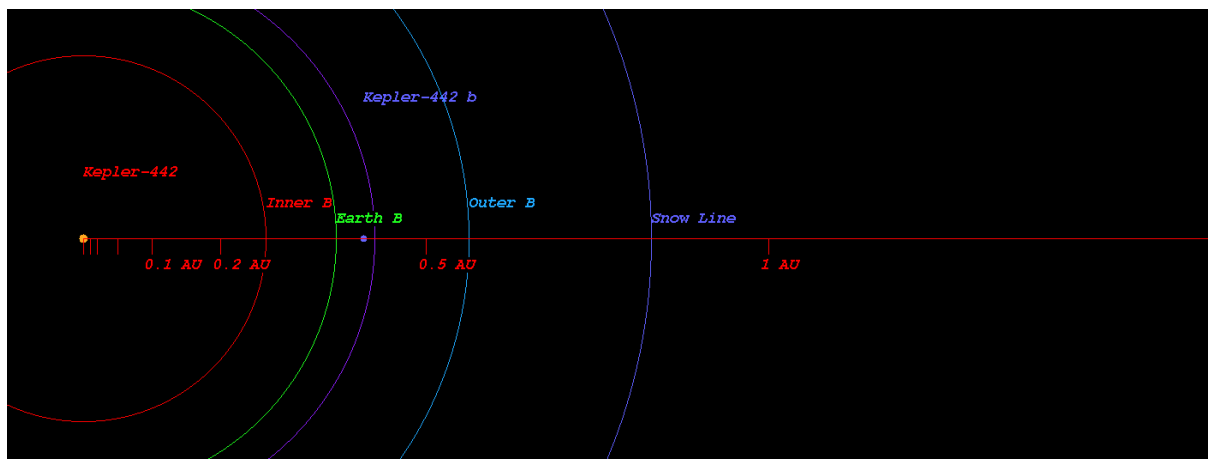
A pdf, 'Exoplanet Discovery and Characterisation' by Professor Don Pollaco can be viewed at <http://www.eso.org/sci/meetings/2010/stars2010/Presentations/3March/Pollacco.pdf>

## **Web sites of interest**

The database ExoKyoto - <http://www.exoplanetkyoto.org/?lang=en> is extremely informative. An example shown here indicates the habitable zone of the star Kepler-442 and the position of potentially habitable planet Kepler-442b.

The Star Kepler-442 's habitable zone is located at the following distance;

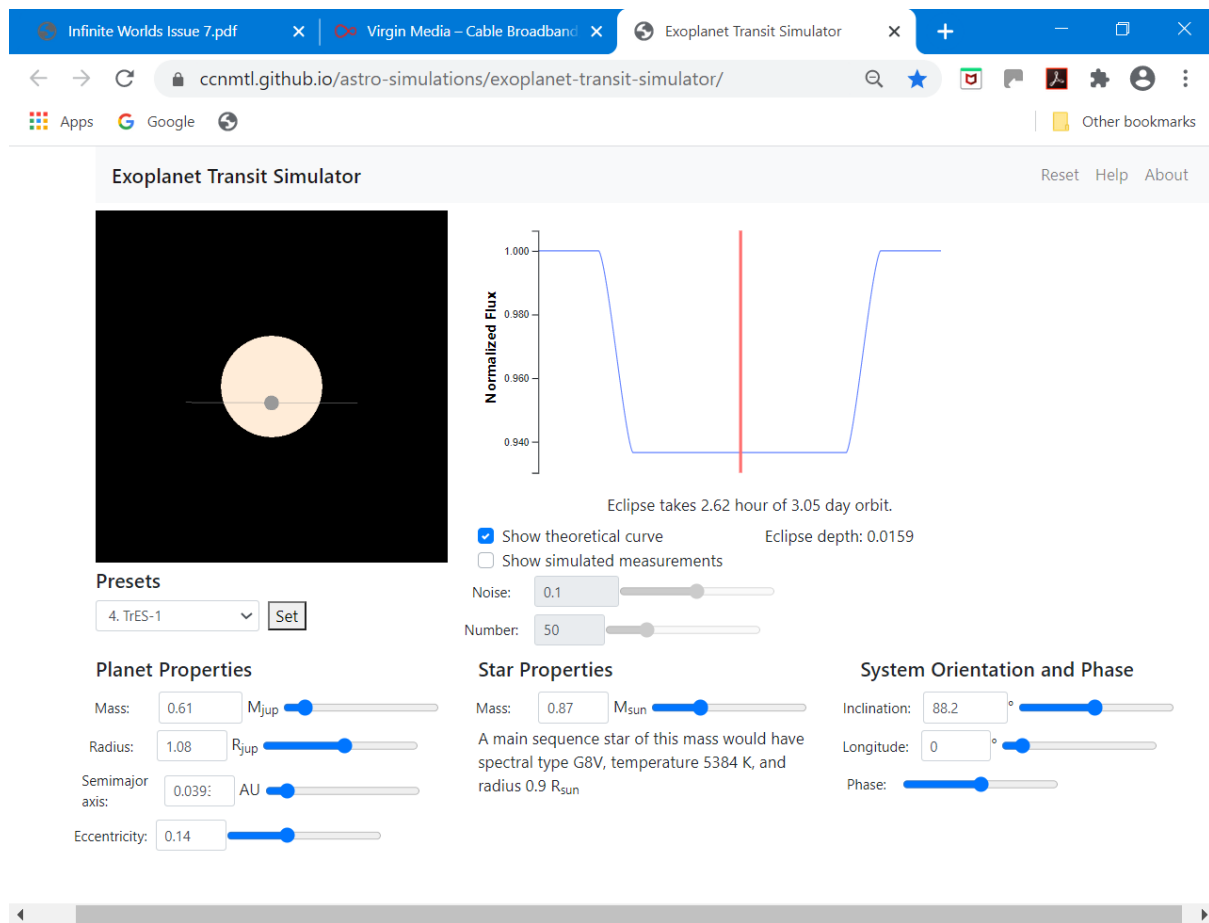
- Inner Boundary: 0.267 AU (40003466.0 km)
- Earth Boundary: 0.370 AU (55295244.2 km)
- Outer Boundary: 0.563 AU (84257715.3 km)
- Kepler-442b's orbit: 0.41 AU (61185529.1 AU)





## Exoplanet Transit Simulator

Planetary and stellar properties can be input to the simulator at <https://ccnmtl.github.io/astro-simulations/exoplanet-transit-simulator/> as shown in the example below



## Publications

Exoplanet Exploration Program Analysis Group (ExoPAG) Report to Paul Hertz Regarding Large Mission Concepts to Study for the 2020 Decadal Survey - [https://cor.gsfc.nasa.gov/docs/ExoPAG\\_Large\\_Missions.pdf](https://cor.gsfc.nasa.gov/docs/ExoPAG_Large_Missions.pdf)

The paper 'Origins of Hot Jupiters' by Dawson and Johnson - <https://arxiv.org/abs/1801.06117> Three options are discussed in the paper; in situ, migration from further out in the disk and planetary scattering

## Astrobiology

### Mars

How Mars might be terraformed. Video; Mars Making the New Earth at - <https://www.youtube.com/watch?v=50N5QoQoc4>

Related books;

- How not to do it. Sci-fi trilogy; 'Red Mars', 'Green Mars', 'Blue Mars' by Kim Stanley Robinson.
- How to do it. 'How to build a habitable planet' by Langmuir and Broecker (revised 2012 edition)

Newly discovered layers of ice buried a mile beneath Mars' north pole are the remnants of ancient polar ice sheets and could be one of the largest water reservoirs on the planet according to scientists. The layers of ice are a record of past climate on Mars in much the same way tree rings are a record of climate on Earth -

<https://www.sciencedaily.com/releases/2019/05/190522141747.htm>

ESA's Mars Express spacecraft has discovered several ponds of liquid water buried under the ice in the south polar region of Mars.

[https://www.esa.int/ESA\\_Multimedia/Videos/2020/09/Mars\\_Express\\_finds\\_more\\_underground\\_water\\_on\\_Mars](https://www.esa.int/ESA_Multimedia/Videos/2020/09/Mars_Express_finds_more_underground_water_on_Mars)

ExoMars finds new gas signatures in the Martian atmosphere -

[https://www.esa.int/Science\\_Exploration/Human\\_and\\_Robotic\\_Exploration/Exploration/ExoMars/ExoMars\\_finds\\_new\\_gas\\_signatures\\_in\\_the\\_martian\\_atmosphere](https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Exploration/ExoMars/ExoMars_finds_new_gas_signatures_in_the_martian_atmosphere)

[NASA's Perseverance Mars rover](#) will search for signs of ancient microbial life in river delta. New research indicates many of the valley networks scarring the surface of Mars were caused by water melting under glacial ice, not by free-flowing rivers -

[https://astronomynow.com/2020/08/03/sub-glacial-melting-not-flowing-rivers-may-explain-martian-channels/?utm\\_source=Astronomy+Now+Newsletter&utm\\_campaign=fc29014638-5&utm\\_medium=email&utm\\_term=0\\_e789188a36-fc29014638-151098305&mc\\_cid=fc29014638&mc\\_eid=789a337ae4](https://astronomynow.com/2020/08/03/sub-glacial-melting-not-flowing-rivers-may-explain-martian-channels/?utm_source=Astronomy+Now+Newsletter&utm_campaign=fc29014638-5&utm_medium=email&utm_term=0_e789188a36-fc29014638-151098305&mc_cid=fc29014638&mc_eid=789a337ae4)

European scientists will help select rocks and soil from Mars in the search for life on our planetary neighbour -

[https://www.esa.int/Science\\_Exploration/Human\\_and\\_Robotic\\_Exploration/Exploration/A\\_European\\_dream\\_team\\_for\\_Mars](https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Exploration/A_European_dream_team_for_Mars)

## **Venus**

The best evidence for life beyond Earth has been found in the most surprising of places – the atmosphere of Venus. A team led by Jane Greaves, who is a professor at Cardiff University, has detected the presence of phosphine gas in Venus' clouds

<https://astronomynow.com/2020/09/14/possible-evidence-found-for-life-on-venus/>

[https://www.planetary.org/articles/venus-phosphine-biosignature?autologin=true&utm\\_campaign=downlink&utm\\_medium=email&utm\\_source=20200918&s\\_src=downlink&s\\_subsrc=20200918](https://www.planetary.org/articles/venus-phosphine-biosignature?autologin=true&utm_campaign=downlink&utm_medium=email&utm_source=20200918&s_src=downlink&s_subsrc=20200918)

<https://www.youtube.com/watch?v=pHCEBlpBdMo>

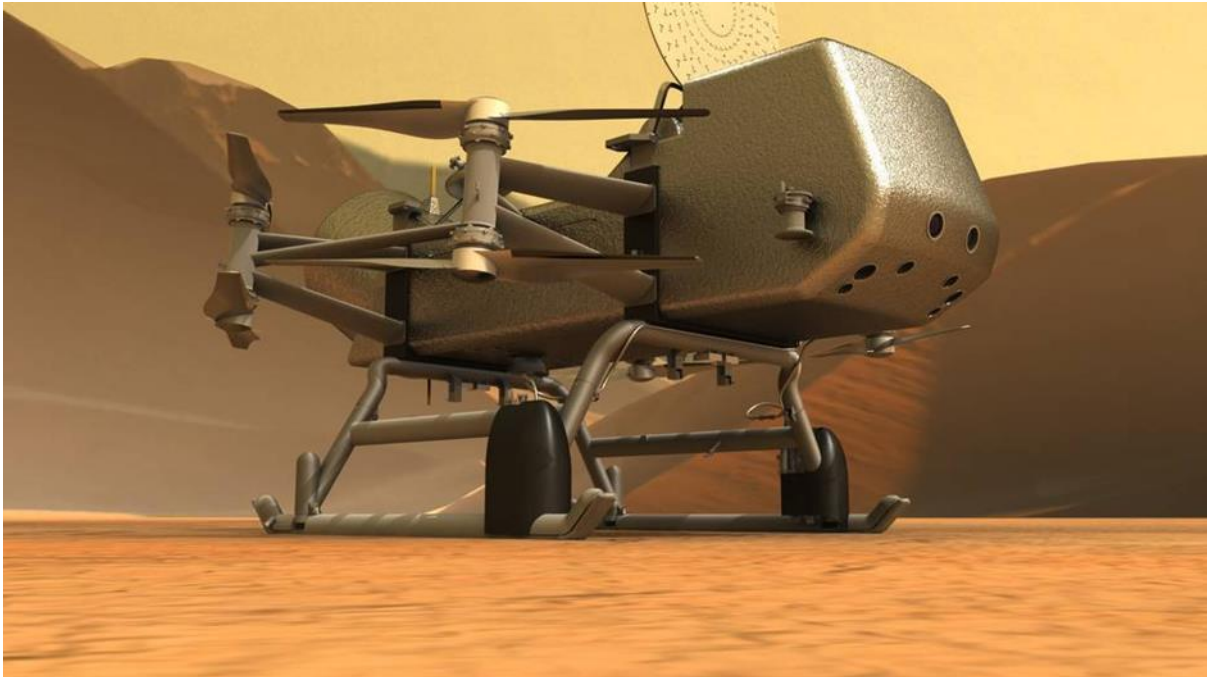
## **Juice mission to Jupiter's icy moons**

Video 'What Saturn's moon, Titan, could teach us about the origins of life' -

[https://www.ted.com/talks/elizabeth\\_zibi\\_turtle\\_what\\_saturn\\_s\\_most\\_mysterious\\_moon\\_could\\_teach\\_us\\_about\\_the\\_origins\\_of\\_life?utm\\_source=recommendation&utm\\_medium=email&utm\\_campaign=explore&utm\\_term=newest-talks-6](https://www.ted.com/talks/elizabeth_zibi_turtle_what_saturn_s_most_mysterious_moon_could_teach_us_about_the_origins_of_life?utm_source=recommendation&utm_medium=email&utm_campaign=explore&utm_term=newest-talks-6) NASA's Dragonfly — a robotic rotorcraft-lander that's designed to hop across the surface of an extra-terrestrial body — is set to voyage deep into the solar system to explore Titan, Saturn's largest moon, in 2026.

Planetary scientist Elizabeth Turtle shares how studying this mysterious moon that's thought to resemble the early Earth could bring us closer to understanding the habitability of other planets — and the origin of life itself.

NASA is pushing back the launch date for [Dragonfly](#), a flying spacecraft that will explore Saturn's moon Titan. Dragonfly was originally scheduled to launch in 2026 but will now blast off in 2027.



Artist's Impression of Dragonfly on Titan's surface

Credits: NASA/Johns Hopkins APL

### **British Interplanetary Society Astrobiology lecture**

A brief history of Astrobiology is highlighted in this talk by Michael Franks, – recorded on 2020 July 13 - <https://www.youtube.com/watch?v=-IAgVchSgS4&feature=youtu.be> It starts with the first astrobiologist Giordano Bruno who was a contemporary of Galileo. Bruno taught that there was a multitude of life on many worlds. Bruno was burnt at the stake.

It then moves onto “What is Life?” analysing the definition used by NASA and considers the Drake Equation – how many intelligent civilisations there may be in the Galaxy. The Fermi Paradox is addressed and why, if the Universe has existed of over 13 billion years, and contains billions of worlds, we have not detected any signs of alien intelligence.

The talk finally considers whether life can be found in other places in the Solar System such as the moons of Jupiter and the other outer planets and how we might find life on exoplanets.

### **Meet the experts, ESA video – Extreme Life**

Microbial life is known to survive in all sorts of extreme environments by going into a dormant state. Could they have survived long trips around our galaxy to seed life on Earth? Astrobiologist Nicol Caplin talks extreme life in this episode of Meet The Experts.

[https://www.esa.int/ESA\\_Multimedia/Sets/Meet\\_the\\_ESA\\_experts/\(result\\_type\)/videos](https://www.esa.int/ESA_Multimedia/Sets/Meet_the_ESA_experts/(result_type)/videos)

Note; Please scroll down the web page to access this video

### **Extra-terrestrials**

Why they're almost certainly out there by Chris Crowe -

<https://www.youtube.com/watch?v=9NrpFi2lpfk>

Our galaxy is home to billions of habitable planets. Chris Crowe guides us through the heavens on a journey to explore how many Earth-like planets our Universe contains. By

examining the latest exoplanet discoveries, he conveys his confidence that they're definitely out there somewhere

Chris Crowe is an astrophysicist, teacher and public lecturer. A Fellow of the Royal Astronomical Society, he received his Masters' degrees in both Theoretical Physics and Mathematics before completing a PhD in Astrophysics

### **Is there life on Naknar Three** (not to be taken too seriously)

This is a lecture Professor Charles Cockell gives each year to his undergraduate astrobiology students at the end of their course. It's a lecture by an alien about a distant world, Naknar3, which turns out to be a familiar place.... In the lecture, the alien explains why it can't possibly be a location for complex life, let alone intelligence. It invites his students to think about our assumptions on habitability and life and whether these assumptions are right.

The lecture is designed to give the impression that our views of life are narrow. However, can sulphate reduction really power an intelligence? Would an alien really conclude that low UV radiation would be bad for life? Perhaps, after all, we are not so wrong in the way in which we assess the habitability of other planets. What do you think?

### **Space – stepping stones to other star systems**

My thanks to Steve Knight, Hampshire Astronomical Group, for links to a number of the videos mentioned here.

### **The Moon**

NASA's Artemis mission to the Moon - <https://www.youtube.com/watch?v=qMMguZLZxhk>

NASA's Artemis plan to land first woman, next man on Moon in 2024

<https://www.nasa.gov/press-release/nasa-publishes-artemis-plan-to-land-first-woman-next-man-on-moon-in-2024/>

### **Blue Origin – New Shepherd**

Launched on 2020 October 13 - tested key technologies, the Deorbit, Descent, and Landing Sensor Demonstration, for NASA's return to the Moon -

<https://www.blueorigin.com/news/new-shepard-mission-ns-13-launch-updates>



## Mars

One very small step on the road to Mars – on 2020 August 4th ground crews at the SpaceX launch facility in Boca Chica, Texas, accomplished a major milestone. After 11 months of prototyping, testing, and more than a few explosions, the fifth Starship prototype (SN5) successfully completed a 150 meter (~500 ft) hop test and landed safely again. This latest test puts SpaceX on track towards full-scale orbital testing of their future launch vehicle - <https://www.universetoday.com/147321/finally-spacex-starship-prototype-sn5-flies-just-over-150-meters-into-the-air/>

Is Elon Musk planning to send elephants to Mars? Watch this video to find out - <https://www.youtube.com/watch?v=-kU6fMGh4I4>

What will SpaceX do when they get to Mars ? From how they would even get there, to what the steps would be to make a full colony – this video reveals what SpaceX would do if they were to get to Mars. <https://www.youtube.com/watch?v=AtK-ieNwYmw>

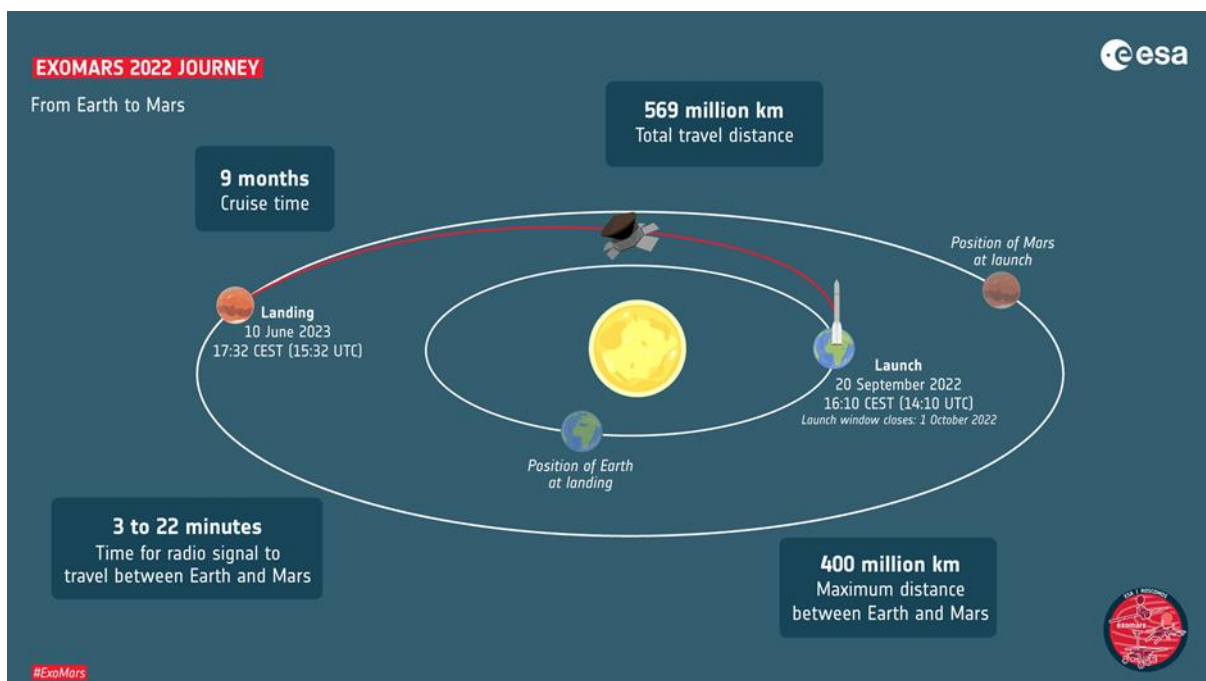
Emirates Mars mission - <https://www.emiratesmarsmission.ae/> and [https://www.planetary.org/explore/space-topics/space-missions/hope.html?autologin=true&utm\\_campaign=downlink&utm\\_medium=email&utm\\_source=20200724](https://www.planetary.org/explore/space-topics/space-missions/hope.html?autologin=true&utm_campaign=downlink&utm_medium=email&utm_source=20200724)

The Emirates Mars Mission "Hope Probe" will be the first probe to provide a complete picture of the Martian atmosphere and its layers when it reaches the red planet's orbit in 2021. It will help answer key questions about the global Martian atmosphere and the loss of hydrogen and oxygen gases into space over the span of one Martian year.

ESA's ExoMars 2022

The path from Earth to the Red Planet is set -

[https://www.esa.int/Science\\_Exploration/Human\\_and\\_Robotic\\_Exploration/Exploration/ExoMars/The\\_way\\_forward\\_to\\_Mars](https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Exploration/ExoMars/The_way_forward_to_Mars)



From Earth to Mars

Credit ESA

China launched its first rover to Mars, known as Tianwen-1, on 2020 July 23

[https://www.planetary.org/explore/space-topics/space-missions/tianwen-1.html?autologin=true&utm\\_campaign=downlink&utm\\_medium=email&utm\\_source=20200724](https://www.planetary.org/explore/space-topics/space-missions/tianwen-1.html?autologin=true&utm_campaign=downlink&utm_medium=email&utm_source=20200724) .

Planetary Society's guide to the 2020 July Mars launches plus a guide to Mars and every Mars mission -

[https://www.planetary.org/articles/mars2020?autologin=true&utm\\_campaign=downlink&utm\\_medium=email&utm\\_source=20200731&s\\_src=downlink&s\\_subsrc=20200731](https://www.planetary.org/articles/mars2020?autologin=true&utm_campaign=downlink&utm_medium=email&utm_source=20200731&s_src=downlink&s_subsrc=20200731)

### **Beyond**

The prospect of interstellar travel is no longer sci-fi and how it could be achievable within our lifetime is described on this video. Options for interstellar travel - from traditional rocket fuel to antimatter drives are suggested for travel to other star systems? - 'Five real possibilities for interstellar travel' - <https://www.youtube.com/watch?v=EzZGPCyrpSU>

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2020 October add date