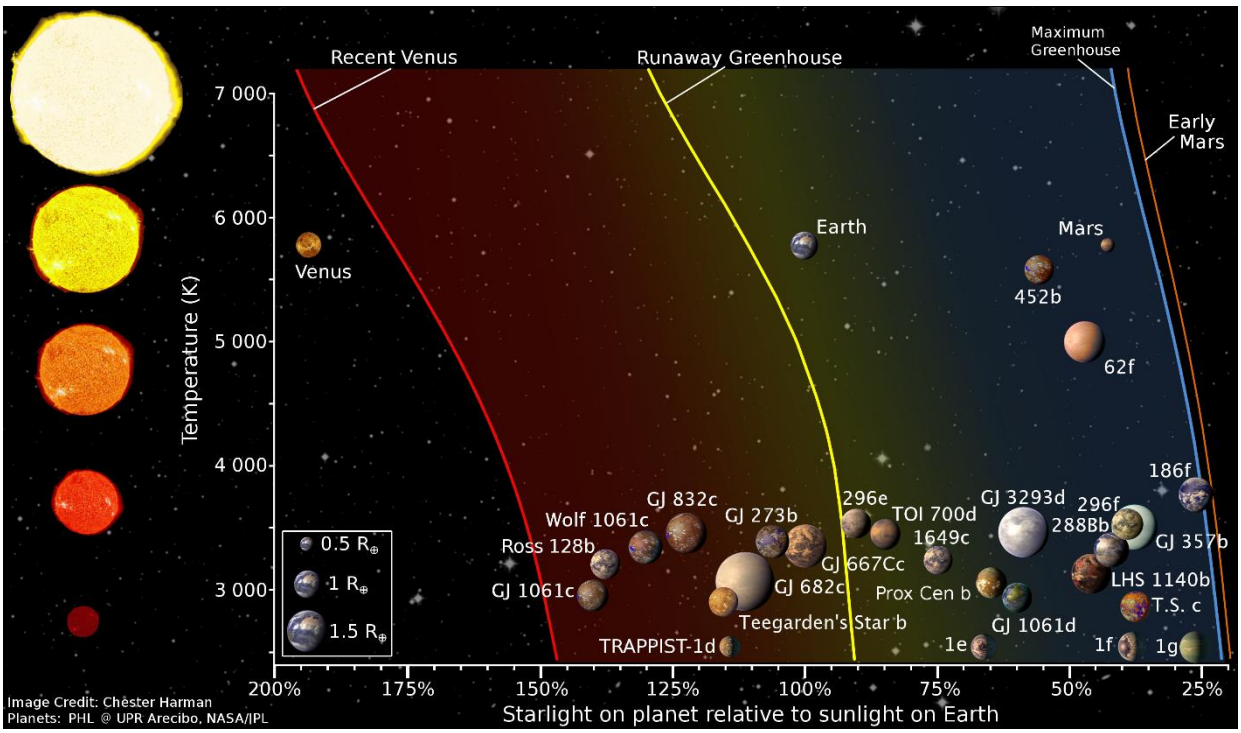
British Astronomical Association
Supporting amateur astronomers since 1890

Infinite Worlds

The e-magazine of the

Exoplanets Division
of the
Asteroids and Remote Planets Section



Habitable Zones for 1 Earth mass planet Credit Ravi Kumar Kopparapu

Issue 20 2023 October

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Section officers

ARPS Section Director	Dr Richard Miles
Assistant Director (Occultations)	Tim Haymes
Assistant Director (Exoplanets)	Roger Dymock

Exoplanet Technical Advisory Group (ETAG)

Simon Downs, Steve Futcher, Paul Leyland, David Pulley, Mark Salisbury, Americo Watkins

Exoplanets Division website

Variations on an exoplanet theme

The Exoplanet Division held an all-day on-line meeting on 2023 September

Saturday 30th Sep 2023. The speakers and their topics are listed below.

Videos of all the presentation are available on the meeting page

Introduction and Overview - Roger Dymock (Assistant Director BAA Exoplanet Division)

A summary of the many types of, and reasons for, transit variations plus some of the observatories participating in exoplanet observation

Introduction – Rodney Buckland (OU Tutor)

Exoplanet Transit Timing Variations: a key to unlocking

the secrets of stellar systems – Heidi Hodkinson In researching the evolution of analytic and numerical TTV analysis methods, Heidi considers whether pro-am collaboration could contribute to the process of TTV analysis.

Stellar variability – Professor Don Pollacco

All stars show signs of activity and these can seriously affect transit and radial velocity measurements. For under sampled transit light curves this can have a negative effect on timing precision and any modelling. For the characterization of small planets (both bulk and atmospheric measurements) activity will be the limiting factor. Here, we'll look at the causes and effects of activity and ongoing mitigation techniques.

Computational Modelling of Transit Timing Variations – Jack Lloyd-Walters

Applications of Python in the Simulation of Transit Timing Variation, Analytical Approximations of TTV Models, and Model Fitting of Exoplanetary Systems by Parameter Optimisation.

Analysis of periodic variations in exoplanet observations and an example in KELT-9b - Stephen Mills

The Generalised Lomb-Scargle periodogram is a powerful tool for spotting periodic variations in data. Stephen has applied this tool to ExoClock Data Release 3 and discusses the tool and the periodic variations found, in particular those found in KELT-9b.

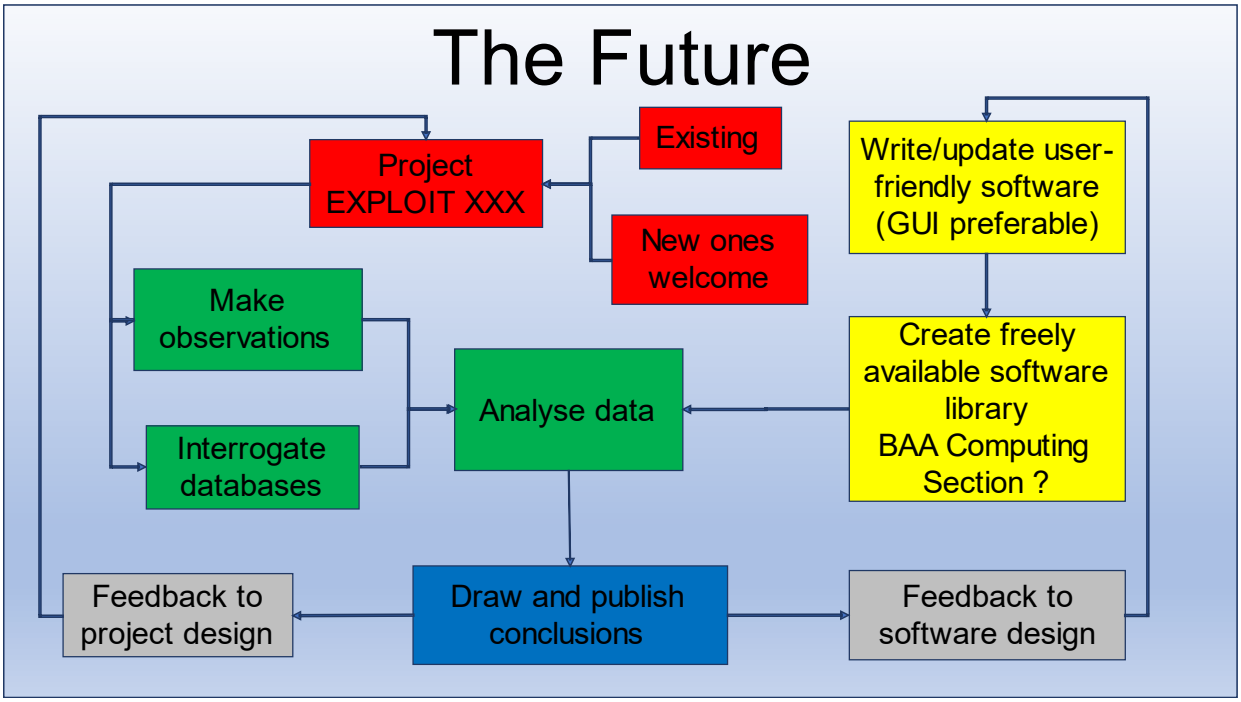
Determining the potential habitability of transiting exoplanets – Emily Peters

In researching theories about the radius and width of habitable zones around stars, Emily has considered the habitability of three 'hot Jupiters' using 1D climate models and evaluated the impact of orbital parameters on exoplanet habitability.

What next? – Rodney Buckland, Roger Dymock

Some preliminary thoughts to be progressed by Rodney Buckland and myself and whoever may wish to contribute.

1) Objective is to expand our activities by not only observing transits but also interpreting the variations so recorded.
2) In addition the Habitable Zone calculator/software will be of use to those interested in astrobiology and will benefit from a better understanding of exoplanet orbits e.g. eccentricity determined by TTV analysis.
3) We also need to consider how to attract new members whether interested in observing or analysis or both.
4) For new observers may need to suggest equipment needed and how to record a transit – much info on Exoplanet and ExoClock websites

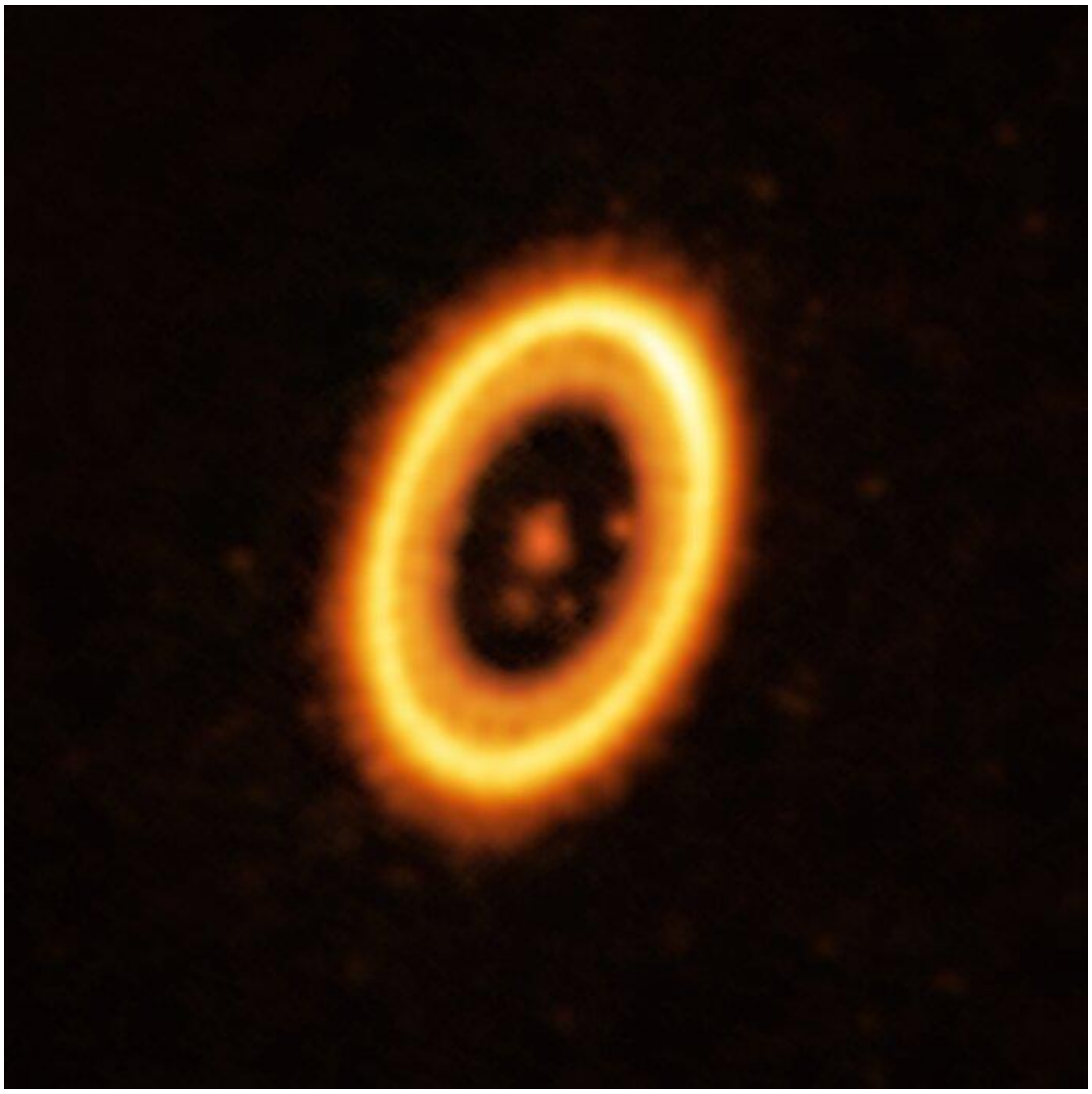


News

Today's score from the NASA Exoplanet Archive, Exoplanet and Candidate Statistics

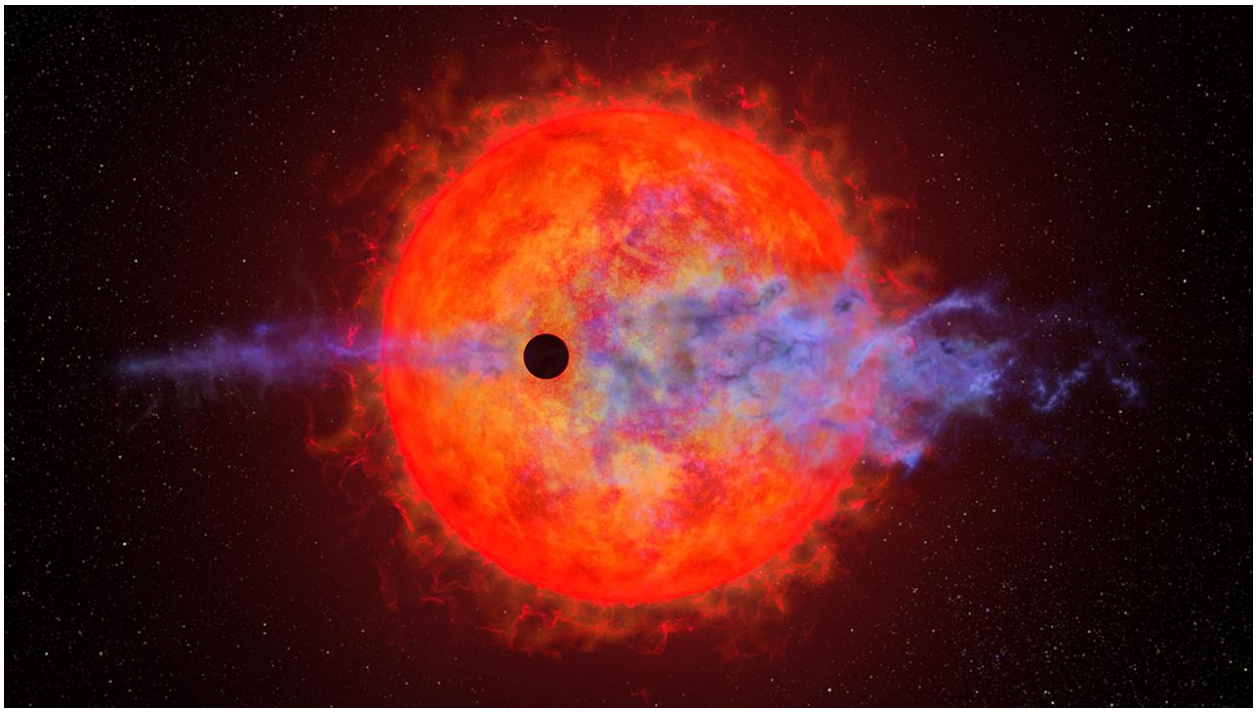
Total conformed exoplanets;	5523
Kepler candidates yet to be confirmed;	1984
K2 candidates yet to be confirmed;	977
TESS candidates yet to be confirmed;	4539

A planet and its Trojan orbiting a star in the PDS 70 system



The above image, credit ALMA (ESO/NAOJ/NRAO) /Balsalobre-Ruza et al., taken with the Atacama Large Millimeter/submillimeter Array (ALMA), in which ESO is a partner, shows the young planetary system PDS 70, located nearly 400 light-years away from Earth. The system features a star at its centre, around which the planet PDS 70b is orbiting. On the same orbit as PDS 70b, astronomers have detected a cloud of debris that could be the building blocks of a new planet or the remnants of one already formed. The ring-like structure that dominates the image is a circumstellar disc of material, out of which planets are forming. There is in fact another planet in this system: PDS 70c, seen at 3 o'clock right next to the inner rim of the disc.

Hubble detects exoplanet AU Mic-b losing its atmosphere



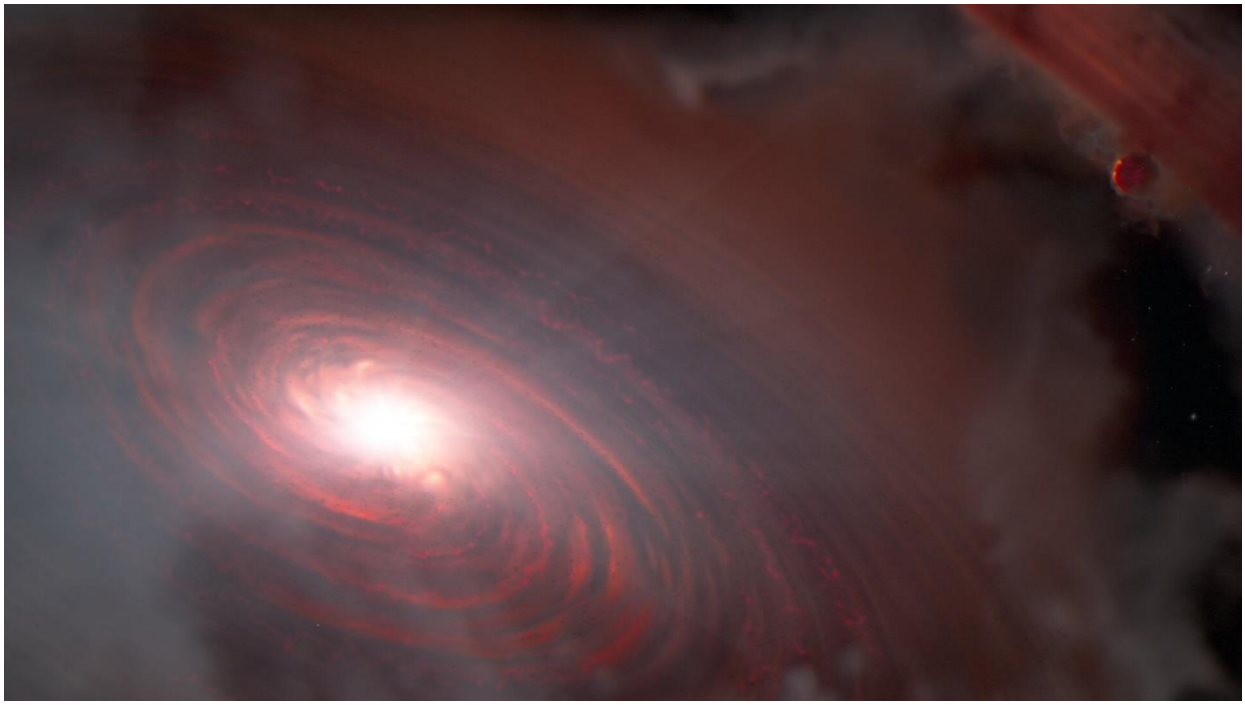
This artist's illustration, above, shows a planet (dark silhouette), AU Microscopii b, passing in front of its host red dwarf star. The planet is so close to the eruptive star a ferocious blast of stellar wind and blistering ultraviolet radiation is heating the planet's hydrogen atmosphere, causing it to escape into space. Four times Earth's diameter, the planet is slowly evaporating its atmosphere, which stretches out linearly along its orbital path. This process may eventually leave behind a rocky core. The illustration is based on measurements made by the Hubble Space Telescope.

First Confirmed Image of Newborn Planet Caught with ESO's VLT

SPHERE, a planet-hunting instrument on ESO's Very Large Telescope, has captured the first confirmed image of a planet caught in the act of forming in the dusty disc surrounding a young star. The young planet is carving a path through the primordial disc of gas and dust around the very young star PDS 70. The data suggest that the planet's atmosphere is cloudy.

Webb detects water vapour in rocky planet-forming zone

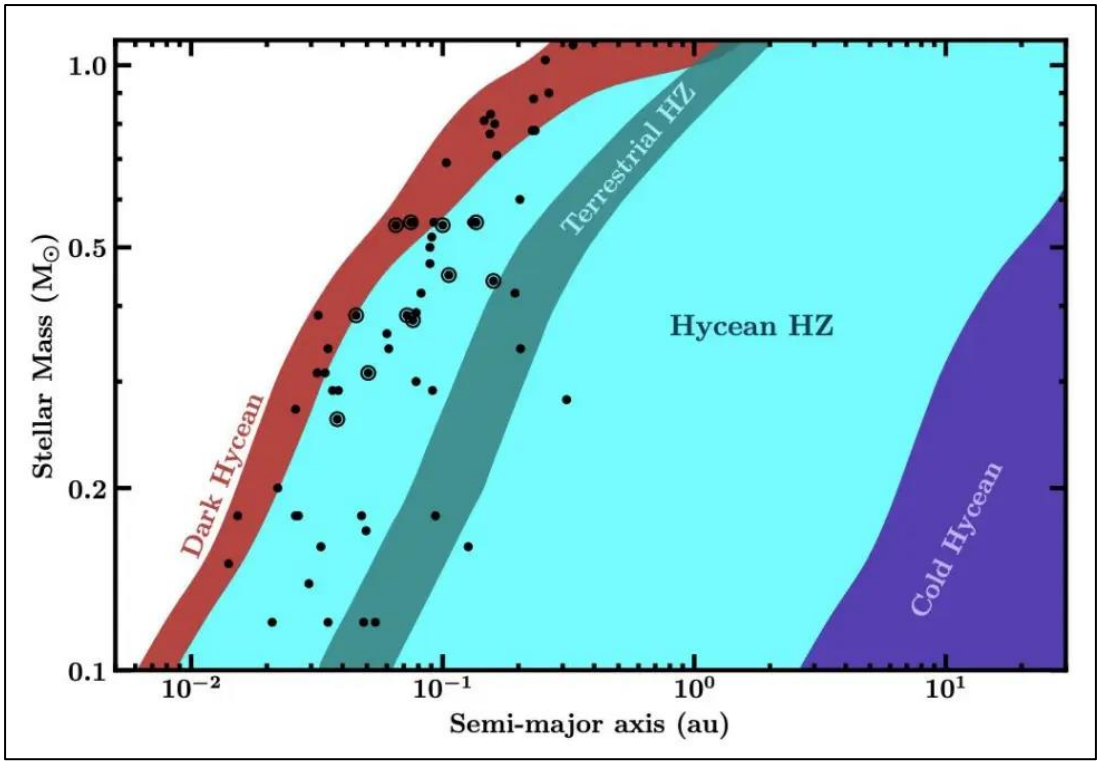
New measurements by the NASA/ESA/CSA James Webb Space Telescope's Mid-InfraRed Instrument (MIRI) has detected water vapour in the inner disc of the system PDS 70, located 370 light-years away. This is the first detection of water in the terrestrial region of a disc already known to host two or more protoplanets.



PDS 70 (artist concept)

Webb discovers methane and carbon dioxide in atmosphere of K2-18 b

A new investigation by an international team of astronomers using data from the NASA/ESA/CSA James Webb Space Telescope into K2-18 b, an exoplanet 8.6 times as massive as Earth, has revealed the presence of carbon-bearing molecules including methane and carbon dioxide. The discovery adds to recent studies suggesting that K2-18 b could be a Hycean exoplanet, one which has the potential to possess a hydrogen-rich atmosphere and a water ocean-covered surface.



Hycean characteristics Credit Nikku Madhusudhan et al

Conferences/Meetings/Seminars/Webinars/Videos

Publications

Paper; Hunting for exoplanets via magnetic star-planet interactions: geometrical considerations for radio emission

Recent low-frequency radio observations suggest that some nearby M dwarfs could be interacting magnetically with undetected close-in planets, powering the emission via the electron cyclotron maser (ECM) instability. Confirmation of such a scenario could reveal the presence of close-in planets around M dwarfs, which are typically difficult to detect via other methods. ECM emission is beamed, and is generally only visible for brief windows depending on the underlying system geometry.

Paper; Exponential distance relation (aka Titius-Bode law) in extra solar planetary systems

In this paper we present phenomenological evidence for the validity of an exponential distance relation (also known as generalized Titius-Bode law) in the 32 planetary systems (31 extra solar plus our Solar System) containing at least 5 planets or more.

Astrobiology and the search for life elsewhere

Exoplanet terminator zones

Are exoplanet 'terminator zones' a lead in the search for life?
In the search for extraterrestrial life, the study of so-called “terminator zones” on exoplanets is becoming more advanced. So far, the search for life as we know it has been largely associated with identifying Earth-like worlds. Exoplanets with terminator zones, on the other hand, are worlds with drastically different temperatures on either side of the planet. These unusual worlds of extremes may challenge our traditional understanding of habitability.

Some exoplanets are tidally locked with their parent star, meaning they rotate at just the right speed to always have the same side pointing at the star as they orbit. Tidal locking (also called synchronous rotation) can create a stationary band on the planet’s surface that’s referred to as the terminator zone: a line separating the scorching — sometimes even volcanic — dayside from the glacial nightside of the exoplanet. Studies of terminator zones have, so far, primarily focused on planets tidally locked with M-dwarf stars, which are significantly dimmer than our own Sun.

Alien life in Universe: Scientists say finding it is 'only a matter of time'

BBC – by Pallab Ghosh, Science Correspondent. Many astronomers are no longer asking whether there is life elsewhere in the Universe. The question on their minds is instead: when will we find it? Many are optimistic of detecting life signs on a faraway world within our lifetimes - possibly in the next few years. And one scientist, leading a mission to Jupiter, goes as far as saying it would be "surprising" if there was no life on one of the planet's icy moons.

Other exoplanet related webpages on the BBC website

Publications

New publications which can be accessed at **National Academies – Science Engineering and Medicine** – free pdf downloads

- Recapturing a Future for Space Exploration: Life and Physical Sciences Research for a New Era

- Pathways to Exploration: Rationales and Approaches for a U.S. program of Human Space Exploration

Web sites of interest

The Planetary Society – Planetary Radio

The Planetary Society's weekly podcast take you to the outer reaches of the Solar System and beyond. Host Sarah Al-Ahmed visits with scientists, engineers, mission leaders, astronauts, advocates, and writers who provide their unique and exciting perspectives on the exploration of our universe. New episodes are published every Wednesday.

Some recent episodes (each 50-60 mins long)

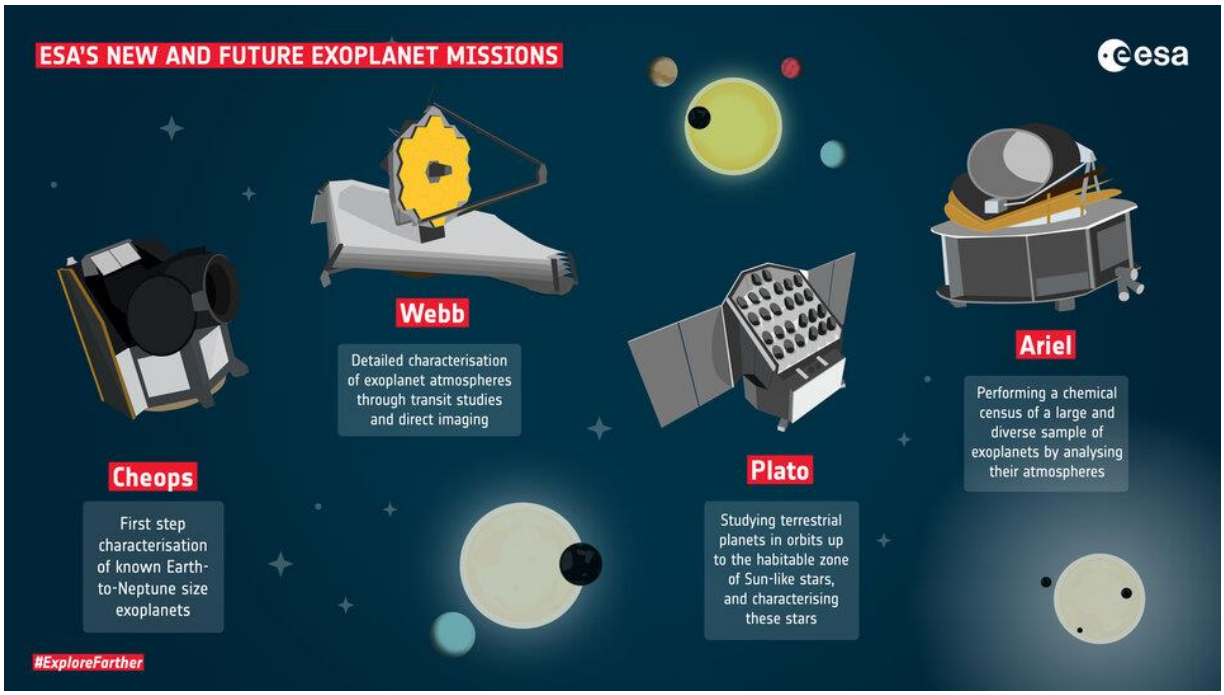
- Subsurface oceans: The hidden potential of Earth-like exoplanets
- JWST detects water vapor in a planet-forming disk
- Mars Life Explorer: The search for extant life on the red planet
- Humans to Mars by the 2030s? NASA Associate Administrators weigh in

Space missions

Ariel passes major milestone

Ariel, ESA's next-generation mission to observe the chemical makeup of distant exoplanets, has passed a major milestone after successfully completing its payload Preliminary Design Review (PDR). The successful completion of the payload PDR marks a crucial step forward for Ariel, demonstrating that the mission's payload design meets all the required technical and scientific specifications, and no holdups were found for the foreseen launch in 2029.The Ariel payload will consist of an integrated suite comprising the telescope, the Ariel infrared spectrometer (AIRS),

and the Fine Guidance System (FGS) module, along with the necessary supporting hardware and services.



Space – stepping stones to other star systems

Terrae Novae 2030+ Strategy Roadmap

The mission of the Terrae Novae exploration programme is to lead Europe's human journey into the Solar system using robots as precursors and scouts, and to return the benefits of exploration back to society. Terrae Novae has the literal meaning of the 'New Worlds' that encompasses the three ESA exploration destinations: Low Earth Orbit (LEO), Moon and Mars. It evokes the spirit of new discoveries, new ambitions, new science, new inspiration, and new challenges. It symbolises the constant quest for technological, process and procurement innovations that result in new and better ways to deliver the programme. It also reflects the aspiration to actively reach out to new partners from beyond the space sector and enlarge the space ecosystem to the commercial sphere.

The Moon

Animation showing the Orion spacecraft, powered by the European Service Module-4, with I-Hab for the Gateway. The mega Moon rocket SLS will propel four astronauts inside Orion to the Moon on Artemis IV as well as deliver the I-Hab module to the lunar Gateway. The international habitat or, I-Hab for short, is one of

ESA’s many contributions to the lunar Gateway – an outpost that will orbit the Moon as part of the Artemis programme.

Mars

Austrian Space Forum

The Austrian Space Forum is one of the leading institutions conducting Mars analogue missions, thus paving the way for the future human exploration of the Red Planet. Experts from a broad variety of disciplines as well as the spaceflight sector constitute the core of the OeWF’s continued endeavour. The OeWF in collaboration with national and international institutions from science and industry is working at the cutting edge of scientific research. In addition the OeWF also contributes significantly to inspiring and educating young people in the sectors of science, technology and engineering.

How you can contribute

As a Citizen Science organization we offer the possibility to volunteer for our Mars simulations. In particularly in the Mission Support Center, people from various backgrounds (flight controllers, media, flight planners, IT…) help to make the simulations a success.

Roger Dymock
ARPS Assistant Director Exoplanets