British Astronomical Association
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Infinite Worlds

The e-magazine of the

Exoplanets Division
of the
Asteroids and Remote Planets Section

Issue 21 **2024 January**

Contents

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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. Videos of the meeting can be viewed here

Software tutorial

A software tutorial, on-line meeting is scheduled for 2024 February 10. A selection of user-friendly software packages mentioned at the 2023 September 30 mtg will be presented in greater detail. These will cover Transit Timing and Depth variations and Habitable Zone determination.

News

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

Total confirmed exoplanets;	5566
Kepler candidates yet to be confirmed;	1984
K2 candidates yet to be confirmed;	977
TESS candidates yet to be confirmed;	4595

Exomoons

Paper – The "Drake equation of exomoons" – a cascade of formation, stability and detection

After 25 years of the prediction of the possibility of observations, and despite the many hundreds of well-studied transiting exoplanet systems, we are still waiting for the announcement of the first confirmed exomoon.

Article - Large exomoons unlikely around Kepler-1625 b and Kepler-1708 b

There are more than 200 moons in our Solar System, but their relatively small radii make similarly sized extrasolar moons very hard to detect with current instruments. The best exomoon candidates so far are two nearly Neptune-sized bodies orbiting the Jupiter-sized transiting exoplanets Kepler-1625 b and Kepler-1708 b, but their existence has been contested.

Rogue planets

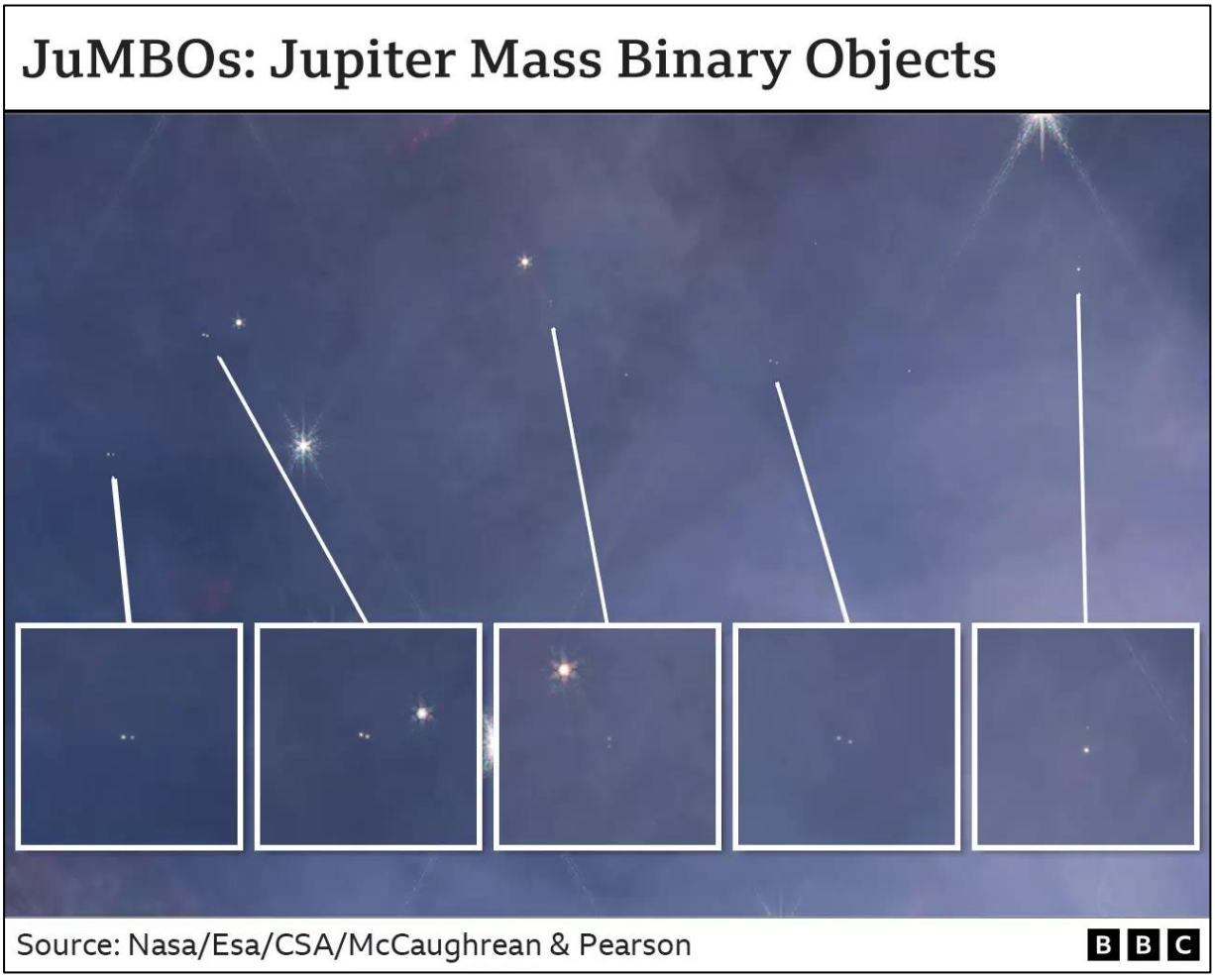
These are free floating planets not part of a stellar system.

[James Webb telescope makes 'JuMBO' discovery of planet-like objects in Orion]

Jupiter-sized "planets" free-floating in space, unconnected to any star, have been spotted by the James Webb Space Telescope (JWST). What's intriguing about the discovery is that these objects appear to be moving in pairs. Astronomers are currently struggling to explain them. The telescope observed about 40 pairs in a fabulously detailed new survey of the famous Orion Nebula. They've been nicknamed Jupiter Mass Binary Objects, or "JuMBOs" for short.

[ESO telescopes help uncover largest group of rogue planets yet]

Rogue planets are elusive cosmic objects that have masses comparable to those of the planets in our Solar System but do not orbit a star, instead roaming freely on their own. Not many were known until now, but a team of astronomers, using data from several European Southern Observatory (ESO) telescopes and other facilities,



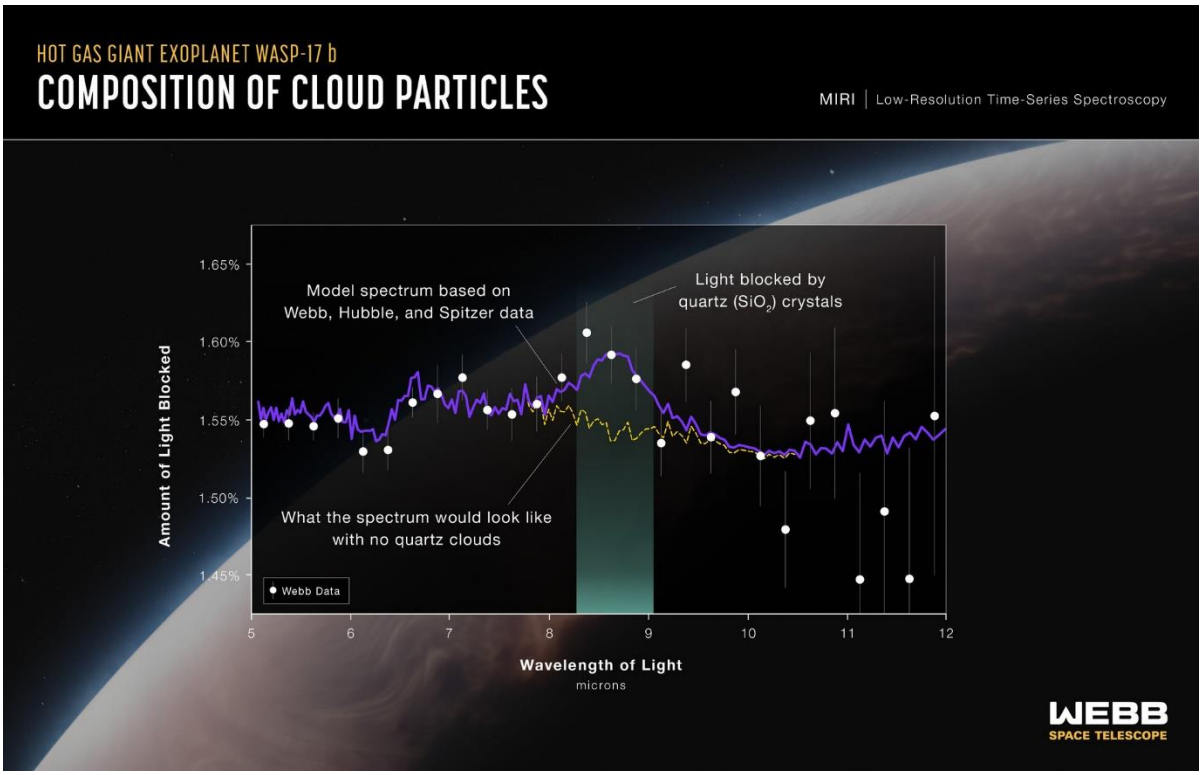
have just discovered at least 70 new rogue planets in our galaxy. This is the largest group of rogue planets ever discovered, an important step towards understanding the origins and features of these mysterious galactic nomads.

Webb spots quartz crystals in clouds of exoplanet WASP-17b

Below is a transmission spectrum of the hot gas giant exoplanet WASP-17 b captured by the NASA/ESA/CSA James Webb Space Telescope's innovative Mid-Infrared Instrument (MIRI) on 12–13 March 2023. It reveals the first evidence for quartz (crystalline silica, SiO2) in the clouds of an exoplanet. This marks the first time that SiO2 has been identified in an exoplanet, and the first time any specific cloud species has been identified in a transiting exoplanet.

Two worlds have ended in a planetary collision – and a new one has begun

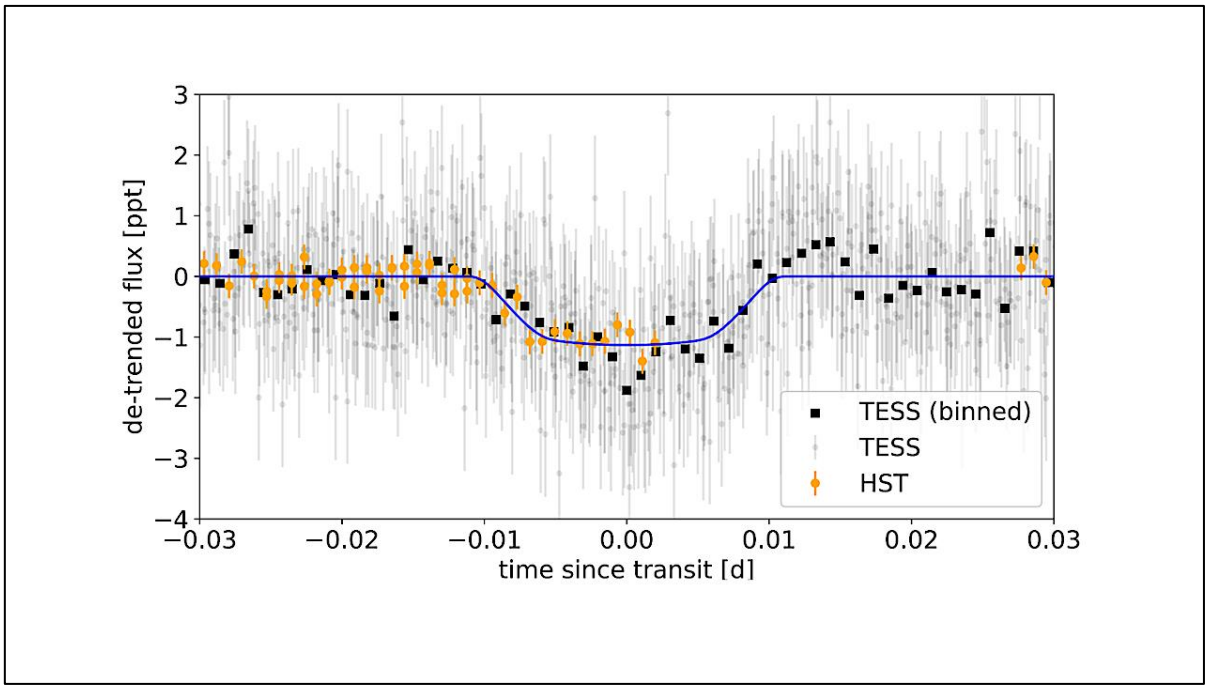
Astronomers have caught two infant worlds slamming together around a young, Sun-like star more than 1,800 light-years away in the constellation Puppis. The impact probably vaporized both planets, creating a huge cloud of debris that still orbits the host star. Ultimately, the vaporized material will settle to form a new, much larger world — and astronomers are watching it all as it happens.



Debris cloud

Hubble measures the size of the nearest transiting Earth-sized planet

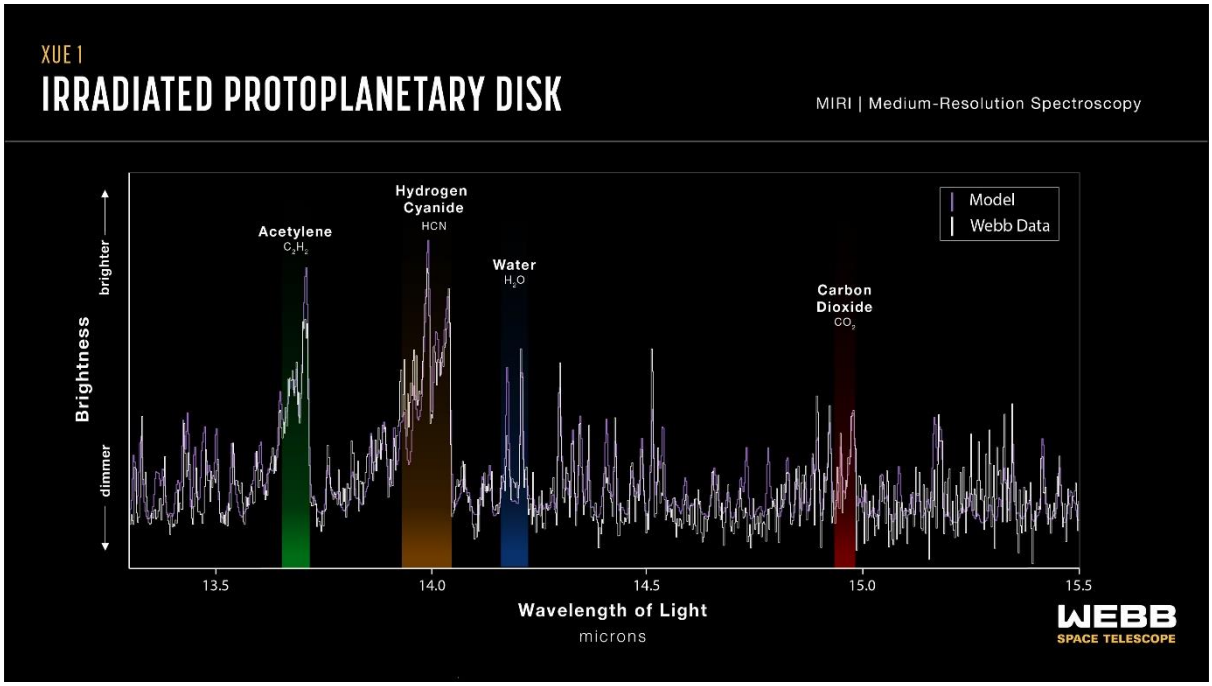
The NASA/ESA Hubble Space Telescope has measured the size of the nearest Earth-sized exoplanet using the transit method – light curve below. The planet, LTT 1445Ac, was first discovered by NASA's Transiting Exoplanet Survey Satellite in 2022. Follow-on studies might indicate what kind of atmosphere, if any, the rocky world might have.



Light curve of LTT 1445Ac Credit; TESS, Hubble

Webb study reveals rocky planets can form in extreme environments

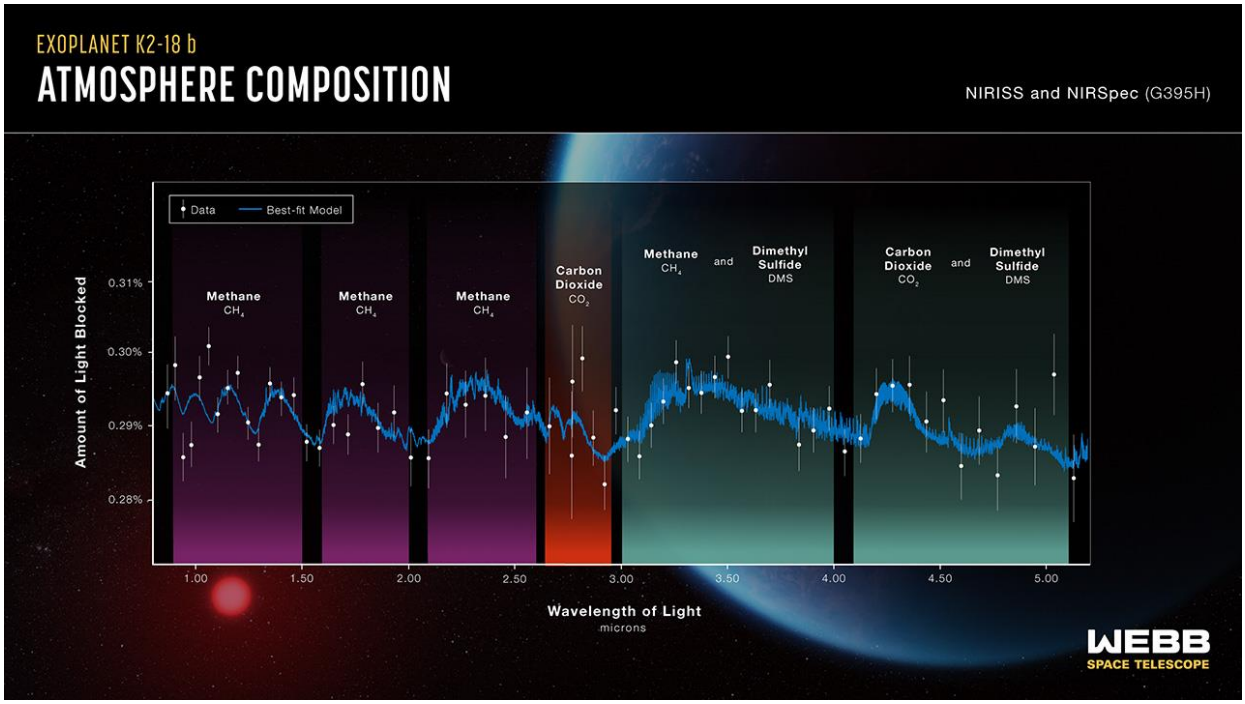
An international team of astronomers have used the NASA/ESA/CSA James Webb Space Telescope to provide the first observation of water and other molecules in the inner, rocky-planet-forming regions of a disc in one of the most extreme environments in our galaxy



Protoplanetary disc XUE 1 (MIRI emission spectrum: 13.3–15.5 microns) Credit ESA

Webb detects organic molecules in the atmosphere of exoplanet K2-18b

The first insight into the atmospheric properties of this habitable-zone exoplanet came from observations with NASA's Hubble Space Telescope. K2-18b orbits the cool dwarf star K2-18 in the habitable zone and lies 120 light-years from Earth in the constellation Leo. Exoplanets such as K2-18 b, which have sizes between those of Earth and Neptune, are unlike anything in our solar system. The suggestion that the sub-Neptune K2-18 b could be a Hycean exoplanet is intriguing, as some astronomers believe that these worlds are promising environments to search for evidence for life on exoplanets.



Spectra of K2-18 b, obtained with Webb's NIRISS (Near-Infrared Imager and Slitless Spectrograph) and NIRSpec (Near-Infrared Spectrograph) displays an abundance of methane and carbon dioxide in the exoplanet's atmosphere, as well as a possible detection of a molecule called dimethyl sulphide (DMS).

Webb detects tiny Quartz Crystals in the clouds of Hot Gas Giant WASP-17b

Researchers using NASA's James Webb Space Telescope have detected evidence for quartz nanocrystals in the high-altitude clouds of WASP-17 b, a hot Jupiter exoplanet 1,300 light-years from Earth. The detection, which was uniquely possible with MIRI (Webb's Mid-Infrared Instrument), marks the first time that silica (SiO2) particles have been spotted in an exoplanet atmosphere.

Planet forming disks (Protoplanetary disk or Proplyds)

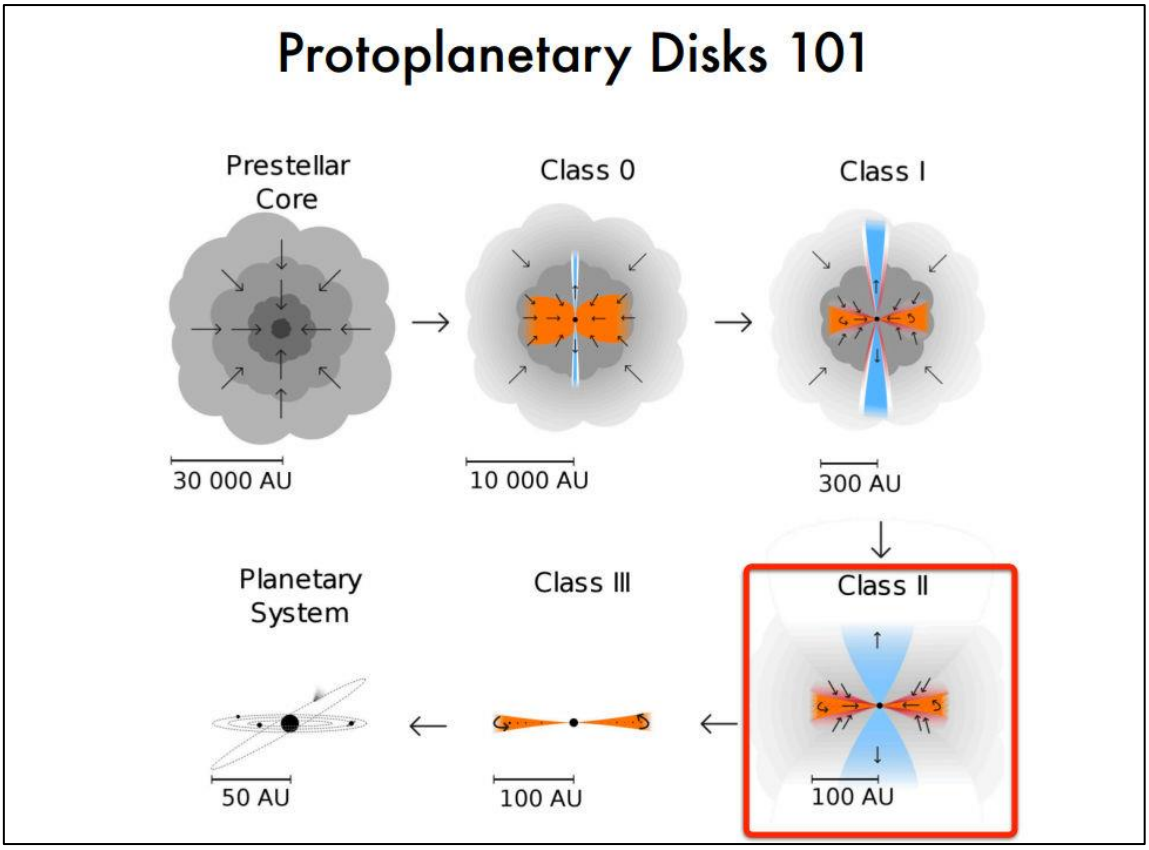
Before referencing some recent findings on this subject an insight into how such disks and planets are formed.

Swinburne University of Technology

- Planet Formation: Disk Formation and Evolution

University of California, Berkeley

- Protoplanetary disks: Updates from Observations



Planetary system formation Credit M. Persson

Rocky planet formation

Webb Study Reveals Rocky Planets Can Form in Extreme Environments

Astronomers discover disc around star in another galaxy for the first time

Astrobiology and the search for life elsewhere

University of Oxford partners with Breakthrough Prize Foundation in search for life beyond Earth

Oxford will be the international headquarters for the Breakthrough Listen initiative, the largest ever astronomical programme searching for 'technosignatures' - evidence of past or present technology that would signal the presence of life beyond planet Earth. The partnership will advance the scope and reach of the Listen programme, putting the UK at the forefront of this rapidly growing field, and inject significant resources into technology and software development at the University of Oxford's Department of Physics.

Origins, Worlds and Life

The next decade of planetary science and astrobiology holds tremendous promise. New research will expand our understanding of our solar system's origins, how planets form and evolve, under what conditions life can survive, and where to find potentially habitable environments in our solar system and beyond. Origins, Worlds, and Life: A Decadal Strategy for Planetary Science and Astrobiology 2023-2032 highlights key science questions, identifies priority missions, and presents a comprehensive research strategy that includes both planetary defence and human exploration.

Paper; Making Habitable Worlds: Planets Versus Megastructures; Raghav Narasimha, Margarita Safonova and Chandra Sivaram, Indian Institute of Astrophysics, Bangalore, 560034, India

A civilization can expand to a system that has planet(s) in the habitable zone (HZ), or a planet can be moved into it. Alternatively, a free-floating planet (FFP) can be captured and moved into the HZ.

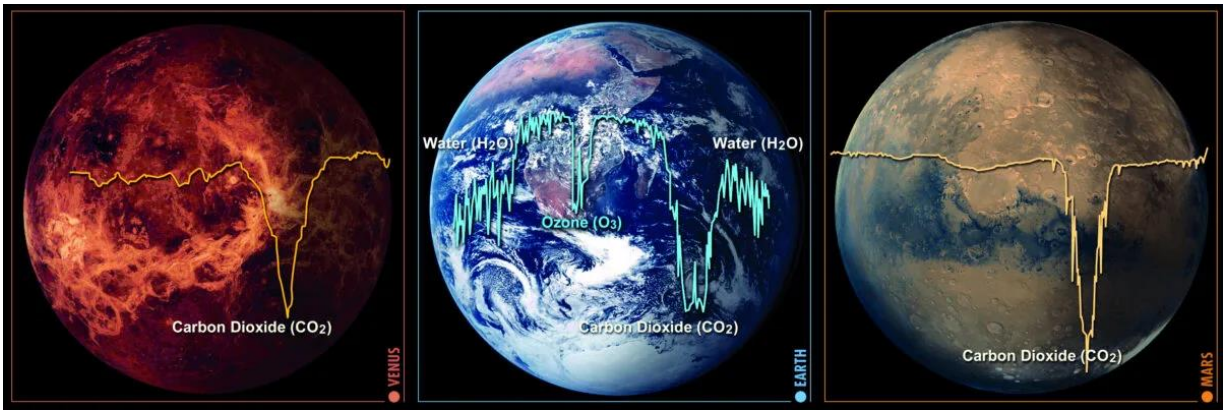
Paper; Beyond the Drake Equation: A Time-Dependent Inventory of Habitable Planets and Life-Bearing Worlds in the Solar Neighbourhood; Piero Madau

The paper introduces a mathematical framework for statistical exoplanet population and astrobiology studies that may help directing future observational efforts and experiments. The approach is based on a set of differential equations and provides a time-dependent mapping between star formation, metal enrichment, and the occurrence of exoplanets and potentially life-harbouring worlds over the chemopopulation history of the solar neighbourhood.

How astronomers search for life on exoplanets

One of humanity’s biggest questions remains: “Are we alone?” For nearly half a century, astronomers have looked for messages from extraterrestrial intelligences that might reach Earth. Many other astronomers hope to answer this question by taking detailed observations of exoplanets: planets orbiting distant stars. But how can astronomers hope to answer this kind of question by observing planets they'll

never get to visit? And how (or, when) will we know if a claim of a sign of life is believable?



SPECTRA FROM DIFFERENT EARTH-LIKE PLANETS Of the four terrestrial planets in our Solar System (Mercury, Venus, Earth and Mars) the last three possess atmospheres. These are the kinds of spectra we would expect when searching for Earth-like planets in other solar systems. Image: ESA

Publications

Books

A City on Mars: Can We Settle Space, Should We Settle Space, and Have We Really Thought This Through? by Dr. Kelly Weinersmith and Zach Weinersmith, published by Particular Books

Establishing long-term presence beyond Earth is now firmly viewed as the collective goal for humanity, some even believe it to be the only way to ensure our survival. The moon and Mars are thought to be the most exciting destinations thought to be within reach. There are many questions about becoming multiplanetary we haven't explored yet, like having space kids, building space farms and creating space nations in a peaceful way. This book analyses many questions and challenges about human space settlement by blending science, psychology, law (and humour).

Software

Peranso

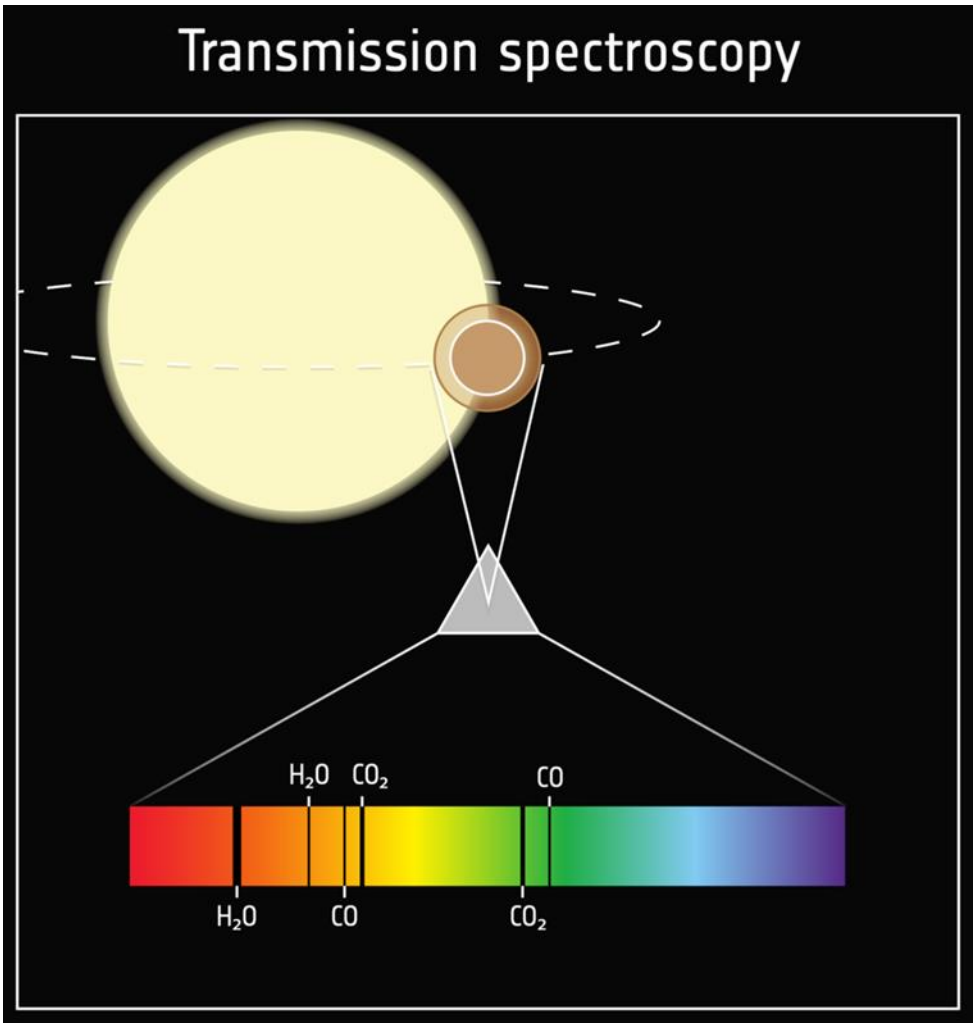
Peranso (Light curve and Period Analysis Software) has a new facility which allows one to download and analyse data from space missions. A tutorial covering TESS data can be found here I have listed this as EXPLOIT 701 on this page.

Space missions

Ariel moves from drawing board to construction phase

Very good news for all contributing observations to the related ExoClock project.

Ariel, ESA's mission to identify the chemical elements in exoplanetary atmospheres, successfully passed the spacecraft preliminary design phase and now moves from the 'drawing board' to the construction phase.



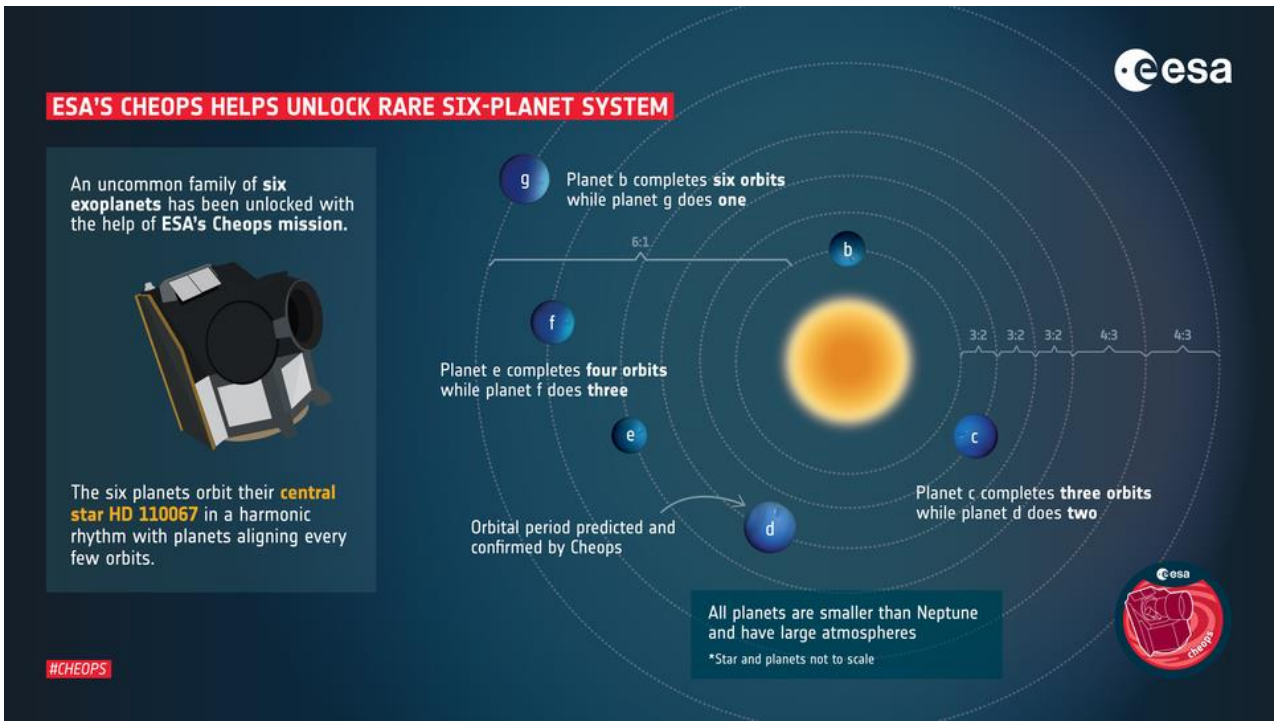
Atmospheric analysis Credit ESA

Ariel will use transmission spectroscopy to identify exoplanet atmospheric components as shown in the diagram above.

ESA's Cheops helps unlock rare six-planet system

A rare star system with six exoplanets has been unlocked with the help of ESA's Cheops mission. The discovery is particularly valuable because the planets' orbital

configuration shows that the system is largely unchanged since its formation more than a billion years ago.

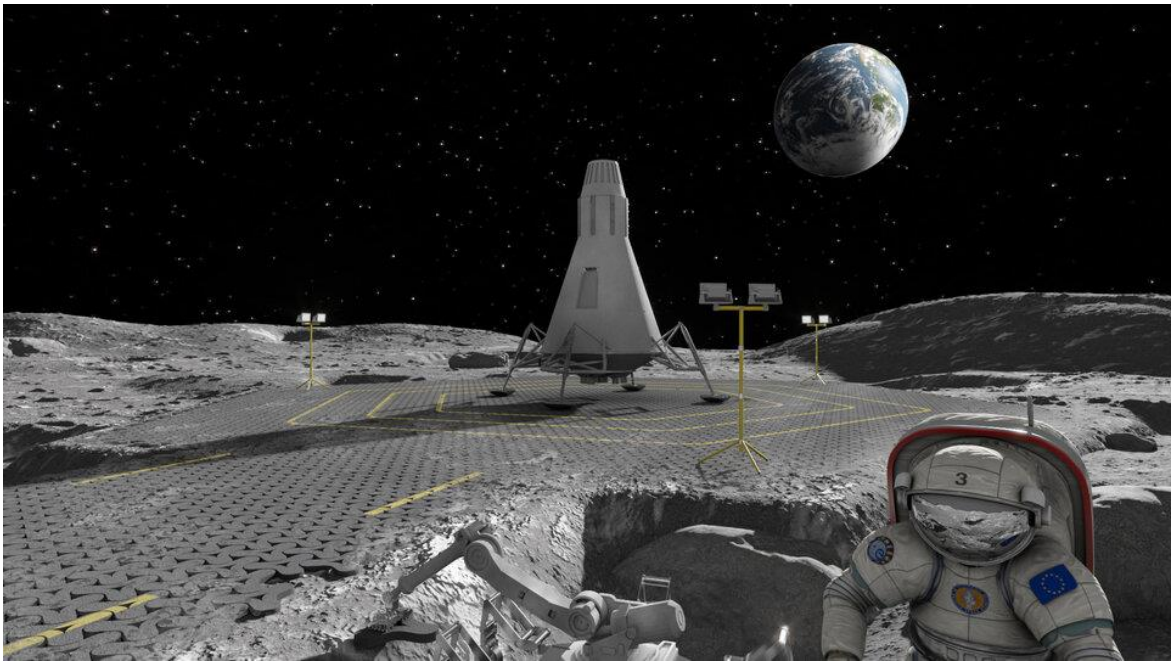


HD110067 system Credit ESA

Space – stepping stones to other star systems

How to make roads on the Moon

When astronauts return to the lunar surface they are probably going to be doing more driving than walking – but to keep billowing moondust at bay they are going to need roads. An ESA project reported in today's Nature Scientific Reports tested the creation of roadworthy surfaces by melting simulated moondust with a powerful laser.



Paved surfaces around a Moon base Credit ESA

[Blue Origin reveals mock-up of Blue Moon lunar lander prototype]

Blue Origin has unveiled a full-sized mock-up of an uncrewed version of its [Blue Moon lunar lander] that will test technologies intended for a crewed version it is developing for NASA's Artemis effort. The lander is designed to deliver three tons of cargo to the lunar surface. The first flight of Blue Moon Mark 1 will be what the company calls the "Pathfinder Mission," designated MK1-SN001. "MK1-SN001 proves out critical systems, including the BE-7 engine, cryogenic fluid power and propulsions systems, avionics, continuous downlink communications, and precision landing,"

Happy New Year to you all

Roger Dymock
ARPS Assistant Director Exoplanets

PS – Any thoughts on what the Exoplanet Division should or shouldn't be doing in the coming years would be welcome.