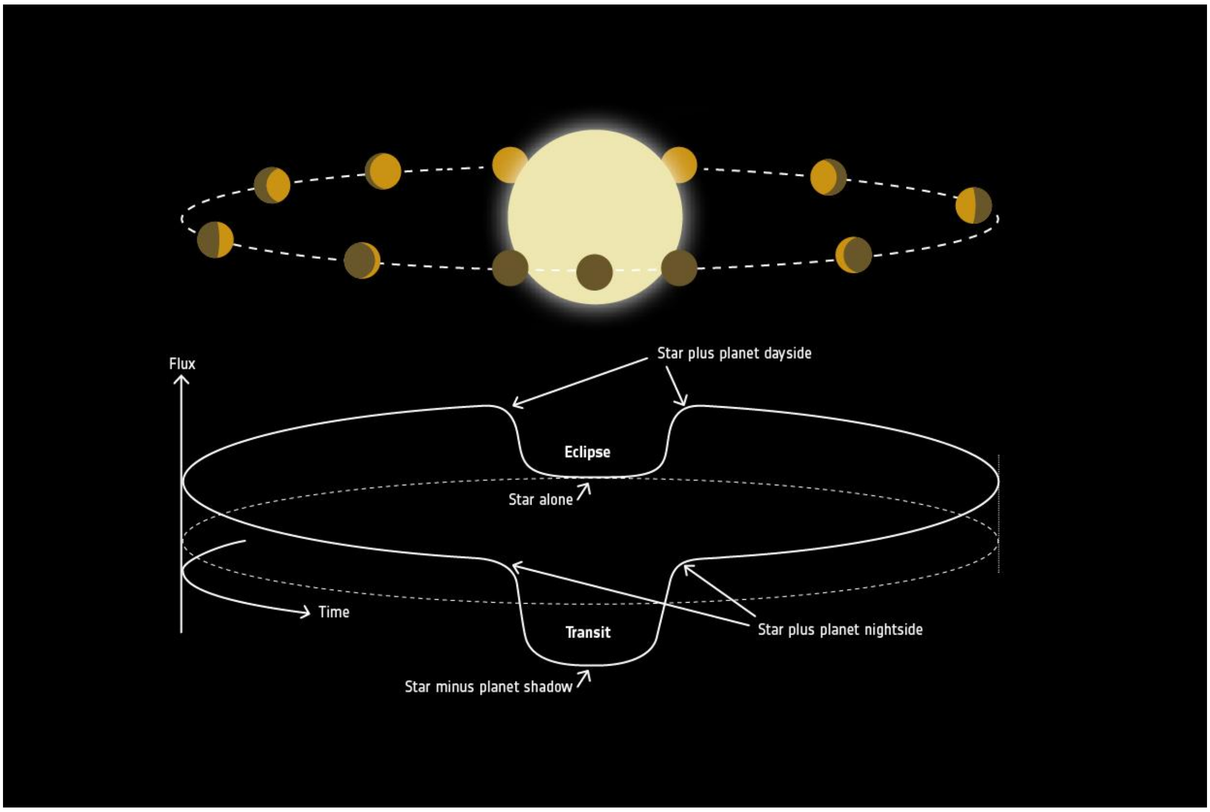
British Astronomical Association
Supporting amateur astronomers since 1890

Infinite Worlds



Phase curve showing an exoplanet transit and eclipse Credit ESA

The e-magazine of the

Exoplanets Division
of the
Asteroids and Remote Planets Section

Issue 16 2022 October

Contents

Section officers

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Assistant Director (Occultations)	Tim Haymes
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Simon Downs, Steve Futcher, Paul Leyland, David Pulley, Mark Salisbury, Americo Watkins

Exoplanets Division website

EXoPLanet Orbit REsearch - EXPLORE

The aim of the EXPLORE project is to build on the Exoplanet Division's participation in ExoClock by searching for additional objects, e.g., exoplanets, their moons, comets and interstellar wanderers and observe eclipses and phase curves of detected and confirmed exoplanets (see cover). ExoClock supports the Ariel space mission which will survey approximately 1000 targets. Some of these will not have been observed for several years and therefore predicted transit times could be in error and thus missed by Ariel when imaging that particular event. ExoClock participants' observations of such transits update the ephemerides of the Ariel targets. EXPLORE offers a growth path for experienced observers to verify that such observations are within the capabilities of amateur observers whilst newcomers can cut their teeth supporting ExoClock by observing transits before moving on to the more challenging photometry.

Rodney Buckland is very much the brains behind this project and is work is much appreciated.

Practical and theoretical objectives necessary to achieve the aim of this project are;

Practical;

- contributing to the ExoClock program by observing transits of known exoplanets
- searching for additional objects as mentioned above by imaging the host star while the known exoplanet is not transiting (out-of-transit)
- seeking opportunities for amateurs to use robotic telescopes such as the Europlanet Telescope Network

Theoretical:

- searching on-line databases for indications, e.g. Transit Timing Variations (TTVs), of additional exoplanets
- modelling exoplanet/exomoon transits

A more complete description features in the October issue of the Journal of the British Astronomical Association.

A one-day ZOOM meeting is planned for 2022 November 12 and full details will be announced in the October issue of the Journal of the British Astronomical Association

The agenda, also below, and joining instructions can be found on the BAA website here.

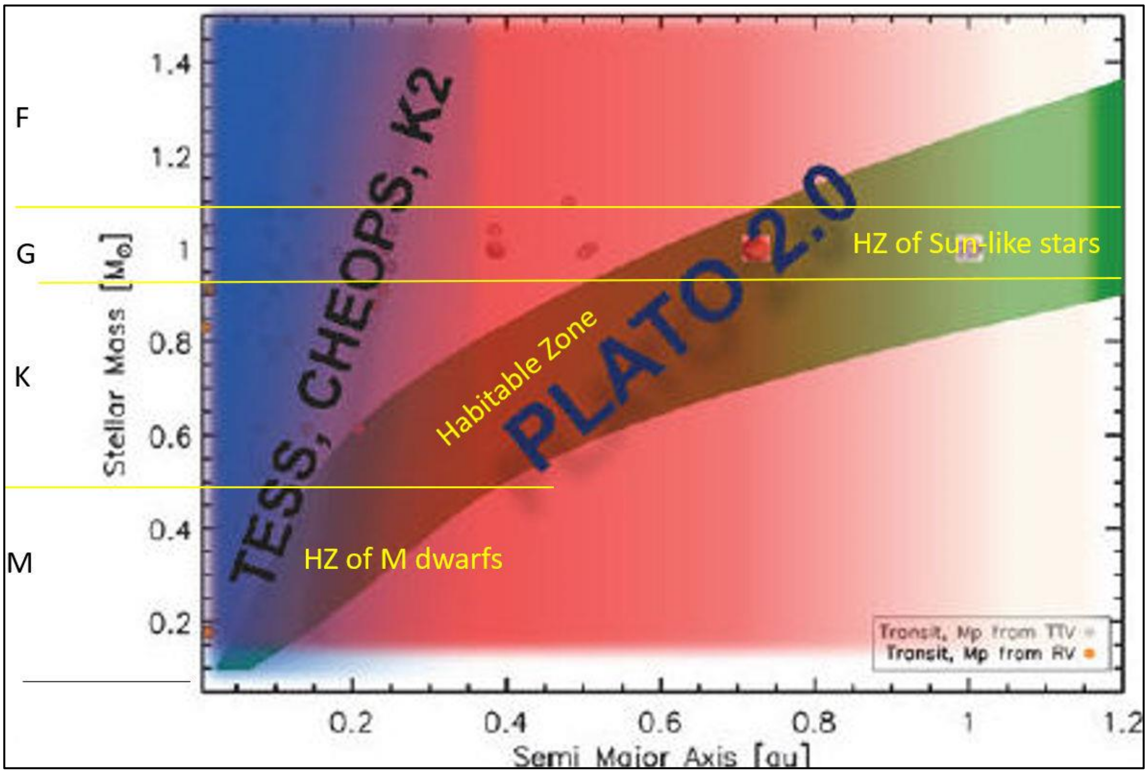
Asteroid and Remote Planets Section
Exoplanet Division

EXPLORE - ExoPLanet Orbit REsearch
An Introduction to the Project

10:00-10:30	Introduction - Exoplanet Division update - EXPLORE introduction	Roger Dymock
10:30-11:15	Ariel and ExoClock - Mission and observational efficiency - ExoClock – a model of pro-am collaboration	Anastasia Kokori
11:15-11:30	Break	

11:30-12:15	EXPLORE Part 1 Detecting exoplanets – opportunities for all - observation - modelling - searching databases - Zooniverse	Rodney Buckland
12:15-12:45	How to discover an exoplanet (telescope and camera not required)	Roger Dymock
12:45-13:30	Lunch break	
13:30-14:15	EXPLORE Part 2 - introduction to HOPS - synchronous observations to detect shallow transits - data mining transit observations for variable star photometry	Martin Crow
14:15- 15:00	AstroImageJ - An alternative to HOPS	Richard Lee
15:00-15:15	Break	
15:15-15:45	Observing with robotic telescopes	Rodney Buckland
15:45:16:15	Q and A	Roger Dymock Rodney Buckland Martin Crow
16:15	Close	

Project update
PLATO



The above chart, from the PLATO Definition Study Report, shows stellar mass and type vs planetary semi-major axis. Other missions, e.g., TESS, K2 and CHEOPS, will detect and characterise small planets in the habitable zone of M dwarfs but only PLATO will be able to characterise planets in the habitable zone of Sun-like stars.

The Ground Observation Program is beginning to take shape and amateur astronomers will be able to participate. A PLATO Ground-based Observational Program (GOP), hybrid meeting, is to be held on 17-19 October 2022. If you wish to register, send an email to platogop.workshop2022@gmail.com

The original project document is here and will be updated as more information on the program becomes available.

News

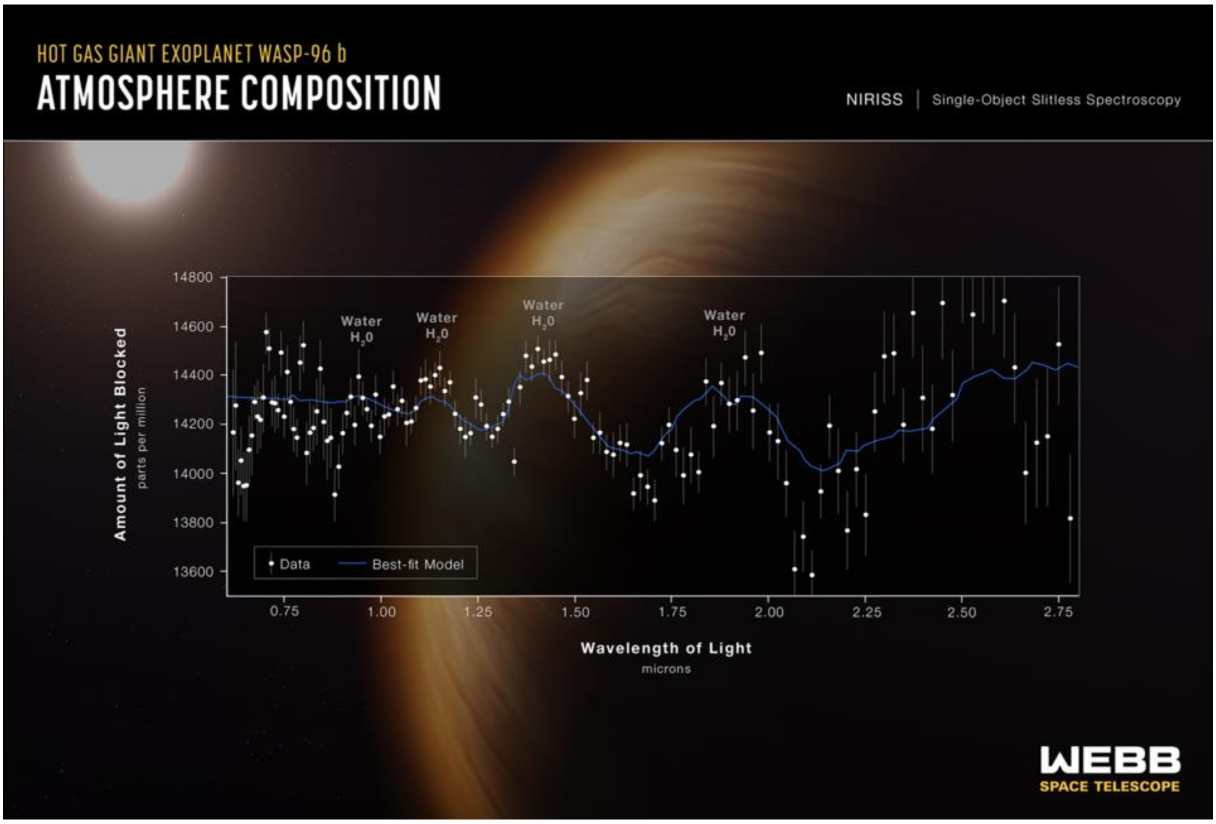
Frank Donald Drake – May 28, 1930 – September 2 2022

He was an American astrophysicist and astrobiologist and died at Aptos, California, USA. He began his career as a radio astronomer, studying the planets of the Solar System and later pulsars. Drake expanded his interests to the search for extra-terrestrial intelligence (SETI), beginning with Project Ozma in 1960, an attempt at extra-terrestrial communications. He developed the Drake equation, which attempts to quantify the number of intelligent lifeforms that could potentially be discovered. Working with Carl Sagan, Drake helped to design the Pioneer plaque, the first physical message flown beyond the Solar System, and was part of the team that developed the Voyager record. Drake designed and implemented the Arecibo message in 1974, an extra-terrestrial radio transmission of astronomical and biological information about Earth. Drake worked at the National Radio Astronomy Observatory, Jet Propulsion Laboratory, Cornell University, University of California at Santa Cruz and the SETI Institute.

Today's score

Total conformed exoplanets	5178
Kepler candidates	2708
TESS candidates	3940

James Webb Space Telescope reveals atmosphere of distant planet in exquisite detail

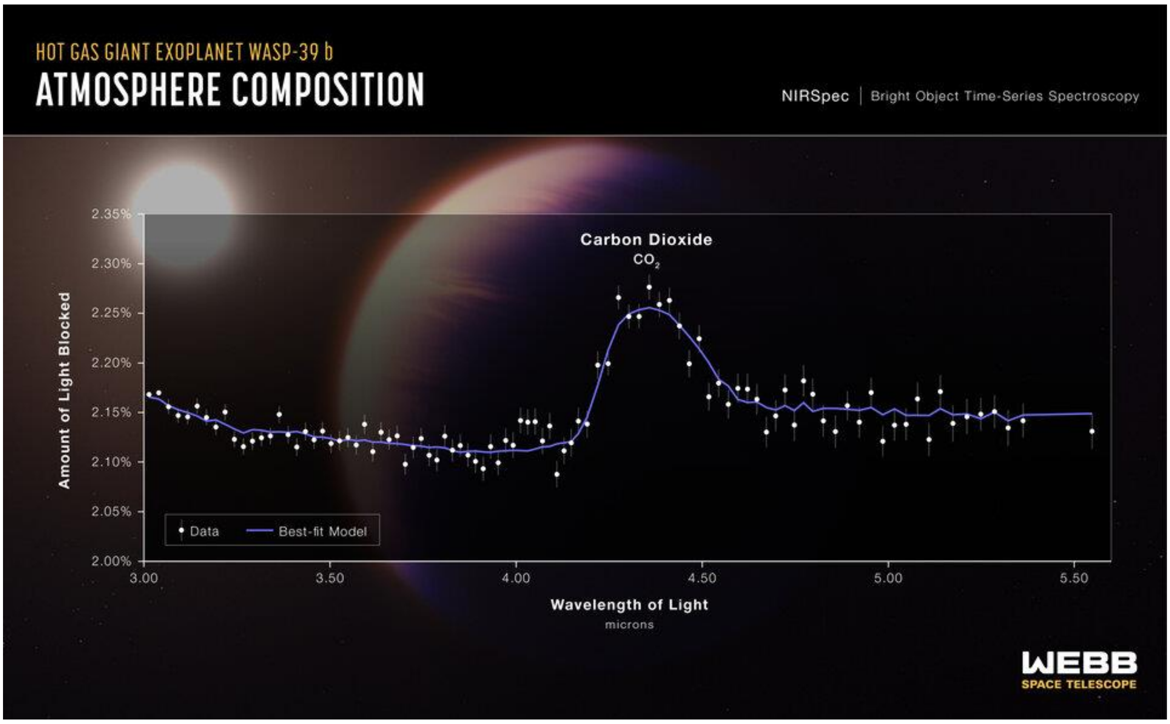


Exoplanet WASP-95b. NIRISS transmission spectrum Credit ESA/JWST

JWST's enormous mirror and precise instruments joined forces to capture the most detailed measurements of starlight filtering through the atmosphere of a planet outside our Solar System to date. The spectrum of light – which contains information about the makeup of a planetary atmosphere 1,150 light-years away – reveals the distinct signature of water. The strength of the signal that JWST detected hints at the significant role the telescope will play in the search for potentially habitable planets in the coming years. JWST's powerful new view also shows evidence of haze and clouds that previous studies of this planet did not detect.

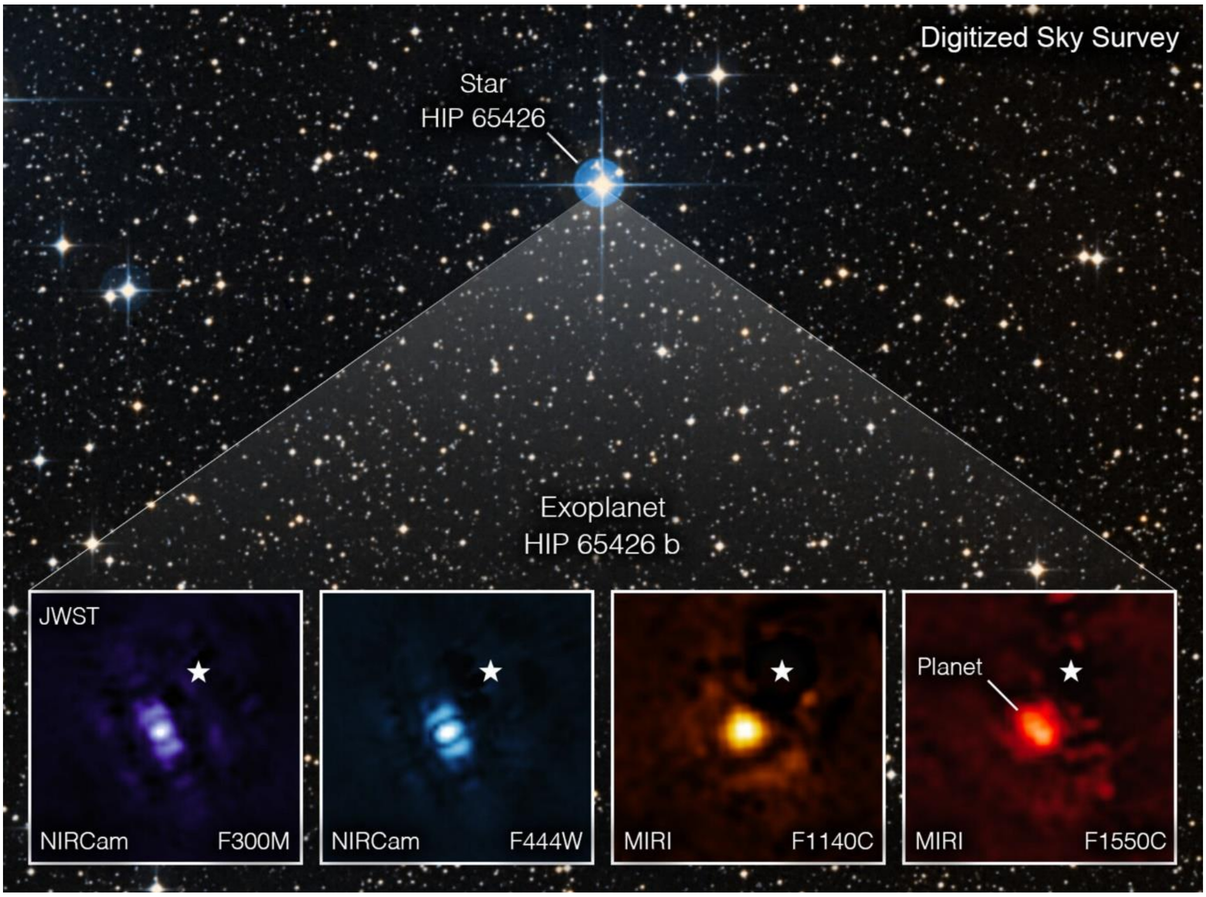
JWST detects carbon dioxide in exoplanet atmosphere

The NASA/ESA/CSA James Webb Space Telescope has found definitive evidence for carbon dioxide in the atmosphere of a gas giant planet, WASP-39b, orbiting a Sun-like star 700 light-years away. The result provides important insights into the composition and formation of the planet, and is indicative of Webb's ability to also detect and measure carbon dioxide in the thinner atmospheres of smaller rocky planets.



WASP-39b NIRSPEC transmission spectrum Credit JWST

JWST takes its first exoplanet image



Exoplanet HI{ 65426b Credit ESA/JWST

The exoplanet in Webb's image, HIP 65426 b, is about six to eight times the mass of Jupiter. It is young as planets go – about 15 to 20 million years old, compared to our 4.5-billion-year-old Earth. In each filter image, the planet appears as a slightly differently shaped blob of light. That is because of the particulars of Webb's optical system and how it translates light through the different optics. Purple shows the NIRCam instrument's view at 3.00 micrometres, blue shows the NIRCam instrument's view at 4.44 micrometres, yellow shows the MIRI instrument's view at 11.4 micrometres, and red shows the MIRI instrument's view at 15.5 micrometres. The small white star in each image marks the location of the host star HIP 65426.

Conferences/Meetings/Seminars/Webinars/Videos

Inaugural Forming and Exploring Habitable Worlds Meeting will be held in Edinburgh, UK 07-13 November 2022

Forming and Exploring Habitable Worlds is a multi-discipline international meeting taking place in Edinburgh, UK, in November 2022. This event is to accommodate up to 120 in-person delegates of all career stages based in a range of relevant employment sectors. A hybrid model is envisaged to be delivered so as to broaden participation by accommodating virtual attendance of additional delegates.

The Second Penn State SETI Symposium 2023 June 19-22
All talks can be found here.

NoRCEL's Blue Earth Project 2023 Event (BEP2023)
"Is it time for planet B?"
Stephen Hawking proposed a doomsday scenario in which humanity might have as little as 100 years before leaving Earth, while Elon Musk does not want to wait for that long. Is this how we should confront existential threats to our presence on Earth, or is this a misleading and potentially dangerous or counterproductive direction of thought? Where lies our responsibility for the ecosystem that we depend on? Whatever the answer might be, the future of humanity depends on sound action and must not be left to speculative visions. Join a panel discussion covering a range of perspectives, including existential risk, planetary science, biodiversity, future of humanity, and anthropology.

Imagining Other Earths - Coursera
Are we alone? This course introduces core concepts in astronomy, biology, and planetary science that enable the student to speculate scientifically about this profound question and invent their own solar systems.

Publications
Book; Astrobiology, Discovery and Societal Impact by Steven J Dick
This book examines the humanistic aspects of astrobiology, systematically discussing the approaches to, and critical issues and implications of discovering life beyond Earth

Steven J. Dick (born October 24, 1949, Evansville, Indiana) is an American astronomer, author, and historian of science most noted for his work in the field of astrobiology. Dick served as the Chief Historian for the National Aeronautics and Space Administration from 2003 to 2009[1] and as the Baruch S. Blumberg NASA/Library of Congress Chair in Astrobiology from 2013 to 2014.[2] Before that, he was an astronomer and historian of science at the United States Naval Observatory in Washington, DC, from 1979 to 2003.

Paper; Searching for techno signatures in exoplanetary systems with current and future missions
Techno signatures refer to observational manifestations of technology that could be detected through astronomical means. Most previous searches for techno signatures have focused on searches for radio signals, but many current and future observing facilities could also constrain the prevalence of some non-radio techno signatures. This search could thus benefit from broader participation by the astronomical community, as contributions to techno signature science can also take the form of negative results that provide statistically meaningful quantitative upper limits on the presence of a signal. This paper provides a synthesis of the recommendations of the 2020 Techno Climes workshop, which was an online event intended to develop a research agenda to prioritize and guide future theoretical and observational studies techno signatures.

Paper; Proximity of exoplanets to first-order mean-motion resonances
Planetary formation theories and, more specifically, migration models predict that planets can be captured in mean-motion resonances (MMRs) during the disc phase. The distribution of period ratios between adjacent planets shows an accumulation in the vicinity of the resonance, which is not centred on the nominal resonance but instead presents an offset slightly exterior to it. Here we extend on previous works by thoroughly exploring the effect of different disc and planet parameters on the resonance offset during the disc migration phase.

Paper; Transit least-squares survey IV. Earth-like transiting planets expected from the PLATO mission
In its long-duration observation phase, the PLATO satellite (scheduled for launch in 2026) will observe two independent, nonoverlapping fields, nominally one in the northern hemisphere and one in the southern hemisphere, for a total of four years. The exact duration of each pointing will be determined two years before launch. Previous estimates of PLATO's yield of Earth-sized planets in the habitable zones (HZs) around solar-type stars ranged between 6 and 280.

Paper; Transit Light-curves for Exomoons: Analytical Formalism
The photometric transit method has been the most effective method to detect and characterize exoplanets as several ground-based as well as space-based survey missions have discovered thousands of exoplanets using this method. With the advent of the upcoming next generation large telescopes, the detection of exomoons in a few of these exoplanetary systems is very plausible. In this paper, we present a comprehensive analytical formalism in order to model the transit light curves for such moon hosting exoplanets. In order to achieve analytical formalism, we have considered circular orbit of the exomoon around the host planet, which is indeed the case for tidally locked moons. The formalism uses the radius and orbital properties of both the host planet and its moon as model parameters. The co-alignment or non-coalignment of the orbits of the planet and the moon is parameterized using two angular parameters and thus can be used to model all the possible orbital alignments for a star-planet moon system. This formalism also provides unique and direct solutions to every possible star-planet moon three circular body alignments. Using the formula derived, a few representative light curves are also presented.

Are planets with two stars promising places for life? - The Planetary Society
Single stars like our Sun aren't the galactic norm; at least half the stars in our Milky Way galaxy exist in pairs as binary stars. Several are trinary or more. It begs the question: could an Earth-sized planet in a favourable orbit around two stars support life?

Astrobiology

Searching for evidence of life in the Venusian clouds

A private mission to Venus is coming together. Rocket Lab shared new details about its planned mission to search for evidence of life in the Venusian clouds, inspired by recent evidence that points to the possible presence of phosphine, a potential biosignature, in the planet's upper atmosphere.

Could there be life under the Martian surface?
NASA's InSight mission is winding down, but a much more ambitious life-hunting lander bound for the red planet is already taking shape. It's the Mars Life Explorer, also known as MLE. This exciting new concept got a boost in April 2022 when it was prioritized by the U.S. National Academies Planetary Science and Astrobiology Decadal Survey. Regarded by NASA as a "to-do" direct from the planetary science community, the report recommended that MLE should be the next medium-class mission in NASA's Mars Exploration Program (MEP).

Emergence of Life – on-line course offered by Coursera
How did life emerge on Earth? How have life and Earth co-evolved through geological time? Is life elsewhere in the universe? Take a look through the 4-billion-year history of life on Earth through the lens of the modern Tree of Life! This synthesis emphasizes the universality of the emergence of life as a prelude for the search for extra-terrestrial life.

This course actually started on 2022 August 4th but, hopefully, will run again.

Origins – Formulation of the Universe, Solar System, Earth and Life – on-line course offered by Coursera.
This course tracks the origin of all things – from the Big Bang to the origin of the Solar System and the Earth. It follows the evolution of life on our planet through deep geological time to present life forms.

Webs sites of interest
Space Telescopes Advanced Research Group on the Atmospheres of Transiting Exoplanets
STARGATE use both observations and theoretical models to examine the environment of different exoplanets. Observations of transiting exoplanets and measurements of their atmospheres have been published using both ground- and space-based telescopes. Theoretical work includes 3D global circulation models, the generation of large forward model grids, and retrievals. We specialize in atmospheric characterization using the three main methods for transiting exoplanets; transmission, emission, and phase curves.

Stellar Planet - Dr. Hannah R Wakeford
Hannah is a lecturer in Astrophysics in the School of Physics at the University of Bristol, UK. Hannah leads a group investigating the atmospheres of transiting exoplanets using space-based telescopes.

Hannah is on the executive committee of the Space Telescopes Advanced Research Group for the Atmospheres of Transiting Exoplanets (STARGATE) collaboration, a collaboration which spans institutes across the UK and USA. Her work focuses on characterising the atmospheres of exoplanets through observations with the Hubble Space Telescope, and working towards a better understanding of how exoplanets can be explored further with Webb. Hannah has also developed theoretical models for exotic clouds in exoplanet atmosphere and uses them to interpret observations and make prediction for future studies.

Next Generation Transit Survey – NGTS

The Next-Generation Transit Survey (NGTS) is a wide-field photometric survey designed primarily to find and characterise transiting exoplanets. NGTS employs an array of small fully-robotic telescopes operating at red-optical wavelengths (520-890nm) thereby maximizing sensitivity to bright but relatively cool and small host stars (K and early-M spectral type). NGTS data are made publicly available through the ESO Data Archive.

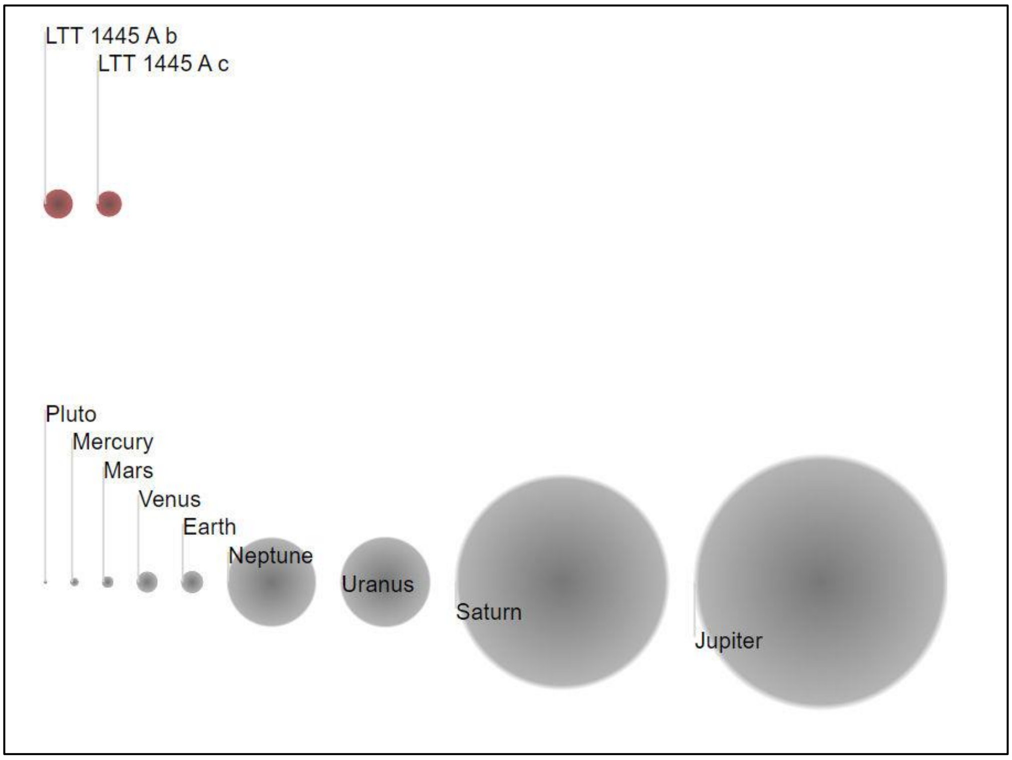
Space missions

Twinkle

Twinkle is an upcoming space-based telescope with a 0.45 m primary aperture and a broad visible to infrared wavelength coverage (0.5 – 4.5 μm). The Twinkle space mission (Stotesbury et al. 2022) will conduct two simultaneous surveys during its first three years of operation, which is scheduled to begin in 2025. While one of these will focus on studying objects within our own solar system, the other will be dedicated to the study of extrasolar targets. A large portion of the latter survey will be used to study exoplanet atmospheres.

A paper, Twinkle – a small satellite spectroscopy mission for the next phase of exoplanet science describes the mission.

A further paper, 'Is LTT 1445 Ab a Hycean World or a cold Haber World? Exploring the Potential of Twinkle to Unveil Its Nature' can be found here



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The above diagram, from the Open Exoplanet Catalogue compares the, approximate, sizes of LTT 1445 planets with those in the Solar System.

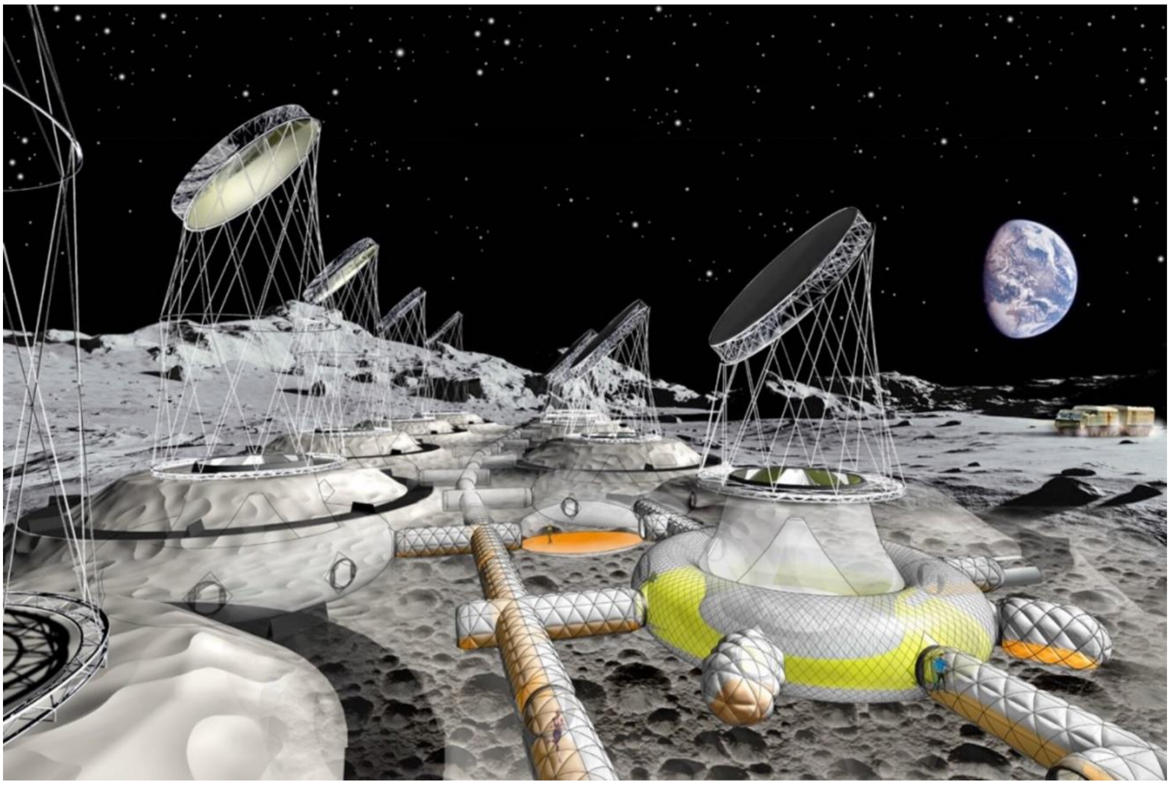
Space – stepping stones to other star systems

ESA to embolden Europe's space exploration

A 12-strong advisory group is to guide ESA's human and robotic space exploration as the agency aims to increase European ambitions in space. ESA recently published its exploration roadmap called Terrae Novae 2030+ that sets out its ambitious exploration vision for Europe. Its objectives are threefold: to create new opportunities in low Earth orbit for a sustained European presence after the International Space Station; to enable the first European to explore the Moon's surface by 2030 as a step towards sustainable lunar exploration in the 2030s; and to prepare the horizon goal of Europe being part of the first human mission to Mars.

The Moon

Inflatable Moon base



Inflatable Moon base Credit ESA

A vision of a future Moon settlement assembled from semi-buried inflatable habitats. Sited beside the lunar poles in regions of near-perpetual solar illumination, mirrors positioned above each habitat would reflect sunlight into greenhouses within the doughnut-shaped habitats.

NASA Mission – Lunar Trailblazer

With its Artemis campaign, NASA wants to succeed the Apollo missions by landing humans on the Moon again — this time to stay. Between Apollo and Artemis, one stark difference in exploring our cosmic neighbour is the study of lunar water hence the Lunar Trailblazer mission.

The 210-kilogram (463-pound) Trailblazer spacecraft will launch in 2023 on a SpaceX Falcon 9 rocket alongside a lander that will deliver other NASA instruments to the Moon. After entering a polar lunar orbit, Trailblazer will use its two instruments to map the form, abundance, and distribution of water on the Moon, including ice on its poles and regolith- or rock-associated water in sunlit regions.

Mars
A great deal of interest of late as to the possibility of Martian self-sufficiency.

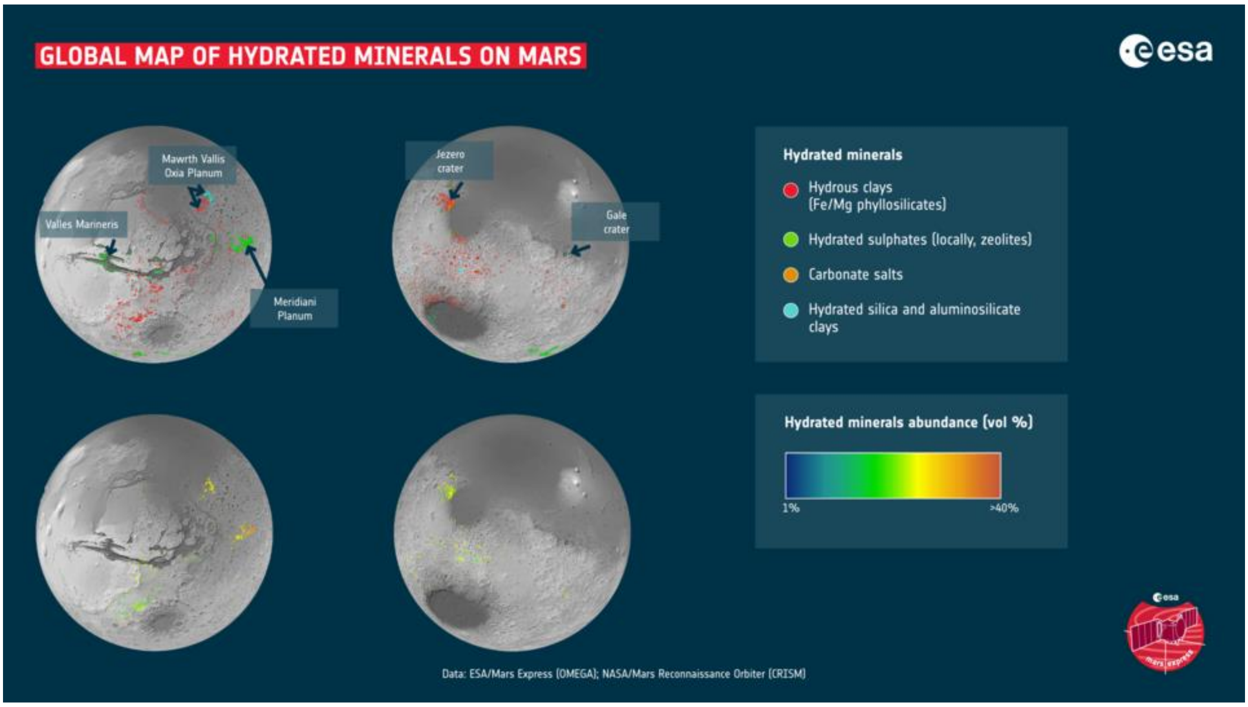
Moon to Mars

NASA's human lunar exploration plans under Artemis call for sending the first woman and first person of colour to the surface of the Moon and establishing sustainable exploration by the end of the decade. Working with U.S. companies and international partners, they will uncover new scientific discoveries and lay the foundation for private companies to build a lunar economy. The agency will use what they learn on the Moon to prepare for humanity's next giant leap – sending astronauts to Mars.

It all starts with U.S companies delivering scientific instruments and technology demonstrations to the lunar surface, followed by a spaceship, called the Gateway, in orbit around the Moon that will support human and scientific missions, and human landers that will take astronauts to the surface of the Moon. The agency's powerful Space Launch System rocket and Orion spacecraft will be the backbone to build the Gateway and transport astronauts to and from Earth.

Water

A new map of Mars, below, is changing the way we think about the planet's watery past, and showing where we should land in the future.



The map shows mineral deposits across the planet and has been painstakingly created over the last decade using data from ESA's Mars Express Observatoire pour la Mineralogie, l'Eau, les Glaces et l'Activité (OMEGA) instrument and NASA's Mars Reconnaissance Orbiter Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) instrument. Specifically, the map shows the locations and abundances of aqueous minerals. These are from rocks that have been chemically altered by the action of water in the past, and have typically been transformed into clays and salts.

Oxygen

The growing list of "firsts" for Perseverance, NASA's newest six-wheeled robot on the Martian surface, includes converting some of the Red Planet's thin, carbon dioxide-rich atmosphere into oxygen. A toaster-size, experimental instrument aboard Perseverance called the Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE) accomplished the task. The test took place April 20, the 60th Martian day, or sol, since the mission landed Feb. 18.

Could we grow potatoes on Mars?

15 min video thanks to Steve Knight, Hampshire Astronomical Group. You can actually buy Martian analogue soil so why not give it a go?

Roger Dymock
ARPS Assistant Director Exoplanets