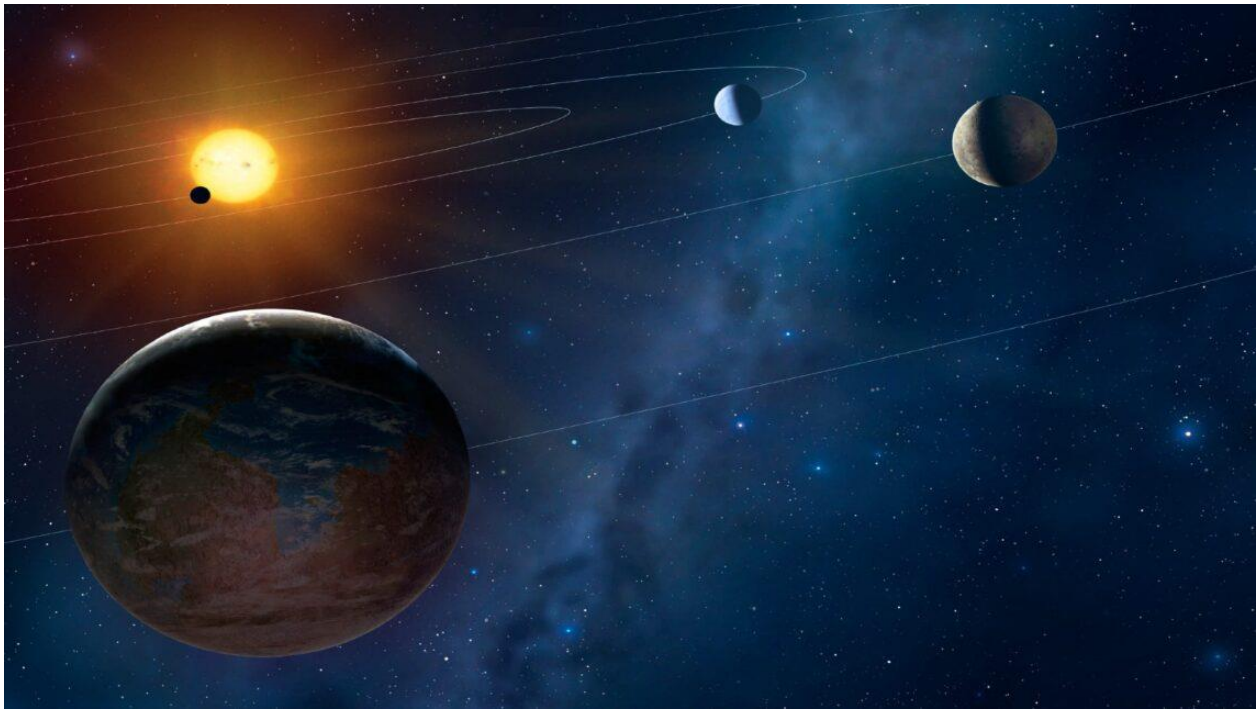
British Astronomical Association
Supporting amateur astronomers since 1890

Infinite Worlds



Four Sub-Earth Planets Orbiting Barnard's Star Credit NASA

The e-magazine of the

Exoplanets Division of the Asteroids and Remote Planets Section

Issue 26 2025 April

Contents

Section officers

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

Exoplanet Technical Advisory Group (ETAG)

Simon Downs, Steve Futcher, Paul Leyland, David Pulley, Mark Salisbury, Americo Watkins. Unfortunately, I haven't been able to call on the expertise of the above for some time and therefore I have decided to disband the group. Thanks for all you help.

Exoplanets Division website

Collaboration with the AAVSO Exoplanet Section

Working on a TTV project so watch this space.

News

Today's score (2025 April 15) from the NASA Exoplanet Archive, Exoplanet and Candidate Statistics

Total confirmed exoplanets;	5869
Kepler confirmed planets	2779
K2 confirmed planets	547
TESS Confirmed Planets;	620

Notes from the BAA Winchester Weekend, 11 – 13 April 2025

Professor David Rothery mentioned the Open University course 'S283 Planetary science and the Search for life' This module tackles fundamental questions about our solar system. How did it form, and how has it evolved? Why aren't all the planets like Earth? How and why did life arise on Earth? Has life appeared elsewhere in the Solar System or beyond, and could it be intelligent? You'll look at the exploration of the Solar System by spacecraft; planetary processes such as volcanism and impacts; the structure of planets and their atmospheres; and asteroids, comets and meteorites.

Professor Mike Edmunds gave a presentation 'The Chemistry of the Universe' which covered; biosignatures, JWST transmission spectroscopy. I couldn't find his presentation on the net but there is a relevant paper A JWST transmission spectrum of a nearby Earth-sized exoplanet

Researchers confirm the existence of an exoplanet in the habitable zone

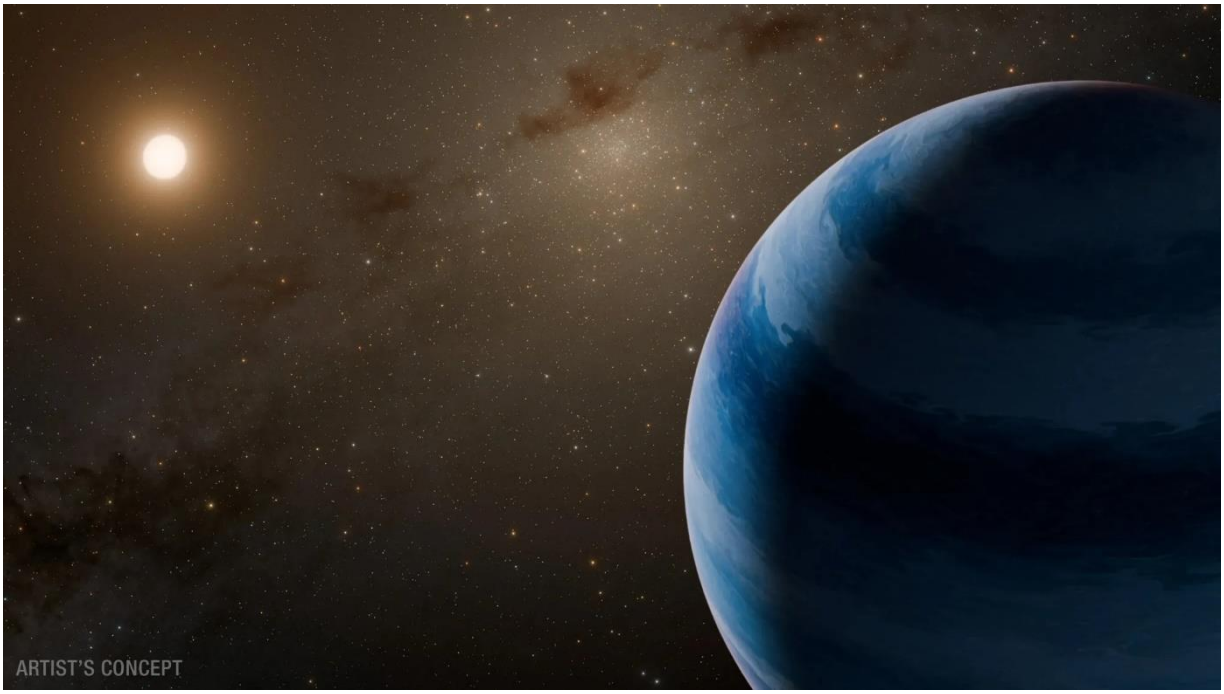
An international team has confirmed the discovery of a super-Earth orbiting in the habitable zone of a nearby Sun-like star. The planet was originally detected two years ago by Oxford University scientist Dr Michael Cretignier. This result, drawing on over two decades of observations, opens a window to future studies of Earth-like exoplanets that may have conditions suitable for life. The findings have been published in Astronomy & Astrophysics. The new planet, named HD 20794 d, has a mass six times that of Earth and orbits a star similar to our Sun, located just 20 light years away. Its orbit places it within the habitable zone of the system, meaning it is at the right distance from its star to sustain liquid water on its surface, a key

ingredient for life as we know it. As the video shows the planet is in an eccentric orbit which takes it into and out of the habitable zone.

Gaia reveals two new mysterious celestial objects

New research using data collected by ESA's Gaia spacecraft confirms the existence of two mysterious celestial objects. Gaia-4b is a 'Super-Jupiter' exoplanet, and Gaia-5b a brown dwarf. These massive objects are unexpectedly orbiting low-mass stars. Gaia-4b is a planet orbiting the previously unremarkable star Gaia-4 around 244 light-years away. Gaia-5b orbits the Gaia-5 star, around 134 light-years away from Earth. These two newly discovered objects are nearby, in our own galactic neighbourhood. Their existence challenges current theories of planet formation, and Gaia's ongoing mission will provide valuable data to help us understand these intriguing objects.

NASA Scientists Spot Candidate for Speediest Exoplanet System

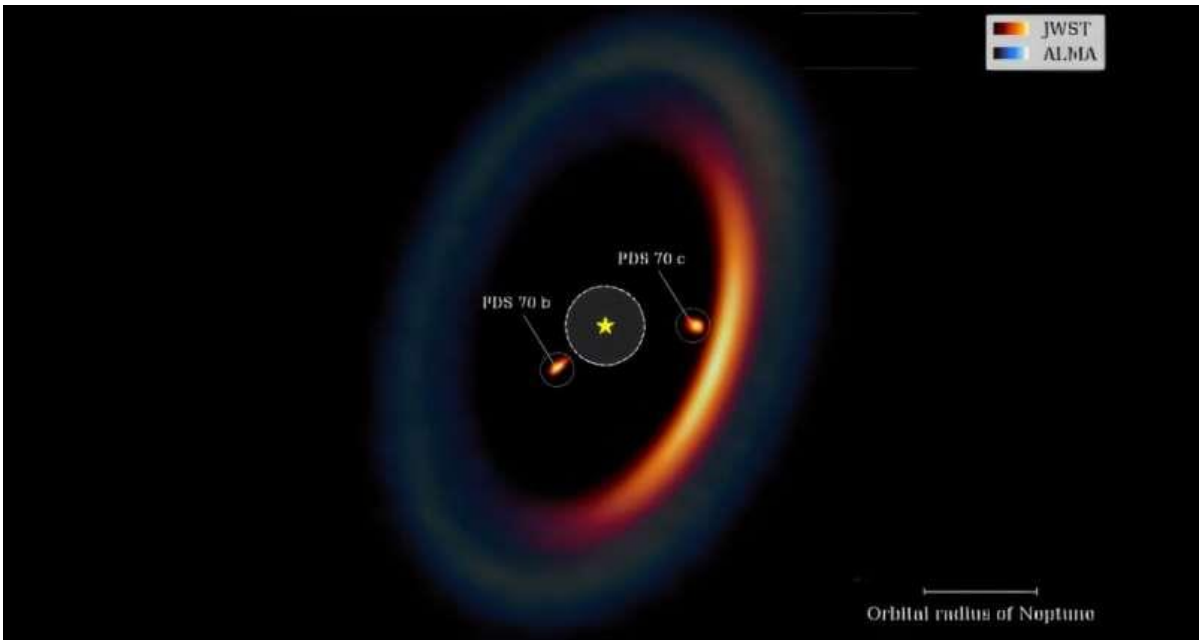


Artist's concept of a super-Neptune world orbiting a low-mass star near the center of our Milky Way galaxy. Scientists recently discovered such a system that may break the current record for fastest exoplanet system, traveling at least 1.2 million miles per hour, or 540 kms per second. Credit NASA/JPL-Caltech/R. Hurt (Caltech-IPAC)

The pair of objects, a super-Neptune world orbiting a low-mass star, was first spotted indirectly in 2011 thanks to a chance alignment. A team of scientists combed through archived data from MOA (Microlensing Observations in Astrophysics) – a

collaborative project focused on a microlensing survey conducted using the University of Canterbury Mount John Observatory in New Zealand — in search of light signals that betray the presence of exoplanets, or planets outside our solar system.

Witnessing the birth of planets: Webb telescope provides unprecedented view into PDS 70 system



A multi-wavelength view of the PDS 70 system reveals the dynamic display between its forming planets. Credit University of Victoria

Canadian astronomers have taken an extraordinary step in understanding how planets are born, using the James Webb Space Telescope (JWST). JWST was used to study PDS 70, a young star with two growing planets in its orbit, PDS 70 b and PDS 70 c. This remarkable system, located 370 light-years away, gives scientists a rare chance to see how planets form and evolve during their earliest stages of development.

Four Sub-Earth Planets Orbiting Barnard's Star from MAROON-X and ESPRESSO

Barnard's star is only six light-years away from the Solar System, but exoplanet researchers have had a hard time confirming whether it hosted any planets. A new paper shares evidence that the star may actually have four planets in orbit around it.

An international team of researchers has used NASA's James Webb Space Telescope to measure the temperature of the rocky exoplanet TRAPPIST-1 b.

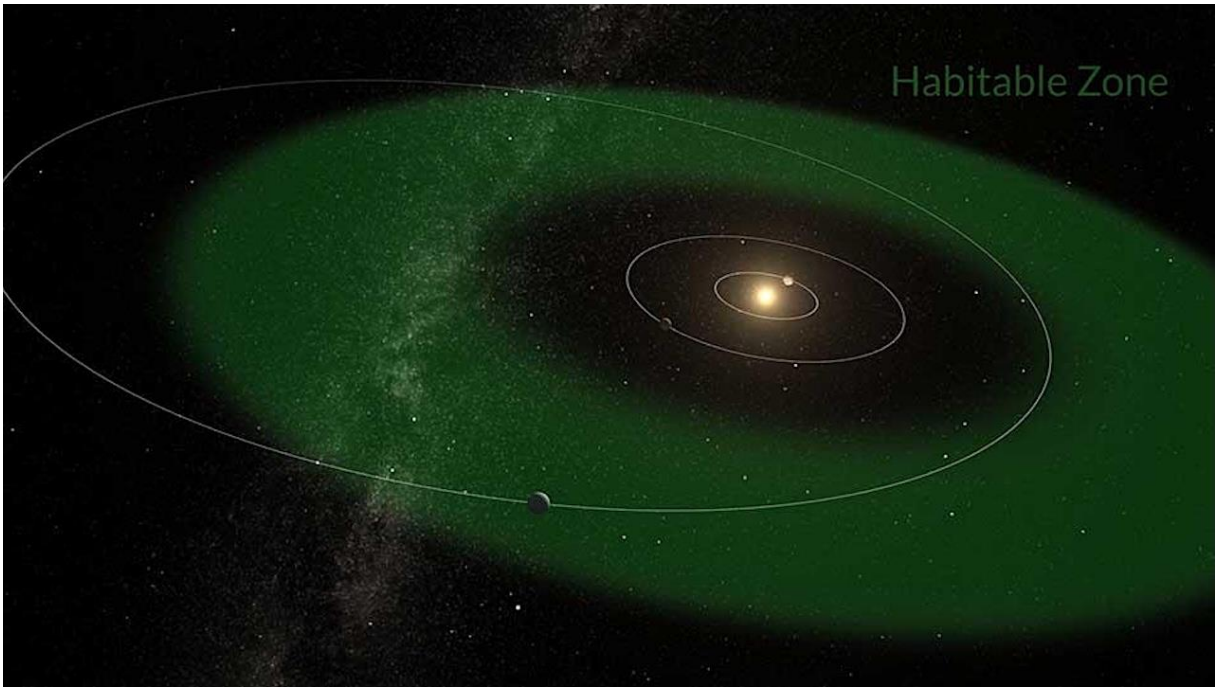
The measurement is based on the planet's thermal emission: heat energy given off in the form of infrared light detected by Webb's Mid-Infrared Instrument (MIRI). The result indicates that the planet's dayside has a temperature of about 500 kelvins (roughly 450 degrees Fahrenheit) and suggests that it has no significant atmosphere. This is the first detection of any form of light emitted by an exoplanet as small and as cool as the rocky planets in our own solar system. The result marks an important step in determining whether planets orbiting small active stars like TRAPPIST-1 can sustain atmospheres needed to support life. It also bodes well for Webb's ability to characterize temperate, Earth-sized exoplanets using MIRI.

NASA's Webb Finds Planet-Forming Disks Lived Longer in Early Universe

New data confirms Hubble finding and refutes current theories of planet formation in universe's early days. Thanks to its extraordinary sensitivity and resolution, Webb just solved a mystery more than two decades old. In 2003, the Hubble Space Telescope saw evidence of a massive planet around an ancient star. This puzzled astronomers, who knew that such stars in the early universe lacked a lot of the heavier elements considered essential for building planets. Current models predict that the disks around this type of star have short lifetimes, so short that planets cannot grow large, or maybe even form at all. Yet, there it was!

Researchers confirm the existence of an exoplanet in the habitable zone

An international team has confirmed the discovery of a super-Earth orbiting in the habitable zone of a nearby Sun-like star. The planet was originally detected two years ago by Oxford University scientist Dr Michael Cretignier.The new planet, named HD 20794 d, has a mass six times that of Earth and orbits a star similar to our Sun, located just 20 light years away. Its orbit places it within the habitable zone of the system, meaning it is at the right distance from its star to sustain liquid water on its surface, a key ingredient for life as we know it.



Artist's impression of HD 20794 d Credit University of Oxford

Meetings

Spectroscopy of Exoplanets Over All Wavelengths 26-29 June 2025

High Leigh Conference Centre (Broxbourne, Hertfordshire)

In an era of challenging new spectroscopic observations of planets outside the Solar System, brown dwarfs and cool stars, it is essential to ensure the provision of adequate atomic and molecular data for analysis and interpretation. A meeting at which observers and those providing data may exchange ideas is being held in the idyllic Hertfordshire countryside at the end of June.

Exoplanets 6 29 June - 03 July 2026, Porto, Portugal

Exoplanet research is experiencing exciting times. Space missions and cutting-edge ground-based instruments are continually uncovering new populations of planets and enabling their detailed characterization. Along with advancements in theoretical models, these discoveries are providing unprecedented insights into the processes of planet formation and evolution, while also revealing the interiors and atmospheres of these distant worlds. In 2026, the PLATO mission will be launched, marking the beginning of a new chapter in this quest. Shortly after, missions like Roman and ARIEL, alongside the first generation of extremely large telescopes, will further complement this exploration. Together with current instruments and missions such as JWST and Gaia, a new window will open allowing a unique view into the diversity

and properties of exoplanets, from hot giant planets to cool Neptunes and rocky worlds. The stage is set to pursue one of the holy grails in the field: detecting and characterizing Earth-like planets, including searching for potential bio-signatures, and understanding their frequency in the Galaxy.

Exoclimes VII Montreal (Canada) from July 7 to 11, 2025.

Exoclimes VII conference will be organized by the Trottier Institute for Research in Exoplanets (https://exoplanetes.umontreal.ca/en/) and held in Montreal (Canada) from July 7 to 11, 2025. To maintain the collaborative spirit of Exoclimes, the number of participants will be limited to 200 Exoclimes is a conference series devoted to the atmosphere, climate, and evolution of sub-stellar bodies from solar system worlds to exoplanets and brown dwarfs.

Detection and Dynamics of Exoplanets (DDE): Interplay between theory and observations University of Coimbra, Portugal, 7 to 11 July 2025

Detecting and characterizing planets in multiple systems is not an easy task, because the traces of each body overlap, and the observations can be reproduced by different orbital configurations. Additionally, in many systems, planets are involved in mean motion resonances or resonant chains, making it even more difficult to disentangle the individual contributions. In the DDE meeting, we aim to bring together communities of observers and theoreticians working on exoplanets. Through the exchange of knowledge and difficulties, we hope that it will be possible to develop common strategies to extract the maximum constraints from 2025 Sagan 2025 Sagan Summer Workshop

2025 Sagan Summer Workshop. Silver Jubilee: Exoplanet Demographics

21-25 July 2025

The topic of the 2025 Sagan Summer Workshop will be the "Demographics of Exoplanets" and will address the contribution of each of the major planet-finding techniques to our overall knowledge of the architecture of exoplanet systems. Along with presentations about each technique and its particular strengths and biases, the workshop will address the synthesis of these results into a complete demographic picture for comparison with models of the formation and evolution of planetary systems. The Workshop will explore gaps in our knowledge and how future missions and surveys will address them. Of particular interest will be understanding the importance of a full demographic picture, including the incidence of Earth-sized

planets in the Habitable Zones of their host stars, to future missions such as the Habitable Worlds Observatory.

EPSC-DPS—EXOA13: Bridging geosciences and astronomy to interpret rocky (exo)planet observations. Finland Hall, Finland, 7-12 September 2025

The coming years will be revolutionary for rocky planet research, with JWST, ELT, ARIEL, and PLATO providing unprecedented observations of rocky exoplanets in our galaxy. At the same time, BepiColombo, the Mars sample return mission, and the Decade of Venus missions will greatly enhance our understanding of the rocky bodies within the Solar System. These missions will offer valuable new observations of the atmospheres and surfaces of these rocky bodies, while Solar System missions will also probe magnetic fields. Interpreting these observations, and leveraging them to constrain the body's interior properties, requires a deeper understanding of how a planet's surface, atmosphere, and interior interact.

EPSC-DPS—EXOA18: Investigating Habitability and Biosignatures within Exoplanet Atmospheres. Finland, 7-12 September 2025

JWST has enabled researchers across the globe to probe the atmospheric composition of exoplanets and investigate the properties of distant planetary systems. Future confirmed and conceptual campaigns such as the ELT, HWO and LIFE aim to pay greater attention to Earth-mass planets orbiting within the habitable zones of their host stars. In anticipation of these missions, this session focuses on the current and future search for biosignatures within the atmospheres of exoplanets, the identification of habitable worlds and the exploration of planetary conditions that support habitability. It solicits contributions from both observers using data collected by past and present instrumentation, as well as atmospheric, stellar activity, and interior modellers looking towards future observations. The session aims to foster new collaborations with observers, modellers, and instrument team members to assess how markers of life and habitability in distant systems may present themselves to us, and the requirements that future observing campaigns need to reliably identify them within planetary parameter space.

Rocky Worlds 4, 19–23 January 2026, Groningen, Netherlands

The planets that are best understood are the four terrestrial planets of our own solar system. Applying the detailed understanding gleaned from these bodies is crucial in our interpretation of exoplanetary systems. With the ongoing programs to search for planets around nearby stars, as well as upcoming ground- and space-based surveys, we can anticipate huge growth in the number and information on detected

rocky exoplanets in the coming decades. As the characterisation of these new planetary systems proceeds it will in turn improve understanding of our own solar system, and in particular of how potentially habitable Earth-like planets may form, evolve, and are distributed throughout the galaxy.

Astrobiology and the search for life elsewhere

The Carl Sagan Institute

Lisa Kaltenegger, the author of the book ‘Alien Earths, Planet Hunting in the Cosmos’ (see 2025 January issue), is the Director of the Carl Sagan Institute. It was founded in 2015 at Cornell University, New York state, USA to find life in the universe. Based on the pioneering work of Carl Sagan at Cornell, its interdisciplinary team is developing the forensic toolkit to find life in the universe, inside the Solar System and outside of it, on planets and moons orbiting other stars. Its website is well worth perusing.

Carl Sagan poses with a model of the Viking lander in Death Valley, CA in 1980.

NASA’s Asteroid Bennu Sample Reveals Mix of Life’s Ingredients

Studies of rock and dust from asteroid Bennu delivered to Earth by NASA’s OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification and Security–Regolith Explorer) spacecraft have revealed molecules that, on our planet, are key to life, as well as a history of saltwater that could have served as the “broth” for these compounds to interact and combine. The findings do not show evidence for life itself, but they do suggest the conditions necessary for the emergence of life were widespread across the early solar system, increasing the odds life could have formed on other planets and moons

The Local Galactic Transient Survey Applied to an Optical Search for Directed Intelligence

The paper, by Alex Thomas and others, explores the possibility of detecting extraterrestrial civilizations using laser-based communication signals. Traditional Search for Extraterrestrial Intelligence (SETI) efforts have focused on radio signals, but the increasing power of laser technology suggests that optical and near-infrared signals could be an alternative means of interstellar communication. The authors propose that an advanced civilization might use a strategy called "intelligent targeting," where laser pulses are directed at habitable zones in different star systems rather than being broadcast indiscriminately.

Publications

Papers

CHEOPS observations confirm nodal precession in the WASP-33 system

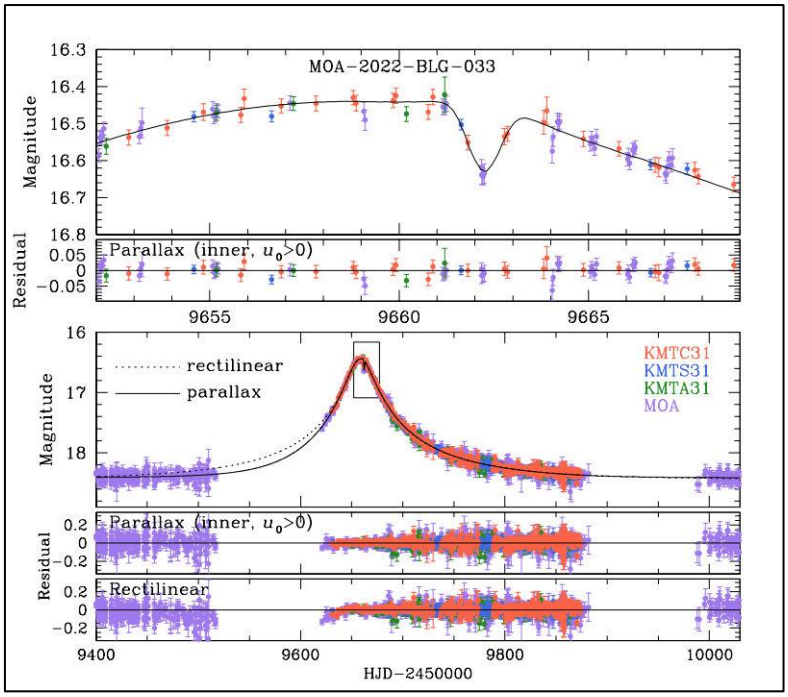
The aim was to observe the transits and occultations of WASP-33b, (also known as WASP-33Ab) which orbits a rapidly-rotating δ Scuti pulsator, with the goal of measuring the orbital obliquity via the gravity-darkening effect, and constraining the geometric albedo via the occultation depth. Methods: Four transits were observed and four occultations with CHEOPS, and a variety of techniques employed to remove the effects of the stellar pulsations from the light curves, as well as the usual CHEOPS systematic effects. A comprehensive analysis of low-resolution spectral and Gaia data to re-determine the stellar properties of WASP-33 was also performed. Nodal precession definition.

TOI-4504: Exceptionally large Transit Timing Variations induced by two resonant warm gas giants in a three-planet system.

This paper presents a joint analysis of TTVs and Doppler data for the transiting exoplanet system TOI-4504. TOI-4504 c is a warm Jupiter-mass planet that exhibits the largest known transit timing variations (TTVs), with a peak-to-node amplitude of $\sim$ 2 days, the largest value ever observed, and a superperiod of $\sim$ 930 d. TOI-4504 b and c were identified in public TESS data, while the TTVs observed in TOI-4504 c, together with radial velocity (RV) data collected with FEROS, allowed a third, non-transiting planet in this system to be uncovered, TOI-4504 d. Transits of TOI4504 b in the TESS data with a period of 2.4261±0.0001 days and a radius of 2.69±0.19 $R_\oplus$ were detected. The RV scatter of TOI-4504 was too large to constrain the mass of TOI-4504 b, but the RV signals of TOI-4504 c & d were sufficiently large to measure their masses.

MOA-2022-BLG-033Lb, KMT-2023-BLG-0119Lb, andKMT-2023-BLG-1896Lb: Three low mass-ratio microlensing planets detected through dip signals

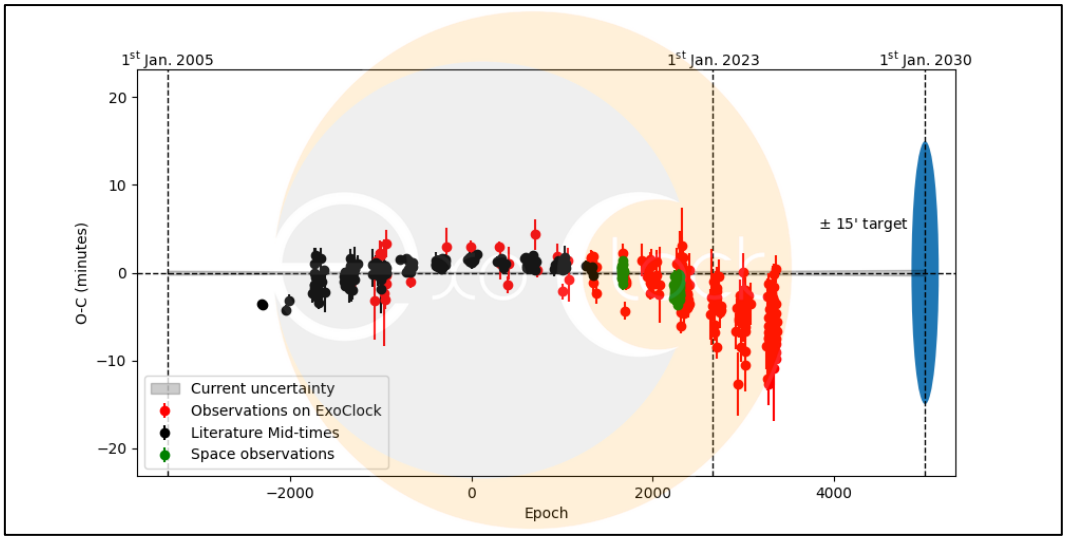
The authors of the paper examined the anomalies in the light curves of the lensing events MOA-2022-BLG-033, KMT-2023-BLG-0119, and KMT-2023-BLG1896. These anomalies share similar traits, occurring near the peak of moderately to highly magnified events and displaying a distinct short-term dip feature. They then conducted detailed modelling of the light curves to uncover the nature of the anomalies. This modelling revealed that all signals originated from planetary companions to the primary lens.



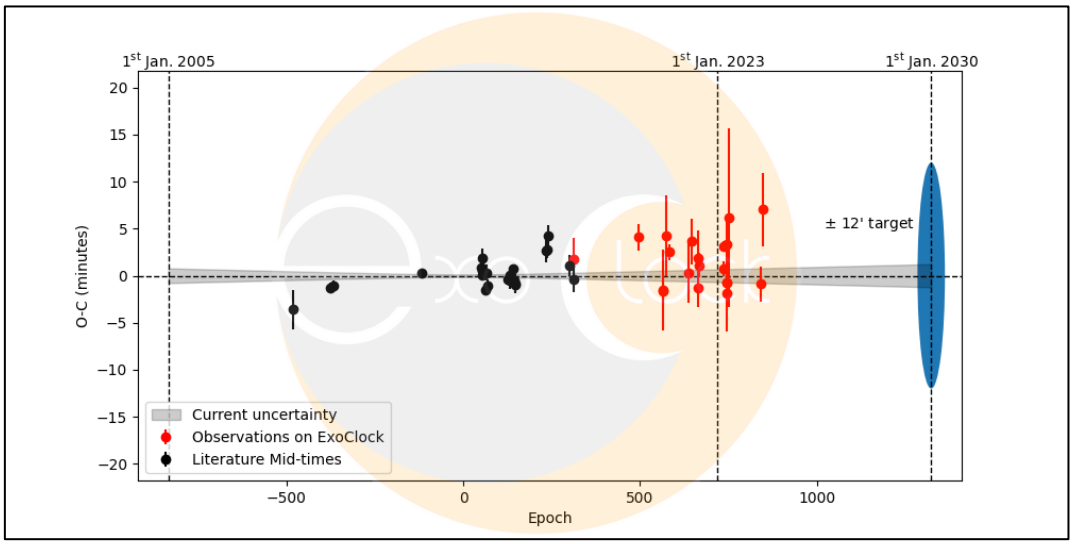
Light curve from the paper of the lensing event MOA-2022-BLG-033 and the model curve. The lower panel offers a comprehensive view of the event, while the upper panel provides a close-up view of the anomaly (the region enclosed by a box in the lower panels.

Exoplanet Ephemerides Change Observations (ExoEcho). I. Transit Timing Analysis of Thirty-Seven Exoplanets using HST/WFC3 Data

The ExoEcho project is designed to study the photodynamics of exoplanets by leveraging high precision transit timing data from ground- and space-based telescopes. Some exoplanets are experiencing orbital decay, and transit timing variation (TTV) is a useful technique to study their orbital period variations. In this study, we have obtained transit middle-time data from the Hubble Space Telescope (HST) observations for 37 short-period exoplanets, most of which are hot Jupiters. Examples of variations in orbital period are WASP-12b (decay) and HAT-P-26b (increasing period). ExoClock data (below) shows these trends.



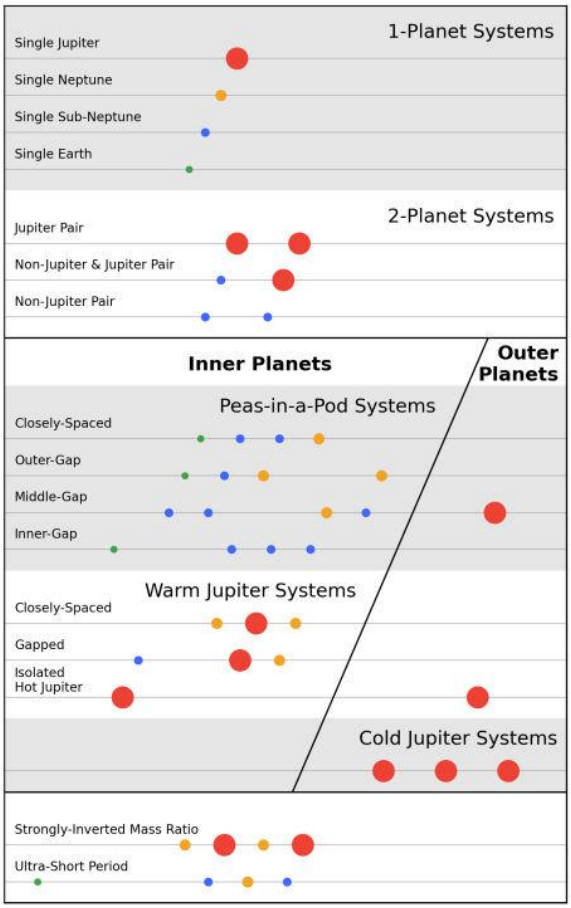
WASP-12b observations from the ExoClock database



HAT-P-26b observations from the ExoClock database

Architecture Classification for Extrasolar Planetary Systems

This paper presents a classification framework for the architectures of planetary systems based on a complete survey of the confirmed exoplanet population. With nearly 6000 confirmed exoplanets discovered, including more than 300 multiplanet systems with N ≥3 planets, the current observational sample has reached the point where it is both feasible and useful to build a classification system that divides the observed population into meaningful categories. This framework provides a criterion to split planetary systems into inner and outer regimes, and then further divides inner systems into dynamical classes.



Quick-reference chart for the classification of planetary systems from the paper CARMENES as an Instrument for Exoplanet Research

CARMENES stands for Calar Alto high-Resolution search for M dwarfs with Exoearths with Near-infrared and optical Échelle Spectrographs. CARMENES took six years from a concept to the start of operations, and a couple more years of initial data collection until the first science publication, but now is revolutionising our knowledge on exoplanets and their stars in our immediate vicinity. Here we describe what CARMENES is: (i) an ultra-stabilised two-channel spectrograph at an almost dedicated 3.5 m telescope in southern Spain that covers in high spectral resolution and without big gaps from 0.52 µm to 1.71 µm; (ii) a science project aimed at comprehensively searching for and studying planetary systems with nearby, bright, M-dwarf hosts, but that also investigates transiting planets around other stars; and (iii) the German-Spanish consortium that designed and built the instrument and that has operated it under guaranteed and legacy time observations.

Space missions

Exobiology Extant Life Surveyor (EELS)

EELS is designed to go places no one has ever seen before, on its own, without real-time human input. The concept for this self-propelled, autonomous robot was inspired by the desire to descend the narrow, geyser-spewing vents in the icy crust of Saturn's moon Enceladus in order to look for signs of life in the ocean below.

EELS 1.0 on the ice Version 1.0 of JPL's EELS robot raises its head from the icy surface of Athabasca Glacier in Alberta, Canada, during field testing in September 2023. Credit NASA/JPL-Caltech

The Pandora Smallsat

Pandora Smallsat home page

The Pandora SmallSat is a NASA flight project aimed at studying the atmospheres of exoplanets—planets orbiting stars outside our Solar System. Pandora will provide the first dataset of simultaneous, multiband (visible and NIR), long baseline observations of exoplanets and their host stars. Pandora is an ambitious project that will fly a 0.44 m telescope in a small form factor. To achieve the scientific goals, the

mission requires a departure from the traditional cost-schedule paradigm of half-meter-class observatories. Pandora achieves this by leveraging existing capabilities that necessitate minimal engineering development, disruptive and agile management, trusted partnerships with vendors, and strong support from the lead institutions. The Pandora team has developed a suite of high-fidelity parameterized simulation and modeling tools to estimate the performance of both imaging channels. This has enabled a unique bottom-up approach to deriving trades and system requirements. Pandora is a partnership between NASA and Lawrence Livermore National Laboratory. The project completed its Critical Design Review in October 2023 and is slated for launch into Sun-synchronous, low-Earth orbit in Fall 2025.

Roger Dymock
ARPS Assistant Director Exoplanets

If you have any comments, articles, etc which you would like included please let me know.