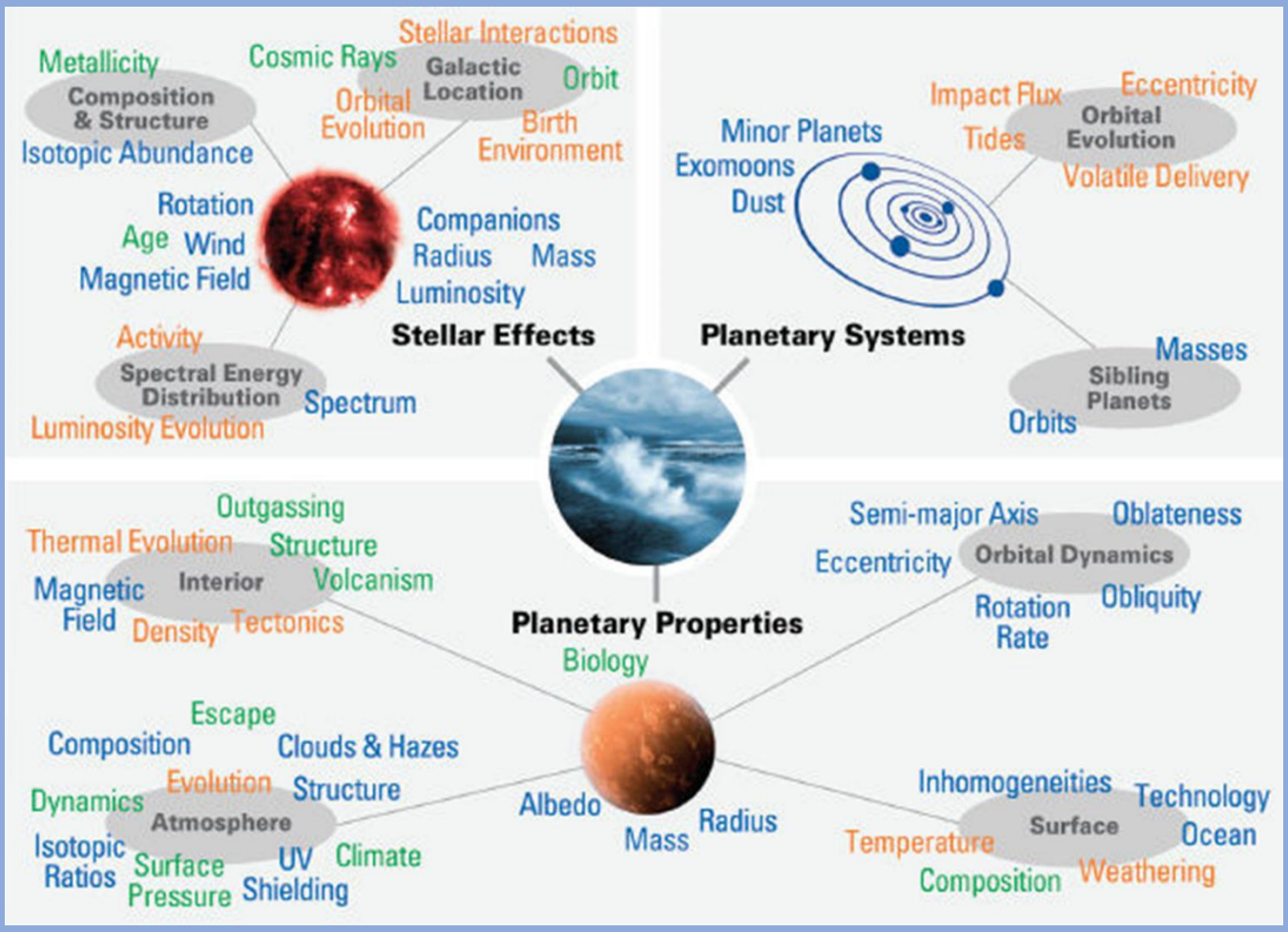
British Astronomical Association
Supporting amateur astronomers since 1890

Infinite Worlds



The e-magazine of the

Exoplanets Division
of the
Asteroids and Remote Planets Section

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Contents

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Exoplanets Division website

Front page image from 'Factors Affecting Exoplanet Habitability'. Credit
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Project update

PLATO

The Ground Observation Program is beginning to take shape and amateur astronomers will be able to participate – more details to follow in due course. The original project document is here.

EXopLanet Out-of-transit Research - EXPLORE

A new project which might also be described as 'beyond ExoClock'.

- support the ARIEL/ExoClock program by observing transits
- search for other planets and moons in known planetary systems using both observations and simulation.

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

Microlensing

Exoplanet Division involvement has been suspended due to very low uptake. Individuals may of course continue to participate and submit results to the BHTOM website. The project document is here.

News

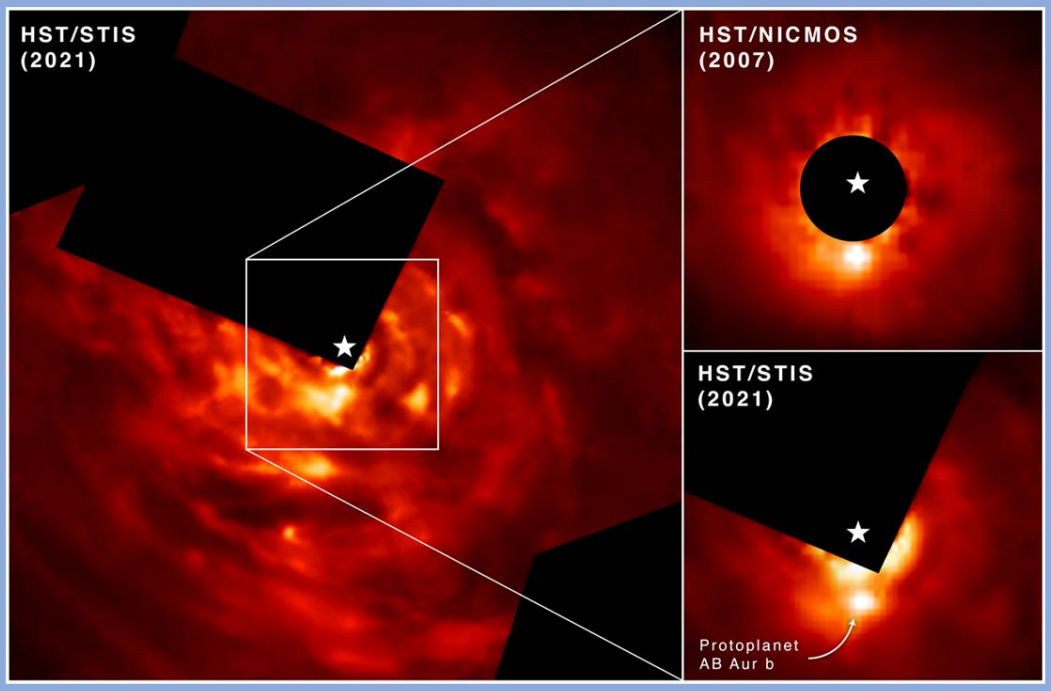
Hubble observations used to answer key exoplanet questions.

Archival observations of 25 hot Jupiters by the NASA/ESA Hubble Space Telescope have been analysed by an international team of astronomers, enabling them to answer five open questions important to our understanding of exoplanet atmospheres. Amongst other findings, the team found that the presence of metal oxides and hydrides in the hottest exoplanet atmospheres was clearly correlated with the atmospheres' being thermally inverted.

China is hatching a plan to find Earth 2.0
Nature article here
After sending robots to the Moon, landing them on Mars and building its own space station, China is now eyeing distant solar systems. The mission will aim to survey planets outside the Solar System in other parts of the Milky Way, with the goal of finding the first Earth-like planet orbiting in the habitable zone of a star just like the Sun. Astronomers think such a planet, called an Earth 2.0, would have the right conditions for liquid water — and possibly life — to exist.

Want to search for habitable exomoons?
This paper lists those exoplanets which may harbour a habitable exomoon. This study focuses on big, rocky exomoons that are capable of maintaining a significant atmosphere.

Recent discoveries
AB Auriga b



CREDITS: SCIENCE: NASA, ESA, Thayne Currie (Subaru Telescope, Eureka Scientific Inc.) IMAGE PROCESSING: Thayne Currie (Subaru Telescope, Eureka Scientific Inc.), Alyssa Pagan (STScI)

Researchers were able to directly image newly forming exoplanet AB Aurigae b over a 13-year span using Hubble's Space Telescope Imaging Spectrograph (STIS) and its Near Infrared Camera and Multi-Object Spectrograph (NICMOS). In the top right, Hubble's NICMOS image captured in 2007 shows AB Aurigae b in a due south position compared to its host star, which is covered by the instrument's coronagraph. The image captured in 2021 by STIS shows the protoplanet has moved in a counter clockwise motion over time.

Kepler-1708 b-i is likely undetectable with HST

Paper by Ben Cassese, David Kipping

The exomoon candidate Kepler-1708 b-i was recently reported using two transits of Kepler data. Supported by a 1% false-positive probability, the candidate is promising but requires follow-up observations to confirm/reject its validity. In this short paper, we calculate the detectability of the exomoon candidate's transit in the next window (March 2023) using the WFC3 instrument aboard the Hubble Space Telescope (HST). Although the noise properties of the James Webb Space Telescope (JWST) have not yet been characterized in flight, we estimate the signal would be easily recovered using NIRSpec operating in its Bright Object Time Series mode.

Comets around Beta Pictoris

An international science team has detected 30 exocomets in orbit around the star Beta Pictoris – the first time the size distribution of small bodies has been measured in a planetary system other than our own. The team used NASA's Transiting Exoplanet Survey Satellite (TESS) to determine the various sizes of the comets. The nuclei of the comets, or their solid, central portions, ranged between 1.8 and 8.6 miles (3 to 14 kilometers) across. The scientists were able to detect such small bodies at such a great distance by spotting their long tails as they crossed the face of their star.

This artist's impression shows exocomets orbiting the star Beta Pictoris. Astronomers analysing observations of nearly 500 individual comets made with the HARPS instrument at ESO's La Silla Observatory have discovered two families of exocomets around this nearby young star. The first consists of old exocomets that have made multiple passages near the star. The second family, shown in this illustration, consists of younger exocomets on the same orbit, which probably came from the recent breakup of one or more larger objects. Credit: ESO/L. Calçada

Conferences/Meetings/Seminars/Webinars/Videos

A video of the Gresham college lecture 'The Future of Life on Earth' given by Professor Roberto Trotta on 2022 May 9th. Although life is probably widespread in the universe, our pale blue dot, Earth, is the only known place harbouring intelligent life. Even if we manage to stave off extinction by climate change, avoid a nuclear apocalypse and the dangers of runaway AI, biological life on our planet will eventually come to an end in about 5 billion years' time. What are the astrophysical dangers to life on Earth, and the prospects for life's survival into the distant future?

IAU Symposium 370: Winds of stars and exoplanets

IAU General Assembly 2022, August 2-11, Busan, Republic of Korea. Winds form an integral part of astronomy - from regulating rotation of stars through enriching galaxies with fresh materials, winds persist during the entire lives of stars and play a key role in shaping the observed exoplanet demographics.

Latsis Symposium: The Origin and Prevalence of Life, 2022 August 30 – September 2

What is life? Where, when and how did life arise on Earth? What ingredients were likely present and how were they delivered to Earth? Why and how did life increase in complexity after a period of ~2 billion years of apparently slow evolution? How did the development of life depend on the surface and interior evolution of the (young) Earth? Under what conditions is life possible and is life likely to exist on other planets or celestial bodies?"

The "Origin and Prevalence of Life" Latsis symposium will – from the perspective of modern natural sciences - discuss our current understanding of possible answers to these questions, highlight controversial viewpoints and discuss how they could be reconciled, and help prioritize and coordinate future research activities at the national and international level.

Forming and Exploring Habitable Worlds, 2022 November 7-13

Forming and Exploring Habitable Worlds is a multi-discipline four to five day international scientific 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.

Publications

In his RAS Free Public Lecture, 'Space exploration and the search for extra-terrestrial life -- with humans and with robots' given on 2022 May 17th. Martin Rees (Lord Rees of Ludlow, OM, FRS, UK's Astronomer Royal) mentioned two books;

The End of Astronauts: Why Robots are the Future of Exploration by himself and Donald Goldsmith

The Age of Spiritual Machines: When Computers Exceed Human intelligence by Ray Kurzwell

Martin Rees's view is that space exploration is better left to robots and that human space faring should be the province of the likes of Elon Musk and Jeff Bezos. The reason being that the likes of NASA and ESA, being publicly funded, would not be prepared to take the risks involved. The privateers, not having to answer to governments or the people, would be and would also attract the risk takers to their missions to Mars for example.

Analysing Transit Timing Variations of Qatar-1b

AAVSO paper. This study investigates 13 transits of Qatar-1b from archival data collected using 6-inch telescopes in the MicroObservatory network. The purpose of this transit analysis was to update transit midpoints of Qatar-1b to maintain the ephemeris. Additionally, the study sought to uncover trends in the transit data, which could provide more information about the exoplanet. In order to achieve this goal, the EXOplanet Transit Interpretation Code (EXOTIC) pipeline was used to process these transits and generate light curves, which were contributed to the American Association of Variable Star Observers (AAVSO) Exoplanet Database. The analysis of the data did not indicate the presence of other planets in the system. This study contributes observations of the star system Qatar-1b and supports the current ephemeris of this planet.

Astrobiology

Life on Earth

In his book 'Otherlands – A World in the Making' Thomas Halliday describes how the first fossilised specimen of a Charnia, a frond like lifeform from the Ediacaran period (635-541 million years ago) was found in Charnwood forest in Leicestershire. Charnia is possibly one of the oldest lifeforms ever discovered and right beneath our feet!

Charnia masoni index fossil, Leicester Museum & Art Gallery, Leicester. Credit Andy Dingley

Planetary Habitability by Stephen R Kane
Understanding planetary habitability is one of the major challenges of the current scientific era, and is a vast inter-disciplinary undertaking that combines planetary science, climate science, and stellar astrophysics. This book provides an overview of the many processes that influence the energy balance of planetary surface environments and control the sustainability of temperate conditions.

Life in the Universe
A Gresham College lecture by Professor Katherine Blundell OBE. How can life form in the Universe, and what are the necessary ingredients for habitability so that planets can sustain life? Can we expect life elsewhere in the solar system, or on exo-planets? This lecture offers a broader perspective from astrobiology, astrochemistry, and astrophysics on the habitability or otherwise of other planets beyond Planet Earth.

Webs sites of interest
Leverhulme Centre for Life in the Universe
The Leverhulme Centre for Life in the Universe (LCLU) brings together researchers from Cambridge's Cavendish Laboratory, Institute of Astronomy, Department of Applied Mathematics and Theoretical Physics, Yusuf Hamied Department of Chemistry, Department of Earth Sciences, Department of Zoology, Department of History and Philosophy of Science, Faculty of Divinity, and the MRC Laboratory of Molecular Biology to enable cross-disciplinary research on the origin, nature, and distribution of life in the Universe.

The Search for Life Elsewhere (or possibly closer to home)
NASA to Set Up Independent Study on Unidentified Aerial Phenomena
NASA is commissioning a study team to start early in the fall (Autumn to us Brits) to examine unidentified aerial phenomena (UAPs) – that is, observations of events in the sky that cannot be identified as aircraft or known natural phenomena – from a scientific perspective. The study will focus on identifying available data, how best to collect future data, and how NASA can use that data to move the scientific understanding of UAPs forward. The limited number of observations of UAPs currently makes it difficult to draw scientific conclusions about the nature of such events. Unidentified phenomena in the atmosphere are of interest for both national security and air safety. Establishing which events are natural provides a key first step to identifying or mitigating such phenomena, which aligns with one of NASA's goals to ensure the safety of aircraft. There is no evidence UAPs are extra-terrestrial in origin (to which I concur – RD).

A Beacon in the Galaxy: Updated Arecibo Message for Potential FAST and SETI Projects
Paper. An updated, binary-coded message has been developed for transmission to extra-terrestrial intelligences in the Milky Way galaxy. The proposed message includes basic mathematical and physical concepts to establish a universal means of communication followed by information on the biochemical composition of life on Earth, the Solar System's time-stamped position in the Milky Way relative to known globular clusters, as well as digitized depictions of the Solar System, and Earth's surface. The message concludes with digitized images of the human form, along with an invitation for any receiving intelligences to respond. Calculation of the optimal timing during a given calendar year is specified for potential future transmission from both the Five-hundred-meter Aperture Spherical radio

Telescope in China and the SETI Institute's Allen Telescope Array in northern California to a selected region of the Milky Way which has been proposed as the most likely for life to have developed. These powerful new beacons, the successors to the Arecibo radio telescope which transmitted the 1974 message upon which this expanded communication is in part based, can carry forward Arecibo's legacy into the 21st century with this equally well-constructed communication from Earth's technological civilization.

Space missions

ARIEL and CHEOPS (from the ExoClock newsletter 2022 June 11)

While the majority of targets within the ExoClock database can be, and have been, followed-up with telescopes from the ground, some are simply too faint, shallow, or long. In these cases, a space-based facility is required. CHEOPS (the CHaracterisating ExOPlanets Satellite) is one space-based telescope that could help us in our mission and every year the facility asks the community for observational proposals for time on the telescope. Therefore, this year we submitted a proposal to observe 9 planets which we believed were difficult, or impossible, from the ground or with TESS. CHEOPS orbits the Earth roughly every 100 minutes and this is the unit of time that is used for awarding observing time. We are pleased to announce we were awarded 130 orbits of time on the spacecraft (~215 hours) to observe 6 targets. Each target will have 2 or 3 transits acquired over the next year or so. For the 3 other targets, it was deemed that either TESS or ground-based telescopes could follow them up.

UK leads new European exoplanet mission

The mission – called Ariel – will study the gases that enshroud some 1000 extrasolar planets to address fundamental questions about how they formed and evolved. Due to launch in 2029, it is the first mission dedicated to this type of analysis. Some £30 million of funding is being supplied by the UK as part of an agreement with ESA member states that confirmed roles for the mission. Proposed by an international consortium led by University College London (UCL), Ariel was selected by ESA from 26 proposals put forward to be the next ‘medium class mission’ in its science programme. It is the third of a trio of dedicated ESA exoplanet missions, following Cheops – which launched in 2019 – and Plato, scheduled for launch in 2026.

James Web Space Telescope

According to the JWST Science Policy Group, over the next year, JWST will spend a full quarter of its time studying exoplanets, and 8.2% of its exoplanet observations staring at the distant star TRAPPIST-1. TRAPPIST-1 is an ultracool M-dwarf, the smallest class of star. Discovered in 2016 and 2017 by the Transiting Planets and Planetesimals Small Telescope (TRAPPIST), seven rocky planets — TRAPPIST-1b, c, d, e, f, g, and h — closely orbit their diminutive host star.

TRAPPIST-1 SYSTEM ARTIST CONCEPT WITH STAR This illustration shows what the TRAPPIST-1 system might look like from a vantage point near planet TRAPPIST-1f (at right).Image: NASA / JPL-Caltech

Space – stepping stones to other star systems

Moon

NASA to set up brewery on the Moon?

The yeast to be used in the experiment is used in wine making. baking and brewing and can help to tell us if humans could survive on the Moon's surface. The BioSentinel mission was selected as one of the secondary payloads, and the sole biological experiment, to fly on the first launch of the Space Launch System rocket for the Artemis I mission. The primary objective of BioSentinel is to develop a biosensor instrument to detect and measure the impact of space radiation on living organisms over long durations beyond low-Earth Orbit (LEO). While progress identifying and characterizing biological radiation effects using Earth-based facilities has been significant, no terrestrial source can fully simulate the unique radiation environment encountered in deep space.

The BioSentinel biosensor utilizes the budding yeast Saccharomyces cerevisiae to query the biological response to ambient deep space radiation, including DNA damage like the formation of double strand breaks (DSBs). DSBs are deleterious DNA lesions that are generated by exposure to highly energetic particles in the deep space radiation spectrum, and that are often repaired without errors by the cell. The biosensor contains two genetically engineered yeast strains: a wild type strain that serves as a control for yeast health and "normal" DNA damage repair, and a rad51 deletion strain, which is defective for DNA damage repair, and will therefore undergo alterations to growth and metabolism as it accumulates radiation damage. These changes will be detected by the biosensor payload.

Plants grown in lunar soil

Scientists have grown plants in soil from the moon, a first in human history and a milestone in lunar and space exploration. In a new paper published in the journal "Communications Biology," University of Florida researchers showed that plants can successfully sprout and grow in lunar soil. Their study also investigated how plants respond biologically to the moon's soil, also known as lunar regolith, which is radically different from soil found on Earth. This work is a first step toward one day growing plants for food and oxygen on the moon or during space missions. More immediately, this research comes as the Artemis Program plans to return humans to the moon.

Mars

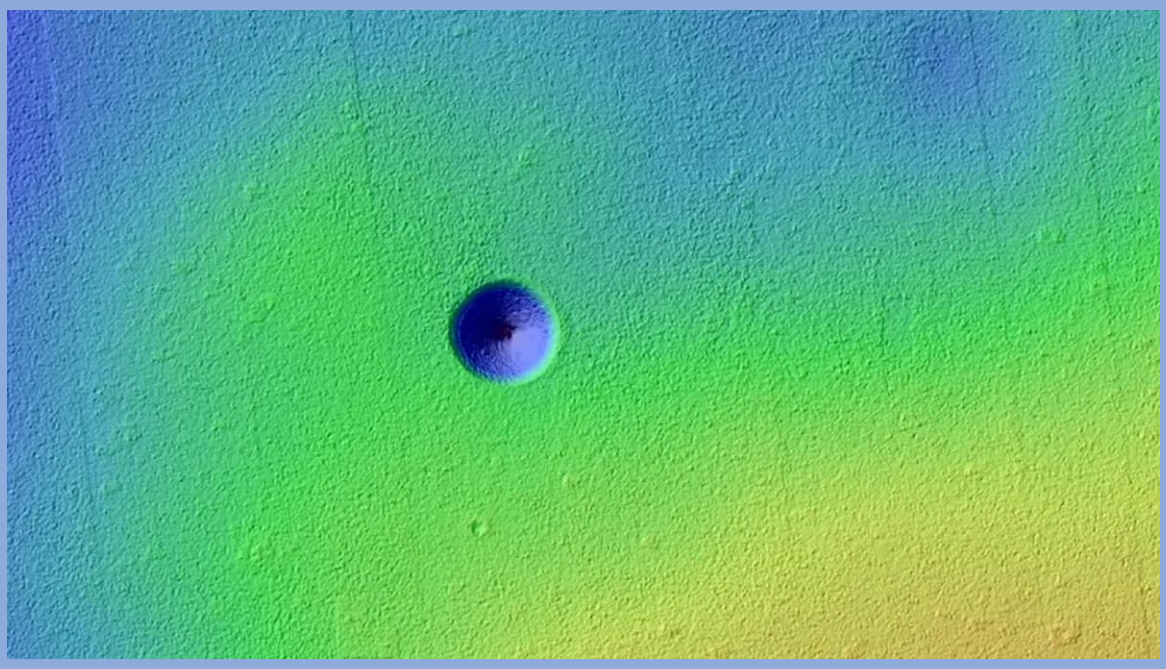
Why the Boring Company is key to Elon Musk's Mar's colony. Using lava tubes as underground habitats. Thanks to Steve Knight for this 15 min video.

Lava tubes: the hidden sites for future human habitats on the Moon and Mars

Lava tubes, underground caves created by volcanic activity, could provide protected habitats large enough to house streets on Mars or even towns on the Moon, according to research presented at the European Planetary Science Congress (EPSC) 2017 in Riga. A further study shows how the next generation of lunar orbiters will be able to use radar to locate these structures under the Moon's surface.

CNET – Welcome to Mars series

A series exploring the red planet.



This massive pit found on the Pavonis Mons volcano on Mars may possibly be an entrance to a lava tube below. Credit NASA/JPL/UArizona

Roger Dymock
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