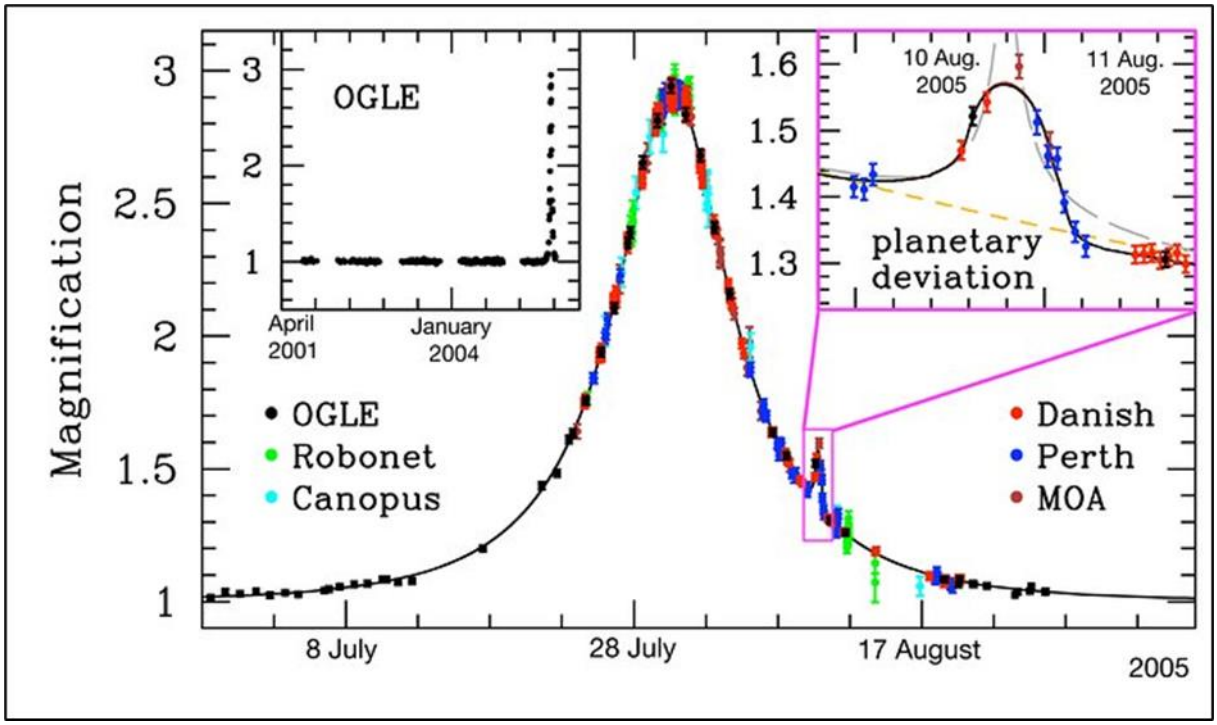
British Astronomical Association
Supporting amateur astronomers since 1890

Infinite Worlds



Light curve of microlensing event OGLE-2005-BLG-390 Credit ESO

The e-magazine of the Exoplanets Division Of the Asteroids and Remote Planets Section

Issue 11 2021 July

Contents

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Exoplanet Technical Advisory Group (ETAG)

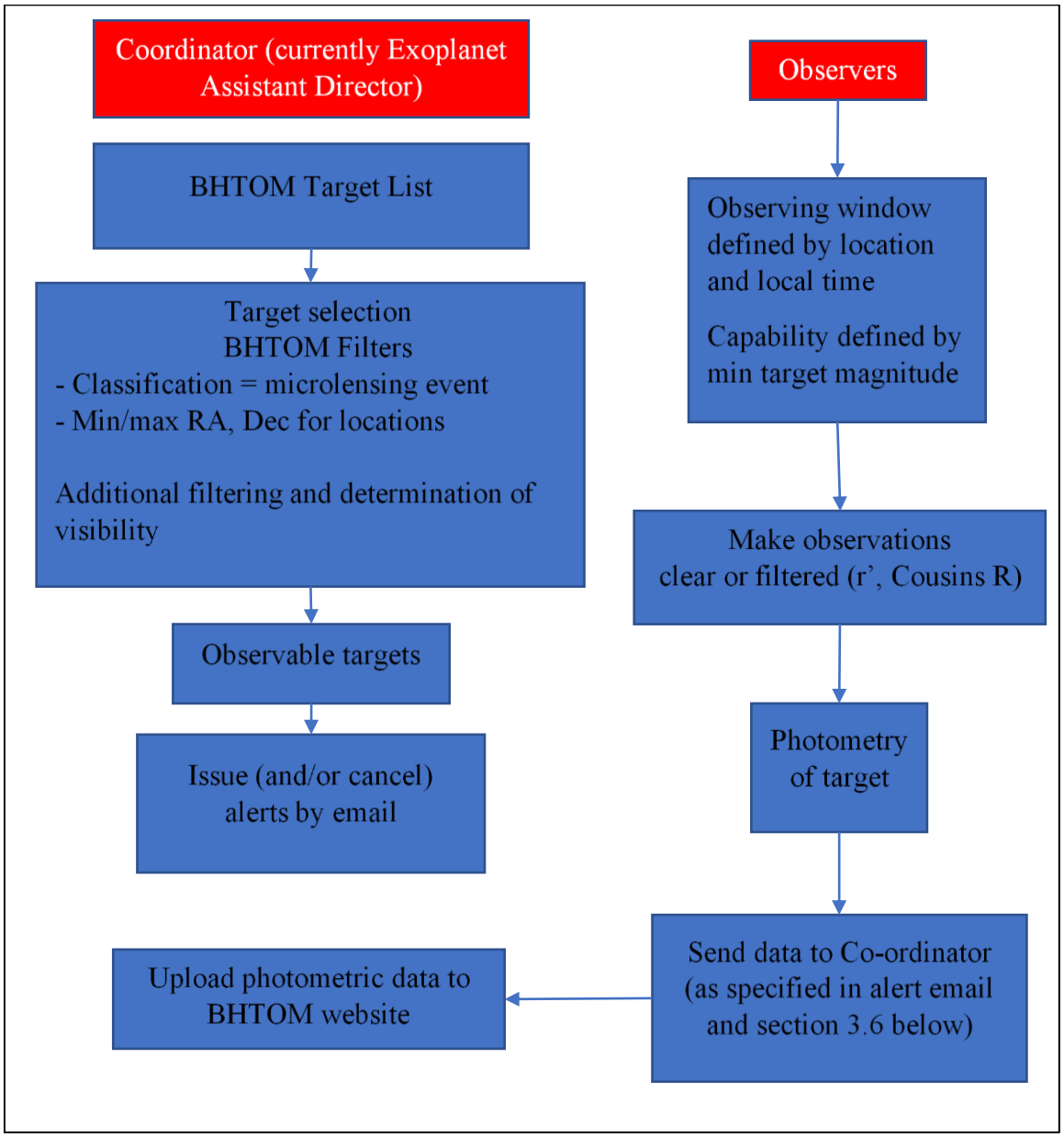
Simon Downs, Steve Futcher, Paul Leyland, David Pulley, Mark Salisbury, Americo Watkins

Microlensing Search for Exoplanets – new pro-am project

Introduction

We at the early stages in this project so your involvement would be most welcome. You will notice that the required frequency of observations is typically, daily, and that there are likely to be just a handful of targets available at any one time, so it should quite easily fit with any other observing program you may be following. The advantage over comet and supernovae hunting is that we do know where to look. Now that the nights are getting longer you have more opportunity to participate in this project!!!

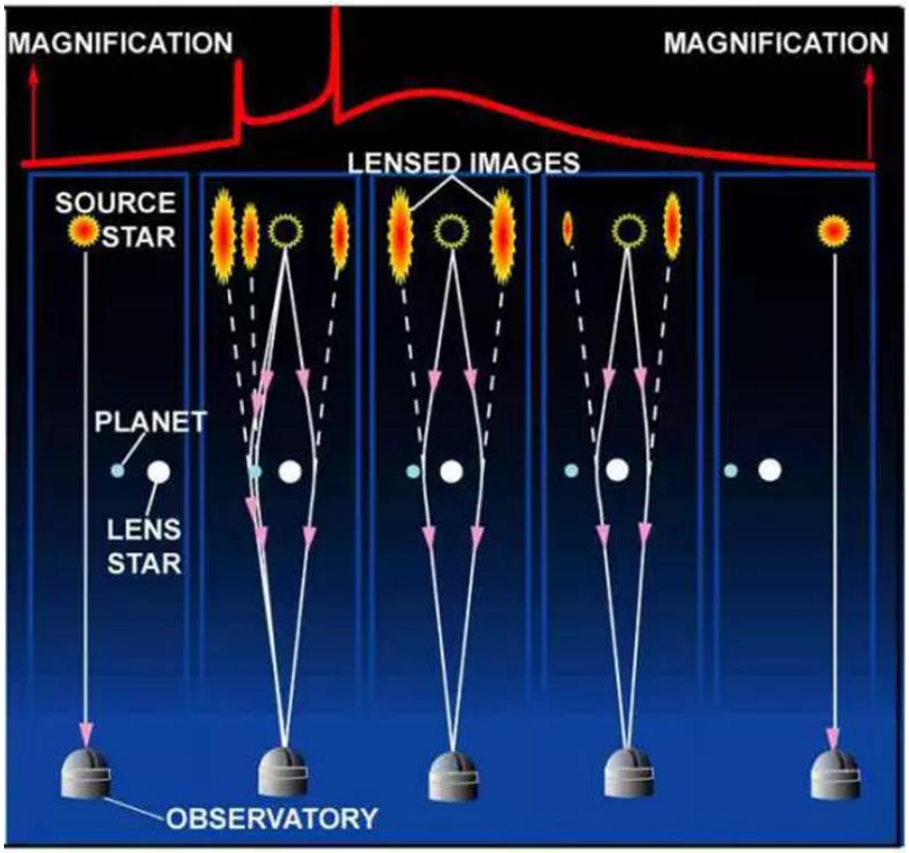
The process flowchart below outlines the steps to be taken by both coordinator and observers.



The project document, observations received and alerts are available here.

What is Gravitational Microlensing?

Gravitational microlensing is an observational effect that was predicted in 1936 by Einstein using his General Theory of Relativity. When one star in the sky appears to pass nearly in front of another, the light rays of the background source star become bent due to the gravitational "attraction" of the foreground star. This star is then a virtual magnifying glass, amplifying the brightness of the background source star, so we refer to the foreground star as the lens star. If the lens star harbours a planetary system, then those planets can also act as lenses, each one producing a short deviation in the brightness of the source.



Planet detection through microlensing

Thus, we discover the presence of each exoplanet, and measure its mass and separation from its star. This technique will tell us how common Earth-like planets are and will guide the design of future exoplanet imaging missions.

141 planets have been discovered from the ground using this technique (2021 March 31). For updates go to the Exoplanet.eu catalog and select Microlensing in the Detection drop-down box. The Nancy Grace Roman Space Telescope microlensing survey will detect many more such planets, including smaller mass planets since the planet "spike" will be far more likely to be observed from a space-based platform. This will lead to a statistical census of exoplanets with masses greater than a tenth of the Earth's mass from the outer habitable zone out to free floating planets. The results from the Roman Space Telescope microlensing survey will

complement the exoplanet statistics from Kepler, and will provide answers to questions about planet formation, evolution, and the prevalence of planets in the galaxy.

An animation can be viewed at https://svs.gsfc.nasa.gov/20242 from which the above text was taken.

See also;
https://en.wikipedia.org/wiki/Gravitational_microlensing#:~:text=Gravitational%20microlensing%20is%20an%20astronomical,of%20the%20light%20they%20emit

News

Peta Bosley

Sad to say that Peta Bosley passed away in hospital on the night of Tuesday April 22nd. Peta, a lively soul who could always give as good as she got, was one of the members of the Exoplanet Technical Advisory Group with a particular interest in astrobiology.

European Space Agency's future missions

ESA's large-class science missions for the timeframe 2035-2050 will focus on moons of the giant Solar System planets, temperate exoplanets or the galactic ecosystem, and new physical probes of the early Universe.

Exoplanet moons?

The paper https://arxiv.org/pdf/2105.12040.pdf was referred to in the Exoplanet News dated 15 June 2021. It mentions the possibility of CHEOPS being able to detect exoplanet moons.

I asked David Brown for his view which is included below.
The signals from even large exomoons are very difficult to detect, and more difficult to distinguish from systematic effects brought on by either the instrument or the data processing. But as the quality of our data improves there is no reason why we shouldn't eventually detect one (relatively) unambiguously, unless they're rare (which seems unlikely based on what we know about planetary system formation and extrapolating from the Solar system).

My initial reaction was that CHEOPS could do it in the right circumstances. It would need to be a bright star (to reduce the scatter in the light curve), with multiple transits of the planet observed (which can be combined to further reduce the scatter), and a relatively large moon (to give a larger signal). The question then becomes "how likely is this scenario", which is a harder question to quantify.

The paper you linked is really interesting. I hadn't considered using tidal theory to model how many exomoons are likely to exist and survive long enough to be detected. The results seem quite encouraging on first read through, though I'd like to go back through the paper in a bit more detail.

There's a 2015 paper from the same group that specifically looks at detectability of exomoons with CHEOPS: https://arxiv.org/pdf/1508.00321.pdf They're reasonably confident that CHEOPS should be able to do it.

I also had a look at the CHEOPS "Red Book", which is the report produced while a space mission is being fully defined and scoped. There's a small section dedicated to exomoons in there, which is also quite optimistic about CHEOPS being able to detect exomoons.

David's presentation on CHEOPS at this years virtual Winchester Weekend can be viewed at https://www.youtube.com/watch?v=XY94FePOwNs after a short talk by myself on the Exoplanet Division.

AN INDEPENDENT ANALYSIS OF THE SIX RECENTLY CLAIMED EXOMOON CANDIDATES by David Kipping finds 'no compelling evidence for exomoons amongst the six KOIs (Kepler Objects of Interest) studied'.

Strange patterns in starlight may (or may not) have revealed moons orbiting exoplanets. Credit dotted zebra / Alamy

Read more: https://www.newscientist.com/article/2247150-astronomers-have-spotted-six-possible-exomoons-in-distant-star-systems/#ixzz71R0rlIok

The California Legacy Survey

Astronomers began a census, called the California Legacy Survey, over three decades ago, and are now releasing a new batch of results. One pattern to emerge from the data is that giant planets tend to reside about 1 to 10 astronomical units (AU) from their host stars, a mostly icy region located beyond the temperate zone of a star. An AU is defined as the distance from Earth to our sun, or about 93 million miles. This is similar to what we see in our own solar system: Earth orbits at 1 AU, Jupiter is situated at about 5 AU, and Saturn at 9 AU.

Recent discoveries

Confirmed exoplanets

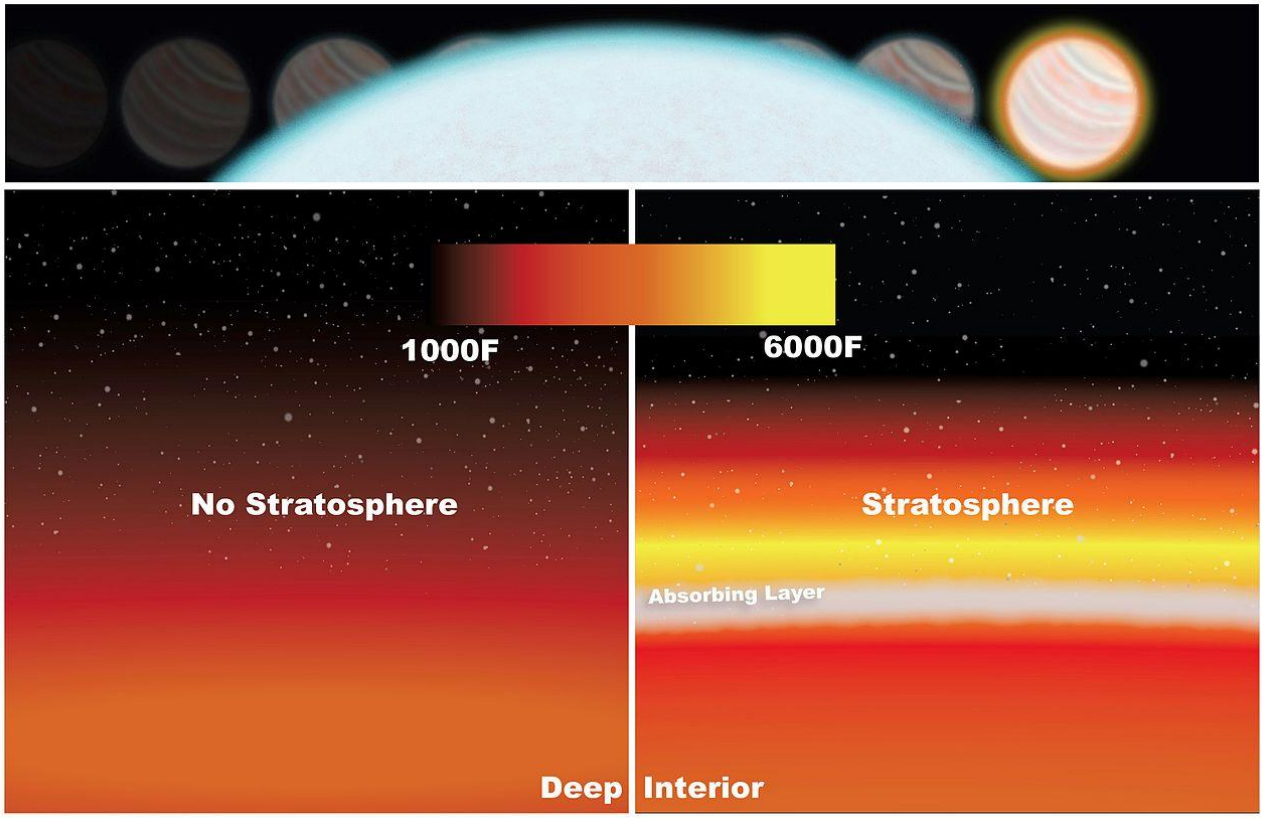
Total stands at 4438 as of 2021 July 20. Access the NASA Exoplanet Archive for a breakdown of confirmed and candidate exoplanets.

Exoplanet GJ 1132b – atmospheric reformation

Scientists using NASA's Hubble Space Telescope have found evidence that this planet, which orbits a distant star, may have lost its original atmosphere but gained a second one through volcanic activity.

The first detection of a hydroxyl radical (OH) emission signature in an exoplanetary atmosphere - WASP-33b

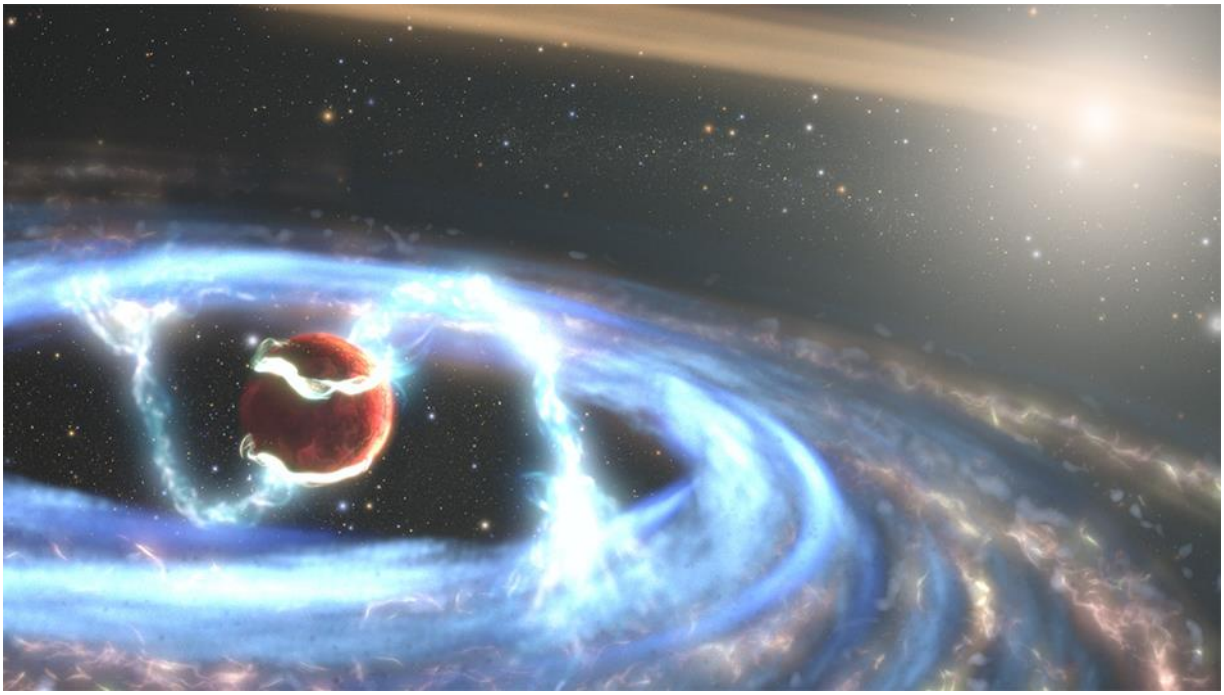
Hydroxyl results from the destruction of water molecules in hot atmospheres – that of WASP-33b reaches 3200°C. A weak water signal was also detected.



Atmosphere of WASP-33b was detected by monitoring light as the planet passed behind its star (top)—higher temperatures result in the low stratosphere due to molecules absorbing radiation from the star (right)—lower temperatures at higher altitudes would result if there were no stratosphere (left). Credit NASA/Goddard

WASP-33b orbits HD15082, located 399 light years away, every 1.2 days at a distance of 3.8 million kilometres. In comparison Mercury's orbit varies from 69.8 to 46.0 million kilometres and its orbital period is 88 days.

Building an exoplanet



Gas and dust are slowly being drawn in as exoplanet PDS 70b builds mass over millions of years. Credit NASA/Hubble site

Researchers using the Hubble Space Telescope measured the mass growth rate for the first time by using the observatory's unique ultraviolet sensitivities to capture radiation from extremely hot gas falling onto the planet. The massive, Jupiter-sized world orbits at approximately the same distance as Uranus does from the Sun moving through gas and dust as it does so. The planet, which began forming approximately 5 million years ago, may be in the tail end of its formation process.

Conferences/Meetings/Seminars/Webinars

Stellar activity and rocky planet detection
Recently, Professor Don Pollacco (University of Warwick) gave the above titled talk to Hampshire Astronomical Group. As he summarises;
- the effects we are trying to measure are always small
- planet detection and characterization is never trivial and prone to large errors
- The measurements get more difficult for smaller and lower mass planets
- as measurements are made relative to the host star then if the star varies the planet measurements are less well defined (implications for atmospheres)
- knowledge of the host is vital: "Know your star, know your planet."
- to put it bluntly, the devil is in the detail – as you will see

Europlanet Science Congress 2021
ODAA4 Open planetary science for effective knowledge co-creation and dissemination.
Convenor: Anastasia Kokori, Co-convenor: Angelos Tsiaras **(**both of the ExoClock project).

Rocky Worlds II, 2022 January 10-12, Oxford, England

National Astronomy Meeting 2021 2021 July 19-23. University of Bath, England
Included in the Special Lunches/discussion sessions is 'Pro-Am collaborations in support of space missions (Friday 23rd July)' by Angelo Tsiaras, Anastasia Kokori, Billy Edwards. In this session they will showcase projects that are built on the collaboration between amateur and professional astronomers with the interest of supporting space missions.

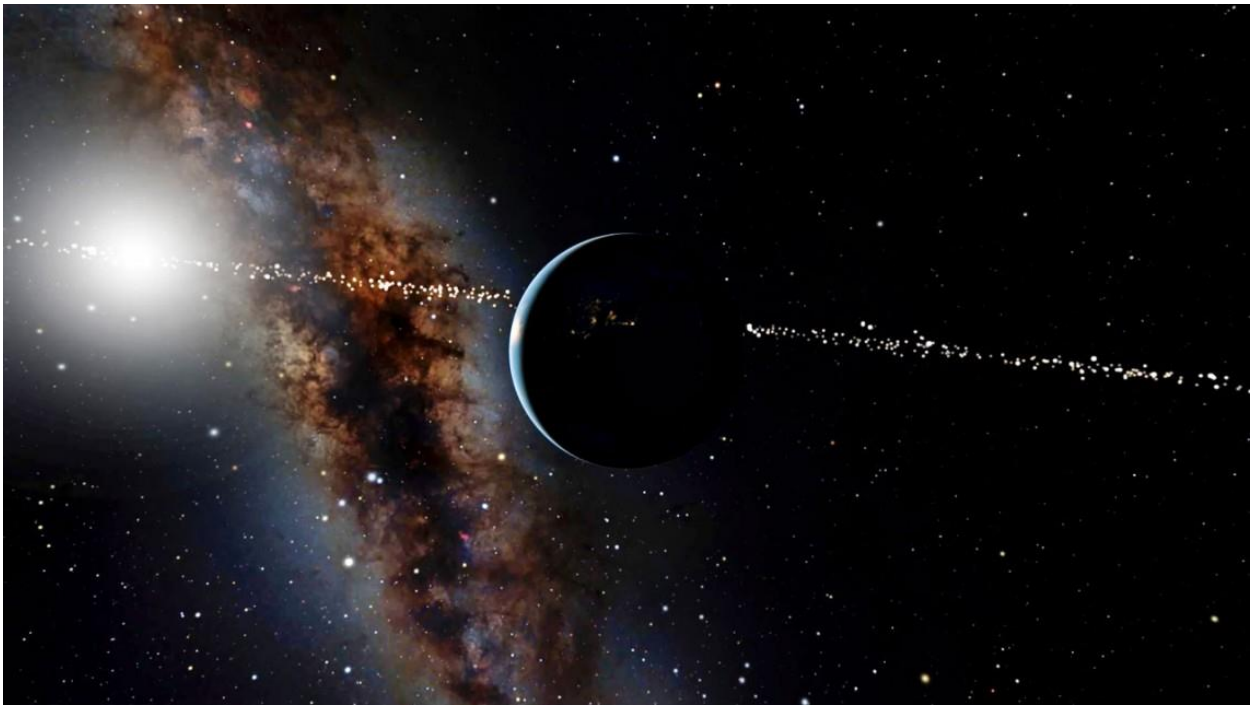
The Nexus for Exoplanet System Science (NExSS) Technosignatures Working Group webinar An introduction to Technosignatures and Their Connection to Searches for Biosignatures

The Institutions of Extraterrestrial Liberty
A four-day series of seminars hosted by the University of Edinburgh (Edinburgh Futures Institute and UK Centre for Astrobiology) with the British Interplanetary Society (UK), the Open Lunar Foundation (US) and the Institute for Liberal Studies (Canada) exploring the conditions for freedom beyond Earth. This is not about the search for life beyond Earth, but it is about the human future beyond Earth and how human societies might evolve over time, which is very much captured by Astrobiology.
Agenda
Recordings
Day 1: https://tinyurl.com/4t7zjv72
Day 2: https://tinyurl.com/2f9n4b72
Day 3: https://tinyurl.com/48rbba2k
Day 4: https://tinyurl.com/5bbey7pr

SETI

Exoplanets get a cosmic front-row seat to find backlit Earth

Perhaps they are watching us. Scientists at Cornell and the American Museum of Natural History have identified 2,034 nearby star-systems – within the small cosmic distance of 326 light-years – that could find Earth merely by watching our pale blue dot cross our sun.



With the plane of the Milky Way galaxy seen stretching from the top to the bottom of the image, this artistic view of the Earth and sun from thousands of miles above our planet, shows that stars (with exoplanets in their own system) can enter and exit a position to see Earth transiting the sun. Credit OpenSpace/American Museum of Natural History

Publications – Books

The Next 500 Years by Christopher E Mason, published by MIT Press

An argument that we have a moral duty to colonize other planets and solar systems--because human life on Earth has an expiration date. Inevitably, life on Earth will come to an end, whether by climate disaster, cataclysmic war, or the death of the sun in a few billion years. To avoid extinction, we will have to find a new home planet, perhaps even a new solar system, to inhabit. In this provocative and fascinating book, Christopher Mason argues that we have a moral duty to do just that.

Twenty Worlds by Niall Deacon, published by Reaktion Books

Thirty years ago the only planets we knew were the ones orbiting our own Sun; we now know of thousands of other worlds orbiting distant stars. In this book astronomer Niall Deacon journeys to twenty of these globes: from giant, blisteringly hot planets orbiting close to their parent stars to planets that float through the cold wilderness of space alone, and from dead stars shredding asteroids to worlds made of diamond and even planets that may be similar to the Earth. Deacon also takes in the latest exoplanet discoveries, and explains how astronomers have come to learn so much about these strange and distant worlds.

The American Astronomical Society (AAS) have partnered with IOP Publishing to create an exciting new collection of astronomy and astrophysics ebooks to further the AAS mission: "to enhance and share humanity's scientific understanding of the universe.

Publications – Papers

Ariel – Enabling planetary science across the light-years

Ariel, the Atmospheric Remote-sensing Infrared Exoplanet Large-survey, was adopted as the fourth medium-class mission in ESA's Cosmic Vision programme to be launched in 2029. During its 4-year mission, Ariel will study what exoplanets are made of, how they formed and how they evolve, by surveying a diverse sample of about 1000 extrasolar planets, simultaneously in visible and infrared wavelengths. It is the first mission dedicated to measuring the chemical composition and thermal structures of hundreds of transiting exoplanets, enabling planetary science far beyond the boundaries of the Solar System.

The Demographics of Exoplanets; B Scott Gaudi, J L Christiansen and M R Meyer

Astrobiology

Course - Astrobiology: Exploring other worlds

In this course we explore the field of astrobiology, an emerging multidisciplinary field. Progress in astrobiology is driven by telescopes on the ground and in space, and by new insights on how life emerged on Earth and its diversity. The topics in this course range from the science of how exoplanets are detected, to the chemistry that supports the argument that the ingredients for life are common in the Universe.

Course Emergence of life

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!

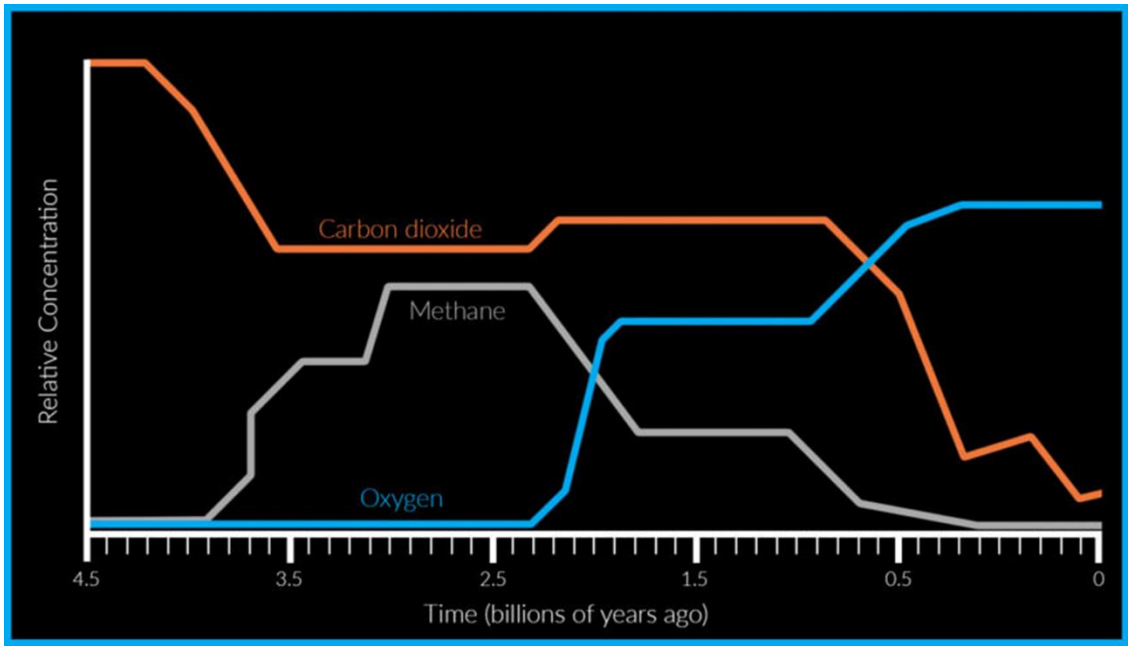
Billion-year-old fossil found in Scotland

A team of scientists, led by the University of Sheffield in the UK and Boston College in the USA, has found a microfossil which contains two distinct cell types and could be the earliest multicellular animal ever recorded. The fossil reveals new insight into the transition of single celled organisms to complex multicellular animals. Modern single celled holozoa include the most basal living animals, the fossil discovered shows an organism which lies somewhere between single cell and multicellular animals.

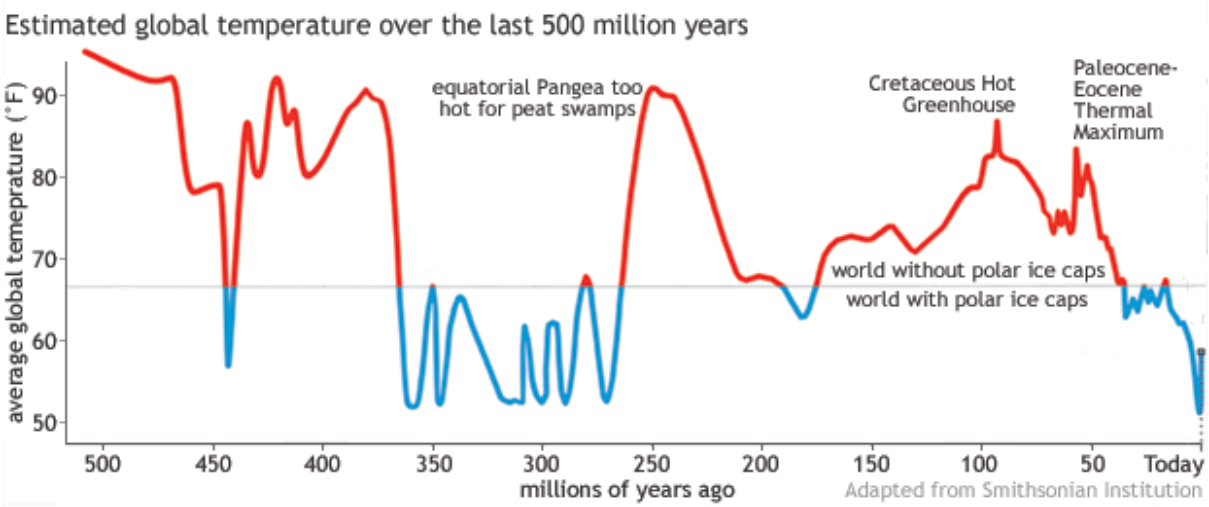
What was Earth like before the age of Dinosaurs?

17 minute video – Thanks to Steve Knight, HAG

Graphs of Earth's atmosphere and temperature referred to in the video.



Composition of Earth's atmosphere



Earth's temperature

Space – stepping stones to other star systems

The Moon

Onwards to the Moon (protests by Blue Origin and Dynetics permitting)– SpaceX Starship SN15 makes a high-altitude test flight and, finally, a safe landing.

Space X StarshipSN15 on the launch pad.

Moon habitat blueprint at Venice Biennale – a detailed concept for a lunar habitat.

Mars

"The First 10,000 Days on Mars" 15 Minute long YouTube video (thanks to Steve Knight, HAG). The story begins in 2024 when Elon Musk and SpaceX launch 5 cargo ships to Mars. They land at Erebus Montes, paving the way for future humans to land, the construction of Mars Base Alpha, plants to grow, and later for a self-sustainable Mars colony. This Mars colonization mini documentary also covers what it is like living on Mars, how many people will be landing during each launch window mission, the Starship fleet, and how the Martian colony grows over the years, between 2024 to 2050. Additional footage from: NASA/JPL/University of Arizona, European Space Agency, SpaceX, AI Space Factory, HASSEL, Tesla, The Boring Company

It might not be quite as straight forward as this video suggests. For an alternative view read the trilogy; Red Mars, Green Mars and Blue Mars by Kim Stanley Robinson.

Exoplanets

It's been suggested that an advance party of robots will be needed if humans are ever to settle on other planets. Sent ahead to create conditions favourable for humankind, these robots will need to be tough, adaptable and recyclable if they're to survive within the inhospitable cosmic climates that await them. The Autonomous Robot Evolution (ARE) project brings together scientists and engineers from four universities in an ambitious four-year project to develop this radical new technology.

Roger Dymock
ARPS Assistant Director Exoplanets