British Astronomical Association
Supporting amateur astronomers since 1890

Infinite Worlds

Location of possible planet in M51 Credit ESA

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

Issue 13 2022 January

Contents

Section officers

ARPS Section Director	Dr Richard Miles
Assistant Director (Astrometry)	Peter Birtwhistle
Assistant Director (Occultations)	Tim Haymes
Assistant Director (Exoplanets)	Roger Dymock

Exoplanet Technical Advisory Group (ETAG)

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

Exoplanets Division website

News

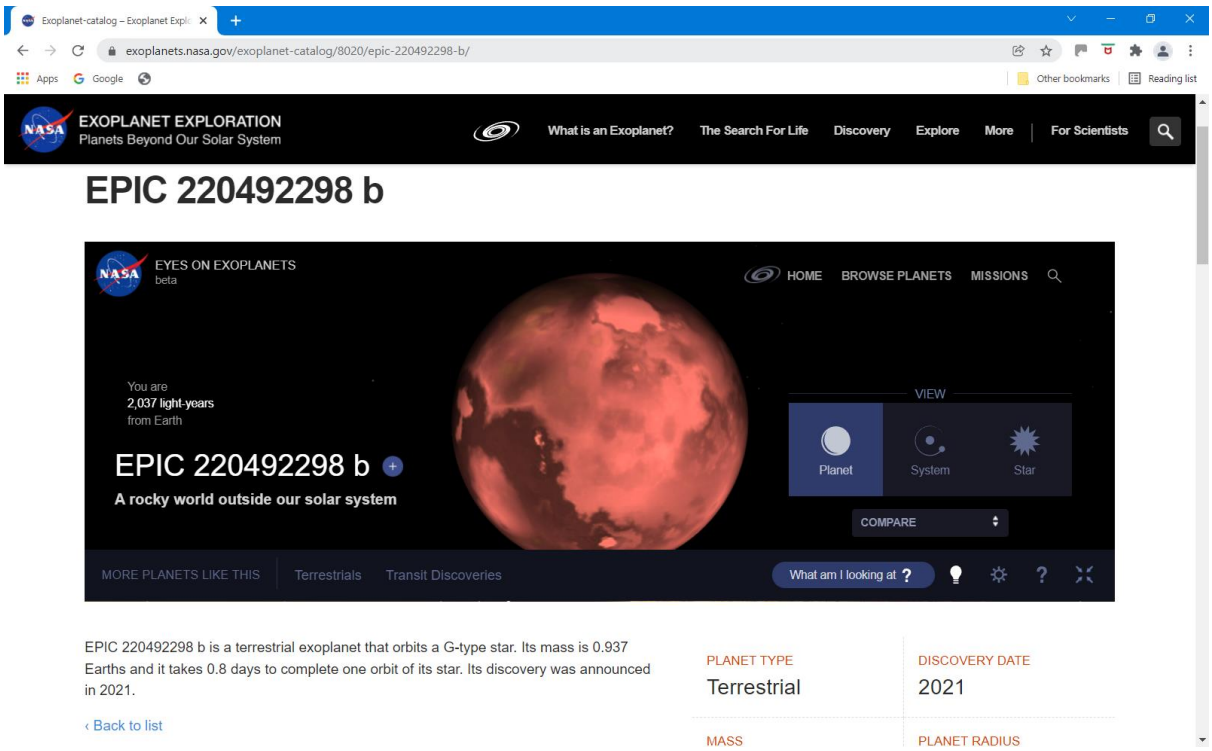
A NASA website of interest – Exoplanet Exploration – Planets Beyond Our Solar System

A quick tour;

- select Discovery
- select Exoplanet Catalog

You can then search by planet name or apply filters e.g; Terrestrial

- select EPIC 220492298 b from list. You can then select data on the; planet (screen shot below), system or star



Example of data from the NASA Exoplanet Exploration website

Recent discoveries

Could this be a planet in another galaxy?

Using ESA's XMM-Newton and NASA's Chandra X-ray space telescopes, astronomers have made an important step in the quest to find a planet outside of the Milky Way. Rosanne di Stefano and colleagues searched in Chandra and XMM-Newton data of three galaxies for such X-ray transits, dips in the light that could be explained by planets. And they found a very special signal in the Whirlpool Galaxy (M51) that they decided to study in more detail. The dip occurred in X-ray binary M51-ULS-1 and completely blocked the signal for a few hours, before it came back again. (see image on Page 1)

Football fans might recognise the name di Stefano. Alfredo di Stefano (1926 – 2014) was regarded as one of the greatest footballers of all time.

Astronomers detect gas released in a giant planetary collision

Artist's impression of impact Credit Institute of Astronomy, University of Cambridge

An international team of astronomers from MIT, the National University of Ireland at Galway, University of Cambridge, and elsewhere have discovered evidence of a giant impact that occurred in a nearby star system, just 95 light years from Earth. The study represents the first detection of a planetary atmosphere that was vaporised by a giant impact**.**

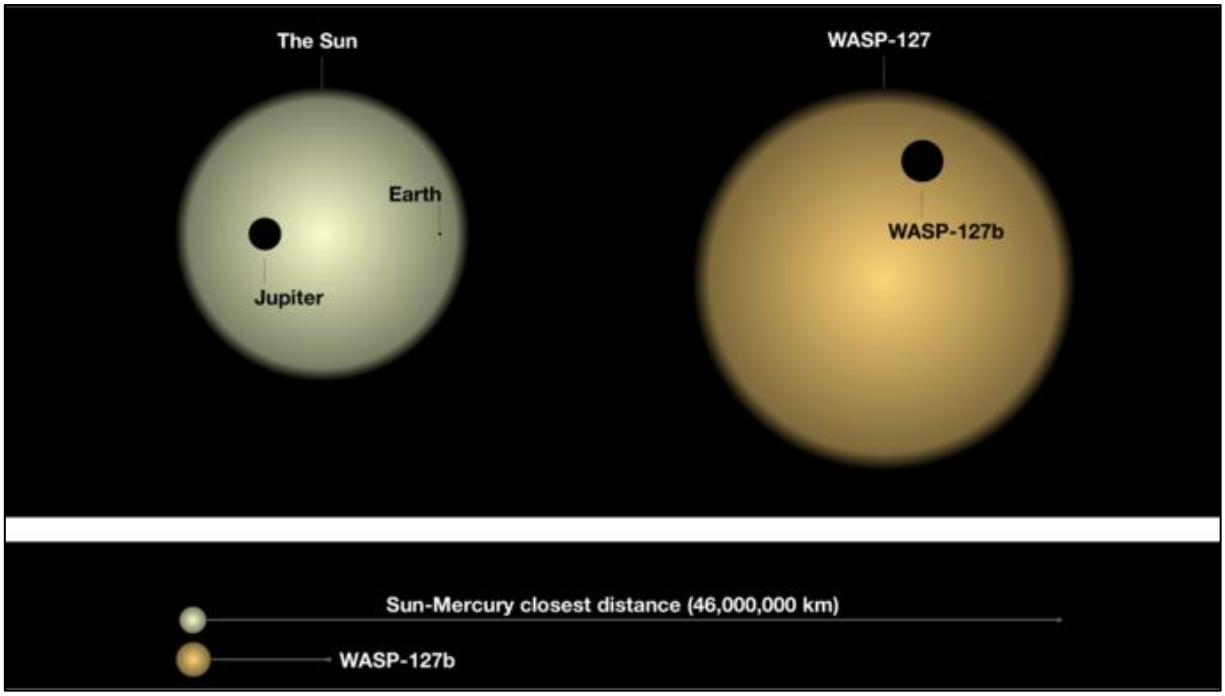
Auroras on nineteen stars hint at hidden exoplanets

An international team of scientists including Leiden's Joe Callingham has discovered nineteen red dwarf stars that unexpectedly emit radio waves. The outbursts possibly originate from interaction with exoplanets. The results of the research appear in two scientific publications.

https://www.universiteitleiden.nl/en/news/2021/10/auroras-on-nineteen-stars-hint-at-hidden-documentexoplanets

Water vapour detected on WASP-127b

The atmosphere exoplanet called WASP-127b has been observed in greater detail than ever before. When probing different regions of WASP-127b's atmosphere scientists detected sodium. Normally, the presence of this element would not come as much of a surprise in such an alien planet, but the element was found at a much lower altitude than expected. Scientists also observed strange water vapor signals that were strong in the infrared but non-existent at visible wavelengths. his implies that water-vapor at lower levels is being screened by clouds that are opaque at visible wavelengths but transparent in the infrared.



Comparison of WASP-127 and the Solar System. Credit David Ehrenreisch, Universite de Geneva and Romain Allart, Universite de Montreal

Polluted white dwarfs

Prior studies have hypothesized that some polluted white dwarfs record continent-like granitic crust—which is abundant on Earth and perhaps uniquely indicative of plate tectonics. But these inferences derive from only a few elements, none of which define rock type. This paper presents the first estimates of rock types on exoplanets that once orbited polluted white dwarfs—stars whose atmospheric compositions record the infall of formerly orbiting planetary objects.

Observing

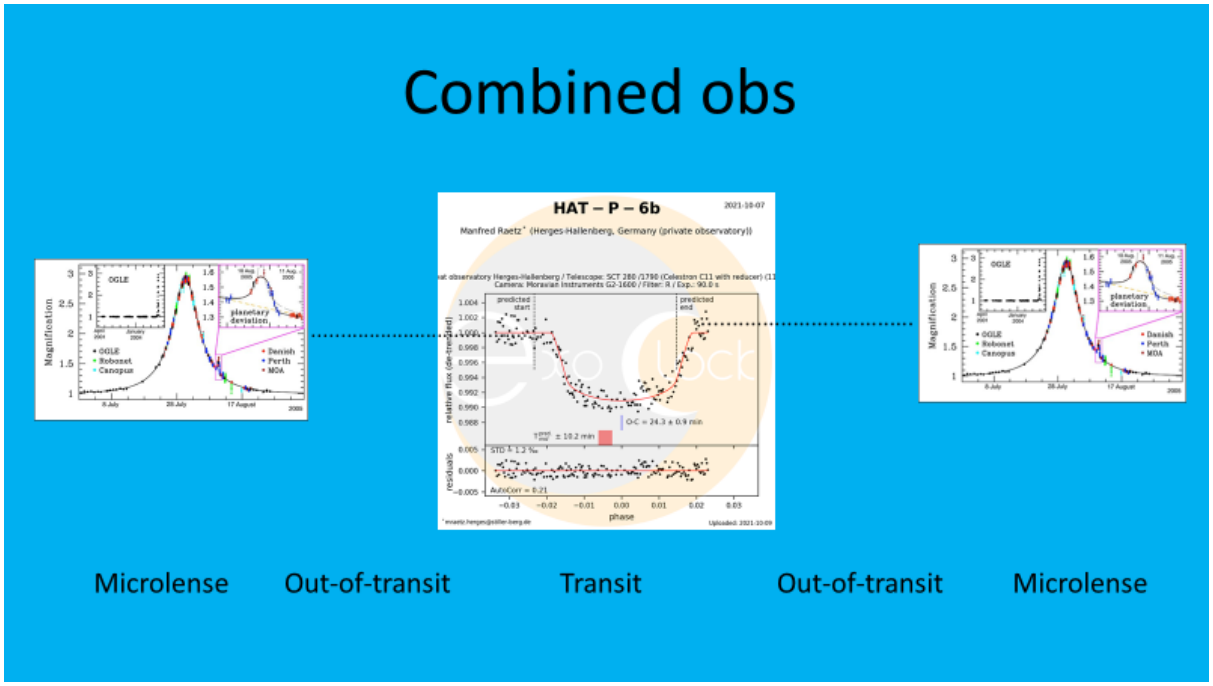
Multi-tasking

For those of you who like to spend long nights at the telescope you could consider combining three observing projects as shown in the diagram below.

1) Microlensing – take an observation at the start and end of your session, ideally every 2 – 3 hours

2) Out-of-transit – image the transit target for as long as possible before and after the known transit to look for additional planets. Such a project is described in Bruce Gary's book 'Exoplanet observing for amateurs'. Available as a pdf or paperback

3) Observations of a known transit over a long period of time may show timing variations which could indicate the presence of another planet

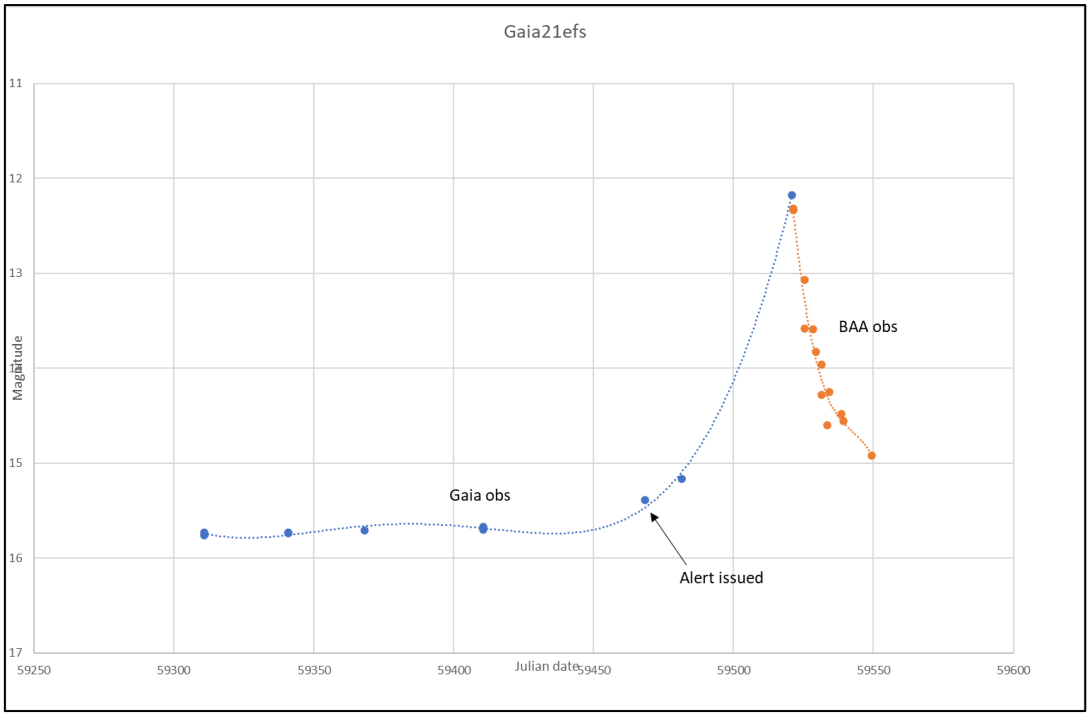


Multi-tasking – three for the price of one

Exoplanet Division project - Microlensing event Gaia21efs

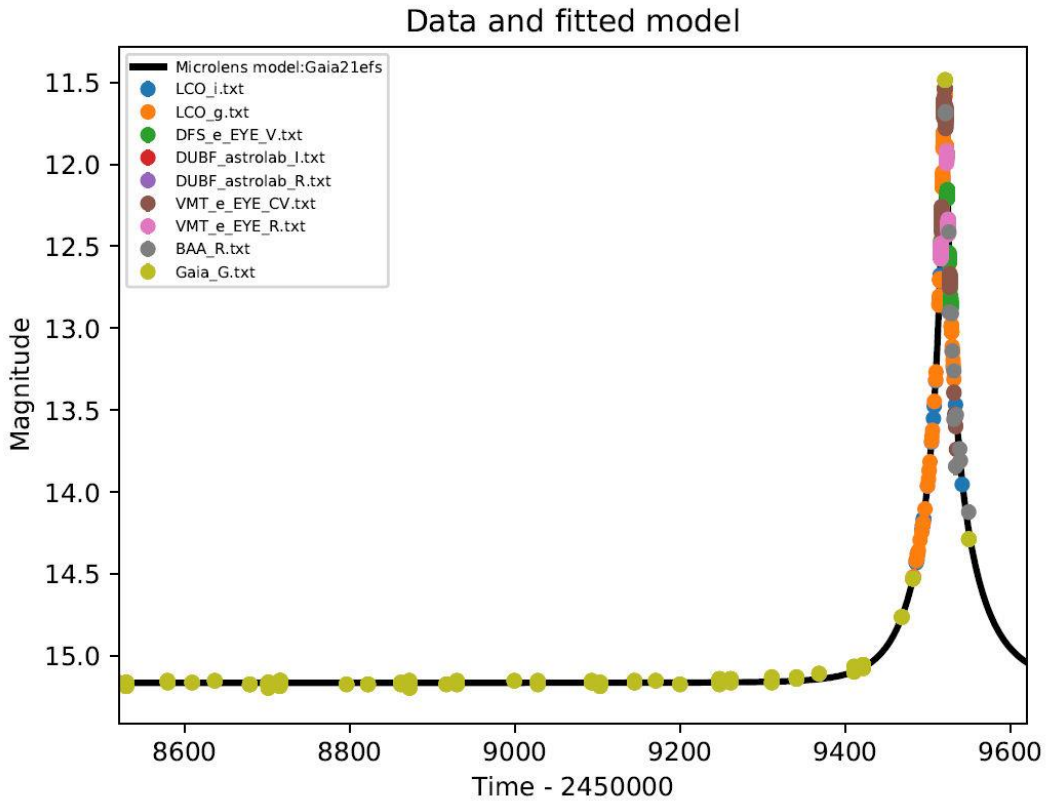
Gaia21efs was a priority target which the Exoplanet Division was requested to observe by Siegfried Vanaverbeke (Postdoctoral researcher at KU Leaven University). It was located at RA 20:29:41.9 Dec +31:17:43 and had a quiescent (Gaia) magnitude; 15.8. It was classified as a candidate microlensing event or Be type outburst by the Cambridge University Gaia Photometric Alerts facility - http://gsaweb.ast.cam.ac.uk/alerts/alert/Gaia21efs/ An alert was issued to BAA Asteroid and Remote Planets Section (which includes the Exoplanet Division) on 2021 November 2

Unfortunately, poor weather prevented continuous observation of this object by BAA members but it was followed from its maximum back to close to its quiescent magnitude – Figure 1.



Gaia and BAA observations of Gaia21efs

Figure 2 shows data from the listed observers combined by Siegfried Vanaverbeke (Belgian VVS, astrolab IRIS and University of Concepcion, Chile) who points out that 'We need accurate measured values for the distance of the source and its angular diameter to compute the mass and distance of the lens'.



Gaia21efs light curve Credit Siegfried Vanaverbeke

Robin Leadbeater obtained several spectra of the source star, Figure 3. These ruled out the possibility of a Be stars brightening (These are hot main sequence B stars with H alpha emitting circumstellar discs which can drift up in brightness as the disc forms, and so mimic the early stage of a microlensing event.) The spectra showed no emission lines and identified it as a K type star, reddened by interstellar dust, likely a giant given the brightness at the parallax distance given by Gaia.

Robin noted; Spectra can only rule out or support the microlensing hypothesis, not confirm it. (Any changes in the spectrum would have indicated a potential alternative cause of the brightness change). There has been no significant change in the spectra as the star faded supporting the microlensing hypothesis. The shape and symmetry of the photometric light curve (Figure 2) now pretty much seals it as microlensing and my further spectra support that. (Only a microlensing event or eclipsing binary would be expected to leave the spectrum unchanged through a significant change in brightness)

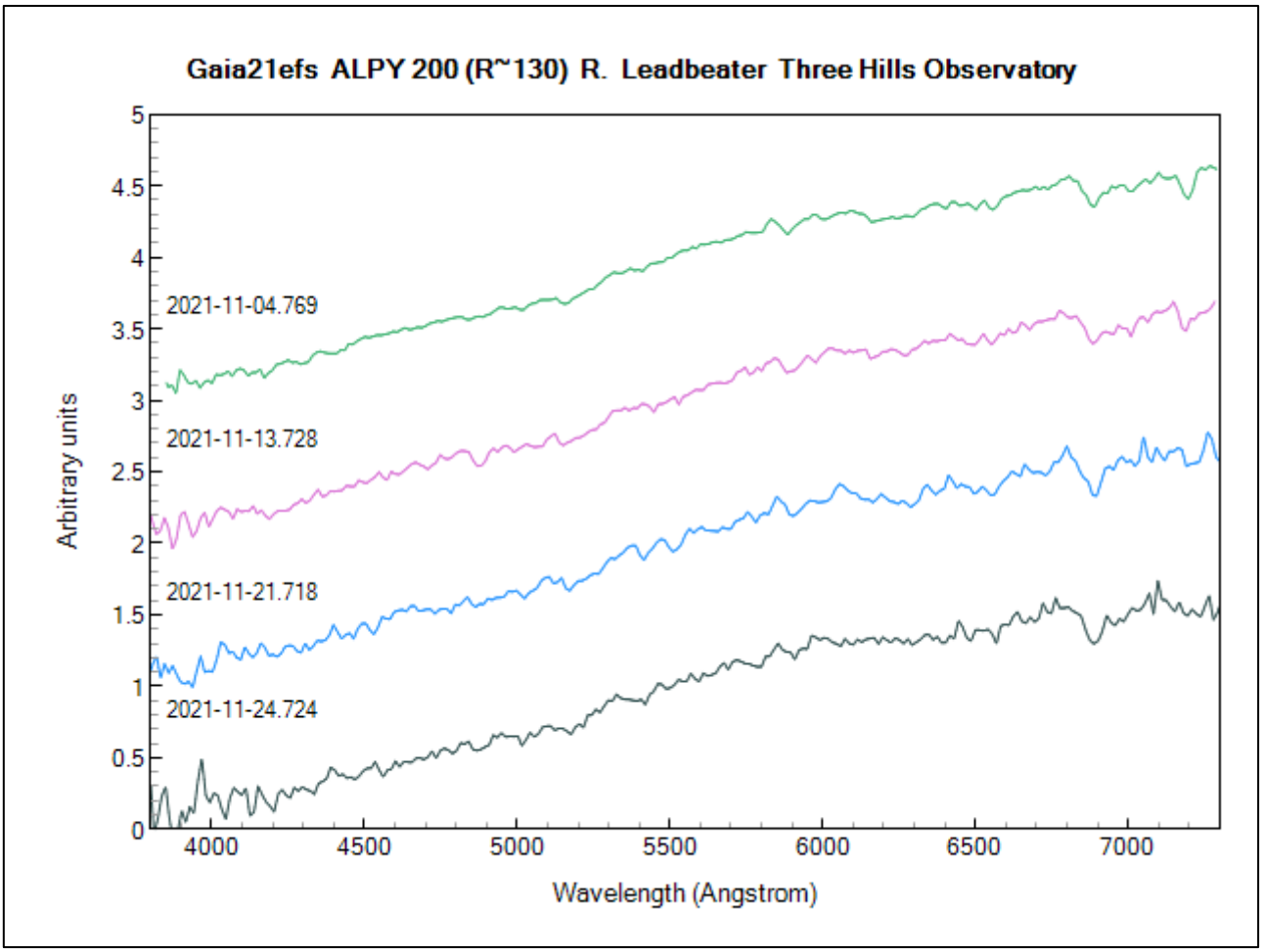


Figure 3. Spectra of Gaia21efs as it faded Credit Robin Leadbeater

Figure 4 shows both the as-measured spectrum and the de-reddened version. Robin explains this thus; Interstellar extinction from dust, etc, alters the spectrum, making it redder. This is normally described in terms of the difference between the measured and expected B-V magnitude E(B-V). This object as measured is very red but is clearly not a cool star. (No TiO absorption bands in the spectrum). The galactic extinction in that direction is high at E(B-V) =0.7. Once the spectrum has been corrected for interstellar extinction (dereddening it by this amount) we can see that the spectrum is in fact a good match to a K type star

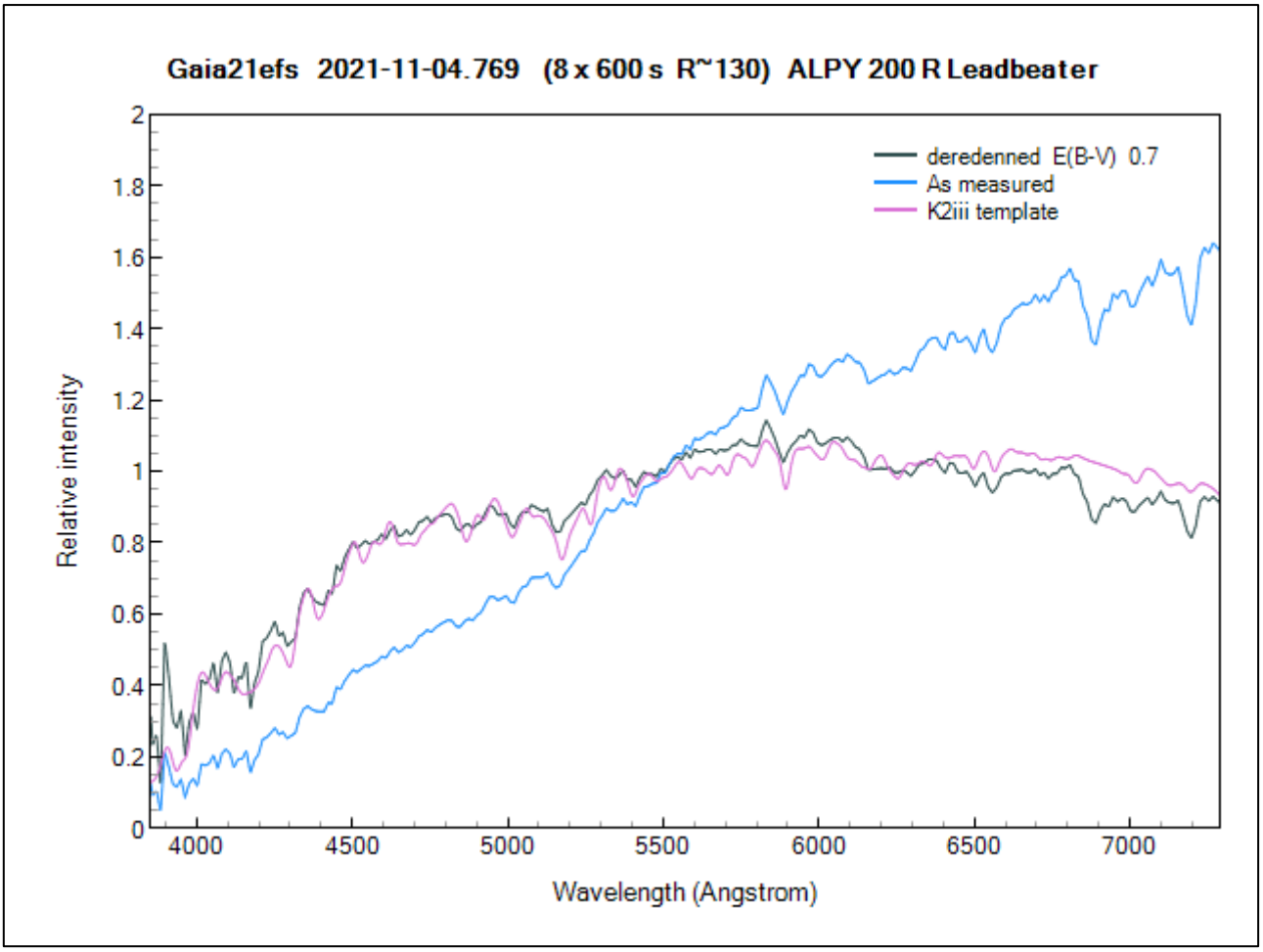


Figure 4. De-reddened spectra Credit Robin Leadbeater

This object is also the subject of an article 'A first look at the galactic microlensing event Gaia21efs' by Christopher Lloyd, Tonny Vanmunster and Sjoerd Dufoer in the 2021 December Variable Star Section Circular

Microlensing search for exoplanets

Jupiter-size planet orbiting a Red Dwarf star

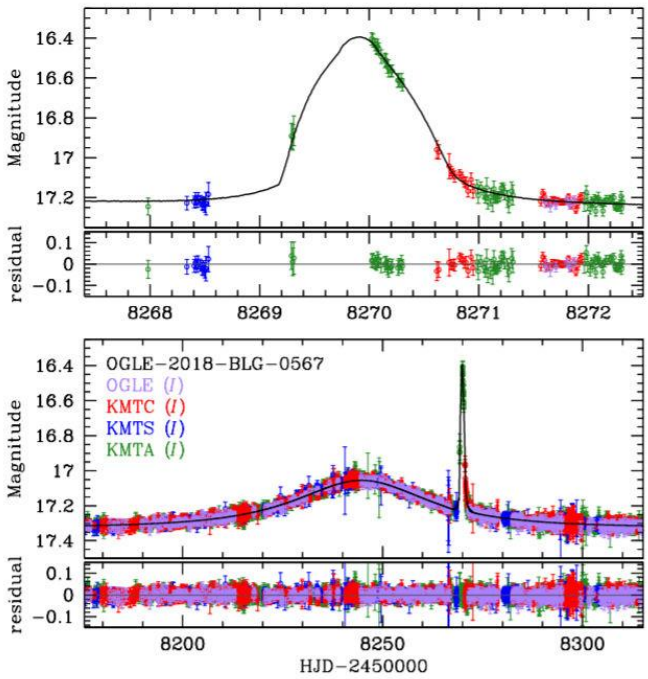
Studies have shown that the remnants of destroyed planets and debris-disk planetesimals can survive the volatile evolution of their host stars into white dwarfs. The microlensing event MOA-2010-BLG-477Lb12, using near-infrared observations from the Keck Observatory and reported in this paper, showed that the system contains a 0.53 ± 0.11 M⊙ white-dwarf host orbited by a 1.4 ± 0.3 Jupiter-mass planet. This system is evidence that planets around white dwarfs can survive the giant and asymptotic giant phases of their host's evolution, and supports the prediction that more than half of white dwarfs have Jovian planetary.

Galactic Plane eXoplanet Survey (GPX)

GPX-1 b, a transiting mini-Neptune, is the first substellar object discovered by GPX

Microlensed planets OGLE-2018-BLG-0567L b and OGLE-2018-BLG-0962L b

Two recent discoveries reported in this paper.



Light curve of OGLE-2018-BLG-0567 – planetary 'spike' at 8270

Conferences/Meetings/Seminars/Webinars/Videos

Gresham Astronomy Lectures in 2022 (exoplanet related)

Click the links to register for lectures

MARCH

Planetary Universe by Professor Katherine Blundell

Wednesday, March 30, 2022 6:00 PM gres.hm/planetary-universe

Museum of London / Online Or watch later

How can new worlds be discovered, and how many exo-planets might be out there? What does today's technology in astronomical observatories now enable, and what is it that holds us back from finding what is actually out there? What hinders us from pushing forwards the frontiers of space science?

MAY

The Future of Life on Earth by Professor Roberto Trotta

Monday, May 9, 2022 1:00 PM gres.hm/future-life

Barnard's Inn Hall/ Online Or watch later

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?

JUNE
Life in the Universe by Professor Katherine Blundell
Wednesday, June 1, 2022 6:00 PM gres.hm/life-universe
Museum of London / Online Or watch later
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.

Publications

Pathways to Discovery in Astronomy and Astrophysics for the 2020s A lengthy document but does include some interesting material relating to exoplanets

Eggshell planets

The Effects of Planetary and Stellar Parameters on Brittle Lithospheric Thickness
Paul K. Byrne,Bradford J. Foley,Marie E. S. Violay,Michael J. Heap,Sami Mikhail

The outer layer of a rocky planetary body is generally rigid and behaves in a brittle manner. The thickness of this layer is important in governing numerous aspects of that body's geological character, including whether it can support plate tectonics and even retain habitable conditions at the surface. Factors inherent to the planet, such as size, interior temperature, composition, and even climate affect the thickness of this outer layer, but so too do factors specific to the host star, including how luminous and far away it is. We ran a large set of computer models to see how various combinations of planetary and stellar properties influence the thickness of a planetary body's outer layer. Our models predict that worlds that are small, old, or far from their star likely have thick, rigid layers but, in some circumstances, planets might have an outer brittle layer only a few kilometers thick. These worlds, which we call “eggshell planets,” might resemble the lowlands on Venus, and we suggest that at least three such extrasolar planets are already known. We propose that these planets be examined with planned and future space telescopes to test if our models are correct.

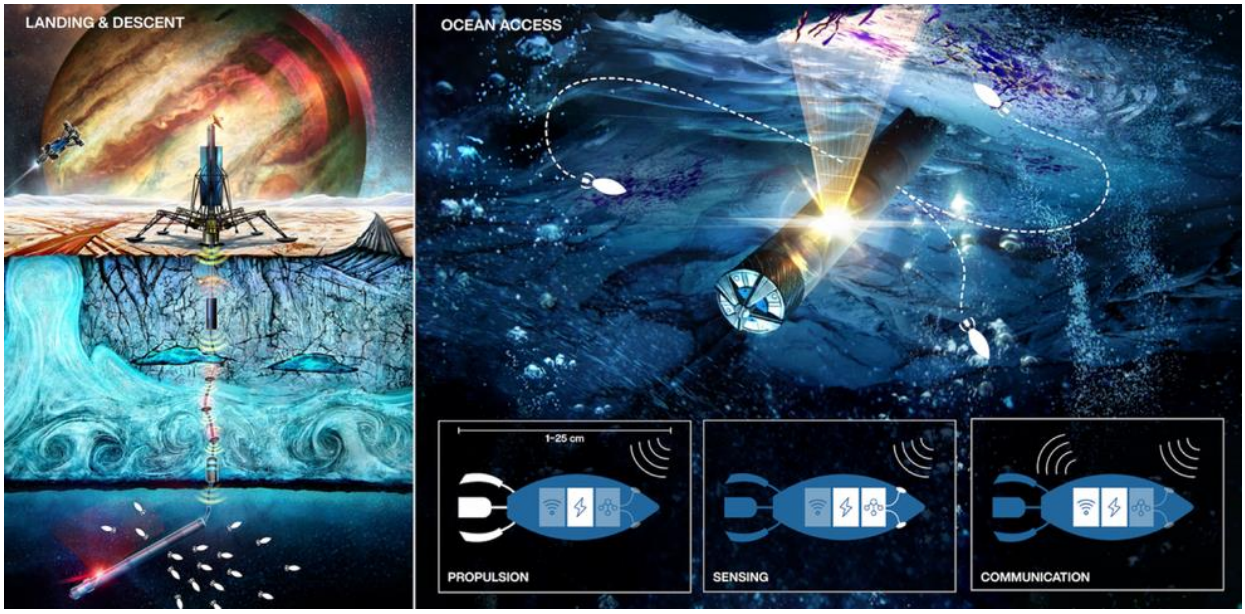
Institute of Physics

The Astronomy and Space section is well worth a visit.

Astrobiology

Sensing with Independent Micro-swimmers (SWIM)

The next decades of space exploration will focus on Ocean Worlds – especially Enceladus, Europa, and Titan – whose liquid oceans beneath kilometres of icy crust are some of the most likely locations beyond Earth to harbour life. To access these aquatic environments, NASA is developing numerous ocean-access mission concepts, including the Scientific Exploration Subsurface Access Mechanism for Europa (SESAME) class of thermo-mechanical drilling robots. We propose developing SWIM – Sensing with Independent Micro-swimmers – dramatically expand the capabilities of SESAME-class ocean-access robotic missions and significantly increase their likelihood of detecting evidence of habitability / biomarkers / life.



SWIM concept of operations, including lander / ocean-access cryobot (Left) and deployed micro-swimmers (Right) with independent propulsion, sensing and two-way ultrasound communication to the cryobot mothercraft. Credits; Ethan Schaler

How planets may be seeded with the chemicals necessary for life

Analysis of unique "fingerprints" in light emitted from material surrounding young stars has revealed “significant reservoirs” of large organic molecules necessary to form the basis of life. Dr John Ilee, Research Fellow at the University of Leeds who led the study, says the findings suggest that the basic chemical conditions that resulted in life on Earth could exist more widely across the Galaxy. The large organic molecules were identified in protoplanetary disks circling newly formed stars. A similar disk would have once surrounded the young Sun, forming the planets that now make up our Solar System. The presence of the molecules is significant because they are “stepping-stones” between simpler carbon-based molecules such as carbon monoxide, found in abundance in space, and more complex molecules that are required to create and sustain life.

Astrogeology

We have astrobiology so I wondered if there was science of such a name. In deed there is and it also goes under the guise of Planetary geology or Exogeology. Britannica defines it as; ‘Astrogeology is concerned with the geology of the solid bodies in the solar system, such as the asteroids and the planets and their moons. Research in this field helps scientists to better understand the evolution of the Earth in comparison with that of its neighbours in the solar system’.

Exogeology is a research area that is bringing astronomers, planetary scientists and geologists together to explore what exoplanets might look like, geologically speaking. For many scientists, exogeology is a natural extension of the quest to identify worlds that could support life.

Related links:
Exogeology from Polluted White Dwarfs
USGS Astrogeology Science Center

The Search for Life Elsewhere

The International Academy of Astronautics (IAA) formally established a committee for SETI science as far back as the early 1970s. Over the decades, it has variously been known as the IAA SETI Committee, the IAA SETI Permanent Study Group (SPSG), and most recently as the IAA SETI Permanent Committee. The Committee currently operates under the IAA Commission on Space Physical Sciences. The current leadership of this Committee is as follows:

Chair: Michael Garrett, UK
Co-Vice-Chair: Andrew Siemion, USA
Co-Vice-Chair: Carol Oliver, Australia
Secretary: Lori Walton, Canada

The Chair of the IAA SETI Permanent Committee provides a Status Report to the International Academy of Astronautics annually. Our most recently filed Status Report can be downloaded by following this link

Breakthrough Listen

Breakthrough Listen recently made an intriguing detection using the Parkes "Murriyang" Telescope in Australia, while observing Proxima Centauri, the Sun's nearest neighbouring star. Data spanning a frequency range of 700 MHz to 4 GHz were run through Listen's search pipeline, resulting in the detection of a narrow-band signal, persisting over five hours of observation, that had some of the expected characteristics of an extra-terrestrial transmission. Informally dubbed "BLC1" (Breakthrough Listen Candidate 1), the Listen science team at Berkeley SETI Research Center has spent several months subjecting the signal to further tests. Ultimately the team determined that the candidate signal appears to be interference from human technology, but the analysis provides an excellent test of Listen's pipeline.

Is there anyone out there?

Galileo project launch

From the website; The goal of the Galileo Project is to bring the search for extra-terrestrial technological signatures of Extra-terrestrial Technological Civilizations (ETCs) from accidental or anecdotal observations and legends into the mainstream of transparent, validated and systematic scientific research. This ground-based project searches for physical objects, rather than electromagnetic signals, associated with extra-terrestrial technological equipment.

Are We Alone in the Universe? NASA Calls for New Framework

How do we understand the significance of new scientific results related to the search for life? When would we be able to say, "yes, extra-terrestrial life has been found?"

NASA scientists are encouraging the scientific community to establish a new framework that provides context for findings related to the search for life. Writing in the journal Nature, they propose creating a scale for evaluating and combining different lines of evidence that would ultimately lead to answering the ultimate question: Are we alone in the universe?

In the new article led by Jim Green, the agency's chief scientist, a NASA group offers a sample scale to use as a starting point for discussions among anyone who would use it, such as scientists and communicators. They envision a scale informed by decades of experience in astrobiology, a field that probes the origins of life on Earth and possibilities of life elsewhere.

Space missions

ARIEL and the ExoClock project

ESA and Airbus have signed a contract to move forward with the design and construction of the Atmospheric Remote-sensing Infrared Exoplanet Large-survey, Ariel, planned for launch in 2029.

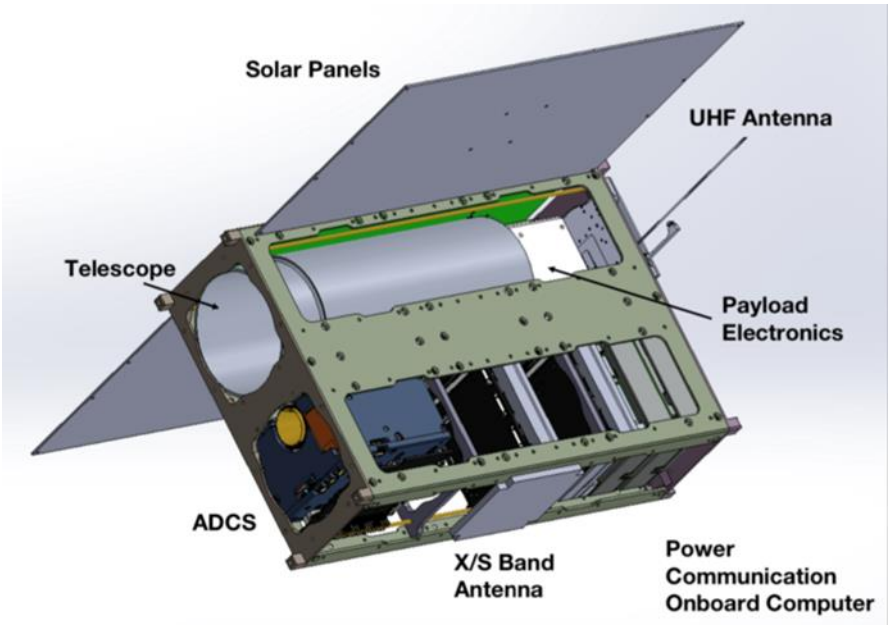
The Exoplanet Division has been successfully participating in the Exoclock project since its inception.

Colorado Ultraviolet Transit Experiment (CUTE)

The Colorado Ultraviolet Transit Experiment (CUTE) is a 4-year, NASA-funded project to design, build, integrate, test, and operate a 6-unit CubeSat (30 cm x 20 cm x 10 cm). CUTE is planned to have a 1-year nominal mission lifetime and was launched on 2021 September 27. Using near-ultraviolet (NUV) transmission spectroscopy from 255 to 330 nm CUTE will characterize the composition and mass-loss rates of exoplanet atmospheres by measuring how the NUV light from the host star is changed as the exoplanet transits in front of the star and passes through the planet's atmosphere. Transit lightcurves created from CUTE observations will provide constraints on the composition and escape rates of these atmospheres, and may provide the first concrete evidence for magnetic fields on extrasolar planets.

TOLIMAN space telescope

The objective of this this mission is to discover new planets potentially capable of sustaining life around Earth's nearest neighbour, Alpha Centauri. The proposed project will look for planets in the 'Goldilocks' zone around the star system just four light years away, where temperatures could allow for liquid surface water on rocky planets. Work on the project began in 2021 April but the launch date I s not yet known. Scientists from the University of Sydney, in partnership with the Breakthrough Initiatives in California, Saber Astronautics in Australia and NASA's Jet Propulsion Laboratory, have named the project TOLIMAN, the Arabic-derived name for Alpha Centauri from antiquity.



Proposed TOLIMAN telescope

Space – stepping stones to other star systems

Very near Earth

European research for interplanetary isolation Isolation affects people in different ways. Studies on how humans cope with stress in a secluded environment and with little social interaction are useful to learn about ourselves in challenging times – and to test whether our species is fit for long journeys to other planets.

Maybe this research could help with the problems of loneliness on this planet.

Mars

'Martian' tomato ketchup https://qz.com/2086637/heinz-grew-martian-tomatoes-that-are-good-enough-for-ketchup/

Destination Mars – From the Moon to the Red planet – 54 min video thanks to Steve Knight, Hampshire Astronomical Group. Mankind is entering a new era of space travel. Astronauts are set to return to the moon before the decade is out. And scientists and visionaries say: humans will soon set foot on a foreign planet for the first time: Mars.

A list of Space Time – Science Shows can be found here.

Happy New Year
Roger Dymock
ARPS Assistant Director Exoplanets