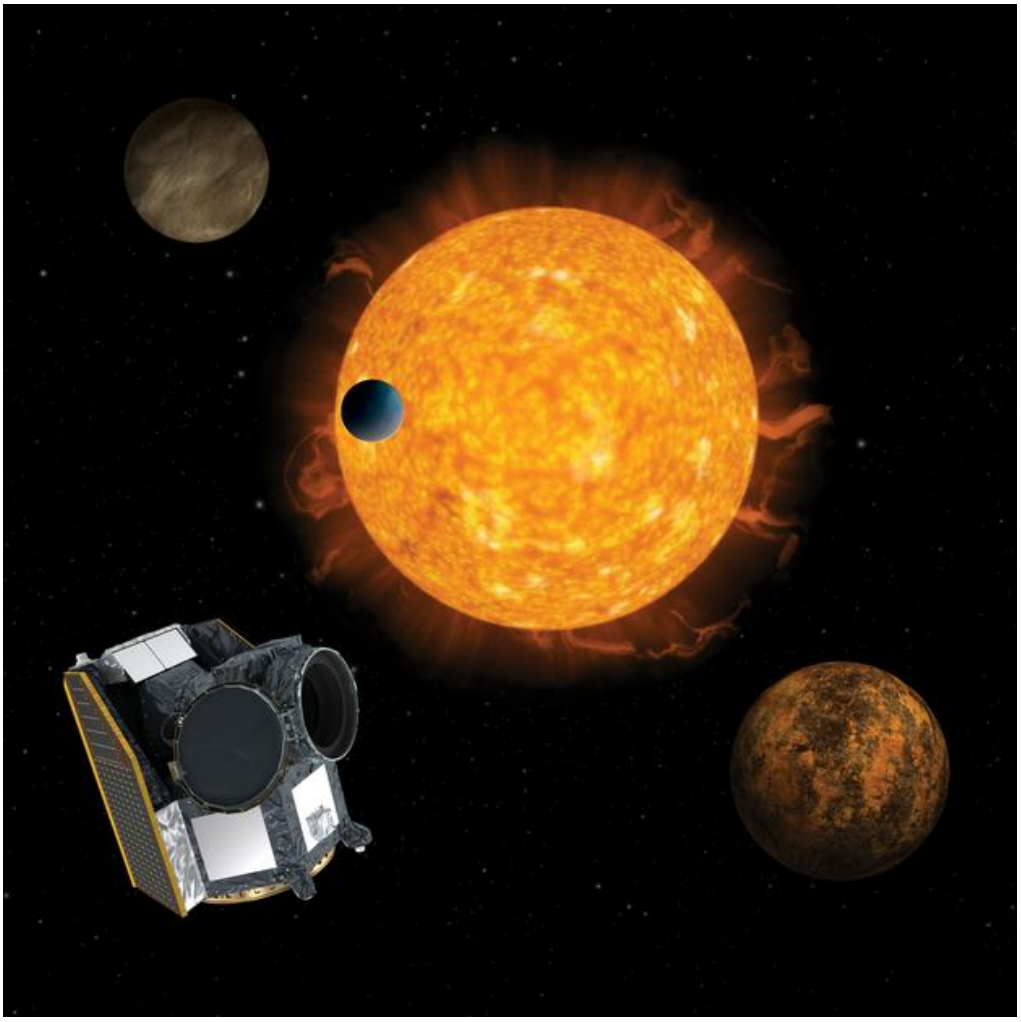
British Astronomical Association
Supporting amateur astronomers since 1890

Infinite Worlds



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

Issue 3 2019 June

Cover image. Artists impression of CHEOPS (CHaracterising ExOPlanet Satellite – credit ESA/ATG medialab) - http://sci.esa.int/cheops/ - will be the first mission dedicated to searching for exoplanetary transits by performing ultrahigh precision photometry on bright stars already known to host planets. Launch is scheduled for the period 2019 October 15 to 2019 November 14.

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)
Peta Bosley, Simon Downs, George Faillace, Steve Futcher, Paul Leyland, David Pulley, Mark Salisbury, Americo Watkins

Progress report

Having set up the Division and described the processes imaging and analysis processes I believe the next stage should be to define an imaging project or projects on which we might concentrate our efforts. Of course all are free to follow their own path but some focus might be helpful both for newcomers and the more experienced. My thanks to those who have contributed material.

BAA Photometry Database

If you have exoplanet transit light curves could I enter a pleas for you to input your data to the BAA Photometry Database recently modified by Andrew Wilson to accept such data. User Guides are available via the Help button.

Potential projects

Some suggestions. I know that some of you have already been successful in some of the areas mentioned below but comment as to their feasibility or otherwise would be appreciated. If you have other projects on the go which the Division might pursue please let me know.

Imaging stars with a known exoplanet. In Chapter 3 of his book 'Exoplanet Observing for Amateurs', Bruce Gary describes a project which might be of interest - Bright Transiting Exoplanets (BTEs)– which he defines as host stars brighter than mag 14. Using the Exoplanet Transit Database Transit predictions website you can obtain data, including magnitude and magnitude drop, for future transits for your location. Selecting any particular object from the

list on the left of the page leads to a list of previous observations against which you can compare your results.

Monitoring stars with known exoplanets out of transit
Known exoplanets may well have additional companions so observing the BTEs mentioned above at times other than those for known transits may yield a discovery. To maximise the chances of such a discovery the impact parameter, closeness of the known transit to the centre of the star, needs to be much less than 1.0 which indicates a grazing transit. This value can be obtained from the Exoplanet.eu website by selecting All Catalogues and then the star/planet of interest.

Stars in multiple star systems
The Catalogue of exoplanets in binary star systems lists both binary and multiple star systems (70% of Main Sequence stars in the solar neighbourhood are members of such systems). Exoplanets can be detected by both the transit method and Eclipse Timing Variations (ETVs). An orbiting planet will cause variations in eclipse timing and does not need to be in the line of sight. ETVs are in the order of seconds so this would represent a fairly challenging project.

MicroObservatory Robotic Telescope Network
A chance for those without access to a suitable telescope to observe and analyse exoplanet transits. Martin Fowler mentioned this facility during his presentation, Adventures with a robotic telescope – from supernovae to exoplanets, at the BAA meeting on 2019 March 17. The exoplanet part of the presentation begins at approximately 26 minutes. There is also a video of Martin's pipeline for analysing exoplanet transits using Muniwin photometry software.

Planet Hunters TESS
A Citizen Science project using data from the Transiting Exoplanet Survey Satellite. Over the next two years TESS will be busy surveying **two-hundred-thousand** bright nearby stars, measuring and recording their brightness every two minutes. This project's findings may even bring us one step closer to answering the question: Are we alone in the Universe?

Pro-am collaboration
An area we do need to look at and will be discusses in the next emagazine unless anyone as an immediate project they would like to recommend.

Meetings
Asteroid and Remote Planets Section (ARPS) meeting. 2019 September 29th at Clanfield, Hampshire hosted by Hampshire Astronomical Group (HAG) – see https://britastro.org/arps2019
Please note that pre-booking via the BAA shop is required - follow the link on the above mentioned page.

Provisional agenda.

Agenda					
From	**To**	**Subject**	**Speaker**	**Chair person**	**Content**
09:30		Doors open			
10:00	10:15	Welcome	Richard Miles	Richard Miles	
10:15	10:45	Presentation 1	Richard Miles		Asteroid Section status, future projects, mtgs (WWE section mtg, Exoplanet workshop
10:45	11:15	Presentation 2	HAG tba		Asteroid projects
11:15	11:45	Tea Break			
11:45	12:30	Presentation 3	Professional astronomer - tba		Exoplanet mission - CHEOPS
12:30	13:30	Lunch break			
13:30	14:00	Presentation 4	Roger Dymock	Roger Dymock	Exoplanet Division status, future projects
14:00	14:30	Presentation 5	Peta Bosley		Astrobiology, intro to, courses
14:30	15:00	Presentation 6	HAG tba		Exoplanet projects (HAG or Portsmouth Uni)
15:00	15:30	Tea break			
15:30	16:00	Presentation 7	Tim Haymes		Asteroid occultations
16:00	16:30	Presentation 8	Mark Salisbury		Exoplanet transit imaging
16:30	17:00	Presentation 9	Martin Fowler		Exoplanet observations using the MicroObservatory Robotic Telescope Network
17:00	17:15	Question time	Richard Miles, Roger Dymock, Presenters	Richard Miles	Questions and comments from attendees
17:15	17:20	Closing comments	RM		

ARPS Meeting. 2020 April 4th; ARPS meeting on the Saturday afternoon of the BAA Winchester Weekend – April 3rd to 5th . Please book early as this event sells out very quickly.

Exoplanet workshop 2020 January (date and location to be fixed). Possible topics; imaging, AIJ light curve generation, transit fitting, deriving system/planet parameters, remote imaging using the MicroObservatory Robotic Telescope Network.

Tools

Observing planner

This paper - Efficient Follow-up of Exoplanet Transits Using Small Telescopes – describes an on-line tool for the prediction of exoplanet transit light curves. An example prediction is shown in Figure 1.

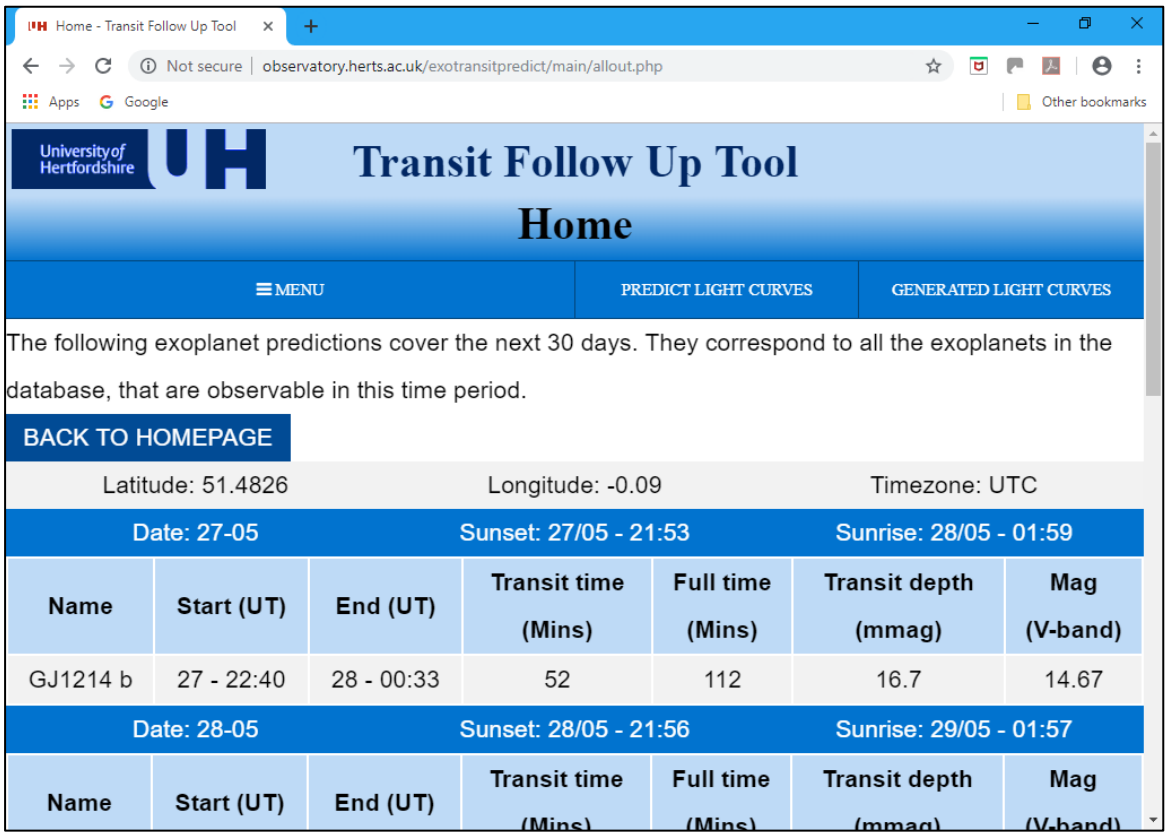


Figure 1. Transit Follow Up Tool Home Page

Stellarium

Stellarium is the only planetarium I have come across that plots exoplanets. You will need to enable the Exoplanet plug in by opening the Configuration dialogue, Figure 2 – Spanner icon on left toolbar or function key, F2. In the Configuration window select the Plug-ins tab and Exoplanets from the list on the left. Check the Load at start-up option and then Configure to select the setting you need (I have ticked all of them).

A particular exoplanet (or rather host star), HAT-P-36 in this example, can be selected using the Search window. The position and data for the star is shown – Figure 3. I will cover this in more detail in a future issue

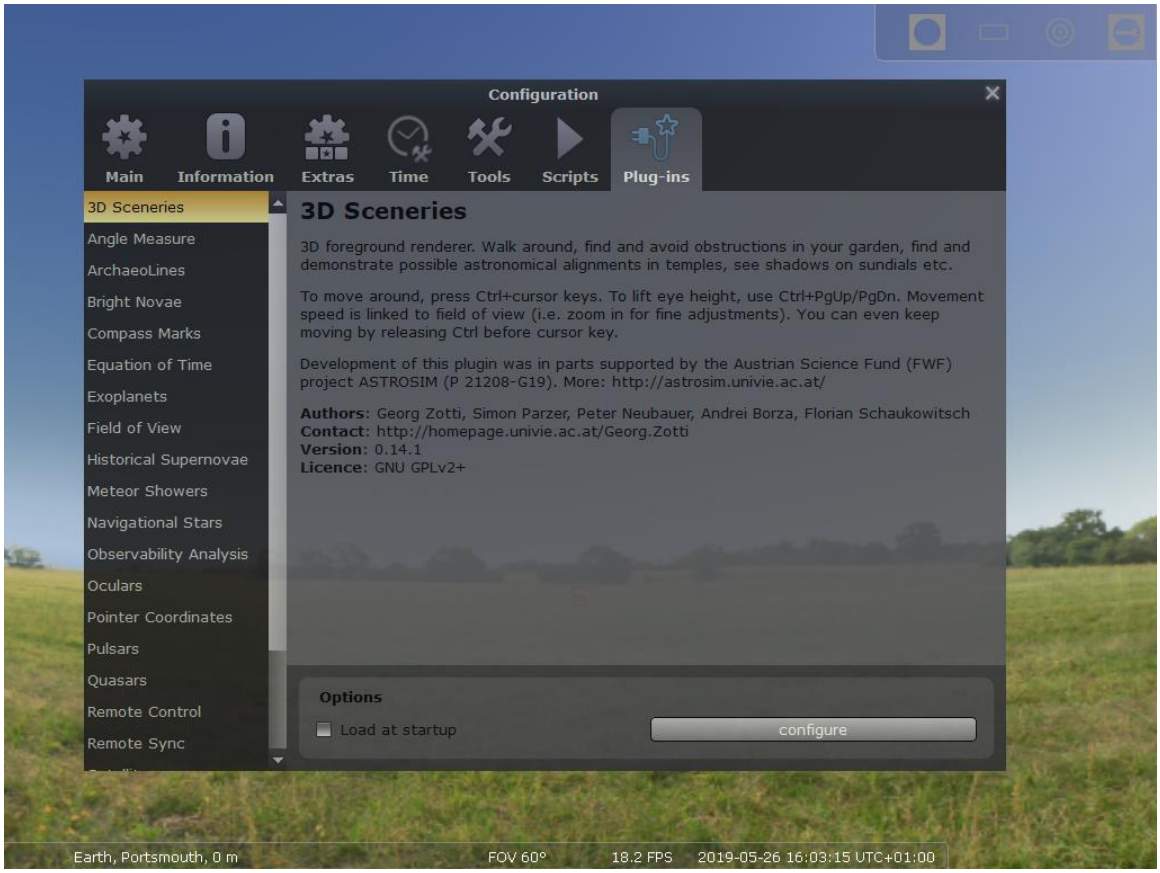


Figure2. Stellarium Configuration dialogue

Figure 3. Stellarium display of HAT-P-36

News

This section covers miscellaneous exoplanet related matters that have recently come to my attention.

The Cambridge Exoplanet Research Centre

The Cambridge Exoplanet Research Centre is a collaborative instrument for Cambridge University researchers conducting research activities related to exoplanets and life in the Universe. It combines the interests and research capabilities of the involved Cambridge institutes into a comprehensive integrated program, while promoting excellence and innovation in a field that is at the cutting edge of modern science.

Although not aimed specifically at amateur astronomers it may be worth keeping an eye on this website for the latest in exoplanet research.

Exoplanet classification

The Planetary Habitability Laboratory's Periodic Table (below) classifies exoplanets by size and their distance from their host stars (zones) – Figure 4.

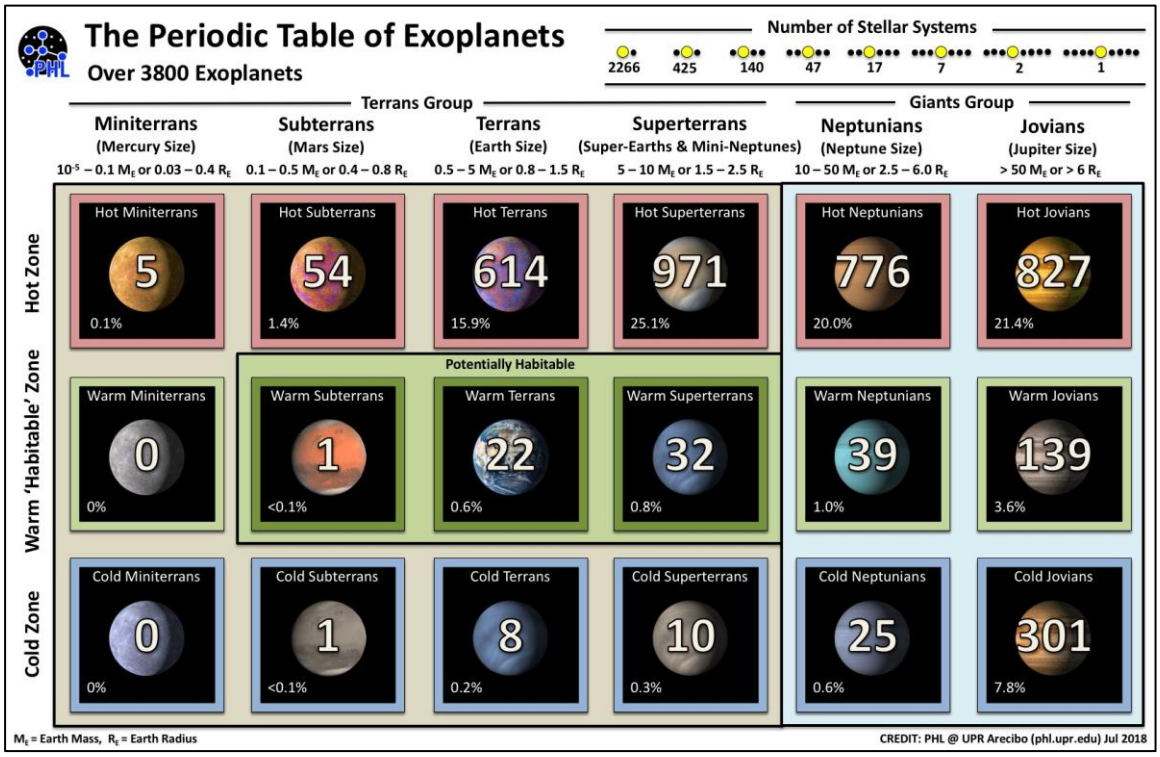


Figure 4. Planetary Habitability Laboratory's Periodic Table of Exoplanets

Researchers at the Universities of Zurich and Cambridge have discovered a new, exotic class of exoplanets. With a mass near 5x that of Earth these fall into the Superterrans category. They were formed at high temperatures close to their host star and contain high quantities of calcium, aluminium and their oxides, including sapphire and ruby – Figure 5 - but are unlikely to have an iron core - https://www.ast.cam.ac.uk/content/sapphires.and.rubies.sky

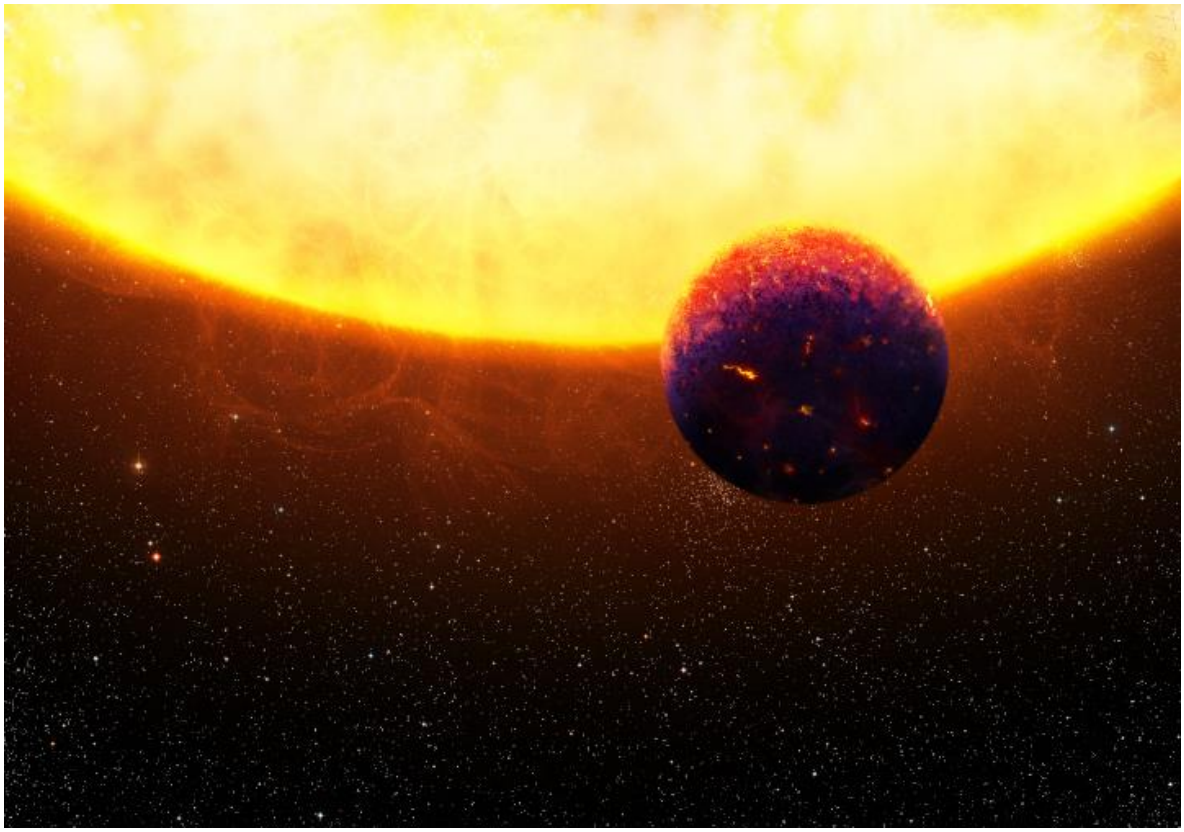


Figure 5. Artists impression of 55 Cancri e, that is rich in sapphires and rubies and might shimmer in blue and red colours Credit Thibaut Roger

Exoplanets larger than Earth but smaller than Neptune, Superterrans in the above Periodic Table of Exoplanets – are a class of planet not found in our Solar System. Read more in the Planetary Society's report. Figure 6 compares planetary mass and radius for both Solar System planets and exoplanets.

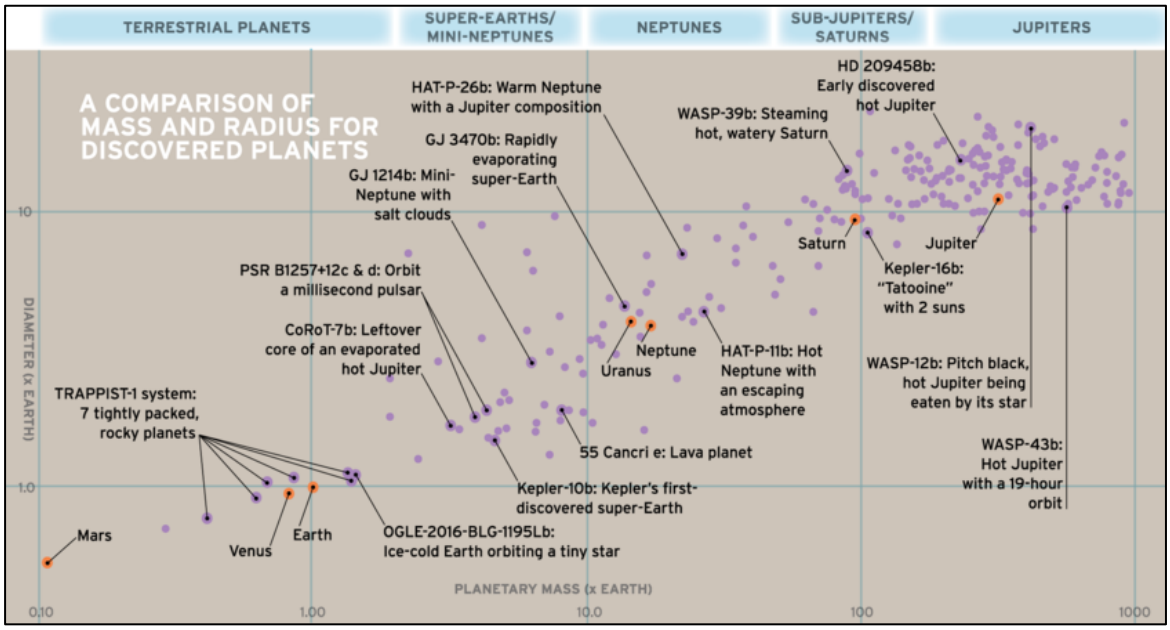


Figure 6. Mass-Radius comparison for discovered exoplanets. Credit Emily Lakdawalka and Loren A. Roberts for the Planetary Society

Asteroseismology
It is possible to derive exoplanet host-star properties from asteroseismology observations i.e. radius, density, mass, distance and age - https://arxiv.org/pdf/1504.07992.pdf and https://www.aanda.org/articles/aa/pdf/2014/06/aa23408-14.pdf The more we know about the host star the more we can learn about the properties of the associated exoplanetary systems https://arxiv.org/pdf/1711.01281.pdf

The PLAnetary Transits and Oscillations of stars (PLATO) mission will investigate seismic activity in stars enabling the precise characterisation of the planet's host star including its age.

Exoplanet discoveries

Ever growing totals
The Exoplanet.eu catalogue lists 4071 planets, 3043 planetary systems and 659 multiple planet systems.

Barnard's star b
The nearest single star to the Sun hosts an exoplanet at least 3.2 times as massive as Earth — a so-called super-Earth. One of the largest observing campaigns to date using data from a world-wide array of telescopes, including ESO's planet-hunting HARPS instrument, have revealed this frozen, dimly lit world. The newly discovered planet is the second-closest known exoplanet to the Earth. Barnard's star is the fastest moving star in the night sky.

Who isn't searching for exoplanets these days ?

Exoplanet search projects
The Wikipedia page List of exoplanet search projects includes 48 ground base projects, 9 past and current space missions, 5 planned space missions and 9 proposed space missions.

Automated Planet Finder (APF) at the Lick Observatory. Lick Observatory's newest telescope, the APF, was fully commissioned on Mt. Hamilton in August 2013. This is the first telescope capable of detecting rocky planets that might support life in other solar systems. Extrasolar planetary research has been very successful at Lick Observatory. By operating robotically on every clear night of the year, the APF is efficient in discovering extrasolar planets. The Levy spectrometer has cutting-edge components and higher resolution, which increases astronomers' ability to detect these planets.

CARMENES high-resolution spectrograph The Calar Alto high-Resolution search for M dwarfs with Exoearths with Near-infrared and optical Échelle Spectrographs is a next-generation instrument built for the 3.5m telescope at the Calar Alto Observatory by a consortium of German and Spanish institutions. It consists of two separated spectrographs covering the wavelength ranges from 0.52 to 0.96 μm and from 0.96 to 1.71 μm with spectral resolutions R = 80,000-100,000, each of which performs high-accuracy radial-velocity measurements (~1 m s^{-1}) with long-term stability. The fundamental science objective of CARMENES is to carry out a survey of ~300 late-type main-sequence stars with the goal of detecting low-mass planets in their habitable zones.

High Accuracy Radial Velocity Planet Searcher (HARPS) on the ESO La Silla 3.6m telescope is dedicated to the discovery of exoplanets

High Resolution Echelle Spectrometer (HIRES) on the Keck telescope is used to search for exoplanet using the radial velocity method

Microlensing Network for the Detection of Small Terrestrial Exoplanets – MiNDSTEp
The adopted three-step strategy of survey, follow-up, and anomaly monitoring for identifying planetary signals would not succeed without the first step, on which MiNDSTEp critically relies on microlensing surveys such as OGLE or MOA, whereas only the two latter steps are realized by the MiNDSTEp observations themselves. The MiNDSTEp campaign keeps its operational efforts to a minimum by making use of the innovative approach by ARTEMiS (Automated Robotic Terrestrial Exoplanet Microlensing Search) for a fully-deterministic selection of targets, and moreover by profiting from the powerful (freely-available) tools for visualizing the acquired data in real time.

Planet Finder Spectrograph on the 6.5 m Magellan II telescope. The Carnegie Planet Finder Spectrograph (PFS) searches for extrasolar planets with the 6.5 meter Magellan II Telescope at Las Campanas Observatory in Chile. It detects exoplanets through their gravitational influence on their host stars, which cause Doppler shifts in the stellar spectra that can be measured to give the stellar velocities to a precision better than 1 meter per second. As the planets orbit their hosts, the measured stellar velocities vary periodically, revealing the planetary presence and information about their masses and orbits.

Transiting Exoplanet Survey Satellite (TESS)
The NASA Exoplanet Archive lists; 15 confirmed discoveries, 662 candidates and 405 candidates yet to be confirmed.

On-line Courses recently noted

An introduction to exoplanets – The Open university.
The course introduces our Galaxy's population of planets, and some of their many surprises. It explains the methods used by astronomers to study exoplanets, and provides a general introduction to the methods of scientific inquiry. The course culminates in discussion of life elsewhere in our Galaxy.

Astrobiology: Exploring Other Worlds – The University of Arizona
How are astronomers approaching their search for life in the universe? What have we learned from the surge of exoplanets discoveries? How likely is it that Earth does not host the only life in the Universe? 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.

This course started on May25th but it is quite possible that it will be rerun.

Literature Watch

Literature Watch, put together by Paul Leyland (Roger Dymock for this issue), is intended to be a regular feature of the newsletter in which readers' attention is directed to (relatively) recent papers, popular articles, blog postings, podcasts, conference announcements, conference proceedings and the like. Readers are encouraged to send in suggestions for

future columns, either to Roger Dymock at roger.dymock@ntlworld.com or to Paul Leyland directly at paul@brnikat.com

Agnostic approaches to life detection - Downloadable as a PDF
Current strategies for biosignature detection rely mainly on identification of well-established and widely accepted features associated with terran life and signatures of biologic processes, such as particular classes of molecules and isotopic signatures, enantiomeric excesses, and patterns within the molecular weights of fatty acids or other lipids. Yet as we begin to explore icy moons of Jupiter and Saturn and other destinations beyond Earth, it is important to develop life detection methods that identify unknowable, unfamiliar features and chemistries that may represent processes of life as-yet unrecognized.

An Astrobiology Strategy for the Search for Life in the Universe
Downloadable as a free PDF In 2017 the US Congress directed NASA to enter into an arrangement with the National Academies of Sciences, Engineering, and Medicine to develop a science strategy for astrobiology that would outline key scientific questions, identify the most promising research in the field, and indicate the extent to which the mission priorities in existing decadal surveys address the search for life's origin, evolution, distribution, and future in the universe.

Dynamical Habitability of Planetary Systems
Downloadable as a PDF The problem of the stability of planetary systems, a question that concerns only multiplanetary systems that host at least two planets, is discussed in this paper. The problem of mean motion resonances is addressed prior to discussion of the dynamical structure of the more than 350 known planets. The difference with regard to our own Solar System with eight planets on low eccentricity is evident in that 60% of the known extrasolar planets have orbits with eccentricity $e > 0.2$. We theoretically highlight the studies concerning possible terrestrial planets in systems with a Jupiter-like planet. We emphasize that an orbit of a particular nature only will keep a planet within the habitable zone around a host star with respect to the semimajor axis and its eccentricity.

Eclipse Timing Variations of Planets in P-Type Binary Star systems
Downloadable as a PDF In close eclipsing binaries, measurements of the variations in the binary's eclipse timing may be used to infer information about the existence of planets in P-Type motion. To study the possibility of detecting such planets with CoRoT and Kepler, we calculated eclipse timing variations (ETV) for different values of the mass and orbital elements of the perturbing planet. These investigations are a continuation of the work of Schwarz et al. (2011).

Engaging Citizen Scientists to Keep Transit Times Fresh and Ensure the Efficient Use of Transiting Exoplanet characterisation Missions.
Downloadable as a PDF. This white paper advocates for the creation of a community-wide program to maintain precise mid-transit times of exoplanets that would likely be targeted by future platforms. Given the sheer number of targets that will require careful monitoring between now and the launch of the next generation of exoplanet characterization missions, this network will initially be devised as a citizen science project—focused on the numerous amateur astronomers, small universities and community colleges and high schools that have access to modest sized telescopes and off-the-shelf CCDs.

Exoplanet Science Strategy
A publication for the US National Academies of Sciences, Engineering and Medicine.

Downloadable as a PDF. Exoplanet science over the coming decades aims to achieve two overarching goals:
1) Understand the formation and evolution of planetary systems as products of the process of star formation, and characterize and explain the diversity of planetary system architectures, planetary compositions, and planetary environments produced by these processes.
2) Learn enough about the properties of exoplanets to identify potentially habitable environments and their frequency, and connect these environments to the planetary systems in which they reside. Furthermore, researchers need to distinguish between the signatures of life and those of nonbiological processes, and search for signatures of life on worlds orbiting other stars.

Factors Affecting the Nature and Identification of Planetary Habitability.
This presentation is available as a PDF. This presentation includes; requirements for life, habitable zones, space missions, factors affecting habitability, host stars and the evolution of planetary systems.

Finding Exoplanets Around Eclipsing Binaries: A Feasibility Study Using Mt Kent and Moore Observatories
Downloadable as a PDF The project aims to test the feasibility of using Mt Kent and Moore Observatories to find exoplanets in orbit around eclipsing binary stars. For these stars the timing of eclipse variations caused by an orbiting planet is something suited to small telescopes as it relies on timing precision that can be readily obtained.

Global Exploration Roadmap
This new edition of the Global Exploration Roadmap reaffirms the interest of 14 space agencies to expand human presence into the Solar System, with the surface of Mars as a common driving goal. It reflects a coordinated international effort to prepare for space exploration missions beginning with the International Space Station (ISS) and continuing to the lunar vicinity, the lunar surface, then on to Mars.

NASA Astrobiology Strategy
NASA's strategic objective in planetary science is to determine the content, origin, and evolution of the Solar System and the potential for life elsewhere (2014 NASA Science Plan). Astrobiology research sponsored by NASA focuses on three basic questions: How does life begin and evolve? Does life exist elsewhere in the Universe? What is the future of life on Earth and beyond? Over the past 50 years, astrobiologists have uncovered a myriad of clues to answering these Big Questions.

Searching for Life Across Space and Time – Proceedings of 2017 workshop
Downloadable as free PDF and also available as a paperback and ebook. The search for life is one of the most active fields in space science and involves a wide variety of scientific disciplines, including planetary science, astronomy and astrophysics, chemistry, biology, chemistry, and geoscience. In December 2016, the Space Studies Board hosted a workshop to explore the possibility of habitable environments in the solar system and in exoplanets, techniques for detecting life, and the instrumentation used. This publication summarizes the presentations and discussions from the workshop.

ExoPlanetNews
A monthly electronic newsletter listing abstracts of newly accepted papers in the Exoplanet Field and can be found at the following link or you can sign up to receive it via e-mail.

The Exoplanet Podcast
Discussions of all things exoplanetary.

And finally…
Something to soothe the nerves http://www.planetary.org/explore/the-planetary-report/a-kepler-orrery.html?utm_campaign=etpr&utm_medium=email&utm_source=v39n01

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2019 June 1st