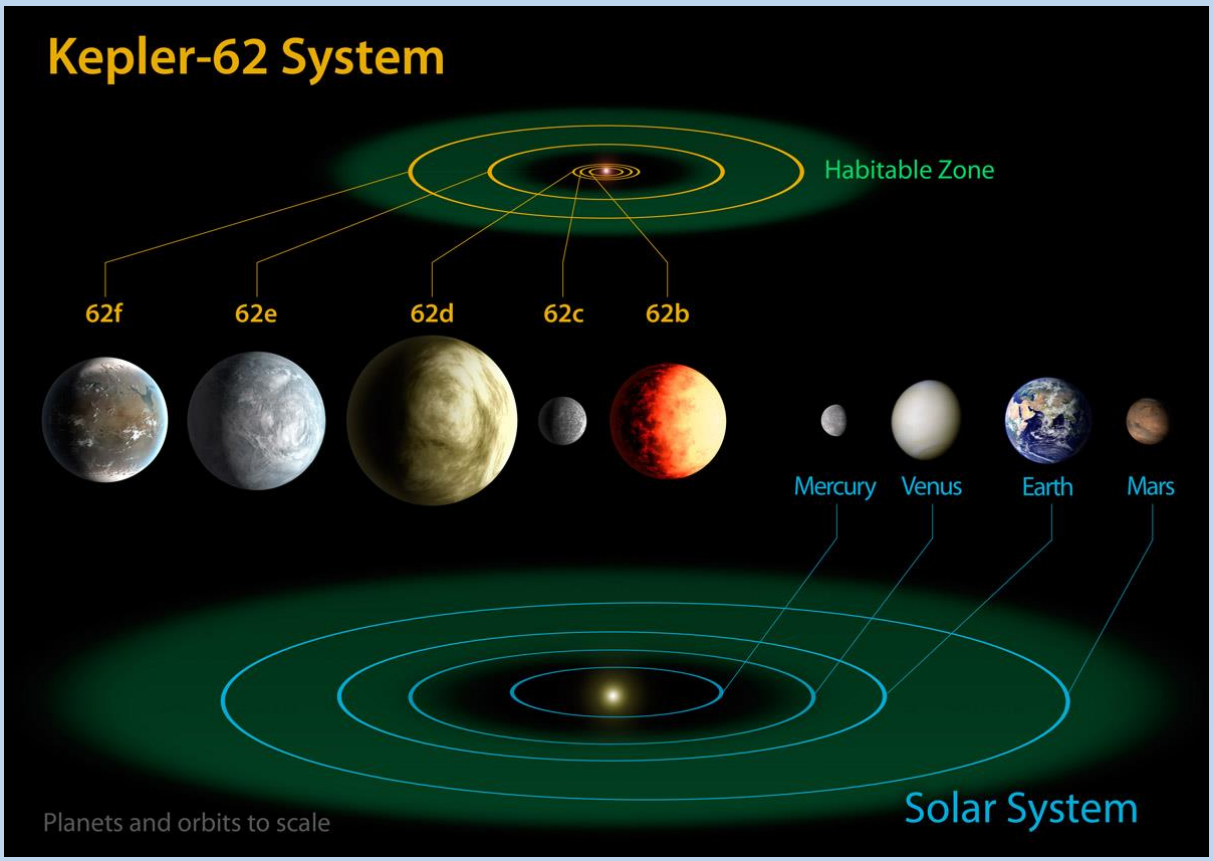
British Astronomical Association
Supporting amateur astronomers since 1890

Infinite Worlds



Credit NASA Ames/JPL-Caltech

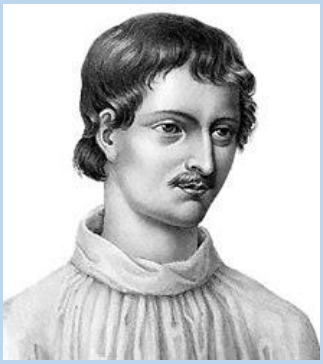
The e-magazine of the Exoplanets Division Of the Asteroids and Remote Planets Section

Issue 1 2018 September

There is no bigger question in science than the search for extra-terrestrial life

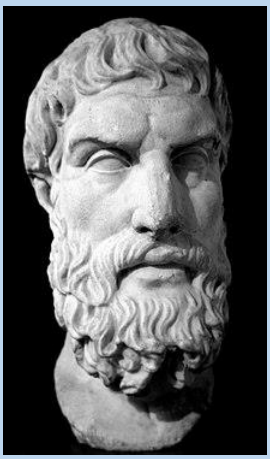
Professor Stephen Hawking. Credit The Stephen Hawking Foundation

There are countless suns and countless Earths all rotating around their suns in exactly the same way as the seven planets of our system…The countless worlds in the universe are no worse and no less inhabited than our own Earth. (from 'De L'infinito E Mondi' published in 1584)



Giordano Bruno

There are infinite worlds both like and unlike this world of ours inhabited by living creatures and plants and other things we see in this world.



Epicurus (in a letter to Herodotus around 300BC)

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Section officers

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

Volunteers to coordinate the activities listed below will be welcome. Please contact Roger Dymock (roger.dymock'at'ntlworld.com) **if you are interested**
- Observation (transits, microlensing, radial velocity measurements)
- Astrobiology
- Citizen Science
- Exoplanet Studies
- Opportunities for pro-am collaboration
- Search for Extra-Terrestrial Intelligence (SETI)
- Space

Website
Address to be advised

Introduction

On 2018 September 5th the BAA Council accepted a proposal for the work of the Asteroids and Remote Planets Section to be expanded to include exoplanets.

Welcome to the first issue of the newsletter of the newly formed Exoplanets Division of the Asteroids and Remote Planets Section of the British Astronomical Association. First of all, my grateful thanks to all of you who have given your support to this venture and provided guidance and examples of your work.

The typeface is a little large compared with other printed material you may receive but I hope this will enable those, like me, of a certain age to read it comfortably without having to resort to a magnifying glass. Nothing fancy – just text and related images. The various subjects mentioned will be enlarged upon in future issues. Early on I plan to cover;
- transit observations from choosing targets to deriving light curves
- characterising an extrasolar system. The various parameters and how to measure them

The Earth wasn't formed in a day and so it will be with this adventure. We may well go down a few blind alleys along the way but hopefully we will continue to make steady progress.

Potential activities are listed after the News section but please let me know if you have any thoughts on these and possible projects that might be instigated. If you have a current project and would like others to join in please use the Exoplanets forum on the BAA website,

https://britastro.org/, to solicit participants. I suggest we use this forum for communication in general.

Items for this magazine covering any of the proposed activities will be gratefully received.

News

Probing Planets in Extragalactic Galaxies Using Quasar Microlensing

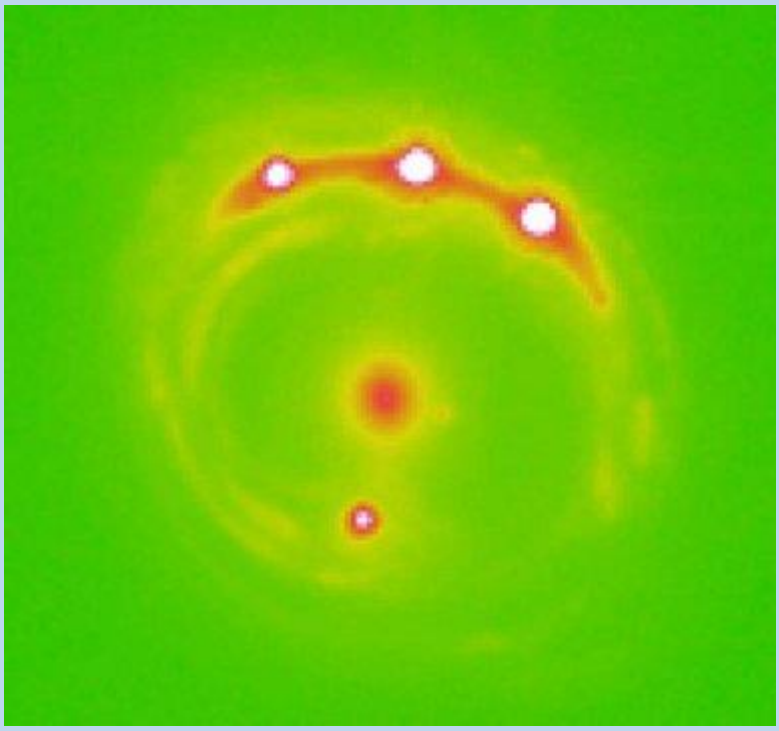

Image of the gravitational lens RX J1131-1231 galaxy with the lens galaxy at the center and four lensed images of the background quasar. It is estimated that there are trillions of planets in the center elliptical galaxy in this image. Credit: University of Oklahoma

Previously, planets have been detected only in the Milky Way galaxy. Here, we show that quasar microlensing provides a means to probe extragalactic planets in the lens galaxy, by studying the microlensing properties of emission close to the event horizon of the supermassive black hole of the background quasar, using the current generation telescopes. We show that a population of unbound planets between stars with masses ranging from Moon to Jupiter masses is needed to explain the frequent Fek line energy shifts observed in the gravitationally lensed quasar RXJ1131-1231 at a lens redshift of z=0.295 or 3.8 billion light-years away. We constrain the planet mass fraction to be larger than 0.0001 of the halo mass, which is equivalent to 2,000 objects ranging from Moon to Jupiter mass per main sequence star. https://arxiv.org/abs/1802.00049

News links

Exoplanet News is a monthly electronic newsletter listing abstracts of newly accepted papers in the exoplanet field - http://nccr-planets.ch/exoplanetnews/

https://www.skyandtelescope.com/astronomy-news/exoplanets/

https://exoplanets.nasa.gov/news/?page=0&per_page=40&order=publish_date+desc%2C+created_at+desc&search=

https://www.sciencedaily.com/news/space_time/extrasolar_planets/

http://www.astronomy.com/news/2018/07/new-detection-method-could-quickly-reveal-exoplanets-with-earth-like-orbits

Objectives and activities

Foster interests in all aspects of exoplanets by advising members of; latest developments, on-line courses, meetings, resources via a regular newsletter and the section's website

Encourage and provide support for practical projects both amateur and pro-am and promote a greater understanding of exoplanet discoveries and properties. The list is considerable and it will take some time to implement all aspects supporting the need for a dedicated section. Not all of the observational activities mentioned are currently within the capabilities of amateurs but the time may come…

For those who are new to this particular game a brief description of these various activities follows. It may seem slightly strange to incorporate some of these in a BAA section but I do believe we should broaden our horizons to encourage people into the fold who may not wish to or be unable to carry out observations. If you are skilled in any aspect then a future edition of the newsletter awaits your input!!!

Practical

- Transit imaging
- Gravitational microlensing follow-up
- Radial velocity measurements using spectroscopy
- Participation in pro-am projects e.g.
    - Atmospheric Remote Sensing Infrared Exoplanet Large-survey (ARIEL)
    - Transiting Exoplanet Survey Satellite (TESS)
- Citizen science on-line analysis of transit light curves to search for exoplanets
- Search for extra-terrestrial intelligence
    - SETI@Home – use of home PCs to scan data from radio telescopes
    - Radio telescopes – Project Argus looking for signs of extra-terrestrial intelligence

Theoretical

- Keeping up to date on exoplanets in general
- Knowledge of ground and space-based observatories and technology
- Understanding astrobiology (by on-line courses for example)
- Why we need to leave Earth – a multi-planet species

Education and outreach

- Awareness of courses (mostly on-line)
- Further education projects relating to transit light curves. My local society, Hampshire Astronomical Group, work with Portsmouth University students to obtain and analyse light curves and this could be a template for such projects
- Presentations to local astronomical societies

Establishing links with related organisations

- UK Exoplanet Community
- Centre for Exoplanet Science
- UK Centre for Astrobiology
- Planetary Society
- British Interplanetary Society
- SETI Institute

Transit imaging

When an exoplanet passes in front of it host star, as seen from Earth, it blocks some of the host star's light which manifests itself as a very slight reduction in magnitude. An example light curve, obtained by Mark Salisbury is shown in Figure 1.

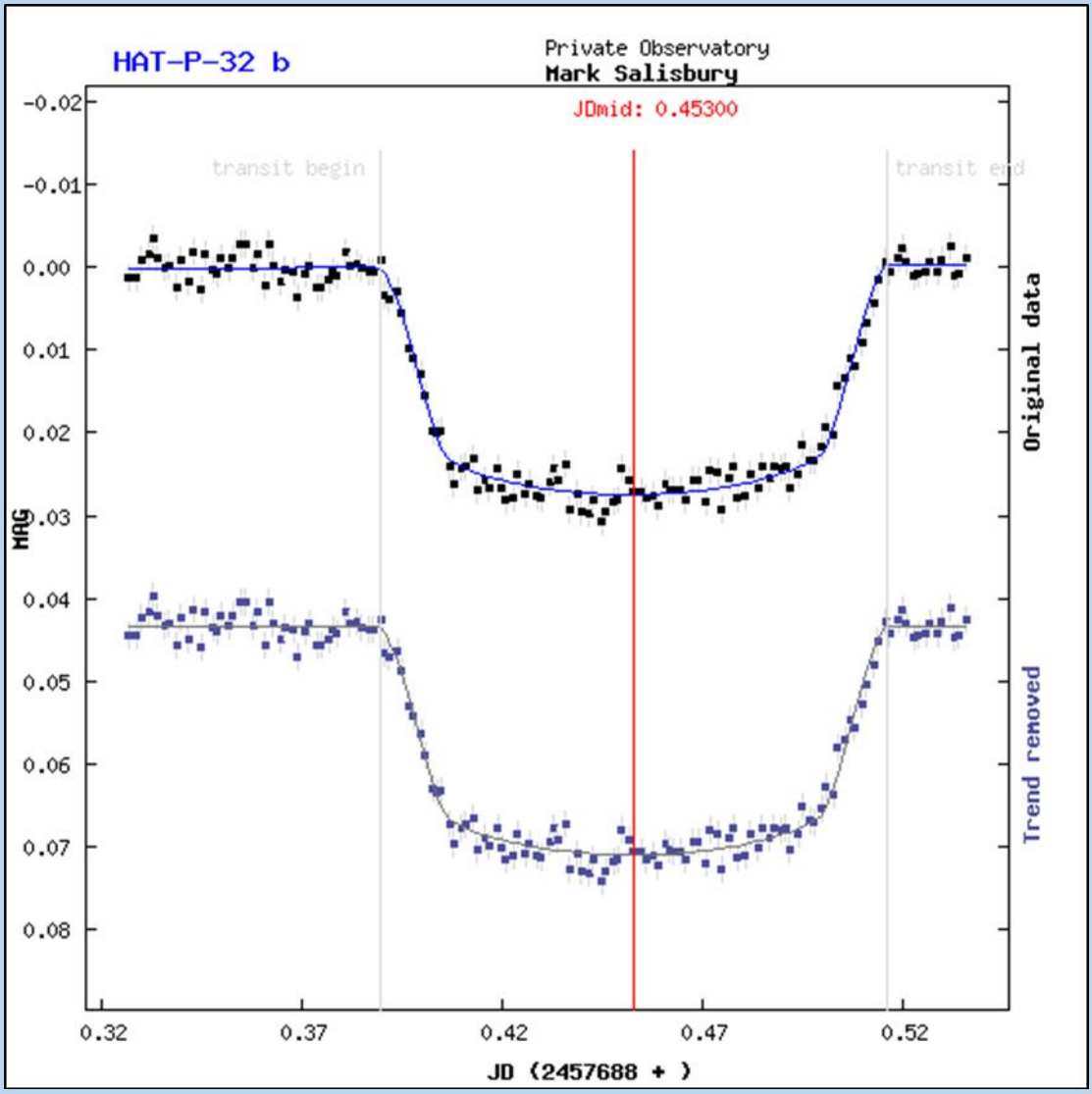

Figure 1. Transit light curve of HAT-P-32 b obtained by Mark Salisbury, 2016 Oct 26 19:41 to Oct 27 00:29, using a 0.4m f6.8 telescope plus SBIG ST10XME CCD camera

Gravitational microlensing follow-up
When a foreground object, usually a star, passes in front of a more distant star it acts as a lens momentarily magnifying the light from that star. If there is a planet orbiting the nearer star a shorter duration brightening may also occur – Figure 2.

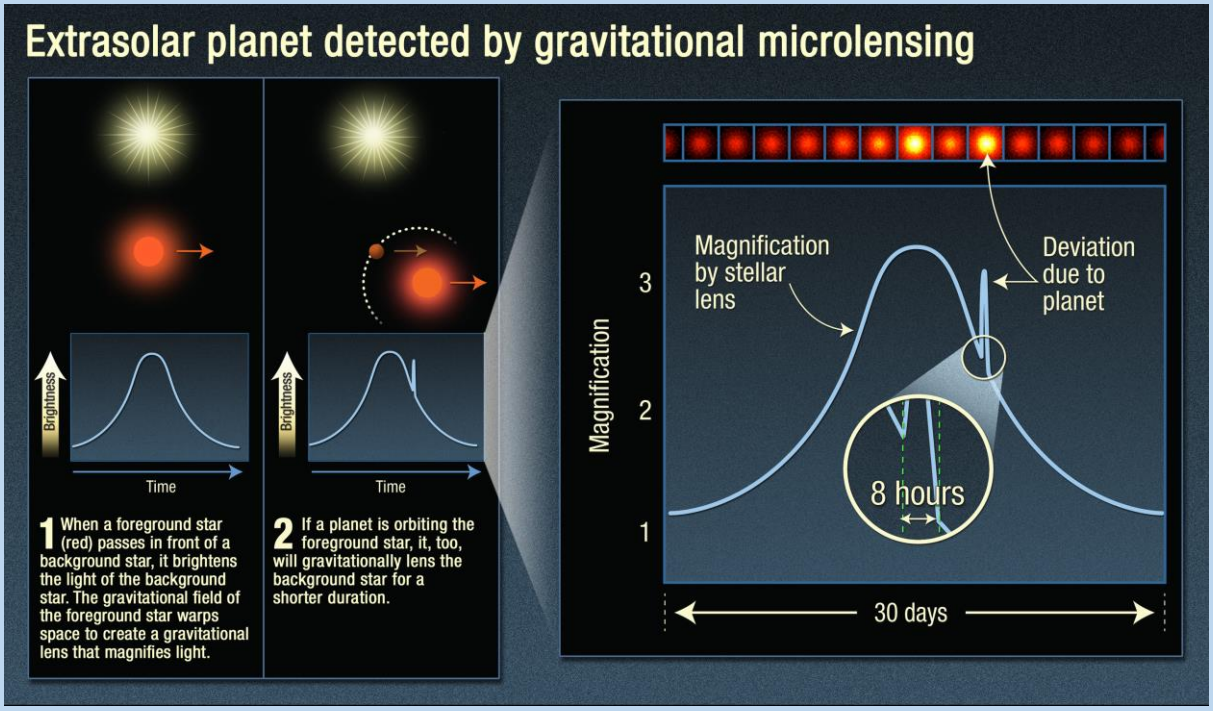

Figure 2. Gravitational microlensing Credit NASA, ESA and K. Sahu (STSCi)

MicroFUN is an informal consortium of observers dedicated to photometric monitoring of interesting microlensing events in the Galactic Bulge. Their primary scientific objective is to observe those high-magnification microlensing events that offer the greatest potential for detecting extra-solar planets orbiting the lensing star – http://www.astronomy.ohio-state.edu/~microfun/

Radial velocity measurements
The radial velocity method relies on the fact that a star does not remain completely stationary when it is orbited by a planet. It moves, very slightly, in a small circle or ellipse, responding to the gravitational tug of its smaller companion. When viewed from a distance, these slight movements affect the star's spectrum. If the star is moving towards the observer, then its spectrum would appear slightly shifted towards the blue; if it is moving away, it will be shifted towards the red – Figure 3. Large planets orbiting close to their host star (hot Jupiters for example) are most likely detectable by this method as they exert a larger pull than small Earth sized planets or more distant larger planets.

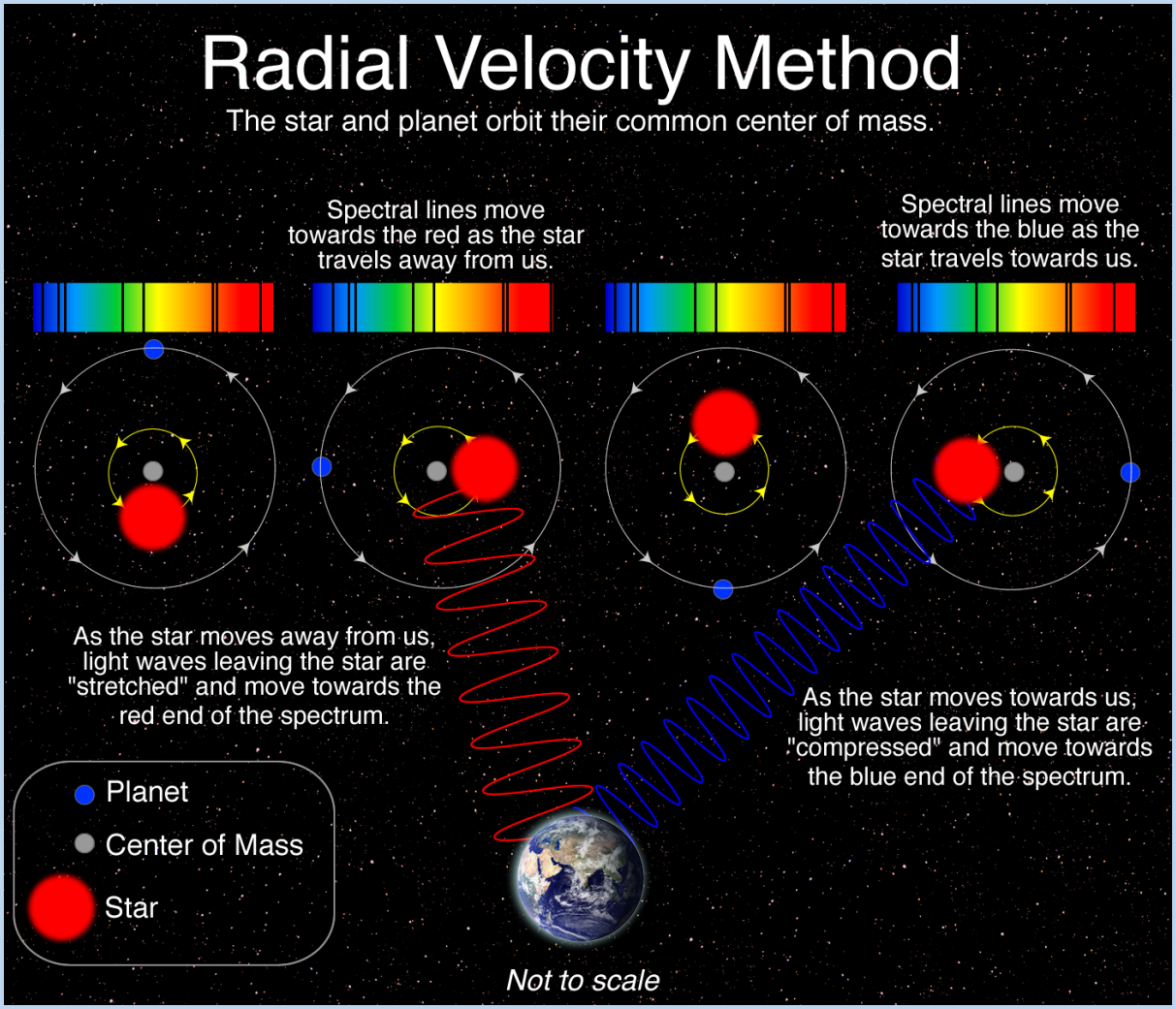

Figure 3. Detecting exoplanets by the radial velocity method. Credit Las Cumbres Observatory

Christian Buil explains how this is done at http://www.astrosurf.com/buil/extrasolar/obs.htm His presentation on this subject can be found at http://www.astrosurf.com/buil/exoplanet/exo_buil.pdf However this is in French so translation to English anyone ?

Astrobiology

Another aspect of exoplanets which can be explored via on line courses e.g. Astrobiology and the Search for Extra-terrestrial Life https://www.coursera.org/learn/astrobiology This course is taught by Professor Charles Cockell of the University of Edinburgh and I would recommend his book on the subject – Astrobiology: Understanding Life in the Universe, £33.98 from Amazon.

Citizen science

There are two Citizen Science websites which provide transit light curves for analysis - Planet Hunters and Exoplanet Explorers. Both Planet Hunters, https://www.planethunters.org/, and Exoplanet Explorers, https://www.zooniverse.org/projects/ianc2/exoplanet-explorers enable users to search Kepler data for light curves indicative of transiting exoplanets.

Exoplanet studies
On-line courses are a great way of learning about these celestial bodies. Many, if not most, can be accessed for free and pursued at one's own pace. Some are available on specific dates and others continuously so. For example;
Astrophysics: Exploring Exoplanets https://www.edx.org/course/astrophysics-exploring-exoplanets-anux-anu-astro2x-1
Alien Worlds: The Science of Exoplanet Discovery and Characterization
https://www.edx.org/course/alien-worlds-science-exoplanet-discovery-bux-astr105x-0

Opportunities for pro-am collaboration
There are a number of spacecraft dedicated to observing exoplanets and some which are only involved for part of their imaging schedule. As there may be opportunities for pro-am collaboration keeping abreast of developments is an important activity for the section.

For example;

ARIEL
Atmospheric Remote Sensing Infrared Exoplanet Large-survey - https://ariel-spacemission.eu/ - due to launch in 2018

CHEOPS
Characterising ExOplanet Satellite - http://sci.esa.int/cheops/ - is the first mission dedicated to searching for exoplanetary transits by performing ultra-high precision photometry on bright stars already known to host planets. The mission's main science goals are to measure the bulk density of super-Earths and Neptunes orbiting bright stars. Launch scheduled for 2018.

ESPRESSO
Echelle Spectrograph for Rocky Exoplanet and Stable Spectroscopic Observations - https://www.eso.org/sci/facilities/paranal/instruments/espresso.html ESPRESSO, the successor to HARPS, is the ESO/VLT high-resolution spectrograph for measuring precise radial velocities on a long time span with the main scientific aim to detect and characterise Earth twins in the inhabitable zone of solar-like stars.

Gaia
Objective is to chart about 0ne million stars in the Milky Way - http://sci.esa.int/gaia/ An exoplanets page is at http://sci.esa.int/gaia/58784-exoplanets/

HST
Hubble Space Telescope - http://sci.esa.int/hubble/ Astronomers using the NASA/ESA Hubble Space Telescope have detected helium in the atmosphere of the exoplanet WASP-107b - http://sci.esa.int/hubble/60245-hubble-detects-helium-in-the-atmosphere-of-an-exoplanet-for-the-first-time-heic1809/ - This is the first time this element has been detected in the atmosphere of a planet outside the Solar System. The discovery demonstrates the ability to use infrared spectra to study exoplanet extended atmospheres.

Kepler
Specifically designed to survey our region of the Milky Way in order to discover Earth=size and smaller exoplanets - https://www.nasa.gov/mission_pages/kepler/main/index.html
Sadly it will soon run out of fuel.

TESS
Transiting Exoplanet Survey Satellite (TESS) - https://tess.gsfc.nasa.gov/ - launched 2018 April 18

Search for Extra-terrestrial Intelligence (SETI)
SETI is an exploratory science that seeks evidence of life in the universe by looking for some signature of its technology. Our current understanding of life's origins on Earth suggests that, given a suitable environment and sufficient time, life will develop on other planets. Whether evolution will give rise to intelligent, technological civilisations is open to speculation.

Seti@home is a scientific experiment that uses internet-connected computers to analyse signals picked up by radio telescopes – see https://setiathome.berkeley.edu/

Project Argus is an effort to deploy small radio telescopes around the world in an all-sky survey for microwave signals of possible intelligent extra-terrestrial origin – see http://www.setileague.org/argus/whargus.htm

Space
Interest in journeying to and settling on and eventually an exoplanet, most likely via the stepping stones of the Moon, Mars may seem more the province of organisations such as the British Interplanetary Society. Perhaps a little controversial but it excites people and may bring in new members so I believe we should understand developments in manned and unmanned space missions to these celestial bodies.

Roger Dymock
Assistant Director Exoplanets
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