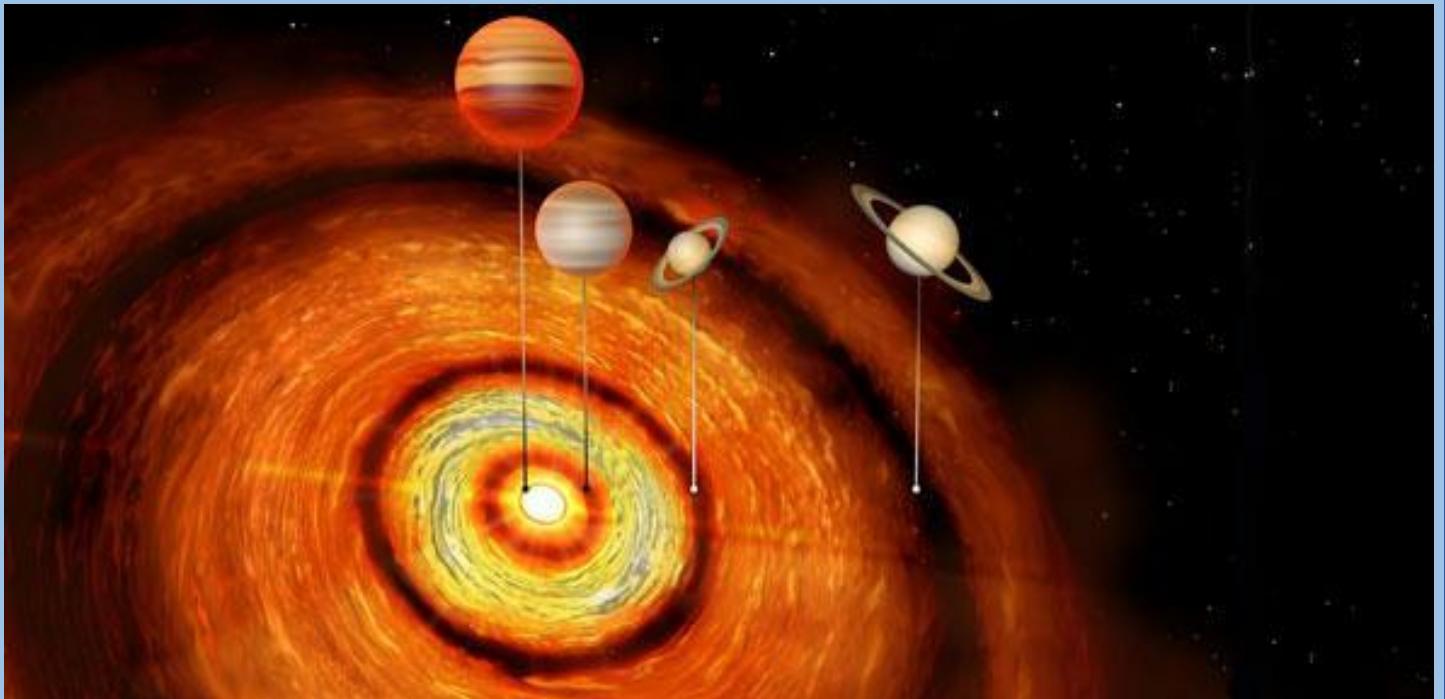




British Astronomical Association
Supporting amateur astronomers since 1890

Infinite Worlds



Artists impression of dust disk and planets orbiting CI Tau

Credit Amanda Smith IoA

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

Issue 2

2019 January

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Section officers

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Exoplanet Technical Advisory Group (ETAG)

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

“The universe is a pretty big place. If it’s just us, seems like an awful waste of space



Carl Sagan

BAA Photometry Database

The screenshot shows the BAA Photometry Database website. At the top left is the BAA logo (a star in a circle) and the text "British Astronomical Association Supporting amateur astronomers since 1890". To the right is a white box containing a light curve plot. Further right are four buttons: "Home", "Login", "Help", and "BAA". Below this is a large heading "Welcome to the BAA Photometry Database". Underneath is a paragraph of text: "This database contains the visual and electronic photometric observations of the British Astronomical Association with observations dating back to 1862. Observations may be reviewed and downloaded by using the buttons below. Please acknowledge the BAA in any publications where this data is used by including the following note (or similar):- 'The BAA Photometry Database is acknowledged as the (part) source of data on which this article was based.'" Below this text is a dark blue box with white text. It has a heading "Review Data" and two buttons: "Review Observations" and "Standing Data and Summaries". Below that is a heading "Observer Area" and a button "Login".

Good work by Andy Wilson has morphed the VSS database into the BAA Photometry Database so that both asteroid and exoplanet input (as well as variable star) light curves data can be. This can be accessed at via [the link](#) on the Exoplanets webpage or at <https://britastro.org/photdb/> Observers will need a login and then can submit observations of Variable Stars, Exoplanets and Asteroids. A single registration is all that is needed.

Guides are available at;

<https://britastro.org/photdb/help/UploadingObsToBAAPhotDb.pdf>

https://britastro.org/photdb/notes_submissions.php

In order to give it a good test and ensure we have a 'local' database for transit light curves produced by BAA members could I please ask you to upload such data you may have and advise Andy Wilson, copy me, of any problems you may encounter. Also, please let me know when you have uploaded data so that I can get some practice accessing the database.

The various links mentioned above have been added to the Exoplanet website

Progress and priorities

So, what have we done and what are we planning to do?

Story so far (mostly administrative tasks);

- ARPS/Exoplanets organisation in place
- Website set up
- Articles published in the Journal of the BAA and Astronomy Now
- Two issues of the emagazine published

- Imaging and analysis process by Mark Salisbury due to be published in February issue of Astronomy Now'
- Exoplanet display at 2019 Winchester Weekend
- ARPS (including Exoplanets) meeting scheduled for 2019 September 29 (see below)
- Ditto for Winchester Weekend in 2020 (see below)

Priorities

- Upload existing transit light curves to BAA Photometry Database (please)
- Write detailed imaging and analysis process (Mark Salisbury has kindly agreed to do this)
- Define exoplanet transit projects suitable for beginners through to experts
- Explore possibility of holding a 'hands-on' workshop to work through imaging and analysis process
- Explore possible collaboration in pro-am projects
- Encourage participation in Citizen Science activities
 - Examining on-line data for exoplanet transits
 - SETI@Home
- Learn from the involvement of other national organisations in exoplanet observation

To be prioritised and scheduled

- Gravitational microlensing follow-up
- Radial velocity measurements using spectroscopy
- Develop interests in Astrobiology and Space

Meetings

2019 April 5 to 7

The ARPS Exoplanet Division will have a display at this year's Winchester Weekend meeting so please let me have your views on the past, present and future. See you there.

2019 September 29

An [Asteroid and Remote Planets Section](#) meeting, hosted by [Hampshire Astronomical Group](#) will be held at Clanfield, Hampshire. The content will be approximately 50% asteroids and 50% exoplanets. Details will appear on the BAA website Events page at <https://britastro.org/arps2019> Please book in advance via the BAA office.

If you would like to make a presentation at this meeting please let me know.

Outline agenda

Presentations can be shorter or longer but, in total, should fill the time between breaks

From	To	Subject	Speaker	Chair person
09:30		Doors open		
10:00	10:15	Welcome	Richard Miles	
10:15	10:45	Presentation 1		Richard Miles
10:45	11:15	Presentation 2		
11:15	11:45	Tea Break		
11:45	12:15	Presentation 3		
12:15	12:45	Presentation 4		

12:45	13:30	Lunch break	
13:30	14:00	Presentation 5	Roger Dymock
14:00	14:30	Presentation 6	
14:30	15:00	Presentation 7	
15:00	15:30	Tea break	
15:30	16:00	Presentation 8	
16:00	16:30	Presentation 9	
16:30	17:00	Question time	Richard Miles, Roger Dymock, Presenters

2020 Winchester Weekend

An Asteroid and Remote Planets Section meeting will be held on the Saturday afternoon.

Exoplanets an overview

I thought it a useful exercise to see how the various proposed activities might tie together. The different aspects are shown in different colours in the diagram below. The boxes enclosed by double lines indicate areas of possible involvement by amateur astronomers. To quote the late Steven Hawking “There is no bigger question in science that the search for extraterrestrial life’. The key boxes in the diagram are thus ‘Habitable?’ and ‘Inhabited?’

Considering life as we know it;

Astronomy

- delivers various ways of remotely detecting and characterising exoplanets. For example; is the planet approximately Earth sized and in the habitable zone?
- determines through spectroscopy if potential biosignatures have been detected. It is not currently possible to state whether a biosignature is evidence of life or caused by non-biological means hence the use of ‘potential’

Astrobiology

- defines the limits to habitability

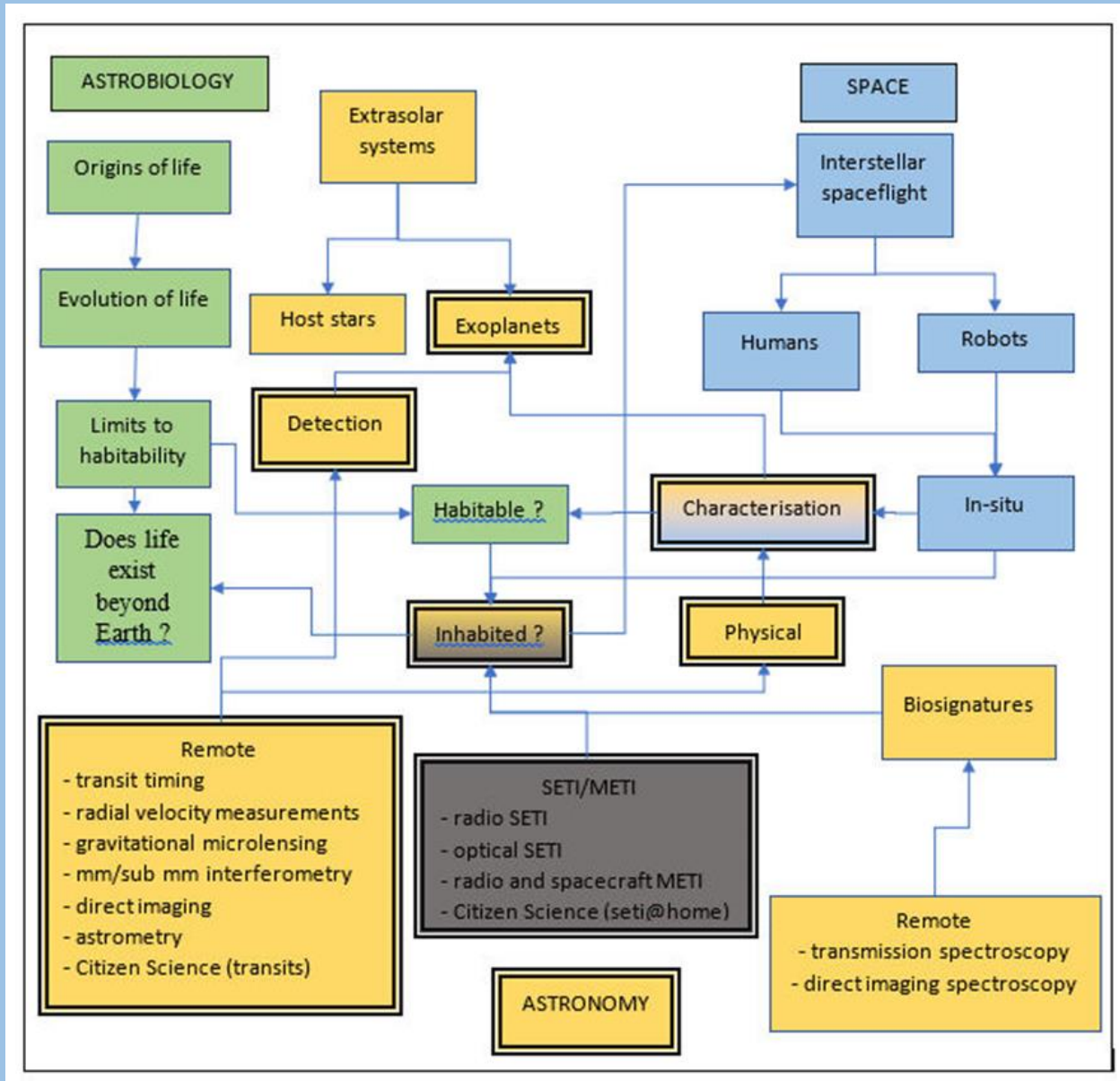
Space

- at some future date robotic or human exploration, if it becomes possible, will determine if the planet is habitable and inhabited
- the link between ‘Inhabited?’ and ‘Interstellar spaceflight’ is there because, as we might journey to another stellar system, its inhabitants might also visit us. Our current knowledge does not allow for this and if and when this might be possible is highly debateable. Your views on this would be most welcome and for more on this subject you might like to read ‘The Physics of Interstellar Travel’ on [Dr. Micho Kaku’s website](#)

Search for Extraterrestrial Intelligence (SETI)

- receipt of signals from intelligent life on the planet will indicate that it is inhabited assuming we can make sense of them

If the planet is inhabited the question posed by astrobiology ‘Does life exist elsewhere in the universe?’ will finally be answered.



Exoplanet Transit Imaging and Analysis Process ETIP

This procedure will be developed over the coming months. Experienced imagers will already be aware of and utilise many of the points mentioned here and newcomers should find it assists in developing their skills. I believe it will be helpful if 'we all sing from the same hymn sheet' but do please suggest improvements to this process. An outline is at <https://britastro.org/node/16553> and is reproduced below. I am indebted to Mark Salisbury who volunteered to do this and his article on this subject will appear in the February issue of Astronomy Now.

Introduction

- Number & types of transiting planets known
- Current and planned surveys (SWASP, NGTS, TESS, Twinkle etc)

Why observe Exoplanets

- Interest factor, UK based surveys and strong professional community
- Rapidly increasing number of known systems
- Niche created for amateurs where pros take short snapshot data and cannot follow all systems all the time
- Long term timing behaviour can lead to new discoveries providing information on system components, formation and dynamical history
- Long term monitoring of host stars, "know thy star, know thy planet" & discovery of new field variable

What equipment is required

- Good mount tracking/guiding
- Almost any size/type of telescope
- Cooled CCD
- Timing management
- Photometric filters
- Aim of millimag photometry is achievable

Which systems make good targets

- Follow up of known systems
- Visibility, matching targets to capability
- Short and ultra-short period Hot Jupiter

A typical observing session

- Planning; Tools available, Out of transit coverage
- Obtaining data and improving photometry; timing of data, SNR, filters, binning, focussing, tracking, cadence, calibration data, practice and persistence!

Producing a light curve

- AstroImageJ; data reduction, ensemble photometry

How to analyse the results

- Model fitting; ETD and Exofast
- Phase folding
- What can you expect to achieve/what should you aim for

Sharing your findings

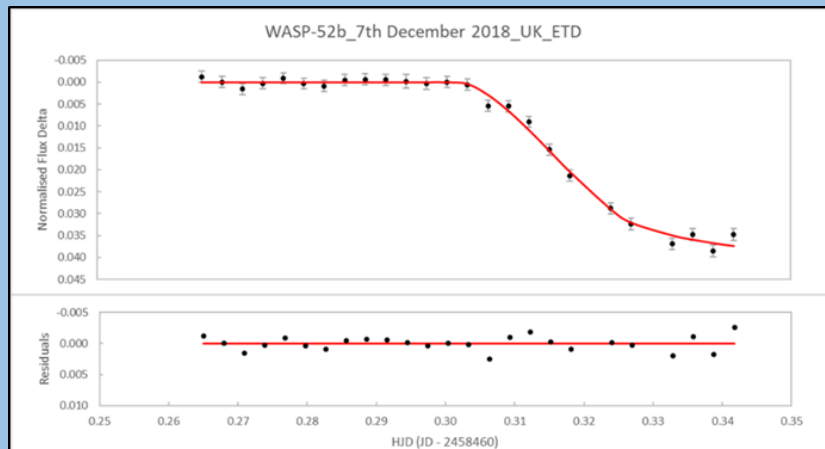
- BAA photometry database
- Exoplanet Transit Database (ETD)
- The BAA Exoplanet Division; member pages, social media
- Pro-Am collaboration; publications

Resources and avenues for study

- Some planets ideal as first targets
- BAA Exoplanet webpage; more in-depth emagazine articles, Exocast, OU and other further study options

Observations

Transit light curve



A recent observation by Mark Salisbury of WASP-52b obtained on 7th December from the UK with a 0.4m telescope, ST-10XME and Rc filter with a 4 minute cadence. Model fit is from ETD (TRESKA). The scatter in the out of transit measurement is less than

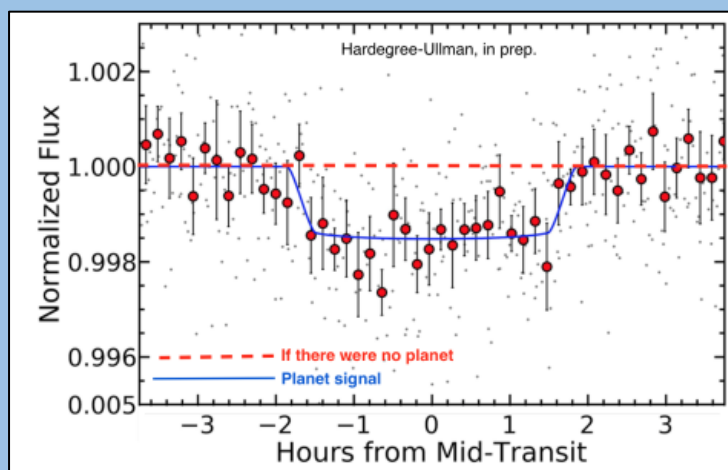
0.8 parts per thousand. Poor weather prevented the complete transit being observed.

Another way of discovering exoplanets

Those of you who attended the BAA Christmas lecture at the Institute of Physics on 2018 December 8th will have seen the lecture, '[Protoplanetary discs revealed: new results from ALMA and elsewhere](#)' given by Professor Catherine Clarke. Well worth a look if you couldn't get to the meeting. More on the Atacama Large Millimeter/submillimetre Array [here](#) with images of protoplanetary disks [here](#)

An Astronomy Now article describing the protoplanetary disk around CI Tau is [here](#) and a paper on the same subject can be accessed [here](#)

Citizen science discoveries



Volunteers accessing the [Exoplanet Explorers](#) website have contributed to the discovery of two exoplanets. One, [K2-138g](#), is in addition to five orbiting a Sun-like star K2-138 and the other, [K2-288Bb](#) is just under twice the size of Earth in or around the habitable zone of its M class red-dwarf host star. The host star is the secondary star in a binary star system. The confirmatory light curve obtained by the Exoplanet Explorers research team using the Spitzer Space telescope is shown on the left

Links to three Citizen Science exoplanet hunting websites can be found on the Exoplanet web links page;

Exoplanet Explorers <https://www.zooniverse.org/projects/ianc2/exoplanet-explorers>

Planet Hunters TESS <https://www.zooniverse.org/projects/nora-dot-eisner/planet-hunters-tess>

New links added to the Exoplanet website (https://britastro.org/section_front/15474)

Astrobiology at NASA <https://astrobiology.nasa.gov/>

Czech Astronomical Society <https://www.astro.cz/>

- Variable Star and Exoplanet Section <http://var2.astro.cz/EN/index.php>

- Transiting Exoplanets and Candidates (TRESKA) <http://var2.astro.cz/tresca/?lang=en>

Dimension 4 <http://www.thinkman.com/dimension4/>

European Astrobiology Institute <http://europeanastrobiology.eu/>

HATNet Exoplanet Survey <https://hatnet.org/>

Initiative for Interstellar Studies <https://i4is.org/>

MEarth Project <https://www.cfa.harvard.edu/MEarth/Welcome.html>

NASA Astrobiology Institute <https://nai.nasa.gov/>

Open University <http://www.open.ac.uk/>

- S382 Astrophysics <http://www.open.ac.uk/courses/modules/s382>

Part 1, Stellar Evolution and Nucleosynthesis,

Part 2, Astrophysical Data Analysis

Part 3, Transiting Exoplanets (Based around the book 'Transiting Exoplanets' by Carole Haswell)

Paul B. Rimmer <https://www.mrao.cam.ac.uk/~pbr27/>

Planet Finders https://www.zooniverse.org/projects/nora-dot-eisner/planet-finders?utm_source=Newsletter&utm_campaign=pfbeta16oct2018

Planet Hunters – TESS <https://www.zooniverse.org/projects/nora-dot-eisner/planet-hunters-tes>

Sarah Rugheimer <https://www.jesus.ox.ac.uk/people/dr-sarah-rugheimer>

SuperWASP <https://exoplanetarchive.ipac.caltech.edu/docs/SuperWASPMission.html>

Astrobiology

One of the questions posed by Astrobiology is ‘What is the future of life on Earth?’ Elon Musk, not being content with setting up a Martian colony, has founded a company, [Neurolink](#), to develop a Brain Machine Interface (BMI) also known as a Brain Computer Interface (BCI). Not to be confused with Body Mass Index which tells us we are too fat. Neurolink wants to blend man and machine to make cyborgs so perhaps Musk’s Martian colony will be populated with such creatures and not we mere humans.

Space

New Horizons journey to the stars

Objects in the outer Solar System, the Edgeworth-Kuiper Belt and the Oort Cloud, are sometimes put forward as possible staging posts for when we journey to the stars. The New Horizons spacecraft passed by one such object, Ultima Thule/2014 MU69/Minor planet 485968 – on New Year’s Day.

It left Earth in 2006 January 19 so has taken just under 13 years to travel 4 billion miles (6.5 billion kilometres) or 43 AU. One of the nearest Earth-like exoplanets is Proxima Centauri b which is 4.2 light years away. Now one lightyear is 63240 AU so travelling at the same speed it would take a spacecraft just over 80000 years to reach that planet. Neither Dan Dare’s rockets or suspended animation are likely to get us there in one piece and alive. As Professor Don Pollaco stated in his talk to the Hampshire Astronomical Group in 2015 ‘We are going to need new physics to reach exoplanets’.

China's moon mission



China's Chang'e-4 probe made a successful landing on the Moon's far side on 2019 January 3. This image shows that the rover has made its first foray across the surface. Radio telescopes located on the surface or orbiting the Moon would be free of interference from Earthly signals. One such proposal is the Dark Ages Radio Explorer (DARE) satellite being put forward by the University of Colorado - <https://www.colorado.edu/dark-ages-radio-explorer/> Surface based telescopes might also be appealing to the Planetary Society's [SETI Institute](#)

SpaceX



The Starhopper is an important building block in Elon Musk's plan to fly passengers around the Moon and eventually establish a colony on Mars. The 40metre tall vehicle will take off, hover at a height of 5 km/3 mls and then return to a controlled landing. Its first test flight may have taken place by the time you read this.

[More on the Moon and Mars missions](#)

Publications and other media

Literature watch

Literature Watch, put together by Paul Leyland, 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. This first column is rather sparse because the concept was proposed only a few days ago and I've not yet had time to collect a substantial body of material. 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

We'll start the ball rolling with the extremely useful NASA Exoplanet Archive <https://exoplanetarchive.ipac.caltech.edu> where you will find data on almost every known exoplanet and a variety of tools to manipulate it. Amongst its many facilities is the ability to predict ephemerides of exoplanet transits and to search light curves for possible transit events in the data.

The most generally successful period detection tool on that page uses the Boxcar Least Squares algorithm to search for periodic dips in the light curve. Two papers show that better techniques exist. The first is "Transit Least Squares: An optimized transit detection algorithm to search for periodic transits of small planets" by Michael Hippke and René Heller, the preprint for which is at <https://arxiv.org/abs/1901.02015>. The authors show that rather than searching for a rectangular shaped dips in the light curve, markedly better detection rates are achieved by fitting a physically more plausible flat-bottomed U-shaped dip. They make their source code available for anyone who wishes to take this further.

The final paper isn't that recent but I only came across it a couple of weeks ago. It's well known (or should be) that least squares fitting is very sensitive to outliers and that robust statistics can do a much better job.

https://cran.r-project.org/web/packages/RobPer/vignettes/RobPer_vignette.pdf describes a package for the R statistics programming environment. Although the examples the authors (Anita M. Thieler, Roland Fried & Jonathan Rathjens) provide come from gamma ray astronomy their lessons are just as applicable in any field where periodic data is buried within noisy data.

Books

Two books recently added to the Publications page on the Exoplanet website;

- The Exoplanet Handbook (Second Edition) by Michael Perryman, published by Cambridge University Press 2018, £56.99 (Hardback)
- Transiting Exoplanets by Carole A. Haswell, published by Cambridge University Press, 2010, £31.99 (Paperback)

ExoPlanetNews

ExoPlanetNews is 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. <http://nccr-planets.ch/exoplanetnews/>

The Exoplanet Podcast

Discussions of all things exoplanetary. Examples of recent episodes;

[Exocast-28 b](#), 2018 September – [Special guest: Daniel Angerhausen \(Observing from the stratosphere\) – Technosignatures – News – HD 209458 b.](#)

[Exocast-29 b](#), 2018 October – [Special guest: Sarah Hörst \(planetary atmospheres from the lab\) – Exomoons – News – Titan/"Sol g VI" – Exocup2018.](#)

Search for Extraterrestrial Intelligence (SETI)



The Canadian Hydrogen Intensity Mapping Experiment (CHIME) caused some excitement recently when it detected a repeating Fast Radio Burst (FRB). This is only the second such burst detected and alien intelligences received an outing in the media. For the real story go to <http://www.chime-experiment.ca/> The excitement is covered in the News section and a description of Fast Radio Bursts under that heading.

Thus, the search continues.

Roger Dymock
Assistant Director Exoplanets
2019 January 18