ExoPlanet News
An Electronic Newsletter

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1 Editorial

Welcome to the ninety seventh edition of ExoPlanet News. As usual, we have an excellent selection of abstracts this month along with a selection of jobs, conferences and announcements. I'm particulary pleased to have received a thesis abstract for inclusion this month, and would encourage other readers to send these in too.

One thing that caught my eye in the arXiv listings this month is a series of papers on Exoplanet Biosignatures which are part of a NASA Nexus for Exoplanet System Science (NExSS) to be submitted to Astrobiology (below). When this newsletter began almost 10 years ago, the prospect of detecting biosignatures may have seemed a long way off, but it no longer seems such a remote prospect.

astro-ph/1705.05791 : **Exoplanet Biosignatures: A Review of Remotely Detectable Signs of Life** by
Edward W. Schwieterman, et al.
astro-ph/1705.06381 : **Exoplanet Biosignatures: A Framework for Their Assessment** by
David C. Catling, et al.
astro-ph/1705.07098 : **Exoplanet Biosignatures: Observational Prospects** by
Yuka Fujii, et al.
astro-ph/1705.07560 : **Exoplanet Biosignatures: Understanding Oxygen as a Biosignature in the Context of Its Environment** by
Victoria S. Meadows, et al.
astro-ph/1705.08071 : **Exoplanet Biosignatures: Future Directions** by
Sara I. Walker, et al.

Best wishes
Andrew Norton
The Open University

2 Abstracts of refereed papers

Lightning Chemistry on Earth-like Exoplanets

A. Ardaseva[1], P. B. Rimmer[1], I. Waldmann[2], M. Rocchetto[2], S. N. Yurchenko[2], Ch. Helling[1], J. Tennyson[2]

[1] Centre for Exoplanet Science, SUPA, School of Physics and Astronomy, Univ of St Andrews, North Haugh, St Andrews, KY16 9SS, UK
[2] Department of Physics and Astronomy, University College London, London, WC1E 6BT, UK

Monthly Notices of the Royal Astronomical Society, accepted (arXiv:1704.07917)

We present a model for lightning shock induced chemistry that can be applied to atmospheres of arbitrary H/C/N/O chemistry, hence for extrasolar planets and brown dwarfs. The model couples hydrodynamics and the STAND2015 kinetic gas-phase chemistry. For an exoplanet analogue to the contemporary Earth, our model predicts NO and NO_2 yields in agreement with observation. We predict height-dependent mixing ratios during a storm soon after a lightning shock of NO $\approx 10^{-3}$ at 40 km and $NO_2 \approx 10^{-4}$ below 40 km, with O_3 reduced to trace quantities ($\ll 10^{-10}$). For an Earth-like exoplanet with a CO_2/N_2 dominated atmosphere and with an extremely intense lightning storm over its entire surface, we predict significant changes in the amount of NO, NO_2, O_3, H_2O, H_2, and predict significant abundance of C_2N. We find that, for the Early Earth, O_2 is formed in large quantities by lightning but is rapidly processed by the photochemistry, consistent with previous work on lightning. The effect of persistent global lightning storms are predicted to be significant, primarily due to NO_2, with the largest spectral features present at ~ 3.4 μm and ~ 6.2 μm. The features within the transmission spectrum are on the order of 1 ppm and therefore are not likely detectable with JWST. Depending on its spectral properties, C_2N could be a key tracer for lightning on Earth-like exoplanets with a N_2/CO_2 bulk atmosphere, unless destroyed by yet unknown chemical reactions.

Download/Website: `https://arxiv.org/abs/1704.07917`

Contact: `pr33@st-andrews.ac.uk`

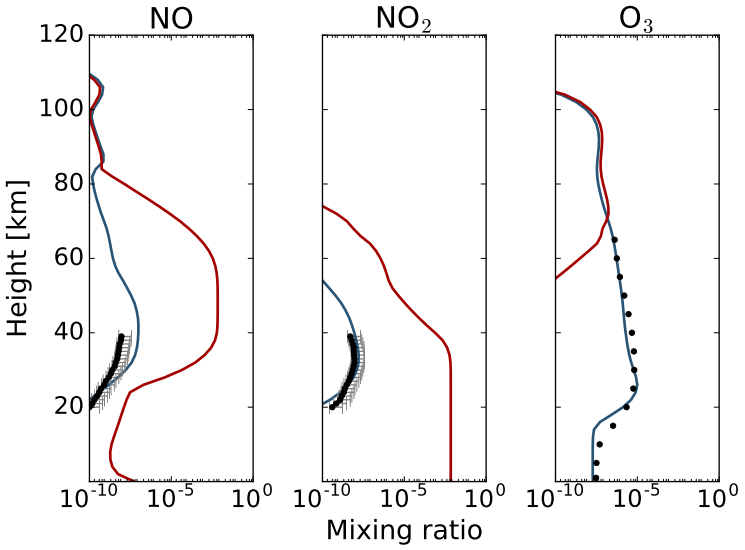

Figure 1: (Ardaseva et al.) The atmospheric profiles of NO, NO_2, and O_3 for the Contemporary Earth. Red line – with lightning, blue line – without, black dots – balloon observations (NO and NO_2 from Sen et al. 1998, O_3 from Massie et al. 1981).

The Northern Arc of ϵ Eridani's Debris Ring as Seen by ALMA

M. Booth[1,2], W. R. F. Dent[3], A. Jordán[2,4], J-F. Lestrade[5], A. S. Hales[3,6], M. C. Wyatt[7], S. Casassus[8,9], S. Ertel[10], J. S. Greaves[11], G. M. Kennedy[7], L. Matrà[7], J-C. Augereau[12] and E. Villard[3]

[1] Astrophysikalisches Institut und Universitätssternwarte, Friedrich-Schiller-Universität Jena, Schillergäßchen 2-3, 07745 Jena, Germany
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[3] Joint ALMA Observatory, Alonso de Córdova 3107, Vitacura 763-0355, Santiago, Chile
[4] Millennium Institute of Astrophysics, Vicuña Mackenna 4860, Santiago, Chile
[5] Observatoire de Paris, PSL Research University, CNRS, Sorbonne Universités, UPMC, 61 Av. de l'Observatoire, F-75014 Paris, France
[6] National Radio Astronomy Observatory, 520 Edgemont Road, Charlottesville, Virginia, 22903-2475, USA
[7] Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UK
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Monthly Notices of the Royal Astronomical Society, in press (arXiv:1705.01560)

We present the first ALMA observations of the closest known extrasolar debris disc. This disc orbits the star ϵ Eri, a K-type star just 3.2 pc away. Due to the proximity of the star, the entire disc cannot fit within the ALMA field of view. Therefore, the observations have been centred 18″ North of the star, providing us with a clear detection of the northern arc of the ring, at a wavelength of 1.3 mm. The observed disc emission is found to be narrow with a width of just 11-13 AU. The fractional disc width we find is comparable to that of the Solar System's Kuiper Belt and makes this one of the narrowest debris discs known. If the inner and outer edges are due to resonances with a planet then this planet likely has a semi-major axis of 48 AU. We find tentative evidence for clumps in the ring, although there is a strong chance that at least one is a background galaxy. We confirm, at much higher significance, the previous detection of an unresolved emission at the star that is above the level of the photosphere and attribute this excess to stellar chromospheric emission.

Download/Website: `https://doi.org/10.1093/mnras/stx1072`

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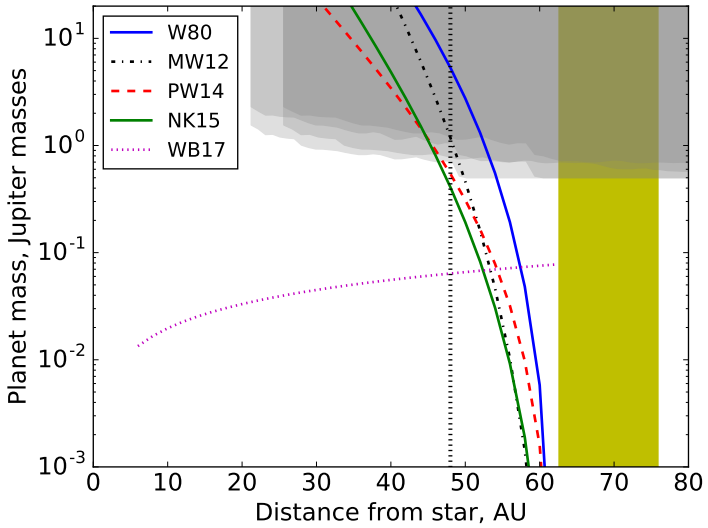

Figure 2: (Booth et al.) Dynamical estimates for the mass of a planet as a function of semi-major axis compared to observational limits. The lines given are based on the equations of Wisdom (W80; 1980), Mustill & Wyatt (MW12; 2012), Pearce & Wyatt (PW14; 2014), Nesvold & Kuchner (NK15; 2015) and Wyatt et al. (WB17; 2017). The vertical (yellow) shaded region represents the location of the main ring and the vertical dotted line at 48 AU shows where a planet would need to be to have 3:2 and 2:1 MMRs that coincide with the discs inner and outer edges. The observational limits (represented by the grey shading) are from Janson et al. (2015).

The O_2 A-band in fluxes and polarization of starlight reflected by Earth-like exoplanets

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The Astrophysical Journal, in press, arXiv:1704.06247

Earth-like, potentially habitable exoplanets are prime targets in the search for extraterrestrial life. Information about their atmosphere and surface can be derived by analyzing light of the parent star reflected by the planet. We investigate the influence of the surface albedo A_s, the optical thickness b_{cloud} and altitude of water clouds, and the mixing ratio η of biosignature O_2 on the strength of the O_2 A-band (around 760 nm) in flux and polarization spectra of starlight reflected by Earth-like exoplanets. Our computations for horizontally homogeneous planets show that small mixing ratios ($\eta < 0.4$) will yield moderately deep bands in flux and moderate to small band strengths in polarization, and that clouds will usually decrease the band depth in flux and the band strength in polarization. However, cloud influence will be strongly dependent on their properties such as optical thickness, top altitude, particle phase, coverage fraction, horizontal distribution. Depending on the surface albedo, and cloud properties, different O_2 mixing ratios η can give similar absorption band depths in flux and band strengths in polarization, in particular if the clouds have moderate to high optical thicknesses. Measuring both the flux and the polarization is essential to reduce the degeneracies, although it will not solve them, in particular not for horizontally inhomogeneous planets. Observations at a wide range of phase angles and with a high temporal resolution could help to derive cloud properties and, once those are known, the mixing ratio of O_2 or any other absorbing gas.

Download/Website: `https://arxiv.org/abs/1704.06247`

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On The Feasibility of Exomoon Detection Via Exoplanet Phase Curve Spectral Contrast

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Monthly Notices of the Royal Astronomical Society, in press (arXiv:1705.05203)

An exoplanet-exomoon system presents a superposition of phase curves to observers - the dominant component varies according to the planetary period, and the lesser varies according to both the planetary and the lunar period. If the spectra of the two bodies differs significantly, then it is likely there are wavelength regimes where the contrast between the moon and planet is significantly larger. In principle, this effect could be used to isolate periodic oscillations in the combined phase curve. Being able to detect the exomoon component would allow a characterisation of the exomoon radius, and potentially some crude atmospheric data.

We run a parameter survey of combined exoplanet-exomoon phase curves, which show that for most sets of planet-moon parameters, the lunar component of the phase curve is undetectable to current state-of-the-art transit observations. Even with future transit survey missions, measuring the exomoon signal will most likely require photometric precision of 10 parts per million or better.

The only exception to this is if the moon is strongly tidally heated or in some way self-luminous. In this case, measurements of the phase curve at wavelengths greater than a few microns can be dominated by the lunar contribution. Instruments like the James Webb Space Telescope and its successors are needed to make this method feasible.

Download/Website: `https://arxiv.org/abs/1705.05203`

Contact: `dhf3@st-andrews.ac.uk`

Relativistic Generalization of the Incentive Trap of Interstellar Travel with Application to Breakthrough Starshot

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(submitted), arXiv:1705.01481

As new concepts of sending interstellar spacecraft to the nearest stars are now being investigated by various research teams, crucial questions about the timing of such a vast financial and labor investment arise. If humanity could build high-speed interstellar lightsails and reach the α Centauri system 20 yr after launch, would it be better to wait a few years, then take advantage of further technology improvements to increase the speed, and arrive earlier despite waiting? The risk of being overtaken by a future, faster probe has been described earlier as the incentive trap. Based on 211 yr of historical data, we find that the speed growth of human-made vehicles, from steam-driven locomotives to Voyager 1, is much faster than previously believed, about $4.72\,\%$ annually or a doubling every 15 yr. We derive the mathematical framework to calculate the minimum of the wait time t plus travel time $\tau(t)$ and extend two exponential growth law models into the relativistic regime. We show that the minimum of $t + \tau(t)$ disappears for nearby targets. There is no use of waiting for speed improvements once we can reach an object within about 20 yr of travel, irrespective of the actual speed. In terms of speed, the $t + \tau(t)$ minimum for a travel to α Centauri will occur once $19.6\,\%$ the speed of light (c) become available, in agreement with the $20\,\%\,c$ proposed by the Breakthrough Starshot Initiative. If interstellar travel at $20\,\%\,c$ can be obtained within 45 yr from today and if the kinetic energy could be increased at a rate consistent with the historical record, then humans can reach the ten most nearby stars within 100 yr from today.

Download/Website: `https://arxiv.org/abs/1705.01481`

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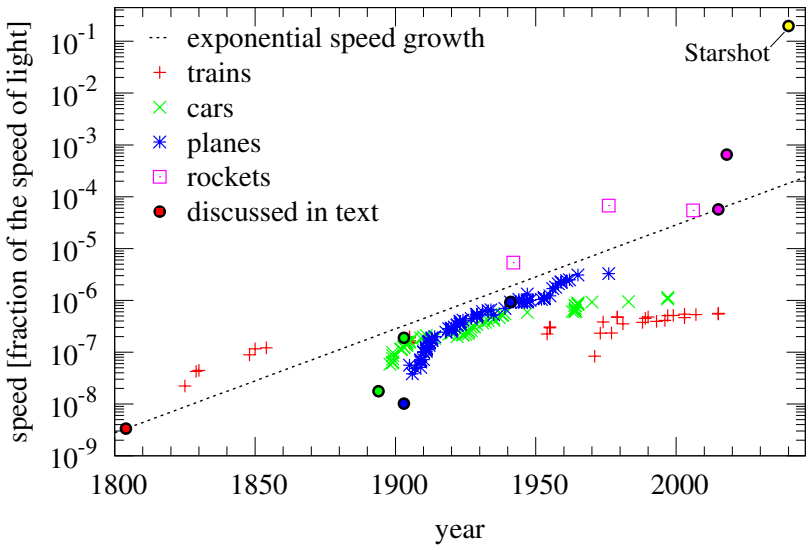

Figure 3: (Heller) Historical speed records of trains, cars, planes, and rockets. Black-rimmed data points are discussed in the main text of the paper. The proposed scenario for Breakthrough Starshot is shown in the upper right corner.

Volcanism and outgassing of stagnant-lid planets: Implications for the habitable zone

L. Noack, A. Rivoldini, T. Van Hoolst
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Physics of the Earth and Planetary Interiors, in press (DOI 10.1016/j.pepi.2017.05.010)

Rocky exoplanets are typically classified as potentially habitable planets, if liquid water exists at the surface. The latter depends on several factors like the abundance of water but also on the amount of available solar energy and greenhouse gases in the atmosphere for a sufficiently long time for life to evolve. The range of distances to the star, where surface water might exist, is called the habitable zone. Here we study the effect of the planet interior of stagnant-lid planets on the formation of a secondary atmosphere through outgassing that would be needed to preserve surface water. We find that volcanic activity and associated outgassing in one-plate planets is strongly reduced after the magma ocean outgassing phase for Earth-like mantle compositions, if their mass and/or core-mass fraction exceeds a critical value. As a consequence, the effective outer boundary of the habitable zone is then closer to the host star than suggested by the classical habitable zone definition, setting an important restriction to the possible surface habitability of massive rocky exoplanets, assuming that they did not keep a substantial amount of their primary atmosphere and that they are not in the plate tectonics regime.

Download/Website: `http://www.sciencedirect.com/science/article/pii/S0031920116301509`

Contact: `lena.noack@fu-berlin.de`

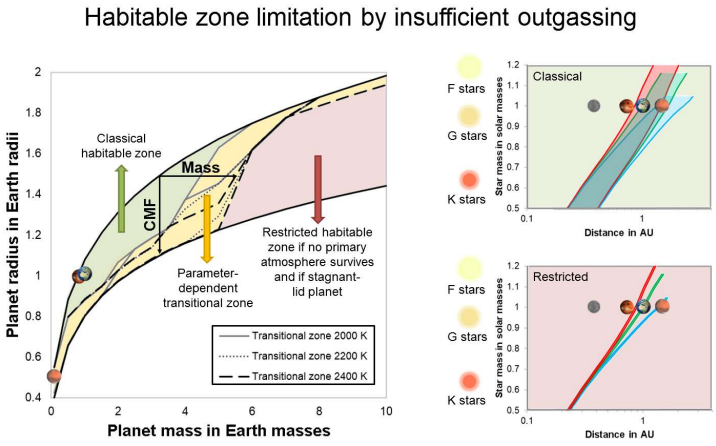

Figure 4: (Noack et al.) Left: Sketch of a mass-radius diagram indicating the mass-radius range, where the classical HZ definition can be applied (green area), the range where the HZ may be restricted due to limited outgassing (red area) and the transitional regime in-between (yellow area). The width of the transitional zone depends on the assumed composition of the mantle. Here we assume a dry peridotite composition. Black arrows indicate the influence of mass and core-mass fraction (CMF) on the transition from classical to restricted HZ definition. Right: Habitable zone without constraints (top) and without greenhouse gases (bottom) at different stellar ages 0 Gyr (red lines), 4.5 Gyr (green lines) and 10 Gyr (blue lines) using the moist and maximum greenhouse effect limits by Kopparapu et al. (2013a,b). The green and red background colors correspond to the coloured areas in the left plot.

3 Thesis Abstracts

Lightning on exoplanets and brown dwarfs: Modelling and detection of lightning signatures throughout the electromagnetic spectrum

G. Hodosán
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PhD thesis, 04/2017

Lightning is an important electrical phenomenon, known to exist in several Solar System planets. Amongst others, it carries information on convection and cloud formation, and may be important for pre-biotic chemistry. Exoplanets and brown dwarfs have been shown to host environments appropriate for the initiation of lightning discharges. In this PhD project, I aim to determine if lightning on exoplanets and brown dwarfs can be more energetic than it is known from Solar System planets, what are the most promising signatures to look for, and if these ”exo-lightning” signatures can be detected from Earth.

This thesis focuses on three major topics. First I discuss a lightning climatology study of Earth, Jupiter, Saturn, and Venus. I apply the obtained lightning statistics to extrasolar planets in order to give a first estimate on lightning occurrence on exoplanets and brown dwarfs. Next, I introduce a short study of potential lightning activity on the exoplanet HAT-P-11b, based on previous radio observations. Related to this, I discuss a first estimate of observability of lightning from close brown dwarfs, with the optical Danish Telescope. The final part of my project focuses on a lightning radio model, which is applied to study the energy and radio power released from lightning discharges in hot giant gas planetary and brown dwarf atmospheres. The released energy determines the observability of signatures, and the effect lightning has on the local atmosphere of the object.

This work combines knowledge obtained from planetary and earth sciences and uses that to learn more about extrasolar systems. My main results show that lightning on exoplanets may be more energetic than in the Solar System, supporting the possibility of future observations and detection of lightning activity on an extrasolar body. My work provides the base for future radio, optical, and infrared search for ”exo-lightning”.

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4 Announcements

Fizeau exchange visitors program in optical interferometry - call for applications

European Interferometry Initiative
Opticon/H2020

www.european-interferometry.eu, application deadline: Jun. 15

The Fizeau exchange visitors program in optical interferometry funds (travel and accommodation) visits of researchers to an institute of his/her choice (within the European Community) to perform collaborative work and training on one of the active topics of the European Interferometry Initiative. The visits will typically last for one month, and strengthen the network of astronomers engaged in technical, scientific and training work on optical/infrared interferometry. The program is open for all levels of astronomers (Ph.D. students to tenured staff), with priority given to PhD students and young postdocs. Non-EU based missions will only be funded if considered essential by the Fizeau Committee. Applicants are strongly encouraged to seek also partial support from their home or host institutions.

The deadline for applications is June 15. Fellowships can be awarded for missions to be carried out between August and November 2017!
Further informations and application forms can be found at: www.european-interferometry.eu
The program is funded by OPTICON/H2020.

Please distribute this message also to potentially interested colleagues outside of your community!

Looking forward to your applications,
Josef Hron & Péter Ábrahám
(for the European Interferometry Initiative)

Download/Website: `http://www.european-interferometry.eu`

Contact: `fizeau@european-interferometry.eu`

5 Jobs and Positions

Cambridge Exoplanet Research Centre invites proposals for Winton Exoplanet Fellowships

Didier Queloz
Battcock Centre for Experimental Astrophysics, Cavendish Laboratory, J J Thomson Avenue, Cambridge CB3 0HE, UK

To work in a department affiliated to the Cambridge Exoplanet Research Centre, by April 2018

Further to the recent initiative from Winton Philanthropies to offer Winton Exoplanet Fellowships , we invite applications from young scientists with PhD (obtained by September 30th, 2017), interested in conducting theoretical or observational research in planetary/exoplanetary astronomy in a department affiliated to the Cambridge Exoplanet Research Centre.

To apply, send by 4th July 2017, to D. Queloz (dq212@cam.ac.uk), a single pdf file including:

- A letter of intent with explicit mention of one or two potential faculty hosts
- Curriculum Vitae
- A concise research proposal (1 page, excluding references and figures)
- Publication list

During the summer, selected candidates will be invited by identified host faculty members to collaborate on the application material and complete research proposal to be submitted by September 1st, 2017 to Winton Philanthropies. Candidates will not be permitted to participate in multiple applications with different institutions and must be in a position to hold the Fellowship at a UK university. In October 2017 Winton Philanthropies will announce awardees and the fellowships must commence within six months of the award.

Important dates:

July 4th Deadline to send initial applications to dq212@cam.ac.uk

September 1st Full application submitted to Winton Philanthropies

April 2018 Fellowship commenced

Download/Website: `http://exoplanets.phy.cam.ac.uk/`
Contact: `dq212@cam.ac.uk`

Postdoctoral Position(s) in Exo-Planetary Science

Prof. Ray Jayawardhana
York University, Toronto, Canada

Toronto, Canada, 2017

Applications are invited for one or more postdoctoral positions at York University in Toronto. The succcessful candidate will work with Professor Ray Jayawardhana and his collaborators on observational and analytical studies of extra-solar planets and related topics such as planet formation and sub-stellar objects. Photometric and spectroscopic characterization of extra-solar planets is of particular interest. Group members use data from VLT, Subaru, Gemini, Keck, CFHT, Kepler, and other major observatories, and are also involved in science planning for the NIRISS instrument on JWST and the SPIRou instrument for CFHT. The successful candidate will also have the opportunity to collaborate with Professor John Moores at York, and with other members of the Technologies for Exo-Planetary Science (TEPS) program, funded by NSERC at $1.65 million, at institutions across Canada and abroad. The position is for two years, with extension to a third year possible, and comes with a competitive salary and funds for research expenses. Start date is flexible, ideally between July-October 2017.
Applicants should send their curriculum vitae, a description of research interests and plans and a list of publications, and should arrange for three letters of recommendation to be sent directly to Marlene Caplan (marlene@yorku.ca). All materials should be submitted electronically. Applications are accepted until the position is filled, and those received before June 15, 2017 will receive full consideration. Early expressions of interest and inquiries are welcome, and should be made to rayjay@yorku.ca.

Contact: `rayjay@yorku.ca`

6 Conference announcements

Know Thy Star - Know Thy Planet. Assessing the Impact of Stellar Characterization on Our Understanding of Exoplanets

David Ciardi
Caltech, USA

Pasadena Hilton, October 9-12, 2017

Registration and abstract submission are now open for the Know Thy Star Know - Thy Planet Conference to be held October 9-12, 2017 in Pasadena, CA.

This four-day meeting will focus on the needs for stellar characterization, bound (and unbound) companions, false positive assessment, and planetary characterization with an emphasis on the techniques necessary to accomplish these goals. The follow-up needs for radial velocity, transit, direct imaging, and microlensing detections of planets are similar but also different in detail.

This meeting will gather experts in the field to understand community needs for follow-up observations in the era of *K2* and *TESS* and leading into *JWST*, *PLATO*, and *WFIRST*. A preliminary agenda can be found on the conference website.

NASA attendees: Please forecast your attendance at this conference through your center as soon as possible. The NCTS number is 29202-18.

Important Dates

- April 28: Registration and Abstract Submission Site Available
- July 28: Abstract Submission Deadline
- September 7: Registration Deadline and Hotel Reservation Deadline at the Pasadena Hilton
- October 2: Deadline to purchase tickets for conference social events
- October 8: Opening reception at El Cholo restaurant
- October 9-12: Know Thy Star - Know Thy Planet conference at the Pasadena Hilton

Download/Website: `http://nexsci.caltech.edu/conferences/2017/knowthystar/`
Contact: `knowthystar@ipac.caltech.edu`

2017 Sagan Summer Workshop: Microlensing in the Era of WFIRST

D. Gelino, R. Paladini
NASA Exoplanet Science Institute, California Institute of Technology, Pasadena, CA, USA

Pasadena, CA, August 7-11, 2017

The 2017 Sagan Summer Workshop workshop will focus on searching for planets with WFIRST microlensing. Leaders in the field will discuss the importance of microlensing to understanding planetary populations and demographics, especially beyond the snow line. They will review the microlensing method, both in the context of current capabilities and the future WFIRST microlensing survey. In addition, speakers will address the broad potential of the WFIRST's Wide Field Imaging microlensing survey for (non-microlensing) science in the galactic bulge. Attendees will participate in hands-on group projects related to the WFIRST microlensing planet survey and will have the opportunity to present their own work through short presentations (research POPs) and posters. Please visit the website to view the agenda.

Topics to be covered include:

- Microlensing Science: Current and Future
- An Introduction to the Theory of Microlensing
- Fitting Microlensing Light Curves
- The K2/C9 and Spitzer Microlens Parallax Campaigns
- The WFIRST Microlensing Survey
- Planet Populations Beyond the Snow Line: Formation and Demographics
- Galactic Science with Wide Field imaging Data in the Galactic Bulge, including microlensing and Galactic Structure
- Finding Exotic Massive Objects with Microlensing

Important Dates

- January 27, 2017: On-line Registration period open
- May 26, 2017: POP/Poster/Talk submission period open and on-line lunch and workshop dinner purchase periods open

- July 14, 2017: deadline for POP/Poster/Talk submission and deadline to purchase lunches and workshop dinner
- July 29, 2017: final agenda posted
- August 7-11, 2017: Sagan Exoplanet Summer Workshop

Download/Website: `http://nexsci.caltech.edu/workshop/2017`
Contact: `sagan_workshop@ipac.caltech.edu`

7 As seen on astro-ph

The following list contains all the entries relating to exoplanets that we spotted on astro-ph during May 2017. If you see any that we missed, please let us know and we'll include them in the next issue.

astro-ph/1705.00288 : **An analytical model for the evolution of the protoplanetary discs** by *Fazeleh Khajenabi, Kimia Kazrani, Mohsen Shadmehri*
astro-ph/1705.00625 : **Spectral Resolution-linked Bias in Transit Spectroscopy of Extrasolar Planets** by *Drake Deming, Kyle Sheppard*
astro-ph/1705.00659 : **HD 202206 : A Circumbinary Brown Dwarf System** by *G. Fritz Benedict, Thomas E. Harrison*
astro-ph/1705.00799 : **Survey of cold water lines in protoplanetary disks: indications of systematic volatile depletion** by *Fujun Du, et al.*
astro-ph/1705.01058 : **OGLE-2013-BLG-0132Lb and OGLE-2013-BLG-1721Lb: Two Saturn-mass Planets Discovered around M-dwarfs** by *Przemek Mroz, et al.*
astro-ph/1705.01285 : **Transit Detection of a "Starshade" at the Inner Lagrange Point of an Exoplanet** by *Eric Gaidos*
astro-ph/1705.01336 : **Optical and Near-Infrared Spectra of sigma Orionis Isolated Planetary-mass Objects** by *M.R. Zapatero Osorio, V.J.S. Bejar, K. Pena Ramirez*
astro-ph/1705.01545 : **The Gold Standard: Accurate Stellar and Planetary Parameters for Eight Kepler M dwarf Systems Enabled by Parallaxes** by *Andrew W. Mann, et al.*
astro-ph/1705.01553 : **Roche-lobe overflow in eccentric planet-star systems** by *Fani Dosopoulou, Smadar Naoz, Vassiliki Kalogera*
astro-ph/1705.01560 : **The Northern Arc of epsilon Eridani's Debris Ring as Seen by ALMA** by *Mark Booth, et al.*
astro-ph/1705.01625 : **SIMP J013656.5+093347 is Likely a Planetary-Mass Object in the Carina-Near Moving Group** by *Jonathan Gagne, et al.*
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