ExoPlanet News
An Electronic Newsletter

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Contents

1 Editorial

Welcome to edition 117 of the ExoPlanet News!

We are very happy to have again a great collection of paper abstracts, conference announcements and job ads. Have a look and share with anyone who might be interested! Of course we also have the monthly update from the NASA exoplanet archive and an overview of new exoplanet related articles from astro-ph. The Latex template for submitting contributions, as well as all previous editions of ExoPlanet News, can be found on the ExoPlanet News webpage (http://nccr-planets.ch/exoplanetnews/).

After the submission deadline for the Astro2020 Science White Papers at the beginning of March on the NASA side, we would like to draw your attention to the fact that there is now a new call out on the European side for Science White Papers to help define the long-term plan for the ESA science programme:

http://sci.esa.int/director-desk/61190-call-for-white-papers-in-the-voyage-2050-long-term-plan-in-the-esa-science-programme/

The deadline is August, 5, 2019, and a workshop to present the white papers is planned for October. So, there is some time to prepare...

The next issue of the ExoplanetNews will appear April 15, 2019.
Thanks for all your support and best regards from Switzerland,

Sascha P. Quanz
Christoph Mordasini
Yann Alibert
Adrien Leleu

2 Abstracts of refereed papers

Predictions of the *WFIRST* Microlensing Survey. I. Bound Planet Detection Rates

Matthew T. Penny[1], *B. Scott Gaudi*[1], *Eamonn Kerins*[2], *Nicholas J. Rattenbury*[3], *Shude Mao*[4,5,2], *Annie C. Robin*[6], *Sebastiano Calchi Novati*[7]

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ApJS, 2019ApJS..241....3P

The *Wide Field InfraRed Survey Telescope* (*WFIRST*) is the next NASA astrophysics flagship mission, to follow the *James Webb Space Telescope*. The *WFIRST* mission was chosen as the top-priority large space mission of the 2010 astronomy and astrophysics decadal survey in order to achieve three primary goals: to study dark energy via a wide-field imaging survey, to study exoplanets via a microlensing survey, and to enable a guest observer program. Here we assess the ability of the several *WFIRST* designs to achieve the goal of the microlensing survey to discover a large sample of cold, low-mass exoplanets with semimajor axes beyond roughly one astronomical unit, which are largely impossible to detect with any other technique. We present the results of a suite of simulations that span the full range of the proposed WFIRST architectures, from the original design envisioned by the decadal survey, to the current design, which utilizes a 2.4 m telescope donated to NASA. By studying such a broad range of architectures, we are able to determine the impact of design trades on the expected yields of detected exoplanets. In estimating the yields we take particular care to ensure that our assumed Galactic model predicts microlensing event rates that match observations, consider the impact that inaccuracies in the Galactic model might have on the yields, and ensure that numerical errors in light-curve computations do not bias the yields for the smallest-mass exoplanets. For the nominal baseline *WFIRST* design and a fiducial planet mass function, we predict that a total of $\sim$1400 bound exoplanets with mass greater than $\sim 0.1 M_\oplus$ should be detected, including $\sim$200 with mass $< \sim 3 M_\oplus$. WFIRST should have sensitivity to planets with mass down to $\sim 0.02 M_\oplus$, or roughly the mass of Ganymede.

Download/Website: `https://arxiv.org/abs/1808.02490`

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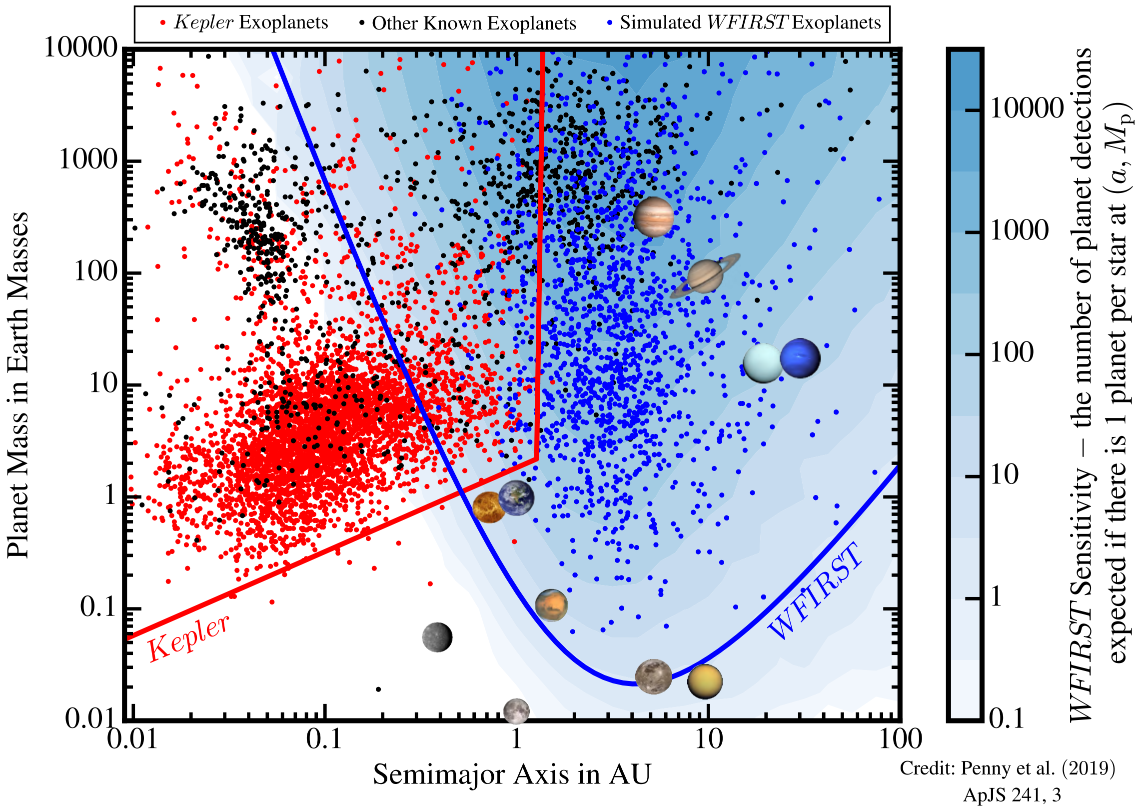

Figure 1: Comparison of the *WFIRST* Cycle 7 design sensitivity to that of *Kepler* in the planet mass-semimajor axis plane. The red line shows an approximation of the *Kepler* planet detection limit based on Burke et al. (2015). Blue shading shows the number of *WFIRST* planet detections during the mission if there is one planet per star at a given mass and semimajor axis point; this is directly proportional to the average detection efficiency. The thick, dark blue line is an functional fit to the three- detection per mission contour, while the lighter blue line barely visible beneath it is the actual contour. Red dots show *Kepler* candidate and confirmed planets; black dots show all other known planets extracted from the NASA exoplanet archive (accessed 2018 February 28 Akeson et al. 2013). Blue dots show a simulated realization of the planets detected by the *WFIRST* microlensing survey, assuming our fiducial planet mass function, though note that in constructing this sample of simulated detections we did not simulate planets smaller than $0.03 M_{\oplus}$ or with semimajor axis less than 0.3 au. Solar system bodies are shown by their images, including the satellites Ganymede, Titan, and the Moon at the semimajor axis of their hosts. Images of the solar system planets credit to NASA. The data and scripts used to make this plot are available at `https://github.com/mtpenny/wfirst-ml-figures`.

Atmospheres on Nonsynchronized Eccentric-tilted Exoplanets I: Dynamical Regimes

Kazumasa Ohno[1] *& Xi Zhang*[2]
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Astrophysical Journal, in press

Relatively long-period nonsynchronized planets—such as warm Jupiters—potentially retain the primordial rotation, eccentricity, and obliquity that might encapsulate information on planetary climate and formation processes. To date, there has not been a systematic study on climate patterns on these planets that will significantly influence their observations. Here we investigate the atmospheric dynamics of nonsynchronized, fast-rotating exoplanets across various radiative timescales, eccentricities, and obliquities using a shallow water model. The dynamical pattern can be demarcated into five regimes in terms of radiative timescale $\tau_{\rm rad}$ and obliquity θ. An atmosphere with $\tau_{\rm rad}$ shorter than a planetary day usually exhibits a strong day–night temperature contrast and a day-to-night flow pattern. In the intermediate $\tau_{\rm rad}$ regime between a planetary day and a year, the atmosphere is dominated by steady temperature and eastward jet patterns for $\theta \leq 18^\circ$ but shows a strong seasonal variation for $\theta \geq 18^\circ$ because the polar region undergoes an intense heating at around the summer solstice. If $\tau_{\rm rad}$ is larger than a year, seasonal variation is very weak. In this regime, eastward jets are developed for $\theta \leq 54^\circ$ and westward jets are developed for $\theta \geq 54^\circ$. These dynamical regimes are also applicable to the planets in eccentric orbits. The large effects of exoplanetary obliquities on circulation patterns might offer observational signatures, which will be investigated in Paper II of this study.

Download/Website: `https://arxiv.org/abs/1903.00907`

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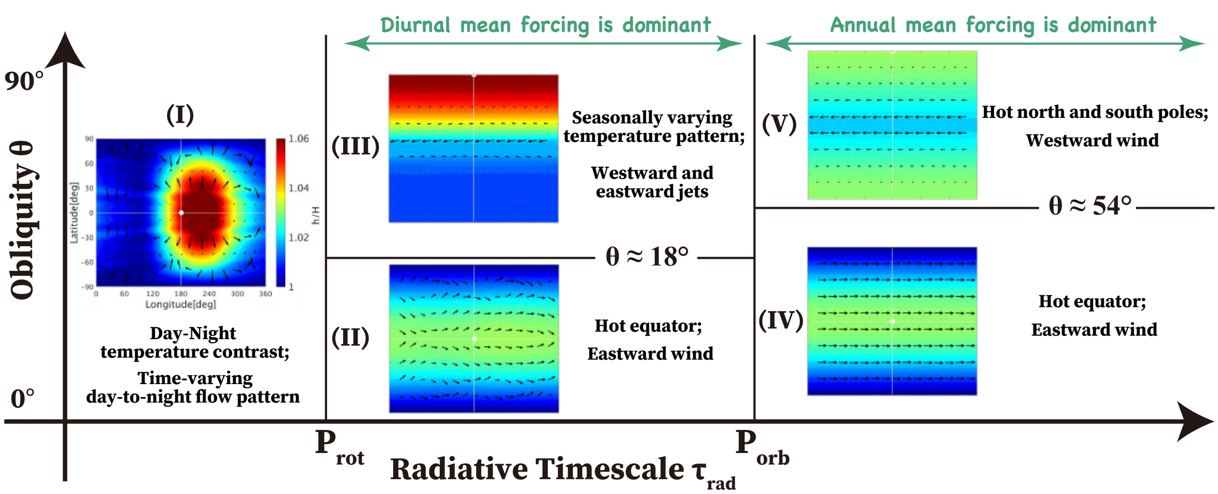

Figure 2: Schematic diagrams of dynamical regimes for ET planets. The dynamical regime might be classified into five regimes in terms of the temperature and wind patterns. For retrograde-rotating planets with $\theta > 90^\circ$, one can translate the vertical axis to $180^\circ - \theta$.

Atmospheres on Nonsynchronized Eccentric-Tilted Exoplanets II: Thermal Light Curves

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[2] Department of Earth and Planetary Sciences, University of California Santa Cruz

Astrophysical Journal, in press

Thermal light-curve analysis is a powerful approach to probe the thermal structures of exoplanetary atmospheres, which are greatly influenced by the planetary obliquity and eccentricity. Here we investigate the thermal light curves of eccentric-tilted exoplanets across various radiative timescales, eccentricities, obliquities, and viewing geometries using results of shallow-water simulations presented in Ohno & Zhang (2019). We also achieve an analytical theory of the thermal light curve that can explain general trends in the light curves of tilted exoplanets. For tilted planets in circular orbits, the orbital phase of the flux peak is largely controlled by either the flux from the hot spot projected onto the orbital plane or the pole heated at the summer solstice, depending on the radiative timescale $\tau_{\rm rad}$, planetary day $P_{\rm orb}$, and obliquity θ. We find that tilted planets potentially produce the flux peak after the secondary eclipse when obliquity is $\theta > 90^\circ$ for the hot regime $\tau_{\rm rad} \ll P_{\rm rot}$, or $\theta > 18^\circ$ for the cool regime $\tau_{\rm rad} \gg P_{\rm rot}$. For tilted planets in eccentric orbits, the shape of the light curve is considerably influenced by the heating at the periapse. The flux peak occurring after the secondary eclipse can be used to distinguish tilted planets from nontilted planets when the periapse takes place before the secondary eclipse. Our results could help to constrain exoplanet obliquities in future observations.

Download/Website: `https://arxiv.org/abs/1903.00908`

Contact: `ohno.k.ab@eps.sci.titech.ac.jp`

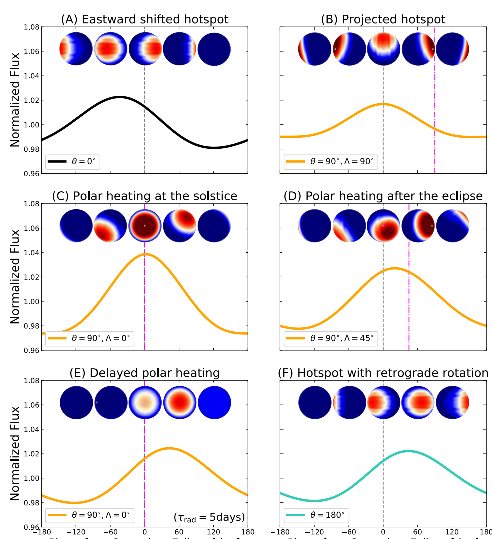

Figure 3: Typical shapes of light curves with height fields on the visible hemisphere. The vertical axis is the emergent flux normalized by the time average, and the horizontal axis is the orbital phase from the secondary eclipse. The radiative timescale is $\tau_{\rm rad} = 0.1$ day for panels (A)–(D) and (F) and $\tau_{\rm rad} = 5$ days for panel (E). The gray dotted and pink dash-dotted lines denote the phase of secondary eclipse and the northern summer solstice, respectively.

An alternative interpretation of the exomoon candidate signal in the combined *Kepler* and *Hubble* data of Kepler-1625

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Astronomy & Astrophysics, accepted (arXiv:1902.06018)

Kepler and *Hubble* photometry of a total of four transits by the Jupiter-sized Kepler-1625 b have recently been interpreted to show evidence of a Neptune-sized exomoon. The key arguments were an apparent drop in stellar brightness after the planet's October 2017 transit seen with *Hubble* and its 77.8 min early arrival compared to a strictly periodic orbit. The profound implications of this first possible exomoon detection and the physical oddity of the proposed moon, that is, its giant radius prompt us to examine the planet-only hypothesis for the data and to investigate the reliability of the Bayesian Information Criterion (BIC) used for detection. We combine *Kepler*'s Pre-search Data Conditioning Simple Aperture Photometry (PDCSAP) with the previously published *Hubble* light curve. In an alternative approach, we perform a synchronous polynomial detrending and fitting of the *Kepler* data combined with our own extraction of the *Hubble* photometry. We generate five million Parallel-Tempering Markov Chain Monte Carlo (PTMCMC) realizations of the data with both a planet-only model and a planet-moon model and compute the BIC difference (ΔBIC) between the most likely models, respectively. ΔBIC values of -44.5 (using previously published *Hubble* data) and -31.0 (using our own detrending) yield strong statistical evidence in favor of an exomoon. Most of our orbital realizations, however, are very different from the best-fit solutions, suggesting that the likelihood function that best describes the data is non-Gaussian. We measure a 73.7 min early arrival of Kepler-1625 b for its *Hubble* transit at the $3\,\sigma$ level. This deviation could be caused by a 1 d data gap near the first *Kepler* transit, stellar activity, or unknown systematics, all of which affect the detrending. The radial velocity amplitude of a possible unseen hot Jupiter causing Kepler-1625 b's transit timing variation could be some 100 m s^{-1}. Although we find a similar solution to the planet-moon model as previously proposed, careful consideration of its statistical evidence leads us to believe that this is not a secure exomoon detection. Unknown systematic errors in the *Kepler*/*Hubble* data make the ΔBIC an unreliable metric for an exomoon search around Kepler-1625 b, allowing for alternative interpretations of the signal.

Download/Website: `https://arxiv.org/abs/1902.06018`

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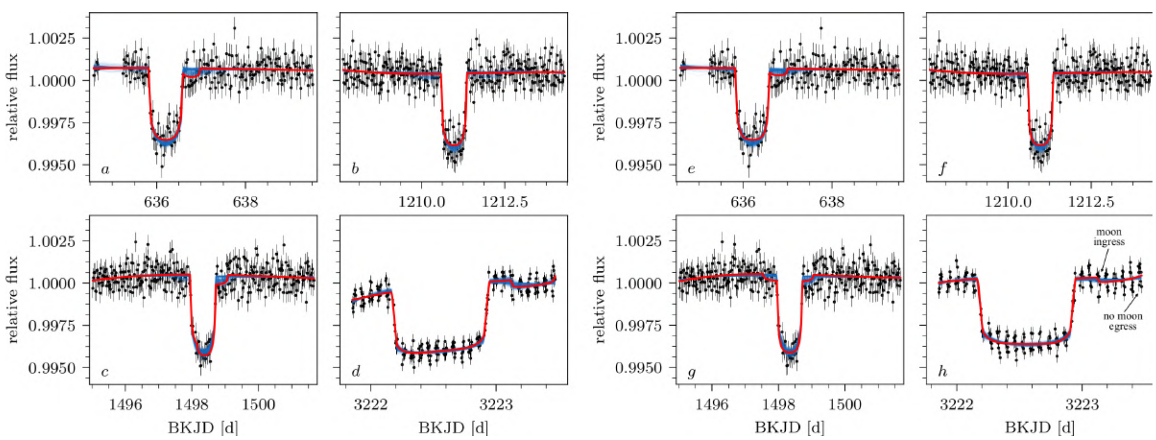

Figure 4: Orbital solutions for Kepler-1625 b and its suspected exomoon based on the combined *Kepler* and *Hubble* data. (*a,b,c*) *Kepler* PDCSAP flux and (*d*) the quadratic detrending of the *Hubble* data from Teachey & Kipping (2018b). Blue curves show 1 000 realizations of our PTMCMC fitting of a planet-moon model. Our most likely solution (red line) is very similar to the one found by Teachey & Kipping (2018b), but differs significantly from the one initially found by Teachey & Kipping (2018a). (*e,f,g*) *Kepler* PDCSAP flux and (*h*) our own detrending of the *Hubble* light curve (in parallel to the fitting). The ingress and egress of the model moon are denoted with arrows and labels in panel *h* as an example.

Optimized transit detection algorithm to search for periodic transits of small planets

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Astronomy & Astrophysics, 2019A&A...623A..39H

We present a new method to detect planetary transits from time-series photometry, the Transit Least Squares (`TLS`) algorithm. `TLS` searches for transit-like features while taking the stellar limb darkening and planetary ingress and egress into account. We have optimized `TLS` for both signal detection efficiency (SDE) of small planets and computational speed. `TLS` analyses the entire, unbinned phase-folded light curve. We compensate for the higher computational load by (i.) using algorithms like "Mergesort" (for the trial orbital phases) and by (ii.) restricting the trial transit durations to a smaller range that encompasses all known planets, and using stellar density priors where available. A typical K2 light curve, including 80 d of observations at a cadence of 30 min, can be searched with `TLS` in ~ 10 s real time on a standard laptop computer, as fast as the widely used Box Least Squares (`BLS`) algorithm. We perform a transit injection-retrieval experiment of Earth-sized planets around sun-like stars using synthetic light curves with 110 ppm white noise per 30 min cadence, corresponding to a photometrically quiet $K_P = 12$ star observed with Kepler. We determine the SDE thresholds for both `BLS` and `TLS` to reach a false positive rate of 1 % to be SDE = 7 in both cases. The resulting true positive (or recovery) rates are $\sim$ 93 % for `TLS` and $\sim$ 76 % for `BLS`, implying more reliable detections with `TLS`. We also test `TLS` with the K2 light curve of the TRAPPIST-1 system and find six of seven Earth-sized planets using an iterative search for increasingly lower signal detection efficiency, the phase-folded transit of the seventh planet being affected by a stellar flare. `TLS` is more reliable than `BLS` in finding any kind of transiting planet but it is particularly suited for the detection of small planets in long time series from Kepler, TESS, and PLATO. We make our `python` implementation of `TLS` publicly available.

Download/Website: `https://www.aanda.org/articles/aa/abs/2019/03/aa34672-18/aa34672-18.html`

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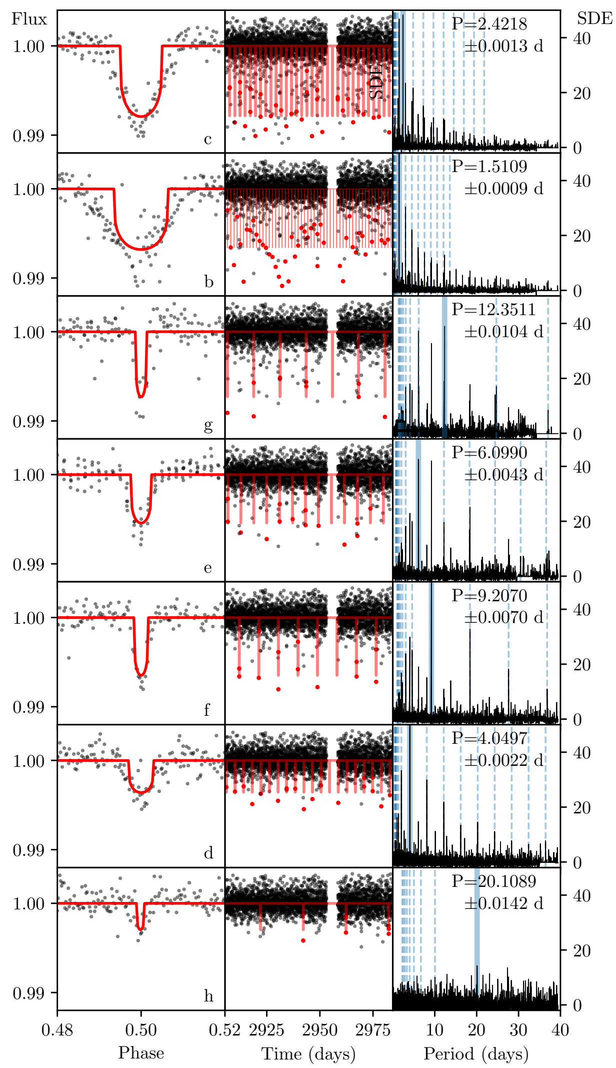

Figure 5: Demonstration of the `TLS` performance on the TRAPPIST-1 system. *Left*: Phase-folded transit light curve for the respective period and epoch at SDE maximum (black dots). The best-fit transit model (fitted for transit duration and depth) with quadratic stellar limb darkening is shown with a red solid line. Planet names are indicated in the lower right corner of each panel. Planets are sorted from top to bottom in the order of detection from an iterative `TLS` search of the K2 light curve. Planet "h" (bottom panels) is a false positive and not related to the actual detection of TRAPPIST-1 h. *Center*: The entire K2 light curve of TRAPPIST-1 with the detected in-transit data points highlighted in red. Transits detected in previous iterations were masked. *Right*: SDE(P) diagram for the light curve shown in the center.

Connecting substellar and stellar formation. The role of the host star's metallicity.

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Astronomy & Astrophysics, in press, arXiv:1903.01141

Most of our current understanding of the planet formation mechanism is based on the planet metallicity correlation derived mostly from solar-type stars harbouring gas-giant planets. To achieve a far more reaching grasp on the substellar formation process we aim to analyse in terms of their metallicity a diverse sample of stars (in terms of mass and spectral type) covering the whole range of possible outcomes of the planet formation process (from planetesimals to brown dwarfs and low-mass binaries). Our methodology is based on the use of high-precision stellar parameters derived by our own group in previous works from high-resolution spectra by using the iron ionisation and equilibrium conditions. All values are derived in an homogeneous way, except for the M dwarfs where a methodology based on the use of pseudo equivalent widths of spectral features was used. Our results show that as the mass of the substellar companion increases the metallicity of the host star tendency is to lower values. The same trend is maintained when analysing stars with low-mass stellar companions and a tendency towards a wide range of host star's metallicity is found for systems with low mass planets. We also confirm that more massive planets tend to orbit around more massive stars. The core-accretion formation mechanism for planet formation achieves its maximum efficiency for planets with masses in the range 0.2 and 2 M_{Jup}. Substellar objects with higher masses have higher probabilities of being formed as stars. Low-mass planets and planetesimals might be formed by core-accretion even around low-metallicity stars.

Download/Website: https://arxiv.org/abs/1903.01141

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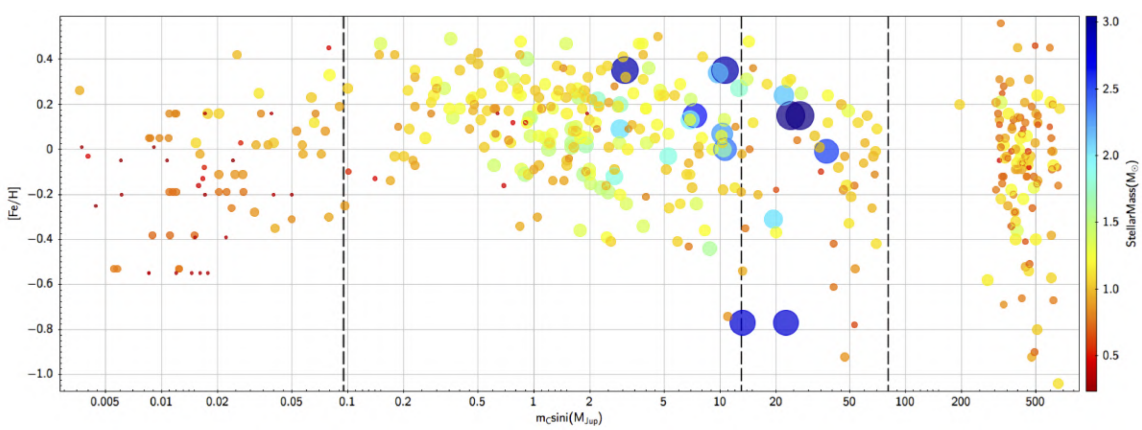

Figure 6: Stellar metallicity of the host stars as a function of the minimum mass of the substellar companions. Different colours and symbol sizes indicate the mass of the host star. Vertical dashed lines indicate the standard mass loci of low-mass planets, gas-giant planets, brown dwarf, and stellar companions, from left to right, respectively.

MOVES II. Tuning in to the radio environment of HD189733b

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Monthly Notices of the Royal Astronomical Society, accepted (arXiv:1903.01809)

We present stellar wind modelling of the hot Jupiter host HD189733, and predict radio emission from the stellar wind and the planet, the latter arising from the interaction of the stellar wind with the planetary magnetosphere. Our stellar wind models incorporate surface stellar magnetic field maps at the epochs Jun/Jul 2013, Sep 2014, and Jul 2015 as boundary conditions. We find that the mass-loss rate, angular momentum-loss rate, and open magnetic flux of HD189733 vary by 9%, 40%, and 19% over these three epochs. Solving the equations of radiative transfer, we find that from 10 MHz–100 GHz the stellar wind emits fluxes in the range of 10^{-3}–5 μJy, and becomes optically thin above 10 GHz. Our planetary radio emission model uses the radiometric Bode's law, and neglects the presence of a planetary atmosphere. For assumed planetary magnetic fields of 1–10 G, we estimate that the planet emits at frequencies of 2–25 MHz, with peak flux densities of $\sim 10^2$ mJy. We find that the planet orbits through regions of the stellar wind that are optically thick to the emitted frequency from the planet. As a result, unattenuated planetary radio emission can only propagate out of the system and reach the observer for 67% of the orbit for a 10 G planetary field, corresponding to when the planet is approaching and leaving primary transit. We also find that the plasma frequency of the stellar wind is too high to allow propagation of the planetary radio emission below 21 MHz. This means a planetary field of at least 8 G is required to produce detectable radio emission.

Download/Website: `https://arxiv.org/abs/1903.01809`

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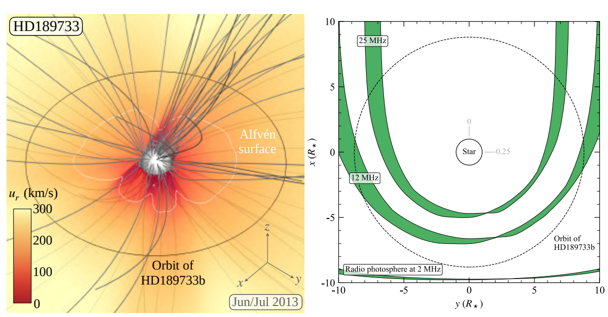

Figure 7: Simulated stellar wind of HD189733 at Jun/Jul 2013. Grey lines show the large-scale structure of the magnetic field of the star, which is embedded in the stellar wind. The profile of the radial velocity (u_r) of the stellar wind in the orbital plane of the planet is shown. The orbit at 8.8 $R_\star$ is shown with a black circle, and the Alfvén surface is shown in white. *Right:* Radio photospheres of the stellar wind at the calculated frequencies of 2, 12, and 25 MHz, in the orbital plane of the planet. The planetary orbit is shown as a black dashed circle, and the star is shown in the centre. Orbital phases of 0 and 0.25 are marked near the star. In our calculation, the observer is looking along the x-axis in the positive direction.

Hot Exoplanet Atmospheres Resolved with Transit Spectroscopy (HEARTS) II. A broadened sodium feature on the ultra-hot giant WASP-76b

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Astronomy & Astrophysics, in press (arXiv:1902.00001)

High-resolution optical spectroscopy is a powerful tool to characterise exoplanetary atmospheres from the ground. The sodium D lines, with their large cross sections, are especially suited to studying the upper layers of atmospheres in this context. We report on the results from HEARTS, a spectroscopic survey of exoplanet atmospheres, performing a comparative study of hot gas giants to determine the effects of stellar irradiation. In this second installation of the series, we highlight the detection of neutral sodium on the ultra-hot giant WASP-76b. We observed three transits of the planet using the High-Accuracy Radial-velocity Planet Searcher (HARPS) high-resolution spectrograph at the European Southern Observatory (ESO) 3.6m telescope and collected 175 spectra of WASP-76. We repeatedly detect the absorption signature of neutral sodium in the planet atmosphere ($0.371 \pm 0.034\%$; $10.75\,\sigma$ in a 0.75 Å passband). The sodium lines have a Gaussian profile with full width at half maximum (FWHM) of $27.6 \pm 2.8\ km\ s^{-1}$. This is significantly broader than the line spread function of HARPS ($2.7\ km\ s^{-1}$). We surmise that the observed broadening could trace the super-rotation in the upper atmosphere of this ultra-hot gas giant.

Download/Website: `https://arxiv.org/abs/1902.00001`

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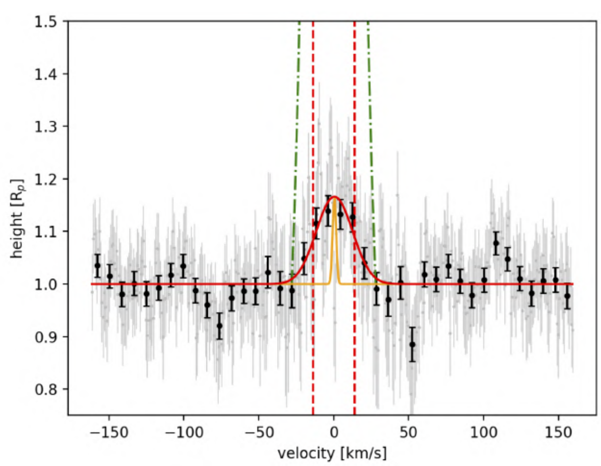

Figure 8:

Co-added lines of the HARPS transmission spectrum sodium doublet as a function of velocity. The line centre was set to zero. The data are shown in grey and binned x10 in black. A Gaussian fit is shown in red with its FWHM marked by the red dashed lines. The HARPS instrumental line spread function (FWHM = 2.7 km s^{-1}) is shown in orange and the escape velocity as green dotted-dashed lines. The FWHM velocity does not exceed the escape velocity at any point, making the atmospheric escape of sodium unlikely. The best Gaussian fit to the data is significantly wider than the instrumental response, but the corresponding velocity is well below the escape velocity of WASP-76b.

The Metallicity-Period-Mass Diagram of low-mass exoplanets

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[7] Departamento de Ciencias Fisicas, Universidad Andres Bello, Fernandez Concha 700, Las Condes, Santiago, Chile
[8] Aix Marseille Univ, CNRS, CNES, LAM, Marseille, France

Monthly Notices of the Royal Astronomical Society, in press (2019MNRAS.tmp..637S/arXiv:1903.04937)

The number of exoplanet detections continues to grow following the development of better instruments and missions. Key steps for the understanding of these worlds comes from their characterization and its statistical studies. We explore the metallicity-period-mass diagram for known exoplanets by using an updated version of The Stellar parameters for stars With ExoplanETs CATalog (SWEET-Cat), a unique compilation of precise stellar parameters for planet-host stars provided for the exoplanet community. Here we focus on the planets with minimum mass below 30 $M_\oplus$ which seems to present a possible correlation in the metallicity-period-mass diagram where the mass of the planet increases with both metallicity and period. Our analysis suggests that the general observed correlation may be not fully explained by observational biases. Additional precise data will be fundamental to confirm or deny this possible correlation.

Download/Website: `https://arxiv.org/abs/1903.04937`

Contact: `sergio.sousa@astro.up.pt`

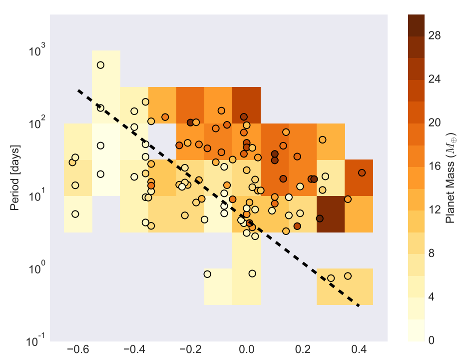

Figure 9: The Period-Metallicity diagram for low-mass planets ($< 30M_\oplus$) with homogeneous parameters in SWEET-Cat and with planetary masses derived with at least 20% precision. The color scheme represents the planet mass (in $M_\oplus$). The colored background corresponds to the diagram binned average planet mass. The dashed black line is the linear fit of the data for a constant mass of $10M_\oplus$. The possible correlation observed in this diagram, can be strongly affected by observational biases, but we show that these biases alone cannot entirely explain the general interdependence observed in the MPM diagram. More precise data will be fundamental to confirm this possible interesting correlation which can provide important constraints to the theories of planet formation and evolution.

Exploring the formation by core accretion and the luminosity evolution of directly imaged planets: The case of HIP 65426 b

G.-D. Marleau[1,2], *G. A. L. Coleman*[1], *A. Leleu*[1], *C. Mordasini*[1]

[1] Physikalisches Institut, Universität Bern, Gesellschaftsstr. 6, 3012 Bern, Switzerland
[2] Institut für Astronomie und Astrophysik, Eberhard Karls Universität Tübingen, Auf der Morgenstelle 10, 72076 Tübingen, Germany

Astronomy & Astrophysics, in press; arXiv:1902.01869

Context. A low-mass companion to the two-solar mass star HIP 65426 has recently been detected by SPHERE at around 100 au from its host. Explaining the presence of super-Jovian planets at large separations, as revealed by direct imaging, is currently an open question.
Aims. We want to derive statistical constraints on the mass and initial entropy of HIP 65426 b and to explore possible formation pathways of directly imaged objects within the core-accretion paradigm, focusing on HIP 65426 b.
Methods. Constraints on the planet's mass and post-formation entropy are derived from its age and luminosity combined with cooling models. For the first time, the results of population synthesis are also used to inform the results. Then, a formation model that includes N-body dynamics with several embryos per disc is used to study possible formation histories and the properties of possible additional companions. Finally, the outcomes of two- and three-planet scattering in the post-disc phase are analysed, taking tides into account for small-pericentre orbits.
Results. The mass of HIP 65426 b is found to be $m_{\mathrm{p}} = 9.9^{+1.1}_{-1.8}\,M_{\mathrm{J}}$ using the hot population and $m_{\mathrm{p}} = 10.9^{+1.4}_{-2.0}\,M_{\mathrm{J}}$ with the cold-nominal population. We find that core formation at small separations from the star followed by outward scattering and runaway accretion at a few hundred astronomical units succeeds in reproducing the mass and separation of HIP 65426 b. Alternatively, systems having two or more giant planets close enough to be on an unstable orbit at disc dispersal are likely to end up with one planet on a wide HIP 65426 b-like orbit with a relatively high eccentricity (0.5).
Conclusions. If the scattering scenario explains its formation, HIP 65426 b is predicted to have a high eccentricity and to be accompanied by one or several roughly Jovian-mass planets at smaller semi-major axes, which also could have a high eccentricity. This could be tested by further direct-imaging as well as radial-velocity observations.

Download/Website: `https://arxiv.org/abs/1902.01869`

Contact: `gabriel.marleau{@space.unibe.ch,@uni-tuebingen.de}`

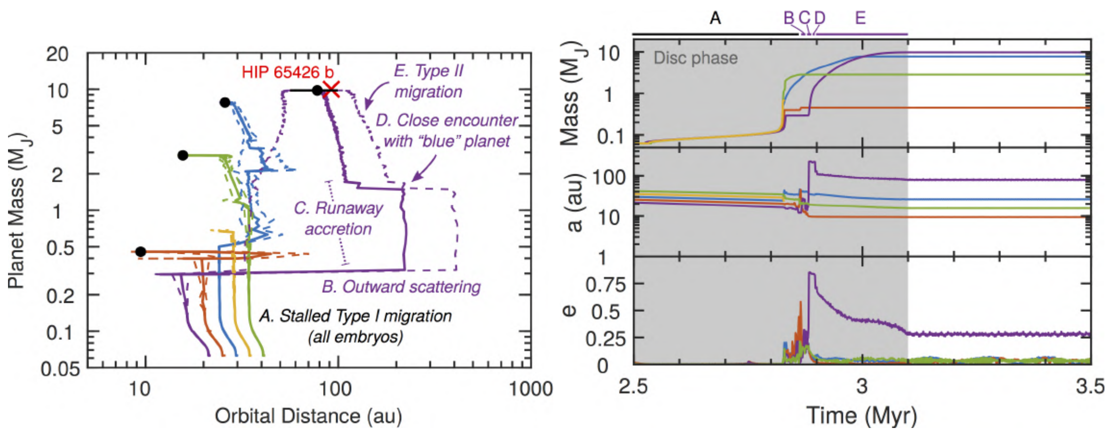

Figure 10: Possible formation scenario for HIP 65426 b. *(Left)* Mass–orbital-distance evolution of the multi-planet system. Solid lines show the planets' semimajor axes, while dashed lines show the planets' pericentres and apocentres. *(Right)* Mass, semi-major axis, and eccentricity of the planets over time. *(Description)* Several planets migrate inward in type I migration and begin to accrete gas. As their migration stalls, the 'blue planet' undergoes runaway gas accretion ($\sim$ 2.8 Myr). This planet scatters the 'purple planet' out to 200 au ($\sim$ 2.85 Myr), which goes into runaway gas accretion in the outer disc, allowing it to become very massive. The purple planet's eccentricity leads to another interaction with the blue planet (2.9 Myr), slightly circularising the orbit of the purple planet. It then migrates inwards in the type II regime whilst accreting more gas. When the disc fully disperses (3.1 Myr), it finishes growing and migrating with a mass and semimajor axis similar to HIP 65426 b.

3 Jobs and Positions

PhD Research Fellowship position in Planetary Sciences

Stephanie C. Werner
Centre for Earth Evolution and Dynamics, University of Oslo, Norway

A PhD Research Fellowship position in Planetary Sciences is available at the Centre for Earth Evolution and Dynamics (CEED) at the University of Oslo (UiO).
Will we find another Earth? Using all currently available data for exoplanets and our understanding of planetary system evolution, the goal is to examine how likely it is that we will find a planet in similar conditions like those of our Earth. One of the goals is to predict the potential planets from star composition, condensation sequences, degassing, and star planet interaction. This approach is highly challenging as it covers the entire planet formation and evolution, but also allows for a large diversity of studies.
The application deadline is June 12, 2019.

Download/Website: `https://www.jobbnorge.no/en/available-jobs/job/165949/`

Contact: `stephanie.werner@geo.uio.no`

PhD position

Prof. Emeline Bolmont

Observatory of GENEVA, Sept. 2019

One 4-year PhD position is currently available at the University of Geneva Department of Astronomy starting on September 1st 2019. The successful candidate will perform simulations of the atmospheres of planets around low-mass stars to prepare for future atmospheric characterization. They will be fully integrated within the Exoplanet Team at the Observatory of Geneva.

PhD position: Atmospheres of planets around low-mass stars

Applications are invited for a research assistant (PhD student) position at the University of Geneva (Geneva Observatory) working with Prof. Emeline Bolmont on the modeling and future characterization of temperate/hot rocky planets around low-mass stars. The successful applicant is expected to work with a global climate model to study the effect of a variety of different parameters on the atmosphere and habitability of planets. The work will involve to run extensive simulations with the 3D Global Climate Model LMDz and analyze the resulting outputs. The LMDz (`http://lmdz.lmd.jussieu.fr/`) is a generic version of the Earth global climate model used to compute global warming. The student will also work on the implementation of new physical processes in the model, in particular the heat flux due to tidal dissipation inside the planet and the impact of volcanic gases and aerosols on the atmosphere. This PhD will bring an important modeling effort for the preparation of future atmospheric characterization missions (such as the JWST, E-ELT, RISTRETTO and NIRPS).

Setting: The Geneva Observatory offers one of the most vibrant environment worldwide for exoplanet research. Nearly 60 people contributes to the exoplanet team (`www.exoplanets.ch`), currently including 9 faculty members, 11 postdoctoral researchers, 19 PhD students, and 17 project staff members. Research topics include exoplanet detection, exoplanet characterization (atmospheres, interiors), planetary system dynamics, and instrumentation. Team members are directly involved into a large number of projects, including photometric instruments (CHEOPS, TESS, PLATO, NGTS), high-resolution spectrographs (HARPS, HARPS-North, NIRPS and ESPRESSO) and direct imaging (SPHERE@VLT). The exoplanet team is also part of PlanetS (`www.nccr-planets.ch`), a Swiss research network focused on exoplanetary science, which includes 130 scientists from the Universities of Geneva,

Bern, Zurich and the Lausanne and Zurich Polytechnic Schools. The successful applicant will be able to take advantage of this unique collaborative framework and also participate to at least one observational run per year. The University of Geneva is an equal opportunity employer committed to diversity in its workplace.
Start date: September 2019.
Duration: This is a 4-year position.
Salary: 48,000 CHF/year gross salary, according to rules of the University and Canton of Geneva.
Deadline: Candidates are encouraged to apply by April 1st, 2019, but later applications will be reviewed until the position is filled.
Requirements: A MSc degree in astronomy, astrophysics or related fields. The successful applicant will be immersed in a team work environment, therefore good team playing abilities and focus will be praised soft skills. The following application materials should be encapsulated within a single pdf and sent to emeline.bolmont@unige.ch

- A curriculum vitae (2 pages);
- A cover letter (1 page) listing the names of 2 references/referees.

Up to two letters of recommendation should be sent directly to Prof. Bolmont by the referees themselves.

Download/Website: `http://nccr-planets.ch/`

Contact: `emeline.bolmont@unige.ch`

Postdoc position on exoplanet science

Luca Fossati

Space Research Institute, Graz, Austria, October 2019

The institute invites applications for a three years postdoc position at the Space Research Institute (IWF, Graz; `http://www.iwf.oeaw.ac.at/home/`) in Austria to join the exoplanet research group led by Dr. Luca Fossati.

The Space Research Institute is involved in about 20 missions led by most of the world main space agencies. The exoplanet group focuses on the characterisation of exoplanet atmospheres. The group, currently composed of the group leader and six postdocs, is highly international and fosters close collaborations among the team members. Furthermore, the group is heavily involved in the ESA/NASA exoplanet missions CHEOPS, PLATO, ARIEL, and CUTE.

The applicant must hold a PhD in Physics, Geophysics, Astrophysics, or a related field. Preference will be given to candidates with experience in the analysis of exoplanet photometric/spectroscopic transit observations. The successful applicant is expected to work on the analysis of CHEOPS data belonging to the Guaranteed Time Observing program. The successful applicant will also be encouraged to pursue independent research, possibly in line with the group's interests.

The primary goal of CHEOPS (`http://sci.esa.int/cheops/`) is detecting and precisely measuring transits of planets orbiting bright stars, most of them already known to host planets: the ideal sample for follow-up atmospheric characterisation observations. CHEOPS has been scheduled for launch between the 15^{th} of October and the 14^{th} of November 2019, with a 3.5 years nominal timespan for science operations.

The appointment begins not later than October 2019, and will be for three years, with a possible three years extension depending on performance and funding availability. Salary will be Grade IV/2 (about 42,500 Euro per year, gross), according to the scale of the Austrian Academy of Sciences.

A valid application must include 1) curriculum vitae, 2) publication list, 3) research statement (max 3 pages), 4) academic certificates, and 5) names of two persons willing to send letters of recommendation. Applications should be sent via email to luca.fossatioeaw.ac.at in a single PDF file. The closing date of applications is the 31^{st} of March 2019.

The Austrian Academy of Sciences is an equal opportunity employer and in particular invites women to apply.

For more information, contact Dr. Luca Fossati (luca.fossati@oeaw.ac.at).

Download/Website: `http://jobregister.aas.org/ad/66b36ec2`

Contact: `luca.fossati@oeaw.ac.at`

Two tenure-track positions in astronomy

Prof. Michał Hanasz
Toruń Center for Astronomy, Nicolaus Copernicus University, Toruń, Poland

Toruń, Poland, negotiable

The Centre for Astronomy (CA) of the Nicolaus Copernicus University in Toruń (Poland) welcomes applications from world-class researchers for two adjunct (research associate) tenure track faculty positions.
The priority areas are exoplanets, stellar astronomy and the interstellar medium. However, we emphasize that the positions are open to researchers in other fields of astronomy and astrophysics. We welcome applications from both theorists and observers.
These research positions include teaching responsibilities. It is expected that the two new faculty members will contribute to the strategic goals of CA through excellence in research, teaching, and other professional activities. They will be vigorous drivers of CA research programs, will win grants, supervise graduate students and teach undergraduates. The Centre for Astronomy, located in Piwnice near Toruń, is a part of the Faculty of Physics, Astronomy and Informatics. It is one of the leading Polish astronomical institutions. The main instrument of CA is a 32-metre radio telescope, a unique structure of this kind in Central-Eastern Europe. We also own several smaller optical telescopes and host our own in-house computer cluster. The prospects for additional research funding are high for strongly motivated young researchers in Poland.
We offer a tenure-track type contract. The salary of the successful candidate will be comparable to that of Polish researchers in the same career stage. Additional benefits are negotiable.

Download/Website: `https://www.umk.pl/en/employment/?class=Offer&Lang=en&Id=3596 and https://www.umk.pl/en/employment/?class=Offer&Lang=en&Id=3597`

Contact: `dyrekcja.ca@umk.pl`

Job Title: Project Scientist

Vacancy in the Directorate of Science in the European Space Agency

Location: ESA/ESTEC, Noordwijk, The Netherlands, Application deadline: 4 April 2019

Job description:

Working in the Science Support Office of the Directorate of Science and following a period of familiarisation, the postholder will initially be assigned to the post of ARIEL Study or Project Scientist, depending on the mission phase.

The Science Support Office provides study and project scientist support to the Science Directorate's missions throughout all phases including study, implementation, operations and post-operations and is responsible for ensuring that the maximum scientific return is achieved within the technical and programmatic constraints.

ARIEL is a mission to study exoplanets by conducting atmospheric 0.5-8 μm transit and eclipse spectroscopy and optical photometry. Currently in its study phase, ARIEL is being prepared for launch in 2028. Its results will supplement those of ESA's CHEOPS and PLATO missions which focus on high precision photometry of exoplanets, as well as the NASA/ESA/CSA JWST observatory mission which will perform detailed spectroscopic observations of exoplanets.

More information:

For more information about working for ESA consult the ESA Careers webpage at:

Download/Website: `http://tinyurl.com/y3am4rd2`

In order to read this vacancy notice in full (which is important), and to respond to it online (which is mandatory) the direct link is:

Download/Website: `http://tinyurl.com/yy3zl63t`

If for any reason there is a problem with these links google ESA careers and look for Project Scientist and the reference number 8608. **Important: Deadline for applying is 4 April 2019.**

4 Conferences & Workshops

EPSC-DPS Joint meeting 2019

EXO12. Host Stars and Exoplanet Systems: Atmospheric Escape and Space Plasma Environment

Vincent Bourrier, Maxim Khodachenko and co-conveners Navin Dwivedi, Luca Fossati, Ildar F. Shaikhislamov, Aline A. Vidotto

Centre International de Conférences de Genève (CICG) in Geneva, Switzerland, 15-20 September 2019

We would like to highlight the session dedicated to exoplanet upper atmospheres and their host stars that will be organized during the EPSC-DPS 2019 conference in Geneva (https://www.epsc-dps2019.eu/).

In this session, we aim to bring together observers and theorists to discuss recent developments regarding planetary atmospheric escape as well as the radiation, plasma, and magnetic environments of planetary systems. Many questions remain to be addressed regarding the state of close-in exoplanet atmospheres and of their interactions with the host star. Observations and studies of atmospheric escape can bring crucial information about both planets and their star. They further suggest that this mechanism can significantly impact the evolution and potential habitability of close-in planets. This session will thus put a special focus on escaping exoplanet atmospheres and their observational signatures, welcoming contributions on topics related to planetary system evolution, stellar and planetary wind interactions, stellar plasmas and radiative impacts on planetary environments. We will discuss which observing and modeling tools are available, or should be developed, to study these phenomena.

We would like to encourage all people interested in this topic to submit an abstract, in particular early career scientists. The abstract submission deadline is 8 May 2019.

Download/Website: `https://meetingorganizer.copernicus.org/EPSC-DPS2019/session/34011`

Astrophysical Dynamics

Tsung-Dao Lee Institute

Shanghai, July 7-9, 2019

Dynamics plays an important role in some of the most interesting problems in astrophysics, from planet formation to galaxy evolution. This international conference will cover select topics on astrophysical dynamics, with focus on current outstanding problems and issues that may be of common interest to different dynamics communities. The conference will follow the IAU Symposium on Galactic Dynamics (co-sponsored by the T.D.Lee Institute) that takes place in Shanghai in the previous week.
The conference will consist of invited/solicited talks (some chosen from submitted abstracts) and posters, with ample time for discussion. While the three-day meeting (with registration on July 6) will focus on science, we will also use the occasion (e.g. banquet) to celebrate the 70th birthday of Professor Doug Lin.

Download/Website: `http://tdli.sjtu.edu.cn/astrod/index.html`

Contact: `leeastronomy@sjtu.edu.cn`

SAVE THE DATE: ARIEL public conference

Organised by the ARIEL Science Advisory Team

ESA/ESTEC, Noordwijk, The Netherlands, 14-16 January 2020

ARIEL, the Atmospheric Remote-sensing Infrared Exoplanet Large-survey, will study what planets are made of and how planetary systems form and evolve by surveying a large, diverse sample of many hundred extrasolar planets. Observations will be carried out simultaneously in visible and infrared wavelengths, covering the range 0.5-7.8 μm with high precision. ARIEL is the first space mission dedicated to measuring the chemical composition and thermal structures of a large well constructed sample of transiting and eclipsing exoplanets, enabling planetary science far beyond the boundaries of the Solar System.

In March 2018, ARIEL was selected as M4, the fourth medium-sized (M-class) mission in ESA's Cosmic Vision Plan. ARIEL is now in phase B1, the next major milestone is adoption in November 2020.

This meeting is organised in order to involve the exoplanet community at large in the mission, to present the mission as proposed for adoption, and to get feedback and have discussions with the community as to how best involve the community in the longer term.

More information will follow later, for now **save the date 14-16 January 2020 in your diaries!**

2019 Sagan Summer Workshop: Astrobiology for Astronomers

E. Furlan, D. Gelino
NASA Exoplanet Science Institute, California Institute of Technology, Pasadena, CA, USA

Pasadena, CA, July 15-19, 2019

The 2019 Sagan Summer Workshop will focus on astrobiology and will feature introductions on the formation of Earth and terrestrial planets, their evolution over time, current geochemical cycles on Earth, and the emergence of life on Earth. Our knowledge of Exo-Earths will be reviewed, including demographics, composition, atmospheric signatures, and comparison with Earth. Detection of biosignatures, with an emphasis on false positives and false negatives, will also be discussed. Attendees will participate in hands-on group projects related to astrobiology and will have the opportunity to present their own work through short presentations (research POPs) and posters.

The Sagan Summer Workshops are aimed at graduate and post doctoral level students, however anyone who is interested in learning more about the field is welcome to attend.

Registration to attend the workshop are now available along with the complete agenda. The hotel reservation link is also posted on the workshop website.

Important Dates

- March 25: Travel Support decisions announced via email
- May 9: POP/Poster/Talk submission link available
- early June: food ordering site open
- June 13: Hotel Reservation Deadline for workshop hotel
- June 28: Deadline to submit POP and poster presentations
- July 5: Final agenda posted with POP schedule

- July 15-19: Sagan Exoplanet Summer Workshop

Download/Website: http://nexsci.caltech.edu/workshop/2019
Contact: sagan_workshop@ipac.caltech.edu

5 Exoplanet Archive Updates

February Updates at the NASA Exoplanet Archive

The NASA Exoplanet Archive team
Caltech/IPAC-NASA Exoplanet Science Institute, MC 100-22 Pasadena CA 91125

Pasadena CA USA, March 11, 2019

Note: Data for all new planets can be viewed in the Confirmed Planets (`http://bit.ly/2MqFnub`), Composite Planet Data (`http://bit.ly/2l84Qw9`), and Extended Planet Data (`http://bit.ly/2NLy1Ci`) tables. New microlensing solutions are in the Microlensing Data table (`http://bit.ly/2JQr180`).

February 21, 2019

Microlensing Magic: We have one new microlensing planet, KMT-2016-BLG-1107 b, and eight more microlensing solutions for four microlensing planets: MOA-2010-BLG-073L b, MOA-2011-BLG-293L b, MOA-2011-BLG-322L b, and MOA-2012-BLG-006L b.

The new planet's data can be found in the Confirmed Planets, Composite Planet Data, and Extended Planet Data tables. The new solutions are in the Microlensing Planets interactive table.

Also, we've added new transmission spectroscopy data for XO-2 N b (`http://bit.ly/2tw6FqK`).

February 14, 2019

Countdown to 4,000 Planets! We're only 84 confirmed planets away from reaching 4,000 in the archive! To celebrate this next milestone, we're having a contest!

Show or tell us in your own words or images what YOU think the 4000th planet could look like. Would it be a puffy hot Jupiter in a binary system? Or a rocky super-Earth in a multi-planet system? Or perhaps it's a world made entirely of water or ice?

This contest is open to all ages, and entries can be anything from a crayon drawing to a haiku. Get creative!

To enter, publicly tweet to us at @NASAExoArchive or post on our Facebook page with a link to your entry. You must include the **#Exoplanet4K** hashtag to be entered in the random drawing. The winner, randomly drawn from all entries, will receive a full-color print of the 55 Cancri e poster from the Exoplanet Travel Bureau. Have fun and good luck!

New Data This Week: We've added HATS-70 b, GJ 143 b, HD 23472 b & c to the archive, as well as new planet parameter sets for X0-2 N b. These data can be found in the Confirmed Planets, Composite Planet Data, and Extended Planet Data tables.

There are also new transmission spectra for X0-2 N b (`http://bit.ly/2tw6FqK`) and XO-1 b (`http://bit.ly/2UolZBC`), and new microlensing solutions for MOA-2008-BLG-310L b and MOA-2009-BLG-319L b.

February 7, 2019

21 Confirmed Planets Added: Several previously removed planets were added back to the archive this week based on radial velocity data published in Udry et al. 2018, as well as some new planets from the same paper. There is another planet, K2-292 b (a.k.a. HD 119130 b) from Luque et al. 2018, new planet parameter sets for K2-264 b & c and HD 20782 b, and new transmission spectroscopy for XO-2 N b.

The full list of planets from the Udry paper are: HD 20003 b & c, HD 20781 b, c, d & e, HD 21693 b & c, HD 31527 b, c & d, HD 45184 b & c, HD 51608 b & c, HD 134060 b & c, and HD 136352 b, c, & d. The reinstated planets are listed on the Removed Targets page (`http://bit.ly/2ToWIXN`).

The new planet and stellar data can be accessed from the Confirmed Planets, Composite Planet Data, and Extended Planet Data tables.

Download/Website: `https://exoplanetarchive.ipac.caltech.edu`

Contact: `mharbut@caltech.edu`

6 As seen on astro-ph

The following list contains all the entries relating to exoplanets that we spotted on astro-ph during February 2019.

February 2019

astro-ph/1902.00001: **Hot Exoplanet Atmospheres Resolved with Transit Spectroscopy (HEARTS) - II. A broadened sodium feature on the ultra-hot giant WASP-76b** by *J. V. Seidel et al.*
astro-ph/1902.00005: **Dust trapping in protoplanetary disks** by *Nienke van der Marel*
astro-ph/1902.00036: **Scattered light shadows in warped protoplanetary discs** by *Rebecca Nealon et al.*
astro-ph/1902.00047: **Topography of (exo)planets** by *François Landais, Frederic Schmidt, Shaun Lovejoy*
astro-ph/1902.00085: **Cloud Atlas: High-Contrast Time-Resolved Observations of Planetary-Mass Companions** by *Yifan Zhou et al.*
astro-ph/1902.00168: **The Synthetic ALMA Multiband Analysis of the Dust Properties of the TW Hya Protoplanetary Disk** by *Seongjoong Kim et al.*
astro-ph/1902.00280: **A generic frequency dependence for the atmospheric tidal torque of terrestrial planets** by *Pierre Auclair-Desrotour, Jérémy Leconte, Cyril Mergny*
astro-ph/1902.00367: **Accretion of water in carbonaceous chondrites: current evidence and implications for the delivery of water to early Earth** by *Josep M. Trigo-Rodríguez et al.*
astro-ph/1902.00437: **On the 9:7 Mean Motion Resonance Capture in a System of Two Equal-mass Super-Earths** by *Zijia Cui, John C. B. Papaloizou, Ewa Szuszkiewicz*
astro-ph/1902.00500: **Stellar Spectroscopy in the Near-infrared with a Laser Frequency Comb** by *Andrew J. Metcalf et al.*
astro-ph/1902.01222: **Preliminary model of the outer disk of RU Lup presently showing only four dark gaps** by *Dimitris M. Christodoulou, Demosthenes Kazanas*
astro-ph/1902.01283: **Correction to: Effect of the rotation and tidal dissipation history of stars on the evolution of close-in planets** by *Emeline Bolmont, Stéphane Mathis*
astro-ph/1902.01316: **A giant impact as the likely origin of different twins in the Kepler-107 exoplanet system** by *Aldo S. Bonomo et al.*
astro-ph/1902.01417: **Occurrence Rates of Planets orbiting FGK Stars: Combining Kepler DR25, Gaia DR2 and Bayesian Inference** by *Danley C. Hsu et al.*
astro-ph/1902.01869: **Exploring the formation by core accretion and the luminosity evolution of directly imaged planets: The case of HIP 65426 b** by *Gabriel-Dominique Marleau et al.*
astro-ph/1902.01881: **So close, so different: characterization of the K2-36 planetary system with HARPS-N** by *M. Damasso et al.*
astro-ph/1902.01897: **Imaging the Distribution of Solids in Planet-forming Disks undergoing Hydrodynamical Instabilities with the Next Generation Very Large Array** by *L. Ricci et al.*
astro-ph/1902.02057: **The misaligned orbit of the Earth-sized planet Kepler-408b** by *Shoya Kamiaka et al.*
astro-ph/1902.02103: **Ocean Dynamics and the Inner Edge of the Habitable Zone for Tidally Locked Terrestrial Planets** by *Jun Yang et al.*
astro-ph/1902.02789: **K2-288Bb: A Small Temperate Planet in a Low-mass Binary System Discovered by Citizen Scientists** by *Adina D. Feinstein et al.*
astro-ph/1902.03553: **Thermo-compositional diabatic convection in the atmospheres of brown dwarfs and in Earth's atmosphere and oceans** by *P. Tremblin et al.*
astro-ph/1902.03684: **Should N-body integrators be symplectic everywhere in phase space?** by *David M. Hernandez*
astro-ph/1902.03867: **Tidal Heating and the Habitability of the TRAPPIST-1 Exoplanets** by *Vera Dobos, Amy C. Barr, László L. Kiss*
astro-ph/1902.03891: **CLIcK: a Continuum and Line fItting Kit for circumstellar disks** by *Yao Liu, Ilaria Pascucci, Thomas Henning*

astro-ph/1902.03900: **A resonant pair of warm giant planets revealed by TESS** by *David Kipping et al.*

astro-ph/1902.03924: **First observation of a planetary transit with the SPARC4 CCD: improved parameters for HATS-24b** by *Janderson M. Oliveira, Eder Martioli, Marcelo Tucci-Maia*

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