ExoPlanet News
An Electronic Newsletter

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Contents

1 Editorial

Welcome to edition 106 of the ExoPlanet News!

A big "Thank You" to all of you who sent input for this edition of the newsletter! Please keep sending contributions in the form of accepted papers covering all fields related to (exo)planet research, conference or workshop announcements, job ads or any other information relevant to the wider exoplanet community. The current Latex template for submitting contributions of any kind, as well as all previous editions of ExoPlanet News, can be found at http://nccr-planets.ch/exoplanetnews/.

Also, we are currently updating the information available on the ExoPlanet News webpage mentioned above. If you have suggestions for additional links to be added, please get in touch with us. This could be links to other newsletters, exoplanet related missions or projects, or databases for instance. As usual, we would be happy to receive feedback concerning the newsletter. The editorial team can be reached by sending an email to exoplanetnews@nccr-planets.ch.

The next issue of the newsletter will appear May 14, 2018.

Thanks for all your support and best regards from Switzerland

Sascha P. Quanz
Yann Alibert
Adrien Leleu
Christoph Mordasini

Univ. of Bern, Univ. of Geneva, ETH Zürich, Univ. of Zürich, EPF Lausanne
The National Centers of Competence in Research (NCCR) are a research instrument of the Swiss National Science Foundation.

2 Abstracts of refereed papers

Kuiper Belt Analogues in Nearby M-type Planet-host Systems

G. M. Kennedy[1], *G. Bryden*[2], *D. Ardila*[3,4], *C. Eiroa*[5], *J.-F. Lestrade*[6], *J. P. Marshall*[7], *B. C. Matthews*[8,9], *A. Moro-Martin*[10], *M. C. Wyatt*[11]

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Monthly Notices of the Royal Astronomical Society, in press (2018arXiv180302832K)

We present the results of a *Herschel* survey of 21 late-type stars that host planets discovered by the radial velocity technique. The aims were to discover new disks in these systems and to search for any correlation between planet presence and disk properties. In addition to the known disk around GJ 581, we report the discovery of two new disks, in the GJ 433 and GJ 649 systems. Our sample therefore yields a disk detection rate of 14%, higher than the detection rate of 1.2% among our control sample of DEBRIS M-type stars with 98% confidence. Further analysis however shows that the disk sensitivity in the control sample is about a factor of two lower in fractional luminosity than for our survey, lowering the significance of any correlation between planet presence and disk brightness below 98%. In terms of their specific architectures, the disk around GJ 433 lies at a radius somewhere between 1 and 30au. The disk around GJ 649 lies somewhere between 6 and 30au, but is marginally resolved and appears more consistent with an edge-on inclination. In both cases the disks probably lie well beyond where the known planets reside (0.06-1.1au), but the lack of radial velocity sensitivity at larger separations allows for unseen Saturn-mass planets to orbit out to ~5au, and more massive planets beyond 5au. The layout of these M-type systems appears similar to Sun-like star + disk systems with low-mass planets.

Mass semi-major axis diagrams showing the GJ 433, GJ 581, and GJ 649 planets (dots), the approximate RV sensitivity (lines), and the possible range of disk locations (hatched regions, showing the disk extent in the case of GJ 581). In each case, with the possible exception of GJ 433, there remains room in the detection space for sizeable planets that reside between the known planets and the disk, but that could not have been detected with the current RV observations.

Download/Website: `http://adsabs.harvard.edu/abs/2018arXiv180302832K`

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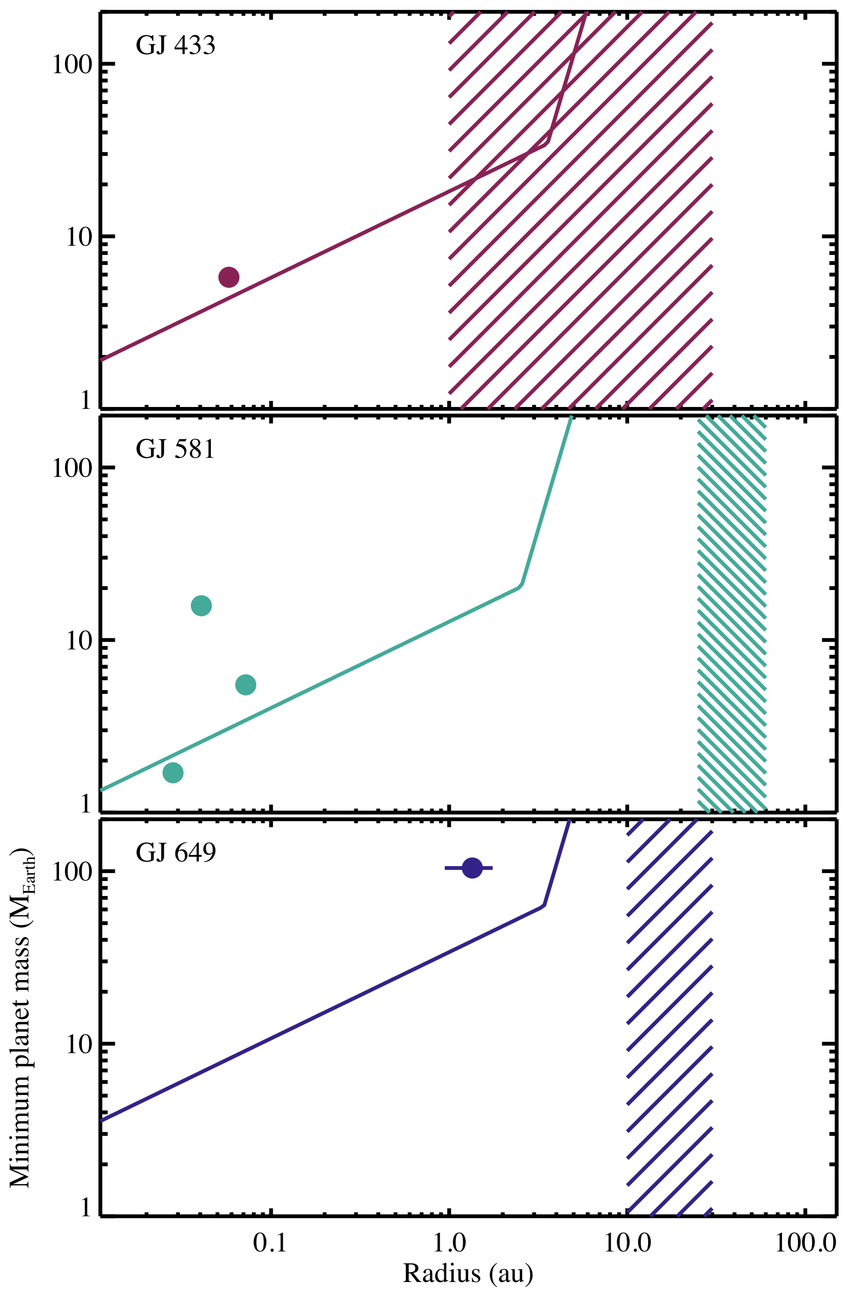

Figure 1: Mass semi-major axis diagrams showing the GJ 433, GJ 581, and GJ 649 planets (dots), the approximate RV sensitivity (lines), and the possible range of disk locations (hatched regions, showing the disk extent in the case of GJ 581). In each case, with the possible exception of GJ 433, there remains room in the detection space for sizeable planets that reside between the known planets and the disk, but that could not have been detected with the current RV observations.

A Universal Break in the Planet-to-Star Mass-Ratio Function of Kepler MKG stars

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The Astrophysical Journal Letters, in press (arXive-Code:1803.00777)

We follow the microlensing approach and quantify the occurrence of *Kepler* exoplanets as a function of planet-to-star mass ratio, q, rather than planet radius or mass. For planets with radii $\sim 1-6\,R_\oplus$ and periods < 100 days, we find that, except for a normalization factor, the occurrence rate vs q can be described by the same broken power law with a break at $\sim 3\times10^{-5}$ independent of host type for hosts below $1\,M_\odot$. These findings indicate that the planet-to-star mass ratio is a more fundamental quantity in planet formation than planet mass. We then compare our results to those from microlensing for which the overwhelming majority satisfies the $M_{\rm host} < 1\,M_\odot$ criterion. The break in q for the microlensing planet population, which mostly probes the region outside the snowline, is ~3-10 times higher than that inferred from *Kepler*. Thus, the most common planet inside the snowline is ~3-10 times less massive than the one outside. With rocky planets interior to gaseous planets, the Solar System broadly follows the combined mass-ratio function inferred from *Kepler* and microlensing. However, the exoplanet population has a less extreme radial distribution of planetary masses than the Solar System. Establishing whether the mass-ratio function beyond the snowline is also host type independent will be crucial to build a comprehensive theory of planet formation.

Download/Website: http://adsabs.harvard.edu/abs/2018arXiv180300777P

Contact: pascucci@lpl.arizona.edu

High-energy environment of super-Earth 55 Cnc e I: Far-UV chromospheric variability as a possible tracer of planet-induced coronal rain

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Astronomy & Astrophysics, in press (arXiv:1803.10783)

The high-energy X-ray to ultraviolet (XUV) irradiation of close-in planets by their host star influences their evolution and might be responsible for the existence of a population of ultra-short period planets eroded to their bare core. In orbit around a bright, nearby G-type star, the super-Earth 55 Cnc e offers the possibility to address these issues through transit observations at UV wavelengths. We used the Hubble Space Telescope to observe the transit in the far-ultraviolet (FUV) over three epochs in April 2016, January 2017, and February 2017. Together, these observations cover nearly half of the orbital trajectory in between the two quadratures, and reveal significant short- and long-term variability in 55 Cnc chromospheric emission lines. In the last two epochs, we detected a larger flux in the C III, Si III, and Si IV lines after the planet passed the approaching quadrature, followed by a flux decrease in the Si IV doublet. In the second epoch these variations are contemporaneous with flux decreases in the Si II and C II doublet. All epochs show flux decreases in the N V doublet as well, albeit at different orbital phases. These flux decreases are consistent with absorption from optically thin clouds of gas, are mostly localized at low and redshifted radial velocities in the star rest frame, and occur preferentially before and during the planet transit. These three points make it unlikely that the variations are purely stellar in origin, yet we show that the occulting material is also unlikely to originate from the planet. We thus tentatively propose that the motion of 55 Cnc e at the fringes of the stellar corona leads to the formation of a cool coronal rain. The inhomogeneity and temporal evolution of the stellar corona would be responsible for the differences between the three visits. Additional variations are detected in the C II doublet in the first epoch and in the O I triplet in all epochs with a different behavior that points toward intrinsic stellar variability. Further observations at FUV wavelengths are required to disentangle definitively between star-planet interactions in the 55 Cnc system and the activity of the star.

Download/Website: `https://arxiv.org/abs/1803.10783`

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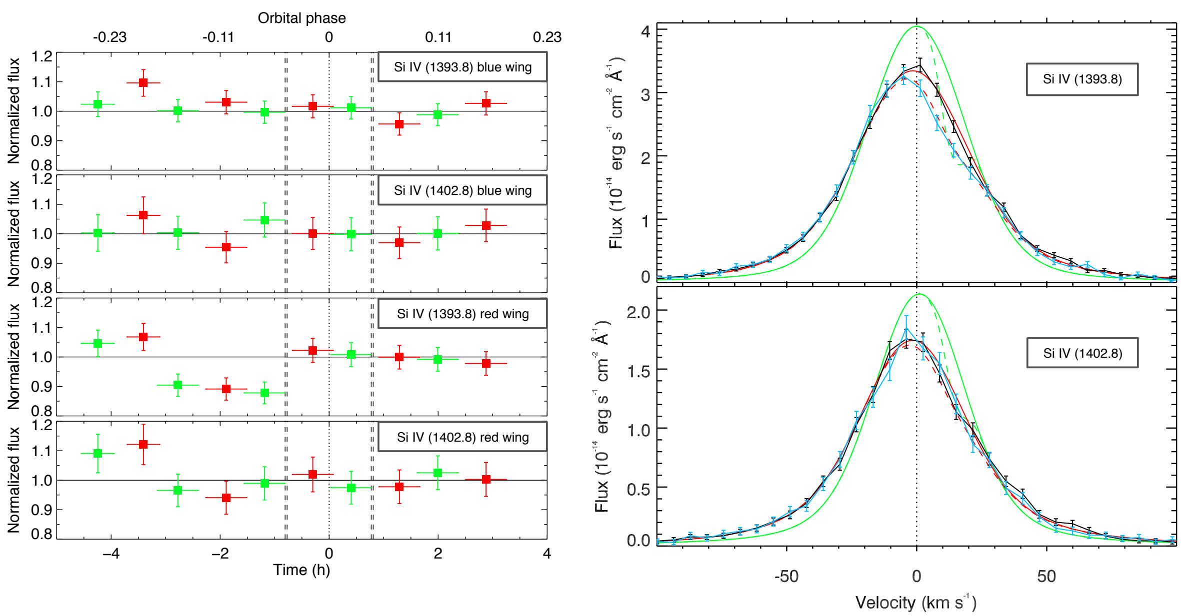

Figure 2: Possible signature of interaction between 55 Cnc e and its host-star. *Left panel:* Flux integrated in the blue and red wings of the stellar SiIV doublet in two independent epochs (green and red), showing a brightening about -4 h before the transit of 55 Cnc e, followed by absorption visible in the strongest doublet line. Both features could trace coronal plasma destabilized by the motion of the planet, cooling down to chromospheric temperatures (thus seen in emission) and then to sub-chromospheric temperatures (thus seen in absorption) as it falls down as a cool rain to lower altitudes . *Right panel:* SiIV doublet averaged over the two epochs, plotted in the star rest frame. Black spectra correspond to the intrinsic stellar line. By comparison, blue spectra (averaged within about -3 h and -1 h) show a clear absorption signature at redshifted velocities, which is consistent with absorption from an optically thin cloud of cool ionized silicon gas falling toward the star. The green (before convolution) and red (after convolution) profiles correspond to a best-fit model for the intrinsic stellar line (solid line) and the occulting cloud (dashed line).

Catching drifting pebbles I. Enhanced pebble accretion efficiencies for eccentric planets

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A&A, in press (arxiv:1803.06149)

Coagulation theory predicts that micron-sized dust grains grow into pebbles, which drift inward towards the star when they reach sizes of mm−cm. When they cross the orbit of a planet, a fraction of these drifting pebbles will be accreted. In the pebble accretion mechanism, the combined effects of the planet's gravitational attraction and gas drag greatly increase the accretion rate. We calculate the pebble accretion efficiency ε_{2D} – the probability that a pebble is accreted by the planet – in the 2D limit (pebbles reside in the midplane). In particular, we investigate the dependence of ε_{2D} on the planet eccentricity and its implications for planet formation models. We conduct N-body simulations to calculate the pebble accretion efficiency in both the local frame and the global frame. With the global method we investigate the pebble accretion efficiency when the planet is on an eccentric orbit. We find that the local and the global methods generally give consistent results. However, the global method becomes more accurate when the planet is more massive than a few Earth masses or when the aerodynamic size (Stokes number) of the pebble is larger than 1. The efficiency increases with the planet's eccentricity once the relative velocity between the pebble and the planet is determined by the planet's eccentric velocity. At high eccentricities, however, the relative velocity becomes too high for pebble accretion. The efficiency then drops significantly and the accretion enters the ballistic regime. We present general expressions for ε_{2D}. Applying the obtained formula to the formation of a secondary planet, in resonance with an already-formed giant planet, we find that the embryo grows quickly due to its higher eccentricity. The maximum ε_{2D} for a planet on an eccentric orbit is several times higher than for a planet on a circular orbit, but this increase gives the planet an important headstart and boosts its following mass growth. The recipe for ε_{2D} that we have obtained is designed to be implemented into N-body codes to simulate the growth and evolution of planetary systems.

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Increased Heat Transport in Ultra-Hot Jupiter Atmospheres Through H_2 Dissociation/Recombination

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Astrophysical Journal Letters, accepted for publication (arXiv:1802.07725)

A new class of exoplanets is beginning to emerge: planets whose dayside atmospheres more closely resemble stellar atmospheres as most of their molecular constituents dissociate. The effects of the dissociation of these species will be varied and must be carefully accounted for. Here we take the first steps towards understanding the consequences of dissociation and recombination of molecular hydrogen (H_2) on atmospheric heat recirculation. Using a simple energy balance model with eastward winds, we demonstrate that H_2 dissociation/recombination can significantly increase the day–night heat transport on ultra-hot Jupiters (UHJs): gas giant exoplanets where significant H_2 dissociation occurs. The atomic hydrogen from the highly irradiated daysides of UHJs will transport some of the energy deposited on the dayside towards the nightside of the planet where the H atoms recombine into H_2; this mechanism bears similarities to latent heat. Given a fixed wind speed, this will act to increase the heat recirculation efficiency; alternatively, a measured heat recirculation efficiency will require slower wind speeds after accounting for H_2 dissociation/recombination.

Download/Website: https://arxiv.org/abs/1802.07725

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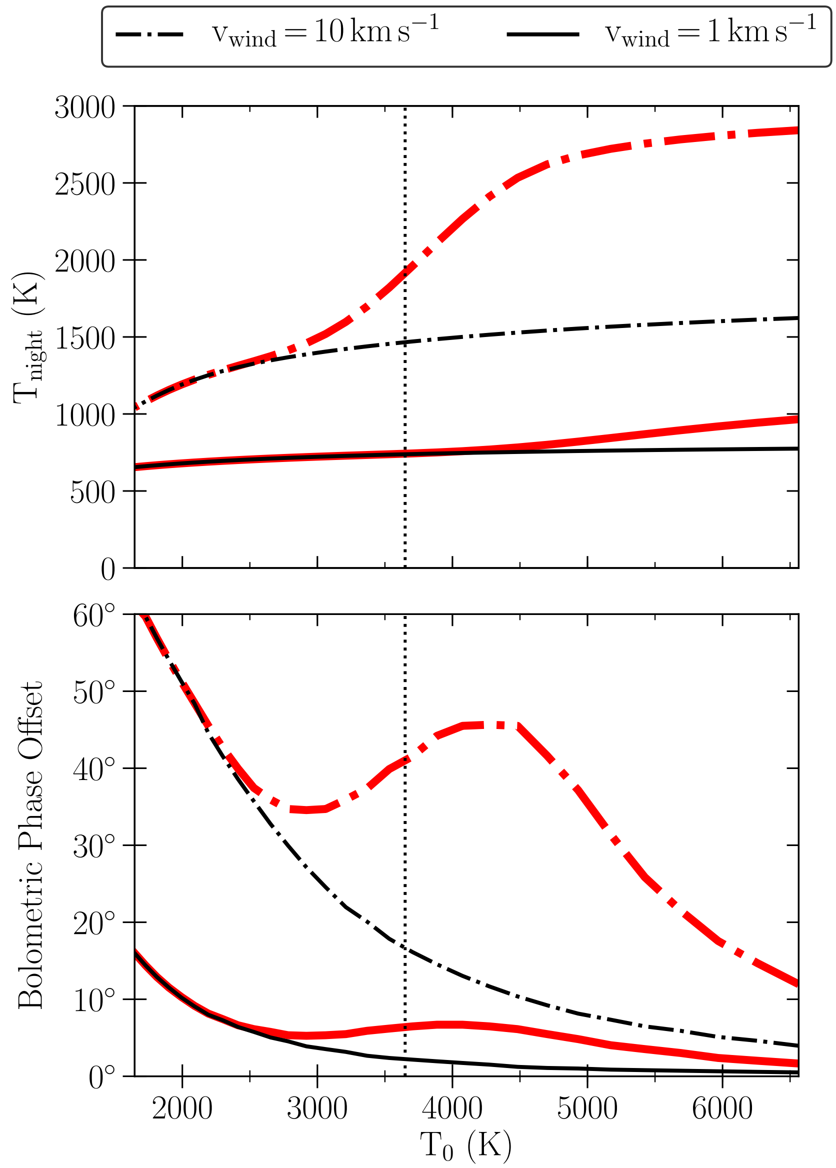

Figure 3: Trends in nightside apparent temperature and phase offset as a function of irradiation temperature ($T_0 \equiv T_{*,\rm eff}\sqrt{R_*/a}$), given theoretical bolometric phasecurve measurements. Thick, red lines show models including H_2 dissociation/recombination for WASP-12b, while thin, black lines show models neglecting these effects. Models sharing the same wind speed share linestyles, and all models assume a Bond albedo of 0.3 (which is typical for hot Jupiters; Zhang et al. 2018; Schwartz et al. 2017). A vertical dotted line shows the location of WASP-12b

Signatures of Young Planets in the Continuum Emission From Protostellar Disks

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The Astrophysical Journal, in press (arXiv:1608.05123v2)

Many protostellar disks show central cavities, rings, or spiral arms likely caused by low-mass stellar or planetary companions, yet few such features are conclusively tied to bodies embedded in the disks. We note that even small features on the disk's surface cast shadows, because the starlight grazes the surface. We therefore focus on accurately computing the disk's thickness, which depends on its temperature. We present models with temperatures set by the balance between starlight heating and radiative cooling, that are also in vertical hydrostatic equilibrium. The planet has 20, 100, or 1000 Earth masses, ranging from barely enough to perturb the disk significantly, to clearing a deep tidal gap. The hydrostatic balance strikingly alters the model disk's appearance. The planet-carved gap's outer wall puffs up under starlight heating, throwing a shadow across the disk beyond. The shadow appears in scattered light as a dark ring that could be mistaken for a gap opened by another more distant planet. The surface brightness contrast between outer wall and shadow for the 1000-Earth-mass planet is an order of magnitude greater than a model neglecting the temperature disturbances. The shadow is so deep it largely hides the planet-launched spiral wave's outer arm. Temperature gradients are such that outer low-mass planets undergoing orbital migration will converge within the shadow. Furthermore the temperature perturbations affect the shape, size, and contrast of features at millimeter and centimeter wavelengths. Thus radiative heating and cooling are key to the appearance of protostellar disks with embedded planets.

Download/Website: `http://arxiv.org/pdf/1608.05123v2.pdf`

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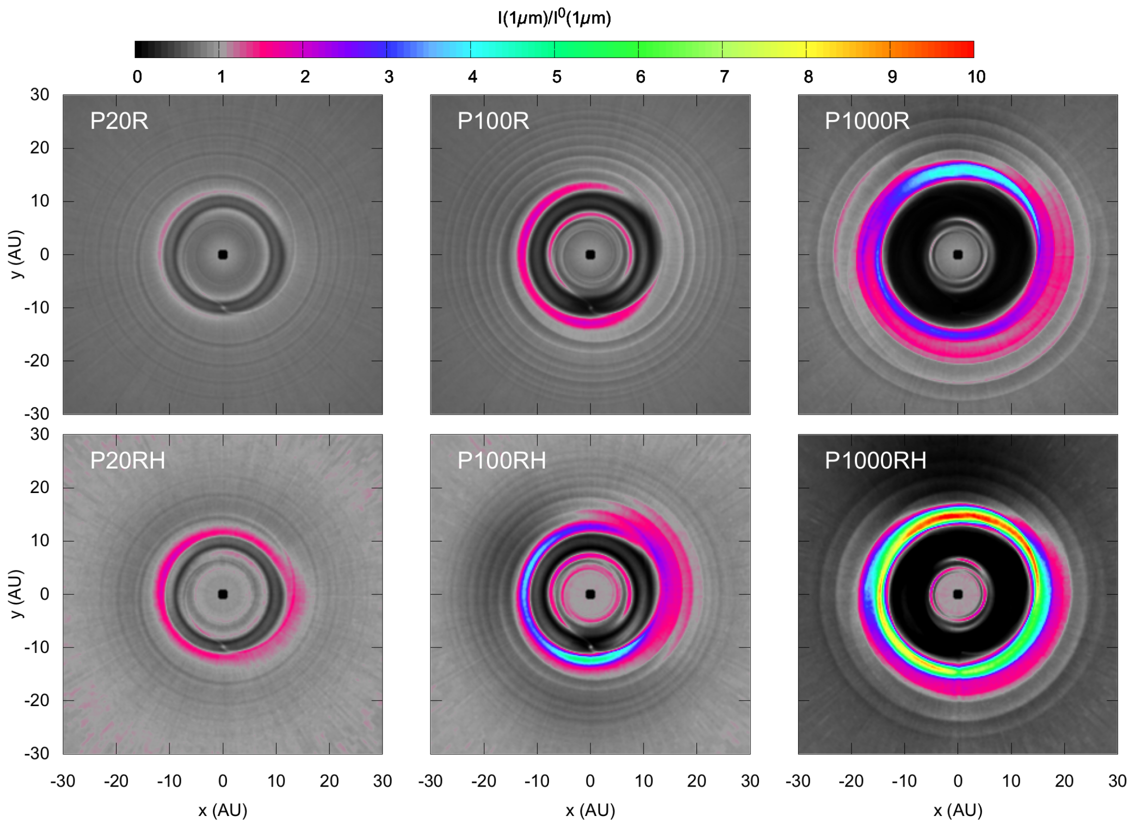

Figure 4: Maps of the 1-μm scattered light for the 20 (left), 100 (middle), and 1000-Earth-mass cases (right) viewed face-on. The intensity is relative to that at the same location in the absence of the planet. The top row shows models in radiative but not hydrostatic equilibrium. The bottom row has the corresponding versions in both radiative and hydrostatic balance.

Puzzling out the coexistence of terrestrial planets and giant exoplanets. The 2/1 resonant periodic orbits

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Astronomy & Astrophysics, in press

Hundreds of giant planets have been discovered so far and the quest of exo-Earths in giant planet systems has become intriguing. In this work, we aim to address the question of the possible long-term coexistence of a terrestrial companion on an orbit interior to a giant planet, and explore the extent of the stability regions for both non-resonant and resonant configurations.
Our study focuses on the restricted three-body problem, where an inner terrestrial planet (massless body) moves under the gravitational attraction of a star and an outer massive planet on a circular or elliptic orbit. Using the Detrended Fast Lyapunov Indicator (DFLI) as a chaotic indicator, we constructed maps of dynamical stability by varying both the eccentricity of the outer giant planet and the semi-major axis of the inner terrestrial planet, and identify the boundaries of the stability domains. Guided by the computation of families of periodic orbits, the phase space is unravelled by meticulously chosen stable periodic orbits, which buttress the stability domains.
We provide all possible stability domains for coplanar symmetric configurations and show that a terrestrial planet, either in mean-motion resonance or not, can coexist with a giant planet, when the latter moves on either a circular or an (even highly) eccentric orbit. New families of symmetric and asymmetric periodic orbits are presented for the 2/1 resonance. It is shown that an inner terrestrial planet can survive long time spans with a giant eccentric outer planet on resonant symmetric orbits, even when both orbits are highly eccentric. For 22 detected single-planet systems consisting of a giant planet with high eccentricity, we discuss the possible existence of a terrestrial planet. This study is particularly suitable for the research of companions among the detected systems with giant planets, and could assist with refining observational data.

Download/Website: `https://doi.org/10.1051/0004-6361/201732058`

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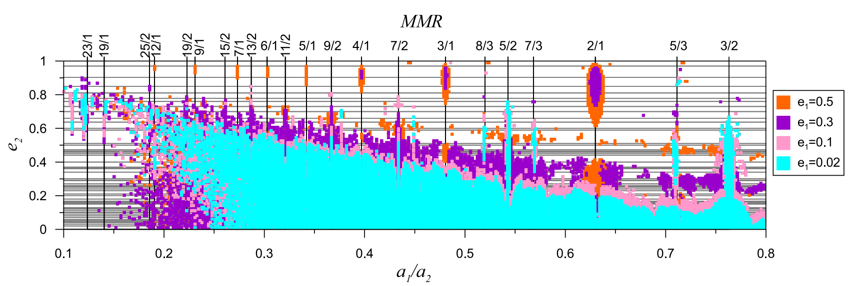

Figure 5: Long-term stable coplanar symmetric orbits. Emphasis is given to terrestrial planets of low eccentricity values, e_1, and in case of multiple points on the grid with value $\log(DFLI) \leq 2.5$ only the one with the lowest value e_1 is coloured. Plotted in the background with solid grey lines are the 93 planetary systems possessing one giant of mass $[1-5]m_J$ at $a_2 \geq 1.0$ AU.

Spectra of Earth-like Planets Through Geological Evolution Around FGKM Stars

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The Astrophysical Journal, published, ADS: (http://adsabs.harvard.edu/abs/2018ApJ...854...19R)

Future observations of terrestrial exoplanet atmospheres will occur for planets at different stages of geological evolution. We expect to observe a wide variety of atmospheres and planets with alternative evolutionary paths, with some planets resembling Earth at different epochs. For an Earth-like atmospheric time trajectory, we simulate planets from prebiotic to current atmosphere based on geological data. We use a stellar grid F0V to M8V ($T_{\rm eff}$ = 7000 K to 2400 K) to model four geological epochs of Earth's history corresponding to a prebiotic world (3.9 Ga), the rise of oxygen at 2.0 Ga and at 0.8 Ga, and the modern Earth. We show the VIS - IR spectral features, with a focus on biosignatures through geological time for this grid of Sun-like host stars and the effect of clouds on their spectra.
We find that the observability of biosignature gases reduces with increasing cloud cover and increases with planetary age. The observability of the visible O_2 feature for lower concentrations will partly depend on clouds, which while slightly reducing the feature increase the overall reflectivity thus the detectable flux of a planet. The depth of the IR ozone feature contributes substantially to the opacity at lower oxygen concentrations especially for the high near-UV stellar environments around F stars. Our results are a grid of model spectra for atmospheres representative of Earth's geological history to inform future observations and instrument design and are available online at: http://carlsaganinstitute.org/data/

Download/Website: https://arxiv.org/abs/1712.10027

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H^- Opacity and Water Dissociation in the Dayside Atmosphere of the Very Hot Gas Giant WASP-18 b

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Astrophysical Journal Letters, published (arXiv:1801.02489)

We present one of the most precise emission spectra of an exoplanet observed so far. We combine five secondary eclipses of the hot Jupiter WASP-18 b ($T_{day} \sim 2900$ K) that we secured between 1.1 and 1.7 μm with the WFC3 instrument aboard the Hubble Space Telescope. Our extracted spectrum (S/N=50, R∼40) does not exhibit clearly identifiable molecular features but is poorly matched by a blackbody spectrum. We complement this data with previously published Spitzer/IRAC observations of this target and interpret the combined spectrum by computing a grid of self-consistent, 1D forward models, varying the composition and energy budget. At these high temperatures, we find there are important contributions to the overall opacity from H^- ions, as well as the removal of major molecules by thermal dissociation (including water), and thermal ionization of metals. These effects were omitted in previous spectral retrievals for very hot gas giants, and we argue that they must be included to properly interpret the spectra of these objects. We infer a new metallicity and C/O ratio for WASP-18 b, and find them well constrained to be solar ([M/H]= -0.01 ± 0.35, C/O < 0.85 at 3σ confidence level), unlike previous work but in line with expectations for giant planets. The best fitting self-consistent temperature-pressure profiles are inverted, resulting in an emission feature at 4.5 μm seen in the Spitzer photometry. These results further strengthen the evidence that the family of very hot gas giant exoplanets commonly exhibit thermal inversions.

Download/Website: `https://arxiv.org/pdf/1801.02489.pdf`

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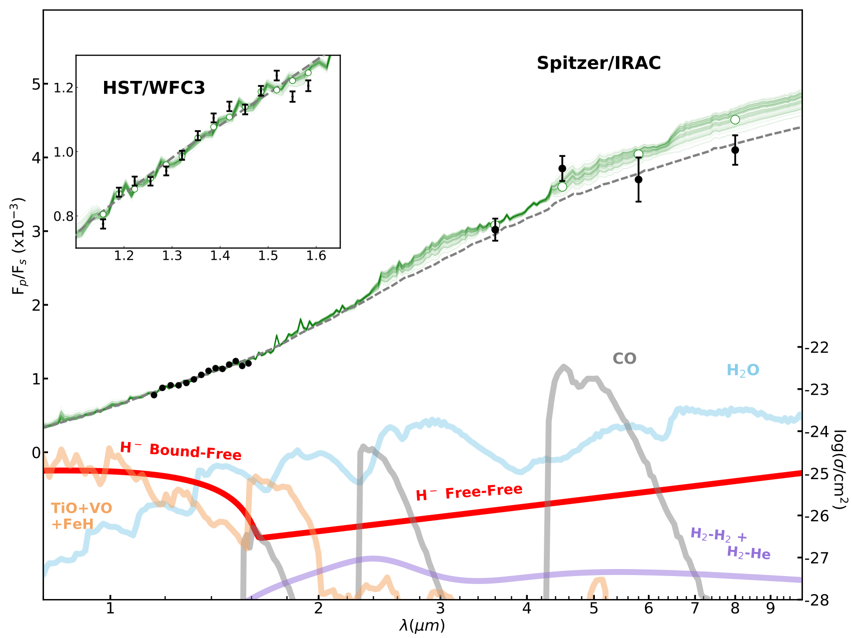

Figure 6: Dayside eclipse spectrum (black points) from this work and previous Spitzer observations compared to best-fit model spectrum (white circles). The best-fit model has a reduced chi-squared of 2.0. In green are 100 samples from the posterior of the model spectrum derived from the grid retrieval, and in grey the best-fit blackbody spectrum to the WFC3 data of 2890±47 K. Dominant opacity cross sections weighted by their molecular abundances ($\log(\sigma)$) are shown for key molecules, taken at a pressure level of 0.33 bar (the peak of the WFC3 emission).

3 Conference announcements

Observing the Sun as a Star: Would we find the solar system if we saw it?

A. Reiners & D. Latham

Göttingen, Germany, 10 – 13 September 2018

The Workshop "Observing the Sun as a Star: Would we find the solar system if we saw it?" will present a comprehensive overview about the role of the Sun and the solar system in exoplanet research. The Workshop will be held from September 10 to 13, 2018, in the Historic Observatory, Göttingen, Germany.

Pre-registration and abstract submission are now open with deadline June 06, 2018. Registration and type of contribution will be confirmed by the LOC shortly after the deadline. There is no registration fee.

INVITED SPEAKERS:
Drake Deming (University of Maryland)
Nadège Meunier (Observatoire de Grenoble)
Steve Saar (Harvard CfA)
Heather Cegla (University of Geneva)
Sandra Jeffers (Institute for Astrophysics Göttingen)
Alexander Shapiro (Max-Planck Institute for Solar System Research Göttingen)
Fabienne Bastien (Penn State University)
Antonino Lanza (Osservatorio Astrofisico di Catania)
Mark Giampapa (NSO)
David Phillips (Harvard CfA)
Tilo Steinmetz (Menlo Systems)
Klaus Strassmeier (Leibniz-Institut fr Astrophysik Potsdam)
Philipp Huke (Institute for Astrophysics Göttingen)
Artie Hatzes (Thuringia State Observatory Tautenburg)
Eric Ford (Penn State University)

SOC: Andrew Cameron (University of St Andrews), Dainis Dravins (University of Lund), Xavier Dumusque (University of Geneva), David Latham (Harvard-Smithsonian Center for Astrophysics, co-Chair), Raphaëlle Haywood (Center for Astrophysics, Harvard University), Natasha Krivova (Max-Planck Institut for Solar System Research, Göttingen), Anne-Marie Lagrange (Université Grenoble), Ansgar Reiners (Georg-August Universität Göttingen, co-Chair), Wolfgang Schmidt (Kiepenheuer-Institut für Sonnenphysik, Freiburg).

Download/Website: `http://sun-as-a-star.astro.physik.uni-goettingen.de`

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2018 Sagan Summer Workshop: Did I Really Just Find an Exoplanet?

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

Pasadena, CA, July 23-27, 2018

The 2018 Sagan Summer Workshop will gather leaders in the field to focus on follow-up work to validate and characterize exoplanet discoveries. The follow-up needs for direct imaging, astrometry, and microlensing, radial velocity and transit detections of planets are similar but differ in the details. These differences will be discussed and explored covering what each method can detect and the shortcomings of each, with particular focus on the transit and radial velocity techniques. Attendees will participate in hands-on group projects applying tools to real data in order to validate planets. They 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.

Topics to be covered include:

- Transit Photometry
- Follow-up Observations of Transit Candidates
- Radial Velocity Surveys
- Understanding Host Stars
- Planetary Characterization Observations
- Microlensing
- Finding Planets with Direct Imaging
- Astrometry

Important Upcoming Dates

- May 1, 2018: POP/Poster/Talk submission link available and Food Ordering site open
- June 22, 2018: Hotel Reservation Deadline for both workshop hotels
- July 6, 2018: Deadline to submit POP and poster presentations
- July 13, 2018: Final agenda posted with POP schedule; deadline for food purchases
- July 23-27, 2018: Sagan Exoplanet Summer Workshop

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