ExoPlanet News
An Electronic Newsletter

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Contents

1 Editorial

Welcome to the sixty seventh edition of ExoPlanet News. This month's newsletter is a little shorter than usual, especially compared to the double-month edition last time, but nonetheless I am sure you will find plenty of interest contained here.
As most readers will surely know, there were two important pieces of news from ESA this month. The CHEOPS mission was formally adopted for the first S-class launch in 2017 and PLATO was selected for the M3 launch in 2024. Congratulations to all the people involved in both teams. I look forward to this newsletter reporting the first results from both missions in years to come.
The next edition of the newsletter will be sent out at the end of March 2014. Please send anything relevant before then to exoplanet@open.ac.uk, and it will appear in the next edition. Remember that past editions of this newsletter, submission templates and other information can be found at the ExoPlanet News website: http://exoplanet.open.ac.uk.

Best wishes
Andrew Norton
The Open University

2 Abstracts of refereed papers

The puzzling chemical composition of GJ 436b's atmosphere: influence of tidal heating on the chemistry

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The Astrophysical Journal, published, volume 781, article id 68

The dissipation of the tidal energy deposited on eccentric planets may induce a heating of the planet that affects its atmospheric thermal structure. Here we study the influence of tidal heating on the atmospheric composition of the eccentric (e = 0.16) "hot Neptune" GJ 436b, for which inconclusive chemical abundances are retrieved from multiwavelength photometric observations carried out during primary transit and secondary eclipse. We build up a one-dimensional model of GJ 436b's atmosphere in the vertical direction and compute the pressure-temperature and molecular abundances profiles for various plausible internal temperatures of the planet (up to 560 K) and metallicities (from solar to 100 times solar), using a radiative-convective model and a chemical model which includes thermochemical kinetics, vertical mixing, and photochemistry. We find that the CO/CH_4 abundance ratio increases with metallicity and tidal heating, and ranges from 1/20 to 1000 within the ranges of metallicity and internal temperature explored. Water vapour locks most of the oxygen and reaches a very high abundance, whatever the metallicity and internal temperature of the planet. The CO_2/H_2O abundance ratio increases dramatically with metallicity, and takes values between 10^{-5}-10^{-4} with solar elemental abundances and $\sim$0.1 for a metallicity 100 times solar. None of the atmospheric models based on solid physical and chemical grounds provide a fully satisfactory agreement with available observational data, although the comparison of calculated spectra and observations seem to point to models with a high metallicity and efficient tidal heating, in which high CO/CH_4 abundance ratios and warm temperatures in the dayside atmosphere are favoured.

Download/Website: `http://iopscience.iop.org/0004-637X/781/2/68/`

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Spitzer Observations of the Thermal Emission from WASP-43b

J. Blecic[1], *J. Harrington*[1,2], *N. Madhusudhan*[3], *K. B. Stevenson*[1], *R. A. Hardy*[1], *P. E. Cubillos*[1,2], *M. Hardin*[1], *M. O. Bowman*[1], *S. Nymeyer*[1], *D. R. Anderson*[4], *C. Hellier*[4], *A. M. Smith*[4], *A. C. Cameron*[5]

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The Astrophysical Journal, published (2014ApJ...781..116B)

WASP-43b is one of the closest-orbiting hot Jupiters, with a semimajor axis of a = 0.01526 $\pm$ 0.00018 AU and a period of only 0.81 days. However, it orbits one of the coolest stars with a hot Jupiter (T_* = 4520 $\pm$ 120 K), giving the planet a modest equilibrium temperature of T_eq = 1440 $\pm$ 40 K, assuming zero Bond albedo and uniform planetary energy redistribution. The eclipse depths and brightness temperatures from our jointly fit model are 0.347% $\pm$ 0.013% and 1670 $\pm$ 23 K at 3.6 μm and 0.382% $\pm$ 0.015% and 1514 $\pm$ 25 K at 4.5 μm. The eclipse timings improved the estimate of the orbital period, by a factor of three and put an upper limit on the eccentricity. We use our *Spitzer* eclipse depths along with four previously reported ground-based photometric observations in the near-infrared to constrain the atmospheric properties of WASP-43b. The data rule out a strong thermal inversion in the dayside atmosphere of WASP-43b. Model atmospheres with no thermal inversions and fiducial oxygen-rich compositions are able to explain all the available data. However, a wide range of metallicities and C/O ratios can explain the data. The data suggest low day-night energy redistribution in the planet, consistent with previous studies, with a nominal upper limit of about 35% for the fraction of energy incident on the dayside that is redistributed to the nightside.

Download/Website: `http://adsabs.harvard.edu/abs/2014ApJ...781..116B`

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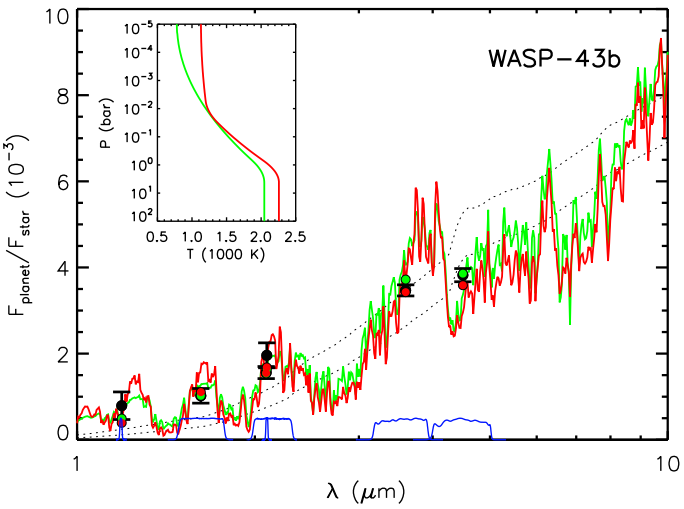

Figure 1: (Blecic et al.) Observations and model spectra for dayside thermal emission from WASP-43b. The black filled circles with error bars show our data in *Spitzer* IRAC channels 1 (3.6 μm) and 2 (4.5 μm) and previously published ground-based near-infrared data in narrow-band photometry at 1.19 μm and 2.09 μm (Gillon et al. 2012) and in broadband photometry at 1.6 μm and 2.1 μm (Wang et al. 2013). The solid curves show the model spectra in the main panel, and the corresponding temperature–pressure profiles, with no thermal inversions, in the inset. The green and red curves correspond to models with compositions of nearly solar and 10 times solar metallicity, respectively. Both models fit the data almost equally well. The dashed curves show blackbody spectra corresponding to planetary brightness temperatures of 1670 K and 1514 K, the observed brightness temperatures in the *Spitzer* IRAC channels 1 and 2, respectively.s

Stellar Diameters and Temperatures V. Eleven Newly Characterized Exoplanet Host Stars

Kaspar von Braun[1,2], Tabetha S. Boyajian[3], Gerard T. van Belle[4], Stephen R. Kane[9], Jeremy Jones[5], Chris Farrington[7], Gail Schaefer[7], Norm Vargas[7], Nic Scott[7], Theo A. ten Brummelaar[7], Miranda Kephart[3], Douglas R. Gies[5], David R. Ciardi[6], Mercedes López-Morales[8], Cassidy Mazingue[2], Harold A. McAlister[7], Stephen Ridgway[10], P. J. Goldfinger[7], Nils H. Turner[7], Laszlo Sturmann[7]

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Monthly Notices of the Royal Astronomical Society, published (http://adsabs.harvard.edu/doi/10.1093/mnras/stt2360)

We use near-infrared interferometric data coupled with trigonometric parallax values and spectral energy distribution fitting to directly determine stellar radii, effective temperatures, and luminosities for the exoplanet host stars 61 Vir, ρ CrB, GJ 176, GJ 614, GJ 649, GJ 876, HD 1461, HD 7924, HD 33564, HD 107383, and HD 210702. Three of these targets are M dwarfs. Statistical uncertainties in the stellar radii and effective temperatures range from 0.5% – 5% and from 0.2% – 2%, respectively. For eight of these targets, this work presents the first directly determined values of radius and temperature; for the other three, we provide updates to their properties. The stellar fundamental parameters are used to estimate stellar mass and calculate the location and extent of each system's circumstellar habitable zone. Two of these systems have planets that spend at least parts of their respective orbits in the system habitable zone: two of GJ 876's four planets and the planet that orbits HD 33564. We find that our value for GJ 876's stellar radius is more than 20% larger than previous estimates and frequently used values in the astronomical literature.

Download/Website: `http://mirasolinstitute.org/kaspar/Publications.htm`

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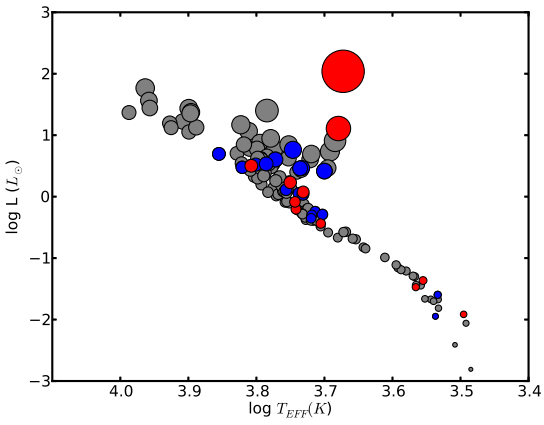

Figure 2: (von Braun et al.) Empirical H-R Diagram for all main-sequence stars with interferometrically determined radii whose random uncertainties are smaller than 5%, as published and compiled in Boyajian et al. (2012b, 2013). The diameter of each data point is representative of the respective stellar radius. Error bars in effective temperature and luminosity are smaller than the size of the data points. Previously published exoplanet host stars are identified in blue. The exoplanet host stars that are presented in this work are shown in red. Stars that do not host any published exoplanets are shown in grey.

Migration of Earth-size planets in 3D radiative discs.

E. Lega, A. Crida, B. Bitsch, A. Morbidelli

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Monthly Notices of the Royal Astronomical Society, in press, (arXiv:1402.2834)

In this paper, we address the migration of small mass planets in 3D radiative disks. Indeed, migration of small planets is known to be too fast inwards in locally isothermal conditions. However, thermal effects could reverse its direction, potentially saving planets in the inner, optically thick parts of the protoplanetary disc. This effect has been seen for masses larger than 5 Earth masses, but the minimum mass for this to happen has never been probed numerically, although it is of crucial importance for planet formation scenarios. We have extended the hydro-dynamical code FARGO to 3D, with thermal diffusion. With this code, we perform simulations of embedded planets down to 2 Earth masses. For a set of discs parameters for which outward migration has been shown in the range of $[5, 35]$ Earth masses, we find that the transition to inward migration occurs for masses in the range $[3, 5]$ Earth masses. The transition appears to be due to an unexpected phenomenon: the formation of an asymmetric cold and dense finger of gas driven by circulation and libration streamlines. We recover this phenomenon in 2D simulations where we control the cooling effects of the gas through a simple modeling of the energy equation.

Download/Website: `http://arxiv.org/abs/1402.2834`

Contact: `elena@oca.eu`

Revisiting parameters for the WASP-1 planetary system

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Acta Astronomica, in press, (arXiv:1402.6518)

We present thirteen new transit light curves for the WASP-1 b exoplanet. Observations were acquired with 0.5 - 1.2-m telescopes between 2007 and 2013. Our homogeneous analysis, which also includes the literature data, results in determining precise system parameters. New values are in agreement with those reported in previous studies. Transit times follow a linear ephemeris with no sign of any transit time variations. This finding is in line with the paradigm that Jupiter-like planets on tight orbits are devoid of close planetary companions.

Download/Website: `http://ttv.astri.umk.pl`

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A High False Positive Rate for Kepler Planetary Candidates Of Giant Stars Using Asterodensity Profiling

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[2] Sagan Fellow

The Astrophysical Journal, in press (arXiv:1401.1207)

Asterodensity Profiling (AP) is a relatively new technique for studying transit light curves. By comparing the mean stellar density derived from the transit light curve to that found through some independent method, AP provides information on several useful properties such as orbital eccentricity and blended light. We present an AP survey of 40 *Kepler* Objects of Interest (KOIs), with a single transiting candidate, for which the target star's mean stellar density has been measured using asteroseismology. The ensemble distribution of the AP measurements for the 30 dwarf stars in our sample shows excellent agreement with the spread expected if the KOIs were genuine and have realistic eccentricities. In contrast, the same test for the 10 giants in our sample reveals significant incompatibility at $4\,\sigma$ confidence. Whilst extreme eccentricities could be invoked, this hypothesis requires four of the KOIs to contact their host star at periastron passage, including the recently claimed confirmation of Kepler-91b. After carefully examining several hypotheses, we conclude that the most plausible explanation is that the transiting objects orbit a different star to that measured with asteroseismology - cases we define as false-positives. Based on the AP distribution, we estimate a false positive rate for *Kepler's* giant stars with a single transiting object of FPR$\simeq 70 \pm 30\%$.

Download/Website: `http://arxiv.org/pdf/1401.1207.pdf`

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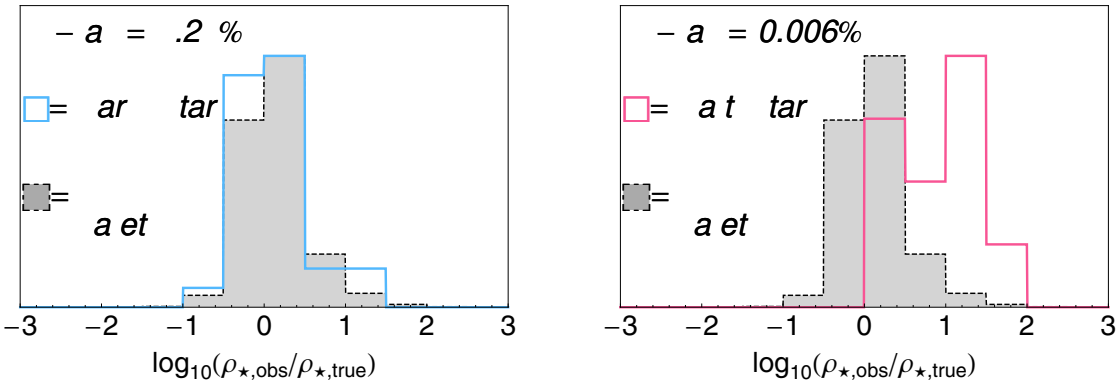

Figure 3: (Sliski & Kipping) Histograms of $(\rho_{\star,\mathrm{obs}}/\rho_{\star,\mathrm{astero}})$ for KOIs studied in this work. On the left we show the results for those KOIs orbiting dwarf stars ($\log g > 3.7$) and on the right those for giant stars ($\log g \leq 3.7$), demonstrating the clear difference between the two subsets. The gray histrogram shows that which would be expected if only the photo-eccentric effect was occuring and the eccentricity distribution matched that observed from the radial velocity planets (Kipping 2013) (deliberately binned to the same scale).

Accretion of Jupiter-mass Planets in the Limit of Vanishing Viscosity

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Astrophysical Journal, published (2014ApJ...782...65S)

In the core-accretion model the nominal runaway gas-accretion phase brings most planets to multiple Jupiter masses. However, known giant planets are predominantly Jupiter-mass bodies. Obtaining longer timescales for gas accretion may require using realistic equations of states, or accounting for the dynamics of the circumplanetary disk (CPD) in the low-viscosity regime, or both. Here we explore the second way by using global, three-dimensional isothermal hydrodynamical simulations with 8 levels of nested grids around the planet. In our simulations the vertical inflow from the circumstellar disk (CSD) to the CPD determines the shape of the CPD and its accretion rate. Even without prescribed viscosity Jupiter's mass-doubling time is $\sim 10^4$ years, assuming the planet at 5.2 AU and a Minimum Mass Solar Nebula. However, we show that this high accretion rate is due to resolution-dependent numerical viscosity. Furthermore, we consider the scenario of a layered CSD, viscous only in its surface layer, and an inviscid CPD. We identify two planet-accretion mechanisms that are independent of the viscosity in the CPD: (i) the polar inflow – defined as a part of the vertical inflow with a centrifugal radius smaller than 2 Jupiter-radii and (ii) the torque exerted by the star on the CPD. In the limit of zero effective viscosity, these two mechanisms would produce an accretion rate 40 times smaller than in the simulation.

Download/Website: `http://adsabs.harvard.edu/abs/2014ApJ...782...65S`

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The atmospheric chemistry of the warm Neptune GJ 3470b: Influence of metallicity and temperature on the CH_4/CO ratio

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Astronomy & Astrophysics, published (2014A&A...562A..51V)

Current observation techniques are able to probe the atmosphere of some giant exoplanets and get some clues about their atmospheric composition. However, the chemical compositions derived from observations are not fully understood. For instance, the CH_4/CO abundance ratio is often inferred to be different from the value that has been predicted by chemical models. Recently, the warm Neptune GJ 3470b has been discovered, and because of its close distance from us and high transit depth, it is a very promising candidate for follow-up characterisation of its atmosphere. We study the atmospheric composition of GJ 3470b to compare to the current observations of this planet and to prepare for future ones but also to understand the chemical composition of warm (sub-)Neptunes as a typical case study. The metallicity of such atmospheres is totally uncertain and are likely to vary to values up to 100 $\times$ solar. We explore the space of unknown parameters to predict the range of possible atmospheric compositions. We use a one-dimensional chemical code to compute a grid of models with various thermal profiles, metallicities, eddy diffusion coefficient profiles, and stellar UV incident fluxes. Thanks to a radiative transfer code, we then compute the corresponding emission and transmission spectra of the planet and compare them with the observational data already published. Within the parameter space explored we find that methane is the major carbon-bearing species in most cases. We, however, find that for high metallicities with a sufficiently high temperature, the CH_4/CO abundance ratio can become lower than unity, as suggested by some multiwavelength photometric observations of other warm (sub-)Neptunes, such as GJ 1214b and GJ 436b. As for the emission spectrum of

GJ 3470b, brightness temperatures at infrared wavelengths may vary between 400 and 800 K depending on the thermal profile and metallicity. Combined with a hot temperature profile, a substantial enrichment in heavy elements by a factor of ≥ 100 with respect to the solar composition can shift the carbon balance in favour of carbon monoxide at the expense of methane. Nevertheless, current observations of this planet do not allow us yet to determine which model is more accurate.

Download/Website: `http://adsabs.harvard.edu/abs/2014A%26A...562A..51V`

Contact: `olivia.venot@ster.kuleuven.be`

3 PhD Theses

Transmission Spectroscopy: First Glimpses of Far-Off Worlds

C.M. Huitson[1,2]

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[2] Center for Astrophysics and Space Astronomy, University of Colorado, 389UCB, Boulder, CO, 80302, USA

PhD thesis, Accepted

Since the first discovery of a transiting planet in 2000, transmission spectroscopy has proved essential for characterising the rapidly increasing number of known extrasolar planets. When a planet is in a favourable alignment, it periodically passes (transits) in front of its host star, during which time it blocks a fraction of the stellar light. During a transit, the starlight passes through the planetary atmosphere, causing the signatures of atoms or molecules present in that atmosphere to imprint themselves on the stellar spectrum, allowing direct observation of a planet's atmospheric composition.

At the start of this thesis, only two planets (HD 189733b and HD 209458b) had been studied in any detail, mainly from space. The two planets showed surprisingly different qualities for two objects with only a small temperature difference between them, and motivated both wider and more detailed studies of the exoplanet population. Since the start of my PhD, the amount of exoplanet knowledge has grown rapidly, with observations from the ground becoming important, and with studies branching out towards new planets. There are several contributions made by this thesis to the field.

Chapter 3 details the detection of the resolved sodium D doublet in the atmosphere of HD 189733b, a planet with a featureless broad-band transmission spectrum dominated by Rayleigh scattering. The results confirmed the presence of sodium absorption as well as resolving the feature for the first time, and placing constraints on relative abundances. Furthermore, in Chapter 4, I outline a method based on earlier work which allows observers to retrieve atmospheric temperature information from resolved spectral features. This method is applied to the observations of HD 189733b, showing that the planet has a hot thermosphere similar to HD 209458b. The models are then also used in later chapters.

I then present the first results from a ground-based optical long-slit spectroscopic survey in Chapter 5, and the first results from a space-based optical-near-IR spectroscopic survey in Chapter 6. From the ground, I detect absorption from sodium in the atmosphere of XO-2b, making this the first planet with sodium and potassium detected in its atmosphere. I also find that the Na I D feature lacks broad line wings, suggesting haze or cloud cover. From space, I observed the transmission spectrum of WASP-19b, finding solar abundance water features and a likely lack of predicted TiO features. WASP-19b is the first planet to have confirmed water features at solar-abundance level. In Chapter 7, I conclude and discuss future work, including a project aimed at understanding why WASP-19b lacks TiO features, and projects which move beyond the hot Jupiter class.

Download/Website: `http://hdl.handle.net/10871/13955`

Contact: `catherine.huitson@colorado.edu`

4 Announcements

2014B NASA Keck Call for General Observing Proposals

Dr. Dawn M. Gelino
NASA Exoplanet Science Institute

Proposals Due: March 20, 2014, 4 pm PDT

NASA is soliciting proposals for the use of the two 10m W. M. Keck Telescopes for the 2014B observing semester (August 2014 - January 2015). Complete call information will be made available on the website below by mid-February and all proposals are due by **20 March 2014 at 4 pm PDT**.
The opportunity to propose as Principal Investigators for NASA time on the Keck Telescopes is open to all U.S.-based astronomers (a U.S.-based astronomer has his/her principal affiliation at a U.S. institution). *Investigators from institutions outside of the U.S. may participate as Co-Investigators*.
NASA intends the use of the Keck telescopes to be highly strategic in support of on-going space missions and/or high priority, long term science goals. NASA Keck time is open to a wide range of disciplines and proposals are sought in the following areas: (1) investigations in support of EXOPLANET EXPLORATION science goals and missions; (2) investigations of our own SOLAR SYSTEM; (3) investigations in support of COSMIC ORIGINS science goals and missions; (4) investigations in support of PHYSICS OF THE COSMOS science goals and missions; and (5) direct MISSION SUPPORT in any of the previous four areas.
The proposal process is being handled by the NASA Exoplanet Science Institute (NExScI) at Caltech.

Download/Website: `http://nexsci.caltech.edu/missions/KeckSolicitation/index.shtml`

Contact: `KeckCFP@ipac.caltech.edu`

5 Conference announcements

2014 Sagan Summer Workshop: Imaging Planets and Disks

C. Brinkworth
NASA Exoplanet Science Institute, California Institute of Technology, Pasadena, CA, USA

Pasadena, CA, July 20-25, 2014

Registration and the application for financial aid for the 2014 Sagan Exoplanet Summer Workshop on "Imaging Planets and Disks" hosted by the NASA Exoplanet Science Institute (NExScI) is now available. The workshop will take place on the Caltech campus July 20 - 25, 2014. The workshop is intended for graduate students and postdocs, however all interested parties are welcome to attend.
The 2014 workshop will explore current techniques and technology used to image exoplanets and debris disks, as well as the underlying science driving the modeling of exoplanetary atmospheres and disk structure. Leaders in the field will summarize the current state of the art in science, hardware, and software for both ground and space-based missions and data. Prospects for future space instruments will also be discussed. Attendees will participate in hands-on exercises to gain experience working with imaging data, astrophysical models, and instrument design. Attendees will also have the opportunity to present their own work through short presentations (research POPs) and posters.
Important Dates

- March 7: Financial Support applications and supporting letter of recommendation due
- March 24: Financial Support decisions announced via email

- April 2: POP/Poster submission page on-line
- June 20: Early on-line registration ends
- July 4: POP/Poster Submission deadline and hotel registration deadline to be eligible for group rate
- July 11: On-line registration closed and final agenda posted
- July 20: Sagan Exoplanet Summer Workshop Opening Reception
- July 21-25: 2014 Sagan Exoplanet Summer Workshop

Download/Website: `http://nexsci.caltech.edu/workshop/2014`
Contact: `sagan_workshop@ipac.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 2014. If you see any that we missed, please let us know and we'll include them in the next issue.

astro-ph/1402.0077 : **Effects of stellar flybys on planetary systems: 3D modeling of the circumstellar disks damping effects** by *Giovanni Picogna, Francesco Marzari*
astro-ph/1402.0392 : **Warm formaldehyde in the Oph IRS 48 transitional disk** by *Nienke van der Marel et al.*
astro-ph/1402.0509 : **Forming Circumbinary Planets: N-body Simulations of Kepler-34** by *Stefan Lines, et al.*
astro-ph/1402.0533 : **Transport of solids in protoplanetary disks: Comparing meteorites and astrophysical models** by *Emmanuel Jacquet*
astro-ph/1402.0592 : **The Earth as an extrasolar transiting planet - II: HARPS and UVES detection of water vapor, biogenic O_2, and O_3** by *Luc Arnold, et al.*
astro-ph/1402.0814 : **Accuracy tests of radiation schemes used in hot Jupiter global circulation models** by *David Skalid Amundsen, et al.*
astro-ph/1402.0846 : **Near-IR Direct Detection of Water Vapor in Tau Boo b** by *Alexandra C. Lockwood, et al.*
astro-ph/1402.1085 : **Galactic planetary science** by *Giovanna Tinetti*
astro-ph/1402.1169 : **Exoplanetary Atmospheres** by *Nikku Madhusudhan, et al.*
astro-ph/1402.1180 : **Accretion in giant planet circumplanetary disks** by *Sarah L. Keith, Mark Wardle*
astro-ph/1402.1344 : **The multifaceted planetesimal formation process** by *Anders Johansen et al.*
astro-ph/1402.1482 : **WASP-20b and WASP-28b: a hot Saturn and a hot Jupiter in near-aligned orbits around solar-type stars** by *D. R. Anderson, et al.*
astro-ph/1402.1907 : **Star-Disc-Binary Interactions in Protoplanetary Disc Systems and Primordial Spin-Orbit Misalignments** by *Dong Lai*
astro-ph/1402.2378 : **Thermal-orbital coupled tidal heating and habitability of Martian-sized extrasolar planets around M stars** by *Daigo Shoji, Kei Kurita*
astro-ph/1402.2728 : **A dynamical test for terrestrial planets in the habitable zone of HD 204313** by *E. Thilliez, et al.*
astro-ph/1402.2792 : **Evolution of a disc-planet system with a binary companion on an inclined orbit** by *M. Xiang-Gruess, J.C.B. Papaloizou*
astro-ph/1402.2834 : **Migration of Earth-size planets in 3D radiative discs** by *E. Lega, A. Crida, B. Bitsch, A. Morbidelli*
astro-ph/1402.3308 : **On the evolution of the CO snow line in protoplanetary disks** by *Rebecca G. Martin, Mario Livio*

astro-ph/1402.3421 : **The Dynamics and Scaling Laws of Planetary Dynamos Driven by Inertial Waves** by *P. A. Davidson*
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