1 Editorial

Welcome to the 89th edition of Exoplanet News. After the last few bumper editions, this month’s newsletter is on the slim-side, and no-one has submitted any new conference announcements or job advertisements. However, several of the conferences and job adverts included in last month’s edition still have not reached their application deadlines, so please do refer back to the June newsletter in case you missed any.

As things seem to be already winding a little for the (northern hemisphere) summer, the newsletter will take a break in August, but I plan to return with the next edition at the beginning of September. So please keep your abstracts and announcements coming over the next couple of months and please encourage colleagues who work in the exoplanet area to submit items to the newsletter, if they’ve not yet done so!

best wishes
Andrew Norton
2 Abstracts of refereed papers

The Origin and Evolution of Saturn, with Exoplanet Perspective

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Saturn formed beyond the snow line in the primordial solar nebula that made it possible for it to accrete a large mass. Disk instability and core accretion models have been proposed for Saturn’s formation, but core accretion is favored on the basis of its volatile abundances, internal structure, hydrodynamic models, chemical characteristics of protoplanetary disk, etc. The observed frequency, properties and models of exoplanets provide additional supporting evidence for core accretion. The heavy elements with mass greater than ¹⁴He make up the core of Saturn, but are presently poorly constrained, except for carbon. The C/H ratio is super-solar, and twice that in Jupiter. The enrichment of carbon and other heavy elements in Saturn and Jupiter requires special delivery mechanisms for volatiles to these planets. In this chapter we will review our current understanding of the origin and evolution of Saturn and its atmosphere, using a multi-faceted approach that combines diverse sets of observations on volatile composition and abundances, relevant properties of the moons and rings, comparison with the other gas giant planet, Jupiter, analogies to the extrasolar giant planets, as well as pertinent theoretical models.

Download/Website: https://arxiv.org/abs/1606.04510
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Search for light curve modulations among Kepler candidates: Three very low-mass transiting companions

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Light curve modulations in the sample of Kepler planet candidates allows the disentangling of the nature of the transiting object by photometrically measuring its mass. This is possible by detecting the effects of the gravitational pull of the companion (ellipsoidal modulations) and in some cases, the photometric imprints of the Doppler effect when observing in a broad band (Doppler beaming). We aim to photometrically unveil the nature of some transiting objects showing clear light curve modulations in the phase-folded Kepler light curve. We selected a subsample among the large crop of Kepler objects of interest (KOIs) based on their chances to show detectable light curve modulations, i.e., close (a < 12 R_*) and large (in terms of radius, according to their transit signal) candidates. We modeled their phase-folded light curves with consistent equations for the three effects, namely, reflection, ellipsoidal and beaming (known as REB modulations). We provide detailed general equations for the fit of the REB modulations for the case of eccentric orbits. These equations are accurate to the photometric precisions achievable by current and forthcoming instruments and space missions. By using this mathematical apparatus, we find three close-in very low-mass companions (two of them in the brown dwarf mass domain) orbiting main-sequence stars (KOI-554, KOI-1074, and KOI-3728), and reject the planetary nature of the transiting objects (thus classifying them as false
positives). In contrast, the detection of the REB modulations and transit/eclipse signal allows the measurement of their mass and radius that can provide important constraints for modeling their interiors since just a few cases of low-mass eclipsing binaries are known. Additionally, these new systems can help to constrain the similarities in the formation process of the more massive and close-in planets (hot Jupiters), brown dwarfs, and very low-mass companions.

*Download/Website:* http://arxiv.org/abs/1606.02398

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**Figure 1:** (Lillo-Box et al.) Fitting results for one of the KOIs analyzed in this work. The top panel shows a close view of the out-of-eclipse time interval where the light curve modulations are detectable. The middle panel shows the complex light curve including the eclipse and an inset showing each contribution to the out-of-eclipse modulations. In the bottom panel, we show the residuals of the fit. Gray circles represent 500 bins along the orbit and red circles represent binnings of 100 datapoints. The best one hundred models are shown with black lines and the best model is shown with a blue line.
A Dynamical Analysis of the Kepler-80 System of Five Transiting Planets

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The Astronomical Journal, in press

Kepler has discovered hundreds of systems with multiple transiting exoplanets which hold tremendous potential both individually and collectively for understanding the formation and evolution of planetary systems. Many of these systems consist of small planets with periods less than ~50 days known as Systems with Tightly-spaced Inner Planets, or STIPs. One especially intriguing STIP, Kepler-80 (KOI-500), contains five transiting planets: f, d, e, b, and c with periods of 1.0, 3.1, 4.6, 7.1, 9.5 days, respectively. We provide measurements of transit times and a transit timing variation (TTV) dynamical analysis. We find that TTVs cannot reliably detect eccentricities for this system, though mass estimates are not affected. Restricting the eccentricity to a reasonable range, we infer masses for the outer four planets (d, e, b, and c) to be \(6.75^{+0.69}_{-0.51}, 4.13^{+0.81}_{-0.95}, 6.93^{+1.05}_{-0.70}\), and \(6.74^{+1.23}_{-0.86}\) Earth masses, respectively. The similar masses but different radii are consistent with terrestrial compositions for d and e and \(\sim 2\%\) H/He envelopes for b and c. We confirm that the outer four planets are in a rare dynamical configuration with four interconnected three-body resonances that are librating with few degree amplitudes. We present a formation model that can reproduce the observed configuration by starting with a multi-resonant chain and introducing dissipation. Overall, the information-rich Kepler-80 planets provide an important perspective into exoplanetary systems.

Download/Website: http://mmacdonald.altervista.org/kepler-80.html
Contact: mmacdonald2012@my.fit.edu

Figure 2: (MacDonald et al.) Time evolution of the four different three-body resonances seen in Kepler-80. In Kepler-80, all four of the possible lowest-order three-body resonances are librating with very small \(~3^\circ\) libration amplitudes. This four-planet configuration is rare among known planetary-like systems, though three-body (Laplace-like) resonances have been seen. The 191-day conjunction cycle (corresponding to the super-period from the near two-body resonances) is clearly seen. On a longer \(~10\)-year timescale, three-body resonance libration is clearly seen. In both cases, the interlocking resonances produce the same timescale for conjunctions and three-body resonance period. Libration centers are shifted from 0 or 180 degrees due to the torque from the planet not in the resonance. This configuration matches the expected result of formation by planetary migration.
Search for an exosphere in sodium and calcium in the transmission spectrum of exoplanet 55 Cancri e

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[Abridged] The aim of this work is to search for an absorption signal from exospheric sodium (Na) and singly ionized calcium (Ca\(^+\)) in the optical transmission spectrum of the hot rocky super-Earth 55 Cancri e. Although current best-fitting models to the planet mass and radius require a possible atmospheric component, uncertainties in the radius exist, making it possible that 55 Cnc e could be a hot rocky planet without an atmosphere. High resolution (R\(\sim\)110000) time-series spectra were analysed of five transits of 55 Cancri e, obtained with three different telescopes (UVES/VLT, HARPS/ESO 3.6m & HARPS-N/TNG). Targeting the sodium D lines and the calcium H and K lines the potential planet exospheric signal was filtered out from the much stronger stellar and telluric signals, making use of the change of the radial component of the orbital velocity of the planet over the transit from -57 to +57 km sec\(^{-1}\).

Combining all five transit data sets we detect a signal potentially associated with sodium in the planet exosphere at a statistical significance level of 3\(\sigma\). Combining the four HARPS transits that cover the calcium H and K lines, we also find a potential signal from ionized calcium (4.1\(\sigma\)). Interestingly, this latter signal originates from just one of the transit measurements - with a 4.9\(\sigma\) detection at this epoch. Unfortunately, due to the low significance of the measured sodium signal and the potentially variable Ca\(^+\) signal, we estimate the p-values of these signals to be too high (corresponding to \(<4\sigma\)) to claim unambiguous exospheric detections. By comparing the observed signals with artificial signals injected early in the analysis, the absorption by Na and Ca\(^+\) are estimated to be at a level of approximately 2.3\(\times\)10\(^{-3}\) and 7.0\(\times\)10\(^{-2}\) respectively, relative to the stellar spectrum.

Download/Website: http://arxiv.org/abs/1606.08447

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Figure 3: (Ridden-Harper et al.) The signal of ionized calcium from the HARPS A data set both not binned (dotted line) and binned (solid black line) every 0.05\(\AA\) or 3.8 km sec\(^{-1}\). This binning regime results in a detection that has a S/n of \(~4.9\sigma\).
First detection of gas-phase methanol in a protoplanetary disk

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The first detection of gas-phase methanol in a protoplanetary disk (TW Hya) is presented. In addition to being one of the largest molecules detected in disks to date, methanol is also the first disk organic molecule with an unambiguous ice chemistry origin. The stacked methanol emission, as observed with ALMA, is spectrally resolved and detected across six velocity channels (>3σ), reaching a peak signal-to-noise of 5.5σ, with the kinematic pattern expected for TW Hya. Using an appropriate disk model, a fractional abundance of $3 \times 10^{-12} - 4 \times 10^{-11}$ (with respect to H₂) reproduces the stacked line profile and channel maps, with the favoured abundance dependent upon the assumed vertical location (midplane versus molecular layer). The peak emission is offset from the source position suggesting that the methanol emission has a ring-like morphology: the analysis here suggests it peaks at ≈30 AU reaching a column density ≈3 − 6 × 10¹² cm⁻². In the case of TW Hya, the larger (up to mm-sized) grains, residing in the inner 50 AU, may thus host the bulk of the disk ice reservoir. The successful detection of cold gas-phase methanol in a protoplanetary disk implies that the products of ice chemistry can be explored in disks, opening a window to studying complex organic chemistry during planetary system formation.

Download/Website: http://cdsads.u-strasbg.fr/abs/2016ApJ...823L..10W
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3 As seen on astro-ph

The following list contains all the entries relating to exoplanets that we spotted on astro-ph during June 2016. If you see any that we missed please let us know and we’ll include them in the next issue.

astro-ph/1606.00440 : Dynamical mass and multiplicity constraints on co-orbital bodies around stars by Dimitri Veras, Thomas R. Marsh, Boris T. Gaensicke
3 AS SEEN ON ASTRO-PH


astro-ph/1606.01264: Transiting exoplanet candidates from K2 Campaigns 5 and 6 by Benjamin J. S. Pope, Hanna Parviainen, Suzanne Aigrain


astro-ph/1606.03030: Analytical investigation of the decrease in the size of the habitable zone due to limited CO₂ outgassing rate by Dorian S. Abbot


astro-ph/1606.03134: Limits on Planetary Companions from Doppler Surveys of Nearby Stars by Andrew W. Howard, Benjamin J. Fulton

astro-ph/1606.03522: A Simple Analytical Model for Rocky Planet Interior by Li Zeng, Stein B. Jacobsen


astro-ph/1606.04162: The properties of heavy elements in giant planet envelopes by Francois Soubiran, Burkhard Militzer


astro-ph/1606.04509: The magnetorotational instability in debris-disc gas by Quentin Kral, Henrik Latter


on the Edge of the Period–Mass Desert by G.A. Bakos et al.
astro-ph/1606.05678: Benford’s distribution in extrasolar world: Do the exoplanets follow Benford’s distribution? by Abhishek Shukla, Ankit Kumar Pandey, Anirban Pathak
astro-ph/1606.05714: Ionization of protoplanetary disks by galactic cosmic rays, solar protons, and by supernova remnants by Ryuho Kataoka, Tatsuhiro Sato
astro-ph/1606.05828: Candidate Water Vapor Lines to Locate the H$_2$O Snowline through High-Dispersion Spectroscopic Observations I. The Case of a T Tauri Star by Shota Notsu, et al.
astro-ph/1606.06243: Tidal evolution of CoRoT massive planets and brown dwarfs and of their host stars by Sylvio Ferraz-Mello
astro-ph/1606.06492: First detection of gas-phase methanol in a protoplanetary disk by Catherine Walsh et al.
astro-ph/1606.06945: The microlensing rate and distribution of free-floating planets towards the Galactic bulge by M. Ban, E. Kerins, A.C. Robin
astro-ph/1606.07266: The abundance and thermal history of water ice in the disk surrounding HD142527 from the DIGIT Herschel Key Program by M. Min, et al.
astro-ph/1606.07438: Secular dynamics of multiplanet systems: implications for the formation of hot and
warm Jupiters via high-eccentricity migration by Adrian S. Hamers, et al.
astro-ph/1606.07546

astro-ph/1606.07743

Orbital stability of coplanar two-planet exosystems with high eccentricities by Kyriaki I. Antoniadou, George Voyatzis
astro-ph/1606.07819

Long-term stability of the HR 8799 planetary system without resonant lock by Ylva Gotberg, et al.
astro-ph/1606.08027

astro-ph/1606.08088

In Situ and Ex Situ Formation Models of Kepler 11 Planets by Gennaro D'Angelo, Peter Bodenheimer

Five Planets Transiting a Ninth Magnitude Star by Andrew Vanderburg, et al.
astro-ph/1606.08441

astro-ph/1606.08498

Sparse aperture masking at the VLT II. Detection limits for the eight debris disks stars β Pic, AU Mic, 49 Cet, η Tel, Fomalhaut, g Lup, HD181327 and HR8799 by L. Gauchet, et al.
astro-ph/1606.08622

Probing TRAPPIST-1-like systems with K2 by Brice-Olivier Demory, et al.
astro-ph/1606.08623

Tides and angular momentum redistribution inside low-mass stars hosting planets: a first dynamical model by A. F. Lanza, S. Mathis
astro-ph/1606.08846

A novel high-contrast imaging technique based on optical tunneling to search for faint companions around bright stars at the limit of diffraction by Dominik Derigs, et al.
astro-ph/1606.08848

Relative Likelihood for Life as a Function of Cosmic Time by Abraham Loeb, Rafael A. Batista, David Sloan
astro-ph/1606.08855

Hiding Planets Behind a Big Friend: Mutual Inclinations of Multi-Planet Systems with External Companions by Dong Lai, Bonan Pu
astro-ph/1606.08926

On the Habitability of Our Universe by Abraham Loeb
astro-ph/1606.08992

Our Sky now and then — searches for lost stars and impossible effects as probes of advanced extra-terrestrial civilisations by Beatriz Villarroel, Inigo Imaz, Josefine Bergstedt
astro-ph/1606.09172

Lightning climatology of exoplanets and brown dwarfs guided by Solar System data by Gabriella Hodosan, et al.
astro-ph/1606.09174

On the Formation and Chemical Composition of Super Earths by Matthew Alessi, Ralph E. Pudritz, Alex J. Cridland
astro-ph/1606.09179

New debris disks in nearby young moving groups by A. Moor, et al.
astro-ph/1606.09246

No Timing Variations Observed in Third Transit of Snow-Line Exoplanet Kepler-421b by Paul A. Dalba, Philip S. Muirhead
astro-ph/1606.09352

astro-ph/1606.09580

About Exobiology: The Case for Dwarf K Stars by M. Cuntz, E. F. Guinan