ExoPlanet News
An Electronic Newsletter

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Contents

1 Editorial

Welcome to the 85th edition of Exoplanet News, back after our Christmas and New Year break.

I wanted to highlight an important anniversary this month, namely the 100th anniversary of the UK's Royal Astronomical Society first admitting women as Fellows. Some of the events to celebrate this are described on the RAS website at http://www.ras.org.uk/news-and-press/news-archive/264-news-2016/2766-100-years-and-counting-women-in-the-ras-go-from-strength-to-strength. For this newsletter and the community it represents, it is particularly good news to see two exoplanet scientists featured in the RAS exhibition (http://women.ras.ac.uk/) which has commissioned photographic portraits of 21 astronomers and geophysicists, representing the rich diversity of female fellows in the Society, from around the UK, and at different levels in their careers. Congratulations to **Giovanna Tinetti** and **Carole Haswell** for appearing in this group.

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. Although note that my updates to the website only become live over-night. So if you want to get the newsletter as soon as it is ready, please subscribe and get it by email on the day it's released.

Best wishes
Andrew Norton
The Open University

Figure 1: Women and the RAS: portraits of 21 leading UK astronomers and geophysicists, including exoplanet scientists Giovanna Tinetti (bottom row, 2nd) and Carole Haswell (top row, 1st). (Courtesy: Maria Platt-Evans)

2 Abstracts of refereed papers

Formation and Stellar Spin-Orbit Misalignment of Hot Jupiters from Lidov-Kozai Oscillations in Stellar Binaries

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Monthly Notices of the Royal Astronomical Society, published (2016, MNRAS, 456, 3671)

Observed hot Jupiter (HJ) systems exhibit a wide range of stellar spin-orbit misalignment angles. This paper investigates the inward migration of giant planets due to Lidov-Kozai (LK) oscillations induced by a distant stellar companion. We conduct a large population synthesis study, including the octupole gravitational potential from the stellar companion, mutual precession of the host stellar spin axis and planet orbital axis, tidal dissipation in the planet, and stellar spin-down in the host star due to magnetic braking. We consider a range of planet masses ($0.3 - 5\,M_J$) and initial semi-major axes ($1 - 5$ AU), different properties for the host star, and varying tidal dissipation strengths. The fraction of systems that result in HJs depends on planet mass and stellar type, with $f_{\rm HJ} = 1 - 4\%$ (depending on tidal dissipation strength) for $M_p = 1\,M_J$, and larger (up to 8%) for more massive planets. The production efficiency of "hot Saturns" ($M_p = 0.3M_J$) is much lower, because most migrating planets are tidally disrupted. We find that the fraction of systems that result in either HJ formation or tidal disruption, $f_{\rm mig} \simeq 11 - 14\%$ is roughly constant, having little variation with planet mass, stellar type and tidal dissipation strength. The distribution of final HJ stellar obliquities exhibits a complex dependence on the planet mass and stellar type. For $M_p = (1 - 3)M_J$, the distribution is always bimodal, with peaks around $30°$ and $130°$. The distribution for $5M_J$ planets depends on host stellar type, with a preference for low obliquities for solar-type stars, and higher obliquities for more massive ($1.4M_\odot$) stars.

Download/Website: `http://mnras.oxfordjournals.org/content/456/4/3671`

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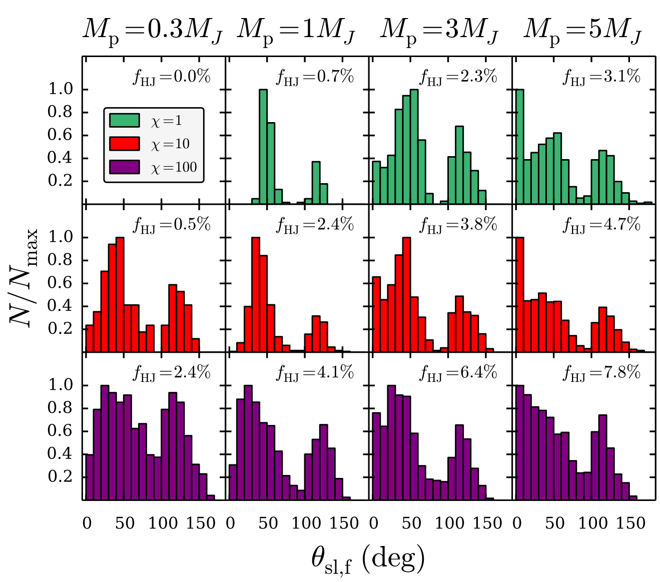

Figure 2: (Anderson et al.) Final distributions of the stellar spin-orbit angle ($\theta_{sl,f}$) for HJs around G stars, illustrating the effects of varying planet mass and tidal dissipation strength χ. Each column shows a different planet mass, and each row shows a different value of the tidal dissipation parameter $\chi = 1$, as labeled. The production fraction of HJs ($f_{\rm HJ}$) increases with planet mass, because higher mass planets are able to withstand tidal disruptions more easily. For most planet masses, increasing χ broadens the distribution of $\theta_{sl,f}$, but the overall shape (usually bimodal) remains unchanged.

Rotation and Winds of Exoplanet HD 189733b Measured with High-dispersion Transmission Spectroscopy

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The Astrophysical Journal, published (2016, ApJ, 817, 106)

Giant exoplanets orbiting very close to their parent star (hot Jupiters) are subject to tidal forces expected to synchronize their rotational and orbital periods on short timescales (tidal locking). However, spin rotation has never been measured directly for hot Jupiters. Furthermore, their atmospheres can show equatorial super-rotation via strong eastward jet streams, and/or high-altitude winds flowing from the day- to the night-side hemisphere. Planet rotation and atmospheric circulation broaden and distort the planet spectral lines to an extent that is detectable with measurements at high spectral resolution. We observed a transit of the hot Jupiter HD 189733 b around 2.3 μm and at a spectral resolution of $R \sim 10^5$ with CRIRES at the ESO Very Large Telescope. After correcting for the stellar absorption lines and their distortion during transit (the Rossiter–McLaughlin effect), we detect the absorption of carbon monoxide and water vapor in the planet transmission spectrum by cross-correlating with model spectra. The signal is maximized (7.6σ) for a planet rotational velocity of $(3.4^{+1.3}_{-2.1})$ km s^{-1}, corresponding to a rotational period of $(1.7^{+2.9}_{-0.4})$ days. This is consistent with the planet orbital period of 2.2 days, and therefore with tidal locking. We find that the rotation of HD 189733 b is longer than 1 day (3σ). The data only marginally (1.5σ) prefer models with rotation versus models without rotation. We measure a small day- to night-side wind speed of $(-1.7^{+1.1}_{-1.2})$ km s^{-1}. Compared to the recent detection of sodium blueshifted by (8 ± 2) km s^{-1}, this likely implies a strong vertical wind shear between the pressures probed by near-infrared and optical transmission spectroscopy.

Download/Website: `http://arxiv.org/abs/1512.05175`

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Uncovering the planets and stellar activity of CoRoT-7 using only radial velocities

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Astronomy & Astrophysics, in press (arXiv:1601.07495)

Stellar activity can induce signals in the radial velocities of stars, complicating the detection of orbiting low-mass planets. We present a method to determine the number of planetary signals present in radial-velocity datasets of active stars, using only radial-velocity observations. Instead of considering separate fits with different number of planets, we use a birth-death Markov chain Monte Carlo algorithm to infer the posterior distribution for the number of planets in a single run. In a natural way, the marginal distributions for the orbital parameters of all planets are also inferred. This method is applied to HARPS data of CoRoT-7. We confidently recover both CoRoT-7b and CoRoT-7c although the data show evidence for additional signals.

Download/Website: `http://arxiv.org/abs/1601.07495`

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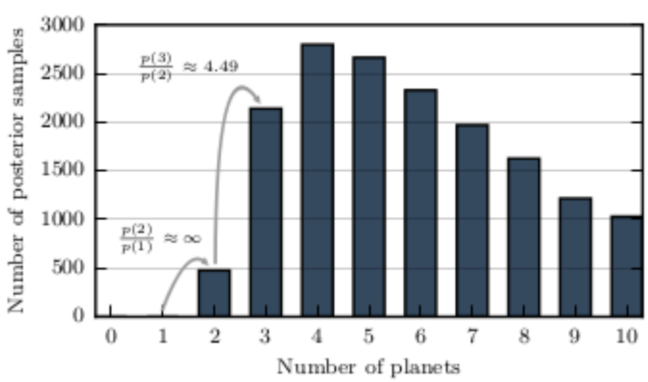

Figure 3: (Faria et al.) Posterior distribution for the number of planets N_p. The counts are number of posterior samples in models with a given number of planets. The two ratios of probabilities between models with 1, 2 and 3 planets are highlighted; note that $p(0) = p(1) = 0$.

The HARPS search for southern extra-solar planets XL. Searching for Neptunes around metal-poor stars

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Astronomy & Astrophysics, in press (arXiv:1601.07535)

Stellar metallicity – as a probe of the metallicity of proto-planetary disks – is an important ingredient for giant planet formation, likely through its effect on the timescales in which rocky/icy planet cores can form. Giant planets have been found to be more frequent around metal-rich stars, in agreement with predictions based on the core-accretion theory. In the metal-poor regime, however, the frequency of planets, especially low-mass planets, and how it depends on metallicity are still largely unknown. As part of a planet search programme focused on metal-poor stars, we study the targets from this survey that were observed with HARPS on more than 75 nights. The main goals are to assess the presence of low-mass planets and provide a first estimate of the frequency of Neptunes and super-Earths around metal-poor stars. We perform a systematic search for planetary companions, both by analysing the periodograms of the radial-velocities and by comparing, in a statistically-meaningful way, models with an increasing number of Keplerians. A first constraint on the frequency of planets in our metal-poor sample is calculated considering the previous detection (in our sample) of a Neptune-sized planet around HD175607 and one candidate planet (with an orbital period of 68.42 d and minimum mass $M_p \sin i = 11.14 \pm 2.47 M_\oplus$) for HD87838, announced in the present study. This frequency is determined to be close to 13% and is compared with results for solar-metallicity stars.

Download/Website: `http://arxiv.org/abs/1601.07535`

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Radial velocity information content of M dwarf spectra in the near-infrared

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Astronomy & Astrophysics, in press (arXiv:1511.07468)

Aims: We evaluate the radial velocity (RV) information content and achievable precision on M0-M9 spectra covering the ZYJHK bands. We do so while considering both a perfect atmospheric transmission correction and discarding areas polluted by deep telluric features, as done in previous works.
Methods: To simulate the M-dwarf spectra, PHOENIX-ACES model spectra were employed; they were convolved with rotational kernels and instrumental profiles to reproduce stars with a $v.sini$ of 1.0, 5.0, and 10.0 km/s when observed at resolutions of 60 000, 80 000, and 100 000. We considered the RV precision as calculated on the whole spectra, after discarding strongly polluted areas, and after applying a perfect telluric correction. In the latter option, we took into account the reduction in the number of recorded photons due to a transmittance lower than unity and considered its effect on the noise of the recorded spectra. In our simulations we paid particular attention to the details of the convolution and sampling of the spectra, and we discuss their impact on the final spectra.
Results: Our simulations show that the most important parameter ruling the difference in attainable precision between the considered bands is the spectral type. For M0-M3 stars, the bands that deliver the most precise RV measurements are the Z, Y, and H band, with relative merits depending on the parameters of the simulation. For M6-M9 stars, the bands show a difference in precision that is within a factor of $\sim$2 and does not clearly depend on the band; this difference is reduced to a factor smaller than $\sim$1.5 if we consider a non-rotating star seen at high resolution. We also show that an M6-M9 spectrum will deliver a precision about two times better as an M0-M3 spectra with the same signal-to-noise ratio. Finally, we note that the details of modeling the Earth atmosphere and interpreting the results have a significant impact on which wavelength regions are discarded when setting a limit threshold at 2-3%. The resolution element sampling on the observed spectra plays an important role in the atmospheric transmission characterization. As a result of the multiparameter nature of the problem, it is very difficult to precisely quantify the impact of absorption by the telluric lines on the RV precision, but it is an important limiting factor to the achievable RV precision.

Download/Website: `http://arxiv.org/abs/1511.07468`

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The Laplace resonance in the Kepler-60 planetary system

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Monthly Notices of the Royal Astronomical Society Letters, published (2016MNRAS.455L.104G)

We investigate the dynamical stability of the Kepler-60 planetary system with three super-Earths. We determine their orbital elements and masses by Transit Timing Variation (TTV) data spanning quarters Q1-Q16 of the KEPLER mission. The system is dynamically active but the TTV data constrain masses to ~ 4 m$_\oplus$ and orbits in safely wide stable zones. The observations prefer two types of solutions. The true three-body Laplace MMR exhibits the critical angle librating around $\simeq 45°$ and aligned apsides of the inner and outer pair of planets. In the Laplace MMR formed through a chain of two-planet 5:4 and 4:3 MMRs, all critical angles librate with small amplitudes $\sim 30°$ and apsidal lines in planet's pairs are anti-aligned. The system is simultaneously locked in a three-body MMR with librations amplitude $\simeq 10^{\mathrm{deg}}$. The true Laplace MMR can evolve towards a chain of two-body MMRs in the presence of planetary migration. Therefore the three-body MMR formed in this way seems to be more likely state of the system. However, the true three-body MMR cannot be disregarded *a priori* and it remains a puzzling configuration that may challenge the planet formation theory.

Download/Website: `http://arxiv.org/abs/1510.02776`

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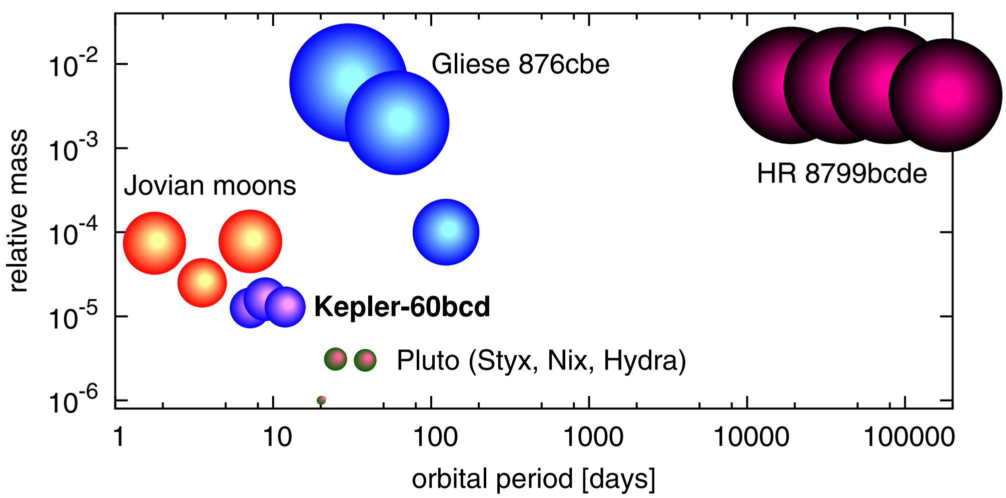

Figure 4: (Gozdziewski et al.) Comparison between the orbital periods and relative masses in the systems of Jovian satellites (Io, Europa, Ganymede), Kepler-60bcd, Gliese 876cbe, HR 8799bcde, and Pluto's moons (Nix, Styx, and Hydra). We note that the mass coordinate of Nix is uncertain, and this moon is marked merely to indicate its position at the orbital distance scale. Planetary companions in all systems are represented by spheres whose radii are proportional to the ratio of the satellites' masses to the mass of the central body. For the Kepler-60 and Jupiter system these mass ratios are roughly of the same order of magnitude $\sim 10^{-5}$. The mass ratios of two gas giants in Gliese 876 and planets of HR 8799 that are involved pairwise in the 2:1 MMRs are two orders of magnitude larger. All that means however that the Laplace resonant configurations can be formed in different environments, spanning wide mass ranges. Curiously, the Laplace resonance in the Kepler-60 system partially fills the wide mass-period relation.

The Sun as a planet-host star: Proxies from SDO images for HARPS radial-velocity variations

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Monthly Notices of the Royal Astronomical Society, in press (arXiv: 1601.05651)

The Sun is the only star whose surface can be directly resolved at high resolution, and therefore constitutes an excellent test case to explore the physical origin of stellar radial-velocity (RV) variability. We present HARPS observations of sunlight scattered off the bright asteroid 4/Vesta, from which we deduced the Sun's activity-driven RV variations. In parallel, the HMI instrument onboard the Solar Dynamics Observatory provided us with simultaneous high spatial resolution magnetograms, Dopplergrams, and continuum images of the Sun in the Fe I 6173Å line. We determine the RV modulation arising from the suppression of granular blueshift in magnetised regions and the flux imbalance induced by dark spots and bright faculae. The rms velocity amplitudes of these contributions are 2.40 m s^{-1} and 0.41 m s^{-1}, respectively, which confirms that the inhibition of convection is the dominant source of activity-induced RV variations at play, in accordance with previous studies. We find the Doppler imbalances of spot and plage regions to be only weakly anticorrelated. Lightcurves can thus only give incomplete predictions of convective blueshift suppression. We must instead seek proxies that track the plage coverage on the visible stellar hemisphere directly. The chromospheric flux index R'_{HK} derived from the HARPS spectra performs poorly in this respect, possibly because of the differences in limb brightening/darkening in the chromosphere and photosphere. We also find that the activity-driven RV variations of the Sun are strongly correlated with its full-disc magnetic flux density, which may become a useful proxy for activity-related RV noise.

Download/Website: `http://arxiv.org/abs/1601.05651`

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Atmospheric electrification in dusty, reactive gases in the solar system and beyond

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Journal in Geophysics, in press (arXiv:1601.04594)

Detailed observations of the solar system planets reveal a wide variety of local atmospheric conditions. Astronomical observations have revealed a variety of extrasolar planets none of which resembles any of the solar system planets in full. Instead, the most massive amongst the extrasolar planets, the gas giants, appear very similar to the class of (young) Brown Dwarfs which are amongst the oldest objects in the universe. Despite of this diversity, solar system planets, extrasolar planets and Brown Dwarfs have broadly similar global temperatures between 300K and 2500K. In consequence, clouds of different chemical species form in their atmospheres. While the details of these clouds differ, the fundamental physical processes are the same. Further to this, all these objects were observed to produce radio and X-ray emission. While both kinds of radiation are well studied on Earth and to a lesser extent on the solar system planets, the occurrence of emission that potentially originate from accelerated electrons on Brown Dwarfs, extrasolar planets and protoplanetary disks is not well understood yet. This paper offers an interdisciplinary view on electrification processes and their feedback on their hosting environment in meteorology, volcanology, planetology and research on extrasolar planets and planet formation.

Download/Website: `http://esoads.eso.org/abs/2016arXiv160104594H`

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Comet formation in collapsing pebble clouds. What cometary bulk density implies for the cloud mass and dust-to-ice ratio.

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Astronomy & Astrophysics, in press (arXiv:1601.05726)

Comets are remnants of the icy planetesimals that formed beyond the ice line in the Solar Nebula. Growing from μm-sized dust and ice particles to km-sized objects is, however, difficult because of growth barriers and time scale constraints. The gravitational collapse of pebble clouds that formed through the streaming instability may provide a suitable mechanism for comet formation. We study the collisional compression of silica, ice, and silica/ice-mixed pebbles during gravitational collapse of pebble clouds. Using the initial volume-filling factor and the dust-to-ice ratio of the pebbles as free parameters, we constrain the dust-to-ice mass ratio of the formed comet and the resulting volume-filling factor of the pebbles, depending on the cloud mass. We use the representative particle approach, which is a Monte Carlo method, to follow cloud collapse and collisional evolution of an ensemble of ice, silica, and silica/ice-mixed pebbles. Therefore, we developed a collision model which takes the various collision properties of dust and ice into account. We study pebbles with a compact size of $1\,\mathrm{cm}$ and vary the initial volume-filling factors, ϕ_0, ranging from 0.001 to 0.4. We consider mixed pebbles as having dust-to-ice ratios between 0.5 and 10. We investigate four typical cloud masses, M, between 2.6×10^{14} (very low) and $2.6 \times 10^{23}\,\mathrm{g}$ (high). Except for the very low-mass cloud ($M = 2.6 \times 10^{14}\,\mathrm{g}$), silica pebbles are always compressed during the collapse and attain volume-filling factors in the range from $\langle\phi\rangle_V \approx 0.22$ to 0.43, regardless of ϕ_0. Ice pebbles experience no significant compression in very low-mass clouds. They are compressed to values in the range $\langle\phi\rangle_V \approx 0.11$ to 0.17 in low- and intermediate-mass clouds ($M = 2.6 \times 10^{17} - 2.6 \times 10^{20}\,\mathrm{g}$); in high-mass clouds ($M = 2.6 \times 10^{23}\,\mathrm{g}$), ice pebbles end up with $\langle\phi\rangle_V \approx 0.23$. Mixed pebbles obtain filling factors in between the values for pure ice and pure silica. We find that the observed cometary density of $\sim 0.5\,\mathrm{g\,cm^{-3}}$ can only be explained by either intermediate- or high-mass clouds, regardless of ϕ_0, and also by either very low- or low-mass clouds for initially compact pebbles. In any case, the dust-to-ice ratio must be in the range of between $3 \leq \xi \leq 9$ to match the observed bulk properties of comet nuclei.

Download/Website: `http://arxiv.org/abs/1601.05726`

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Rossby Wave Instability and Long-Term Evolution of Dead Zones in Protoplanetary Discs

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Monthly Notices of the Royal Astronomical Society, in press (arXiv:1512.04450)

The physical mechanism of angular momentum transport in poorly ionized regions of protoplanetary discs, the dead zones (DZs), is not understood. The presence of a DZ naturally leads to conditions susceptible to the Rossby wave instability (RWI), which produces vortices and spiral density waves that may revive the DZ and be responsible for observed large-scale disc structures. We present a series of two-dimensional hydrodynamic simulations to investigate the role of the RWI in DZs, including its impact on the long-term evolution of the disc and its morphology. The nonlinear RWI can generate Reynolds stresses (effective α parameter) as large as $0.01 - 0.05$ in the DZ, helping to sustain quasi-steady accretion throughout the disc. It also produces novel disc morphologies, including azimuthal asymmetries with $m = 1, 2$, and atypical vortex shapes. The angular momentum transport strength and morphology are most sensitive to two parameters: the radial extent of the DZ and the disc viscosity. The largest Reynolds stresses are produced when the radial extent of the DZ is less than its distance to the central star. Such narrow DZs lead to a single vortex or two coherent antipodal vortices in the quasi-steady state. The edges of wider DZs evolve separately, resulting in two independent vortices and reduced angular momentum transport efficiency. In either case, we find that, because of the Reynolds stresses generated by the nonlinear RWI, gravitational instability is unlikely to play a role in angular momentum transport across the DZ, unless the accretion rate is sufficiently high.

Download/Website: `http://arxiv.org/abs/1512.04450`

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The formation efficiency of close-in planets via Lidov-Kozai migration: analytic calculations

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Submitted to MNRAS, (arXiv:1601.05814)

Lidov-Kozai oscillations of planets in stellar binaries, combined with tidal dissipation, can lead to the formation of hot Jupiters (HJs) or tidal disruption of planets. Recent population synthesis studies have found that the fraction of systems resulting in HJs ($\mathcal{F}_{\rm HJ}$) depends strongly on the planet mass, host stellar type and tidal dissipation strength, while the total migration fraction $\mathcal{F}_{\rm mig} = \mathcal{F}_{\rm HJ} + \mathcal{F}_{\rm dis}$ (including both HJ formation and tidal disruption) exhibits much weaker dependence. We present an analytical method for calculating $\mathcal{F}_{\rm HJ}$ and $\mathcal{F}_{\rm mig}$ in the Lidov-Kozai migration scenario. The key ingredient of our method is to determine the critical initial planet-binary inclination angle that drives the planet to reach sufficiently large eccentricity for efficient tidal dissipation or disruption. This calculation includes the effects of octupole potential and short-range forces on the planet. Our analytical method reproduces the resulting planet migration/disruption fractions from population synthesis, and can be easily implemented for various planet, stellar/companion types, and for different distributions of initial planetary semi-major axes, binary separations and eccentricities. We extend our calculations to planets in the super-Earth mass range and discuss the conditions for such planets to survive Lidov-Kozai migration and form close-in rocky planets.

Download/Website: `http://arxiv.org/abs/1601.05814/`

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The Size Distribution of Inhabited Planets

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MNRAS Letters, published (2016MNRAS.456L..59S)

Earth-like planets are expected to provide the greatest opportunity for the detection of life beyond the Solar System. However our planet cannot be considered a fair sample, especially if intelligent life exists elsewhere. Just as a person's country of origin is a biased sample among countries, so too their planet of origin may be a biased sample among planets. The magnitude of this effect can be substantial: over 98% of the world's population live in a country larger than the median. In the context of a simple model where the mean population density is invariant to planet size, we infer that a given inhabited planet (such as our nearest neighbour) has a radius $r < 1.2r_\oplus$ (95% confidence bound). We show that this result is likely to hold not only for planets hosting advanced life, but also for those which harbour primitive life forms.
Further inferences may be drawn for any variable which influences population size. For example, since population density is widely observed to decline with increasing body mass, we conclude that most intelligent species are expected to exceed 300 kg.

Download/Website: `http://www.thebigalientheory.com`

Contact: `fergus2@icc.ub.edu`

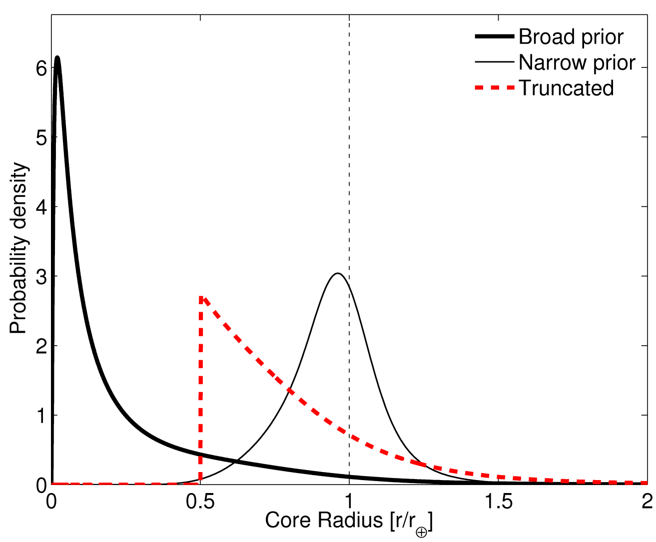

Figure 5: (Simpson) Constraints on the radius r of an inhabited planet, based on a constant mean population density, and after marginalising over the mean and variance of the lognormal distribution. The thick and thin solid lines correspond to the higher and lower set of σ values. The dashed line illustrates the effect of imposing the condition $r > 0.5r_\oplus$, as may be the requirement for an atmospheric water cycle. A common feature is the manner in which super-Earths are disfavoured, regardless of the choice of prior. Broad and narrow lines yield 95% confidence bounds of $r < 0.9r_\oplus$ and $r < 1.2r_\oplus$ respectively, while the dashed line sets $r < 1.4r_\oplus$.

Distinguishing a hypothetical abiotic planet's moon system from a single inhabited planet

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Astrophysical Journal Letters, published (doi:10.3847/2041-8205/817/2/L15)

It has recently been suggested that an exomoon with a CH4 atmosphere, orbiting an abiotic Earth-mass planet with an O2-rich atmosphere, can produce a false positive biosignature at a lowCmoderate spectral resolution (R = /¡=2000). If this were true, inferring the presence of life on exoplanets will be beyond our reach in the next several decades. Here we use a line-by-line radiative transfer model to compute the relevant reflection spectrum between 1 and 3.3 m. We show that it is possible to separate the combined spectra of such planetCmoon systems from an inhabited planet by multiple-band NIR observations. We suggest that future observations near the 2.3 m CH4 absorption band at a resolution of 100 and an SNR of 10 or more may be a good way to distinguish an abiotic planetCmoon system from a inhabited single planet.

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Apodization in high-contrast long-slit spectroscopy II. Concept validation and first on-sky results with VLT/SPHERE

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Astronomy & Astrophysics, in press (arXiv:1512.05378)

Spectral characterization of young, giant exoplanets detected by direct imaging is one of the tasks of the new generation of high-contrast imagers. For this purpose, the VLT/SPHERE instrument includes a unique long-slit spectroscopy (LSS) mode coupled with Lyot coronagraphy in its infrared dual-band imager and spectrograph (IRDIS). The performance of this mode is intrinsically limited by the use of a non-optimal coronagraph, but in a previous work we demonstrated that it could be significantly improved at small inner-working angles using the stop-less Lyot coronagraph (SLLC). We now present the development, testing, and validation of the first SLLC prototype for VLT/SPHERE. Based on the transmission profile previously proposed, the prototype was manufactured using microdots technology and was installed inside the instrument in 2014. The transmission measurements agree well with the specifications, except in the very low transmissions (¡5% in amplitude). The performance of the SLLC is tested in both imaging and spectroscopy using data acquired on the internal source. In imaging, we obtain a raw contrast gain of a factor 10 at 0.3" and 5 at 0.5" with the SLLC. Using data acquired with a focal-plane mask, we also demonstrate that no Lyot stop is required to reach the full performance, which validates the SLLC concept. Comparison with a realistic simulation model shows that we are currently limited by the internal phase aberrations of SPHERE. In spectroscopy, we obtain a gain of $\sim$1 mag in a limited range of angular separations. Simulations show that although the main limitation comes from phase errors, the performance in the non-SLLC case is very close to the ultimate limit of the LSS mode. Finally, we obtain the very first on-sky data with the SLLC, which appear extremely promising for the future scientific exploitation of an apodized LSS mode in SPHERE.

Download/Website: `http://arxiv.org/abs/1512.05378`

Contact: `arthur.vigan@lam.fr`

3 Non-refereed papers

A pragmatic Bayesian perspective on correlation analysis: The exoplanetary gravity - stellar activity case

P. Figueira[1], *J. P. Faria*[1,2], *V. Zh. Adibekyan*[1], *M. Oshagh*[1,3], *N. C. Santos*[1,2]
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[3] Institut für Astrophysik, Georg-August-Universität, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

Accepted for publication in the peer-reviewed proceedings of the conference "Habitability in the Universe: From the Early Earth to Exoplanets", arXiv:1601.05107

We apply the Bayesian framework to assess the presence of a correlation between two quantities. To do so, we estimate the probability distribution of the parameter of interest, ρ, characterizing the strength of the correlation. We provide an implementation of these ideas and concepts using `python` programming language and the `pyMC` module in a very short ($\sim$ 130 lines of code, heavily commented) and user-friendly program.
We used this tool to assess the presence and properties of the correlation between planetary surface gravity and stellar host activity level as measured by the $\log(R'_{\mathrm{HK}})$ indicator. The results of the Bayesian analysis are qualitatively similar to those obtained via p-value analysis, and support the presence of a correlation in the data. The results are more robust in their derivation and more informative, revealing interesting features such as asymmetric posterior distributions or markedly different credible intervals, and allowing for a deeper exploration.
We encourage the reader interested in this kind of problem to apply our code to his/her own scientific problems. The full understanding of what the Bayesian framework is can only be gained through the insight that comes by handling priors, assessing the convergence of Monte Carlo runs, and a multitude of other practical problems. We hope to contribute so that Bayesian analysis becomes a tool in the toolkit of researchers, and they understand by experience its advantages and limitations.

Download/Website: `http://arxiv.org/abs/1601.05107`

Contact: `pedro.figueira@astro.up.pt`

Post-main-sequence planetary system evolution

Dimitri Veras
Department of Physics, University of Warwick, Coventry CV4 7AL, UK

Invited Review Article for Royal Society Open Science, in press (arXiv:1601.05419)

The fates of planetary systems provide unassailable insights into their formation and represent rich cross-disciplinary dynamical laboratories. Mounting observations of post-main-sequence planetary systems necessitate a complementary level of theoretical scrutiny. Here, I review the diverse dynamical processes which affect planets, asteroids, comets and pebbles as their parent stars evolve into giant branch, white dwarf and neutron stars. This reference provides a foundation for the interpretation and modelling of currently known systems and upcoming discoveries.

Download/Website: `http://arxiv.org/abs/1601.05419`

Contact: `d.veras@warwick.ac.uk`

4 Conference announcements

Planetary Formation session at COSPAR 2016

Diego Turrini[1], *Sho Sasaki*[2]
[1] INAF-IAPS, Via Fosso del Cavaliere 100, 00133 Rome, Italy
[2] Osaka University, 1-2-11-801 Sakuranocho, 560-0054 Toyonaka, Japan

Istanbul, Turkey, 30 July – 7 August 2016

The Committee on Space Research (COSPAR) will hold its 41st Scientific Assembly in Istanbul, Turkey, on 30 July - 7 August 2016. The COSPAR Scientific Assemblies supply a forum to all scientists involved in space research for the presentation of their latest scientific results, the exchange of knowledge and also the discussion of space research problems. Together with the now traditional session devoted to exoplanetary studies, event E1.21 ”Exoplanets”, COSPAR 2016 will also hold for the first time a session specifically dedicated to the formation and the evolution of planets and planetary systems, event B0.5 ”Planetary Formation: From Dust to Giant Exoplanets”. This event, currently planned to take place over two half-day sessions, is jointly organized by Commission B ”Space Studies of the Earth-Moon System, Planets, and Small Bodies of the Solar System” and Commission E ”Research in Astrophysics from Space”.

Scientific rationale of event B0.5 ”Planetary Formation: From Dust to Giant Exoplanets”:

Our understanding of planetary formation as derived from the Solar System, for decades the only known example of a planetary system, has been challenged over the last twenty years by the rich diversity of discovered extrasolar planets. The Solar System, however, still represents a unique source of detailed information on the processes shaping the formation and subsequent evolution of planets, both individually and as a whole. Theoretical works on the formation and early dynamical evolution of planetary systems has helped to bridge the gap between the story told by the Solar System and that coming from the extrasolar planets, but the ever growing body of data supplied by space missions and ground-based facilities promises new challenges in the coming years. The aim of COSPAR 2016 event B0.5 ”Planetary Formation: From Dust to Giant Exoplanets” is to offer to all involved communities a common space for discussing new theoretical, observational and laboratory results about the formation and evolution of planetary systems and of their formation environments, the protoplanetary disks.

Abstract submission deadline: 2016 February 12

Scientific Organizing Committee:

Diego Turrini (Main Scientific Organizer, INAF-IAPS, Italy), Sho Sasaki (Deputy Organizer, Osaka University, Japan), Francesca Altieri (INAF-IAPS, Italy), Gennaro D’Angelo (SETI Institute, USA), Francesco Marzari (University of Padova, Italy), Motohide Tamura (National Astronomical Observatory, Japan), Mark Wyatt (University of Cambridge, UK), Hajime Yano (JAXA, Japan).

Download/Website: `https://www.cospar-assembly.org/`

Contact: `diego.turrini@iaps.inaf.it, sasakisho@ess.sci.osaka-u.ac.jp`

2016 Sagan Summer Workshop: Is There a Planet in My Data?

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

Pasadena, CA, July 18-22, 2016

The 2016 Sagan Summer Workshop will focus on data analysis techniques used to find planets in various types of data. In particular, leaders in the field will discuss Monte Carlo Markov Chain (MCMC) and Bayesian inference relevant to transit analysis and spectral retrieval as well as RV analysis. Image processing techniques such as Principal Component Analysis (PCA), LOCI, and KLIP methods will also be discussed. In addition, for each of these areas, noise sources and mitigation strategies will be highlighted. Attendees will participate in hands-on group projects and will have the opportunity to present their own work through short presentations (research POPs) and posters.

Important Dates

- February 5, 2016: On-line Registration and Financial Support application period open
- March 11, 2016: Financial Support application due
- March 25, 2016: Financial Support decisions announced via email
- April 7, 2016: POP/Poster/Talk submission period open
- July 8, 2016: On-line Registration closed; final agenda posted
- July 18-22, 2016: Sagan Exoplanet Summer Workshop

Download/Website: `http://nexsci.caltech.edu/workshop/2016`
Contact: `sagan_workshop@ipac.caltech.edu`

5 Jobs and Positions

PhD position on Venus Clouds & Climate

Dr. D.M. Stam

Delft, The Netherlands, preferably before Summer 2016

Within this 4–year project, Venus' clouds and hazes will be studied using flux and polarization observations by instruments aboard ESA's Venus Express mission. Knowing the properties of Venus' clouds and hazes is crucial for understanding Venus' climate and climates of terrestrial (exo)planets. The analysis will be done with a radiative transfer code covering both the sunlight that is reflected and the thermal radiation that is emitted by Venus. The code will also be applied to terrestrial–like exoplanets. This project involves collaborations with scientists in France, Germany and the UK, as well as with astronomers in Leiden.

The ideal candidate has an MSc in physics, astronomy, planetary sciences or related fields, solid numerical modelling skills, and an aptitude to code development. Experience with analyzing observations would be an asset, as would be knowledge on atmospheric dynamics and/or chemistry and radiative transfer.
For info on the PhD-program at TU Delft and Aerospace Engineering (AE), see:

Download/Website: `graduateschool.tudelft.nl`

Applicants should send a CV, a letter of motivation, and the contact details of two referees to Daphne Stam before February 26th, 2016.

Contact: `d.m.stam@tudelft.nl`

6 As seen on astro-ph

The following list contains all the entries relating to exoplanets that we spotted on astro-ph during December 2015 and January 2016. If you see any that we missed, please let us know and we'll include them in the next issue.

December 2015

astro-ph/1512.00009: **The Initial Mass and Size Distribution of Planetesimals. I. The Effect of Resolution, Gravity, and Initial Conditions in Streaming Instability Calculations** by *Jacob B. Simon, et al.*

astro-ph/1512.00134: **The First Cold Neptune Analog Exoplanet: MOA-2013-BLG-605Lb** by *T. Sumi, et al.*

astro-ph/1512.00151: **A Characteristic Transmission Spectrum dominated by H_2O applies to the majority of HST/WFC3 exoplanet observations** by *Aishwarya R. Iyer, et al.*

astro-ph/1512.00189: **KOI-2939b: the largest and longest-period Kepler transiting circumbinary planet** by *Veselin B. Kostov, et al.*

astro-ph/1512.00417: **The Lick-Carnegie Exoplanet Survey: HD32963 – A New Jupiter Analog Orbiting a Sun-like Star** by *Dominick Rowan, et al.*

astro-ph/1512.00464: **Transit Timing Variation Measurements of WASP-12b and Qatar-1b: No Evidence for Additional Planets** by *Karen A. Collins, John F. Kielkopf, Keivan G. Stassun*

astro-ph/1512.00483: **Zodiacal Exoplanets In Time (ZEIT) I: A Neptune-sized planet orbiting an M4.5 dwarf in the Hyades Star Cluster** by *Andrew W. Mann, et al.*

astro-ph/1512.00502: **Is the Pale Blue Dot unique? Optimized photometric bands for identifying Earth-like exoplanets** by *Joshua Krissansen-Totton, et al.*

astro-ph/1512.00878: **Periodic Halpha variations in GL 581: Further evidence for an activity origin to GL 581d** by *Artie P. Hatzes*
astro-ph/1512.01273: **Variations on Debris Disks III. Collisional Cascades and Giant Impacts in the Terrestrial Zones of Solar-type Stars** by *Scott J. Kenyon, Benjamin C. Bromley*
astro-ph/1512.01329: **The Fourth Microlensing Planet Revisited** by *Philip Yock*
astro-ph/1512.01555: **Magnetospheres of hot Jupiters: hydrodynamic models & ultraviolet absorption** by *R.D. Alexander, et al.*
astro-ph/1512.01747: **Optical-infrared flares and radio afterglows from the tidal disruption of Jovian planets by their host star** by *Ryo Yamazaki, Kimitake Hayasaki, Abraham Loeb*
astro-ph/1512.01865: **Peering into the Giant Planet Forming Region of the TW Hydrae Disk with the Gemini Planet Imager** by *Valerie A. Rapson, et al.*
astro-ph/1512.02003: **Robust TTV Mass Measurements: Ten Kepler Exoplanets between 3 and 8 Earth Masses with Diverse Densities and Incident Fluxes** by *Daniel Jontof-Hutter, et al.*
astro-ph/1512.02141: **The Evolution of Planet-Disk Systems That Are Mildly Inclined to the Orbit of a Binary Companion** by *Stephen H. Lubow, Rebecca G. Martin*
astro-ph/1512.02234: **Rapid radiative clearing of protoplanetary discs** by *Thomas J. Haworth, Cathie J. Clarke, James E. Owen*
astro-ph/1512.02308: **A Multiple Scattering Polarized Radiative Transfer Model: Application to HD 189733b** by *Pushkar Kopparla, et al.*
astro-ph/1512.02388: **Optical SETI Observations of the Anomalous Star KIC 8462852** by *Marlin Schuetz, et al.*
astro-ph/1512.02414: **On the water delivery to terrestrial embryos by ice pebble accretion** by *Takao Sato, Satoshi Okuzumi, Shigeru Ida*
astro-ph/1512.02538: **Turbulent Thermal Diffusion: A Way to Concentrate Dust in Protoplanetary Discs** by *Alexander Hubbard*
astro-ph/1512.02559: **Planet Hunters. VIII. Characterization of 41 Long-Period Exoplanet Candidates from Kepler Archival Data** by *Ji Wang, et al.*
astro-ph/1512.02649: **There might be giants: unseen Jupiter-mass planets as sculptors of tightly-packed planetary systems** by *T.O. Hands, R.D. Alexander*
astro-ph/1512.02706: **Discovery of Rotational Modulations in the Planetary-Mass Companion 2M1207b: Intermediate Rotation Period and Heterogeneous Clouds in a Low Gravity Atmosphere** by *Yifan Zhou, et al.*
astro-ph/1512.02852: **Formation of Terrestrial Planets in Disks with Different Surface Density Profiles** by *Nader Haghighipour, Othon C. Winter*
astro-ph/1512.02965: **Two New Long-Period Giant Planets from the McDonald Observatory Planet Search and Two Stars with Long-Period Radial Velocity Signals Related to Stellar Activity Cycles** by *Michael Endl, et al.*
astro-ph/1512.02998: **Transiting the Sun II: The impact of stellar activity on Lyman-α transits** by *J Llama, E. L. Shkolnik*
astro-ph/1512.03070: **Hot Jupiter Breezes: Time-dependent Outflows from Extrasolar Planets** by *James E. Owen, Fred C. Adams*
astro-ph/1512.03422: **MOA 2011-BLG-028Lb: a Neptune-mass Microlensing Planet in the Galactic Bulge** by *J. Skowron, et al.*
astro-ph/1512.03428: **Orbital Architectures of Planet-Hosting Binaries: I. Forming Five Small Planets in the Truncated Disk of Kepler-444A** by *Trent J. Dupuy, et al.*
astro-ph/1512.03445: **The Kepler Dichotomy in Planetary Disks: Linking Kepler Observables to Simulations of Late-Stage Planet Formation** by *John Moriarty, Sarah Ballard*
astro-ph/1512.03535: **The Inner Debris Structure in the Fomalhaut Planetary System** by *Kate Y. L. Su et al.*
astro-ph/1512.03585: **Secular Dynamics of S-type Planetary Orbits in Binary Star Systems: Applicability**

Domains of First- and Second-Order Theories by *Eduardo Andrade-Ines, et al.*
astro-ph/1512.03596: **Orbital fitting of imaged planetary companions with high eccentricities and unbound orbits – Application to Fomalhaut b and PZ Telescopii B** by *Hervé Beust, et al.*
astro-ph/1512.03722: **Single Transit Candidates from K2: Detection and Period Estimation** by *H.P. Osborn, et al.*
astro-ph/1512.03855: **Probable Spin-Orbit Aligned Super-Earth Planet Candidate KOI-2138.01** by *Jason W. Barnes, et al.*
astro-ph/1512.03945: **Dust Coagulation in the Vicinity of a Gap-Opening Jupiter-Mass Planet** by *Augusto Carballido, Lorin S. Matthews, Truell W. Hyde*
astro-ph/1512.04341: **A continuum from clear to cloudy hot-Jupiter exoplanets without primordial water depletion** by *David K. Sing, et al.*
astro-ph/1512.04437: **They are Small Worlds After All: Revised Properties of Kepler M Dwarf Stars and their Planets** by *E. Gaidos, et al.*
astro-ph/1512.04450: **Rossby Wave Instability and Long-Term Evolution of Dead Zones in Protoplanetary Discs** by *Ryan Miranda, Dong Lai, Heloise Meheut*
astro-ph/1512.04491: **Analysis of the instability due to gas-dust friction in protoplanetary discs** by *Mohsen Shadmehri*
astro-ph/1512.04540: **MagAO Imaging of Long-period Objects (MILO). I. A Benchmark M Dwarf Companion Exciting a Massive Planet around the Sun-like Star HD 7449** by *Timothy J. Rodigas, et al.*
astro-ph/1512.04622: **Disk Dispersal: Theoretical Understanding and Observational Constraints** by *U. Gorti, R.Liseau, Zs. Sandor, C. Clarke*
astro-ph/1512.04908: **Inferring heat recirculation and albedo for exoplanetary atmospheres: Comparing optical phase curves and secondary eclipse data** by *P. von Paris, et al.*
astro-ph/1512.04996: **Planetesimals in Debris Disks** by *Andrew N. Youdin, George H. Rieke*
astro-ph/1512.05154: **Three planets orbiting Wolf 1061** by *D.J. Wright, et al.*
astro-ph/1512.05175: **Rotation and winds of exoplanet HD 189733 b measured with high-dispersion transmission spectroscopy** by *M. Brogi, et al.*
astro-ph/1512.05440: **ALMA Observations of a Gap and a Ring in the Protoplanetary Disk around TW Hya** by *Hideko Nomura, et al.*
astro-ph/1512.05549: **High-precision photometry by telescope defocussing. VIII. WASP-22, WASP-41, WASP-42 and WASP-55** by *John Southworth, et al.*
astro-ph/1512.05710: **Dynamical Constraints on Outer Planets in Super-Earth Systems** by *Matthew J. Read, Mark C. Wyatt*
astro-ph/1512.06149: **Planetary Candidates Observed by Kepler. VII. The First Fully Uniform Catalog Based on The Entire 48 Month Dataset (Q1-Q17 DR24)** by *Jeffrey L. Coughlin, et al.*
astro-ph/1512.06433: **Solution of newly observed transit of the exoplanet HAT-P-24b: no TTV and TDV signals** by *Diana Kjurkchieva, Dinko Dimitrov, Sunay Ibryamov*
astro-ph/1512.06470: **The influence of the Extreme Ultraviolet spectral energy distribution on the structure and composition of the upper atmosphere of exoplanets** by *J.H.Guo, Lotfi Ben-Jaffel*
astro-ph/1512.06698: **FORS2 observes a multi-epoch transmission spectrum of the hot Saturn-mass exoplanet WASP-49b** by *M. Lendl, et al.*
astro-ph/1512.06968: **From Planetesimals to Planets in Turbulent Protoplanetary Disks I. Onset of Runaway Growth** by *Hiroshi Kobayashi, Hidekazu Tanaka, Satoshi Okuzumi*
astro-ph/1512.07197: **Measurements of water surface snow lines in classical protoplanetary disks** by *Sandra M. Blevins, et al.*
astro-ph/1512.07259: **Pan-Planets: Searching for hot Jupiters around cool dwarfs** by *C. Obermeier, et al.*
astro-ph/1512.07316: **The Pan-Pacific Planet Search. IV. Two super-Jupiters in a 3:5 resonance orbiting the giant star HD33844** by *Robert A. Wittenmyer, et al.*
astro-ph/1512.07925: **Super-Earth Atmospheres: Self-Consistent Gas Accretion and Retention** by *Sivan*

Ginzburg, Hilke E. Schlichting, Re'em Sari

astro-ph/1512.08827: **Mass-Radius Relation for Rocky Planets based on PREM** by *Li Zeng, Dimitar Sasselov, Stein Jacobsen*

astro-ph/1512.08875: **Asteroid flux towards circumprimary habitable zones in binary star systems: II. Dynamics** by *D. Bancelin, E. Pilat-Lohinger, A. Bazso*

astro-ph/1512.09142: **Campaign 9 of the $K2$ Mission: Observational Parameters, Scientific Drivers, and Community Involvement for a Simultaneous Space- and Ground-based Microlensing Survey** by *Calen B. Henderson, et al.*

astro-ph/1512.09150: **High-speed photometry of the disintegrating planetesimals at WD1145+017: evidence for rapid dynamical evolution** by *B.T. Gaensicke, et al.*

astro-ph/1512.09342: **3.6 and 4.5 m** *Spitzer* **Phase Curves of the Highly-Irradiated Hot Jupiters WASP-19b and HAT-P-7b** by *Ian Wong, et al.*

January 2016

astro-ph/1601.00008 : **Exoplanet Exploration Program Analysis Group (ExoPAG) Report to Paul Hertz Regarding Large Mission Concepts to Study for the 2020 Decadal Survey** by *B. Scott Gaudi, et al.*

astro-ph/1601.00069 : **Atmospheric Circulation of Hot Jupiters: Dayside-Nightside Temperature Differences** by *Thaddeus D. Komacek, Adam P. Showman*

astro-ph/1601.00358 : **Modeling Dust Emission of HL Tau Disk Based on Planet-Disk Interactions** by *Sheng Jin, et al.*

astro-ph/1601.00452 : **Thermal mass loss of protoplanetary cores with hydrogen-dominated atmospheres: The influences of ionization and orbital distance** by *N. V. Erkaev, et al.*

astro-ph/1601.00505 : **A symmetric inner cavity in the HD 141569A transitional disk** by *J. Mazoyer, et al.*

astro-ph/1601.00789 : **Exomoon Climate Models with the Carbonate-Silicate Cycle and Viscoelastic Tidal Heating** by *Duncan Forgan, Vera Dobos*

astro-ph/1601.00821 : **Molecular formation along the atmospheric mass loss of HD 209458 b and similar Hot Jupiters** by *Rafael Pinotti, Heloisa Maria Boechat-Roberty*

astro-ph/1601.01353 : **Point Source Polarimetry with the Gemini Planet Imager: Sensitivity Characterization with T5.5 Dwarf Companion HD 19467 B** by *Rebecca Jensen-Clem, et al.*

astro-ph/1601.01699 : **Spitzer Observations of OGLE-2015-BLG-1212 Reveal a New Path to Breaking Strong Microlens Degeneracies** by *V. Bozza, et al.*

astro-ph/1601.01846 : **Revisiting the microlensing event OGLE 2012-BLG-0026: A solar mass star with two cold giant planets** by *J.P. Beaulieu, et al.*

astro-ph/1601.02054 : **Modelling the Rossiter-McLaughlin Effect: Impact of the Convective Centre-to-Limb Variations in the Stellar Photosphere** by *H. M. Cegla, et al.*

astro-ph/1601.02058 : **Photo-ionization of planetary winds: case study HD209458b** by *E. M. Schneiter, et al.*

astro-ph/1601.02110 : **Orbital Dynamics of Exoplanetary Systems Kepler-62, HD 200964 and Kepler-11** by *Rajib Mia, Badam Singh Kushvah*

astro-ph/1601.02292 : **Exoplanet Transits Registered at the Universidad de Monterrey Observatory. Part I: HAT-P-12b, HAT-P-13b, HAT-P-16b, HAT-P-23b and WASP-10b** by *Pedro V. Sada, Felipe G. Ramón-Fox*

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