ExoPlanet News
An Electronic Newsletter

No. 70, June 2nd, 2014

Editor: Andrew J. Norton
Department of Physical Sciences, The Open University, Milton Keynes MK7 6AA, UK
exoplanet@open.ac.uk, http://exoplanet.open.ac.uk/

Contents

1 Editorial

Welcome to the 70th edition of ExoPlanet News. This month's edition is a little shorter than usual, but I'm sure there is plenty here to keep people interested until the next edition. As I noted last month, if conference / meeting organisers would like to send me brief reports of their recent meetings, I'd be pleased to include them in future editions.

The next edition of the newsletter will be sent out at the end of June 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

Exoplanet atmospheres with EChO: spectral retrievals using EChOSim

J. K. Barstow[1]*, N. Bowles*[1]*, S. Aigrain*[1]*, L. N. Fletcher*[1]*, P. G. J. Irwin*[1]*, R. Varley*[2]*, E. Pascale*[3]
[1] Department of Physics, University of Oxford, Oxford, UK
[2] Department of Physics, University College London, London, UK
[3] School of Physics and Astronomy, University of Cardiff, Cardiff, UK

Experimental Astronomy, in press (arXiv:1405.3579)

We demonstrate the effectiveness of the Exoplanet Characterisation Observatory mission concept for constraining the atmospheric properties of hot and warm gas giants and super Earths. Synthetic primary and secondary transit spectra for a range of planets are passed through EChOSim (Waldmann & Pascale 2014) to obtain the expected level of noise for different observational scenarios; these are then used as inputs for the NEMESIS atmospheric retrieval code and the retrieved atmospheric properties (temperature structure, composition and cloud properties) compared with the known input values, following the method of Barstow et al. (2013a). To correctly retrieve the temperature structure and composition of the atmosphere to within 2σ, we find that we require: a single transit or eclipse of a hot Jupiter orbiting a sun-like (G2) star at 35 pc to constrain the terminator and dayside atmospheres; 20 transits or eclipses of a warm Jupiter orbiting a similar star; 10 transits/eclipses of a hot Neptune orbiting an M dwarf at 6 pc; and 30 transits or eclipses of a GJ1214b-like planet.

Download/Website: `http://uk.arxiv.org/abs/1405.3579`

Contact: `jo.barstow@astro.ox.ac.uk`

Compact planetary systems perturbed by an inclined companion: I. Vectorial representation of the secular model

G. Boué[1,2]*, D. Fabrycky*[1]

[1] Department of Astronomy and Astrophysics, University of Chicago, 5640 South Ellis Avenue, Chicago, IL 60637, USA
[2] Astronomie et Systèmes Dynamiques, IMCCE-CNRS, UMR 8028, Observatoire de Paris, UPMC, 77 Av. Denfert-Rochereau, 75014 Paris, France

The Astrophysical Journal, in press (arXiv:1405.7632)

The non-resonant secular dynamics of compact planetary systems are modeled by a perturbing function which is usually expanded in eccentricity and *absolute* inclination with respect to the invariant plane. Here, the expressions are given in a vectorial form which naturally leads to an expansion in eccentricity and *mutual* inclination. The two approaches are equivalent in most cases, but the vectorial one is specially designed for those where a quasi-coplanar system tilts as a whole by a large amount. Moreover, the vectorial expressions of the Hamiltonian and of the equations of motion are slightly simpler than those given in terms of the usual elliptical elements. We also provide the secular perturbing function in vectorial form expanded in semimajor axis ratio allowing for arbitrary eccentricities and inclinations. The interaction between the equatorial bulge of a central star and its planets is also provided, as is the relativistic periapse precession of any planet induced by the central star. We illustrate the use of this representation for following the secular oscillations of the terrestrial planets of the solar system, and for Kozai cycles as may take place in exoplanetary systems.

Download/Website: `http://arxiv.org/abs/1405.7632`

Contact: `boue@imcce.fr`

Compact planetary systems perturbed by an inclined companion: II. Stellar spin-orbit evolution

G. Boué[1,2]*, D. Fabrycky*[1]

[1] Department of Astronomy and Astrophysics, University of Chicago, 5640 South Ellis Avenue, Chicago, IL 60637, USA
[2] Astronomie et Systèmes Dynamiques, IMCCE-CNRS, UMR 8028, Observatoire de Paris, UPMC, 77 Av. Denfert-Rochereau, 75014 Paris, France

The Astrophysical Journal, in press (arXiv:1405.7636)

The stellar spin orientation relative to the orbital planes of multiplanet systems are becoming accessible to observations. Here, we analyze and classify different types of spin-orbit evolution in compact multiplanet systems perturbed by an inclined outer companion. Our study is based on classical secular theory, using a vectorial approach developed in a separate paper. When planet-planet perturbations are truncated at the second order in eccentricity and mutual inclination, and the planet-companion perturbations are developed at the quadrupole order, the problem becomes integrable. The motion is composed of a uniform precession of the whole system around the total angular momentum, and in the rotating frame, the evolution is periodic. Here, we focus on the relative motion associated to the oscillations of the inclination between the planet system and the outer orbit, and of the obliquities of the star with respect to the two orbital planes. The solution is obtained using a powerful geometric method. With this technique, we identify four different regimes characterized by the nutation amplitude of the stellar spin-axis relative to the orbital plane of the planets. In particular, the obliquity of the star reaches its maximum when the system is in the Cassini regime where planets have more angular momentum than the star, and where the precession rate of the star is similar to that of the planets induced by the companion. In that case, spin-orbit oscillations exceed twice the inclination between the planets and the companion. Even if mutual inclination is only $\simeq 20^\circ$, this resonant case can cause the spin-orbit angle to oscillate between perfectly aligned and retrograde values.

Download/Website: `http://arxiv.org/abs/1405.7636`

Contact: `boue@imcce.fr`

Tidally distorted exoplanets : density corrections for short-period hot-Jupiters based solely on observable parameters

J. R. Burton[1], *C. A. Watson*[1], *A. Fitzsimmons*[1], *D. Pollacco*[2], *V. Moulds*[1], *S. P. Littlefair*[3], *P. J. Wheatley*[2]

[1] Astrophysics Research Centre, Queen's University Belfast, Belfast, BT7 1NN, UK
[2] Department of Physics and Astronomy, University of Warwick, Coventry, CV4 7AL, UK
[3] Department of Physics and Astronomy, University of Sheffield, Sheffield, S3 7RH, UK

The Astrophysical Journal, accepted (arXiv:1405.1839)

The close proximity of short period hot-Jupiters to their parent star means they are subject to extreme tidal forces. This has a profound effect on their structure and, as a result, density measurements that assume that the planet is spherical can be incorrect. We have simulated the tidally distorted surface for 34 known short period hot-Jupiters, assuming surfaces of constant gravitational equipotential for the planet, and the resulting densities have been calculated based only on observed parameters of the exoplanet systems. Comparing these results to the density values assuming the planets are spherical shows that there is an appreciable change in the measured density for planets with very short periods (typically less than two days). For one of the shortest-period systems, WASP-19b, we determine a decrease in bulk density of 12% from the spherical case and, for the majority of systems in this study, this value is in the range of 1-5%. On the other-hand, we also find cases where the distortion is negligible (relative to the measurement errors on the planetary parameters) even in the cases of some very short period systems, depending on the mass ratio and planetary radius. For high-density gas-planets requiring apparently anomalously large core masses, density corrections due to tidal deformation could become important for the shortest-period systems.

Download/Website: `http://arxiv.org/pdf/1405.1839v1.pdf`

Contact: `jburton04@qub.ac.uk`

TTVFast: An efficient and accurate code for transit timing inversion problems

K. M. Deck[1], *E. Agol*[2], *M. J. Holman*[3], *D. Nesvorný*[4]

[1] Department of Physics and Kavli Institute for Astrophysics and Space Research, MIT, 77 Massachusetts Ave., Cambridge, MA 02139
[2] Department of Astronomy, Box 351580, University of Washington, Seattle, WA 98195
[3] Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA 02138
[4] Southwest Research Institute, Department of Space Studies, 1050 Walnut St., Suite 400, Boulder, Colorado 80302

The Astrophysical Journal, published (2014ApJ...787..132D)

Transit timing variations (TTVs) have proven to be a powerful technique for confirming *Kepler* planet candidates, for detecting non-transiting planets, and for constraining the masses and orbital elements of multi-planet systems. These TTV applications often require the numerical integration of orbits for computation of transit times (as well as impact parameters and durations); frequently tens of millions to billions of simulations are required when running statistical analyses of the planetary system properties. We have created a fast code for transit timing computation, TTVFast, which uses a symplectic integrator with a Keplerian interpolator for the calculation of transit times (Nesvorný et al. 2013). The speed comes at the expense of accuracy in the calculated times, but the accuracy lost is largely unnecessary, as transit times do not need to be calculated to accuracies significantly smaller than the measurement uncertainties on the times. The time step can be tuned to give sufficient precision for any particular system. We find a speed-up of at least an order of magnitude relative to dynamical integrations with high precision using a Bulirsch-Stoer integrator.

Download/Website: `http://adsabs.harvard.edu/abs/2014ApJ...787..132D`

Download/Website: `http://github.com/kdeck/TTVFast`

Contact: `kdeck@mit.edu`

The Albedos of *Kepler's* Close-in super-Earths

B.-O. Demory[1,2]

[1] Astrophysics Group, Cavendish Laboratory, J.J. Thomson Avenue, Cambridge CB3 0HE, UK.
[2] Department of Earth, Atmospheric and Planetary Sciences, MIT, 77 Massachusetts Ave., Cambridge, MA 02139, USA.

Astrophysical Journal Letters, in press (arXiv:1405.3798v1)

Exoplanet research focusing on the characterization of super-Earths is currently limited to those handful targets orbiting bright stars that are amenable to detailed study. This Letter proposes to look at alternative avenues to probe the surface and atmospheric properties of this category of planets, known to be ubiquitous in our galaxy. I conduct Markov Chain Monte Carlo lightcurve analyses for 97 *Kepler* close-in $R_P < 2.0 R_\oplus$ super-Earth candidates with the aim to detect their occultations at visible wavelengths. Brightness temperatures and geometric albedos in the *Kepler* bandpass are constrained for 27 super-Earth candidates. A hierarchical Bayesian modeling approach is then employed to characterize the population-level reflective properties of these close-in super-Earths. I find median geometric albedos A_g in the *Kepler* bandpass ranging between 0.16 and 0.30, once decontaminated from thermal emission. These super-Earths geometric albedos are statistically larger than for hot Jupiters, which have medians A_g ranging between 0.06 and 0.11. A subset of objects, including Kepler-10b, exhibit significantly larger albedos ($A_g >$ 0.4). I argue that a better understanding of the incidence of stellar irradiation on planetary surface and atmospheric processes is key to explain the diversity in albedos observed for close-in super-Earths.

Download/Website: `http://arxiv.org/pdf/1405.3798v1.pdf`

Contact: `bod21@cam.ac.uk`

Disc-protoplanet interaction Influence of circumprimary radiative discs on self-gravitating protoplanetary bodies in binary star systems

M. Gyergyovits[1], *S. Eggl*[1,2], *E. Pilat-Lohinger*[1,4], *Ch. Theis* [3]

[1] Institute for Astrophysics (IfA), University of Vienna, Türkenschanzstrasse 17, A-1180 Vienna
[2] IMCCE - Observatoire de Paris, 77 Avenue Denfert-Rochereau, F-75014 Paris
[3] Planetarium Mannheim, Wilhelm-Varnholt-Allee 1, 68165 Mannheim
[4] Department of Physics, University of Graz, Universitätsplatz 5, 8010 Graz

Astronomy & Astrophysics, in press (arXiv:1405.5056)

More than 60 planets have been discovered so far in systems that harbour two stars, some of which have binary semi-major axes as small as 20 au. It is well known that the formation of planets in such systems is strongly influenced by the stellar components, since the protoplanetary disc and the particles within are exposed to the gravitational influence of the binary. However, the question on how self-gravitating protoplanetary bodies affect the evolution of a radiative, circumprimary disc is still open.

aims: We present our 2D hydrodynamical GPU-CPU code and study the interaction of several thousands of self-gravitating particles with a viscous and radiative circumprimary disc within a binary star system. To our knowledge this program is the only one at the moment that is capable to handle this many particles and to calculate their influence on each other and on the disc.

methods: We performed hydrodynamical simulations of a circumstellar disc assuming the binary system to be coplanar. Our grid-based staggered mesh code relies on ideas from ZEUS-2D, where we implemented the FARGO algorithm and an additional energy equation for the radiative cooling according to opacity tables. To treat particle motion we used a parallelised version of the precise Bulirsch - Stoer algorithm. Four models in total where computed taking into account (i) only N-body interaction, (ii) N-body and disc interaction, (iii) the influence of computational parameters (especially smoothing) on N-body interaction, and (iv) the influence of a quiet low-eccentricity disc while running model (ii). The impact velocities where measured at two different time intervals and were compared.

results: We show that the combination of disc- and N-body self-gravity can have a significant influence on the orbit evolution of roughly Moon sized protoplanets.

conclusions: Not only gas drag can alter the orbit of particles, but the gravitational influence of the disc can accomplish this as well. The results depend strongly on the state of the disc (i.e. quiet or dynamically evolving) - according to encounter-probability distributions, planet formation can be strongly altered if there is a dynamically evolving gas disc - and also on the smoothing parameter.

Download/Website: `http://arxiv.org/abs/1405.5056`

Contact: `markus.gyergyovits@univie.ac.at`

Discovery of a Wide Planetary-mass Companion to the Young M3 Star GU Psc

M.-E. Naud[1], *É. Artigau*[1], *L. Malo*[1], *L. Albert*[1], *R. Doyon*[1], *D. Lafrenière*[1], *J. Gagné*[1], *D. Saumon*[2], *C. V. Morley*[3], *F. Allard*[4], *D. Homeier*[4], *C. A. Beichman*[5], *C. R.Gelino*[5,6], *A. Boucher*[6]

[1] Département de physique and Observatoire du Mont-Mégantic, Universitéde Montréal, Montréal H3C 3J7, Canada
[2] Los Alamos National Laboratory, Los Alamos, NM 87545, USA
[3] Department of Astronomy and Astrophysics, University of California, Santa Cruz, CA 95064, USA
[4] Centre de Recherche Astrophysique de Lyon, UMR 5574 CNRS, Université de Lyon, École Normale Supérieure de Lyon, 46 Allée d'Italie, F-69364 Lyon Cedex 07, France
[5] Infrared Processing and Analysis Center, MS 100-22, California Institute of Technology, Pasadena, CA 91125, USA
[6] NASA Exoplanet Science Institute, California Institute of Technology, 770 S. Wilson Ave., Pasadena, CA 91125, USA

The Astrophysical Journal, published (2014ApJ...787....5N/arXiv:1405.2932v2)

We present the discovery of a co-moving planetary-mass companion $\sim$42″ ($\sim$2000 AU) from a young M3 star, GU Psc, likely member of the young AB Doradus Moving Group (ABDMG). The companion was first identified via its distinctively red i-z color (> 3.5) through a survey made with Gemini-S/GMOS. Follow-up Canada–France–Hawaii Telescope/WIRCam near-infrared (NIR) imaging, Gemini-N/GNIRS NIR spectroscopy and *Wide-field Infrared Survey Explorer* photometry indicate a spectral type of T3.5 $\pm$ 1 and reveal signs of low gravity which we attribute to youth. Keck/Adaptive Optics NIR observations did not resolve the companion as a binary. A comparison with atmosphere models indicates $T_{\rm eff}$ = 1000–1100 K and $\log g$ = 4.5–5.0. Based on evolution models, this temperature corresponds to a mass of 9–13 $M_{\rm Jup}$ for the age of ABDMG (70–130 Myr). The relatively well-constrained age of this companion and its very large angular separation to its host star will allow its thorough characterization and will make it a valuable comparison for planetary-mass companions that will be uncovered by forthcoming planet-finder instruments such as Gemini Planet Imager and SPHERE.

Download/Website: `http://iopscience.iop.org/0004-637X/787/1/5/`

Download/Website: `http://adsabs.harvard.edu/abs/2014ApJ...787....5N`

Download/Website: `arXiv:1405.2932v2`

Download/Website: `https://sites.google.com/site/mbderg/montreal-spectral-library`

Contact: `naud@astro.umontreal.ca`

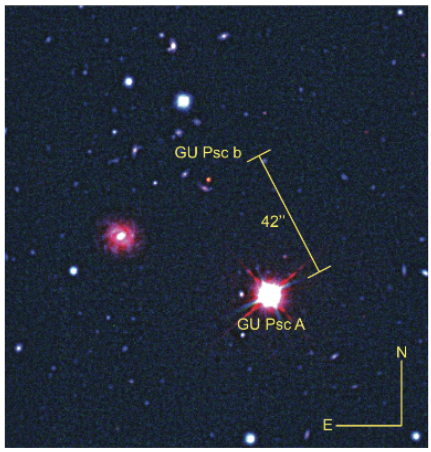

Figure 1: (Naud et al.) Composite Gemini-South/GMOS i (blue), z (green), and CFHT/WIRCam J (red) image of GU Psc and its companion.

Titan solar occultation observations reveal transit spectra of a hazy world

T. D. Robinson[1,2], *L. Maltagliati*[3], *M. S. Marley*[1], *J. F. Fortney*[4]

[1] NASA Ames Research Center, Moffett Field, CA 94035
[2] NASA Astrobiology Institute's Virtual Planetary Laboratory
[3] LESIA, Observatoire de Paris, CNRS, UPMC, Université Paris-Diderot, Meudon, France
[4] Department of Astronomy and Astrophysics, University of California, Santa Cruz, CA 95064

Proceedings of the National Academy of Sciences (PNAS), in press

High altitude clouds and hazes are integral to understanding exoplanet observations, and are proposed to explain observed featureless transit spectra. However, it is difficult to make inferences from these data because of the need to disentangle effects of gas absorption from haze extinction. Here, we turn to the quintessential hazy world—Titan—to clarify how high altitude hazes influence transit spectra. We use solar occultation observations of Titan's atmosphere from the Visual and Infrared Mapping Spectrometer (VIMS) aboard NASA's *Cassini* spacecraft to generate transit spectra. Data span 0.88–5 μm at a resolution of 12–18 nm, with uncertainties typically smaller than 1%. Our approach exploits symmetry between occultations and transits, producing transit radius spectra that inherently include the effects of haze multiple scattering, refraction, and gas absorption. We use a simple model of haze extinction to explore how Titan's haze affects its transit spectrum. Our spectra show strong methane absorption features, and weaker features due to other gases. Most importantly, the data demonstrate that high altitude hazes can severely limit the atmospheric depths probed by transit spectra, bounding observations to pressures smaller than 0.1–10 mbar, depending on wavelength. Unlike the usual assumption made when modeling and interpreting transit observations of potentially hazy worlds, the slope set by haze in our spectra is not flat, and creates a variation in transit height whose magnitude is comparable to those from the strongest gaseous absorption features. These findings have important consequences for interpreting future exoplanet observations, including those from NASA's *James Webb Space Telescope*.

Download/Website: `http://www.pnas.org/cgi/doi/10.1073/pnas.1403473111`

Contact: `tyler.d.robinson@nasa.gov`

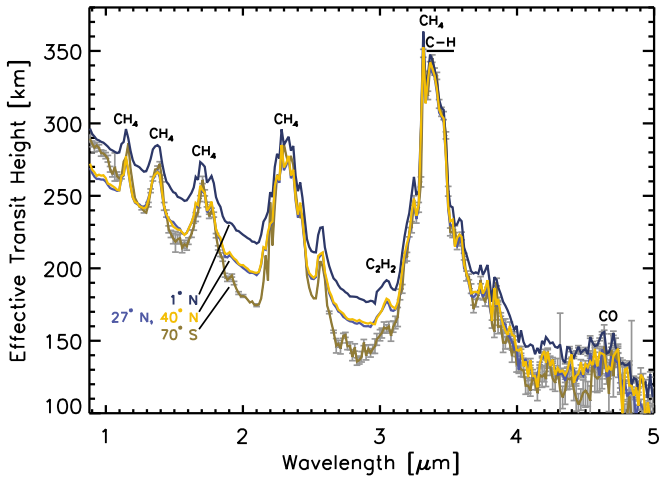

Figure 2: (Robinson et al.) Spectra of effective transit height, $z_{eff,\lambda}$, for four *Cassini*/VIMS occultation datasets. The transit depth signal is proportional to $(z_{eff,\lambda} + R_p)^2$, where R_p is the planetary radius (i.e., 2575 km for Titan). Key absorption features are labeled, and error bars are shown only where the 1-σ uncertainty is larger than 1%.

Revealing Asymmetries in the HD 181327 Debris Disk: A Recent Massive Collision or ISM Warping

C. C. Stark[1], G. Schneider[2], A. J. Weinberger[3], J. H. Debes[4], C. A. Grady[5], H. Jang-Condell[6], M. J. Kuchner[1]

[1] NASA Goddard Space Flight Center, Exoplanets & Stellar Astrophysics Laboratory, Code 667, Greenbelt, MD 20771
[2] Steward Observatory, The University of Arizona, Tucson, AZ 85721
[3] Department of Terrestrial Magnetism, Carnegie Institution of Washington, 5241 Broad Branch Road NW, Washington, DC 20015
[4] Space Telescope Science Institute, Baltimore, MD 21218
[5] Eureka Scientific, 2452 Delmer, Suite 100, Oakland, CA 96002
[6] Department of Physics & Astronomy, University of Wyoming, Laramie, WY 82071

The Astrophysical Journal, in press (arXiv:1405.7055)

New multi-roll coronagraphic images of the HD 181327 debris disk obtained using the Space Telescope Imaging Spectrograph (STIS) on board the Hubble Space Telescope (HST) reveal the debris ring in its entirety at high S/N and unprecedented spatial resolution. We present and apply a new multi-roll image processing routine to identify and further remove quasi-static PSF-subtraction residuals and quantify systematic uncertainties. We also use a new iterative image deprojection technique to constrain the true disk geometry and aggressively remove any surface brightness asymmetries that can be explained without invoking dust density enhancements/deficits. The measured empirical scattering phase function for the disk is more forward scattering than previously thought and is not well-fit by a Henyey-Greenstein function. The empirical scattering phase function varies with stellocentric distance, consistent with the expected radiation pressured-induced size segregation exterior to the belt. Within the belt, the empirical scattering phase function contradicts unperturbed debris ring models, suggesting the presence of an unseen planet. The radial profile of the flux density is degenerate with a radially-varying scattering phase function; therefore estimates of the ring's true width and edge slope may be highly uncertain. We detect large scale asymmetries in the disk, consistent with either the recent catastrophic disruption of a body with mass $> 1\%$ the mass of Pluto, or disk warping due to strong interactions with the interstellar medium (ISM).

Download/Website: `http://arxiv.org/abs/1405.7055`

Contact: `christopher.c.stark@nasa.gov`

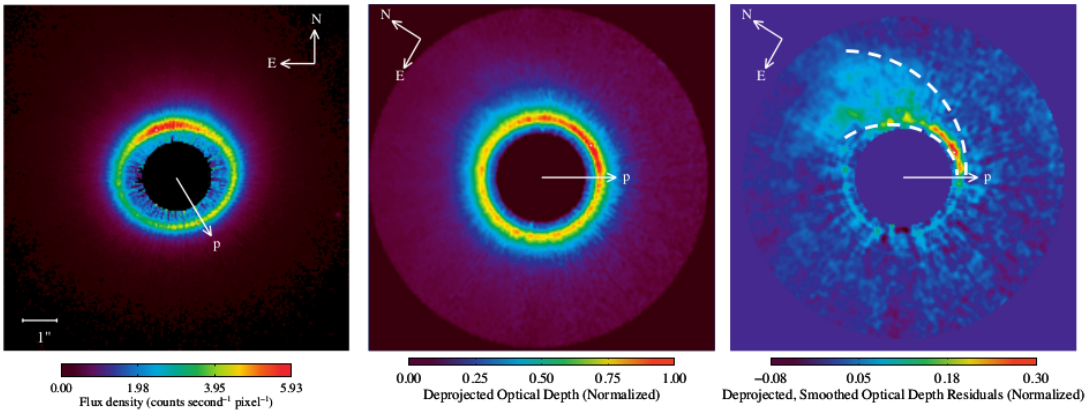

Figure 3: (Stark et al.) Left: New multi-roll STIS image of HD 181327. The longitude of pericenter is indicated with a 'p.' Middle: Deprojected, minimally-asymmetric optical depth—asymmetries remain. Right: Asymmetric residuals, roughly traced by dashed 3σ contours, are consistent with a recent massive collision or ISM warping.

A Parametric Modeling Approach to Measuring the Gas Masses of Circumstellar Disks

J.P. Williams, W.M.J. Best
Institute for Astronomy, University of Hawaii, Honolulu, USA

Astrophysical Journal, in press (arXiv:1312.0151)

The disks that surround young stars are mostly composed of molecular gas, which is harder to detect and interpret than the accompanying dust. Disk mass measurements have therefore relied on large and uncertain extrapolations from the dust to the gas. We have developed a grid of models to study the dependencies of isotopologue CO line strengths on disk structure and temperature parameters and find that a combination of ^{13}CO and C^{18}O observations provides a robust measure of the gas mass. We apply this technique to Submillimeter Array observations of nine circumstellar disks and published measurements of six well studied disks. We find evidence for selective photodissociation of C^{18}O and determine masses to within a factor of about three. The inferred masses for the nine disks in our survey range from $0.7 - 6\,M_{\rm Jup}$, and all are well below the extrapolation from the interstellar medium gas-to-dust ratio of 100. This is consistent with the low masses of planets found around such stars, and may be due to accretion or photoevaporation of a dust-poor upper atmosphere. However, the masses may be underestimated if there are more efficient CO depletion pathways than those known in molecular clouds and cold cores.

Download/Website: `http://arxiv.org/abs/1312.0151`

Contact: `jpw@ifa.hawaii.edu`

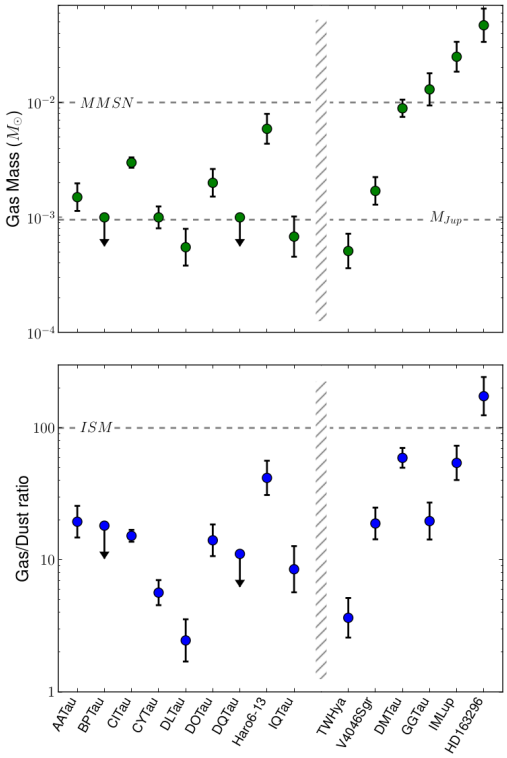

Figure 4: (Williams & Best) The fitted gas masses and inferred gas-to-dust ratios for the nine Taurus disks in the SMA survey and the six comparison disks. The upper panel shows the mean gas masses with dashed lines at the Minimum Mass Solar Nebula ($0.01\,M_\odot$) and a Jupiter mass for comparison. Uncertainties are estimated from the range of the fits and the factor of 3 mass binning, except for the two sources, BP Tau and DQ Tau, which were undetected in ^{13}CO and for which we can only determine upper limits. The lower panel is the ratio of gas mass to the dust mass derived from the continuum flux density, and is compared to the ISM value of 100 shown by the dashed line. The vertical hashes in each panel divide the SMA survey from the comparison disks as these are a more heterogeneous group in terms of stellar type and disk structure.

The 4.5 μm full-orbit phase curve of the hot Jupiter HD 209458b

Robert T. Zellem[1]*, Nikole K. Lewis*[2,11]*, Heather A. Knutson*[3]*, Caitlin A. Griffith*[1]*, Adam P. Showman*[1]*, Jonathan J. Fortney*[4]*, Nicolas B. Cowan*[5]*, Eric Agol*[6]*, Adam Burrows*[7]*, David Charbonneau*[8]*, Drake Deming*[9]*, Gregory Laughlin*[4]*, Jonathan Langton*[10]

[1] Lunar and Planetary Laboratory, University of Arizona, 1629 E. University Blvd., Tucson, AZ 85721, USA
[2] Department of Earth, Atmospheric and Planetary Sciences, MIT, 77 Massachusetts Avenue, Cambridge, MA 02139, USA
[3] Division of Geological and Planetary Sciences, MC 170-25 1200 E. California Blvd., Pasadena, CA 91125, USA
[4] Department of Astronomy & Astrophysics, University of California, Santa Cruz, 1156 High Street, Santa Cruz, CA 95064, USA
[5] Dept. of Earth and Planetary Sciences, Northwestern University, Technological Institute, 2145 Sheridan Road, Evanston, IL 60208, USA
[6] Astronomy Department, University of Washington, Physics-Astronomy Bldg., 3910 15th Ave NE, Seattle, WA 98195 USA
[7] Department of Astrophysical Sciences, Princeton University, 4 Ivy Lane, Peyton Hall, Princeton University, Princeton, NJ 08544, USA
[8] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street MS-16, Cambridge, MA 02138, USA
[9] Department of Astronomy, University of Maryland, College Park, MD 20742, USA
[10] Physics Department, Principia College, 1 Maybeck Place, Elsah, Illinois 62028, USA
[11] Sagan Fellow

arXiv, 1405.5923

The hot Jupiter HD 209458b is particularly amenable to detailed study as it is among the brightest transiting exoplanet systems currently known (V-mag = 7.65; K-mag = 6.308) and has a large planet-to-star contrast ratio. HD 209458b is predicted to be in synchronous rotation about its host star with a hot spot that is shifted eastward of the substellar point by superrotating equatorial winds. Here we present the first full-orbit observations of HD 209458b, in which its 4.5 μm emission was recorded with $Spitzer$/IRAC. Our study revises the previous 4.5 μm measurement of HD 209458b's secondary eclipse emission downward by $\sim$35% to $0.1391\%^{+0.0072\%}_{-0.0069\%}$, changing our interpretation of the properties of its dayside atmosphere. We find that the hot spot on the planet's dayside is shifted eastward of the substellar point by $40.9^\circ \pm 6.0^\circ$, in agreement with circulation models predicting equatorial superrotation. HD 209458b's dayside (T_{bright} = 1499 $\pm$ 15 K) and nightside (T_{bright} = 972 $\pm$ 44 K) emission indicates a day-to-night brightness temperature contrast smaller than that observed for more highly irradiated exoplanets, suggesting that the day-to-night temperature contrast may be partially a function of the incident stellar radiation. The observed phase curve shape deviates modestly from global circulation model predictions potentially due to disequilibrium chemistry or deficiencies in the current hot CH_4 line lists used in these models. Observations of the phase curve at additional wavelengths are needed in order to determine the possible presence and spatial extent of a dayside temperature inversion, as well as to improve our overall understanding of this planet's atmospheric circulation.

Download/Website: `http://arxiv.org/abs/1405.5923`

Contact: `rzellem@lpl.arizona.edu`

3 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 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.

The online submission site for attendee presentations is available on the workshop website. Attendees have the opportunity to present their own work through short presentations (research POPs) and posters.

Important Dates

- 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`

4 As seen on astro-ph

The following list contains all the entries relating to exoplanets that we spotted on astro-ph during May 2014. If you see any that we missed, please let us know and we'll include them in the next issue.

astro-ph/1405.0003 : **3D Structures of equatorial waves and the resulting superrotation in the atmosphere of a tidally locked hot Jupiter** by *Shang-Min Tsai, Ian Dobbs-Dixon, Pin-Gao Gu*

astro-ph/1405.0026 : **Analytical Models of Exoplanetary Atmospheres. II. Radiative Transfer via the Two-Stream Approximation** by *Kevin Heng, Joao Mendonca, Jaemin Lee*

astro-ph/1405.0280 : **Steady-state planet migration by the Kozai-Lidov mechanism in stellar binaries** by *Cristobal Petrovich*

astro-ph/1405.0381 : **Three body resonances in close orbiting planetary systems: Tidal dissipation and orbital evolution** by *John C. B. Papaloizou*

astro-ph/1405.0940 : **Larger Planet Radii Inferred from Stellar "Flicker" Brightness Variations of Bright Planet Host Stars** by *Fabienne A. Bastien, Keivan G. Stassun, Joshua Pepper*

astro-ph/1405.0960 : **Spin-Orbit angle distribution and the origin of (mis)aligned hot Jupiters** by *Aurlien Crida, Konstantin Batygin*

astro-ph/1405.1025 : **Life on a tidally-locked planet** by *Ashok K. Singal*

astro-ph/1405.1050 : **POET: A Model for (P)lanetary (O)rbital (E)volution due to (T)ides on Evolving Stars** by *Kaloyan Penev, Michael Zhang, Brian Jackson*

astro-ph/1405.1056 : **Near-infrared transmission spectrum of the warm-uranus GJ 3470b with the Wide Field Camera-3 on the Hubble Space Telescope** by *David Ehrenreich, et al.*

astro-ph/1405.1203 : **A study of transient dynamics of perturbations in Keplerian discs using a variational approach** by *V. V. Zhuravlev, D. N. Razdoburdin*

astro-ph/1405.1455 : **In Search of Exomoons** by *David M. Kipping*

astro-ph/1405.1559 : **The VLT/NaCo Large program to probe the occurrence of exoplanets and brown dwarfs in wide orbits: I- Sample definition and characterization** by *S. Desidera, et al.*

astro-ph/1405.1560 : **The VLT/NaCo large program to probe the occurrence of exoplanets and brown dwarfs at wide orbits: II- Survey description, results and performances** by *G. Chauvin, et al.*

astro-ph/1405.1667 : **Dynamical behaviour of multiplanet systems close to their stability limit** by *F. Marzari*

astro-ph/1405.1735 : **On the tidal origin of hot Jupiter stellar obliquity trends** by *Rebekah Dawson*

astro-ph/1405.1839 : **Tidally Distorted Exoplanets: Density Corrections for Short-Period Hot-Jupiters based solely on Observable Parameters** by *John Burton, et al.*

astro-ph/1405.1983 : **Direct Imaging of Planet Transit Events** by *Gerard T. van Belle, et al.*

astro-ph/1405.1986 : **Diversity of planetary systems in low-mass disks: Terrestrial-type planet formation and water delivery** by *Maria Paula Ronco, Gonzalo C. de Elia*

astro-ph/1405.2016 : **Filtering out activity-related variations from radial velocities in a search for low-mass planets** by *Mikko Tuomi, et al.*

astro-ph/1405.2060 : **Photo-Dynamical Analysis of Three Kepler Objects of Interest with Significant Transit Timing Variations** by *David Nesvorny, David Kipping, Dirk Terrell*

astro-ph/1405.2127 : **Planetary companions in K giants beta Cancri, mu Leonis, and beta Ursae Minoris** by *B.-C. Lee, et al.*

astro-ph/1405.2259 : **Testing the Titius-Bode law predictions for Kepler multi-planet systems** by *Chelsea X. Huang, Gaspar A. Bakos*

astro-ph/1405.2342 : **Secular Effects of Tidal Damping in Compact Planetary Systems** by *Bradley M. S. Hansen, Norman Murray*

astro-ph/1405.2536 : **Very deep images of the innermost regions of the beta Pictoris debris disc at Lp** by *J. Milli, et al.*

astro-ph/1405.2650 : **Positions of equilibrium points for dust particles in the circular restricted three-body**

problem with radiation by *P. Pastor*

astro-ph/1405.2778 : **Dust Transport in MRI Turbulent Disks: Ideal and Non-ideal MHD with Ambipolar Diffusion** by *Zhaohuan Zhu, James M. Stone, Xue-Ning Bai*

astro-ph/1405.2929 : **The Lick-Carnegie Exoplanet Survey: Gliese 687b: A Neptune-Mass Planet Orbiting a Nearby Red Dwarf** by *Jennifer Burt, et al.*

astro-ph/1405.2932 : **Discovery of a wide planetary-mass companion to the young M3 star GU Psc** by *Marie-Eve Naud, et al.*

astro-ph/1405.3120 : **High-resolution imaging of $Kepler$ planet host candidates. A comprehensive comparison of different techniques** by *J. Lillo-Box, D. Barrado, H. Bouy*

astro-ph/1405.3253 : **Chemistry in an Evolving Protoplanetary Disk: Effects on Terrestrial Planet Composition** by *John Moriarty, Nikku Madhusudhan, Debra Fischer*

astro-ph/1405.3283 : **Accreting planets as dust dams in 'transition' discs** by *James E. Owen*

astro-ph/1405.3284 : **PynPoint Code for Exoplanet Imaging** by *Adam Amara, Sascha P. Quanz, Joel Akeret*

astro-ph/1405.3288 : **TASTE IV. Refining ephemeris and orbital parameters for HAT-P-20b and WASP-1b** by *V. Granata, et al.*

astro-ph/1405.3291 : **Gravito-Turbulent Disks in 3D: Turbulent Velocities vs. Depth** by *Ji-Ming Shi, Eugene Chiang*

astro-ph/1405.3437 : **Convective overstability in accretion disks: 3D linear analysis and nonlinear saturation** by *Wladimir Lyra*

astro-ph/1405.3579 : **Exoplanet atmospheres with EChO: spectral retrievals using EChOSim** by *Joanna K. Barstow, et al.*

astro-ph/1405.3659 : **Kepler-93b: A Terrestrial World Measured to within 120 km, and a Test Case for a New Spitzer Observing Mode** by *Sarah Ballard, et al.*

astro-ph/1405.3711 : **Type II Migration is not Locked to Viscous Disk Evolution** by *Paul C. Duffell, et al.*

astro-ph/1405.3752 : **Giant Planets** by *Tristan Guillot, Daniel Gautier*

astro-ph/1405.3788 : **Chaotic zones around gravitating binaries** by *Ivan I. Shevchenko*

astro-ph/1405.3798 : **The Albedos of Kepler's Close-in super-Earths** by *Brice-Olivier Demory*

astro-ph/1405.4576 : **The Habitable Zone of Inhabited Planets** by *Jorge I. Zuluaga et al.*

astro-ph/1405.4738 : **Disruption of co-orbital (1:1) planetary resonances during gas-driven orbital migration** by *Arnaud Pierens, Sean Raymond*

astro-ph/1405.4780 : **High resolution transmission spectrum of the Earth's atmosphere – Seeing Earth as an exoplanet using a lunar eclipse** by *Fei Yan, et al.*

astro-ph/1405.5056 : **Disc-protoplanet interaction Influence of circumprimary radiative discs on self-gravitating protoplanetary bodies in binary star systems** by *M. Gyergyovits, et al.*

astro-ph/1405.5229 : **Large eccentricity, low mutual inclination: the three-dimensional architecture of a hierarchical system of giant planets** by *Rebekah I. Dawson, et al.*

astro-ph/1405.5284 : **Rapid Evolution of the Innermost Dust Disk of Protoplanetary Disks Surrounding Intermediate-mass Stars** by *Chikako Yasui, et al.*

astro-ph/1405.5354 : **Confirmation of an exoplanet using the transit color signature: Kepler-418b, a blended giant planet in a multiplanet system** by *B. Tingley, et al.*

astro-ph/1405.5416 : **Planetary host stars: Evaluating uncertainties in ultra-cool model atmospheres** by *I. Bozhinova, Ch. Helling, A. Scholz*

astro-ph/1405.5923 : **The 4.5 μm full-orbit phase curve of the hot Jupiter HD 209458b** by *Robert T. Zellem, et al.*

astro-ph/1405.6109 : **Connecting the dots: A versatile terrestrial planet benchmark for the atmospheres of tidally locked Super-Earths** by *Ludmila Carone, Rony Keppens, Leen Decin*

astro-ph/1405.6542 : **ALMA hints at the presence of two companions in the disk around HD 100546** by *Catherine Walsh et al.*

astro-ph/1405.6834 : **A dearth of small particles in debris disks: An energy-constrained smallest fragment**

size by *Sebastiaan Krijt, Mihkel Kama*

astro-ph/1405.7048 : **Observed spectral energy distribution of the thermal emission from the dayside of WASP-46b** by *Guo Chen et al.*

astro-ph/1405.7054 : **Planet formation in stellar binaries I: planetesimal dynamics in massive protoplanetary disks** by *Roman R. Rafikov, Kedron Silsbee*

astro-ph/1405.7055 : **Revealing Asymmetries in the HD 181327 Debris Disk: A Recent Massive Collision or ISM Warping** by *Christopher C. Stark, et al.*

astro-ph/1405.7245 : **Secular orbital evolution of planetary systems and the dearth of close-in planets around fast rotators** by *A. F. Lanza, E. L. Shkolnik*

astro-ph/1405.7379 : **Long Term Evolution of Planet-Induced Vortices in Protoplanetary Disks** by *Wen Fu, Hui Li, Stephen Lubow, Shengtai Li*

astro-ph/1405.7394 : **Exploring the Origins of Carbon in Terrestrial Worlds** by *Edwin A. Bergin, et al.*

astro-ph/1405.7433 : **The Effect of Conjunctions on the Transit Timing Variations of Exoplanets** by *David Nesvorny, David Vokrouhlicky*

astro-ph/1405.7486 : **Evolution of the habitable zone of low-mass stars. Detailed stellar models and analytical relationships for different masses and chemical compositions** by *G. Valle, et al.*

astro-ph/1405.7517 : **Periodic orbits for 3 and 4 co-orbital bodies** by *Patricia Verrier, Colin McInnes*

astro-ph/1405.7632 : **Compact planetary systems perturbed by an inclined companion: I. Vectorial representation of the secular model** by *Gwenael Boue, Daniel Fabrycky*

astro-ph/1405.7636 : **Compact planetary systems perturbed by an inclined companion: II. Stellar spin-orbit evolution** by *Gwenael Boue, Daniel Fabrycky*

astro-ph/1405.7692 : **The protoplanetary disk of FT Tauri: multi-wavelength data analysis and modeling** by *Antonio Garufi, et al.*

astro-ph/1405.7695 : **Three regimes of extrasolar planets inferred from host star metallicities** by *Lars A. Buchhave, et al.*

astro-ph/1405.7707 : **Magnetospheric Structure and Atmospheric Joule Heating of Habitable Planets Orbiting M-dwarf Stars** by *O. Cohen, et al.*

astro-ph/1405.7881 : **The Kepler-10 planetary system revisited by HARPS-N: A hot rocky world and a solid Neptune-mass planet** by *Xavier Dumusque, et al.*