ExoPlanet News
An Electronic Newsletter

No. 2, October 1st, 2007

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Contents

1 Editorial

Welcome to the second edition of ExoPlanet News, an electronic newsletter reporting the latest developments and research outputs in the field of exoplanets.

This newsletter covers a wide range of related research topics, ranging from discoveries and observations of exoplanets, protostellar disks, theoretical simulations of planet formation, exoplanet atmospheres and interiors, comparative planetology, formation and dynamics of planetary systems, planetary evolution and habitability, instrumentation, techniques and missions, origin and evolution of life on terrestrial planets, co-evolution of life, atmospheres and climate, characterisation of terrestrial planets and detection of biomarkers.

The Editors would like to thank the many people who have responded enthusiastically to the initial announcement of ExoPlanet News – we felt that this dedicated Newsletter was timely in a burgeoning community where the pace of new discoveries has become quite astounding.

Past editions, submission templates and other information can be found at the ExoPlanet News website: http://exoplanet.open.ac.uk

We do however rely on you, the subscribers of the newsletter, to send us your abstracts of recent papers, conference announcements, thesis abstracts, job adverts etc. Please send anything relevant to exoplanet@open.ac.uk, and it will appear in the next edition which we plan to send out close to the beginning of each calendar month. Please let us know of anything else you would like to see appear in the Newsletter.

Best wishes
Glenn White and Andrew Norton

2 Abstracts of refereed papers

Direct Measurement of the Radius and Density of the Transiting Exoplanet HD 189733B with the CHARA Array

E. K. Baines[1], *G. T. van Belle*[2], *T. A. ten Brummelaar*[1], *H. A. McAlister*[1], *M. Swain*[3], *N. H. Turner*[1], *L. Sturmann*[1], *and J. Sturmann*[1]

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Astrophysical Journal Letters, published (2007ApJ...661L.195B)

We have measured the angular diameter of the transiting extrasolar planet host star HD 189733 using the CHARA O/IR interferometric array. Combining our new angular diameter of 0.377 ± 0.024 mas with the Hipparcos parallax leads to a linear radius for the host star of $0.779 \pm 0.052\ R_{\rm Sun}$ and a radius for the planet of $1.19 \pm 0.08\ R_{\rm Jup}$. Adopting the mass of the planet as derived by its discoverers, we derive a mean density of the planet of 0.91 ± 0.18 g cm^{-3}. This is the first determination of the diameter of an extrasolar planet through purely direct means.

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Multi-Conjugate Adaptive Optics Images of the Trapezium Cluster

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Astronomy & Astrophysics, in press (astro-ph/0709.3994)

Multi-Conjugate Adaptive Optics (MCAO) combines the advantages of standard adaptive optics, which provides high contrast and high spatial resolution, and of wide field ≈1′imaging. Up to recently, MCAO for astronomy was limited to laboratory experiments. In this paper, we present the first scientific results obtained with the first MCAO instrument put on the sky. We present a new study of the Trapezium cluster using deep MCAO images with a field of view of $1' \times 1'$obtained at the VLT. We have used deep J, H and Ks images recently obtained with the prototype MCAO facility MAD at the VLT in order to search for new members and new multiple systems in the Trapezium cluster. On bright targets (Ks≈9mag), these images allow us to reach ΔKs≈6 mag as close as 0.″4. We report the detection of 128 sources, including 10 new faint objects in the magnitude range between 16.1<Ks<17.9mag. In addition to all previously known multiple systems with separations greater than 0.″1, we confirm the multiplicity of TCC-055. We also report the detection in J, H and Ks of a very red extended embedded protostellar object, HC419, previously detected in the thermal infrared only. The analysis of the first MCAO images obtained on the sky demonstrates not only the technical feasibility of MCAO but also its great potential and versatility in terms of scientific outputs.

Download/Website: `http://arrakeen.free.fr/pub/madorion.pdf`

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SDSS J104341.53+085558.2: A second white dwarf with a gaseous debris disc

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Monthly Notices of the Royal Astronomical SocietyLetters, published (2007MNRAS.380L..35G)

Intermediate resolution spectroscopy of the white dwarf SDSS J104341.53+085558.2 contains double-peaked emission lines of CaII $\lambda\lambda$ 8498,8542,8662 and identifies this object to be the second single white dwarf to be surrounded by a gaseous disc of metal-rich material, similar to the recently discovered SDSS J1228+1040. A photospheric Magnesium abundance of 0.3 times the solar value, determined from the observed MgII λ 4481 absorption line, implies that the white dwarf is accreting from the circumstellar material. The absence of Balmer emission lines and of photospheric HeI λ 4471 absorption indicates that the accreted material is depleted in volatile elements and, by analogy with SDSS 1228+1040, may be the result of the tidal disruption of an asteroid. Additional spectroscopy of the DAZ white dwarfs WD 1337+705 and GD362 does not reveal CaII emission lines. GD362 is one of the few cool DAZ that display strong infrared flux excess, thought to be originating in a circumstellar dust disc, and its temperature is likely too low to sublimate sufficient amounts of disc material to generate detectable CaII emission. WD 1337+705 is, as SDSS 1228+1040 and SDSS J1043+0855, moderately hot, but has the lowest Mg abundance of those three stars, suggesting a possible correlation between the photospheric Mg abundance and the equivalent width of the Ca IIEmission triplet. Our inspection of 7360 white dwarfs from SDSS DR 4 fails to unveil additional strong “metal gas disc” candidates, and implies that these objects are rather rare.

Download/Website: `http://arxiv.org/abs/0705.0447`

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GMRT Low Frequency Observations of Extrasolar Planetary Systems

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Monthly Notices of the Royal Astronomical Society, in press (2007arXiv0708.4079G/0708.4079)

Extrasolar planets are expected to emit detectable low frequency radio emission. In this paper we present results from new low frequency observations of two extrasolar planetary systems (Epsilon Eridani and HD 128311) taken at 150 MHz with the Giant Metrewave Radio Telescope (GMRT). These two systems have been chosen because the stars are young (with ages ¡ 1 Gyr) and are likely to have strong stellar winds, which will increase the expected radio flux. The planets are massive (presumably) gas giant planets in longer period orbits, and hence will not be tidally locked to their host star (as is likely to be the case for short period planets) and we would expect them to have a strong planetary dynamo and magnetic field. We do not detect either system, but are able to place tight upper limits on their low frequency radio emission, at levels comparable to the theoretical predictions for these systems. From these observations we have a 2.5sigma limit of 7.8 mJy for Epsilon Eri and 15.5 mJy for HD 128311. In addition, these upper limits also provide limits on the low frequency radio emission from the stars themselves. These results are discussed and also the prospects for the future detection of radio emission from extrasolar planets.

Download/Website: `http://arxiv.org/abs/0708.4079`

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The response of atmospheric chemistry on earthlike planets around F, G and K Stars to small variations in orbital distance

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Planetary and Space Science, published (2007P&SS...55..661G)

One of the prime goals of future investigations of extrasolar planets is to search for life as we know it. The Earth's biosphere is adapted to current conditions. How would the atmospheric chemistry of the Earth respond if we moved it to different orbital distances or changed its host star? This question is central to astrobiology and aids our understanding of how the atmospheres of terrestrial planets develop. To help address this question, we have performed a sensitivity study using a coupled radiative convective photochemical column model to calculate changes in atmospheric chemistry on a planet having Earth's atmospheric composition, which we subjected to small changes in orbital position, of the order of 5 10% for a solar-type G2V, F2V, and K2V star. We then applied a chemical source-sink analysis to the biomarkers in order to understand how chemical processes affect biomarker concentrations. We start with the composition of the present Earth, since this is the only example we know for which a spectrum of biomarker molecules has been measured. We then investigate the response of the biomarkers to changes in the input stellar flux. Computing the thermal profile for atmospheres rich in H_2O, CO_2 and CH_4 is a major challenge for current radiative schemes, due, among other things, to lacking spectroscopic data. Therefore, as a first step, we employ a more moderate approach, by investigating small shifts in planet star distance and assuming an earthlike biosphere. To calculate this shift we assumed a criteria for complex life based on the Earth, i.e. the earthlike planetary surface temperature varied between $0^{\circ}\mathrm{C} < T_{\mathrm{surface}} < 30^{\circ}\mathrm{C}$, which led to a narrow HZ width of (0.94 – 1.08) astronomical units (AU) for the solar-type G2V star (1.55 – 1.78) AU for the F2V star, and (0.50 – 0.58) AU for the K2V star. In our runs we maintained the concentration of atmospheric CO2 at its present-day level. In reality, the CO2 cycle (not

presently included in our model) would likely lead to atmospheric CO2 stabilising at higher levels than considered in our runs near our quoted 'outer' boundaries. The biomarkers H_2O, CH_4 and CH_3Cl varied by factors 0.08, 17, and 16, respectively in the total column densities on moving outwards for the solar case. Whereas H_2O decreased moving outwards due to cooling hence enhanced condensation in the troposphere, CH_4 and CH_3Cl increased associated with a slowing in $H_2O+O^1D \rightarrow 2OH$, hence less OH, an important sink for these two compounds. Ozone changes were smaller, around a 10% increase on moving outwards partly because cooler temperatures led to a slowing in the reaction between O_3 and O^1D. We also considered changes in species which impact ozone — the so-called family species (and their reservoirs), which can catalytically destroy ozone. Hydrochloric acid (HCl), for example, is a chlorine reservoir (storage) molecule, which increased by a factor 64 in the mid-stratosphere (32 km) on moving outwards for the solar case. For the F2V and K2V stars, similar sources and sinks dominated the chemical biomarker budget as for the solar case and column trends were comparable.

Download/Website: `http://cdsads.u-strasbg.fr/abs/2007P%26SS...55..661G`

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Biomarker Response to Galactic Cosmic Ray-Induced NO_x And The Methane Greenhouse Effect in The Atmosphere of An Earth-Like Planet Orbiting An M Dwarf Star

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Astrobiology, published (2007AsBio...7..208G)

Planets orbiting in the habitable zone of M dwarf stars are subject to high levels of galactic cosmic rays (GCRs), which produce nitrogen oxides (NO_x) in Earth-like atmospheres. We investigate to what extent these NO_Mx species may modify biomarker compounds such as ozone (O_3) and nitrous oxide (N_2O), as well as related compounds such as water (H_2O) (essential for life) and methane (CH_4) (which has both abiotic and biotic sources). Our model results suggest that such signals are robust, changing in the M star world atmospheric column due to GCR NO_x effects by up to 20% compared to an M star run without GCR effects, and can therefore survive at least the effects of GCRs. We have not, however, investigated stellar cosmic rays here. CH_4 levels are about 10 times higher on M star worlds than on Earth because of a lowering in hydroxyl (OH) in response to changes in the ultraviolet. The higher levels of CH_4 are less than reported in previous studies. This difference arose partly because we used different biogenic input. For example, we employed 23% lower CH_4 fluxes compared to those studies. Unlike on Earth, relatively modest changes in these fluxes can lead to larger changes in the concentrations of biomarker and related species on the M star world. We calculate a CH_4 greenhouse heating effect of up to 4K. O_3 photochemistry in terms of the smog mechanism and the catalytic loss cycles on the M star world differs considerably compared with that of Earth.

Download/Website: `http://cdsads.u-strasbg.fr/abs/2007AsBio...7..208G`

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Habitable Planet Formation in Binary-Planetary Systems

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Astrophysical Journal, published (2007ApJ...666...436H)

Recent radial velocity observations have indicated that Jovian-type planets can exist in moderately close binary star systems. Numerical simulations of the dynamical stability of terrestrial-class planets in such environments have shown that, in addition to their giant planets, these systems can also harbor Earth-like objects. In this paper we study the late stage of terrestrial planet formation in such binary planetary systems, and present the results of the simulations of the formation of Earth-like bodies in their habitable zones. We consider a circumprimary disk of Moon- to Mars-sized objects and numerically integrate the orbits of these bodies at the presence of the Jovian-type planet of the system and for different values of the mass, semimajor axis, and orbital eccentricity of the secondary star. Results indicate that Earth-like objects, with substantial amounts of water, can form in the habitable zone of the primary star. Simulations also indicate that by transferring angular momentum from the secondary star to protoplanetary objects, the giant planet of the system plays a key role in the radial mixing of these bodies and the water contents of the final terrestrial planets. We will discuss the results of our simulation and show that the formation of habitable planets in binary planetary systems is more probable in binaries with moderate to large perihelia.

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On the stability of test particles in extrasolar multiple planet systems

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Monthly Notices of the Royal Astronomical Society, (2007MNRAS.374..599R)

We have studied the dynamical evolution of test particles in the planetary systems of Upsilon Andromedae, GJ 876, 47 UMa and 55 Cnc. Using recent radial velocity data of these stars and also utilizing a relatively new radial velocity fitting routine, we have obtained the orbital parameters of the giant planets of these systems, and studied the possibility of their harbouring of terrestrial-class planets and smaller objects. Our results indicate that, unlike the stable orbit of the newly discovered Earth-like planet of GJ 876, the orbit of the recently announced planet of 55 Cnc is unstable. Our simulations also show that the outer planet of 47 UMa may contain Trojan-type asteroids. We present the results of our detailed study of the orbital stability and dynamical behaviour of test particles throughout these systems, and investigate the possibility of stable orbits in their habitable zones. Within the context of the latter, it seems that the two systems of 47 UMa and 55 Cnc are still the only ones with the capability of harbouring habitable planets, although the new influence zones of their giant planets have caused their habitable regions to be different from the ones reported in the literature.

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Characterization of CoRoT target fields with BEST: Identification of periodic variable stars in the IR01 field

P. Kabath[1], *P. Eigmüller*[1], *A. Erikson*[1], *P. Hedelt*[1], *H. Rauer*[1,2], *R. Titz*[1], *T. Wiese*[1]

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Astronomical Journal, in press (2007AJ....134.1560K)

We report on observations of the CoRoT IR01 field with the Berlin Exoplanet Search Telescope (BEST). BEST is a small aperture telescope with a wide field of view (FOV). It is dedicated to search for variable stars within the target fields of the CoRoT space mission to aid in minimizing false-alarm rates and identify potential targets for additional science. CoRoT's observational programm started in February 2007 with the "initial run" field (IR01) observed for about two months. BEST observed this field for 12 nights spread over three months in winter 2006. From the total of 30426 stars observed in the IR01 field 3769 were marked as suspected variable stars and 54 from them showed clear periodicity. From these 19 periodic stars are within the part of the CoRoT FOV covered in our data set.

Download/Website: `http://adsabs.harvard.edu/abs/2007AJ....134.1560K`

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The Rotation Period of the Planet-Hosting Star HD 189733

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Astronomical Journal, in press (astro-ph/0709.2142)

We present synoptic optical photometry of HD 189733, the chromospherically active parent star of one of the most intensively studied exoplanets. We have significantly extended the timespan of our previously reported observations and refined the estimate of the stellar rotation period by more than an order of magnitude: $P = 11.953 \pm 0.009$ days. We derive a lower limit on the inclination of the stellar rotation axis of 56° (with 95% confidence), corroborating earlier evidence that the stellar spin axis and planetary orbital axis are well aligned.

Download/Website: `http://lanl.arxiv.org/abs/0709.2142`

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The HARPS search for southern extra-solar planets XII. A giant planet orbiting the metal-poor star HD 171028

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Astronomy & Astrophysics, in press

In this paper we present the detection of a 1.8 $\mathrm{M_{Jup}}$ planet in a 538-day period trajectory orbiting the metal-poor star HD 171028 ([Fe/H]=-0.49). This planet is the first to be discovered in the context of a HARPS program searching for planets around metal-poor stars. Interestingly, HD 171028 is one of the least metal-poor stars in the sample. This discovery is placed in the context of the models of planet formation and evolution.

Download/Website: `http://www.exoplanets.eu`

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A giant planet orbiting the extreme horizontal branch star V 391 Pegasi

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Nature 449, 189, just published

Fifteen years following the first discoveries, more than 200 extra solar planet candidates are known. Most of them are hosted by core hydrogen burning main sequence stars similar to our Sun, although a few planets orbiting red giant stars have been recently found. When their core hydrogen runs out, main sequence stars undergo a red giant expansion that modifies the planetary orbits and can easily reach and engulf the inner planets. The same will happen to the planets of our solar system in about 5 Gyr and the fate of the Earth is matter of debate. Here we report the discovery of a planetary-mass body ($M \sin i = 3.2\,M_{JUP}$) orbiting the extreme horizontal branch, core helium burning, pulsating star V 391 Pegasi at a distance of about 1.7 AU, with a period of 3.2 yr. The maximum radius of the red giant precursor may have reached 0.7 AU, whereas the orbital distance of the planet during the stellar main sequence phase is estimated to be about 1 AU. This first detection of a planet around a post-red giant star proves that planets with orbital distances < 2 AU can survive the red giant expansion.

Download/Website:

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3 Other abstracts

Terrestrial and Habitable Planet Formation in Binary and Multi-star Systems

N. Haghighipour[1], *Steinn Sigurdsson*[2], *Jack Lissauer*[3], *S. N. Raymond*[4]

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Submitted to NSF Exoplanets Task Force, (astro-ph/0704.0832)

One of the most surprising discoveries of extrasolar planets is the detection of planets in moderately close binary star systems. The Jovian-type planets in the two binaries of Gamma Cephei and GJ 86 have brought to the forefront questions on the formation of giant planets and the possibility of the existence of smaller bodies in such dynamically complex environments. The diverse dynamical characteristics of these objects have made scientists wonder to what extent the current theories of planet formation can be applied to binaries and multiple star systems. At present, the sensitivity of the detection techniques does not allow routine discovery of Earth-sized bodies in binary systems. However, with the advancement of new techniques, and with the recent launch of CoRoT and the launch of Kepler in late 2008, the detection of more planets (possibly terrestrial-class objects) in such systems is on the horizon. Theoretical studies and numerical modeling of terrestrial and habitable planet formation are, therefore, necessary to gain fundamental insights into the prospects for life in such systems and have great strategic impact on NASA science and missions.

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4 Conference announcements

Characteristics and Habitability of Super Earths

Fred Rasio[1], *Sara Seager*[2], *Eric Ford*[3], *Lisa Kaltenegger*[3]

[1] Northwestern University
[2] MIT
[3] CfA, Harvard

Aspen Center for Physics, Aspen, Colorado, 17 August 2008 to 7 September 2008

Over 240 extrasolar planets are known to orbit nearby stars. Several of these are low-mass exoplanets with minimum masses ranging from 5 to 20 Earth masses. These ‘super Earths’ are the first known exoplanets that likely consist substantially of rock, making them possible analogs of the terrestrial planets that support life in our solar system.
A substantial number of super Earths are expected to be discovered in the next year by ground-based radial velocity planet searches for rocky planets and with the COROT Space Telescope that aims to find transiting super Earths. The summer of 2008 will therefore be a critical time to study and explain the super Earth’s dynamical and physical characteristics as they relate to planet habitability. For example, can habitable conditions on these planets be maintained? What causes their eccentricity? How much resulting tidal energy is generated and how much of it reaches the planet’s surface? Do the super Earths have atmospheres or have their atmospheres been evaporated by the parent star? Can we observe their atmospheres, and what atmospheric compositions would be indicative of life? Our workshop will focus on these issues and, more generally, on the habitability and astrophysics of extrasolar Super-Earth-like planets.

Download/Website: http://aspenphys.org/documents/program/summer08.html

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Darwin-TPF Conference 2008, Osservatorio Capo di Monte, Napoli, Italy, March 10-14

Elvira Covino[1] *& Yves Rabbia*[2]
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[2] Observatoire de la Côte d'Azur, Nice, France

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Since the Heidelberg (2003) and the San Diego (2004) conferences, the situation of the DARWIN/TPF project has strongly evolved not only politically, but also scientifically and technologically speaking. New scientific observational and theoretical results have been exhibited, laboratory studies have led to interesting breakthroughs, concepts studies concerning the mission itself, but also precursor missions have been done or are under way. At the dawn of the new European "Cosmic Vision" program where the exoplanets science should have a central position, and according to ESA we are pleased to announce that a DARWIN/TPF conference will be held in Napoli (Italy), from the 10th to the 14th of March 2008.
The goal of this conference is to address both scientific and technological aspects of the mission and particularly:

- Planetary systems diversity: formation and evolution, theoretical and observational approaches,
- Planetary atmospheres, spectral signatures and biomarkers
- Zodiacal matter and exo zodis
- DARWIN / TPFI - TPFC project and related technology, including theoretical and laboratory studies.
- DARWIN / TPF precursors: ground-based and space projects.

The conference will include several invited papers on selected topic (state of the art on exoplanets hunting, planetary atmospheres, search for life ...) and contribution papers (oral presentations and posters).
The Web site: http://www.na.astro.it/darwin-tpf/ will be open soon for registration

Download/Website: `http://www.na.astro.it/darwin-tpf/`

5 As seen on astro-ph

The following list contains all the entries relating to exoplanets that we spotted on astro-ph during September 2007. If you spot any that we missed, let us know and we'll include them in the next issue.

Exoplanets

astro-ph/0708.4300: **Limits on the 2.2 microns contrast ratio of the close orbiting planet HD 189733b** by *Barnes et al.*
astro-ph/0708.4338: **Search for exoplanets with the radial-velocity technique: quantitative diagnostics of stellar activity** by *Desort et al.*
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