ExoPlanet News
An Electronic Newsletter

No. 181, 9 July 2024

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Contents

1 Editorial

Welcome to Edition 181 of the ExoPlanet News!

As usual, we bring you abstracts of scientific papers, job ads, conference announcements, and an overview of exoplanet-related articles on astro-ph. Thanks a lot to all of you who contributed to this issue of the newsletter!

For the next month we look forward to your paper abstracts, job ads or meeting announcements. Also, special announcements are welcome. As always, we would also be happy to receive feedback concerning the newsletter. The LaTeX template (v2.0) for submitting contributions, as well as all previous editions of ExoPlanet News, can be found on the ExoPlanet News webpage (`https://nccr-planets.ch/exoplanetnews/`).

The next issue will appear on 13 August 2024.

Thanks again for your support, and best regards from the editorial team,

Daniel Angerhausen
Leander Schlarmann
Jeanne Davoult
Haiyang Wang
Timm-Emanuel Riesen

2 Abstracts of refereed papers

Towards characterising rocky worlds: Trends in chemical make-ups of M dwarfs versus GK dwarfs

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Astronomy & Astrophysics, arXiv:2407.01177

Elemental abundances of Sun-like stars are crucial for understanding the detailed properties of their planets. However, measuring elemental abundances in M stars is challenging due to their faintness and pervasive molecular features in optical spectra. To address this, elemental abundances of Sun-like stars have been proposed to constrain those of M stars by scaling [X/H] with measured [Fe/H]. This study tests the robustness of this practice using M- and GK-dwarf stellar abundances and rigorous statistical methods. We compile elemental abundances for 43 M dwarfs for 10 major rock-forming elements (Fe, C, O, Mg, Si, Al, Ca, Na, Ni, and Ti) from high-resolution near-infrared stellar surveys. We perform bootstrap-based linear regressions on the M dwarfs to determine the trends of [X/H] vs. [Fe/H] and compare them with GK dwarfs. A 2-sample, multivariate Mahalanobis Distance test is applied to assess the significance of differences in [X/H]–[Fe/H] trends for individual elemental pairs between M and GK dwarfs. The null hypothesis of no significant difference in chemical trends between M and GK dwarfs is strongly rejected for all elements except Si, for which rejection is marginal, and Na and Ni, for which results are inconclusive. This suggests that assuming no difference may lead to biased results and inaccurate constraints on rocky planets around M dwarfs. Therefore, it is crucial for both the stellar and exoplanet communities to recognise these differences. To better understand these differences, we advocate for dedicated modelling techniques for M dwarf atmospheres and more homogeneous abundance analyses. Our statistically constrained trends of [X/H]–[Fe/H] for M dwarfs offer a new constraint on estimating M-dwarf elemental abundances given measured [Fe/H], aiding in characterising the properties of M dwarf-hosted rocky worlds.(Abridged)

Download/Website: `https://arxiv.org/abs/2407.01177`

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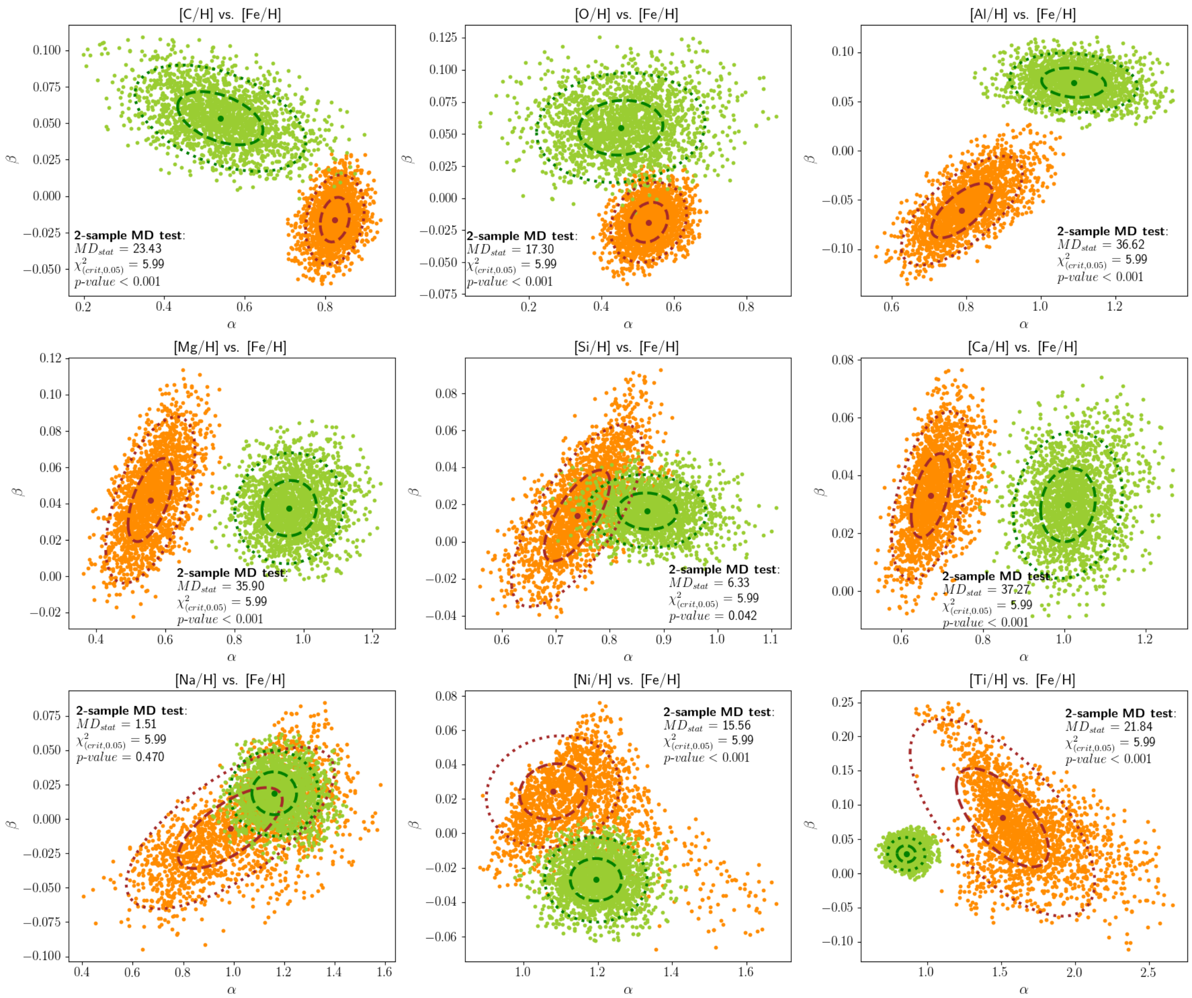

Figure 1: Comparison of the model coefficients (slope α and intercept β) of the chemical trends of [X/H]–[Fe/H] between M dwarfs (orange dots) and GK dwarfs (green dots), along with the statistical test results with a 2-sample multivariate Mahalanobis Distance (MD) test of null hypothesis. The dash and dotted ellipses indicate the 1σ and 2σ contours of their best-fit values (the dots in brown and in darker green). More tests are made in the article with different sample selections. The final results are combined from these different sets of tests.

Resonant sub-Neptunes are puffier

Adrien Leleu[1], *Jean-Baptiste Delisle*[1], *Remo Burn*[2], *André Izidoro*[3], *Stéphane Udry*[1], *Xavier Dumusque*[1], *Christophe Lovis*[1], *Sarah Millholland*[4,5], *Léna Parc*[1], *François Bouchy*[1], *Vincent Bourrier*[1], *Yann Alibert*[6], *João Faria*[1], *Christoph Mordasini*[6], *and Damien Ségransan*[1]

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A&A, published (2024A&A...687L...1L)

A systematic, population-level discrepancy exists between the densities of exoplanets whose masses have been measured with transit timing variations (TTVs) versus those measured with radial velocities (RVs). Since the TTV planets are predominantly nearly resonant, it is still unclear whether the discrepancy is attributed to detection biases or to astrophysical differences between the nearly resonant and non resonant planet populations. We defined a controlled, unbiased sample of 36 sub-Neptunes characterised by *Kepler*, TESS, HARPS, and ESPRESSO. We found that their density depends mostly on the resonant state of the system, with a low probability (of $0.002^{0.01}_{0.001}$) that the mass of (nearly) resonant planets is drawn from the same underlying population as the bulk of sub-Neptunes. Increasing the sample to 133 sub-Neptunes reveals finer details: the densities of resonant planets are similar and lower than non-resonant planets, and both the mean and spread in density increase for planets that are away from resonance. This trend is also present in RV-characterised planets alone. In addition, TTVs and RVs have consistent density distributions for a given distance to resonance. We also show that systems closer to resonances tend to be more co-planar than their spread-out counterparts. These observational trends are also found in synthetic populations, where planets that survived in their original resonant configuration retain a lower density; whereas less compact systems have undergone post-disc giant collisions that increased the planet's density, while expanding their orbits. Our findings reinforce the claim that resonant systems are archetypes of planetary systems at their birth.

Download/Website: `https://www.aanda.org/articles/aa/pdf/2024/07/aa50587-24.pdf`

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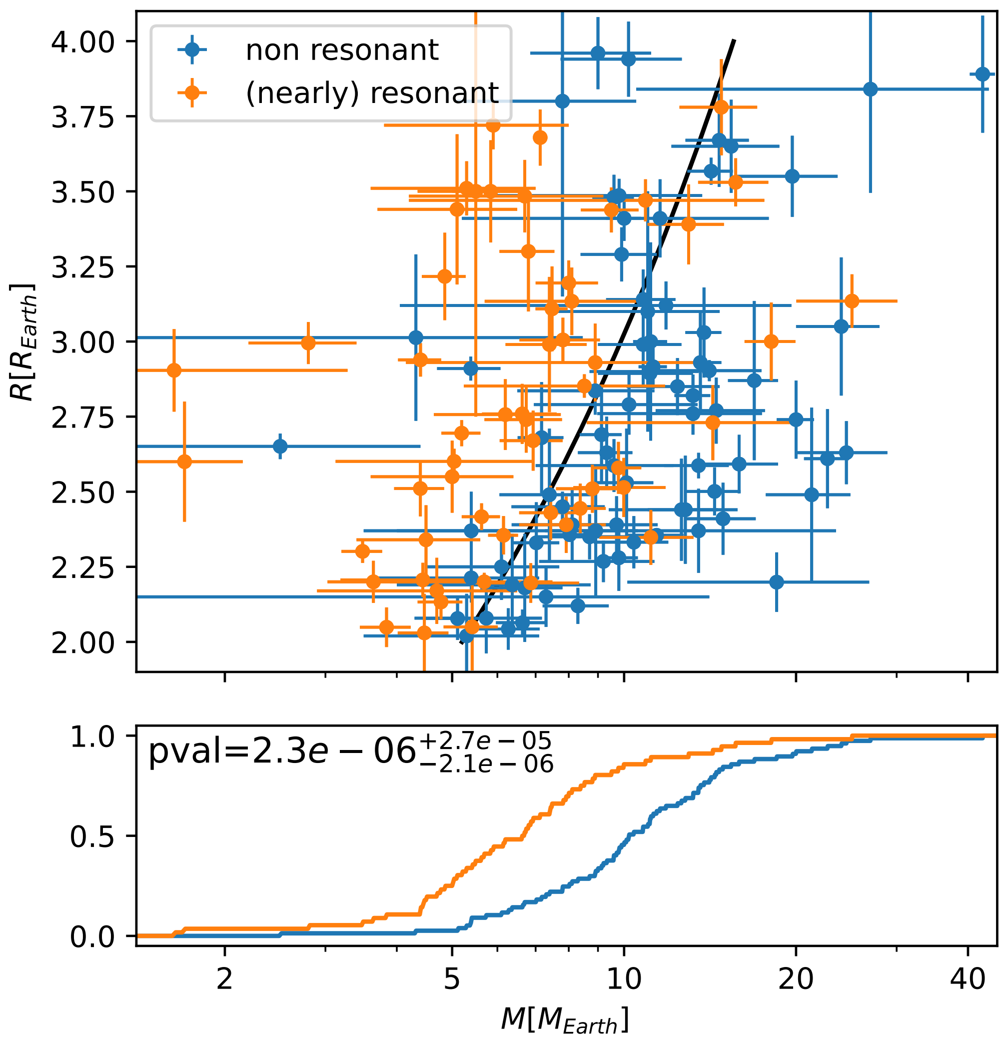

Figure 2: Top panel: Mass-radius relation of the full sample (133 sub-Neptunes) for planets that are (nearly) resonant ($|P_{out}/P_{in} - (k+q)/k| < 0.05$), and non-resonant ($|P_{out}/P_{in} - (k+q)/k| > 0.05$ or single planets), with P_{in} and P_{out} the orbital period of the inner and outer planet, respectively, and k and q are integer. The black line is the sub-Neptune mass-radius relation from Parc et al (2024). The bottom panel shows the cumulative distributions for the planetary masses. The p_{value} is the probability that the distribution of that parameter is drawn form the same underlying distribution for the (nearly)-resonant and non-resonant populations.

From super-Earths to sub-Neptunes: Observational constraints and connections to theoretical models

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Astronomy & Astrophysics, Accepted (arXiv:2406.04311)

The growing number of well-characterized exoplanets smaller than Neptune enables us to conduct more detailed population studies. We have updated the PlanetS catalog of transiting planets with precise and robust mass and radius measurements and use this comprehensive catalog to explore mass-radius (M-R) diagrams. On the one hand, we propose new M-R relationships to separate exoplanets into three populations: rocky planets, volatile-rich planets, and giant planets. On the other hand, we explore the transition in radius and density between super-Earths and sub-Neptunes around M-dwarfs and compare them with those orbiting K- and FG-dwarfs. Using Kernel density estimation method with a re-sampling technique, we estimated the normalized density and radius distributions, revealing connections between observations and theories on composition, internal structure, formation, and evolution of these exoplanets orbiting different spectral types. First, the substantial 30% increase in the number of well-characterized exoplanets orbiting M-dwarfs compared with previous studies shows us that there is no clear gap in either composition or radius between super-Earths and sub-Neptunes. The ”water-worlds” around M-dwarfs cannot correspond to a distinct population, their bulk density and equilibrium temperature can be interpreted by several different internal structures and compositions. The continuity in the fraction of volatiles in these planets suggests a formation scenario involving planetesimal or hybrid pebble-planetesimal accretion. Moreover, we find that the transition between super-Earths and sub-Neptunes appears to happen at different masses (and radii) depending on the spectral type of the star. The maximum mass of super-Earths seems to be close to 10 $M_\oplus$ for all spectral types, but the minimum mass of sub-Neptunes increases with the star's mass, and is around 1.9 $M_\oplus$, 3.4 $M_\oplus$, and 4.3 $M_\oplus$, for M-dwarfs, K-dwarfs, and FG-dwarfs, respectively. The precise value of this minimum mass may be affected by observational bias, but the trend appears to be reliable. This effect, attributed to planet migration, also contributes to the fading of the radius valley for M-planets compared to FGK-planets. While sub-Neptunes are less common around M-dwarfs, smaller ones (1.8 $R_\oplus$ ¡ R_p ¡ 2.8 $R_\oplus$) exhibit lower density than their equivalents around FGK-dwarfs. Nonetheless, the sample of well-characterized small exoplanets remains limited, and each new discovery has the potential to reshape our understanding and interpretations of this population in the context of internal structure, composition, formation, and evolution models. Broader consensus is also needed for internal structure models and atmospheric compositions to enhance density interpretation and observable predictions for the atmospheres of these exoplanets.

Download/Website: `https://arxiv.org/abs/2406.04311`

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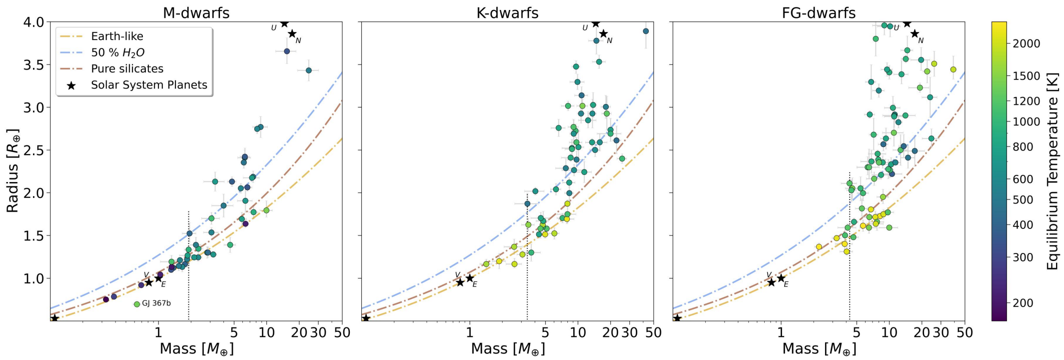

Figure 3: M-R diagram of small planets around M-dwarfs, K-dwarfs, and FG-dwarfs from the PlanetS catalog. The planets are color-coded by their equilibrium temperature calculate within the catalog with a bond albedo of 0 and a total heat redistribution. The composition lines of pure-silicates (brown) from Zeng et al. 2016, Earth-like planets (yellow), and 50% water (blue) from Zeng et al. 2019 are displayed. The vertical dotted lines correspond to the minimum mass of the sub-Neptunes across spectral types (at 1.9, 3.4, and 4.3 $M_\oplus$ for M-, K-, and FG-dwarfs).

Constraints on the formation history and composition of Kepler planets from their distribution of orbital period ratios

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Astronomy & Astrophysics, published (2024A&A...687A..25C/arXiv:2406.08794)

The Kepler high-precision planetary sample has revealed a radius valley, separating compact super-Earths from sub-Neptunes with lower density. Super-Earths are generally assumed to be rocky planets that were probably born in-situ, while the composition and origin of sub-Neptunes remains debated. To provide more constraints on the formation history and composition, based on the planetary sample of Kepler multiple planet systems, we derive the distributions of orbital period ratios of sub-Neptune and super-Earth planet pairs and calculate the normalised fraction of near-first-order mean motion resonances. Using synthetic planetary systems generated by the Generation III Bern Model, we also obtain theoretical predictions of period ratio distributions of planet pairs of different compositions and origins. We find that actual Kepler sub-Neptune pairs show a normalised fraction smaller (larger) than the model predictions for water-rich (water-poor) pairs with confidence levels of about two sigma. The derived normalised fraction of actual Kepler Super-Earth pairs is generally consistent with that of water-poor model planet pairs but significantly smaller than that of synthetic water-rich planet pairs. Based on the distributions of orbital period ratios, we conclude that orbital migration has been more important for sub-Neptunes than for super-Earths, suggesting a partial ex situ formation of the former and an origin of the radius valley caused in part by distinct formation pathways. However, the model comparisons also show that sub-Neptunes in actual Kepler multiple systems are not likely to be all water-rich/ex situ planets but a mixture of the two (in situ/ex situ) pathways. Whereas, Kepler super-Earth planets are predominantly composed by of water-poor planets that were born inside the ice line, likely through a series of giant impacts without large scale migration.

Download/Website: `https://arxiv.org/abs/2406.08794`

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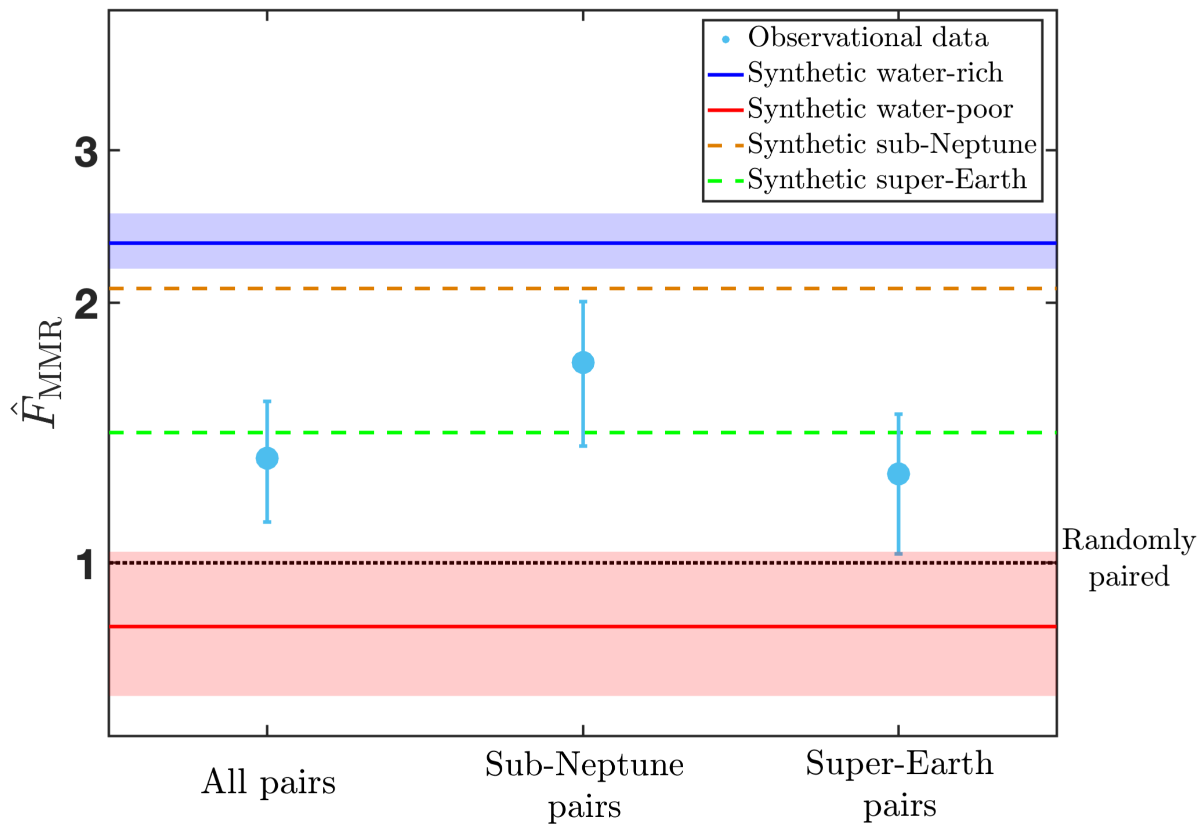

Figure 4: Normalised fraction of near-MMRs pairs, $\hat{F}_{\rm MMR}$ (solid points) with 1σ uncertainties (vertical bars) for all actual planet pairs, sub-Neptune pairs, and super-Earth planet pairs in Kepler multiple transiting systems. The two horizontal solid lines and shaded regions represent the theoretical predictions and 1σ uncertainties of water-rich (blue) and water-poor planet pairs (red) derived from the synthetic sample. The two horizontal dashed lines denote the theoretical predictions of simulated sub-Neptune (brown) and super-Earth (green) pairs derived from the synthetic sample. The result of the randomly paired control sample is plotted as a dotted black line and by definition is equal to unity.

Large Interferometer For Exoplanets (LIFE) – XIII. The value of combining thermal emission and reflected light for the characterization of Earth twins

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Astronomy & Astrophysics, in press (arXiv:2406.13037)

Following the recommendations to NASA (in the Astro2020 Decadal survey) and ESA (through the Voyage2050 process), the search for life on exoplanets will be a priority in the next decades. Two concepts for direct imaging space missions are being developed for this purpose: the Habitable Worlds Observatory (HWO) and the Large Interferometer for Exoplanets (LIFE). These two concepts operate in different spectral regimes: HWO is focused on reflected light spectra in the ultraviolet, visible, and near-infrared (UV/VIS/NIR), while LIFE will operate in the mid-infrared (MIR) to capture the thermal emission of temperate exoplanets.
In this study, we aim to assess the potential of HWO and LIFE to characterize a cloud-free Earth twin orbiting a Sun-like star at a distance of 10 pc, both as separate missions and in synergy with each other. We aim to quantify the increase in information that can be gathered by joint atmospheric retrievals on a habitable planet. We performed Bayesian retrievals on simulated data obtained by an HWO-like mission and a LIFE-like one separately, then jointly. We considered the baseline spectral resolutions currently assumed for these concepts and used two increasingly complex noise simulations, obtained using state-of-the-art noise simulators.
An HWO-like concept would allow one to strongly constrain H_2O, O_2, and O_3 in the atmosphere of a cloud-free Earth twin, while the atmospheric temperature profile is not well constrained (with an average uncertainty ≈ 100 K). LIFE-like observations would strongly constrain CO_2, H_2O, and O_3 and provide stronger constraints on the thermal atmospheric structure and surface temperature (down to ≈ 10 K uncertainty). For all the investigated scenarios, both missions would provide an upper limit on CH_4. A joint retrieval on HWO and LIFE data would accurately define the atmospheric thermal profile and planetary parameters. It would decisively constrain CO_2, H_2O, O_2, and O_3 and find weak constraints on CO and CH_4. The significance of the detection is in all cases greater than or equal to the single-instrument retrievals.
Both missions provide specific information that is relevant for the characterization of a terrestrial habitable exoplanet, but the scientific yield can be maximized by considering synergistic studies of UV/VIS/NIR+MIR observations. The use of HWO and LIFE together will provide stronger constraints on biosignatures and life indicators, with the potential to be transformative for the search for life in the Universe.

Download/Website: `https://arxiv.org/abs/2406.13037`

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No signature of the birth environment of exoplanets from their host stars' Mahalanobis phase space

G. A. Blaylock-Squibbs[1], *R. J. Parker*[1] *and E. C. Daffern-Powell*[1]

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The Astrophysical Journal, published (10.3847/1538-4357/ad4be0)

The architectures of extrasolar planetary systems often deviate considerably from the 'standard' model for planet formation, which is largely based on our own Solar System. In particular, gas giants on close orbits are not predicted by planet formation theory and so some process(es) are thought to move the planets closer to their host stars. Recent research has suggested that Hot Jupiter host stars display a different phase space compared to stars that do not host Hot Jupiters. This has been attributed to these stars forming in star-forming regions of high stellar density, where dynamical interactions with passing stars have perturbed the planets. We test this hypothesis by quantifying the phase space of planet-hosting stars in dynamical N-body simulations of star-forming regions. We find that stars that retain their planets have a higher phase space than non-hosts, regardless of their initial physical density. This is because an imprint of the kinematic substructure from the regions birth is retained, as these stars have experienced fewer and less disruptive encounters than stars whose planets have been liberated and become free-floating. However, host stars whose planets remain bound but have had their orbits significantly altered by dynamical encounters are also primarily found in high phase space regimes. We therefore corroborate other research in this area which has suggested the high phase space of Hot Jupiter host stars is not caused by dynamical encounters or stellar clustering, but rather reflects an age bias in that these stars are (kinematically) younger than other exoplanet host stars.

Download/Website: `https://ui.adsabs.harvard.edu/abs/2024ApJ...968..108B/abstract`

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3 Jobs and Positions

Two exoplanet research fellow positions at Birmingham

Amaury Triaud
Sun, Stars & Exoplanets research group, School of Physics & Astronomy

Deadline, 21 July 2024

The *Sun, Stars and Exoplanets* research group at the University of Birmingham invites inventive and talented individuals to apply for two postdoctoral research positions for an ERC/UKRI funded project entitled CandY: Circumbinary AND rockY that starts on 01 November 2024 and finishes on 31 October 2029.

The successful candidate will join a vibrant group of astronomers. The *Sun, Stars and Exoplanets* group consist of six permanent researchers: Amaury Triaud, Guy Davies, Annelies Mortier, Anjali Piette, Bill Chaplin and Yvonne Ellsworth, along two main research themes: exoplanets and helio/asteroseismology. Members of the group have responsibilities in SPECULOOS, ASTEP, HARPS-N, BiSON, *TESS*, *Kepler* and *PLATO*. The group benefits from newly refurbished offices at the heart of a beautiful campus.

There are two positions for applicants to work with Prof. Amaury Triaud as part of the CandY project.
- For the first position we particularly welcome applicants with expertise in ground & space transit photometry. Experience with photo-dynamical modelling and/or spectro-photometric observations of exoplanet atmospheres will be particularly welcomed.
- For the second position, we are searching for applicants with a proven track record of analysing high-resolution spectra to extract accurate and precise radial velocities, measure stellar activity and retrieve molecular features in exoplanet atmospheres at high-resolution. Experience with N-body integrators, and atmospheric retrieval are also very welcome.
- For both positions, candidates will be asked to go on observing missions in France and Chile.

Mirroring the fact that exoplanets are diverse, we welcome applications from all backgrounds to enrich our research group.

The appointments will be for a three-year term starting on 01 November 2024, with the potential to be extended depending on available funding. The position comes with an allowance to cover international travel and computing. Starting salary is between £34,980 and £44,263 annually, with yearly increments. The full details for the first position can be found at this url:
`https://edzz.fa.em3.oraclecloud.com/hcmUI/CandidateExperience/en/sites/CX_6001/job/4949/`,
and for the second position at this url:
`https://edzz.fa.em3.oraclecloud.com/hcmUI/CandidateExperience/en/sites/CX_6001/job/4950/`.

Applications should include a CV (max 2 pages) with a list of publications (as long as necessary), and a two-page statement describing your research interests and plans, and what expertise and skills you bring to the project, but also to the wider research group. Applicants should also provide contact details for 3 referees. Complete applications should be received by 21 July 2024 for full consideration. In the application form, you will get a question asking to specify your reasons to apply. You should just point to your uploaded documents.
If you think your profile matches both positions, please apply for both but include the same material for both.
We anticipate interviews will take place the week starting on 12 August 2024.

Download/Website: `www.birmingham.ac.uk/sasp/`

Download/Website: `https://edzz.fa.em3.oraclecloud.com/hcmUI/CandidateExperience/en/sites/CX_6001/job/4949`

Download/Website: `https://edzz.fa.em3.oraclecloud.com/hcmUI/CandidateExperience/en/sites/CX_6001/job/4950`

Contact: `a.triaud@bham.ac.uk`

4 Exoplanet Archives

June 2024 Updates at the NASA Exoplanet Archive

The NASA Exoplanet Archive team
Caltech/IPAC-NASA Exoplanet Science Institute, MC 100-22 Pasadena CA 91125

Pasadena CA USA, July 9, 2024

Note: Unless otherwise noted, all planetary and stellar data mentioned in the news are in the Planetary Systems Table, which provides a single location for all self-consistent planetary solutions, and its companion table the Planetary Systems Composite Parameters, which offers a more complete table of parameters combined from multiple references and calculations.

June 27, 2024

Eight New Planets, One New Spectrum

This week's update includes TOI-663 b, c, & d—a three-planet system of transiting sub-Neptunes—and TOI-2374 b and TOI-3071 b, two metal-rich sub-Saturns located in the Neptunian desert. All of these discoveries were found by NASA's TESS.

The other new planets are BD-14 3065 b, KMT-2023-BLG-1431L b, and TIC 365102760 b. You can find all of this week's new planetary data in the Planetary Systems and Planetary Systems Composite tables.

We've also updated Kepler-488 b's status to False Positive Planet based on a published refutation. The object has been removed from the Planetary Systems and Planetary Systems Composite Parameters tables, but its data remain on the Kepler-488 System Overview page, which reflects the object's new status.

We've also added a new WASP-6 b spectrum taken with the Magellan Walter Baade Telescope to our Atmospheric Spectroscopy Table, which now serves five spectra from three telescopes for WASP-6 b. Try our new overplotting feature to compare them on the same plot!

June 12, 2024

Data For 74 Planets!

We've added data for 33 new planets and additional parameter sets for 41 planets that are already in the archive. These data can be viewed by clicking on a system name to go directly to their System Overview page or browse all system parameters in the archive (including this week's new sets) with the Planetary Systems and Planetary Systems Composite tables.

The new planets are HD 73344 b, HD 284149 AB b, KMT-2023-BLG-0469L b, KMT-2023-BLG-0735L b, MOA-2022-BLG-563L b, NGTS-26 b, NGTS-27 b, OGLE-2023-BLG-0836L b, TIC 393818343 b, TOI-128.01 (TOI-128 b), TOI-261.01 (TOI-261 b), TOI-406.01 (TOI-406 b), TOI-654.01 (TOI-645 b), TOI-782 b, TOI-880.02 (TOI-880 b), TOI-907.01 (TOI-907 b), TOI-1410.01 (TOI-1410 b), TOI-1448 b, TOI-1450 A b & c, TOI-1683.01 (TOI-1683 b), TOI-1798.02 (TOI-1798 b), TOI-1806.01 (TOI-1806 b), TOI-2120 b, TOI-2447 b, TOI-3353.01 (TOI-3353 b), TOI-4443.01 (TOI-443 b), TOI-4495.01 (TOI-4495 b), TOI-4527.01 (TOI-4527 b), TOI-4602.01 (TOI-4602 b), TOI-5076 b, TOI-5082.01 (TOI-5082 b), and TOI-5388.01 (TOI-5388 b).

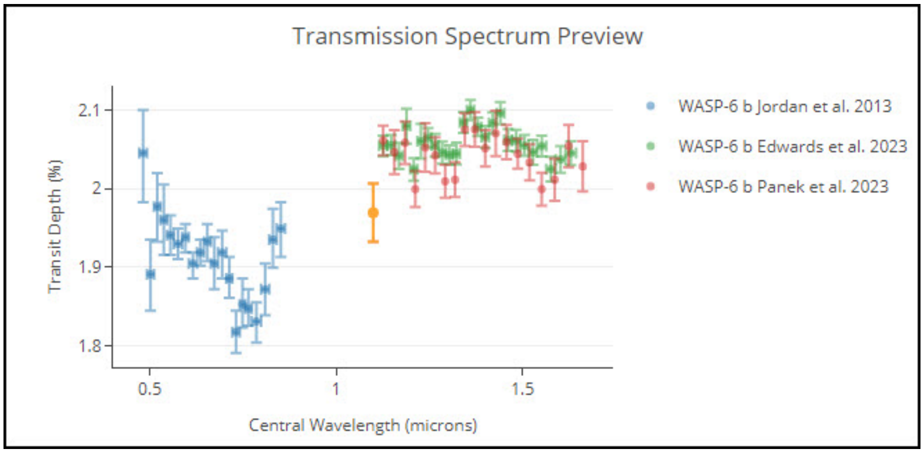

Figure 5: This screen capture demonstrates the Atmospheric Spectroscopy Table's overplotting feature, where multiple spectra of the same type may be compared in the same graph. In this example, the graph contains transmission spectra from three published papers.

The systems with new data this week are Kepler-23 b, c, & d, Kepler-24 b, c, & e, Kepler-26 b & c, Kepler-28 b & c, Kepler-49 b & c, Kepler-52 b & c, Kepler-54 b & c, Kepler-57 b & c, Kepler-58 b & c, Kepler-60 b, c, & d, Kepler-85 b & c, Kepler-128 b & c, Kepler-176 c & d, Kepler-305 b, c, & d, Kepler-345 b & c, L 98-59 b, c, d, & e, TOI-776 b & c, and TOI-2406 b.

Download/Website: `https://exoplanetarchive.ipac.caltech.edu`

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5 As seen on astro-ph

The following list contains exoplanet related entries appearing on astro-ph in 062024.
Disclaimer: The hyperlinks to the astro-ph articles are provided for the convenience of the reader, but the ExoPlanet News cannot be responsible for their accuracy and perpetuity.

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astro-ph/2406.00187: **Are WASP-107-like Systems Consistent with High-eccentricity Migration?** *by Hang Yu, Fei Dai*

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