

Contents

1 Editorial	2
2 Abstracts of refereed papers	3
– Towards characterising rocky worlds: Trends in chemical make-ups of M dwarfs versus GK dwarfs <i>Wang et al.</i>	3
– Resonant sub-Neptunes are puffier <i>Leleu et al.</i>	5
– From super-Earths to sub-Neptunes: Observational constraints and connections to theoretical models <i>Parc et al.</i>	7
– Constraints on the formation history and composition of Kepler planets from their distribution of orbital period ratios <i>Di-Chang Chen, Christoph Mordasini, Ji-Wei Xie, Ji-Lin Zhou & Alexandre Emsenhuber</i>	9
– Large Interferometer For Exoplanets (LIFE) – XIII. The value of combining thermal emission and reflected light for the characterization of Earth twins <i>Alei et al.</i>	11
– No signature of the birth environment of exoplanets from their host stars' Mahalanobis phase space <i>G. A. Blaylock-Squibbs, R. J. Parker & E. C. Daffern-Powell</i>	12
3 Jobs and Positions	13
– Two exoplanet research fellow positions at Birmingham	13
4 Exoplanet Archives	15
– June 2024 Updates at the NASA Exoplanet Archive <i>The NASA Exoplanet Archive team</i>	15
5 As seen on astro-ph	17

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 L^AT_EX 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 Schlarman
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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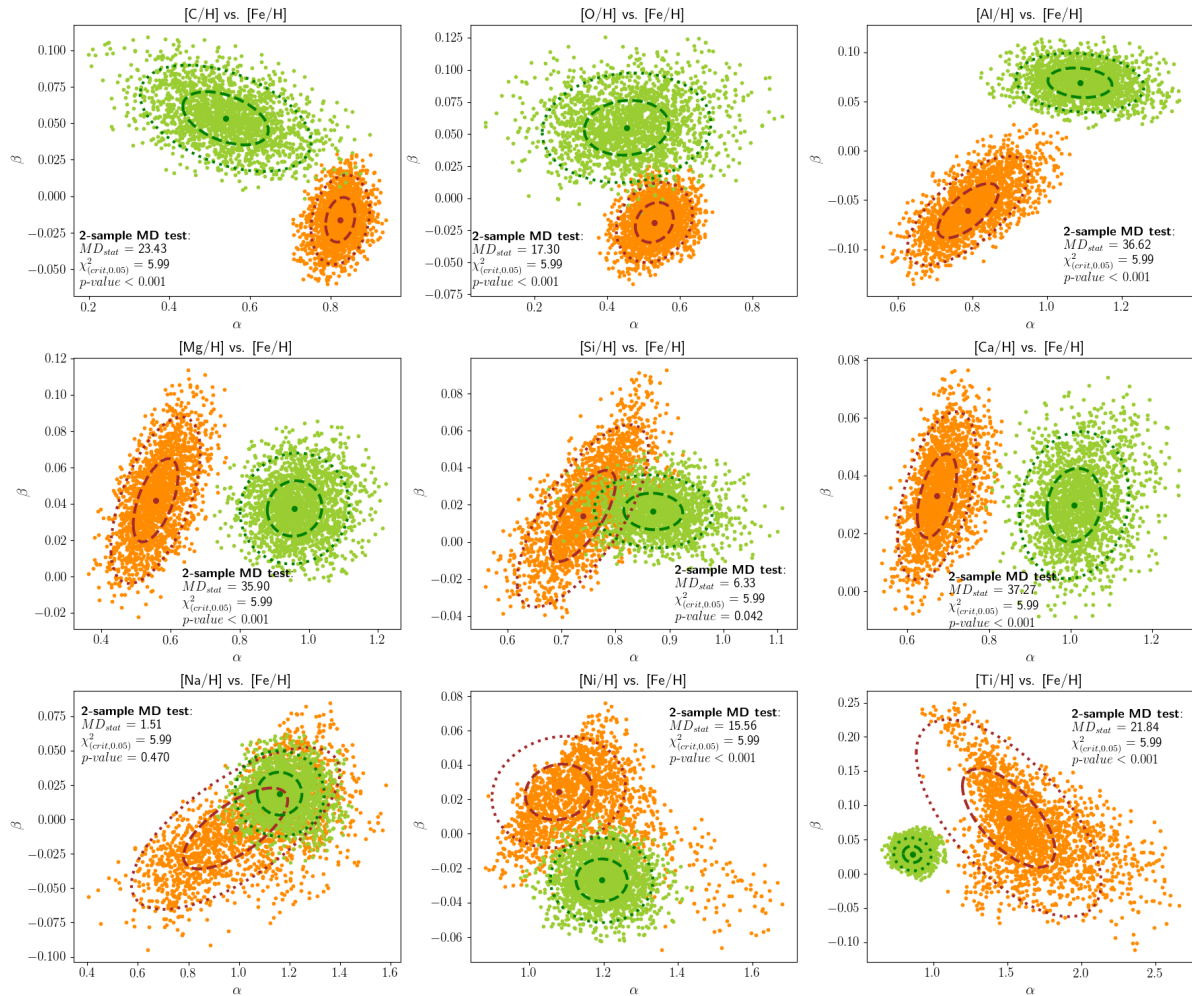


Figure 1: Comparison of the model coefficients (slope α and intercept β) of the chemical trends of $[X/H]-[Fe/H]$ between M dwarfs (orange dots) and GK dwarfs (green dots), along with the statistical test results with a 2-sample multivariate Mahalanobis Distance (MD) test of null hypothesis. The dash 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 Leleu¹, Jean-Baptiste Delisle¹, Remo Burn², André Izidoro³, Stéphane Udry¹, Xavier Dumusque¹, Christophe Lovis¹, Sarah Millholland^{4,5}, Léna Parc¹, François Bouchy¹, Vincent Bourrier¹, Yann Alibert⁶, João Faria¹, Christoph Mordasini⁶, and Damien Ségransan¹

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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 $0.002_{0.001}^{0.01}$) 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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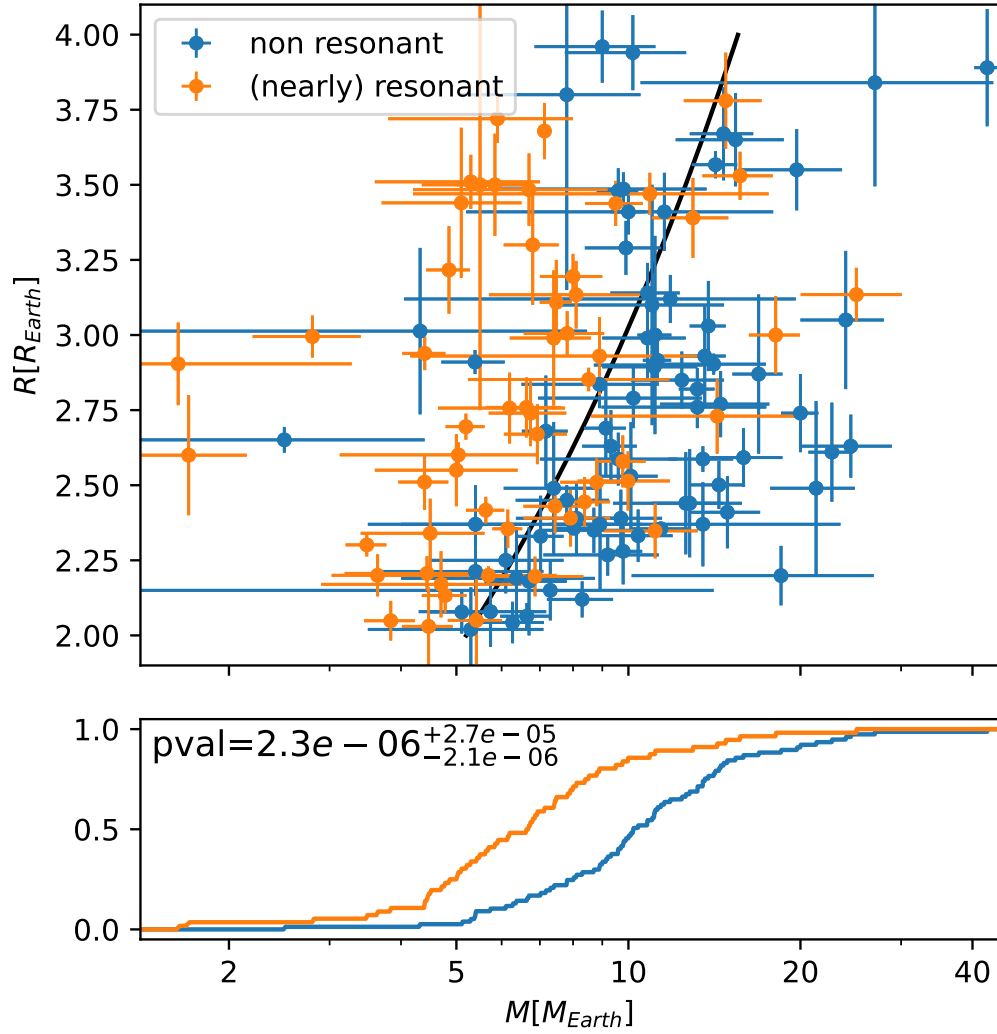


Figure 2: Top panel: Mass-radius relation of the full sample (133 sub-Neptunes) for planets that are (nearly) resonant ($|P_{out}/P_{in} - (k + q)/k| < 0.05$), and non-resonant ($|P_{out}/P_{in} - (k + q)/k| > 0.05$ or single planets), with P_{in} and P_{out} the orbital period of the inner and outer 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 from 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 ($1.8 R_{\oplus} \leq R_p \leq 2.8 R_{\oplus}$) 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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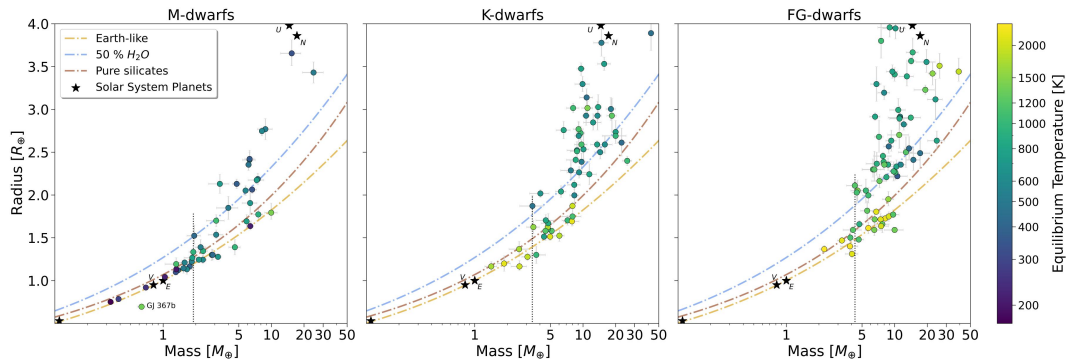


Figure 3: M-R diagram of small planets around M-dwarfs, K-dwarfs, and FG-dwarfs from the PlanetS catalog. The planets are color-coded by their equilibrium temperature calculate within the catalog with a bond albedo of 0 and a total heat redistribution. The composition lines of pure-silicates (brown) 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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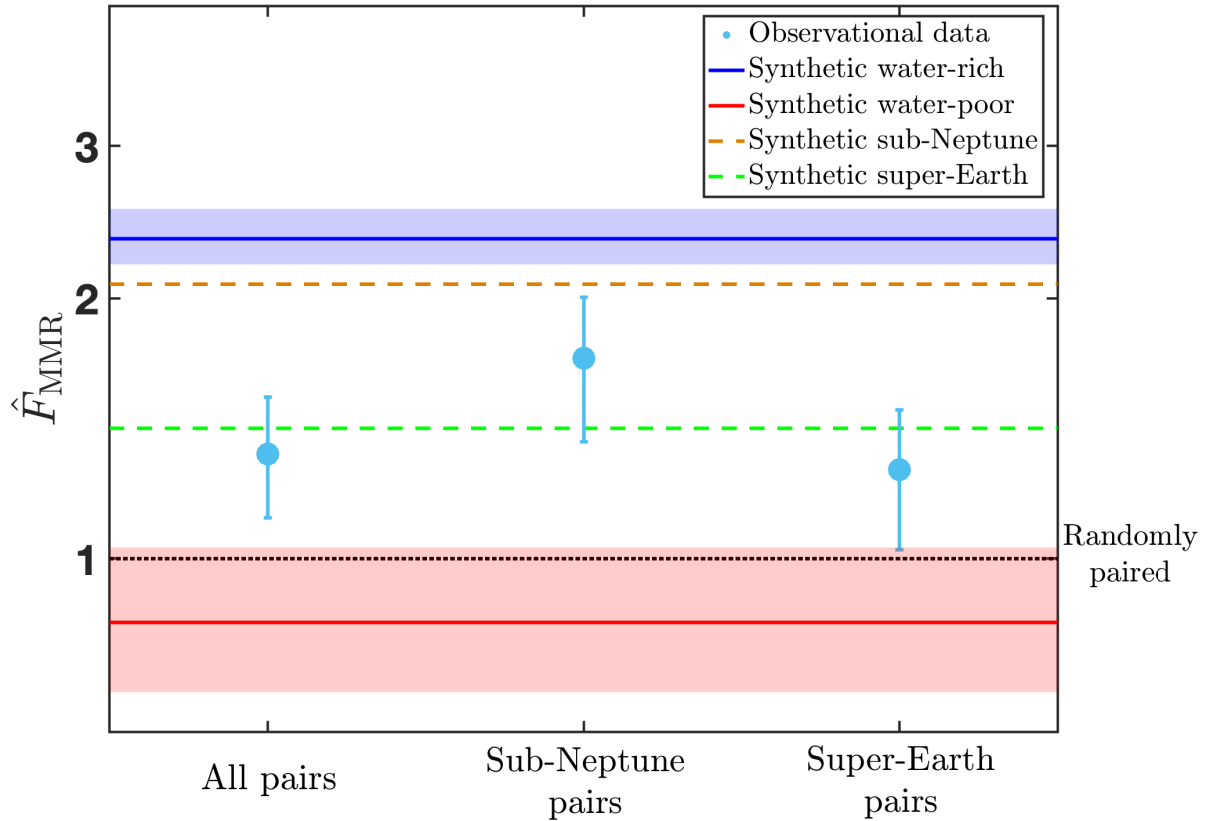


Figure 4: Normalised fraction of near-MMRs pairs, \hat{F}_{MMR} (solid points) with 1σ uncertainties (vertical bars) for all actual planet pairs, sub-Neptune pairs, and super-Earth planet pairs in Kepler multiple transiting systems. The two horizontal solid lines and shaded regions represent the theoretical 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 H₂O, O₂, and O₃ 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 CO₂, H₂O, and O₃ 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 CH₄. A joint retrieval on HWO and LIFE data would accurately define the atmospheric thermal profile and planetary parameters. It would decisively constrain CO₂, H₂O, O₂, and O₃ and find weak constraints on CO and CH₄. 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

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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

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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).

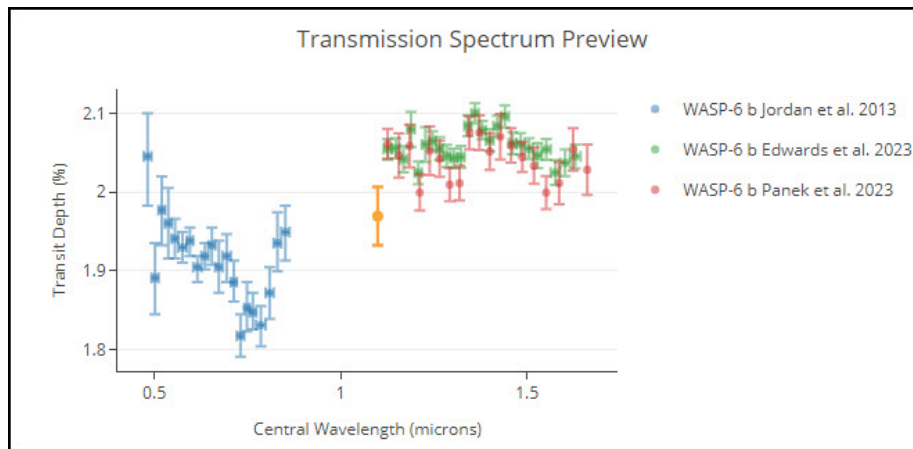


Figure 5: This screen capture demonstrates the Atmospheric Spectroscopy Table’s overplotting feature, where multiple spectra of the same type may be compared in the same graph. In this example, the graph contains transmission spectra from three published papers.

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.

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June 2024

- astro-ph/2405.05115: **Likelihood and appearance of life beyond the Earth: An astronomical perspective** by *Floris van der Tak*
- astro-ph/2406.00229: **Accurate and Model Independent Radius Determination of Single FGK and M Dwarfs Using Gaia DR3 Data** by *Rocio Kiman et al.*
- astro-ph/2406.00187: **Are WASP-107-like Systems Consistent with High-eccentricity Migration?** by *Hang Yu, Fei Dai*
- astro-ph/2406.00107: **Direct Imaging Detection of the Protoplanet AB Aurigae b at Wavelengths Covering Pa β : Rebuttal to Biddle et al. (2024)** by *Thayne Currie*
- astro-ph/2406.00124: **Dust evolution during the protostellar collapse: influence on the coupling between the neutral gas and the magnetic field** by *Valentin Vallucci-Goy et al.*
- astro-ph/2406.00111: **Stellar Characterization and Chemical Abundances of Exoplanet Hosting M dwarfs from APOGEE Spectra: Future JWST Targets** by *Edypo Melo et al.*
- astro-ph/2406.00526: **Early-time small-scale structures in hot-exoplanet atmosphere simulations** by *J. W. Skinner, J. Y-K. Cho*
- astro-ph/2406.00640: **Monte Carlo simulation of UV-driven synthesis of complex organic molecules on icy grain surfaces** by *Yoko Ochiai et al.*
- astro-ph/2406.00794: **Detection of an Earth-sized exoplanet orbiting the nearby ultracool dwarf star SPECULOOS-3** by *Michaël Gillon et al.*
- astro-ph/2406.00875: **Ohm's Law, the Reconnection Rate, and Energy Conversion in Collisionless Magnetic Reconnection** by *Yi-Hsin Liu et al.*
- astro-ph/2406.01809: **Use the 4S (Signal-Safe Speckle Subtraction): Explainable Machine Learning reveals the Giant Exoplanet AF Lep b in High-Contrast Imaging Data from 2011** by *Markus J. Bonse et al.*
- astro-ph/2406.01716: **CHEOPS in-flight performance: A comprehensive look at the first 3.5 years of operations** by *A. Fortier et al.*
- astro-ph/2406.01492: **The TEMPO Survey II: Science Cases Leveraged from a Proposed 30-Day Time Domain Survey of the Orion Nebula with the Nancy Grace Roman Space Telescope** by *Melinda Soares-Furtado et al.*
- astro-ph/2406.02682: **The near-infrared degree of polarization in debris disks. Toward a self-consistent approach to model scattered light observations** by *Johan Olofsson et al.*
- astro-ph/2406.02754: **Warped Disk Evolution in Grid-Based Simulations** by *C. N. Kimmig, C. P. Dullemond*
- astro-ph/2406.02544: **Asymmetry, Gap Opening and High Accretion Rate on DM Tau: A Hypothesis Based on Interaction of Magnetized Disk Wind with Planet** by *Yinhao Wu*
- astro-ph/2406.01955: **Chemical mapping of temperate sub-Neptune atmospheres: Constraining the deep-interior H₂O/H₂ using the atmospheric CO₂/CH₄** by *Jeehyun Yang, Renyu Hu*
- astro-ph/2406.02305: **Debris Disks can Contaminate Mid-Infrared Exoplanet Spectra: Evidence for a Circumstellar Debris Disk around Exoplanet Host WASP-39** by *Laura Flagg et al.*
- astro-ph/2406.02231: **Longitudinal Filtering, Sponge Layers, and Equatorial Jet Formation in a General Circulation Model of Gaseous Exoplanets** by *D. A. Christie et al.*
- astro-ph/2406.02179: **Abundances of trace constituents in Jupiter's atmosphere inferred from Herschel/PACS observations** by *Cyril Gapp et al.*
- astro-ph/2406.03490: **Simultaneous retrieval of orbital phase resolved JWST/MIRI emission spectra of the hot Jupiter WASP-43b: evidence of water, ammonia and carbon monoxide** by *Jingxuan Yang et al.*

- astro-ph/2406.03189: **Novel Atmospheric Dynamics Shape Inner Edge of Habitable Zone Around White Dwarfs** by *Ruizhi Zhan et al.*
- astro-ph/2406.02961: **Carbon Isotope Fractionation of Complex Organic Molecules in Star-Forming Cores** by *Ryota Ichimura et al.*
- astro-ph/2406.03060: **Whistler waves in the quasi-parallel and quasi-perpendicular magnetosheath** by *Ida Svenningsson et al.*
- astro-ph/2406.03094: **BEBOP V. Homogeneous Stellar Analysis of Potential Circumbinary Planet Hosts** by *Alix V. Freckelton et al.*
- astro-ph/2406.03977: **PyExoCross: a Python program for generating spectra and cross-sections from molecular line lists** by *Jingxin Zhang et al.*
- astro-ph/2406.04003: **High contrast at short separation with VLTI/GRAVITY: Bringing Gaia companions to light** by *N. Pourré et al.*
- astro-ph/2406.04160: **Disk Evolution Study Through Imaging of Nearby Young Stars (DESTINY): PDS 111, an old T Tauri star with a young-looking disk** by *Annelotte Derkink et al.*
- astro-ph/2406.04288: **Trials and Tribulations in the Reanalysis of KELT-24 b: a Case Study for the Importance of Stellar Modeling** by *Mark R. Giovinnazzi et al.*
- astro-ph/2406.04450: **Sulfur Dioxide and Other Molecular Species in the Atmosphere of the Sub-Neptune GJ 3470 b** by *Thomas G. Beatty et al.*
- astro-ph/2406.04457: **Cold water emission cannot be used to infer depletion of bulk elemental oxygen [O/H] in disks** by *Maxime Ruaud, Uma Gorti*
- astro-ph/2406.04463: **Revisiting astrophysical bounds on continuous spontaneous localization models** by *Martin Miguel Ocampo et al.*
- astro-ph/2406.03676: **Revisiting the accretion disc spectra of Dwarf Novae and Novalike variables: implications for the standard disc model** by *Gabriella Zsidi et al.*
- astro-ph/2406.04311: **From super-Earths to sub-Neptunes: Observational constraints and connections to theoretical models** by *Léna Parc et al.*
- astro-ph/2406.04870: **The β Pictoris b Hill sphere transit campaign. Paper II: Searching for the signatures of the β Pictoris exoplanets through time delay analysis of the δ Scuti pulsations** by *Sebastian Zieba et al.*
- astro-ph/2406.04946: **Effect of time-varying X-ray emission from stellar flares on the ionization of protoplanetary disks** by *Haruka Washinoue et al.*
- astro-ph/2406.05234: **TESS Hunt for Young and Maturing Exoplanets (THYME) X: a two-planet system in the 210 Myr MELANGE-5 Association** by *Pa Chia Thao et al.*
- astro-ph/2406.05447: **The PLATO Mission** by *Heike Rauer et al.*
- astro-ph/2406.06219: **Mind the gap: Distinguishing disc substructures and their impact on the inner disc composition** by *Jingyi Mah et al.*
- astro-ph/2406.06278: **Three super-Earths and a possible water world from TESS and ESPRESSO** by *M. J. Hobson et al.*
- astro-ph/2406.06493: **Probing the Heights and Depths of Y Dwarf Atmospheres: A Retrieval Analysis of the JWST Spectral Energy Distribution of WISE J035934.06–540154.6** by *Harshil Kothari et al.*
- astro-ph/2406.06688: **9 new M Dwarf Planet Candidates from TESS Including 5 Gas Giants** by *Yoshi Nike Emilia Eschen, Michelle Kunitomo*
- astro-ph/2406.06705: **The largest metallicity difference in twin systems: high-precision abundance analysis of the benchmark pair Krios & Kronos** by *P. Miquelarena et al.*
- astro-ph/2406.05952: **Angular momentum transport via gravitational instability in the Elias 2-27 disc** by *Cristiano Longarini et al.*
- astro-ph/2406.07760: **Rocky planet formation in compact disks around M dwarfs** by *M. Sanchez et al.*
- astro-ph/2406.07749: **Influence of Orbit and Mass Constraints on Reflected Light Characterization of Directly Imaged Rocky Exoplanets** by *Arnaud Salvador et al.*
- astro-ph/2406.07689: **Evidence for Non-zero Turbulence in the Protoplanetary disc around IM Lup** by *Kevin*

- Flaherty et al.*
 astro-ph/2406.07427: **Support for fragile porous dust in a gravitationally self-regulated disk around IM Lup** by *Takahiro Ueda et al.*
- astro-ph/2406.07154: **A portrait of the rotation of Ultra-Cool Dwarfs revealed by TESS** by *D. O. Fontinele et al.*
- astro-ph/2406.07030: **Exoplanets in reflected starlight with dual-field interferometry: A case for shorter wavelengths and a fifth Unit Telescope at VLTI/Paranal** by *S. Lacour et al.*
- astro-ph/2406.06971: **Polar alignment of a dusty circumbinary disc – I. Dust ring formation** by *Jeremy L. Smallwood et al.*
- astro-ph/2406.06885: **The Prevalence of Resonance Among Young, Close-in Planets** by *Fei Dai et al.*
- astro-ph/2406.08677: **Forming the Trappist-1 system in two steps during the recession of the disc inner edge** by *Gabriele Pichierri et al.*
- astro-ph/2406.08558: **High-resolution transmission spectroscopy of warm Jupiters: An ESPRESSO sample with predictions for ANDES** by *Bibiana Prinoth et al.*
- astro-ph/2406.08555: **Buoyancy torques prevent low-mass planets from stalling in low-turbulence radiative disks** by *Alexandros Ziampras et al.*
- astro-ph/2406.08376: **The unresolved mystery of dust particle swarms within the magnetosphere** by *Max Sommer*
- astro-ph/2406.08588: **Composition Tracking for Collisions Between Differentiated Bodies in REBOUND** by *Noah Ferich et al.*
- astro-ph/2406.08304: **NIRPS first light and early science: breaking the 1 m/s RV precision barrier at infrared wavelengths** by *Étienne Artigau et al.*
- astro-ph/2406.08166: **Exploring the ultra-hot Jupiter WASP-178b. Constraints on atmospheric chemistry and dynamics from a joint retrieval of VLT/CRIRES⁺ and space photometric data** by *D. Cont et al.*
- astro-ph/2406.07927: **ExoSpikeNet: A Light Curve Analysis Based Spiking Neural Network for Exoplanet Detection** by *Maneet Chatterjee et al.*
- astro-ph/2406.07896: **Investigating Sulfur Chemistry in the HD 163296 disk** by *Rong Ma et al.*
- astro-ph/2406.08348: **The atmospheric composition of the ultra-hot Jupiter WASP-178 b observed with ESPRESSO** by *Y. C. Damasceno et al.*
- astro-ph/2406.09595: **HD 21520 b: a warm sub-Neptune transiting a bright G dwarf** by *Molly Nies et al.*
- astro-ph/2406.09594: **Turbulence and the characteristics of circumstellar discs** by *R. Riaz et al.*
- astro-ph/2406.09501: **Observational characteristics of circum-planetary-mass-object disks in the era of James Webb Space Telescope** by *Xilei Sun et al.*
- astro-ph/2406.09359: **More Likely Than You Think: Inclination-Driving Secular Resonances are Common in Known Exoplanet Systems** by *Thea Faridani et al.*
- astro-ph/2406.09528: **JWST/NIRCam 4-5 μ m Imaging of the Giant Planet AF Lep b** by *Kyle Franson et al.*
- astro-ph/2406.09275: **The CUISINES Framework for Conducting Exoplanet Model Intercomparison Projects, Version 1.0** by *Linda E. Sohl et al.*
- astro-ph/2406.09225: **Probing atmospheric escape through metastable He I triplet lines in 15 exoplanets observed with SPIRou** by *A. Masson et al.*
- astro-ph/2406.09186: **A formation pathway for terrestrial planets with moderate water content involving atmospheric-volatile recycling** by *Jonas Müller et al.*
- astro-ph/2406.08949: **TOI-837 b: characterisation, formation and evolutionary history of an infant warm Saturn-mass planet** by *M. Damasso et al.*
- astro-ph/2406.08794: **Constraints on the formation history and composition of Kepler planets from their distribution of orbital period ratios** by *Di-Chang Chen et al.*
- astro-ph/2406.09337: **Different Planetary Eccentricity-Period (PEP) Distributions of Small- and Giant-Planets** by *Dolev Bashi et al.*
- astro-ph/2406.10217: **MINDS. A multi-instrument investigation into the molecule-rich JWST-MIRI spectrum**

- of the DF Tau binary system** by *Sierra L. Grant et al.*
- astro-ph/2406.10207: **Latitudinal Asymmetry in the Dayside Atmosphere of WASP-43b** by *Ryan C. Challener et al.*
- astro-ph/2406.10032: **GASTLI: An open-source coupled interior-atmosphere model to unveil gas giant composition** by *Lorena Acuña et al.*
- astro-ph/2406.09957: **Searching for Jupiter and Saturn analog planets with potential icy exomoons – a Panspermia perspective** by *Balazs Bradač*
- astro-ph/2406.09802: **Simulating the Escaping Atmosphere of GJ 436 b with Two-fluid Magnetohydrodynamic Models** by *Lei Xing et al.*
- astro-ph/2406.09863: **Evidence for Morning-to-Evening Limb Asymmetry on the Cool Low-Density Exoplanet WASP-107b** by *Matthew M. Murphy et al.*
- astro-ph/2406.11627: **Seeing the unseen: a method to detect unresolved rings in protoplanetary disks** by *Chiara E. Scardoni et al.*
- astro-ph/2406.09690: **Simulating Brown Dwarf Observations for Various Mass Functions, Birthrates, and Low-mass Cutoffs** by *Yadukrishna Raghunath et al.*
- astro-ph/2406.09641: **Phase-resolving the absorption signatures of water and carbon monoxide in the atmosphere of the ultra-hot Jupiter WASP-121b with GEMINI-S/IGRINS** by *Joost P. Wardenier et al.*
- astro-ph/2406.09893: **The nucleosynthetic fingerprint of the outermost protoplanetary disk and early Solar System dynamics** by *Elishevah van Kooten et al.*
- astro-ph/2406.10335: **Vertical shear instability with dust evolution and consistent cooling times. On the importance of the initial dust distribution** by *Thomas Pfeil et al.*
- astro-ph/2406.10363: **The Focal-plane Actualized Shifted Technique Realized for a Shack Hartmann Wavefront Sensor (fastrSHWFS)** by *Benjamin L. Gerard et al.*
- astro-ph/2406.10384: **Characterizing planetary systems with SPIRou: a temperate sub-Neptune exoplanet orbiting the nearby fully-convective star GJ 1289 and a candidate around GJ 3378** by *C. Moutou et al.*
- astro-ph/2406.10451: **Climate Change Task Force Report for the American Astronomical Society** by *T. A. Rector et al.*
- astro-ph/2406.10547: **Four microlensing giant planets detected through signals produced by minor-image perturbations** by *Cheongho Han et al.*
- astro-ph/2406.10731: **Anisotropic Heating and Parallel Heat Flux in Electron-only Magnetic Reconnection with Intense Guide Fields** by *Jincai Ren et al.*
- astro-ph/2406.10771: **Predicting Exoplanetary Features with a Residual Model for Uniform and Gaussian Distributions** by *Andrew Sweet*
- astro-ph/2406.10901: **Magnetohydrodynamical modeling of star-disk formation: from isolated spherical collapse towards incorporation of external dynamics** by *M. Kuffmeier*
- astro-ph/2406.12037: **C/O Ratios and the formation of wide separation exoplanets** by *Edwin A. Bergin et al.*
- astro-ph/2406.11644: **Detecting Planetary Oblateness in the Era of JWST: A Case Study of Kepler-167e** by *Quanyi Liu et al.*
- astro-ph/2406.11593: **Astrometry as a Tool for Discovering and Weighing Faint Companions to Nearby Stars** by *Timothy D. Brandt*
- astro-ph/2406.11556: **PLATO's signal and noise budget** by *Anko Börner et al.*
- astro-ph/2406.11530: **Insights on the Formation Conditions of Uranus and Neptune from their Deep Elemental Compositions** by *Olivier Mousis et al.*
- astro-ph/2406.11470: **Seven white dwarfs with circumstellar gas discs II: Tracing the composition of exoplanetary building blocks** by *L. K. Rogers et al.*
- astro-ph/2406.13037: **Large Interferometer For Exoplanets (LIFE): XIII. The Value of Combining Thermal Emission and Reflected Light for the Characterization of Earth Twins** by *E. Alei et al.*
- astro-ph/2406.12996: **TOI-2374 b and TOI-3071 b: two metal-rich sub-Saturns well within the Neptunian desert** by *Alejandro Hacker et al.*

- astro-ph/2406.12819: **A Dust-Trapping Ring in the Planet-Hosting Disk of Elias 2-24** by *Adolfo S. Carvalho et al.*
- astro-ph/2406.12813: **Low-mass planets falling into gaps with cyclonic vortices** by *Raúl O. Chametla et al.*
- astro-ph/2406.12798: **The Aligned Orbit of a Hot Jupiter around the M Dwarf TOI-4201** by *Tianjun Gan et al.*
- astro-ph/2406.12340: **Sequential giant planet formation initiated by disc substructure** by *Tommy Chi Ho Lau et al.*
- astro-ph/2406.12765: **Windows Into Other Worlds: Pitfalls in the physical interpretation of exoplanet atmospheric spectroscopy** by *Darius Modirrousta-Galian et al.*
- astro-ph/2406.12716: **Concurrent Accretion and Migration of Giant Planets in their Natal Disks with Consistent Accretion Torque** by *Ya-Ping Li et al.*
- astro-ph/2406.12512: **A new lever on exoplanetary B fields: measuring heavy ion velocities** by *Arjun B. Savel et al.*
- astro-ph/2406.12393: **Ariel stellar characterisation II. Chemical abundances of carbon, nitrogen, and oxygen for 181 planet-host FGK dwarf stars** by *R. da Silva et al.*
- astro-ph/2406.12240: **A Comparative Simulation Study of Hot and Ultra-hot Jupiter Atmospheres using Different Ground-based High-resolution Spectrographs with Cross-correlation Spectroscopy** by *Dwipayan Dubey, Liton Majumdar*
- astro-ph/2406.12239: **The Distribution of Planet Radius in Kepler Multiplanet Systems Depends on Gap Complexity** by *David R. Rice et al.*
- astro-ph/2406.12794: **The Hycean Paradigm in the Search for Life Elsewhere** by *Nikku Madhusudhan*
- astro-ph/2406.13637: **The Source of Hydrogen in Earth's Building Blocks** by *Thomas J Barrett et al.*
- astro-ph/2406.14006: **Revealing asymmetry on midplane of proto-planetary disc through modelling of axisymmetric emission: methodology** by *Masataka Aizawa et al.*
- astro-ph/2406.14072: **IGRINS observations of WASP-127 b: H₂O, CO, and super-Solar atmospheric metallicity in the inflated sub-Saturn** by *Krishna Kanumalla et al.*
- astro-ph/2406.14293: **Abundant hydrocarbons in the disk around a very-low-mass star** by *A. M. Arabhavi et al.*
- astro-ph/2406.14444: **Combining reference-star and angular differential imaging for high-contrast imaging of extended sources** by *Sandrine Juillard et al.*
- astro-ph/2406.14560: **OH mid-infrared emission as a diagnostic of H₂O UV photodissociation. III. Application to planet-forming disks** by *Benoît Tabone et al.*
- astro-ph/2406.14626: **Inner walls or vortices? Crescent-shaped asymmetries in ALMA observations of proto-planetary discs** by *Álvaro Ribas et al.*
- astro-ph/2406.14694: **Presolar grains** by *Nan Liu*
- astro-ph/2406.15611: **Pade: A code for protoplanetary disk turbulence based on Pade differencing** by *Karim Shariff*
- astro-ph/2406.15594: **Detecting and Classifying Flares in High-Resolution Solar Spectra with Supervised Machine Learning** by *Nicole Hao et al.*
- astro-ph/2406.15543: **Multiple Clues for Dayside Aerosols and Temperature Gradients in WASP-69 b from a Panchromatic JWST Emission Spectrum** by *Everett Schlawin et al.*
- astro-ph/2406.15308: **Optically Quiet, But FUV Loud: Results from comparing the far-ultraviolet predictions of flare models with TESS and HST** by *James A. G. Jackman et al.*
- astro-ph/2406.15021: **A computational model for irradiance on close-in planetary systems** by *Mradumay Sadh, Lorenzo Gavassino*
- astro-ph/2406.15136: **Transmission Spectroscopy of the Habitable Zone Exoplanet LHS 1140 b with JWST/NIRISS** by *Charles Cadieux et al.*
- astro-ph/2406.15028: **The high-contrast performance of the Keck Planet Imager and Characterizer** by *Jason J. Wang et al.*
- astro-ph/2406.15622: **Compaction during fragmentation and bouncing produces realistic dust grain porosities**

- in protoplanetary discs** by *Stéphane Michoulier et al.*
- astro-ph/2406.16169: **On the origin of polar planets around single stars** by *Cheng Chen et al.*
- astro-ph/2406.16104: **Interior convection regime, host star luminosity, and predicted atmospheric CO₂ abundance in terrestrial exoplanets** by *Antonin Affholder et al.*
- astro-ph/2406.15986: **Refining the WASP-132 multi-planetary system: discovery of a cold giant planet and mass measurement of a hot super-Earth** by *N. Grieves et al.*
- astro-ph/2406.16029: **Mind the Trap: Non-negligible effect of volatile trapping in ice on C/O ratios in protoplanetary disks and exoplanetary atmospheres** by *N. F. W. Ligterink et al.*
- astro-ph/2406.16024: **Atmospheric Helium Abundances in the Giant Planets** by *N. Nettelmann et al.*
- astro-ph/2406.16274: **Dynamical structures of misaligned circumbinary planets under hierarchical three-body systems** by *Hanlun Lei, Yanxiang Gong*
- astro-ph/2406.16498: **PRODIGE – Planet-forming disks in Taurus with NOEMA** by *R. Franceschi et al.*
- astro-ph/2406.16702: **North-PHASE: Studying Periodicity, Hot Spots, Accretion Stability and Early Evolution in young stars in the northern hemisphere** by *A. Sicilia-Aguilar et al.*
- astro-ph/2406.17093: **Forming Massive Terrestrial Satellites through Binary-Exchange Capture** by *Darren M. Williams, Michael E. Zuger*
- astro-ph/2406.17110: **A multi-frequency spaceborne radar perspective of deep convection** by *Randy J. Chase et al.*
- astro-ph/2406.17934: **Rapid protoplanet formation in vortices: three-dimensional local simulations with self-gravity** by *Wladimir Lyra et al.*
- astro-ph/2406.17671: **Unraveling the binary nature of HQ Tau: A brown dwarf companion revealed using multi-variate Gaussian process** by *Kim Pouilly et al.*
- astro-ph/2406.17648: **Revising Properties of Planet-Host Binary Systems. IV. The Radius Distribution of Small Planets in Binary Star Systems is Dependent on Stellar Separation** by *Kendall Sullivan et al.*
- astro-ph/2406.17367: **Chemical Evolution of Complex Organic Molecules in Turbulent Protoplanetary Disks: Effect of stochastic UV irradiation** by *Taiki Suzuki et al.*
- astro-ph/2406.17332: **The California Legacy Survey V. Chromospheric Activity Cycles in Main Sequence Stars** by *Howard Isaacson et al.*
- astro-ph/2406.17259: **A General-Purpose Transit Simulator for Arbitrary Shaped Objects Orbiting Stars** by *Ushasi Bhowmick, Vikram Khaire*
- astro-ph/2406.17584: **Local Spherical Collapsing Box in Athena++: Numerical Implementation and Benchmark Tests** by *Ziyan Xu et al.*
- astro-ph/2406.18638: **Absence of a Correlation between White Dwarf Planetary Accretion and Primordial Stellar Metallicity** by *Sydney Jenkins et al.*
- astro-ph/2406.18657: **Exploring the Complex Ionization Environment of the Turbulent DM Tau Disk** by *Deryl E. Long et al.*
- astro-ph/2406.18653: **Unveiling the internal structure and formation history of the three planets transiting HIP 29442 (TOI-469) with CHEOPS** by *J. A. Egger et al.*
- astro-ph/2406.18646: **Using 3.4- μ m Variability towards White Dwarfs as a Signpost of Remnant Planetary Systems** by *Joseph A. Guidry et al.*
- astro-ph/2406.18487: **14 New Light Curves and an Updated Ephemeris for the Hot Jupiter HAT-P-54 b** by *Heather B. Hewitt et al.*
- astro-ph/2406.18631: **HATS-38 b and WASP-139 b join a growing group of eccentric hot Neptunes on polar orbits** by *Juan I. Espinoza-Retamal et al.*
- astro-ph/2406.18461: **Broadening the Canonical Picture of EUV-Driven Photoevaporation of Accretion Disks** by *Riouhei Nakatani et al.*
- astro-ph/2406.18271: **Measurement of Solar Differential Rotation by Absolutely Calibrated Iodine-Cell Spectroscopy** by *Yoichi Takeda*
- astro-ph/2406.18267: **New ephemerides and detection of transit-timing variations in the K2-138 system using**

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- astro-ph/2406.18486: **White dwarf constraints on geological processes at the population level** by *Andrew M. Buchan et al.*
- astro-ph/2406.19438: **Shoulder of Dust Rings Formed by Planet-disk Interactions** by *Jiaqing Bi, Min-Kai Lin*
- astro-ph/2406.18991: **Resonant sub-Neptunes are puffier** by *Adrien Leleu et al.*
- astro-ph/2406.18886: **The Space Coronagraph Optical Bench (SCoOB): 5. End-to-end simulations of polarization aberrations** by *Ramya M Anche et al.*
- astro-ph/2406.18834: **Eccentricity and Inclination of Massive Planets Inside Low-density Cavities: Results of 3D Simulations** by *M. M. Romanova et al.*
- astro-ph/2406.19177: **Stability of the Potential Super Jupiter in Alpha Centauri System** by *Tinglong Feng*
- astro-ph/2406.19734: **Weyl formulae for some singular metrics with application to acoustic modes in gas giants** by *Yves Colin de Verdière et al.*
- astro-ph/2406.19843: **First JVLA Radio Observation on PDS70** by *Hauyu Baobab Liu et al.*
- astro-ph/2406.19923: **Water Evolution & Inventories of Super-Earths Orbiting Late M-Dwarfs** by *Keavin Moore et al.*
- astro-ph/2406.20023: **The Mean Longitudinal Magnetic Field and its Uses in Radial-Velocity Surveys** by *F. Rescigno et al.*
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