# ExoPlanet News
An Electronic Newsletter

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## Contents

# 1 Editorial

Dear readers,

Welcome to the June 2022 edition of the ExoPlanet News!

In this issue you will find abstracts of scientific papers, job advertisements, announcements, updates from the Exoplanet archive, and an overview of exoplanet-related articles on astro-ph.

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 for submitting contributions, as well as all previous editions of ExoPlanet News, can be found on the ExoPlanet News webpage (http://nccr-planets.ch/exoplanetnews/).

The next issue will appear on July 12, 2022.

Daniel Angerhausen
Lokesh Mishra
Holly Capelo
Julia Venturini
Timm-Emanuel Riesen

# 2 Abstracts of refereed papers

## Calibrated Gas Accretion and Orbital Migration of Protoplanets in 1D Disc Models

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*Astronomy & Astrophysics, accepted (arXive 2205.02858)*

We aim to develop a simple prescription for migration and accretion in 1D disc models, calibrated with results of 3D hydrodynamic simulations. Our focus lies on non-self-gravitating discs, but we also discuss to what degree our prescription could be applied when the discs are self-gravitating.

We study migration using torque densities. Our model for the torque density is based on existing fitting formulas, which we subsequently modify to prevent premature gap-opening. At higher planetary masses, we also apply torque densities from hydrodynamic simulations directly to our 1D model. These torque densities allow modelling the orbital evolution of an initially low-mass planet that undergoes runaway-accretion to become a massive planet. The two-way exchange of angular momentum between disc and planet is included. This leads to a self-consistent treatment of gap formation that only relies on directly accessible disc parameters. We present a formula for Bondi- and Hill- gas accretion in the disc-limited regime. This formula is self-consistent in the sense that mass is removed from the disc in the location from where it is accreted. Fig. 1 shows an exampe of the time evolution of semi-major axis and mass of a growing, migrating planet. Our proposed model ”High mass torque” is shown as purple dash-dotted line.

We find that the resulting evolution in mass and semi-major axis in the 1D framework is in good agreement with those from 3D hydrodynamical simulations for a range of parameters.

Our prescription is valuable for simultaneously modelling migration and accretion in 1D-models. We conclude that it is appropriate and beneficial to apply torque densities from hydrodynamic simulations in 1D models, at least in the parameter space we study here. More work is needed to in order to determine whether our approach is also applicable in an even wider parameter space and in situations with more complex disc thermodynamics, or when the disc is self-gravitating.

*Download/Website:* `https://arxiv.org/abs/2205.02858`

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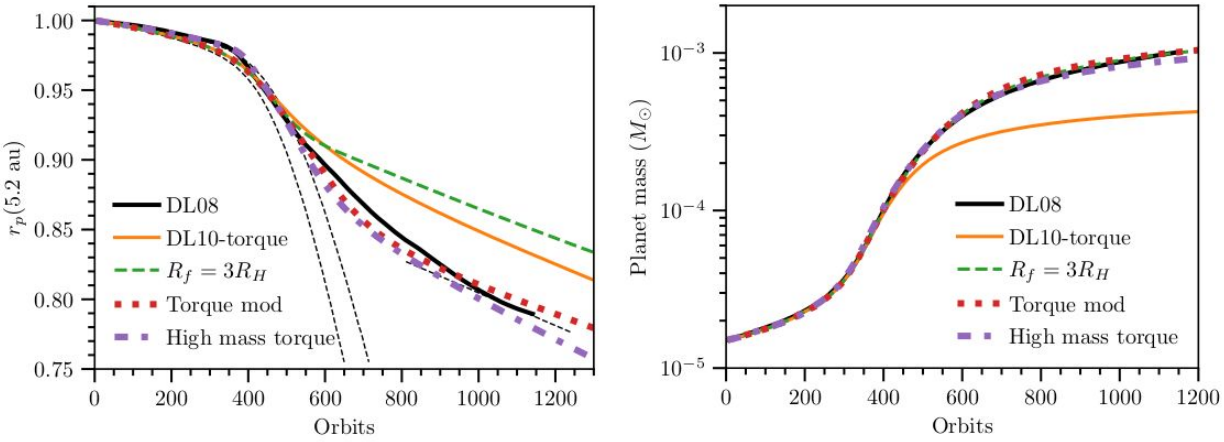

Figure 1: Time evolution of an initially low-mass planet (5 Mearth), starting at 5.2 au in a disc with an initial surface density of $100\ \mathrm{g\,cm^{-2}}$. Left: Semi-major axis. Right: Planetary mass. The figure shows different models for the torque density and the feeding zone radius we studied.

## Dust coagulation during the early stages of star formation: molecular cloud collapse and first hydrostatic core evolution

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*MNRAS, in press (arXiv:2205.07681)*

Planet formation in protoplanetary discs requires dust grains to coagulate from the sub-micron sizes that are found in the interstellar medium into much larger objects. For the first time, we study the growth of dust grains during the earliest phases of star formation using three-dimensional hydrodynamical simulations. We begin with a typical interstellar dust grain size distribution and study dust growth during the collapse of a molecular cloud core and the evolution of the first hydrostatic core, prior to the formation of the stellar core. We examine how the dust size distribution evolves both spatially and temporarily. We find that the envelope maintains its initial population of small dust grains with little growth during these phases, except that in the inner few hundreds of au the smallest grains are depleted. However, once the first hydrostatic core forms rapid dust growth to sizes in excess of 100 $\mu$m occurs within the core (before stellar core formation). Progressively larger grains are produced at smaller distances from the centre of the core. In rapidly-rotating molecular cloud cores, the ‘first hydrostatic core’ that forms is better described as a pre-stellar disc that may be gravitationally unstable. In such cases, grain growth is more rapid in the spiral density waves leading to the larger grains being preferentially found in the spiral waves even though there is no migration of grains relative to the gas. Thus, the grain size distribution can vary substantially in the first core/pre-stellar disc even at these very early times.

*Download/Website:* `https://arxiv.org/abs/2205.07681`

*Download/Website:* `http://www.astro.ex.ac.uk/people/mbate/Animations/DustGrowth.html`

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## The Origin and Evolution of Saturn: A Post-Cassini Perspective

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*"Saturn: The Grand Finale", K. H. Baines et al., eds., Cambridge University Press., in press (arXiv:2205.06914)*

The Saturn System has been studied in detail by the Cassini-Huygens Mission. A major thrust of those investigations has been to understand how Saturn formed and evolved and to place Saturn in the context of other gas giants and planetary systems in general. Two models have been proposed for the formation of the giant planets, the core accretion model and the disk instability model. The heavy element enrichment, core size, and internal structure of Saturn, compared to Jupiter strongly favor the core accretion model as for Jupiter. Two features of the core accretion model that are distinct from the disk instability model are the growth of a core with a mass several times that of the Earth, followed by runaway collapse of gas onto the core once a mass threshold is reached. The heavy element core grows slowly over millions of years through accretion of cm-m sized pebbles, even larger bodies, and moon sized embryos in the gaseous disk. The abundance pattern of heavy elements is thus a key constraint on formation models. C, N, S, and P at Saturn are presently known to varying degree of uncertainty. The He to H ratio in the atmosphere is crucial for understanding heat balance, interior processes, and planetary evolution, but present values at Saturn range from low to high, allowing for a wide range of possibilities. While the very low values are favored to explain excess luminosity, high values might indicate presence of layered convection in the interior, resulting in slow cooling. Additional insight into Saturn's formation comes from the unique data on the rings from Cassini's Grand Finale orbits. While the solar system is the only analog for the extra solar systems, detection of the alkali metals and water in giant exoplanets is useful for understanding the formation and evolution of Saturn, where such data are presently lacking.

*Download/Website:* `https://ui.adsabs.harvard.edu/abs/2022arXiv220506914A/abstract`

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# The GAPS Programme with HARPS-N at TNG. XXXV. Fundamental properties of transiting exoplanet host stars

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*Astronomy and Astrophysics, in press (arXiv: 2205.15796)*

Exoplanetary properties strongly depend on stellar properties: to know the planet with accuracy and precision it is necessary to know the star as accurately and precisely as possible. Our immediate aim is to characterize in a homogeneous and accurate way a sample of 27 transiting planet-hosting stars observed within the GAPS program. Our final goal is to widely analyze the sample by deriving several stellar properties, abundances of many elements, kinematic parameters, and discuss them in a context of planetary formation. We determined stellar parameters ($T_{\rm eff}$, $\log g$, $v \sin i$) and abundances of 26 elements (Li, C, N, O, Na, Mg, Al, Si, S, Ca, Sc, Ti, V, Cr, Fe, Mn, Co, Ni, Cu, Zn, Y, Zr, Ba, La, Nd, Eu). Our study is based on high-resolution HARPS-N@TNG and FEROS@ESO spectra and uniform techniques. Depending on stellar parameters and chemical elements, we used line equivalent widths or spectral synthesis methods. We derived kinematic properties taking advantage of Gaia data and estimated for the first time in exoplanet host stars ages using elemental ratios as chemical clocks. $T_{\rm eff}$ of our stars is of $\sim$4400-6700 K, while [Fe/H] is within $-0.3$ and 0.4 dex. Lithium is present in 7 stars. [X/H] and [X/Fe] abundances vs [Fe/H] are consistent with the Galactic Chemical Evolution. The dependence of [X/Fe] with the condensation temperature is critically analyzed with respect to stellar and kinematic properties. All targets with measured C and O abundances show C/O$<$0.8, compatible with Si present in rock-forming minerals. Mean C/O and [C/O] are slightly lower than the Sun. Most of targets show 1.0$<$Mg/Si$<$1.5, compatible with Mg distributed between olivine and pyroxene, and mean Mg/Si lower than the Sun. HAT-P-26, the target hosting the lowest-mass planet, shows the highest Mg/Si ratio. From our chemo-dinamical analysis we find agreement between ages and position within the Galactic disk. We note a tendency for higher density planets to be around metal-rich stars and hints of higher stellar abundances of some volatiles (e.g., O) for lower mass planets. We cannot exclude that part of our results could be also related to the location of the stars within the Galactic disk. We try to trace the planetary migration scenario from the composition of the planets related to the chemical composition of the hosting stars. This kind of study will be useful for upcoming space missions data to get more insights into the formation/migration mechanisms.

*Download/Website:* `https://arxiv.org/abs/2205.15796`

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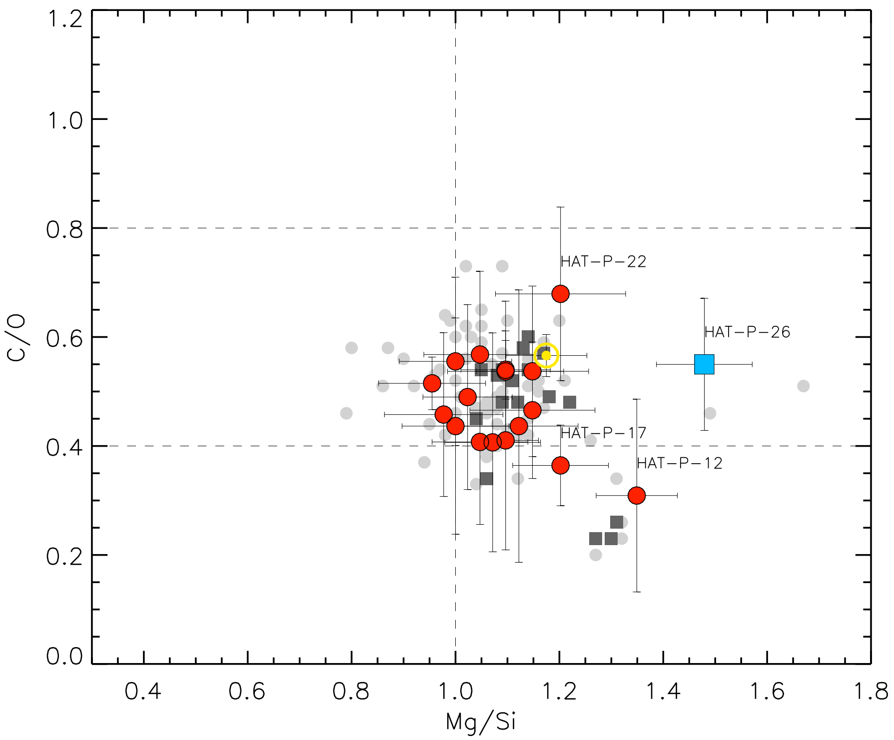

Figure 2: C/O versus Mg/Si. Blue square highlights the only star in our sample hosting a planet with mass less than 30 $M_{\oplus}$. Targets with the highest values of Mg/Si are highlighted. In grey the results by Suarez et al. (2018) for stars hosting low-mass planets ($< 30\,M_{\oplus}$; squares) and high-mass planets ($> 30\,M_{\oplus}$; circles) are overplotted. Vertical line represents Mg/Si=1.0, while horizontal lines are plotted for C/O=0.4, 0.8, as defined by Suarez et al. (2018). Our solar values of $(\mathrm{C/O})_{\odot}$=0.57 and $(\mathrm{Mg/Si})_{\odot}$=1.17 are also represented with a solar symbol (in yellow).

# Transit least-squares survey IV. Earth-like transiting planets expected from the PLATO mission

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*Astronomy & Astrophysics, 2022arXiv220602071H*

In its long-duration observation phase, the PLATO satellite (scheduled for launch in 2026) will observe two independent, non-overlapping fields, nominally one in the northern hemisphere and one in the southern hemisphere for a total of four years. The exact duration of each pointing will be determined two years before launch. Previous estimates of PLATO's yield of Earth-sized planets in the habitable zones (HZs) around solar-type stars ranged between 6 and 280. We use the PLATO Solar-like Light curve Simulator (`PSLS`) to simulate light curves with transiting planets around bright ($m_V \leq 11$) Sun-like stars at a cadence of 25 s, roughly representative of the $> 15,000$ targets in PLATO's high-priority P1 sample (mostly F5-K7 dwarfs and sub-dwarfs). Our study includes light curves generated from synchronous observations of 6, 12, 18, and 24 of PLATO's 12 cm aperture cameras over both 2 yr and 3 yr of continuous observations. Automated detrending is done with the `Wōtan` software and post-detrending transit detection is performed with the Transit Least Squares (`TLS`) algorithm. Light curves combined from 24 cameras yield true positive rates (TPRs) near unity for planets $\geq 1.2\,R_\oplus$ with two transits. If a third transit is in the light curve planets as small as $1\,R_\oplus$ are recovered with TPR $\sim 100\,\%$. We scale the TPRs with the expected number of stars in the P1 sample and with modern estimates of the exoplanet occurrence rates and predict the detection of planets with $0.5\,R_\oplus \leq R_\mathrm{p} \leq 1.5\,R_\oplus$ in the HZs around F5-K7 dwarf stars. For the (2 yr + 2 yr) long-duration observation phase strategy we predict 11–34 detections, for the (3 yr + 1 yr) strategy we predict 8–25 discoveries. These estimates neglect exoplanets with mono transits, serendipitous detections in stellar samples P2–P5, a dedicated removal of systematic effects, and a possible bias of the P1 sample towards brighter stars and high camera coverage due to noise requirements. As an opposite effect, Earth-sized planets might typically exhibit shallower transits around P1 sample stars than we assumed since the P1 sample will be skewed towards spectral types earlier than the Sun-like stars assumed in our simulations. Moreover, our study of the effects of stellar variability on shallow transits of Earth-like planets illustrates that our estimates of PLATO's planet yield, which we derive using a photometrically quiet star like the Sun, must be seen as upper limits. In conclusion, PLATO's detection of about a dozen Earth-sized planets in the HZs around solar-type stars will mean a major contribution to this yet poorly sampled part of the exoplanet parameter space with Earth-like planets.

*Download/Website:* `https://arxiv.org/abs/2206.02071`

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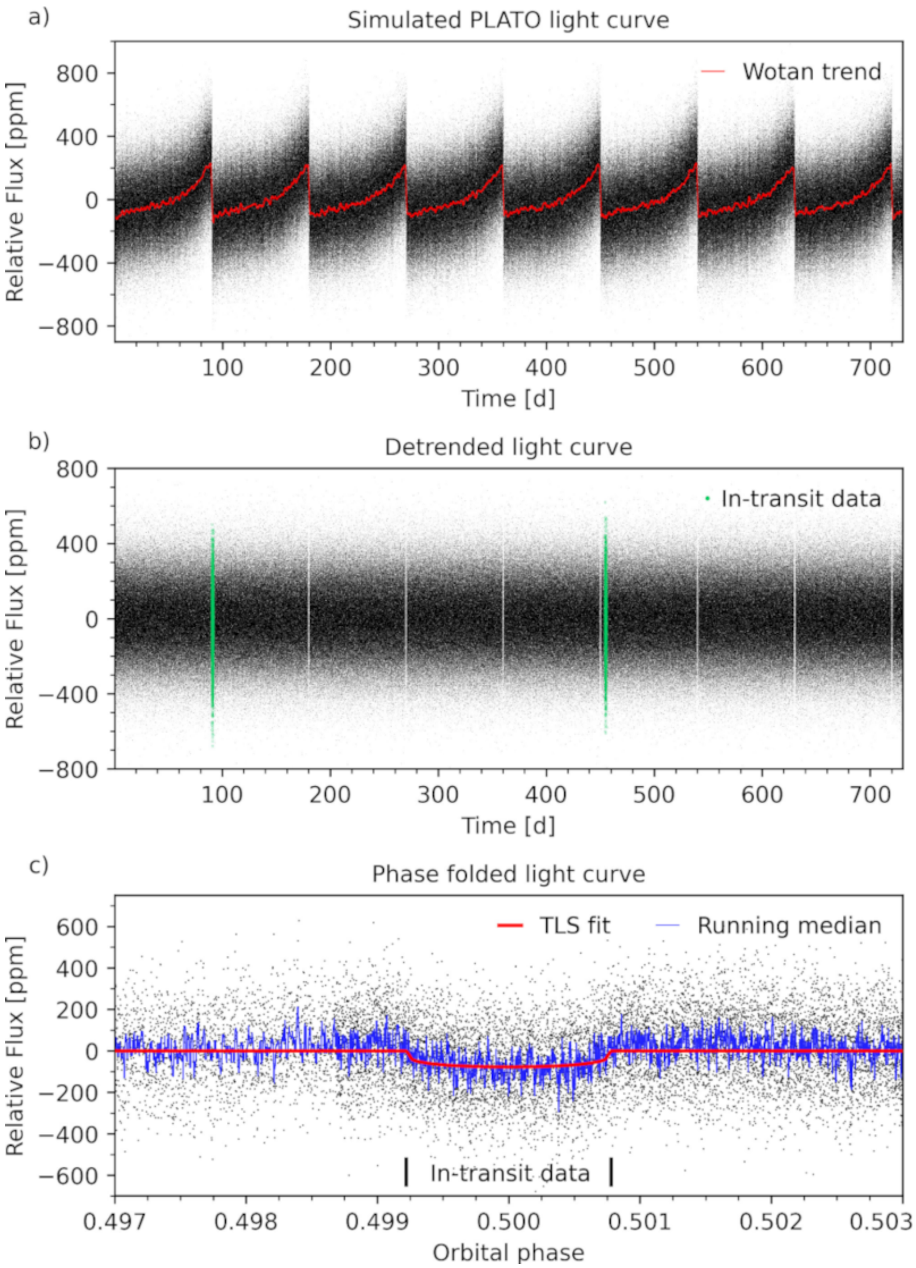

Figure 3: Figure: Illustration of our transit injection and retrieval experiment. Simulations include two transits of an Earth-sized planet with an orbital period of 364 d in a 2 yr light curve of an $m_V = 9$ Sun-like star. (a) PLATO-like light curve generated with `PSLS`. The red line shows the trend computed with `Wōtan`. (b) Light curve after detrending with `Wōtan`. The simulated transits occur at about 91 d and 455 d (highlighted with green points), that is, near quarterly reorientations of the spacecraft. This example was deliberately chosen to illustrate that `Wōtan` and `TLS` can master non-well-behaved systems. (c) Phase-folded light curve of the transit detected with `TLS`. The best model fit is shown with a red line. The 21-bin walking median (10 data points symmetrically around each data point) is shown with a blue line.

# Pandora: A fast open-source exomoon transit detection algorithm

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*Astronomy & Astrophysics(in press), 2022arXiv220509410H*

We present `Pandora`, a new software to model, detect, and characterize transits of extrasolar planets with moons in stellar photometric time series. `Pandora` uses an analytical description of the transit light curve for both the planet and the moon in front of a star with atmospheric limb darkening and it covers all cases of mutual planet-moon eclipses during transit. The orbital motion of the star-planet-moon system is computed with high accuracy as a nested Keplerian problem. We have optimized `Pandora` for computational speed to make it suitable for large-scale exomoon searches in the new era of space-based high-accuracy surveys. We demonstrate the usability of `Pandora` for exomoon searches by first simulating a light curve with four transits of a hypothetical Jupiter with a giant Neptune-sized exomoon in a one-year orbit around a Sun-like star. The 10 min cadence of the data matches that of the upcoming PLATO mission and the noise of 100 parts per million is dominated by photon noise, assuming a photometrically quiet, $m_V = 11$ Sun-like star for practicality. We recover the simulated system parameters with the `UltraNest` Bayesian inference package. The run-time of this search is about five hours on a standard computer. `Pandora` is the first photodynamical open-source exomoon transit detection algorithm, implemented fully in the `python` programming language and available for the community to join the search for exomoons.

*Download/Website:* `https://doi.org/10.1051/0004-6361/202243129`

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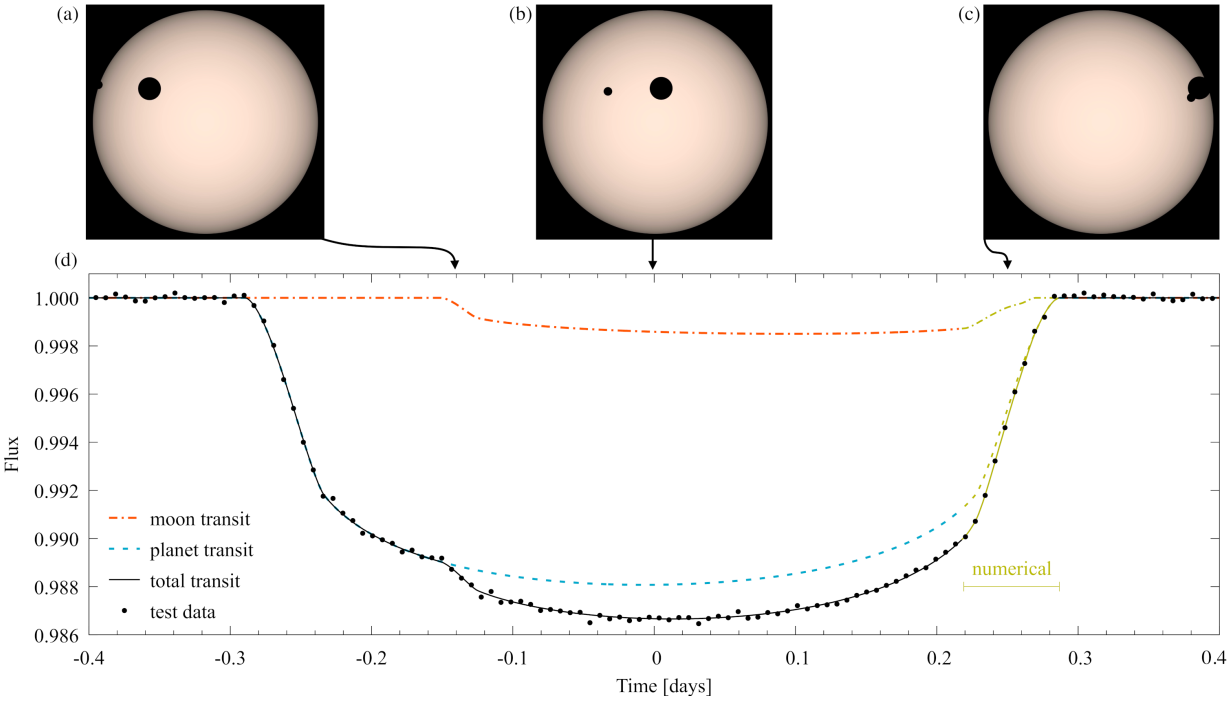

Figure 4: Figure: Output demo of `Pandora` for a system of a Sun-like star, a Jupiter-sized planet in a one-year orbit around that star, and a Neptune-sized moon in a 1.28 d orbit around the giant planet. (a)-(c) Video renderings of the transit. (d) Light curve. The dotted-dashed orange line shows the transit light curve of the exomoon and the dashed blue line the transit light curve of the exoplanet using the analytical solution in both cases. The yellow parts of the moon and planet light curves illustrate numerical simulations. The solid black line shows the combined model. Black dots a simulated observation roughly representative of an $m_V \sim 11$ Sun-like star from the PLATO mission. Digital star colors from Harre & Heller (2021). Animation available at *https://youtu.be/89lEuPgrl8s*

# Polarimetric investigation of selected cloud compositions in exoplanetary atmospheres

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*Astronomy & Astrophysics, in press (arXiv:2205.04815)*

We investigated the impact of selected cloud condensates in exoplanetary atmospheres on the polarization of scattered stellar radiation.

We considered a selection of 25 cloud condensates that are expected to be present in extrasolar planetary atmospheres. Using the three-dimensional Monte Carlo radiative transfer code POLARIS and assuming Mie scattering theory, we calculated and studied the net polarization of scattered radiation as a function of planetary phase angle at optical to near-infrared wavelengths (0.3 $\mu$m to 1 $\mu$m).

In addition to the well-known characteristics in the state of polarization, such as the rainbow determined by the real part of the refractive index, the behavior of the underlying imaginary part of the refractive index causes an increase or decrease in the degree of polarization and a change of sign in the polarization at a characteristic wavelength. In contrast to $Al_2O_3$ and $MgFeSiO_4$, clouds composed of SiO, MnS, $Na_2S$, or ZnS produce a rapidly decreasing degree of polarization with increasing wavelength in the context of an exoplanetary atmosphere. Furthermore, the sign of the polarization changes at a wavelength of about 0.5 $\mu$m to 0.6 $\mu$m, depending on the specific cloud condensate. The resulting net polarization is mainly positive for cloud compositions with large imaginary parts of the refractive index, such as Fe, FeS, and FeO. In addition, for Fe and FeS clouds, the maximum degree of polarization at long wavelengths is shifted to larger phase angles than for FeO.

We found that most of these cloud condensates, such as chlorides, sulfides, or silicates, are distinguishable from each other due to their unique wavelength-dependent complex refractive index. In particular, an increase or decrease of the net polarization as a function of wavelength and a change of sign in the polarization at specific wavelengths are important features for characterizing cloud compositions in exoplanetary atmospheres.

*Download/Website:* `https://arxiv.org/abs/2205.04815`

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# The need for a public forecast of stellar activity to optimise exoplanet radial velocity detections & transmission spectroscopy

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*Monthly Notices of the Royal Astronomical Society, in press (arXiv:2205.11187)*

Advances in high-precision spectrographs have paved the way for the search for an Earth analogue orbiting a Sun-like star within its habitable zone. However, the research community remains limited by the presence of stellar noise produced by stellar magnetic activity. These activity phenomena can obscure the detection of Earth-mass exoplanets and can create parasitic signals in transmission spectra. In this paper, we outline the need for a public forecast of stellar activity, and produce a proof of principle. Using publicly available spectra we are able to forecast stellar minima several years ahead and reach a typical uncertainty on the timing of these minima of $\pm 0.5$ year, similar to the precision reached on our own Sun's magnetic cycle. Furthermore, we use our toy model to show that knowing when to observe can improve the sensitivity of HARPS-North's Solar telescope to low mass planets by up to an order of magnitude, and we show that the majority of exoplanets selected for Early Release Science and Guaranteed Time Observations on the *James Webb* will be observed close or during stellar maxima, incurring a higher risk of stellar contamination. We finish our paper by outlining a number of next steps to create a public forecast usable by teams around the globe, by telescope time allocation committees, and in preparation for spacecrafts such as *Ariel*.

*Download/Website:* `https://arxiv.org/pdf/2205.11187`

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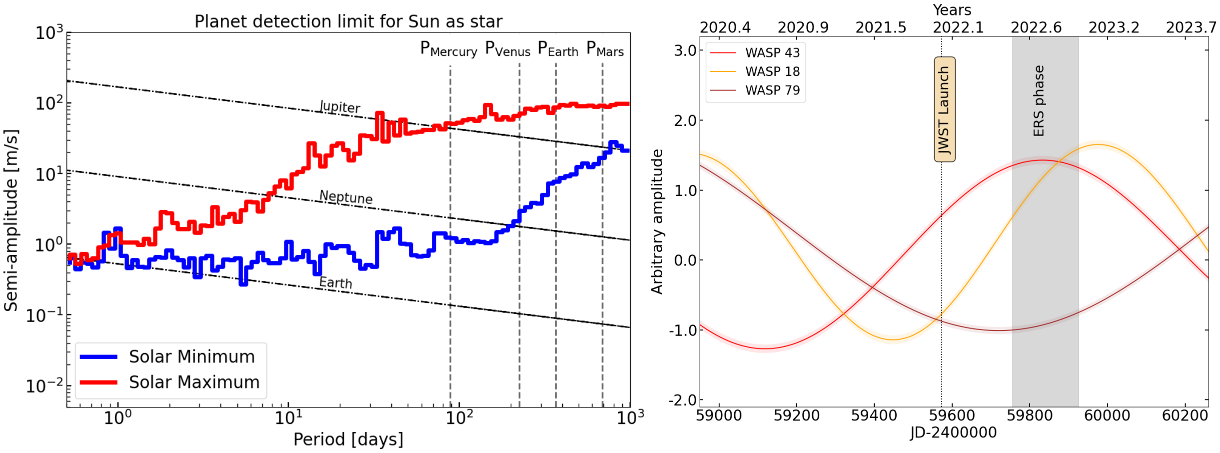

Figure 5: Left panel: The evaluated detection limit for a planetary signal during solar minimum (blue) and solar maximum (red). Diagonal lines are anticipated signals of an Earth, Neptune, and Jupiter mass planet. Right panel: Stellar activity forecast for JWST's ERS targets WASP 43 (red), WASP 18 (orange), and WASP 79 (brown). The vertical dotted line represents the launch of JWST and the grey shaded region represents the ERS observation phase. WASP 43 and WASP 18 are forecasted to be in activity maximum, indicating potential contamination of observations due to high levels of stellar activity.

# RV-detected planets around M dwarfs: Challenges for core accretion models

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*Astronomy & Astrophysics, in press (2022arXiv220512971S)*

Planet formation is sensitive to the conditions in protoplanetary disks, for which scaling laws as a function of stellar mass are known. We aim to test whether the observed population of planets around low-mass stars can be explained by these trends, or if separate formation channels are needed.

We address this question by confronting a state-of-the-art planet population synthesis model with a sample of planets around M dwarfs observed by the HARPS and CARMENES radial velocity (RV) surveys. To account for detection biases, we performed injection and retrieval experiments on the actual RV data to produce synthetic observations of planets that we simulated following the core accretion paradigm.

These simulations robustly yield the previously reported high occurrence of rocky planets around M dwarfs and generally agree with their planetary mass function. In contrast, our simulations cannot reproduce a population of giant planets around stars less massive than 0.5 solar masses. This potentially indicates an alternative formation channel for giant planets around the least massive stars that cannot be explained with current core accretion theories. We further find a stellar mass dependency in the detection rate of short-period planets. A lack of close-in planets around the earlier-type stars ($M_\star \gtrsim 0.4\,M_\odot$) in our sample remains unexplained by our model and indicates dissimilar planet migration barriers in disks of different spectral subtypes.

Both discrepancies can be attributed to gaps in our understanding of planet migration in nascent M dwarf systems. They underline the different conditions around young stars of different spectral subtypes, and the importance of taking these differences into account when studying planet formation.

*Download/Website:* `https://arxiv.org/abs/2205.12971`

*Contact:* `schlecker@arizona.edu`

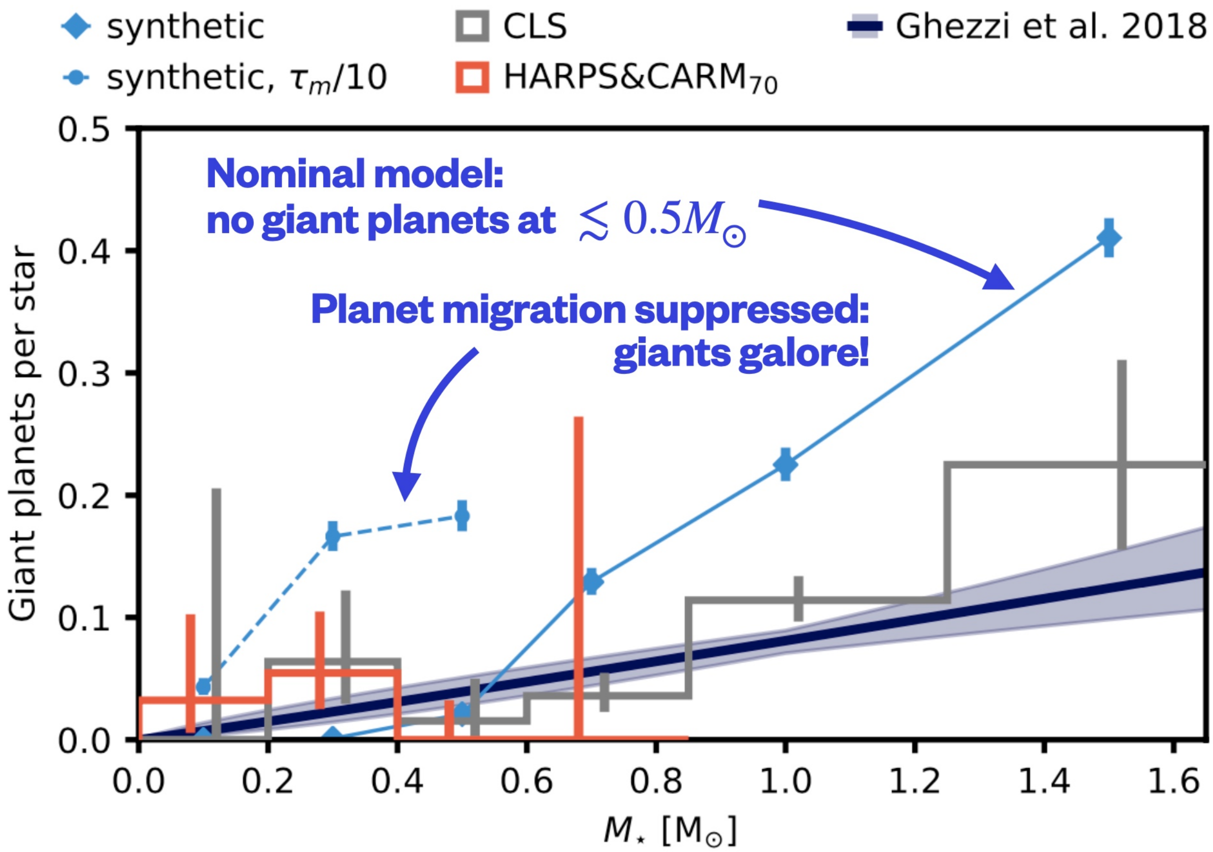

Figure 6: Frequency of giant planets around stars of different masses. Unexpected discoveries of giants around very low-mass stars might indicate a break from the commonly assumed linear trend (dark blue line with confidence intervals). Theoretical models (light blue solid) cannot produce such planets, except when planet migration is suppressed (light blue dashed). Migration traps from substructures in protoplanetary disks may be responsible for such a suppression.

# HD 28109 hosts a trio of transiting Neptunian planets including a near-resonant pair, confirmed by ASTEP from Antarctica

*Georgina Dransfield*[1] *et al.*

[1] School of Physics & Astronomy, University of Birmingham, Edgbaston, Birmingham B15 2TT, United Kingdom

*Monthly Notices of the Royal Astronomical Society, in press (arXiv:2205.09046)*

We report on the discovery and characterisation of three planets orbiting the F8 star HD 28109, which sits comfortably in *TESS*'s continuous viewing zone. The two outer planets have periods of $56.0067 \pm 0.0003$ days and $84.2597^{+0.0010}_{-0.0008}$ days, which implies a period ratio very close to that of the first-order 3:2 mean motion resonance, exciting transit timing variations (TTVs) of up to $60\,\mathrm{mins}$. These two planets were first identified by *TESS*, and we identified a third planet in the *TESS* photometry with a period of $22.8911 \pm 0.0004$ days. We confirm the planetary nature of all three planetary candidates using ground-based photometry from *Hazelwood*, *ASTEP* and *LCO*, including a full detection of the $\sim 9\,\mathrm{h}$ transit of HD 28109 c from Antarctica. The radii of the three planets are $\mathrm{R_b} = 2.199^{+0.098}_{-0.10}\ \mathrm{R_\oplus}$, $\mathrm{R_c} = 4.23 \pm 0.11\ \mathrm{R_\oplus}$ and $\mathrm{R_d} = 3.25 \pm 0.11\ \mathrm{R_\oplus}$; we characterise their masses using TTVs and precise radial velocities from ESPRESSO and HARPS, and find them to be $\mathrm{M_b} = 18.5^{+9.1}_{-7.6}\ \mathrm{M_\oplus}$, $\mathrm{M_c} = 7.9^{+4.2}_{-3.0}\ \mathrm{M_\oplus}$ and $\mathrm{M_d} = 5.7^{+2.7}_{-2.1}\ \mathrm{M_\oplus}$, making planet b a dense, massive planet while c and d are both underdense. We also demonstrate that the two outer planets are ripe for atmospheric characterisation using transmission spectroscopy, especially given their position in the CVZ of *JWST*. The data obtained to date are consistent with resonant (librating) and non-resonant (circulating) solutions; additional observations will show whether the pair is actually locked in resonance or just near-resonant.

*Download/Website:* `https://arxiv.org/pdf/2205.09046.pdf`

*Contact:* `gxg831@bham.ac.uk`

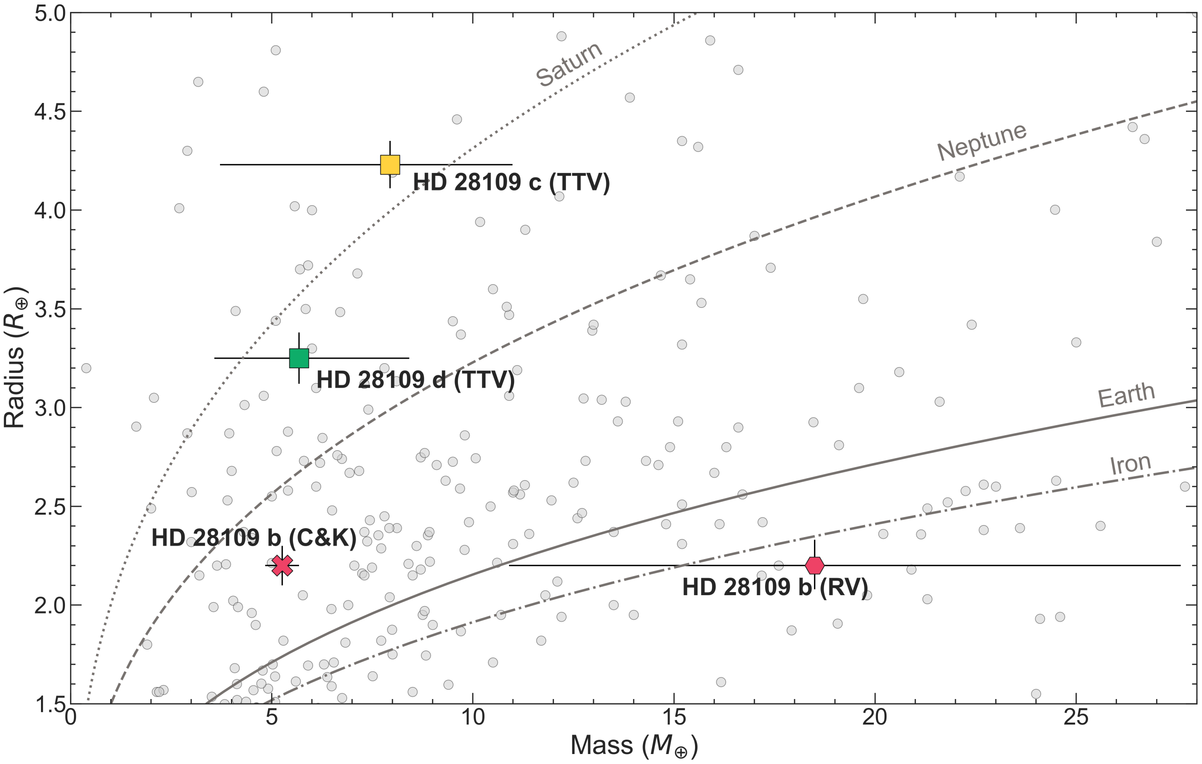

Figure 7: Mass-radius diagram showing the positions of HD 28109 b, c and d. Planets c and d are plotted as squares with their masses are estimated from TTVs. As the mass of planet b is still poorly constrained, we plot its position using its RV estimated mass as a hexagon, while the average mass for planets of its radius (estimated mass following Chen & Kipping (2017)) is plotted as a cross.

# 3 Exoplanet Archive Updates

## May 2022 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, June 13, 2022*

**Note:** Unless otherwise noted, all planetary and stellar data mentioned in the news are in the Planetary Systems Table (`http://bit.ly/2Pt0tM1`), which provides a single location for all self-consistent planetary solutions, and its companion table the Planetary Systems Composite Parameters (`https://bit.ly/2Fer9NU`), which offers a more complete table of parameters combined from multiple references and calculations. Data may also be found in the Microlensing Planets Table (`https://bit.ly/3urUyZU`) and the Direct Imaging Planets Table (`http://bit.ly/3ayD185`).

### May 26, 2022

### Five New Planets

This week's five new planets include three hot Jupiters and a second planet in the Kepler-1656 system.
The new planets are TOI-1181 b, TOI 1516 b, TOI 2046 b, WASP-132 c, and Kepler-1656 c. We've also added new sets of parameters for GJ 411 b & c and Wolf 503 b. This week's release bumps up the archive's total planet count to **5,035**.

### May 12, 2022

### Nine New Planets

This week's nine new planets include three more close-in planets in the TOI-500 system, which lends support to the theory that planets form through gentle secular migration instead of highly eccentric migrations. Read the discovery paper by Serrano et al. 2022 (`https://go.nature.com/3zgRBQZ`).

The new planets are TOI-500 c, d, & e, TOI-1696 b, TOI-1710 b, TOI-2136 b, HD 103891 b, HD 105779 b, and HIP 94235 b.

### ExoFOP-K2 Campaign 9 Contributed Data

We've migrated the K2 Campaign 9 microlensing data from the Exoplanet Follow-up Observing Program (ExoFOP) site. Executed in 2016, K2C9 was designed to simultaneously observe gravitational microlensing events from space with the Kepler telescope and from Earth with ground-based telescopes to see a parallax effect in the shape and time of the lensing events.

Read the documentation and access the data set from the ExoFOP-K2 Campaign 9 page (`https://bit.ly/3Nul4uU`). The Contributed Data page (`https://bit.ly/3NUK7Hk`) also links to the new page.

### Updated Movies

Two of our animated movies based on our pre-generated plots now include more recent archive data:

- **33 Years of Discoveries** shows the number of exoplanet discoveries in mass-period space from 1989 through April 2022: `http://bit.ly/2PP9Ean`.
- **Exoplanets: Cumulative Detections by Discovery Year** is a histogram showing the cumulative number of exoplanet discoveries by detection method each year from 1989 through April 2022: `http://bit.ly/2QsHPlx`.

You can always find these movies on our Pre-generated Plots page (`http://bit.ly/2vMdO8c`), which also contains data plots of current archive data that are ready for use in presentations and publications. All plots are available in a colorblind-friendly palette as well, and some can be customized further using Filtergraph, a data visualization tool developed at Vanderbilt University.

## May 5, 2022

### Seven Planets and 180 Parameter Sets Added

This week's seven new planets were found either through their radial velocities (pi Men d, TYC 2187-512-1 b, and iot Dra c) or spied on by TESS during their transits (TOI-1246 b, c, d, & e). We've also added 180 new sets of parameters—most of them from Patel & Espinoza 2022. Find the new data in the Planetary Systems Table and its companion table, Planetary Systems Composite Parameters.

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

*Contact:* `mharbut@caltech.edu`

# 4 Jobs and Positions

## Post-Doctoral position in the detectability of potential biosignatures in extrasolar planets by developing and applying numerical atmospheric models

*John Lee Grenfell*

Dear Colleagues, The Department of Extrasolar Planets and Atmospheres (EPA) at the DLR Institute for Planetary Research (PF) Berlin has an opening for a post-doctoral research position studying the detectability of potential biosignatures in extrasolar planets by developing and applying numerical atmospheric models. Further details can be found at:
http://s.dlr.de/eso7M
Kind Regards,
John Lee Grenfell DLR-EPA Rutherfordstr. 2 12489 Berlin Germany

*Download/Website:* `http://nccr-planets.ch/`

*Contact:* `exoplanetnews@nccr-planets.ch`

## 3 PhD Opportunities in Interdisciplinary Space Science and Planetary Research

*as part of YRP@Graz, Austria, 1 July 2022*

The Space Research Institute (IWF) is with about 100 employees from twenty nations one of the largest institutes of the Austrian Academy of Sciences (OeAW). The institute is located in the Victor Franz Hess Research Center of the OeAW in the south of Graz. The IWF also operates a world-leading satellite laser ranging station at the Lustbühel Observatory. As part of its Young Researcher Programme YRP@Graz, the Austrian Space Research Institute, the Graz University of Technology, and the University of Graz jointly invite applications for

**3 PHD STUDENT POSITIONs (F*M)**

in interdisciplinary space science and planetary research with the possibility to work also in the field of space instrumentation. The YRP@Graz is a collaboration between the IWF and the Graz University of Technology and the University of Graz. The successful candidates will benefit from joint supervision across at least two research groups of these institutions. The offered PhD projects and further information can be found here: https://www.oeaw.ac.at/en/iwf/research/young-researcher-program-yrpgraz/phd-students

We seek excellent students with a strong background in natural sciences. Successful candidates must hold a Master's degree in physics, astrophysics, geoscience or equivalent or in engineering with focus on space instrumentation at the latest by the starting date of the position, namely in September 2022, but preferably at the time of application. Previous experience on aspects of astrophysics and related fields and a track record of team work will be important criteria for the selection, as will experience in computational coding.

The appointment can begin as early as September 1, 2022, and will be for 3.5 years.

The first stage of the application process is anonymised, the second stage takes the form of an interview. To apply for this position, please use the following link to the anonymised YRP@Graz application questionary: https://www.oeaw.ac.at/iwf/forschung/nachwuchsprogramm-yrpgraz/doktorandinnen/fragebogen. This form includes questions about scientific skills and the candidate's master thesis/project, and asks for a statement of interest, a scientific proposal, and a statement regarding research integrity. Please, submit the form no later than July 1, 2022.

Inquiries about the YRP@Graz position should be directed to Prof Dr Christiane Helling (christiane.helling@oeaw.ac.at) or Dr Ruth-Sophie Taubner (ruth-sophie.taubner@oeaw.ac.at).

*The Austrian Academy of Sciences pursues a non-discriminatory employment policy and values equal opportunities, and diversity. Individuals from underrepresented groups are particularly encouraged to apply.*

*Download/Website:* `https://www.oeaw.ac.at/en/iwf`; `https://www.tugraz.at/en/home/`; `https://www.uni-graz.at/en/`

*Contact:* `ruth-sophie.taubner@oeaw.ac.at`

## Postdoctoral position in astronomical instrumentation

*Brice-Olivier Demory*

*University of Bern, 1 Oct 2022 or later*

Applications are invited for a Postdoctoral position at the Centre for Space and Habitability (CSH, http://csh.unibe.ch) of the University of Bern.
The successful applicant will work in the frame of the new ERC Consolidator project ”SenseLife” of Prof. Brice-Olivier Demory (http://www.saintex.unibe.ch). The Postdoctoral researcher will be expected to contribute to the further development of high-sensitivity polarimeters for field and airborne measurement campaigns.

**Profile** We are looking for an outstanding instrumentation scientist, a team player, who will work in a multidisciplinary group that includes, in addition to astrophysicists, microbiologists and computer scientists. This project will further collaborations with the Universities of Neuchatel, Leiden, Geneva, Zurich and ETH Zurich in the frame of the NCCR PlanetS. The successful applicant will also have the opportunity to be involved in other key activities of the group, such as medical instrumentation for cancer research and surgery at the Faculty of Medicine of the University of Bern. A qualified candidate should have been awarded a PhD on or after 1 October 2016 and have expertise in optical instrumentation design and development. Candidates with further specialisation in adaptive optics or polarimetry are strongly encouraged to apply.

**What we offer** Starting salary is between 87’750 and 99’450 CHF based on experience, with an initial appointment of 2 years. Child allowance and maternity/paternity leave are offered. Part-time appointment is also possible, as well as flexible work patterns. The expected starting date is 1 October 2022. The position comes with a research budget for travel, publication costs and computing resources.

**Application** Applications are invited from all nationalities and should consist of 1) a cover letter, 2) a CV, 3) a summary of past achievements (3 pages max.), 4) a list of publications and 5) the names and contact details of 3 references.
The University of Bern is committed to equality, diversity and inclusion. Individuals from underrepresented groups are particularly encouraged to apply.
Materials should be submitted through the web interface link below.
Applications received by **15 July 2022** will receive full consideration.

*Download/Website:* `https://ohws.prospective.ch/public/v1/jobs/6b262774-42f5-45bb-b244-517474f46b63`

*Contact:* `brice.demory@unibe.ch`

# 5 Conferences and Workshops

## 2022 Sagan Summer Hybrid Workshop: Exoplanet Science in the Gaia Era

*E. Furlan, D. Gelino*
NASA Exoplanet Science Institute, California Institute of Technology, Pasadena, CA, USA

*Hybrid Workshop, July 25-29, 2022*

The 2022 Sagan Summer Workshop will take place July 25-29, 2022. This will be a hybrid workshop with both in-person and on-line attendance. We still have a space left for in-person attendees! Note that in-person attendees are required to verify their COVID vaccination and booster status before their registration is confirmed. Additionally, in person attendees must comply with any mask mandates and public health guidelines from L. A. County, City of Pasadena, and California Institute of Technology that are in place at the time of the workshop. The workshop website will be updated with this information going forward.

The 2022 Sagan Summer Workshop will focus on the topic of exoplanet science in the Gaia era. The ESA Gaia mission has been mapping the Galaxy for over seven years, measuring very accurate positions and motions of over 1 billion stars. It has already greatly contributed to exoplanet science through the determination of more accurate stellar parameters, which in turn improve planet parameters, the detection of stellar companions, and the identification and characterization of young moving groups. In the near future, the unprecedented astrometric accuracy will result in the discovery of new exoplanets, as well as the characterization of known planets. The workshop will introduce the basics of astrometry, the impact of Gaia astrometry on astrophysics, and the astrometric detection and characterization of exoplanets. The synergy between the different planet detection techniques of astrometry, transits, radial velocities, and imaging will be discussed, as well as future advances in astrometry.

The workshop will cover the topics listed below. Please visit the workshop website for the agenda and list of confirmed speakers.

- Astrometry Fundamentals
- Impact of Astrometry on Stellar Astrophysics with Implications for Exoplanet Science
- Astrometry and Companion Detectionl
- Characterizing Directly Imaged Planets and Young Brown Dwarfs
- Next Steps in Astrometry

There is no registration fee for this workshop and registration for both in-person and remote attendance is available on the workshop website.

Please contact us with any questions or to be added to the email list.

*Download/Website:* `http://nexsci.caltech.edu/workshop/2022`
*Contact:* `sagan_workshop@ipac.caltech.edu`

# 6 As seen on astro-ph

The following list contains exoplanet related entries appearing on astro-ph in May 2022.

### May 2022

astro-ph/2205.00006: **Evaluating the Evidence for Water World Populations using Mixture Models** by *Andrew R. Neil, Jessica Liston, Leslie A. Rogers*

astro-ph/2205.00040: **Evidence for the Late Arrival of Hot Jupiters in Systems with High Host-star Obliquities** by *Jacob H. Hamer, Kevin C. Schlaufman*

astro-ph/2205.00067: **A novel framework for semi-Bayesian radial velocities through template matching** by *A. M. Silva et al.*

astro-ph/2205.00091: **Geologic context of the bright MARSIS reflectors in Ultimi Scopuli, South Polar Layered Deposits, Mars** by *M.E. Landis, J.L. Whitten*

astro-ph/2205.00213: **Radial distribution of the carbonaceous nano-grains in the protoplanetary disk around HD 169142** by *Marie Devinat et al.*

astro-ph/2205.00246: **Development of an electron impact ion source with high ionization efficiency for future planetary missions** by *Oya Kawashima et al.*

astro-ph/2205.00454: **Cloud formation in Exoplanetary Atmospheres** by *Christiane Helling*

astro-ph/2205.00813: **Hydrogen emission from meteors and meteorites: mapping traces of H2O molecules and organic compounds in small Solar system bodies** by *Pavol Matlovič et al.*

astro-ph/2205.01103: **The Directly-Imaged Exoplanet Host Star 51 Eridani is a Gamma Doradus Pulsator** by *Aldo G. Sepulveda et al.*

astro-ph/2205.01112: **Kepler and the Behemoth: Three Mini-Neptunes in a 40 Million Year Old Association** by *L. G. Bouma et al.*

astro-ph/2205.01193: **Biological Homochirality and the Search for Extraterrestrial Biosignatures** by *Marcelo Gleiser*

astro-ph/2205.01341: **Global 3D simulation of the upper atmosphere of HD189733b and absorption in metastable HeI and Ly alpha lines** by *M. S. Rumenskikh et al.*

astro-ph/2205.01396: **Unveiling the outer dust disc of TW Hya with deep ALMA observations** by *John D. Ilee et al.*

astro-ph/2205.01471: **A Search for Exoplanets in Open Clusters and Young Associations based on TESS Objects of Interest** by *Qinghui Sun et al.*

astro-ph/2205.01623: **A survey of sodium absorption in ten giant exoplanets with high-resolution transmission spectroscopy** by *Adam B. Langeveld, Nikku Madhusudhan, Samuel H. C. Cabot*

astro-ph/2205.01690: **Characterising Atmospheres of Cloudy Temperate Mini-Neptunes with JWST** by *Savvas Constantinou, Nikku Madhusudhan*

astro-ph/2205.01761: **Fingering convection in the stably-stratified layers of planetary cores** by *Celine Guervilly*

astro-ph/2205.01776: **CO Line Emission Surfaces and Vertical Structure in Mid-Inclination Protoplanetary Disks** by *Charles J. Law et al.*

astro-ph/2205.01860: **TOI-2046b, TOI-1181b and TOI-1516b, three new hot Jupiters from *TESS*: planets orbiting a young star, a subgiant and a normal star** by *Petr Kabáth et al.*

astro-ph/2205.02026: **Early Solar System instability triggered by dispersal of the gaseous disk** by *Beibei Liu, Sean N. Raymond, Seth A. Jacobson*

astro-ph/2205.02126: **Magnetised Winds in Transition Discs I: 2.5D Global Simulations** by *Étienne Martel, Geoffroy Lesur*

astro-ph/2205.02279: **A scaled-up planetary system around a supernova progenitor** by *V. Squicciarini et al.*

astro-ph/2205.02501: **The Discovery of a Planetary Companion Interior to Hot Jupiter WASP-132 b** by *Benjamin J. Hord et al.*

astro-ph/2205.02777: **Relative Habitability of Exoplanet Systems with Two Giant Planets** by *Nora Bailey, Dan*

*Fabrycky*

astro-ph/2205.02858: **Calibrated Gas Accretion and Orbital Migration of Protoplanets in 1D Disc Models** by *Oliver Schib, Christoph Mordasini, Ravit Helled*

astro-ph/2205.02864: **Deep two-phase, hemispherical magma oceans on lava planets** by *Charles-Édouard Boukaré, Nicolas B. Cowan, James Badro*

astro-ph/2205.02874: **Moderately High Obliquity Promotes Biospheric Oxygenation** by *Megan N. Barnett, Stephanie L. Olson*

astro-ph/2205.03298: **The origin of chaos in the Solar System through computer algebra** by *Federico Mogavero, Jacques Laskar*

astro-ph/2205.03461: **Bayesian Characterisation of Circumbinary Exoplanets with LISA** by *Michael L. Katz et al.*

astro-ph/2205.03498: **The mercurial Sun at the heart of our solar system** by *Philip Gordon Judge*

astro-ph/2205.04100: **Giant Planets from the Inside-Out** by *Tristan Guillot et al.*

astro-ph/2205.04170: **Long-term instability of the inner Solar System: numerical experiments** by *Nam H. Hoang, Federico Mogavero, Jacques Laskar*

astro-ph/2205.04277: **Interstellar planetesimals** by *Amaya Moro-Martín*

astro-ph/2205.04294: **Regularized phase-space volume for the three-body problem** by *Yogesh Dandekar et al.*

astro-ph/2205.04693: **Project Lyra: Another Possible Trajectory to 1I/'Oumuamua** by *Adam Hibberd*

astro-ph/2205.04815: **Polarimetric investigation of selected cloud compositions in exoplanetary atmospheres** by *Moritz Lietzow, Sebastian Wolf*

astro-ph/2205.04893: **A dearth of close-in planets around rapidly rotating stars or a dearth of data?** by *Y. S. Messias et al.*

astro-ph/2205.05073: **The Ariel Target List: The Impact of TESS and the Potential for Characterising Multiple Planets Within a System** by *Billy Edwards, Giovanna Tinetti*

astro-ph/2205.05082: **A Novel Solution for Resonant Scattering Using Self-Consistent Boundary Conditions** by *B. Connor McClellan, Shane Davis, Phil Arras*

astro-ph/2205.05085: **A Mathematical Treatment of the Offset Microlensing Degeneracy** by *Keming Zhang, B. Scott Gaudi*

astro-ph/2205.05096: **The First High-Contrast Images of X-Ray Binaries: Detection of Candidate Companions in the $\gamma$ Cas Analog RX J1744.72713** by *M. Prasow-Emond et al.*

astro-ph/2205.05219: **Disruption of Saturn's ring particles by thermal stress** by *Naoyuki Hirata et al.*

astro-ph/2205.05221: **A global system of furrows on Ganymede indicative of their creation in a single impact event** by *Naoyuki Hirata, Ryo Suetsugu, Keiji Ohtsuki*

astro-ph/2205.05237: **The formation of Haumea and its family via binary merging** by *Benjamin Proudfoot, Darin Ragozzine*

astro-ph/2205.05645: **CHES: a space-borne astrometric mission for the detection of habitable planets of the nearby solar-type stars** by *Jianghui Ji et al.*

astro-ph/2205.05669: **Ocean signatures in the total flux and polarization spectra of Earth-like exoplanets** by *Victor J.H. Trees, Daphne M. Stam*

astro-ph/2205.05696: **Direct Imaging and Spectroscopy of Extrasolar Planets** by *Thayne Currie et al.*

astro-ph/2205.05709: **Another Shipment of Six Short-Period Giant Planets from TESS** by *Joseph E. Rodriguez et al.*

astro-ph/2205.05969: **Benchmark tests of transmission spectroscopy using transiting white dwarfs** by *Chengzi Jiang et al.*

astro-ph/2205.06250: **An Integrative Analysis of the Rich Planetary System of the Nearby Star e Eridani: Ideal Targets For Exoplanet Imaging and Biosignature Searches** by *Ritvik Basant, Jeremy Dietrich, Daniel Apai*

astro-ph/2205.06284: **Can Carbon Fractionation Provide Evidence for Aerial Biospheres in the Atmospheres of Temperate Sub-Neptunes?** by *Ana Glidden et al.*

astro-ph/2205.06627: **Modelling stellar activity with Gaussian process regression networks** by *J. D. Camacho, J. P. Faria, P. T. P. Viana*

astro-ph/2205.06757: **An Implementation of Stochastic Forces for the N-body code REBOUND** by *Hanno Rein, Nick Choksi*

astro-ph/2205.06785: **The Effect of Ocean Salinity on Climate and Its Implications for Earth's Habitability** by *Stephanie L. Olson et al.*

astro-ph/2205.06914: **The Origin and Evolution of Saturn: A Post-Cassini Perspective** by *Sushil K. Atreya et al.*

astro-ph/2205.07008: **Dust release from cold ring particles as a mechanism of spoke formation in Saturn's rings** by *Naoyuki Hirata, Hiroshi Kimura, Keiji Ohtsukia*

astro-ph/2205.07037: **To Sample or Not To Sample: Retrieving Exoplanetary Spectra with Variational Inference and Normalising Flows** by *Kai Hou Yip et al.*

astro-ph/2205.07040: **Timing of the faulting on the Wispy Terrain of Dione based on stratigraphic relationships with impact craters** by *Naoyuki Hirata*

astro-ph/2205.07339: **Depletion of Moderately Volatile Elements by Open-System loss in the Early Solar Nebula** by *Debanjan Sengupta et al.*

astro-ph/2205.07522: **MOA-2019-BLG-008Lb: a new microlensing detection of an object at the planet/brown dwarf boundary** by *E. Bachelet et al.*

astro-ph/2205.07542: **Web of resonances and possible path of evolution of the small Uranian satellites** by *C. Charalambous, C.A. Giuppone, O.M. Guilera*

astro-ph/2205.07675: **Further support and a candidate location for Planet 9** by *Hector Socas-Navarro*

astro-ph/2205.07799: **Transfer of Rocks between Planetary Systems: Panspermia Revisited** by *Fred C Adams, Kevin J Napier*

astro-ph/2205.07832: **The Visual Survey Group: A Decade of Hunting Exoplanets and Unusual Stellar Events with Space-Based Telescopes** by *Martti H. K. Kristiansen et al.*

astro-ph/2205.07834: **Patchy nightside clouds on ultra-hot Jupiters: General Circulation Model simulations with radiatively active cloud tracers** by *Thaddeus D. Komacek et al.*

astro-ph/2205.07895: **The Great Planetary Heist: Theft and capture in star-forming regions** by *Emma C. Daffern-Powell et al.*

astro-ph/2205.07921: **The Futility of Exoplanet Biosignatures** by *Harrison B. Smith, Cole Mathis*

astro-ph/2205.07935: **Exomoons as sources of white dwarf pollution** by *Isabella L Trierweiler et al.*

astro-ph/2205.08212: **The specific heat of astro-materials: Review of theoretical concepts, materials and techniques** by *Jens Biele et al.*

astro-ph/2205.08560: **Weak evidence for variable occultation depth of 55 Cnc e with TESS** by *E.A. Meier Valdés et al.*

astro-ph/2205.08703: **Extreme eccentricities of triple systems: Analytic results** by *Abhi Mangipudi et al.*

astro-ph/2205.08900: **Space Weather-driven Variations in Ly alpha Absorption Signatures of Exoplanet Atmospheric Escape: MHD Simulations and the Case of AU Mic b** by *O. Cohen et al.*

astro-ph/2205.09046: **HD 28109 hosts a trio of transiting Neptunian planets including a near-resonant pair, confirmed by ASTEP from Antarctica** by *Georgina Dransfield et al.*

astro-ph/2205.09138: **Trends in Silicates in the $\beta$ Pictoris Disk** by *Cicero X. Lu et al.*

astro-ph/2205.09166: **The Nature of Low-Albedo Small Bodies from 3-$\mu$ m Spectroscopy: One Group that Formed Within the Ammonia Snow Line and One that Formed Beyond It** by *Andrew S. Rivkin et al.*

astro-ph/2205.09183: **Accretion onto a binary from a polar circumbinary disc** by *Jeremy L. Smallwood, Stephen H. Lubow, Rebecca G. Martin*

astro-ph/2205.09319: **A general stability-driven approach for the refinement of multi-planet systems** by *M. Stalport et al.*

astro-ph/2205.09340: **A dynamical definition of the sphere of influence of the Earth** by *Irene Cavallari et al.*

astro-ph/2205.09355: **A CHEOPS Search for Massive, Long-Period Companions to the Warm Jupiter K2-139**

**b** by *Alexis M. S. Smith, Szilard Csizmadia*

astro-ph/2205.09410: **Pandora: A fast open-source exomoon transit detection algorithm** by *Michael Hippke, René Heller*

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