ExoPlanet News
An Electronic Newsletter

No. 139, 12 January 2021

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1 Editorial

Welcome to Edition 139 of the ExoPlanet News! We are pleased to send you the first ExoPlanet newsletter of the new year 2021. 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!

In 2021 our editorial team still consists of Daniel Angerhausen (ETH Zurich), Holly Capelo (Physics Institute Bern), Lokesh Mishra (Physics Institute Bern & Geneva Observatory), and Julia Venturini (ISSI Bern). As always, we would 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 16. February 2021. All the best for a year full of exciting exoplanet science to all of you!

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

Daniel Angerhausen
Julia Venturini
Lokesh Mishra
Holly Capelo

2 Abstracts of refereed papers

Auto-correlation functions of astrophysical processes, and their relation to Gaussian processes; Application to radial velocities of different starspot configurations

M. Perger[1,2], *G. Anglada-Escudé*[1,2], *I. Ribas*[1,2], *A. Rosich*[1,2], *E. Herrero* [1,2], *J. C. Morales*[1,2]

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A&A, in press (2020arXiv201201862P)

Accounting for the effects of stellar magnetic phenomena is indispensable to fully exploit radial velocities (RVs) obtained using modern exoplanet-hunting spectrometers. Correlated time variations are often mitigated by non-trivial noise models in the framework of Gaussian processes (GPs). These models rely on fitting kernel functions that are motivated on mathematical grounds, and whose physical interpretation is often elusive. We aim to establish a clear connection between stellar magnetic activity affecting RVs and their corresponding correlations with physical parameters, and compare this connection with kernels used in the literature. We use simple activity models to investigate the relationship between the physical processes generating the signals and the covariances typically found in data, and to demonstrate the qualitative behaviour of this relationship. We use the `StarSim` code to calculate RVs of an M dwarf with different realistic evolving spot configurations. The auto-correlation function (ACF) of a synthetic data set shows a very specific behaviour and is explicitly related to the kernel. Gaussian process regression is performed using the quasi-periodic (QP) and simple harmonic oscillator (SHO) kernels of the `george` and `celerite` codes, respectively. Comparison of the resulting kernels with the exact ACFs allows us to cross-match the kernel hyper-parameters with the introduced physical values, study the overall capabilities of the kernels, and improve their definition. We find that the QP kernel provides a more straightforward interpretation of the physics. It is able to consistently recover both the introduced rotation period $P_{\rm rot}$ and the spot lifetime. Our study indicates that the performance can be enhanced by fixing the form factor w and adding a physically motivated cosine term with period $P_{\rm rot}/2$, where the contribution to the ACF for the different spot configurations differs significantly. The newly proposed quasi-periodic with cosine (QPC) kernel leads to significantly better model likelihoods, can potentially distinguish between different spot configurations, and can thereby improve the sensitivity of RV exoplanet searches.

Download/Website: `https://arxiv.org/pdf/2012.01862.pdf`

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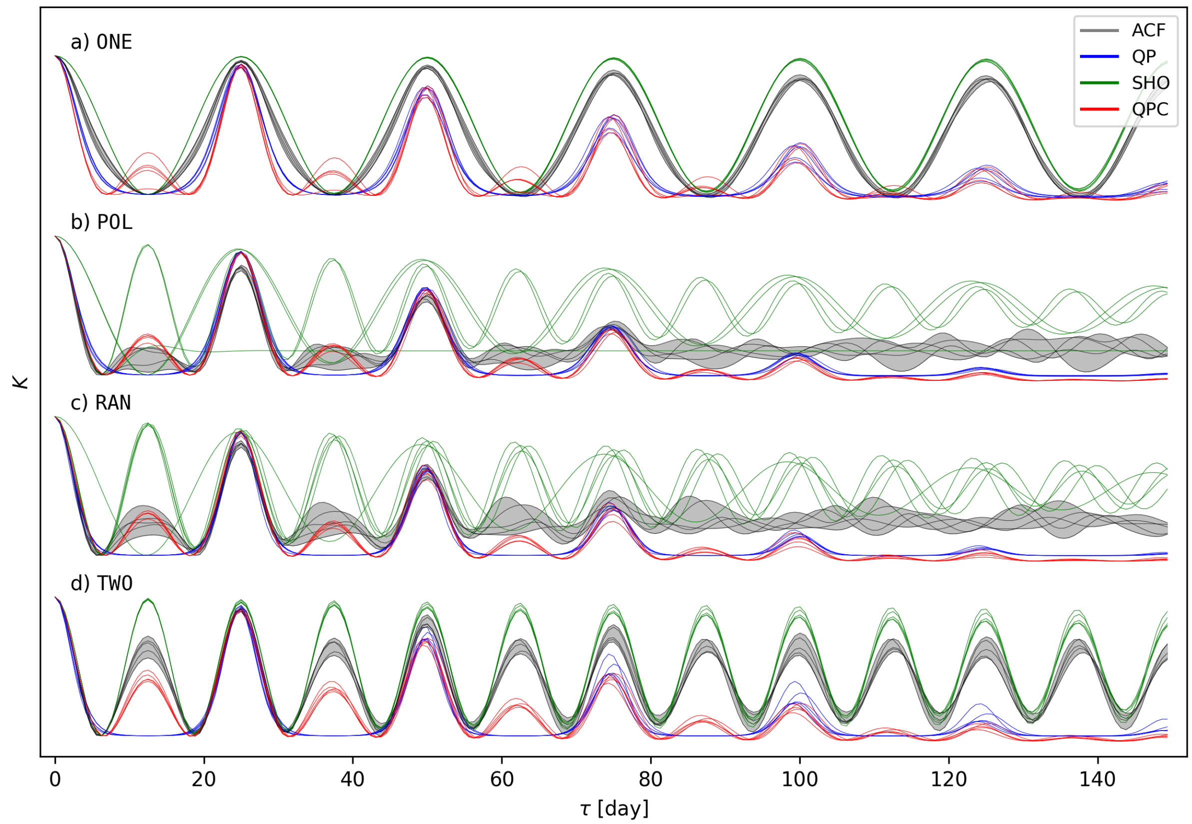

Figure 1: Perger et al.: Auto-correlation functions (ACF, grey and black) and Gaussian process kernels (quasi-periodic QP, blue; simple harmonic oscillator SHO, green; quasi-periodic and cosine QPC, red) with largest fitted likelihoods of all StarSim model RV data sets sorted by spot configuration (from top to bottom spots distributed around one active longitude ONE, a polar spot distribution POL, a random spot distribution RAN, and a distribution around two active longitudes TWO). The SHO kernel has a less prominent correlation decay and puts more weight on correlations at larger τ in comparison to the QP and QPC kernels. We reiterate the fact that the hyperparameters of the kernels are specifically sensitive to the correlations at shorter time-lags because of the linear decrease of the number of data-point pairs N_τ with time-lag τ, i.e. $N_\tau(\tau) = \frac{1-N}{T}\tau + N$.

Search for associations containing young stars (SACY) VIII. An updated census of spectroscopic binary systems exhibiting hints of non-universal multiplicity among their associations

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Astronomy & Astrophysics, Accepted (arXiv:2010.08575v2)

Nearby young associations offer one of the best opportunities for a detailed study of the properties of young stellar and substellar objects thanks to their proximity ($< 200\,$pc) and age ($\sim 5-150\,$Myr). Previous works have identified spectroscopic ($< 5\,$au) binaries, close ($5-1000\,$au) visual binaries, and wide or extremely wide ($1,000-100,000\,$au) binaries in the young associations. In most of the previous analyses, single-lined spectroscopic binaries (SB1) were identified based on radial velocities variations. However, this apparent variation may also be caused by mechanisms unrelated to multiplicity. We seek to update the spectroscopy binary fraction of the Search for Associations Containing Young stars (SACY) sample, taking into consideration all possible biases in our identification of binary candidates, such as activity and rotation. Using high-resolution spectroscopic observations, we produced $\sim$1300 cross-correlation functions (CCFs) to disentangle the previously mentioned sources of contamination. The radial velocity values we obtained were cross-matched with the literature and then used to revise and update the spectroscopic binary (SB) fraction in each object of the SACY association. In order to better describe the CCF profile, we calculated a set of high-order cross-correlation features to determine the origin of the variations in radial velocities. We identified 68 SB candidates from our sample of 410 objects. Our results hint that at the possibility that the youngest associations have a higher SB fraction. Specifically, we found sensitivity-corrected SB fractions of $22^{+15}_{-11}\%$ for ϵ Cha , $31^{+16}_{-14}\%$ for TW Hya and $32^{+9}_{-8}\%$ for β Pictoris, in contrast to the five oldest associations we have sampled ($\sim 35-125$ Myr) which are $\sim 10\%$ or lower. This result seems independent of the methodology used to asses membership to the associations. The new CCF analysis, radial velocity estimates, and SB candidates are particularly relevant for membership revision of targets in young stellar associations. These targets would be ideal candidates for follow-up campaigns using high-resolution techniques to confirm binarity, resolve orbits, and, ideally, calculate dynamical masses. Additionally, if the results on the SB fraction in the youngest associations were confirmed, it could hint at a non-universal multiplicity among SACY associations.

Download/Website: `https://arxiv.org/abs/2010.08575v2`

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Migration of Jupiter-mass planets in low-viscosity discs

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Astronomy and Astrophysics, in press

Type-II migration of giant planets has a speed proportional to the disc's viscosity for values of the α viscosity parameter larger than 10^{-4}. Previous studies based on two-dimensional simulations, have shown that, at even lower viscosities, migration can be very chaotic and is often characterised by phases of fast migration. The reason is that vortices appear in low-viscosity discs due to the Rossby-wave instability at the edges of the gap opened by the planet. Migration is then determined by vortex-planet interactions. Our goal is to study giant planet migration in low-viscosity discs with 3D simulations. In 3D, vortices are more complex than the simple vertical extension of their 2D counterparts; their impact on planet migration is therefore not obvious. We performed numerical simulations using two grid-based codes: FARGOCA for three-dimensional simulations and FARGO-ADSG for the two dimensional case. Two-dimensional simulations were used mainly for preliminary tests to check the impact of self-gravity on vortex formation and on vortex-disc dynamics. After selecting disc masses for which self-gravity is not important at the planet location, three-dimensional simulations without self-gravity can be safely used. We have considered an adiabatic equation of state with exponential damping of temperature perturbations in order to avoid the development of the vertical shear instability. In our nominal simulation, we set $\alpha = 0$ so that only numerical viscosity is present. We then performed simulations with non-zero α values to assess the threshold of prescribed viscosity below which the new migration processes appear. We show that for $\alpha < 10^{-5}$ two migration modes are possible, which differ from classical Type-II migration in the sense that they are not proportional to the disc's viscosity. The first occurs when the gap opened by the planet is not very deep. This occurs in 3D simulations and/or when a big vortex forms at the outer edge of the planetary gap, diffusing material into the gap. The de-saturation of co-orbital and co-rotation resonances keeps the planet's eccentricity low. Inward planet migration then occurs as long as the disc can refill the gap left behind by the migrating planet, either due to diffusion caused by the presence of the vortex or to the inward migration of the vortex itself due to its interaction with the disc. We call this type of migration 'vortex-driven migration', which differs from 'vortex-induced' migration described in Lin and Papaloizou (2010,2011). This migration is very slow and cannot continue indefinitely because eventually the vortex dissolves. The second migration mode occurs when the gap is deep so that the planet's eccentricity grows to a value $e \sim 0.2$ due to inefficient eccentricity damping by co-rotation resonances. Once the planet is on an eccentric orbit, gas can pass through the gap and planet migration unlocks from the disc's viscous evolution. This second, faster migration mode appears to be typical of two-dimensional models in discs with slower damping of temperature perturbations. Vortex-driven migration in low-viscosity discs can be very slow and eventually reverses and stops, offering an interesting mechanism to explain the existence of the cold-Jupiter population, even if these planets originally started growing at the disc's snowline.

Download/Website: `https://arxiv.org/abs/2012.12930`

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MOVES IV. Modelling the influence of stellar XUV-flux, cosmic rays, and stellar energetic particles on the atmospheric composition of the hot Jupiter HD 189733b

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Monthly Notices of the Royal Astronomical Society, in press (arXiv:2012.12132)

Hot Jupiters provide valuable natural laboratories for studying potential contributions of high-energy radiation to prebiotic synthesis in the atmospheres of exoplanets. In this fourth paper of the MOVES (Multiwavelength Observations of an eVaporating Exoplanet and its Star) programme, we study the effect of different types of high-energy radiation on the production of organic and prebiotic molecules in the atmosphere of the hot Jupiter HD 189733b. Our model combines X-ray and UV observations from the MOVES programme and 3D climate simulations from the 3D Met Office Unified Model to simulate the atmospheric composition and kinetic chemistry with the STAND2019 network. Also, the effects of galactic cosmic rays and stellar energetic particles are included. We find that the differences in the radiation field between the irradiated dayside and the shadowed nightside lead to stronger changes in the chemical abundances than the variability of the host star's XUV emission. We identify ammonium (NH_4^+) and oxonium (H_3O^+) as fingerprint ions for the ionization of the atmosphere by both galactic cosmic rays and stellar particles. All considered types of high-energy radiation have an enhancing effect on the abundance of key organic molecules such as hydrogen cyanide (HCN), formaldehyde (CH_2O), and ethylene (C_2H_4). The latter two are intermediates in the production pathway of the amino acid glycine ($C_2H_5NO_2$) and abundant enough to be potentially detectable by *JWST*.

Download/Website: `https://arxiv.org/abs/2012.12132`

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Giant planet migration during the disc dispersal phase

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Astronomy & Astrophysics, in press (arXiv: 2101.01179)

Transition discs are expected to be a natural outcome of the interplay between photoevaporation and giant planet formation. Massive planets reduce the inflow of material from the outer to the inner disc, therefore triggering an earlier onset of disc dispersal due to photoevaporation through a process known as Planet-Induced PhotoEvaporation (PIPE). In this case, a cavity is formed as material inside the planetary orbit is removed by photoevaporation, leaving only the outer disc to drive the migration of the giant planet. We investigate the impact of photoevaporation on giant planet migration and focus specifically on the case of transition discs with an evacuated cavity inside the planet location. This is important for determining under what circumstances photoevaporation is efficient at halting the migration of giant planets, thus affecting the final orbital distribution of a population of planets. For this purpose, we use 2D `FARGO` simulations to model the migration of giant planets in a range of primordial and transition discs subject to photoevaporation. The results are then compared to the standard prescriptions used to calculate the migration tracks of planets in 1D planet population synthesis models. `FARGO` simulations show that once the disc inside the planet location is depleted of gas, planet migration ceases. This contradicts the results obtained by the impulse approximation, which predicts the accelerated inward migration of planets in discs that have been cleared inside the planetary orbit. These results suggest that the impulse approximation may not be suitable for planets embedded in transition discs. A better approximation that could be used in 1D models would involve halting planet migration once the material inside the planetary orbit is depleted of gas and the surface density at the 3:2 mean motion resonance location in the outer disc reaches a threshold value of $0.01\mathrm{g\,cm^{-2}}$.

Download/Website: `https://arxiv.org/abs/2101.01179`

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How dust fragmentation may be beneficial to planetary growth by pebble accretion

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Astronomy & Astrophysics, in press (arXiv:2101.01728)

Pebble accretion is an emerging paradigm for the fast growth of planetary cores. Pebble flux and pebble sizes are the key parameters used in the pebble accretion models. We aim to derive the pebble sizes and fluxes from state-of-the-art dust coagulation models, understand their dependence on disk parameters and the fragmentation threshold velocity, and the impact of those on the planetary growth by pebble accretion. We use a one-dimensional dust evolution model including dust growth and fragmentation to calculate realistic pebble sizes and mass flux. We use this information to integrate the growth of planetary embryos placed at various locations in the protoplanetary disk. Pebble flux strongly depends on disk properties, such as its size and turbulence level, as well as on the dust aggregates fragmentation threshold. We find that dust fragmentation may be beneficial to planetary growth in multiple ways. First of all, it prevents the solids from growing to very large sizes, for which the efficiency of pebble accretion drops. What is more, small pebbles are depleted at a slower rate, providing a long-lasting pebble flux. As the full coagulation models are computationally expensive, we provide a simple method of estimating pebble sizes and flux in any protoplanetary disk model without substructure and with any fragmentation threshold velocity.

Download/Website: `http://arxiv.org/abs/2101.01728`

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NGTS-14Ab: A Neptune-sized transiting planet in the desert

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Astronomy & Astrophysics, in press (arXiv:2101.01470)

Context: The sub-Jovian, or Neptunian, desert is a previously identified region of parameter space where there is a relative dearth of intermediate-mass planets with short orbital periods.
Aims: We present the discovery of a new transiting planetary system within the Neptunian desert, NGTS-14.
Methods: Transits of NGTS-14Ab were discovered in photometry from the Next Generation Transit Survey (NGTS). Follow-up transit photometry was conducted from several ground-based facilities, as well as extracted from TESS full-frame images. We combine radial velocities from the HARPS spectrograph with the photometry in a global analysis to determine the system parameters.
Results: NGTS-14Ab has a radius that is about 30 per cent larger than that of Neptune (0.444 ± 0.030 $\mathrm{R_{Jup}}$) and is around 70 per cent more massive than Neptune (0.092 ± 0.012 $\mathrm{M_{Jup}}$). It transits the main-sequence K1 star, NGTS-14A, with a period of 3.54 days, just far away enough to have maintained at least some of its primordial atmosphere. We have also identified a possible long-period stellar mass companion to the system, NGTS-14B, and we investigate the binarity of exoplanet host stars inside and outside the Neptunian desert using Gaia.

Download/Website: `https://arxiv.org/abs/2101.01470`

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Do instabilities in high-multiplicity systems explain the existence of close-in white dwarf planets?

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MNRASL, published (ADS-Bibcode: 2021MNRAS.501L..43M)

We investigate the origin of close-in planets and related phenomena orbiting white dwarfs (WDs), which are thought to originate from orbits more distant from the star. We use the planetary architectures of the 75 multiple-planet systems (four, five and six planets) detected orbiting main-sequence stars to build 750 dynamically analogous templates that we evolve to the WD phase. Our exploration of parameter space, although not exhaustive, is guided and restricted by observations and we find that the higher the multiplicity of the planetary system, the more likely it is to have a dynamical instability (losing planets, orbit crossing and scattering), that eventually will send a planet (or small object) through a close periastron passage. Indeed, the fraction of unstable four- to six-planet simulations is comparable to the 25–50% fraction of WDs having atmospheric pollution. Additionally, the onset of instability in the four- to six-planet configurations peaks in the first Gyr of the WD cooling time, decreasing thereafter. Planetary multiplicity is a natural condition to explain the presence of close-in planets to WDs, without having to invoke the specific architectures of the system or their migration through the von Zeipel–Lidov–Kozai (ZLK) effects from binary companions or their survival through the common envelope phase.

Download/Website: `https://doi.org/10.1093/mnrasl/slaa193`

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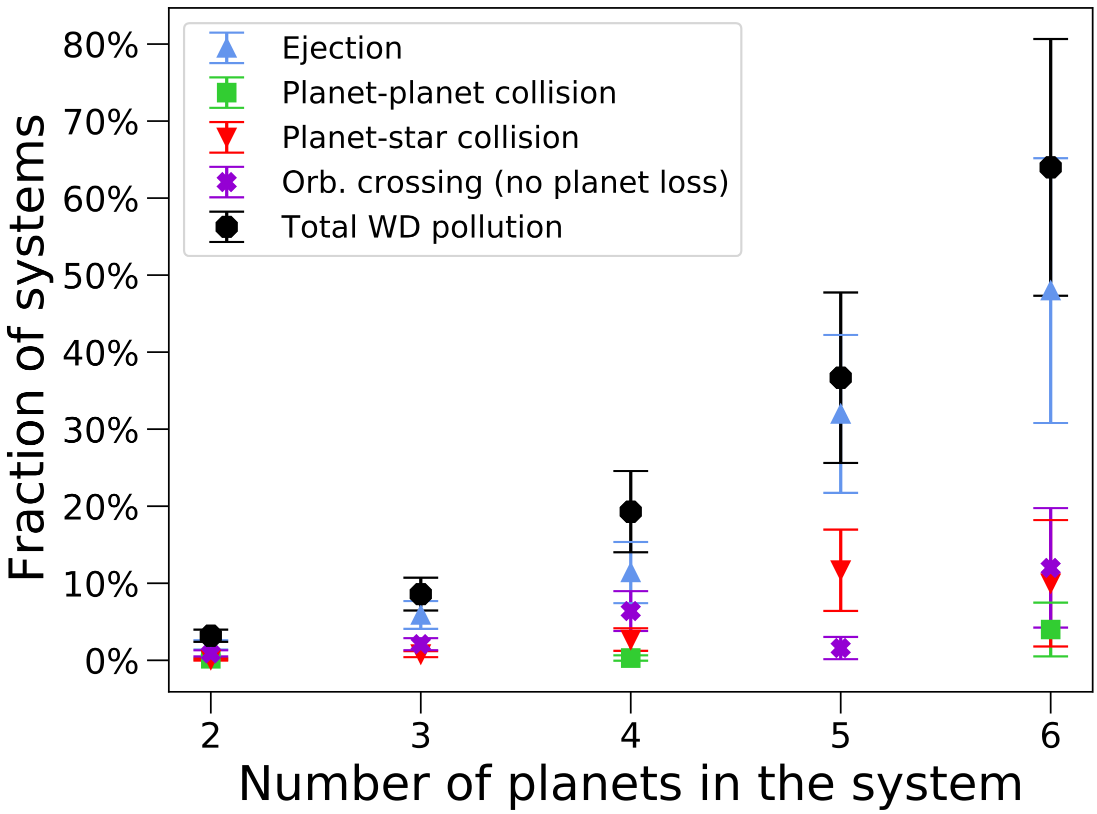

Figure 2: Maldonado et al.:Relative number of multiple-planet systems with respect to the total number of simulations losing planets by Hill and/or Lagrange instabilities as well as the simulations with orbit crossing that do not lose any planet during 10 Gyr. Additionally, we present the total number of simulations that may contribute to WD pollution. Error bars correspond to the standard deviation of the Bootstrap resampling method. Each instability type is marked with a different symbol and colour.

Semianalytical model for planetary resonances: Application to planets around single and binary stars

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Astronomy & Astrophysics, in press (arXiv:2012.12296)

Planetary resonances are a common dynamical mechanism acting on planetary systems. However, no general model for describing their properties exists, particularly for commensurabilities of any order and arbitrary eccentricity and inclination values.
We present a semianalytical model that describes the resonance strength, width, location and stability of fixed points, and periods of small-amplitude librations. The model is valid for any two gravitationally interacting massive bodies, and is thus applicable to planets around single or binary stars.
Using a theoretical framework in the Poincaré and Jacobi reference system, we developed a semianalytical method that employs a numerical evaluation of the averaged resonant disturbing function. Validations of the model are presented that compare its predictions with dynamical maps for real and fictitious systems.
The model describes many dynamical features of planetary resonances very well. Notwithstanding the good agreement found in all cases, a small deviation is noted in the location of the resonance centers for circumbinary systems. As a consequence of its application to the HD31527 system, we found that the updated best-fit solution leads to a high-eccentricity stable libration between the middle and outer planets inside the 16/3 mean-motion resonance (**MMR**). This is the first planetary system whose long-term dynamics appears dominated by such a high-order commensurability. In the case of circumbinary planets, the overlap of N/1 mean-motion resonances coincides very well with the size of the global chaotic region close to the binary, as well as its dependence on the mutual inclination.

Download/Website: `www.fisica.edu.uy/~gallardo/atlas/plares.html`

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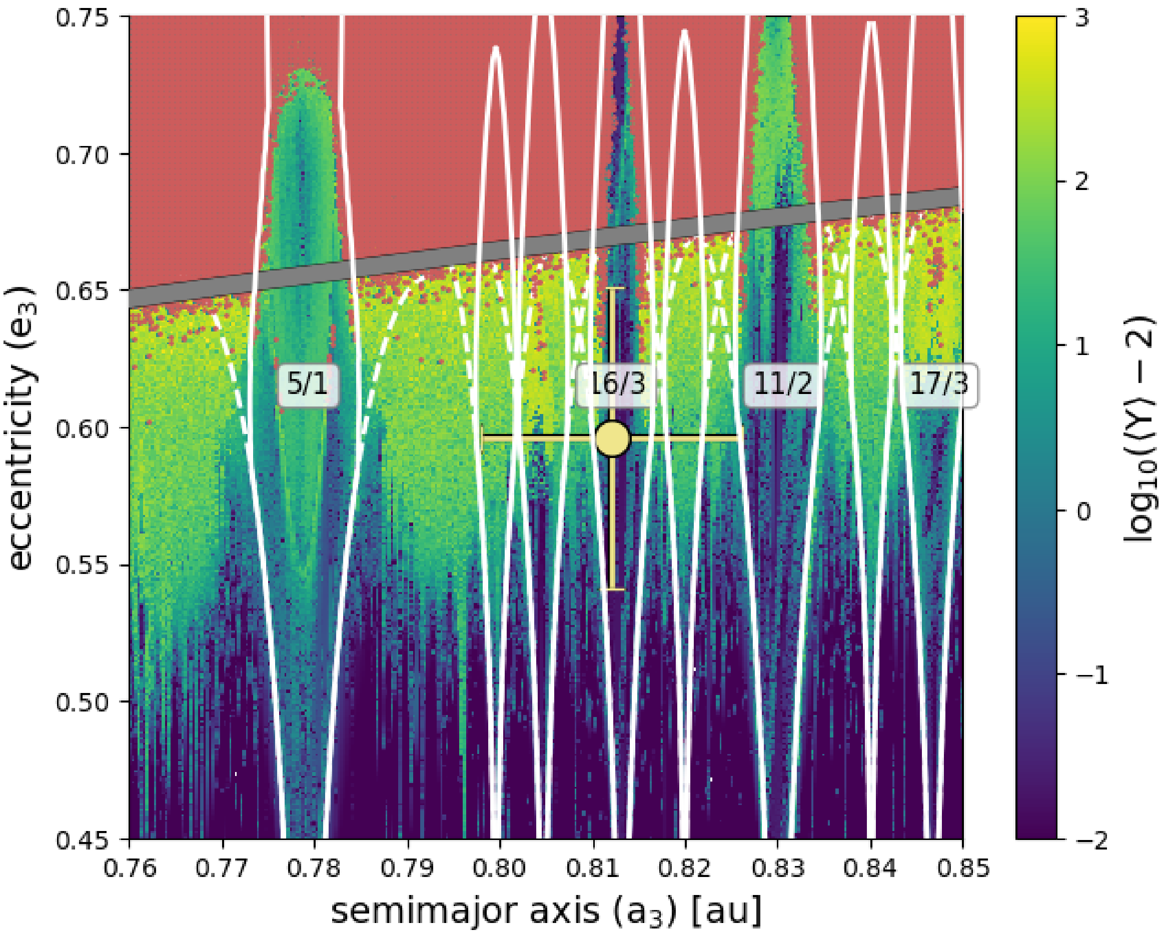

Figure 3: Gallardo et al.: Megno map for the HD31527 system, as obtained from the numerical integration of a grid of 300×300 initial conditions in the (a_3, e_3) plane. All other orbital elements were set to the nominal values. Integration time was set to 10^4 years, and escapes during this time span are highlighted in red. The color code shows values of $(\langle Y \rangle - 2)$. Dark blue corresponds to more regular orbits, and lighter tones of green indicate increasingly chaotic motion. The location of the outer planet is shown with a filled yellow circle, and the collision curve is plotted in gray. The libration widths of the most relevant MMRs determined analytically are plotted as white lines

Three-dimensional continuum radiative transfer of polarized radiation in exoplanetary atmospheres

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Astronomy & Astrophysics, in press (arXiv:2012.12992)

Polarimetry is about to become a powerful tool for determining the atmospheric properties of exoplanets. To provide the basis for the interpretation of observational results and for predictive studies to guide future observations, sophisticated analysis tools are required. Our goal is to develop a radiative transfer tool that contains all the relevant continuum polarization mechanisms for the comprehensive analysis of the polarized flux resulting from the scattering in the atmosphere of, on the surface of, and in the local planetary environment (e.g., planetary rings, exomoons) of extra-solar planets. Furthermore, our goal is to avoid common simplifications such as locally plane-parallel planetary atmospheres, the missing cross-talk between latitudinal and longitudinal regions, or the assumption of either a point-like star or plane-parallel illumination. As a platform for the newly developed numerical algorithms, we use the 3D Monte Carlo radiative transfer code POLARIS. The code is extended and optimized for the radiative transfer in exoplanetary atmospheres. We investigate the reflected flux and its degree of polarization for different phase angles for a homogeneous cloud-free atmosphere and an inhomogeneous cloudy atmosphere. To take advantage of the 3D radiative transfer and to demonstrate the potential of the code, the impact of an additional circumplanetary ring on the reflected polarized flux is studied. The presence of a circumplanetary ring consisting of small water-ice particles has a noticeable impact on the reflected polarized radiation. In particular, the reflected flux strongly increases at larger phase angles if the planetary orbit is seen edge-on because the considered particles tend to scatter forwards. In contrast, the degree of polarization decreases at these phase angles.

Download/Website: `https://arxiv.org/abs/2012.12992`

Contact: `mlietzow@astrophysik.uni-kiel.de`

The search for radio emission from the exoplanetary systems 55 Cancri, υ Andromedae, and τ Boötis using LOFAR beam-formed observations

Jake D. Turner[1,2],*Philippe Zarka*[3,4],*Jean-Mathias Grießmeier*[3,5], *Joseph Lazio*[6],*Baptiste Cecconi*[3,4], *J. Emilio Enriquez*[7,8],*Julien N. Girard*[9,10], *Ray Jayawardhana*[1],*Laurent Lamy*[4], *Jonathan D. Nichols*[11],*Imke de Pater*[12]

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[3] Station de Radioastronomie de Nançay, Observatoire de Paris, PSL Research University, CNRS, Univ. Orléans, OSUC, 18330 Nançay, France
[4] LESIA, Observatoire de Paris, CNRS, PSL, Meudon, France
[5] Laboratoire de Physique et Chimie de l'Environnement et de l'Espace (LPC2E) Université d'Orléans/CNRS, Orléans, France
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[10] AIM, CEA, CNRS, Université Paris-Saclay, Université Paris Diderot, Sorbonne Paris Cité, F-91191 Gif-sur-Yvette, France
[11] Department of Physics and Astronomy, University of Leicester, Leicester, UK
[12] Department of Astronomy, University of California at Berkeley, Berkeley, CA, USA

Astronomy & Astrophysics, in press/(arXiv:2012.07926)

Context. The detection of radio emissions from exoplanets will open up a vibrant new research field. Observing planetary auroral radio emission is the most promising method to detect exoplanetary magnetic fields, the knowledge of which will provide valuable insights into the planet's interior structure, atmospheric escape, and habitability.

Aims. We present LOFAR (LOw Frequency ARray) Low Band Antenna (LBA: 10-90 MHz) circularly polarized beamformed observations of the exoplanetary systems 55 Cancri, υ Andromedae, and τ Boötis. All three systems are predicted to be good candidates to search for exoplanetary radio emission.

Methods. We applied the `BOREALIS` pipeline that we have developed to mitigate radio frequency interference and searched for both slowly varying and bursty radio emission. Our pipeline has previously been quantitatively benchmarked on attenuated Jupiter radio emission.

Results. We tentatively detect circularly polarized bursty emission from the τ Boötis system in the range 14-21 MHz with a flux density of $\sim$890 mJy and with a statistical significance of $\sim 3\sigma$. For this detection, we do not see any signal in the OFF-beams, and we do not find any potential causes which might cause false positives. We also tentatively detect slowly variable circularly polarized emission from τ Boötis in the range 21-30 MHz with a flux density of $\sim$400 mJy and with a statistical significance of $>8\sigma$. The slow emission is structured in the time-frequency plane and shows an excess in the ON-beam with respect to the two simultaneous OFF-beams. While the bursty emission seems rather robust, close examination casts some doubts on the reality of the slowly varying signal. We discuss in detail all the arguments for and against an actual detection, and derive methodological tests that will also apply to future searches. Furthermore, a $\sim 2\sigma$ marginal signal is found from the υ Andromedae system in one observation of bursty emission in the range 14-38 MHz and no signal is detected from the 55 Cancri system, on which we placed a 3σ upper limit of 73 mJy for the flux density at the time of the observation.

Conclusions. Assuming the detected signals are real, we discuss their potential origin. Their source probably is the τ Boötis planetary system, and a possible explanation is radio emission from the exoplanet τ Boötis b via the cyclotron maser mechanism. Assuming a planetary origin, we derived limits for the planetary polar surface magnetic field strength, finding values compatible with theoretical predictions. Further observations with LOFAR-LBA and other low-frequency telescopes, such as NenuFAR or UTR-2, are required to confirm this possible first detection of an exoplanetary radio signal.

Download/Website: `https://arxiv.org/abs/2012.07926`

Contact: `jaketurner@cornell.edu`

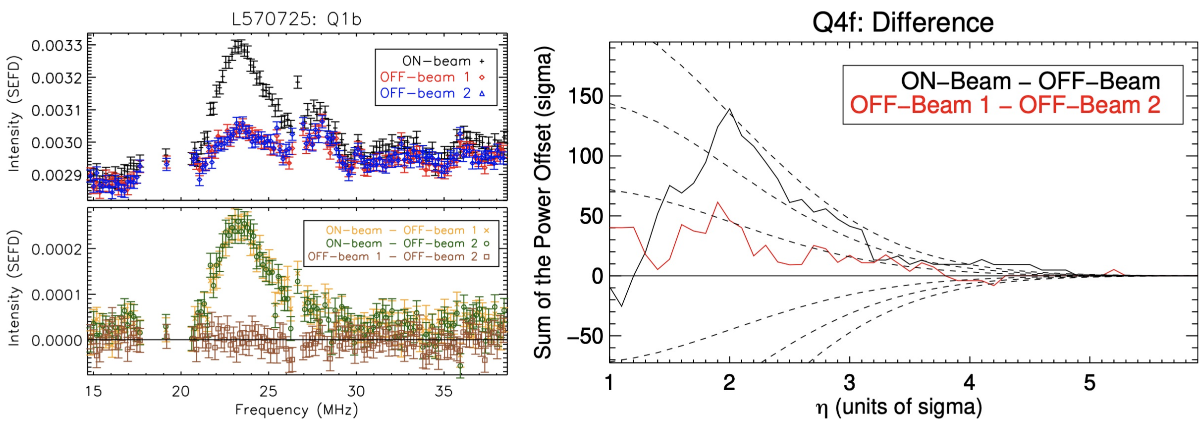

Figure 4: Turner et al.: Tentative detections of circularly polarized radio emission from τ Boötis using beamformed observations from LOFAR. ***Right:*** Integrated spectrum in Stokes-V during the observation L570725. The signal in the ON-beam is concentrated between 21 and 30 MHz and is distinctly different than in both OFF-beams. The two OFF beams are equivalent within the error bars, calculated assuming pure Gaussian noise ($\sigma = 1/\sqrt{b\tau}$). We find by performing Gaussian simulations that the probability to randomly reproduce the signal in the ON-beam curve $1{\times}10^{-18}$. This probability corresponds to a statistically significant detection of 8.6σ. ***Left:*** Burst observable statistic for observation L569131 in the range 14-38 MHz in Stokes-V. The black line is the ON-beam difference with the OFF beam 2 and the red line is the difference between the OFF beams. The dashed lines are statistical limits (1, 2, 3σ) of the difference between all the Q4 values derived from 10000 runs using two different Gaussian distributions. The ON-beam shows an excess above 2 σ statistical significance and is distinctly different from the OFF-beams. The probability to obtain the OFF beam curve by chance is $\sim$81%, whereas it is 7×10^{-4} for the ON-beam curve, corresponding to a 3.2σ detection. A Kolmogorov–Smirnov statistical test on the two curves conclude that the probability to reject the null hypothesis (that the two curves are drawn from the same parent distribution) is 98%.

Decaying Orbit of the Hot Jupiter WASP-12b: Confirmation with TESS Observations

Jake D. Turner[1], *Andrew R. Ridden-Harper*[1], *Ray Jayawardhana*[2]
[1] Department of Astronomy and Carl Sagan Institute, Cornell University, Ithaca, New York 14853, USA
[2] Department of Astronomy, Cornell University, Ithaca, New York 14853, USA

AJ, in press (arXiv:2012.02211)

Theory suggests that the orbits of some close-in giant planets should decay due to tidal interactions with their host stars. To date, WASP-12b is the only hot Jupiter reported to have a decaying orbit, at a rate of 29±2 msec year^{-1}. We analyzed data from NASA's Transiting Exoplanet Survey Satellite (TESS) to verify that WASP-12b's orbit is indeed changing. We find that the TESS transit and occultation data are consistent with a decaying orbit with an updated period of 1.091420090±0.000000041 days and a decay rate of 32.53±1.62 msec year^{-1}. We find an orbital decay timescale of $\tau = P/|\dot{P}| = 2.90 \pm 0.14$ Myr. If the observed decay results from tidal dissipation, the modified tidal quality factor is $Q'_\star$ = 1.39±0.15 $\times 10^5$, which falls at the lower end of values derived for binary star systems and hot Jupiters. Our result highlights the power of space-based photometry for investigating the orbital evolution of short-period exoplanets.

Download/Website: `https://arxiv.org/pdf/2012.02211.pdf`

Contact: `jaketurner@cornell.edu`

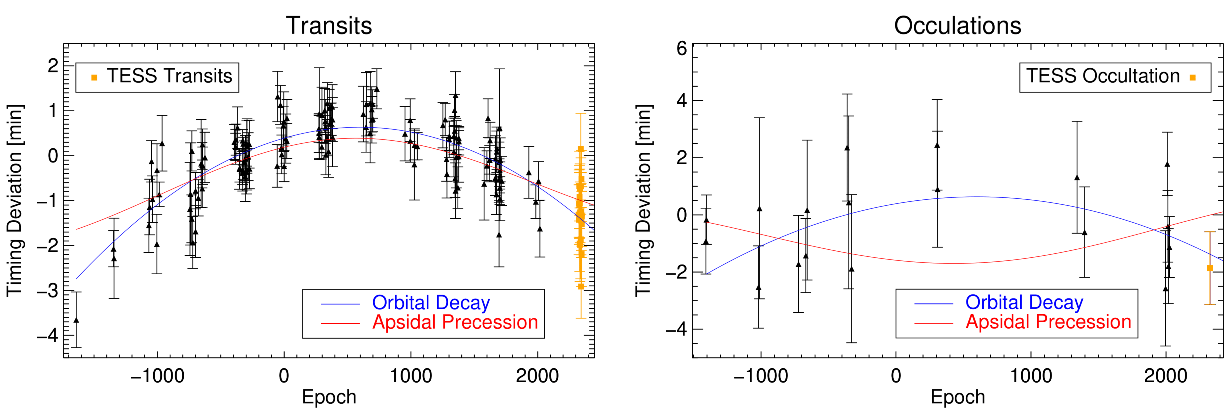

Figure 5: Turner, Ridden-Harper & Jayawardhana: Transit (left) and occultation (right) timing variations after subtracting the data with a constant-period model. The filled black triangles are the data points complied from (Yee, 2020) and the square orange points are from the TESS data in this paper. The orbital decay and apsidal precession models are shown as the blue and red lines, respectively.

Three new late-type stellar companions to very dusty WISE debris disks identified with VLT/SPHERE imaging

E. C. Matthews[1], Sasha Hinkley[2], Karl Stapelfeldt[3], Arthur Vigan[4], Dimitri Mawet[5], Ian J. M. Crossfield[6], Trevor J. David[7], Eric Mamajek[3], Tiffany Meshkat[8], Farisa Morales[3], Deborah Padgett[3]

[1] Observatoire de l'Université de Genève, Chemin Pegasi 51, 1290 Versoix, Switzerland
[2] University of Exeter, School of Physics & Astronomy, Stocker Road, Exeter, EX4 4QL, UK
[3] Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove drive, Pasadena CA 91109, USA
[4] Aix Marseille Univ, CNRS, CNES, LAM, Marseille, France
[5] Cahill Center for Astronomy and Astrophysics, California Institute of Technology, 1200 East California Boulevard, MC 249-17,Pasadena, CA 91125, USA
[6] The University of Kansas, Department of Physics and Astronomy, Malott Room 1082, 1251 Wescoe Hall Drive, Lawrence, KS, 66045,USA
[7] Center for Computational Astrophysics, Flatiron Institute, New York, NY 10010, USA
[8] IPAC, California Institute of Technology, M/C 100-22, 1200 East California Boulevard, Pasadena, CA 91125, USA

The Astronomical Journal, in press (arXiv:2012.03980)

Debris disk stars are good targets for high contrast imaging searches for planetary systems, since debris disks have been shown to have a tentative correlation with giant planets. We selected 20 stars identified as debris disk hosts by the NASA WISE mission, with particularly high levels of warm dust. We observed these with the VLT/SPHERE high contrast imaging instrument with the goal of finding planets and imaging the disks in scattered light. Our survey reaches a median sensitivity of 7.8Mj at 20au and 2.1Mj at 100au. We identified three new stellar companions (HD18378B, HD19257B and HD133778B): two are mid-M type stars and one is late K or early M star, and found three additional stars to have very widely separated stellar companions using the *Gaia* catalog. The stars hosting the three SPHERE-identified companions are all older ($>$700Myr), with one having recently left the main sequence and one a giant star. We infer that the high volumes of dust observed around these stars might have been caused by a recent collision between the planets and planetesimal belts in the system. Future mid-IR spectroscopy may allow the positions and spatial extent of these dust belts to be constrained, thereby providing evidence as to the true cause of the elevated levels of dust around these old systems. None of the disks in this survey are resolved in scattered light.

Download/Website: `https://arxiv.org/abs/2012.03980`

Contact: `elisabeth.matthews@unige.ch`

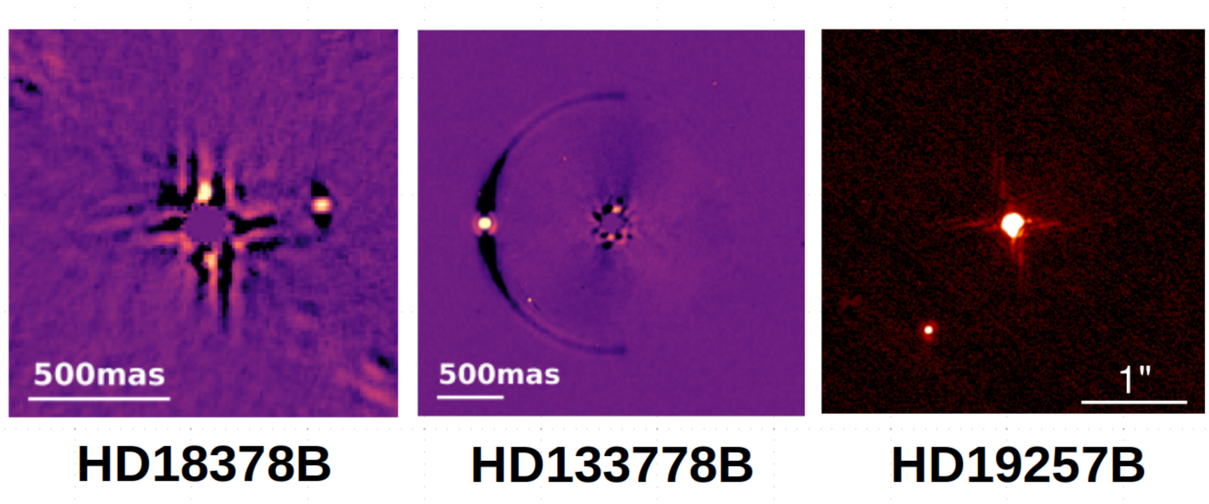

Figure 6: Matthews et al.

3 Jobs and Positions

Several postdoctoral positions on planet formation in Chile. Theory and observations

A. Bayo, J. Olofsson, M.R Schreiber, J. Cuadra (UV, UV-MPIA TG, UTFSM, UAI)
Núcleo Milenio de Formación Planetaria (UV, UTFSM, UAI)

Valparaíso or Viña del Mar, Chile, The earliest possible from Feburary 2021

The Núcleo Milenio for Planet Formation (NPF, http://www.npf.cl/en) multidisciplinary group, formed by researchers in Valparaíso and Viña del Mar, Chile, invites applications to fill **several** postdoctoral positions. The applicants should have a strong interest in (sub)stellar and planet formation, protoplanetary and/or debris discs, including around evolved and/or binary stars, and can have either an observational or theoretical background.
The postdoctoral scholars will be working directly with Amelia Bayo, Johan Olofsson (both at Universidad de Valparaíso), Matthias R. Schreiber (at Universidad Técnica Federico Santa Maria), Jorge Cuadra (at Universidad Adolfo Ibañez), and their respective groups and close collaborators (a total of ∼25 researchers), including Olofsson's Max Planck Tandem Group. Moreover, they will interact with the engineers at UTFSM, Valparaiso, working on new astronomical mirror technology and challenges, in direct contact with the Planet Formation Imager team.
The appointments will be for two years initially, with the possibility of extension for up to three years in total, depending on funding renewal and satisfactory performance. The positions are available immediately, although later starting dates are possible.
The salary and benefits offered are competitive for Chilean standards. The universities provide an active, international academic environment, with weekly seminars and colloquia. As members of the Chilean community, the postdoctoral researchers will qualify to apply for the reserved 10% observing time on all telescopes in Chile.
Applicants should submit to abayo@npf.cl an updated CV and a short (max 3 pages) research statement, plus arrange for 2 reference letters to be sent to the same e-mail address.
For further inquiries please contact NPF Director, Amelia Bayo, or the other NPF members mentioned above (abayo@npf.cl, jolofsson@npf.cl, jcuadra@npf.cl, mschreiber@npf.cl)

Download/Website: `http://www.npf.cl/en/`

Contact: `abayo@npf.cl`

Research Fellow (2+1 yrs) in Exoplanet Atmosphere modelling: polarimetry and spectroscopy

Dr Christiane Helling

Centre for Exoplanet Science, School of Physics & Astronomy, University of St Andrews, UK, starting latest September 2021

We are seeking an ambitious postdoctoral researcher to work on complex weather on cloud-forming gas giants and ultra-hot Jupiters with Dr Christiane Helling to start September 2021. The project focuses on radiative transfer modelling for polarimetry and spectroscopy in preparation for forthcoming observations, incl. JWST.

The candidate is expected to have a PhD in astrophysics with relevant experience in the field of radiative transfer modelling, experience in the modelling of exoplanet/brown dwarf atmospheres is advantageous. The position will involve collaboration with researchers across Europe and within the St Andrews Center for Exoplanet Science. The position includes funding for travel.

Applications should include a 2-page CV, publication list, and a statement (max. 3 pages) of research interests. This should include a summary of past research achievements and statement of future plans. Details of two referees should be provided and letters of reference will be requested following long-listing.

Please consult the webpage for further particulars.

Deadline: 15 February 2021

Download/Website: `https://leap2010.wp.st-andrews.ac.uk/news/jobs/`

Contact: `ch80@st-andrews.ac.uk`

2 Postdoctoral Associate positions on exoplanet atmospheres

Monika Lendl
University of Geneva, chemin Pegasi 51, 1290 Sauverny, Switzerland

University of Geneva, 1 June 2021

Applications are invited for 2 Postdoctocal Assosiate positions at the University of Geneva (Department of Astronomy) working with Dr. Monika Lendl on exoplanet atmospheres as part of her SNF Eccellenza research group.
Position 1 is focused on studying exoplanet atmospheres using space-based photometric data, obtained primarily by the CHEOPS (Characterizing Exoplanets Satellite) mission. The University of Geneva host the CHEOPS Science Operations Centre and the mission Project Science Office. The successful applicant will become part of the CHEOPS mission consortium and will be offered ample opportunity to contribute to the scientific exploitation of CHEOPS. In particular, they are expected to contribute to the exploitation of over 200 days of observations dedicated to exoplanet atmospheric characterisation, in particular through occultation and phase curve measurements. *Duration:* the position has an initial duration of 2 years but may be extended by 2 additional years, depending on performance.
Position 2 is focused on studying exoplanet atmospheres using spectroscopic observations. The successful candidate will be exploiting a large set of transmission spectra obtained through Monika Lendl's CHEWIE (Clouds Hazes and Elements vieWed on gIant Exoplanets) program, which comprises over 100 hours of observing time at the ESO VLT. They will collaborate with local exerts to join these observations with simultaneous high-resolution observations and gain unique insights on the planetary atmospheres. *Duration:* the position has an initial duration of 2 years with a possible extension for a third year, depending on performance.

Setting: The Geneva Observatory offers one of the most vibrant environments worldwide for exoplanet research. The exoplanet team (www.exoplanets.ch) counts over 50 members, currently including 10 faculty members, 12 postdoctoral researchers, 15 PhD students, and 14 project staff members. Research topics include exoplanet detection and characterisation (atmospheres, interiors), planetary system dynamics, and instrumentation. Team members are directly involved in a large number of projects, including photometric instruments (CHEOPS, NGTS, TESS, PLATO), high-resolution spectrographs (ESPRESSO, NIRPS, HARPS and others), direct imaging (SPHERE@VLT) and astrometry (GAIA). The exoplanet team is also part of PlanetS (www.nccr-planets.ch), a Swiss research network focused on exoplanetary science, which includes 130 scientists from the Universities of Geneva, Bern, Zurich and the Swiss Federal Institute of Technology in Zurich (ETHZ). The successful applicants will be able to take advantage of this unique collaborative framework.

The University of Geneva is an equal opportunity employer committed to diversity.

Start date: is flexible; the positions could start as early as June 2021.

Salary: approx. 81,000 CHF/year gross salary, according to rules of the University and Canton of Geneva.

Deadline: Applications received until 28 Feb 2021 will receive full consideration. Later applications will be reviewed until the positions are filled.

Requirements: A PhD degree in astronomy, astrophysics or related fields. Experience in the analysis of exoplanet observations, either of time-series photometry (Position 1), or transmission spectroscopy (Position 2) will be highly valued. The successful applicant will become part of a vibrant team and we especially look for team players with a high level of scientific independence and creativity.

The following application materials should be sent to monika.lendl@unige.ch in a single PDF:

- A curriculum vitae (2 pages)
- A cover letter (1 page), indicating which position the application refers to.
- A short research statement describing past achievements and future projects (max. 2 pages)
- A list of publications

Two letters of recommendation should be sent directly to Monika Lendl by the referees themselves.
Download/Website: `https://jobregister.aas.org/ad/57a6352a`
Contact: `monika.lendl@unige.ch`

PhD position: Impact of stellar activity on exoplanet atmospheres

Monika Lendl
University of Geneva, chemin Pegasi 51, 1290 Sauverny, Switzerland

University of Geneva, 1 June 2021

Applications are invited for a research assistant (PhD student) position at the University of Geneva (Department of Astronomy) working with Dr. Monika Lendl on exoplanet atmospheres as part of her SNF Eccellenza research group.
The PhD project will focus on investigating the impact of stellar phenomena on exoplanet atmospheres and on distinguishing stellar and planetary sources of observational variability. The successful candidate will work on data from the CHEOPS and TESS space missions, and join them with complementary ground-based observations. There will be an extensive observational component to the work, with regular observations at the 1.2m Euler telescope located at La Silla observatory (Chile). The student will be involved in data analysis and interpretation, and in the development of new insights about the atmospheres of highly irradiated planets.

Setting: The Geneva Observatory offers one of the most vibrant environments worldwide for exoplanet research. The exoplanet team (www.exoplanets.ch) counts over 50 members, currently including 10 faculty members, 12 postdoctoral researchers, 15 PhD students, and 14 project staff members. Research topics include exoplanet detection and characterisation (atmospheres, interiors), planetary system dynamics, and instrumentation. Team members are directly involved in a large number of projects, including photometric instruments (CHEOPS, NGTS, TESS, PLATO), high-resolution spectrographs (ESPRESSO, NIRPS, HARPS and others), direct imaging (SPHERE@VLT) and astrometry (GAIA). The exoplanet team is also part of PlanetS (www.nccr-planets.ch), a Swiss research network focused on exoplanetary science, which includes 130 scientists from the Universities of Geneva, Bern, Zurich and the Swiss Federal Institute of Technology in Zurich (ETHZ). The successful applicant will be able to take advantage of this unique collaborative framework.

The University of Geneva is an equal opportunity employer committed to diversity.

Start date: is flexible; the position could start as early as June 2021.

Duration: 4 years (the standard duration of a PhD in Switzerland).

Salary: approx. 47,000 CHF/year gross salary, according to rules of the University and Canton of Geneva.

Deadline: Applications received until 28 Feb 2021 will receive full consideration. Later applications will be reviewed until the position is filled.

Requirements: A MSc degree in astronomy, astrophysics or related fields. The successful applicant will become part of a vibrant team, making the ability to work in a team a strong asset. Experience in scientific programming and experience with Python will be considered as a plus.

The following application materials should be sent to monika.lendl@unige.ch in a single PDF:

- A curriculum vitae (2 pages)
- A cover letter (1 page) listing the names of up to 2 scientists willing to provide references
- Academic transcripts and certificates

Download/Website: `https://jobregister.aas.org/ad/28888f69`
Contact: `monika.lendl@unige.ch`

4 Conferences

2021 Sagan Summer Virtual Workshop: Circumstellar Disks and Young Planets

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

Online Workshop, July 19-23, 2021

The 2021 Sagan Summer Workshop will take place July 19-23, 2021 and will be fully virtual.

The 2021 Sagan Summer Workshop will focus on young planets and the circumstellar disks from which they form during the first few million years of a star's lifetime. The workshop will address how transformational new datasets are allowing us to address key questions about the formation and evolution of planets and their potential habitability; topics will include:

- Properties of transiting young planets detected by the Kepler/K2 and TESS missions
- Gaia identification of groups of young stars and determination of their ages
- Properties of planets and disks imaged directly with ground-based faculties (e.g., Gemini/GPI, SPHERE/VLTI, Keck and ALMA) and space-based telescopes (Spitzer, HST and, soon, JWST)
- Environment influence of an active young star on the evolution of the primordial atmosphere of a young planet
- Theoretical bases for the formation and evolution of a planetary systems, including both the disk and planets
- Attendees will have the chance to submit posters, participate in hands-on data projects, and meet in small groups with our speakers

The workshop will be held via Zoom webinar while aiming to preserve the content and spirit of the previous in-person workshops. The workshop will consist of live and pre-recorded talks, live discussions, hands-on sessions, contributed online posters, and virtual ”lunches with speakers”. As in previous years, all talks will be recorded and posted on the Sagan Summer Workshop YouTube channel. The Sagan Summer Workshops are aimed at advanced undergraduates, grad students, and postdocs, however all are welcome to attend. Registration information for this free workshop will be available in February 2021.

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

Download/Website: `http://nexsci.caltech.edu/workshop/2021`

Contact: `sagan_workshop@ipac.caltech.edu`

GRAVITY+ Community Workshop

L. Kreidberg[1]
[1] Max Planck Institute for Astronomy, 69117 Heidelberg, Germany

virtual, 24 - 25 February, 2020

Dear colleagues,

It is my pleasure to invite you to a virtual community workshop on the planned GRAVITY+ instrument upgrade. The workshop will take place on Zoom on two half-days on 24 - 25 February, 2021.

GRAVITY+ is the first new Very Large Telescope (VLT) instrument selected following the "ESO in the 2030s" review. It will increase the sensitivity, sky coverage, and field of view of the VLT Interferometer (VLTI) to enable milliarcsecond imaging and microarcsecond astrometry in the infrared for a wide new range of Galactic and extragalactic science cases. GRAVITY+ constitutes a phased upgrade of the current, enormously successful GRAVITY instrument. With a final capability of fringe tracking down to K 15 mag, off-axis targets down to K 22 mag will be observable. By opening this new discovery space, the VLTI will become of broad interest to the European science community beyond the classical interferometry fields.

The aim of the community workshop is to present the instrument to potential future users, highlight the major science cases, and present new ideas from the community on the use of the instrument. This ranges from the Galactic Centre, active galactic nuclei, supermassive black hole binaries, tidal disruption event and intermediate mass black holes to the characterisation of exoplanets, young and old stars, and microlenses.

We aim for a wide participation of the ESO user base from Australia to Chile with one European afternoon session (24 February; Galactic science, including exoplanets) and one morning session (25 February; Extragalactic science).

Please register free of charge by 8 February 2021 using the Registration form.

There are also a limited number of time slots available for new ideas for GRAVITY+ science from the community, so please also consider submitting an abstract.

We look forward to welcoming you to the workshop!

With best wishes,

Laura Kreidberg and Sebastian Hoenig, on behalf of the SOC

Download/Website: `https://sites.google.com/view/gravityplus/`

Contact: `kreidberg@mpia.de`

5 Exoplanet Archive Updates

December 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, January 12, 2021

Note: Unless otherwise noted, all planetary and stellar data mentioned in the news are in the Planetary Systems Table (gamma) (`http://bit.ly/2Pt0tM1`), which provides a single location for all self-consistent planetary solutions, and its companion table the Planetary Systems Composite Parameters (beta) (`https://bit.ly/2Fer9NU`), which offers a more complete table of parameters combined from multiple references and calculations. Data can also be found in the Microlensing Data Table (`http://bit.ly/2JQr180`) or Direct Imaging Table (`http://bit.ly/3ayD185`).

December 21, 2020

We're On A Break. See You At AAS 237!

The NASA Exoplanet Archive staff is taking a winter break Dec. 23 through Jan. 3, during which there will be no data or software updates. Responses to Helpdesk tickets and social media may also be delayed.

If you're attending the American Astronomical Society (AAS) winter meeting (`http://bit.ly/3ooXfIp`), held Jan. 11-15, stop by the virtual Caltech/IPAC Archives and NExScI booths and say hello! Our staff will be on hand to Slack chat, give demos of any archive service, and answer those burning questions, like "How do I get my data into the archive?" We also have a webinar planned that will give an overview of ExoFOP and the NASA Exoplanet Archive. All registered meeting attendees are invited to join us at 10:30 a.m. PST/1:30 p.m. EST Monday, January 11.

We wish everyone a safe and relaxing season, and we look forward to adding even more planets for you in 2021! (Maybe we'll even reach 5,000?)

December 17, 2020

For our **FINAL** 2020 data release, we present 17 new planets—more than half of them transits discovered by NASA's TESS. This brings the archive's total confirmed planet count to **4,324**. Also, we are only 9 discoveries away from the 100th published, confirmed TESS planet!

The new planets are: TOI-481 b, TOI-892 b, TIC 237913194 b, HD 190007 b, HD 216520 b, HD 216520 c, TOI-122 b, TOI-237 b, WASP-186 b, WASP-187 b, K2-111 c, LP 714-47 b, TOI-942 b & c, WASP-107 c, TOI-251 b, and HAT-P-68 b.

December 10, 2020

A Gift to Users: Updated Planetary Systems Tables and Overviews

We're happy to announce the latest upgrade to the Planetary Systems tables and the redesigned System Overview pages!

The Planetary Systems (PS) table, now in gamma, and Planetary Systems Composite Parameters (PSCP) table, now in beta, have been improved and enhanced based on user feedback and testing. Changes include:

- Update to data content, including more complete information on the number of stars in a system.
- TICv8 asymmetric uncertainties handled properly.
- Null references are properly attributed.
- Stellar spectra columns updated to reflect proper published planet-star solutions.
- Planetary Systems Composite Parameters population has improved population of parameters.
- Overall general improvements on the content based upon continued data validation.
- Numerous bug fixes to graphical interface for both tables, including:
- Correct filtering and sorting on date and character columns.
- Updates to the columns shown by default for Planetary Systems and Planetary Systems Composite Parameters tables.
- Update to TAP service to include the Gaia ID (already included in the interactive display).

In addition, the redesigned System Overview pages have also been bumped up to beta with the following updates:

- Improved visualization of multi-star systems.
- More complete support for Ancillary Data associated within a system.
- Updates to the color schemes, highlighting, and labeling.
- Access the redesigned Overview pages by clicking on a Planet Name in either the PS or PSCP table.

For a complete list of improvements for each version of the tables, as well as the System Overviews, see the Archive 2.0 Release Notes page (`http://bit.ly/3rVQPTx`).

These improvements are part of the previously announced Archive 2.0 effort to create a more integrated and streamlined NASA Exoplanet Archive, which involves retiring the Confirmed Planets, Extended Planet Parameters, and Composite Parameters tables and replacing them with the Planetary Systems and Planetary Systems Composite Parameters tables, redesigning the consolidating overview pages, and serving archive data through a new Table Access Protocol (TAP) service.

Please note *the retiring data tables will continue to be maintained for the coming months—with the aim of decommissioning these tables in February 2021*. More information—including a mapping of data between the old and new tables—is in this Transition document (`https://bit.ly/3jLgrhl`).

December 3, 2020
A planet found with gravitational microlensing, MOA-2013-BLG-220L b, and new transmission spectra are this week's new data. The planets with new transmission spectra are WASP-31 b, KELT-11 b, WASP-21 b, HAT-P-12 b, WASP-74 b, and WASP-67 b; find them in the Transmission Spectroscopy interactive table (`http://bit.`

ly/2B54JfR). The new MOA planet data is in the Microlensing Planets Table, as well as the Planetary Systems Table and its companion table the Planetary Systems Composite Parameters, and the soon-to-be-retired Confirmed Planets, Composite Planet Data, and Extended Planet Data interactive tables.

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6 As seen on astro-ph

List of exoplanet related entries seen on astro-ph during December 2020.

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astro-ph/2012.01486: **Refined System Ephemeris for Four Transiting Hot Jupiters using Ground-Based and TESS Observations** by *Fatemeh Davoudi et al.*
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