# ExoPlanet News
An Electronic Newsletter

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## Contents

# 1 Editorial

Welcome to edition 124 of the ExoPlanet News!

The end of this year is exciting for exoplanetary sciences with two key events: the Nobel Price awarded to M. Mayor and D. Queloz, and the expected launch of CHEOPS!

Please keep sending contributions in the form of accepted papers covering all fields related to (exo)planet research, conference or workshop announcements, job ads or any other information relevant to the wider exoplanet community. The current Latex template for submitting contributions of any kind, as well as all previous editions of ExoPlanet News, can be found at http://nccr-planets.ch/exoplanetnews/.

The next issue will appear 11 November 2019.

Thanks for all your support and best regards from Switzerland

Yann Alibert
Sascha P. Quanz
Adrien Leleu
Christoph Mordasini

# 2 Abstracts of refereed papers

### Investigating the gas-to-dust ratio in the protoplanetary disk of HD 142527

*K.-L. Soon*[1], *M. Momose*[1], *T. Muto*[2], *T. Tsukagoshi*[3], *A. Kataoka*[3], *T. Hanawa*[4], *M. Fukagawa*[3], *K. Saigo*[3], *H. Shibai*[5]

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*PASJ, in press (arXiv:1909.06745)*

We present ALMA observations of the 98.5 GHz dust continuum and the $^{13}$CO $J = 1-0$ and C$^{18}$O $J = 1-0$ line emissions of the protoplanetary disk associated with HD 142527. The 98.5 GHz continuum shows a strong azimuthal-asymmetric distribution similar to that of the previously reported 336 GHz continuum, with a peak emission in dust concentrated region in the north. The disk is optically thin in both the 98.5 GHz dust continuum and the C$^{18}$O $J = 1-0$ emissions. We derive the distributions of gas and dust surface densities, $\Sigma_{\rm g}$ and $\Sigma_{\rm d}$, and the dust spectral opacity index, $\beta$, in the disk from ALMA Band 3 and Band 7 data. In the analyses, we assume the local thermodynamic equilibrium and the disk temperature to be equal to the peak brightness temperature of $^{13}$CO $J = 3-2$ with a continuum emission. The gas-to-dust ratio, G/D, varies azimuthally with a relation $G/D \propto \Sigma_{\rm d}^{-0.53}$, and $\beta$ is derived to be $\approx 1$ and $\approx 1.7$ in the northern and southern regions of the disk, respectively. These results are consistent with the accumulation of larger dust grains in a higher pressure region. In addition, our results show that the peak $\Sigma_{\rm d}$ is located ahead of the peak $\Sigma_{\rm g}$. If the latter corresponds to a vortex of high gas pressure, the results indicate that the dust is trapped ahead of the vortex, as predicted by some theoretical studies.

*Download/Website:* `https://arxiv.org/abs/1909.06745`

*Contact:* `munetake.momose.dr@vc.ibaraki.ac.jp`

### Ingredients for Solar-like Systems: protostar IRAS 16293-2422 B versus comet 67P/Churyumov–Gerasimenko

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*Monthly Notices of the Royal Astronomical Society, in press (arXiv:1908.11290)*

Our modern day Solar System has $4.6 \times 10^9$ yrs of evolution behind it with just a few relics of its birth conditions remaining. Comets are thought to be some of the most pristine tracers of the initial ingredients that were combined to produce the Earth and the other planets. Other low-mass protostars may be analogous to our proto-Sun and hence, could be used to study the building blocks necessary to form Solar-like systems. This study tests this idea on the basis of new high sensitivity, high spatial resolution ALMA data on the protoplanetary disc-scales ($\sim 70$ au) of IRAS 16293-2422 and the bulk composition of comet 67P/Churyumov-Gerasimenko, as determined for the first time with the unique in situ monitoring carried out by *Rosetta*. The comparative analysis of the observations from the Protostellar Interferometric Line Survey (PILS) and the measurements made with Rosetta Orbiter Spectrometer for Ion and Neutral Analysis (ROSINA) shows that the relative abundances of CHO-, N-, and S-bearing molecules correlate, with some scatter, between protostellar and cometary data. A tentative correlation is seen for the first time

for P- and Cl-bearing compounds. The results imply that the volatile composition of cometesimals and planetesimals is partially inherited from the pre- and protostellar phases of evolution.

*Download/Website:* `https://academic.oup.com/mnras/advance-article/doi/10.1093/mnras/stz2430/5558253`

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## An Empirical Mass-Radius Relation for Cool Giant Planets

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*Published, 2019RNAAS...3..128T*

Probabilistic relationships between the mass and radius of planets are useful for a variety of purposes, including estimating the yields of planet discovery efforts and the radii of discovered planets given their masses. Previous work on giant planets often do not make the important distinction between cool and (inflated) hot giants. This can lead to needlessly large uncertainties and overestimated radii for the cooler objects. Using hierarchical bayesian modeling and the AIC model selection criterion, we identify an empirical mass-radius relationship for cool giant planets above 15 Earth masses. It takes the form of a quadratic function in log mass, with a power-law dispersion. Parametric uncertainties from MCMC are provided, and we compare our results with the outputs of interior structure models and the radii of the solar system giant planets, which fit comfortably within our relation.

*Download/Website:* `https://iopscience.iop.org/article/10.3847/2515-5172/ab4353`

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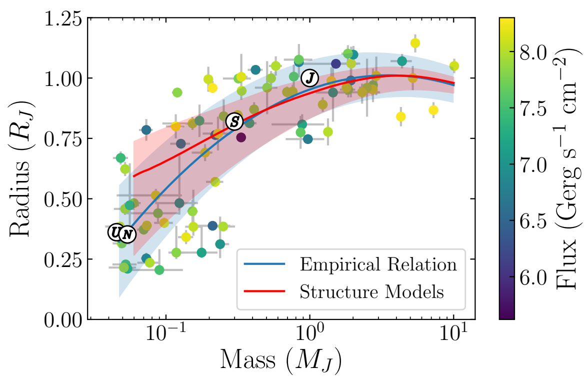


Figure 1: The masses and radii of 81 observed cool giant planets with $1\sigma$ errorbars, along with Jupiter, Saturn, Uranus and Neptune. The $\log_{10}$ of the incident flux is indicated by the color, to show that it does not affect the radius. The fit and $1\sigma$ dispersion from Eq. **??** and the posterior mean parameters are shown in blue. The relation from the structure models of Thorngren et al. (2016) is shown in red, where the dispersion is from the uncertainty in the mass-metallicity relation.

## Planet and star synergy at high spectral resolution. A rationale for the characterisation of exoplanet atmospheres

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*Astronomy & Astrophysics, in press (arXiv:1909.11807)*

Spectroscopy of exoplanet atmospheres at high resolving powers is rapidly gaining popularity to measure the presence of atomic and molecular species. While this technique is particularly robust against contaminant absorption in the Earth's atmosphere, the non stationary stellar spectrum, in the form of either Doppler shift or distortion of the line profile during planetary transits, creates a non-negligible source of noise that can alter or even prevent detection.

We aim at using state-of-the art three-dimensional stellar simulations to directly remove the signature of the star from observations, and prior to cross correlation with templates for the planet's atmosphere, commonly used to extract the faint exoplanet signal from noisy data.

We compute synthetic spectra from 3D simulations of stellar convection resolved both spatially and temporally, and we couple them with an analytical model reproducing the correct geometry of a transiting exoplanet. We apply the method to the early K-dwarf, HD 189733, and re-analyse transmission and emission spectroscopy of its hosted exoplanet. In addition, we also analyse emission spectroscopy of the non transiting exoplanet 51 Pegasi b, orbiting a solar-type star.

We find a significant improvement in the planet detectability when removing the stellar spectrum with our method. In all cases, we show that the method is superior to a simple parametrisation of the stellar line profile or to the use of one-dimensional stellar models. We show that this is due to the intrinsic treatment of convection in 3D simulations, which allows us to correctly reproduce asymmetric and/or blue-shifted spectral lines, and intrinsically model center-to-limb variation and Rossiter-McLaughlin effect potentially altering the interpretation of exoplanet transmission spectra. In the case of 51 Pegasi b, we succeed at confirming a previous tentative detection of the planet's $K$-band spectrum due to the improved suppression of stellar residuals.

Future high-resolution observations will benefit from the synergy with stellar spectroscopy, and can be used to test the correct modelling of physical processes in stellar atmospheres. We highlight key improvements in modelling techniques and knowledge of opacity sources to extend this work to shorter wavelengths and later-type stars.

*Download/Website:* `https://ui.adsabs.harvard.edu/abs/2019arXiv190911807C/abstract/`

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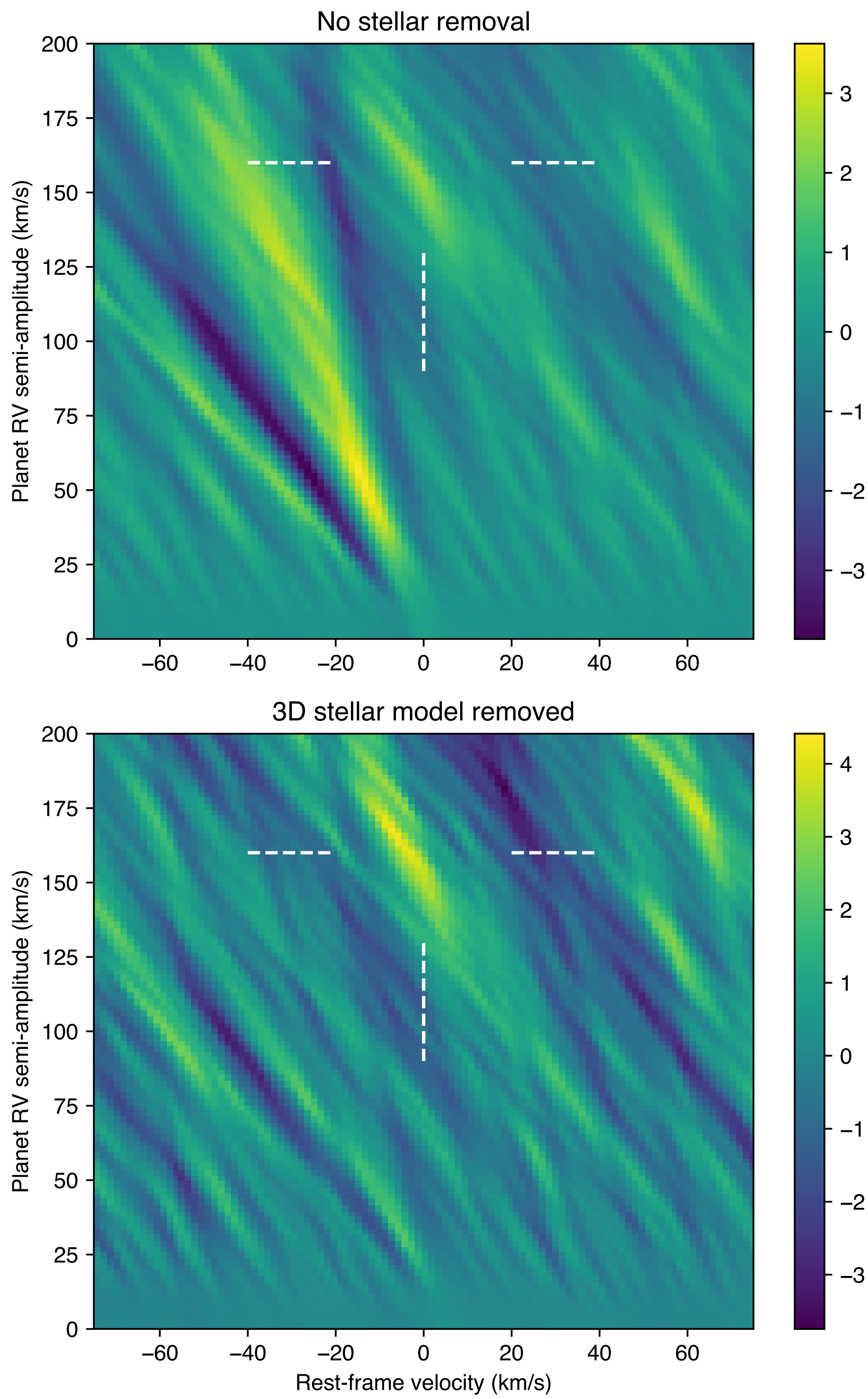


Figure 2: Total cross correlation S/N (peak divided by standard deviation) obtained from the emission spectra of exoplanet HD 189733 b processed without removing the spectrum of the parent star (top panel, analogous to de Kok et al. 2013) and by removing a spatial and temporal average of the 3D simulation (bottom panel). A clear detection of the planet, marked with white dashed lines, appear in the latter case.

## Analytic Planetary Transit Light Curves and Derivatives for Stars with Polynomial Limb Darkening

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*The Astronomical Journal, in press (arXiv:1908.03222)*

We derive analytic, closed-form solutions for the light curve of a planet transiting a star with a limb darkening profile which is a polynomial function of the stellar elevation, up to arbitrary integer order. We provide improved analytic expressions for the uniform, linear, and quadratic limb-darkened cases, as well as novel expressions for higher order integer powers of limb darkening. The formulae are crafted to be numerically stable over the expected range of usage. We additionally present analytic formulae for the partial derivatives of instantaneous flux with respect to the radius ratio, impact parameter, and limb darkening coefficients. These expressions are rapid to evaluate, and compare quite favorably in speed and accuracy to existing transit light curve codes. We also use these expressions to numerically compute the first partial derivatives of exposure-time averaged transit light curves with respect to all model parameters. An additional application is modeling eclipsing binary or eclipsing multiple star systems in cases where the stars may be treated as spherically symmetric. We provide code which implements these formulae in C++, Python, IDL, and Julia, with tests and examples of usage.

*Download/Website:* `https://github.com/rodluger/Limbdark.jl`

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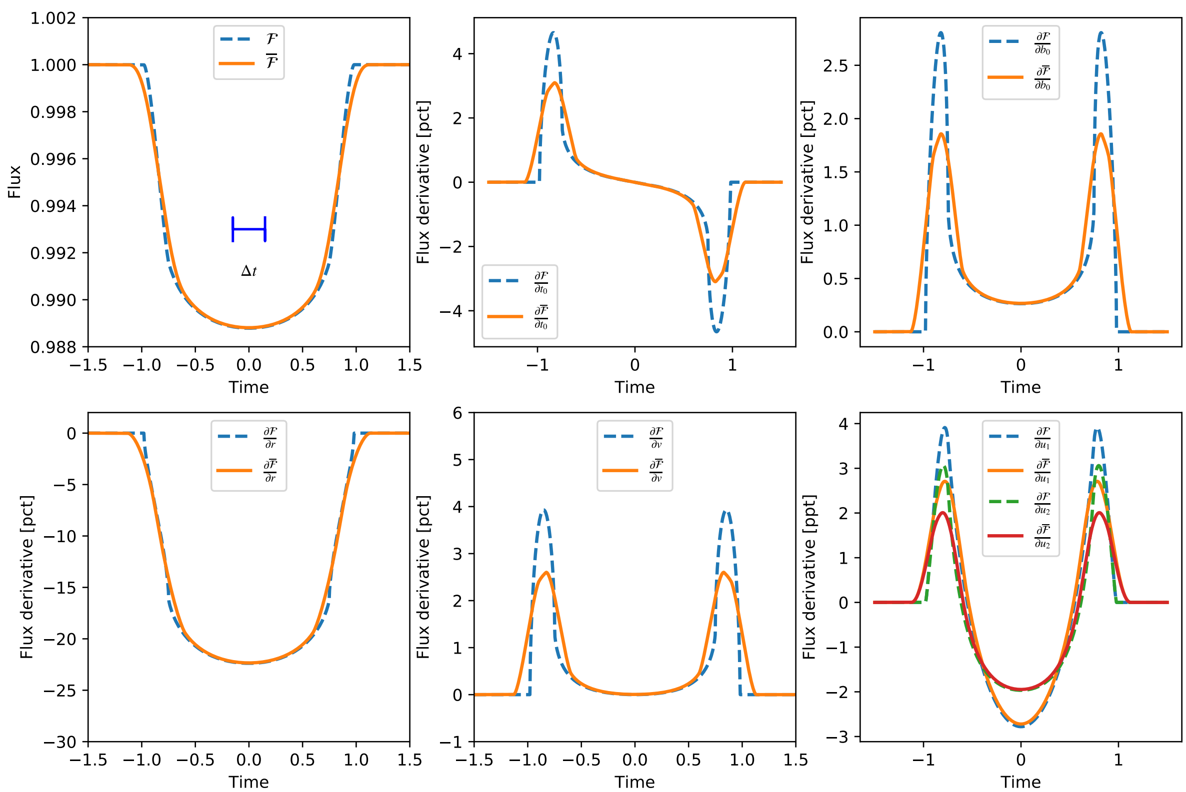


Figure 3: Comparison of the normalized flux and its derivatives with ($\bar{F}$) and without ($F$) time-integration (see solid and dashed lines, respectively). The integration time, $\Delta t = 0.3$, is indicated in the upper left panel with a horizontal blue line. The derivatives are computed with respect to $\{r, t_0, v, b_0, u_1, u_2\}$, where $r$ is the radius-ratio, $t_0$ is the central time of transit, $v$ is the sky velocity (in stellar radii per time unit), $b_0$ is the impact-parameter mid-transit, and $u_1$ and $u_2$ are the linear and quadratic limb-darkening parameters. The parameters are given by $r = 0.1$, $t_0 = 0$, $v = 1$, $b_0 = 0.5$ , and $u_1 = u_2 = 0.3$.

## Detection of H$\alpha$ emission from PZ Tel B using SPHERE/ZIMPOL

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*Astronomy & Astrophysics, in press (arXive: 1910.00269)*

H$\alpha$ is a powerful tracer of accretion and chromospheric activity, which has been detected in the case of young brown dwarfs and even recently in planetary mass companions (e.g. PDS70 b and c). H$\alpha$ detections and characterisation of brown dwarf and planet companions can further our knowledge of their formation and evolution, and expanding such a sample is therefore our primary goal. We used the Zurich Imaging POLarimeter (ZIMPOL) of the SPHERE instrument at the Very Large Telescope (VLT) to observe the known $38 - 72\mathrm{M_J}$ companion orbiting PZ Tel, obtaining simultaneous angular differential imaging observations in both continuum and narrow H$\alpha$ band. We detect H$\alpha$ emission from the companion, making this only the second H$\alpha$ detection of a companion using the SPHERE instrument. We used our newly added astrometric measurements to update the orbital analysis of PZ Tel B, and we used our photometric measurements to evaluate the H$\alpha$ line flux. Given the estimated bolometric luminosity, we obtained an H$\alpha$ activity ($\log(\mathrm{L_{H\alpha}/L_{bol}})$) between $-4.16$ and $-4.31$. The H$\alpha$ activity of PZ Tel B is consistent with known average activity levels for M dwarf of the same spectral type. Given the absence of a known gaseous disk and the relatively old age of the system (24 Myr), we conclude that the H$\alpha$ emission around PZ Tel B is likely due to chromospheric activity.

*Download/Website:* `https://arxiv.org/abs/1910.00269`

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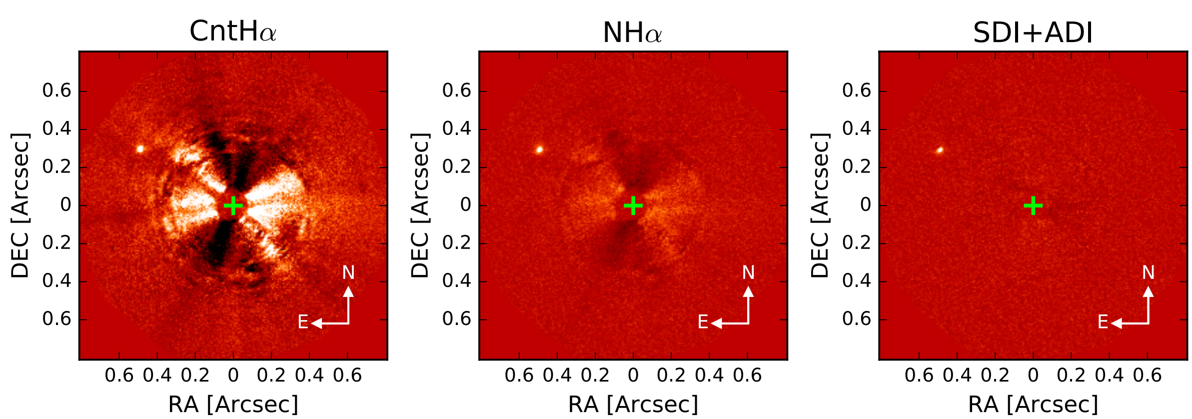


Figure 4: Reduced images showing PZ Tel B. In all three images the green cross marks the position of the central star, the data is oriented with north up, and the companion is clearly visible NE of the star. The images are normalised and the colour map was chosen for a better visualisation of the data. *Left panel*: classical ADI reduced image of the continuum H$\alpha$ filter frames. *Central panel*: classical ADI reduced image of the narrow band H$\alpha$ filter frames. *Right panel*: ASDI analysis.

## Exploring the conditions for forming cold gas giants through planetesimal accretion

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*Astronomy & Astrophysics, in press (arXiv:1909.10429)*

The formation of cold gas giants similar to Jupiter and Saturn in orbit and mass is a great challenge for planetesimal-driven core accretion models because the core growth rates far from the star are low. Here we model the growth and migration of single protoplanets that accrete planetesimals and gas. We integrated the core growth rate using fits in the literature to $N$-body simulations, which provide the efficiency of accreting the planetesimals that a protoplanet migrates through. We take into account three constraints from the solar system and from protoplanetary discs: (1) the masses of the terrestrial planets and the comet reservoirs in Neptune's scattered disc and the Oort cloud are consistent with a primordial planetesimal population of a few Earth masses per AU, (2) evidence from the asteroid belt and the Kuiper belt indicates that the characteristic planetesimal diameter is 100 km, and (3) observations of protoplanetary discs indicate that the dust is stirred by weak turbulence; this gas turbulence also excites the inclinations of planetesimals. Our nominal model built on these constraints results in maximum protoplanet masses of 0.1 Earth masses. Ignoring constraint (1) above, we show that even a planetesimal population of 1,000 Earth masses, corresponding to 50 Earth masses per AU, fails to produce cold gas giants (although it successfully forms hot and warm gas giants). We conclude that a massive planetesimal reservoir is in itself insufficient to produce cold gas giants. The formation of cold gas giants by planetesimal accretion additionally requires that planetesimals are small and that the turbulent stirring is very weak, thereby violating all three above constraints.

*Download/Website:* `https://arxiv.org/abs/1909.10429`

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## Beyond the exoplanet mass-radius relation

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*Astronomy & Astrophysics, published (2019A&A..630..A135)*

Mass and radius are two fundamental properties for characterising exoplanets, but only for a relatively small fraction of exoplanets are they both available. Mass is often derived from radial velocity measurements, while the radius is almost always measured using the transit method. Our goal is to derive the radius of exoplanets using only observables extracted from spectra used primarily to determine radial velocities and spectral parameters.
We worked with a database of confirmed exoplanets with known radii and masses, as well as the planets from our Solar System. Using random forests, a machine learning algorithm, we computed the radius of exoplanets and compared the results to the published radii. Our code, `BEM`, is available online. The estimated radii reproduce the spread in radius found for high mass planets better than previous mass-radius relations. The average radius error is $1.8\,R_\oplus$ across the whole range of radii from 1-22 $R_\oplus$. We find that a random forest algorithm is able to derive reliable radii, especially for planets between $4\,R_\oplus$ and $20\,R_\oplus$ for which the error is under 25%.
The random forest algorithm is a promising method for deriving exoplanet properties. We show that the exoplanet's mass and equilibrium temperature are the relevant properties that constrain the radius, and do so with higher accuracy than the previous methods.

*Download/Website:* `https://doi.org/10.1051/0004-6361/201936049`

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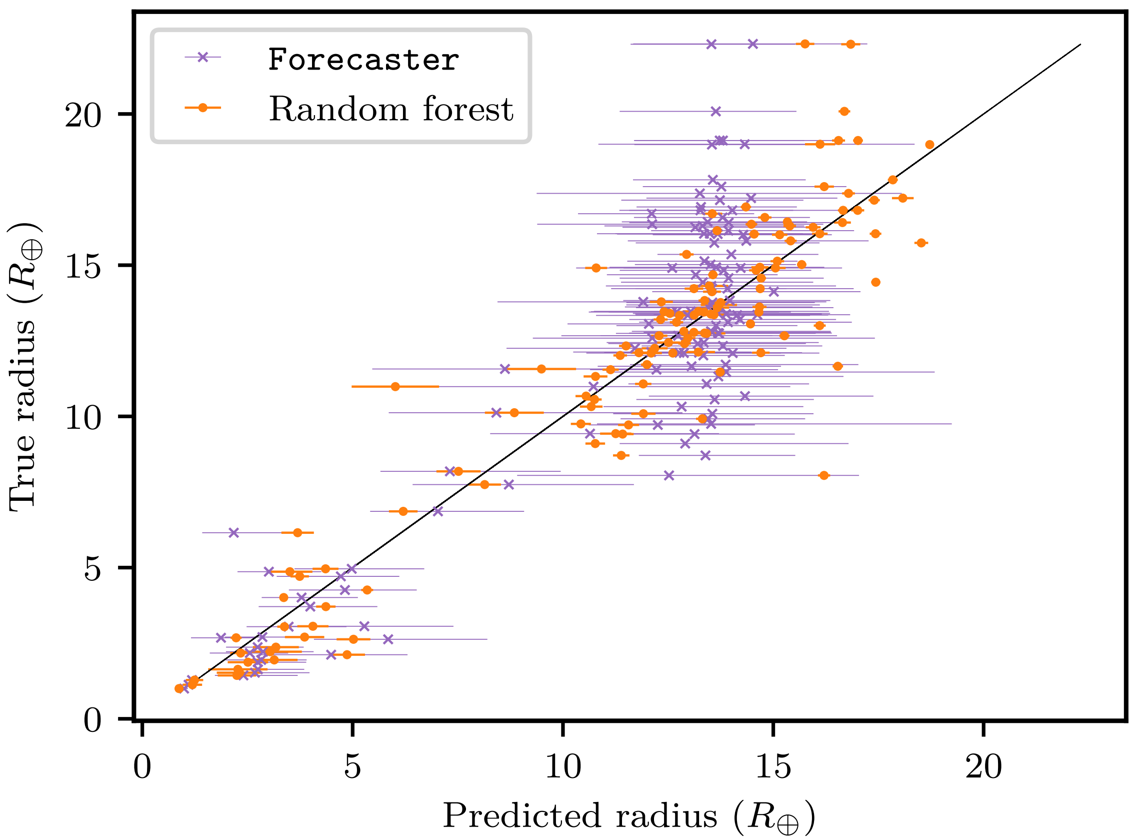


Figure 5: True radii as a function of predicted radii for test set. Radii obtained with the random forest algorithm `BEM` (orange dots) and the `Forecaster` code (purple crosses) are compared with the 1:1 line.

## From the stellar properties of HD 219134 to the internal compositions of its transiting exoplanets.

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*Astronomy & Astrophysics, in press (arXiv:1909.10058)*

The harvest of exoplanet discoveries has opened the area of exoplanet characterisation. But this cannot be achieved without a careful analysis of the host star parameters. The system of HD 219134 hosts two transiting exoplanets and at least two additional non-transiting exoplanets. We revisit the properties of this system using direct measurements of the stellar parameters to investigate the composition of the two transiting exoplanets. We used the VEGA/CHARA interferometer to measure the angular diameter of HD 219134. We also derived the stellar density from the transits light curves, which finally gives a direct estimate of the mass. This allowed us to infer the mass, radius, and density of the two transiting exoplanets of the system. We then used an inference model to obtain the internal parameters of these two transiting exoplanets. We measure a stellar radius, density, and mass of $R_\star = 0.726 \pm 0.014\ R_\odot$, $\rho_\star = 1.82 \pm 0.19\ \rho_\odot$, and $M_\star = 0.696 \pm 0.078\ M_\odot$, respectively; there is a correlation of 0.46 between $R_\star$ and $M_\star$. This new mass is lower than that derived from the C2kSMO stellar evolutionary model, which provides a mass range of 0.755−0.810 (±0.040) $M_\odot$. Moreover, we find that planet *b* and *c* have smaller radii than previously estimated of 1.500 ± 0.057 and 1.415 ± 0.049 $R_\oplus$ respectively; this clearly puts these planets out of the gap in the exoplanetary radii distribution and validates their super-Earth nature. Planet *b* is more massive than planet *c*, but the former is possibly less dense. We investigate whether this could be caused by partial melting of the mantle and find that tidal heating due to non-zero eccentricity of planet *b* may be powerful enough. The system of HD 219134 constitutes a very valuable benchmark for both stellar physics and exoplanetary science. The characterisation of the stellar hosts, and in particular the direct determination of the stellar density, radius, and mass, should be more extensively applied to provide accurate exoplanets properties and calibrate stellar models.

*Download/Website:* `https://ui.adsabs.harvard.edu/abs/2019arXiv190910058L`

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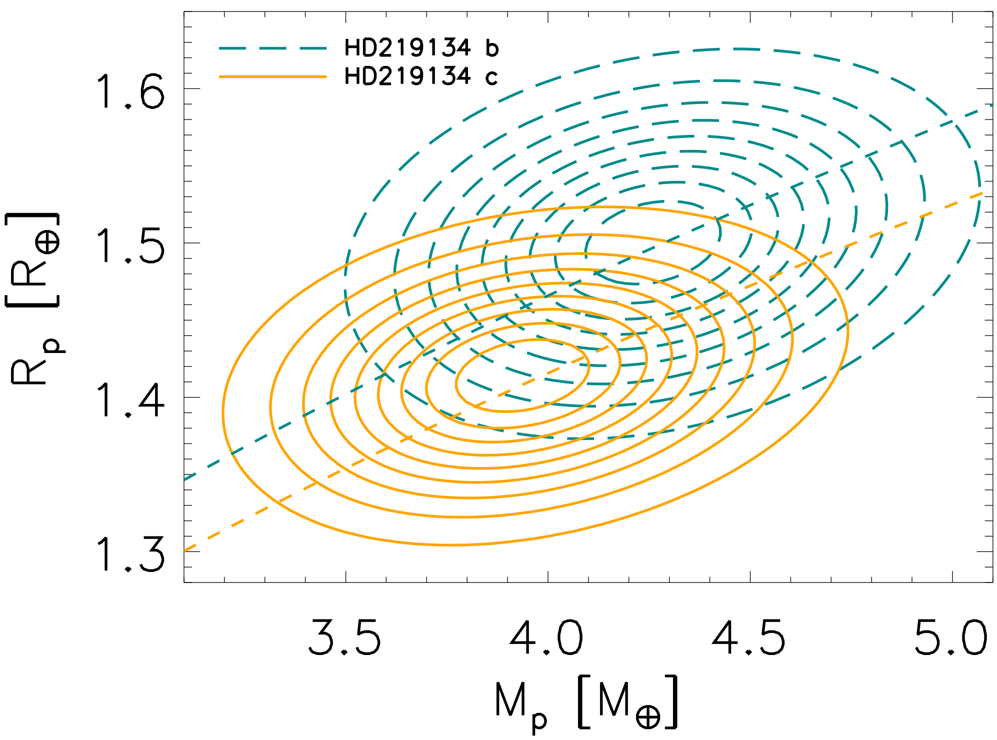


Figure 6: Joint likelihood of the planetary mass and radius for planet *b* (green long-dashed line) and planet *c* (yellow solid line). The 9 contour lines separate 10 equal-sized intervals between 0 and the maximum of the joint likelihood $f_p(M_p, R_p)$. The dashed lines show the iso-densities corresponding to the mean densities of planets *b* and *c*.

## Doppler tomography as a tool for detecting exoplanet atmospheres

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*Monthly Notices of the Royal Astronomical Society, in press (arXiv:1909.09219)*

High-resolution Doppler spectroscopy is a powerful tool for identifying molecular species in the atmospheres of both transiting and non-transiting exoplanets. Currently, such data is analysed using cross-correlation techniques to detect the Doppler shifting signal from the orbiting planet. In this paper we demonstrate that, compared to cross-correlation methods currently used, the technique of Doppler tomography has improved sensitivity in detecting the subtle signatures expected from exoplanet atmospheres. This is partly due to the use of a regularizing statistic, which acts to suppress noise, coupled to the fact that all the data is fit simultaneously. In addition, we show that the technique can also effectively suppress contanimating spectral features that may arise due to overlapping lines, repeating line patterns, or the use of incorrect linelists. These issues can confuse conventional cross-correlation approaches, primarily due to aliasing issues inherent in such techniques, whereas Doppler tomography is less susceptible to such effects. In particular, Doppler tomography shows exceptional promise for simultaneously detecting multiple line species (e.g. isotopologues), even when there are high contrasts between such species – and far outperforms current CCF analyses in this respect. Finally, we demonstrate that Doppler tomography is capable of recovering molecular signals from exoplanets using real data, by confirming the strong detection of CO in the atmosphere of $\tau$ Boo b. We recover a signal with a planetary radial velocity semi-amplitude $K_p = 109.6 \pm 2.2$ km s$^{-1}$, in excellent agreement with the previously reported value of $110.0 \pm 3.2$ km s$^{-1}$.

*Download/Website:* `https://arxiv.org/abs/1909.09219`

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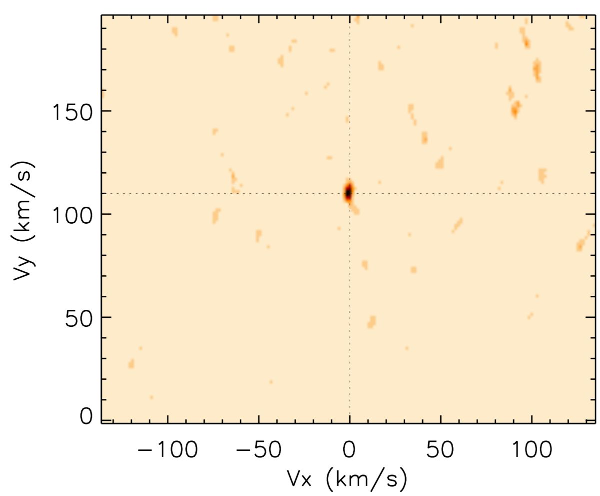


Figure 7: Doppler tomogram of the $\tau$ Boo b system using a CO linelist. The intersection of the dashed lines indicates the expected location of the planetary signature based on the detection of Brogi et al. (2012). CO is clearly detected in the Doppler tomogram at the expected location.

## Fast and Precise Light Curve Model for Transiting Exoplanets with Rings

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*Monthly Notices of the Royal Astronomical Society, published (2019MNRAS.tmp.2201R)*

The presence of silicate material in known rings in the Solar System raises the possibility of ring systems existing even within the snow line – where most transiting exoplanets are found. Previous studies have shown that the detection of exoplanetary rings in transit light curves is possible, albeit challenging. To aid such future detection of exoplanetary rings, we present the Polygon+Segments model for modelling the light curve of an exoplanet with rings. This high-precision model includes full ring geometry as well as possible ring transparency and the host star's limb darkening. It is also computationally efficient, requiring just a 1D integration over a small range, making it faster than existing techniques. The algorithm at its core is further generalized to compute the light curve of any set of convex primitive shapes in transit (*e.g.* multiple planets, oblate planets, moons, rings, combination thereof, etc.) while accounting for their overlaps. The PYTHON source code is made available.

*Download/Website:* `https://github.com/EdanRein/pyPplusS`

*Contact:* `edanrein2000@gmail.com`

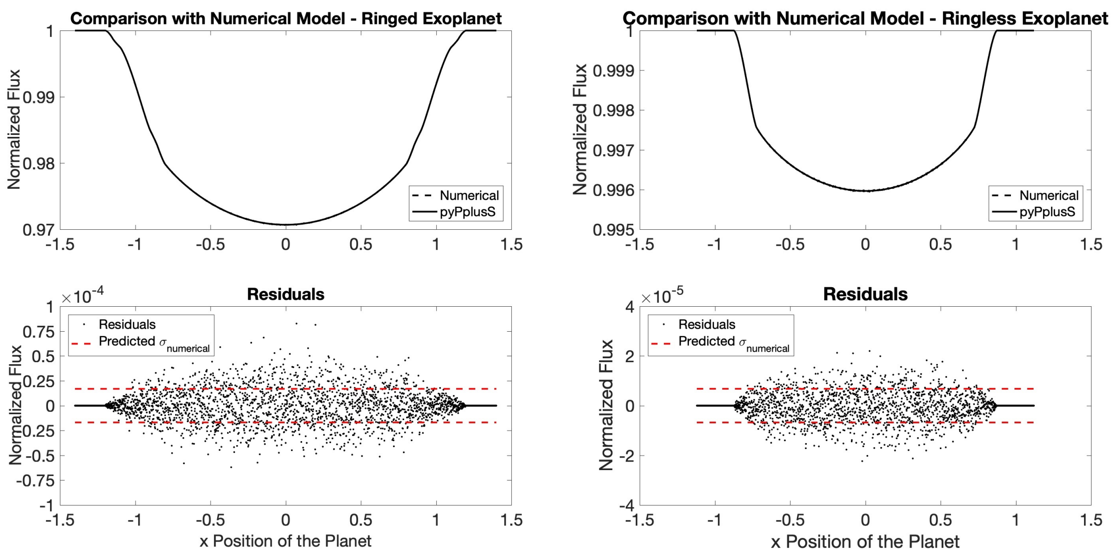


Figure 8: A comparison between the numerical model and the `pyPplusS` model in two configurations. **Right:** A Saturn-sized, ringless exoplanet. **Left:** A ringed exoplanet with an opaque ring. **Top panels:** In both configurations, the two model light curves are indistinguishable. **Bottom panels:** Both panels show the difference between `pyPplusS` and the numerical model (note the y-axis scale). The numerical model is predicted to be precise to $\sigma_{\mathrm{model}} \sim 6.77 \cdot 10^{-6}$, $\sim 1.69 \cdot 10^{-5}$ (right and left configurations, respectively, marked as red horizontal dashed lines) - and indeed the deviations are of that scale.

## Precise Radial Velocities of Cool Low Mass Stars With iSHELL

*B. Cale*[1], *P. Plavchan*[1], *D. LeBrun*[1], *J. Gagné*[2], *P. Gao*[3], *A. Tanner*[4], *C. Beichman*[5], *S.X. Wang*[6], *E. Gaidos*[7], *J. Teske*[6], *D. Ciardi*[8], *G. Vasisht*[5], *S. Kane*[9]

[1] George Mason University
[2] Université de Montréal
[3] University of California, Berkeley
[4] Mississippi State University
[5] NASA Jet Propulsion Laboratory
[6] Carnegie Department of Terrestrial Magnetism
[7] University of Hawaii
[8] California Institute of Technology
[9] Lowell Observatory

*ApJ, Accepted for publication (2019) (arXiv:1908.07560)*

The coolest dwarf stars are intrinsically faint at visible wavelengths and exhibit rotationally modulated stellar activity from spots and plages. It is advantageous to observe these stars at near infrared (NIR) wavelengths (1-2.5 $\mu$m) where they emit the bulk of their bolometric luminosity and are most quiescent. In this work we describe our methodology and results in obtaining precise radial velocity (RV) measurements of low mass stars using K-band spectra taken with the R ∼ 80,000 iSHELL spectrograph and the NASA Infrared Telescope Facility (IRTF) using a methane isotopologue gas cell in the calibration unit. Our novel analysis pipeline extracts RVs by minimizing the RMS of the residuals between the observed spectrum and a forward model. The model accounts for the gas cell, tellurics, blaze function, multiple sources of quasi-sinusoidal fringing, and line spread function of the spectrograph (LSF). The stellar template is derived iteratively using the target observations themselves through averaging barycenter-shifted residuals. We have demonstrated 2 m/s precision for the M4 dwarf Barnard's Star and 5 m/s for the K dwarf 61 Cygni A over one-year timescales, and 3 m/s over a month for the M2 dwarf GJ 15 A. This work demonstrates the potential for iSHELL to determine dynamical masses for candidate exoplanets discovered with the NASA *TESS* mission, and to search for exoplanets orbiting moderately active and/or young K & M dwarfs.

*Download/Website:* `https://arxiv.org/abs/1908.07560`

*Contact:* `bryson.cale1@gmail.com`

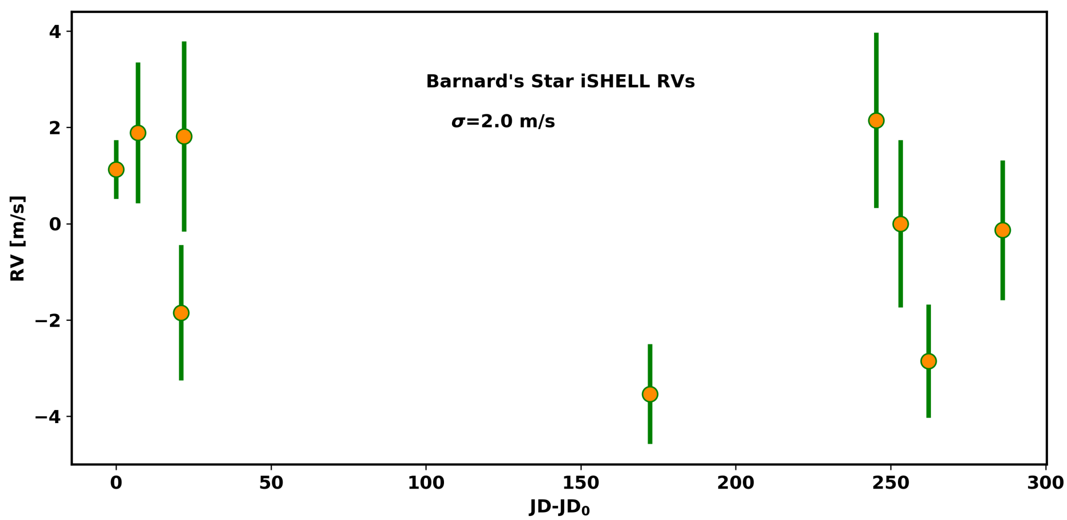


Figure 9: Radial velocities of Barnard's Star taken with the iSHELL spectrograph on IRTF spanning one year. The unweighted rms is 2 m/s. With iSHELL we aim to follow-up transiting exoplanet candidates orbiting cool stars discovered with the NASA *TESS* mission.

# 3 Thesis

## Know thy Star, Know thy Planet – Disentangling Planet Discovery & Stellar Activity

*H.A.C. Giles*
Observatoire de Genève, Chemin des Maillettes 51, 1290 Versoix, Switzerland

*Kepler* and *K2* have enabled not only searches for exoplanets but also to study stars. This thesis focuses on two goals: characterising starspots on *Kepler* stars; and detecting and following up *K2* exoplanet candidates.
Starspot evolution produces quasi-sinusoidal light curves which evolve as the spots grow and decay. Fitting ACFs of light curves with apodised periodic functions, I found a correlation between starspot size, decay lifetime and stellar effective temperature. This method is used as part of RV follow-up for planet-hosting stars.
Additionally, *K2* light curves were analysed using a new pipeline and received follow-up with the Swiss Telescope in La Silla, Chile. This generated two confirmed planets: K2-140b, a Jupiter-like planet orbiting in 6.57 days, the 9th hot Jupiter from *K2*; and K2-311b, a single-transit-event lasting 54 hours. With RV follow-up and other tools, this Jupiter-sized planet orbits in ~10 years. This is currently the longest-period transiting planet discovered.
This thesis contributes to future exoplanet endeavours to discover smaller planets in distant orbits, by providing techniques for exoplanet follow-up and improving our knowledge and understanding of stellar activity.

*Download/Website:* `https://archive-ouverte.unige.ch/unige:123850`

*Contact:* `hgiles@aip.de`

# 4 Jobs and Positions

### Postdoctoral position on exoplanet imaging using extreme adaptative optics.

*Department of Astronomy, University of Geneva, Switzerland, December 2019 - February 2020*

The exoplanet team of Geneva University has an opening for a postdoctoral researcher on exoplanet imaging using extreme adaptive optics. The project aims at identifying and studying the physics (chemical composition, evolution, mass determination) of ultra-cool companions to nearby main sequence stars in the separation range of 10-100 AU. Such a challenging feat is possible thanks to: **a)** a unique sample of nearby stars with promising low mass companion candidates derived from 20 years of precise radial velocity measurements with CORALIE/HARPS and close to 5 years of astrometric measurements with GAIA; **b)** state of the art high contrast imaging & spectroscopic instruments(SPHERE/GPI) that allow us to detect and characterize faint companions with contrast as high as 300 000 ($\Delta$mag=13.5-14) in the near infrared.
Successful candidates will also be encouraged to develop independent projects in collaboration with members of the Geneva University Exoplanet group.

The Department of Astronomy of the University of Geneva offers a modern and vibrant work environment, with a wide range of activities including theory, numerical simulations, observations and instrumental developments in the domains of exoplanets, stellar physics, galactic dynamics, observational cosmology and high-energy astrophysics. Our exoplanet team is renowned for its strong involvement in exoplanet detection, the determination of the planet physical properties, the characterization of exoplanetary atmospheres, and the development of world-class instrumentation. We are also co-leading the Swiss-wide National Centre of Competence in Research (NCCR) PlanetS (www.nccr-planets.ch), dedicated to the study of the origin, evolution, and characterization of planets inside and outside our Solar System, providing the applicants with opportunities to develop collaborations with members of the large PlanetS community.
Applicants are expected to have a strong experience in high contrast imaging of exoplanets and/or brown dwarfs as well as an excellent knowledge of data reduction and image processing. The duration of the postdoc contract is 2 years, with possible extension to a third year depending on available funds. The positions are funded by Swiss National Science Foundation with a gross salary around 80,000 CHF and are open for immediate start.
Interested candidates can contact and send their application to Dr. Damien Ségransan (damien.segransan@unige.ch). The application should contain *in a singe pdf file*:
a curriculum vitae; a publication list; a one page (max) motivation letter; a short research statement describing past achievements and future projects. Applicants should arrange for up to two letters of recommendation to be sent to the same address. The deadline is October 31st, 2019 but applications will accepted until the positions are filled.

*Download/Website:* `https://exoplanets.ch/vacancies/`

*Contact:* `damien.segransan@unige.ch`

## Trottier Postdoctoral Fellow

*Prof. René Doyon*
Université de Montréal, Montréal, QC, Canada

*Montréal, Canada, Starting date: May to September 2020*

The Institute for Research on Exoplanets (iREx), affiliated with the physics department of the University of Montreal (UdeM), invites applications for a postdoctoral fellowship in experimental, observational or theoretical astrophysics applied to the study of exoplanets. A number of iREx projects are described below for reference.

Applicants should submit a curriculum vitae, a list of publications, and a statement of research interests (max 2 pages), and should arrange to have three referees send a letter of reference. All application materials including letters of reference must be received electronically at the following address: **irex@astro.umontreal.ca**, by **December 2nd, 2019 for full consideration. This position will, however, remain open until filled.**

**A PhD in physics, astronomy or related discipline is required at the time when the position starts.** Preference will be given to applicants within 3 years of obtaining their PhD.

The iREx consists of a growing team of over 45 people (professors, postdocs, research assistants and students) mostly from UdeM and McGill University all working on various research programs focused on the study of exoplanets and related fields of stellar astrophysics. Members of iREx are actively involved in large international projects related to the detection and characterisation of exoplanets, notably the future James Webb Space Telescope (JWST), SPIRou, NIRPS and high-dispersion spectroscopy for 8-10m and giant telescopes. In addition, iREx researchers will have access to guaranteed observing time with JWST, SPIRou and NIRPS. More information on iREx research programs can be found here: http://www.exoplanetes.umontreal.ca/research/?lang=en.

The successful applicant is expected to start between **May and September 2020**. The position is for two years, renewable for a third year subject to performance and availability of funds.

**Social Benefits:**
Postdoctoral researchers at iREx at UdeM enjoy a comprehensive benefits package, see: http://www.fesp.umontreal.ca/fileadmin/Documents/PDF/GuideStagiairePostdoctoral_Eng.pdf

**Website:**
http://www.exoplanetes.umontreal.ca/trottier-postdoctoral-fellowship-at-irex-2020-in-exoplanetary-astrophysics/?lang=en

*Contact:* `nathalie@astro.umontreal.ca`

## Postdoctoral Researcher in Exoplanets

*Matthew Penny*

*Baton Rouge, Louisiana, USA, Start date flexible*

Applicants are sought for a postdoctoral researcher position at Louisiana State University to work in the area of exoplanets and/or time-domain survey astronomy. The researcher will work within Professor Matthew Penny's group on analysis of data from ongoing surveys, or preparations for upcoming surveys, of exoplanet demographics using the transit or gravitational microlensing techniques. The researcher will also have the opportunity to develop and apply machine learning techniques in collaboration with members of LSU's Center for Computation and Technology. **Past experience in one of the group's areas of research is not required**.
Possible work includes:
• Analysis and modeling of data for the MISHAPS transit survey;
• Analysis and modeling of ground-based microlensing survey data;
• Simulation of future space-based microlensing surveys by WFIRST and Euclid.

Review of applications will begin Nov 7th 2019. Start date flexible.

See AAS Job register post for more details:

*Download/Website:* `https://jobregister.aas.org/ad/1653625f`

*Contact:* `penny1@lsu.edu`

## Postdoctoral position in exoplanet research

*Ulrike Heiter and Nikolai Piskunov*
Department of Physics and Astronomy, Uppsala University, Sweden

*Uppsala University, from 1 Jan 2020*

The Department of Physics and Astronomy (IFA) at Uppsala University and the Swedish Collegium for Advanced Studies (SCAS; `http://www.swedishcollegium.se`) invite applications for a postdoctoral position in exoplanet research. This position is hosted jointly by IFA and SCAS. The effective workplace of the successful applicant will be IFA, but the holder of this position will also be affiliated with SCAS as a *Thunberg fellow*. The postdoctoral fellow is expected to work on projects related to the theme "Exoplanets and Biological Activity on Other Worlds" within the Natural Sciences Programme at SCAS.
To qualify for an employment as a postdoctor you must have a PhD degree or a foreign degree equivalent to a PhD degree in Physics, Astronomy or equivalent. The PhD degree must have been obtained no more than three years prior to the application deadline. Employment as a postdoctor is for two years. More information about the position can be found in the detailed announcement published on the website of Uppsala University.
Applications should be submitted via the on-line application system, following the link given in the detailed announcement. Your application should contain a letter describing yourself and your qualifications and research interests (max 2 pages). It should also contain a CV including contact information for at least two reference persons (e-mail address and phone number), a copy of your PhD degree certificate, and a full publication list. The deadline for applying for this position is **15 November 2019**.

*Download/Website:* `https://www.uu.se/en/about-uu/join-us/jobs/`

*Contact:* `ulrike.heiter@physics.uu.se`

# 5 Conference announcements

## Exoplanet Vision 2050

*Chair: László L. Kiss*

*Budapest, Hungary, 20-21(-22) November 2019*

Since the first exoplanet discoveries in the nineties, our knowledge about these extra-solar bodies expanded in a huge extent thanks to the space-based and ground-based missions, the developing observation techniques and theoretic works. During these few decades, we witnessed some unexpected discoveries, and we might wonder what surprises the future missions still hold for us.

The aim of the Exoplanet Vision 2050 workshop is to bring (mostly but not exclusively) European exoplanet researchers together and to discuss our future in the coming decades, both observationally and theoretically. What do we think is going to happen realistically by the middle of the 21st century? What shall we tell our students to come to learn from us so that they can shape the future of this particular branch of science?

The workshop will take place in Budapest, Hungary on 20-21 November 2019 at the Konkoly Observatory. The two-days workshop will be a satellite event of the World Science Forum - Thematic Session entitled ”Hunting for alien worlds: recent advances in exoplanet research”. This short session will be held on 22 November at the Hungarian Academy of Sciences. Participants are welcome to join in both events.

There is no registration fee, but participants must registrate to the workshop by sending an e-mail to Vera Dobos to dobos@konkoly.hu with the information of your name and affiliation. If you would like to present your research work and ideas at the workshop, please include in the e-mail a title of your talk before 21 October so that we can select contributing talks for the programme. Please also indicate whether you plan to participate at event on Friday at the Academy.

*Download/Website:* `https://konkoly.hu/exoplanetvision2050`

*Contact:* `dobos@konkoly.hu`

## 2020 Sagan Summer Workshop: Finding and Characterizing Exoplanets with Extreme Precision Radial Velocities

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

*Pasadena, CA, July 20-24, 2020*

Join us in 2020 for the 20th Sagan Summer Workshop! This year's topic is extreme precision radial velocity for finding and characterizing exoplanets. Attendees will participate in hands-on group projects and will have the opportunity to present their own work through short presentations (research POPs) and posters. More details will be posted on the workshop website in early 2020.

The Sagan Summer Workshops are free to attend and are aimed at graduate and post doctoral level students, however anyone who is interested in learning more about the field is welcome to attend. Videos of presentations from past summer workshops are available on the Sagan Exoplanet Summer Workshop YouTube channel.

*Download/Website:* `http://nexsci.caltech.edu/workshop/2020`

*Contact:* `sagan_workshop@ipac.caltech.edu`

## Exoplanets 3


The registration for *Exoplanets 3* has opened today. The deadline for registration and abstract submission is January 31, 2020. Selection of talks will be made by February 28, 2020.

*Download/Website:* `http://www.exoplanets.world`

*Contact:* `exo3@mpia.de`

## 50th Saas-Fee Advanced Course: Astronomy in the Era of Big Data

*Yann Alibert, Kevin Heng, Danuta Sosnowska, Nathan Hara, Xavier Dumusque, Lucio Mayer*

*Saas-Fee, Switzerland, March 15 - 20, 2020*

The 2020 Saas-Fee Advanced Course of the Swiss Society for Astrophysics and Astronomy (SSAA) will be held from Sunday, 15 March to Friday, 20 March 2020 in Saas-Fee, in the Swiss Alps. This course has taken place annually since 1971 and will be devoted in 2020 to:

**Astronomy in the Era of Big Data**.

The three lecturers will be:
- Dr. Roberto Trotta (Imperial College London)
- Prof. Suzanne Aigrain (University of Oxford)
- Prof. Marc Huertas-Company (Paris Observatory)

Attendance will be limited by space, so please check out the meeting's webpage and pre-register now. We will alert you when the full registration page is available.

*Download/Website:* `http://nccr-planets.ch/saasfee2020/`

# 6 Announcements

## Fizeau exchange visitors program in optical interferometry - call for applications

*European Interferometry Initiative*

*www.european-interferometry.eu, application deadline: Nov. 15*

The Fizeau exchange visitors program in optical interferometry funds (travel and accommodation) visits of researchers to an institute of his/her choice (within the European Community) to perform collaborative work and training on one of the active topics of the European Interferometry Initiative. The visits will typically last for one month, and strengthen the network of astronomers engaged in technical, scientific and training work on optical/infrared interferometry. The program is open for all levels of astronomers (Ph.D. students to tenured staff), with priority given to PhD students and young postdocs. Non-EU based missions will only be funded if considered essential by the Fizeau Committee. Applicants are strongly encouraged to seek also partial support from their home or host institutions.

The deadline for applications is November 15. Fellowships can be awarded for missions to be carried out between mid January 2020 and July 2020!

Further informations and application forms can be found at: www.european-interferometry.eu
The program is funded by OPTICON/H2020.

Please distribute this message also to potentially interested colleagues outside of your community!

Looking forward to your applications,
Josef Hron & Péter Ábrahám
(for the European Interferometry Initiative)

*Download/Website:* `http://www.european-interferometry.eu`

*Contact:* `fizeau@european-interferometry.eu`

## Call for Applications for the 2020 NASA Hubble Fellowship Program

*Dr. Andrew Fruchter, Space Telescope Science Institute*

*Dr. Dawn M. Gelino, NASA Exoplanet Science Institute*

*Dr. Paul Green, Smithsonian Astrophysical Observatory*

*Applications Due: November 4, 2019 at 7:00 PM EST (4:00 PM PST 24:00 UTC),*

On behalf of the NASA Astrophysics Division, the Space Telescope Science Institute (STScI) announces the annual call for applications for postdoctoral fellowships under the NASA Hubble Fellowship Program (NHFP), to begin in the Fall of 2020.

The NHFP supports promising postdoctoral scientists performing independent research that contributes to NASA Astrophysics (see https://science.nasa.gov/astrophysics/ for more information). The research may be theoretical, observational, and/or instrumental. If your application is successful you will become an Einstein, Hubble or Sagan fellow, depending on the area of your research. We are continuing the legacy of those three earlier programs in this way, and through joint management of the program by STScI, in collaboration with the Chandra X-ray Center and the NASA Exoplanet Science Institute.

The NHFP is open to applicants of any nationality who have earned (or will have earned) their doctoral degree on or after January 1, 2017 in astronomy, physics, or related disciplines. The duration of the Fellowship is up to three years: an initial one-year appointment, and two annual renewals contingent on satisfactory performance and availability of NASA funds.

Eligibility may extend to those who received their PhD as early as January 1, 2016, if professional work was necessarily delayed by personal or family considerations. Such extended eligibility must be justified in an email to nhfp@stsci.edu at least 2 weeks in advance of the application deadline.

We anticipate offering up to 24 NHFP Fellowships this year. The Fellowships are tenable at a U.S. host institution of the fellow's choice, subject to a maximum of two new fellows per host institution per year, and no more than 5 granted to a single host institution in any 3 year period.

The Announcement of Opportunity, which includes detailed program policies and application instructions, will be available September 3 at: http://nhfp.stsci.edu. Applicants should follow the instructions in the Announcement and also read the Frequently Asked Questions page. Please send further inquiries to nhfp@stsci.edu.

NHFP Fellowships are open to English-speaking citizens of all nations. All applicants will receive consideration without regard to race, creed, color, age, gender, gender identity or expression, sexual orientation or national origin. Women and members of minority groups are strongly encouraged to apply.

**Key Dates**

- November 4, 2019, 7:00 PM EST (4:00 PM PST 24:00 UTC): Applications due
- November 8, 2019: Letters of reference due
- By early February 2020: Award offers made; new appointments to begin on or about Sept. 1, 2020

*Download/Website:* `http://nhfp.stsci.edu`
*Contact:* `nhfp@stsci.edu`

# 7 Exoplanet Archive Updates

## September 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, October 14, 2019*

**Note:** All new planetary data can be viewed in the Confirmed Planets (`http://bit.ly/2MqFnub`), Composite Planet Data (`http://bit.ly/2l84Qw9`), and Extended Planet Data (`http://bit.ly/2NLy1Ci`) tables. New microlensing solutions are in the Microlensing Data table (`http://bit.ly/2JQr18O`).

### September 26, 2019

There are two new confirmed planets this week, NGTS-6 b and WASP-180 A b, as well as additional parameter sets for 13 known planets.

Data for the 28 K2 candidates listed in Zink et al. (2019) (`http://bit.ly/2AZ0Fuy`) are also now available through our K2 Candidates table (`http://bit.ly/2vexgKd`).

### September 12, 2019

**Eleven New Planets:** We've added 11 planets this week, including HR 5183 b, which was discovered by Caltech graduate student Sarah Blunt and noted in the news (`http://bit.ly/30Xgdtb`) for its unusual orbit. We've also added 21 new microlensing solutions to the Microlensing Planets interactive table (`http://bit.ly/2JQr18O`).

The new planets are: HR 5183 b, WASP-169 b, WASP-171 b, WASP-175 b, WASP-182 b, KELT-24 b, OGLE-2018-BLG-0740L b, OGLE-2018-BLG-1011L b & c, KMT-2016-BLG-0212L b, and OGLE-2016-BLG-1067L b.

**More than 800 New K2 Candidates:** The 818 K2 planet candidates published in Kruse et al. (2019) (`http://bit.ly/2p8xd2m`) are now available through our K2 Candidates table (`http://bit.ly/2vexgKd`).

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

*Contact:* `mharbut@caltech.edu`

# 8 As seen on astro-ph

The following list contains all the entries relating to exoplanets that we spotted on astro-ph during September 2019.

**September 2019**

astro-ph/1909.00362: **Geoscience for understanding habitability in the solar system and beyond** by *Veronique Dehant et al.*

astro-ph/1909.00648: **Dynamical environments of relativistic binaries: The phenomenon of resonance shifting** by *Ivan I. Shevchenko, Guillaume Rollin, José Lages*

astro-ph/1909.00706: **The Observability Of Vortex-Driven Spiral Arms In Protoplanetary Disk: Basic Spiral Properties** by *Pinghui Huang et al.*

astro-ph/1909.00718: **Optimizing exoplanet atmosphere retrieval using unsupervised machine-learning classification** by *Joshua J.C. Hayes et al.*

astro-ph/1909.00759: **Super-Earth masses sculpted by pebble isolation around stars of different masses** by *Beibei Liu et al.*

astro-ph/1909.00831: **GJ 357: A low-mass planetary system uncovered by precision radial-velocities and dynamical simulations** by *James S. Jenkins et al.*

astro-ph/1909.01075: **Kinematic Model revisits high obliquity, high angular momentum Earth as Moon's origin** by *Bijay Kumar Sharma*

astro-ph/1909.01661: **Predicting the observational signature of migrating Neptune-sized planets in low-viscosity disks** by *Philipp Weber et al.*

astro-ph/1909.01719: **The Rate of Planet-star Coalescences Due to Tides and Stellar Evolution** by *Alexander V. Popkov et al.*

astro-ph/1909.01913: **The Effect of the Approach to Gas Disk Gravitational Instability on the Rapid Formation of Gas Giant Planets** by *Alan P. Boss*

astro-ph/1909.02006: **A Staggered Semi-Analytic Method for Simulating Dust Grains Subject to Gas Drag** by *Jeffrey Fung, Dhruv Muley*

astro-ph/1909.02031: **Probing planet formation and disk substructures in the inner disk of Herbig Ae stars with CO rovibrational emission** by *Arthur D. Bosman et al.*

astro-ph/1909.02161: **The Potential of Exozodiacal Disks Observations with the WFIRST Coronagraph Instrument** by *B. Mennesson et al.*

astro-ph/1909.02407: **Linking Zonal Winds and Gravity: The Relative Importance of Dynamic Self Gravity** by *Johannes Wicht et al.*

astro-ph/1909.02427: **The Discovery of the Long-Period, Eccentric Planet Kepler-88 d and System Characterization with Radial Velocities and Photodynamical Analysis** by *Lauren M. Weiss et al.*

astro-ph/1909.02928: **Oceanographic Constraints on Exoplanet Life** by *Stephanie L. Olson, Malte Jansen, Dorian S. Abbot*

astro-ph/1909.03000: **TESS observations of the WASP-121 b phase curve** by *Tansu Daylan et al.*

astro-ph/1909.03010: **Optical phase curve of the ultra-hot Jupiter WASP-121b** by *V. Bourrier et al.*

astro-ph/1909.03233: **2.5-D retrieval of atmospheric properties from exoplanet phase curves: Application to WASP-43b observations** by *Patrick G.J. Irwin et al.*

astro-ph/1909.03722: **Eigenvectors, Circulation and Linear Instabilities for Planetary Science in 3 Dimensions (ECLIPS3D)** by *Florian Debras et al.*

astro-ph/1909.04046: **The Climates of Other Worlds: A Review of the Emerging Field of Exoplanet Climatology** by *Aomawa L. Shields*

astro-ph/1909.04059: **Dynamical Interactions in the Planetary System GJ4276** by *Fergus Horrobin, Hanno Rein*

astro-ph/1909.04162: **From scattered-light to millimeter emission: A comprehensive view of the Gyr-old system of HD 202628 and its eccentric debris ring** by *Virginie Faramaz et al.*

astro-ph/1909.04389: **No further evidence for a transiting inner companion to the hot Jupiter HATS-50b** by *Matthias Mallonn*
astro-ph/1909.04395: **On the origin of wide-orbit ALMA planets: giant protoplanets disrupted by their cores** by *Jack Humphries, Sergei Nayakshin*
astro-ph/1909.04444: **Revisiting MOA 2013 BLG-220L: A Solar-type star with a super-Jupiter companion** by *Aikaterini Vandorou et al.*
astro-ph/1909.04507: **Studying the Solar system dynamics using pulsar timing arrays and the LINIMOSS dynamical model** by *Y. J. Guo et al.*
astro-ph/1909.04536: **ODEA: Orbital Dynamics in a complex Evolving Architecture – Application to the planetary system HD 106906** by *L. Rodet et al.*
astro-ph/1909.04558: **Star catalog position and proper motion corrections in asteroid astrometry II: The Gaia era** by *Siegfried Eggl et al.*
astro-ph/1909.04642: **Water Vapor on the Habitable-Zone Exoplanet K2-18b** by *Björn Benneke et al.*
astro-ph/1909.04674: **The DSHARP Rings: Evidence of Ongoing Planetesimal Formation?** by *Sebastian M. Stammler et al.*
astro-ph/1909.04698: **The changing rotational light-curve amplitude of Varuna and evidence for a close-in satellite** by *Estela Fernández-Valenzuela et al.*
astro-ph/1909.04740: **Keck Observations Confirm a Super-Jupiter Planet Orbiting M-dwarf OGLE-2005-BLG-071L** by *David P. Bennett et al.*
astro-ph/1909.04854: **OGLE-2018-BLG-1700L: Microlensing Planet in Binary Stellar System** by *Cheongho Han et al.*
astro-ph/1909.04884: **The potassium absorption on HD189733b and HD209458b** by *Engin Keles et al.*
astro-ph/1909.05218: **Water vapour in the atmosphere of the habitable-zone eight Earth-mass planet K2-18 b** by *Angelos Tsiaras et al.*
astro-ph/1909.05252: **Radial velocity confirmation of K2-100b: a young, highly irradiated, and low density transiting hot Neptune** by *O. Barragán et al.*
astro-ph/1909.05264: **An Integrable Model for the Dynamics of Planetary Mean Motion Resonances** by *Sam Hadden*
astro-ph/1909.05851: **Interstellar comet C/2019 Q4 (Borisov)** by *Piotr Guzik et al.*
astro-ph/1909.05866: **Effects of Magnetic Fields on the Location of the Evaporation Valley for Low-Mass Exoplanets** by *James E Owen, Fred C Adams*
astro-ph/1909.05878: **The Likelihood of Detecting Young Giant Planets with High Contrast Imaging and Interferometry** by *A. L. Wallace, M. J. Ireland*
astro-ph/1909.05978: **Near-equilibrium isotope fractionation during planetesimal evaporation** by *E.D. Young et al.*
astro-ph/1909.06111: **Velocity distribution function of Na released by photons from planetary surfaces** by *Diana Gamborino, Peter Wurz*
astro-ph/1909.06255: **Constraints on the occurrence and distribution of 1–20 $m_{Jup}$ companions to stars at separations of 5–5000 au from a compilation of direct imaging surveys** by *Frédérique Baron et al.*
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