ExoPlanet News
An Electronic Newsletter

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1 Editorial

Welcome to Edition 141 of the ExoPlanet News!

In this November issue you will find abstracts of scientific papers, Exoplanet Archive updates, job postings, announcements for a workshop, visitor program, lectures on Solar System formation, the latest exoplanet talks, and an overview of exoplanet-related articles on astro-ph.

We remind you of some guidelines for using our templates. If you follow these guidelines, you will make our job easier:

- Please rename the *.tex* file you send from *abstract_template* to something with your last name, like *jobs_smith* or *announcement_miller*
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- Figure: attach it to the e-mail without large white margins. It should be one single pdf file per abstract.
- Prior to submission, please remember to comment the three lines which start the tex document and the last line which ends the document.
- Please remember to fill the brackets {} after the title with author names.

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

The next issue will appear on April 13, 2021.

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

2 Abstracts of refereed papers

The Effect of the Approach to Gas Disk Gravitational Instability on the Rapid Formation of Gas Giant Planets. II. Quadrupled Spatial Resolution

A. P. Boss[1]

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The Astrophysical Journal, in press (arXiv:3632511)

Observations support the hypothesis that gas disk gravitational instability might explain the formation of massive or wide-orbit gas giant exoplanets. The situation with regard to Jupiter-mass exoplanets orbiting within ~ 20 au is more uncertain. Theoretical models yield divergent assessments often attributed to the numerical handling of the gas thermodynamics. Boss (2019) used the β cooling approximation to calculate three dimensional hydrodynamical models of the evolution of disks with initial masses of 0.091 $M_\odot$ extending from 4 to 20 au around 1 $M_\odot$ protostars. The models considered a wide range (1 to 100) of β cooling parameters and started from an initial minimum Toomre stability parameter of $Q_i = 2.7$ (gravitationally stable). The disks cooled down from initial outer disk temperatures of 180 K to as low as 40 K as a result of the β cooling, leading to fragmentation into dense clumps, which were then replaced by virtual protoplanets (VPs) and evolved for up to ~ 500 yr. The present models test the viability of replacing dense clumps with VPs by quadrupling the spatial resolution of the grid once dense clumps form, sidestepping in most cases VP insertion. After at least ~ 200 yr of evolution, the new results compare favorably with those of Boss (2019): similar numbers of VPs and dense clumps form by the same time for the two approaches. The results imply that VP insertion can greatly speed disk instability calculations without sacrificing accuracy.

Download/Website: `https://aboss.dtm.carnegiescience.edu/ftp-files/beta-quad.pdf`

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A pebble accretion model for the formation of the terrestrial planets in the solar system

Anders Johansen[1,2], *Thomas Ronnet*[2], *Martin Bizzarro*[1], *Martin Schiller*[1], *Michiel Lambrechts*[2], *Åke Nordlund*[3], *Helmut Lammer*[4]

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Science Advances, published (arXiv:2102.08611)

Pebbles of millimeter sizes are abundant in protoplanetary discs around young stars. Chondrules inside primitive meteorites – formed by melting of dust aggregate pebbles or in impacts between planetesimals – have similar sizes. The role of pebble accretion for terrestrial planet formation is nevertheless unclear. Here, we present a model where inward-drifting pebbles feed the growth of terrestrial planets. The masses and orbits of Venus, Earth, Theia (which later collided with Earth to form the Moon), and Mars are all consistent with pebble accretion onto protoplanets that formed around Mars' orbit and migrated to their final positions while growing. The isotopic compositions of Earth and Mars are matched qualitatively by accretion of two generations of pebbles, carrying distinct isotopic signatures. Last, we show that the water and carbon budget of Earth can be delivered by pebbles from the early generation before the gas envelope became hot enough to vaporize volatiles.

Download/Website: `https://advances.sciencemag.org/content/7/8/eabc0444`

Contact: `Anders.Johansen@sund.ku.dk`

A Near-Infrared Chemical Inventory of the Atmosphere of 55 Cancri e

E. K. Deibert[1,2], *E. J. W. de Mooij*[3], *R. Jayawardhana*[4], *A. Ridden-Harper*[4], *S. Sivanandam*[1,2], *R. Karjalainen*[5,6,7], *M. Karjalainen*[5]

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The Astronomical Journal, in press (arXiv:2102.08965)

We present high-resolution near-infrared spectra taken during eight transits of 55 Cancri e, a nearby low-density super-Earth with a short orbital period ($<$ 18 hours). While this exoplanet's bulk density indicates a possible atmosphere, one has not been detected definitively. Our analysis relies on the Doppler cross-correlation technique, which takes advantage of the high spectral resolution and broad wavelength coverage of our data, to search for the thousands of absorption features from hydrogen-, carbon-, and nitrogen-rich molecular species in the planetary atmosphere. Although we are unable to detect an atmosphere around 55 Cancri e, we do place strong constraints on the levels of HCN, NH_3, and C_2H_2 that may be present. In particular, at a mean molecular weight of 5 amu we can rule out the presence of HCN in the atmosphere down to a volume mixing ratio (VMR) of 0.02%, NH_3 down to a VMR of 0.08%, and C_2H_2 down to a VMR of 1.0%. If the mean molecular weight is relaxed to 2 amu, we can rule out the presence of HCN, NH_3, and C_2H_2 down to VMRs of 0.001%, 0.0025%, and 0.08% respectively. Our results reduce the parameter space of possible atmospheres consistent with the analysis of HST/WFC3 observations by Tsiaras et al. (2016), and indicate that if 55 Cancri e harbors an atmosphere, it must have a high mean molecular weight and/or clouds.

Download/Website: `https://arxiv.org/abs/2102.08965`

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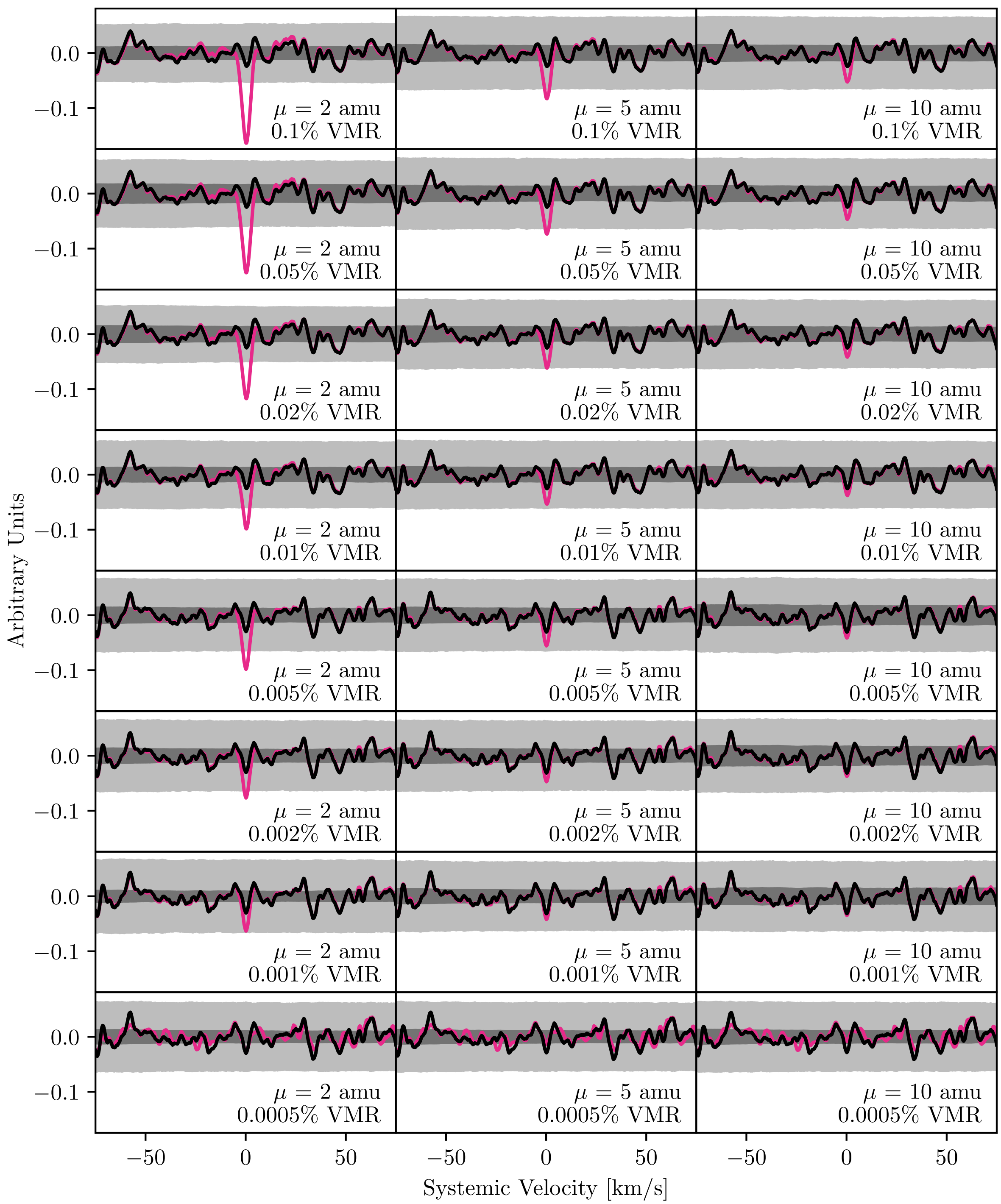

Figure 1: The results of injecting HCN models of various strengths into our data and carrying out the Doppler cross-correlation process. In all panels, the black line represents the original data and the magenta line represents the data with an atmospheric model injected. The volume mixing ratio and mean molecular weight of each model are indicated in the bottom right of the panel. The dark- and light-grey contours in each panel correspond to 1σ and 3σ confidence levels, respectively. The data have been phase-folded and sliced at the orbital velocity of 55 Cnc e, $K_p \approx 231.4$ km/s. We are able to rule out atmospheric HCN at a mean molecular weight of 2 amu with a volume mixing ratio as low as 0.001%, and at a mean molecular weight of 5 amu with a volume mixing ratio as low as 0.02%.

Radiative scale-height and shadows in protoplanetary disks

Matías Montesinos [1,2,3], Nicolás Cuello[4,5,3], Johan Olofsson[1,3], Jorge Cuadra[6,3], Amelia Bayo[1,3], Gesa H.-M. Bertrang[7], Clément Perrot[1,3,8]

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The Astrophysical Journal, in press (arXiv:2102.02874)

Planets form in young circumstellar disks called protoplanetary disks. However, it is still difficult to catch planet formation in situ. Nevertheless, from recent ALMA/SPHERE data, encouraging evidence of the direct and indirect presence of embedded planets has been identified in disks around young stars: co-moving point sources, gravitational perturbations, rings, cavities, and emission dips or shadows cast on disks. The interpretation of these observations needs a robust physical framework to deduce the complex disk geometry. In particular, protoplanetary disk models usually assume the gas pressure scale height given by the ratio of the sound speed over the azimuthal velocity $H/r = c_s/v_k$. By doing so, radiative pressure fields are often ignored, which could lead to a misinterpretation of the real vertical structure of such disks. We follow the evolution of a gaseous disk with an embedded Jupiter-mass planet through hydrodynamical simulations, computing the disk scale height including radiative pressure, which was derived from a generalization of the stellar atmosphere theory. We focus on the vertical impact of the radiative pressure in the vicinity of circumplanetary disks, where temperatures can reach 1000 K for an accreting planet and radiative forces can overcome gravitational forces from the planet. The radiation pressure effects create a vertical, optically thick column of gas and dust at the protoplanet location, casting a shadow in scattered light. This mechanism could explain the peculiar illumination patterns observed in some disks around young stars such as HD 169142 where a moving shadow has been detected or the extremely high aspect ratio $H/r \sim 0.2$ observed in systems like AB Aur and CT Cha.

Download/Website: `https://arxiv.org/abs/2102.02874`

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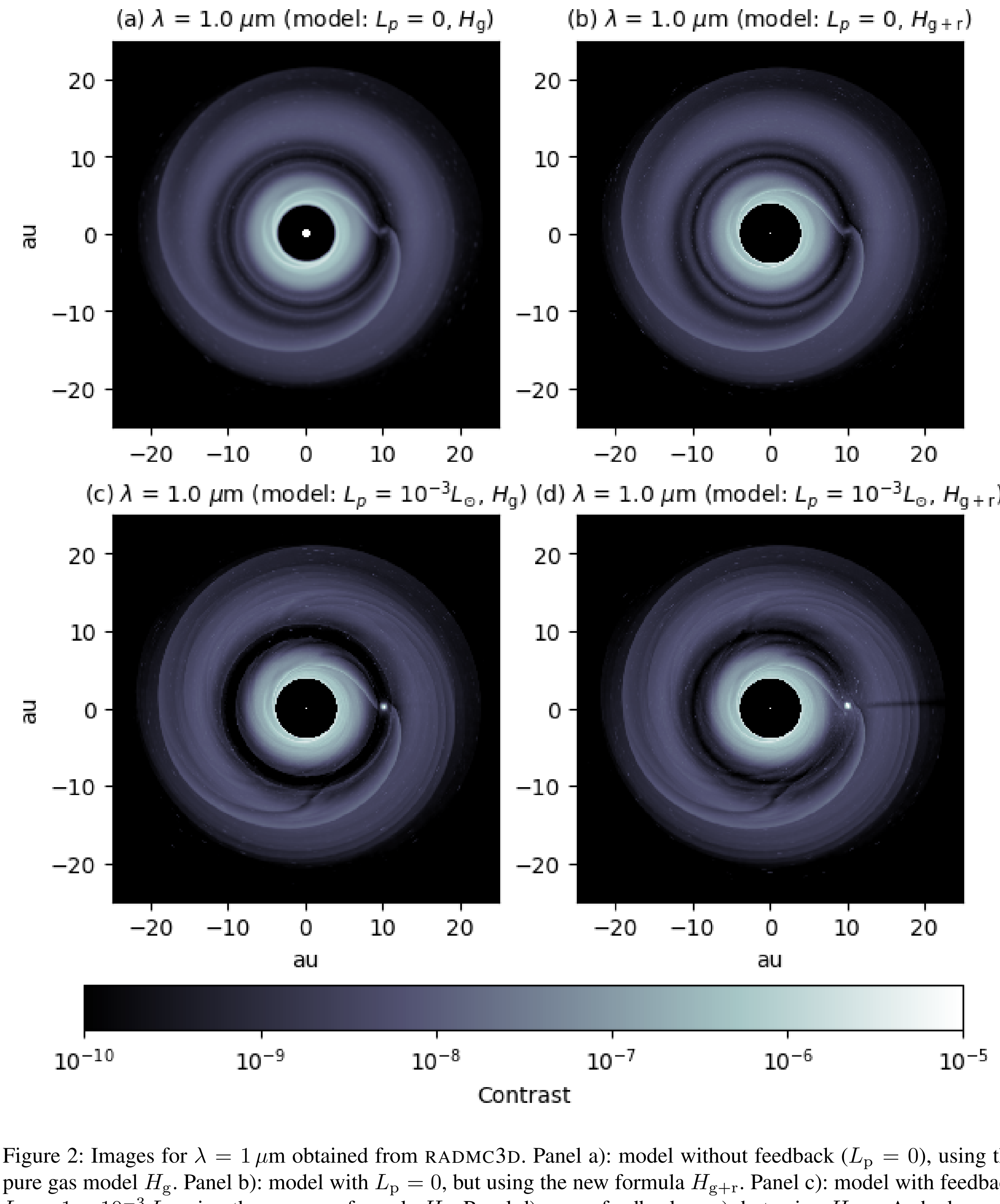

Figure 2: Images for $\lambda = 1\,\mu$m obtained from RADMC3D. Panel a): model without feedback ($L_\mathrm{p} = 0$), using the pure gas model H_g. Panel b): model with $L_\mathrm{p} = 0$, but using the new formula $H_\mathrm{g+r}$. Panel c): model with feedback $L_\mathrm{p} = 1 \times 10^{-3}\,L$, using the pure gas formula H_g. Panel d): same feedback as c), but using $H_\mathrm{g+r}$. A shadow cast from the planet location is observed in this model.

The JADE code: Coupling secular exoplanetary dynamics and photo-evaporation

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Astronomy & Astrophysics, published (doi:10.1051/0004-6361/202039452)

Close-in planets evolve under extreme conditions, which raises questions about their origins and current nature. Two evolutionary mechanisms thought to play a predominant role are orbital migration, which brings them close to their star, and atmospheric escape under the resulting increased irradiation. Yet their relative roles remain poorly understood, in part because we lack numerical models that couple the two mechanisms with high precision and on secular timescales. To address this need, we developed the Joining Atmosphere and Dynamics for Exoplanets (JADE) code, which simulates the secular atmospheric and dynamical evolution of a specific planet around its star, and can include the perturbation induced by a distant third body. On the dynamical side, the three dimensional evolution of the orbit is modeled under stellar and planetary tidal forces, a relativistic correction, and the action of the distant perturber. On the atmospheric side, the vertical structure of the atmosphere is integrated over time based on its thermodynamical properties, inner heating, and the evolving stellar irradiation, which results, in particular, in extreme ultraviolet induced photo-evaporation.

The JADE code is benchmarked on GJ436 b, which is a prototype of the evaporating giants on eccentric, misaligned orbits at the edge of the hot Neptunes desert. We confirm previous results that the orbital architecture of GJ436 b is well explained by Kozai migration and bring to light a strong interplay between its atmospheric and orbital evolution. During the resonance phase, the atmosphere pulsates in tune with the Kozai cycles, which leads to stronger tides and an earlier migration. This triggers a strong atmospheric evaporation several billion years after the planet formed, refining the paradigm that mass loss is dominant in the early age of close-in planets. These results suggest that the edge of the desert could be formed of warm Neptunes whose evaporation was delayed by Kozai migration. They strengthen the importance of coupling atmospheric and dynamical evolution over secular timescales, which the JADE code will allow for one to simulate for a wide range of systems.

Download/Website: `https://arxiv.org/abs/2103.02627`

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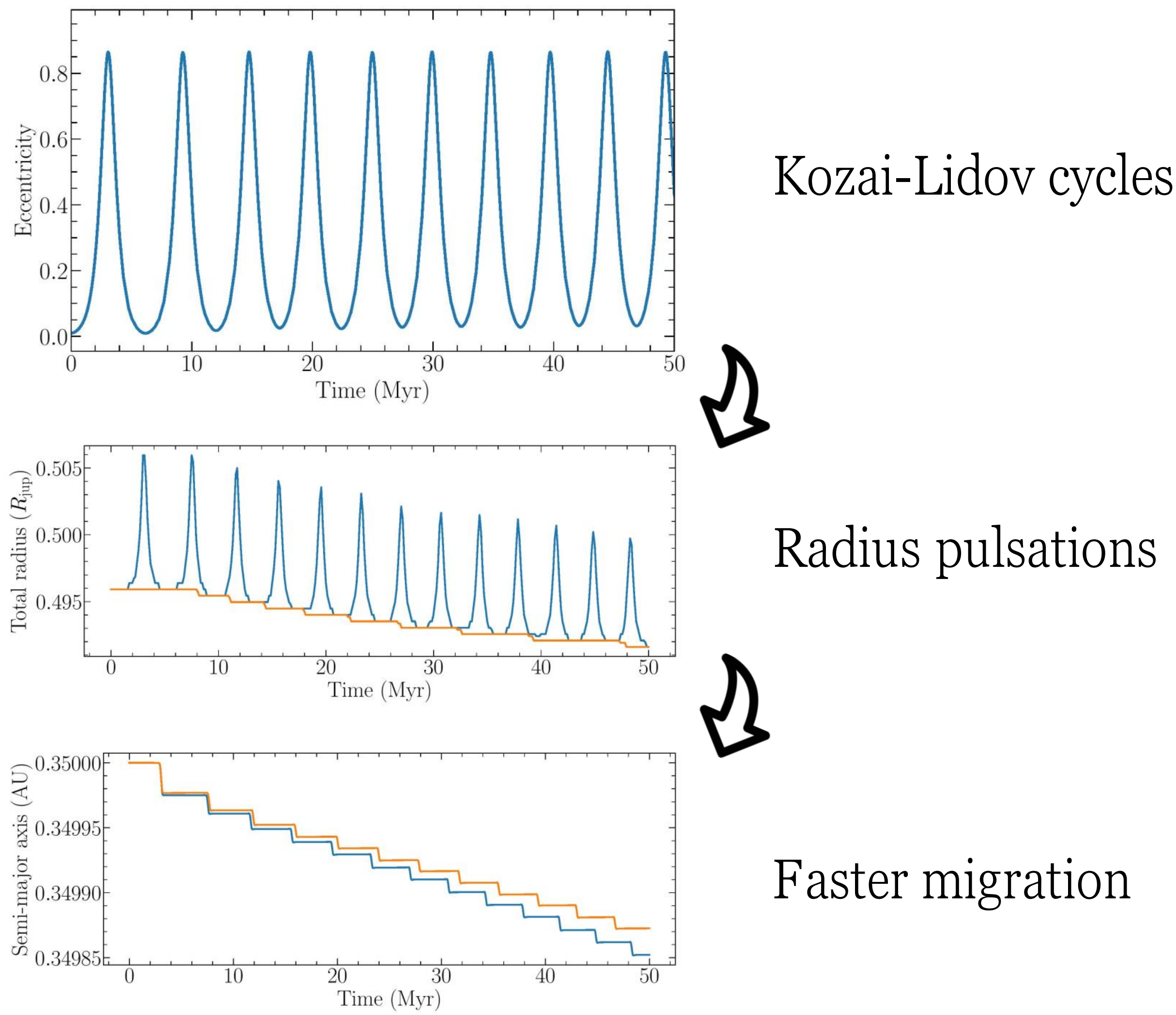

Figure 3: Possible interplay between secular dynamics and atmospheric evolution of GJ436 b, as unveiled by the JADE code. *Top*: a Kozai–Lidov resonance induced by a distant perturber generates large eccentricity oscillations. *Middle*: the periodic rise in eccentricity translates into shorter mean planet–star distance and higher stellar irradiation. This causes the atmosphere to heat up and pulsate in tune with Kozai cycles (blue), as opposed to the case where this dynamical feedback is not taken into account (orange). *Bottom*: the increases in radius lead to stronger tidal effects and thus a faster migration (blue), as compared to the case where the atmosphere is not modelled (orange).

Fomalhaut b could be massive and sculpting the narrow, eccentric debris disc, if in mean-motion resonance with it

T. D. Pearce[1], *H. Beust*[2], *V. Faramaz*[3], *M. Booth*[1], *A. V. Krivov*[1], *T. Löhne*[1], *P. P. Poblete*[1]

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Monthly Notices of the Royal Astronomical Society, in press (arXiv:2103.04977)

The star Fomalhaut hosts a narrow, eccentric debris disc, plus a highly eccentric companion Fomalhaut b. It is often argued that Fomalhaut b cannot have significant mass, otherwise it would quickly perturb the disc. We show that material in internal mean-motion resonances with a massive, coplanar Fomalhaut b would actually be long-term stable, and occupy orbits similar to the observed debris. Furthermore, millimetre dust released in collisions between resonant bodies could reproduce the width, shape and orientation of the observed disc. We first re-examine the possible orbits of Fomalhaut b, assuming that it moves under gravity alone. If Fomalhaut b orbits close to the disc midplane then its orbit crosses the disc, and the two are apsidally aligned. This alignment may hint at an ongoing dynamical interaction. Using the observationally allowed orbits, we then model the interaction between a massive Fomalhaut b and debris. Whilst most debris is unstable in such an extreme configuration, we identify several resonant populations that remain stable for the stellar lifetime, despite crossing the orbit of Fomalhaut b. This debris occupies low-eccentricity orbits similar to the observed debris ring. These resonant bodies would have a clumpy distribution, but dust released in collisions between them would form a narrow, relatively smooth ring similar to observations. We show that if Fomalhaut b has a mass between those of Earth and Jupiter then, far from removing the observed debris, it could actually be sculpting it through resonant interactions.

Download/Website: `https://ui.adsabs.harvard.edu/abs/2021arXiv210304977P/abstract`
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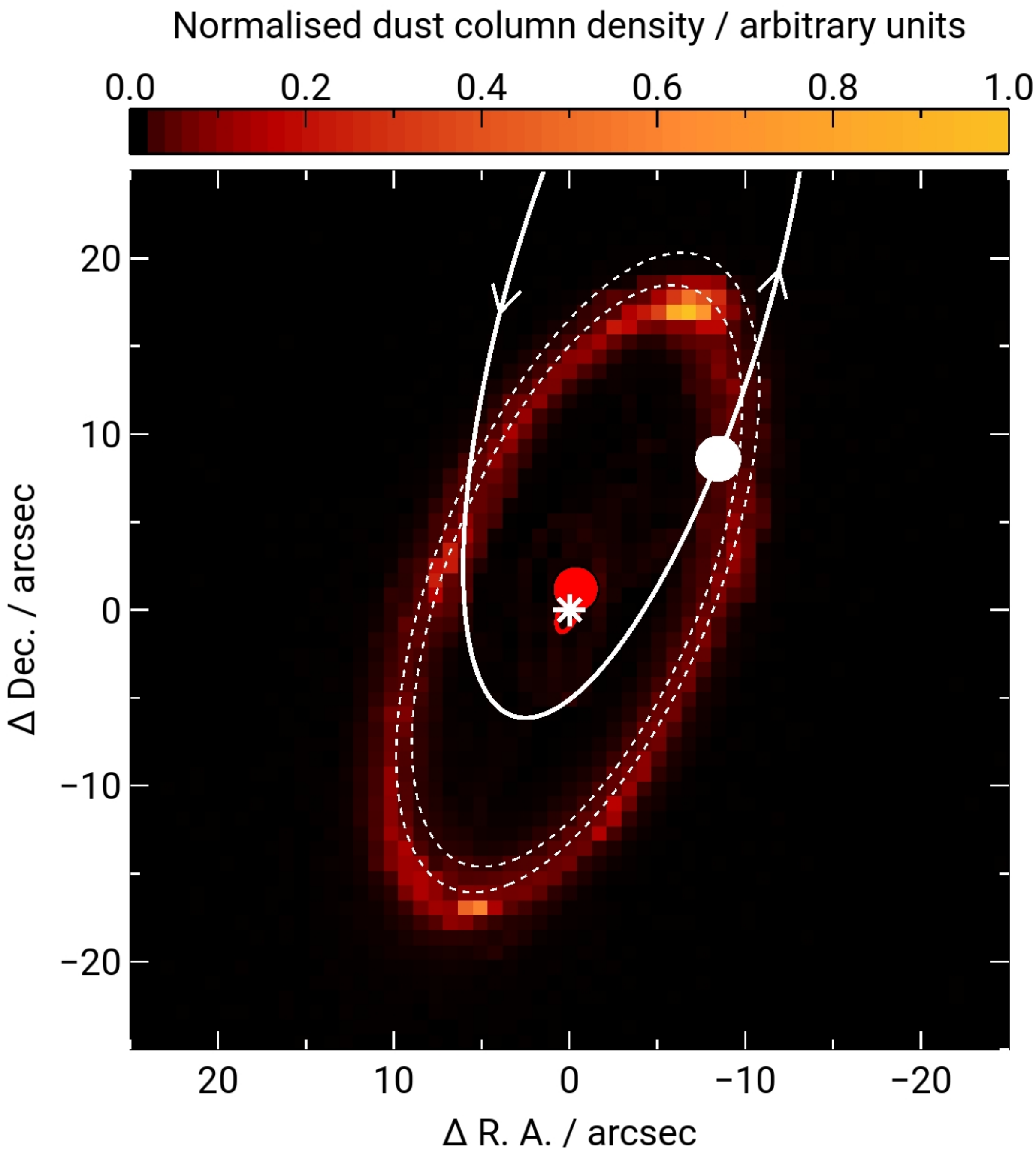

Figure 4: Predicted morphology of millimetre dust in the Fomalhaut system, if the parent bodies are in resonance with a Neptune-mass, coplanar Fomalhaut b on one particular observationally-allowed orbit. The white circle, solid white line and asterisk are Fomalhaut b, its orbit, and the star, respectively. The red circle and red line are a hypothetical inner planet and its orbit, respectively, and the dashed white lines are the FWHM edges of the observed disc. The (unseen) resonant parent bodies occupy orbits similar to the simulated dust ring, and are stable for the stellar lifetime despite crossing the orbit of a massive, eccentric Fomalhaut b. These large resonant bodies would have a clumpy distribution, but dust released in collisions between them would have the relatively smooth morphology shown.

Orbital misalignment of the super-Earth π Men c with the spin of its star

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Monthly Notices of the Royal Astronomical Society, published (2021MNRAS.502.2893K)

Planet-planet scattering events can leave an observable trace of a planet's migration history in the form of orbital misalignment with respect to the stellar spin axis, which is measurable from spectroscopic timeseries taken during transit. We present high-resolution spectroscopic transits observed with ESPRESSO of the close-in super-Earth π Men c. The system also contains an outer giant planet on a wide, eccentric orbit, recently found to be inclined with respect to the inner planetary orbit. These characteristics are reminiscent of past dynamical interactions. We successfully retrieve the planet-occulted light during transit, and find evidence that the orbit of π Men c is moderately misaligned with the stellar spin axis with $\lambda = 24.0 \pm 4.1$ deg ($\psi = 26.9^{+5.8}_{-4.7}$ deg). This is consistent with the super-Earth π Men c having followed a high-eccentricity migration followed by tidal circularisation, and hints that super-Earths can form at large distances from their star. We also detect clear signatures of solar-like oscillations within our ESPRESSO radial velocity timeseries, where we reach a radial velocity precision of $\sim$20 cm s^{-1}. We model the oscillations using Gaussian processes and retrieve a frequency of maximum oscillation, $\nu_{\rm max} = 2771^{+65}_{-60}\,\mu$Hz. These oscillations makes it challenging to detect the Rossiter-McLaughlin effect using traditional methods. We are, however, successful using the *reloaded* Rossiter-McLaughlin approach. Finally, in an Appendix we also present physical parameters and ephemerides for π Men c from a Gaussian process transit analysis of the full TESS Cycle 1 data.

Download/Website: `https://arxiv.org/abs/2007.11564`

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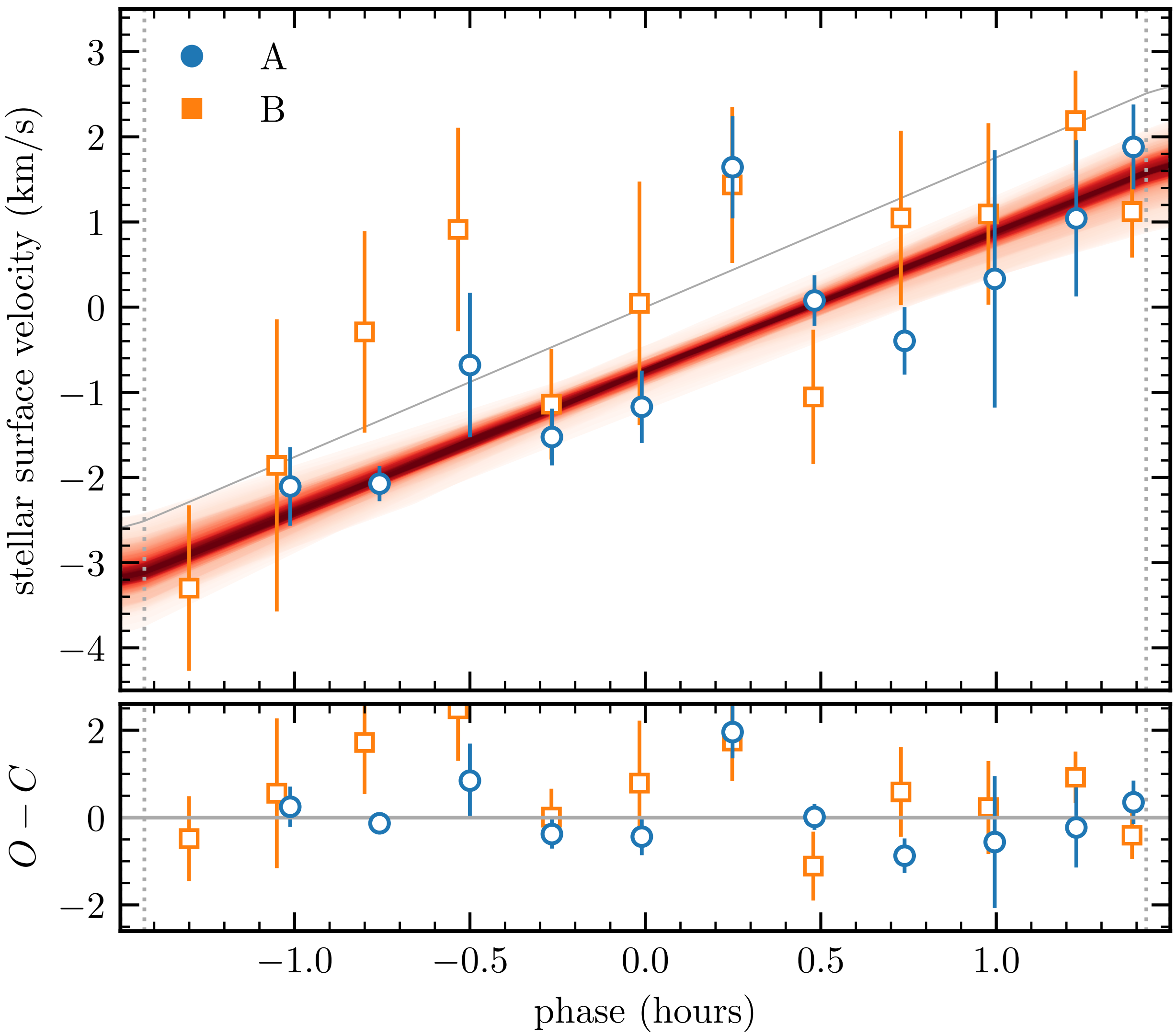

Figure 5: *Upper panel:* The local surface velocities obtained from fitting Gaussian profiles to the in-transit residual CCFs, shown as blue circles and orange squares for runs A and B, respectively. The red shaded area denote the 50th – 99th percentiles of the models generated from the posterior distribution of the fit. As a reference, the grey line denotes the $\lambda = 0^\circ$ line, which shows that alignment is firmly rejected. *Lower panel:* The residuals from the best-fitting model.

The Hawaii Infrared Parallax Program. V. New T-Dwarf Members and Candidate Members of Nearby Young Moving Groups

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The Astrophysical Journal, in press (arXiv:2102.05045)

We present a search for new planetary-mass members of nearby young moving groups (YMGs) using astrometry for 694 T and Y dwarfs, including 447 objects with parallaxes, mostly produced by recent large parallax programs from UKIRT and *Spitzer*. Using the BANYAN Σ and LACEwING algorithms, we identify 30 new candidate YMG members, with spectral types of T0$-$T9 and distances of $10 - 43$ pc. Some candidates have unusually red colors and/or faint absolute magnitudes compared to field dwarfs with similar spectral types, providing supporting evidence for their youth, including 4 early-T dwarfs. We establish one of these, the variable T1.5 dwarf 2MASS J21392676+0220226, as a new planetary-mass member ($14.6^{+3.2}_{-1.6}$ $M_{\rm Jup}$) of the Carina-Near group (200 ± 50 Myr) based on its full six-dimensional kinematics, including a new parallax measurement from CFHT. The high-amplitude variability of this object is suggestive of a young age, given the coexistence of variability and youth seen in previously known YMG T dwarfs. Our four latest-type (T8$-$T9) YMG candidates, WISE J031624.35 + 430709.1, ULAS J130217.21 + 130851.2, WISEPC J225540.74 $-$ 311841.8, and WISE J233226.49 $-$ 432510.6, if confirmed, will be the first free-floating planets ($\approx 2 - 6$ $M_{\rm Jup}$) whose ages and luminosities are compatible with both hot-start and cold-start evolutionary models, and thus overlap the properties of the directly-imaged planet 51 Eri b. Several of our early/mid-T candidates have peculiar near-infrared spectra, indicative of heterogenous photospheres or unresolved binarity. Radial velocity measurements needed for final membership assessment for most of our candidates await upcoming 20–30 meter class telescopes. Finally, we compile all 15 known T7$-$Y1 benchmarks and derive a homogeneous set of their effective temperatures, surface gravities, radii, and masses.

Download/Website: `https://ui.adsabs.harvard.edu/abs/2021arXiv210205045Z/abstract`

Contact: `zhoujian@hawaii.edu`

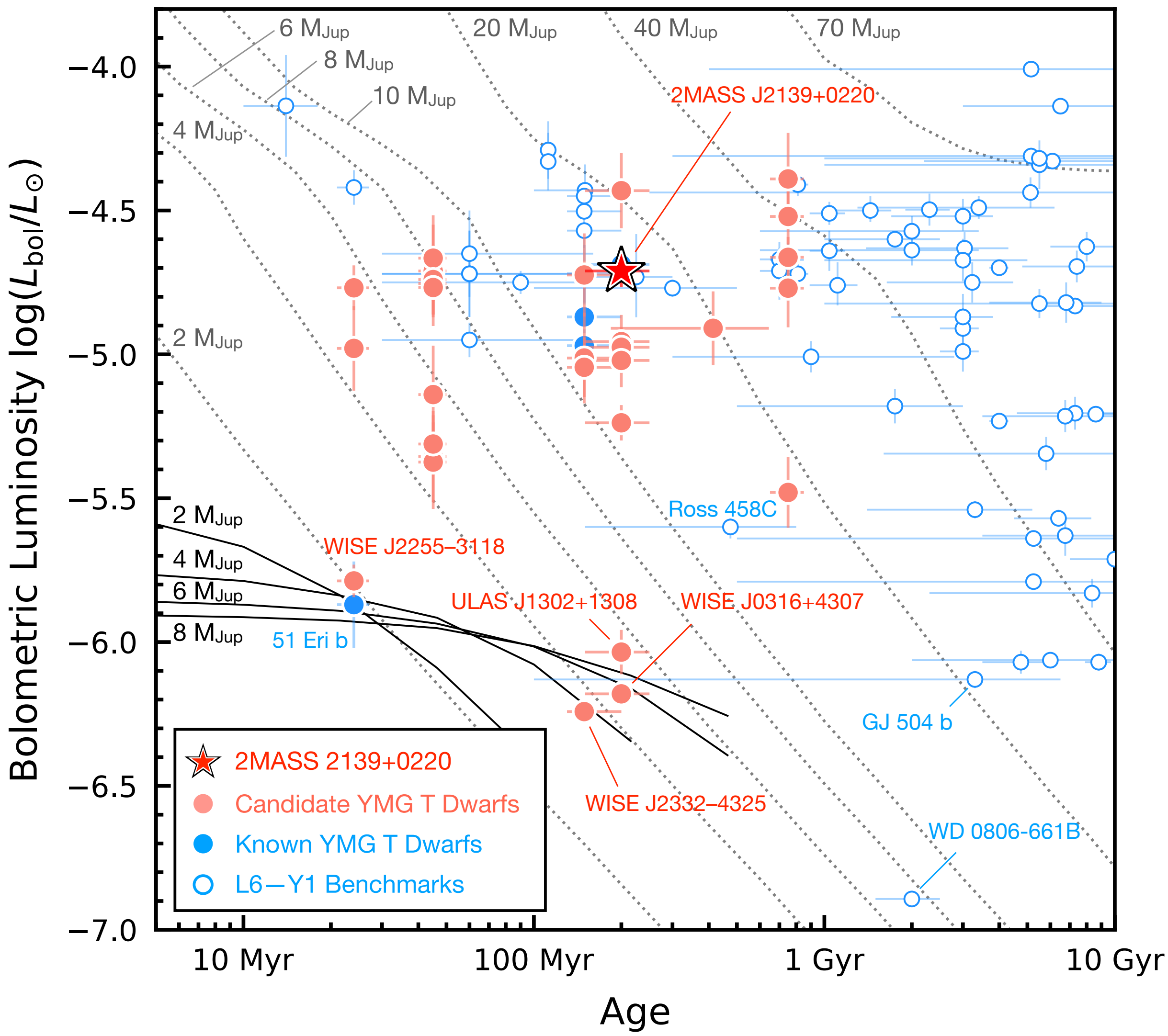

Figure 6: Derived bolometric luminosities and ages of our identified candidates (light red), by assuming they are all YMG members. We use the red star to mark our newly confirmed Carina-Near member 2MASS J2139 + 0220 and use blue solid circles for our recovered YMG T dwarfs. We overlay the L6−Y1 benchmarks (blue open circles) compiled by Zhang et al. (2020) and this work (Tables 4 and 5), the hot-start Saumon & Marley (2008) hybrid evolutionary models (dashed grey lines), and the cold-start Fortney et al. (2008) evolutionary models (black solid lines). We find WISE J0316 + 4307 (T8), WISE J2255 − 3118 (T8), ULAS J1302 + 1308 (T8.5), and WISE J2332 − 4325 (T9) are all potential analogs of 51 Eri b, having much fainter $L_{\rm bol}$ than the other benchmark ultracool dwarfs with similar ages.

3 Jobs and Positions

Postdoc position in numerical methods for exoplanet spectral calculations

Paul Mollière

APEx department, Max Planck Institute for Astronomy, Heidelberg, Job start no later than Jan 1, 2022

We invite applications for a 3-year postdoctoral research position in the APEx Department of the Max Planck Institute for Astronomy, Heidelberg (www.mpia.de). APEx is a new department, founded in 2020 to characterize the atmospheric physics and chemistry of extrasolar planets.

The successful applicant will work with Paul Mollière on the in-house radiative transfer and retrieval code for exoplanet atmospheres (petitRADTRANS, see https://petitradtrans.readthedocs.io/), with a special focus on preparing the code for the analysis of data taken with the next-generation telescopes such as JWST and the ELTs. Necessary calculations will be mostly performed on the computing clusters of MPIA or the high-performance computing clusters (CPU & GPU) of the Max Planck Society (https://www.mpcdf.mpg.de).

The specific goals of the position are:

- to streamline and optimize the code's structure,
- to enable the code to quickly calculate spectra from 3-d atmospheric structures at both low and high spectral resolution,
- to optimize the code's performance, also making use of GPU acceleration.

While the focus of this position is mainly on code development, the successful applicant may also contribute to exoplanet characterization studies carried out at the department. The successful applicant can dedicate 20% of their time to pursuing independent research projects. The position can be filled immediately, with an ideal starting date no later than Jan 1, 2022.

- Applicants do not need prior experience in the field of exoplanets.
- must have a Ph.D. in astronomy, astrophysics, or a related field.
- should have extensive experience with numerical methods, programming skills in Python, and a compiled language such as C/C++/Fortran.
- ideally have prior experience with high-performance computing or GPU acceleration, but this experience can also be acquired while working in the advertised position.

Details on the position and how to apply can be found here:
https://jobregister.aas.org/ad/204a6c54
The deadline for submission is April 23, 2021.
Any inquiries about the position can be send to molliere@mpia.de.

The Max Planck Society is an equal opportunity employer, and we particularly welcome applicants from groups who have been traditionally underrepresented in astronomy. The MPIA supports its employees in their search for suitable childcare. For questions concerning promoting and monitoring equal opportunity for all MPIA employees, please contact Thavisha Dharmawardena (dharmawardena@mpia.de) and regarding disabilities Ralf Launhardt (rl@mpia.de). Both of them will keep any communications confidential.

Download/Website: `https://jobregister.aas.org/ad/204a6c54`
Contact: `molliere@mpia.de`

PhD position on tidal decay of hot Jupiters

Dr Alexis Smith
Institute of Planetary Research, German Aerospace Center (DLR), Rutherfordstr. 2, 12489 Berlin, Germany

Berlin, Germany, Summer 2021

The Institute of Planetary Research, which is part of the German Aerospace Center (DLR) is advertising a paid PhD studentship, funded by the German Research Foundation (DFG). The position is to work with Dr Alexis Smith in Berlin on the tidal decay of hot Jupiter exoplanets.

The deadline for applications is the 7th of April 2021. The successful applicant will be able to start in May 2021, although this is somewhat negotiable.

Full details of the position are available at the link below, and applications must be submitted though this webpage.

For informal questions, please contact Dr Alexis Smith.

Download/Website: `https://www.dlr.de/dlr/jobs/en/desktopdefault.aspx/tabid-10596/1003_read-4582`

Contact: `alexis.smith@dlr.de`

4 Announcements

ESA Archival Research Visitor Programme

Guido De Marchi

ESAC (Spain) and ESTEC (Netherlands), Autumn 2021 to Spring 2022

To increase the scientific return from its space science missions, the European Space Agency (ESA) welcomes applications from scientists interested in pursuing research projects based on data publicly available in the ESA Space Science Archives.

The ESA Archival Research Visitor Programme is open to scientists, at all career levels, affiliated with institutes in ESA Member States and Collaborating States. Early-career scientists (within 10 years of the PhD) are particularly encouraged to apply. PhD students are also welcome to apply through their supervisors.

During their stay, visiting scientists will have access to archives and mission specialists for help with the retrieval, calibration, and analysis of archival data. In principle, all areas of space research covered by ESA science missions can be supported.

Residence lasts typically between one and three months, also distributed over multiple visits. Research projects can be carried out at ESAC (Madrid, Spain) and at ESTEC (Noordwijk, Netherlands). To offset the expenses incurred by visitors, ESA covers travel costs from and to the home institution and provides support for lodging expenses and meals.

Applications received before 30 April 2021 will be considered for visits in autumn/winter (2021/2022).

For further details, including areas of research and contact information, please refer to the website and email address indicated below.

Download/Website: `http://www.cosmos.esa.int/web/esdc/visitor-programme`

Contact: `arvp@cosmos.esa.int`

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

Free registration for the 2021 Sagan Summer Workshop is now available on the workshop website.

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. The preliminary agenda is available on the workshop website.

The workshop will be held via Zoom webinar and Slack will be used to facilitate discussion before, during, and after the workshop. The workshop will consist of live and pre-recorded talks, live discussions, hands-on sessions, contributed online posters and poster sessions, 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. Please visit the workshop website to register and to view the agenda.

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

Contact: `sagan_workshop@ipac.caltech.edu`

Lectures on solar system formation available on-line

Alessandro Morbidelli[1]
[1] Observatoire de la Côte d' Azur, Nice, France

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I have prepared 3h of recorded lectures on Solar System formation for the school " Planets, exoplanets and their systems in a broad and multidisciplinary context" organized by the *Instituto de Astrofísica de Andalucía*. They are divided in two parts: the first on constraints and the second on models and scenarios. They are now available on-line at the addresses reported below.

Download/Website:
https://lagrange.oca.eu/images/LAGRANGE/pages_perso/morby/LaraSchool-morbidelli-partI.mp4
https://lagrange.oca.eu/images/LAGRANGE/pages_perso/morby/LaraSchool-Morbidelli-PartII.mp4

Contact: morby@oca.eu

5 As seen on Exoplanet-talks.org

Download/Website: `http://exoplanet-talks.org`

Contact: `info@exoplanet-talks.org`

Instruction video: http://exoplanet-talks.org/talk/164
Direct imaging of protoplanets - Recent results and future perspectives by *Valentin Christiaens* – talk/264
Hemispheric Tectonics on super-Earth LHS 3844b by *Tobias Gabriel Meier* – talk/263
Chemical composition of exoplanetary atmospheres due to pebble and planetesimal accretion by *Aaron Schneider* – talk/262
The high energy environment and atmospheric escape of small exoplanets by *Leonardo dos Santos* – talk/261
Confirmation of Asymmetric Iron Absorption in WASP-76b with HARPS by *Aurora Kesseli* – talk/260
The nature of the Radius Valley: insights from combined formation and evolution models by *Julia Venturini* – talk/259
The French Participation to the ESA Ariel Mission by *Pierre Drossart* – talk/258
[extended] A faint companion around CrA-9: protoplanet or obscured binary? by *Valentin Christiaens* – talk/257

6 Exoplanet Archives

February 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, March 16, 2021

February 18, 2021

Twelve Planets Added, Including TOI-178 System

This week we welcome 12 new members to the confirmed planet club, including the six-planet TOI-178 system believed to have one of the most complex resonance chains ever observed.

The new planets are: NGTS-13 b, HD 110113 b & c, TOI-178 b, c, d, e, f, & g, HD 4760 b, HD 96992 b, and TYC 0434-04538-1 b.

Check out the new planetary data in the Planetary Systems Table (gamma) (`http://bit.ly/2Pt0tM1`) and its companion table, Planetary Systems Composite Parameters (beta) (`https://bit.ly/2Fer9NU`), which offers a more complete table of planet parameters combined from multiple references and calculations. The Confirmed Planets, Composite Planet Data, and Extended Planet Data interactive tables are also currently updated with new planetary and stellar data, but will be retired in late March 2021. See this Transition document (`https://bit.ly/3jLgrhl`) and the Archive 2.0 Release Notes (`https://bit.ly/3rVQPTx`) for more information.

Download/Website: `https://exoplanetarchive.ipac.caltech.edu`
Contact: `mharbut@caltech.edu`

7 As seen on astro-ph

astro-ph/2102.00052: **Phase curve and variability analysis of WASP-12b using TESS photometry** by *Niall Owens et al.*

astro-ph/2102.00074: **Water Production Rate of C/2020 F3 (NEOWISE) from SOHO/SWAN over Its Active Apparition** by *M.R. Combi et al.*

astro-ph/2102.00203: **A Heavy Molecular Weight Atmosphere for the Super-Earth Men c** by *A. García Muñoz et al.*

astro-ph/2102.00211: **Neutral metals in the atmosphere of HD149026b** by *Masato Ishizuka et al.*

astro-ph/2102.00220: **Influence of Biomass Emissions upon Habitability, Biosignatures and Detectability in Earth-like Atmospheres** by *Stefanie Gebauer et al.*

astro-ph/2102.00465: **Terrestrial Exoplanet Simulator (TES): an error optimal planetary systems integrator that permits close encounters** by *Peter Bartram, Alexander Wittig*

astro-ph/2102.00715: **Ejby – A new H5/6 ordinary chondrite fall in Copenhagen, Denmark** by *H. Haack et al.*

astro-ph/2102.00775: **Spiral structures in gravito-turbulent gaseous disks** by *W. Béthune, H. Latter, W. Kley*

astro-ph/2102.00939: **Steady State by Recycling prevents Premature Collapse of Protoplanetary Atmospheres** by *T. W. Moldenhauer et al.*

astro-ph/2102.01077: **A Note on Planet Size and Cooling Rate** by *Johnny Seales, Adrian Lenardic*

astro-ph/2102.01081: **On a Possible Solution to the Tidal Realignment Problem for Hot Jupiters** by *Kassandra R. Anderson, Joshua N. Winn, Kaloyan Penev*

astro-ph/2102.01095: **Confirmation of Asymmetric Iron Absorption in WASP-76b with HARPS** by *Aurora Y. Kesseli, I.A.G. Snellen*

astro-ph/2102.01110: **Dust Transport in Protoplanetary Disks with Wind-driven Accretion** by *Zitao Hu, Xue-Ning Bai*

astro-ph/2102.01125: **Revisiting the Planet Mass and Stellar Metallicity Relation for Low-Mass Exoplanets Orbiting GKM Class Stars** by *Jonathan H. Jiang et al.*

astro-ph/2102.01230: **A thermophysical and dynamical study of the Hildas (1162) Larissa and (1911) Schubart** by *C. F. Chavez et al.*

astro-ph/2102.01559: **Preliminary mission profile of Hera's Milani CubeSat** by *Fabio Ferrari et al.*

astro-ph/2102.01715: **The Demographics of Wide-Separation Planets** by *B. Scott Gaudi*

astro-ph/2102.01835: **Icy Exomoons Evidenced by Spallogenic Nuclides in Polluted White Dwarfs** by *Alexandra E. Doyle, Steven J. Desch, Edward D. Young*

astro-ph/2102.01890: **KMT-2018-BLG-1025Lb: microlensing super-Earth planet orbiting a low-mass star** by *Cheongho Han et al.*

astro-ph/2102.01910: **A Search for Optical Laser Emission from Proxima Centauri** by *Geoffrey W. Marcy*

astro-ph/2102.02130: **Constraining the surface properties of Helene** by *Carly J.A. Howett, Emilie Royer*

astro-ph/2102.02216: **Ring Formation in Protoplanetary Disks Driven by an Eccentric Instability** by *Jiaru Li et al.*

astro-ph/2102.02220: **Memories of past close encounters in extreme trans-Neptunian space: Finding unseen planets using pure random searches** by *C. de la Fuente Marcos, R. de la Fuente Marcos*

astro-ph/2102.02222: **Two Massive Jupiters in Eccentric Orbits from the TESS Full Frame Images** by *Mma Ikwut-Ukwa et al.*

astro-ph/2102.02233: **The Habitable-zone Planet Finder Detects a Terrestrial-mass Planet Candidate Closely Orbiting Gliese 1151: The Likely Source of Coherent Low-frequency Radio Emission from an Inactive Star** by *Suvrath Mahadevan et al.*

astro-ph/2102.02303: **Jetting during oblique impacts of spherical impactors** by *Shigeru Wakita et al.*

astro-ph/2102.02312: **Eigenstates of Quasi-Keplerian Self-Gravitating Particle Discs** by *Walker Melton, Konstantin Batygin*

astro-ph/2102.02316: **Dust Traps and the Formation of Cavities in Transition Discs: A millimetre to sub-millimetre comparison survey** by *Brodie J. Norfolk et al.*

astro-ph/2102.02362: **Resolving the History of Life on Earth by Seeking Life As We Know It on Mars** by *Christopher E. Carr*

astro-ph/2102.02843: **Host-star and exoplanet compositions: a pilot study usinga wide binary with a polluted white dwarf** by *Amy Bonsor et al.*

astro-ph/2102.02874: **Radiative scale-height and shadows in protoplanetary disks** by *Matías Montesinos et al.*

astro-ph/2102.03007: **Constraining Protoplanetary Disk Accretion and Young Planets Using ALMA Kinematic Observations** by *Ian Rabago, Zhaohuan Zhu*

astro-ph/2102.03194: **Detecting Atmospheric Molecules of Temperate Terrestrial Exoplanets using High-Resolution Spectroscopy in the Mid Infrared Domain** by *Yuka Fujii, Taro Matsuo*

astro-ph/2102.03230: **Formation conditions of Titan and Enceladus' building blocks in Saturn's circumplanetary disk** by *Sarah Anderson, Olivier Mousis, Thomas Ronnet*

astro-ph/2102.03255: **3-D climate simulations for the detectability of Proxima Centauri b** by *Daniele Galuzzo et al.*

astro-ph/2102.03387: **The HARPS search for southern extra-solar planets XLV. Two Neptune mass planets orbiting HD 13808: a study of stellar activity modelling's impact on planet detection** by *E. Ahrer et al.*

astro-ph/2102.03427: **Observable Predictions from Perturber-coupled High-eccentricity Tidal Migration of Warm Jupiters** by *Jonathan M. Jackson et al.*

astro-ph/2102.03433: **Cyanogen, cyanoacetylene, and acetonitrile in comet 67P and their relationship to the cyano radical** by *N. Hänni et al.*

astro-ph/2102.03454: **The Sizes and Albedos of Centaurs 2014 YY 49 and 2013 NL 24 from Stellar Occultation Measurements by RECON** by *Ryder H. Strauss et al.*

astro-ph/2102.03459: **A Rapid Method For Orbital Coverage Statistics With J2 Using Ergodic Theory** by *Andrew J. Graven, Alan H. Barr, Martin W. Lo*

astro-ph/2102.03480: **Aerosols in Exoplanet Atmospheres** by *Peter Gao et al.*

astro-ph/2102.03899: **Observational Signatures of Tightly Wound Spirals Driven by Buoyancy Resonances in Protoplanetary Disks** by *Jaehan Bae, Richard Teague, Zhaohuan Zhu*

astro-ph/2102.04385: **Search for (sub)stellar companions of exoplanet hosts by exploring the second ESA-Gaia data release** by *K.-U. Michel, M. Mugrauer*

astro-ph/2102.04648: **Characterizing the dust content of disk substructures in TW Hya** by *Enrique Macias et al.*

astro-ph/2102.04666: **Global Climate Model Occultation Lightcurves Tested by August 2018 Ground-Based Stellar Occultation** by *Sihe Chen et al.*

astro-ph/2102.04772: **The curse of clouds** by *Joanna K. Barstow* astro-ph/2102.05009: **Theoretical constraints imposed by gradient detection and dispersal on microbial size in astrobiological environments** by *Manasvi Lingam*

astro-ph/2102.05027: **Nitrogen Dioxide Pollution as a Signature of Extraterrestrial Technology** by *Ravi Kopparapu et al.*

astro-ph/2102.05045: **The Hawaii Infrared Parallax Program. V. New T-Dwarf Members and Candidate Members of Nearby Young Moving Groups** by *Zhoujian Zhang et al.*

astro-ph/2102.05064: **Hot Jupiters: Origins, Structure, Atmospheres** by *Jonathan J. Fortney, Rebekah I. Dawson, Thaddeus D. Komacek*

astro-ph/2102.05076: **The Reflectance of Cold Classical Trans-Neptunian Objects in the Nearest Infrared** by *Tom Seccull, Wesley C. Fraser, Thomas H. Puzia*

astro-ph/2102.05159: **Imaging low-mass planets within the habitable zone of Centauri** by *K. Wagner et al.*

astro-ph/2102.05305: **Cloud Parameterizations and their Effect on Retrievals of Exoplanet Reflection Spectroscopy** by *Sagnick Mukherjee, Natasha E. Batalha, Mark S. Marley*

astro-ph/2102.05353: **Limits on the presence of planets in systems with debris disks: HD 92945 and HD 107146** by *D. Mesa et al.*

astro-ph/2102.05384: **Haze seasonal variations of Titan's upper atmosphere during the Cassini Mission** by *Benoît Seignovert et al.*

astro-ph/2102.05420: **HATS-34b and HATS-46b: Re-characterisation Using TESS and Gaia** by *Emma M. C. Louden, Joel D. Hartman*

astro-ph/2102.05601: **No Evidence for Orbital Clustering in the Extreme Trans-Neptunian Objects** by *K. J. Napier et al.*

astro-ph/2102.05672: **The Pictoris b Hill sphere transit campaign. Paper I: Photometric limits to dust and rings** by *M. A. Kenworthy et al.*

astro-ph/2102.05763: **Impact of photochemical hazes and gases on exoplanet atmospheric thermal structure** by *Panayotis Lavvas, Anthony Arfaux*

astro-ph/2102.05808: **Relative occurrence rates of terrestrial planets orbiting FGK stars** by *Sheng Jin*

astro-ph/2102.05905: **ALMA Observations of the Asymmetric Dust Disk around DM Tau** by *Jun Hashimoto et al.*

astro-ph/2102.06031: **Dynamical orbital evolution scenarios of the wide-orbit eccentric planet HR 5183b** by *Alexander J. Mustill et al.*

astro-ph/2102.06049: **TESS Hunt for Young and Maturing Exoplanets (THYME) IV: Three small planets orbiting a 120 Myr-old star in the Pisces–Eridanus stream** by *Elisabeth R. Newton et al.*

astro-ph/2102.06066: **TESS Hunt for Young and Maturing Exoplanets (THYME) V: A Sub-Neptune Transiting a Young Star in a Newly Discovered 250 Myr Association** by *Benjamin M. Tofflemire et al.*

astro-ph/2102.06173: **Formation of Venus, Earth and Mars: Constrained by isotopes** by *H. Lammer et al.*

astro-ph/2102.06209: **Estimate on dust scale height from ALMA dust continuum image of the HD 163296 protoplanetary disk** by *Kiyoaki Doi, Akimasa Kataoka*

astro-ph/2102.06338: **Exploring HNC and HCN line emission as probes of the protoplanetary disk temperature** by *Feng Long et al.*

astro-ph/2102.06523: **A survey of exoplanet phase curves with Ariel** by *Benjamin Charnay et al.*

astro-ph/2102.06574: **Fireball characteristics derivable from acoustic data** by *Luke McFadden et al.*

astro-ph/2102.06664: **Vortex structures and electron beam dynamics in magnetized plasma** by *V.I. Maslov et al.*

astro-ph/2102.06683: **On the stickiness of CO2 and H2O ice particles** by *Sota Arakawa, Sebastiaan Krijt*

astro-ph/2102.06754: **Precise transit and radial-velocity characterization of a resonant pair: a warm Jupiter TOI-216c and eccentric warm Neptune TOI-216b** by *Rebekah I. Dawson et al.*

astro-ph/2102.06914: **Evidence for post-nebula volatilisation in an exo-planetary body** by *John H. D. Harrison, Oliver Shorttle, Amy Bonsor*

astro-ph/2102.07338: **OGLE-2018-BLG-0567Lb and OGLE-2018-BLG-0962Lb: Two Microlensing Planets through Planetary-Caustic Channel** by *Youn Kil Jung et al.*

astro-ph/2102.07634: **Thermal alteration of CM carbonaceous chondrites: mineralogical changes and metamorphic temperatures** by *Ashley J. King, Paul F. Schofield, Sara S. Russell*

astro-ph/2102.07671: **Normal forms for the Laplace resonance** by *Giuseppe Pucacco*

astro-ph/2102.07677: **A backward-spinning star with two coplanar planets** by *Maria Hjorth et al.*

astro-ph/2102.07837: **A Readily Implemented Atmosphere Sustainability Constraint for Terrestrial Exoplanets Orbiting Magnetically Active Stars** by *Evangelia Samara, Spiros Patsourakos, Manolis K. Georgoulis*

astro-ph/2102.07898: **On the Correlation between Hot Jupiters and Stellar Clustering: High-Eccentricity Migration Induced by Stellar Flybys** by *Laetitia Rodet, Yubo Su, Dong Lai*

astro-ph/2102.07963: **Protoplanetary disk formation from collapse of prestellar core** by *Yueh-Ning Lee, Sébastien Charnoz, Patrick Hennebelle*

astro-ph/2102.08066: **Exoplanets Prediction in Multiplanetary Systems** by *Mahdiyar Mousavi-Sadr, Ghassem Gozaliasl, Davood M. Jassur*

astro-ph/2102.08133: **Characterisation of 92 Southern TESS Candidate Planet Hosts and a New Photometric [Fe/H] Relation for Cool Dwarfs** by *Adam D. Rains et al.*

astro-ph/2102.08282: **Persephone: A Pluto-System Orbiter and Kuiper Belt Explorer** by *Carly Howett et al.*

astro-ph/2102.08300: **Analysis of NASA's DSN Venus Express radio occultation data for year 2014** by *Edoardo Gramigna et al.*

astro-ph/2102.08392: **Metastable Helium Reveals an Extended Atmosphere for the Gas Giant HAT-P-18b** by *Kimberly Paragas et al.*

astro-ph/2102.08472: **Titan: Earth-like on the Outside, Ocean World on the Inside** by *Shannon M. MacKenzie et al.*

astro-ph/2102.08488: **On the Capture of Interstellar Objects by our Solar System** by *K. J. Napier, F. C. Adams, K. Batygin*

astro-ph/2102.08611: **A pebble accretion model for the formation of the terrestrial planets in the Solar System** by *Anders Johansen , Thomas Ronnet , Martin Bizzarro , Martin Schiller , Michiel Lambrechts , Åke Nordlund , Helmut Lammer*

astro-ph/2102.08612: **Can planets be pushed into a disc inner cavity by a resonant chain?** by *S. Ataiee, W. Kley*

astro-ph/2102.08781: **Disk Evolution Study Through Imaging of Nearby Young Stars (DESTINYS): Late infall causing disk misalignment and dynamic structures in SU Aur** by *C. Ginski et al.*

astro-ph/2102.08839: **Higher Compact Multiple Occurrence Around Metal-Poor M-Dwarfs and Late K-Dwarfs** by *Sophie G. Anderson et al.*

astro-ph/2102.08902: **HD 76920b pinned down: a detailed analysis of the most eccentric planetary system around an evolved star** by *C. Bergmann et al.*

astro-ph/2102.08965: **A Near-Infrared Chemical Inventory of the Atmosphere of 55 Cancri e** by *Emily K. Deibert et al.*

astro-ph/2102.08978: **K2-138 g: Spitzer Spots a Sixth Planet for the Citizen Science System** by *Kevin K. Hardegree-Ullman et al.*

astro-ph/2102.09155: **Simulations of Dynamical Gas-Dust Circumstellar Disks: Going Beyond the Epstein Regime** by *Olga P. Stoyanovskaya et al.*

astro-ph/2102.09304: **The Impact of a Stealth CME on the Martian Topside Ionosphere** by *Smitha V. Thampi et al.*

astro-ph/2102.09424: **Planets Across Space and Time (PAST). I. Characterizing the Memberships of Galactic Components and Stellar Ages: Revisiting the Kinematic Methods and Applying to Planet Host Stars** by *Di-Chang Chen et al.*

astro-ph/2102.09441: **A super-Earth on a close-in orbit around the M1V star GJ 740. A HADES and CARMENES collaboration** by *B. Toledo-Padrón et al.*

astro-ph/2102.09570: **The Physics of Falling Raindrops in Diverse Planetary Atmospheres** by *Kaitlyn Loftus, Robin Wordsworth*

astro-ph/2102.09577: **The TW Hya Rosetta Stone Project IV: A hydrocarbon rich disk atmosphere** by *L. Ilsedore Cleeves et al.*

astro-ph/2102.10144: **NEOExchange – An online portal for NEO and Solar System science** by *T. A. Lister et al.*

astro-ph/2102.10288: **A faint companion around CrA-9: protoplanet or obscured binary?** by *V. Christiaens et al.*

astro-ph/2102.10326: **Automated identification of transiting exoplanet candidates in NASA Transiting Exoplanets Survey Satellite (TESS) data with machine learning methods** by *Leon Ofman et al.*

astro-ph/2102.10595: **Constraints on the latitudinal profile of Jupiter's deep jets** by *E. Galanti et al.*

astro-ph/2102.11311: **A Pluto–Charon Concerto II. Formation of a Circumbinary Disk of Debris After the Giant Impact** by *Scott J. Kenyon, Benjamin C. Bromley*

astro-ph/2102.11399: **The Manifold Of Variations: impact location of short-term impactors** by *Alessio Del Vigna, Linda Dimare, Davide Bracali Cioci*

astro-ph/2102.11463: **OGLE-2018-BLG-1428Lb: a Jupiter-mass planet beyond the snow line of a dwarf star** by *Yun-Hak Kim et al.*

astro-ph/2102.11534: **Statistical analysis of fireballs: Seismic signature survey** by *T. Neidhart et al.*

astro-ph/2102.11640: **Mass and density of the transiting hot and rocky super-Earth LHS 1478 b (TOI-1640 b)** by *M. G. Soto et al.*

astro-ph/2102.11675: **Oxygen as a control over 2.4 billion years of Earth's atmospheric evolution** by *Gregory Cooke et al.*

astro-ph/2102.11688: **Cloud property trends in hot and ultra-hot giant gas planets (WASP-43b, WASP-103b, WASP-121b, HAT-P-7b, and WASP-18b)** by *Ch. Helling et al.*

astro-ph/2102.11760: **The rotational and divergent components of atmospheric circulation on tidally locked planets** by *Mark Hammond, Neil T. Lewis*

astro-ph/2102.11837: **Fast 2-impulse non-Keplerian orbit-transfer using the Theory of Functional Connections** by *Allan K. de Almeida Junior et al.*

astro-ph/2102.11875: **A coplanar circumbinary protoplanetary disk in the TWA 3 triple M dwarf system** by *Ian Czekala et al.*

astro-ph/2102.11990: **Surface Gravity of Rotating Dumbbell Shapes** by *Wai-Ting Lam, Marian Gidea, Fredy R Zypman*

astro-ph/2102.12011: **Finding Signs of Life in Transit: High-resolution Transmission Spectra of Earth-like Planets around FGKM Host Stars** by *Lisa Kaltenegger, Zifan Lin*

astro-ph/2102.12346: **On the stellar clustering and architecture of planetary systems** by *V. Adibekyan et al.*

astro-ph/2102.12444: **The Chemical link between stars and their rocky planets** by *Vardan Adibekyan et al.*

astro-ph/2102.12506: **New Mid-Infrared Imaging Constraints on Companions and Protoplanetary Disks around six Young Stars** by *D. J. M. Petit dit de la Roche et al.*

astro-ph/2102.12537: **Collision rates of planetesimals near mean-motion resonances** by *Spencer C. Wallace, Thomas. R. Quinn, Aaron C. Boley*

astro-ph/2102.12831: **MRI-active inner regions of protoplanetary discs. I. A detailed model of disc structure** by *Marija R. Jankovic et al.*

astro-ph/2102.12854: **Linking Zonal Winds and Gravity II: explaining the equatorially antisymmetric gravity moments of Jupiter** by *Wieland Dietrich et al.*

astro-ph/2102.13521: **The 2018 Martian Global Dust Storm over the South Polar Region studied with MEx/VMC** by *J. Hernández-Bernal et al.*

astro-ph/2102.00044: **Multi-Wavelength Photometry Derived from Monochromatic Kepler Data** by *Christina Hedges et al.*

astro-ph/2102.01697: **Mapping stellar surfaces II: An interpretable Gaussian process model for light curves** by *Rodrigo Luger, Daniel Foreman-Mackey, Christina Hedges*

astro-ph/2102.01774: **starry**$_{p}rocess : InterpretableGaussianprocessesforstellarlightcurves\ by$***Rodrigo Luger, Daniel Foreman***

astro-ph/2102.01999: Precise radial velocities of giant stars XV. Mysterious nearly periodic radial velocity variations in the eccentric binary Cygni by *Paul Heeren et al.*

astro-ph/2102.02225: Water in star-forming regions (WISH): Physics and chemistry from clouds to disks as probed by Herschel spectroscopy by *E.F. van Dishoeck (Leiden), L.E. Kristensen (Copenhagen), the WISH team (50 co-authors)*

astro-ph/2102.02324: The SPIRou wavelength calibration for precise radial velocities in the near infrared by *M. J. Hobson*

astro-ph/2102.02815: Backyard Worlds: Planet 9 Discovery of an Unusual Low-mass Companion to an M Dwarf at 80 pc by *Austin Rothermich et al.*

astro-ph/2102.04328: Magnetic field amplification by the Weibel instability at planetary and astrophysical high-Mach-number shocks by *Artem Bohdan et al.*

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