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6. Dynamics
7. Instrumentation / Future
8. Habitability & Astrobiology
9. Machine Learning / Techniques / Methods

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Lili Alderson (University of Bristol). *LRG-BEASTS: Ground-based Detection of Sodium and a Steep Optical Slope in the Atmosphere of the Highly Inflated Hot-Saturn WASP-21b*. **1.1**	We present the optical transmission spectrum of the highly inflated Saturn-mass exoplanet WASP-21b, using three transits obtained with the ACAM instrument on the William Herschel Telescope through the LRG-BEASTS survey (Low Resolution Ground-Based Exoplanet Atmosphere Survey using Transmission Spectroscopy). Our transmission spectrum covers a wavelength range of 4635-9000Å, achieving an average transit depth precision of 197ppm compared to one atmospheric scale height at 246ppm. Whilst we detect sodium absorption in a bin width of 30Å, at >4 sigma confidence, we see no evidence of absorption from potassium. Atmospheric retrieval analysis of the scattering slope indicates that it is too steep for Rayleigh scattering from H2, but is very similar to that of HD189733b. The features observed in our transmission spectrum cannot be caused by stellar activity alone, with photometric monitoring and Ca H&K analysis of WASP-21 showing it to be an inactive star. Our work demonstrates that WASP-21b is an excellent target for future infra-red observations to constrain its atmospheric metallicity, and could be a key comparison planet to the JWST Early Release Science Program target WASP-39b.
Nora Bailey (University of Chicago). *Period Ratio Sculpting Near Second-Order Mean-Motion Resonances*. **6.1**	Second-order mean-motion resonances lead to an interesting phenomenon in the sculpting of the period ratio distribution due to their shape and width in period-ratio/eccentricity space. As the osculating periods librate in resonance, the time-averaged period ratio approaches the exact resonance location. The width of second order resonances increases with increasing eccentricity, and thus more eccentric systems have a stronger peak at the resonance location when averaged over sufficient time. The libration period is short enough that this time-averaging behavior is expected to appear on the timescale of the Kepler mission. In this talk, I will present results obtained from N-body integrations of simulated planet pairs near the 5:3 and 3:1 mean-motion resonances. I will demonstrate how these results constrain the eccentricity distributions of real Kepler planets near second-order resonance, placing an upper limit on the Rayleigh scale parameter, σ, at $\sigma = 0.245$ (3:1) and $\sigma = 0.095$ (5:3) at 95% confidence.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Corey Beard (University of California, Irvine). *AO Follow Up for High Value HPF Targets*. **4.1**	Abstract: With the advent of TESS and the discovery of thousands of TESS Objects of Interest (TOIs), Adaptive Optics (AO) observations of stars have become a vital tool for ruling out close companions. Binary star systems are extremely common in the Milky Way, and frequently masquerade as transiting exoplanets, or as radial velocity (RV) signatures. AO observations are a fast way of ruling out such close-companion explanations, and allow us to push forward with RV results, with confidence. Our team uses the Habitable-Zone Planet Finder (HPF) for RV follow up of many interesting planet candidates, and I have developed a pipeline that reduces AO data taken at Lick Observatory to compliment these efforts. This AO data has proven for multiple systems that AO data still has great value in ruling out close companions. I will introduce the concepts of AO image reduction, the generation of contrast curves, and the ruling out of close companions. I will spend most time highlighting some interesting HPF targets that have used Shane AO data in their analysis, or will use it in the near future.
Hayley Beltz (University of Michigan). *Exploring the effects of active magnetic drag in a GCM of Ultra-Hot Jupiter WASP-76b*. **1.2**	Ultra-hot Jupiters represent an exciting avenue for testing extreme physics and observing atmospheric circulation not found in our solar system. These high temperatures result in ionized particles moving through the atmosphere, generating magnetic fields in the planet. Until now, treatment of magnetic drag in 3D models of ultra-hot Jupiters has been uniform drag timescales applied evenly throughout the planet. In this work, we apply our locally calculated active magnetic drag treatment in our GCM of the planet WASP-76b. We find the effects of this treatment to be most visible in the upper atmosphere, with strong differences between the day and night side circulation. This treatment of magnetic drag will help aide our understanding of the atmospheric circulations of ultra-hot Jupiters.
Galen Bergsten (University of Arizona). *Kepler's Planet Radius Valley as a Function of Stellar Mass*. **5.1**	The "radius valley" is a feature in the short-period, small exoplanet population (in Kepler and K2 data) showing an abundance of super-Earths and mini-Neptunes, with a relatively scarce population of intermediate-sized planets between the two. Several studies explore the radius valley's dependence on host star properties, specifically stellar age and mass, with a wide range of treatments to the population of small close-in planets. Correcting for survey/vetting biases without the unnecessary removal of data is essential to studying the true distribution of small planets and their host stars. We employ updated stellar properties and implement refined measures of completeness and reliability to observe how the Kepler small planet population varies as a function of stellar mass. These results are extrapolated into the Habitable Zone, placing an estimate on the occurrence rate of habitable, Earth-like planets that still retain their atmospheres. We further attempt to constrain the degree of stripped cores "contaminating" the super-Earth population as a function of period. Our ongoing efforts connect these findings to planetary evolution, and will help constrain models of photoevaporation and core powered mass loss.
Ell Bogat (NASA GSFC / CRESST II / SURA). *Predictions for High-Contrast Imaging of Confirmed Exoplanets with the Nancy Grace Roman Space Telescope*. **T**	The Nancy Grace Roman Space Telescope Coronagraph Instrument (CGI) will expand the range of directly imaged exoplanets to cold Jovian analogs observed in reflected visible light. In this talk, we share predictions for the mass and orbit retrieval of such planets using CGI. We have modeled the relative astrometry and fluxes of a preliminary "shortlist" of confirmed exoplanets that are favorable target candidates for CGI. For planets whose exact mass and orbit inclination are unknown (as is the case with most planets discovered through radial velocity measurements), we model a range of inclination cases from 20- to 90-degrees and infer the remainder of the orbital parameters necessary for modeling. For each planet and inclination case, we analyze the simulated data assuming only a few available observation epochs. By comparing the "true" planet parameters to the "measured" parameters that we extract, we predict the ability of the Roman CGI to perform orbit and mass retrieval of the target planet in the ideal case. We aim to evaluate the best known planets to image during the 5-year prime mission of the Roman Space Telescope, and to provide insight into the geometrical constraints of exoplanet characterization and orbit retrieval with direct imaging.

Name (Affiliation). *Title*. Where.	Abstract
Kiersten Boley (The Ohio State University). *Constraining the Metallicity required for Planet Formation*. **3.1**	Planet formation has been shown to be strongly correlated with host star metallicity, which is thought to be a proxy for disk solids. Observationally, previous works have indicated that planets preferentially form around stars with solar and super solar metallicities. Given these findings, it is challenging to form planets within metal-poor environments, particularly for hot Jupiters that are thought to form via metallicity-dependent core accretion. We present a study of hot Jupiters around metal-poor stars to understand how the lack of metals stifles planet formation. Previous studies on this topic have been limited due to small sample sizes. However, with the vast amount of high-quality data sets from TESS, it is now possible to probe planet occurrence in the metal-poor regime. We use a large sample of halo stars observed by TESS to constrain the upper limit of hot Jupiter occurrence within the metal-poor regime ($-2.0 \leq$ [Fe/H] ≤ -0.6). Placing the most stringent upper limit on hot Jupiter occurrence, we found the mean 1-σ upper limit to be 0.19 % for radii 0.8 -2 RJ and periods 0.5–10 days. This result is consistent with previous predictions indicating that there exists a certain metallicity below which no planets can form.
Alice Booth (Leiden Observatory). *An inherited complex organic reservoir in a warm planet-hosting disk*. **3.9**	Quantifying the composition of the material in protoplanetary disks is paramount to determine the potential for exoplanetary systems to produce and support habitable environments. A key complex organic molecule (COM) to detect is methanol (CH3OH). CH3OH primarily forms at low temperatures on the surface of icy dust grains and is a necessary basis for the formation of more complex species like amino acids and proteins. We report the detection of CH3OH in the planet-hosting disk around a Herbig star. The disk is warm and therefore does not host a significant CO ice reservoir. We argue that the CH3OH cannot form in situ and that the disk, therefore, had to inherit COMs rich ice from an earlier cold dark cloud phase. This is strong evidence that at least some of the organic material survives the disk formation process and can then be incorporated into forming planets, moons and comets.
Peter Braunschweig (UMBC/GSFC/CRESST II). *Near-UV Transit Observation of Hot Jupiters with Swift*. **1.3**	Hot Jupiters under extreme flux from their host stars can exhibit mass loss and an extended atmosphere that can be detected by transit observations in the near-UV. We present observations of WASP-121 b and other hot giant planets using the Swift Ultraviolet/Optical Telescope (UVOT) in the UVM2 band (λc = 2246 Å). We compare the near-UV transit depths to new optical observations with the Transiting Exoplanet Survey Satellite (TESS). In some cases, the data suggest a deeper transit, but not to a significant degree due to the low precision of the Swift observations. For WASP-121b, higher precision NUV measurements with the HST have already confirmed a deeper transit. Further observations will be needed to confirm deeper transits of the other planets. Our results demonstrate the utility of the UVOT as a tool to study transiting hot Jupiters.
Garett Brown (University of Toronto). *Quantifying the Effects of Weak Stellar Flybys on the Solar System*. **6.4**	The architecture and evolution of planetary systems are shaped in part by stellar flybys. The strength and frequency of stellar flybys vary over system lifetimes as local stellar environments mature. Within this context, we look at flyby encounters which are too weak to immediately destabilize a planetary system but are nevertheless strong enough to measurably perturb a system's dynamical state. We estimate the strength of such perturbations on a secularly evolving system using a simple analytic model and confirm those estimates with direct N-body simulations. We then run long-term integrations of our own Solar System and show that even small perturbations from stellar flybys can significantly affect the stability of planetary systems over their lifetime. Due to the coupled nature of the Solar System, we find that small perturbations to Neptune's orbit cascade inward, increasing the likelihood that the inner Solar System will destabilize. We find that interactions which change the semi-major axis of Neptune by >0.03 AU are significantly more likely to destabilize the Solar System.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Aritra Chakrabarty (Indian Institute of Astrophysics). *Probing the Hot-Jupiter Atmospheres through Polarized Reflected Light*. **T**	Polarimetric studies of hot-Jupiters are gaining momentum in the exoplanet community as these studies provide an alternative way to probe their atmospheres. Atmospheric scattering causes the starlight reflected from a planet to be polarized in the optical and NIR region and the net disk-integrated polarization should be non-zero owing to the asymmetrical illumination of the planetary disk. In this talk, I will present a novel approach to calculate the azimuth-dependent reflected intensity vectors at each location on the planetary disk by solving the vector radiative transfer equations that describe the linear polarization as well as a numerical recipe to integrate those intensity vectors over the disc to get the reflected flux and its state of polarization. Our calculations incorporate self-consistent atmospheric models of exoplanets over a wide range of equilibrium temperature, surface gravity, atmospheric composition, and cloud structure. I will also present our models for the well-studied hot-Jupiter HD189733b for different chemical compositions and cloud structures, indicating the level of precision required by future observations to detect the polarization from this planet. The generic nature and the accuracy offered by our models make them an effective tool for modeling the future observations of the polarized light reflected from exoplanets.
Ryan Challener (University of Michigan). *A Three-Dimensional Exoplanet Eclipse Mapping Technique for the JWST Era*. **T**	Atmospheric retrieval and mapping are key tools to understanding the behavior of exoplanet atmospheres. Due to past and current data limitations, present analyses are one- or two-dimensional. These analyses can be biased, since exoplanet atmospheres are inherently three-dimensional, with at least dusk and dawn terminators, offset hotpots, day-night temperature contrasts, and poles. With the advent of JWST, a three-dimensional approach will be required to accurately model the data. Here, we present a method to vertically combine maximally-informative thermal maps, calculated individually from each spectral channel, to perform a simultaneous three-dimensional retrieval using spectroscopic eclipse observations. We discuss applications to synthetic observations of HD 209458 b, in preparation for JWST data. This software, once complete, will be made available as an open source tool for the community.
Greg Cooke (University of Leeds (UK)). *Oxygen's 2.4 billion year control on Earth's atmosphere with consequences for exoplanet biosignatures*. **8.1**	Since the Great Oxidation Event approximately 2.4 billion years ago, oxygen (O_2) concentrations have fluctuated until reaching modern day levels, with O_2 now comprising 21% of the atmosphere. Given the geological history of terrestrial bodies in the solar system, telescopes will likely find an exoplanet in a particular geological regime, with the Proterozoic being the longest geological period from Earth's history. Chemistry-climate simulations using the Whole Atmosphere Community Climate Model (WACCM) will be presented, where oxygen concentrations were altered from pre-industrial levels to possible Proterozoic levels of 10%, 1%, 0.5%, and 0.1% of the present atmospheric level. These simulations represent not only Earth through time, but possible Earth-analogue exoplanets that orbit a Sun-like (G-type) star. Reduced O_2 changes the chemical regimes for these atmospheres and lowers the ability for atmospheric CH_4 to accumulate. With a reduced O_3 shield, enhanced photolysis produces increased chemical destruction in a Proterozoic-like atmosphere, such that possible transmission spectra observations of these inhabited exoplanets will likely result in a false-negative (a null result) for detecting the presence of life. Thus, at least for transmission spectra, dedicated larger telescopes would be needed to confirm biosignatures on these Earth-analogue exoplanets during an equivalent Proterozoic-like period.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Miles Currie (University of Washington). *Informing planetary environmental context with the ELTs*. **1.4**	In the near future, we will be able to search for life, habitability, and evolved planetary climates on terrestrial exoplanets using extremely large ground-based telescopes (ELTs). The ELTs can access the visible and near infrared wavelengths, where the O2 bands are prominent, and will complement the James Webb Space Telescope's strength in longer wavelength molecule detection. Although O2 is the most readily detectable biosignature on an Earth-like world for high-resolution observations, using the ELTs to detect other environmental molecules or alternative biosignatures has not been fully explored. To better understand the accessibility of environmental context using ground-based telescopes, we simulate high-resolution observations of Earth-like atmospheres orbiting a range of M-dwarf hosts, ensuring photochemical consistency with each host star's spectral type. Using the cross-correlation technique, we determine the detectability of O2, O3, CH4, CO2, CO, and H2O in these atmospheres. We match the O2 detectability calculations of previous studies, and show that CH4 and CO2 are potentially accessible for nearby systems. Our results demonstrate that the upcoming ELTs could play a major role in terrestrial exoplanet characterization beyond O2 detection, and can inform observing strategies for future space-based direct imaging missions.
Fei Dai (Caltech). *TOI-1444b and a Comparative Analysis of the Ultra-short-period Planets with Hot Neptunes*. **T**	We report the discovery of TOI-1444b, a 1.4-$R_\oplus$ super-Earth on a 0.47-day orbit around a Sun-like star discovered by {\it TESS}. We measured planetary mass to be $3.87 \pm 0.71 M_\oplus$. TOI-1444b joins the growing sample of 17 ultra-short-period planets with measured masses and sizes, most of which are compatible with an Earth-like composition. We take this opportunity to examine the expanding sample of ultra-short-period planets ($<2R_\oplus$) and contrast them with the newly discovered sub-day hot Neptunes ($>3R_\oplus$ TOI-849 b, LTT9779 b and K2-100). We find that 1) USPs have predominately Earth-like compositions with inferred iron core mass fractions of 0.32$\pm$0.04; and have masses below the threshold of runaway accretion ($\sim 10M_\oplus$), while sub-day hot Neptunes are above the threshold and have H/He or other volatile envelope. 2) USPs are almost always found in multi-planet system consistent with a secular interaction formation scenario; hot Neptunes tend to be ``lonely''. 3) USPs occur around solar-metallicity stars while hot Neptunes are mainly found around higher metallicity stars. 4) In all these respects, the sub-day hot Neptunes show more resemblance to hot Jupiters than the smaller USP planets, although sub-day hot Neptunes are rarer than both USP and hot Jupiters by 1-2 orders of magnitude.
Zoe de Beurs (University of Texas at Austin). *Exoplanet Detection Using AI: Removing Stellar Activity Signals from Radial Velocity Measurements Using Neural Networks*. **T**	Exoplanet detection with precise radial velocity (RV) observations is currently limited by spurious RV signals introduced by stellar activity. Here we show that machine learning techniques (linear regression, neural networks) can effectively remove these activity signals from RV observations. Previous efforts have focused on carefully filtering out activity signals in time using Gaussian process regression (e.g. Haywood et al. 2014). Instead, we separate activity signals from true center-of-mass RV shifts using only changes to the average shape of spectral lines, and no information about when the observations were collected. We demonstrate our technique on simulated data, reducing the RV scatter from 82.0 cm/s to 3.1 cm/s, and on approximately 700 observations taken nearly daily over three years with the HARPS-N Solar Telescope, reducing the RV scatter from 1.47 m/s to 0.78 m/s (a 47% or factor of ≈ 1.9 improvement). In the future, these or similar techniques could remove activity signals from observations of stars outside our solar system and eventually help detect habitable-zone Earth-mass exoplanets around Sun-like stars. In this way, improvements in RV precision could significantly accelerate the characterization of habitable zone Earth-sized exoplanets.

Name (Affiliation). ***Title*****.** **Where.**	**Abstract**
Emily Deibert (University of Toronto). *A Near-Infrared Chemical Inventory of the Atmosphere of 55 Cancri e*. **T**	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, NH3, and C2H2 that may be present. Our results reduce the parameter space of possible atmospheres consistent with a previous 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.
Luciano del Valle (NPF (Nucleo Milenio de Formacion Planetaria)). *Water delivery: The effect of volatile evaporation propultion in planetesimals*. **T**	The amount of water on the early solar system (SS), at the moment of Earth formation, is believed to be relatively low in the inner SS. For this reason different mechanisms of water delivering toward Earth have been propose to explain the formation of its ocean. One possible mechanism to drive the migration of water bearing planetesimals from the outer region of the SS toward Esrth is the gravitational perturbation produced by the migration, and/or growth, of giant planets. We propose that a similar migratory effect can by achieve if its considered the recoil force, or thrust, due to the out-gassing of volatile elements that are buried on planetesimals. To explore the effect of this thrust force in the evolution of planetesimals of the SS we run a set of N-Body simulations. We show that the volatile thrust can drive outer planetesimals (a>2.5AU) toward the inner SS in a few Myrs. Also we show that even in the absence of giant planets the volatile thrust can feed the inner planets with enough water bearing planetesimals in order to form an ocean, which not only has important consequences for the SS but also for ocean formation in exoplanets.
Jiayin Dong (Penn State). *In Situ versus Disk Migration Origins of Warm Jupiters: Prediction on Nearby Companions*. **3.2**	More than two dozens of Warm Jupiters have been found with nearby companions, including many with a companion in/near orbital resonances. To understand the formation of such systems, we explore the in-situ and disk-driven migration origin channels of Warm Jupiters and how these two formation pathways affect the companion properties of Warm Jupiters. We simulate a disk of isolation mass embryos with either an inward migrating Jupiter or allowing one massive embryo to grow to a Jupiter mass planet. Using the N-body code REBOUND and REBOUNDx, we evolve the system for the protoplanetary disk stage and the stage after the disk dissipation. Our preliminary results show that Warm Jupiter migration enhances embryo collisions and produces Neptune-mass embryos trapped into its mean-motion resonance. In the poster, I will present the resulting planetary system architectures from the two scenarios and discuss the similarities/differences in the companion properties. I will also make predictions on the observed companion properties for the transit and radial-velocity surveys.
Lauren Doyle (University of Warwick). *Exoplanet demographics and detection: Mercury transit as a probe of solar variability and planetary architecture*. **T**	Characterising a star in great detail is vital for understanding exoplanets. This is because stellar physics can impact important exoplanet parameters such as radii, mass, and planet atmosphere determinations. Understanding the formation, migration and evolution of exoplanets is of fundamental importance when considering the existence of life outside our solar system. Furthermore, understanding stellar physics can be crucial when searching for low mass, long period planets (Earth-twins) due to signals being lost within stellar ‘noise’. In this talk, we will present our most recent results utilising the reloaded Rossiter-McLaughlin (RRM) technique on the 2016 Sun/Mercury transit with HARPS-N. The RRM uses transiting planets to probe and spatially resolve the star, investigating stellar properties such as differential rotation and centre-to-limb convective variations. By doing this we are able to measure the differential rotation and use it to decouple the projected equatorial velocity of the star, to measure the stellar inclination. We can combine this with the projected obliquity to determine the true 3D obliquity. Overall, the Sun/Mercury transit is a test (as we already know the solar and planetary properties) allowing for further validation of the method and will aid in exploring potential degeneracies.

Name (Affiliation). *Title*. Where.	Abstract
Christian Eistrup (MPIA, Heidelberg, Germany). *From Midplane to Planets - The Chemical Fingerprint of a Disk*. **T**	Since the dawn of times, humankind has wondered about the formation and volatile composition of planet atmospheres. Connecting the observed composition of exoplanets to their formation sites often involves comparing the observed planetary atmospheric carbon-to-oxygen (C/O) ratio to a disk midplane model with a fixed chemical composition. In this scenario, chemistry evolution in the midplane prior to and during the planet formation era is not considered. The C/O ratios of gas and ice in disk midplane are simply defined by volatile icelines in a midplane of fixed chemical composition. However, kinetic chemical evolution during the lifetime of the gaseous disk can change the relative abundances of volatile species, thus altering the C/O ratios of planetary building blocks. In my chemical evolution models, I utilize a large network of gas-phase, grain-surface and gas-grain interaction reactions, thus providing a comprehensive treatment of chemistry. In my talk, I will show how chemical evolution can modify disk midplane chemistry, and how this affects the C/O ratio of giant planet-forming material. I will argue that midplane chemical evolution needs to be addressed when predicting the chemical makeup of planets and their atmospheres.
Elizabeth Ellithorpe (University of Oklahoma). *Possible Origins of Planetary Spin-Orbit Misalignment in S-Type Binary Systems*. **6.2**	In the early stages of their lives, stars very often are part of a binary pair or a higher order multiple. Such a prevalence of binary systems means that they should be included in discussions of the evolution of exoplanetary systems. We utilize a hybrid symplectic integrator to evolve a system of s-type planets in a co-planar binary that is in turn evolved through an embedded cluster environment. In a non-negligible number of cases, the cluster perturbs the binary companion onto an eccentric orbit, causing an orbital instability in the 4 gas giants that we place around the primary. In addition to characterizing these instabilities, we also look at the changes in orbital architecture for the planetary systems that have undergone a loss of 1 or more planets. We find that there is a marked difference in the eccentricity and spin-orbit angle distributions of planetary systems that have undergone an instability compared to those that remain stable for the duration of our 10 Myr simulations. The preference for these unstable systems to occupy higher spin-orbit angles than their stable counterparts indicates that interactions with a binary companion could be a source of highly inclined hot jupiters seen in exoplanet observations.
Adina Feinstein (University of Chicago). *Disentangling Stellar Activity During a Transit of the 23 Myr Planet V1298 Tau c*. **T**	Young transiting exoplanets (< 100 Myr) provide crucial insight into atmospheric evolution. However, detailed transmission spectroscopy and measuring atmospheric mass loss is made even more challenging due to the general increased activity and prominent disk inhomogeneities present on young stars. Here, I will present spectroscopic observations of a full transit of V1298 Tau c, a 23 Myr planet orbiting a young solar analogue, from January, 2020. Through detailed analysis, we find evidence that V1298 Tau c is transiting at an active latitude. Additionally, we find that H-alpha smoothly decreases during the transit. While this could be a tentative detection of an extended young atmosphere, we find this variation is consistent with other young stars observed over six hours. We show this variation can also be explained by the presence of starspots and facular regions. More observations both in- and out-of the transits of V1298 Tau c are required to determine the nature of the H-alpha detection.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Dax Feliz (Vanderbilt University). *NEMESIS: Exoplanet Transit Survey of Nearby M-Dwarfs in TESS FFIs*. **T**	In this work, we present the analysis of 33,054 M-dwarf stars located within 100 parsecs in the Transiting Exoplanet Survey Satellite (TESS) Full Frame Images (FFIs) of the observed sectors 1 to 5. We present a new pipeline called NEMESIS which was developed to extract detrended photometry and perform transit searches of single sector data in TESS FFIs. As many M-dwarfs are faint and are not observed with a 2 minute cadence by TESS, FFI transit surveys can give an empirical validation of how many planets are missed by using the 30 minute cadence data. In this work, we detected 183 threshold crossing events and present 29 planet candidates for sectors 1 to 5, 24 of which are new detections. Our sample contains orbital periods ranging from 1.25 to 6.84 days and planetary radii from 1.26 to 5.31 Earth radii. With the addition of our new planet candidate detections along with previous detections observed in sectors 1 to 5, we calculate an integrated occurrence rate of 2.49 +/- 1.58 planets per star for the period range between [1,9] days and planet radius range between [0.5,11] Earth radii. We project an estimated yield of 122 +/- 11 transit detections of nearby M-dwarfs. 23 of our new candidates have Signal to Noise ratios > 7, Transmission Spectroscopy Metrics > 38 and Emission Spectroscopy Metrics > 10.
Laura Flagg (Rice University). *Hot Start Formation Implied by Detection of CO in CI Tau b*. **T**	We analyzed high resolution IR spectra of CI Tau, the host star of one of the few young planet candidates amenable to such observations. We confirm the planet's existence with a direct detection of CO in the planet's atmosphere. We determine a mass of 11.6 Mjup based on the amplitude of the planet's radial velocity variations. We estimate the planet's flux contrast with its host star to obtain an absolute magnitude estimate for the planet of 8.17 in the K band. This magnitude implies the planet formed via a "hot start" formation mechanism. This makes CI Tau b the youngest confirmed exoplanet as well as the first exoplanet around a T Tauri star with a directly determined, model-independent, dynamical mass.
Francesco Flammini Dotti (Xi'an Jiaotong-Liverpool University and University of Liverpool). *The role of the star cluster on planetary systems's dynamical evolution*. **6.3**	As most stars tends to aggregate in dense clusters, it is interesting to study the dynamics of planetary systems in these systems to explain the proprieties of the exoplanets found in our Galaxy. Using the NBODY6++GPU code for the star cluster dynamics and REBOUND for the planetary systems, integrated in the AMUSE environment, we present how Solar-like systems interact with the clustered environment. We use different clusters' initial conditions, changing virial ratio and stellar density, evolving all clusters for 50 Myr. The encounter strength, the relative velocity of the encountering star and the star cluster density are the main factors that alter the planetary system architecture. Since the Solar system is one of the most complex planetary system, we explore the influence of the star cluster on it. The entire planetary systems survive in the majority of cases, but other systems have either lost the most external planets, and others have lost all of them. However, in most cases, their orbital parameters result perturbated from their original configuration, and the secular evolution is slightly changed, in respect of the field star scenario.
Clémence Fontanive (CSH, University of Bern). *The Census of Exoplanets in Visual Binaries*. **4.2**	While numerous exoplanets have now been uncovered in stellar binaries, the impact of companion stars on planet formation and evolution is still not understood. From the Gaia DR2 catalog and an extensive literature search, we compiled the largest list to date of planets orbiting stars in visual comoving binaries out to 200 pc, providing a broad overview of exoplanets in resolved binary systems. In this talk, I will present results of raw population trends seen in the gathered compilation, which allows to investigate the multiplicity of planetary systems as a function of planet properties, and to understand the effects of binary properties on the resulting planetary architectures.
Searra Foote (Arizona State University). *The Search for Life*. **8.2**	The search for life is an interdisciplinary effort that requires an understanding of life on Earth, which includes characteristics of habitability, signs life produces, and the origin of life. This information, along with statistical analysis, allows for a more reliable search.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Rodolfo Garcia (University of Washington). *The potential for habitability after the runaway greenhouse phase for planets around low-mass stars*. **T**	The habitable zone around a low-mass star is not static. Many planets that currently orbit within their host star's habitable zone have lost water due to photodissociation from high XUV radiation from their host star in the past. Whether a planet is habitable after this runaway greenhouse phase depends both on how much water remains in the planetary system and whether greenhouse warming from atmospheric carbon dioxide prevents habitable surface temperatures. We simulate the interior thermal evolution of the planet to estimate abundances of water and carbon dioxide in the atmosphere from eruption rates. We also simulate the evolution of the host star to calculate the rate of water loss prior to the planet entering the habitable zone. We validate our model by reproducing the 92 bars of carbon dioxide and 30 ppm of water vapor observed in Venus' atmosphere today. We then apply this validated model to calculate the coupled atmosphere-interior evolution of the potentially habitable TRAPPIST-1 planets, assuming Earth-like compositions. We find that planets that have outgassed too much carbon dioxide during their runaway greenhouse phase will, despite being in the habitable zone, become Venus-like worlds with thick carbon dioxide atmospheres and no liquid water.
Tyler Gardner (University of Michigan). *ARMADA: A unique hunt for exoplanets and low-mass companions to hot stars*. **T**	Current exoplanet detection methods struggle to probe the planet occurrence rate around intermediate mass (>1.5 Msun) main-sequence stars. Weak and broad spectral lines make the radial velocity detection method difficult for main-sequence A and B-type stars. Long-baseline interferometry provides a feasible method for discovering giant planets in the ≈au regime given that the star is part of a binary system. One star can be used as an interferometric reference, making it possible to achieve ≈10 micro-arcsecond precision on relative position. This precision makes it possible to detect the "wobble" imparted on a star by an orbiting giant exoplanet. We present initial results of our ARMADA survey of hot binary stars with the MIRC-X instrument at the CHARA array and the GRAVITY instrument at VLTI. We discuss the limits our survey will place on how giant planet formation scales with stellar mass, as well as with binary separation.
Christian Gilbertson (Pennsylvania State University). *Improving the Sensitivity of Doppler Exoplanet Surveys by Jointly Modeling Telluric Features and Stellar Variability*. **T**	Recently, several extreme precision radial velocity (EPRV) spectrographs have been providing high-resolution and high signal-to-noise spectra with the express purpose of exoplanet discovery and characterization. A significant barrier to this endeavor is the existence of time-variable features in the spectra from both telluric absorption and stellar variability. Traditional methods discard significant portions of data to minimize the effects of telluric contamination, but new data-driven methods may enable the use of a larger fraction of the available data. While there exist methods for modeling out the telluric features (e.g. Bedell et al. 2019) or the stellar variability (e.g. Gilbertson et al. 2020) individually, there is a need for new tools that are capable of modeling them simultaneously. Here we present StellarSpectraObservationFitting.jl (SSOF), a Julia package for creating data-driven linear models for the time-variable spectral features in both the observer and observed frames. SSOF outputs estimates for the radial velocities, template spectra in both the observer and barycentric frames, and scores that quantify temporal variability of time-variable telluric and stellar features. The resulting model can be used to aid in mitigating remaining sources of correlated noise in the radial velocity time series and improving the effective precision of upcoming exoplanet surveys.

Name (Affiliation). *Title*. Where.	Abstract
Jennifer Greco (Uppsala University/SCAS). *Deriving Parameters of Ultracool Dwarfs Using High-Resolution Spectroscopy*. **4.3**	Ultracool dwarfs, a mix of the lowest mass stars and brown dwarfs (substellar object too low mass to initiate stable hydrogen fusion), are the lowest mass products of star formation. The lack of a stable internal energy source causes brown dwarfs to cool as they age, causing them to exhibit a mass-luminosity-age relation, which complicates efforts to measure their fundamental parameters (e.g. M, Teff). We have obtained the first high-resolution (R˜45,000) H- and K-band spectral sequence of ultracool dwarfs using the Immersion Grating INfrared Spectrometer (IGRINS). Our sequence spans the spectral types from M1.5V to T6, and includes known low-gravity objects at six spectral types ranging (M9, L0, L1, L2, L3, L5), which we plan to use to empirically search for gravity sensitive features. We have compared 22 of our objects to synthetic spectra created from the model atmospheres of Saumon & Marley (2008) to measure specific properties including effective temperature, cloud properties, rotational velocities, and surface gravity.
Bethan Gregory (University of St Andrews, Scotland). *Photochemical modelling of atmospheric O_2} confirms two steady states*. **1.5**	Observations and modelling of exoplanet atmospheres are exciting frontiers of current research, with oxygen, ozone and methane in combination considered a potential biosignature. An improved understanding of how these gases interact with one another and how their concentrations have evolved on Earth can aid understanding of their evolution in other planetary atmospheres. Ozone and O2 concentrations are closely related, as shown by previous 1-D photochemical models, which used fixed mixing ratio lower boundary conditions. Here, we revise the classic results using fixed flux lower boundary conditions in our photochemical model, and show a bimodal distribution for model Earth atmosphere solutions. Most solutions have either trace O2/O3 (pO2 < 6×10-7 atm) or high O2/O3 (pO2 > 2×10-3 atm) concentrations. This confirms previous biogeochemical modelling studies, suggesting that O2 levels in the window between may be unstable to small perturbations in flux, and therefore unlikely to have existed for long periods of time on Earth. We use these constraints to suggest that pO2 in the middle part of Earth's history may have been at least 1% of the present atmospheric level, which is higher than some geological evidence proposes. Our results demonstrate the importance of carefully prescribing model boundary conditions.
Arvind Gupta (Penn State). *Optimizing Radial Velocity Follow-up Strategies for Single-Transit Exoplanet Candidates*. **T**	The exoplanet yield of the ongoing TESS mission is expected to surpass that of Kepler, and the relatively bright stars observed by TESS will significantly enhance the potential of RV follow-up. Yet TESS is more sensitive to detection biases than its predecessor, as close to 75% of the sky coverage of the TESS primary mission has a continuous time baseline of just 27 days. In these regions of the sky, TESS will observe no more than a single transit for any exoplanet with an orbital period longer than a month. The orbital parameters that can be derived for these "single-transit planet candidates" (STPCs) will be poorly constrained relative to those derived for exoplanets observed to transit multiple times, posing a challenge for follow-up observations. But these long-period planets are nevertheless worth confirming and characterizing. Here, I present a framework for maximizing the efficiency of RV observations of STPCs. By leveraging information on exoplanet populations from Kepler, I show that it is possible to develop an informed follow up strategy even without strong constraints on the orbital period or eccentricity. I also highlight how this information can be used to design dynamic, adaptive observing schemes for queue-based instruments such as NEID.

Name (Affiliation). *Title*. Where.	Abstract
Justin Harrell (University of Delaware). *Improving the Lomb-Scargle Periodogram with Bronez Multitapers*. **T**	Modern exoplanet searching heavily relies on various adaptations of the Lomb-Scargle periodogram to ascertain the frequency information from unevenly sampled radial velocity measurements. The Lomb-Scargle periodogram suffers from strong spectral leakage, where it reports spurious variance estimations at a given frequency caused by relatively far-away frequencies, making it difficult to correctly extract planetary signals. We introduce an adapted version of the Bronez [1988] multitaper method for generating a much more accurate frequency-domain representation of radial velocity measurements. By using a set of multiple, orthogonal tapering functions, we can minimize the spectral leakage in frequency, obtain control over a bias vs variance trade-off, and produce spectra with high dynamic range. Because each taper provides an independent estimate of the power spectrum, we are also able to average over these estimates in leave-one-out fashion to generate confidence intervals on the power spectra. We will present multitaper power spectra of radial velocity and stellar activity measurements for 3 star systems and compare these with their Lomb-Scargle counterparts. We aim to demonstrate that our mitigation of spectral leakage provides optimal circumstances for the identification of planetary signals.
Kevin Hayakawa (UCLA). *Debris Rings from Extrasolar Irregular Satellites*. **3.3**	Irregular satellites are the minor bodies found orbiting all four Solar System giant planets with large semimajor axes, eccentricities, and inclinations. Previous studies have determined that the Solar System's irregular satellites are extremely collisionally evolved populations today, having lost ≈99% of their initial mass over the course of hundreds of Myr. In this paper, we show that circumstellar disks can result from the dust generated by these collisions. Radiation pressure, quantified by the parameter beta, is the driving force behind the liberation of dust grains from the planetary Hill sphere. Our simulated disks reproduce many of the same features seen in observed debris disks, such as thin ring morphology, a large blowout size, and azimuthal symmetry. We identify a critical intersection of (beta≈0.1, t≈10 years) that tells us the minimum size at which dust grains can exit the Hill sphere and how long it will take. Since a relation exists between beta, dust grain size, and observing wavelength, this also provides a future road map for observers. We find that our systems satisfy the definition of a narrow ring put forth by Hughes et al. (2018), $\Delta R / R < 0.5$.
Matthias He (Penn State). *The Conditional Occurrence of Planetary Companions to Transiting Exoplanets and their Impact on Radial Velocity Follow-up Observations*. **5.2**	Population studies of Kepler's multi-planet systems have revealed a great deal of structure in their underlying architectures. These population models can now be used to make predictions about the presence and properties of additional planets in systems with known transiting planets. Here, I will describe how we use a statistical model for the distribution of planetary systems to compute the conditional occurrence of planets given a Kepler-detectable planet. While unseen planets may potentially be discovered by radial velocity (RV) follow-up observations, they can also add a source of systematic error in efforts to fit the semi-amplitude (K) of the transiting planet. I will show that attempts to measure the K of the transiting planet when there are an unknown number of planets often requires significantly more observations than in the ideal case (when there are no additional planets). Planets around 10 day periods, common among the TESS planet candidates, with K comparable to the single-measurement RV precision typically require ≈100 observations to measure their K to within 20% error. These results highlight an important and previously unaccounted for source of error in measuring the masses of transiting planets with RV follow-up, which should be considered when planning RV surveys.

Name (Affiliation). *Title*. Where.	Abstract
Alexis Heitzmann (University of Southern Queensland). *Big baby planets around young, active stars*. **2.1**	Although our understanding of how planetary systems come to exist has drastically improved over the last two decades, there is still plenty of research to be made around the formation and evolution of massive, short-orbit exoplanets e.g. hot Jupiters, warm Neptunes. Do they form through migration mechanism or through in-situ formation? By better understanding the occurrence rates of these types of planets in every stage of a star's life, we can better understand their fate and hope to favor one formation/evolution mechanism over another. In this context, it is crucial to estimate the population of these weird planets around young stars. Unfortunately, probing young stars is notoriously difficult due to their strong magnetic activity (or 'jitter') inducing spurious radial velocity (RV) signals that often mask the planet(s) RV signature(s) used to detect them. I started my PhD by attempting to recover simulated planetary signatures hidden behind real stellar RV data exhibiting large jitter to grasp the limit of our capabilities. I now focus on characterizing real planetary systems around very young stars, gathering the most information possible about these systems such as planet mass, stellar behavior or obliquity and eccentricity of the system.
Katharine Hesse (MIT). *Title: TOIs from the First 10 Months of the TESS Extended Mission*. **5.3**	On July 4th 2020, TESS (Transiting Exoplanet Survey Satellite) completed its original two year prime mission, from which 2241 TOIs (TESS Objects of Interest) were alerted. There have been 354 TOIs alerted with data from the extended mission as of April 1st 2021, which is comparable to the 335 TOIs alerted within the first 10 months of the prime mission, and many more TOIs are anticipated. New TOIs from the extended mission are primarily fainter targets missed by the original 10.5 TESS magnitude threshold for vetting, low signal-to-noise targets with increased signal-to-noise from additional data, and single transits from Y1 with additional transits in Y3 allowing possible periods to be identified. Overall, the extended mission TOIs are similar to the prime mission TOIs in terms of period and radius distribution. The proportion of extended mission TOIs with longer periods and smaller radii is slightly larger than primary mission TOIs due to the longer observation baseline. As the extended mission progresses, this trend is expected to continue, allowing TESS to find more TOIs in this sparsely populated region of parameter space.
Rae Holcomb (UC Irvine). *Measuring Stellar Rotation Periods Using Automated Autocorrelation Analysis on TESS Light Curves*. **T**	As the astronomical community continues to search for small terrestrial planets near our detection limits, it becomes increasingly important to accurately characterize host star activity, particularly the stellar rotation. The Transiting Exoplanet Survey Satellite (TESS) provides photometric time series for hundreds of thousands of stars, making it possible for the first time to perform an all-sky survey of stellar rotation. I use autocorrelation analysis to create a robust and automated algorithm to measure the periods of fast rotators in the TESS sample. I use 2-minute cadence light curves from TESS Sectors 1-26 to search for rotation periods of <13 days among approximately 150,000 main-sequence stars of type G-M. I am able to positively identify rotation periods in agreement with rotation surveys performed on the Kepler field, thus demonstrating the potential of this method for extracting stellar parameters from large datasets with minimal supervision. The resulting sample of rotation periods provide a dataset to inform target selection for future planet searches, identify young systems for studies of planet formation, and correct for stellar activity signals during planet characterization.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Justin Hom (Arizona State University). *A Uniform Study of Directly Imaged Debris Disks*. **3.10**	Spatially resolved images of debris disks are necessary to determine disk geometric properties and the scattering phase function (SPF) which quantifies the brightness of scattered-light flux as a function of phase angle. The combination of high contrast and high angular resolution imaging is required to obtain these important aspects of debris disks, and we report on an adaptive optics 1.25-2.2 micron imaging survey of 17 high infrared excess debris disks observed with a Gemini Large and Long Program (LLP) utilizing the Gemini Planet Imager (GPI). The sample is composed of stars ranging in ages of 10-500 Myr and spectral types A-G. To-date, few SPF have been measured and no uniform study modeling the geometry and SPFs of even a sample of disks using a consistent methodology exists. These properties are both linked to the collisional state of the disk. We quantitatively explore geometric properties such as disk scale height and whether most debris disks are characterized by a similar SPF as suggested by previous studies. By determining the best-fitting models for these systems, the disk scale height and SPFs can be estimated and compared between host stars of different ages and masses, as well as examples from the Solar System.
Callie Hood (UC Santa Cruz). *High-Precision Abundances for Substellar Atmopsheres: Medium Resolution Retrieval of T9 Dwarf*. **4.4**	Brown dwarf spectra offer vital testbeds for our understanding of the chemical and physical processes that sculpt substellar atmospheres. Recently, atmospheric retrieval approaches have been successfully applied to a number of low-resolution (R≈100) spectra of T and Y dwarfs, yielding constraints on the abundances of chemical species and temperature structures of these atmospheres. Medium-resolution spectra of brown dwarfs may offer additional insight, as molecular features should be more easily disentangled from one another and the thermal structure of the upper atmosphere is more readily probed. Furthermore, kinematic information such as the radial and rotation velocities of these objects can be retrieved directly from the spectra. We present preliminary results from applying the CHIMERA retrieval framework to a high signal-to-noise, medium-resolution (R≈6000) FIRE spectrum of a T9 dwarf from 0.85-2.5 microns. At 60x higher spectral resolution than previous retrievals, a number of novel challenges arise, which we explore. We compare these retrieval results to those obtained for a R≈100 spectrum of the same object, revealing how constraints on atmospheric abundances greatly improve with increased spectral resolution. We discuss lessons learned from this work in preparation for JWST observations of substellar objects at medium (R≈2700) spectral resolution.
Ben Hord (University of Maryland, College Park/GSFC). *A Uniform Search for Nearby Planetary Companions to Hot Jupiters in TESS Data Reveals Hot Jupiters are Still Lonely*. **T**	We present the results of a uniform search for additional planets around all stars with confirmed hot Jupiters observed by the Transiting Exoplanet Survey Satellite (TESS) in its Cycle 1 survey of the southern ecliptic hemisphere. Our search comprises 189 total planetary systems with confirmed planets with Rp >4 Earth radii and orbital period <10 days. The Transit Least Squares (TLS) algorithm was utilized to search for periodic signals that may have been missed by other planet search pipelines. Our search yielded no new statistically-validated planetary candidates within P <14 days. A lack of planet candidates nearby hot Jupiters in the TESS data supports results from previous transit searches, now down to the photometric precision of TESS. This is consistent with expectations from a high eccentricity migration formation scenario, but additional formation indicators are needed for definitive confirmation. We injected transit signals into the hot Jupiter light curves to probe the detectable parameter space of potential planet signals using our pipeline and estimate an upper limit for the number of nearby companions in the overall hot Jupiter population. This study demonstrates how TESS uniquely enables comprehensive searches for nearby planetary companions to nearly all the known hot Jupiters.

Name (Affiliation). *Title*. Where.	Abstract
James Jackman (Arizona State University). *The Disconnect between UV and White-Light Flares in Low-Mass Stars*. **T**	Stellar flares are explosive phenomena that release radiation across the entire electromagnetic spectrum. The far-UV emission from flares can dissociate atmospheric species, abiotically generate biosignatures and exacerbate atmospheric erosion. Yet, the near-UV flux from flares may be necessary for the emergence of life on rocky planets around low-mass stars such as TRAPPIST-1. A detailed knowledge of the UV energies and rates of flares is therefore essential for our understanding of the habitability of exoplanets around low-mass stars. However, measurements of UV flare rates require expensive campaigns with HST. Because of this, current habitability studies use UV flare rates based on extrapolations from white-light optical surveys such as TESS. However, despite their use in contemporary habitability studies, such extrapolations are untested and their accuracy at any age or activity level remains unconstrained. To this end, we have combined TESS white-light and archival GALEX UV photometry for a set of M dwarfs to test the UV predictions of habitability studies. We will show how white-light flare studies underestimate the UV rates of flares, our work to try and correct for this effect, and the impact our results have on our current understanding of the UV environments of exoplanets around M dwarfs.
Jonathan Jackson (Penn State University). *Observable Predictions from High-eccentricity Migration of Warm Jupiters*. **T**	The origin of warm Jupiters (giant planets with periods between 10 and 200 days) is an open question in exoplanet science. I will report on our investigation of a particular migration theory in which a warm Jupiter is coupled to a perturbing companion planet that excites secular eccentricity oscillations in the warm Jupiter, leading to periodic close stellar passages that can tidally shrink and circularize its orbit. If such companions exist in warm Jupiter systems, they are likely to be massive and close-in, making them potentially detectable. We generate a set of warm Jupiter-perturber populations capable of engaging in high-eccentricity tidal migration and calculate the detectability of the perturbers. We show that a small percentage of these perturbers should be detectable in the Kepler lightcurves, but most should be detectable with precise radial velocity measurements over a 3-month baseline and Gaia astrometry. We find these results to be robust to the assumptions made for the perturber parameter distributions. If a high-precision radial velocity search for companions to warm Jupiters does not find evidence of a significant number of massive companions over a 3-month baseline, it will suggest that perturber-coupled high-eccentricity migration is not the predominant delivery method for warm Jupiters.
John Christy Johnson (University of Alberta). *Narrowing the List of Molecules as Potential Biosignature Gases for the Search for Life on Exoplanets*. **1.6**	Thousands of exoplanets orbit nearby stars and the possibility that one of them may contain extraterrestrial life should be explored. Earth’s atmospheric spectrum has a few characteristic gases (O2,CH4,N2O) and others are posited to appear on exo-Earths (e.g., dimethyl sulfide and CH3Cl). Seager et al. (2016) provided a list of potential biosignatures that could be examined to allow for the further narrowing of gases that could be valuable in determining exoplanet habitability and signs of life. Here, we build on this previous work by examining gas stability and volatility in Earth-like temperatures and pressures. This allows us to further refine the number of potential gases that are useful. We draw and expand upon two viable biosignature gases: Methyl chloride (CH3Cl) and dimethyl sulfide (CH3SCH3or DMS). The biggest limitation is this: the biochemistry and ecology of a potential biosignature vary even among Earth-life and so cannot be assumed to be the same on other worlds. 1. S. Seager, W. Bains and JJ. Petowski (2016). Toward a List of Potential Biosignature Gases for the Search for Life on Exoplanets and Applications to Terrestrial Biochemistry. Astrobiology 16(6): 465-85.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Peter Anto Johnson (University of Alberta). *Limitations of the TESS in characterizing the first habitable-zone Earth-sized planet*. **2.2**	Recently, the TOI-700 System was characterized as the first habitable-zone Earth-sized planet using Transiting Exoplanet Survey Satellite (TESS). Ground-based follow-up combined with diagnostic vetting and validation tests enables this system to rule out common astrophysical false-positive scenarios and validate the planetary data. However, TESS systems are restricted by a Nyquist limit that can interfere with internal structure data, especially at different oscillation modes. Another key limitation is the necessity of an ultra-stable light source for standardization purposes. Although several studies have shown promise, reliable data has yet to be validated. Reference: The First Habitable-zone Earth-sized Planet from TESS. I. Validation of the TOI-700 System" Gilbert EA, Barclay T, Schlieder JE, et al. (14 August 2020). The Astronomical Journal. DOI: 10.3847/1538-3881/aba4b2
Sinclaire Jones (Princeton University). *Precise Stellar Parameters in the Near-Infrared with HPF-SpecMatch*. **T**	In its all-sky survey of transiting exoplanets, the Transiting Exoplanet Survey Satellite (TESS) has detected thousands of transiting exoplanet candidates, most of which orbit nearby M-dwarf stars. In order to characterize these systems, ground based follow up is needed, which requires a precise characterization of the host star. Currently, the Habitable-zone Planet Finder (HPF)—a near-infrared spectrograph on the 10m Hobby-Eberly Telescope—is conducting the HPF-TESS program, an ongoing follow-up program to characterize promising transiting M-dwarf planet candidates from TESS. In this talk, I will discuss the HPF-SpecMatch code, a tool we developed to empirically determine stellar parameters (effective temperatures, metallicities, and surface gravities) using a library of as-observed stars with HPF, with a particular focus on M-dwarf systems. We have used HPF-SpecMatch to characterize the stellar properties of three TOI M-dwarf planet-hosting systems published by our team—including TOI-1266, a multi-planet system of two planets where one planet sits in the Exoplanet Radius Valley, and TOI-1899, the first warm Jupiter discovered orbiting an M-dwarf—with more systems in preparation. The code for HPF-SpecMatch will be made public in a forthcoming publication, opening doors for further accurate and precise characterizations of stars and their exoplanets using high-resolution near-infrared spectra.
Shubham Kanodia (The Pennsylvania State University). *Unearthing the dependence of exoplanet populations on stellar parameters using high dimensional nonparametric techniques*. **5.4**	With the advent of a new generation of instrumentation, we're developing the capabilities to measure precise planetary parameters for planets orbiting M dwarfs. In this presentation, I will discuss novel statistical techniques which leverage the precise measurements of planetary and stellar properties, by using nonparametric methods of modelling and inference. These models allow us to jointly model the exoplanet mass, radius, and insolation along with stellar mass and metallicity. In particular for the low mass M dwarfs, the dependence on stellar mass can be quite pronounced due to the large variation in stellar mass across the spectral sub type (≈ 6x - 7x). I will discuss a few examples of the application of this technique: in particular with respect to the trends seen in the Jupiter and Neptune planet populations with respect to different stellar parameters. Another such example is the change in radius-period gap with stellar mass, metallicity and insolation. These high dimensional frameworks offer a holistic approach to study the interdependence of various observed exoplanet and host stellar properties.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Marina Lafarga Magro (University of Warwick). *Mapping magnetic activity indicators across the M dwarf domain*. **2.3**	Stellar activity poses one of the main obstacles for the detection and characterisation of exoplanets around cool stars, as it can induce radial velocity (RV) signals that can hide or mimic the presence of companions. Several activity indicators are routinely used to identify activity-related signals in RV measurements, but not all indicators trace exactly the same effects, nor are any of them always effective in all stars. In this work, we evaluate the performance of a set of common spectroscopic activity indicators for 98 M dwarfs observed with CARMENES. We find that different indicators behave differently depending on the mass and activity level of the target star. In addition, we also observe that stars at the low-mass end of the sample show the lowest RV scatter, which could potentially hint at different manifestations of activity compared to higher-mass stars, as well as being better candidates for planet searches. Overall, our results show that when assessing the origin of an RV signal, it is critical to take into account a large set of indicators, or at least the most effective ones considering the characteristics of the star, as failing to do so may lead to false planet claims.
Ekaterina Landgren (Cornell University). *Introducing SWAMP-E: Shallow-Water Atmospheric Model in Python for Exoplanets*. **1.7**	Accurate modeling of exoplanet atmospheres can help inform and constrain observations. Current efforts to model exoplanet atmospheres primarily focus on minimal-complexity one-dimensional models, which miss some key atmospheric mechanisms, and high-complexity computationally expensive three-dimensional models. Therefore there is a natural gap for 2D shallow-water equations models. Many previous such models are built in Fortran, which makes them difficult to adapt to the needs of exoplanet science. Our model, SWAMP-E (Shallow-Water Atmospheric Model in Python for Exoplanets), can accurately and rapidly explore vast parameter space. The code is flexible, modular, built fully in Python, and could be easily adapted to model a variety of dissimilar space objects, from Brown Dwarfs to smaller, terrestrial planets. The Python code will produce the thermal maps necessary for the generation of phase curves and secondary eclipse maps, which will help constrain and make predictions for observations. We intend to make the code open-source to serve the planetary science community. Here I will present the circulation regimes we have explored in hot Jupiters and discuss plans for future exploration of smaller, cooler planets.
Alexis Lavail (Uppsala University, the Swedish Collegium for Advanced Study). *CRIRES+ at the 8-m Very Large Telescope: high-resolution near-infrared spectroscopy for you and me*. **7.1**	CRIRES+ is the fully refurbished and enhanced near-infrared CRyogenic high-resolution InfraRed Echelle Spectrograph (CRIRES) that is now offered to the entire astronomical community. CRIRES+ enables a variety of long awaited scientific opportunities, and its main science goal is the study of exoplanetary atmospheres. In this poster, I will present the capabilities of the instrument. CRIRES+ is an adaptive optics fed high-resolution (R=100000 or R=50000) near-infrared spectropolarimeter installed at a 8-m unit telescope of the Very Large Telescope in Paranal, Chile. CRIRES+ operates in spectroscopy mode from 0.95 to 5.2 µm (YJHKLM bands) and in spectropolarimetry mode between 0.95 and 2.5 µm (YJHK). The instrument boasts an overall increase in efficiency compared to the original CRIRES, a tenfold increase in simultaneous wavelength coverage (now ≈150 nm), and improved stability and repeatability. The upgrade comprises a new powerful pipeline as well as new wavelength calibration capabilities including new gas cells and a Fabry-Perot etalon The unique combination of the 8-m VLT collecting power, the R=100000 spectral resolution, and spectroscopic coverage up to 5.2 µm makes CRIRES+ a game-changing instrument for the study of exoplanetary atmospheres, stellar magnetism, low-mass objects, and other science cases.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Charles Law (Harvard University). *Chemical Structures in Protoplanetary Disks at 10 au scales: First results from the Molecules with ALMA at Planet-forming Scales (MAPS) Large Program*. **T**	Planets form and obtain their compositions in dust- and gas-rich disks around young stars. Dust substructure at the au-to-10 au scale is commonplace in these disks, as revealed by the DSHARP program, but far fewer observations have probed gas substructure at similar scales. To address this, I will present initial results from the Molecules with ALMA at Planet-forming Scales (MAPS) Large Program, which explores radial and vertical chemical structures at 10 au scales in five disks where dust substructure is detected and planet formation appears to be ongoing. The MAPS observations reveal a striking diversity in the radial morphologies of molecular line emission in protoplanetary disks. Chemical substructures are ubiquitous and extremely varied with a wide range of radial locations, widths, and depths. This suggests that planets form in diverse chemical environments both across disks and at different radii within the same disk. I will discuss the implications of these findings in the context of interactions between gas and dust substructures and the volatile and organic compositions of incipient planets. I will also provide some conclusions about what MAPS is teaching us about the chemistry of planet formation and how this relates to the observed diversity of known exoplanetary systems.
W. Garrett Levine (Yale University). *1I/2017 (`Oumuamua): A Solar System Small-Body Analogue, or an Exotic Object?*. **3.4**	1I/2017 (`Oumuamua), the first-detected interstellar interloper near the Earth, provided an unprecedented view of a small body that originated outside of the Solar nebula. Surprisingly, the large inferred Galactic population of similar objects from the detection of `Oumuamua at a geocentric distance of 0.16AU is in slight tension with current models of planetesimal production in protoplanetary disks. Furthermore, `Oumuamua's physical and dynamical properties do not fit within the current astronomical taxonomy and may demand an explanation outside of conventional avenues of exoplanetary system formation. One such interpretation is that `Oumuamua contained a component of molecular hydrogen ice. In this presentation, we discuss the compatibility of this substance with observations of `Oumuamua and examine the feasibility of building these objects. We focus on the starless cores of Giant Molecular Clouds, the only known environments which could reach the frigid conditions necessary for hydrogen ice deposition. Via energy balances arguments, simple analytic and numerical models of accretion, and the classic Kolmogorov framework of turbulence, we characterize the possibilities for growth and barriers to assembly in size regimes ranging from micron-sized dust to required kilometer-scale progenitors of `Oumuamua. Finally, we provide predictions on interstellar objects relevant to the Vera Rubin Observatory.
Andrea Lin (Pennsylvania State University). *The NEID Solar Feed: Observing the Sun as an Exoplanet Host Star*. **T**	The newest generations of EPRV (extreme-precision radial velocity) instruments are reaching levels of precision where the primary factor limiting detection of small planets is no longer instrumental but rather astrophysical in origin. Stellar spectroscopic variability as a result of convective and magnetic activity can produce quasi-periodic RV variations at the m/s level, completely drowning out small-amplitude planetary signals. An increasingly popular method for addressing these challenges is to observe the Sun -- the most well-characterized star by far -- with small solar telescopes coupled to these instruments, producing rich and homogeneous data sets with which to test strategies and algorithms for mitigating stellar activity as well as instrumental systematics. We have built a solar feed system to carry out these "Sun-as-a-star" observations with NEID, the new EPRV instrument on the WIYN 3.5m at Kitt Peak National Observatory, and we will soon be releasing the solar data publicly for the community to use. In this presentation, I will discuss the design, deployment, and operation of the NEID solar feed, as well as RV results from the first few months of operation.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Emma Louden (Yale University). *Back of the Book Answers: Using the Sun to Explore the Effects of Starspots on Spectra*. **T**	The EXtreme PREcision Spectrograph (EXPRES) controls instrumental errors resulting in an instrumental precision of 4-7 cm/s. Our on-sky velocity measurements contain radial velocities from planets, p-modes, and granulation. In theory, activity signals are imprinted in the star in a different way than orbital signals. The Sun presents a case where we can closely monitor spatial inhomogeneities with SDO and simultaneously use a solar feed to EXPRES. This project makes use of the unique dataset presented by EXPRES solar spectra to determine if we can see the impact of starspots in the spectra. Being able to disentangle stellar activity from orbital signals is essential for the future of exoplanet detection and by using this close to home test case we can learn exactly if/how starspot show up in the spectra.
Jack Lubin (University of California, Irvine). *TESS-Keck Survey V: Masses of Three Sub-Neptunes Orbiting HD 191939 and the Discovery of a Warm Jovian Plus a Distant Sub-Stellar Companion*. **T**	We present HD191939 (TOI-1339), which hosts three transiting planets discovered by the TESS mission. The planets have periods of 9, 29, and 38 days each with similar sizes from 3 to 3.4 Earths. To further characterize the system, we measured the radial velocity (RV) of HD191939 over 415 days with Keck/HIRES and APF/Levy. We find M_b = 10.4 +/- 0.9 and M_c = 7.2 +/- 1.4 Earths, which are low compared to most known planets of comparable radii. The RVs yield only an upper-limit on M_d (<5.8 Earths at 2 sigma). The RVs further reveal a fourth planet with a minimum mass of 0.34 +/- 0.01 Jupiters and an orbital period of 101.4 +/- 0.4 days. Despite its non-transiting geometry, secular interactions indicate that planet e is nearly coplanar (Inclination < 10 degrees). We identify a second non-transiting sub-stellar companion with a mass of 2-43 Jupiters and period of 4.5-35 Earth years based on a joint analysis of RVs and astrometry. As a bright star hosting multiple planets with well-measured masses, HD191939 presents many options for comparative planetary astronomy including characterization with JWST.
Evelyn Macdonald (University of Toronto). *Dayside land on tidally locked rocky planets*. **8.3**	A planet's surface conditions can significantly impact its climate and habitability. In this work, we use the 3D general circulation model ExoPlaSim to systematically vary dayside land cover on a tidally locked rocky planet under two extreme and opposite continent configurations: either all of the land or all of the ocean is centred at the substellar point. We identify water vapour and sea ice as competing drivers of climate, and we identify land-dependent regimes under which one or the other dominates. We find that land fraction and distribution can change the globally averaged surface temperature by up to 15K, and water vapour by up to an order of magnitude. The most discrepant models have partial dayside land cover with opposite continent configuration. Since these planets' surfaces will not be directly observable using transit spectroscopy, I will discuss how these climate differences likely represent a fundamental uncertainty in the climates of tidally locked planets, even if their atmospheric composition is well-known.
Marissa Maney (Penn State). *Detection and Characterization of Transiting Planets Orbiting Nearby TESS M-dwarfs*. **T**	The Transiting Exoplanet Survey Satellite (TESS) has detected thousands of transiting exoplanet candidates around nearby bright stars. A number of these exoplanet candidates orbit nearby M-dwarfs and are advantageous targets for future transmission spectroscopic observations. Precision ground-based transit observations are necessary to confirm and further characterize these planet candidates. In this talk, I will discuss our transit-detection pipeline that we have developed to detect periodic transit events in TESS data using the Box-Least-Squares (BLS) algorithm, independent of the official TESS transit-detection pipeline. I will discuss the performance of our pipeline on both TESS 2min and 30min cadence data to detect periodic transiting events. I will also discuss our precision ground-based transit follow-up efforts to confirm promising planet candidates, which we have detected using this pipeline. In particular, I will highlight two planets we have detected and confirmed using this approach: (1) the hot super-Neptune TOI-1728b orbiting the bright M-dwarf TIC-285048486 (TOI-1728), which we confirmed by precision ground-based observations using small-aperture telescopes and (2) the single-transiting warm Jupiter TOI-1899b orbiting the early M-dwarf TIC-172370679 (TOI-1899), which is the first discovered transiting warm Jupiter orbiting an M-dwarf.

Name (Affiliation). *Title*. Where.	Abstract
Raquel Martinez (The University of Texas at Austin). *The Demographics of Wide Planetary-Mass and Substellar Companions and Their Circum(sub)stellar Disks through PSF Fitting of Spitzer/IRAC Archival Images*. **9.1**	The last decade has seen the discovery of a growing population of planetary-mass and substellar companions (≈<20 MJup) to young stars which are often still in the star-forming regions where they formed. These objects have been found at wide separations (>100 AU) from their host stars, challenging existing models of both star and planet formation. Demographic trends with mass and separation should distinguish between these formation models. The extensive Spitzer/IRAC data set of every major star-forming region and association within 300 pc has great potential to be mined for wide companions. In this poster I will present the latest developments of an automated pipeline I have developed to find wide-orbit PMCs of stars via PSF subtraction in Spitzer/IRAC images. An MCMC algorithm is the backbone of this PSF subtraction routine that efficiently creates and subtracts χ2-minimizing instrumental PSFs, measuring the mid-infrared photometry of these systems. I will present a re-analysis of archival Spitzer/IRAC images of 20 stars (G0-M7.5) known to host companions (1.2″-12.3″), reporting new mid-IR photometric measurements of this sample of wide-orbit companion systems. I will also discuss my ongoing follow-up observations of wide planetary-mass/substellar companion systems with ground-based telescopes, and the outlook for future observations with space-based telescopes.
Allison McCarthy (Boston University). *The Variability of SIMP 0136 as Measured by the PINES Analysis Toolkit*. **2.4**	The Perkins Infrared Exosattelite Survey (PINES) is a ground-based search for transiting exosatellites orbiting L and T type dwarfs. To extract light curves and search for transiting satellites in PINES data, the PINES team developed a custom data reduction pipeline called the pines_analysis_toolkit (PAT), optimized for wide-field infrared images. I applied PAT to archival data of SIMP J013656.5+093347 — a known variable T2.5 type dwarf with rotation period ≈2.4 hours. The pines_analysis_toolkit revealed more structure in the object's light curve than was previously found, including a periodic feature at half of the known rotation period. Moving forward, objects in the PINES sample will be analyzed using the pines_analysis_toolkit, and the results from SIMP J013656.5+093347 provide evidence that variability signatures can be extracted from the PINES data.
Elizabeth Melton (Pennsylvania State University). *The AutoRegressive Planet Search method applied to HATSouth and TESS*. **T**	In the search for exoplanets using photometric transits, the AutoRegressive Planet Search (ARPS) method uses autoregressive integrated moving average (ARIMA) statistical models to treat the stochastic and autocorrelated noise in stellar light curves combined with a Transit Comb Filter and a Random Forest machine learning classifier to identify exoplanet transit signals. This method has been applied to the 4-year Kepler data where new candidates were identified. Here we apply the ARPS method to the Hungarian-made Automated Telescope Network South (HATSouth) and the TESS surveys, both with their own challenges to overcome. The classifier is trained on transits injected into lightcurves, and qualitative vetting is needed to reduce False Positive signals. At present, we have analyzed approximately 2 million HATSouth light curves and have identified over 150 new exoplanet candidates, potentially doubling the number of HATSouth-discovered exoplanets. Preliminary results from application of ARPS to 0.9 million stars in TESS Full Frame Images will also be reported. The performance of ARPS compared to traditional statistical approaches will be discussed.
Ismael Mireles (University of New Mexico). *Evaluation of Community TOIs and Results*. **2.5**	After nearly three years of observations, the TESS mission has led to over 2600 TESS Objects of Interest (TOIs) being alerted. Of these, 161 TOIs were alerted because they were first identified as Community TOIS (CTOIs). The sample of promoted CTOIs includes full frame image (FFI) targets that are fainter than the Tmag = 10.5 cutoff used by QLP vetting and single transits that were rejected by the periodic signal searches from the QLP and SPOC pipelines. Here we detail the process by which these CTOIs were promoted to TOIs and present examples that highlight how the community has supplemented the standard TESS pipelines. The inclusion of these community targets will help explore longer-period planets as well as fainter targets that would have otherwise not been alerted as TOIs.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Sarah Moran (Johns Hopkins University). *The Complexity of Oxygenated Planetary Hazes Near and Far*. **T**	Photochemical hazes are found across the solar system and in exoplanet atmospheres, with important effects on atmospheric chemistry and subsequent possible impacts on observations. These hazes can impact both atmospheric observations and interpretations with current observatories like Hubble, in the future with JWST and ground-based observatories, as well as with upcoming planetary missions. I will present results of the composition and spectra of haze particles produced from exoplanet and Triton laboratory studies in the JHU PHAZER laboratory. With high resolution mass spectrometry, we detect many complex molecular species in the haze particles, including those with prebiotic applications. I will specifically delve into the role of oxygen-bearing species on the chemical behavior of haze particles. Finally, I will discuss how we can apply what we've learned from the laboratory into atmospheric models for existing and future observations of sub-Neptune-sized exoplanets as well as Neptune's moon, Triton.
Matthew Murphy (University of Arizona). *A Cloudy but Stable Giant: No sign of weather induced variability between Spitzer phase curves of WASP-43b*. **T**	When observing exoplanet atmospheres, the possible effects of weather are often ignored. There is clearly global weather on Solar System planets and is likely on exoplanets as well, although there is little theoretical guidance on what to expect. These atmosphere observations are time-intensive, so most are only observed once and we assume this single epoch shows the atmosphere in equilibrium, with no temporal variability. No exoplanet has received repeat phase curve observations at the same wavelength, leaving this assumption untested. Atmospheric data is our primary insight into compositions and formation scenarios, so understanding potential time variability in the data is important. I will present three Spitzer/IRAC phase curves of the hot Jupiter WASP-43b. These are the first repeat infrared phase curves of a single exoplanet, expanding upon existing repeat eclipse measurements since phase curves probe global weather, rather than just the dayside. We did not see significant variation between the three phase curves, allowing us to place strict limits on the presence of weather on WASP-43b. Lack of variability implies that most hot Jupiter atmospheres are relatively stable over time, which has important implications for 1) theoretical atmospheric dynamics, 2) interpreting past data, and 3) planning future JWST observations.
Giang Nguyen (York University). *Modelling the atmosphere of lava planet K2-141b*. **T**	Lava planets are rocky planets that orbit closely to their host stars and much of their surfaces are covered with molten magma. These planets are hot enough to vapourize rocks which creates a thin mineral vapour atmosphere. Due to these planets' extreme orbital configuration, lava planets are some of the best targets to observe an extra-solar terrestrial atmosphere. K2-141b is a recently discovered lava planet and we simulate its atmosphere using an idealized hydrodynamical model. The model determines the atmospheric temperature, wind velocity, and surface pressure which are then used to simulate future observations of K2-141b. We tested for an Na, SiO and SiO2 dominant atmosphere and found that the Na atmosphere, with 14 kPa surface pressure, is thickest while the SiO2 atmosphere, with 240 Pa, is thinnest. However, the SiO2 atmosphere is warmer which makes it easier to observe via spectroscopy. We also estimate the ocean circulation required to maintain surface-atmosphere mass balance and found that Na redistribution in the ocean is orders of magnitude larger than the bulk silicate flow. This suggests that a steady-state Na atmosphere cannot be sustained, and the planet's surface will evolve over time.

Name (Affiliation). *Title*. Where.	Abstract
Jacob Nibauer (University of Pennsylvania). *Statistics of the Chemical Composition of Solar Analog Stars and Links to Planet Formation*. **T**	The Sun is depleted in refractory (rock-forming) elements relative to nearby solar analogs, suggesting a potential indicator of planet formation. Given the small amplitude of the depletion (≈0.05 dex), previous analyses have relied on high signal-to-noise stellar spectra and a strictly differential approach to determine elemental abundances of nearby solar analogs relative to the Sun. In this work, we develop an alternative hierarchical Bayesian modeling approach that can be applied to larger samples of stars with lower precision abundance measurements. Using chemical abundance determinations from the Apache Point Observatory Galactic Evolution Experiment (APOGEE-2) and the stellar parameter and chemical abundance pipeline (ASPCAP DR16), we place constraints on the statistical properties of the elemental abundances, including correlations with condensation temperature and the fraction of stars with refractory element depletions. We find evidence for two populations: a refractory depleted population of stars that make up the majority of solar analogs including the Sun, and a comparatively refractory enriched population of stars that make up between 10-30% of our solar neighborhood sample. Such trends, if robustly linked to the formation of planetary systems, provide a means to connect stellar chemical abundance patterns to planetary systems over large samples of Milky Way stars.
Christopher O'Connor (Cornell University). *Enhanced Lidov-Kozai migration of the transiting planet WD1856b*. **T**	We illustrate the possible origin of the transiting giant planet WD1856+534 b, the first strong exoplanet candidate orbiting a white dwarf, through high-eccentricity migration (HEM) driven by the Lidov-Kozai (LK) effect. The host system's overall architecture is a hierarchical quadruple in the '2+2' configuration, owing to the presence of a companion system of two M-dwarfs. We show that a secular inclination resonance in 2+2 systems can significantly broaden the LK window for extreme eccentricity excitation ($e > 0.999$), allowing the giant planet to migrate for a wide range of initial orbital inclinations. Octupole effects can also contribute to the broadening of the 'extreme' LK window. By requiring that perturbations from the companion stars be able to overcome short-range forces and excite the planet's eccentricity to an extreme value, we obtain an absolute lower limit for the planet's semimajor axis just before migration. We find that, if WD1856b migrated via the 2+2 resonance, it most likely originated from ≈30-60 AU (or ≈10-20 AU during the host's main-sequence phase). Our work provides helpful context for efforts to characterize WD1856b's atmosphere and properties.
Terese Olander (Uppsala University). *Comparative high-resolution spectroscopy of M dwarfs – exploring non-LTE effects*. **4.5**	M dwarfs are attractive target stars for exoplanets. To assess exoplanet habitability around them, their atmospheric parameters need to be accurately determined. Advances in high-resolution spectroscopy in the near-infrared have opened up the possibility of improving M dwarf analysis. There have recently been several methods published on fitting the observed high-resolution spectra with synthetic spectra using different instruments and theoretical approaches. We present a comparison of stellar parameters derived by three different approaches for 11 different stars in common between three studies. The derived effective temperature values agree within uncertainties for most stars while the surface gravity and metallicity show a larger spread. For half of the stars, the differences are larger than the given uncertainties. To investigate the diverging results, we asses non-LTE effects in the parameter range of M dwarfs for K and Fe. Non-LTE effects are negligible for Fe I in M-dwarf atmospheres but are important for K I. These effects, leading to potassium abundance and metallicity corrections on the order of 0.2 dex, may be responsible for some of these discrepancies. The aim is to validate and improve the method of fitting synthetic spectra to observed spectra for M dwarfs.

Name (Affiliation). *Title*. Where.	**Abstract**
Ares Osborn (University of Warwick, UK). *A new exoplanetary system from TESS: TOI-431, a super-Earth and a sub-Neptune transiting a bright, early K dwarf, with a third RV planet*. **T**	We present the bright, multi-planet system TOI-431, characterised with photometry (from TESS, LCO, NGTS, and Spitzer) and radial velocities (from HARPS, HIRES, iSHELL, FEROS, and MINERVA-Australis). TOI-431b is a super-Earth with a period of 0.49 days, a radius of 1.28 REarth, a mass of 2.96 MEarth, and a density of 7.70 gcm-3; TOI-431d is a sub-Neptune with a period of 12.46 days, a radius of 3.29 REarth, a mass of 8.82 MEarth, and a density of 1.36 gcm-3. We find a third planet candidate, TOI-431c, in the HARPS and HIRES RV data, but it is not seen to transit in the TESS light curves. It has an Msini of 2.90 MEarth, and a period of 4.85 days. TOI-431d likely has an extended atmosphere and is one of the most well-suited TESS discoveries for atmospheric characterisation, while the super-Earth TOI-431b may be a stripped core. These planets straddle the radius gap, presenting an interesting case-study for atmospheric evolution, and TOI-431b is a prime TESS discovery for the study of rocky planet phase curves.
Anusha Pai Asnodkar (The Ohio State University). *Measuring Rapid Global-Scale Winds on KELT-9 b*. **T**	Hot Jupiters (HJs) present an extreme case for exploring the conditions that regulate planetary atmospheres because they experience intense irradiation from their host stars that gives rise to global-scale winds. Models of HJ atmospheres predict day-to-nightside winds (winds flowing from the side of the planet facing its host star to the side facing away from the star) and equatorial jets (winds that entirely circulate around the planet) with speeds on the order of a few km/s. We apply high-resolution transmission spectroscopy using the PEPSI spectrograph on the Large Binocular Telescope to empirically constrain ≈10 km/s day-to-nightside winds traced by Fe II features in the atmosphere of KELT-9 b, an ultra-hot Jupiter that remains to date the hottest known planet. Reconciling our findings with archival HARPS-N datasets suggests multi-epoch variability of atmospheric circulation on KELT-9 b, a prediction from certain models that has not been observed yet. Additionally, we combine the datasets to estimate the planet's mass as a double-lined spectroscopic binary and find that the value reported in the discovery paper is underestimated by nearly a factor of 2; this has dramatic consequences for models of atmospheric escape, a phenomenon of great interest to many observational studies of KELT-9 b.
Skyler Palatnick (University of Pennsylvania). *Validation of HD 183579b using archival radial velocities: a warm-neptune orbiting a bright solar analog*. **T**	As exoplanetary science matures into its third decade, we are increasingly offered the possibility of pre existing, archival observations for newly detected candidates. This is particularly poignant for the TESS mission, whose survey spans bright, nearby dwarf stars in both hemispheres, which are precisely the types of sources targeted by previous radial velocity (RV) surveys. On this basis, we investigated whether any of the TESS Objects of Interest (TOIs) coincided with such observations, from which we find 18 single planet candidate systems. Of these, one exhibits an RV signature that has the correct period and phase matching the transiting planetary candidate with a false alarm probability of less than 1 percent. After further checks, we exploit this fact to validate HD 183579b (TOI-1055b). This planet is less than 4 Earth Radii and has better than 33 percent planetary mass measurements, thus advancing the TESS primary objective of finding 50 such worlds. We find that this planet is amongst the most accessible small transiting planets for atmospheric characterization. Our work highlights that the efforts to confirm and even precisely measure the masses of new transiting planet candidates need not always depend on acquiring new observations - that in some instances these tasks can be completed with existing data.

Name (Affiliation). *Title*. Where.	Abstract
Michael Palumbo (Penn State). *GRASS: Distinguishing Planets From Granulation with a Synthetic Spectra Generator*. **4.6**	Owing to recent advances in radial-velocity instrumentation and observation techniques, the detection of Earth-twins around Sun-like stars may soon be primarily limited by intrinsic stellar variability. Several processes contribute to this variability, including magnetic activity, pulsations, and granulation. Many previous studies have focused on techniques to mitigate signals from pulsations and magnetic activity. We will explore the impact of the shifting and skewing of spectral lines by turbulent granulation cells, an effect which has only been partially addressed by empirically-motivated observation strategies and 3D MHD simulations. Since granular motions imprint their effects on spectral lines differently than magnetic activity, a new approach to mitigating spectral variability due to granulation may be required. To aid in this effort, we have developed a tool that generates synthetic stellar spectral time series using spatially- and temporally-resolved solar observations as input. This tool, which we dub the GRanulation And Spectrum Simulator (GRASS), is the first empirical model for spectral line variability in a star with known center-of-mass radial velocity behavior. We present GRASS, explain its methodology, and discuss its implications for disentangling the effects of granular noise from true Doppler shifts.
Mayukh Panja (Max Planck Institute for Solar System Research). *Stellar RV calculations from realistic MHD atmospheres of spots, plages, and quiet star regions*. **T**	We performed realistic 3D simulations of the photospheric structure of complete starspots and their penumbrae for a range of cool main-sequence stars, namely the spectral types - G2V, K0V, and M0V. We used the MURaM radiative MHD code which has been used extensively to compute realistic sunspots. Using these atmospheres we first calculated the center-to-limb variation of spot intensity contrasts at different wavelengths for all of the spectral types. Finally, we generated synthetic line profiles for different features on the stellar disk - quiet star, umbra, penumbra, and plage and combined them to create disk integrated line profiles. These profiles were then used toquantify the effects of starspots with different filling factors on the radial velocity (RV) of stars. Our realistic atmospheres offer us the opportunity to incorporate, for the first time, the effect of flows within starspots in synthetic RV calculations.
Adiv Paradise (University of Toronto). *Exoplanets Over Lunch: Enabling new science with ExoPlaSim, a really fast and easy GCM*. **1.8**	Growing numbers of newly-discovered Earth-sized planets in the habitable zone have driven growing interest in understanding their climates, across the field of planetary science. However, the 3D models we use to study those climates have historically been computationally expensive, difficult to learn, and complex to configure, posing a significant barrier to many who would like to build intuition for planetary climate, or quickly explore possible climate states for planet candidates. Furthermore, studies of planetary parameter spaces have been limited to small numbers of models. I will present ExoPlaSim, a GCM that is fast enough to model an Earth-like planet's climate over your lunch break, flexible enough to handle habitable planets around both Sun-like stars and M dwarfs, and easy enough to learn that you can install it via pip, configure it in a Python Jupyter notebook, and begin modelling climates in under half an hour--even on your laptop. I will discuss some of the use cases this enables, such as large parameter space surveys, tests of climate physics, and rapid path-finding models for observers seeking to screen potentially-habitable planet candidates.
Vanessa/Vaughn Parts (Penn State University). *Improving RV Measurements by Mitigating Magnetic Activity-Induced Noise*. **T**	Stellar magnetic activity produces effects on spectral lines that hamper our ability to precisely measure exoplanet masses from the radial velocity (RV) effects that these planets have on their host stars' spectra. In order to disentangle signatures of magnetic activity from RV signatures, I have modeled the Zeeman effect on selected magnetically-sensitive near infrared lines using the Hanle and Zeeman Light (HAZEL) code. Using SDO data on the Sun's magnetic field as input, I integrated over the solar disk to model the net effect on the Fe I 15648.5Å line and found that the difference in the line shape between a low-activity and a high-activity day is easily detectable with an SNR of 1,000. In the future, I will refine this method working with high-SNR (easily ≥1,000) solar spectra obtained through laser heterodyne radiometry (LHR), which involves using a single-frequency laser to heterodyne an IR spectrum down to radio frequencies. Using this technique on disk-integrated solar spectra will pave the way for mitigating magnetic activity-induced noise in IR spectra of nearby stars, enabling RV measurement precision down to the 10cm/s level.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Dewy Peters (Kapteyn Astronomical Institute). *Habitable Environments in Late Stellar Evolution: Conditions for Abiogenesis in the Planetary Systems of White Dwarfs*. **8.4**	With very high potential transit-depths and an absence of stellar flare activity, the planets of White Dwarfs (WDs) are some of the most promising in the search for detectable life. There is considerable evidence from spectroscopic and photometric observations that both terrestrial and gas-giant planets are capable of surviving post-main sequence evolution and migrating into the WD phase. WDs are also capable of hosting stable Habitable Zones outside orbital distances at which Earth-mass planets would be disintegrated by tidal forces. To reach the WD phase, a main-sequence star has to progress along the Asymptotic Giant Branch (AGB) around which Circumstellar Envelopes (CSEs) are found to be rich in some of the simple molecules from which amino acids and simple sugars can be synthesised. It is found that in addition to retaining most of a 1bar atmosphere, planets at orbital distances equivalent to Saturn and the Kuiper Belt would be able to accrete between 1 and 20 times the mass of Earth's atmosphere from the CSE, and therefore likely a sufficiently high mass of prebiotic material to be useful in facilitating the emergence of life.
Caprice Phillips (The Ohio State University). *Detecting Biosignatures in the Atmospheres of Gas Dwarfs with JWST*. **T**	No planet in the Solar System exists that is analogous to super-Earths and mini-Neptunes, a class of exoplanets with radii between those of Earth and Neptune (gas dwarf planets). Because of stronger gravity than Earth, the new class of exoplanet can retain a sizable hydrogen-dominated atmosphere. JWST will offer unprecedented insight into the atmospheric composition of potentially habitable gas dwarf planets through transmission and emission spectroscopy, whose reducing atmospheres have entirely different chemistry from an inhabited Earth-like planet with an oxidizing atmosphere. We investigate the detectability of NH3 (ammonia, a potential biosignature) in the atmospheres of seven potentially habitable gas dwarf planets using various JWST instruments (NIRISS, NIRSpec, and MIRI). We use open-source packages petitRADTRANS and PandExo to model atmospheres and simulate JWST observations. We consider different scenarios by varying cloud conditions, mean molecular weights (MMWs), and NH3 mixing ratios, and define a metric to quantify detection significance and provide a ranked list for JWST observations. It is challenging to search for the 10um NH3 with MIRI given a noise floor of 100 ppm for emission spectroscopy. NIRISS and NIRSpec are feasible under optimal conditions such as a clear sky and low MMWs for a number of gas dwarf planets.
Myriam Prasow-Émond (Université de Montréal). *First Detection of Candidate Exoplanets and Brown Dwarfs Orbiting X-Ray Binaries via Direct Imaging*. **T**	X-ray binaries provide fantastic laboratories for understanding the physics of matter under the most extreme conditions. However, there are currently no observational constraints on the AU-size environments of these extreme systems and it remains unclear how the accretion onto the compact objects or the explosions giving rise to the compact objects interact with their immediate surroundings. Here, we present the first high-contrast adaptive optics images of X-ray binaries aiming to probe a variety of phenomena from protoplanetary discs, to debris discs and fallback discs, as well as orbiting planetary companions. These observations target all X-ray binaries within ≈2 kpc accessible with NIRC2 on KECK. We present key results from this campaign, including the discovery of candidate brown dwarfs and exoplanets orbiting the Gamma-Cassiopeiae analog X-ray binary RX J1744.7-2713. Our talk emphasizes that such observations may indeed provide a major breakthrough in the field, not only for our understanding of the circumbinary environment of X-ray binaries, but also our understanding of how discs and planets can form even in the most extreme environments.

Name (Affiliation). *Title*. Where.	Abstract
Victor Ramirez Delgado (University of Delaware). *Disentangling stellar variability from radial velocities using the coherence method*. **T**	High precision radial velocity (RV) measurements have led to the need of better diagnosing stellar activity in exoplanet detections. Here we introduce the magnitude-square coherence as a diagnostic of activity-driven RV variations. This analysis is done in the frequency domain by estimating the cross and auto correlation between RV and an activity indicator. The coherence coefficient shows that values near zero indicate that the activity indicator is not a good predictor of RV, while values near one mean that RV is well modeled by the activity indicator. We studied the coherence method using observations of HD 26965 and CoRoT-7. For CoRoT-7, the stellar RV signals from the literature are coherent with at least one activity indicator, while the planet signal reported by Queloz et. al (2009) does not show up in any of the coherences. The analysis of HD 26965 reveals that the proposed planet signal from Díaz et al. (2018) has a significant coherence with the H-alpha measurements. Furthermore, the separation between the planet and rotation frequencies are almost indistinguishable based on their Rayleigh criterion, suggesting that the planet period comes from HD26965's rotation Ultimately, our results demonstrate that coherence can diagnose frequencies where stellar activity manifests in the RVs.
Tyler Richey-Yowell (Arizona State University). *The Ultraviolet Imperative for Assessing the Habitability of Planets Orbiting K Stars*. **4.7**	Efforts to discover and characterize habitable zone planets have primarily focused on Sun-like stars and M dwarfs. Yet the intermediate K stars provide an appealing compromise between these two extremes that has been relatively unexplored. Compared to solar-type stars, K stars are more abundant, maintain longer main-sequence lifetimes, and their planets are more suitable to observations based on the mass and radius ratios of the planet to star. While M stars also excel in these regards, they have been observed to have frequent flares with ultraviolet (UV) energies over 100 times greater than anything observed in the recent history of our Sun. Therefore, K stars may provide "super-habitable" environments for exoplanets that are more easily detectable and characterizable. Understanding the UV radiation incident on planets is pivotal in determining the habitability of any planets orbiting these stars, as well as our ability to observe any potential biosignatures in their atmospheres. With this aim, we observed a sample of K stars in the near-UV and far-UV at three representative ages using the Cosmic Origins Spectrograph on the Hubble Space Telescope (HST) to spectroscopically analyze the UV evolution of K stars. Here, we present the first results of this HST program. We will discuss the evolution of both the continuum and line emission from K stars from ages 40 Myr to ≈Gyrs, representing key periods in planetary atmospheric formation.
Keighley Rockcliffe (Dartmouth College). *A Lyman-alpha transit left undetected: the environment and atmospheric behavior of K2-25b*. **T**	K2-25b is a Neptune-sized exoplanet (3.45 Earth radii) that orbits its M4.5 host with a period of 3.48 days. Due to its membership in the Hyades Cluster, the system has a known age (680 Myr). K2-25b's youth and its similarities with Gl 436b suggest that K2-25b could be undergoing strong atmospheric escape. We observed two transits of K2-25b at Lyman-alpha using HST/STIS in order to search for escaping neutral hydrogen. We find that R_p/R_s < 0.99 (0.48) at 95% confidence by fitting the light curve of the Lyman-alpha blue-wing (red-wing). We reconstructed the intrinsic Lyman-alpha profile of K2-25, finding the Lyman-alpha flux to be 2.17 erg/s/cm^2 at 1 AU from the star. From XMM-Newton observations, we determined the X-ray flux at 1 AU to be 5.88 erg/s/cm^2. Based on the XUV flux, we estimated the maximum energy-limited mass loss rate of K2-25b to be 11.8 x 10^10 g/s (0.62 Earth masses per 1 Gyr), five times larger than the similarly estimated mass loss rate of Gl 436b (2.2 x 10^10 g/s). Broadly, a non-detection of a Lyman-alpha transit could be due to, e.g., atmosphere composition or the system's youth. Further observations could provide more stringent constraints.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Phoebe Sandhaus (Pennsylvania State University). *Simulating the Effects of Outer Giant Planets on Inner Super-Earths with In Situ Formation Models*. **3.5**	The Kepler mission found a large number of planets between the sizes of Earth and Neptune, planets that have no Solar System analog. These planets, termed super-Earths, have a wide variety of diverse compositions and orbital properties. We seek to explore the effects on inner super-Earth formation, and thus this observed diversity of planetary properties, by adding outer giant planets into the initial phase of planet formation simulations. These simulations begin during the end stages of the gas phase of the protoplanetary disk and continue through the post-gas phase. We compare the final planetary properties of our simulated systems to simulations that do not include outer giant planets and to properties of observed systems from Kepler data.
Tajana Schneiderman (Massachusetts Institute of Technology). *CO gas from the aftermath of a giant impact in the HD 172555 system*. **T**	In the latest stages of their formation, terrestrial planets are expected to grow and evolve through giant impacts, releasing debris that can be detected as infrared emission. We present the first ALMA detection of CO gas co-located with impact-produced debris in orbit around the 23 Myr old A star HD 172555. Spectral modeling shows that CO is distributed in a ring centered at 7.5 AU, with a width of 3.3 AU. The dust composition, size distribution, mass, as well as the presence and morphology of CO gas, indicate that the gas and dust are unlikely to be primordial, originating in an in-situ asteroid belt, or transported inwards from an external, as-yet unobserved belt. On the other hand, a planetary impact between volatile rich Earth/super-Earth sized bodies >0.2 Myr ago can explain the observed dust and gas properties. Specifically, with a progenitor mass of ≈5 earth masses, either an immediate atmospheric stripping event of a heavy, CO_2 dominated atmosphere, or a prolonged thermal stripping scenario of a light, H_2/He dominated atmosphere are plausible. In short, the HD 172555 system presents the most compelling evidence for the release of gas in the aftermath of a giant impact to-date.
Maria Schutte (University of Oklahoma). *Modeling Starspot Features on a Solar-like Star with an M-dwarf Companion*. **T**	Understanding magnetic activity on the surface of stars other than the Sun is particularly important for planet hosting stars since exoplanet analyses must include these effects to properly characterize the exoplanet's atmosphere. Using data from the Kepler spacecraft, we use the starspot modeling program STSP to measure the position and size of spots for KOI-340 (WISE J195039.52+474804.8) which is an eclipsing binary consisting of Solar-type star ($M_{} = 1.10 |pm 0.07 M_{|odot}$) *with an M-dwarf companion* ($M_{} = 0.214 \pm 0.006 M_{\odot}$). STSP uses a novel technique to measure the spot positions and radii by using the transiting secondary as a magnifying glass to probe down to less than 1% changes in the surface brightness of the star for high-precision photometry. Preliminary results show the minimum size of spot features on KOI-340 is 10% the size of the star i.e. two times larger than the size of the majority of Sunspots and Sunspot groups at Solar maximum (Howard et al. 1984). Though KOI-340 has a similar T_{eff} (5770 K) as the Sun, it rotates at a rate of 12.9 days, which is ≈2 times faster than the Sun and could be contributing to the larger spots. A similar analysis showed that a K4 dwarf HAT-P-11 has similar size spots as the Sun, but there are ≈100x more of them (Morris et al. 2017). This analysis is part of a larger program to characterize starspot properties using high precision transiting exoplanet light curves across a range of spectral types and rotation rates. This research is funded through NSF grants 1907622, 1909506, 1909682, 1910954.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Soumya Sengupta (Indian Institute of Astrophysics). *Effects of thermal emission on Chandrasekhar's semi-infinite diffuse reflection problem*. **1.9**	Chandrasekhar's analytical results of semi-infinite diffuse reflection problem is crucial in astrophysical context. However, the atmospheric emission effect was not taken into account in this model, and the solutions are applicable only for diffusely scattering atmosphere in absence of emission. We extend the model by including the thermal emission B(T), and present how this affects Chandrasekhar's analytical end results. We use Invariance Principle Method to find the radiative transfer equation accurate for diffuse reflection in presence of B(T). Then the modified scattering function S(μ,ϕ;μ_0,ϕ_0) for different kind of phase functions are derived. We find that, the scattering function S(μ,ϕ;μ_0,ϕ_0) as well as diffusely reflected specific intensity I(0,μ;μ_0) for different phase functions are modified due to the emission B(T) from τ=0 layer. In both cases, B(T) is added to the results of only scattering case derived by Chandrasekhar, with some multiplicative factors. Thus the diffusely reflected spectra will be enriched and carries the temperature information of atmosphere. As the effects are additive in nature, hence our model reduces to the sub-case of Chandrasekhar's scattering model in B(T)=0 case. We conclude that our generalized model is more accurate due to the inclusion of the thermal emission effect in Chandrasekhar's semi-infinite atmosphere problem.
James Sikora (Bishop's University). *Testing Radius Valley Mass-Loss Mechanisms With Kepler*. **T**	One of the intriguing outcomes of the Kepler mission was the discovery of a large number of short-period planets with radii between that of Earth and Neptune that have no direct Solar System analog. Extensive ground-based follow-up observations lead to the discovery of a gap in the distribution of planetary radii — the so-called radius valley — that separates the super-Earths and sub-Neptunes. Identifying the most probable theory that has been proposed to explain this feature's origin will ultimately have important implications for our understanding of planetary formation and evolution. We will present a state-of-the-art re-analysis of the Kepler sample and how it compares with the predictions of two specific theories: the photoevaporation and core-powered mass-loss theories. Lastly, we will discuss how future surveys may provide a means of better constraining the radius valley's origin.
Peter Smith (Arizona State University). *Measurement of a Carbon Isotope in a Hot Jupiter Using High Resolution Cross Correlation Spectroscopy*. **T**	High resolution cross-correlation spectroscopy (HRCCS) is an emerging method for ground-based exoplanet characterization. It utilizes the time resolved Doppler shift of planetary lines as the planet orbits its host star to separate the planet signal from the stationary stellar and telluric signals. HRCCS has been the only method to reliably detect carbon bearing species in transiting exoplanet atmospheres. Recent observations of hot Jupiter WASP-77 Ab have enabled us to place precise constraints not only on the abundance of CO, but on the 12C/13C carbon isotope as well. To date, this is the first isotope measurement for a transiting exoplanet. Such measurements can help us shed light on where planets formed in the protoplanetary disk, and isotope spectroscopy will soon become a common tool for exoplanet characterization.
Riccardo Spinelli (Università degli Studi dell'Insubria). *High energy radiation effects on planetary habitability*. **8.5**	Several factors contribute to the presence and development of life on a planet. In addition to particular intrinsic properties of the planet and the presence of liquid water on its surface, the high-energy radiation environment can favour the synthesis of RNA, drive chemistry and evolution of planetary atmospheres, inhibit photosynthesis, induce biomolecules destruction. The properties of the high energy radiation environment are mainly determined by the host star, but occasionally also by nearby transient astrophysical events (e.g. supenovae and gamma ray bursts). With the aim to assess the influence of the stellar high-energy emission, I present the study of the X-ray-UV emission of LHS 1140, an M dwarf that hosts a super-Earth in the habitable zone. The results of the analysis allowed me to infer the actual habitability of LHS 1140b. On larger distance scales, I investigated the role of transient astrophysical events in jeopardizing life on Earth and on other planets in our Galaxy through a theoretical model, that connects the rate of these events to the specific star formation and metallicity evolution within the Galaxy. I identified the safest places and epochs within our Galaxy, sheltered by these events.

Name (Affiliation). *Title*. Where.	Abstract
Eleanor Spring (University of Amsterdam). *Black Mirror: A Dedicated Search for Reflected Light from 51 Pegasi b with High-Resolution Spectroscopy*. **1.1**	It is challenging to isolate the light reflected by exoplanet atmospheres with current instrumentation due to their 10^(-4) - 10^(-10) contrasts. Yet, these reflective properties are key to understanding the chemical and physical processes in exoplanet atmospheres. Furthermore, reflected light in the optical covers a key O_2 feature at 760nm that forms part of a set of potential biomarkers. Thus, developing techniques to robustly extract reflected light spectra of exoplanets is crucial, despite its difficulty. Here, we present our search for reflected light from the atmosphere of the non-transiting hot Jupiter 51 Peg b, by adapting cross-correlation techniques with high-resolution spectroscopy (HRS, R>100,000), previously honed in the infrared. We used a dedicated 4-half night program with HARPS-N. We found no significant signal of reflected light from 51 Peg b and determined an upper limit on the reflected light contrast ratio of 5.4 x 10^(-5). Assuming the typical radius of similar mass transiting planets, we determine an albedo of Ag<0.4. Additionally, we show that the line broadening of the reflected light due to the differences in the star's and planet's rotational and orbital velocities is significant, and therefore should be taken into account in order to perform a robust analysis when searching for a reflected light signal from short orbit exoplanets.
Sarthak Srivastava (Nanyang Technological University). *A Two-dimensional Numerical Model for comparative study of Gravity Waves on different Planets*. **1.11**	A two-dimensional nonlinear, compressible numerical model has been developed to study atmospheric coupling due to vertically propagating Gravity Waves (GWs). The model can simulate both acoustic and gravity waves and includes viscous dissipation. The hyperbolic advection equations without viscosity are solved using the Lax-Wendroff method. The parabolic diffusion terms are solved implicitly using an iterative scheme. The model is validated by comparing numerical solutions against analytical results from linear theory. A case study of tsunami generated GWs on Earth is presented whereby the model is forced through tsunamigenic sea-surface displacement. The properties of simulated GWs closely match those derived from ionospheric sounding observations reported in literature. Another application for Martian ice cloud formation is discussed where GWs from topographic sources are shown to create cold pockets with temperatures below the CO2 condensation threshold. The validated model is then applied to evaluate GW momentum flux in exoplanet atmospheres with different planetary parameters.
Asa Stahl (Rice University). *A Publically Available Precision RV Pipeline For IGRINS*. **9.2**	Application of the radial velocity (RV) technique in the near infrared is valuable because of the diminished impact of stellar activity at longer wavelengths, making it particularly advantageous for the study of late-type stars. We present the IGRINS RV open source python pipeline for computing infrared RV measurements from reduced spectra taken with IGRINS, an R ≈ 45,000 spectrograph with simultaneous coverage of the H band and K band. Using a modified forward modeling technique, we construct high resolution telluric templates from A0 standard observations on a nightly basis to provide a source of common-path wavelength calibration while mitigating the need to mask or correct for telluric absorption. Without any additional instrument hardware, we are able to achieve precisions of 26.8 m/s in the K band and 31.1 m/s in the H band for narrow-line hosts. These precisions are empirically determined by a monitoring campaign of two RV standard stars as well as the successful retrieval of planet-induced RV signals for both HD189733 and tau Boo; furthermore, our results affirm the presence of the Rossiter-McLaughlin effect for HD189733. IGRINS RV extends another important science capability to IGRINS, with publicly available software designed for widespread use.
Xianyu Tan (University of Oxford). *Atmospheric dynamics of brown dwarfs and isolated young giant planets*. **1.12**	Observations of brown dwarfs (BDs), free-floating planetary-mass objects, and directly imaged extrasolar giant planets (EGPs) exhibit rich evidence of large-scale weather. Understanding the mechanisms driving the atmospheric circulation of BDs and directly imaged EGPs is crucial to interpret the observed lightcurve variability. We proposed a thermally-driven mechanism linked to cloud radiative feedback. In this presentation, we introduce the principle of this mechanism and highlight the properties of the resulting circulation patterns. I will show that this mechanism can generate vigorous atmospheric flows, including turbulence, vortices, waves, and zonal jets under certain circumstances. Implications for observations will also be discussed.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Shih-Yun Tang (NAU & Lowell Observatory). *Impacts of Water Latent Heat for Ultra-Cool Objects' Thermal Structure: Brown Dwarfs and Free-Floating Planets*. **T**	Brown dwarfs are critical to the study of planetary atmospheres as they are self-luminous and often exist in isolation. As increasing numbers of ultra-cool objects with effective temperatures $\le$250K are expected to be found by future space missions (e.g., JWST) and next-generation ground-based telescopes (e.g., TMT, GMT, etc.), studies of atmospheric processes relevant to these bodies are urgently needed, especially with regard to the role of latent heat release from water condensation. In this study, we explore the impact of including a moist convective adiabat in a 1-D (vertical) atmospheric model over a range of effective temperatures, metallicities, and gravities. With water vapor having a volume mixing ratio of ≈2.6% in the metal-rich environment, our results show significant changes in the pressure-temperature profile with and without accounting for the release of water latent heat. The impact of latent heat release for the nearest Y2 dwarf, WISE 0855, is detectable and discussed here. We also discuss near- and mid-infrared spectral features that are most sensitive to metallicity; observations of these features could help with understanding the formation history of an object (i.e., distinguish a brown dwarf from a free-floating planet).
Santiago Torres (UCLA). *Raining Rocks in Exo-Worlds*. **T**	The existence of an atmosphere is thought to be vital for the occurrence of life on planets. However, the presence of planetary atmospheres is in jeopardy because of the constant bombardment of cometary bodies, which at worst can lead to a complete atmospheric loss - from planets like Mars up to hot Jupiters. To understand the vulnerability of the planetary atmospheres in different environments, we explored the dynamical evolution of exo-comets around exo-worlds, including a large variety of planetary system architectures. We first explored the parameter space by taking an analytical approach to calculate the rate of exo-comet impacts for each planetary system known to date. For a test case, we evolved the entire planetary system using detailed N-body simulations, which captures the dynamical evolution of the planets as well as comet bombardment. Our predictions will provide the required environment and dynamical properties in which an exo-world can both sustain an atmosphere for long and in which conditions the atmospheres should be evolving as an effect of cometary bombardment.
Noah Tuchow (Pennsylvania State University). *Relative Biosignature Yields: Assessing the Habitable Histories of Stellar Systems*. **8.6**	Future exoplanet direct imaging missions, such as HabEx and LUVOIR, will select target stars to maximize the number of Earth-like exoplanets that can have their atmospheric compositions characterized. Because one of these missions' aims is to detect biosignatures, they should also consider the long-term habitability of planets around these stars. We have developed a framework for computing relative biosignature yields among potential target stars, given a model of habitability and biosignature genesis, and planetary occurrence rates. For different model choices we find that the stellar populations preferred by our metrics vary drastically in terms of stellar masses and ages. The most physically motivated models for biosignature occurrence depend on the duration that a planet has been habitable, which requires precise stellar evolutionary tracks to accurately assess. We analyze the sensitivity of our biosignature yield metrics and other derived stellar properties, such as masses and ages, to stellar model uncertainties and systematic uncertainties in observed stellar properties. We determine the required precision needed to rank target stars according to our long-term habitability metrics and the extent to which obtaining more precise stellar properties decreases the uncertainty in relative biosignature yields.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
Adrienne Vescio (Arizona State University). *Investigating the Relationship Between Host Star Metallicity and Exoplanet Occurrence*. **5.5**	Over the years since the discovery of exoplanets, research has been performed investigating the correlations between host star and planet characteristics in an effort to better understand the conditions that best promote planetary formation and system longevity. Growing our knowledge in these areas supports efforts to discover planets that are most likely to host life. Here, we discuss a related effort investigating the relationship between host star metallicity and exoplanet frequency as it relates to a visible pattern in abundance ratio. In applicable plots comparing the abundance ratios of fundamental system building blocks, we observe a separation of the stellar population into two distinct groups, which were selected by eye and individually investigated. Through efforts to uncover potential effects of this separation, we find that there is a uniform discrepancy between populations, in which one has, on average, over twice the occurrence of planet-hosting stars. We anticipate that this finding and subsequent research to follow will allow for better understanding of planetary formation and how it depends on the abundances of basic elemental building blocks contained in the protoplanetary disk.
Alexandr Volvach (Radio Astronomy Laboratory of Crimean Astrophysical Observatory). *Water maser monitoring observations of star with exoplanets IRAS 16293-2422*. **3.6**	Alexandr Volvach (1), Larisa Volvach (1), Michail Larionov (2) (1) Radio Astronomy of Crimean Astrophysical Observatory RAS, Katsively (2) Astro Space Center, Lebedev Physical Institute RAS, Moscow The double system of solar masses IRAS 16293-2422 has been studied for more than 30 years as an example of a binary protosolar system. The existence of compact unresolved emission A1 possibly connected with to the dusty circumstellar disk by a size of low 3.6 au. The detail A2 was resolved and consisted with a gas-gust circumstellar disk by a size of 12 au. Detailed monitoring about one year of the water vapor maser in the double protostar object nearly solar masses IRAS 16293-2422 was performed. The observations were made at the frequency 22.235 GHz of the $6_{16} – 5_{23}$ water-vapor maser transition. For observation used the 22-m Simeiz telescope (RT-22). A unusual powerful short maser are was detected, occurred at the top of a longer but less powerful are, possibly initiating a powerful maser radiation of more short maser one.
William Waalkes (University of Colorado Boulder). *TOI 122b and TOI 237b, two small warm planets orbiting inactive M dwarfs, found by TESS*. **2.6**	We report the discovery and validation of TOI 122b and TOI 237b, two warm planets transiting inactive M dwarfs observed by TESS. Our analysis shows TOI 122b has a radius of 2.72±0.18 Re and receives 8.8±1.0×Earth's bolometric insolation, and TOI 237b has a radius of 1.44±0.12 Re and receives 3.7±0.5×Earth insolation, straddling the 6.7×Earth insolation that Mercury receives from the sun. This makes these two of the cooler planets yet discovered by TESS, even on their 5.08-day and 5.43-day orbits. Their relatively nearby distances (62.23±0.21 pc and 38.11±0.23 pc, respectively) make them potentially feasible targets for future radial velocity follow-up and atmospheric characterization, although such observations may require substantial investments of time on large telescopes.
Jason Williams (University of Southern California / Carnegie Observatories). *Design and Development of Henrietta, a high-precision ground-based NIR spectrograph to detect exoplanet atmospheres*. **7.2**	Henrietta is a near-infrared (NIR) long-slit/multi-object cryogenic spectrograph to be deployed at the 1-m Swope Telescope at Las Campanas Observatory. Henrietta is designed to survey the molecular content of exoplanet atmospheres from .97 – 1.8 microns at a resolution of 200. The primary driver of Henrietta is the noticeable gap in ground-based spectrophotometric precision from the optical to the infrared and the need for high precision spectrophotometric follow ups relevant to JWST. I will discuss how Henrietta seeks to resolve this gap and achieve near photon-noise limited observations by mitigating three insidious sources of noise and systematics: atmospheric scintillation, NIR sky emission, and subpixel quantum-efficiency fluctuations in H2RG arrays. Henrietta will have first light in August of 2022 and if it reaches its design goal it will enable the robust detection of exoatmospheres from the ground, become a 'finder scope' for JWST, and act as a testbed for future instruments to achieve high spectrophotometric precision from the ground.

Name (Affiliation). ***Title*****. Where.**	**Abstract**
James Windsor (Northern Arizona University). *Clouds Near and Far: A 1D Microphysical Cloudy-clear Climate Model*. **8.7**	Clouds substantially impact the climate and atmospheric structure of worlds throughout our Solar System. Furthermore, a critical feature of habitable planets, like our Earth, is that a substantial fraction of their visible disk is obscured by clouds. Ultimately, as the James Webb Space Telescope and other key observational facilities become operational, forward model sophistication must also evolve. One-dimensional planetary atmosphere models offer a powerful and computationally efficient approach to exploring a broad range of planetary and atmospheric conditions while preserving radiative transfer sophistication. Here we couple CLIMA (Kasting 1988; Kopparapu et al. 2013) to a well-established one-dimensional microphysical cloud model (Ackerman & Marley 2001) via a two-column (clear versus clouded) treatment of the atmosphere, following Marley et al. (2010). The most well-known terrestrial planet whose climate heavily depends on the influence of clouds is Earth. Thus, we present a validation of our new Microphysical Cloudy-clear Climate Model (MCCM) against Earth, following similar techniques outlined in Kopparapu et al. (2013). The development of this next-generation one-dimensional climate model seeds opportunities to explore cloud-influenced Habitable Zones (Kopparapu et al. 2013) and myriad explorations of unique exoplanet climates.
Lindsey Wiser (Arizona State University). *Self-Consistent Atmospheric Constraints for a Population of Hot Jupiters*. **T**	Transit and eclipse spectroscopy offer insights into the chemical and radiative properties of extrasolar planets, but inferring said properties from their spectra requires data-model comparisons. Typically, Bayesian atmospheric retrieval methods have been used to derive these properties. Retrievals generally make minimal assumptions allowing for more flexibility in the fits and potentially illuminating unknown physics, but this also creates the possibility of unphysical atmospheric determinations. In this work, we combine Bayesian parameter estimation tools with a new grid of self-consistent, one-dimensional, radiative-convective equilibrium models. We constrain metallicities, carbon-to-oxygen ratios, and heat redistributions for a population of hot Jupiters from their dayside thermal emission spectra, using data from a uniform data-reduction of Hubble WFC3 and Spitzer observations. The self-consistent approach mitigates the possibility of unphysical solutions, resulting in robust atmospheric inferences. We will present our self-consistent constraints on these fundamental atmospheric properties in the context of current retrieval results, and compare our findings to predictions from planet formation theories. Our nominal model fits to each object will be extrapolated to the James Webb Space Telescope wavelengths, as well as high-resolution, cross-correlation instruments, in order to identify observational setups that best address any degeneracies.
Inbok Yea (University of Delaware). *GPI Image and Analysis of the Debris Disk HD 15115*. **3.7**	Debris disk morphology provides information about the dynamical environment of circumstellar dust. Asymmetry and other shape distortions can signal that the disk is interacting with the ISM or being stirred by nearby planets. For this study, we analyzed GPI corona graphic images of the disk around HD 15115, dubbed the “blue needle.” Previous studies with STIS, SPHERE, and ALMA have shown a brightness asymmetry and suggested that two distinct dust belts might orbit the star. Our analysis reveals the same brightness asymmetry, plus a warp on the Eastern limb. A future research goal is to search for evidence of a second dust belt.

Name (Affiliation). ***Title*****.** **Where.**	**Abstract**
Tze Yeung Mathew Yu (UCLA). *Assembly of Super-Earth Systems in a Magnetospherically Truncated Protoplanetary Disk*. **3.8**	In the last decade, many works tried to explain the origin of the observed close-in Super-Earth and Sub-Neptune population using type-I migration during the protoplanetary disk phase; it is anticipated that disk-planet interaction moves them close to their host stars and the migrational effect is negated near 10-days orbit by invoking planet trap. Most works assume truncations in the protoplanetary disks caused by the host stars' magnetic field and employ sharp drop-offs in surface densities to model the truncations. In this presentation, we will show that we can construct a more realistic model by re-applying existing accretion disk model around white dwarfs to protoplanetary disks accreting onto their host star. In our model, we consider not only the host star's magnetic field truncating the disk but also the field diffusing into the inner region of the disk. We treat both accretion heating in the disk and passive heating from the host star self-consistently. We will demonstrate that model parameters, such as magnetic-field strengths and profiles, strongly affect the migrational behavior of planets in our model, which is critical in understanding the orbital distribution of observed close-in super-Earths. A subset of our parameter is able to produce populations similar to observations.
Brianna Zawadzki (Penn State University). *Regularized Maximum Likelihood Techniques for ALMA Spectral Line Imaging*. **T**	Radio interferometers incompletely and noisily sample the visibility function of an astronomical source, making the recovery of the true sky brightness distribution an ill-defined inverse problem. While image-plane deconvolution algorithms like CLEAN have been the go-to tool for most radio astronomers, recently, Regularized Maximum Likelihood (RML) imaging techniques have shown potential to synthesize images with better angular resolution and image fidelity, especially for continuum observations (e.g., see EHT M87 results). Building on this momentum, we are developing algorithms that extend RML imaging algorithms to ALMA spectral line observations, which will be useful for the kinematic detection of planets in protoplanetary disks and finely detailed astrochemical characterization. As part of this effort, we are vetting several "image priors" to identify the most useful for the varied morphologies of spectral line emission. In this presentation I will discuss the foundational principles of RML imaging and describe our ongoing work in designing a community-facing Python package for ALMA spectral line imaging.
Jinglin Zhao (Penn State University). *FourIEr phase SpecTrum Analysis (FIESTA) to disentangle planets from stellar activities*. **2.7**	In the radial velocity detection of exoplanets, the planetary signal, i.e., the Keplerian Doppler wobbling of stars can be mimicked by stellar activities that deform the spectral line profiles, which results in apparent radial velocity shifts. Traditionally, stellar activity indicators assist in ruling out false planet detections but lacks robustness and consistency. We've been developing the FourIEr phase SpecTrum Analysis (FIESTA) to parametrise spectral line profile variability in Fourier space for this challenge. The cross-correlation function of each stellar spectrum is decomposed into Fourier basis functions and parametrised by their amplitudes and phases. We show such a parametrisation preserves all the information of the line profile and robustly traces the line variability, with examples of the SOAP solar simulations and the 3 years of HARPS-N solar observations.