14-17 October 2025

Tartu, Estonia

Exploring Star-Planet-Disk Connections

CONFERENCE ABSTRACT BOOK

Funded by the European Union

UK Research and Innovation

Table of Contents

Introduction

The study of the star-planet-disk connections is crucial for understanding the formation and evolution of planetary systems, including our own. Stars, disks, and planets are not isolated entities, but are intrinsically linked by their formation processes and shared chemical environments. By examining how these components interact, we can gain insight into the initial conditions that govern planet formation, the evolution of planetary atmospheres, and the potential habitability of exoplanets. In an era of rapid advances in exoplanet detection and characterization, this field is more relevant than ever for unveiling the diversity of planetary systems and understanding the forces that shape them.

The scope of the conference "Exploring Star-Planet-Disk Connections" will span a wide array of topics, including methods to study stellar atmospheres, the challenges of stellar characterization in the era of large-scale space missions, and the chemical processes within disks that influence planet formation and composition, providing a holistic view of planetary system formation and evolution. This timely meeting offers a platform for researchers to share their latest findings and collaborate on solutions to some of the most pressing challenges in the field.

This is the final conference of the EXOHOST project being coordinated by the Tartu Observatory, University of Tartu from 2023 to 2025. EXOHOST is a Twinning project with the main goal to build excellence in spectral characterization of exoplanet hosts and other stars at Tartu Observatory. Our partners in the project are Uppsala University, Space Research Institute of the Austrian Academy of Sciences, and University College London. This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101079231 (EXOHOST), and from UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (grant number 10051045).

Session 1: Fundamental Stellar Properties

Understanding the key physical properties of stars — such as mass, radius, age, and temperature — that are crucial for interpreting exoplanet observations and evolution.

Invited Speaker: **Camilla Danielski** - *The Star Sets the Stage: Understanding Exoplanets Through Their Hosts*

(University of Valencia, Spain)

To understand the nature of exoplanets, we must move beyond studying them in isolation and instead characterize entire planetary systems. The fundamental, chemical and dynamical properties of host stars set the scale for planetary parameters and shape their evolution, while the Galactic environment in which a system forms can influence the diversity of planetary architectures and atmospheres. Ensuring consistency in stellar characterization is also crucial, so that observed correlations reflect genuine astrophysical trends rather than analysis artefacts. In this talk, I will give an overview of these themes and discuss how expanding our target selection across a wide range of chemical and dynamical environments—from local overdensities to the Galactic halo, and across different stellar evolutionary phases—will be key to uncovering how planets form and evolve under diverse conditions.

Alix Freckelton - *The Gr8stars Catalogue: a Public Library of FGKM Dwarf Spectra and Their Homogeneously Derived Parameters.*

(University of Birmingham)

Advances in instrumentation and techniques are leading us into a new era of stellar and exoplanetary studies. A homogeneous, precise, and accurate source of stellar parameters for bright stars is crucial for many studies, including, but not limited to, designing radial velocity exoplanet surveys, performing precision stellar abundance analyses, and planning future direct imaging surveys. I introduce the Gr8stars catalogue, which currently provides uniformly formatted spectra and homogeneous atmospheric parameters, determined using the PAWS pipeline, for 1715 FGKM main sequence stars in the solar neighbourhood. Ongoing expansions to the catalogue will ultimately result in the classification of nearly 6000 main sequence stars with $G < 8$, further improving the usefulness of Gr8stars in studying stellar composition, host-star characterization, and evolutionary trends. Future plans for the Gr8stars collaboration include the comparison of atmospheric parameters determined by varying spectroscopic methods across parameter space, stellar activity investigations, and detailed stellar abundances studies. In this talk I will present the Gr8stars catalogue, detail the PAWS spectroscopic pipeline and present the resulting homogeneous properties of these bright nearby stars.

Lara Piscarreta - *Accretion Makes Young Stars Look Old: Lessons from Orion*

(European Southern Observatory (ESO))

The observed decline in protoplanetary disk frequency with increasing age in nearby star-forming regions implies typical disk lifetimes of a few Myr, setting constraints on the timescales of planet formation and disk dispersal. However, in the Orion Nebula, some pre-main sequence (PMS) stars exhibiting infrared excess

and strong H-alpha emission (signatures of ongoing accretion) appear anomalously old (≳10 Myr) in optical colour-magnitude diagrams (CMDs).

To investigate this discrepancy, we conducted a spectroscopic analysis of PMS stars located in the Orion Nebula using VLT/X-Shooter. We derived stellar parameters (effective temperature, extinction, stellar luminosity), accretion diagnostics (accretion luminosity, mass accretion rate), and lithium equivalent-widths across a sample of 40 PMS with isochronal ages spanning from ~1 to >30 Myr. After accounting for extinction and excess continuum emission coming from the accretion process, we find that most of the seemingly old stars occupy positions in the HR diagram consistent with a younger population (1–5 Myr). Strong lithium absorption and typical accretion-to-stellar luminosity ratios further support their youth. Moreover, these seemingly old stars typically show some of the highest accretion luminosities in the sample.

This study highlights how accretion affects the photometry of PMS stars and the importance of accounting for this effect to obtain reliable age estimates. In this talk, I will explore how ongoing accretion can shift stars in optical CMDs, and how this impacts our understanding of stellar ages and disk evolution in young clusters.

Matthias Ammler-von Eiff - *How to Improve the Characterization of Distant Stars with Transiting Exoplanets?*

(MPI for Solar System Research)

The accurate determination of the host star parameters is essential to characterize their orbiting planets. In the PLATO mission, the target sample consists of stars with V <= 13 mag, many of which may be too faint for the full characterization via asteroseismology and ground-based spectroscopy, as is planned for the brighter targets. Additionally, these stars tend to be distant, making interstellar extinction a more significant factor compared to other PLATO targets.

To assess the limitations of the stellar characterization and to explore possible solutions in preparation for PLATO, we reviewed the stellar parameters of all 36 CoRoT planet hosts. These are typically faint (V=12-16 mag) and can be as distant as 1 kpc and more.

We identified independent constraints that do not rely on details of stellar modelling, in particular stellar density based on transit light curves and distance from Gaia astrometry. We compared these to published estimates of extinction and effective temperature for CoRoT targets with planets. This way, we can determine how accurate stellar parameters are and reassess extinction. We found that published estimates of extinction and effective temperature do not match the constraints in several cases.

After constraining extinction and effective temperature, we can compute the radii of the host stars from stellar density and Gaia distance in a homogeneous way. To our knowledge, this is the first comprehensive characterization of the full set of CoRoT host stars using precise distances from Gaia. These findings provide a framework for improving stellar characterization in the PLATO mission, particularly for faint planet host stars.

Nicola Miller - *Eclipsing Binaries as Benchmark Stars: Addressing the "Effective Temperature" Elephant in the Room*

(Uppsala University)

Detached eclipsing binaries (DEBs), especially double-lined systems (SB2 DEBs), are becoming recognized as high-quality benchmarks for stellar astrophysics thanks to recent improvements in the precision of their measured model-independent masses and radii. This is thanks to high-quality space-based photometry (e.g. TESS, Kepler, CHEOPS) and radial velocity measurements from stable high-resolution échelle spectra, which now make it common to reach <0.2% precision in these properties. DEBs can therefore provide extremely rigorous benchmarking constraints for a wide range of applications, e.g. calibrating stellar evolution models, testing asteroseismic scaling relations, and validating machine-learning pipelines such as those used in exoplanet host star characterization (e.g. PLATO, 4MOST). However, effective temperature (Teff) remains a persistent limitation on the usefulness of DEBs as benchmarks, due to large systematic uncertainties and inconsistent methodologies throughout literature. I will present results from our ongoing work to address this issue: we use a novel method to measure fundamental Teff for stars in non-spatially-resolved DEBs by measuring bolometric flux contributions from multi-band light curves, and angular diameter from stellar radii and parallax. I will highlight interesting examples from our growing sample of well-characterized FGK-type DEBs, and discuss possible future extensions to the method and its applications.

Andreas Quirrenbach - *Terrestrial Planets Orbiting Low-mass Stars*

(Landessternwarte, ZAH, U Heidelberg)

Main-sequence stars with masses less than 0.6 Solar masses (i.e., M dwarfs) offer unique opportunities for studies of rocky planets that are currently not possible for Solar-type stars. Due to the low mass and small size of the host star, the sensitivity of radial-velocity and transit searches reaches down to 1 Earth mass and radius, allowing the computation of meaningful planet densities. A large JWST programme has just started with the goal of determining whether these planets have atmospheres. Statistical analyses of M-star planet surveys provide an overview of their terrestrial planet and super-Earth population including multiple systems, shedding insight into planet formation in disks of stars down to the hydrogen burning limit. I will present and discuss results from the CARMENES radial-velocity survey, the CARMENES-TESS programme as well as other instruments, and provide an outlook of what we can expect from new data that will become available over the next few years.

Tõnis Eenmäe - *Enhancing Northern Sky Monitoring: Upgrades to Tartu Observatory's 1.5 m Telescope for High-Resolution Spectroscopy and Multi-Band Photometry*

(Tartu Observatory, University of Tartu)

Telescopes at Tartu Observatory offer unique guaranteed access to objects in the Northern Hemisphere, facilitating long-term monitoring of various targets. Our largest, 1.5 m instrument, has recently undergone significant upgrades, including the installation of a medium-resolution fibre-fed echelle spectrograph covering a wavelength range from 380 nm to 910 nm. This spectrograph offers flexibility with input options between two different fibre sizes, enabling retrieval of spectra with spectral resolution up to R=33,000.

Moreover, a custom-designed 4-channel instrument cube has been integrated, allowing for the attachment of two additional instruments to the telescope. Among these additions is a photometer equipped with Johnson-Cousins BVRcIc, Sloan u'g'r'i'z', and H-alpha filters. These upgrades enhance the capabilities of our spectroscopic and photometric observations, particularly for studying celestial objects and phenomena such as exoplanet transits, properties of exoplanet host stars, photometry of asteroids, and different types of transients.

In our presentation, we will provide an update on the status of these projects, detailing the improvements made and the impact on our observational capabilities.

Mengfei Sun - *Planetary Edge Trends (PET) I. The Inner Edge-Stellar Mass Correlation*

(Nanjing University)

Recent advancements in exoplanet detection have led to over 5,700 confirmed detections. The planetary systems hosting these exoplanets exhibit remarkable diversity. The position of the innermost planet (i.e., the inner edge) in a planetary system provides important information about the relationship of the entire system to its host star properties, offering potentially valuable insights into planetary formation and evolution processes. In this work, based on the Kepler Data Release 25 (DR25) catalogue combined with LAMOST and Gaia data, we investigate the correlation between stellar mass and the inner edge position across different populations of small planets in multi-planetary systems, such as super-Earths and sub-Neptunes. By correcting for the influence of stellar metallicity and analysing the impact of observational selection effects, we confirm the trend that as stellar mass increases, the position of the inner edge shifts outward. Our results reveal a stronger correlation between the inner edge and stellar mass with a power-law index of 0.6-1.1, which is larger compared to previous studies. The stronger correlation in our findings is primarily attributed to two factors: first, the metallicity correction applied in this work enhances the correlation; second, the previous use of occurrence rates to trace the inner edge weakens the observed correlation. Through comparison between observed statistical results and current theoretical models, we find that the pre-main-sequence (PMS) dust sublimation radius of the protoplanetary disk best matches the observed inner edge-stellar mass. Therefore, we conclude that the inner dust disk likely limits the innermost orbits of small planets, contrasting with the inner edges of hot Jupiters, which are associated with the magnetospheres of gas disks, as suggested by previous studies. This highlights that the inner edges of different planetary populations are likely regulated by distinct mechanisms.

Session 2: Stellar Activity

Exploring how stellar magnetic activity, variability, and flares impact both the detection of planets and the interpretation of their atmospheres.

Invited Speaker: **Savita Mathur** - *Magnetic Lives of Solar-like Stars: Implications for Exoplanet Study*

(IAC, Spain)

The search for exoplanets has been at the heart of recent and ongoing space missions such as CoRoT, Kepler, TESS, and soon PLATO, with particular emphasis on identifying potentially habitable worlds. Beyond orbital conditions determined by the host star's spectral type, the magnetic activity of the star plays a crucial role: high activity levels can erode planetary atmospheres and strongly influence the prospects for life. In addition, stellar activity can hamper exoplanet detection. Understanding how stellar magnetic activity evolves throughout a star's lifetime is therefore fundamental for assessing habitability and the detection.

In this review, I will present our current knowledge of the magnetism of solar-like stars, from the main sequence to the red-giant branch. I will highlight results obtained with the Kepler mission, where precise photometry enabled the measurement of stellar surface rotation periods and activity levels for thousands of stars. These studies shed light on the evolution of rotation and magnetism and their consequences for star–planet interactions. I will conclude with perspectives for the upcoming PLATO mission, which will provide unprecedented constraints on stellar magnetic activity and its impact on exoplanet characterization.

Fatemeh Zahra Majidi - *Mauve: a Three-year UV-Vis Survey Dedicated to Monitor Stellar Activity and Variability*

(Blue Skies Space)

Mauve is a satellite equipped with a 13 cm telescope and a UV-Visible spectrometer (with an operative wavelength range of 200-700 nm) conceived to measure the stellar magnetic activity and variability. The science programme will be delivered via a multi-year collaborative survey programme, with thousands of hours each year available for long baseline observations of hundreds of stars, unlocking a significant time domain astronomy opportunity. Mauve's mission lifetime is 3 years with the ambition of 5 years, and it will cover a broad field in the sky (–46.4 to 31.8 degrees in ICRS) during this period. Booked to launch in October 2025, Mauve's science team will form prior to the launch date, defining the observation strategy and targets.

This facility was conceived to support pilot studies and new ideas in science and is fully dedicated to time-domain astronomy. The main surveys to be executed by Mauve are long baseline observations of flare stars (eruptive Wolf–Rayet stars, UV Ceti stars, etc.), RS CVn variables, eclipsing binaries, Herbig Ae/Be stars, exoplanet hosts, hot stars, etc. Besides these major science themes, the spectrometer's data can be utilized to support and complement existing and upcoming facilities as a pathfinder, or conduct simultaneous/follow-up observations.

Eike Wolf Guenther - *The First Spectroscopic Screening of Exoplanet Host Stars of PLATO*

(Thüringer Landessternwarte Tautenburg)

PLATO is the next generation exoplanet mission. Its main science goals are the very accurate determination of the masses, radii and ages of extrasolar planets, including planets smaller than two Earth-radii in the habitable zones of solar-like

(F5-K7) stars. However, stars of other spectral types will also be observed. As part of the follow-up observations, all planet-candidate host stars will be observed spectroscopically. The aims of this first screening are the removal of false positives, the characterization of the host stars, and the RV-measurements to determine the masses of gas-giant planets.

Furthermore, we will also search for non-transiting planets with long orbital periods. Of key importance is the determination of the rotation-velocities, $v \cdot \sin i$, the effective temperatures, and the activity levels of the host stars. These parameters are required to estimate how many RV-measurements must be taken to determine the masses of the planets. These values will also be used to identify the best targets for future observations. We have built a dedicated instrument for the first screening for the southern PLATO-field, called PLATOspec, and we are planning to build up a network of telescopes in the northern hemisphere for similar purposes. The most active star in the southern PLATO-field is UY Pic, a visual binary with an age of 70 Myrs. We report on the results of a spectroscopic monitoring campaign obtained simultaneously with TESS. The purpose of the campaign was to study the relation between the RV-variations, the photometric variations, and the various activity indicators obtained from the spectra. In this way we develop a method that allows us to estimate the activity noise of the RV-measurements from the photometric variations and the activity indicators.

Hala Alqubelat - *Accretion Variability and Binarity in Young Stars: Insights from DQ Tau and Transition Disks*

(European Southern Observatory (ESO))

Accreting binary systems interact dynamically with their circumstellar and circumbinary environments, producing variability across multiple wavelengths and timescales. Understanding these variations is crucial for constraining accretion physics and disk structures.

DQ Tau is a short-period (15.698 days), highly eccentric (e = 0.6), equal-mass binary exhibiting sharp accretion bursts near periastron. The orbital motion clears the inner region, enabling the formation of multiple accretion disks. The circumbinary accretion streams are strongly influenced by the system's orbital parameters. Using VLT/UVES and VLT/X-Shooter, we applied the broadening function (BF) technique to calculate radial velocities (RVs) across multiple epochs. The BF analysis reveals two distinct RV signatures, confirming the equal-mass components. Over time, we observe changes in BF peak heights (flux ratios) tied to orbital phase, offering insights into veiling on each star.

I will present results from spectral disentangling of DQ Tau, deriving accretion rates for both stars, and show how pulsed accretion affects measured RVs over 10 orbits from a recent JWST, LCO, X-Shooter, and UVES campaign.

DQ Tau has shaped our understanding of young binaries, but how far can we push binarity studies in variable accretors? I will highlight disks with large, dust-free cavities seen in ALMA continuum images, proposing they are carved by stellar or substellar companions. I will discuss RV variations observed with ESPRESSO/VLT over 3 years for 12 transition disks, and the possible binary configurations responsible for the observed cavities. Finally, I will address how to disentangle RV variations caused by stellar activity versus planetary companions.

Telmo Monteiro - *Analysis of NIR Activity Indices for Exoplanet Detection and Characterization*

(Institute of Astrophysics and Space Sciences)

Stellar variability can impact planetary signals detected via the RV method. This is often addressed by tracking spectral lines sensitive to magnetic or/and temperature changes in the stellar atmosphere. With the growing use of NIR instruments like

NIRPS, understanding NIR activity indicators is crucial, as their sensitivity may vary with stellar properties.

We performed an in-depth analysis of 16 NIR activity lines in 20 M and K NIRPS-GTO stars to identify the best indicators for tracking stellar variability across different stellar characteristics, using simultaneous observations with HARPS and NIRPS high-resolution spectrographs. Effective temperature, metallicity, pEW(Hα) and rotation periods were compiled for all stars. ACTIN was used to extract activity indices based on the Hα and Na I lines in the visual range. These, along with the FWHM of NIRPS CCF, served as anchors for activity level and variability. Activity indices were extracted from the 16 NIR lines and compared across stellar parameters using Spearman correlations with the anchor indices and GLS periodograms to recover the stellar rotation period.

We found that a 0.6 Å central bandpass for Hα is optimal for both M and FGK stars (Gomes da Silva et al. 2022). No single NIR indicator consistently traced activity across all stars, but several were effective for specific stellar parameters and observational ranges. Thus, the best approach is to select the optimal indicator case by case, with individual bandpass optimization, although this limits generalization. Additionally, we developed AMATERASU, a tool for easy extraction of pseudo-equivalent width-based activity indices with varying central bandpasses, generating time series and using GLS periodograms to identify periods close to user-defined inputs.

This work provides a systematic analysis of the activity sensitivity of new and previously studied NIR lines and introduces a new tool to support stellar activity tracking in the visual and NIR regimes.

Simranpreet Kaur - *Polarized Radio Emission from Scallop-shell Stars: The Case of J0508-21 and DG Cvn*

(Institute of Space Sciences (ICE-CSIC), Barcelona)

Scallop-shell stars (SSSs) or Complex Periodic Variables (CPVs) are a recently discovered class of young M dwarfs, which show quasi-periodic dips in their optical light curves that are stable over tens to hundreds of rotation cycles. The origin of these dips is not well understood, however the most promising scenarios involve the presence of gas trapped in huge prominences or dust from the debris disk or a disrupting rocky planet at the co-rotation radius. The talk will focus on the radio observations of two of the radio loud SSSs: J0508-21 and DG CVn. J0508-21 was observed at 575–720 MHz with the uGMRT in two epochs of 7 hours each. We detected ~mJy level fluxes with high circular polarization, along with an ~hour-long helicity reversal in both epochs, happening at a similar rotational phase. This suggests presence of two emission components: a persistent gyro-synchrotron emission and a short-duration, auroral like emission, likely powered by the ECM mechanism, possibly resulting from a Jupiter-Io like interaction between the star and the occulting material. On the other hand, DG CVn displays a weakly polarized, quiescent component along with ~100% polarized bursts lasting from minutes to over half an hour during its 14 hours of VLA observations at 1.5 GHz. Some of these bursts also show a drift in frequency and time, which could be caused due to beaming effects or the motion of the source and are consistent with plasma or ECM mechanisms. Overall, these observations reveal that the SSSs are no longer constrained to optical observations only, and how the radio observations can help reveal the underlying processes, highlighting the need to have more contemporaneous/simultaneous multi-wavelength observations of such systems.

Gloria Canocchi - *Challenging Na Detections in the Atmospheres of Giant Exoplanets with 3D Non-LTE Stellar Spectra*

(Stockholm University)

Transmission spectroscopy from high-resolution ground-based spectrographs is one of the most powerful techniques for characterizing the atmospheres of giant exoplanets. Previous studies have highlighted the importance of correcting the transmission spectra for the center-to-limb variation (CLV) and the Rossiter-McLaughlin (RM) effect arising as the planet transits the stellar disk. If not properly corrected, these effects can indeed resemble or cancel out planetary absorption in certain cases, thus affecting the determination of elemental abundances in the planetary atmospheres, as shown by Yan et al. (2017).

However, commonly used 1D plane-parallel LTE atmosphere models fail to reproduce spatially resolved observations of the solar disk. 3D radiation hydrodynamic models and non-local thermodynamic equilibrium (non-LTE) line formation are required for an accurate modelling of the CLV effect.

Sodium is by far the most detected species in transmission spectra, through the analysis of the Na I D lines, which are affected by strong 3D non-LTE effects.

In this talk, I will present new results regarding the analysis of these lines in ESPRESSO data of several benchmark gas giants, by modelling their CLV and RM effect using 3D non-LTE radiative transfer. These kinds of studies will be fundamental in preparation for the ELT in order to be able to fully exploit its capabilities in the near future.

Bertram Bitsch - *Introduction of the COST Action CA22133 PLANETS*

(University College Cork)

COST Actions are projects funded by the European Union to bring scientists working on similar topics together. In particular the COST Action CA22133 PLANETS is designed to advance our understanding of planet formation by focusing on different aspects from laboratory experiments to simulations. The COST Action also organizes (online) presentations and workshops, meetings and allows members to apply for funding to visit conferences as well as to visit collaborators. In this talk I will introduce the scientific goals of the COST Action CA22133 PLANETS, how you can become a member of the COST Action, and how you can benefit from joining.

Session 3: Stellar Chemical Composition

Characterizing the elemental abundances of stars to understand their formation history and the chemical environment where planets emerge.

Invited Speaker: **Elisa Delgado Mena** - *The Impact of Stellar Composition: from Galactic Chemical Evolution to Planet Formation*

(CAB, Spain)

The characterization of solar-type stars is fundamental for various fields in astrophysics, including exoplanet detection and the chemical evolution of our Galaxy. In particular, the determination of chemical abundances for stars at different metallicities and ages provides us with a key insight on how and when the various chemical elements were formed within the Galaxy. The chemical trends observed in different parts of the Galaxy (thin disk, thick disk, bulge and halo) also serve to understand how those different populations were formed. On the other hand, knowing the particular characteristics of a given star is essential to be able to detect its hosted planets as well as to characterize their mass, radius, structure and bulk internal composition. The probability of finding planets is clearly related to the chemical makeup of the stars and these planets in turn can have an influence on the stellar composition. In this talk I will review some of the important advances in these topics.

Edita Stonkute - *Chemical Signatures of Planet-Hosting Stars*

(Institute of Theoretical Physics and Astronomy, Vilnius University)

With the recent discovery of numerous exoplanets, our observational studies aim to understand the relationship between stars and their planets by analysing the elemental compositions of stars that host these planets. Accurate and consistent determinations of stellar atmospheric parameters and chemical compositions across various Galactic components are essential for advancing our understanding of exoplanet formation and evolution.

To achieve this, we require homogeneous abundance measurements for a statistically significant number of planet-hosting stars, along with a substantial comparison sample. Our follow-up programme employs the high-resolution Vilnius University Echelle Spectrograph at the Moletai Observatory's 1.65 m telescope to study these stars. This state-of-the-art spectrograph allows us to perform detailed and precise analyses, making it an invaluable tool for our research.

We have determined the atmospheric parameters, kinematics, ages, and abundances of elements such as C, N, O, Mg, Si, and neutron-capture elements. In this presentation, I will share our findings from the analysis of 160 stars with planets, highlighting the potential connections between stars and their planetary companions.

Our work showcases the capabilities of the advanced instrumentation available in Lithuania, emphasising the significant contributions that can be made to the field of exoplanetary science using the Vilnius University Echelle Spectrograph.

Masanobu Kunitomo - *New-Generation Solar and Stellar Models Including Accretion*

(Kurume University)

We present our theoretical models of the Sun and other stars, including accretion processes. Traditionally, star formation and planet formation have been studied independently. However, we now know that the first phase of stellar evolution is affected by the accretion from protoplanetary disks. Planet formation theory predicts that the composition of the gas accreted by the star must have been variable: the growth and inward drift of dust in the disk leads to a "pebble wave" of increased metallicity, followed by a phase in which the exhaustion of the pebbles and the formation of planets leads to the accretion of metal-poor gas. Our solar models show that the low-metallicity protosolar accretion is imprinted onto our Sun's core, which has a higher metallicity by up to 5% and consequently, a higher temperature than predicted by standard models. Our model with accretion simultaneously reproduces the observations of solar neutrino fluxes and the low-metallicity surface (Asplund et al. 2021). In addition to the Sun, the metal-poor protostellar accretion has a stronger impact on A-type stars, which have a thin or no surface convective zone. We argue that the accretion is a strong candidate for the origin of λ Boo stars.

In the main sequence, dynamical instability of planetary systems leads to planet(esimal) accretion, which increases the stellar surface metallicity. Again, the accretion signature is expected to be stronger in A-type stars. However, in this scenario, one should also pay attention to the effect of radiative levitation, in which radiation pressure pushes heavy elements upward in the stellar interior. From the comparison between the models of A-type stars and a large sample of stellar abundances from GALAH and Gaia surveys, we found ~30 stars that exhibit accretion signatures. We suggest that these stars would be prime targets investigated in detail by PLATO.

Neda Hejazi - *A New Method to Measure the Detailed Chemical Abundances of Cool Dwarfs and Its Application to Star-Planet Chemical Connection Studies*

(University of Kansas / Universidad de Tarapaca)

JWST has opened up new vistas to precisely determine the chemical composition of exoplanets around low-mass stars. Searching for chemical links between stars and their planets thus demands abundance measurements of JWST planet hosts. We present a new methodology to reliably measure the detailed abundances of different key (up to 15) elements in cool dwarfs with 3100<Teff<4900 K using an in-depth high-resolution spectroscopy. We develop an automatic, line-by-line, synthetic model-fitting code, AutoSpecFit, which performs a series of minimization processes along with a meticulous routine to locally normalize the observed flux, and accounts for the complex correlations between the abundances of different elements via an iterative procedure. Using the high-resolution (R=45,000), NIR IGRINS spectra, we measure the abundances of the K dwarf WASP-107 (Hejazi et al. 2023) hosting a super-Neptune planet and the M dwarf K2-18 (Hejazi et al. 2024) hosting a sub-Neptune planet; both planets have been targeted by JWST observations. Using our inferred C/O ratios, we trace the formation location of these planets relative to the ice lines within the protoplanetary disk, and along with Mg/Si, we constrain the proportion of rock-forming silicates in their rocky cores. By measuring the C/O ratio of a young M-type T Tauri star, DH Tau A, using its IGRINS spectra, we reveal a chemical homogeneity between the star and its super-gas giant companion, suggesting a direct and fast gravitational collapse, rather than a slow core accretion process for the formation of the companion (Hejazi et al. 2025). We further measure the abundances of the M dwarf GJ 341 using its IGRINS spectra, which are then used to estimate the core mass fraction, iron mass fraction, and bulk molar ratios of the orbiting small rocky planet (also targeted by JWST) through interior models. We

are currently measuring the abundances of 8 rocky-planet cool dwarfs and the relevant results are discussed in this presentation.

Jiayue Zhang - *Unveiling the Chemical Abundance Pattern of Solar Analogues Hosting Debris Disks*

(Tsinghua University)

The peculiar depletion of refractory elements in the solar photosphere compared to nearby solar twins remains a mystery in stellar astrophysics and star-planet connection. Recent studies suggest possible links to planet formation or disk-related processes. However, debris disks, tracers of planet formation, have been largely unexplored in this context. We propose the first systematic observations of the chemical abundances of 69 solar analogues with confirmed debris disks using high-resolution spectroscopy. By comparing their detailed abundance patterns, especially the [X/Fe] versus condensation temperature (Tc) slope, with a large control sample of over 17,000 solar-analogue stars, we aim to identify potential chemical signatures imprinted by disk-related evolution. Our results will provide crucial insights into the origin of the solar abundance anomaly and constrain the chemical evolution pathways of planetary systems.

Sandipan Borthakur - *Stellar Photospheric Contamination in Early-Type Stars - from Protoplanetary to Debris Disks*

(OeAW Space Research Institute)

Young stars accrete material from their protoplanetary disks, which can contaminate the stellar photosphere. This is especially noticeable in hot stars with radiative envelopes, where slower mixing in the photosphere preserves these contamination signatures over longer timescales. The accreted material carries a chemical imprint, particularly in disks with gaps, where dust is trapped at the outer edge while gas moves inward. This results in the accretion of dust-poor material, leading to a photospheric abundance pattern with depletion of refractory elements (e.g., Fe, Mg), while volatile elements (e.g., C, O) remain unchanged. These chemically peculiar stars are known as lambda Bootis type stars. These contamination signatures in the stellar photosphere give us valuable insights into the elemental composition of the inner disk since the accreted material comes from this region.

In this talk, I will present our study of the photospheric composition of young A-type stars hosting debris disks, a later stage in protoplanetary disk evolution. While debris disks have low accretion rates that don't significantly affect the stellar photosphere, there has been little work on abundance anomalies in these stars. We analysed the high-resolution spectra of six such stars and identified two that exhibit lambda Bootis type peculiarities. This talk will discuss the origins of these peculiarities in these two stars and compare young debris disk-hosting stars with their protoplanetary disk-hosting counterparts. Understanding these anomalies may provide insights into similar lambda Bootis type stars over 100 million years old, where accretion from a circumstellar disk is not expected.

Veronika Mitrokhina - *Detectability of Deuterium in the Spectra of A-type Stars*

(Tartu Observatory, University of Tartu)

Deuterium (D) was primarily produced during Big Bang Nucleosynthesis, with a primordial abundance of [D/H] = $(2.58 \pm 0.13) \times 10^{-5}$ (Cyburt et al. 2016). Deuterium is easily destroyed in stellar interiors through astration (Epstein et al. 1976) making its detection in stellar atmospheres unlikely unless external processes, such as planetary engulfment, temporarily enhance surface abundances. A-type stars, with radiative envelopes, provide a favourable environment for the survival of accreted deuterium.

In this study, we explore the detectability of deuterium in A-type stars, which possess radiative envelopes that can delay the mixing and destruction of accreted material. We generated synthetic spectra for stars with effective temperatures between 7500 and 12500 K and a surface gravity of log g = 4.0 using the ZEEMAN spectrum synthesis code and a grid of ATLAS9 model atmospheres. The linelist was modified by manually inserting the deuterium lines, focusing on the optical wavelength region.

We applied a Markov Chain Monte Carlo (MCMC) analysis to estimate upper limits for deuterium detection across varying signal-to-noise ratios (SNRs) and temperatures.

Our results show that the Hα region provides a significantly more sensitive diagnostic of deuterium than Hβ. We provide upper limits on detectable deuterium abundances as a function of SNR. Extending this analysis to real observations will enable new insights into the processes of stellar surface contamination.

Karolina Szewczyk - *Disk Caught at the Transition from Protoplanetary to Debris Stage*

(University of Leeds)

Forming planetary systems in the transition from protoplanetary to debris disks are so rare, that only one such object, HD 141569, was known until now. Using ALMA Band 6 observations, we present the detection of gas and millimetre dust in another recently dispersed disk around a 2 Myr-old intermediate-mass star. We searched for continuum, 12CO, 13CO, and C18O (all J=2-1) emission. The detected 12CO gas and dust emission results in CO gas and dust masses of the order Mco=10^-4 Mearth and Mdust=0.01 Mearth. From the non-detections of 13CO and C18O we provide upper limits on the total CO gas mass of around Mco=10^-2 Mearth, suggesting that the 12CO emission may be optically thick and hence implying that the CO gas mass we derive should be considered as a lower limit. The asymmetry of dust distribution around our target is a feature also seen in HD 141569, and both systems exhibit gas emission arising from a region inside to the dust emission. These may represent hallmark features of the transition from gas-dominated to solid body-dominated disk physics. Moreover, our target star shows a 12 μm fractional excess comparable to HD 141569, which falls within the transitional phase between protoplanetary and debris disk. Studying these unique systems helps us understand the processes that drive gas dispersal and its influence on the early stages of formation and evolution of planets and planetary systems, providing new insights into disk evolution at this transitional stage.

Andrea Perdomo García - *Most Planet-Hosts Have Sub-Solar Metallicities, But Solar or Super-Solar Iron*

(Max-Planck-Institut für Astronomie)

Observational studies of star-planet connection assume that the iron abundance [Fe/H] is a proxy of stellar metal mass fraction Z. The available data indicate that the probability of finding a giant planet increases with [Fe/H] of the host, while the probability to find smaller planets does not correlate with [Fe/H]. These empirical relationships agree with the core-accretion scenario or extensions thereof. However, while the observations are based on [Fe/H], the planet population synthesis models use Z to characterize the dust-to-gas ratio in the protoplanetary disks where the planets are formed.

We study the empirical trends for all known stellar hosts using Z instead of [Fe/H]. We use the GALAH, APOGEE, and Gaia stellar catalogues, and we find the abundances and relevant parameters of the host stars for all confirmed and candidate exoplanets from exoplanet.eu and TESS objects of interest in the 4MOST field of view. We also include in our sample the Kepler objects of interest and K2 fields. We use the stellar abundance of O, C, Mg, Si, Fe to compute Z.

The resulting distribution of stellar hosts is skewed towards sub-solar Z, suggesting that most planets form in a different chemical regime compared to the Solar System. The number of planet-hosts systematically increases with decreasing Z both for giant planets and smaller planets hosts. However, an overturn occurs at Z=0.003 and hosts numbers decrease with Z, although at these Z-ranges the statistics are very poor. Nevertheless, the decrease is consistent with the overall metallicity distribution functions for stars in Galactic populations, indicating that there is no strong evidence for the paucity of planet formation at very low metallicities.

Our results indicate that the correlation of planet hosts with stellar metallicity Z is radically different from what was reported previously, which has major consequences for the interpretation of observed star-planet statistics in the context of planet formation models.

Session 4: Elemental Abundances in Planet Formation

Examining how stellar and disk compositions shape planet formation, including the chemical links between stars, protoplanetary disks, and emerging planets.

Invited Speaker: **Diego Turrini** - *Genetic Links and Compositional Connections between Stars, Their Circumstellar Disks and Their Planets*

(INAF, Italy)

The formation histories of planets are shaped by the physical and astrochemical properties of their native protoplanetary disks, which in turn are born from the star formation process and are linked to those of their host stars. While the existence of these connections is certain, the ways in which their interactions determine the initial conditions and the outcomes of planet formation are much less so. In particular, it is unknown which factors determine the dominant planetary building blocks, pebbles or planetesimals, in individual disks, which in turn determine the characteristics of the planetary systems that will form there. A growing body of work highlights that the nature of the planetary building blocks leaves a signature in how planet formation connects the composition of forming planets to that of their native disks, and argues that the combined study of stellar and planetary compositions opens a window into the formation histories and environments of planets. In this talk I will review recent advances in our growing understanding of this multifaceted problem.

Bertram Bitsch - *The Limits of Planetesimal Formation at Low Metallicity*

(University College Cork)

Planets form in protoplanetary disks surrounding newly formed stars, where dust grains clump to form km-sized planetesimals. Models indicate that the location of the water ice line could be a prime location to form the first planetesimals (e.g. Drazkowska et al. 2016). The core accretion scenario predicts an increasing giant planet formation efficiency with increasing host star metallicity (e.g. Johnson et al. 2010). On the other hand, observations indicate that the occurrence rate of super-Earths is independent of metallicity, but drops sharply at [Fe/H]<-0.5 (Boley et al. 2024). While previous planet formation models can explain both trends (e.g. Ndugu et al. 2018, Emsenhuber et al. 2021), it is unclear how the detailed chemical abundances influence planet formation.

Observations of stellar abundances indicate that carbon and oxygen scale differently with [Fe/H] due to different Galactic production sites (e.g. Buder et al, 2018). Traditionally planet formation simulations have included the overall scaling of the dust-to-gas ratio with [Fe/H], but did not include scalings for the individual compositions (e.g. C/O ratio). However, a lower C/O ratio would result in a larger water content in the protoplanetary disk (e.g. Bitsch & Battistini 2020), which could enhance the formation of planetesimals at the water ice line. We employ a 1D planetesimal formation model following previous recipes (Andama et al. 2024), where we investigate how the disk's C/O ratio influences the formation of planetesimals at low metallicity. In particular, I will show how the lower limit of the dust-to-gas ratio that allows the formation of planetesimals shifts with increasing water fractions at the same dust-to-gas ratio. This opens up the possibility to trace planetesimal formation at the water ice line by detailed stellar abundances of planet host stars at low metallicity via their C/O ratio, thus constraining our understanding of planetesimal formation at low metallicity.

Daisy Turner - *Investigating Star-Planet Compositional Ties for Systems with Host Stars of Varying Composition*

(University of Birmingham)

As stars and planets are formed in the same environment, it is conceivable that a fundamental connection exists between the compositions of planets and their host stars. Exploring this relationship offers insights into the intricate history of the systems' formation and evolution. I investigate both the existence and complexity of a systematic relationship between the compositions of host stars and their planets. To unravel such complexities, a diverse stellar sample that spans a wide range of chemical balances is needed. I put emphasis on the [α/Fe] variety, as these α-elements are present in the interiors of rocky exoplanets. Planets orbiting iron-poor stars are thus of particular interest, offering an opportunity to study stars with compositions like and unlike the Sun. By leveraging planetary interior modelling, I analyse how the elemental abundances of these stars relate to the inferred compositions of their orbiting small planets. Here, I present results from the analysis of an extensive and homogeneous sample. Understanding these trends is crucial for refining models of planet formation and assessing the diversity of planetary systems beyond our own.

Giulia Ricciardi - *Compact or Large? CO Observations of the Faintest Planet-Forming Disks*

(European Southern Observatory (ESO))

Planet-forming disks observed by ALMA surveys often exhibit surprisingly faint continuum and CO emission, raising doubts about whether these disks contain enough material to account for the known exoplanet population. Despite this, the fainter end of the disk population - which shows compact, unresolved continuum emission and non-detections in CO isotopologues - has received little detailed investigation. It remains unclear whether this is due to faint but spatially extended emission or intrinsically compact disk structures. Distinguishing between these scenarios is crucial: if such disks are indeed compact, including their gaseous components, and optically thick, their inner regions could harbour significant reservoirs of material, potentially capable of forming gas giants within Jupiter's orbital radius. In my talk I present new ALMA data that target 13CO (3-2) and 12CO (3-2) lines in 18 CO-faint Lupus disks, probing the gaseous component of the faintest planet-forming disks. If the observations confirm that these disks are radially compact and optically thick, we could imply a substantial planet-forming capacity within 10 au in a significant fraction of Lupus disks. Furthermore, if these disks are indeed compact, they challenge widely accepted theories of disk evolution, such as viscous evolution and MHD-driven processes, which cannot account for such small outer radii. Since Lupus is a young, low-density star-forming region, external truncation processes are also unlikely to explain these compact gaseous structures, further emphasizing the need for a revised understanding of disk evolution.

Heather Johnston - *The Rise and Fall of the Giant Planet Occurrence Rate*

(University of Exeter)

Intermediate-mass stars are (i) most likely to host a giant planet, (ii) host gas-rich debris disks, and (iii) evolve differently from their low-mass counterparts. I will explore planet formation around these intermediate-mass stars and the role of pre-main sequence stellar evolution. I present the results of our planet population synthesis in which we model the rise and fall of the giant planet occurrence rate as a function of stellar mass and metallicity. Our results show that the accretion rate is a key mechanism that governs the occurrence rate distribution. We find that giant planets around more massive stars tend to be (i) more massive, (ii) form at a faster rate, and (iii) undergo runaway gas accretion at different locations than around low-mass stars. Hence, we can infer that giant planet composition may vary with stellar mass.

Jason Ran - *Bayesian Constraints on Planet Formation Models with Population Synthesis and Simulation Based Inference*

(University College London)

The discovery of thousands of exoplanets has enabled extensive statistical analyses of exoplanet demographics. Further, advancements in spatially resolved, multi-wavelength observations of protoplanetary disks have revealed rich details about the dynamics, structure, and chemistry of planet-forming environments. Large-scale catalogues of such disk observations, combined with host star information, have opened new pathways for demographic studies that are critical to the development of self-consistent planet formation theories.

One powerful approach to bridging disk and exoplanet demographics is exoplanet population synthesis, which provides a framework for testing planet formation models. However, even the simplest such models are highly nonlinear, involving complex, high-dimensional parameter spaces that are typically addressed using numerical simulations. This complexity introduces significant challenges in constraining model parameters and comparing competing formation theories due to potential degeneracies.

In this talk, I will introduce a novel Bayesian method for constraining planet formation parameters using normalizing flows and simulation-based inference. This machine learning technique models the probability density of planet formation outcomes conditioned on formation parameters. By leveraging this probabilistic approach, we can robustly quantify uncertainties, disentangle model degeneracies, and enable principled comparisons between competing theories in a natural Bayesian framework.

Nidhi Rohit Bangera - *Unpacking Disequilibrium Chemistry in Exoplanet Atmospheres: From C/O Constraints to Sulphur Photochemistry*

(Institut für Weltraumforschung)

The interpretation of exoplanetary spectra is often complicated by atmospheric disequilibrium processes that alter the expected chemical concentrations. 1D kinetic-photochemical models offer a framework to quantify these effects and to constrain elemental ratios, such as the carbon-to-oxygen (C/O) ratio, which are believed to serve as tracers of planet formation histories.

We apply such a 1D model to the atmosphere of WASP-69b, exploring variations in C/O, vertical eddy diffusion strength (Kzz), and gas temperature. The resulting parameter space exploration reveals strong degeneracies among these parameters, with multiple combinations producing equally viable fits to high-resolution spectral data. This analysis highlights the sensitivity of retrieved atmospheric properties to prior assumptions and model configurations. Another key result indicates that the concentrations of photochemically produced species (e.g. C2H2 and HCN) are inversely related to the strength of vertical mixing, suggesting a potential diagnostic for constraining Kzz.

The chemical network used in the model is further extended to include sulphur-ion species, allowing for a more complete treatment of sulphur photochemistry under various atmospheric conditions. With this we aim to assess the sulphur-to-nitrogen (S/N) ratio as a complementary tracer of planetary formation histories, particularly in scenarios with enriched metallicity and non-solar elemental abundances.

Anna Thomas - *Population Synthesis to Investigate the Effect of Volatile to Refractory Sulphur Conversion on the Production of Hot and Cold Gas Giants*

(University College London)

Planet population synthesis is an integral useful tool for linking the currently observed exoplanet population to formation environments (protoplanetary disks). We present the first individual planet growth tracks and example planet populations from the code. Furthermore, we explore their composition. Most studies attempting to link giant planet composition to their formation history have focussed on the carbon-to-oxygen ratio (C/O) in gas or solids. Sulphur has always been assumed to be 100% refractory in such models, thus making its abundance a tracer of accreted rocky solids. However, sulphur also has a volatile reservoir that is known to be dominant at the onset of star and planet formation. We have applied a novel gas-grain conversion of sulphur to study how the formation trajectories of giant planets relate to the final composition of their cores and gas envelopes.

Sébastien Paine - *Photoevaporated Dust Disk Models and Synthetic Observations*

(Queen Mary University of London)

The environment in which circumstellar disks evolve plays a crucial role in their evolution and the formation of planets. In stellar clusters, nearby large stars will irradiate gas and dust: heating the disk and entraining planet-forming solids. An important, but under-studied aspect of this is what sizes of dust get entrained in the disk wind. This affects the amount and position of planet-forming solids, as well as dust shielding the disk from UV radiation. We have developed a particle solver to track the entrainment of dust in multi-dimensional simulations of photo-evaporating disks. Dust entrainment varies significantly depending on where from the disk surface the dust is launched into the wind: from sub-micron above the disk up to 100 μm near the disk outer edge. However, we also find that the dust opacity is mostly uniform from all directions. This has implications for the structure of gas mass loss and observational characteristics of proplyds. Here, we present synthetic images and SEDs of these evaporated disk models at various wavelengths, including optical, IR and mm and discuss what can be learned from them.

Sydney Vach - *The Occurrence and Evolution of Short-Period, Small Planets Younger than 1 Gyr*

(University of Southern Queensland)

We present the occurrence rates and evolution in radius and orbital period of short-period, small planets within their first billion years. We present evidence that young planets around FGK-type stars contract rapidly during the first 200 million years, and that population matches the Kepler demographic at the 500 Myr to 1 Gyr timescale. Our young planet population study helps to break the decade-old degeneracy between gas-rich and water-rich super-Earth and sup-Neptune interior models. Our results are most consistent with small close-in planets around FGK stars being formed gas-rich with puffy hydrogen-helium envelopes, juxtaposing ocean-world models that are largely steady state in radius over the same timeframe. For the <200 Myr population, we measure an occurrence rate for sub- and super-Neptunes of 22% (+8.6/-6.8) and 13% (+4.9/-3.9), respectively, finding an overabundance compared to the mature Kepler distribution at the >2.6 sigma level. This overabundance disappears at the ~500 Myr timescale (<1 sigma level) as the planet population evolves to match the observed demographics of the Kepler yield.

Luke Keyte - *The Chemical Composition of Externally Irradiated Disks*

(Queen Mary University of London)

Most stars form within dense clusters, where protoplanetary disks are exposed to intense ultraviolet radiation from nearby massive stars. Despite the prevalence of these environments, our understanding of how such radiation influences disk composition remains surprisingly limited. In this talk, I will share recent insights into how external UV irradiation affects disk chemistry and shapes planet formation pathways. Our studies uncover complex effects that challenge conventional models. Although UV radiation is quickly attenuated near the disk surface, reprocessed radiation can penetrate deeper, altering temperature profiles and changing volatile abundances. Photoevaporative winds induced by external UV radiation can significantly enhance molecular emission, producing observational signatures that could be mistakenly interpreted as evidence of altered disk chemistry. I will contextualize these findings with respect to recent ALMA and JWST observations, and discuss their implications for interpreting chemical inventories across diverse star-forming regions — from isolated disks to dense clusters where most planetary systems originate.

Session 5: Stellar Abundances & Planet Composition

Connecting stellar elemental abundances to the composition of exoplanets.

Invited Speaker: **Vardan Adibekyan** - *From Stellar Atmospheres to Planetary Interiors*

(IA, Portugal)

Stars and planets emerge together from the same primordial material, shaping and reshaping one another through a variety of interconnected processes. Stellar radiation governs the evolution of protoplanetary disks and thereby planet formation, while, conversely, processes such as planet engulfment can leave measurable chemical fingerprints on stellar atmospheres. Because protoplanetary disks dissipate within just a few million years—well before most planets can be detected—stellar atmospheres provide the only long-lived record of the disk's original chemistry. In this talk, I will review the compositional link between stars and planets, emphasizing how stellar abundances inform our understanding of planetary formation, system architecture, and interior chemistry.

Yoshi Eschen - *Chemical Fingerprints: Decoding Stellar Abundance Influence on Planetary Composition*

(University of Warwick)

Planets and stars form from the same proto-stellar material. Hence the stellar refractory elemental abundances are assumed to be strongly linked to rocky planet interiors. This is also found for the refractory elemental abundances of the Sun and Earth. For exoplanets, this compositional link has been recently suggested and explored in small demographic studies. However, the sample of rocky planets around metal-poor, alpha-enhanced stars is limited. This makes it challenging to find and validate potentially vital chemical trends. We present a novel machine learning approach to identify planet hosting stars of interest to fill in the lack of well-characterised small planets around metal-poor stars. This algorithm leverages stellar abundances from the large stellar surveys of APOGEE and GALAH to classify host stars chemically. We then searched for planets around these golden targets.

We present newly characterized systems containing super-Earths and sub-Neptunes around metal-poor, alpha-enhanced stars of the thick disk. These planetary systems were observed with transit photometry and radial velocity allowing us to measure their radius and masses precisely. We used our obtained planet properties to model their interior structures using specialized tools which output the core and mantle mass fractions. These give insights into the elemental abundance ratios of the planets. Hence, we directly study the connection between the planet and host star abundances.

These new discoveries significantly add to the sample of rocky planets around thick disk stars and will be followed by further detections and characterizations from our machine learning algorithm. Placing our new and upcoming systems in demographic context, we are now able to further explore the link between stellar refractory elemental abundances and their impact on small planets in a larger and more diverse sample. This enables insights into planet formation across the Galaxy.

Maria Tsantaki - *The Exoplanet Population in the Galactic Context from the Ariel Mission Candidate Sample*

(Osservatorio Astrofisico di Arcetri - INAF)

Stellar populations differ significantly across the Galaxy in terms of chemistry, kinematics, and age, which is likely to affect planet demographics. Our neighbourhood is occupied by young, metal-rich stars located in the thin disk, whereas the halo and thick disk host older and metal-poor stars. In this talk, I will present our results on the role of the Galactic environment in shaping planetary systems based on the candidate sample from the Ariel space mission in collaboration with the Ariel stellar characterization working group.

We first derived precise stellar parameters from high-resolution spectra and homogeneous stellar masses from isochrone fitting for 358 planet hosts. We then investigated the connection of planetary properties with the different Galactic disk populations. In particular, we find that giant planets are more frequent around more metal-rich stars that belong to the Galactic thin disk, while lower-mass planets are found in more metal-poor environments and are more frequent in the thick disk, thus orbiting older stars.

Additionally, our analysis reveals a close relationship between stellar mass and giant planet radius, with more inflated planets at lower metallicities. We also investigate the correlations between stellar and planetary masses and planet multiplicity. Our results highlight the importance of Galactic chemical evolution, although often overlooked, on the current distribution of planet populations. Understanding planet formation across the Galaxy can shed light on the habitability in the Galactic context.

Kevin Schlaufman - *Terrestrial Exoplanet Internal Structure Constraints on Planet Formation Enabled by Comprehensive Host Star Characterization*

(Johns Hopkins University)

Exoplanet mass and radius inferences fundamentally rely on host star mass and radius inferences. Despite the importance of host star mass, radius, and elemental abundance inferences for the derivation of exoplanet internal structure constraints, published constraints have often been based on inferences that are not self-consistent. For 24 dwarf stars hosting terrestrial exoplanets, we use astrometric and photometric data plus high-resolution spectroscopy to infer accurate, precise, homogeneous, and physically self-consistent photospheric and fundamental stellar parameters as well as elemental abundances. We infer updated planetary masses and radii using these data plus Doppler and transit observables, then use the complete data set to derive constraints on the core-mass fractions of these terrestrial exoplanets. We find that the population of resonant or plausibly resonant terrestrial exoplanets represented by Kepler-36 b and Kepler-105 c has a significantly lower mean core-mass fraction than the rest of the terrestrial exoplanets in our sample. Their resonant configurations suggest that they migrated inwards from more distant formation locations, and we attribute their low densities to the incorporation and retention of significant amounts of water during their formation. We confirm that the ultra-short-period exoplanets 55 Cnc e and WASP-47 e have densities inconsistent with pure rock compositions. We propose that they are both the stripped cores of mini-Neptunes and associate their low densities with the presence of significant amounts of hydrogen, helium, water, and/or other volatiles in their interiors. Contrary to previous studies, we find no evidence for a significant population of dense, super-Mercury type planets. Likewise, we fail to recover the recently identified relationship between host star

age and terrestrial planet core-mass fraction. We show that the latter relationship is a consequence of observational biases.

Alexandra Lehtmets - *Stellar Abundance Anomalies in A–F Type Stars and the Role of Planetary Contamination*

(Tartu Observatory, University of Tartu)

Close-in giant exoplanets around A–F type stars are subject to intense stellar irradiation, leading to atmospheric evaporation and possible mass transfer towards the host star. If a fraction of this planetary material is accreted, it could modify the stellar photospheric composition, producing subtle abundance of anomalies indicative of stellar contamination. This mechanism was proposed by Jermyn & Kama (2018) as a potential indirect pathway for probing exoplanetary atmospheric composition.

In this preliminary study, we investigate whether such contamination could contribute to the observed chemical peculiarities in A–F type stars hosting close-in gas giants. We are currently identifying suitable systems and compiling stellar abundance data from literature and spectroscopic catalogues. The stellar sample will be divided into two groups based on estimated extreme-ultraviolet (EUV) flux: stars with strong EUV radiation, where contamination is expected to be suppressed due to efficient ionisation and dispersal of planetary material, and stars with weaker EUV flux, where accretion may be more likely.

A reference "zero-line" will be constructed to represent baseline stellar abundances, allowing comparison with systems showing potential contamination signatures. The goal is to determine whether abundance deviations correlate with conditions favorable for planetary material accretion, providing population-level constraints on how often and under what circumstances stellar photospheric contamination may occur.

Subsession on Disks

Antonio Garufi - *300 Disks Imaged, and Counting…*

(INAF, Istituto di Radioastronomia, Bologna)

The extensive sample of high-resolution images from near-IR high-contrast instruments and ALMA has now reached a level of maturity that allows for comprehensive demographic studies of planet-forming disks. I present the current state of disk evolution characterization, examining how various stellar and environmental factors influence this process based on a dataset of over 300 disks observed over the past decade.

Karina Mauco - *Characterization of Protoplanetary Disks Near and Far: a Complementary Perspective*

(European Southern Observatory (ESO))

Given the variety of properties found in planetary systems in our Galaxy, to understand disk evolution and planet formation, we must analyse general disk and host star properties measured in a large statistical sample of systems at different evolutionary stages and environments. Disks in nearby regions, without the presence of massive stars, evolve differently than disks in highly irradiated environments, where the far-UV radiation fields from OB-type stars disperse the closest protoplanetary disks from the outside in. Since the majority of (exo)planet host stars (including our Solar System) form in dense and massive stellar clusters in which the presence of OB-type stars dominates the radiation field, disk evolution studies must consider internal as well as external factors shaping the evolutionary path of protoplanetary disks in a complementary way.

During this talk, I will focus first on how the most "typical" disks in nearby regions (without massive stars) look in dust continuum emission. Then, I will contrast these results with those found in a more representative cluster in Orion.

I will show the results of dust continuum analysis of 80 disks in 4 nearby star-forming regions (low-UV environment), tracing the small, more "typical" disks as part of the DECO ALMA large programme. I will show dust disk size estimates and dust morphology identification done through visibility fitting with GALARIO. In contrast, I will also describe how disk evolution is affected by the feedback from massive OB stars in more distant clusters, focussing on the more representative sigma-Orionis cluster. I will show the potential of using optical forbidden lines to study both internally and externally driven disk winds. In the case of sigma-Orionis, the innermost regions of the cluster are clearly affected by external irradiation from the massive system sigma Ori, suggesting a coevolution of internal and external winds in these disks.

Mari-Liis Aru - *Studying the Effect of the Environment on Disk Evolution with MUSE*

(European Southern Observatory (ESO))

The first protoplanetary disks were detected in the Orion Nebula Cluster (ONC) with the Hubble Space Telescope (HST) in the 1990s. These disks appeared with teardrop-shaped clouds of ionized gas surrounding them, clearly visible in optical forbidden emission lines. This characteristic shape is caused by OB stars, which emit UV radiation and irradiate the disks. Such objects, called proplyds, provide a unique opportunity to study how the external UV environment affects the size, mass, and the survival timescale of disks—a critical factor for planet formation.

I will present results based on the IFU data of 12 proplyds in the ONC acquired with VLT/MUSE in Narrow Field Mode. This data reveals the size of the ionization front as a function of the ionizing field in a multitude of optical forbidden emission lines, most of which were never studied with HST.

Analysis of these first spatially and spectrally resolved images of proplyds, combined with available ALMA data, allows us to provide constraints on the mass loss rate of these objects. We also detect a forbidden carbon emission line in proplyds, which we show to trace the surface of the disk and the base of externally photoevaporative wind. Finally, I will discuss constraining the physical conditions of proplyds, and the measurements of selected emission line ratios.

Characterizing these objects in relative proximity sets the precedent for future studies in more distant and massive star-forming regions.

Daniel Daza Valdebenito - *Hydrodynamical Simulations of Planet-Disk Interactions in PDS 70*

(Universidad de Chile)

The interaction of planets with the disk from which they form produces characteristic features visible in the thermal emission of the dust as observed by ALMA. However, in many cases we are left with the doubt whether the observed features are indeed due to the presence of a planet, or caused by a different hydrodynamical process. The system PDS 70 is therefore special and highly important: it poses a unique testbed for this planet-disk interaction. As to date, it is the only disk where two giant protoplanets have been detected and confirmed via direct imaging. We use new insights from high-resolution, multifrequency observations in ALMA bands 3, 4, 7, and 9 to compare them to 2D hydrodynamical simulations using FARGO3D and study the radiative transfer of the disk using RADMC-3D. We explore which are the conditions that allow us to reproduce the large gap, the faint inner ring, and the prominent vortex in the disk. Comparing the observations with the hydrodynamical simulations we study the role of planetary migration, accretion, disk turbulence and temperature. I present the mechanism that allows the formation of the structures in the disk, the distribution and dynamics of the dust, and the characterization of the emission from PDS 70 and its protoplanets.

Thi My Hanh Tran - *Exploration of the Inner Region of the System HD 142527*

(Centre de Recherche Astrophysique de Lyon)

HD 142527 is a well-studied Herbig Ae/Be star surrounded by a transitional disk with a large dust cavity, spiral structures, and a known accreting dwarf companion. Despite extensive observations, the system's inner regions remain poorly understood, particularly regarding their influence on disk morphology and planet formation. Aiming to probe the inner region of HD 142527, we use new dedicated post-processing methods on high-contrast imaging data of VLT/SPHERE instruments at visible and near-infrared wavelengths in order to identify previously undetected companion(s) and/or structures and explore their potential role in shaping the disk's morphology and evolution. We report on the discovery of new inner disk features. These new features could be dynamically linked to the companions, suggesting ongoing interactions that influence the disk's structure. We will present our study of these inner features and their dynamical link with the known and additional companions in this system to better understand the system's architecture and evolution.

Zuzanna Jonczyk - *Gone with the Wind: CO Depletion in Magnetically-Driven Protoplanetary Disks*

(University of Leeds)

Recent ALMA observations have revealed a significant decrease in the gas-phase CO abundance within protoplanetary disks, with CO abundances depleted by up to two orders of magnitude relative to the interstellar medium. One plausible explanation for this depletion is CO sequestration in ice on the surfaces of large grains. An essential ingredient of this mechanism is the diffusion of CO from the upper layers of the disk to the midplane, where temperatures are low enough for CO to freeze out. The efficiency of CO sequestration is therefore sensitive to the strength of turbulence in the disk, requiring turbulent alpha parameters of around 10^-3 to produce sufficient depletion on Myr timescales. However, ALMA has revealed that mm-sized grains form thin dust layers in protoplanetary disk mid-planes, indicating that turbulence may be much weaker than this. MHD winds are therefore currently considered important in the outer regions of the protoplanetary disk, and their effects on disk composition are yet to be understood. I will present the results of new work investigating the impact of MHD-driven winds on the depletion of CO. I use state-of-the-art cuDisc simulations to model dust-gas dynamics, grain growth, and freeze-out, investigating the impact of these processes on gas-phase CO abundance to understand how CO depletion in wind-driven discs compares with viscous discs.

Yinuo Han - *High-Resolution ALMA Imaging of Extrasolar Planetesimal Belts*

(Caltech)

Debris disks in the outer planetary system are analogues of the Solar System's Kuiper belt, consisting primarily of planetesimals and the dust and gas that they create via frequent collisions. These belts are both the successors to protoplanetary disks and a component of the mature planetary system with which they continue to interact, allowing for the formation and evolutionary process of the planetary system to imprint structures on the debris disk. Reading this structural information relies on the robust imaging of disks. Over the past decade, ALMA has resolved several dozen debris disks. More recently, the ALMA survey to Resolve exoKuiper belt Substructures (ARKS) has resolved two dozen of them at unprecedented resolution, allowing for substructures to be searched for and linked to the architecture and evolutionary history of planetary systems. These observations have enabled some of the first statistical analyses of how the structure of debris disks could reflect the evolution of the wider planetary system and the properties of the host star. This talk will discuss results from an analysis that compares between the structure of debris disks and protoplanetary disks to better understand their connection. Correlations between stellar mass, luminosity, age, disk mass, and the radial and vertical distribution of the disk will also be explored and discussed in the context of processes such as the perturbation of minor bodies by planets, collisions between planetesimals, the influence of stellar radiation on the disk, and the evolution of solid material from protoplanetary to debris disks.

Session 6: Future Instrumentation

Mission-by-mission overview of upcoming facilities and instruments that will shape exoplanets and host star science in the coming decades.

Invited Speaker: **Giovanna Tinetti** - *Ariel Space Mission*

(KCL, UK)

Invited Speaker: Heike Rauer, **Juan Cabrera**, and the PLATO Team - *PLATO*

(DLR, Germany)

PLATO, the 3rd Medium class ESA's mission, is being built to detect and characterize extrasolar planets by photometrically monitoring a large number of stars. PLATO will detect small planets around bright stars, including terrestrial planets in the habitable zone of Sun-like stars. PLATO will also study the (host) stars using asteroseismology, allowing us to determine the stellar properties with high accuracy (radius, mass, age), substantially enhancing our knowledge of stellar structure and evolution. Radial velocity observations from ground will allow characterizing planets for their radius and mass (hence density), and age with high accuracy. The mission will provide a catalogue of well-characterized exoplanets up to intermediate orbital periods, relevant for a meaningful comparison to planet formation theories and to better understand planet evolution. In addition, PLATO´s Guest Observer programme will allow for a large number of complementary science cases, based on proposals from the community.

PLATO is scheduled for a launch date at the end 2026 on an Ariane 6 rocket. The payload instrument consists of 26 cameras with 12 cm aperture each. For at least four years, the mission will perform high-precision photometric measurements of about 150,000 stars per field, with 2 long pointings foreseen.

The payload and the spacecraft have recently arrived in a cleanroom in the ESA facilities in the Netherlands for further testing. In this talk we will present the current status of the mission and review the expected science performance for the project, resulting in the key scientific results that can be achieved by the mission.

Invited Speaker: **Daniel Angerhausen** - *LIFE Looks for Life - Characterizing Rocky Worlds with the Large Interferometer For Exoplanets Concept*

(ETH Zürich, Switzerland)

The detection and atmospheric characterization of a significant number of temperate and rocky exoplanets, including the search for habitable and potentially inhabited planets, is arguably the major goal of exoplanetary science and one of the most challenging questions in 21st century astrophysics. In this contribution we present an update on the LIFE (Large Interferometer For Exoplanets) mission, which addresses this challenge by investigating the scientific potential and technological viability of an ambitious mission employing a formation-flying nulling interferometer in space working at mid-infrared wavelengths. LIFE, in synergy with other planned future missions, will for the first time in human history enable us to conduct studies in "Comparative Exobiology" – understanding life and habitability in the context of the diversity of planetary systems that might host it. Progress in our understanding of the exoplanet population as well as significant breakthroughs in relevant technologies justify the need, but also the feasibility for future life detecting missions to investigate some of the most fundamental questions of humankind. LIFE directly engages with the scientific theme of identifying and characterizing temperate exoplanets in the mid-infrared (MIR), a topic accorded 'highest scientific priority' by ESA's Voyage 2050 Senior Committee report as a potential focus for a future L-class mission within the ESA Science Programme. We will present the unique discovery space for a mid-infrared mission, in particular for the detection of atmospheric biosignatures in exoplanets and summarize additional relevant LIFE related work. We will discuss the international scope of the initiative (including contributions from the US, Japan and Australia) and will highlight synergies between LIFE and NASA's future Habitable Worlds Observatory mission.

Invited Speaker: **Ana Ines Gomez de Castro** - *The Unique Capabilities of the Habitable Worlds Observatory for the Investigation of the Evolution of Young Planetary Systems*

(UCM, Spain)

The Habitable Worlds Observatory (HWO) is the next NASA flagship mission. This large telescope will be equipped with instrumentation to image and analyse the radiation from Earth-like planets orbiting nearby stars. In this talk, I will present a short summary of the current status of the mission and the European participation in it. I will also present the current status of our understanding of the star-disk interaction during the evolution of young planetary disks and the contribution of future HWO instrumentation to the study of this process.

Invited Speaker: **Marica Valentini** - *The Milky Way in the 4MOST era*

(AIP, Germany)

4MOST is a new survey facility that will be available at the ESO's 4m-VISTA telescope at Paranal, Chile. 4MOST uniquely combines a large field of view (4.4 square degrees) with a high multiplex fibre positioner. Of the 2436 fibres available for science, 1624 fibres will feed two low-resolution optical spectrographs ($R = \lambda/\Delta\lambda \sim 6500$) while 812 fibres will feed the high-resolution optical spectrograph ($R \sim 20,000$). At the end of October 2025, the first scientific light is planned, and this means that the crucial scientific verification phase will start soon after, with the first data and results from 4MOST data foreseen for mid-2026.

I will give an overview of the status of the instrument and of the planned galactic science projects that will be pursued through the Consortium and the Community programs that constitutes the unique operational scheme implemented by 4MOST.

Invited Speaker: **Enric Palle** - *Probing the Cradle of Planets: How ANDES@ELT will Unravel the Link between Protoplanetary Disks and Exoplanetary Systems*

(IAC, Spain)

The chemical and dynamical properties of protoplanetary disks set the initial conditions for planet formation and ultimately dictate the diversity of observed exoplanets. However, a critical gap remains in our understanding of the inner disk regions (<20 au), where the majority of planets are believed to form. Characterizing the gas properties, accretion processes, and angular momentum extraction mechanisms in this unresolved region is essential for connecting disk evolution to the final architectures and atmospheric compositions of planetary systems.

The ANDES spectrograph on the Extremely Large Telescope (ELT) will be a transformative instrument for this field. Its unique combination of high spectral resolution (R ~ 100,000) and high spatial resolution (via an AO-assisted Integral Field Unit) will allow us to spatially and spectrally resolve the inner regions of nearby protoplanetary disks. ANDES will directly probe the physics of disk winds and jets—the primary mechanisms for disk dispersal and angular momentum transport—by measuring kinematics in key forbidden lines like [O I] 630 nm and [Fe II] 1.64 μm. Furthermore, its possible extension to cover the K-band (currently a goal) would enable studies of molecular winds (e.g., H_2 at 2.12 μm) and hot molecular gas (e.g., CO rovibrational bands), providing a complete picture of the disk's thermochemical structure.

This detailed characterization of the initial conditions will be directly linked to ANDES's groundbreaking studies of the exoplanet populations these disks produce. The instrument will conduct atmospheric reconnaissance of everything from young, accreting giant planets to the atmospheres of terrestrial planets in the habitable zones of M-dwarfs. By measuring atmospheric compositions, dynamics, and isotopic ratios, ANDES will provide the empirical data needed to test planet formation and migration models.

In this talk, I will present the capabilities of ANDES and demonstrate how its observations of disks, planets, and their host stars will provide an unprecedented, holistic view of the life cycle of planetary systems. Operating in synergy with contemporaneous facilities like JWST, ALMA, and Ariel, ANDES will fundamentally advance our understanding of the intricate relationships between stars, their disks, and the planets they nurture.

Poster session

Colin Folsom - *Chemical Traces of Selective Accretion in the HD 135344 Binary System*

(Tartu Observatory, University of Tartu)

The chemical fingerprints of recent accretion can be found in spectra of some A- and B-type stars. These stars have radiative atmospheres, where mixing is slow, and thus can build up a layer of recently accreted material at their surface. When there is a dust trap in the disk around a star, such as a gap in the disk due to planet formation, this can lead to an inner disk depleted in refractory elements. This refractory depletion can then be detectable in the surface chemical abundances of the star. The HD 135344 binary system, with an A-type primary and an F-type secondary, is a particularly interesting case. The primary displays a clear refractory depletion, while the secondary is chemically normal. In the primary, accretion has halted and the current depletions appear to be a relic of earlier accretion. In the secondary, accretion is ongoing, although the star has a significant amount of surface convection, potentially washing out any traces of accreted abundances. In order to more fully characterize our uncertainties, and thus understand the differences between these stars, we used a novel MCMC based approach to deriving chemical abundances from observed spectra.

Timothy Rawle - *ESA Ariel Science Archive*

(European Space Agency)

ESA's Ariel (Atmospheric Remote-sensing Infrared Exoplanet Large survey) aims to characterize the atmospheres of more than 500 diverse exoplanets during a 3.5-year mission launching in 2029. A combination of optical-to-mid-infrared spectroscopic and photometric time series, covering transits, eclipses and, in some cases, entire orbital phase curves, will enable analysis of the atmospheric structure, elemental composition and variation, including cloud properties and distribution, as well as further investigation into the impact of stellar host activity. The ESA Ariel Science Archive, hosted by the ESAC Science Data Centre (ESDC) near Madrid in Spain, will serve the broad community with all levels of scientific product generated at the ESA Science Operations Centre using the official Ariel Mission Consortium data processing pipeline. In this presentation, we introduce the concept for the Ariel Archive and solicit community input to ensure it meets the demands of modern European research into exoplanetary systems.

Tomoyuki Kudo - *Low Water Ice Abundance in the Disk Surface of AB Aur: Insights from Polarimetric Observations*

(Subaru telescope / National Astronomical Observatory of Japan)

Water (H2O) ice grains play an important role in planet formation and related matters. Therefore, revealing water ice distribution within a protoplanetary disk is a critical work for understanding planet formation. Polarimetric observations are a powerful technique for tracing scattered light from dust grains at the disk surface. We deployed thermal infrared (TIR) polarization capabilities on the existing IRCS+AO at the Subaru Telescope, Hawaii. Water ice has a strong spectral feature at a wavelength of 3 μm. A comparison of high-resolution polarized images obtained at 3 μm and its adjacent wavelengths allows us to probe the presence of H2O ice grains in disks. We carried out polarization imaging observations of AB Aur in the K, H2O ice and L'-bands. The disk structure has been clearly detected in all bands. Compared to the radiative transfer models, our results are consistent with a water-ice mass fraction less than ~ 5%. We cannot rule out the presence of ice-rich grains in the disk surface if a carbonaceous material exists as a highly absorptive form. However, if the ice-poor scenario is the case, the inferred water-ice abundance is lower than what has been found in other studies, such as disk observations and solar system observations, suggesting an efficient removal of water ice from the near-infrared scattering surface. Adding polarized imaging data in the J-, H-, and Ks-bands from Subaru/HiCIAO, we also found that the polarized disk-scattered light colour is better explained by porous grains than non-porous grains. In this poster, we report detailed results on the presence of H2O ice and the dust properties in the disk surface around AB Aur.

Alexandra Lehtmets - *Investing Circumstellar Atomic Radiation-driven Dynamics*

(Tartu Observatory, University of Tartu)

In our study, we investigate how early-type stars influence the gases escaping from exoplanet atmospheres into space. We focus on two key aspects: how the star's radiation force and gravity affect the path of these gases, and how fast neutral atoms speed up before changing into ions. By combining theories and models, we aim to understand these processes better. Our research not only deepens our understanding of exoplanets but also sheds light on their relationship with the stars they orbit. Additionally, our models could help predict which chemical elements end up accreting onto the host star. For early-type stars, our predictions might even show up as observable patterns in their spectra, because one of the unique features of early-type stars is that material accreting onto them can easily “pollute” the photosphere.

Anna Maria Weiß - *The New Exoplanet TOI 1147b: a Hot Jupiter Orbiting Its Subgiant-Class Star in a Highly Elliptical Orbit*

(Leibniz-Institute for Astrophysics Potsdam)

This study aims to identify and characterize a novel extrasolar planetary system. To achieve this, periodic transit events were analysed within the light curves obtained from the Transiting Exoplanet Survey Satellite (TESS). To determine the nature of the transiting object, its mass was estimated using radial velocity measurements.

TOI 1147 was subsequently observed utilizing the STELLA Échelle Spectrograph at the Izaña Observatory, Tenerife. The light curves of TOI 1147 exhibit a periodic dimming event occurring every 10.9 days. Over approximately 280 days of observational data, the same periodicity detected in TESS data was confirmed. These measurements facilitated the determination of the system's architecture and the assessment of additional planetary bodies. The newly discovered exoplanet, TOI 1147b, has a derived mass of 1.3 MJ and a radius of 2.3 RJ, classifying it as a ""puffy"" exoplanet. Moreover, its orbit is highly elliptical, with an eccentricity of e = 0.64. Spectroscopic analysis using STELLA Échelle Spectrograph provided insights into the host star, particularly through the evaluation of the Hα-Index. The results indicate that TOI 1147 is a Sun-like, low-activity star undergoing stellar evolution. Additionally, radial velocity data revealed the presence of a third, long-period companion in the system, which was not detected via transit observations. This object also exhibits a high eccentricity, warranting further investigation. These findings contribute to the broader understanding of planetary system diversity and formation mechanisms. The ongoing observational campaign at the Izaña Observatory aims to refine the orbital and physical parameters of the system through additional spectroscopic data collection. Future studies will focus on characterizing the long-period companion and its dynamical influence on the planetary system.

Prateek Boga - *Characterizing Atmospheres of Ultra Hot Jupiters with the 2m Wendelstein Telescope.*

(Ludwig Maximilian University / Universitat Sternwarte München)

Ultra Hot Jupiters (UHJs) are gas giant exoplanets located close to their host stars, making them some of the brightest targets for exoplanet studies. Their extreme exposure to stellar radiation results in strong spectral features, enabling detailed investigations into their chemical makeup, thermal profiles, and atmospheric dynamics. While large-aperture telescopes have typically been used for atmospheric studies, this project aims to showcase the capabilities of medium-aperture facilities, specifically the Wendelstein 2m telescope with the FOCES high-resolution (HR) spectrograph, to achieve comparable results.

Our analysis pipeline refines observed spectra through preprocessing steps and uses cross-correlation techniques to extract planetary signals. To ensure the reliability of the method, we have validated the pipeline by comparing it with previous research and performing injection-recovery tests using synthetic templates from petitRADTRANS. The study focuses on identifying atomic and ionic species with distinct spectral signatures in UHJs, using KELT-20b as a case example.

Preliminary results highlight the potential of intermediate-aperture telescopes for high-resolution spectroscopic studies, offering new insights into the atmospheric properties of UHJs. This research demonstrates that telescopes with apertures smaller than 4 meters can make substantial contributions to exoplanet characterization, opening the door to more accessible and diverse high-resolution observations of planetary atmospheres.

Ugnė Jonauskaitė - *Chemical Analysis of Solar Twin and Analogue Stars*

(Institute of Theoretical Physics and Astronomy, Vilnius University)

As of April 2025, there are around 5900 confirmed exoplanets detected in the Milky Way, and the number is constantly growing. In addition, the accuracy of determined planetary physical and orbital parameters is also improving. Thanks to a large amount of available data about exoplanets and their stars it is now possible to investigate the distributions of various planetary physical and orbital parameters, as well as their correlations with the parameters of their stars and the chemical abundances of elements in their atmospheres.

A large number of exoplanets have been detected around stars like the Sun. Solar twin and analogue stars have similar physical parameters (effective temperature, surface gravity) to the Sun and are assumed to have similar evolutionary histories. Because of this, they are useful when analysing various stellar chemical abundance trends.

Using spectra from the Vilnius University Echelle Spectrograph, I have determined the chemical abundances of alpha-, iron-group and heavy elements for 29 solar twins and analogues with confirmed exoplanets. I looked for potential correlations between the chemical compositions of planetary host stars and the parameters of the planets orbiting them. In this poster, I will present my findings.

Heleri Ramler - *Hot Stars in the Ariel Mission Sample: Intermediate-Mass Star and Planet Correlations*

(Tartu Observatory, University of Tartu)

Early F- and A-type stars, with masses above 1.4 solar masses, are underrepresented in planet host studies, yet they offer a unique probe of intermediate-mass star–planet connections. We present a homogeneous spectroscopic and photometric analysis of 18 such stars from the Ariel Mission Candidate Sample. Their radiative envelopes preserve surface chemical signatures that may trace accretion or planet formation history. We explore correlations between stellar mass, metallicity, and the presence of giant planets, providing insights into the formation and evolution of planetary systems around early-type stars.

Nicola Miller - *Towards a Homogeneous Sample of M-dwarf Properties and Abundances for the PLATO Mission*

(Uppsala University)

Over 70% of stars in the local solar neighbourhood are M-dwarfs, and they are frequent hosts of exoplanets. However, their cool, complex atmospheres and intrinsic faintness present significant observational and modelling challenges. The upcoming PLATO mission is expected to observe over 5000 early- to mid-type M-dwarfs, providing high-precision light curves for exoplanet detection, along with extensive spectroscopic follow-up from ground-based facilities. We present a fast and reliable pipeline for deriving homogeneous stellar parameters and chemical abundances by combining photometric and spectroscopic data within a Bayesian framework. The spectroscopic module uses an artificial neural network (ANN) to determine effective temperatures, metallicity and abundances from H-band spectra, with log g being constrained by the photometric module to break degeneracy. We discuss the pipeline's performance, recent and planned improvements, and validation using benchmark stars. The resulting catalogue of homogeneous M-dwarfs parameters from this pipeline will provide a vital foundation for PLATO's stellar and exoplanet science for low-mass stars.

Elisa Guerriero - *Advancing Exoplanet Atmosphere Characterization Through Cryogenic Aluminium Optics: The Ariel Mission*

(INAF-OAPA)

Ariel is an ESA space telescope mission that will survey the atmospheres of ~1000 exoplanets through secondary transit spectroscopy. It is on track for launch in 2029.

By measuring the molecular compositions of these exoplanets and their elemental abundances, Ariel will reveal how planet formation shapes atmospheric chemistry. The telescope covers wavelengths from 0.5 to 7.8 µm, spanning visible to infrared light to capture a broad range of atmospheric constituents. This capability is enabled by Ariel's innovative telescope design, featuring an off-axis Cassegrain with a 1.2 × 0.7 m elliptical primary mirror made of aluminium, operating at ~55 K. The all-aluminium mirrors and optical bench cool uniformly, minimizing thermal distortions. Ariel's primary mirror – the first of its size made from aluminium for space – required new manufacturing and polishing techniques to achieve ~10 nm RMS surface roughness and ~60 nm RMS figure accuracy. The aluminium optics are silver-coated to maximize reflectivity in visible light, ensuring excellent optical performance across the full spectral range. Ariel's two science instruments operate in parallel to cover this range. The Ariel InfraRed Spectrometer (AIRS) will provide spectroscopy from ~1.95–7.8 µm, capturing key molecular absorption bands, while the Fine Guidance System (FGS) will offer three photometric channels in visible/near-infrared (~0.5–1.2 µm) and a low-resolution spectrometer from 1.2–1.95 µm. By recording 0.5–7.8 µm simultaneously, Ariel can disentangle planetary atmospheric signals from stellar activity by comparing variations across multiple wavelengths.

The talk will address the target selection strategies, describe AIRS and FGS instruments, and illustrate the technological processes developed to manufacture aluminium optics for VIS/IR applications.

Zoe Parker - *Searching for Unusual Planetary Systems with Massive Debris Disks*

(University of Leeds)

Debris disks are fundamental to providing a complete understanding of planetary systems and their evolution. Despite this importance, there is an observed lack of bright 'extreme' debris disks with a high fractional luminosity > 10^-2, which prevents us from studying how extreme debris disk processes operate. This raises the question – are bright debris disks intrinsically rare, or are current surveys not wide enough to find them in the local population? A large-scale analysis designed to specifically search for and resolve cold, bright massive extreme debris disks is the only answer to this question.

Thompson et al. (2010) described a crossmatching method in which extragalactic surveys could be utilized as wide, shallow debris disk surveys. We have implemented a similar method using the Herschel-ATLAS DR1 field combined with Gaia DR3. We utilize a Bayesian likelihood ratio technique used for galaxies to identify debris disk signatures, initially providing around 10,000 matches from a starting 1.5 million Gaia star sample. After statistical cuts, we find 41 candidates in an area of 161.6 degrees squared in the equatorial plane. Our sample represents the lowest tier on a 'wedding cake' survey model – a wide search that has the power to identify rare examples of extreme debris disks.

For the most interesting candidates, a proposal for follow up imaging with ALMA to gain details on each disk was done. This will confirm new extreme debris disks, as well as investigate key properties such as size, mass, morphology and properties of any detected belts.

Our survey explores main sequence FGK stars from the optical to the far infrared wavelengths. We have expanded the field area from previous surveys and also increased the number and distance range of stars we are searching. Our approach has the potential to grow the number of detected extreme debris disks by an order of magnitude, providing a unique sample to test models of their properties and early evolution.

Sumit Roy Pronoy - *Do Low Metallicity Multiple-Star Systems Contain Giant Planets? Large Exoplanets' Relation with Host Stars' Stellar Metallicity around G-class Stars*

(CSR Department, Epyllion Group)

Stellar metallicity and its relation to orbiting planets play a crucial role in planetary formation and the architecture of planetary systems. Here, we used updated parameters for stars and planets from the NASA Exoplanet Archive to investigate the relationship between the radius of massive exoplanets orbiting G-class stars and the metallicity of their host stars, for planets with radii greater than 6 Earth radii. In multiple star systems, we found a probable inverse relationship between radius and stellar metallicity, which becomes stronger with declining metallicity and increasing planet size. Our small data set (around 95) shows a low R-squared value (0.07) and a low P-value (0.006). We separated the data for the radial velocity and transit methods of planet detection. For the radial velocity method, the slope value and P-value are -2.19 and 0.028, respectively, and there is only one data point with an uncertainty value among the 65 data points. Additionally, we are studying whether other parameters of stars and planets may play any role in this observed relationship. This suggests that the observed inverse exponential relationship may not be fully explained by observational biases alone. However, more accurate data and analysis will be needed for further confirmation.