# UKI Discs 2025 – Abstracts

## Review Talk: Protoplanetary Discs

John Ilee (Leeds)

## Review Talk: Debris Discs

Minjae Kim (MSSL, UCL)

## Review Talk: White Dwarf Discs

Amy Bonsor (Cambridge)

**Session: Disc Structure and Evolution**

## Insights into early stages of disk evolution

Fabiola Antonietta Gerosa (UCL)

In the last couple of years, ALMA observations of embedded disks around Class 0/I protostars (<1 Myr) have provided new insights into the evolution of gas and dust in young disks, offering comparisons with evolved Class II disks (>1 Myr). Two main surprises have arisen from these observations. First, some Class 0/I disks display sub-structures–such as central cavities, rings, gaps, and large-scale asymmetries–that suggest planet formation might begin in these early stages. Second, most gas evolution occurs between the Class 0/I and Class II stages, slowing significantly during the later Class II phase (AGE-PRO I paper). In this talk, I will present our theoretical work on modeling the disk formation and its evolution up to later stages, exploring how the possible outcomes of this process depend on the initial properties of the infalling cloud. By linking our results to observations, we aim to better understand the primary physical processes that govern disk evolution and, possibly, early planet formation.

## The fate of the 2nd circumbinary disc – post-AGB binaries

Anna Penzlin (LMU Munich)

At the end of the life of binary stars, the ejected stellar envelope reforms a circumbinary disc. This late time disc is a unique environment, that can give us key insights into the evolution of stars, disc dynamics and even constrain the possibility and timing of planet formation in discs. Now with VLTI/GRAVITY such disc can be spatially observed. However, modelling such system spatially has so far not been investigated as the environment of the circumbinary disc not just incorporates the varying gravitational potential of two star, but also the high luminosity in the post-AGB phase

irradiating and evaporating the disc. In our 2D hydrodynamic models we include the effects of heating through irradiation and viscosity, surface cooling and evaporation losses to the disc. With these models we can understand the evolution of the disc and the onset and timing of rapid dispersal of the disc. At the same time we analyse the interaction between the binary stars and the disc and track how the orbits of the binaries are influenced by the presence of the disc. We find that binary orbital parameters have a strong effect on the disc survival and that the balance between viscous flow in the disc and the level of photoevaporative losses can help us to find the time of rapid disc dispersal, setting the time for any secondary formation of bodies in the second disc of binary stars.

## $\rho$ Ophiuchi and the hidden mass reservoir

Isaac Radley (Leeds)

Observations of planet-forming disks at millimetre wavelengths are often hindered by high optical depths, leading to unexpectedly low disk masses, an essential measurement needed to understand planet formation. Optical depths are significantly lower in the cm regime, but these observations are often contaminated by ionised gas emission from winds, jets and magnetospheric activity. Therefore, it is essential to obtain both high-resolution and high-sensitivity observations of young stellar objects in order to accurately disentangle these emission mechanisms.

I will present my multiwavelength study of the Rho-Ophiuchus star forming region utilising high-resolution observations from JWST, ALMA and the VLA, spanning 5 orders of magnitude (micron to cm) and multiple evolutionary stages (Class 0-III). Our results indicate several objects are dominated by dust thermal emission up to 44 GHz with 10's-100's of Earth masses of large ($\sim$cm-sized) grains present, even at the earliest stages of planet formation. Additionally, for frequencies ¡44 GHz we find a significant fraction (>20%) of the observed flux can be attributed to ionised gas emission, however, the emission mechanism itself appears to depend on evolutionary stage.

Alas, even with the VLA's most extended configuration, our analysis is still limited by comparatively poor angular resolution for frequencies $\leq$22 GHz. Fortunately, the next generation of interferometers (SKA, ngVLA) will drastically improve the resolution and sensitivity of future radio observations. These enhancements will enable us to probe the innermost regions of planet-forming disks and unambiguously determine the emission mechanisms at work, furthering our understanding of planet formation.

## Debris-disc masses: first constraints from narrow discs

Tim Pearce (Warwick)

Debris discs, like the Asteroid Belt and Kuiper Belt, appear to be fundamental components of planetary systems. Yet despite their ubiquity, we do not know their most fundamental property: mass. This is because debris-disc observations only detect dust, whilst the larger planetesimals, which dominate disc mass, are undetectable with current technology. Hence we do not know how massive debris discs are, and the estimates we do have can vary by 4 orders of magnitude. Yet knowing debris-disc masses would unlock a new window on planetary systems: they can tell us how systems form, how they evolve, and how debris affects planet orbits.

I try to find novel ways to finally constrain debris-disc masses. A promising avenue is dynamics: massive discs behave differently to less-massive ones. However, there is no 'one-size-fits-all' approach; different discs have different dynamics, and a technique to weigh one disc may not work for another.

In this talk I demonstrate a new technique to weigh narrow discs like Fomalhaut. The masses of these discs cannot be too high, nor their debris bodies too large, or else the discs would scatter themselves apart. Using n-body simulations and collisional analytics, I demonstrate that the largest objects in Fomalhaut's disc must be smaller than 200 km (20% of Pluto's radius), and the total disc mass below 700 Earth masses. These are new, independent dynamical constraints, which can be paired with other theory to open a new window onto the formation and evolution of debris discs.

## The Secret Lives of Disks: the earliest stages

Maria Jose Maureira (MPE)

Characterizing the physical conditions of disks surrounding young protostars that are still actively accreting from their surroundings is crucial to understanding the mass assembly process of stars and the mechanisms for early planet formation. While the majority of theoretical investigations into the first steps to form planetesimals are still using physical properties akin to more evolved disks past the main accretion phase, it is expected that the physical properties in much younger disks will be different. In this talk, I will present ALMA observations with a resolution of 6 au towards young protostellar disks, with various morphologies and multiplicities. Using a multi-wavelength approach, we find that these disks are very optically thick, even at 3 mm. These high optical depths can help hiding the presence of early' gaps' related to the planet formation process, and also push the disk masses beyond the threshold for gravitational instability. The observations are also questioning the common assumption that star irradiation alone is the main mechanism controlling the disk temperature. Instead, the observed temperatures suggest that some young disks are 'active', thus also heated due to accretion and shocks

## (Sub)mm Analysis of HD 32297's Edge-on Debris Disk

Patricia Luppe (Trinity)

We present a detailed submillimeter analysis of the debris disk around HD 32297, a young A star with a nearly edge-on orientation and one of the largest known infrared excesses among main-sequence stars. Using high-resolution ALMA observations in Bands 7, 8, and 10, we investigate the disk's vertical and radial structure at wavelengths sensitive to different dust grain sizes. Our modelling approach combines data with angular resolution down to 50 milliarcseconds (∼6.5 AU), allowing us to resolve the disk's vertical extent with high precision. This is one of the first cases where the vertical structure of a debris disk can be traced as a function of radius, offering new constraints on the spatial distribution of grain sizes and dynamical stirring processes. The disk's remarkably edge-on and well-defined structure provides a rare opportunity to probe vertical morphology directly.

## The ODISEA Project: Planet Formation in $\rho$ Ophiuchi

Camilo González-Ruilova (USantiago)

Ophiuchus is one of the closest and youngest star-forming regions to our planet, making it a perfect laboratory to study star and planet formation. The Ophiuchus DIsk Survey Employing ALMA (ODISEA) originally targeted  300 YSOs at different stages of evolution (from SED Class I to III) in Band-6 and at modest resolution. After several follow up programs, there are now observations on multiple frequencies, sensitivities and angular resolutions. That data allows us to explore the "big picture" of disk evolution and planet formation at different scales, from outflows and envelopes, to planet-induced substructures in protoplanetary disk. In this talk, I will present a summary of the main results from the ODISEA project, including on environment around very low mass stars and proto brown dwarfs, the large gaseous structures interacting with the ISM, the statistics for disk masses and sizes around single and multiple systems, and the evolution of substructures within massive protoplanetary disks. Furthermore I will also present ongoing projects on the statistics of molecular line structures along the whole ODISEA survey, the multi frequency analysis of 100 Ophiuchus sources, the detection of substructure in new Band-8 data, and the very recent modeling of planet-induced substructures driving the observed diversity of disk morphology (see companion figure). In conclusion, this is going to be a "brief" summary of the main past, present and future results on disk evolution and planet formation from the ODISEA survey.

## Asymmetric debris disks: how do eccentric rings glow?

Joshua Lovell (CfA Harvard-Smithsonian)

Fomalhaut and HR4796 are A–type main sequence stars host to famous examples of narrow, eccentric debris disks. Eccentric rings are an important class of sub-structured debris disks, since these are unique testbeds to understand how asymmetric planetary system architectures evolve over Myr–Gyr timescales. But an open problem remains in this understanding: what has driven the eccentricities into these disks? I will present new ALMA observations and modeling of both debris disks of Fomalhaut and HR4796, using models that consider unique eccentricity distributions. I will show that these two seemingly very similar rings host very different millimeter properties, and demonstrate with models that these are fully in keeping with these hosting distinct eccentricity distributions. I will show how constraints on the eccentricity distributions of these rings allow us to test planet-disk and stellar-disk interaction theories, and what these constraints imply about the differences in either their formation processes, or their long-term evolution.

## The transition from protoplanetary to debris discs

Benjamin Homewood (Exeter)

The transition phase from protoplanetary to debris discs is a key yet unavoidable process, nonetheless poorly constrained, crucial to the evolutionary timeline of circumstellar discs. HD141569 is a circumstellar disc perfectly placed within this transition window. The circumstellar disc offers a unique opportunity to understand how this rapid transition occurs and the dynamic processes that govern it. Previous scattered light observations have shown that this disc has many asymmetric rings. There exist two main hypotheses to explain these rings, with the key difference being the predicted distribution of large mm-sized grains. In this talk, I will present new ALMA observations of this system tracing the distribution of the mm-sized grains. Using the image and viability analysis tools, I have determined the radial distribution of large grains, which displays multiple rings similar to those seen in scattered light. We determine if the multiple rings seen in scattered light observations are caused by the photoelectric instability (PeI) or planets carving gaps. Our results suggest that the mechanism responsible for creating the multiple rings also affects the large dust grains and thus the PeI is disfavoured. Our results bridge the gap on a period of circumstellar disc evolution, which is currently unconstrained by our present understanding, between gas-rich protoplanetary discs and gas-poor debris discs. Adding to the broader picture of planetary formation. Thus, highlighting the crucial nature of this system and its further investigation.

## VLTI reveals the inner disc of a massive protostar

Maria Koutoulaki (Leeds)

Massive stars impact a vast range of scales and processes, from re-ionisation of the Universe, to the physical and chemical evolution of galaxies, to regulation of the interstellar medium, to formation of star clusters, and even to formation of planets around stars in such clusters. The formation and/or migration of these planets are significantly affected by the structure of the young inner disc and the physical processes that rule its early evolution. In recent years, significant progress has been made in understanding the formation of high-mass young stellar objects (MYSOs). The latest observational and theoretical studies present evidence that MYSOs are born in the same way as their low-mass counterparts, via disc accretion, rather than through coalescence of lower mass stars. While the existence of massive protostellar discs has now been established, little is known about how they eventually disperse, and how this is linked to the central protostar. In this talk, I will present our results on M8 EIR, a famous MYSO with a mass of 13.5 $M_{\odot}$. From previous interferometric observations an inner hole of around 30 au is needed to fit the SED and interferometric data simultaneously. In this study, we combine PIONIER and GRAVITY near-infrared interferometric data and high spectral resolution IGRINS spectra to shed light on the inner disc of the source. Moreover, using the emission lines present, such as the Br$\gamma$, NaI and CO lines, we investigate the accretion and ejection properties of the source and get a size of the gaseous disc.

## Planetesimals in debris discs and dust grain sizes

Jonathan Marshall (ASIAA)

Planetesimals, i.e. asteroids and comets, form within gas- and dust-rich protoplanetary discs. These minor bodies are the building blocks of planets. Not all planetesimals are swept up into planets during their formation, and remnant belts may persist for the lifetime of the host star and beyond. Once a high enough threshold velocity is reached, collisions between planetesimals within these belts produces a self-sustaining cascade of smaller bodies down to (sub-)micron sized dust grains. This dusty debris most commonly reveals itself by the presence of excess emission above the stellar photosphere at infrared to millimetre wavelengths. These 'debris discs' may therefore be considered larger, more massive analogues of the Solar system's Asteroid or Edgeworth-Kuiper belts.

Here we present radiative transfer modelling of 133 spatially resolved debris discs, calculating the dust grain minimum size, exponent of the size distribution, and total dust mass.The inferred composition and size distribution of debris dust is strongly dependent on constraining the spatial distribution of that dust and its emission out to millimetre wavelengths. From the steepness of the dust size distribution we may determine the nature of the dust-producing bodies (either fluffy comets or compacted asteroids) and their composition (through the presence of mid-infrared spectral features). Understanding these bodies in conjunction with the presence of planetary companions, determined either directly from imaging or indirectly from the disc architecture, provides a more complete picture of the internal dynamics of these systems and the impact it may have on, e.g., habitability.

## Spiral Arms in a Nearly Broken Protoplanetary Disc

Sahl Rowther (Leicester)

We perform three-dimensional smoothed particle hydrodynamics simulations to investigate the formation of spiral arms in misaligned circumbinary discs. In a nearly broken disc the misaligned inner and outer discs interact at two nodes, launching leading spiral arms that do not rotate with the disc. These spirals vanish when the disc is fully broken or aligned. Our results show that the formation of leading spirals is driven by the relative misalignment of the inner and outer disc, and does not depend on the disc physics. With live radiative transfer, the shadows cast by the misaligned inner disc are also able to launch trailing spiral arms that only appear at high misalignments when the discs are disconnected. When the disc is strongly misaligned, leading and trailing spiral arms can both appear and interact with one other. At lower misalignments, the impact of shadows is negligible and leading spiral arms are seen instead.

## Planets and Substructure Feedbacks on Disk Thermal Structure

Kan Chen (UCL)

Protoplanets can interact with their natal disks and form gas and dust substructures in disks. How these planet-induced substructures (e.g., gaps and rings) affect the disk temperature, and how that in turn affects the substructures, remains unclear. We aim to study disk substructures and thermal structure self-consistently, and to explore their impact on the volatile distribution. To this end, we perform multi-fluid hydrodynamical simulations and radiative transfer simulations in an iterative method to study planet-disk interactions. We find that the temperature in a structured disk, due to giant planet formation, significantly deviates from that of a smooth disk. The midplane temperature in gaps can increase by tens of Kelvin, causing volatile sublimation, radial shifts and multiplication of icelines. Meanwhile, comparing our multi-dust models with previous gas-only models, we find that the multi-dust model produces slightly shallower gaps with temperatures about 10 K higher than those of a gas-only model. The multi-dust model also shows that the temperature at dust rings formed by pressure bumps can drop by several Kelvin and act as a volatile freeze-out region. Nevertheless, the ice distribution is not significantly affected by whether the models include dust or not. In addition, we investigate the effect of varying viscosity. The disk midplane is about 10 K warmer when increasing $\alpha$ from $10^{-4}$ to $10^{-2}$. However, increasing viscosity suppresses gap opening and decreases the gap temperature enhancement. Therefore, there is no simple correlation between the iceline locations and viscosities. In addition, we provide a potential observational strategy to test the gap temperature change with ALMA observations.

## Externally irradiated planet-forming disks

Thomas Haworth (QMUL)

I will present an overview of some of the rapid recent progress in the study of externally irradiated disks, including the effect on their physical parameters (mass/radius/lifetime), chemistry and planet formation. I will do so both from the perspectives of theoretical modelling and multi-wavelength, multi-facility observations. I will also describe some ways in which we can further develop our understanding through observations of more massive, distant, stellar clusters.

## The Lifetimes and Evolution of Discs in Starburst Environments

Matt Cusack (Cardiff)

Circumstellar discs accompany nascent stars in a wide range of environments. It is without doubt that environment will have an impact on the properties, lifetimes and evolution of said discs and their host stars. Since many star forming regions host strong ambient radiation fields, it is necessary to model the effect of this environment on discs. We will present the first simulations to both follow the formation of discs from cloud-scale initial conditions, and explore the effect of different ambient radiation fields on disc properties. We have performed "zoom-in" simulations that begin at pc-scale clouds and follow the formation of discs down to sub-AU scales. We find that the wider environment has a large effect on the properties and evolution of discs, emphasising the need to model disc formation starting from cloud scales. Stronger radiation fields induce changes in the large scale environment that trickle down to disc scales, affecting the stability, fragmentation and temperature profiles of the discs. Our results highlight the importance of modelling not only discs themselves, but the wider environment they exist within, for both standard and enhanced radiation fields.

## Role of Cluster Environment on Protoplanetary Disks

Saumya Gupta (QMUL)

Stars are building blocks of Universe and yet, our understanding about star formation is insufficient to comprehend the role of star-forming environment on stellar evolution and related processes. This work is an important step to understand role of cluster environment on circumstellar disks and brown dwarfs. To attain these objectives, we have studied three feedback-driven clusters, ONC, Cygnus OB2 and IC 1396. We have used the JWST F187N and F182M images to study the proplyds and find how mass-loss rates vary across ONC as a function of UV flux. Our results suggests a strong effect of photoevaporation on protoplanetary disks in accordance with the standard disk models. We next use Subaru HSC observations to study Cygnus and IC 1396 and adopt a multi-wavelength approach to obtain diskless and disk-bearing sources. A low circumstellar disk fraction obtained for central 18' radius area suggests that external photoevaporation drives disk dissipation in Cygnus OB2. We next study how stellar feedback affects brown dwarf regime in IC 1396 using multi-wavelength data. We find 62 brown dwarf members and use them to determine mass distribution in the region. A comparative study of star-to-brown dwarf ratio in IC 1396 along with 14 other star forming regions with diverse cluster environments suggests that factors like stellar density and UV flux do affect brown dwarf formation efficiency. This study provides substantial evidence of how star population is affected by stellar feedback and will pave the way for further studies.

**Session: Disc Processes**

## High angular resolution evidence of dust traps from deep ALMA Band 3 observations of LkCa15

Anibal Sierra (UCL)

Dust traps are the most promising mechanisms to explain the observed substructures in protoplanetary discs. In this work, we present high-angular resolution (60 mas, 9.4 au) and high-sensitivity ALMA observations at 3 mm of the transitional disc around LkCa15. The new data, combined with previous high-resolution observations at $\lambda = 0.87$, 1.3 mm, make LkCa15 an ideal laboratory for testing the dust trapping mechanism. We found that the width of the three rings decreases linearly with frequency, and the spectral indices show local minima at the locations of the rings, consistent with dust trap models. Multiwavelength modelling confirms that the dust surface density and maximum grain size peak at 69 and 101 au, and suggestive peak at 42 au.

The inner disc shows bright and unresolved emission at 3 mm, exhibiting low spectral indices, which are consistent with free–free emission from an ionized jet or disc wind. Dust evolution models and radiative transfer calculations suggest that a viscosity coefficient of $\alpha = 10^{-3}$, a fragmentation velocity of 10 m/s, and DSHARP opacities provide the best match to the observed properties.

## Planet migration in Turbulent Disc

Yinhao Wu (Leicester)

We investigate the impact of disc turbulence on the formation and survival of mean-motion resonances (MMRs) during planetary migration, using global hydrodynamical simulations of low-mass planets embedded in protoplanetary discs. When turbulence is weak, planets can robustly capture into resonances such as the 3:2, with resonance stability largely insensitive to laminar viscosity over a wide range. However, strong turbulence induces stochastic torques and disrupts classical Type I migration, driving chaotic orbital evolution and enhancing the overstability of resonant libration. This leads to premature resonance escape and promotes tighter orbital configurations, such as 4:3 or 5:4 resonances. We identify a turbulence-driven transition from classical to chaotic migration, characterized by a threshold mass ratio scaling with the Reynolds stress parameter. These results suggest that active disc turbulence broadens the conditions under which MMRs are bypassed or broken, reducing the frequency of long-lived resonant chains and potentially suppressing three-body interactions. Our findings are consistent with recent TESS observations showing that younger systems more frequently exhibit resonant configurations, whereas older systems display wider period ratio dispersions than can be explained by turbulent migration alone. Additional post-disc dynamical processes are likely required to fully reproduce the observed spread.

## Gone with Wind: CO depletion in MHD-wind driven discs

Zuzanna Jonczyk (Leeds)

Recent ALMA observations have revealed a significant decrease in gas-phase CO abundance within protoplanetary discs, with CO depleted by up to two orders of magnitude relative to the interstellar medium. A plausible explanation is CO sequestration in ice on the surfaces of large grains. This mechanism relies on the diffusion of CO from the upper disc layers to the midplane, where temperatures are low enough for freeze-out. The efficiency of this process is sensitive to turbulence strength, with alpha parameters around $10^{-3}$ required to achieve sufficient depletion on the Myr timescales over which the depletion is observed to occur. However, ALMA has also shown that mm-sized grains form thin midplane dust layers, suggesting that turbulence may be much weaker and MHD winds are prevalent. I will present new results from state-of-the-art cuDisc simulations that model dust-gas dynamics, grain growth, and CO freeze-out to investigate the role of MHD winds in gas-phase CO depletion. Comparing wind-driven and viscously evolving discs, we find that MHD winds significantly enhance CO depletion, turbulence alone cannot account for it, and winds result in shorter depletion timescales. These results suggest that MHD winds may play a key role in shaping disc composition and help explain the rapid CO depletion observed by ALMA.

## MRI and vertical oscillations in distorted disks

Loren Held (DAMTP Cambridge)

Recent observations and global numerical simulations have revealed that many disks of all types (protoplanetary disks, X-ray binaries, active galactic nuclei) are distorted: either warped due a misalignment in the system, or non-circular as a result of orbital eccentricity or tidal deformation by a binary companion. Warped, eccentric, and tidally distorted discs are not in vertical hydrostatic equilibrium, and thus exhibit vertical oscillations in the direction perpendicular to the disc, a phenomenon that is absent in circular and flat discs. In extreme cases, this vertical motion is manifested as a vertical 'bouncing' of the gas, potentially leading to shocks and heating, as observed in recent global numerical simulations. In previous work we isolated the physics of purely hydrodynamic vertical oscillations in discs by means of quasi-2D and fully 3D local (shearing-box) models and made the important discovery that the disk can become parametrically unstable to developing inertial waves, leading to an initially flat disk developing a warp as well as non-linear phenomena such as shocks. Given the importance of the magnetorotational instability (MRI) in driving accretion in the highly ionized disks found in the inner regions of protoplanetary disks, X-ray binaries, and active galactic nuclei, we have extended our previous work to determine how turbulence due to the MRI dampens these vertical oscillations, and in particular how the parametric instability (which results in the disk developing a warp or bending mode) interacts with magnetic fields and with the MRI (which dominates angular momentum transport).

## Dust dynamics in the inner regions of protoplanetary disks

Thomas Jannaud (DAMTP Cambridge)

The study of protoplanetary disks is of particular interest, as it may explain how the gas and dust they are made of aggregate to eventually form planets. There has recently been tremendous progress in this field, spearheaded by many observations in the radio and infrared bands (ALMA, SPHERE, GRAVITY, ...). Those help constrain models of the earliest stages of planetary formation. The wealth of physics happening in protoplanetary disks left many important questions unanswered, especially in their inner regions (0.03 to 5 au) where core accretion occurs. To fully understand accretion and ejection in this zone, one needs to take into account the presence of both gas and dust, as well as the influence of non-ideal MagnetoHydroDynamic (MHD) effects. The latter help shape the transition between an inner turbulent region (active zone) and an outer laminar region (dead zone). This transition, thought to be around 1 au, controls the pile-up of dust as well as the ejection of magnetic winds. Our aim is to study the interdependence of these two processes to better understand planet formation in the inner disk, using 3D global MHD simulations of the protoplanetary disks inner regions. We will show the ability of the active/dead zone interface to trap dust, as well as the influence of MHD winds on the efficiency of the trapping. This will allow us to estimate the disk characteristics required for this trapping to be long enough to allow dust grains to aggregate and core accretion to start.

## Gas Heating & Cooling in Debris Discs: Insights from $\beta$ Pic

Sana Ahmed (Trinity)

Debris discs, the extrasolar analogues of the Kuiper belt, had largely been considered gas-free since their discovery. In the past decade, there has been increasing evidence for the presence of gas in these discs. ALMA's advanced sensitivity has resulted in the detection of atomic (CI, OI, CII) and molecular (CO) emissions in over 20 exocometary belts, mostly around young stellar systems of ages 10 - 40 Myr. The gas release mechanisms are likely to be different from the heating and sublimation-driven release of volatile ice in solar system comets. The proposed mechanisms include the collisional vaporisation of small grains and photodesorption from icy grains. The gas and the surrounding dust interact through several charge and energy exchange processes. The main heating processes are (1) energetic photoelectrons emitted from the dust grains and (2) energy released due to photoionisation of the gas. Gas-grain collisions either heat or cool the gas, depending on the gas and dust temperatures. Cooling also occurs due to the collisional excitation of the fine structure atomic levels and the molecular rovibrational levels. The collisionally excited levels decay radiatively, converting thermal energy to photons, thereby cooling the gas. In this presentation, I will discuss the various heating and cooling mechanisms for the gas in debris discs. I will also present the modelled temperature structure for parameters representative of the $\beta$ Pictoris disc.

## A mechanism to form radially compact protoplanetary discs

Simin Tong (Leicester)

Radially compact protoplanetary discs ($\lesssim$ 50 au) are typically interpreted as the result of rapid dust loss in the absence of effective dust traps, but high-resolution observations by ALMA demonstrate that substructures are common in these discs. We propose that fragmentation of fragile pebbles beyond the dead zone provides an effective alternative mechanism to form compact discs (Tong & Alexander 2025). We study dust coagulation and fragmentation in discs formed by this mechanism using DustPy and generate synthetic observations. We find that these discs have sizes determined by the extent of their dead zones. Accounting for dust porosity and less fragile pebbles does not change the disc sizes significantly. The smooth dust morphology can be altered only when pressure bumps are present in the dead zone. However, pressure bumps at small radii ($\lesssim$ 10 au) are ineffective traps, which can replenish inner discs with small grains, effectively hiding the traps in the optically thick inner disc. This proposed mechanism can also form structures that strikingly resemble those seen in recent high-resolution observations of compact discs, such as Sz 66 and MP Mus.

**Session: Time Domain Studies of Discs**

## WD Debris Disks: Variability Incompatible with Canonical Model

Hiba Tu Noor (UCL)

In this talk, I present all available multi-epoch 3.6 and 4.5 micron photometry from Spitzer Space Telescope observations of white dwarf debris disks, including weekly cadence observations of 16 relatively bright systems, and 5 h staring-mode observations for five of these. Significant variability is detected in 85% of disks and across all timescales probed, from minutes to weeks to years, where the largest flux changes correlate with the longest time baselines, and the infrared excesses persist over at least a decade. While each source is idiosyncratic, the overall results indicate the most variable disks correlate with those that are the brightest (dustiest), and also among those with detected gas, demonstrating both dust and gas are produced via ongoing collisions. There is a correlation between flux and colour changes, where disks tend to appear redder when dimmer and bluer when brighter, consistent with an excess of small dust grains produced in collisions, followed by a gradual return to equilibrium. The overall results are a drastic departure from the predictions of the canonical disk in both flux and colour, but are broadly consistent with collisional evolution based on a simple model. This dataset constitutes a legacy resource that can inform time-series studies of polluted and dusty white dwarfs, and importantly serve as a basis for future disk modelling, beyond the pioneering canonical framework.

## Characterising a WD with transiting debris in the habitable zone

Akshay Robert (UCL)

The recent discoveries of transits around white dwarfs have provided unique and powerful insights into their circumstellar debris discs. This family of white dwarfs with transiting debris exhibits significant diversity, where some display line-of-sight gas absorption while others are highly dynamic with large scale heights.

In 2022, a white dwarf was reported to have transiting debris at an orbital period of 25h, which places its circumstellar material in the habitable zone, where a planetary surface can support liquid water. The light curves show myriad unusual features, with the most pronounced dimming components every 23 min – the 65th harmonic of the fundamental period – and numerous orbital drifters.

I will present time-resolved X-Shooter spectroscopic data of WD1054–226, which demonstrate significant spectroscopic variability, a hallmark of circumstellar gas along the line of sight. Our team has also obtained ultraviolet spectra with Hubble, which will crucially allow us to differentiate between volatile and refractory compositions of the parent body, and near-infrared light curves from HAWK-I, which enable investigations into the colour dependence, and therefore the size distribution, of the transiting material. Finally, an update will be provided on the long-term stability of the 65th harmonic, transit timing variations and the presence of the drifting components over a timescale of four years, facilitated by new multi-band light curves from ULTRACAM.

## Temporal variation of warps & shadows in protoplanetary discs

Katie Milsom (Exeter)

Scattered light observations have revealed that shadows are a common feature in protoplanetary discs. Shadows can be caused if part of the disc is warped (the orbital plane of the disc changes with radius) such that the warp blocks the stellar light from reaching parts of outer disc. A warp can be induced by an external torque perturbing the disc, such as a misaligned companion, a misaligned magnetic field, or a fly-by. We model the temporal variation of a warped disc using 1D warp propagation theory combined with a fast radiative transfer code to produce scattered light images to simulate the temporal variation of the shadows cast across the disc. These 1D models are less computationally expensive than full hydrodynamical simulations allowing us to explore the parameter space more fully and to run models for longer. We present the results of our modelling for warps induced by a fly-by encounter where the outer disc becomes warped and the shadow induced rocks back and forth. We also present warps due to a misaligned companion both internal and external to the disc. We combine these models to simulate a misaligned companion in a gap in the disc. Here we see the inner disc warp and precess round and the outer disc warps separately, overall producing a broad shadow across the outer disc which covers over half the disc. Our models provide physical explanations for the morphology of disc shadows observed in scattered light surveys such as DESTINYS or Gemini-LIGHTS.

## Eruptive Variables in Nearby Star-Forming Regions with VVV

Hariharan Muthu (Herts)

Episodic accretion, a common yet poorly understood process in low-mass star formation, was proposed to address the luminosity problem in protostars. These short bursts of disk-driven accretion significantly impact planet formation, disk chemistry, and the luminosity spread observed in pre-MS clusters. YSOs undergoing episodic accretion vary with diverse amplitudes and timescales and display somewhat unpredictable spectra. We conducted a comprehensive search of the VVV/VIRAC2 database of the southern Milky Way, aiming to identify large numbers of new eruptive variables, enable statistical investigation of the temporal behaviour and determine associations with nearby pre-main sequence clusters and star formation regions. We found 371 new eruptive variable candidates in the range $2 \leq \Delta K_s \leq 4$ mag. We present our initial assessment of their light curve properties. In addition, we use Gaussian Mixture Models to calculate the probability of association with pre-main sequence clusters, using VIRAC2 and Gaia astrometry, and we find that 82 candidates are likely cluster members. These associations with relative nearby clusters will enable a better understanding of the incidence of eruptive variability in the context of their parent populations, which inform estimates of age, mass and environment.

## Unveiling the variability of massive YSOs with the VVV/X survey

Gabriella Zsidi (Herts)

Massive stars are important building-blocks of our Galaxy, yet their formation process remains a matter of debate. While some theories propose that massive star formation is a scaled-up version of low-mass star formation, the strong radiation pressure from high-mass stars would theoretically halt accretion as fusion begins – making the formation of stars more massive than $\sim$10 $M_\odot$ difficult to explain. With the aim of understanding the complex behavior of massive young stellar objects (MYSOs) and shedding new light on the dynamic processes governing massive star formation, we explore the extensive near-infrared monitoring provided by the VVV/X survey. By identifying nearly 200 MYSOs within the VVV/X dataset, leveraging previous results from the RMS survey, we found that a substantial fraction of MYSOs show significant variability on long timescales (years). These variations suggest that interactions with the disk strongly influence the system luminosity despite the high luminosity of the central star. Most light curves show stochastic changes with amplitudes up to 3 magnitudes in some cases, however, some systems reveal a long-term oscillating trend. To understand the physical origin of these variations, we characterized their amplitudes, timescales, and near-infrared color changes. Additionally, we complemented the dataset with mid-infrared observations from the WISE satellite and found that the mid-infrared light curves generally exhibit smaller variability amplitudes, although the overall variability patterns closely resemble those seen in the near-infrared.

## Non-Thermal Radio Variability in YSOs: A VLBA Census of the ONC

Eoin O'Kelly (Herts)

Star formation is associated with high-energy processes and Young Stellar Objects (YSOs) are known to be energetic radio sources. Radio observations enable studies of high-energy processes such as powerful magnetic reconnection flares which are thought to impact disk and even planet formation through irradiation of the associated disk. The Orion Nebula Cluster (ONC) is a relatively close region of active star formation which allows the study of many sources simultaneously. YSO emission is either thermal free-free or non-thermal gyrosynchrotron. VLBI observations are only sensitive to non-thermal emission resulting in 'filtering out' of thermal emission. This allows a census of the non-thermal source population and associated variability. Phase referenced VLBI observations allow high precision astrometry and thus measurements of absolute proper motions. The high resolution of the VLBA is one milliarcsecond corresponding to 0.4 AU at the distance of the ONC. We present multi-epoch results of VLBA data in the C-band (4-8 GHz) covering almost a decade. This is focused on the non-thermal source population, associated radio variability and proper motions. There are currently limited examples of flares on shorter timescales e.g. hours or even minutes. We find variability occurring on different timescales with the highest occurring across two years associated with a class I YSO. The high resolution combined with astrometry allow for the search for multiple systems in otherwise inaccessible parameter space.

## The Missing YSO Outbursts: Mid-IR Selected Eruptive YSOs

Calum Morris (Valparaíso)

Over the last decade of observation, numerous eruptive variable YSOs have been found by the VVV consortium. Thus far these have focused on the highest amplitude sources (>3 mag in $K_s$), however the most embedded sources will often have sparse sampling, or levels of extinction such that amplitudes in the NIR bands are below thresholds that would have been previously searched. Our work combining the VVV time-series with the MIR selected SPICY YSO catalogue (Kuhn et al. 2021), has uncovered >1000 potential candidate variable YSOs with high amplitudes observed in the

MIR NEOWISE data. Some of these have already been observed with Magellan-FIRE, including: a new FUor candidate with >7 mag outburst, several lower-amplitude long duration variables with absorption spectra, as well as emission line objects resembling quasi-periodic EXors. We are starting to scratch the surface of this sample, and have begun to estimate physical parameters of the YSOs, as well as combining our data with numerous archival observations.

**Session: Disc Composition**

## Dust compositions in white dwarf disks

Andrew Swan (Warwick)

White dwarfs provide detailed insights into the nature of exoplanetesimals. Accretion of rocky material is commonplace, and metal abundances measured in hundreds of stellar photospheres reveal the bulk elemental compositions of accreted planetesimals. The mineralogy of that planetary debris is critical to understanding formation conditions and thermal histories, but remains poorly constrained. I will present early results from JWST spectroscopy of several white dwarf disks, whose distinct 10-micron silicate features indicate diversity in the composition, grain size and crystallinity of the circumstellar dust.

## Inside the water snowline: connecting disk evolution to JWST spectra

Till Käufer (Exeter)

The MIRI instrument aboard the James Webb Space Telescope probes the gas content in the inner regions of protoplanetary disks. The interpretation of MIRI spectra in the context of the early stages of planet formation is a highly debated topic. Observed excess cold-water emission in compact discs has been linked to the drift and sublimation of icy pebbles. If confirmed this would put important constraints on disk evolution and dynamics. However, dynamics in the inner disk are complicated by the interplay between pebbles delivering volatiles, gas dynamics, and local chemistry. To disentangle these processes, detailed models are needed to trace the sublimated ice from the midplane to the observable surface layer. We present a new 2D dynamical disk model that finds the time-dependent radial and vertical water distribution through advection, diffusion, and chemical processing, and pebbles influx from the outer disk. The model extends to simulating JWST/MIRI spectra, including dust opacity evolution, providing time evolution of key observables due to disk evolution. Using these models, we examine the link between pebble drift and observed cold water mass in disks. Additionally, we show what signs transport processes will leave on JWST/MIRI spectra of disks and how they are distinguishable from signatures of disk chemistry.

## ARKS: Resolved 12CO/13CO Ratios in Debris Discs

Sorcha Mac Manamon (Trinity)

Belts of exocomets, also known as debris discs, are extrasolar Kuiper belt analogs. They are ubiquitous around nearby stars, particularly young main sequence stars at a few 10s of Myr (∼75% occurrence rate). Emission from collisionally-produced dust has long been observed in these belts, but until recently these belts were thought to be gas free. One of ALMA's greatest discoveries, enabled by its unprecedented sensitivity, has been the presence of gas in now over 20 exocometary belts. This is likely a product of exocometary release, giving us access to the volatile composition of exocomets for the first time.

In this talk, I will present gas results from the ALMA survey to Resolve exoKuiper belt Substructures (ARKS) ALMA Large Program, which aimed at characterising 18 exoKuiper belts at unprecedented sensitivity and resolution. I will present the 12CO and 13CO spectrospatial distribution for all detected systems, and the first derived 12CO/13CO isotopologue ratio in a debris disc. I will discuss how this ratio suggests that both isotopologues are either optically thick or optically thin throughout the planetary systems, as we have determined that the 12CO emission is optically thin throughout one spectrospatially resolved disk.

## Chemical co-evolution of dust and gas in protoplanetary discs

Tamara Molyarova (Leeds)

Chemistry in protoplanetary discs determines the environment for planet formation. Recent JWST observations reveal a diversity of chemical composition in the inner discs, with emission from H2O, C2H2, CO2 and HCN varying between the objects. This emission correlates with global system parameters, such as disc size and stellar mass, which is attributed to a major role of dust radial drift in the transport of the volatiles. Radial drift brings large dust grains covered with molecular ices from the outer to inner disc regions, where they sublimate at their snowlines, altering the elemental ratios in gas and ice phases and ultimately affecting the observable molecular content. Dust traps can impede the radial drift and interrupt the inward transport of molecules, while chemical reactions can produce species with different snowline locations, affecting the elemental enrichment. In this work, we simulate dust evolution and drift together with the chemical evolution in an ensemble of protoplanetary disc models to investigate how disc properties, particularly the presence of planet-induced dust traps, affect the composition of the inner and outer disc. We use 1D viscous disc evolution model with evolving dust combined with time-dependent chemical kinetics including surface chemistry. We consider models with and without planet-induced gaps and determine the conditions necessary to obtain water- or hydrocarbon-rich inner discs. We discuss the role of chemical processes other than thermal desorption and adsorption in setting the composition of the inner and outer disc and the implications for planet formation.

## Chemical Compositions of Disk-instability planets

George Blaylock-Squibbs (UCLan)

In this talk I will discuss the formation of giant planets via gravitational instabilities within protoplanetary disks (top-down formation) and my work investigating if planets that form this way will have significantly different atmospheric chemical abundances compared to planets that form via core accretion (bottom-up formation). I will provide an overview on previous work in the field in which the elemental abundance ratios of exoplanets have been used to infer where those planets formed within protoplanetary disks, with respect to different molecular ice lines. I will then extend this idea by discussing the different conditions that gas and dust will evolve in for both core accretion and gravitational instability formation models. My work makes extensive use of the Phantom smoothed-particle hydrodynamics (SPH) code to simulate disks with the chemical evolution being performed using the KROME package as a post process. Using these methods I have chemically evolved the SPH particles that will end up near to forming planets. The abundances of these particles can then shed light on the likely atmospheric composition of the resultant planet. The results of this work will enable us to more accurately determine not only the formation history of giant exoplanets, but it will also help us understand their chemical inventories.

**Session: Formation of Planets & Brown Dwarfs**

## V960 Mon b: a dust-embedded substellar object formed by GI?

Anuroop Dasgupta (ESO)

V960 Mon is an FU Orionis object that shows strong evidence of a gravitationally unstable spiral arm that is fragmenting into several dust clumps. We report the discovery of a new substellar companion candidate around this young star, identified in high-contrast L'-band imaging with VLT/ERIS. The object is detected at a projected separation of 0.898″ with a contrast of $(8.39 \pm 0.07) \times 10^{-3}$. The candidate lies close to the clumps previously detected in the sub-mm (at 1.3 mm) and is co-located with extended polarized IR signal from scattered stellar irradiation, suggesting it is deeply embedded. The object is undetected in the SPHERE H-band total intensity, placing an upper mass limit of $\sim$38 $M_{\rm Jup}$ from the contrast curve. Using evolutionary models at an assumed age of 1 Myr, we estimate a mass of $\sim$660 $M_{\rm Jup}$ from the L' brightness; however, this value likely includes a significant contribution from a disk around the companion. The discrepancy between near- and mid-infrared results again suggests the source is deeply embedded in dust. This candidate may represent an actively accreting, disk-bearing substellar object in a young, gravitationally unstable environment.

## Planet formation by disc fragmentation: the impact of dust growth on opacity

Hans Lee (Leicester)

It is often argued that gravitational instability of realistic protoplanetary discs is only possible at distances larger than $\sim$60 au from the central star, requiring high disc masses and accretion rates, and that therefore disc fragmentation results in the production of brown dwarfs rather than gas giant planets. However, the effect of dust growth on opacity can be very significant but has not been taken into account in the models of fragmenting discs. We consider dust opacity that depends on both temperature and maximum grain size, and using it, we estimate the properties of a critically fragmenting protoplanetary discs. We find that dust growth promotes disc fragmentation at disc radii as small as ∼30 au. The critical disc masses and accretion rates are smaller, and the initial fragment masses are in the gas giant planet mass regime. We conclude that formation of gas giant planets by disc fragmentation may be more likely than usually believed, and that future numerical models of the process must take into account both dust growth and dust mobility with respect to gas.

## Planet formation sculpted by infall: the importance of multi-scale turbulence

Andrew Winter (QMUL)

Growing evidence is showing that planet formation does not proceed in isolated discs of dust and gas, as has long been assumed. Instead, protoplanetary discs are often associated with large scale structures that appear to be gas infalling from the interstellar medium (ISM). These structures have been identified around even mature discs, in which planet formation is well underway. In this talk, I show that disc properties can be reproduced directly by this process of infall, suggesting that forming planets may be constantly supplied by new material. Beyond the theoretical predictions, I show that stellar accretion is correlated with environment in the local, mature star forming region Lupus, connecting the parsec-scale ISM over-densities to the scale of the stellar radius. This has broad implications for planet formation, suggesting that the properties of all planets may be tied to the large (galactic) scale fluctuations in the interstellar medium.

## Sandwiched planet formation: restricting the mass of a middle planet

Farzana Meru (Warwick)

Planetary systems come in all shapes and sizes, with a vast diversity in the properties of the systems. From a simple theoretical perspective, we would expect planetary systems to form with the more massive planets in the outer parts of the system. However, this is not necessarily the case suggesting that sequential planet formation is a complex process. In this talk I will discuss a possible formation scenario whereby a small planet might form and be "sandwiched" in between two more massive planets.

## Towards a population synthesis study of increasingly realistic protoplanetary discs

Adam Koval (Edinburgh)

Simulations of collapsing giant molecular clouds show protostars forming with discs that may be massive enough to be susceptible to the gravitational instability. This instability may play a key role in both the formation of the star itself, and in the formation of giant planets through disc fragmentation. We extract a set of young discs ($<10^5$ yrs) from global collapse simulations (Bate 2012), which span a range of early evolutionary conditions and provide physically motivated, non-idealized initial conditions for high-resolution re-simulation. Using a novel particle-splitting technique that preserves the original density structure, we upscale the resolution of these discs to accurately treat gravitational fragmentation. Furthermore, given that fragmentation is highly sensitive to gas cooling and full radiative transfer is computationally expensive, we use a new cooling prescription based on optical depth estimation and particularly suited to disc-like geometries. These high-resolution simulations with more accurate cooling should provide a valuable insight into the frequency of disc fragmentation and any resultant protoplanetary population. We present preliminary results which show that some of the discs undergo fragmentation, including indications of triggered fragmentation. These early results lay the groundwork for a population-level study of disc fragmentation and giant planet formation in physically motivated, non-idealized discs.

## Testing planet formation via GI: FU Ori outbursts and Free-Floating Planets

Sergei Nayakshin (Leicester)

"It has been long argued that gas giant planets may form by fragmentation of massive gaseous disc, whereas lower mass solid cores (1-10 Earth masses) may form via dust concentrations collapse in the spiral density arms. FU Ori outbursts and FFPs offer valuable constraints on these ideas. FU Ori outbursts are rare but powerful accretion outbursts of young stars. Historically, only a handful of sources was known, but recent wide sky surveys expanded the sample ten folds, uncovering outbursts on stars from 0.2 to 20 Msun. I overview observational evidence, from low mass to high mass star outbursts, and theoretical models, arguing that this activity requires disc instabilities and massive planets. The youth and mass budget of the planets indicate their birth in the outer fragmenting proto-planetary disc, followed by a rapid inward migration into the star. We present 2D/3D simulations of discs with several embedded giant planets, showing that stochastic nature of disc torques in gravitationally unstable discs leads to planet eccentricity pumping and orbital crossings. I argue one recent FU Ori outburst is powered by such an eccentric planet. Furthermore, I show that in discs with embedded giant planets and solid cores, a significant fraction of the latter is ejected from the protoplanetary disc by close interactions with the migrating giant. This FFP production channel differs from the similar ideas in the Core Accretion scenario in many observables, such as the FFP mass spectrum, ejection velocities, timing of the ejections, and the FFP number produced per system.

## Planet formation in spontaneous dust traps in magnetized disks

Timmy Delage (Imperial)

An outstanding gap in the current planet formation theory is about the first steps of the planet formation process; namely how, when and where the initially ISM-like solid dust particles grow into pebbles and planetesimals, the building blocks of planetary cores. Protoplanetary disks provide the initial conditions for the planet formation process. They are magnetized and weakly ionized accretion disks that are subject to the magnetorotational instability (MRI), one of the main magnetized processes responsible for their angular momentum transport and gas turbulence. The nonideal magnetohydrodynamic (MHD) effects prevent the MRI from operating everywhere in PPDs, leading to a complex dichotomy between MRI active regions with higher gas turbulence and non-MRI regions with lower gas turbulence. In this talk, I will present the first numerical framework that describes the evolution of PPDs over millions of years powered by the MRI. It captures the MRI driven gas evolution via nonideal MHD calculations, which accounts for the dynamics and growth of the solid dust particles. An MRI powered mechanism that can spontaneously generate short- and long-lived pressure maxima in the PPD is unveiled. Within the long-lived pressure maxima, solid dust particles can efficiently be trapped, grow into pebbles, and reach high enough dust-to-gas mass ratios to potentially trigger the formation of planetesimals via the streaming instability. These planetesimals and pebbles can further rapidly interact to form planetary cores.

**Session: Exoplanet Discs & Planetesimal Signatures**

## Exocomets Overview

Daniela Iglesias (Leeds)

This talk will present a general overview of what the scientific community refers to as “exocomets” – comet-like bodies orbiting stars beyond our Solar System. I will begin by tracing the history of their discovery, with a special focus on the ground-breaking detections in the Beta Pictoris system, and place these findings within the broader context of exoplanet research. I will delve into the definition of exocomets, comparing them to Solar System comets and interstellar objects, and address their detection both around main-sequence stars and white dwarfs. I will present the diverse observational techniques used to study exocomets, distinguishing between the detection of exocometary bodies and the material they release. A comprehensive summary of all known exocometary systems will be presented, including those identified through spectroscopy and photometry. This will encompass systems orbiting white dwarfs, along with key statistics and trends. Finally, I will discuss what these discoveries reveal about planetary systems’ evolution and offer a glimpse into the exciting future of exocomet research.

## The search for Exorings and a Short Period Circumsecondary Disk Candidate

Niamh Mallaghan (QUB)

In our Solar system all the giant planets have rings, but their origin and evolution are still uncertain. For exorings even less is known. I will discuss the importance of a large-scale systematic search for exorings and the steps I am taking towards achieving this. Once exoring candidates have been found then they need to be characterised. Therefore, I will also discuss the enigmatic 'Dusty Object' in Orion. Its eclipses were first observed by NGTS in 2017 with a 0.69-day period. The eclipses are extremely asymmetric, variable, and show substructure, while the out-of-eclipse light-curve shows strong modulations. These features cannot be explained by a simple transiting planet or brown dwarf. I will discuss some of the hypotheses for this object, specifically focusing on the potential of it being a circumsecondary disk with possible exorings.

## Discs around planetary-mass objects: new insights from JWST

Belinda Damian (St Andrews)

Circumstellar discs, a natural byproduct of the formation of low-mass stars (LMS) and substellar objects, are crucial in setting the conditions and timescale for planet formation. These discs have been observed around free-floating planetary-mass objects (FFPMOs) and LMS at young ages. We first highlight the analyses of disc properties around brown dwarfs and LMS in nearby low mass and distant high mass environments, examining how their properties are affected by the UV radiation of nearby massive stars. We then present the near- and mid-infrared spectra of eight young FFPMOs with masses of 5–10 MJup, obtained using the NIRSpec and MIRI instruments on the James Webb Space Telescope. The photospheric spectra of our targets show a clear diversity at similar temperatures, especially in the 3-5 micron range, unaccounted for by existing atmospheric models. We find silicate absorption features in the photospheres of two of our targets, the first such detections in very young FFPMOs, indicating silicate clouds in their cool atmospheres. The remaining six objects show mid-infrared excess emission above the photosphere, as well as silicate emission features, demonstrating the presence of discs. The shape and strength of the latter features constitute strong evidence of grain growth and crystallisation, akin to that observed in discs around higher-mass brown dwarfs and stars. Our findings highlight i) the significant influence of stellar feedback on disc evolution in young star-forming regions and ii) that the presence and characteristics of discs around FFPMOs point to the potential for the formation of rocky companions.

## When Worlds Collide: Imaging post-impact debris in HD172555

Zoe Roumeliotis (Trinity)

Even after the gas-rich protoplanetary disk phase ends, terrestrial planet formation continues in the inner regions of planetary systems. The era of giant impacts, between 10 and 100 Myr of a system's lifetime, is the time when planetary embryos grow through mutual collisions to form terrestrial planets. Direct evidence of giant impacts in exoplanetary systems remains scarce, except for one system: HD172555, a 23 Myr-old A star in the Beta Pic moving group. To date, this system remains the only one in the Solar neighborhood with multiple conclusive lines of evidence of a giant impact. This planetary system hosts warm, $\sim$290 K dust with mid-IR spectral features from glassy

silica, requiring a high velocity, and an ALMA detection of CO gas from atmospheric stripping in the same, terrestrial planet-forming region at a few au from the star. In this talk, I will present new Atacama Large Millimeter/submillimeter Array (ALMA) Band 7 (880 $\mu$m) dust continuum and molecular gas line observations of HD 172555. These observations allow me to zoom into the innermost  au region of this system at an unprecedented resolution of $\sim$1.5 au, spatially resolving both dust continuum and CO lines for the first time. I fit the ALMA visibilities with RADMC-3D radiative transfer models to constrain the spatial structure of post-impact gas and dust. This enables me to characterize the location of the impact, as well as the properties and composition of the impacting planets. In doing so, I constrain models of planetary-scale collisions in unprecedented detail.