Discs on the Exe

From protostellar discs to debris discs and planets

Contributed Talks

1 Protoplanetary disc formation, clusters and Class 0/I discs

1.1 Evidence for Dust Grain Growth in the Class I Protostellar Disk IRS 63 from Polarized Emission

Presenter: Audrey Burggraf
Affiliation: Queen's University

A key challenge in understanding dust grain growth in protostellar disks is determining the grain sizes. Self-scattered polarized emission from disks constrains dust grain sizes through polarization patterns that depend on grain size, disk geometry, and optical depth.

We analyze multi-wavelength ALMA observations (Bands 4-7) of polarized emission in the Class I protostellar disk IRS 63.

We detect wavelength-dependent changes in polarization morphology and fraction. Assuming spherical grains in the central disk, our modelling finds the grains are compact with a maximum size of $\sim$ a few hundred microns. These grains are larger than typical interstellar medium grains, indicating grain growth in the disk. Additionally, we use a neural network to model polarized emission from non-spherical grains to better constrain grain shapes and sizes in the disk.

Constraining grain sizes in young disks is essential for understanding early planet formation and how micron-sized grains evolve into planets.

1.2 A Dust-Embedded Substellar Companion Candidate Formed by Gravitational Instability in the FUor System V960 Mon

Presenter: Anuroop Dasgupta
Affiliation: European Southern Observatory

FU Orionis objects (FUors) are young stars undergoing dramatic accretion outbursts, and their massive, gravitationally unstable disks represent compelling environments for substellar companion formation via gravitational instability (GI). We present high-contrast L'-band imaging of the FUor system V960 Mon with VLT/ERIS, targeting dust clumps previously identified in ALMA continuum observations coincident with a fragmenting gravitationally unstable spiral arm. We detect a new point-like source at a projected separation of 0.898" $\pm$ 0.009" with contrast $(8.39 \pm 0.07) \times 10^{-3}$. Non-detection in archival SPHERE H-band imaging places a strict upper mass limit of $\sim$38 Jupiter masses, while the L'-band flux excess indicates dominant circumsubstellar dust emission rather than photospheric light. Extended polarized flux perpendicular to the primary confirms the candidate is deeply embedded in circumstellar material. These results represent one of the most compelling observational candidates for substellar companion formation via gravitational instability identified to date.

1.3 Protostellar Disk Formation with Non-Ideal Magnetohydrodynamics and Jet Feedback

Presenter: Nina Filippova
Affiliation: The University of Texas at Austin

While recent surveys have resolved hundreds of nearby protostellar disks, numerical simulations assuming ideal magnetohydrodynamics (MHD) have historically struggled to achieve disk formation due to efficient angular momentum removal by magnetic torques. Non-ideal MHD effects, which become relevant at the low ionization fractions typical of molecular clouds, have been shown to reduce the effectiveness of magnetic braking and promote disk formation. We use the GIZMO code with non-ideal MHD (Ohmic resistivity, ambipolar diffusion, and Hall effect) and the STARFORGE numerical framework for star formation and stellar feedback to follow the gravitational collapse of turbulent molecular cloud cores down to the formation and evolution of protostellar disks in multiple stellar systems. We compare the effects of assuming ideal vs. non-ideal MHD with various prescriptions for the dust grain size and cosmic ray ionization rate as well as the inclusion of sub-grid protostellar jet feedback on disk formation and evolution.

1.4 Does the environment affect the planet formation?

Presenter: Camilo Gonzalez-Ruilova
Affiliation: USACH

Studies of star-disk interactions are typically conducted on large spatial scales (thousands of au) within molecular clouds, while planet-disk interactions are examined on much smaller scales (<100 au) through substructures such as rings, gaps, and cavities. In this talk, I present the largest census within the same molecular cloud, Ophiuchus Molecular Cloud, connecting these two regimes. Using observations from Atacama Large Millimeter/submillimeter Array (ALMA), we analyze Class I-III young stellar objects and investigate the presence of large-scale gaseous structures-outflows, envelopes, and streamers-and their relation to substructures in protoplanetary disks. The study combines high angular resolution and high sensitivity data at multiple wavelengths, particularly Bands 6 and 8. This work provides the most comprehensive view to date of how protostar-cloud interactions and disk morphology jointly influence the evolution of protoplanetary disks and the emergence of planetary systems.

1.5 Planetesimal formation during the buildup of protoplanetary disks with substructure

Presenter: Michael Hammer
Affiliation: MPS

Recent observations of protoplanetary discs show that discs can develop gaps and rings very early on, even around the time when the disc is still forming. We use DustPy and TriPodPy to study whether planetesimals can form through a 1-D dust evolution model that incorporates the buildup of the disc itself, building on previous work by also incorporating those very early gaps and rings into these models. We find that adding in the pressure bumps thought to be responsible for those gaps and rings can help planetesimals form earlier than in a smooth disc with no substructure. We also track the evolution of different molecular components, with a focus on CO and water in particular. We show that discs can develop a very different distribution of CO ice when taking disc buildup and substructure into account.

1.6 Probing Accretion and Multiplicity in Massive Young Stellar Objects with VLTI

Presenter: Maria Koutoulaki
Affiliation: University of Leeds

Massive stars play a fundamental role in shaping the interstellar medium and driving the evolution of galaxies, yet the processes governing their formation remain debated. Increasing observational evidence suggests that massive young stellar objects (MYSOs) form through disc accretion similarly to low-mass stars, but the innermost disc regions where mass accretion and outflows originate are still poorly constrained. In this talk, I present spatially resolved observations of the inner environments of several MYSOs obtained with VLTI/GRAVITY and/or VLTI/PIONIER, complemented by high-resolution IGRINS spectroscopy. By resolving the continuum and key diagnostic emission lines such as Brγ, Na I, and CO, we probe the structure and kinematics of the inner disc. The observations reveal compact gaseous emission interior to the dust continuum and signatures of disc substructures and possible companions in some sources, providing new constraints on accretion, multiplicity, and the early evolution of massive protostellar discs.

1.7 The Dynamic Inner Disks of Variable Accretors with VLTI

Presenter: Aaron Labdon
Affiliation: ESO

The inner disks of FUors are poorly understood places that offer clues to both the causes and evolution of FUor outbursts. These are not static places, but dynamic during accretion outbursts. By combining never-before-seen archival VLTI data with new GRAVITY data, we reveal the evolution of inner disks. We will present evidence of infalling material, disk depletion and new companions, which allow us to comment on potential triggering mechanisms and the effect of outbursts on planet formation processes. In particular, we find multiple cases where inner disks are severely depleted as accretion outbursts end, for both FUor and EXor type outbursts.

1.8 The interplay between infall and gravitational instability

Presenter: Cristiano Longarini
Affiliation: Institute of Astronomy, University of Cambridge

Young protoplanetary discs interact strongly with their surrounding environment through ongoing infall from the natal envelope. This continuous mass loading increases the disc mass and can drive the system toward gravitational instability. In this talk, I will explore the properties of infall-driven gravitational instability, focusing on the emergence of a self-regulated state in which angular momentum is efficiently transported throughout the disc. Using a combination of one-dimensional models and three-dimensional simulations, I will discuss how sustained infall influences the dynamical evolution of young discs and highlight the importance of this early phase in setting the initial conditions for planet formation.

1.9 Dust Substructure Impacting Dust Diffusion: A Tale of Two Disks

Presenter: Sarah Sadavoy
Affiliation: Queen's University

We present radiative transfer models of two Class I protostellar disks, IRS 63 and GSS 30 IRS 3, using ALMA observations at 0.87, 1.3, 1.7, and 2.0 mm. We consider models with and without rings and we model each ALMA band separately and then for the combined observations. We find that structured models are typically favoured over smooth models only at the longer wavelength bands, suggesting that optical depth limits the modelling capabilities. We also find that the two disks show distinct properties, with GSS 30 having signs of both radial drift and vertical dust settling, but IRS 63 has little evidence of either. We propose that the presence of rings in IRS 63 has hindered dust diffusion in that disk compared to GSS 30. These results suggest that the disk structures can have a significant impact on dust populations and ultimately planet formation.

1.10 Large Nonthermal Velocity Dispersion in the Outer Disk of HL Tau

Presenter: Jinshi Sai
Affiliation: Kagoshima University

Turbulence in protoplanetary disks plays a key role in disk evolution and planet formation, yet its strength remains poorly constrained in embedded Class 0/I systems. In this talk, I will present the first direct measurement of the nonthermal velocity dispersion in the late Class I disk of HL Tau using ALMA archival data of H2CO emission. With parametric model fitting, we find strong turbulence reaching $\sim$60% of sound speed at outer radii (r>100 au) of the disk. In contrast, previous studies inferred much weaker turbulence-below a few percent of the sound speed-in the inner disk (r<100 au) from the dust-ring scale heights. Our results therefore reveal a striking radial contrast in turbulence strength across the disk. The large nonthermal motions in the outer disk may be explained by turbulence driven by gravitational instability or by ongoing envelope infall.

1.11 Mining the ALMA Archive: Building a Catalog of Structured Young Protostellar Disks - Preliminary Results!

Presenter: Lance Schonberg
Affiliation: Queen's University at Kingston, Ontario

Most research on disk substructure in Young Stellar Objects (YSOs) has been done on older, unembedded objects, but recent studies have found structure in $\sim$10 Class 0 and I YSOs. Selecting archival ALMA projects, I am building a catalog of young, structured disks using model fitting of visibility data.

This catalog improves on the number of young YSOs with observed substructure by more than an order of magnitude, becoming the largest collection of such objects to date. I will present preliminary results covering the $\sim$200 objects out of 2000 surveyed from more than a dozen ALMA projects. From this sample, I find $\sim$50% of the selected objects may have substructure. Further, I have identified some sources with extended emission such as envelope structure and streamers as well as unresolved binaries. The final catalog will be a valuable resource for the star formation community.

1.12 Evolution of dust in a protoplanetary disc driven by stellar flybys: implications for the streaming instability

Presenter: Wei-Shan Su
Affiliation: Institute of Astronomy and Astrophysics, Academia Sinica

Stellar flybys are a common dynamical process in young stellar clusters and can significantly reshape protoplanetary discs. However, their impact on dust dynamics remains poorly understood, particularly in the weakly coupled regime (St$\gg$1). We present three-dimensional hydrodynamical simulations of parabolic stellar flybys-both coplanar and inclined-interacting with a gaseous and dusty protoplanetary disc. Gas and dust spirals differ in morphology and position, with their offset enhancing dust accumulation measured through the linear growth of the streaming instability. Flybys with mass equal to the central star (1 $M_\odot$) truncate the disc, producing tightly wound, ring-like spirals that promote dust coagulation. Moreover, an equal-mass flyby raises growth rates well above the critical clumping threshold after periastron, suggesting that such encounters may foster conditions favourable for dust clumping. These findings offer new perspectives on the morphological imprint of dynamical encounters in dusty disc environments.

1.13 Evidence for Gravitationally Unstable Disks Toward Orion Protostars

Presenter: John Tobin
Affiliation: NRAO

We present a small ALMA survey toward 5 massive (M$\sim$0.1 M_sun) and large (R $>$ 50 au) protostellar disks located within the Orion molecular clouds in ALMA 0.87$\sim$mm continuum at 0.04" resolution and 13CO/C18O molecular line emission at 0.12" resolution. The disks toward these Class 0 and I protostars are well-resolved in the observations. At least two disks show evidence for spiral structure in their dust continuum emission. The spiral structure is further revealed using image-based and visibility-based techniques to assess the robustness of the spiral structure. Despite more parameters, there is statistical preference for the model with two spiral arms rather than an axisymmetric or single spiral model. Further analysis of the protostar and disk hosting the most prominent spirals reveals that it may have Toomre Q low enough for self-gravity to drive the formation of spiral arms.

1.14 Unveiling planet forming discs with the Square Kilometre Array

Presenter: Anastasia Topalidou
Affiliation: University of Leeds

Constraining the amount of material available for planet formation in protoplanetary disks is essential for understanding planet formation. Centimetre wavelength observations probe the largest dust grains in an optically thin regime, but can also be contaminated by emission from ionised gas. I will present a recent multiwavelength survey of young stellar objects in Ophiuchus A from JWST, ALMA and the VLA; where the latter are the most sensitive and highest resolution cm-wave observations of YSOs to-date. Our results show several YSOs appear to be entirely dust dominated down to wavelengths as long as 6cm, making them ideal targets to search for grain growth. However, preliminary modelling suggests that unphysically large masses of dust would be required to match the observations. Detailed radiative transfer modelling allows us to decompose the dust and ionised gas, revealing the true amount of raw material for planet formation in these disks for the first time.

1.15 Disk-Surface Avalanche Accretion as a Trigger of FU Orionis-type Outbursts

Presenter: Yisheng Tu
Affiliation: University of Michigan

FUor outbursts represent dramatic heating and accretion events in young stellar objects, yet the mechanisms that trigger them and their impact on long-term disk evolution remain poorly understood. We use radiative non-ideal MHD simulations to investigate both the onset of FUor outbursts and their subsequent evolution. Our results show that an outburst can be triggered by the development of a disk-surface avalanche accretion stream, which rapidly transports mass inward and concentrates magnetic flux, igniting magnetorotational instability (MRI) in the inner disk. This mechanism naturally produces observable signatures in the light curve and significantly alters the thermal and magnetic structure of the disk. We also demonstrate how the outburst eventually subsides when radiative cooling overwhelms MRI heating, returning the disk to a magnetically inactive state. Finally, we discuss the implications of FUor-like events for the transport of solids and the evolving structure of forming protoplanetary disks.

1.16 Planetesimal Formation during Disc Formation across the Stellar Mass Spectrum

Presenter: Joe Williams
Affiliation: University of Exeter

The cause and timing of planetesimal formation remains a key unsolved problem in planet formation and protoplanetary disc studies. Modern studies often utilise the migrating water snowline to invoke planetesimal formation. We use a 1D viscous evolution model, coupled with the Shu-Ulrich infall model and including pebble growth, drift, and planetesimal formation to explore how planetesimals form across a range of stellar masses due to the movement of the snowline during disc formation. We find that pebble drift and planetesimal formation - modern cornerstones of planet formation - occur on very different time and spatial scales, and are sensitive to the initial conditions of the collapsing cloud building the disc. We discuss how radiogenic heating from Aluminium-26 will dehydrate and chemically partition planetesimals into distinct populations. We also show that planets forming around low-mass M-dwarfs are likely to form as barren rocky worlds, potentially explaining the lack of atmospheres observed by JWST.

1.17 A Plausible Pathway to CAI-formation in the Early Solar Nebula

Presenter: Peter Woitke
Affiliation: Space Research Institute (IWF), Schmiedlstraße 6, 8042 Graz, Austria

We propose a viable pathway for the formation of calcium-aluminum-rich inclusions (CAIs) in the early solar nebula. I will demonstrate how the intense viscous heating in the earliest disc evolutionary phases leads to silicate sublimation. Once the silicates are gone, the dust becomes transparent, and the heat can be radiated away. This forms an efficient thermostat mechanism that maintains the inner disc right at the silicate sublimation temperature. Under these circumstances, Al-Ca-Ti oxides are the only remaining condensates. These particles have time to anneal and coagulate, forming large crystalline particles that are slowly dragged out with the viscously spreading disc. Once these particles reach a distance of approximately 0.5 au, silicates re-condense on the surface of the Ca-Al-rich particles, forming the matrix. This CAI production mechanism operates for about the first 50,000 years of disc evolution.

1.18 Dust and Gas Properties of All Known Embedded Class 0/I Disks in Taurus

Presenter: Noshin Yesmin
Affiliation: University of Virginia

Envelope-embedded Class 0/I disks are the earliest stage of protoplanetary disk evolution and set the initial conditions for subsequent disk evolution and planet formation. We present a study of dust and gas in 26 embedded systems in Taurus, comprising all known Class 0/I disks in the region, using high-resolution ALMA and VLA continuum observations with CO line data to isolate compact disk emission and constrain dust masses, disk radii, and gas masses. From the continuum data, we find that Taurus Class 0/I disks are fainter than those in Orion, comparable to Perseus, and brighter than those in Ophiuchus, suggesting environmental differences across star-forming regions. Within Taurus, Class I disks are brighter than Class II disks, but their dust mass distributions are similar. We estimate gas masses from CO data and find gas-to-dust ratios comparable to the ISM and higher than those in Taurus Class II disks.

1.19 Gravitational instability in the youngest discs

Presenter: Alison Young
Affiliation: University of Leeds

We revisit the conditions under which protostellar discs may be subject to the gravitational instability by conducting a suite of SPH simulations with improved radiative transfer. We find that the conditions for spiral formation and fragmentation differ from earlier results. Notably, even discs with radii of $\sim$50 au can fragment in their outer regions, implying that GI driven planet formation is not restricted to only very large discs. Stellar irradiation provides additional thermal support, allowing discs to remain stable at higher masses; systems can reach $\gtrsim$0.4 M* without fragmenting, preserving substantial material for planet formation. The resulting long lived spiral structures tend to be compact and flocculent, suggesting that prominent, large scale spirals are not the typical outcome of GI.

2 Protoplanetary disc structures and their evolution

2.1 Dusty warps in the local frame: instability and fast clumping

Presenter: Hossam Aly
Affiliation: TU Delft

Warps are responsible for various global disc phenomena and observational signatures and have mostly been studied using global hydrodynamical simulations. However, their role in planet formation and affecting dust instabilities is best studied in a local frame. I will present recent efforts in modelling dusty warps in a local shearing box and show that warps can cause dust instabilities that lead to fast dust concentrations, much faster than the streaming instability. I will also show analytical and modelling efforts to investigate the effects of dust on the parametric instability.

2.2 Gaps and rings: A near-universal trait of extended protoplanetary discs

Presenter: Quincy Bosschaart
Affiliation: ESO

Substructures such as rings and gaps are commonly observed in protoplanetary discs and play a key role in dust evolution and planet formation. However, a fraction of extended discs (Rdust > 30 au) in nearby star-forming regions have remained unresolved, leaving their substructure content uncertain. In this talk, I will present new high-resolution ALMA Band 6 observations (∼0.12") of 26 previously unresolved discs within 200 pc, completing the high-resolution sample of extended discs in nearby star-forming regions. Radial profiles were analysed to identify rings, gaps, and cavities. Seventeen discs show clear substructures, while the remaining systems appear compact or ambiguous due to inclination effects or possible binarity. Combined with literature data, the full sample of 730 discs shows that nearly all extended discs contain substructures, with detection rates of ∼91%, increasing to ∼98% after accounting for high-inclination systems. These results suggest that substructures are a near-universal feature of extended protoplanetary discs.

2.3 Multi-frequency analysis of protoplanetary disks: Constraining dust mass across evolutionary classes

Presenter: Prachi Chavan
Affiliation: Diego Portales University

The total dust mass in protoplanetary disks represents the reservoir available to form planets. However, dust mass estimates derived from the classical single-frequency (sub)millimeter flux measurements appear systematically lower than the solid content present in massive exoplanets and exoplanetary systems. Multi-frequency analysis offers a more robust approach by simultaneously constraining dust temperature, surface density, and maximum grain size, directly impacting dust mass estimates. I will present the results from ALMA continuum observations of a total of 44 Class I and II disks in the Ophiuchus molecular cloud, based on radiative transfer modeling in Bands 3, 4, 6, 7, and 8. I will show the derived radial profiles of dust properties, along with the effects on optical depths and spectral indices across different ALMA bands. Finally, I will present the resulting dust-mass underestimation factors, which may help address the mass-budget problem and improve our understanding of planet-formation processes.

2.4 The Smallest Structured Disks

Presenter: Pietro Curone
Affiliation: Universidad de Chile

Surveys of nearby star-forming regions have shown nearly all extended (>30 au) protoplanetary disks have dust substructures. However, the vast majority of the disk population is compact and remains unresolved. Unhampered radial drift should rapidly deplete smooth disks; the survival of compact Class II disks after a few Myr suggests hidden dust traps must exist to halt migration. To address this, this talk presents new high signal-to-noise, 0.9 mm ALMA observations of 11 exceptionally small disks in the Lupus region, exploiting the maximum angular resolution at this wavelength of 0.015 arcsec (∼2 au). Spatially resolving all targets, visibility fitting yields an average dust radius of 6 au and reveals substructures in ∼50% of the sample, including a clear transition disk with a 1 au inner cavity. These results are the first to indicate substructures are ubiquitous across the disk population, directly probing planet formation conditions on Solar System scales.

2.5 Probing disk dynamics and dust evolution through shadows in protoplanetary disks: A case study of HD 142527 disk

Presenter: Yuya Fukuhara
Affiliation: Academia Sinica Institute of Astronomy and Astrophysics

Cooling rates in protoplanetary disks are key to understanding disk dynamics and dust properties. We present a novel method to constrain dust grain size by estimating cooling timescales in transition disks with shadows cast by inclined inner disks. By comparing three-dimensional surface models from infrared scattered light with sub-millimeter continuum maps, we derive cooling timescales from spatial offsets between irradiated and shadowed regions. Applying this method to the HD 142527 disk, we find that the northern shadow cools within a few percent of the orbital period. This timescale satisfies requirements for vertical shear instability, producing turbulence levels consistent with infrared observations. It also indicates a maximum grain size of 0.1-1 mm from an analytic model. Our results demonstrate that estimating cooling timescales is a powerful tool for probing disk physics and dust evolution. Our approach can be applied to other shadowed transition disks to reveal planetesimal formation stages.

2.6 The full NIR census. Disks and environment across regions and time

Presenter: Antonio Garufi
Affiliation: IRA Bologna, INAF

We compiled a list of 268 planet-forming disks with near-infrared maps obtained through more than 15 years of high-contrast imaging. This census reveals a wide diversity of disk and ambient morphologies and provides insights into the timescales for the formation of substructures and for disk-environment interactions. In particular, we propose that several types of substructures, both in the outer disk and at stellar scales, may be induced by late infall from the surrounding medium, highlighting the fundamental role of the environment in planet formation.

2.7 Discs of PEBBLeS

Presenter: Jane Greaves
Affiliation: Cardiff university

PEBBLeS is the Planet Earth Building Blocks Legacy e-MERLIN Survey, which images dust emission at radio wavelengths. Together with the very high resolution, this allows to detect planet-forming material in the disc mid-plane. I will discuss the top level results of the recently completed 1000+ hour survey. There are some surprises, including growth to pebble sizes taking longer than the protostellar phase, and disc asymmetries that could be planets forming by gravitational instability. The survey is a successful precursor to Cradle of Life science with the SKA.

2.8 Providing clarity on the transition phase from protoplanetary to debris discs

Presenter: Benjamin Homewood
Affiliation: University of Exeter

The transition phase from protoplanetary to debris discs is a key, unavoidable process, poorly constrained, and crucial to the evolutionary timeline of circumstellar discs. HD141569 is a circumstellar disc perfectly placed within this transition window, offering a unique opportunity to understand how this rapid transition occurs and the dynamic processes that govern it. Previous scattered-light observations reveal multiple asymmetric rings. Two main hypotheses explain these rings, differing primarily in their predicted distribution of large mm-sized grains. I present new ALMA observations of this system, tracing the distribution of mm-sized grains. Using the image and visibility analysis tools, we determine the radial distribution of large grains, revealing multiple rings similar to those in scattered light. In addition, performing visibility-domain non-parametric modelling to identify regions of asymmetry. We determine whether these structures arise from photoelectric instability (PeI), planets, or flybys. 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 in our present understanding between gas-rich protoplanetary discs and gas-poor debris discs. Highlighting the crucial nature of this system and its further investigation regarding planet formation.

2.9 Probing the inner disk wind of RU Lup with the fluorescence molecular hydrogen

Presenter: Dominika Itrich
Affiliation: University of Arizona

The evolution of gas in protoplanetary disks sets direct constraints on the formation and evolution of planets. Disk winds play an essential role in disk evolution by removing angular momentum from the disk and, as a result, driving accretion onto the star. Until now, disk winds have been characterised through the analysis of secondary tracers, mainly forbidden atomic lines. However, the main mass component of disks and winds is molecular hydrogen (H2), which is very difficult to detect directly. Here, we present H2 observations from HST/STIS/MAMA-FUV. We mapped the inner disk wind of RU Lup and obtained the spatially resolved information of the fluorescence H2 emission. We derived wind properties: velocity structure, collimation, physical properties, mass loss rate, and compare them to literature measurements using secondary tracers. We supplement our study by the simultaneous measurements of the mass accretion rates onto the star.

2.10 The Impact of Late-stage Infall on Protoplanetary disk Structure and Evolution

Presenter: Jibin Joseph
Affiliation: Leibniz Institut fur Astrophysik

Observations of large-scale streamers around proto-planetary disks suggest that late-stage accretion from the environment can significantly influence disk mass and angular momentum. We use 3D adaptive-mesh refined (AMR) simulations with the NIRVANA code to model cloud-disk interactions. Our setup covers large spatial scales (~10,000 AU) while maintaining high resolution (~1 AU) to capture accurately both the disk dynamics and streams of infalling gas. In our fiducial models, late-stage infall readily forms an eccentric, turbulent secondary disk. This turbulence drives accretion and creates a shallow, unstable gap between the primary and secondary disks, leading to vortex formation. Using a passive tracer fluid to model well-coupled dust in the cloud, we find that fresh dust initially persists only in the outer disk. Rayleigh-Taylor like instabilities at the outer shear layers facilitate dust diffusion into mid-layers over secular timescales, suggesting that late-stage infall may not efficiently replenish dust in the innermost regions.

2.11 Model-Independent 3D Mapping of Mid-Inclination Protoplanetary Disks

Presenter: Jensen Lawrence
Affiliation: Massachusetts Institute of Technology

Model-independent observational constraints on the three-dimensional structure of protoplanetary disks are crucial for understanding disk physics and elucidating planet formation. Here, we develop a methodology for analyzing mm/sub-mm spectral observations of gas-phase line emission from mid-inclination ($30° \lesssim i \lesssim 75°$) protoplanetary disks that empirically maps the (r, φ, z) geometry, emission intensity, and velocity of three vertically distinct regions in the disk: the front emission surface, back emission surface, and the emitting region closest to the midplane. As a proof of concept, we apply this technique to new 13CO and C18O observations, along with archival 12CO observations, of the HD 163296 protoplanetary disk. This produces tight constraints on multiple key disk properties including the midplane temperature and vertical gradients in temperature and velocity, establishing this methodology as a powerful technique for future analyses of other mid-inclination disks.

2.12 When Shadows Move: Probing Dynamic Inner Disks with Multi-Epoch Scattered-Light Imaging

Presenter: Jinlin Li
Affiliation: Peking University

Shadows in scattered-light images of protoplanetary disks provide a unique probe of the unresolved inner AU, where disk structure and planet formation are shaped. We present a multi-epoch near-infrared scattered-light study of 28 protoplanetary disks observed with VLT/SPHERE over the past decade. We find that shadow variability is common, with changes occurring on timescales from days to years. These variations indicate dynamically evolving inner disks and place constraints on mechanisms such as companion-driven inner-disk precession, misaligned inner disks, and asymmetric dusty structures near the star. Our results suggest that the inner regions of planet-forming disks are often not static or axisymmetric, but instead host diverse, time-variable asymmetries. Shadow variability therefore provides a powerful indirect probe of AU-scale disk structures that remain inaccessible to direct imaging and offers new insight into the environments where terrestrial planets may form.

2.13 A VLT/MUSE Survey for Accreting Planets/jets/winds in 67 Protoplanetary Discs

Presenter: Zhuhai Li
Affiliation: Peking University

The evolution of protoplanetary discs is governed by the transport of angular momentum. We present a survey of 67 discs with VLT/MUSE, revealing a collection of 27 jets and 14 winds. These outflows provide a direct window into magneto-centrifugal angular-momentum transport mechanism, a key driver in the transition from primordial Class 0/I discs to debris systems. By assuming intrinsically symmetric jets, we obtain the first large-scale estimates of internal disc extinction, offering critical new constraints on disc composition and structure. By forward modelling, we estimate winds launching radii, assessing the relative roles of MHD and photoevaporative winds.

Apart from these extended sources, and following the landmark detection of PDS 70 b and c, we search for accreting planet candidates. By comparing each system's contrast curve to the measured Hα emission of PDS 70 b and c, we assess how common such accreting planets can be in protoplanetary discs.

2.14 Characterizing dust in protoplanetary disks with quantitative polarimetry

Presenter: Jie Ma
Affiliation: Institut de Planetologie et d'Astrophysique de Grenoble

Scattered-light polarimetry provides direct access to the dust grains properties in the surface layers of protoplanetary discs. We present a quantitative analysis of polarimetric observations of 19 circumstellar disks obtained with VLT/SPHERE at both visible and near-infrared wavelengths. By systematically correcting for the PSF convolution effect, we measure the intrinsic polarised disk reflectance at different wavelengths and derive the disc colors for each system. The results reveal not only systematic trends between dust properties and stellar types for the full sample, but also dust species variation within individual disks linked to local dynamical structures. We demonstrate that polarimetric imaging can provide quantitative and comparative constraints on dust evolution, offering new insight into grain growth and the physical processes shaping planet-forming environments.

2.15 DEMOS: understanding disc evolution models from observed demographics

Presenter: Lorenzo Malanga
Affiliation: Universita degli Studi di Milano

To date, neither of the two main competing evolutionary models for protoplanetary discs, namely the viscous-photoevaporative paradigm nor the MHD winds model, has been ruled out by observations. Due to the high number of sources observed by large surveys, population synthesis is a powerful tool to distinguish the evolution mechanism in observations. We developed DEMOS (Disc Evolution Models from Observed Statistics) a Bayesian inference tool that aims to estimate the model parameters and the initial conditions that best reproduce observed star-forming regions. DEMOS is designed to exploit the full richness of observed distributions of stellar mass, disc mass, mass accretion rate and disc radius as well as the fraction of accreting objects. We applied the tool to the Lupus star-forming region, we derived the set of model parameters that best reproduce the observed population for both the viscous and MHD winds frameworks and compared the predictions of the two models.

2.16 Dust-driven vertical shear instability in a local and isothermal shearing box

Presenter: Jip Matthijsse
Affiliation: TU Delft

We investigate a dust-driven vertical shear instability (DVSI) in a radially local, vertically stratified isothermal shearing box. Unlike the classical vertical shear instability, which relies on baroclinicity from global thermodynamic gradients, DVSI is triggered by dust backreaction that generates axisymmetric vertical shear in an otherwise barotropic setup. We construct vertically stratified two-fluid equilibria including dust diffusion and initialise 2D hydrodynamical simulations with FARGO3D. To isolate DVSI from drag-driven instabilities, we adopt a "dust-analogue" model in which dust backreaction is imposed as a prescribed height-dependent acceleration on the gas. DVSI grows fastest away from the midplane where vertical shear is strongest, exciting radially short, vertically extended modes. The instability saturates through a Kelvin-Helmholtz-like parasitic instability that fragments coherent shear modes into smaller eddies, sustaining anisotropic turbulence and vertical stirring. These results show that dust-induced vertical shear alone can drive vertical mixing in an isothermal local model.

2.17 JWST Imaging of Edge-on Protoplanetary Disks: Dust Evolution, Disk Structure, and a new Path to Ice Abundances

Presenter: Francois MENARD
Affiliation: CNRS-IPAG. Grenboble

By occulting direct starlight and presenting their vertical structures directly, edge-on disks are unique systems for imaging in scattered starlight. From the optical to the mid-infrared, the wavelength dependence of the dust lane thickness provides clues about grain sizes and dust settling. JWST provided broadband images of 16 edge-on systems, from 1 to 21 microns, yielding fascinating results: 1) several systems still appear as bipolar nebulae at 21 microns; 2) two show PAH emission extending far beyond the disk; 3) disks seen in silhouette or 4) with unique mid-IR outflow features unseen before; 5) targets transitioning from bipolar nebulae in the optical to PSF-dominated in the mid-IR. Finally, new approaches were identified for measuring ice abundances in highly inclined (optically thick) protoplanetary disks that overcome the saturation of ice bands that will offer the ability to derive absolute and relative ice abundances in the outer disk for the first time.

2.18 Probing Pebbles in Protoplanetary Discs with ALMA Band 1

Presenter: James Miley
Affiliation: ALMA Observatory

ALMA Band 1 (35-50 GHz; 6-8.6 mm) opens a new observational window on the largest solids in protoplanetary discs, directly probing the pebble population responsible for planet formation. Here I will present spatially resolved 7 mm observations of the famous HD 163296 disc, among the first obtained with ALMA at these wavelengths. Imaging using both CLEAN and minimum-entropy methods robustly recovers radial substructures associated with known dust rings, demonstrating the ability of Band 1 to trace particle concentrations. By combining these data with archival multi-wavelength observations, I derive spatially resolved spectral indices and perform multi-wavelength modelling to constrain the maximum grain size, size distribution, and composition of the dust population. The results provide direct evidence for pebble-sized grains concentrated in disc substructures. These observations demonstrate the transformative potential of ALMA Band 1 for studying grain growth, dust evolution, and the physical processes driving planet formation in discs.

2.19 Tracing vertical variations of turbulence from molecular line ALMA observations of protoplanetary disks.

Presenter: Teresa Paneque-Carreno
Affiliation: University of Michigan

As a natural outcome of various instabilities, turbulence is expected to appear as random velocity motions that mix the planet-forming material and aid disk evolution by acting as an effective viscosity and removing angular momentum. However, current methods using complex radiative transfer models have failed to detect turbulent eddies, except in a couple of standalone cases. In this work, we present a new methodology that traces the broadening effect that turbulence has on molecular linewidths, by modelling the line profile of optically thin molecular species observed by ALMA. Using resolved observations of multiple lines, located across the disk extent, we put limits on the vertical and radial variations of turbulence. These constraints are crucial, as they link back to the underlying instability responsible for triggering the velocity dispersions. We show that disks may be more turbulent than previously thought, opening a new chapter in our understanding of disk evolution.

2.20 Circumbinary disc truncation is dynamical, not secular

Presenter: Enrico Ragusa
Affiliation: Universita degli Studi di Milano

Discs surrounding binary stars develop central cavities due to the gravitational influence of the binary. Classical analytical models predict cavity sizes of roughly two to three times the binary separation by balancing tidal torques with viscous torques in the disc. However, numerical simulations often produce larger, time-variable cavities, suggesting the standard torque-balance picture is incomplete.

In this presentation, we analyse 72 hydrodynamical simulations to reassess the cavity truncation mechanism. Besides the well-known dependence of the cavity size on binary separation, eccentricity, and mass-ratio, we also find a dependence on instantaneous cavity eccentricity and its apsidal alignment with the binary, which together determine the pericentre of the innermost disc orbit. This supports a dynamical, not secular, interpretation of circumbinary cavity formation.

We propose a semi-analytical model in which truncation is governed by dynamical orbital stability through resonance overlap and chaotic motion, rather than torque balance, while hydrodynamical effects introduce secondary corrections.

2.21 Compact CO emission and no evidence of radial drift. ALMA observations of the faintest planet-forming disks.

Presenter: Giulia Ricciardi
Affiliation: ESO Garching

Planet-forming disks often exhibit faint continuum and CO emission, raising doubts about whether they contain enough material to form the known exoplanet population. The faintest disks - showing compact, unresolved continuum and non-detections in CO isotopologues - remain poorly explored. They may be spatially extended but below detection limits, or intrinsically compact. Only the latter can contain enough hidden material to form planets. In this talk, I'll present the first systematic analysis of the CO-faintest disks in Lupus. We find optically thick 12CO and 13CO emission confined to small structures (<40au), with no robust evidence for radial drift. Through modeling viscous and MHD-driven cases, we constrain the narrow disk masses and turbulence ranges to reproduce such compact gas disks. Finally, I'll present new, high-resolution ALMA data of 33 spectroscopically well-characterized protoplanetary disks, fully characterizing the gaseous component, particularly the faint emission regime, to extend the investigation of compact disks to a broader and more diverse population.

2.22 Constraining disk and planet properties from dust substructures in exoALMA disks

Presenter: Alessandro Ruzza
Affiliation: Universita degli studi di Milano

The exoALMA program provided a comprehensive view of the morphology and kinematics of 15 protoplanetary disks, offering a well-characterized sample for population-level analysis. Continuum observations revealed numerous dust substructures, possible signatures of embedded planets. Under this assumption, we analyzed the observed morphologies with the simulation-based inference tool DBNets2.0, inferring the putative planet masses and the disk α-viscosity, scale height, and dust Stokes number required to reproduce 19 substructures in 13 of the 15 exoALMA disks. In this talk, I will present the outcome of this analysis. We compared our results with the literature and explored the implications of the inferred properties for disk evolution and planet migration. The implied viscous accretion timescales are generally too long to explain the observed stellar accretion rates, and inward migration is expected to be the more frequent scenario. These results demonstrate the potential of dust substructures and SBI methods to characterize protoplanetary systems.

2.23 Hints of Disk Substructure in the First Brown Dwarf with a Dynamical Mass Constraint

Presenter: Alejandro Santamaria Miranda
Affiliation: Observatorio Astronomico Nacional

We present high-resolution ALMA observations of the Class II brown dwarf 2MASS J04442713+2512164 (2M0444), one of the brightest and best-studied BD disks. Our 0.89 mm continuum and 12CO (3-2) line data reach a spatial resolution of 0.046 arcsec ($\sim$6.4 au), enabling the first dynamical mass measurement in the substellar regime from ALMA data. We constrain the central mass to 0.043-0.092 Msun, confirming the object as a brown dwarf, and reveal a gas-to-dust disk size ratio >6, indicating efficient radial drift. Despite the expected loss of large grains due to drift, we detect tentative evidence for substructure in the dust continuum: a gap and ring pair at ∼14-16 au, consistent with the presence of a dust trap. Visibility fitting with frank and galario supports this scenario. If caused by an embedded planet, the gap would be consistent with a low-mass (0.3-7.7 Mearth) rocky planet formed via core accretion. These results challenge current models of disk evolution and planet formation in the very low-mass regime. Our study opens a new window into the early evolution of brown dwarf disks and emphasizes the importance of high angular resolution to characterize their architecture.

2.24 ALMA 2D Super-resolution Imaging Survey of Ophiuchus Class I/Flat-spectrum/II Disks: The Onset of Substructure Formation and Disk Evolution

Presenter: Ayumu Shoshi
Affiliation: Kyushu University

We present a super-resolution survey of protoplanetary disks in the Ophiuchus molecular cloud to constrain when and how millimeter substructures emerge. We employ two-dimensional super-resolution imaging based on sparse modeling for ALMA archival Band 6 continuum data, obtaining au-scale (0".02-0".2) images for 78 spatially resolved disks spanning Class I, flat-spectrum, and Class II stages. Detectable substructures are found in ∼30-40% of the sample, including 15 newly identified cases. Combining these results with the eDisk survey shows that current substructure detections are restricted to later accretion phases (bolometric temperature$\gtrsim$200-300 K) and large dust disks ($\gtrsim$30 au). We further examine the size-luminosity relation and find that only Class II disks with substructures exhibit a markedly steeper radius-luminosity scaling, consistent with long-lived dust traps (e.g., planet-induced pressure bumps) shaping the global disk properties.

2.25 What can we learn about dust growth from ubiquitous dust rings?

Presenter: Simin Tong
Affiliation: University of Leicester

Ring-like dust structures are ubiquitous in protoplanetary discs, and are thought to be the sites where small dust particles accumulate and grow into larger grains. Multi-wavelength ALMA observations show that in several discs, the maximum dust size is limited to mm or sub-mm sizes, at radii from a few to hundreds of au, posing a challenge to dust evolution theory. In this talk, I will address this tension between observations and theoretical predictions by combining recent high-resolution ALMA observations with dust evolution models. Beyond offering a new interpretation of the observations, I will show how these results can constrain the combination of disc turbulence and dust fragility. I will also discuss the sequence of multiple dust ring formation, and a possible mechanism for explaining the unusually faint inner dust rings observed in discs such as AA Tau and LkHa 330.

2.26 Can planets form in the rings of protoplanetary disks?

Presenter: Elena Viscardi
Affiliation: European Southern Observatory

The leading theory of planet formation is the Streaming Instability (SI), a hydrodynamical process that triggers planetesimal formation in dust overdensities, such as rings. By measuring the dust mass and particle sizes in these rings, we can test whether the conditions required to trigger SI are met. In this talk, I discuss the dust properties of GM Aur and HD 163296. New high-resolution VLA observations of GM Aur allow us to constrain the dust mass and size distribution in its two rings. Combining this with kinematically derived gas properties, we measure the Stokes number and dust-to-gas ratio, quantifying the rings' potential to trigger SI. In HD 163296, we use the dust extinction of the CO back surface to directly measure the optical depth at two wavelengths. This provides key constraints on dust composition, the missing ingredient in dust analyses and the planets' building material.

2.27 A fast tree algorithm for multi-component coagulation equation

Presenter: Taichi K. Watanabe
Affiliation: The Graduate University for Advanced Studies, SOKENDAI / NAOJ

The coagulation simulations of dust aggregates with multiple components or properties, such as mass and porosity, are computationally expensive. Here, we present a novel coagulation algorithm, inspired by the gravitational N-body tree algorithm. The conventional direct method calculates the coagulation of all the bin pairs in the dust-property distribution, requiring O(N^(2d)) operations for d components with N bins per component. In contrast, our tree method groups the "distant" bins in the dust-property space, reducing the computational cost to O(d N^d log N). The performance evaluation showed that our tree method was faster than the direct method by tens of times with the same accuracy for d=2. Our algorithm can evolve the dust mass-porosity distribution in protoplanetary disks, ultimately revising planet formation models.

2.28 Runaway planetesimal formation in turbulent dust rings driven by a dust growth-concentration feedback loop

Presenter: Ziyan Xu
Affiliation: University of Copenhagen

High-resolution ALMA observations reveal that dust in protoplanetary disks commonly concentrates into narrow rings, which are widely interpreted as dust traps and promising sites of planetesimal formation via streaming instability. However, how dust evolution within these rings interacts with dust diffusion and feedback processes to regulate the onset of planetesimal formation remains understudied.

We investigate this problem by combining local MHD simulations of streaming instability and global DustPy model of planetesimal formation in dust rings with dust evolution. The simulations show that dust clumping in rings increases the local dust loading, suppressing turbulence and dust diffusion. When incorporated into DustPy, this process produces a positive loop between dust growth and concentration / diffusion suppression that can trigger runaway planetesimal formation in rings. In rings undergoing active planetesimal formation, the midplane dust-to-gas ratio self-regulates near the streaming instability clumping threshold, consistent with the marginally clumping behavior inferred for many ALMA rings.

2.29 Dynamical and Thermodynamical Roles of Shadows in Protoplanetary Disks

Presenter: Shangjia Zhang
Affiliation: Columbia University

Protoplanetary disks are primarily heated by irradiation from their central stars, and the geometry of illumination can strongly influence disk dynamics. Many disks exhibit shadows cast by misaligned inner disks, producing large-scale azimuthal temperature asymmetries. We show that such asymmetric heating can drive a wide range of dynamical structures, including spirals, rings and gaps, vortices, eccentric disks, and warps, depending on the illumination geometry. Illumination therefore couples radiative transfer and hydrodynamics and can influence long-term disk evolution. This framework is directly testable observationally. Thermal structures inferred from disk images predict corresponding gas kinematics that can be verified with molecular line observations from ALMA. Joint modeling of near-infrared scattered light, millimeter dust continuum, and gas line emission can constrain radiative cooling timescales and dust-gas collisional coupling, providing new thermodynamic constraints on disk structure and dust size distributions.

2.30 Spirals, rings, and vortices shaped by shadows in protoplanetary disks

Presenter: Alexandros Ziampras
Affiliation: LMU Munich

Numerous protoplanetary disks exhibit shadows in scattered light observations. These shadows are typically cast by misaligned inner components and are associated with observable structures in the outer disk, such as bright arcs and spirals. Investigating the dynamics of the shadowed outer disk is therefore essential in understanding the formation and evolution of these structures. We study the formation of substructure in shadowed disks with multifluid radiation hydrodynamics simulations. Spiral arms are launched at shadow edges, leading to the formation of gaps, rings, or even vortices well within 100 kyr. Synthetic observations show that such features should be clearly observable in both scattered light and millimeter continuum emission, providing a new way to probe the presence of substructure in protoplanetary disks. Our results suggest that the formation of rings and gaps is a common process in shadowed disks, and can explain the rich radial substructure observed in several protoplanetary disks.

3 Disc chemistry

3.1 Two's company: a second detection of refractory solid condensation from a thermostat region in an embedded protostar

Presenter: Femke Ballieux
Affiliation: Leiden Observatory

The formation of planets such as Earth starts with the recondensation of refractory minerals from hot gas close to a protostar. Recently, crystalline silicates were found to be recondensing from a reservoir of hot SiO gas around Class I protostar HOPS-315 (McClure+25), making it the first detection of this so-called t=0 phase of planetesimal formation. We present James Webb Space Telescope observations of an even younger Class I protostar, showing that it is also undergoing the t=0 moment. We model bands of a number of absorption bands, including SiO, $\rm{H_2O}$, CO, $\rm{CO_2}$, HCN, and $\rm{C_2H_2}$, as well as more massive hydrocarbons. We find that this source is more carbon-rich than HOPS-315, finding that its more carbon-rich chemistry is possibly related to dust processing.

3.2 Chemical Diversity in Externally Irradiated Disks: JWST and ALMA Observations of NGC 1977

Presenter: Ryan Boyden
Affiliation: University of Virginia

I will present new JWST MIRI/MRS and ALMA Band 7 observations of 8 externally irradiated disks in the Orion NGC 1977 cluster. NGC 1977 hosts an external UV field that is weaker than those found at the centers of O-star-hosting clusters, but stronger than those found in low-mass star-forming regions. We aim to constrain the impact of these "intermediate" UV fields-the most common UV fields found in nearby ($d < 1$ kpc) star-forming environments-on the chemistry of planet formation. The MIRI/MRS spectra reveal a rich chemical diversity in the inner disks, from H2O-rich to lacking molecular emission. The ALMA observations reveal resolved disks spanning a range of masses, sizes, and mm-dust morphologies. Our results indicate that intermediately irradiated disks host the same inner chemistry as isolated disks. The presence of massive, extended disks, however, indicates this diversity is not driven by disk truncation from external photoevaporation.

3.3 Born in ice and steam

Presenter: Valentin Christiaens
Affiliation: CEA

An increasingly exhaustive inventory of warm molecules present in the inner part of protoplanetary discs has been gathered with spectroscopic JWST observations, yet very little spatially resolved spectral information could be extracted to date. In parallel, ice volatiles have only been characterized either at very early stages, or in discs seen edge-on. Here I will present the results of the application of a molecular mapping algorithm to JWST/NIRSpec data of PDS 70, where we obtain for the first time: (i) maps of the CO, CO2 and OCN- ice distributions in a non-edge on class II disc, (ii) maps of the CO gas emission and absorption throughout the disc, and (iii) localized enhanced signatures of CO gas emission and CO ice absorption around protoplanets b and c, respectively. These results demonstrate the potential of our molecular mapping approach to constrain the composition of the material fed to embedded forming planets.

3.4 A JWST census of inner-disk organics: Linking disk chemistry to accretion and pebble drift

Presenter: Maria Jose (Majo) Colmenares Diaz
Affiliation: University of Michigan

Organic molecules are abundant in protoplanetary disks, yet the origin of their striking diversity remains poorly understood. The unprecedented sensitivity and resolving power of JWST opens a new window into these environments. We present a JWST survey of 40 T Tauri disks, the largest uniform study to date, probing the terrestrial planet-forming region. The sample spans stellar masses of 0.3-1.5 Msun and exhibits a wide range of chemical complexity, with individual disks showing between 1 and 10 detected organic species. Using LTE slab modeling, we derive emitting masses and temperatures, enabling a statistical comparison of slab-derived gas properties (as opposed to fluxes) with stellar and disk parameters. We find strong correlations between organic content, accretion rate, and dust disk size, suggesting that pebble drift regulates the organic inventory of inner disks. We also derive empirical gas-phase C/O ratios for 20 systems, finding values near or below solar.

3.5 DECO reveals C/O ratio trends as traced by large hydrocarbons

Presenter: Lucy Evans
Affiliation: University of Leeds

How can we characterise the chemical connection between disks and the exoplanets forming within? With large observational surveys of exoplanets planned, similar surveys of disks are required to fully probe this connection. The ALMA Large Program DECO (ALMA Disk-Exoplanet C/Onnection) includes 80 disks in four star-forming regions - comfortably the largest such survey. A big question that DECO aims to address is how the C/O ratio, known to affect planetary composition, differs across this huge sample; while all are T-Tauri disks surrounding low-mass stars, they vary significantly in mass, size and extent. In this talk I will show DECO HC3N and c-C3H2 results, comparing these with smaller hydrocarbons (HCN and C2H). I will present the detection statistics of these known high-C/O environment tracers and correlations with star-forming region, stellar spectral type and disk properties. I will compare these to the DECO-extracted global C/O ratio in the disks.

3.6 Tracing isotopologue chemistry in inner regions of planet-forming disks

Presenter: Jayatee Kanwar
Affiliation: University of Michigan

JWST observations of planet-forming disks have revealed rare isotopologues including the detection of 13CCH2, H218O, C18O16O, H13CN, HC15N etc. around T Tauri and very low-mass stars, raising fundamental questions about isotopic fractionation under disk conditions. To interpret these detections, we developed a comprehensive chemical network incorporating isotopologues of C, N and O and coupled it with time-dependent thermochemical disk models. We explore a range of C/O ratios including solar and greater than unity, to investigate how excess carbon partitioned into CO versus 13CO is redistributed into hydrocarbons and other carbon-bearing species over time. Preliminary models successfully produce 13C-bearing species including 13CCH2 and doubly substituted 13C2H2, demonstrating that thermochemical disk models can form such species. We will present the physical and chemical conditions most favorable for their formation across different C/O regimes.

3.7 Revisiting the Physical and Chemical Structure of HD 163296 using an Extensive Suite of ALMA Molecular Lines: Mapping the Building Blocks of Giant Planets

Presenter: Parashmoni Kashyap
Affiliation: National Institute of Science Education and Research (NISER) Bhubaneswar

Exoplanet atmospheres inherit elemental and molecular compositions from natal protoplanetary disks, making disk structure and chemistry essential for understanding exoplanet diversity. HD 163296, with prominent rings and gaps, is a benchmark system for studying wide-orbit giant planet formation. We present a coupled physical and chemical analysis of this disk using ALMA observations of 27 molecular transitions across 10 species, the largest molecular inventory analysed simultaneously for a single disk. Combining spectral retrievals with thermochemical modelling, we constrain temperature, density, and molecular abundances in planet-forming regions. These ten molecular tracers collectively indicate a super-solar gas-phase C/O ratio. High-resolution DCO^+ imaging reveals triple-ring chemical substructures aligned with dust rings, providing constraints on the disk's midplane conditions. The inferred chemistry is consistent with JWST-derived giant exoplanet atmospheres, linking disk chemistry to planetary compositions and identifying structured disks as key reservoirs of planet-forming material.

3.8 The impact of Dust Sublimation and Composition on Accretion Outbursts in Protoplanetary Disks

Presenter: Nicolas Kaufmann
Affiliation: LMU (University of Munich)

The inner edge of the MRI dead zone has been shown to be unstable and trigger periodic accretion outbursts. Previous studies neglected or strongly simplified the role of the dust composition and, as a consequence, the dust's sublimation behaviour. In this study, we investigate the effect that more sophisticated dust models, including sublimation and condensation, have on the dynamics of these outbursts. We find that the strength of these outbursts strongly depends on the sublimation temperature of the different chemical components of the dust. In the most extreme case for very low sublimation temperatures, outbursts are suppressed. Additionally, we show the impact these accretion outbursts have on the dust composition in the inner disk by flushing the close-in material onto the star during the burst and heating up the dust beyond its sublimation temperature.

3.9 Dust removal via growth in the upper disc layers and its influence on the C/O ratio

Presenter: Beatrice Kulterer
Affiliation: University of Virginia

The chemical composition of forming planets is set by the elemental composition of material in protoplanetary discs and varies from object to object. Understanding the evolution of key elemental ratios, such as the Carbon-over-Oxygen (C/O) ratio, requires a comprehensive modeling framework of the physical and chemical properties during the lifetime of protoplanetary. As protoplanetary discs are not static it is also important to consider how the drift and settling of dust grains influences elemental ratios. I will present modeling work that also investigates dust grain removal from the upper layers of the disk due to grain growth coupled to an extensive chemical model. I will show how this can affect the C/O ratio and the abundances of small organic molecules during the lifetime of protoplanetary disks and discuss why including this process is crucial to gain a better understanding of the diversity of the chemical composition of forming planets.

3.10 Toward the First Comprehensive Picture of Vertical Chemical Structure Across a Sample of Protoplanetary Disks

Presenter: Romane Le Gal
Affiliation: IPAG/IRAM

Protoplanetary disks are intrinsically three-dimensional and highly structured. While ALMA has revealed a rich diversity of radial dust and gas substructures (rings, cavities, spirals, and azimuthal asymmetries) their vertical structure remains poorly constrained. Yet this structure, from the hot atmosphere to the warm molecular layer and cold midplane, is key to understanding how disk physical conditions shape planet-forming environments. Edge-on disks offer a unique opportunity to directly disentangle radial and vertical components and to image disk stratification unambiguously. We present an ALMA Large Program designed to map the vertical chemical structure of nine carefully selected edge-on disks, all complemented by JWST observations. This survey will robustly constrain the link between dust and gas distributions and provide a benchmark for understanding disk diversity, vertical layering, and the initial chemical conditions inherited by forming planets.

3.11 A fish out of water: unique observations of water in planet-forming disks

Presenter: Margot Leemker
Affiliation: University of Milan

Water is a crucial ingredient for life on Earth. Furthermore, water enhances planet formation and is the main carrier of oxygen, one of the most abundant elements. Still, the trail of water from clouds to planets is unclear. Water on Earth may be inherited from its parent molecular cloud, but it is also possible that water has been destroyed and reformed along the water trail from cloud to disk. In addition, spatially resolved observations of water in disks are extremely rare, hiding one of the most important molecules at the moment planets are forming. In this talk I will show the latest results looking at water in disks, including the first spatially resolved observations of the main water isotopologue tracing the spatial extent of water, and the most rare isotopologue observed to date tracing whether or not water is inherited from the earliest phases of star and planet formation.

3.12 Dust-processing in an FUor-type protoplanetary disk

Presenter: Foteini Lykou
Affiliation: Konkoly Observatory, HUN-REN CSFK

FUor-type stars are the most extreme accretors among all eruptive variable young stars. They undergo outbursts that can increase luminosity by up to 100× and last for decades, accreting significant mass from their disks. These events are expected to alter the chemical, mineralogical, and structural properties of protoplanetary disks, such as changes in the snowline and/or formation of sub-structures, thus influencing planet formation. However, clear observational evidence of such changes is rare, previously seen only in a few systems like the FUor V883 Ori and the less-energetic EX Lupi. This work will present a multi-wavelength study of the effects of a recent outburst in the protoplanetary disk of the FUor-type PR Ori B. We focus on changes in the chemical composition of the circumstellar material seen through mid-infrared spectroscopy, and on probable structural changes in the disk inferred from high-angular-resolution observations from the VLTI and ALMA.

3.13 ALMA CHEER: CharacterizingPlanet-Forming Chemistry around Herbig Stars

Presenter: Jamila Pegues
Affiliation: University of Virginia

Planets, from rocky cores to gas giants, form from protoplanetary disks around an exquisite variety of young stars. By characterizing planet-forming chemistry in disks across the young stellar distribution, we can better understand how planetary systems, like the Solar System, come to be. Herbig stars, which inhabit the massive end of the young stellar distribution, cultivate particularly unique disk environments. These bright young stars are also excellent labs for studying the chemistry of giant planet formation. Here we present a systematic ALMA survey of planet-forming chemistry across a large sample of Herbig protoplanetary disks. We describe preliminary work in characterizing the sample's molecular tracers of ionization and cold chemistry, two processes that play critical roles in driving disk and planet composition. We place our findings within the context of the broader Herbig disk population, and we compare our results to planet-forming disk chemistry around Sun-like and lower-mass stars.

3.14 Setting the stage for molecular complexity: detecting the water snowline with ALMA

Presenter: Luna Rampinelli
Affiliation: Universita degli Studi di Milano

Water plays a key role in planet formation, by regulating the composition of the planetary material and dust dynamical processes at the base of planetesimal formation. While water in protoplanetary disks has been predominantly observed at infrared wavelengths, the powerful capabilities of ALMA now offer an unprecedented opportunity to map the spatial distribution of water vapor at millimeter wavelengths. I will present new spatially resolved observations of water vapor in the planet-hosting disk of HD 100546, directly imaging the water snowline in a disk for the first time. I will also show how combining water and methanol ALMA observations of this disk allows to reveal the chemical complexity built in the planet-forming material. These breakthrough observations pave the way for a deeper understanding of the water budget and distribution in the birthplace of planets, and the evolution of molecular complexity eventually incorporated in the building-blocks of planets.

3.15 Chemical Divergence and Water Depletion: Gas Properties of Evolved Upper Scorpius Disks Revealed by JWST/MIRI

Presenter: Eshan Raul
Affiliation: University of Wisconsin-Madison

Tracing the chemical evolution of protoplanetary disks over time requires observations at different ages. We present the results of a JWST/MIRI MRS survey of 10 disks (ages 2-6 Myr, spectral types M0-M4.5) in the Upper Scorpius region. Using MCMC slab modeling, we detect a variety of molecular emission. We classify each disk along two independent axes-a Water Classification based on H2O line luminosity (Water-Rich, Water-Poor, or Water-Absent) and a Special Chemotype based on the dominant non-water chemistry (Organic-Rich, CO2-Dominated, or Molecule-Absent)-

and find an unexpectedly high diversity of distinct chemical compositions within our population. Notably, Upper Scorpius disks also show systematically lower water fluxes by factors of 10-1000. In particular, disks with strong carbon-based molecular features but no observed H2O defy expectations of an inner-disk dust cavity, but instead indicate that the presence of a strong outer-disk dust trap largely controls the chemical outcome.

3.16 The evolution of discs through their chemistry: comparing models with JWST observations of Class I & II discs

Presenter: Andrew Sellek
Affiliation: Leiden Observatory

During protoplanetary discs' lifetimes, their physical properties evolve via gas and dust dynamical processes including accretion and radial drift. By redistributing molecules, these processes also drive evolution in chemical composition, including in the inner regions where JWST is probing the molecular content at different evolutionary stages. I will present predicted inner-disc elemental abundances from disc evolution models, discussing the influence of properties including the disc size and ionization rate, and thereby demonstrate how incorporating outer disc chemical evolution can explain the observed trend in C/O with stellar mass. The models also predict that icy-pebble delivery to the inner disc peaks in the young Class I phase: I will compare those predictions with new JWST-MIRI/MRS observations of such discs, highlighting differences with their older Class II counterparts that help distinguish between competing effects of various dynamical processes. Thus, we can reveal what sets the chemistry inherited by the first forming planets.

3.17 From Infalling Gas to a Chemical Fountain

Presenter: Joe Stadler
Affiliation: ESO

Planet formation does not occur in isolation. Recent studies indicate that stellar flybys and ongoing gas infall from the remnant molecular cloud can significantly impact disk evolution and its planet-forming potential. Yet these environmental effects remain poorly constrained observationally. A striking test case is the quadruple star system HD34700 and its richly structured circumbinary transition disk. ALMA 12CO line observations reveal complex gas kinematics, including pronounced non-Keplerian motions that align with the scattered-light spiral arms and are consistent with infalling gas streamers. Meanwhile, the underlying 13CO and C18O lines are less perturbed, tracing the Keplerian rotation, but show tentative evidence of anticyclonic vortex motions co-located with the disk's highly asymmetric dust continuum crescent. The potential vortex appears to act as a chemical fountain from which outflowing methanol has been detected, and may have formed due to the late-stage gas infall that triggered the Rossby Wave Instability.

3.18 Young disks with JWST/MIRI: dissecting physical components at the onset of planet formation

Presenter: Łukasz Tychoniec
Affiliation: Leiden Observatory

The protostellar stage is a critical phase, early in the stellar evolution (< 0.5 Myr), during which a disk of gas and dust forms, setting the chemical budget for planet formation. With the spectral range, sensitivity, and resolution of JWST-MIRI, we are now capable of characterising these warm inner (<10au) planet-forming regions for the first time for those young disks. I will present new JWST-MIRI data on Class I disks, showing a large variety of molecular emission and absorption features of H2O, CO2, HCN, and C2H2. By comparing the data with previous VLT-CRIRES observations that spectrally resolve CO emission, we can pinpoint the origin of the molecular emission and disentangle the contributions of disks, winds, and envelope emission. Overall, our new data reveal the crucial transition between young, embedded disks and mature T-Tauri disks, testing theories of enhanced water delivery in the early stages.

3.19 When You Form a Planet Is Important: An Age Dependent Study of JWST Spectra Throughout Planet Formation

Presenter: Abygail Waggoner
Affiliation: University of Wisconsin-Madison

The location of and process in which planets form dictate the material available to them and whether that planet could someday be habitable. But what about when a planet forms? In this contribution, we present JWST MIRI spectra of thirty protoplanetary disks of similar stellar types spanning the star and planet formation process (0.5∼6 Myr). We find gas mass decreases with time, and the thermal structure and gas composition of the inner disk (<10au) morphs with age (particularly true for H2O). Oxygen bearing species, such as H2O and CO2, seem to evolve differently than organic species, such as C2H2 and HCN, leading to an overall increase in the C/O ratio over time. We discuss possible origins of these trends, such as pebble accretion and destruction of refractory materials, and the implications of an age dependent chemical and thermal structure on the formation of terrestrial planets.

3.20 Following the Water Trail in Planet-forming Disks: Developing a Theoretical Framework to Interpret Observations

Presenter: Levi Walls
Affiliation: University of Michigan

The D/H ratio in the Solar System is used as a fingerprint to trace the origins of Earth's water as different water reservoirs hold slightly different enrichments. We aim to understand how this "deuterium fingerprint" may evolve in chemically and dynamically complex planet-forming disks. This is done in a coupled, azimuthally symmetric 3D framework where gas, dust, and ice hydrodynamics are modeled with LA-COMPASS, and the time-dependent water chemistry is computed using a modified version of Astrochem. Advection and diffusion of gas with the simultaneous drift of dust and ice in this 3D framework shape the water distribution throughout the disk. Sublimated water is continually supplied by icy pebbles drifting inward past the water snowline. Gas-phase reprocessing of this water drives an order of magnitude decrease in the water D/H inside the snowline, which is imprinted in ice on small grains that diffuse outward beyond the water snowline.

4 Planets in discs and how they shape them

4.1 A promising unique CPD candidate in the Eta Cha Association

Presenter: Felipe Alarcon
Affiliation: Universita degli studi di Milano

We present a circumplanetary disk (CPD) candidate within the Eta Cha association. Consistent multi-wavelength data-including millimeter dust continuum, infrared, and optical, alongside broad CO emission-point to a planetary-mass companion in EK Cha. This Class III system represents a "bridge" between gas-rich Class II phase and debris disks. Unlike the PDS 70 or WISPIT 2 systems, this candidate is detached from the primary disk, but still within a 50 au separation, placing it in a more compact configuration than typical Planetary-Mass Companions. Objects in Eta Cha offer a distinct observational advantage, their evolved state minimize dust extinction while retaining enough material to capture planet formation in-situ. Furthermore, infrared evidence of resonant structures tracing small dust suggests the early development of a "proto-exoKuiper" belt in EK Cha. Given the scarcity of confirmed protoplanets, EK Cha provides a unique laboratory for understanding planetary systems in a later stage of disk evolution.

4.2 Radio emission mechanisms from protoplanet PDS70c

Presenter: Simon Casassus
Affiliation: U. de Chile

While most directly imaged candidate protoplanets are Halpha sources, PDS70c is the only example known to have a radio counterpart. By contrast to optical measurements, which are affected by extinction in the protoplanetary gap, the radio signal directly probes the protoplanetary environement, provided the emission mechanisms are known. I will summarise the observational information on the radio signal from PDS70c, covering both multi-frequency and variability measurements. The data that rule out thermal emission from a dusty environment, and instead link the radio signal from PDS70c to a standing shock at the surface of a circum-planetary disk.

4.3 The Arc in the DX Cha Circumbinary System: Evidence For a Retrograde Circumbinary Disk

Presenter: Cheng Chen
Affiliation: Bishop's University

Observations of the binary system DX Cha reveal a compact ring at 0.43 au, located just outside the binary orbit. This proximity contradicts standard prograde simulations, which predict a large inner cavity cleared by gravitational torques. Conversely, our simulations demonstrate that a retrograde disk can remain stable much closer to the binary, forming arc-like structures that align with the data. We therefore suggest that DX Cha's circumbinary disk orbits in a retrograde direction. This finding highlights the importance of studying compact disks, as confirming retrograde orbits would have profound implications for our understanding of star and planet formation.

4.4 Direct Imaging of Protoplanet Candidates in Protoplanetary Disks Using VLT/ERIS NIX L-band Observation

Presenter: Swastik Chowbay
Affiliation: Universita di degli studi di milano

We present our study using the VLT/ERIS NIX imager observations at 3.8 μm to directly detect protoplanet candidates responsible for the observed kinematic signatures in protoplanetary disks. By taking advantage of the long-wavelength sensitivity of the L-band, we aim to reduce the impact of circumstellar and circumplanetary dust extinction, significantly improving our ability to resolve thermal emissions from embedded protoplanets. Our targets, identified through ALMA observations of prominent spiral structures and kinematic deviations, are ideal candidates for direct imaging. This work aims to confirm the planetary nature of these features and provides initial constraints on the luminosities of the detected planets. These observations represent a crucial step in integrating kinematic and photometric techniques to calibrate the mass-luminosity relationship of young protoplanets and enhance our understanding of planet formation processes. Our findings highlight the potential of combining ALMA and NIX data to advance the study of planetary genesis in diverse disk environments.

4.5 Substructure formation in the PDS 70 disk

Presenter: Daniel Daza Valdebenito
Affiliation: University of Copenhagen

PDS70 stands out as the first protoplanetary disk in which two directly imaged, accreting protoplanets have been confirmed. These planets reside within a large cavity, surrounded by a ring composed of gas and dust. Observations reveal strong dust trapping and radial segregation, an arm-like structure, and an azimuthal asymmetry interpreted as dust trapping inside a vortex. The goal is to reproduce the observed substructures in ALMA Bands 3, 4, 7, 9, and investigate their origin through planet-disk interactions. We performed two-dimensional hydrodynamical simulations and conduct radiative transfer post-processing of PDS70. We included the two detected planets, and simulate the response of the gas and four discrete sizes of dust. The simulations recover a radial segregation, indicating that small grains leak into the gap and consistent with dust trapping at the pressure maximum. A weak vortex formed in the early stages, however, it presents a high azimuthally spread distribution along with a low contrast in the synthetic images. We find that the model that includes such a vortex does not replicate the inner shoulder associated with strong leaking of dust grains into the gap, even when adopting a temperature profile built to account for both features simultaneously. In an alternative model of increased viscosity this radial structure can be reproduced, but no vortex develops. These results support the interpretation that substructures in PDS70 may arise from the dynamical interaction between gas, dust, and planets. Better constraints on disk viscosity and grain size distribution are needed to fully characterize these substructures and improve model-observation comparisons.

4.6 The Future is Now: Protoplanetary Discs with ELT/METIS

Presenter: Iain Hammond
Affiliation: Max Planck Institute for Astronomy

Protoplanet imaging and characterisation is an observational challenge, even for 8m class AO-equipped telescopes. The first light of ELT/METIS is expected late 2029, providing six times better angular resolution than JWST and two orders of magnitude deeper sensitivity in the L'-band than VLT and Keck. To prepare ourselves for this leap in data quality, we have began simulating METIS observations of protoplanetary discs. We couple radiative transfer of discs to end-to-end instrument simulations from HEEPS, including coronagraphic compontents, pupil effects, non-common path aberrations and angular- and reference star differential imaging. We present early expectations for the fidelity of METIS observations towards typical protoplanetary discs, substructure recovery, protoplanet detection and characterisation, and early signs of limitations. Such predictions motivate our final observing strategy and ideal targets for first light.

4.7 A Stellar Flyby in Action: Untangling the Dynamics of HD 141569's Hybrid Disc

Presenter: Arcelia Hermosillo Ruiz
Affiliation: University of Exeter

Hybrid discs are characterized by their non-negligible amount of gas and optically thin dust, making them a blend between protoplanetary and debris disc, and thus, suspects of transitioning between those two phases. The hybrid disc around the ∼5 Myr Herbig Be/Ae star HD 141569A is an intriguing example. Its 500 au wide disc has multiple rings, gaps, and spirals, and is surrounded by two spatially resolved M stars at 900 au away on-sky, which could be shaping some of these structures. We use new observational constraints to infer the locations of yet-undiscovered planet(s) and calculate the flyby trajectory of the binary, and use a suite of Nbody and SPH simulations to investigate their interaction with the disc. We vary the extent of the initial disk, the masses and locations of planets, and the trajectory of the M-binary, and show how their combination can lead to the complex observed structure. Importantly, the Nbody and SPH simulations produce different morphologies, illustrating the effect of gas in shaping the dynamics of dust as opposed to planetesimals.

4.8 A multifluid approach for pebble accretion

Presenter: Tom Konijn
Affiliation: Delft University of Technology

Pebble accretion is widely considered a key, and probably necessary, ingredient for rapid planet formation. However, most studies still rely on simplified gas prescriptions or assume a single particle size (monodisperse). For this work, we revisit pebble accretion using a multifluid hydrodynamical model that evolves the gas and multiple pebble species (polydisperse) self-consistently. This allows us to move beyond static background discs and directly study how the planet's perturbation of the gas affects the accretion of solids. We find that perturbing the disc modifies the accretion efficiency systematically with Stokes number. We find lower total accretion because of this perturbation of the gas. Interestingly, we see the ratio between poly-, and monodisperse accretion to be significantly higher than previous estimations. These results demonstrate the importance of self-consistent gas evolution, not only for polydisperse pebble accretion, but also for understanding the transition from pebble accretion to isolation and gap opening.

4.9 Imaging and characterizing forming exoplanets in their birth environment

Presenter: Justin Latour
Affiliation: University of Liege

Studying planet formation is crucial to understand the diversity in observed exoplanets; however, few protoplanets have been confirmed so far. HD 135344B presents a protoplanetary disk with spiral arms and a large cavity depleted of gas and dust. These structures may be due to interactions with an embedded companion, which makes HD 135344B a prime target for the search of protoplanets.

We analyze archival NACO and SPHERE datasets spanning 10 years. An annular version of the 4S algorithm used on non-coronagraphic data, bypassing the inner working angle of the coronagraph, makes it possible to reach unprecedented contrasts at small angular separations. We characterize protoplanet candidate signals, and upper limits on planetary companions are systematically derived within the cavity. The time baseline of our observations allows us to study the spirals dynamics, suggesting the existence of a spiral-driving protoplanet on an orbit that coincides with a dust filament observed with ALMA.

4.10 Spectroscopic Confirmation of the Planet WISPIT 2c

Presenter: Chloe Lawlor
Affiliation: University of Galway

The multi-ringed disk in the WISPIT 2 system was recently confirmed to host a 5 M_Jup gas giant planet, orbiting in its large, 60 au gap, making it the first such detection in a multi-ringed class II system. We will discuss a new exciting discovery that confirms the existence of a second embedded planet in the system. The new planet, WISPIT 2c, was confirmed using VLTI/GRAVITY observations, where the extracted spectrum shows a characteristic CO feature at 2.3 microns. The new planet is twice as massive as 2b and orbits significantly closer to its host star, at roughly 14 au. We will discuss our atmospheric grid modelling, which places the planet at an effective temperature of ~1700 K and a mass of 8-12 M_J. With two confirmed gas giant planets embedded in its disk, WISPIT 2 now becomes only the second of its kind, after PDS 70.

4.11 Accretion onto CPDs and from CPDs onto planets: Observations and theory

Presenter: Gabriel-Dominique Marleau
Affiliation: Universitat Duisburg-Essen

Circumstellar discs are also planet-forming discs. Gas enters the Hill sphere opened by a forming gas giant but how does it reach the planet? Circumplanetary discs (CPDs) are well known from simulations and have also been clearly inferred from recent observations. Are CPDs thick or thin and can we identify this observationally? And how is the gas actually added to the planet: by boundary-layer accretion or magnetospheric accretion? What about the accretion shock?

We use a combination of multidimensional radiation-hydrodynamical simulations, semianalytical derivations (be reassured, only digestible details in the talk), and high-spectral-resolution observations to study how gas is accreting onto gas giants and their discs, both for planetary-mass accretors in (semi-)isolation and in gaps in protoplanetary discs. We also address the thermochemical feedback on the circumstellar disc. Finally, we predict how upcoming facilities such as the ELT will be crucial to study these processes in detail.

4.12 IRAS 04125: the misaligned puzzle

Presenter: Rebecca Nealon
Affiliation: Monash University

The IRAS01425+2902 wide binary system was recently reported to have both a young planet and a puzzling geometric arrangement, where the planet and binary both orbit edge-on, but misaligned by to the circumprimary disc. This is the youngest transiting planet yet to be detected but its misalignment to the disc is difficult to explain. We propose that IRAS04125 was formed through the unstable dissolution of a triple system. We model this with simulations of a flyby, mimicking the instantaneous ejection of a third star. We consider the evolution of the stellar, planetary and disc components. We show that the peculiar geometry inferred from observations can be recreated in our simulations. We also find that the planet develops a retrograde orbit to the disc, creating a strong prediction for future testing of our model. Because the planet in IRAS04125 is so young, this has strong implications for planet formation time-scales.

4.13 Modified gas dynamics via solid back-reaction and its implications for the migration of low-mass planets in dusty discs

Presenter: Andras Nemeth
Affiliation: Eotvos Lorand University

The migration of low-mass planets is governed by the interplay between gravitational torques from the gaseous and solid components of the protoplanetary disc. Performing 2D global hydrodynamic simulations in locally isothermal discs, we investigate the often-neglected back-reaction of solid material on gas dynamics across varying metallicities, Stokes numbers, and accretion efficiencies. Results demonstrate that the combined effect of back-reaction and planetary accretion frequently flips total torques from negative to positive, particularly for Earth-sized embryos. To validate these findings, we performed simulations using Adaptive Mesh Refinement (AMR) to allow for self-consistent migration tracks. The observed directions of planetary migration consistently align with our calculated torque predictions. In metal-rich discs, standard linear scaling prescriptions fail for weakly coupled solid species (St <= 2), as feedback-driven gas perturbations in the co-orbital region heavily modify the gas torques. We conclude that including solid back-reaction is essential for accurate migration modelling.

4.14 The complex kinematic structure of GQ Lup

Presenter: Pietro Pirola
Affiliation: Universita degli studi di Milano

While planet-disc interactions are widely studied, most analyses lack precise knowledge of the planet's position or motion. GQ Lup represents a unique system where a directly imaged companion (10-30MJ), perturbing the primary disc, has a tightly constrained orbit at a separation wide enough to resolve kinematic perturbations in the surrounding gas. In this work, we use high-spectral and spatial resolution ALMA observations to link the orbital motion of GQ Lup b to the intricate kinematic structure of the gas surrounding the primary. Furthermore, GQ Lup b is known to host a circumplanetary disc (CPD): by combining continuum and line observations, we provide robust constraints on its physical conditions. Our results provide a comprehensive view of the interaction between a massive companion and the circumstellar disc, investigating both gas kinematics and CPD structure.

4.15 INSECT: Investigating the NaScent Environment of Circumbinary planeTs

Presenter: Camila Pulgares
Affiliation: University College London

Circumbinary planets around binary stars have been detected in observations from Kepler and TESS. Some of these binaries are close enough to host circumbinary disks. In such systems, several mechanisms absent in single-star environments can affect the dynamical evolution of the disk and prevent the in-situ formation of close-in planets. Consequently, the formation and evolution of circumbinary planets remain open questions.

We present new ALMA Bands 6 and 7 observations of the dust continuum and gas emission of six circumbinary disks. By fitting the interferometric visibilities with Galario and Frankenstein, we can constrain the dust disk morphology and explore how its geometrical properties relate to those of the central binary. Combining this analysis with observations of CO isotopologues and N2H+ allows us to investigate the physical processes shaping circumbinary disk environments and their implications for planet formation.

4.16 JWST/NIRCam constraints on planetary perturbers in seven nearby debris disc systems

Presenter: Vito Squicciarini
Affiliation: University of Exeter

We present results from a JWST/NIRCam coronagraphic survey of seven nearby stars with precise astrometry from Hipparcos and Gaia, enabling dynamical constraints on potential planetary-mass companions. Five systems reveal debris discs directly detected with JWST/NIRCam, allowing us to identify and characterize their morphology and geometry, while the remaining targets have discs previously imaged with Herschel, ALMA, and scattered light. These data provide strong constraints on system architectures and orbital planes. Combined with Hipparcos-Gaia astrometry, they tightly restrict the allowed mass-semi-major axis parameter space of potential perturbers. No planetary companions are detected. However, the resulting limits exclude large regions of parameter space for wide-orbit massive planets. In particular, for one star, we build on a detailed analysis that enables a more precise determination and exclusion of plausible planetary scenarios shaping the disc. This work highlights the power of combining high-contrast imaging, debris discs, and astrometry to probe wide-orbit exoplanets.

4.17 Using Gaia astrometry to identify planets and companions around Young Stellar Objects

Presenter: Miguel Vioque
Affiliation: European Southern Observatory

The Gaia mission has opened a new window into the study of star and planet formation, as well as circumstellar discs. Gaia astrometry can be used to identify planets and companions within protoplanetary and debris discs. This presentation highlights several scientific results based on analysing the Gaia astrometry of Young Stellar Objects, ranging from newly identified protoplanet candidates to the use of Gaia measurements to inform the physical interpretation of disc substructures, as well as a reassessment of multiplicity in circumbinary and transition disc populations. The impact of disc gravity, accretion, scattered light, dippers, starspots, and outflows on Gaia astrometry is also evaluated. Finally, this presentation discusses prospects for the upcoming Gaia Data Release 4 (December 2026), including its expected impact on multiplicity and planet formation studies, as well as the detection of a new population of protoplanets and planets in debris discs once all individual Gaia epochs become available.

4.18 Global View of Circumplanetary Disk from a Dilated-evolution Method

Presenter: Yu Wang
Affiliation: Tsinghua University

Accreting giant planets gather nebular gas into circumplanetary disks (CPDs), which regulate material delivery and serve as the cradle for satellite formation. Characterizing CPD structure is numerically challenging due to the extreme resolution and small timesteps required to resolve both the planet's vicinity and the protoplanetary disk. We propose to solve this issue by dilated evolution: a novel method that accelerates simulations toward a steady state. Using this approach, we present global simulations resolving the CPD down to Jupiter's surface. We find that meridional accretion into the CPD is highly asymmetric, characterized by a localized stream plunging into the disk at $\sim$0.2 Hill radii. Momentum transport within the CPD is efficiently driven by spiral shocks, resulting in an effective viscous alpha $\sim$0.01. This implies a highly turbulent environment. These well-resolved gas density and flow structures also provide key insights into the observability of CPDs via continuum emission and gas kinematics.

4.19 Insights on plant-disc interactions from the deepest ALMA observations of PDS 70 to date

Presenter: Francesco Zagaria
Affiliation: MPIA

Catching giant protoplanets is our best opportunity to explain the properties of their fully formed siblings. The current dearth of directly imaged protoplanets, while an arduous obstacle in this quest, comes with an unparalleled wealth of data for the few known protoplanet-hosting systems. PDS 70, the first disc where two accreting gas giants were directly imaged, is an ideal example. In less than a decade, ALMA observed it for $\sim$24 hrs on-source (at 0.9 mm). In my talk, I will discuss the results of my effort to combine those data, including the deepest and highest angular resolution continuum images of PDS 70 to date and spectral line cubes of CO isotopologues, UV chemistry, ionization, and shock tracers. This dataset provides the best opportunity so far of revealing how gas giants interact with their hosting disc, accrete gas, and regulate material delivery to the terrestrial planet formation zone.

5 Protoplanetary disc dispersal

5.1 Mapping Proplyd Outflows with JWST/NIRSpec

Presenter: Nick Ballering
Affiliation: Space Science Institute

I will present deep JWST/NIRSpec IFU observations of three large proplyds in the Orion Nebula Cluster that illustrate the physical and chemical structure of externally-irradiated disks and FUV-driven photoevaporative outflows. Warm molecular gas (H2, CO, OH, CH+) is detected from the central disks. A neutral atomic flow - revealed prominently by OI and CI - surrounds the disk and extends into the core of the proplyd tail. This neutral component is a key prediction of photoevaporation models but was difficult to study in detail until now. This, in turn, is surrounded by a cometary-shaped ionization front traced by a forest of HI and He recombination lines. The proplyd tails are particularly bright in PAH emission, suggesting that PAHs are efficiently swept into the flow by radiation pressure. CO2 ice is detected from the disk of all three proplyds, confirming that ice can survive in strongly irradiated disks.

5.2 Investigating the Limits of Primordial Disc Survival: Discovery of Accreting "Peter Pan" Discs in 10-100 Myr Clusters

Presenter: Gregory Ben
Affiliation: Indian Institute of Science Education and Research Tirupati, India

Understanding the shift from primordial protoplanetary discs to debris systems is critical in planet formation. Our blind survey of 32 young clusters (1-100 Myr) using Gaia, 2MASS, and WISE reveals that typical disc decay timescales increase with wavelength (t=1.6 Myr at lower wavelengths vs. $\sim$4.4 Myr at 12 um), supporting inside-out disc clearing models. Furthermore, we observe that the median mass of disc-hosting stars decreases in clusters older than 40 Myr, indicating that primordial discs survive longer around lower-mass stars. From this survey, we identified 120 old full-disc candidates. Additionally, NEOWISE time-domain data indicate irregular variability (Δ(mag) ~ 0.5) in 20% of these sources, suggesting late-stage planetesimal interactions. Finally, we present results from optical/NIR spectroscopic follow-up of the old full-disc candidates, confirming accretion signatures in four sources belonging to older stellar groups ($>$10 Myr). These detections confirm the persistence of gas-rich, accreting discs ("Peter Pan discs").

5.3 Debris Disc Formation via External Photoevaporation

Presenter: Heather Johnston
Affiliation: University of Exeter

A key open question in debris disc research is: where and how do these planetesimals form? The streaming instability is a leading mechanism, requiring a locally enhanced dust-to-gas ratio to trigger gravitational collapse into planetesimals. However, it remains unclear what processes drive this enrichment at the disc outer edge, setting the eventual architecture of the debris disc. We propose that external photoevaporation (EPE) is an efficient trigger. Using the dust and gas evolution code DustPy coupled with an FUV EPE prescription, we model the evolution of protoplanetary discs over 15 Myr. We find that strong EPE drives planetesimal formation via streaming instability at the truncated disc outer edge, with the resulting planetesimal belt width directly sensitive to the FUV field strength. Notably, high FUV levels (>500 G0) provide a pathway to form wide planetesimal belts at large orbital radii, with important implications for the diversity of observed debris disc architectures.

5.4 Formation of Multiple Dynamical Classes in the Kuiper Belt via Disk Dissipation

Presenter: Tommy Chi Ho Lau
Affiliation: University of Chicago

Planetesimal formation likely lasted for millions of years in the solar nebula, and the cold classicals in the Kuiper Belt are suggested to be the direct products of streaming instability. The presence of minor planetary bodies in the outer solar system and the exo-Kuiper belts provide key constraints to planet formation models. In this work, we connected dust drift and coagulation, planetesimal formation, N-body gravity, pebble accretion, planet migration, planetary core accretion, gap opening, and internal photoevaporation in one modeling framework. We demonstrate that multiple classes of minor planets, or planetesimals, can form during disk dissipation and remain afterwards, including a scattered group, a resonant group, and a dynamically cold group. We also conducted a parameter study which showed that this is not a universal case, where the outcome is determined by the competition for dust between planetesimal formation and pebble accretion.

5.5 Disk evolution in Taurus: Rapid and complete dispersal of protoplanetary disks, and the birth of debris disks

Presenter: Josh Lovell
Affiliation: Harvard-Smithsonian Center for Astrophysics

Planet and planetesimal formation likely occur early in the development of planetary systems around young stars in protoplanetary disks. How protoplanetary disks disperse, and planetesimal belts are born remain poorly understood however, given biases in YSO surveys that have typically focused on the earliest disk evolutionary stages. I will highlight new findings from the SMA Taurus Survey, which has obtained new millimeter observations of 60+ Gaia-2MASS-WISE confirmed Class III YSOs to investigate the final stages of protoplanetary disk evolution. I will show that mid-infrared spectral slope measurements provide a very strong indicator of millimetric disk properties, and present an updated millimeter luminosity distribution for Taurus YSOs. The distribution is bifurcated, and suggests protoplanetary disk dispersal from the class II to III stage is rapid, near-complete (>99%), and homologous. We also present a mid-infrared excess disk population that may trace planetesimal belts that typically do not survive to the main sequence.

5.6 Using JWST H2 observations to constrain external photoevaporation in the ONC

Presenter: Raphael Meshaka
Affiliation: Queen Mary University of London

Most stars form in dense clusters, where external photoevaporation by massive stars drives rapid protoplanetary disc dispersal. Quantifying this process is crucial to determine the gas reservoir available for planet formation. Yet, the micro-physics of the photoevaporative wind remains poorly constrained. I will present a detailed analysis of molecular hydrogen emission in two Orion Nebula Cluster proplyds, using JWST/NIRSpec MSA data. We identify over 20 H2 transitions per object, providing a unique diagnostic of the warm gas within the wind. To interpret these observations, we employ the Meudon PDR Code, taking advantage of its advanced treatment of H2 excitation, including non-LTE effects such as UV pumping. By fitting the observed H2 lines, we derive constraints on the external FUV radiation field, mass-loss rates, and dust grain properties. Our results show how advanced PDR modelling can bring new insights into the impact of external photoevaporation in high UV environments.

5.7 Emergence of the youngest debris discs

Presenter: Olja Panic
Affiliation: University of Leeds

The youngest debris discs ($<$10Myr) are central for our understanding of the early evolution of planetary systems. We give an overview of our recent results regarding this elusive stage. Enabled by Gaia and WISE archives, and spectroscopic surveys, we identified a statistical sample of pre-main-sequence stars surrounded by debris discs. We find a decreasing trend of the infrared excess fractions over time, indicative of a progressive clearing of these young debris discs. With ALMA, we characterise a few unique exemplars of young debris discs where dust belts coexist with the, likely primordial, gas. Scattered light colours of their progenitors - the protoplanetary discs around A-type stars - show absence of sub-micron dust needed for FUV photoevaporation of their gas. This suggests that gas may survive into the debris disc phase, but our statistical comparisons to the overall protoplanetary disc sample show that this occurs as an exception, rather than a rule.

5.8 Unveiling Wide-Angled H2 Winds and Collimated Fine-Structure Jets from the Edge-on Disk HV Tau C with JWST and ALMA

Presenter: Vinod Chandra Pathak
Affiliation: Tata Institute of Fundamental Research (TIFR), Mumbai

Mass-loss through winds and jets plays a crucial role in regulating protoplanetary disk evolution and angular momentum transport. However, molecular winds in evolved Class II disks remain poorly explored. Using mid-infrared observations from JWST/MIRI-MRS, we investigate spatially resolved pure rotational H_2 emission from the nearly edge-on Class II disk HV Tau C. The emission reveals a wide-angled molecular wind extending beyond both near-IR scattered-light emission and the compact ALMA dust and gas disk. Rotational diagram analysis indicates two temperature components: a warm component($\sim$600K) and a hot component($\sim$2000K). Position-velocity analysis shows outward motions of several tens of km/sec with dynamical timescales of tens to hundreds of years. We also detect collimated jets traced by fine-structure lines such as [Fe II], [Ne II], and [Ar II]. We compare mass-loss rates in the molecular wind and atomic jets with the accretion rate to assess their role in angular momentum removal and disk dispersal.

5.9 Beyond vanilla external photoevaporation: What processes sculpt the Trumpler 14 proplyds?

Presenter: Tyger Peake
Affiliation: Queen Mary University of London

External irradiation of protoplanetary discs, by massive stars, disperses the disc and forms objects known as proplyds. Recent JWST/NIRCam F466N observations of Trumpler 14 shows objects with proplyd morphologies in regions of harsher UV environments than have previously been observed. To interpret the observations we have developed a general model of dynamical dust escape, from which we produce synthetic observables. We apply this to two key physical scenarios. Firstly, long and narrow gas free dusty tails can be explained by radiation pressure ejecting dust directly out of a gas poor disc. Particularly high mass loss rates of approximately 5e15 g/s are required, raising the question of the grains replenishment, e.g. collisions. Secondly, broad and short tails can be explained by grains entrained in external photoevaporative winds, which become redirected by radiation pressure or a bow shock into a tail. Both models can explain the observed proplyds in Trumpler 14.

5.10 The Transition Disc Illusion: How 2D Photoevaporation Traps Dust Without Clearing Gas

Presenter: Giovanni Picogna
Affiliation: USM - LMU Munich

For decades, the standard paradigm has held that internal photoevaporation efficiently carves clean, empty gas cavities in protoplanetary discs, directly producing the transition discs we observe. By self-consistently coupling the evolving disc structure with photoevaporative flows in 2D radiation-hydrodynamical simulations, we revealed a very different dynamical reality. Once a density depression begins to form, the local mass-loss rate sharply drops, effectively choking off the wind. Simultaneously, viscous inflow and radial surface flows partially refill the gap. The result is not a clean cavity, but an expanding shallow gas depression. Nevertheless, a pressure maxima forms at the outer edge of the gas depression acting as a dust trap, creating the observational illusion of a cleared transition disc. Finally, we provide a new, dynamic 1D mass-loss prescription that captures this stalling behavior, offering an updated tool for planet population synthesis models.

5.11 Accretion and disk evolution across environments: insights from a VLT/X-Shooter survey in Orion A

Presenter: Lara Piscarreta
Affiliation: European Southern Observatory (ESO)

Characterizing how accretion parameters scale with stellar and disk properties at a population-level across different environments is key to understanding the physical processes that drive protoplanetary disk evolution and dispersal. The last decade has seen growing efforts towards homogeneous spectroscopic studies of accretion in young stellar populations, though most have targeted nearby, low-density regions, leaving more massive and representative star-forming environments less explored. With this in mind, I will present a VLT/X-Shooter study of accretion in young stellar objects across the entire Orion A complex ($\sim$90 pc). By disentangling the stellar, extinction, and accretion contributions and performing a cross-region analysis, I will discuss how stellar-accretion-disk scaling relations compare across regions that, combined, span more than four orders of magnitude in FUV field strengths. I will further discuss the implications and limitations of this comparison for the dependence of disk lifetime on the environment.

5.12 Precise determination of protoplanetary disc lifetimes and accretion timescales in a single star-forming region

Presenter: Fabian Polnitzky
Affiliation: RWTH Aachen University

Determining the lifetime of protoplanetary discs is key to understanding the timescale of planet formation. However, comparing data from different star-forming regions at different distances introduces biases because of sample completeness and the environment. To overcome this, one has to rely on the study of single star-forming regions, which introduces its own set of challenges. In recent times, a new clustering of the Scorpius-Centaurus OB association has been proposed, revealing more than 30 clusters, with ages coherently determined to range from 3 to 21 million years. In my talk, I will present how this data and Bayesian modelling can be used to estimate a more certain disc lifetime, almost twice as large as previous estimates. Additionally, the same approach can be used to determine the accretion timescale and I will present the relation to the disc lifetime and what consequences this can have on planet formation.

5.13 A NIRSpec survey of proplyds. How do planet-forming discs react to external UV radiation?

Presenter: Ciaran Rogers
Affiliation: European Space Agency/Space Telescope Science Institute

Most of the stars and planets in the Milky Way formed in dense stellar clusters containing at least one high-mass star. High-mass stars produce intense UV radiation, capable of ionising the surrounding nebular gas, as well as irradiating the nearby planet-forming discs. This can kick-start dramatic mass-loss for the discs. The most famous example of this process, known as external photoevaporation, is found in the nearest high-mass star forming region, Orion. Here, planet-forming discs are seen with ionised shells of escaping disc material. These objects are known as proplyds. The details of how discs respond to external UV, including the disc lifetime, chemistry, dust evolution, and accretion, remains debated. We have observed 88 externally irradiated planet-forming discs in the Orion Nebula Cluster with the NIRSpec micro-shutter assembly. In this talk, the first near-infrared spectra of these proplyds will be shown, and the fate of their discs discussed.

5.14 Dynamical Evolution of Planetary Systems in Dense Stellar Environments

Presenter: Santiago Torres
Affiliation: Instituto de Astrofisica de Canarias

The dynamical evolution of minor bodies such as asteroids and comets plays a fundamental role in shaping planetary systems. Interactions with planets and passing stars sculpt structures such as the Kuiper Belt and the Oort Cloud and can eject cometary material into interstellar space. Because most planetary systems form within stellar clusters rather than in isolation, close stellar encounters during the early stages of evolution can leave long-lasting dynamical imprints on debris disks. These processes determine the distribution of small bodies and contribute to the formation of resonant populations, disk-like reservoirs, and distant cometary clouds similar to those observed in the outer Solar System.

In this talk, I will present my recent results on the dynamical evolution of planetary systems and debris disks under the combined influence of planets and stellar encounters in dense stellar environments. Using numerical simulations, I investigate how birth environments influence the architecture of planetary systems and trigger the formation of extended reservoirs such as Kuiper belts and Oort clouds. These processes naturally lead to the formation of both intracluster and interstellar objects, linking the evolution of planetary systems to the population of small bodies traveling through interstellar space.

5.15 Are discs around Herbig stars primordial?

Presenter: Andrew Winter
Affiliation: Queen Mary University of London

Herbig stars, broadly defined, are young, disc-hosting stars with intermediate stellar masses ($>\sim$1.5 solar masses). Slightly more massive than typical known exoplanet hosts, they are an important population for understanding how planet formation processes scale with host star mass. In this talk, I discuss the outcome of a new, comprehensive interferometric survey of nearby Herbig stars, and use it to infer a declining lifetime with stellar mass. I also discuss how the combination of high accretion rates, low disc masses and apparently extended (several Myr) lifetimes pose a serious problem if the discs are primordial. I suggest some solutions: one of which rapid, sustained replenishment of the disc due to late stage infall from the ISM, with a variety of consequences for planet formation.

5.16 Effects of stellar X-ray photoevaporation on planetesimal formation via the streaming instability

Presenter: Xuchu Ying
Affiliation: Zhejiang University

Photoevaporation is a major driver of protoplanetary disk dispersal, yet its role in planetesimal formation remains uncertain. The streaming instability (SI), a leading candidate mechanism, requires enhanced local dust-to-gas ratios that may emerge during disk evolution. We investigate how stellar X-ray photoevaporation affects dust evolution in late-stage disks using global simulations that couple gas evolution, photoevaporation, dust coagulation, fragmentation, and radial drift. As a photoevaporative cavity forms and expands, a pressure maximum develops at its outer edge, trapping drifting dust and increasing the local metallicity. Under suitable conditions, these enhancements can facilitate the SI. This pathway is favored in larger, metal-rich, low-viscosity disks and around stars with stronger X-ray radiation. Our results suggest a potentially important link between disk dispersal and the environments conducive to planetesimal formation.

6 Debris Discs

6.1 Breaking NLTE Excitation Degeneracies in Debris Disks: Insights from β Pictoris

Presenter: Sana Ahmed
Affiliation: Trinity College Dublin

We present a 1D radial thermophysical model to break degeneracies in the excitation conditions of cold gas in debris disks. The model self-consistently computes gas temperature and electron density, which govern NLTE excitation of the gas. The temperature is determined by considering heating due to photoelectrons emitted from the dust and the energy released due to photoionisation/dissociation. Cooling occurs due to the collisional excitation of the fine structure atomic levels and the molecular rovibrational levels. The electron density is computed by solving ionisation balance in the gas by including recombination of ionised carbon to form neutral carbon, and electron capture by dust grains. With the resulting excitation conditions, we estimate emission fluxes using a radiative transfer model that incorporates vertical photon escape and radial pumping. We apply this framework to interpret the CI, CII, OI, and CO emission from the β Pictoris debris disk.

6.2 A Hierarchical Bayesian Population Study of Debris Discs

Presenter: Rossella Anania
Affiliation: Trinity College Dublin

Dusty circumstellar belts, known as debris discs, are common features of planetary systems. The REASONS survey includes 74 belts spanning a wide range of distances, <150 pc, stellar masses, 0.2-3 Msun, and ages, 10-5000 Myr, with measured mm fluxes (yielding dust disc mass estimates) and disc radii. This is the optimal dataset enabling statistical studies of the debris disc population including information on disc radii for the first time. We perform a population study using a novel hierarchical Bayesian framework in which belts evolve following a collisional cascade. By including the selection biases of REASONS and comparing the synthetic and observed populations, we constrain the main properties of the underlying belt population. This approach allows us to make arguments about the initial distribution of fractional luminosities, belt radii, planetesimal sizes initiating the cascade, and stellar parameters, and offers an useful framework for future population studies of debris discs.

6.3 Constraining the origin of gas in debris discs: Extreme dust size segregation in HD21997 with JWST and ALMA

Presenter: Raphael Bendahan-West
Affiliation: University of Exeter

ALMA observations over the past decade have revealed that many young debris discs contain vast amounts of CO gas, yet its origin remains uncertain: either primordial, dominated by remnant H_2 from the protoplanetary disc phase, or secondary, produced by ongoing destruction of volatile-rich planetesimals. In gas-rich systems, small dust grains appear shifted significantly outward compared to large grains, beyond what radiation forces alone predict. Gas drag pushes small grains outward, and how far they migrate depends on the gas surface density, providing a diagnostic tool to distinguish primordial from secondary gas origins.

I will present JWST coronagraphic observations of HD21997, probing the small dust distribution of this archetypal gas-rich disc for the first time. While ALMA traces large grains between 60 and 120 au, JWST reveals small grains peaking at 150 au, a remarkable 60au offset. Through dust migration modelling, I will show how the synergy between ALMA and JWST can be used to dynamically constrain the origin of gas in debris discs.

6.4 A JWST and ALMA view of the warm dust in the Eta Crucis debris disk

Presenter: Jake Byrne
Affiliation: Trinity College Dublin

Warm dust interior to outer exocometary belts provides a key opportunity to test whether icy material is transported inward to terrestrial planet regions in nearby planetary systems. We present JWST/MIRI F2550W resolved imaging of the nearby η Crucis system, which hosts both warm dust and an outer belt previously resolved with ALMA. Our observations resolve the warm component as a continuous inner disk extending inward from the outer belt, providing direct evidence for ongoing inward transport of material. This system therefore offers one of the first opportunity to combine resolved JWST mid-infrared imaging with ALMA millimetre observations to study the connection between warm and cold dust in a planetary system. Joint modelling of the JWST and ALMA images constrains the dust size distribution in both regions, allowing us to distinguish between transport driven by Poynting-Robertson drag and inward scattering.

6.5 Survival of vortices in gas-rich debris disks

Presenter: Fernando Castillo
Affiliation: Universidad de Santiago de Chile

Contrary to earlier expectations, recent observations have revealed substantial amounts of gas in several debris discs. The presence of gas raises the question of the extent to which it can influence the dynamics of dust particles. Can gas-driven dynamics sculpt debris discs and produce substructures similar to those observed in protoplanetary discs? In this talk, I explore the conditions under which vortices can be excited in gas-rich debris discs and place constraints on the required gas-to-dust ratios, the lifetime of these structures, and their expected occurrence. I will present numerical simulations performed with the hydrodynamical code dusty FARGO-ADSG, aimed at providing a dynamical framework for interpreting recent observations of substructures in debris rings, like the one in the ARKS survey.

6.6 Probing debris disk vertical dynamics with multi-wavelength imaging

Presenter: Yinuo Han
Affiliation: Caltech

A critical observational constraint on debris disk dynamics that we are beginning to place is the disk's scale height as a function of wavelength. This allows us to assess the balance between dynamical effects such as viscous stirring, collisional damping, gas drag and radiation pressure, which form the basis of our ability to make further inferences on interactions with other components of the planetary system (e.g., planets). In the archetype debris disk of the A star beta Pictoris, recent analysis finds the disk is vertically 50% thicker in the mid-infrared than in the millimetre. This is consistent with the effect of radiation pressure and random collisions and shows that collisional damping is not dominant. We also discuss joint modelling efforts of the debris disk around the M star AU Mic with JWST/NIRCam and ALMA imaging, which do not reveal this variation, providing an interesting contrast around a low-luminosity star.

6.7 Dust-Gas Coupling in Gas-Rich Debris Discs: The Case of HD 131488 in Scattered Light and Thermal Emission

Presenter: Shivam Joshi
Affiliation: University of Vienna, Institute for Astronomy

Debris discs are traditionally treated as gas-poor, optically thin dust rings – similar to our Solar systems. Yet the growing number of gas detections is forcing us to rethink how dust - gas interactions shape the structure of planetesimal belts. HD 131488 is an especially interesting case as it is a remarkably narrow, bright ring with a substantial amount of CO gas comparable to that of old protoplanetary discs. We model HD131488 in both thermal emission and scattered light in a self-consistent approach to reproducing the disc as seen by ALMA and VLT/SPHERE. Our modelling shows that the large particles seen at ALMA wavelengths and often assumed to trace the planetesimal belt might be off-set from the actual parent belt. A sufficiently dense gas component could both (i) broaden the distribution of small grains seen in scattered light and (ii) trap and pull larger grains inwards towards the pressure maximum, naturally producing the narrow ring as seen with ALMA. Our model explains the morphology of HD 131488 and highlights how strong dust-gas coupling may operate in gas-rich debris discs.

6.8 Evidence for Vertical Flaring and Elevated Optical Depth in the HD 32297 Debris Disc

Presenter: Patricia Luppe
Affiliation: Trinity College Dublin

The edge-on debris disc around HD 32297 reveals two unexpected structural properties that challenge standard assumptions about debris disc architecture. Our modelling of the disc's high-resolution emission indicates evidence for vertical flaring, a morphology not yet seen in any debris disc. The modelled vertical thickness increases with radius, although the physical mechanism responsible for this behaviour remains unclear, making HD 32297 an important target for future dynamical investigation.

The disc also displays an optical depth higher than typically observed in debris discs, while still remaining below the threshold of full optical thickness. At present, the origin of this elevated optical depth is undetermined, and multiple mechanisms remain possible.

HD 32297's nearly edge-on geometry enables these features to be detected with exceptional clarity. Together, the modelling-revealed vertical flaring and elevated optical depth position this disc as a compelling new benchmark for understanding the diversity of debris disc structures.

6.9 Mapping the Vertical Distribution of CO in the Edge-on Debris Disc HD32297

Presenter: Sorcha Mac Manamon
Affiliation: Trinity College Dublin

Belts of exocomets are common around nearby stars, particularly young (∼tens of Myr) main-sequence systems, with occurrence rates of ∼75%. While emission from collisionally produced dust has long been observed, these discs were thought to be gas-poor. However, one of ALMA's major discoveries has been the detection of gas in more than 20 exocometary belts, likely released from volatile-rich exocomets and providing a new probe of their composition.

I present an analysis of the vertical and radial distribution of CO in the edge-on debris disc HD32297, using ARKS ALMA observations. Deprojected radial profiles of CO at multiple heights show the gas is vertically extended and uniform, with no evidence for midplane CO freeze-out. These observations are being further investigated using radiative transfer modelling to constrain the gas temperature, molecular mass, and the origin of the gas in HD32297.

6.10 Are planets responsible for gaps and eccentricities in debris disks?

Presenter: Elisabeth Matthews
Affiliation: Max Planck Institute for Astronomy

Debris disks have long been thought to be associated with the presence of giant exoplanets, particularly when the disk shows warps or eccentricity. However, these hypothesised giant exoplanets have largely remained elusive, prompting a rethink about disk-sculpting mechanisms. I will present recent JWST observations of the most eccentric known debris disk, reaching Saturn-mass sensitivities at wide separations. With JWST imaging, archival RVs, and astrometric data, we rule out massive planets at all separations interior to the disk, posing an open question as to what drives the disk eccentricity. I will also present results from a ground-based high-contrast imaging survey of disk stars. We identify a candidate exoplanet and a resolved stellar binary interior to a debris disk, a resolved triple star system with a protoplanetary disk, and several debris disks in scattered light, together providing a new observational sample to study the interactions of disks, planets and stars.

6.11 Searching for Unusual Planetary Systems with Massive Debris Disks Using Herschel-ATLAS and Gaia

Presenter: Zoe Parker
Affiliation: University of Leeds

Debris disks offer key insights into planetary formation and evolution, yet the brightest "extreme" debris disks (with fractional luminosities > 10^-2) remain poorly constrained. Their apparent rarity limits tests of high-mass, high-collision-rate disk evolution and raises a fundamental question: are extreme debris disks intrinsically rare, or simply under-detected?

I address this using a novel wide-area search that repurposes extragalactic far-infrared surveys as debris disk discovery tools. By combining Herschel-ATLAS observations with Gaia DR3 astrometry, I identify cold, luminous debris disk candidates around main-sequence stars. Broadband photometry from the optical to the far-infrared is used to identify infrared excesses and reject extragalactic contaminants.

This approach yields a statistically selected sample spanning a larger area and parameter space than previous targeted surveys. I will present results from a successful SMA pilot study of 15 candidates, demonstrating the power of wide-field data to uncover rare, massive debris disks and motivating future ALMA observations.

6.12 When worlds collide: Characterising post-impact molecular gas in the terrestrial region of HD 172555

Presenter: Zoe Roumeliotis
Affiliation: Trinity College Dublin

After the gas-rich protoplanetary disk dissipates, terrestrial planet formation continues in planetary systems. During the era of giant impacts, planetary embryos grow through mutual collisions to form terrestrial planets. Direct evidence of giant impacts in exoplanetary systems remains scarce; HD172555 is the only system in the Solar neighbourhood with multiple conclusive lines of evidence of a giant impact. In this talk, I will present a new ALMA molecular line survey of HD172555. These observations allow me to zoom into the innermost ∼au region of this system at an unprecedented resolution of ∼1.5 au. I fit the ALMA image cubes with radiative transfer models to constrain the spatial and temperature structures and mass of this post-impact gas disk. This allows me, for the first time, to set compositional constraints on stripped atmospheric gas, its post-impact evolution, and its effect on the dynamics of the post-impact debris.

6.13 Debris Discs Also Shape their Planets

Presenter: Dominic Samra
Affiliation: University of Chicago

A number of recent JWST observations of hot Jupiters have inferred high-altitude, small cloud particles, not consistent with expectations from equilibrium condensation (e.g. WASP-17b). Exozodis are known to be prevalent in a large fraction of nearby stellar systems, although most exoplanet hosting systems are distant enough that their discs remain below detection limits. In-spiralling dust from debris discs in these systems could accrete onto the planet and provide a source of material and seeds for this high-altitude cloud formation. We model dust accretion onto a WASP-17b analog planet as a constant top-of-atmopshere (TOA) flux of both solid particles and ablated gas using PICASO + CARMA atmosphere and cloud formation models. We find that a high TOA flux of 10ˆ11 g/s significantly enhances the formation of cloud particles in the upper atmosphere, and this can cause muting of spectral features by ∼20-30% compared to the no accretion case.

6.14 A First-of-Its-Kind ALMA Investigation of Gas Origins in the 49 Ceti Debris Disk

Presenter: Catherine Sarosi
Affiliation: University of Exeter

Among the growing number of debris disks known to host molecular gas, the majority are consistent with second-generation, volatile-rich gas (primarily CO) liberated from planetesimals. However, for some young debris discs that host comparatively massive reservoirs of molecular gas, it is not yet clear whether the gas is inherited from the protoplanetary disk phase or is secondary, like the older, lower-mass systems.

49 Ceti hosts one such debris disk and is ideal for studying gas origins, as it boasts unusually comprehensive ALMA emission line observations. Thus, we present parametric modeling of new and archival ALMA observations of CO and CI in 49 Ceti. By measuring the optically thin C18O emission line ratio and the gas scale height, we constrain the gas temperature and composition. We also describe how gas evolution modeling informs the interpretation of scale height and the role of fluorescence in altering the level populations

6.15 Exocometary molecules at the epoch of volatile delivery

Presenter: Kevin Smith
Affiliation: Trinity College Dublin

The presence of exocometary gas in young (10-100 Myr) debris disks presents a unique opportunity to probe the composition of exocomets during the late stages of terrestrial planet formation. This is the evolutionary stage when ice-rich impacts are proposed to change the volatile environment of terrestrial planets, setting the stage for prebiotic chemistry. In these young exocometary belts, high concentrations of debris result in frequent collisions and release of molecular gas, which can be observed in absorption against the stellar background in edge-on systems.

We present JWST/NIRSpec G235H near-IR observations of exocometary molecules released in the ∼15 Myr-old exocometary belt around the A star HD110058. We survey OH, H2O, CO2 and compare with the known CO absorption lines to determine whether exocometary compositions around HD110058 are similar to comets in our Solar System, and to demonstrate the feasibility of future exocometary compositions studies around other planetary systems with JWST.

6.16 Probing the Collisional Cascade in AU Mic with Resolved Vertical Structures at Multiple Wavelengths

Presenter: Brianna Zawadzki
Affiliation: Wesleyan University

Debris disks are dusty belts around >10 Myr old main sequence stars, providing an observational bridge between protoplanetary disks and fully-formed exoplanets. One key debris disk process is the collisional cascade, the incremental grinding down of planetesimals to sub-micron sized particles that are removed by stellar processes. The fundamental distributions governing collisional cascade physics can be observationally probed by resolving the vertical scale height at several wavelengths tracing ∼mm-sized grains, which are large enough to be insensitive to stellar radiation and thus directly probe disk dynamics. Previous vertical measurements of AU Mic at 1.3 mm and 0.45 mm challenged theoretical predictions, suggesting that smaller grains are dynamically cooler. We present new 2.65 mm ALMA observations and modeling of AU Mic, making it the first debris disk with three resolved scale heights at mm wavelengths and enabling multiwavelength analyses that illuminate the physics of collisional cascades.