The innermost region of protoplanetary discs and its connection to the origin of planets.

15–19 OCTOBER 2018

ESO HQ, GARCHING BEI MÜNCHEN, GERMANY

TAKE A CLOSER LOOK

Program & Abstracts

Take a close look

The quest for detecting exoplanets (e.g., via Kepler and HARPS RV surveys) has revealed the existence of a large population of systems comprising one to several planets very close to the central star, i.e. at distances of 0.1-1 au, even around TTauri (age<5 Myr) stars. These are usually slightly bigger than the Earth and up to Neptune sizes, with rare Jupiter analogues. This finding differs to what we observe in our own Solar System, and raises the question of how such planets form. From a theoretical point of view, it is still hard to show that these planets formed in-situ, but it is similarly complicated to explain this large population of close-in planets as a result of migration through the disk. Additional evidence of the importance of this region comes from our own Solar System, where studies have established that material routinely observed in meteorites (e.g., Ca-Al-rich inclusions, CAI) must have formed very close to the central star, or in a very hot region of the disc.

To advance our understanding of planet formation and migration, it is crucial to study the conditions within the inner regions of their progenitor protoplanetary discs. The innermost part of the disc is where most of the star-disc interaction processes take place. The magnetic field topology of the central star truncates the disc at a few stellar radii and drives accretion of material onto the central star, as well as the ejection of fast-collimated jets and slow winds. Recent studies indicate that this star-disc interaction evolves quickly at the same time that giant planet formation ceases. Also, this region is known to undergo rapid evolution, for example, short or long lasting dimming events (e.g., AA-Tau, RW Aur, dippers). This rapid evolution is, in itself, likely to impact the formation of planets. Finally, a fraction of discs known as transition discs, show a deficit of dust in the inner few au of the disc, which could be related to the mechanism driving disc evolution in this planet-forming region.

Studies of this key inner disc region require innovative techniques and a wide range of instrumentations, since radio interferometers cannot resolve spatial scales smaller than 10 au in most discs. Observations with instruments on the ESO/VLT and VLTI and other facilities provide us with unprecedented detail and motivate this workshop. Specifically, this workshop aims at discussing the present-day knowledge of the morphology and composition of the innermost regions of the disc, of the star-disc interaction processes, and of the theories to describe the evolution of the innermost regions of discs and of the formation of close-in planets.

SOC

Hussain, G. (ESO) (chair)
Benisty, M. (IPAG Grenoble)
Birnstiel, T. (LMU Munich)
Bouvier, J. (IPAG Grenoble)
Calvet, N. (U. Michigan)
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Manara, C.F. (ESO) (organizer)
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LOC

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Giuliana Cosentino
Stefano Facchini
Anna Miotello
Tereza Jeăábková
Enrique Sanchis Melchor
Tomáš Tax
Maria Giulia Ubeira Gabellini

Workshop venue

The workshop will be held in the ESO Auditorium, located at:

Karl-Schwarzschild-Str. 2, Garching b. München.

Contact phone and fax number

Contact phone number: +49 89 320 060 (ESO Reception Desk)
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Registration

Registration will take place on Monday, October 15th in front of the new auditorium (Eridanus) from 12:30.

Contact

Please use the following email-address to contact us: `tcl2018@eso.org`

Webpage

https://www.eso.org/sci/meetings/2018/tcl2018.html

What's in the booklet

Program Overview

Monday, Oct 15

12:30	Registration
13:30	Welcome
13:50	**Session 1 – Close-in exo-planets observations and origin**
18:00	Reception at Supernova
18:15	Planetarium show & visit of exhibition
& 18:45	(two groups of ∼70 people)
19:15	Food served in the Supernova building

Tuesday, Oct 16

09:00	**Session 2 – Morphology of the inner disk**
12:30	Lunch
16:50	Poster viewing with Beer and Brezn

Wednesday, Oct 17

09:00	Session 2 continues
09:40	**Session 3 – Evolution of protoplanetary disks**
12:30	Lunch
17:00	Poster viewing with Beer and Brezn

Thursday, Oct 18

09:00	**Session 4 – Angular momentum transport and connection of outer and inner disk**
12:30	Lunch
14:00	**Session 5 – Star-disk interaction**
16:30	Breakout Sessions
	AUDITORIUM ERIDANUS RW Aur: origin of the dimming events
19:00	Social dinner: Gasthof Neuwirt in Garching

Friday, Oct 19

09:00	Session 5 continues
11:00	**Final Discussion and Concluding Remarks**
12:30	End of program

Monday, Oct 15

12:30	**Registration**		
13:30	**Introduction**		

Session 1 – Close-in exo-planets observations and origin

13:50	Haywood, Raphaëlle	Invited review	Current status of the observational search for close-in planets
14:30	Ormel, Chris	Invited review	Theories of formation of close-in exo-planets
15:10	Kreplin, Alexander		VLTI+ALMA imaging of potential planet-formation processes in the pre-transitional disc of V1247 Ori
15:30	Mendigutía, Ignacio		Detecting signatures of planet formation in disks around young stars
15:50	**Break**		
16:20	Keppler, Miriam		Discovery of a planetary mass companion in the gap of the transition disk PDS 70
16:40	Jankovic, Marija		Formation of close-in super-Earths: dust enrichment of the inner disk due to the MRI
17:00	Ogihara, Masahiro		Formation of close-in super-Earths from embryos with suppressed type I migration
17:20	Drazkowska, Joanna		Planetesimal formation in the inner region of the protoplanetary disk
17:40	Tan, Jonathan		Inside-Out Planet Formation

18:00	**Reception at Supernova**
18:15 & 18:45	Planetarium show and visit of the exhibition (two groups of ∼70 people)
19:15	**Food served in the Supernova building**

Tuesday, Oct 15

Session 2 – Morphology of the inner disk

09:00	Facchini, Stefano	Invited review	The inner regions of protoplanetary disks: a dynamical perspective
09:40	Kraus, Stefan	Invited review	Spatially resolved observations of inner disc structure
10:20	Banzatti, Andrea	Invited talk	Observing the evolution of exoplanet-forming disks at 0.01-10 au with gas, dust, and wind tracers
10:50	**Break**		
11:30	Ansdell, Megan		Misaligned inner disk demographics using "dipper" stars
11:50	Pinilla, Paola		Variable Outer Disk Shadowing Around the Dipper Star J160421.7-213028
12:10	Nealon, Rebecca		Warping protoplanetary discs by planets on inclined orbits
12:30	**Lunch**		
14:00	Brown, Alexander		Dust and Gas Composition at the Inner Edge of the Transitional Disk Surrounding 7Myr old T Cha
14:20	Arulanantham, Nicole		Mapping the Inner Disk Gas around Young Stars in the Lupus Complex
14:40	France, Kevin	Invited talk	UV Characterization of Inner Disks: from Hubble to LUVOIR
15:10	Perraut, Karine		The inner dust rim of protoplanetary disks as probed by GRAVITY
15:30	**Break**		
16:00	Matter, Alexis	Invited talk	Observing and characterizing the planet-forming region of protoplanetary disks with MATISSE
16:30	Davies, Claire		Grain growth-induced curvature of the inner rim of protoplanetary disks
16:50	**Beer and Brezn**		**Poster Viewing**
19:00	**End of day**		

Wednesday, Oct 17

09:00	Garufi, Antonio		The outer disk knows about the inner disk
09:20	Ricci, Luca		Imaging the inner regions of protoplanetary disks with sub-millimeter and millimeter interferometry

Session 3 – Evolution of protoplanetary disks

09:40	Rosotti, Giovanni	Invited review	Disc evolution processes: how they affect the inner disc
10:20	McClure, Melissa	Invited review	Eye to the telescope: observing the inner 1 AU of protoplanetary disks
11:00	**Break**		
11:30	Parker, Raeesa		Understanding the formation and distribution of cm-sized dust grains in DG Tau A
11:50	Bitsch, Bertram		Origin of super-Earths planets: influence of pebble accretion, migration and instabilities
12:10	McNally, Colin		How planets move in the inner disc
12:30	**Lunch**		
14:00	Bosman, Arthur		Inner disk chemistry and the effects of drifting icy grains: the case of CO2
14:20	Booth, Richard		The inner disc tracers of the physics and chemistry of disc evolution
14:40	Chen, Christine	Invited talk	Observing the Inner Regions of Protoplanetary Disks with JWST
15:10	Simon, Jake		What Drives Accretion in Protoplanetary Disks?
15:30	**Break**		
16:00	Ballabio, Giulia		Empirical diagnostics of protoplanetary disc winds
16:20	Picogna, Giovanni		The dispersal of planet-forming discs. A new generation of X-ray photoevaporation models.
16:40	Monsch, Kristina		The imprint of X-ray photoevaporation on the orbital distribution of giant planets
17:00	**Beer and Brezn**		**Poster viewing**
19:00	**End of the day**		

Thursday, Oct 18

Session 4 – Angular momentum transport and connection of outer and inner disk

09:00	Sheikhnezami, Somayeh	Invited review	Disk-outflow interaction: exchange of mass and angular momentum
09:40	García López, Rebeca	Invited review	Observations of outflows and angular momentum transport from the inner to the outer disk
10:20	Dougados, Catherine		What can jets and outflows tell us about the central astronomical units ?
10:40	**Break**		
11:10	McGinnis, Pauline		Spectral signatures of jets and winds in the young, open cluster NGC 2264
11:30	Nisini, Brunella		Connection between jets, winds and accretion in T Tauri stars
11:50	Fischer, Will		Complementary Insights from Helium 10830 in the Age of Interferometry
12:10	Nolan, Chris		Determining the launching regions of centrifugally-driven disc winds from non-ideal MHD simulations
12:30	**Lunch**		

Session 5 – Star-disk interaction

14:00	Gregory, Scott	Invited review	The impact of magnetic fields on the star-disk interaction and planet formation
14:40	Venuti, Laura	Invited review	Observations of star-disk interaction and link to disk evolution at the epoch of planet formation
15:20	Takasao, Shinsuke		Fast accretion onto a weakly magnetized star
15:40	Alencar, Silvia		The inner disk structure of the classical T Tauri star LkCa 15
16:00	**Break**		
16:30	**Breakout Sessions**		
	Auditorium Eridanus – RW Aur: origin of the dimming events		
	Pavo, Tucana, Dorado, Vela – Rooms to be requested by participants for oher sessions		
18:00	**End of the day**		
19:00	Social Dinner		Gasthof Neuwirt Garching

Friday, Oct 19

09:00	Hill, Colin		Magnetic Fields and Planets of Weak-line T Tauri Stars
09:20	Beccari, Giacomo		Accretion properties of low-mass stars in the Large Magellanic Cloud: the case of LH95
09:40	Aly, Hossam		Dusty warps: Can Warps in Protoplanetary Discs Form Dust Traps?
10:00	Ramsay, Suzanne	Invited talk	Looking closely at protoplanetary discs with the European ELT and its instruments
10:30	**Break**		
11:00	**Final Discussion and Concluding Remarks**		
12:30	**End of Program**		

Breakout session 1 – RW Aur: Origin of the dimming events

16:30	Facchini, Stefano	Brief overview on the RW Aur dimming events
16:40	Lamzin, Sergei	Analysis of photometric and polarimetric observations of RW Aur A: arguments in favor of dusty wind
16:45	Safonov, Boris	Resolving dusty wind of RW Aur A
16:50	Koutoulaki, Maria	Shedding light on the dimming events of the CTTS RW Aur A.
16:55	Günther, H. Moritz	X-ray news from RW Auriga: Optical dimming with iron rich plasma and an exceptional column density
17:00	Gárate, Matias	The dimmings of RW Aur. Is the accretion of dust preceding an outburst?
17:05	Discussion on RW Aur lead by S. Facchini	

List of Posters

Talk Abstracts

Close-in exo-planets observations and origin

Raphaëlle Haywood Monday, 13:50

Current status of the observational search for close-in planets

I will give an overview of the current state of detection and characterisation of the general properties (radius, mass, orbital period) of close-in exoplanets. This talk will mainly focus on the small-sized (super-Earth to Neptune-sized) planets discovered and characterised through transit and radial-velocity monitoring. I will review recent observational evidence for distinct populations of planets, as well as observed trends in planet and host star properties. Finally, this talk will address some of the challenges that we currently face, notably for ground-based, resource-intensive radial-velocity follow-up of transiting planet candidates. These challenges include optimising observational sampling, accounting for stellar activity signals and correcting for observational biases.

Chris Ormel Monday, 14:30

Theories of formation of close-in exo-planets

Arguably the greatest surprise in exoplanetology has been the sheer number of close-in planets detected by missions as Kepler. These planets tend to be larger than Earth, predominately terrestrial by composition, but with significant envelopes of hydrogen/helium. They are further seen in "packed", multiplanetary configurations, quite unlike that of the solar system. How did they form? I will review the leading theories of in situ formation and distant formation, followed by planet migration. These theories give different predictions for the composition, and architecture of the close-in planetary systems. I will then discuss alternative formation scenarios, such as the pebble accretion paradigm, where planet growth is fueled by a steady supply of small particles, and the hypothesis that planets start forming at special locations.

Alexander Kreplin Monday, 15:10

VLTI+ALMA imaging of potential planet-formation processes in the pre-transitional disc of V1247 Ori

In this talk we present the results from our multi-wavelength, multi-epoch high-angular resolution imaging campaign on the pre-transitional V1247 Ori. Our observations cover the wide wavelength range from the visible (SPHERE), near-IR (VLTI+NACO+Keck+Subaru), mid-IR (VLTI+Gemini), to the sub-mm (ALMA, SMA). We detect extreme asymmetries on scales from 5 to 150 au that we interpret as signposts of ongoing planet formation. VLTI interferometry reveals optically-thick dust near the dust sublimation radius as well as an extended disc gap that is filled with a population of very small dust grains. Further out in the disc, our ALMA 0.04"-resolution imaging reveals a ring-shaped inner disc component with a prominent asymmetry and a sharply confined crescent structure, resembling morphologies seen in theoretical models of vortices formation. In the near-IR we detect a strong asymmetric structure that moved in position angle (PA) from -52 to +38 within 22 months, consistent with Keplerian motion of a companion on an 5 au orbit. This companion candidate is located too close to trigger the vortex, but might be responsible for clearing the region inside the ring observed with ALMA+VLTI.

Ignacio Mendigutía Monday, 15:30

Detecting signatures of planet formation in disks around young stars

The detection of forming planets in protoplanetary disks around young stars remains merely anecdotal, with only a few candidates proposed to date. HD 100546 and LkCa 15 are two of the most representative candidates, given that their circumstellar disks may host (proto-) planetary systems with several planets each. I will summarize some of the main properties of HD 100546 as inferred from spectrometry, spectro-interferometry and high-resolution polarized imaging with X-SHOOTER, AMBER and SPHERE on the VLTs. In particular, we have detected a possible radial inflow connecting the outer and the inner disk of HD 100546. This could be an exceptional structure that may indicate the presence of additional planets in formation (Mendigutía et al. 2017, A&A, 608, A104). I will also discuss the potential of spectro-astrometry to detect planets in formation based on recently obtained ISIS/WHT data of LkCa 15. Indeed, spectro-astrometry can be particularly useful to detect accreting planets on angular scales of of (sub-) mas without the need of complex instrumentation but from long-slit spectrographs mounted on mid-size telescopes.

Miriam Keppler Monday, 16:20

Discovery of a planetary mass companion in the gap of the transition disk PDS 70

Only few detections of planet candidates in disks exist, and most of them are still debated. We obtained multi-wavelength observations of the 5 Myr old pre-transition disk PDS70 (with SPHERE, NaCo, NICI, ALMA), and detected a planetary-mass companion in the gap at 22 au from the star (Keppler et al. 2018, accepted). The detection is confirmed at multiple epochs, in different filter bands of infrared instruments. The companion's luminosity is consistent with that of an L-type dwarf, and evolutionary tracks suggest a 5-9 Jupiter mass planet. Our polarimetric data reveal for the first time scattered light from an inner disk inside about 17 au. Although our ALMA data show that the inner disk is well detected in the gas CO line, it appears faint in the dust continuum, suggesting a depletion of large grains, possibly filtered by the planet. The system provides an ideal laboratory to study the co-existence of a planet in a transition disk with an inner disk, and represents a first hand example to observationally challenge models of inner disk physics, transport of material through the disk gap and dust evolution in the inner disk regions.

Marija Jankovic Monday, 16:40

Formation of close-in super-Earths: dust enrichment of the inner disk due to the MRI

Do the ubiquitous short-period super-Earths/mini-Neptunes form in situ, in the inner protoplanetary disk? If so, the key step to planet formation is dust enrichment of the inner disk. In the outer disk the dust particles are expected to quickly grow by coagulation and drift inwards due to gas drag. The inner disk structure, governed by viscous accretion due to the magneto-rotational instability (MRI), features a local gas pressure maximum that could potentially trap the drifting dust particles. We consider evolution of dust, including growth, radial drift and fragmentation, in a steady-state gas disk, with the inner disk gas structure self-consistently determined from MRI criteria (Mohanty et al. 2017). We find that in the inner disk the dust particle size is limited by fragmentation due to relative turbulent velocities. The particles remain too small to feel significant gas drag and therefore do not accumulate at the local gas pressure maximum. However, as a decrease in particle size also implies less radial drift for the particles from the outer disk, this ultimately leads to dust enhancement throughout the inner disk, interior to the pressure maximum.

Masahiro Ogihara Monday, 17:00

Formation of close-in super-Earths from embryos with suppressed type I migration

Formation models of close-in super-Earths can be divided into two groups; namely, in-situ formation models and migration models. Planets with masses larger than Mars mass undergo rapid inward migration (type I migration) in a standard protoplanetary disk. Therefore, migration models appear to be plausible. On the other hand, it has been proposed that type I migration can be suppressed in an evolving protoplanetary disk due to disk winds. We investigate orbital evolution of planetary embryos in a disk that viscously evolves under the effects of disk winds. The aim is to examine whether observed distributions of close-in super-Earths can be reproduced by simulations. We perform N-body simulations of super-Earth formation and find that the type I migration is significantly suppressed in a disk with flat surface density profile. After planetary embryos undergo slow inward migration, they are captured in a chain of resonant planets. The resonant chain undergoes late orbital instability during the gas depletion, leading to a non-resonant configuration. We also find that observed distributions of close-in super-Earths (e.g., period ratio) can be reproduced by results of our simulations.

Joanna Drazkowska Monday, 17:20

Planetesimal formation in the inner region of the protoplanetary disk

Formation of the first gravitationally bound building blocks of planets, called planetesimals, is one of the most prominent challenges faced by our understanding of planet formation. As the dust growth is limited by fragmentation and radial drift, the direct growth to planetesimal sizes seems unlikely. However, the same processes drive the global redistribution of solids and may lead to a pile-up of pebbles that triggers planetesimal formation. I will present the recent models which combine dust growth, radial drift, and planetesimal formation via streaming instability. These results consistently show that the first planetesimals are more likely to be formed in the inner regions of the protoplanetary disk, where the dust growth timescale is shorter than the radial drift timescale.

Jonathan Tan Monday, 17:40

Inside-Out Planet Formation

I present a short overview of the Inside-Out Planet Formation (IOPF) model (Chatterjee & Tan 2014, ApJ, 780, 53) for sequential in situ formation of the Kepler-discovered super-Earth population of close-in multi-planet systems at the pressure trap associated with a retreating dead zone inner boundary. I then discuss latest work exploring theoretical aspects of the model, including calculations of the structure of the inner disk, simulations of the gap opening process leading to pebble isolation and capture of H/He atmospheres. I end with a summary of observational tests of this planet formation model.

Morphology of the inner disk

Stefano Facchini Tuesday, 09:00

The inner regions of protoplanetary disks: a dynamical perspective

The high abundance of planets orbiting within 1 au from the central star, near the silicate sublimation front, poses many questions about their origin. An observational and theoretical characterisation of the inner disk (<1 au) is needed. Relatively simple hydrostatic equilibrium models have been successful in reproducing many observational constraints of the inner rim. Radiation hydrodynamics simulations are now showing that these models are hydrodynamically stable. Magnetohydrodynamical effects are also important in the very inner regions, where the high ionisation fraction couples gas motions with the magnetic field. MHD effects reproduce observed variability in the NIR, and can generate a local pressure maximum at $\sim$1 au scale where radially drifting pebbles can accumulate. Magnetic torques can also induce warps, casting an asymmetric shadow onto the outer regions of the disk. A similar dynamical effect can be induced by companions breaking the inner disk, and disconnecting its precession from the outer regions.

Stefan Kraus Tuesday, 09:40

Spatially resolved observations of inner disc structure

In this talk I will review how spatially resolved observations have helped to shape our understanding of protoplanetary disc structure and of the physical processes taking place in the inner-most astronomical unit. I will discuss the evidence for an optically-thin cavity and a "puffed-up rim" near the dust sublimation radius and how infrared interferometric observations have helped to establish the current generation of irradiative disc models. Multi-wavelength interferometric observations revealed also systems with clear signatures of grain growth or extended optically thin gaps, likely tracing systems in the later stages of disc evolution and of ongoing planet formation. Besides the dust disc, interferometric observations with high spectral dispersion have also resulted in direct constraints on the gas distribution and velocity field on sub-AU scales and have provided direct evidence for disc wind launched from the inner few astronomical units. Finally, I will discuss some of the open questions and outline future opportunities in the field.

Andrea Banzatti Tuesday, 10:20

Observing the evolution of exoplanet-forming disks at 0.01-10 au with gas, dust, and wind tracers

I will present results from a multi-wavelength and multi-tracer campaign to observe the evolution of protoplanetary disks at 0.01-10 au at the time of exoplanet formation. The backbone of this work is the combined analysis of recent surveys of moderate-to-high-resolution spectroscopy (R $\sim$ 700-100,000) of molecular gas emission at infrared wavelengths (2.9-35 um), as collected from a suite of instruments on the ground and in space (VLT-CRIRES, VLT-VISIR, Spitzer-IRS, Keck-NIRSPEC, IRTF-iSHELL). I will present and discuss three major findings of this campaign, as published in a series of papers in the last few years: 1) the location and excitation of CO gas reveals the formation of disk cavities and gaps in the 0.01-10 au disk region, 2) these cavities show a large depletion of both dust and gas, with some structures that models propose to be related to planet-disk interactions, and 3) disk chemistry evolves during formation of these cavities, with inner disks being dried-up from their water. I will mention new directions that we are investigating in synergy with the kinematics and evolution of disk-dispersing winds, with new results from a survey of high-resolution [OI] spectra. (Id be happy to focus more on a few specific aspects of this large multi-faceted work depending on what the SOC finds best for the session in which they wish me to speak)

Megan Ansdell Tuesday, 11:30

Misaligned inner disk demographics using "dipper" stars

Dippers are a fairly common class of variable star whose optical light curves exhibit episodic day-long drops in flux up to a few tens of percent. Dippers exhibit infrared excesses indicative of protoplanetary disks, and their optical flux dips are consistent with extinction by transiting dusty structures orbiting near the star-disk co-rotation radius. Current mechanisms explaining dippers require nearly edge-on viewing geometries, as they invoke occulting structures embedded in a thin disk. However, the handful of dippers with high-resolution sub-mm/mm data reveal outer disks that span the full range of disk inclinations, from face-on to edge-on. This suggests that a potentially common feature of protoplanetary disks is a misaligned inner disk component. To investigate the distribution of misaligned inner disks, we are collecting high-resolution sub-mm/mm images of dipper stars using ALMA to constrain outer disk inclinations. Confirming an isotropic inclination distribution for dippers would favor models with interesting implications for terrestrial planet formation zones, including disk warps caused by inclined protoplanets and scattered planetesimals due to migrating planets.

Paola Pinilla Tuesday, 11:50

Variable Outer Disk Shadowing Around the Dipper Star J160421.7-213028

In this talk, I will present recent results from SPHERE/VLT and complementary ALMA observations of the disk around the dipper star J160421.7-213028. This is one of the brightest and most massive disk detected in the old star forming region, Upper Sco (sim10Myr old). It is a transition disk, with a depleted inner cavity and a ring-like structure, which might indicate the presence of a massive planet inside the cavity. Our observations using SPHERE in 2015, allowed to detect the ring in scattered light and showed the presence of a dark dip, and of a possible secondary one. These two dark regions are thought to be due to a highly misaligned inner disk, with respect to the outer disk. In 2016 and 2017, we followed-up the disk with infrared scattered light images obtained at 9 epochs, obtaining a sample separated by days, weeks, months, and years. In our images, we clearly detect two shadows along the ring, and found that they are variable in both amplitude and morphology. This indicates that the innermost regions are highly dynamic and complex, which is likely connected to the origin of the variable, aperiodic, and dimming events obtained from the K2 light curve.

Rebecca Nealon Tuesday, 12:10

Warping protoplanetary discs by planets on inclined orbits

Current observations from ALMA have identified unique features in protoplanetary discs around young stars, including warps in the disc (e.g. TW Hya, HD 100453 and HD 135344B) and strongly misaligned inner discs (e.g. HD 100546 and AA Tau). For these systems in particular, observations rule out the influence of a secondary star suggesting that as yet unseen planets may be the cause. A planet that is capable of driving these features in the disc would be required to maintain an orbit that is inclined to the disc plane on long timescales, in contradiction with analytical expectations and current planet formation theory. Our initial investigation focuses on the evolution of a planet on an inclined orbit using three-dimensional numerical simulations. We will present these preliminary results and consider the significance of the disc structures found using synthetic observations.

Alexander Brown Tuesday, 14:00

Dust and Gas Composition at the Inner Edge of the Transitional Disk Surrounding 7Myr old T Cha

The young (7 Myr) 1.5 solar mass T Tauri star T Cha shows dramatic variability due to optical extinction variations of up to 3 magnitudes on few hour time-scales with no obvious periodicity. We have conducted a major multi-spectral-region observing campaign to study the UV/X-ray/optical variability of T Cha. For 5 weeks (2018 Feb 9–Mar 17) we monitored the optical variability using LCOGT (Chile/South Africa/Australia) and SMARTS telescopes in Chile. We observed T Cha during 3 coordinated observations (each 5 HST orbits + 25 ksec XMM; on 2018 Feb 22, Feb 26, Mar 2) using HST COS/STIS to measure the FUV/NUV spectra and XMM-Newton to measure the corresponding X-ray spectra. The observed spectral changes are well correlated and demonstrate the influence of the same inner disk absorbing material in all the spectral regions observed. By examining which spectral features change and by how much we determine the location of different emitting regions relative to the absorbers along the line-of-sight to the star. In this talk we describe the dust and gas properties at T Cha's inner disk edge and show that the solid phase material consists almost entirely of very large grains/particles.

Nicole Arulanantham Tuesday, 14:20

Mapping the Inner Disk Gas around Young Stars in the Lupus Complex

We present a study of molecular hydrogen in a thin surface layer of the disks around five young stars in the Lupus complex. Each system was observed with the Cosmic Origins Spectrograph (COS) onboard the Hubble Space Telescope (HST). We detect a population of fluorescent H2 in all five sources, where the molecules are excited by LyA photons. The location of the emitting gas is constrained to within 15 AU of the central stars because of the temperature required for LyA fluorescence to proceed ($T \sim 1500$-2500 K). We have used the H2 emission lines to a) estimate the strength of the LyA radiation field that reaches the inner disk and b) extract the radial distribution of hot gas in the inner disk. The objects presented here have very different outer disk morphologies, as seen by ALMA via 890 micron dust continuum emission, ranging from full disks with no signs of cavities to systems with large regions that are clearly depleted (e.g. TYC 7851, with a cavity extending to 75 and 60 AU in dust and gas, respectively). Our results are interpreted in conjunction with sub-mm data from the five systems in an effort to piece together a more complete picture of the overall disk structure.

Kevin France Tuesday, 14:40

UV Characterization of Inner Disks: from Hubble to LUVOIR

Ultraviolet spectroscopy is a unique tool for observing molecular gas in the inner disk as the strongest electronic band systems of H2 and CO reside in the 100 – 170 nm bandpass. In particular, fluorescent H2 spectra are sensitive to trace amounts of gas, making them an extremely useful probe of remnant gas at r $<$ 10 AU during the dissipation of the primordial disk. Similarly, absorption line spectroscopy through high-inclination disks is the only direct observational technique to characterize co-spatial populations of key molecules (CO, H2O, OH, etc.) with H2. Finally, far- and near-UV (100 – 400nm) observations offer the most direct empirical technique for identifying and quantifying the mass-accretion rate onto young stars. I will present a brief overview of the state-of-the-field in UV observational studies of protoplanetary environments and present a prospectus for future observations with international space observatories of the next two decades. I will focus on the exciting observational possibilities offered by UV spectroscopy with the LUVOIR Surveyor, and conclude by describing the status of the UV instruments being designed for the design reference mission.

Karine Perraut Tuesday, 15:10

The inner dust rim of protoplanetary disks as probed by GRAVITY

Understanding the observed diversity of planetary systems requires to better probe the initial conditions of their formation, which are intrinsically linked to the physical conditions at play in protoplanetary disks. The nature and the interplay of the different processes as accretion flows, winds, dust grain coagulation within the innermost central regions ($<$ 5 au) are still poorly constrained. Only optical long-baseline interferometry can bring spatially resolved constraints on this region and on the mechanisms that shape it. As an illustration, the broad H-band interferometric observations of the PIONIER Large Program of about 50 Herbig AeBe stars have shown that the sublimation front is generally rather smooth, wide, in agreement with the presence of multiple dust grain populations, and that its thickness is larger than predicted by hydrostatic models. The GRAVITY YSO Large Program based on GTO time aims at completing this statistical study by probing the inner disk thermal emission in the K band, in a systematic and homogeneous approach. In this talk we will present the first results obtained by analyzing the continuum observations of a sample of about 20 HAEBEs and T Tauris.

Alexis Matter Tuesday, 16:00

Observing and characterizing the planet-forming region of protoplanetary disks with MATISSE

MATISSE is the mid-infrared spectro-interferometer for the VLTI. It combines four apertures in the L, M and N bands (from 3 to 13 microns) with spectral resolutions ranging from 30 to 4500. It is designed to provide polychromatic images and advanced multi-wavelength model fitting. One of the driving science cases of the instrument is the observation of the inner regions (0.1 to 10 au) of protoplanetary disks. With a mas-scale angular resolution, MATISSE will be able to detect and image au-scale structures (rims, gaps, cavities, spirals, asymetries) in those planet-forming regions. Its spectroscopics capabilities and extended spectral coverage will allow to characterize at the same time the spatial distribution and chemical characteristics of the warm dust (composition, grain size, cristallinity) and gas material. MATISSE is currently in its commissioning phase at the VLTI with a first report to ESO in June 2018 to offer MATISSE in low spectral resolution in the fall 2018 ESO Call for Proposal. In this talk, i will thus present the scientific potential of MATISSE for disk observations along with the commissioned performances in various spectral resolutions in the L, M and N bands.

Claire Davies Tuesday, 16:30

Grain growth-induced curvature of the inner rim of protoplanetary disks

Milliarcsecond resolution near infrared (NIR) interferometry of Herbig AeBe stars revealed a size-luminosity relation, indicating the circumstellar component arose from a dust sublimation rim, Rsub. However, evidence is mounting from e.g. NIR spectro-interferometry that optically thick material also exists interior to Rsub. Here, I present results from our comprehensive analysis of the spectral energy distribution (SED) and NIR interferometry of HD142666 using geometric and radiative transfer models. Our dataset offers the most complete uv-plane coverage obtained for a Herbig AeBe star across the NIR, featuring previously unpublished 330m-baseline CHARA Array data, allowing us to place strong constraints on the disk viewing geometry. We find that disk models incorporating grain growth to micron-size in the inner au are required to simultaneously fit the SED and visibilities. Furthermore, models in which rim curvature arises due to the sublimation temperature's dependence on gas density better fit the data than those where curvature arises due to grain growth-induced dust settling. Contrary to prior studies, we find no direct indication of optically thick material interior to Rsub.

Antonio Garufi Wednesday, 09:00

The outer disk knows about the inner disk

The morphology and composition of star and inner disk also have an impact on the disk structure at larger radii. In fact, the shadows, spirals, rings that have been recurrently imaged at > 5 au can be traced back to stellar mass and metallicity as well as to the presence of a misaligned inner belt within a disk cavity. We show the trends found over a large sample of objects and discuss the possibility that the inner disk may also regulate the planet formation by affecting the outer disk properties.

Luca Ricci Wednesday, 09:30

Imaging the inner regions of proto-planetary disks with sub-millimeter and millimeter interferometry

Interferometric observations at sub-millimeter/millimeter wavelengths can provide images of nearby young disks with spatial resolutions of a few astronomical units. I will present the recent results obtained from the ALMA Large Program of proto-planetary disks, which have identified a number of disk substructures in the dust continuum emission all the way down to a few au from the central star. Some of these substructures are likely associated with the presence of one or more proto-planets in the disk. I will also describe the potential of the Next Generation Very Large Array (ngVLA) in the study of the disk inner regions. The ngVLA is a future large interferometric array that will investigate the structure of disks with spatial resolutions < 1 au in nearby star forming regions.

Evolution of protoplanetary disks

Giovanni Rosotti Wednesday, 09:40

Disc evolution processes: how they affect the inner disc

Most planets discovered by Kepler are super-Earths with small gaseous atmospheres, showing that they formed in a gas-rich environment. In this review I will discuss the three main processes affecting the gas in the inner disc: accretion, photo-evaporation, and the formation of giant planets. In the conventional view of proto-planetary discs, the inner disc is "fed" by the outer disc where most of the mass resides and its evolution is intimately linked to the overall evolution of the disc. Alternatively, large mass reservoirs close to the star are required, predicting much higher densities for the formation environment of the Kepler-discovered planets. I will discuss the current observational constraints on this topic, provided by combining different indicators tracing the inner (accretion onto the star) and outer (ALMA observations) disc for large samples of stars. The two main candidates for the accretion mechanism are angular momentum transport by viscosity and angular momentum removal by winds. I will discuss how the properties of the inner disc change depending on which dominates, with important implications for the location of the water snow-line and planetary migration. The inner disc is also subject to the photo-evaporative wind. With time, this depletes the inner disc of material (forming a so-called transition disc), ultimately setting the timescale available for super-Earths to assemble their gaseous atmospheres. The last piece in the puzzle to describe the evolution of the inner disc is giant planet formation. Giant planets affect how much mass gets in the inner disc by cutting the supply of material to the inner disc, in this way hastening the dispersal of the inner disc; in turn their migration is affected by how much material is left in the disc.

Melissa McClure Wednesday, 10:20

Eye to the telescope: observing the inner 1 AU of protoplanetary disks

Observations of the inner 1 AU of protoplanetary disks illuminate many important physical processes during star and planet formation. Mid-infrared data probes warm gas and dust within the terrestrial planet forming region, providing constraints on the disk chemistry in a region critical to the formation of life. Near-infrared data can be attributed to the sublimation of dust in the inner disk "rim", which may serve as a brake on early migrating hot Jupiters, as well as the gas inside the rim. Visible and ultraviolet observations trace hot, dense gas that is accreting along the magnetic field lines onto the star, shifting the central radiation field to higher energies. The physical structures probed by these three wavelength regimes change dramatically as the star evolves, acquiring mass through both steady and episodic accretion and eventually cutting off its access to the outer disk mass reservoir through gap formation due to disk dissipation or planet formation. I will review the inner disk properties inferred from previous and current spectroscopic and interferometric campaigns and discuss the implications for further investigation with upcoming observing facilities.

Raeesa Parker Wednesday, 11:30

Understanding the formation and distribution of cm-sized dust grains in DG Tau A

Planet Earth Building-Blocks - a Legacy eMERLIN Survey is mapping pebbles (cm-sized dust grains) at 5 cm wavelengths for protostars at a range of evolutionary stages and masses. The survey focuses on nearby star-forming regions to systematically study discs with a high potential for planet formation. The 40 mas resolution (5-9 AU) allows us to separate disc zones comparable to where terrestrial and gas giant planets form in our Solar System. The ability to image grain growth within a few AU of young stars is a unique eMERLIN capability, allowing the investigation of how planetary cores are made and the search for protoplanet candidates. We present observations of DG Tau A (Class I-II, low-mass) at 4-6 cm, where the disc is resolved and easily distinguished from jet emission. The extended source flux is significantly higher than predicted, suggesting a pile-up of dust grains with sizes $\sim$1 cm. We compare the disc environments of DG Tau A and TW Hya, focussing on exploring the pebble-sized grain surface densities between 0.1 to $\sim$16 AU from the star. We discuss the benefits of follow-up observations in near-IR wavelengths necessary to understand planet formation in these systems.

Bertram Bitsch Wednesday, 11:50

Origin of super-Earths planets: influence of pebble accretion, migration and instabilities

The majority of detected exoplanets are close-in super Earths (planets of a few Earth masses) orbiting their host star roughly inside 0.5 AU. Additionally nearly all systems of super Earths feature multiple planets within the same system, where the period ratios between adjacent planets are mostly outside of resonance. However, their formation is still mysterious. We present here new simulations that have the potential to explain the formation pathway of super Earths. We follow the growth, migration, and composition of planetary embryos of just a tiny fraction of the Earth mass to full grown planetary systems, where solid accretion is enhanced through pebble accretion. Our main findings include: a) A difference of about a factor two in pebble flux separates true terrestrial planet analogues, which are finally assembled after the gas disc dissipates, with super Earths formed completely during the gas-disc phase b) Chains of migrating super Earths pile up in resonances, which break during late instabilities, where the resulting planetary systems match very well with the Kepler observations.

Co-authors: A. Izidoro, A. Johansen, A. Morbidelli, S. Raymond, S. Jacobson, M. Lambrechts

Colin McNally Wednesday, 12:10

How planets move in the inner disc

The inner region of the dead zone in a protoplanetary disc is likely predominantly lacking in viscosity-inducing turbulence. In addition to a disc wind driving accretion through upper layers, models suggest the midplane can be threaded by a Hall-effect generated large-scale horizontal magnetic field. I will describe the novel torques acting on low-mass (sub-earth) planets and cores elucidated in McNally et al. 2017 and 2018 which apply in this region of the disc. Dynamical corotation torque effects lead to new flow-locked and runaway migration regimes for these planets. Migration behaviour can also bifurcate sharply as a function of the planet mass/disc surface density. I will also describe ongoing work on the behaviour of super-earth planets in this regime, which are able to significantly alter the disc surface density profile in the thin inner disc and generate Rossby-wave vortices.

Arthur Bosman Wednesday, 14:00

Inner disk chemistry and the effects of drifting icy grains: the case of CO2.

The efficiency of radial transport of icy solid material from the outer disk to the inner disk is currently unconstrained. Efficient radial transport of icy dust grains could significantly alter the composition of the gas in the inner disk. Using a 1D viscous disk model, the effects of accretion flow and radial drift on the abundance of CO2 in the inner regions of protoplantary disks have been modelled and the results and implications of these models will be presented. Models show, that even without radial drift, CO2 is quickly added to the inner disk equilibriating the inner disk CO2 abundance with the ice abundance. This predicts CO2 abundances up to three orders of magnitudes higher than the abundances inferred from infrared observations by Spitzer. A range of potential physical and chemical mechanisms to try to explain this discrepancy as are discussed. Prediction are made for JWST-MIRI observations to discern the different scenarios.

Richard Booth Wednesday, 14:20

The inner disc tracers of the physics and chemistry of disc evolution.

Protoplantetary discs play an essential role in our understanding of planet formation, with the chemical competition of planets offering an exciting way to probe conditions where they form. One challenge today in assessing the mass and bulk composition of protoplanetary discs is that many key species are hidden from view, being frozen out in the mid-plane throughout large portions of protoplanetary discs. Conversely, in inner regions of discs many species are directly observable in atomic, gaseous form, thus avoiding these difficulties. Since the composition of the inner disc is connected to the outer disc through the radial transport of gas and dust, it provides a way to constrain both the chemical and transport processes acting in protoplanetary discs. I will present the results of a new investigation into the interplay between chemical evolution and radial transport through accretion and radial drift, discussing how the composition of the inner disc changes in response to these processes. I will discuss these results in the context of inner disc observations and what they mean for the growth and transport of dust, and implications for the chemical evolution of the outer disc.

Christine Chen Wednesday, 14:40

Observing the Inner Regions of Protoplanetary Disks with JWST

Multi-wavelength observations have painted a detailed picture of the inner regions of protoplanetary disks, characterizing the structure and properties of dust from the sublimation radius to the terrestrial planet zone and the kinematics of gas either accreting onto the star or outflowing from the disk. The excellent sensitivity and angular resolution of the James Webb Space Telescope (JWST) at near- to mid-infrared wavelengths are poised to revolutionize our understanding of the inner regions of protoplanetary disks. Specifically, JWST will enable detailed characterization of faint and young protoplanetary disks and demographic studies of more distant objects, including disks in the metal-poor Large Magellanic Cloud. In addition, medium resolution spectroscopy (R$\sim$3000) using the integral field units will enable mapping molecular and atomic line emission across disks. Indeed, Guaranteed Time Observer (GTO) and Early Release Science (ERS) teams have already submitted observing programs detailing their plans. I will present the JWST capabilities for observing protoplanetary disks using specific GTO and ERS programs to illustrate how observations can be planned.

Simon Jake Wednesday, 15:10

What Drives Accretion in Protoplanetary Disks?

It is still uncertain what exactly is responsible for driving angular momentum transport in protoplanetary disks, thus setting the environment in which planets are born. This transport may find its origin in turbulence driven by the magnetorotational instability (MRI), magnetically driven winds that remove angular momentum vertically, or some combination of both. In this talk, I will describe how ALMA observations of the outer disk, coupled with state-of-the-art numerical simulations, are constraining accretion processes in the inner disk regions. In particular, I will show that in the outer disk, both weak magnetic fields and very low ionization levels are necessary in order to be consistent with low turbulence values inferred from observations. These considerations have led to a new model for protoplanetary disks, in which a large-scale vertical magnetic field confined to the inner disk blocks ionizing radiation from reaching the outer disk, while allowing the inner disk to continually accrete. I will finish the talk by describing several powerful predictions made by this new model that can be tested with future observations of the inner regions of protoplanetary disks.

Giovanni Picogna Wednesday, 16:20

The dispersal of planet-forming discs. A new generation of X-ray photoevaporation models.

The modality of disc dispersal is thought to be of fundamental importance to planet formation, yet the responsible mechanism is still largely unconstrained. Photoevaporation from the central star is currently a promising avenue to investigate, but the models developed to date do not yet have enough predictive power for a piecewise comparison with the observations. We focus on creating new and improved hydrodynamical models of wind profiles from stellar irradiation at different wavelengths (EUV, X-rays) in order to have better constraints for current and future observations. We provide several fits of the total mass-loss rate as a function of stars X-ray luminosity, stellar mass, and carbon depletion, which can be used as simple prescriptions in population synthesis models of planet formation, as well as to produce line profiles within the wind for different disc inclinations. We find that the total mass-loss rate is increased by a factor 2 with respect to the previous models and the X-ray photoevaporation can explain a larger fraction of observed transition discs. Although these differences are small, they can significantly impact planet formation and their architecture.

Kristina Monsch Wednesday, 16:40

The imprint of X-ray photoevaporation on the orbital distribution of giant planets

Recent exoplanet surveys have highlighted the existence of an impressive diversity of planetary systems, raising the question of how systems similar to our own can form and develop. The key to explaining the diversity of planetary systems is in the understanding of the statistical trends that are emerging from the recent wealth of exoplanet data. One of these is the non-uniform distribution of the semi-major axes of gas giants. Giant planets are found to preferentially clump up at orbital radii of 1-2 au and finding what determines this peak is of strong interest. It has recently been suggested that this distribution may be established during the time of planetary migration in the protoplanetary disc, being halted by X-ray driven photoevaporation (Ercolano & Rosotti, 2015). We have searched for signatures of this process by correlating the X-ray luminosity of host stars with the semi-major axis distribution of their giant planets. Our statistical analysis of the observational data confirms a prominent feature that is also predicted by simulations, further strengthening the conclusion that X-ray photoevaporation may be shaping the architecture of planetary systems.

Angular momentum transport and connection of outer and inner disk

Somayeh Sheikhnezami Thursday, 9:00

Disk-outflow interaction: exchange of mass and angular momentum

Jets and outflows from YSO and AGNs affect their environment, and, thus, the formation process of the objects that are launching them. Numerous studies investigate effects of such feedback mechanisms in star and planet formation and galaxy formation. However, a quantitative investigation of how much mass, momentum, or energy from the infall is actually recycled into a high-speed outflow needs to resolve the innermost jet-launching region and to model the physical process of launching directly. According to the current understanding, accretion and ejection are related to each other. One efficient way to remove angular momentum from a disk is to connect it to a magnetized outflow. In this talk, I will present the recent studies of the detailed physics of accretion-ejection structure in the inner part of the disk focusing on launching process of an outflow from a magnetically diffusive accretion disk The main question we address is which kind of disks launch jets and which kind of disks do not? in addition, I will talk about the observed non-axisymmetric structures in the disk-jet structure by extending the model to 3 dimensions and including the companion in the setup.

Rebeca García López Thursday, 09:40

Observations of outflows and angular momentum transport from the inner to the outer disk

Viscous disks have been at the base of our current understanding of angular momentum transport and disk accretion. However, new theoretical studies predict that turbulence might not be efficient enough to carry angular momentum in the inner layers of circumstellar disks within 0.5 to 10 au from the source. Instead, strong MHD disk winds are thought to be launched in this central region, carrying away the excess angular momentum in a very efficient way. Recently, IR interferometers have begun to resolve the inner disk regions of protoplanetary disks. These studies surprisingly reveal the presence of wind emission in the innermost regions of disks, within a few stellar radii from the source, and thus indicate that MHD winds might play a major role in the removal of angular momentum. A new generation of much powerful interferometric instruments, more sensitive and with improved imaging capabilities is now coming on stream. In this talk, I will review the latest findings in the field of high angular resolution observations of protoplanetary disks, and how these studies can help us to constrain the inner disk structure and evolution.

Catherine Dougados Thursday, 10:20

What can jets and outflows tell us about the central astronomical units?

One of the crucial open question in star formation is to understand the link between the accretion of matter onto the young star and the launching of large scale jets and outflows. In particular, the role played by the jets and outflows in the extraction of mass and angular momentum from the protoplanetary disk are still critical open issues. I will review in this talk recent observational constraints derived from ALMA observations of inner molecular outflows associated with two young sources at different evolutionary stages. Both outflows are shown to originate within 20 au of the central source. We report clear detection of rotation signatures in the same sense as the underlying accretion disk. Properties of these outflows are shown to compare weill with predictions from steady MHD disk winds. however, an origin in a turbulent mixing layer associated with bow-shock wings cannot be fully excluded at this stage. Implications for the inner disk physics and evolution will be discussed.

Pauline McGinnis Thursday, 11:10

Spectral signatures of jets and winds in the young, open cluster NGC 2264

We present a study of the [OI]6300 emission line, a well-known tracer of jets and winds, detected in spectra of 108 T Tauri stars and 2 Herbig Ae/Be stars in the ∼5Myr old cluster, NGC 2264. We identify 3 main features of this line: a high-velocity component (HVC), believed to originate in protostellar jets, and a broad and narrow low-velocity components (BLVC and NLVC). We search for correlations between these components and stellar/disk/accretion properties, as well as high-precision CoRoT light curves, to investigate the link between the outflows responsible for these features and the star and disk. We find that the HVC is most often associated with sources whose light curves are attributed to an unstable accretion regime and that the internal stellar structure does not seem to influence its occurrence among T Tauri stars. The [OI]6300 line profile shows signs of evolving as the accretion disk disperses: the HVC and BLVC disappear as the inner disk becomes optically thin. Since the NLVC seems to originate farther out in the disk (up to ∼15au from the central object) than the HVC and BLVC (within ∼3au), this supports the scenario of inside-out gas dissipation of the inner disk.

Brunella Nisini Thursday, 11:30

Connection between jets, winds and accretion in T Tauri stars

In low mass young stars, mass loss is intimately related to disc accretion, contributing to the removal of angular momentum excess and to the dissipation of disk gas that eventually leads to the formation of protoplanetary systems. To understand the role of the mass loss phenomena on the disc evolution it is of key importance to address their frequency and properties on large samples of sources within individual star-forming regions. I present here a survey on the occurrence of fast jets and slow winds in a sample of 130 T Tauri stars of the Lupus, Chameleon and sigma Ori clouds, observed with X-shooter at VLT. The two phenomena have been traced by means of optical forbidden line emission, and their properties compared with stellar and accretion properties of the central star. In particular, I will show that there is a large diversity of jet properties among sources with the same mass and mass accretion rates, suggesting that the evolution of jets proceeds with timescales shorter than the accretion evolution.

Will Fischer Thursday, 11:50

Complementary Insights from Helium 10830 in the Age of Interferometry

The atomic helium line at 10830 Angstroms readily shows deep absorption features on both the red and blue sides of line center. Due to helium's high excitation potential, these absorption features probe accretion and outflow, respectively, in the innermost 0.1 AU of accreting star-disk systems. I will present spectra of this transition in young stellar objects with a range of inclination angles and accretion rates, including stars that are undergoing luminosity outbursts. The profiles will be interpreted in light of recent high-resolution images of these systems that probe somewhat larger scales in the inner disk.

Chris Nolan Thursday, 12:10

Determining the launching regions of centrifugally-driven disc winds from non-ideal MHD simulations

Protostellar discs play an important role in star formation, acting as the primary mass reservoir for accretion onto young stars and regulating the extent to which angular momentum and gas is released back into stellar nurseries through the launching of powerful disc winds. In this talk, we present a novel approach to modelling the wind-launching region in protostellar disks, which enables us to map out the regions of protostellar disks where wind launching could be viable. We combine a series of 1.5D semi-analytic, steady-state, vertical disc-wind solutions into a radially extended 1+1.5D model, incorporating all three diffusion mechanisms (Ohm, Hall and ambipolar). From these models we observe that the majority of mass outflow via disc winds occurs over a radial width of a fraction of an astronomical unit, with outflow rates attenuating rapidly on either side. We also find that the mass accretion rate, midplane plasma beta, surface density profile and ionisation structure each have significant effects on both the location of the wind-launching region and the ejection/accretion ratio.

Star-disk interaction

Scott Gregory Thursday, 14:00

The impact of magnetic fields on the star-disk interaction and planet formation

Magnetic fields play a major role in controlling the final stages of low-mass star formation, while stars are still interacting with planet-forming disks. Stellar magnetic fields influence the structure of inner-disks, the migration of planets, and, via the star-disk interaction, the rotational evolution of stars. To date, only fragmentary observational information is available on how magnetic fields vary with the fundamental stellar parameters. I will review our understanding, and the gaps in our knowledge, of magnetism in young accreting stars. I will discuss how magnetic fields may impact the migration and formation of planets. Throughout the review particular emphasis will be placed on the need for time domain multi-wavelength observations.

Laura Venuti Thursday, 14:40

Observations of star-disk interaction and link to disk evolution at the epoch of planet formation

Our view of the star-disk interaction has recently been revolutionized by space-borne missions like CoRoT and Kepler/K2. Thanks to their sub-1% photometric precision, sub-hour sampling, and continuous monitoring for weeks to months, these campaigns have provided first detailed atlases of the short- to mid-term variability of young stars, thus revealing the manifold photometric behaviors of disk-bearing objects. In this review, we explore the observational signatures and intrinsic timescales of the various physical processes at play in young star-disk systems. At least two distinct paradigms of star-disk interaction emerge: i) the unstable regime, characterized by stochastic, short-lived accretion bursts and rapidly evolving accretion features; ii) the stable regime, with ordered accretion streams from the inner disk to the star, and accretion features that persist over many rotational cycles. These distinct scenarios may be related to different stages of the inner disk evolution. The mechanisms which regulate the star-disk interaction on timescales of days typically exhibit a relatively stable nature on timescales of years, although with a more erratic behavior on the shorter term.

Shinsuke Takasao Thursday, 5:20

Fast accretion onto a weakly magnetized star

Generally it has been assumed that the presence of a fast (close to the escape velocity) accretion is an indication of the magnetospheric accretion. However, observations indicate that fast accretion also occurs even in a weakly magnetized stars like Herbig Ae stars, which poses a question about the picture of accretion we have developed. We performed 3D MHD simulations by using the Athena++ code, and analyzed the accretion from an MRI (Magneto-Rotational Instability)-active disk onto a weakly magnetized star. As a result, we found that fast accretion to a high-latitude, which is similar to the magnetospheric accretion, is possible even without the stellar magnetosphere. Our results suggest a possibility that stars without the magnetosphere can show a violent accretion behavior associated with X-ray activities. We will discuss the physics of the accretion on the basis of our simulations.

Silvia Alencar Thursday, 15:40

The inner disk structure of the classical T Tauri star LkCa 15

LkCa 15 is a classical T Tauri star surrounded by a transition disk fromwhich accretion is ongoing. We analysed quasi-simultaneous spectropolarimetric and photometric data obtained in two observing seasons, covering several stellar rotational periods. We characterized the star-disk interaction and derived the accretion flow properties and the magnetic field at the stellar surface. We determined the stellar rotation period of 5.7 days and show that the light curve presents a typical dipper behavior, suggesting the existence of an inner disk warp that eclipses the star periodically, which is a surprising configuration for a transition disk system with a 50 au inner hole. The spectroscopic variability indicates the presence of a highly inclined inner disk that interacts with the stellar magnetosphere, which contrasts with the observed moderate inclination of the outer disk and suggests a misalignment between the inner and outer disks of this interesting transition disk system.

Colin Hill Friday, 09:00

Magnetic Fields and Planets of Weak-line T Tauri Stars

T-Tauri stars are late-type pre-main-sequence stars that are gravitationally contracting towards the main sequence. Magnetic fields largely dictate the angular momentum evolution of these stars and can affect the formation and migration of planets. Thus, characterizing their magnetic fields is critical for testing and developing stellar dynamo models, and theories of low-mass star and planet formation. I will present the results so far of the MaTYSSE project, that aims to map the magnetic fields of weak-line T Tauri stars, and detect close-in giant planets.

Giacomo Beccari Friday, 09:20

Accretion properties of low-mass stars in the Large Magellanic Cloud: the case of LH95

We present recent results on accretion properties of low-mass stars in the metal-poor star forming region (SFR) LH95 within the Large Magellanic Cloud (LMC). Using wide-band optical and narrow-band Halpha photometry obtained with the Hubble Space Telescope, we identify, within an initial catalogue of about 25000 sources, ∼250 bona fide pre-main sequence (PMS) stars with Halpha excess emission, for which we derive physical and accretion parameters. We identify two different populations of PMS stars: younger than 8 Myr with high levels of accretion rates and assembled in groups around massive stars, and ∼10-50 Myr old stars with lower levels of accretion rates and uniformly distributed within the region without evidence of clumping. We compare our results with those obtained in Galactic SFRs with close-to-solar metallicities and in other clusters of the LMC and we put them in the context of future ESO/ESA facilities/missions, like the E-ELT and James Webb Space Telescope.

Hossam Aly Friday, 09:40

Dusty warps: Can Warps in Protoplanetary Discs Form Dust Traps?

The interaction between gas and dust in protoplanetary discs plays a crucial role in the evolution of dust grains and formation of planetesimals. Warps are observed to be common in these systems. I will present a theoretical investigation on how warps can impact the distribution of dust in discs and potentially form dust traps, which can help overcome the meter-sized barrier. Moreover, I will present an investigation into how warps, induced by binary gravitational torque on a misaligned disc, can explain the observed large cavity in the dust ring around the GG Tau A binary system.

Suzanne Ramsay Friday, 10:00

Looking closely at protoplanetary discs with the European ELT and it instruments

In this talk we will present the prospects for exploring the innermost regions of protoplanetary discs with the new European Extremely Large Telescope (ELT). Construction of the telescope is underway and the suite of instruments that will be available at first light and beyond are being designed. Most of these instruments will be equipped with adaptive optics systems that will reach the diffraction limit of the enormous 39-m telescope aperature. When coupled with a strong emphasis on observations at infrared wavelengths (0.8-19microns), the telescope and its instruments are expected to compliment JWST and ALMA perfectly and to add significantly to our knowledge of the physics and chemistry of discs. Details of the instruments will be presented along with some of the disc-related science cases that will be enabled by the new facility.

RW Aur: origin of the dimming events

Sergei Lamzin Thursday, 16:40

Analysis of photometric and polarimetric observations of RW Aur A: arguments in favor of dusty wind

Results of UBVRIJHKLM photometry and VRI polarimetry of a young star RW Aur A observed during 2010-11 and 2014-18 dimming events are presented. Polarization degree p of RWAur A at this period has reached 30 % in I band. As in the case of UXORs so called 'blueing effect' in the color-magnitude V vs. B-V, V-R, V-I diagrams of the star and strong anticorrelation between p and brightness were observed. But duration and amplitude of the eclipses as well as value and orientation of polarization vector in our case differ significantly from that of UXORs. We concluded that dimmings of RW Aur A occured due to eclipses of the star and inner regions of its disk by axisymmetric dust evelope created by disk wind. Taking into account both scattering and absorption of stellar light by the evelope we explain the main features of the lightcurve and polarization degree – magnitude dependence as well as estimate parameters of the dusty wind: mass loss rate, transverse component of the wind velocity, gas particle density.

Boris Safonov Thursday, 16:45

Resolving dusty wind of RW Aur A

RW Aur is a young star with protoplanetary disk. The star shows irregular eclipses similar to UXORs, but with larger amplitude and duration. It also demonstrates extraordinary high polarization degree in minimum light. These features may be explained by emergence of dusty wind in 2010 (Dodin et al 2018, submitted). We observed the object using speckle polarimetry in 0.5-0.8 mkm range using a dedicated instrument installed at 2.5-m telescope of SAI MSU. The instrument combines features of speckle interferometer and two-beam polarimeter. We detected a fan-shaped reflection nebula on the angular scale 50-100 mas in the closest vicinity of the RW Aur A. The parameters of this nebulosity are consistent with suggestion that it is actually dust expelled from protoplanetary disk by the wind.

Maria Koutoulaki Thursday, 16:50

Shedding light on the dimming events of the CTTS RW Aur A.

The study of the inner gaseous disc of YSOs is crucial to understand the physical processes ruling disc evolution and its connection with planet formation. In this talk, I will present our results on the inner disc properties of the CTTS RW AurA. The RW Aur system has captured the attention of astronomers for its dimming events. By using X-SHOOTER spectra in the bright and dim states, we compare the NIR CO emission in order to shed light on this mystery. In general, the CO emission traces a warm (T=2000-5000K) and dense (NCO> 10^{12} cm-2) gas as expected in the innermost region of discs. Both states need a cool (T=2600K) and dense (NCO=7×10^{20}cm-2) gas to reproduce the observations, with the emitting region located just inside the dust sublimation radius. By comparing the SED (from ∼300 to ∼1000 nm) and the CO emission of both states, we find that the dimming can be due to absorption by a layer of large grains with optical depth slowly declining from 2.8 to 1.6. The accretion rate remains constant (Macc∼2e-8 Mo/yr) if one assumes that the same layer of dust also occults the accretion line emitting region. This excludes accretion bursts as the main cause of RW AurA brightness variability.

Hans Moritz Günther Thursday, 16:55

X-ray news from RW Auriga: Optical dimming with iron rich plasma and an exceptional column density

RW Aur A has undergone a visual dimming event in 2011 lasting about half a year and further dimming since 2014. We report on new Chandra X-ray data taken in 2017, when the optical flux was almost 2 mag below the long-term average. The observed X-ray spectrum is more absorbed by a column density of a few 10^{23}cm^{-2} and shows significantly more hot plasma than in X-ray observations taken before the dimming. An emission feature at 6.62 keV indicates an Fe abundance an order of magnitude above Solar, in contrast with previous sub-Solar Fe abundance measurements. Comparing X-ray absorbing column density N_H and optical reddening A_V, we find that either the gas-to-dust ratio in the absorber is orders of magnitude higher than in the ISM or the absorber has undergone significant dust evolution. Given the high column density coupled with changes in the X-ray spectral shape, this absorber is probably located in the inner disk. We speculate that a break-up of planetesimals or a terrestrial planet could supply large grains causing gray absorption; some of these grains would be accreted and enrich the stellar corona with iron which could explain the inferred high abundance.

Matías Gárate Thursday, 17:00

The dimmings of RW Aur. Is the accretion of dust preceding an outburst?

In the recent years, RW Aur A has presented multiple dimming events that last for a few months. The origin of this phenomena remains yet to be uncovered, although several explanations are available. Using numerical simulations, we study how the dust accumulates in a dead zone located at the inner regions of the protoplanetary disk. Should the dead zone be re-activated, all the accumulated material will be flushed towards the star, in particular, the dust excess will travel faster than the gas, potentially blocking the starlight and causing the dimming events. Afterwards the accretion of gas will follow, causing an outburst.

Poster Abstracts

Peter Abraham

A high spatial resolution view of the silicates in young eruptive stars

The unpredictable eruptions of FU Ori- and EX Lup-type young pre-main sequence stars are expected to have a strong impact on the surrounding circumstellar material, and thus on the initial conditions of planet formation. The episodically increased luminosity of the central object may drive structural, chemical and mineralogical changes in the inner disk. Here we present a study of the silicate component in a sample of 11 young eruptive stars. We use archival mid-infrared interferometric observations obtained with the MIDI instrument on the VLTI. We compare the observed emission/absorption profiles of the 10 micrometer silicate feature with spectral templates of amorphous dust and comet Hale-Bopp. The interferometric data allow us to perform the analysis on different spatial scales between 1-2 au and 20-30 au. In particular, we aim to reveal the expected existence of crystalline silicates in the environment of the high luminosity FU Orionis objects, which has never been observed so far. Our results provide the first high resolution view of the silicate particles in young eruptive stars, and help to outline those astrophysical situations when mineralogical changes occur in space.

Sareh Ataiee Torshizi

Spiral shock heating in protoplanetary disks: effect on the water snowline

The location of the water snowline, which is the closest snowline to the star, has an important effect on the formation of planets and their composition. The location of the snowline depends strongly on the heating processes inside the disk. In addition to irradiative heating and viscous heating, we show that heating via spiral shocks emerging from an embedded high mass planet can also have a significant effect on the location and shape of the snowline, sometimes moving it outward by a factor of two.

Francesca Bacciotti

Clues on grain size and settling in protoplanetary disks from ALMA polarimetric studies

We have obtained ALMA polarimetric data at 870 microns (Band 7) and 0."2 resolution for the protoplanetary disks around DG Tau and CW Tau, two T Tauri systems with well known jets. In both targets the results are consistent with dust self-scattering being at the origin of the polarization pattern. The polarization maps highlight structural details not derivable from the analysis of the total emission alone. Such substructures are likely related to changes in the optical depth, and can betray a change in the physical structure of the disk. The measured values of the polarization fraction give constraints to the maximum size of the grains giving rise to observed patterns. This size is found to be in the range 50 - 150 microns in our targets. Meanwhile, the polarization maps combined with dust opacity estimates give constraints on the scale height of such grains. Overall, we find that these grains are larger and more settled toward the midplane in CW Tau than in DG Tau. These results confirm that polarization can be a fundamental complement to observations in total emission, for the investigation of the structure and of the evolution of protoplanetary disks.

Trisha Bhowmik

Resolved spectro-polarimetry of debris disk HD32297 observed with SPHERE/VLT

Young debris disks are faint compared to their host stars requiring post-processing techniques like angular differential imaging (ADI) for high-contrast imaging, which, in turn, causes bias in the intensity map of the disk structure. We account for this bias by generating a model grid and processing it through an ADI algorithm which is further fitted to the data, channel per channel, to build the spectrum of either a part or the complete disk. Different polarimetric models convolved with the instrument PSF are also fitted with original data to retrieve physical observable like surface brightness or contrast. We will present our preliminary results for high contrast images (DPI, DBI and CI) of the debris disk: HD32297 obtained using IRDIS and IFS spectrographs on SPHERE-VLT. We estimate the fraction of polarization comparing the corrected polarimetric flux to the ADI corrected flux of total intensity images. The total intensity spectrum obtained for this disk confirms it to be a bright symmetrical disk with visibly flat spectrum indicating particular grain characteristics (size, chemistry and distribution) which will be discussed further in the talk.

Eloise Birchall

Early evolution of protostellar discs

Star and planet formation are intimately entwined, and it is difficult to consider one without its implications for the other. Here I will discuss the initial results of my simulations of the formation of a protostellar disc and its associated chemical and physical evolution to investigate the implications this has for the earliest stages of planet formation. Meteoritic evidence (such as high temperature inclusions) suggests certain temperature and density processing histories throughout the Sun's protostellar disc, however such environments are not typically found in observations or simulations of other discs. I use the magneto-hydrodynamic adaptive mesh refinement code FLASH to simulate the collapse of a cloud into a star and disc, and follow the path of gas throughout the disc using tracer particles to probe the disc environment. The information from the tracer particles can then be compared with what is observed and found in meteoritic data to understand the links between the earliest stages of star and planet formation.

Jerome Bouvier

Take a closer look at... the SPIDI project

The "Star-Inner Disk-Planets Interactions" (SPIDI) project aims at detecting nascent inner planets still embedded in the circumstellar disk of young stars and orbiting close to the magnetospheric truncation radius. The poster will describe the motivations and recent progresses that led to the SPIDI project and the approaches that we will follow to address the challenge of isolating a planetary signal buried in the large variability of young stars induced by the magnetic star-disk interaction. This project has received funding from the European Research Council (ERC) under the European Unions Horizon 2020 research and innovation programme (grant agreement No 742095)

Robert Brunngraeber

Observing asymmetric structures in protoplanetary disks with MATISSE

We present a quantitative analysis of the potential capabilities of detecting local brightness asymmetries in circumstellar disks with the VLTI in the MIR wavelength range. To evaluate planet formation theories, direct observations of protoplanets still embedded in their host disk are indispensable. Due to the small angular separation from their host star, only long-baseline interferometry provides the angular resolution to detect disk asymmetries caused by protoplanets at (sub-)au scales. In particular, infrared observations are crucial to observe scattered stellar radiation and thermal re-emission in the vicinity of these planets directly. For this purpose, we performed mock observations with MATISSE in the L, M and N bands, based on radiative transfer simulations of protoplanetary disks hosting embedded companions. We find that the flux ratio of the embedded source to the central star can be as low as 0.6 % for a detection at a feasible significance level due to the heated dust in the vicinity of the embedded source. Furthermore, we find that the likelihood for detection is highest for sources at intermediate distances (2–5 au) and disk masses not higher than about 1e-4 $M_{\odot}$.

Juan Andrés Cahuasquí

A closer look at the circumbinary cavity of the V892 Tau system through multiepoch MIDI observations

V892 Tau, in the Taurus-Auriga star forming region at 140 pc, is a Herbig AeBe binary system with a separation of ca. 50 mas ($\sim$7 AU) and a 13-year period. The pair is surrounded by a large circumbinary disk truncated at a radius of ca. 18 AU. To resolve the nature of the IR flux lacking in the SED of the system, the 9-year baseline observations with MIDI/VLTI, distributed into two epochs in 2004, one in 2009 and two in 2013, were analyzed with a temperature gradient model aiming at simultaneously reproducing the mid-infrared visibilities, differential phases and SED for three different scenarios: 1) binary pair + circumbinary disk; 2) binary pair + circumbinary disk + circumstellar disk surrounding one component; and 3) binary pair + circumbinary disk + hot component. Our model coupled to the fit optimizer MAGIX reveals that the observational measurements are best reproduced by the configuration that includes the hot component in the neighborhood of the central pair, and whose location is well determined by the sensitivity of the differential phases. We discuss the possible nature and morphology of this additional component and its observational role in our interferometric data.

Andres Carmona

Tracing the gas surface density profile the inner disk of transition disks with VLT/CRIRES

To derive the surface density inside the dust cavities of transition disks is paramount to understand their origin. We performed deep observations of CO emission at 4.7 micron of the transition disks HD 139614 and HD 169142 with VLT/CRIRES. We detect 12CO, 13CO, and C18O emission in the sources. We model the CO isotopologues emission-line profiles, spectroastrometry signature, and rotational diagrams with a grid of flat Keplerian disks in LTE. We find 12CO gas emission inside the dust cavity (R=6au for HD 139614, R=20 au for HD 169142) down to a radius of 0.5 - 1 au. We find strong evidence for gas density drops inside the dust cavities, however, we dont find evidence for gas gaps larger than 3 au in the disk. Our models suggest NH column densities inside the dust cavity of 5×10^{19} -$10^{21}\,\mathrm{cm}^{-2}$ (10^{-4} - 2×10^{-3} g cm^{-2}) assuming a NCO/NH = 10^{-4}. These column densities are lower than the extrapolated gas surface density from the outer disk and are hard to reconcile with the accretion rates measured for the objects (10^{-8} and 10^{-9} Msun/yr for HD 139614, HD 169142 respectively). Gas density drops and no gas gaps are consitent with the pressence of $a < 2\,M_J$ embedded giant planet.

Simon Casassus

The shadowed ring of DoAr44

Optical/IR images of transition disks (TDs) have revealed deep decrements in the outer regions of HAeBes HD142527 and HD100453, that can be interpreted as shadowing from sharply tilted inner disks, such that the outer disks are directly exposed to stellar light. We report similar dips in SPHERE+IRDIS differential polarized imaging (DPI) of TTauri DoAr44. With a fairly axially symmetric and face-on ring in the sub mm radio continuum, we propose that DoAr 44 is also a warped system. We constrain the warp geometry by comparing radiative transfer predictions with the DPI data in H band. An inner disk tilt of 30+-5deg accounts for the shape of the DPI decrements. The observed DPI shadows are much deeper than in the radio: while the intensity drops by ∼88% in the DPI images, the radio decrements are relatively shallow with a drop of ∼25% at 330GHz. This is consistent with the RT predictions. ALMA long-baseline observations should allow the observation of the warped gas kinematics inside the cavity of DoAr44.

Paolo Cazzoletti

CN emission

CN emission lines are among the brightest, and have been observed in the last 20 years with single dish observations. With modern interferometers, we are now able to spatially resolve CN emission, which often shows ring-like structures. We investigate whether such structures trace the morphology of the disks, or if they have a chemical origin. By using the thermochemical code DALI, we conclude that CN formation is triggered by the existence of vibrationally excited H2, produced by FUV pumping of H2. Herbig stars therefore generally have larger rings and higher CN fluxes than T Tauri. Disks with higher masses and flaring also show stronger CN emission and larger rings. CN observations could in the future provide important constraints on some important disk physical parameters, and in particular CN flux and ring size will help to put constraints on the FUV flux from the central star, a critical parameter for the evolution of the inner disk.

Lei Chen

Spectral evolution and radial dust transport in the disk of the prototype young eruptive star EX Lup

During the outbursts of EXor stars, the enhanced illumination from the central region heats the inner disk surface within 1 au to a high temperature, permitting pristine amorphous silicate grains to anneal into crystalline ones. The first direct evidence of this process was the discovery of crystalline features in our Spitzer spectrum of the prototype star EX Lup during its 2008 outburst. Our VLTI/MIDI observation during the outburst constrained that the newly formed crystals are in a compact region within 1 au. We analyzed post-outburst Spitzer, VLTI/MIDI, and new VLT/VISIR data and found that the crystalline silicate features faded with time and finally disappeared within several years after the outburst. We interpret the temporal change of the spectrum with a scenario that the crystalline silicate grains created in the inner region are transported outwards, forming a crystal-rich expanding shell. Our radiative transfer modeling successfully reproduced the features in the post-outburst spectra. The mass of crystal grains in our model is consistent with an origin in the heated inner disk surface. The expanding velocity of the shell is also constrained.

Fernando Cruz-Saenz de Miera

The circumbinary spiral arms of L1551 IRS 5: a new discovery with ALMA

Most solar-type stars are created in multiple star systems. One of the effects of how the presence of a companion star influences the circumstellar environment is the formation of circumbinary disks surrounding circumstellar disks. Planetary formation in these systems is affected by the influence the multiple components have over the gas and dust. For example, the two stars truncate each other's disks inhibiting the formation of planets. On the other hand, circumbinary disks can feed material into the circumstellar disks and enhance planetary formation. L1551 IRS 5 is an interesting target to study the effects of multiplicity over dust and gas dynamics. The system is composed by a circumbinary disk surrounding two circumstellar disks, each surrounding a low mass star. Here we present ALMA observations of the 1.3 mm continuum at 20 au resolution in which we resolve both circumstellar disks and, for the first time, resolve structural details in the circumbinary disk. The circumbinary disk has a radius of ∼100 au and it is composed of three spiral arms: two spiral arms to the south and one spiral arm to the north, which appears to be connected to the northern circumstellar disk.

Giovanni Dipierro

Gas and multi-species dust dynamics in viscous discs: the importance of the dust back-reaction

We study the dynamics of a viscous protoplanetary disc hosting a population of dust grains with a range of sizes. We compute steady-state solutions, and show that the radial motion of both the gas and the dust can deviate substantially from those for a single-size dust population. Although the aerodynamic drag from the dust on the gas is weaker than in the case where all grains are optimally coupled to the gas, the cumulative "back-reaction" of the particles can still alter the gas dynamics significantly. In typical protoplanetary discs, the net effect of the dust back-reaction decreases the gas accretion flow compared to the dust-free (viscous) case, even for dust-to-gas ratios of order 1%. In the outer disc, where dust grains are typically less strongly coupled to the gas and settle towards the midplane, the dust back-reaction can even drive outward gas flow. The resulting dust and gas dynamics can give rise to observable structures, such as gas and dust cavities. Our results show that the dust back-reaction can play a major role in both the dynamics and observational appearance of protoplanetary discs, and cannot be ignored in models of protoplanetary disc evolution.

Suzan Edwards

Forbidden Lines and Disk Winds

Low excitation optical forbidden lines are one of the defining characteristics of accreting T Tauri stars. These lines are predominantly blueshifted, indicating winds and disk occultation, with profiles that can be decomposed into kinematic components attributed to high velocity collimated jets (HVC) and lower velocity disk winds (LVC). Recently the LVC has been further decomposed into two further kinematic components, a broad one (BC) attributed to an inner disk wind and a narrow one (NC) attributed to a slower outer disk wind. Using high resolution spectra from Kecks HIRES and Magellans MIKE spectrograph for a sample of 65 T Tauri stars, 48 of which also include [SII 4068] as well as [OI 6300 and [OI 5577], we make a detailed comparison of these various kinematic components both with each other and with additional system properties such as inclination, accretion luminosity, and disk structure. Two important new findings are establishing a connection between the properties of the HVC and the LVC that point to a physical link between them, and determining forbidden line ratios that demonstrate the LVC components arise under conditions of thermal excitation, allowing mass loss rat

Jessica Erkal

Spectro-Imaging the Bipolar Jet from DO Tau

The aim of our study is to investigate T Tauri jet kinematics, shock morphology and plasma parameters to further constrain models of jet launching. Observations were conducted using GEMINI/NIFS+AO to obtain H-band IFU data. This is the first time the DO Tau bipolar jet has been imaged at such high angular resolution close to the star. The brighter blue-shifted jet is detected as close as 0.1" from the star and extends to 1.2", while the counter-jet appears only at 1.0" extending to 1.5". Morphology of the blue-shifted jet reveals a 0.1" variation in its axis centroid at distances beyond 0.6", which could result from jet wiggling, or the presence of a knot or bow-shock. No variation is measured closer to the jet base. The morphology reveals a difference in position angle of the jet and counter-jet. Jet kinematics show jet velocities in line with the literature. We search for variations in radial velocity across the jet, which may signal jet rotation. The DO Tau disk rotation sense was studied using complementary Plateau de Bure data. We derive estimate electron density and mass flux from Fe II lines. Finally, we discuss the constraints brought by these data on jet launching models.

Fabio Eupen

Interferometric observations of the circumstellar disk environments in close binary stars

The inner structure of protoplanetary disks can be strongly affected by the presence of the companion in close binary stars with ∼au separation, where the dispersal of the circumstellar components may occur over time scales as short as 10000 yrs. The interferometric view helps us to understand better the disk-binary interaction in such systems. We present multi epoch interferometric observations of disks in close binaries based on VLTI-MIDI (mid-IR), AMBER and GRAVITY (near-IR) data in the continuum, combined with photometric measurements. The optimization of temperature gradient models based on Markov Chain Monte Carlo simulations suggests the presence of hot dust within the circumbinary cavity for at least two of our studied objects, the ∼7 au Herbig V892 Tau and the ∼1 au T Tauri WW Cha at an age of ∼2 Myr. In the latter case, our findings are consistent with circumstellar dust surrounding each of the binary components. Such studies are a good test-bench for theoretical models that predominantly predict rapid disrupting of the circumstellar disks.

Ruben Fedriani

Revealing the true nature of high-mass YSO jets

In contrast with low-mass young stellar objects (LMYSOs), very little is known about high-mass YSOs (HMYSOs). Latest results indicate that HMYSOs might be born in a similar way as LMYSOs, i.e., through disc accretion and jet ejection. HMYSOs are deeply embedded in their parent cloud and are at kpc distance, hindering direct imaging of their accretion discs. Jets then become essential to understand the physical properties of the central source. High-resolution near-IR VLT instruments allow us to study HMYSO jets down to au scales and compare them with the low-mass regime. In this talk, I will present VLT/ISAAC, SINFONI, and CRIRES results on two HMYSOs. Spectro-astrometry is used to retrieve information about the jet down to mas scales (∼tens of au at kpc distance). High-resolution spectroscopy allows us to retrieve the kinematic and dynamic properties of the massive jets. Additionally, HST imaging in the [FeII] shows the jet structure close to the star. Finally, these properties are compared with low-mass jets, suggesting that the formation of HMYSOs might be just a scaled-up version of their low-mass counterparts, and their properties scale with mass.

Tommaso Grassi

Formation of the First Solids at the Birth of Our Solar System: a microphysical ab-initio model.

Calcium-aluminium- rich inclusions (CAIs) believed to have condensed from a hot metal-rich gas close to the protosun, but no coherent formation theory exists. We present a novel detailed microphysical description of CAI condensation embedded in a state-of-the-art numerical model of star formation. Our model can explain the meteoritic evidence representing a strong constraint for future global simulations of Solar System formation.

Vladimir Grinin

The unusual photometric activity of the weak line T Tauri star V715 Per

The multi-year photometric observations of the weak line T Tauri star V715 Per in optical (V RI) and near infrared (JHK) bands have revealed an unusual combination of two different types of the photometric activity: low amplitude periodic brightness changes with P = 5.23 days and algol-like minima which are typical for the UX Ori stars. The minima have been observed during about 6 years and then have suddenly stopped. The periodic variability of this objects was observed earlier by Cohen et al. (2004) and interpreted as a rotational brightness modulation of a spotted star. We argue that the physics of this phenomenon is similar to that suggested by Bouvier et al. (1999) for the classical T Tauri star AA Tau: periodic occultation of the star by the warped inner disk. The observations have shown that the amplitude of the periodic brightness variations decreased at the time when the star demonstrated the UX Ori type activity. We argue that both these phenomena were caused by the temporary increase of the mass accretion rate onto the star, that led to reduction of the warped inner disk radius.

Thomas Hands

Mass transfer, loss and dynamical evolution of debris discs in young open clusters

We perform high-N, direct summation N-body simulations of the early phases of open cluster evolution. The stars in our clusters host populations of test particles arranged in Kuiper-belt style planetesimal discs. We evolve the clusters and debris discs simultaneously in one simulation, such that the exact cluster potential is known at each time-step, and no approximations are required to determine the effect the cluster environment has on the planetesimals. We show that the early stages of evolution for Hyades-style clusters readily lead to the transfer of planetesimals between stars, free-floating planetesimals (such as A/2017 U1), and dynamically excited planetesimal discs. We also show that planetesimals captured from the stellar birth environment are not necessarily dynamically distinct from those native to a star. We discuss the implications of our results for both our own solar system and exoplanetary systems.

Daniel Harsono

High spatial resolution of an embedded disk TMC1A

Planets form through local collapse within a massive, gaseous, circumstellar disk and/or grain growth. As the disks are the sites of planet formation, the physical and chemical structures of disks during their formation have a direct impact on the formation of planetary bodies. With ALMA in its long baselines configuration (16 km baselines yielding a resolution of 3-6 AU), we are currently targeting young protostellar regions to zoom in on outflow launching, early disk evolution, and star- and planet-formation. We will here present an overview of the program and spatially resolved observations of the gas and dust toward TMC1A.

Thomas Haworth

Disc evolution in different cluster environments

Planet forming discs typically survive for a few up to around ten million years. During this time the parent star still resides within its natal cluster and hence may be subject to environmental effects such as gravitational encounters (e.g. as in the case of RW Aur) or irradiation by other cluster members. Recent research has demonstrated that irradiation generally dominates (Winter et al. 2018). I'll present the latest results from a large programme of research into photoevaporation of discs as a function of UV field strength, stellar mass and disc mass/radius. This includes the upcoming FRIED grid of publicly available mass loss rates that will be valuable for viscous evolutionary models of discs and can also be used to compute the evolution of discs in star cluster formation and feedback calculations (Haworth et al. in prep). This grid can also be used to trivially estimate mass loss rates for real systems. I'll also demonstrate that the proto Trappist-1 disc-to-star mass ratio has to be high at $\sim$0.3, but the disc is still expected to be stable. This has important consequences for models trying to explain the observed Trappist-1 planets (Haworth et al. 2018)

Nuria Huelamo

Searching for accreting protoplanets with SPHERE/ZIMPOL at the VLT

In this poster I present high angular resolution observations of two transition disks with SPHERE/ZIMPOL at the VLT. We have observed the targets in both the Hα and Continuum filters to detect strong accreting protoplanets inside the disk gaps. I discuss the main results, including upper limits to the companion accretion rates at different separations from the central object.

Gaitee Hussain

Evolving magnetism in intermediate mass PMS stars

On the main sequence, only 5-10% of intermediate mass stars ($> 1.2M_{\odot}$) host strong large-scale surface magnetic fields. These magnetic field topologies tend to be relatively simple dipolar fields that are stable over decades. However, all stars with masses between $1.2 - 4M_{\odot}$ undergo a T Tauri star stage during their pre-main sequence evolution, during which they possess outer convective envelopes and (presumably) dynamo activity. We present the results of our spectropolarimetric study of a sample of 38 intermediate-mass PMS stars. Magnetic fields are detected in the cooler half of our sample, strongly suggesting the magnetic incidence drops very quickly (within 0.1 Myr) as the radiative core exceeds $0.75R_{*}$ (or $0.98M_{*}$). The properties of the spectropolarimetric signatures also imply an increase in the field complexity as the radiative core develops; this is the first indication that intermediate-mass T Tauri stars show similar behaviour to their low-mass counterparts and has a corresponding implication for their early angular momentum evolution.

Michael Ireland

Radiative acceleration on dust as a sorting process in gaseous inner disks.

Poynting-Robertson drag is a well known mechanism for sorting grains in debris disks. In gaseous protoplanetary disks, the combination of radiative acceleration and gas drag can also sort grains, removing micron sized grains and leaving very small grains or grains transparent to $\sim$1 micron wavelength radiation. I will show how these processes work most effectively for transition disks, explaining some of their curious properties, and how shielding by a structured inner disk is critical to understanding the effectiveness of this mechanism.

Valentin Ivanov

The Day on other worlds

The rotation of sub-stellar companions contains a record of the angular momentum distribution processes during their formation, and of the tidal interactions during their evolution. The planet rotation measurements are potential constraints on both planet formation and evolution theories. The diurnal periods are only known for the Solar System planets from direct observations, for Beta Pic b from rotational line broadening and for 2M1207b from cloud modulation. I will describe results from a program to measure the diurnal periods of sub-stellar companions with masses in the range 11-20 Mj from rotational modulation observations. This objects fill in the gap in the parametric space between the Solar system and exoplanets on one hand, and the brown dwarfs, on the other.

Marija Jankovic

Spectral evolution and radial dust transport in the disk of the prototype young eruptive star EX Lup

FU Orionis-type stars (FUors) are young stellar objects experiencing large optical outbursts due to highly enhanced accretion from the circumstellar disk onto the star. FUors are often surrounded by envelopes, which have a significant role in the outburst mechanism. Conversely, the subsequent eruptions gradually clear up the envelope material and drive the embedded, Class I protostar on its way to become a disk-only, Class II T Tauri star. The Haro 5a/6a system is a bipolar reflection nebula in Orion. The central high luminosity protostar, Haro 5a IRS, bears many similarities to FUors. Here we present ALMA observations of the 1.3 mm continuum and CO lines at 70 au resolution of Haro 5a IRS, which we analyze together with archival Hubble Space Telescope images. The high spatial resolution data reveal the kinematics of the circumstellar material in unprecedented detail, showing a complex combination of disk rotation, envelope infall, and a giant molecular outflow, further complicated by obscuring filaments in the area.

Mihkel Kama

Using accretion to probe inner disk gas-to-dust ratios, physics, and composition

Stars over 1.4 times more massive than the sun have radiative envelopes where mass is mixed slowly. This allows them to retain freshly accreted material on their surface, which offers us an unprecedented window into the detailed elemental composition of the gas and solid components of the inner disk. We analyse a sample of Herbig Ae/Be systems and determine the gas-to-dust ratio in each of their inner disks. We further constrain the fraction of sulfur retained in rocks, and investigate the behaviour of key elements such as carbon, oxygen, iron, and magnesium. Finally, we obtain some constraints on cavity and gap formation history in a few disks and highlight synergies with other observational studies of the inner regions.

Seongjoong Kim

The synthetic ALMA multiband analysis of the dust properties of the TW Hya protoplanetary disk

We performed the synthetic multiband analysis to find the best ALMA band set for constraining the dust properties of the TW Hya protoplanetary disk. We find two conditions for the good ALMA band sets providing narrow constraint ranges on dust properties; 1) Band 9 or 10 is included in the band set and 2) Enough frequency intervals between the bands. These are related with the conditions which give good constraints on dust properties; including both optically thick and thin bands in the band set, large ( ), and low dust temperature at high-frequency bands. To examine our synthetic analysis results, we apply the multiband analysis to ALMA archival data of the TW Hya disk at Band 4, 6, 7, and 9. Band [9,6,4] set provides the dust properties close to the model profile with narrow constraint ranges, while Band [7,6,4] set shows the deviations of dust properties from the model profile with too broad constraint range to specify the values. Based on these features, we conclude that the synthetic multiband analysis is well consistent with the results derived from real data.

Lucia Klarmann

Constraining the dust properties and shape of the inner rim with NIR interferometry

The dust in the inner region of PPDs is the base material for terrestrial planet formation. The arrival of PIONIER, GRAVITY and MATISSE allows spatially resolved high quality observations of this region. Interferometric observations are often interpreted using simplified components to describe the source emission. To find out how results derived in this way relate to the true structure and physics of this region, we created physical models including dust evaporation and formation and "observed" these models in the same way as observations are treated. The inner rim position can be very well constrained, even for only partially resolved objects, and the radial extend of the rim to within a factor of 2, but not better, for resolved objects. Comparing with the recent PIONIER survey of Lazareff17, we find that the rim position of most Herbig stars can be explained using olivine grains with an MRN like size distribution, but also with small olivine grains and the presence of forsterite or iron. For some objects, we can not re-create the amount of NIR flux from the rim, indicating that additional components like disk winds or MHD effects should be included in the modelling process.

Jacques Kluska

High angular resolution campaign reveals a specific evolutionary stage of a pre-transitional disk

HD179218 is a Herbig star surrounded by a pre-transitional disk. Its extremely large apparent size in the near-infrared makes it an outlier in the sample of Herbig stars observed by interferometry. We present the results of an observational campaign on this object, involving different high angular resolution techniques, such as polarimetric direct imaging (SPHERE/ZIMPOL), aperture masking (KECK/NIRC2) and long baseline interferometric instruments (VLTI/AMBER-MIDI-PIONIER and CHARA/CLASSIC-CLIMB), and different wavelengths, from visible to mid-infrared. Combining these observations led us to conclusions that could not be reached taking each of these observations alone. We constrained the radius of the disk rim in the mid-infrared to be $\sim$10au. The emission in the near-infrared is extending from the star up to the disk rim, having a high temperature ($\sim$1500K). We postulated that quantum heated particles can be responsible for such a high temperature that far from the star. This points toward a disk that is in a peculiar evolutionary state where the inner disk was accreted onto the star and the rest of the disk is being photo-evaporated by high energy photons from the star.

Jacques Kluska

A perturbed inner disk rim of the possibly protoplanetary circumbinary disk around a post-AGB binary

Several post-AGB binaries appear to be surrounded by disks of dust and gas. These disks are formed from the matter expelled from the evolved star at the end of the AGB phase that gravitationally interacted with the companion. The disks display a Keplerian rotation profile and share several common features with protoplanetary disks around young stars despite a different formation scenario. We will present the near-infrared interferometric imaging observations of the circumbinary disk around the post-AGB binary system IRAS08544-4431. A classical radiative transfer model of a protoplanetary disk in hydrostatic equilibrium is able to reproduce both the SED and the interferometric observations. As in protoplanetary disks, the inner disk rim seems to be ruled by dust sublimation physics. However, we find non-axisymmetric structures in the disk that likely originate from the disk/binary interactions. Studying these disks more deeply could reveal that they can be a promising place for second-generation planet formation.

Julia Kobus

Constraining the structure of the potential planet-forming region with MATISSE/VLTI and ALMA

We evaluate the potential of the combination of observations with MATISSE/VLTI and ALMA to constrain the radial profile, the flaring, and the scale height of the dust phase in the potential planet-forming region of circumstellar disks in nearby star-forming regions. This study is motivated by the fact that multi-wavelength long-baseline interferometric observations are a very promissing approach to study the initial conditions of planet formation as they trace different disk layers with spatial resolutions comparable to our own solar system. Our study is based on 3D radiative transfer simulations of wavelength-dependent visibilities one would obtain with MATISSE as well as ALMA maps. We find that with ALMA one can derive significant constraints on the disk surface density in the innermost disk region within reasonable integration times, whereas constraining the density structure with MATISSE alone is very challenging. However, the estimation of basic disk parameters can be considerably improved by combining the complementary MATISSE and ALMA observations. We also find that ALMA is sensitive to the amount of large dust grains settled to the disk midplane.

Agnes Kospal

Mass transport in the FUor-candidate system Haro 5a IRS in Orion

FU Orionis-type stars (FUors) are young stellar objects experiencing large optical outbursts due to highly enhanced accretion from the circumstellar disk onto the star. FUors are often surrounded by envelopes, which have a significant role in the outburst mechanism. Conversely, the subsequent eruptions gradually clear up the envelope material and drive the embedded, Class I protostar on its way to become a disk-only, Class II T Tauri star. The Haro 5a/6a system is a bipolar reflection nebula in Orion. The central high luminosity protostar, Haro 5a IRS, bears many similarities to FUors. Here we present ALMA observations of the 1.3 mm continuum and CO lines at 70 au resolution of Haro 5a IRS, which we analyze together with archival Hubble Space Telescope images. The high spatial resolution data reveal the kinematics of the circumstellar material in unprecedented detail, showing a complex combination of disk rotation, envelope infall, and a giant molecular outflow, further complicated by obscuring filaments in the area.

Anton Krieger

Characterization of young accreting planets

We identify observational quantities which allow us to constrain the prevalent physical conditions in the immediate environment of protoplanets during the final stage of their formation. For this purpose, we perform high-resolution 3D hydrodynamic simulations of protoplanetary disks (PPDs) using the TRAMP code (Klahr et al. 1999). The internal energy density of the disk is locally increased through accretion onto the planet, as well as the effects of compression and viscous heating. By post-processing the results using the Monte-Carlo radiative transfer code Mol3D (Ober et al. 2015), which takes into account both stellar irradiation as well as the additional energy density of the disk, we produce precise temperature and intensity maps. In a final step we apply the CASA simulator to obtain realistic high-angular resolution ALMA observations. This enables us to determine the observational accuracy needed to constrain selected properties of protoplanets and their environment. We will also evaluate the feasibility of observing PPDs and the process of accretion onto protoplanets using modern (e.g., ALMA, MATISSE, SPHERE) as well as future observatories/instruments (e.g., JWST, ELT).

Michael Küffmeier

Constraining the origin of misalignment between inner and outer disks

The increasing number of highly resolved protoplanetary disk observations reveals a tremendous diversity of star-disk systems. Despite the abundant variety, these observations allow us to identify recurrent patterns in the zoo of protoplanetary disks. Apart from the frequent occurrence of gap and ring structures in the disks, several observations (e.g. HD100453 or HD142527) show stars hosting a small inner and a larger outer disks whose rotational axes are misaligned with respect to each other. Different mechanisms have been suggested as the origin of misalignment, namely: 1) an inclined planet inside the disk, 2) a companion possibly exciting the outer disk and 3) late infall of molecular cloud material with different angular momentum onto the star-disk system. We particularly focus on modeling the influence of a companion on a star-disk system using the moving-mesh code AREPO. Furthermore, we constrain the role of infall by analyzing zoom-in simulations of young stars forming in the environment of Giant Molecular Clouds. Finally, we discuss whether the differences in disk orientation may lead to distinct orbital inclinations of inner and outer planets.

Philip Lucas

YSO Variability as seen with VVV and UKIDSS

The VISTA Variables in the Via Lactea Survey (VVV) provides a 5 year time series of 2 micron photometry for YSOs across a large part of the Galactic plane. This, along with the two-epochs of UKIDSS GPS data in the north, has provided the first large samples of highly variable YSOs (Delta K = 1 to 5 mag). The observed variability probes processes in the inner accretion disc that cause changes in accretion rate or variable extinction. Gravitational instabilities on larger scales may also be involved. We present new results, including a much enlarged sample of YSOs with Delta K above 3 mag. We also introduce the ongoing VVVX extension to VVV.

Carlo Felice Manara

Why do protoplanetary disks appear not massive enough to form the known exoplanet population?

When and how planets form in protoplanetary disks is still a topic of discussion. Exoplanet detection surveys and protoplanetary disk surveys are now providing results that allow us to have new insights. We collect the masses of confirmed exoplanets and compare their dependence with stellar mass with the same dependence for protoplanetary disk masses measured in ~1-3 Myr old star-forming regions. The latter are recalculated by us using the new estimates of their distances derived from Gaia DR2 parallaxes. We note that single and multiple exoplanetary systems form two different populations, probably pointing to a different formation mechanism for massive giant planets around very low mass stars. While expecting that the mass in exoplanetary systems is much lower than the measured disk masses, we instead find that exoplanetary systems masses are comparable or higher than the most massive disks. This same result is found also by converting the measured planet masses into heavy-element content (core masses for the giant planets and full masses for the super-Earth systems) and by comparing this value with the disk dust masses. Unless disk dust masses are heavily underestimated, this is a big conundrum. An extremely efficient recycling of dust particles in the disk cannot solve this conundrum. This implies that either the cores of planets have formed very rapidly ($<$0.1-1 Myr) and large amount of gas is expelled on the same timescales from the disk, or that disks are continuously replenished of fresh planet-forming material from the environment. These hypotheses can be tested by measuring disk masses in even younger targets and by better understanding if and how the disks are replenished by their surroundings.

Ezequiel Manzo Martínez

The evolution of the inner regions of protoplanetary disks: a statistical study

We perform a statistical study to test the evolution of the inner regions of protoplanetary disks. We compare synthetic SEDs with near and mid-IR photometric data obtained for disk-bearing stars in stellar clusters of different ages.We use a modified version of the D'Alessio models, which include a parametrized approach for the curvature of the inner wall. We define a disk color excess (DCE) from observed IR colors and use the models to reproduce observed distributions of these DCEs, in the IRAC and MIPS 24 bands. We find that the decrease in the DCEs with the age is related to the degree of dust settling in the disk as well as the height of the inner wall. Our study shows that disks settle in very short timescales and at 5 Myr most of the disks have settled. We also find that at 1-3Myr, most of the disks have wall heights of 3.8H. At 5-10 Myr the wall heights are of the order of 0.5 H. This suggests that 5 Myr is a crucial stage where the disks reach a very advanced evolutionary stage. This is the first statistical study looking for trends of evolution, using observational constrains that include several stellar clusters with near and mid-IR data , in an age interval from 1-10Myr.

Ignacio Mendigutía

Linking young stars, clouds, and galaxies through stellar accretion rates

The mass accretion rate and the circumstellar gas disk mass of young, Class II stars are linearly correlated. Similarly, the star formation rate linearly correlates with the dense gas mass involved in the formation of stars for distant galaxies and star-forming clouds in our Galaxy. We show that both relations could be unified. We find a statistically significant correlation between the rate of gas transformed into stars and the mass of gas directly involved on star formation, ranging 16 orders of magnitude and encompassing kpc-size galaxies, pc-size star forming clouds within our Galaxy, and young stars with au-size protoplanetary disks. We propose a bottom-up explanation, suggesting that a relation between the stellar mass accretion rate and the total circumstellar mass (disk+envelope in Class 0/I stars) drives the correlation in clouds (hosting stars) and galaxies (hosting clouds). If confirmed, theories aiming to explain the correlations for stars, clouds, and galaxies should not remain isolated from each other. Instead, all scales and physical systems involved in one single, global correlation must be considered.

Farzana Meru

Is the ring inside or outside the planet?: The effect of planet migration on dust rings

Not available

Dominique Meyer

MHD protostar-disc interaction.

Magnetospheric accretion of circumstellar disc material is a mechanism that affects a variety of astrophysical objects, from young low-mass stellar objects to compact objects, such as white dwarves and neutron stars. Within this picture, the accretion flow in their inner circumstellar disc is channeled along the stellar magnetic field lines and ultimately shocks the stellar surface, inducing an exchange of mass, angular momentum and energy that can spin up/down the star itself and modify its intrinsic evolution. We will look at preliminary results of non-ideal 2.5-dimensional simulations of the surroundings of magnetised rotating young stars and explore how different parameters of the problem can affect the accretion dynamics and change their spin evolution and emission properties.

Tomohiro Mori

Time- and spatially resolved observations for pre-transitional disk of GM Aur.

Various observations have revealed that many transitional disks have non-uniform spatial structures possibly generated by disk-planet interactions. To investigate the presence of those non-uniform structures at very close to the star, we performed monitoring observations for young stellar objects (YSOs) hosting transitional disks from 2012 to 2015. We present light curve of one object GM Aur, which has been known to have cavity structure extending $\sim$20 au in radius. We detect significant variability in I-(0.8 microns), R-(0.69 microns) and V- (0.55 microns). The reddening is consistent with dust extinction with Rv=5.5. A 5.98-days periodicity is also significantly found with a periodogram analysis. These results indicate that the observed variability can be mainly attributed to dusty clump orbiting at near the co-rotation radius (0.08 au) of the object. To investigate this object further, we performed VLTI/AMBER data reduction. An extended structure with radius of $>$ 0.5 au is spatially resolved. Radiative transfer modeling with RADMC-3D indicates the presence of ring component with temperature of 800 K in the inner disk at 0.5 au.

Brunella Nisini

GIARPS High-resolution observations of T Tauri stars (GHOST): first results on jet emission

We present the first results of an optical/infrared spectroscopic survey conducted with the GIARPS (GIANO-B+HARPS-N) facility at the Telescopio Nazionale Galileo (TNG) on a sample of T Tauri stars of the Taurus/Auriga cloud. The combined GIARPS wide spectral coverage (0.4-0.7 and 1-2.4 micron) and very high spectral resolution (R= 50,000 in the IR and 100,0000 in the optical) are ideal to simultaneously derive stellar and accretion parameters, constrain the properties of the inner disk and the associated winds and jets. In this poster we will in particular present the results of the analysis of the forbidden lines observed in a sub-sample of objects. From different line ratios we have derived the physical parameters (temperature, density, ionization fraction and metallicity) of the gas as a function of velocity, providing important benchmarks for jet and winds formation models.

Åke Nordlund

Thermal Processing and Fractionation in Stellar Outflows: Evidence from Abundance Correlations

Stellar outflows, emanating from the innermost regions of protoplanetary accretion disks, and the associated high temperatures, can explain systematic chemical abundance differences between CI-chondrites, the Sun and stars very similar to the Sun (solar twins). Correlations with condensation temperatures of observed abundance differences are a natural consequence of thermal processing of pristine dust into on the one hand gas that escapes the system, and on the other hand solids depleted in volatiles that remain in the system. Chondrules have volatile depletion patterns that match and probably reflect this process, showing that these approximately mm-size particles must have formed under high vapor pressure conditions, resulting either from extremely enhance dust to gas ratios, or (more likely) from levels of gas pressure that only occur in the very innermost regions of disks. Formation under such conditions is also compatible with their cooling times of order days, arising from near adiabatic expansion and reflecting typical dynamical times at the base of outflows. Corroboration cosmochemical evidence also bear evidence of an intense, early chondrules formation epoch.

Monika Petr-Gotzens

Tracing the inner circumstellar disk via photometric variability studies

Stellar accretion during the pre-main sequence phase is known to occur in non-periodic, often intense, bursts. These accretion bursts are accompanied by strong photometric brightness variations of the star, typically on time-scales of months or longer. At the same time smaller amplitude changes in the pre-main sequence star's light curve, on time scales of weeks and days, are expected due to inner disk warps and accretion columns that move into the line of sight as the star-disk system rotates. In this contribution we present our observational programme to study the variability of several hundreds of PMS stars in the low metallicity environment of the Magellanic Clouds. The signatures of the photometric variability shall allow us to obtain evidence for the accretion phenomena (bursts or steady accretion) and inner disk morphologies present for PMS stars in the Magellanic Clouds. Comparisons with Galactic samples will show if/how metallicity plays a role for the physics of accretion from the inner circumstellar disk and its evolution.

Jaime Pineda

High-resolution image of HD 100546: asymmetric ring and upper limits to circumplanetary disk

We present long baseline ALMA observations of the 870um dust continuum adn CO (3–2) emission from the protoplanetary disk around the Herbig Ae/Be star HD 100546, which is one of the few systems claimed to have two young embedded planets. We resolve the disk emission into an asymmetric ring between 20-40 au, but there is no detection of the circumplanetary disk (CPD) at the position of the claimed protoplanets. We compare the CO morphology and kinematics to the continuum emission, and present evidence for a spiral feature. We present upper-limits to the planetary mass and the CPD, and compare to results from previous numerical simulations to rule-out some models.

Christophe Pinte

Radiation-hydrodynamics modelling of the inner disc

We present a new versatile modelling tool, combining the Smooth Particle MHD code PHANTOM with the radiative transfer code MCFOST. We have developed a new framework based on a Voronoi mesh to perform live coupling of the two codes, allowing us to include accurate 3D, wavelength dependent and, anisotropic continuum and line transport of radiation in a MHD code. We illustrate how this method is particularly suited to study the inner disc, and focus on the interaction of a planet with the disc close to its inner edge.

Kim Pouilly

Spectroscopic and photometric variability of a CTTS: HQ Tau

We studied the spectroscopic and photometric variation of the Classical T Tauri Star (CTTS) HQ Tau. We used the spectroscopic data from ESPaDOnS, the echelle spectrometer mounted at the Canada-France-Hawa Telescope (CFHT), and the photometric data from the Kepler K2 mission. We first determined HQ Taus stellar parameters, using ZEEMAN code and CESTAM models. We then looked for a periodic variability in the HQ Taus lightcurve and spectrum through periodogram analysis, radial velocity, veiling, and emission line study. Finally we interpret the results obtained and try to connect spectroscopic and photometric variability within the framework of magnetospheric accretion.

Tae-Soo Pyo

Extended He I Emission from DG Tau

We present spatially resolved 1.06-2.08 um IFU spectra towaard DG Tau obtained by AO assisted NIFS/GEMINI. We found that the He I 1.083 um emission is extended along the [Fe II] jet direction both blueshifted and redshifted side. The peak velocity is increasing from 0 to the [Fe II] jet velocity ($\sim$ 100 km/s) with the distance. The velocity width of He I emission is 2.35 times wider than that of [Fe II] 1.257 um. He I shows P-Cygni profile with blueshifted absorption and broad emission around the rest velocity. The spatial extension and broad velocity width are represented that the He I emission has dual origins both shock in collimated jet and stellar wind close to star.

Enrique Sanchis Melchor

Forecasting Detectability of Protoplanets embedded in Disks using hydrodynamic simulations

We present an observability model that can be used to predict expected magnitudes for young planets embedded in transition disks, still affected by extinction due to material in the disk. We focus on Jupiter-size planets at a late stage of their formation when the planet has carved a deep gap in the gas and dust distribution and the disk could be transparent to the planet flux at certain wavelengths. The expected magnitude at typically observed bands in the IR is estimated by means of three-dimensional hydrodynamical models, performed for several planet masses. Observed fluxes are obtained by combining these models to giant planet evolutionary models for typical extinction properties of the material. We find the detectability of the embedded planets with masses approximately 1-2Mjup to be strongly dependent on the assumed disc masses and on the wavelength considered. For most cases these planets would be hard to observe at the J-, H- and K-bands. On the other hand planets of masses approaching 5Mjup are always detectable. We derive observability curves that we then apply to the transition disks around CQ Tau and TW Hya

P. Christian Schneider

The Vertical Structure of Inner Disks - Gray, Red, and Gas extinction

The periodic occulations of the central star in AA Tau-like objects provides an excellent opportunity to study the vertical structure of the inner disk. We present a series of flux-calibrated Xshooter spectra covering the full variability range from the brightest to the dim state. The flux evolution requires two components, red and gray absorption with variable contributions. Combined with the rotation period, this gives the vertical heights of the two extinction components. We also measure the an increase in gas absorption lines during dimmer phases. However, the increase in gas column density falls short of expectations based on ISM ratios, which points to an absorber with a low gas content.

Benjamin Setterholm

A Closer Look at the Inner Disks of Herbig Ae Stars HD 163296 and HD 190073

We combine multi-epoch, H- and K-band observations from the VLTI and the CHARA interferometers to present the most complete published sample of high angular resolution measurements of the Herbig Ae Stars HD 163296 and HD 190073. We confirm previous results suggesting that significant near-infrared emission originates from within the supposed dust destruction radius of this class of object, and further characterize the emission profile. In particular, we find that the inner-disk brightness profile for both objects is remarkably Gaussian-like, with little to no sign of a sharp edge expected from a sublimation front. Moreover, the observed H- and K-band sizes of these disks are the same within $(3 \pm 3)\%$ for HD 163296 and $(6 \pm 10)\%$ for HD 190073. We use these results to explore potential mechanisms for the observed inner emission and find evidence that the observed spectral types of these heavy accretors are biased towards higher temperatures due to emission from the accretion shock/boundary layer.

Anibal Estuardo Sierra Morales

Dust concentration and emission in protoplanetary disks vortices

We study the dust concentration and emission in protoplanetary disks vortices. We extend the Lyra-Lin solution for the dust concentration of a single grain size to a power-law distribution of grain sizes. Assuming dust conservation in the disk, we find an analytic dust surface density as a function of the grain radius. We calculate the increase of the dust-to-gas mass ratio and the slope of the dust size distribution due to grain segregation within the vortex. We apply this model to a numerical simulation of a disk containing a persistent vortex and we find the disk emission at millimeter wavelengths corresponding to synthetic observations with ALMA and VLA. The simulated maps at 7mm and 1cm show a strong azimuthal asymmetry due to the disks becomes optically thin while the vortex remains optically thick. The large vortex opacity is mainly due to an increase in the dust-to-gas mass ratio, however, the change in the slope of the dust size distribution also increases the opacity by a factor of two.

Michal Siwak

Space and ground-based study of star-disc interaction processes in classical T Tauri-type stars

Over the last decade, the MOST satellite provided a handful of high-precision light curves of pre-main sequence stars. TW Hya - the closest CTTS to us and accreting disc plasma with a moderate rate of 1e-9 solar mass per year - was observed seven times. It always showed slightly different light variations, either more or less irregular, what may be interpreted that accretion can switch between an unstable and a moderately stable regime. Interestingly, RU Lup having one of the highest known accretion rates (1e-8) always showed irregular behavior typical for unstable accretion, while slowly accreting (1e-11) IM Lup showed regular light variations both in space-based and in long-term ASAS data, what is typical for stable accretion regime. All the above appears to be in agreement with the numerical picture successively developed by Dr. M. Romanova group. Their models predict also waves induced in the disc plasma structure due to interactions with a rotating tilted magnetosphere of a star. In particular, the solution for CTTS with enhanced accretion is one of several possibilities that can be used for interpretation of quasi-periodic light variations arising in the inner disc of FU Ori.

Alana Sousa

A study of transition disk properties belonging to the cluster NGC 2264

Disk holes are inferred from infrared observations of T Tauri stars, indicating the existence of a transitional phase between thick disks and debris disks. We searched for transition disk belonging to the young (∼3Myr) cluster NGC 2264. Using parameters obtained in the observational multiwavelength campaign CSI2264 we characterized the accretion, disk and stellar parameters of transition disk candidates and compared them with systems with a full disk and diskless systems. We have modeled 409 T Tauri stars with the Hyperion SED code that allowed us to classify the systems as full disk (52%), diskless (41%) and transition disk candidate (7%). The presence of a hole in the inner disk does not stop the accretion process, since 82% of transition disk stars are accreting and show Halpha, UV excess and mass accretion rates at the same level as full disk systems. With the output parameters of the SED model we estimated the inner hole size and found sizes from 0.1 to 78AU for the transition disks. 34% of transition disks present hole sizes that can be explained by photoevaporation from stellar radiation. The other accreting transition disks can be good candidates to have inner planets.

Sebastian Stammler

A Closer Look on Dust Growth: The Spectral Index

Dust particles grow in protoplanetary disks by collisional agglomeration from sub-micrometer sizes up to pebbles where further growth is hindered by processes like bouncing/fragmentation or radial drift. In addition to the particle size, dust evolution also changes other properties, such as the porosity due to fractal growth and collisional compactification or the chemical composition if particles cross ice lines. These properties influence the dust opacities and therefore the optical depth in the continuum emission. Since the spectral index in the long-wavelength limit is sensitive to the optical depth and the dust opacities, it can be used to investigate particle growth. In this talk I will present simulations of dust evolution in protoplanetary disks and show how particle growth changes the spectral index within the disk over time. Since the growth time scale is shortest in the inner disk, dust evolution happens from the inside to the outside. This induces a wave-like pattern in the spectral index that propagates outwards in the disk. Observing this feature might shed light on how far dust growth already proceeded in protoplanetary disks.

Camille Stock

Observing variability in young stellar objects in the infrared

Young stellar objects (YSOs) are characterised by accretion of matter through disks and ejection through jets. Both mechanisms are closely associated, however, their link is still not completely understood. In the past, these processes have been considered steady. Most recent observations, supported by theoretical models, indicate, however, that they are mostly episodic for a large range of stellar masses and ages and play a fundamental role in protostellar evolution. We have been using spectroscopic and imaging data from VLTI/ISAAC and SINFONI from different epochs (2005 and 2013) in the NIR to probe the kinematic and dynamic properties of IRS54, a very low-mass YSO, (0.2 Msun, Lbol ~0.78Lsun, Class I YSO) in the J, H, and K bands. To investigate the variability, we used the line emission of [FeII] (at 1.257, 1.644 microns) and BrG (2.166 microns). Correcting for visual extinction (~16mag in 2005 and ~29mag in 2013), we calculated the mass accretion rate to be $\sim 5 \times 10^{-9}$ Msun yr^{-1} in 2005 and $\sim 1 \times 10^{-7}$ Msun yr^{-1} in 2013. We found that its large variability is due to episodic accretion, making IRS54 the lowest mass outbursting YSO ever detected.

Larisa Tambovtseva

Revealing the circumstellar environment of the Herbig Be star VV Ser by emission line modelling

Great progress in understanding the principal physical mechanisms acting in emitting regions and regulating accretion and outflow processes were achieved by non-LTE modelling of the emission spectra of Herbig AeBe stars. Nevertheless, modelling of individual stars opens new problems in the interpretation of these mechanisms. We present results of non-LTE modelling of the H-alpha and Br-gamma lines in the spectrum of the Herbig Be star VV Ser, as well as the comparison of the spatial extension of the line and continuum emitting regions obtained by infrared interferometric observations. VV Ser belongs to a subclass of the UX Ori type stars (UXORs) with large extinction and that are observed nearly edge-on through its dusty protoplanetary disk. We give possible different explanations of a mutual presence of the narrow single-peaked Br-gamma and wide double-peaked H-alpha line profiles of this star. The influence of the accreting matter, outflows in the form of a disk or polar wind, and dust scattering on the line profiles is shown. The results of modelling can be applied to young stars with large circumstellar extinction and to UXORs during their phase of its brightness minima.

Tomáš Tax

Asymmetric CQ-Tau transition disk at high angular resolution

CQ-Tau is a typical transition disk, presenting large asymmetries in the continuum emission, as well as in the gas line emission. Due to all these features and especially their large inner cavities, transition disks are one of the best planet candidate targets, according to many theoretical studies. In this poster, I present high angular resolution data from ALMA band 6 with detailed analysis and measurements of the CQ-Tau transition disk.

Benjamin Tessore

Non-LTE atomic line formation in accretion disk around young stars

The planets forming in the accretion disk of young stars are yet unseen by the new generation of instruments whereas their study is crucial for understanding the evolution of inner planetary systems. Analysis of stellar spectra provides good proxies for studying and detecting such planetary systems. However, disentangling the signal due to the planets and to the star in stellar spectra could be cumbersome. Therefore, detailed spectral synthesis in realistic simulations of star-planets-disk system are crucial for detecting planets and studying their evolution within the accretion region. This spectral synthesis requires the solution of a set of statistical equilibrium equations for the atomic species of interest. The cornerstone of non equilibrium lines formation is obtaining the levels populations pertaining to the atom for which the lines belong to. In this poster, I present how the non-LTE problem for multi-level atomic systems is implemented and solved in the Monte-Carlo code MCFOST.

Thanawuth Thanathibodee

A Multiwavelength Glimpse of the End of Accretion in T Tauri Stars

It is accepted that accretion of T Tauri Stars follows the magnetospheric accretion paradigm. Under this framework, the inner gas disk is truncated at a few stellar radii; material from the disk flows along the stellar magnetic field lines onto the star, producing accretion shocks near the stellar surface. However, it is still unclear how the accretion proceeds at very low accretion rates, or how accretion stops. Here we present observations and modeling of a number of low accretors covering a large parameter space, in a search for a possible connection between the properties of the inner gas disk and accretion onto the star. We apply magnetospheric accretion and accretion shock models to optical and near-infrared observations of accretion signatures to calculate mass accretion rates onto the star and estimate the geometry of the magnetosphere. The inner gas disk is probed by HST FUV spectroscopic observations of H2 lines. Our results give insights into the star-disk interface near the final stages of accretion.

Maria Giulia Ubeira Gabellini

An unbiased SPHERE-IFS Survey of Nearby Herbig Ae/Be Stars: Are All Group I Disks Transitional?

Maaskant et al. (2013) have proposed a model in which the Herbig Ae/Be stars with the strongest far-infrared excesses (the Meeus et al. Group I sources) have large disk gaps (possibly opened by newly formed planets) and may thus be considered transitional. One strong prediction from this model is that the Group I sources should have a larger spatial extent (as seen in scattered light) than the Group II Herbig stars. Giving constraints on the existence of gaps is important also for the evolution of the inner disk, particularly concerning the study of the disk accretion. We have developed a novel algorithm (SADI) for the removal of speckles from near-infrared VLT/SPHERE Integral Field Spectrograph (IFS) data, based on the wavelength-dependent position of speckles and the independence from it of real features (disks asymmetries and companions). This algorithm allowed us to detect so far four new companion candidates and six disk structures in a sample of 23 nearby Herbig stars. The ratio between the number of disk detections over the total number of Group I and Group II targets are found to be significantly different, in agreement with the expectations from the Maaskant et al. model.

Takahiro Ueda

Dust-pileup at the dead-zone inner edge and implications for the disk shadow

The dead-zone inner edge is a preferential site of rocky planetesimal formation via the dust-pileup followed by the streaming instability. We performed simulations of one-dimensional dust and gas disk evolution to investigate the properties of a dust-pileup at the dead-zone inner edge. We show that a strong dust-pileup at the dead-zone inner edge occurs only for conditions where the dimensionless stopping time of dust is much larger than the turbulence parameter alpha in the dead-zone. We found that if the critical fragmentation velocity of silicate dust is 1 m/s, alpha value in the dead-zone should be lower than 0.0003 to operate the dust-pileup. Using the dust distribution obtained above, we performed the radiative transfer simulations with RADMC-3D to construct models of the inner region of disks including the effect of the dust-pileup. We found that if dust concentrates on the dead-zone inner edge, the dust-pileup casts a shadow behind it, which could be extended to $\sim$10 au. The shadow would be a useful tracer of the dust-pileup and we can constrain the turbulence strength through it. In this poster, I would like to discuss the observability of the shadow based on our results.

Benedetta Veronesi

Coupled or not coupled, that is the question. An hint on the disc mass

Recent high resolution and high sensitivity observations of protoplanetary discs are showing us peculiar substructures, such as spirals, gaps and horseshoes. Disc instabilities and planets have been proposed to be responsible for their formation. However, their origin is still very debated, in particular it is not clear how their shape depends on the disc mass and on the coupling between the gas and the dust component of the disc. I will present the results of our hydrodynamical modeling of the protoplanetary disc HD135344B (Garufi et al. 2013, van der Marel et al. 2016), that shows a distinctive spiral structure in scattered light and an asymmetric horseshoe in the dust continuum. We performed hydrodynamical and Monte Carlo Radiative Transfer simulations of a protoplanetary disc with two embedded planets, varying the total gas mass of the disc. Furthermore, I will present preliminary results in order to find if it is possible to estimate the total disc mass in protoplanetary discs by the combined hydrodynamical modeling of planet-induced disc substructures observed in scattered light (micron-sized grains) and in the dust continuum (mm-sized grains).

Paul Woods

Nature Astronomy: a journal for the community

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Claudio Zanni

Understanding the spin evolution of classical TTauri stars

The spin evolution of classical TTauri stars (CTTS) represents a puzzling problem. Since they are still contracting and accreting, these protostars would be expected to spin-up at breakup speed in a few million years. On the other hand, as soon as they emerge from the Class 0-I embedded phases, they are observed to rotate with periods between 1-10 days, well below their breakup limit. In addition, the evolution of the rotational distribution in open clusters of different ages suggests that TTauri stars do not dramatically spin up as long as they are surrounded by their accretion disks. An efficient spin-down mechanism is required to explain the spin evolution of CTTS. This poster presents a brief review of different mechanisms associated with the magnetic star-disk interaction that could determine the spin evolution of accreting pre-main-sequence stars. A suitable torque parametrization derived from numerical models can be used to compute the long-term evolution of stellar rotation. These results can provide different constraints to the models and shed light on our current understanding of the star-disk interaction process.

Apostolos Zormpas

Planet formation hotspots in Transition Disks

We study the growth and the dynamics of dust and planetesimals in pressure bumps. Performing 1-D simulations and adding an axisymmetric stationary pressure bump, we find the accretion rate of dust particles into the pressure bump and the size distribution of the particles entering it. Using parameterized models of planetesimal formation (Drazkowska & Dullemond 2014), we calculate how much dust is transformed into planetesimals, to study the effectiveness of planetesimal formation and the evolution of the dust-to-gas ratio in pressure bumps. Moreover, we expect to use pressure bumps with finite life time and improve upon previous works (e.g. Pinilla et al. 2012a). With this, we plan to constrain bump amplitudes, bump sizes and life times, consistent with recent surveys of protoplanetary disks in dust continuum and with observed dust disk life times. This will allow us to investigate the efficiency of particle trapping in time-dependent pressure maxima and their possible relation to type-1 transition disks. This way, we plan to evaluate which mechanisms could be at play in forming and shaping dust traps based on their life times or amplitudes.