Protoplanetary disks

Monday, 25 June 2018 - Thursday, 28 June 2018

Osservatorio Astronomico di Roma, Monte Porzio Catone (RM), Italy

Programme

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Monday 25 June 2018

Registration (14:00-14:30)

Welcome and intro (14:30-15:00)

time	title
14:30	Welcome by the OAR Director Lucio A. Antonelli
14:35	The JEDI collaboration *Presenter: NISINI, Brunella*
14:45	INAF perspective on optical/IR instrumentation *Presenter: FONTANA, Adriano*

Formation of protostellar disks and jets (chair S. Antoniucci) (15:00-19:00)

time	title
15:00	Protostellar jets: the revolution with ALMA and NOEMA (I) *Presenter: PODIO, Linda* Fast and collimated molecular jets as well as slower wide-angle outflows are observed since the earliest stages of the formation of a new star, when the protostellar embryo accretes most of its final mass from the dense parental envelope. Early theoretical studies suggested that jets have a key role in this process as they can transport away angular momentum thus allowing the star to form without reaching its break-up speed. However, an observational validation of these theories is still challenging as it requires to investigate the interface between jets and disks on scales of fractions to tens of AUs. For this reason, many questions about the origin and feedback of protostellar jets remain unanswered, e.g. are jets ubiquitous at the earliest stages of star formation? Are they launched by a magneto-centrifugal mechanism as suggested by theoretical models? Are they able to remove (enough) angular momentum? What is the jet/outflow feedback on the forming star-disk system in terms of transported mass/momentum and shock-induced chemical alterations? The advent of millimetre interferometers such as NOEMA and ALMA with their unprecedented combination of angular resolution and sensitivity are now unraveling the core of pristine jet-disk systems. While NOEMA allows to obtain the first statistically relevant surveys of protostellar jet properties and ubiquity, recent ALMA observations provide the first solid signatures of jet rotation and new insight on the chemistry of the protostellar region. I will review the most recent and exciting results obtained in the field and show how millimetre interferometry is revolutionising our comprehension of protostellar jets.
15:30	Jets, winds and accretion shocks around the protostellar system HH212 (I) *Presenter: BIANCHI, Eleonora* Thanks to the unmatched combination of high-sensitivity and high-angular resolution provided by the new generation facilities such as ALMA and NOEMA, it is now possible to investigate in details the earliest stages of the Sun-like star formation. More specifically, the inner protostellar jet can be now imaged at spatial scales lower than 50 AU from the driving protostar, where the effects connected with the accreting disk play an important role. In other words, it is time to reconsider the protostellar jet-disk system as a whole. One of the still unaswered questions is the origin of the chemically enriched gas around Sun-like protostars: are they jet-driven shocked regions? Certainly shocks enrich the gas-phase with the molecular species deposited onto the dust grain mantles and/or locked in the refractory dust cores. In these processes are involved not only the high-velocity shocks produced by protostellar jets, but also the slow accretion shocks located close to the so-called centrifugal barrier, i.e. the interface between the infalling envelope and the self-gravitating rotating disk. Both these kind of shocks are factories of interstellar complex organic molecules (iCOMs), which can be used to probe both the kinematics and the chemistry of the inner protostellar jet/disk system. With this in mind, we will discuss recent results obtained with ALMA-Band 7 Cycle 4 observations towards the HH212-mm protostellar system. We successfully imaged water and (deuterated) iCOMs molecular lines on Solar System spatial scales, finding for the first time signatures of a chemically enriched disk wind.
16:00	SKA (I) *Presenter: UMANA, Grazia*
16:30	Tea break

17:00	Protostars: Forges of cosmic rays? (I) *Presenter: PADOVANI, Marco* It is largely accepted that Galactic cosmic rays, which pervade the interstellar medium, originate by means of shock waves in supernova remnants. Cosmic rays activate the rich chemistry that is observed in a molecular cloud and they also regulate its collapse timescale, determining the efficiency of star and planet formation, but they cannot penetrate up to the densest part of a molecular cloud, where the formation of stars is expected, because of energy loss processes and magnetic field deflections. Recently, observations towards young protostellar systems showed a surprisingly high value of the ionisation rate, the main indicator of the presence of cosmic rays in molecular cloud. Synchrotron emission, the typical feature of relativistic electrons, has been also detected towards the bow shock of a T Tauri star. Nevertheless, the origin of these signatures peculiar to accelerated particles is still puzzling. Here we show that particle acceleration can be driven by shock waves occurring in protostars through the diffusive shock acceleration mechanism. We find that shocks in protostellar jets and on the protostellar surface can be strong accelerators of thermal particles, which can be easily boosted up to relativistic energies. Our results demonstrate the possibility of accelerating particles during the early phase of a proto-Solar-like system and can be used as the argument to support available observations. The existence of an internal source of energetic particles can have a strong and unforeseen impact over the stellar and planet formation process as well as on the formation of pre-biotic molecules. Finally, I will discuss the challenges for current and future telescopes such as ALMA, SKA, and CTA.
17:30	First disk-mediated accretion burst from a massive proto(star): how accretion turns into ejection *Presenter: CARATTI O GARATTI, Alessio* How massive stars form and evolve in their early phase is still debated. Here, we report on the discovery and follow-up of the first disk-mediated accretion burst from a 20 solar mass protostar, S255IR NIRS3. Our results strengthen the idea that massive stars form through disks via episodic accretion, pointing to a common formation mechanism across the entire stellar mass spectrum. Moreover, our data reveal a tight correlation between the burst, the onset of a methanol maser flare and boosting of pre-existent radio jet emission.
17:50	A far-infrared catalogue of dense cores and protostars in the Lupus complex *Presenter: BENEDETTINI, Milena* I will present the catalogues of the dense cores and YSOs/protostars of the Lupus I, III, and IV molecular clouds, compiled with compact sources extracted from the five Herschel photometric maps between 70 and 500 micron. The physical properties of the detected objects were derived by fitting their spectral energy distributions. For YSOs/protostars a wide SED was built by complementing the Herschel data with mid- and near-infrared fluxes. A total of 532 dense cores, out of which 103 are presumably prestellar in nature, and 38 YSOs/protostars have been detected in the three clouds. Almost all the prestellar cores are associated to filaments but only about one third of the starless cores and protostars. Prestellar core candidates are found even in filaments that are on average thermally subcritical and over a background column density lower than that measured in other regions so far. The evolutionary status of the YSOs and protostars were estimated using two indicators: the spectral index between 2.2 and 24 micron and the fitting of the spectral energy distribution from near- to far-infrared wavelengths. For most of the objects, the evolutionary stage derived with the two methods are in agreement.
18:10	HD142527: A crime scene investigation *Presenter: PRICE, Daniel* What is the origin of the large horseshoe, cavity, spiral arms. fast radial flows, warps and shadows in HD142527? I will present results of our recent attempts to model this mysterious disc, formerly regarded as a transitional disc. I will show that the interaction with the observed highly eccentric and inclined binary companion can explain most of the `weird' phenomena in this disc, suggesting it should be firmly reclassified as circumbinary. How such inclined and eccentric companions arise in nature opens many questions.
18:30	Discussion on early evolution (Claudio Codella moderator)

Tuesday 26 June 2018

Disk accretion and star-disk interaction (chair B. Stelzer) (09:00-13:00)

time	title
09:00	The TNG and its instruments after 20 years of operations (I) *Presenter: PORETTI, Ennio* TNG is operative since 20 years. We will briefly review the changes occurred in these 20 years and how the current focal plane instrumentation has been updated to face the open problems of modern astrophysics. A look to the near future is also indispensable: inputs from the community are welcome.
09:30	Understanding the evolution of mass accretion to explain the evolution of disks (I) *Presenter: MANARA, Carlo Felice* Low-mass pre-main-sequence stars interact with their surrounding protoplanetary disks through accretion of material onto the star and emission of material through winds. These processes regulate the evolution of protoplanetary disks and thus their ability to form planets. Star-disk interaction processes are best studied spectroscopically. Instruments like the VLT/X-Shooter spectrograph allow us to observe simultaneously the signatures of the accretion process, such as the UV-excess and the emission lines, together with lines tracing winds and outflows, such as helium lines and forbidden lines. At the same time, such spectra allow us to robustly derive the physical parameters of the central objects, such as their temperature and their mass. When this information is combined with observations of disks at sub-mm wavelengths with ALMA it is then possible to quantitatively constrain disk evolution mechanisms, and thus to define the physical conditions in which planets form. I will report on the dependence of the mass accretion rate with stellar mass and disk mass for the complete samples of low-mass objects in the Lupus and Chamaeleon star-forming regions. I will show how the mass accretion rate scales with a steeper slope with the stellar mass for very low-mass stars with respect to solar mass stars, and how the mass accretion rate scales almost linearly with the disk mass in these young regions. I will report on the first results on these relations in the older Upper Scorpius region, and I will then discuss the theoretical framework we are working on to explain these observations.
10:00	The inner astronomical units of protoplanetary disks: and interferometric view *Presenter: GARCIA LOPEZ, Rebeca* The physical structure and processes in the inner regions of protoplanetary disks within 5 au from the source are still poorly constrained, yet they are key for understanding planet formation. Only recently, IR interferometers have been able to perform the first statistical study of the dust in the inner disk, but a similar study on the gas is still lacking. In this talk, I will present the first results of GRAVITY/VLTI GTO program on YSOs. Through this ambitious project we aim at spatially resolving the hot (Brγ) and warm (CO) gas in disks, as well as the dust emission on a large sample of young objects ($\sim$100) spanning a wide range of masses, ages and disk properties. This will allow us to investigate for the first time the structure, evolution and dynamics of disks at sub-au scales by probing the gas and dust content simultaneously in a systematic and homogeneous way.
10:20	Modeling the spin evolution of classical TTauri stars *Presenter: ZANNI, Claudio* 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 displayed by open clusters of different ages suggests that the rotation of TTauri stars still surrounded by their accretion disks could stay approximately constant for a few million years. Clearly, an efficient spin-down mechanism is required to explain the spin evolution of CTTS. I will briefly review different models of the magnetic interaction of a slowly rotating protostar with a surrounding accretion disk that have been proposed in the literature to explain the angular momentum evolution of accreting pre-main-sequence stars. I will then use a suitable torque parametrization derived from numerical models of stellar winds and magnetic star-disk interaction to compute the long-term evolution of the stellar angular momentum. These results can be directly compared to the observed evolution of the stellar rotational distribution, providing different constraints to the models and shedding light on our current understanding of the star-disk interaction process.
10:40	Coffee break

11:10	Accretion variability in young, low mass stars (I) *Presenter: VENUTI, Laura* We present and discuss the manifold photometric behaviors of young, low-mass stars with active accretion disks. This review is based on results from recent space-borne missions, most notably CoRoT and Kepler/K2. Thanks to their sub-1% photometric precision, sub-hour time sampling, and continuous time coverage for spans of weeks to months, these campaigns have provided first detailed atlases of the short- to mid-term variability of young, disk-bearing stars. Distinct variability types identified include the bursters (with stochastic, short-lived brightening events), the dippers (with recurring or aperiodic fading events), and the quasi-periodic variables. The first class likely reflects unstable disk accretion, with strong mass accretion rates (M_acc), as suggested by complementary UV observations. The other two photometric classes may instead be related to a stable, funnel-flow accretion regime, with more moderate M_acc. While the strength of M_acc variability can vary broadly from object to object, typical M_acc variations amount to <0.1 dex on timescales of hours, and to ~0.5 dex on timescales of days to weeks; the latter persist on timescales of up to several years. Geometric effects linked to rotational modulation can statistically explain a significant fraction (up to 75%) of the observed M_acc variability. This suggests that the global accretion geometry in young stars typically persists over many rotational cycles, although single accretion events may exhibit more erratic behavior on the shorter term.
11:40	Mass accretion rates from HST data: the case of LH95 in the Large Magellanic Cloud *Presenter: BIAZZO, Katia* 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 optical and Halpha photometry obtained with the Hubble Space Telescope, we identify, within the initial catalogue of about 25000 sources, 245 bona fide pre-main sequence (PMS) stars with Halpha excess emission, for which we measure 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 facilities, like the James Webb Space Telescope.
12:00	Multi-wavelength and multi-disciplinary approach to the study of the emission from accretion/ejection processes in young stars with disks: combining observations, numerical models, and laboratory experiments *Presenter: BONITO, Rosaria* A multi-band investigation of the emission from young stars with disks allows us to obtain a complete characterization of these complex systems, accounting for their accretion and outflow activity. All the components contributing to the emission can strongly influence also the evolution of their disks and possibly the formation of exo-planetary systems. Combining multi-wavelength observations, magnetohydrodynamical models, and laboratory experiments following a multi-disciplinary approach, we aim at a more complete characterization of young stars with accretion/ejection processes at work. We present X-ray and optical analysis of line profiles and Doppler shift for specific objects (e.g. TW Hya) as well as in statistical samples (NGC 2264) and discuss future perspectives with next generation instruments: Athena and LSST. In particular, LSST main characteristics will be presented in the context of the investigation of young stars as this survey will allow us to increase the number of young stars whose accretion/outflow activities can be fully characterized exploiting also the variability of these processes. A science case for the Mini Survey and Deep Drilling Field proposals in LSST in the context of young stars will be discussed.
12:20	Discussion on accretion (Juan Alcala' moderator)

Lunch (13:00-14:30)

Protoplanetary disks (chair A. Frasca) (14:30-18:30)

time	title
14:30	Pushing Adaptive Optics to the extreme: better, bluer and wider (I) *Presenter: RAGAZZONI, Roberto*

15:00	SHARK-VIS: the High Resolution Visible Imager of LBT *Presenter: PEDICHINI, Fernando* The fore coming SHARK-VIS high resolution imaging camera will exploit the LBT adaptive optics performance at visible wavelengths (400-1000 nm) yielding a diffraction limited psf core with a FWHM of 18 mas at H-alpha. This resolution together with the high frame rate and the use of peculiar post processing techniques will allow the observer to reach contrast of 1e-5 at 100 mas on sources brighter than Rmag 12. An overview of the project, whose first light is foreseen in the first half of 2019, and the expected performances will be presented related to selected science cases.
15:20	Five years that changed our optical/NIR view of protoplanetary disks (I) *Presenter: GARUFI, Antonio* The onset of optical/NIR surveys of young stars imaged with Polarimetric Differential Imaging (PDI) has been a game changer for our understanding of protoplanetary disks. Thanks to the contributed effort of Subaru/HiCiao, VLT/NACO, VLT/SPHERE, and GPI, we could resolve with unprecedented resolution several sub-structures at the disk surface from few to hundreds of au from the star. We show the method and the improvement of this type of observations and discuss the implications to the recurrent existence of these disk features.
15:50	Photoevaporation and close encounters: how the environment around Cygnus~OB2 affects the evolution of protoplanetary disks *Presenter: GUARCELLO, Mario* Cygnus OB2 is the most massive stellar association within 2 kpc from the Sun. Given its large content of massive stars, counting tens of O and 3 WR stars, and thousands of young low mass stars, Cygnus OB2 is the best target to study how massive stars affect the star formation process in the parental cloud and the evolution of nearby protoplanetary disks. I will present the results of our study on the feedback provided by the environment in Cygnus OB2 on disk evolution, combining the X-ray data from the 1.08 Msec Chandra Cygnus OB2 Legacy Project (P.I. J. J. Drake) with an extensive set of optical and infrared data of the association. I will analyze and compare the destructive feedback provided by disk photoevaporation induced by the intense local UV field and close encounters between members of the association, and I will show evidence indicating that disk evolution in an environment similar to Cygnus OB2 is seriously affected by externally induced photoevaporation while close encounters do not provide an important feedback.
16:10	Tea break
16:40	Revealing the evolution of disks at 0.01-10 au from high-resolution IR spectroscopy (I) *Presenter: BANZATTI (STREAMING), Andrea* 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 ~ 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) some of these cavities show a interesting dichotomy in the distribution of gas and dust, and 3) disk chemistry evolves during formation of these cavities, with inner disks being dried-up from their water. I will discuss these discoveries in the context of the increasingly detailed picture of the evolution of exoplanet-forming disks at < 10 au.
17:10	Laboratory investigations aimed to study the chemical and physical properties of protoplanetary disk dust *Presenter: PALUMBO, Maria Elisabetta* Infrared observations of edge-on protoplanetary disks clearly show the presence of absorption features assigned to refractory dust grains and to solid phase molecules which form the so called icy grain mantles. It is generally accepted that in protoplanetary disks dust grains suffer from thermal and energetic processing (i.e. UV and ion irradiation) caused by the central protostar. The chemical and physical properties of disk dust can be obtained by the comparison between observations and laboratory spectra of dust grain analogs. In laboratory investigations gas phase species are accreted on a cold substrate (10-20 K) under vacuum. Both inert materials and dust grain analogs can be used as substrate. Transmittance infrared spectra of the samples are taken at low temperature and after energetic processing and during warm up. Laboratory studies have shown that the chemical composition and the physical structure of the sample can be modified by energetic and thermal processing. Furthermore the profile (shape, width and peak position) of IR bands is a tracer of both the chemical and physical properties of the sample. Here we will present some recent experimental results obtained in the Laboratorio di Astrofisica Sperimentale at INAF - Osservatorio Astrofisico di Catania and will discuss their relevance for the interpretation of the spectra that will be collected by the James Webb Space Telescope.

17:30 **Three stars, two disks, one system**

Presenter: SISSA, Elena

V4046 Sgr is a close binary with accretion signature.
GSC 07396-00759 is instead a very active but not accreting M1-type star.
These three form a dynamically bound system, likely member of the Beta Pictoris Moving Group.
Although V4046 Sgr is surrounded by a gas-rich disk, the characteristics of the newly detected GSC disk all together tend to favor an evolved/debris disk nature over a primordial/gas-rich disk.
This makes the system composed of V4046 Sgr and GSC 07396-00759 an interesting laboratory for studying the different evolutionary timescales of coeval disks.

17:50 **The GENESIS-SKA project: looking for Solar System analogs**

Presenter: CODELLA, Claudio

The recipe to make a habitable planet like our own Earth requires a relatively small rocky planet, at the right distance from the host star, with a not-too-thick atmosphere which should be rich in volatiles and capable of developing complex organic molecules chemistry. Searches for exoplanets have shown a large degree of diversity among planetary systems, but have left still unanswered the two fundamental questions of how common planetary systems like our own are and of how general are the processes that allow for creating habitable planets. Understanding the formation of planetary systems and the chemical processing of the volatiles that are going to form their atmospheres is therefore key to understand the origins of the Solar System. Key questions still to be addressed are: (i) how solids overcome the growth barriers to become rocky cores, (ii) how the formation of giant planets and their interaction with gas and solids in disks affect the formation of planets, and (iii) how chemically complex are the volatiles delivered on the pristine planetary atmospheres.

The SKA telescope, and more specifically the GENESIS-SKA project, will allow us to study in detail the evolution of dust as it evolves into planetesimals and rocky planets and to detect heavy complex organic molecules that today are beyond the reach of our observing capabilities. The GENESIS-SKA project, supported as PRIN-INAF, is carrying on studies on dust evolution, planet formation, and pre-biotic chemical complexity, in the context of preparation of SKA Key Programmes. More specifically, we are featuring a brand new synergy (in the INAF framework) between astronomical observational (e.g. VLA, GBT, ALMA, IRAM, LBT, VLT) and modeling efforts, laboratory experiments, and state-of-the-art quantum-chemical computations.

18:10 **Are we alone in the Universe? A unique opportunity for science outreach in GENESIS-SKA project context**

Presenter: BOCCATO, Caterina

The GENESIS-SKA project is supported as PRIN-INAF and its main goal is to study dust evolution, planet formation, and pre-biotic chemical complexity, in the context of preparation of SKA Key Programmes. The funding PRIN-INAF also accounts for communication, public and industrial outreach of the projects' scientific goals and results. This is the reason why GENESIS-SKA has a dedicate outreach work package and a specific activities' plan which, in this talk, we would like to present and discuss with the scientific community. To do this we also take advantage of previous professional engagement in other outreach activities, in general, and, in particular, in the INAF supported GAPS (Global Architecture of Planetary Systems) observational project.

The big question that GENESIS-SKA will address is: What physical and chemical conditions, during the early formation phases of planetary systems, can determine the rise of life? It is quite clear that these scientific aspects are especially well suited for outreach, being related to the fundamental question of broad interest: How did life emerge? In this context the work will be done in synergy with the central INAF communication office as well as with the SKA Organisation (in particular the Cradle of life key science driver), in order to promote the INAF image focusing on its leading role on the SKA-related activities on the Origins of Life. We will focus on disseminating, throughout different approaches, the main scientific aspects both to peers, to general public, to schools, and to all those industries potentially interested in SKA. Moreover, in order to trigger the "wow factor" to get the youngest' interest, we are planning the realization of a virtual reality exhibit.

Wednesday 27 June 2018

Protoplanetary disks (chair R. Garcia Lopez) (09:00-13:15)

time	title
09:00	ALMA (I) *Presenter: TESTI, Leonardo*
09:30	Disks ALMA observations and dust evolution (I) *Presenter: TAZZARI, Marco*
10:00	Gas and dust connection in protoplanetary disks (I) *Presenter: MIOTELLO, Anna* With the advent of ALMA, complete surveys of protoplanetary disks are being carried out in different star forming regions with the attempt to simultaneously constrain the gas and dust disk masses as well as the gas/dust mass ratio. More specifically, continuum and CO isotopologues observations are used to trace the bulk of the dust and the gas respectively. The main result from such surveys is that CO-based gas masses are very low, often smaller than one Jupiter Mass. Moreover, gas/dust mass ratios are much lower than the value of 100 found in the ISM. This can be interpreted either as rapid loss of gas, or as a chemical effect removing carbon from CO and locking it into more complex molecules or in larger bodies. Previous data cannot distinguish between the two scenarios. Statistical analysis of the gas and dust contents have been investigated providing some hints on the nature of these low gas/dust ratio values. Observations of [CI] lines and more complex C-bearing molecules could help us measuring the volatile carbon abundance in disks and determining whether carbon depletion, rather than gas depletion, is at play. Hydrocarbons, such as C2H and c-C3H2, are shown to be good tracers of the carbon abundance and C/O ratio in disks, thus they are promising species to calibrate CO-based disk masses and gas/dust ratios.
10:30	Coffee break
11:00	ALMA view of protoplanetary disks *Presenter: FEDELE, Davide* Planet formation is one of the most fundamental process in modern astrophysics as it is tightly linked to the origin of life. With more than 3000 planets known so far we are learning that planetary systems are ubiquitous in the Galaxy and their architectures are highly heterogeneous. These findings challenge our understanding of the planet formation mechanism. Protoplanetary disks offer a unique laboratory to investigate the early phases of planet formation and evolution. A major contribution to this field is coming from the Atacama Large Millimeter Array (ALMA). For the first time indeed, we are now able to detect and spatially resolve the emission coming from the cold disk interior where planet formation takes place. I will present recent results based on ALMA observations of gas and dust in disks.
11:15	Towards the molecular complexity in protoplanetary disks *Presenter: FAVRE, Cecile* The formation of planets together with that of comets and asteroids occurs within the protoplanetary disk surrounding a Sun-like young star. Consequently, the properties of emerging planets along with their primi-tive atmospheres may be shaped by the chemical composition of the disk. Nonetheless, one of the most important questions in Astrochemistry and Astrobiology is whether the molecules found in protoplanetary disks are of direct interstellar medium heritage or whether they have been altered or formed in the protosolar nebulae. At the present time, of the over 180 molecules detected in the interstellar and circumstellar media, approxima-tively twenty molecules have been detected in protoplanetary disks. Thanks to recent progress in instrumentation (i.e. high angular resolution and high sensitivity) for (sub)millimeter arrays, such as ALMA, new outstanding results have been obtained. I will review some notable results on the detection of organic molecules, including prebiotic molecules (i.e. molecules that might have made possible the appearance of life on Earth), S-bearing and carbon-chains species towards protoplanetary disks. Finally, based on our recent ALMA observation of formic acid, I will show that complex organic chemistry is taking place in objects where planet formation occurs.

11:30	Understanding planet formation: looking at «teenage» giant planets (I) *Presenter: D'ORAZI, Valentina* Observational constraints on planet formation mechanisms and corresponding timescales can be set through exoplanetary study by using two main approaches. (i) We can investigate relatively old stars hosting giant planets, and then inferring fundamental properties going reversely in time. (ii) On the other hand, a complimentary and much more powerful approach consists in looking at planets during their formation stage, or just after: unfortunately and mainly due to technical limitations (lack of young stars nearby, observational biases related to the different techniques) only a handful of objects have been discovered. The results collected so far seem to indicate that a comprehensive knowledge of the formation and evolution properties is still wanting. In this talk I will review the current status of the field involving observations of protoplanets (i.e., ages less than roughly 10 Myr) and discuss the current limitations related to the different observational techniques (direct and indirect). I will also discuss the impact that near and next future facilities (e.g., JWST, E-ELT) will have in this research field.
12:00	On The Secular Evolution of GG Tau A Circumbinary Disc: A Misaligned Disc Scenario *Presenter: HOSSAM, Aly* The binary system GG Tau A is observed to have a circumbinary disc with a dust ring located further out than expected from tidal truncation theory. Given the binary separation, this large cavity can be explained by relaxing the assumption of a co-planar disc and instead fit the observations with a mis-aligned circumbinary disc around an eccentric binary with a wider semi-major axis. I present the results of SPH simulations to check this possibility and investigate the long term evolution of such a system. I find that a misalignment angle of 30 degrees and a binary eccentricity of 0.45 fit both the astrometric data and the disc cavity.
12:20	Can spirals and axisymmetric structures give us a proxy for the total disc mass? The case of HD135344B *Presenter: VERONESI, Benedetta* In recent years, the Atacama Large millimeter/submillimter Array (ALMA) and the Spectro-Polarimetric High-contrast Exoplanet Research (SPHERE) instrument at the VLT have given us high resolution and high sensitivity observations of protoplanetary discs, showing peculiar substructures, such as spirals, gaps and horseshoes. Disc instabilities and planets have been proposed to be responsible for their formation, but their origin is still very debated, in particular how their shape depends on the disc mass. I will present the results of our hydrodynamical modeling of the protoplanetary disc HD135344B (Garufi et al. 2013, van der Marel et al. 2016, Stolker et al. 2016, Maire et al. 2017), that shows a distinctive spiral structure in scattered light and an axisymmetric horseshoe in the dust continuum. We performed hydrodynamical simulations (PHANTOM, SPH code by Price et al., 2017) and Monte Carlo Radiative Transfer simulations (RADMC-3D, by Dullemond et al. 2012) of a protoplanetary disc with two embedded planets, varying the total gas mass and the aspect ratio (H/R) of the disc. We found that the spiral structure, observed in scattered light, is well reproduced by a massive planet in the outer region of the disc. However, it is still not completely clear if the horseshoes like structure seen in the mm continuum images is due to the same outer planet. 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). To pursue this aim, we are performing SPH simulations of a protoplanetary disc with two embedded planets, varying the gas mass component.
12:40	Discussion on disks (Giuseppe Lodato moderator)

Lunch (13:15-14:30)

Jets and winds (chair C. Codella) (14:30-18:30)

time	title
14:30	Overview of JWST and its GTO programs on star and planet formation (I) *Presenter: CARATTI O GARATTI (FOR TOM RAY), Alessio* The James Webb Space Telescope (JWST) is due for launch in 2020. Optimized for near to mid-infrared wavelengths, it is the largest telescope ever put in space. One of the main science drivers is understanding star and planet formation: thus the study of outflows and disks is central not only to the JWST guaranteed time program but will also be the focus of many open time proposals. After briefly reviewing the four main instruments: NIRCAM, NIRSPEC, NIRISS and MIRI, the broad goals of the star and planetary formation guaranteed time programs will be outlined including the study of chemical processes in the inner disk, the effects of metalicity on accretion, and the atomic and molecular properties of embedded outflows.

14:50	Optical imaging of jets with extreme AO systems (I) *Presenter: ANTONIUCCI, Simone* The new generation of instruments equipped with extreme adaptive optics modules has recently started to provide impressive images of structures around young stellar systems at unprecedented angular resolution and contrast. In this presentation, I will show recent optical images of jets from young stars taken with VLT/SPHERE, in which for the first time we probe angular separations from the driving source below 0.1 arcsec. I will present a morphological analysis of the innermost sections of the jet and discuss how this can provide not only clues on the jet formation and collimation mechanisms, but also indicate the presence of undetected companions to the star or peculiar features on the disk, which can induce a jet wiggling. I will finally give an overview of what we can expect in this field for the near future, also considering the advent of new extreme AO instruments, such as LBT/SHARK.
15:20	ALMA polarimetric studies of rotating jet/disk systems *Presenter: BACCIOTTI, Francesca* We have recently obtained ALMA Band 7 polarimetric data for the young systems DG Tau and CW Tau, for which the rotation properties of jet and disk have been investigated in previous high angular resolution studies. The motivation was to test the models of magneto-centrifugal launch of jets via the determination of the magnetic configuration at the disk surface. Non-spherical dust grains tend to aling with their short axes parallel to the magnetic field, and in this case the dust radiation is polarized, with polarization vectors perpendicular to the direction of the magnetic field lines. We thus planned to compare the rotation properties in these systems with the observed magnetic field geometry. We present here the first results of the project, illustrating the different interpretations. The analysis of these data reveals that dust self-scattering concurs strongly to shape the polarization patterns.It is shown that even if no information on the magnetic field can be derived in this case, the polarization data are a powerful tool for the diagnostics of the dust properties in disks.
15:40	The Sardinia Radio Telescope (I) *Presenter: LEURINI, Silvia* In this talk, I will review the current status of the Sardinia Radio Telescope and the near-future technical developments. In particular, I will discuss the new generation receivers and focus on the spectroscopic capabilities of the telescope and on the impact that the SRT could have in the field of star formation .
16:00	Tea break
16:30	Analysis of high-resolution spectra of young stars: looking for wind signatures (I) *Presenter: RIGLIACO, Elisabetta* Slow-winds have been found to be almost ubiquitous around young stars. These winds, together with magnetospheric accretion, are the main players in the evolution and dispersal of protoplanetary disk material, and they can be magnetically or thermally driven. In this contribution I will present a few results obtained combining observations conducted with the high-resolution spectrograph UVES in different observing campaign. The observations span over objects that ar i) in different evolutionary stages (classical T Tauri stars and stars harboring a transitional disk); ii) high-accretors with/without prominent jet features; iii) in different star forming regions. The analysis will focus mainly on the [OI] optical forbidden lines, and our findings will be discussed in the light of other campaign conducted in recent years with other lower-resolution instruments.

17:00	**The dispersal of planet-forming discs. A new generation of X-ray photoevaporation models** *Presenter: PICOGNA, Giovanni* 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. Wind profiles and rates play a very important role in understanding disc dispersal as well as in the feedback of this process on planet formation and migration (e.g. Ercolano et al. (2015), Ercolano & Pascucci (2017), Jennings et al. (2018)). We started in Munich a joint project, together with ESO, Max-Planck Institute, the University of Heidelberg, and Tuebingen, to improve our understanding of the transition discs population from both a theoretical and observational point of view. Our work focuses on creating new and improved hydrodynamical models of wind profiles from stellar irradiation at different wavelengths (EUV, X-rays, FUV) in order to have better constraints for current and future observations. The prescription to model X-ray disc photoevaporation used in the last decade is based on fits to the hydrodynamical models by Owen et al. (2010). A major limitation of this approach is that the temperature in the wind is determined independently of the local column density. In this study we released this limitation by running a set of hydrodynamical simulation with the modern code PLUTO (Mignone et al., 2007), where the temperature is a function not only of the local density but also of the column density. We provide several fits of the total mass-loss rate as a function of star's X-ray luminosity and disc cavity for transition discs which can be used as simple prescriptions in population synthesis models of planet formation, as well as line profiles produced within the wind for different 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 (e.g. via streaming instability) and the final parking place of planets during their migration. We are expanding this study by probing also the effect of different stellar masses and metallicity depletion in the outer disc. A major effort is also directed towards an implementation of a realistic chemical network into PLUTO, by adopting the chemistry package KROME (Grassi et al., 2014), in order to determine the temporal and spatial evolution of some of the key chemical species locked into ices (CO, H2O, CH3OH) when coupled with the dynamics of a protoplanetary disk.
17:20	**GIARPS High-resolution observations of T Tauri stars (GHOST): first results on jet emission** *Presenter: GIANNINI, Teresa* T Tauri stars of the Taurus/Auriga star-forming clouds are a paradigmatic sample for star formation studies. In spite of that, a comprehensive and systematic analysis of the Taurus population with the goal of deriving all the relevant source parameters with sufficient accuracy, is still missing. To fill this gap we have started an observational program (GHOST) with the GIARPS@TNG facility. Its combined wide spectral coverage (optical/near-infrared) and very high spectral resolution are ideal to simultaneously derive both the stellar accretion and ejection parameters. In this presentation I'll show the first results of jet emission. From line ratios of forbidden lines we have derived the physical parameters (temperature, density and ionization fraction) in the jet accelaretion zone. These results will provide important benchmarks for jet launching models.
17:40	**Properties of a Jet from the T Tauri Star TH 28: a Combined Spectroscopic Study With MUSE and X-Shooter** *Presenter: MURPHY, Aisling* The second generation ESO VLT instruments MUSE and X-Shooter offer valuable tools for examining the structure and origin of jets. MUSE is an integral field spectrograph with a relatively large field of view and a significant spectral range. Thus numerous important forbidden emission lines can be simultaneously studied in a large portion of the jet. X-Shooter is a broadband spectrograph with an even larger spectral range than MUSE, extending into the J, H and K NIR bands. X-Shooter has proven to be especially useful for simultaneous accretion and outflow studies of jet driving source. This poster will present a MUSE pilot study of two jets, the jet from the T Tauri star SZ 102 and the irradiated jet HH 399. In the case of SZ 102 several epochs of X-Shooter data were also available which allowed us to combine both instruments to comprehensively investigate this jet.
18:00	**Discussion on jets and winds (Jochen Eisloeffel)**

Thursday 28 June 2018

Formation of protoplanets (chair D. Fedele) (09:00-13:30)

time	title
09:00	The Extremely Large Telescope (I) *Presenter: PADOVANI, Paolo* I will present an overview of the current status of the Extremely Large Telescope (E-ELT) project, concentrating on recent developments. I will then discuss the ELT instruments and then briefly address the proto-planetary disk science topics, which these instruments will address.
09:30	The complex interplay between gas and dust in protoplanetary disks (I) *Presenter: FACCHINI, Stefano* The high sensitivity and angular resolution of ALMA and optical and NIR imagers are providing new insights on the typical properties of protoplanetary disks. A plethora of substructures are currently being observed, ranging from rings and gaps to spirals and strong azimuthal asymmetries. Most of these features have been characterized in continuum emission, from optical to cm wavelengths, and many models have been invoked to explain their origin. A key observational diagnostic to discriminate between the different models are spatially resolved molecular line emission, which can directly probe the gas temperature and density structure. In this talk I will show how the combination of continuum and CO observations can put stringent constraints on the physical origin of these substructures, in particular rings, gaps and azimuthal asymmetries. In the hypothesis of embedded planets sculpting the disk, the combined information of gas and dust can be used to infer the mass of the purported planet(s). Both dynamical and thermal coupling between gas and dust has to be considered when interpreting the observations and correctly estimate fundamental disks properties as simple as their outer radius.
10:00	Search and characterization of young planets with GAPS *Presenter: BENATTI, Serena* The “GAPS” (Global Architecture of Planetary Systems) project gathers a large part of the Italian community working on exoplanets. In the past 5 years our radial velocity survey with HARPS-N at TNG was focused to the search and characterization of planetary systems around stars with different characteristics (M dwarf, stars with already known planets, metal-poor stars, members of open clusters, …), producing important results as well as a robust and competitive community. Thanks to the integration of GIARPS (GIANO-B & HARPS-N) at TNG in 2017, GAPS has the opportunity to explore new perspectives on the exoplanet search: the simultaneous visible and near infrared observations can help to discriminate the nature of the radial velocity variation when observing very active stars, which is a difficult achievement with previous techniques and instrumentation. Taking advantage of the GIARPS capabilities, the Young Objects sub-program of the new GAPS2 survey focused its attention to the first stages of planetary systems formation. Recent results suggest that we could expect a large fraction of hot Jupiters around very young stars with respect to the old ones (Donati et al. 2016, Yu et al. 2017), but the current statistic is far to be complete. Of course, the observation of this kind of objects allows us to study the ongoing planet formation and to compare the planet properties at different time scales, helping to investigate the role played by the migration mechanisms, the formation sites and the orbit evolution on their observed diversity. During the first part of the program we gained the expertise to properly model the stellar activity (Gaussian processes) starting from a suitable observing strategy, which is a crucial issue when dealing with young stars. Our target sample includes members in young associations (e.g., Taurus): some of them are known to host confirmed or candidate hot Jupiters. In this talk I will present the main objectives of our program and the preliminary results.

10:20 Disk-planet interaction: theory confronts observations (I)

Presenter: DIPIERRO, Giovanni

Recent spectacular high resolution observations of gaps and ring-like structures in nearby dusty protoplanetary disks have revived interest in studying gap-opening mechanisms. Among all the models proposed to explain the rings and gaps observed in these systems, the planet hypothesis is the most important to test, in order to advance our fundamental understanding of planet formation and explain the characteristics of observed exoplanets.
In this talk I give an overview of the theory of disk-planet interaction in protoplanetary disks, with a focus on the physics of gap opening in dusty viscous protoplanetary disks. I describe the three distinct physical mechanisms for dust gap opening by embedded planets in protoplanetary disks. Starting from numerical evidences, I present a grain size-dependent criterion for dust gap opening in viscous protoplanetary disks by revisiting the theory of dust drift to include disk-planet tidal interactions and viscous forces. These analytical estimates are particularly helpful to appraise the minimum mass of an hypothetical planet carving gaps in disks observed at long wavelengths and high resolution. These findings are applied to the case of the HLTau protoplanetary disks, showing that the three gaps detected by ALMA can be described by the presence of sub-Jupiter mass planets.

10:50 Coffee break

11:20 Eccentricity evolution during planet-disc interaction

Presenter: RAGUSA, Enrico

During the process of planet formation, the planet-discs interactions might excite (or damp) the orbital eccentricity of the planet. In this talk, I will present two long (t ~ 3x10^5 orbits) numerical simulations: (a) one (with a relatively light disc, M_d/M_p=0.2) where the eccentricity initially stalls before growing at later times and (b) one (with a more massive disc, M_d/M_p=0.65) with fast growth and a late decrease of the eccentricity. We recover the well-known result that a more massive disc promotes a faster initial growth of the planet eccentricity. However, at late times the planet eccentricity decreases in the massive disc case, but increases in the light disc case. Both simulations show periodic eccentricity oscillations superimposed on a growing/decreasing trend and a rapid transition between fast and slow pericentre precession. The peculiar and contrasting evolution of the eccentricity of both planet and disc in the two simulations can be understood by invoking a simple toy model where the disc is treated as a second point-like gravitating body, subject to secular planet-planet interaction and eccentricity pumping/damping provided by the disc.
I will show how the counterintuitive result that the more massive simulation produces a lower planet eccentricity at late times can be understood in terms of the different ratios of the disc-to-planet angular momentum in the two simulations. In our interpretation, at late times the planet eccentricity can increase more in low-mass discs rather than in high-mass discs, contrary to previous claims in the literature.

11:40 Exploring the role of planetesimals stirred by forming giant planets in shaping the characteristics of protoplanetary disks

Presenter: TURRINI, Diego

The dust population in circumstellar disks is expected to steadily decrease with age due to its growth from µm-sized particles to planetesimals and planets. Using HD 163296's circumstellar disk as a test-bench, we show that the formation of giant planets globally dynamically excites the planetesimal population embedded in disks. This dynamical excitation leads to a marked increase in planetesimal impact velocities that enhances the collisional dust production, rejuvenating the grain population in the µm size range and creating the conditions for halting or reversing the expected dust decreasing trend. We use N-body simulations and statistical methods to assess the response of a planetesimal swarm populating HD 163296's disk to the formation of its three giant planets, and impact experiments and scaling laws to evaluate the outcomes of planetesimal collisions in different impact velocity regimes. We show that the appearance of HD 163296's giant planets results in tenfold-to-hundredfold increases in the collisional dust production and can still be significantly contributing to the observed dust-to-gas ratio in the disk. In addition to dust resurgence, the resulting high impact velocities could release transient, non-equilibrium gas species like H$_{2}$O due to ice sublimation. The orbital velocities of the dynamically excited planetesimals, being supersonic with respect to the gas, could also produce bow shocks and possibly cause a broadening of the gas emission lines in the affected regions.

12:00	Non-spherical dust dynamics in protoplanetary disks: the effects of particle nonsphericity on the evolution timescales. *Presenter: IVANOVSKI, Stavro* Recent high-resolution ALMA observations of protoplanetary disks (e.g. Isella et al. 2016, PRL, 117; ALMA Partnership et al. 2015, ApJ Lett. 808:L3,10pp) triggered interest in studying solid bodies in discs at different scales, ranging from small sub-micron grains up to solid bodies of sizes of hundreds of meters, for which the dynamical evolution is governed by the interaction with the gas in the disk. For subsonic motion, the interaction with the gas causes a drag force acting on the dust particle that results in dust acceleration or deceleration. If the mean free path of the gas molecules is much larger than the size of the particles, the particles move in Epstein regime. In such regime, the difference in particle shape, size and composition lead to different aerodynamics and particle speeds. Applying the non-spherical dust dynamics model developed for cometary environment (Ivanovski et al. 2017, Icarus 282, 333-350), we study the dynamics of non-spherical particles in protoplanetary disks when the gas flow is in Epstein regime. In particular, we revise the timescales of the dimensionless stopping time (tstop = mv/Fdrag, with m and v being particle mass and velocity, Fdrag the drag force) and the settling timescale in the vertical settling phenomena in disks. We obtain the dust terminal velocities owing to the assumed shape/elongation and the region at which the settling could occur as a function of the particle non-sphericity. The results of this study have a direct application to the investigation of the effects of the unseen planetesimal population of protoplanetary disks to the evolution of their dusty environments (Turrini et al., submitted, arXiv:1802.04361).
12:20	Evolution of early Protoplanetary systems embedded in gaseous disks under perturbation of passing-by stars. *Presenter: PINTO, Luis Diego* The recent detection of planetary systems around stars embedded in Open Clusters opened new perspectives on the study of the primordial evolution of gas matter and on the subsequent formation of planets. In such complex environments, the disks may interact with the other cluster field-stars, and follow a different evolution with respect to the well-known simpler case of isolated systems. For such purposes, a new SPH tree-based algorithm has been developed, which takes into account the coupled dynamical evolution of stars and planets in their circumstellar gaseous disk. Our first parametric modelization focuses on the evolution of young protoplanetary systems perturbed by passing-by stars. In particular, we aim to the understanding of the evolution of the primordial Solar System which, according to recent models, is thought to be born in an Open Cluster.
12:40	Discussion on disk-planets interation (Raffaele Gratton moderator))
13:10	Conclusions

Light lunch (13:30-14:30)