Program and Book of Abstracts

Program

Day 1, Sunday June 9, 2019

19h30 - Registration and welcome reception at Nafplia Palace Hotel & Villas

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Day 2, Monday June 10, 2019

08:00-08:45 Registration
08:45-09:00 Welcome by the Organizers

Session I -- The life and works of Ake Nordlund (chair: Sami Dib)

09:00-09:30 Uffe Jorgensen (I)

Session II -- Galactic scale star formation (chair: Yuri Fujii)

09:30-10:00 Davide Elia (I)
10:00-10:30 Diane Cormier (I)

10:30-11:00 Poster Session - Coffee break

11:00-11:30 Eve Ostriker (I)
11:30-11:45 Cecilia Bacchini
11:45-12:00 Thales Gutcke
12:00-12:15 Tim-Eric Rathjen
12:15-12:30 Florent Renaud
12:30-12:45 Alexander Marchuk
12:45-13:00 Sacha Hony

13:00-15:30 Lunch break

Session III -- Molecular cloud formation & properties (chair: Davide Elia)

15:30-16:00 Huabai Li (I)
16:00-16:30 Paolo Padoan (I)
16:30-16:45 Di Li
16:45-17:00 Masato Kobayashi

17:00-17:30 Poster Session, - Coffee break

17:30-17:45 Fabio Santos
17:45-18:00 Leire Beitia-Antero
18:00-18:15 Christopher Wareing
18:15-18:30 Daniel Seifried

18:30-18:35 Poster flash presentations: Izquierdo, Komsaczewski, Mao, Mazumdar, Scholtys

18:35-19:05 Discussion. Moderator: Sami Dib

19:30-20:30 Public Lecture by Dr. Danae Polychroni at the centre for Hellenic Studies/Nafplio

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Day 3, Tuesday June 11, 2019

Session IV -- Molecular cloud fragmentation, filaments/cores, CMF/IMF (chair: Di Li)

09:00-09:30 Philippe Andre (I)
09:30-09:45 Dario Colombo
09:45-10:00 Doris Arzoumanian
10:00-10:15 Dana Alina
10:15-10:30 Kate Pattle

10:30-11:00 Poster Session - Coffee break

11:00-11:30 Troels Haugboelle (I)
11:30-12:00 Patrick Hennebelle (I)
12:00-12:15 Alessio Traficante

12:15-12:30 Thomas Nony
12:30-12:45 Rachel Smullen
12:45-13:00 Marco Lombardi

13:00-15:30 Lunch break

Session V -- Low mass star formation, disks, non-ideal MHD effects (chair: Diego Turrini)

15:30-16:00 Sarah Sadavoy (I)
16:00-16:30 Kengo Tomida (I)
16:30-16:45 Mathilde Gaudel
16:45-17:00 Kazuki Tokuda

17:00-17:30 Poster Session, - Coffee break

17:30-17:45 Yu-Qing Lou
17:45-18:00 Michael Kueffmeier
18:00-18:15 Sayantan Auddy
18:15-18:30 Koraljka Muzic

18:30-18:45 Poster flash presentations: Abad, H.-R. Chen, Fiorellino, Guszejnov, Sharma, Tang, Yeshengbieke, Bhandare, Higuchi, Kupilas, C.W Lee, Nagy, Saad, Verliat, Wurster

18:45-19:15 Discussion. Moderator: Shantanu Basu

Day 4, Wednesday June 12, 2019

Session VI -- Solar/Stellar Physics, connections to star formation (chair: Doris Arzoumanian)

08:45-09:15 Bengt Gustaffson (I)
09:15-09:45 Thomas Nordlander (I)
09:45-10:00 Anish Amarsi
10:00-10:15 Salvatore Colombo
10:15-10:30 Sergio Dzib
10:30-10:45 Nino Kochiashvili
10:45-11:00 Mauricio Tapia
11:00-11:15 Raul Jimenez

11:15-11:17 Poster flash presentation: Guarcello, N. Medina

12:00-19:30 Excursions

20:30- Conference dinne: restaurant Fougaro

Day 5, Thursday June 13, 2019

Session VII -- High mass star formation -- Early phases, individual objects (chair: Dimitris Stamatellos)

09:00-09:30 Sylvain Bontemps (I)
09:30-10:00 Rolf Kuiper (I)
10:00-10:15 Jordan Molet
10:15-10:30 Adam Ginsburg

10:30-11:00 Poster Session - Coffee break

11:00-11:15 Nanda Kumar
11:15-11:30 Patrick Koch
11:30-11:45 Johan van der Walt
11:45-12:00 Aida Ahmadi
12:00-12:15 Igor Zinchenko
12:15-12:30 Willice Obonyo

12:30-12:35 Poster flash presentations: Arnold, Matsushita, Persi, Zhou

12:35-13:00 Discussion. Moderator Mauricio Tapia

13:00-15:30 Lunch break

Session VIII -- Stellar clusters, massive stars in clusters, stellar feedback (chair: Koraljka Muzic)

15:30-16:00 Annie Zavagno (I)
16:00-16:30 Richard Wunsch (I)
16:30-16:45 Morten Andersen
16:45-17:00 Zeinab Khorrami

17:00-17:30 Poster Session - Coffee break

17:30-17:45 Christine Allen
17:45-18:00 Jakob Ward
18:00-18:15 Anna Rosen
18:15-18:30 Jeong-Gyu Kim

18:30-18:35 Poster flash presentations: Beradze, Bratsolis, Gonzalez-Samaniego, Jaffa, Sartorio

18:35-19:05 Discussion. Moderator: Patrick Hennebelle

Day 6, Friday June 14, 2019

Session IX -- Planet/Solar system formation (chair: Anna Rosen)

09:00-09:30 Diego Turrini (I)
09:30-10:00 Jonathan Tan (I)
10:00-10:15 Mario Guarcello
10:15-10:30 Andrew Winter

10:30-11:00 Poster Session - Coffee break

11:00-11:30 Yuri Fujii (I)
11:30-11:45 Dimitris Stamatellos
11:45-12:00 Kevin Baillie
12:00-12:15 Martin Pessah
12:15-12:30 Sin-iti Sirono

12:30-12:31 Poster flash presentation: Popovas

12:31-12:46 Raphael Mignon-Risse (belongs to session X)

12:46-13:15 Discussion. Moderator: Troels Haugboelle

13:15-15:30 Lunch break

Session X -- Advances in code development for astrophysical fluid dynamics (chair: Daniel Seifried)

15:30-16:00 Jim Stone (I)
16:00-16:30 Ake Nordlund (I)
16:30-16:45 Jon Ramsey

16:45-17:15 Poster session - Coffee break

17:15-17:30 Maya Petkova
17:30-17:45 Bert Vandenbroucke

17:45-17:46 Poster flash presentation: Lomax

17:46-18:15 Discussion. Moderator: Kengo Tomida

18h15:18:30 Conference summary

Abstracts

Monday, June 10, 2019

Name: Uffe Jorgensen (I)
Institution: Niels Bohr Institute

Title: From stellar to exoplanetary atmospheres

Abstract: Åke played a central role in the development of the MARCS stellar atmosphere code right from the early states in the 1970's and onward. In the 1980's we developed the code together to include molecular opacities for cooler stars. Today the code includes cloud formation too, and experiments are being made to extend it to computing exoplanetary atmospheres. The advantage of starting with a stellar atmosphere code to produce models for exoplanet atmospheres is the high level and variety of tests the code has been through, with more than 2,000 citations in the scientific literature to its tests, applications and confrontation with observational data. I will here discuss the perspectives and challenges of the development toward construction of exoplanetary atmospheres, and the possibilities of identifying life on Earth-like exoplanets in the foreseeable future by use of such atmospheric modelling and comparison of the associated synthetic spectra with upcoming observations.

Name: Davide Elia (I)
Institution: INAF-IAPS, Rome, Italy

Title: Star formation across the whole Milky Way: the role of Galactic plane surveys

Abstract: To understand the star formation processes a deep insight, in terms of both resolution and sensitivity, into star forming objects is needed, observing both continuum and line emission over a wide spectral range. However, an even exhaustive knowledge for a handful of well-studied sources or regions is not able to produce a possible "universal" recipe. In this respect, statistical studies based on many thousands sources are essential both to suggest or to confirm general trends, and to provide large numbers of candidates for possible follow-up observations. This is the role of large surveys of the Galactic plane, which also provide a fundamental picture of connections among large-to-small scale structures in the interstellar medium. In this way, a view of the entire Milky Way as a whole star forming entity can be obtained, and compared with global star formation properties of external galaxies. In this talk I will illustrate how physical properties of clumps in the Galactic plane, as estimated in the first instance from far infrared photometry only, allow us, in themselves, to recognize global evolutionary trends. In particular, I'll discuss separately the results of the Hi-GAL survey for the inner and the outer Galaxy, the latter presented for the first time. I'll also discuss the distance bias on the estimate of the derived physical parameters. Finally I will show how all this information is combined to infer global properties of star formation in the Milky Way.

Name: Diane Cormier (I)
Institution: CEA, Saclay, France

Title: Cold gas in nearby galaxies

Abstract: Modern observatories such as ALMA have opened up new areas of research to study star formation in galaxies. In particular, it is the first time that we can explore and survey emission from the dense, molecular gas that is closely linked to the formation of new stars. I will talk about on-going efforts to observe the cold, star-forming gas and to characterize its properties (such as masses, efficiencies, physical conditions, cloud metrics) in nearby spiral and dwarf galaxies. Results show strong variations that correlate to some extent with the galactic environment. Clearly, the role of the environment in setting the cloud properties and, in turn, the star-formation activity of galaxies needs to be better understood.

Name: Eve Ostriker (I)
Institution: Princeton University, USA

Title: TBD
Abstract: TBD

Name: Cecilia Bacchini (C)
Institution: University of Bologna & University of Groningen, Italy/The Netherlands

Title: Volumetric star formation laws of disc galaxies

Abstract: Star formation laws are fundamental relations between the gas content of a galaxy and its star formation rate (SFR) and play key roles in galaxy formation and evolution models. Generally, the Kennicutt law is advocated to link the surface densities of SFR and gas (HI+H2) with a sharp drop in the star formation efficiency (SFE) at low surface densities, but it is still unclear if a more fundamental correlation exists for the volume densities. We present new empirical star formation laws of disc galaxies based on volume densities. Assuming the hydrostatic equilibrium, we calculated the radial growth of the thickness of gaseous discs in 12 nearby star-forming galaxies. Thus, we could convert the observed surface densities of gas and SFR into the de-projected volume densities. We found a tight correlation with slope between 1.3-1.9 involving the volume densities of gas and SFR with a significantly smaller scatter than the Kennicutt law and no change in the slope over five orders of magnitude. Our result suggests that the slope break of the Kennicutt law is due to the disc flaring rather than to a drop in the SFE. Surprisingly, we discovered an unexpected correlation between the HI and SFR volume densities, indicating that atomic gas is a good tracer of the cold star-forming gas, especially in low density HI-dominated environments. In order to further test these correlations, we used gas and SFR measurements in the Milky Way (MW). Indeed, our Galaxy is a unique place where one can observe both the gas 3D distribution and the vertical structure of the youngest stars, which can be used to estimate the SFR volume density. We found that our volumetric star formation laws are valid in the MW, indicating that they may be universal for star-forming galaxies.

Name: Thales Gutcke (C)
Institution: Max Planck Institute for Astrophysics, Garching, Germany

Title: Simulating a metallicity-dependent IMF

Abstract: Observational and theoretical arguments increasingly suggest that the initial mass function (IMF) of stars may depend systematically on environment, yet most cosmological galaxy formation models to date assume a universal IMF. I will present state-or-the-art cosmological simulations of the formation of Milky Way analogues run ab initio with an empirically derived metallicity-dependent IMF in order to characterize the associated uncertainties. I show that the non-linear effects due to IMF variations typically have a limited impact on the morphology and the star formation histories of the formed galaxies. The results support the view that constraints on stellar-to-halo mass ratios, feedback strength, metallicity evolution and metallicity distributions are in part degenerate with the effects of a non-universal, metallicity-dependent IMF. Interestingly, the empirical relation used between metallicity and the high mass slope of the IMF does not aid in the quenching process. It actually produces up to a factor of 2-3 more stellar mass if feedback is kept constant. Additionally, the enrichment history and the $z = 0$ metallicity distribution are significantly affected. In particular, the alpha enhancement pattern shows a steeper dependence on iron abundance in the metallicity-dependent model, in better agreement with observational constraints.

Name: Tim-Eric Rathjen (C)
Institution: Max Planck Institute for Astrophysics, Garching, Germany

Title: The strong impact of cosmic rays on the structure of the ISM and outflows

Abstract: Cosmic rays are a fundamental constituent of the interstellar medium (ISM). However, the impact of this relativistic component is neglected in most numerical ISM studies. We present results from the - worldwide - first three-dimensional magneto-hydrodynamic simulations of a multi-phase ISM accurate modeling of all major 'feedback' sources from massive stars: stellar winds, radiation, supernovae and cosmic ray injection and diffusion. We demonstrate how cosmic rays help accelerating warm gas resulting in a smoother and colder outflow structure, in much better agreement with many observations. The results indicate a paradigm shift in our understanding of galactic outflows.

Name: Florent Renaud (C)
Institution: Lund University, Sweden

Title: Turbulences?

Abstract: Interstellar turbulence is a key ingredient in shaping the ISM and regulating star formation. However, due to enormous dynamical ranges, its nature(s) and injection scale(s), and how they vary across time and space, are not fully understood. In this talk, I will show results from galaxy-scale simulations explaining how kpc-driving of turbulence affects both the rate and efficiency of star formation. I will show that interacting galaxies trigger the onset of compression-dominated turbulence leading to starbursts, but that this turbulence is fundamentally different from that modelled in small-scale, closed boxes of ISM, and discuss possible reasons and implications. I will finally present potential perspectives of bridging the gap between the injection of turbulence at galactic scale and its effect down to stellar scales.

Name: Alexander Marchuk (C)
Institution: Saint-Petersburg State University, Russia

Title: Gravitational instability and star formation in NGC 628

Abstract: The gas-stars instability criterion for infinitesimally thin disc was applied to the galaxy NGC 628. Instead of using the azimuthally averaged profiles of data the maps of the gas surface densities (THINGS, HERACLES), of the velocity dispersions of stars (VENGA) and gas (THINGS) and of the surface brightness of the galaxy (S4G) were analyzed. All these maps were collected for the same region with a noticeable star formation rate and were superimposed on each other. Using the data on the rotation curve values of Qeff were calculated for each pixel in the image. The areas within the contours Qeff < 3 were compared with the ongoing star formation regions and showed a good coincidence between them. The Romeo-Falstad disc instability diagnostics taking into account the thickness of the stellar and gas layers does not change the result. If the one-fluid instability criterion is used, the coincidence is worse. The analysis was carried out for the area r < 0.5r25. Leroy et al. (2008) using azimuthally averaged data obtained Qeff ≈ 3 − 4 for this area of the disc, which makes it stable against non-axisymmetric perturbations and gas dissipation, and does not predict the location of star forming regions. Since in the galaxies the distribution of hydrogen and the regions of star formation is often patchy, the relationship between gravitational instability and star formation should be sought using data maps rather than azimuthally averaged data.

Name: Sacha Hony (C)
Institution: --

Title: PAH emission across star forming regions in the Magellanic Cloud Galaxies

Abstract: Polycyclic Aromatic Hydrocarbon (PAH) emission is a powerful probe of the physics inside star forming complexes, that is set to regain the forefront with the advent of JWST. Because PAHs are excited predominantly in the photon dominated regions (PDRs), i.e. the places where a strong radiation field illuminates the neutral ISM, their emission provides a unique window into how newly formed stars affect their environment. PAH molecules play a pivotal role in the heating of the neutral gas through the photo-electric effect. I will present the results from our Spitzer/IRS mapping analysis of the LMC and SMC galaxies (PIs Kemper and Bolatto). We have targeted more than 30 star-forming regions with extensive (20-50pc size), spatially resolved (pc scale resolution) mid-IR spectral mapping to determine the response of the PAH emission to the radiation of the luminous young stars. We find: 1) very strong variations in the local PAH to continuum ratios directly related to the radiation environment 2) significant variations on the PAH ionisation state (traced by band ratios) that correlation with the dust continuum colour temperature 3) significant differences in the median PAH band ration from star-forming region to star forming region and galaxy to galaxy, related to the predominant excitiation state of the ISM 4) a significant dependence of the median observed band ratios with the spatial resolution of the observation These results serve as templates for studying the radiative feedback from massive star formation and form a solid basis for planning and interpreting the enormous wealth of mid-IR spectroscopy that JWST will perform.

Name: Huabai Li (I)
Institution: Chinese University of Hong Kong

Title: The Tai Chi in Star Formation

Abstract: "It is the way of Heaven to diminish superabundance and to supplement deficiency." said Laozi (~600 BC). I will share my observations of gravity, turbulence and magnetic fields in molecular clouds, which seem to teach me the same lesson.

Name: Paolo Padoan (I)
Institution: ICREA & Institute of Cosmos Sciences, University of Barcelona

Title: The Turbulent Nature of Molecular Clouds

Abstract: I will briefly review Åke's contributions to this field, focusing on statistical properties of supersonic MHD turbulence, some specific properties of MC turbulence, and the origin of MCs. I will then present results from our latest AMR simulations of SN-driven ISM turbulence, on a scale of 250 pc. I will discuss the nature of the SN-driven turbulence in the general ISM and within MCs, the issue of MC formation and lifetime, and the origin of global MC properties such as the viral parameter and the star formation rate. I will argue that SN-driven turbulence can explain most observed MC properties, and is thus the main agent controlling MC formation and star formation in the ISM.

Name: Di Li (C)
Institution: National Astronomical Observatory, China (NAOC)

Title: Absorption Probes of Dark Molecular Gas (DMG)

Abstract: CO has been the de-facto tracer of molecular gas in galaxies. In the past decade, it becomes well accepted that CO along with HI emission misses a major component of gaseous ISM, the so-called dark molecular gas (DMG), which consists of abundant H2, but does not produce detectable CO emission, rendering X-factor useless. DMG has been revealed systematically by diffuse gamma-ray analysis (such as Fermi) and comparison with dust (such as Planck). The difficulties of quantifying DMG come from both physics, i.e., sub-thermal excitation, and chemistry, i.e., non-canonical abundance due to .e.g. insufficient self-shielding. We report here a series of absorption studies of DMG. Through HI Narrow Self-Absorption (HINSA-Li & Goldsmith 2003), we measured the temperature of C+ traced DMG to be around 55K (Tang et al. 2016) and also made the first detection of the birth of a nearby dark cloud (Zuo et al. 2018). Through quasar absorption, we measured the OH excitation temperature to be around 3 K (Li et al. 2018), thus provided a plausible explanation for its apparent weakness in emission. By comparing absorption measurements with diffuse gamma-ray (Remy et al. 2017), we showed that the OH and CH abundance tracks well the total content of DMG, therefore their equivalent X-factors are better tracers of ISM ((Xu & Li 2016), particularly in the extinction range between Av 0.1 and 2. The next generation absorption surveys from FAST, SKA1, etc. will provide definitive answers to the total quantity of ISM (McClure-Griffith et al. 2015), Galactic star formation efficiency, and their dependence on various parameters.

Name: Masato Kobayashi (C)
Institution: Osaka University

Title: The Time Evolution of the Multiphase Interstellar Medium in Shocked Layers

Abstract: The interstellar medium (ISM) in present-day massive galaxies consist of multiphase medium such as warm neutral medium (WNM), cold neutral medium (CNM), and molecular clouds. Thermal instability is believed to be the responsible mechanism to start the phase transition from WNM into CNM (e.g., Field et al. 1969, Wolfire et al. 1995). This transition requires some external trigger to override the pressure equilibrium between WNM and CNM. Supersonic shock propagation is a promising trigger originated from expanding HII regions, supernova remnants, and galactic spiral shocks, where the conversion takes place in the post-shock layer. As an analogy to such phase transition, many previous studies largely simulate converging flow systems and measure the properties of the multiphase ISM formed in the shock-compressed layer (Hennebelle & Perault 1999, Heitsch et al. 2005, Vazquez-Semadeni et al. 2006, Inoue & Inutsuka 2008, Iwasaki et al. 2019). To connect these studies to galactic-scale star formation, we perform a series of converging flow hydrodynamics simulations by increasing the flow velocity and varying the spatial resolution. Our results suggest that velocity dispersion in dense parts (> 100 /cm^3) remains less than 10 km/s even in high velocity cases (>20 km/s), and the WNM to CNM mass ratio is almost unity within 3 Myr. Our resolution studies show that shock front position may differ up to 20 percent both in space and time, but the bulk properties (i.e., velocity dispersion and the mass ratio) do not change significantly. We also investigate a single shock propagation instead of converging flow system. The results indicate that the shock front position is less perturbed in single shock propagations.

Name: Fabio Santos (C)
Institution: Max-Planck Institute for Astronomy

Title: The far-infrared polarization spectrum of Rho Ophiuchi A from HAWC+/SOFIA observations

Abstract: In this work, we report polarimetric observations of the densest portions of the Rho Ophiuchi molecular complex (known as Rho Oph A) from HAWC+/SOFIA. Rho Oph A was mapped with HAWC+ bands C (89 microns) and D (154 microns). This allowed us to examine the slope of the polarized emission spectrum by defining the quantity R_DC = p(D)/p(C), where p(C) and p(D) represent polarization degrees in bands C and D, respectively. We notice a clear correlation between R_DC and the molecular hydrogen column density across the cloud. A positive slope dominates the lower density and well illuminated portions of the cloud (which is warmed up by the Oph S1 massive star), whereas a transition to a negative slope is observed at the denser and less evenly illuminated cloud core. We interpret the trends as due to a combination between: (1) Warm grains at the cloud outskirts, which are efficiently aligned from the abundant exposure to radiation from Oph S1, as proposed from the radiative torques theory; and (2) Cold grains deep in the cloud core which are poorly aligned due to shielding from external radiation. To test this assumption, we developed a very simple toy model using a spherically symmetric cloud core based on Herschel data, and verified that the calculated variation of R_DC is consistent with the observations. This result introduces a new method that can be used to probe the grain alignment efficiency in molecular clouds, based on the analysis of the far-infrared polarization spectrum.

Name: Leire Beitia-Antero (C)
Institution: AEGORA Research Group, Universidad Complutense de Madrid

Title: Numerical simulations of MHD wave propagation into molecular clouds

Abstract: As magnetic fields play an important role in the formation and evolution of molecular clouds and filaments, it is important to study their role in the coupling between the clouds and the diffuse ionized medium. In this regime, where the transition between the warm, ionised medium to the cold, molecular one takes place, small charged dust grains may play an important role by enabling the coupling with the magnetic field inside the cloud and facilitating the penetration of MHD waves inside it. To study numerically this interaction, we have implemented the dynamics of charged dust grains inside the MHD code Athena. Besides the dominant Lorentz force and the already implemented aerodynamical drag, we have included a drag term that accounts for the coupling with the ionised species and another term that accounts for the interaction between particles mediated by the gas charged species. In this contribution, we present an early report of our results.

Name: Christopher Wareing (C)
Institution: University of Leeds

Title: MHD simulation of cloud formation by the thermal instability and consequent massive star feedback

Abstract: We have used the AMR magnetohydrodynamic code, MG, to perform 3D MHD simulations of the formation of a molecular cloud through the action of the thermal instability, with self-gravity and magnetic fields. Two initial diffuse atomic conditions have been investigated: 1) a 100 pc-diameter 17,500 solar mass spherical cloud; and 2) a 200 pc-diameter 135,000 solar mass spherical cloud. For both initial conditions, we investigated the hydrodynamic case of no magnetic field and the magnetic case of magnetic/thermal pressure equivalence (plasma beta=1). A range of structures form with molecular cloud densities. In particular, the hydrodynamic case shows that the thermal instability dynamically forms sheets and filaments. The natural width of the filaments is 0.1-0.3\,pc. Following this, clumps grow at the intersections of filaments with size-scales of 2 to 5\,pc and aspect ratios around unity. Imposed on the entire potential well of the cloud, the FellWalker routine finds 21 distinct clumps. The properties of these clumps are in agreement with clumps observed in molecular clouds, showing "turbulence-like" power spectra of density and velocity. Given their positions, at the interconnections of the filamentary network, many show evidence of infalling linear structure. Not all are gravitationally bound, but the convergent nature of the infall and increasing central density in each suggest they are highly-likely to form stars. Further simulation of the most massive clump reveals the final gravitational collapse of the clump, to resolved levels of density six orders of magnitude higher than the initial condition (i.e. to n$_{\rm H} > 10^6$\,cm$^{-3})$ and temperatures <10K. The magnetic case sees material 'trace a flow' along the magnetic field lines and form an initially thick, but at late times thin, corrugated sheet-like cloud perpendicular to the magnetic field. In projection, the cloud appears remarkably filamentary. 'Striations' parallel to the magnetic field, hour-glass magnetic field configurations and integral-shaped filaments are reproduced. Into these structures we have introduced mechanical stellar feedback from single and multiple massive stars ranging from 15 to 120 solar masses and their consequent supernovae. We conclude with a demonstration that the striking structure of the Rosette Nebula can be understood in terms of these cloud formation models with supporting evidence from Planck-based magnetic field observations and Gaia-based proper motions of the stars in the central cluster

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Name: Daniel Seifried (C)
Institution: University of Cologne

Title: Simulating molecular clouds and its link to observations

Abstract: We present novel simulations of molecular cloud formation in galactic disks within the SILCC collaboration (Seifried et al., 2017, MNRAS, 472, 4797). The simulations combine for the first time high spatial resolution (0.1 pc), the impact of the large-scale, galactic environment, as well as a detailed chemical network for H_2 and CO formation. The simulations thus provide a unique tool to discuss important aspects of molecular cloud formation: the (1) chemo-dynamical evolution and (2) the comparison with actual observations by means of synthetic observations. We will show that both, H_2 and CO have to be modelled on-the-fly in the simulations with sub-parsec resolution. We show the complex behaviour of the transition of atomic hydrogen to molecular hydrogen, where H_2 is present in rather low-density gas (~ 30 cm^-3) due to turbulent mixing from the denser regions. As the X_CO factor obtained from synthetic CO(1-0) observations shows a significant scatter among the different clouds, we suggest an alternative way to overcome the problem of CO-dark gas with a significantly higher accuracy. Finally, in view of the increasing number of

polarisation observations, we present synthetic dust polarisation maps created with the POLARIS code, which contains - for the first time - a self-consistent description of dust grain alignment efficiencies (Seifried et al., 2019, MNRAS, 482, 2697). We will show that observed polarisation vectors in clouds probe the real field structure with an accuracy of about 5 degree and that the long-debated de-polarisation on clouds scales results from strongly tangled field lines rather than inefficient grain alignment. We will also compare our results with current observations by the Planck and BlastPol collaboration and give guides for future polarisation observations.

Name: Andres Izquierdo (P)
Institution: Jodrell Bank centre for Astrophysics - The University of Manchester

Title: Turbulent statistics of resolved molecular clouds in a galactic potential

Abstract: We present a statistical analysis of the dynamical and morphological features of a representative set of molecular clouds extracted from high-resolution regions of galactic MHD simulations from our Cloud Factory simulation suite. The clouds are at similar evolutionary states but have experienced different physical processes: 1. The dynamics are purely dominated by the large-scale potential of the galactic disc. 2. The galactic potential is present and gas self-gravity is turned on. 3. The galactic potential, the self-gravity and supernovae feedback are turned on. To compare to observations, we perform radiative transfer simulations to predict the dust continuum and 12CO J=1-0 line emission of the representative molecular clouds. Using the synthetic images we then apply the Principal Component Analysis (PCA) reduction technique and estimated a structure size--line width relation for each of the physical scenarios. The statistical analysis suggests that, even though purely gravitational effects are necessary to reproduce the standard observational laws, they are not sufficient. An extra injection of energy from Supernovae events seems to play a key role in establishing the global turbulent field and the local dynamics and morphology of molecular clouds in Milky Way-like galaxies.

Name: Emily Komsaczewski (P)
Institution: Astronomical Observatory of the Jagiellonian University, Poland

Title: Spectroscopic Diagnostics of Mid-Infrared Features of ISM in Dark Globule, DC 314.8-5.1

Abstract: We present an analysis of infrared features of interstellar matter in the dark globule DC 314.8-5.1. Specifically, we present an analysis of the polycyclic aromatic hydrocarbon (PAH) infrared emission features in the dark globule. We show that these features can be used to determine conditions of the system, such as the ionization parameter. The dark globule is shown to have an ionization parameter that increases with proximity to the serendipitous field star, HD 130079, located in the eastern boundary of the cloud. We detect the presence of many strong PAH bands, including the features at 7.7, 11.2, and 12.7 microns. In addition, we inspect the variance of several key PAH and H_2 emission features and their intensity distributions over projected distance. We conclude that the dark globule is at the onset or just prior to low-mass star formation.

Name: Shengkai Mao (P)
Institution: Princeton University

Title: Identifying gas structures and their correlations with star formation in ISM disk simulations

Abstract: We test techniques for identifying gaseous structures in the TIGRESS MHD simulations, which self-consistently model star formation and effects of feedback in the three-phase ISM at parsec scales. We quantify the dynamical properties of these structures and their correlation with star formation. One technique uses the gravitational potential to identify bound objects by comparing thermal, turbulent, and magnetic energy with gravitational energy relative to isopotential contours. A second technique identifies objects above fixed density thresholds (rho_th), and look at estimated virial parameters as well as the fraction of gas that is bound, for each object. We find that apparently bound objects (by estimated virial parameter) can be unbound (by the true gravitational potential), and bound objects can be apparently unbound. The bound mass is a small fraction of the total mass and resides in structures of mass < 10^4 Msun. For each category of objects, we correlate time series of mass per free-fall time to SFR and infer the efficiency per free-fall time (eps_ff). We quantify correlation with star formation for each object category by measuring uncertainty in eps_ff. In bound objects we find eps_ff ~ 0.4 and in number density 100 cm^-3 we find eps_ff ~ 0.1. Lower density objects have lower eps_ff and worse correlation (uncertainty). The reduced correlation of M/t_ff with SFR for low-density objects implies the trends of eps_ff i.e. lower eps_ff(rho > rho_th) at low rho_th is due to increased M(rho> rho_th) rather than slower SF.

Name: Parichay Mazumdar (P)
Institution: Max Planck Institute for Radio Astronomy

Title: LASMA (13CO, J= 3-2) Survey of the Milky Way

Abstract: Surveys of the Milky Way are fundamental tools to obtain reliable constraints for the gas distribution for the models that aim to simulate our Galaxy's spiral arms and bar potentials. While continuum surveys (e.g.- GLIMPSE, Hi-GAL, ATLASGAL, MIPSGAL) trace the dense ISM and recent star forming activity going on in the Milky Way; spectroscopic follow-ups (e.g. GRS, HOPS, CHIMPS, COHRS, SEDIGISM) reveal the kinematics (radial velocities and kinematic distances) of the molecular clouds and clumps detected in the continuum surveys. They also constraint their dynamical state in addition to gas excitation, chemical abundances and turbulence. With advancements in technology we are able to observe the Galaxy with much higher angular resolution than in the past revealing cloud sub-structures as well as providing us with a more detailed view on the large-scale structure of the molecular gas. In this talk I will present the on-going survey of the inner Milky Way in 12/13CO (J=3-2) performed with the LASMA seven pixel array receiver operated at the Atacama Pathfinder EXperiment (APEX) telescope in Chile and the early science from the data collected so far.

Name: Jeremy Scholtys (P)
Institution: Université Laval à Québec & Université Paris-Sud

Title: Filament formation in MHD turbulence : a parameter study of magnetic field amplitude and turbulent forcing

Abstract: Infrared cirrus clouds in the North Celestial Loop display filamentary structures in HI column density and dust integrated emission maps. Two of them, the Spider and Ursa Major molecular clouds, contain only a small mass of CO and estimations of their magnetic and turbulent kinetic energies outweigh by 3 orders of magnitude their gravitational energy.These clouds could therefore be HI transitioning to molecular gas while their physical properties are predominantly due to magnetohydrodynamic (MHD) turbulence. Being above the plane, the Spider and Ursa Major clouds provide a simplified environment without the ambiguity caused by galactic rotation or the complex radiation fields caused by ionizing stars in the vicinity. Simulations of diffuse HI with turbulent forcing and magnetic fields have been shown to produce more elongated structures than in the hydrodynamic case, i.e. magnetic fields and velocity shears induced by turbulence align and stretch the flow. Also, observations of filaments in diffuse atomic show that they tend to be preferentially oriented parallel to the magnetic fields, in accordance with the simulations. With that in mind, a series of turbulent MHD simulations was undertaken with the aim to compare these molecular clouds as seen in 21cm and dust maps with synthetic HI observations. Filament extraction methods have then been used to study the filaments' geometrical properties and their dependance on the turbulent forcing parameters and magnetic field amplitude. Preliminary results will be shown.

Name: Marcin Kupilas (P)
Institution: University of Leeds

Title: Shocking interactions with inhomogeneous clouds

Abstract: This poster will present the results of a hydrodynamical study of shocks interacting with inhomogeneous giant molecular clouds (GMC's). Thermal instability, magnetic fields, turbulence, shocks and flows all play a role in setting the properties of GMCs. Here, we elucidate the role of shocks further by running a shock over a cloud that is evolving structure due to thermal instability and gravity only. Using the AMR code MG, we investigate several density contrast ratios between

the cloud and the surroundings in order to explore both radiative and adiabatic shock regimes. The global behaviour of the cloud and the properties of the clumps are closely studied. The range of resulting cloud evolution will be shown in this poster. Our results will be used to study feedback from massive stars, which are known to have a disproportionate effect on their local environment and the wider interstellar medium (ISM).

Tuesday, June 11, 2019

Name: Philippe André (I)

Institution: Laboratoire d'Astrophysique de Paris-Saclay (AIM) - CEA Saclay

Title: Fragmentation of molecular clouds, filaments, the core mass function and the origin of the IMF

Abstract: The origin of the initial mass function (IMF) is one of the most debated issues in astrophysics. I will discuss new insights into this problem based on a systematic census of prestellar cores and molecular filaments in nearby clouds taken as part of the Herschel Gould Belt survey. The Herschel results point to the key role of the quasi-universal filamentary structure pervading molecular clouds. They suggest that the dense cores making up the peak of the prestellar core mass function (CMF) - and indirectly the peak of the IMF - result from gravitational fragmentation of molecular filaments near the critical mass per unit length. The Salpeter power-law tail of the CMF/IMF may arise from a combination of two effects: 1) a power-law distribution of filament masses per unit length built up by accretion, and 2) the differential growth of a Kolmogorov-like initial spectrum of density fluctuations along the filaments.

Name: Dario Colombo (C)

Institution: Max Planck Institute for Radio Astronomy

Title: The resolved properties of the molecular clouds in the inner and outer Galaxy

Abstract: Modern high resolution, molecular gas surveys of the Galactic Plane are unveiling an astonishing picture of the three-dimensional gas organization of the Milky Way. This provides the opportunity to investigate the building blocks of the molecular medium, the Molecular Clouds (MCs), in an unprecedented level of detail. We will present a catalog of more than 90000 objects from the Structure, excitation, and dynamics of the inner Galactic interstellar medium (SEDIGISM) and CO(3-2) High-Resolution Survey (COHRS) data. The decomposition technique we use, SCIMES (Spectral Clustering for Interstellar Molecular Emission Segmentation), allows for a statistical analysis of integrated as well as resolved properties of the clouds. We will show how morphology, star formation efficiency, clump formation efficiency, and kinematics vary within those gas structures and with respect to the Galactic environments. Together, we will introduce a first glimpse of the new, APEX CO(2-1) high resolution survey of the outer Galaxy (OGHReS) and the properties of the clouds in this un-explored part of the Milky Way. These pioneer studies represent a step forward not only to a future, systematic cataloging of all discrete molecular gas features of our own Galaxy, but also for our understanding of the molecular cloud structure in nearby galaxies which is still elusive even with the advent of ALMA.

Name: Doris Arzoumanian (C)

Institution: CAUP Porto

Title: Filament and sheet-like-cloud interaction: Hint to understand the history of star formation

Abstract: Molecular clouds are observed to be filamentary and the densest of these filaments have recently been identified as the main sites of star formation. Filamentary molecular clouds are proposed to be formed out of dense and cold atomic clouds as a result of multiple compressions from propagating shock waves through the interstellar medium (ISM). The typical timescale of such shock compressions is estimated to be on average about 1 Myr. After each passage of a wave, the properties of the shocked molecular medium are modified. Thus, the present morphologies of the density, velocity, and magnetic field structures are usually not those corresponding to the initial conditions at the molecular cloud formation epoch, but are probably the result of their sequential alteration due to interactions with multiple propagating ISM waves. Investigating the interaction of star-forming filaments with their surroundings may be important to understanding the history of star formation. In this talk, I will present new mapping observations towards a star-forming filament in the Taurus molecular cloud, where we identify extended structures (detected in 13CO and 12CO) with line-of-sight velocities redshifted and blueshifted with respect to the average velocity of the filament identified in C18O. Based on combined analyses of velocity integrated channel maps and intensity variations of the optically thick 12CO spectra on and off the filament, we propose a 3-dimensional structure of the cloud. We further suggest a multi-interaction scenario where sheet-like extended structures interact, in space and time, with star-forming filaments (formed by, e.g., previous episodes of propagating waves) and are responsible for their compression and/or disruption, playing an important role in the star formation history along the filaments (Arzoumanian et al. 2018). I will also discuss the velocity structure of a very faint young filament suggesting a filament formation process due to the convergence of a flow of matter generated by the bending of the ambient magnetic field structure induced by a shock compression.

Name: Dana Alina (C)
Institution: Nazarbayev University

Title: Interstellar magnetic fields and filaments hosting cold clumps
Abstract: It is now commonly accepted that magnetic field is one of the principal actor in structuring the interstellar matter (ISM) and in the process of star formation along with gravity and turbulence. However, it is still unknown what is its actual role in the formation and evolution of filaments and dense cores. Polarimetric data of dust emission polarization is well suited to probe magnetic filed structure in dense, cold interstellar medium and to provide hints on dust physics through the efficiency of grains alignment with respect to the magnetic field lines. I will present a statistical analysis of the relative orientation between the plane-of-sky magnetic field and the filaments associated with the Galactic Cold Clumps - the very cold condensations of ISM that could host regions of star formation. We have extracted 90 filaments from the Planck 353 GHz data all over the sky using the Rolling Hough Transform. After subtracting the background component, we have found different behaviours in terms of relative orientation depending on the environment density, and on the density contrast between the filaments and their environment (Alina et al. submitted). Having separated clumps contribution from the total signal, we have revealed differences in the alignment of the clumps with respect to the filaments' magnetic field. I will also present our results from a statistical analysis toward over 1000 Galactic Cold Clumps and their hosting filaments (Ristorcelli et al. in prep.). We have derived the variations of the polarization fraction and polarization angle dispersion function with the column density. I will discuss the anti-correlations found in terms of depolarization either due to the lower efficiency of dust alignment with the magnetic field in dense medium (as expected from the Radiative Torque Alignment theory) or to the geometry of the magnetic field along the line of sight. These results will be put in perspective of the SPICAL-POL (B-BOP) scientific objectives.

Name: Kate Pattle (C)
Institution: National Tsing Hua University

Title: The JCMT BISTRO Survey: Variation of magnetic field and grain alignment properties within the Ophiuchus Molecular Cloud
Abstract: The role and relative importance of magnetic fields in the late stages of mass assembly within molecular clouds remains highly uncertain. In this talk I will discuss recent results from the JCMT (James Clerk Maxwell Telescope) POL-2 polarimeter and the JCMT BISTRO (B-Fields in Star-Forming Region Observations) survey, which is currently mapping star-forming regions within 2 kpc of the Solar System in submillimetre polarized light. The resolution and sensitivity of the BISTRO observations allows magnetic fields to be traced from low to high densities in star-forming gas, and provides new insights into the depths into molecular clouds to which dust grains are aligned with the magnetic field. I will particularly discuss recent observations of the nearby Ophiuchus molecular cloud, a well-studied and well-resolved site of low-to-intermediate-mass star formation. The proximity of this molecular cloud allows for detailed investigation of the variation of magnetic field morphology, energetic balance, and dust grain alignment with local environment within an individual star-forming region. Our results demonstrate that the magnetized behaviour of individual star-forming clumps is strongly influenced by local effects and stellar feedback.

Name: Troels Haugboelle (I)
Institution: Niels Bohr Institute

Title: From clouds to stars, a turbulent story
Abstract: The formation of stars is a fundamental piece of the life-cycle of matter in the Universe, with consequences for understanding the energy input and development on large scales of the interstellar medium in galaxies, and the creation of planetary systems around the new-born stars on small scales. The problem is inherently multi-scale in nature, because self-gravity connects the dynamics of molecular clouds parsecs in size to the accretion flow and collapse of single cores that eventually become stars, spanning several million in dynamical range.

A fundamental characteristic of star formation is the stellar initial mass function. In the last two decades the IMF the cloud scale properties of turbulent fragmentation together with assumptions about the conversion of self-gravitating cores in to stars has been used to build a theory for the initial mass function. Using a set of large-scale simulations of star formation, requiring more than 100 million CPU-hr, describing the evolution over several million years of a four-parsec star forming region with a maximum resolution of 25 AU, we explore the necessary ingredients to properly recover the observed IMF. We compare our results with the predictions of the turbulent-fragmentation scenario for the origin of the stellar IMF, and show how it is in accordance with our simulations. Using a large dynamic range in both space and time we recover for the first time the full spectrum of stellar masses from brown dwarfs to massive stars, and test the numerical convergence, and the dependence of the IMF on physical parameters. We find strong support for the model predictions, and predict an initial time evolution of the IMF.

Name: Patrick Hennebelle (I)
Institution: CEA

Title: What sets the initial mass function of stars ?
Abstract: I will present numerical simulations and analytical arguments to investigate the origin of the stellar mass distribution. In particular I will argue that the peak of the IMF is set by the mass of the first hydrostatic Larson core and equal to about 10 times its value.

Name: Alessio Traficante (C)
Institution: IAPS-INAF

Title: From clouds to clumps: multi-scale dynamics in 70 micron quiet star-forming regions
Abstract: In a hierarchical view of the star formation process the material flows from large molecular clouds down to clumps and cores. A main open question in this paradigm is if the gravity dominates and drives the observed supersonic non-thermal motions during the collapse, in particular in high-mass regions, and at which scales becomes eventually dominant over the turbulence of the interstellar medium. In this talk I will focus on the dynamics and gravo-turbulent properties of a sample of 70 micron quiet clumps and of the filaments in which they are embedded. The dynamics at the clump scales is analysed combining the results of two surveys of 70 micron quiet clumps carried out with the IRAM 30m telescope which cover a wide range of masses and surface densities; these clumps are embedded in filaments that have been identified and extracted from the Hi-GAL survey, and their dynamics has been evaluated with ancillary CO data. I will show the correlation between the kinematic signatures at large-scales and at the clump-scales of these regions, which is particularly significant in the more massive objects. These results support the theories that consider the observed non-thermal motions as mainly driven by the gravitational collapse at all scales for the most massive star-forming regions.

Name: Thomas Nony (C)

Institution: IPAG

Title: The IMF origin and episodic accretion constrained by a rich cluster of massive cores and outflows

Abstract: I will present our study of W43-MM1, the archetype precursor of starburst clusters (~2 x 104 Msun within 6 pc2, SFR = 6000 Msun/Myr). Thanks to the high-angular resolution of ALMA, the large W43-MM1 mosaic revealed more than hundred cores with typical sizes of 2000 AU. The Core Mass Function (CMF) built from this sample covers an unprecedented mass range and contains cores forming solar-type stars up to the highest-mass stars. I will first show that the CMF slope is quantitatively flatter than that of the reference IMF of Salpeter (Motte, Nony, Louvet et al. 2018). This seriously challenges our understanding of the origin of the IMF, an issue addressed by the ALMA-IMF Large Program, whose first results will be presented. I will then present the cluster of CO and SiO protostellar outflows we discovered in W43-MM1. Despite the complex environment inside which these ~35 outflow lobes develop, a detailed study of their position-velocity diagram revealed clear events of episodic ejection (Nony et al. in prep). The typical timescale found between two ejecta of these 2-100 Msun protostars is longer than that found for low-mass protostars and suggests that the accretion process has a ~500 yr episodicity.

Name: Rachel Smullen (C)
Institution: University of Arizona

Title: The highly variable time evolution of cores

Abstract: Decades of work studying molecular clouds have striven to understand the initial conditions of star formation. However, observations will never be able to study the long-term evolution of individual cores. We aim to connect the observed core properties with the initial conditions using hydrodynamical simulations of a low mass star forming region. We have developed an algorithm to follow core properties through time using cores identified with the dendrogram hierarchical structure method. We find that, while the global distributions of core properties match well with observations and other theoretical work, individual cores can have a stochastic variability on timescales of <50 kyr upwards of 50% for many of the common properties measured in cores, such as mass, Mach number, and virial parameter. The variability is slightly smaller for isolated, non-star forming cores and increases with the presence of protostars or core number in the local environment. In this talk, I will highlight some of the shortcomings of core identification using hierarchical structure and urge caution when interpreting instantaneous core properties as representative of a core's global evolution.

Name: Marco Lombardi (C)
Institution: Università di Milano

Title: Star formation in nearby molecular clouds

Abstract: In this talk I will discuss the star formation properties in nearby (d < 500 pc) molecular clouds. To this purpose I combine many different datasets, including Pan-STARRS and 2MASS for extinction maps, Herschel and Planck for dust emission maps, and Spitzer and Wise for protostar identification. The results obtained show that a series of scaling laws appears to play an important role to understand the cloud star efficiency. Gaia parallaxes, used to infer the shape and orientation of each cloud, can be used to link the observed projected density to the (more physical) 3D gas density of each cloud.

Name: Sarah Sadavoy (I)
Institution: Harvard-Smithsonian Center for Astrophysics

Title: From Cores to Disks: Tracing Protostars, Disks, and Magnetic Fields with High Resolution Observations

Abstract: The field of star formation is rapidly changing with the development of high resolution instrumentation at (sub)millimeter wavelengths with ALMA and recent upgrades to the NOEMA and VLA interferometers. With these facilities, we are now able to probe protostar environments on scales of 10-100 au, probing protostar multiplicity, disk structure, and the role of ideal and non-ideal magnetic effects on disk formation and evolution. In this presentation, I will review recent observational progress in using high resolution observations to study the formation and evolution of disks and stellar multiplicity, as well as tracing magnetic fields down to disk scales through observations of dust polarization. I will highlight open questions that need to be explored, and offer methods for future investigations into the formation of both stars and planets.

Name: Kengo Tomida (I)
Institution: Osaka University / Princeton University

Title: Formation and Early Evolution of Circumstellar Disks

Abstract: Angular momentum transport by magnetic fields is the key physical process in star and disk formation processes. Non-ideal magnetohydrodynamic effects such as Ohmic dissipation and ambipolar diffusion extract magnetic flux and suppress angular momentum transport. Using MHD simulations we found that these effects can resolve the so-called magnetic braking catastrophe in the early phase of star formation. We also investigated the long-term evolution of the disk using a sink particle technique. As the accretion continues, the disk acquires larger angular momentum and grows in the size and mass. We compared our simulations with recent ALMA observations by synthetic observations, and found that our models are in good agreement with some objects.

Name: Mathilde Gaudel (C)
Institution: CEA

Title: Angular momentum properties of young protostellar envelopes from the CALYPSO survey

Abstract: One of the main challenges to the formation of solar-like stars is the "angular momentum problem": if the angular momentum of the protostellar envelope is totally transferred to the central embryo during the main accretion phase, the gravitational force cannot counteract the centrifugal force and the stellar embryo fragments prematurely before reaching the main sequence. Thus, the rotating envelope needs to redistribute its angular momentum by 5 to 10 orders of magnitude. Class 0 protostars are key objects to understand the distribution of angular momentum and therefore identify the mechanisms responsible for the angular momentum redistribution: they grow by accretion of the matter from the surrounded envelope (Menv>>Mstar) extending to scales 10000 au. At the end of this cornerstone phase, most of the final stellar mass has been accreted and the embryo is surrounding by a large disk (100 au). In order to tackle this issue, we used high angular resolution observations (0.5'', i.e. ~100 au) from the CALYPSO (Continuum and Lines in Young Protostellar Objects, PI: Ph. André) IRAM large program for a sample of 11 Class 0 protostars with d<250 pc. We studied in detail the kinematics and established, for the first time homogeneously in a large sample, robust constraints on the radial distributions of specific angular momentum within protostellar envelopes in a large range of scales from ~100 to 5000 au (Gaudel et al. 2019, submitted). Two distinct regimes are revealed: a relatively constant profile at small scales (<1000 au) and an increasing of the angular momentum at larger radii (1000-5000 au). The constant profile shows that the specific angular momentum of the material directly involved in the star formation (<1000 au) is "only" 3 orders of magnitude larger than the typical one of T-Tauri stars. I will discuss disk formation and magnetic braking as possible solution to reconnect the angular momentum observed in the protostellar envelopes to the T-Tauri stars. Furthermore, velocity gradients observed on large scales (>3000 au) - that are historically used to measure the rotation of the core and quantify the angular momentum problem (Goodman et al. 1993, Caselli et al. 2002, Ohashi et al. 1997) - are not due to pure envelope rotation. I will examine the influence of the interstellar filament dynamics (turbulence, collapse, shocks) within which protostars are buried and the imprints of the initial conditions of the pre-stellar phase in the large scales of the envelope.

Name: Kazuki Tokuda (C)
Institution: Osaka Prefecture University

Title: A detailed ALMA study of an early stage of protostar formation in a highly dynamical dense core

Abstract: Observational studies of the earliest stage of star formation is a key to investigate the initial conditions of star formation, e.g., the way of the fragmentation and the dynamical collapse. One of the observational difficulties is to appropriately identify such high-density cores just around the moment of protostar formation because the timescale is quite short. Although some ALMA 12m array observations toward dense cores often fail to detect well-developed structures, our recent ALMA observations toward a protostellar core, MC27/L1521F in Taurus, have been revealing highly complex structure, such as arc-like structures and fragmentation of starless dense gas, with the sizes several tens au to a few thousands of au at an early stage of the low-mass multiple protostar formation. These facts suggest that the initial condition of star formation is highly dynamical in nature, which is considered to be a key factor in understanding fundamental issues of star formation such as the formation of multiple stars and the origin of the initial mass function of stars (Tokuda et al. 2014, 2016). Further high-angular resolution observations have been done toward this source in ALMA Cycle 3 with the beam size of ~20 au. The observation resolved for the first time the rotation of the tiny disk around the associated VeLLO (Very Low-Luminosity Object) and revealed that the stellar mass gets already ~0.2 Mo in spite of the low luminosity of L <0.07 Lo. Furthermore, although the VeLLO is located just at the very center is located just at the center of the high-density core, mass inflow on to the protostar seems to be halted (Tokuda et al. 2017). We suggest that a highly dynamical (turbulent) environment seen in this system may be a hint to understand the sudden stop of the mass accretion. Actually, the high resolution 12CO observations resolved for the first time complex warm (>15-60 K) filamentary/clumpy structures, which have not been observed in cold cores like this, with the sizes from a few tens of au to ~1,000 au. We suggest that the warm CO gas may be consequences of shock heating or turbulent dissipation induced by interactions among the different density/velocity components originated from the turbulent motions in the core (Tokuda et al. 2018). These facts may challenge our current understanding of the low-mass (multiple) star formation, in particular, the relation between the mass accretion process onto the protostar/circumstellar disk and the turbulent motions. We are also revisiting the source selection of such high-density cores as possible sources having complex structures using our ACA survey, and ALMA archives. We found that a very low-mass (~0.2-0.4 Mo) core, MC5-N, in the Taurus L1495 region has a highly concentrated (column) density distribution with the possible substructures. This core is considered to be a suitable target to investigate the detailed structures on the verge of very-low mass star or brown dwarf formation using the ALMA 12m array (Tokuda et al. 2019 submitted to PASJ).

Name: Yu-Qing Lou (C)
Institution: Tsinghua University, Physics Department and Tsinghua Center for Astrophysics

Title: Solution to the Luminosity Problem in Star Formation

Abstract: Spherical hydrodynamic models with a polytropic equation of state (EoS) for forming protostars are revisited in order to resolve the so-called luminosity conundrum highlighted by observations. For a molecular cloud (MC) core with such an EoS with polytropic index $\gamma > 1$, the central mass accretion rate (MAR) decreases with increasing time as a protostar emerges, giving a sensible solution to this luminosity problem. As the MAR decreases, the protostellar luminosity also decreases, meaning that it is invalid to infer the star formation time from the currently observed luminosity using an isothermal model. Furthermore, observations of radial density profiles and the radio continua of numerous MC cores evolving towards protostars also suggest that polytropic dynamic spheres of $\gamma > 1$ should be adopted as physical models. References: [1]Gao, Yang; Lou, Yu-Qing; Variable protostellar mass accretion rates in cloud cores, MNRAS: Letters, 466, Issue 1, p.L53-L57 [2] Li, DaLei; Lou, Yu-Qing; Esimbek, Jarken, Lane-Emden equation with inertial force and general polytropic dynamic model for molecular cloud cores, MNRAS, 473, Issue 2, p.2441-2464 [3] Lou, Yu-Qing; Hu, Xu-Yao; Gravitational collapse of conventional polytropic cylinder, MNRAS, 468, Issue 3, p.2771-2780 [4] Lou, Yu-Qing; Hu, Xu-Yao; General polytropic self-gravitating cylinder free-fall and accreting mass string with a chain of collapsed objects, MNRAS, 459, Issue 2, p.2014-2029 [5] Lou, Yu-Qing; Xing, Heng-Rui, General polytropic magnetohydrodynamic cylinder under self-gravity, MNRAS: Letters, 456, Issue 1, p.L122-L126 [6] Fu, Tian-Ming; Gao, Yang; Lou, Yu-Qing, Starless Cloud Core L1517B in Envelope Expansion with Core Collapse, The Astrophysical Journal, 741, Issue 2, article id. 113, 16 pp. (2011).

Name: Michael Küffmeier (C)
Institution: Institut für Theoretische Physik Heidelberg (ITA)

Title: Zooming-in protostellar formation

Abstract: Planets form in accretion disks that are themselves a by-product of stars forming in different environments of Giant Molecular Clouds. To account for the environmental effects, we carried out zoom-in simulations with the magnetohydrodynamical code RAMSES and showed that the accretion process of stars is heterogeneous in space, time and among different protostars with a tendency of more violent accretion for deeply embedded objects. Against the background of observed structures -- likely associated with planet formation -- in disks younger than 1 Myr, even infall of relatively little mass compared to the hosting star onto the young disk may significantly enhance the mass budget available for planets forming in these disks. To follow-up on this idea, we evolve the embedded star-disk systems more detailed (e.g. by accounting for the effects of ambipolar diffusion) and/or further in time using the new code framework DISPATCH. Together with more simplified parameter studies, we are able to better constrain the effect of infalling material onto young disks, i.e., at the stage before and during the onset of planet formation. By taking a closer look, we investigate the effect of the larger-scale dynamics on the mechanisms occurring at small distances from the protostar (~0.1 to ~10 au), such as launching of outflows or alignment of inner disks. To embrace the scope of this conference, early results of these zoom-in attempts will be shown and discussed in this talk

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Name: Koraljka Muzic (C)
Institution: CENTRA, University of Lisbon

Title: Brown dwarf formation across environments

Abstract: With masses below 0.08 Msun, brown dwarfs (BDs) are the link between stars and planets. Understanding their origin has been one of the major motivations for recent deep studies of star forming regions as well as a driver for development of state-of-the-art simulations. Deep surveys show that BDs are an ubiquitous outcome of star formation, with about 0.2-0.5 substellar objects formed for each star. One of the big questions in BD studies is whether the birth environment may affect their formation efficiency, as expected from several formation theories. The prediction is that high gas or stellar densities, as well as the presence of massive OB stars may be the factors that boost the frequencies of newly formed BDs with respect to stars. To test these predictions, we compare the outcome of our decade-long deep survey SONYC, in which we characterized substellar populations of several nearby star forming regions, with the results of our new search for substellar objects in massive young clusters RCW 38 and NGC 2244, characterized by drastically different star forming environments than those where BDs have been studied so far. In this contribution, I will present the current status of young BD studies, compare the low-mass Initial Mass Functions in a variety of Milky Way environments, and outline the impact of these results on our understanding of BD formation processes.

Name: Víctor Almendros Abad (P)
Institution: Center for Astrophysics and Gravitation (CENTRA), University of Lisbon

Title: The (sub)stellar content of the massive young cluster NGC 2244

Abstract: Young star clusters are the primary locations of star formation, and the main suppliers of (sub)stellar objects in the Universe. They give birth to objects spanning at least 4 orders of magnitude in mass, from the most massive stars reaching several tens of solar masses, down to the substellar objects below the deuterium-burning limit. Richly populated young clusters provide an ideal testbed to probe a variety of yet unsolved questions related to star, brown dwarf, and cluster formation. In this contribution, I will present our recent work on the massive young (2 Myr) cluster NGC 2244, located in the center of the Rosette Nebula, at a distance of 1.6 kpc. Our deep photometric survey lead to the first Initial Mass Function (IMF) of the cluster extending well into the

substellar regime, down to ~0.02 Msun. In the spectroscopic follow-up using KMOS/VLT, we obtained ~140 spectra of candidate low-mas stellar and substellar objects. In combination with archival spectra of more massive stars, we present the first spectroscopic IMF of NGC 2244, along with the first bona-fide brown dwarfs located at kpc distances.

Name: Huei-Ru Vivien Chen (P)
Institution: National Tsing Hua University

Title: Filamentary Accretion Flows in the IRDC M17 SWex

Abstract: Although filamentary structures are ubiquitous in molecular clouds, basic observational constraints are needed to clarify the role of filaments in the mass assembly of stars. Using ALMA Band 3, we have performed full-synthesis imaging of the N2H+ (1-0) emission with a spatial resolution of 0.034pc in the remarkable IRDC complexes, M17 SWex, where a delayed onset of massive star formation was reported in the two hubs at the convergence of multiple filaments of parsec length. We identify five filaments with FilFinder and fit the filament width with RadFil. The gas kinematics are obtained by fitting all the hyperfine components of N2H+ (1-0) spectra. About 1/3 of the spectra display multiple velocity components. We then derive velocity gradients along the filaments with principal component analysis. The mass accretion rates along the filaments are up to 10^-4 Msun/yr and significant to affect the hub dynamics within one free-fall time of 10^5 yr. The N2H+ filaments are in equilibrium with virial parameter in the range of 0.6-1.8 and with possible support from magnetic fields. We compare virial parameters measured in the N2H+ filament, NH3 filament, 870um dense clumps, and 3mm dense cores. The decreasing trend in virial parameter with decreasing spatial scale persists. Meanwhile, virial parameter also decreases with decreasing fraction of non-thermal motions . Together with the absence of massive prestellar and protostellar cores previously reported, the observation results are consistent with the hierarchical gravitational collapse scenario.

Name: Fatemeh Danesh Manesh (P)
Institution: Ferdowsi University of Mashhad

Title: Gravitational instability of filamentary molecular clouds

Abstract: Gravitational instability of filamentary molecular clouds leads to formation of high-density regions which are sites of star formation. The presence of magnetic field can hinder or facilitate this process. We investigate the fragmentation of a filamentary molecular cloud with uniform density and different mass per unit length. We also study the effect of magnetic field orientation by taking into account parallel and perpendicular magnetic field in respect to the filament axis. To this end, we use three-dimensional smoothed particle magnetohydrodynamic simulation with the Phantom code. We study the filament evolution and fragment formation including the filament width, number of fragments and their mass distribution and also compare their separation with the linear theory.

Name: Eleonora Fiorellino (P)
Institution: ESO - INAF - Universita' di Roma Tor vergata

Title: A census of dense cores in the Serpens region from the Herschel Gould Belt survey

Abstract: The Herschel Gould Belt survey mapped the far-infrared dust continuum emission from nearby star-forming regions, to better understand how the prestellar core phase influences the star formation process. I'll present the complete census of dense cores in the Serpens. This star-forming region, located at 436 pc, nearby the Aquila Rift complex, is characterized to be a young (less than 1Myr) and active low-mass and active star-forming region. I'll present the statistics of prestellar core in this region, discussing their gravitational stability, and particularly focusing on its core mass function, and its connection with the stellar initial mass function. The correlation between the spatial distribution of cores and the filamentary structure of the cloud is also explored. Finally, I'll present a comparison between our results and both previous literature on Serpens complex and Herschel studies on other Gould Belt star-forming regions.

Name: David Guszejnov (P)
Institution: UT Austin

Title: Is it possible to reconcile extragalactic IMF variations with a universal Milky Way IMF?

Abstract: One of the most robust observations of the stellar initial mass function (IMF) is its near-universality in the Milky Way and neighboring galaxies. But recent observations of early-type galaxies can be interpreted to imply a bottom-heavy IMF, while others of ultra-faint dwarfs could imply a top-heavy IMF. This would impose powerful constraints on star formation models. We explore what sort of cloud-scale IMF models could possibly satisfy these constraints. We utilize simulated galaxies which reproduce (broadly) the observed galaxy properties, while they also provide the detailed star formation history and properties of each progenitor star-forming cloud. We then consider generic models where the characteristic mass of the IMF is some arbitrary power-law function of progenitor cloud properties, along with well-known literature IMF models. We show that no IMF models currently in the literature - nor any model where the turnover mass is an arbitrary power-law function of a combination of cloud temperature/density/size/metallicity/velocity dispersion/magnetic field - can reproduce the claimed IMF variation in ellipticals or dwarfs without severely violating observational constraints in the Milky Way. Specifically, they predict too much variation in the extreme environments of the Galaxy, compared to that observed. Either the IMF varies in a more complicated manner, or alternative interpretations of the extragalactic observations must be explored.

Name: Ekta Sharma (P)
Institution: Indian Institute of Astrophysics

Title: Molecular filament formation and filament-hub interaction: LDN 1172/1174 dark nebula

Abstract: The LDN 1172/1174 complex represents a cometary shaped hub-filament morphology containing a number of clumps all along the filament and towards hub around HD 200775. NGC 7023 is a well known reflection nebula in LDN 1174 which is illuminated by an intermediate mass Herbig Be (B3) star HD 200775, in the Cepheus constellation at a distance of ∼ 340 pc. These clumps in the filaments might collapse into stars depending on the interplay of magnetic field, gravity and turbulence. The studies on the origin of filaments pose a crucial step in deciding the evolution of these clumps. Being relatively isolated star forming region, L1172/L1174 gives us an opportunity to get a glimpse of filament formation. To understand the dynamics of filament and its relation with magnetic structures on the periphery of cloud, kinematical studies over the whole filament have been conducted using molecular line observations of 12CO, C18O, N2H+(1-0) and CS (2-1) using 14-m single dish telescope at Taeduek Radio Astronomical Observatory (TRAO). In this talk, I will discuss the kinematics of this particular filament with respect to the magnetic field orientation (from optical polarization measurements) at the outer periphery of the cloud.

Name: Ya-Wen Tang (P)
Institution: Institute of Astronomy and Astrophysics, Academia Sinica

Title: Gravity, Magnetic Field and Turbulence: Relative Importance and Impact on Fragmentation in the Infrared Dark Cloud G34.43

Abstract: We investigate the interplay between magnetic field, gravity, and turbulence in the fragmentation process of cores within the filamentary infrared dark cloud G34.43. We observe the magnetic field (B) morphology across G34.43, traced with thermal dust polarization at 350 micron with an angular resolution of 10" (0.18 pc), and compare with the kinematics obtained from N_2H^+ across the filament. We derive local velocity gradients from N_2H^+, tracing motion in the plane of sky, and compare with the observed local B field orientations in the plane of sky. The B field orientations are found to be perpendicular to the long axis of the filament toward the MM1 and MM2 ridge, suggesting that the B field can guide material toward the filament. Toward MM3, the B field orientations appear more parallel to the filament and aligned with the elongated MM3 core, hinting a different B field role. Besides a large-scale east-west velocity gradient, we find a close alignment between local B field orientations and local velocity gradients toward the MM1/MM2 ridge. This local correlation in alignment supports a scenario where gas motions and B field lines are

intertwined. Additionally, this alignment appears to be anti-correlated with total thermal dust emission, showing a tightening alignment with growing emission. We analyze and quantify B field, gravity, turbulence, and their relative importance toward the three cores with various techniques. We extract all quantities over two scales, a larger clump area at 0.6 pc scale and the smaller core area at 2 pc scale. While we find that gravitational energy, B field, and turbulent pressure all grow systematically from large to small scale for the three cores, we reveal that the ratios among the three constituents develop clearly differently over scale. We propose that this varying relative importance between B field, gravity, and turbulence over scale drives and explains the different fragmentation types seen at sub-pc scale (no fragmentation in MM1; aligned fragmentation in MM2; clustered fragmentation in MM3). We discuss uncertainties, subtleties, and robustness of our conclusion, and we stress the need of a multi-scale joint analysis to understand the dynamics in these systems.

Name: Jiaerken Yeshengbieke (P)
Institution: Xinjiang Astronomical Observatory, CAS, China

Title: Large scale H2CO mapping observation to Perseus moleuclar cloud

Abstract: The large scale H2CO absorption line and H110 radio recombination line have been observed at 6cm waveband towards the Perseus Molecular Cloud using the Nanshan 25m telescope operated by the Xinjiang Astronomical Observatory, CAS. This first observation of the H2CO absorption line determine the most of the molecular regions that are affected by cosmic wave background in the Perseus molecular complex and show some of the dynamic properties. The value of the excitation temperature for H2CO may be estimated assuming that the column densities of H2CO and 13CO(1-0) are correlated. The intensity and velocity distributions of H2CO and 13CO(1-0) do not agree well with each other, which confirms that the H2CO absorption structure is mostly determined by the excitation of the molecules resulting from CMB rather than by the availability of molecular material as represented by the distribution.

Name: Asmita Bhandare (P)
Institution: Max Planck Institute for Astronomy

Title: Core and disk properties: from low- to high-mass star formation

Abstract: Stars are formed by the gravitational collapse of dense, gaseous and dusty cores within magnetized molecular clouds. Understanding the complexity of the numerous physical processes involved in the very early stages of star formation requires detailed thermodynamical modeling in terms of radiation transport and phase transitions. For this we use a realistic gas equation of state via a density and temperature-dependent adiabatic index and mean molecular weight to model the phase transitions. We perform molecular core collapse simulations including the stages of first and second hydrostatic core formation in spherical symmetry using a gray treatment of radiative transfer coupled with hydrodynamics as detailed in Bhandare et al. 2018. We investigate the properties of Larson's first and second cores and expand these collapse studies, for the first time to span a wide range of initial cloud masses from 0.5 Msun to 100 Msun. Thereby, we reveal a strong dependence of a variety of first core properties on the initial cloud mass. We find that the first core radius and mass increase from the low-mass to the intermediate-mass regime and decrease from the intermediate-mass to the high-mass regime. Most importantly, the lifetime of first cores strongly decreases towards the intermediate- and high-mass regime. Here, we demonstrate that low-mass protostars evolve through two distinct stages of formation of the first and second hydrostatic cores. In contrast, in the high-mass star formation regime, the collapsing cloud cores rapidly evolve through the first collapse phase and essentially immediately form Larson's second cores. Furthermore, based on our new 2D radiation-hydrodynamics simulations, I will discuss the impact of different cloud properties on the formation of early disks around these objects.

Name: Koki Higuchi (P)
Institution: Kyushu University

Title: MHD effects in lower metallicity star formation

Abstract: The star-forming environment varies from place to place and era to era in galaxies. In addition, stars are closely related to galaxy formation and the chemical evolution of the universe. Thus, the star formation process should be clarified in order to understand the history of the universe. The evolution of collapsing clouds embedded in different star-forming environments is investigated using three-dimensional non-ideal magnetohydrodynamics simulations considering different cloud metallicities and ionization strengths. With all combinations of these considered values, different star-forming environments are prepared and simulated. We research the evolution of magnetic field and protostellar outflows in lower metallicity star formation process.

Name: Chang Won Lee (P)
Institution: Korea Astronomy and Space Science Institute

Title: Study on the formation of Possible Precursors of Proto-Brown Dwarfs: L328-IRS and Others

Abstract: In the poster we would like to introduce our efforts on a systematic search for proto-brown dwarf candidates. Mainly we will introduce the results of ALMA observations for L328-IRS, a proto-brown dwarf candidate, to attempt to precisely measure its central mass in order to investigate whether L328-IRS is in the substellar mass regime. Then we will present some results of our recent CO outflow survey for 68 Very Low Luminosity Objects (VeLLOs) using single-dish observations in CO isotopologues to help to identify 15 proto-brown-dwarf (proto-BD) candidates which have the small mass accretion rate (∼10−8–10−7Msun/yr) much lower than that of the protostar candidates. We will also show some preliminary results of the ALMA observations for the proto-BD candidates.

Name: Zsofia Nagy (P)
Institution: Max-Planck-Institute for Extraterrestrial Physics

Title: The chemical structure of the starless core L1521E

Abstract: L1521E is a dense starless core in Taurus which was found to have relatively low molecular depletion. We have obtained ~2.5x2.5 arcminute maps in transitions of key molecular species, including C17O, CH3OH, c-C3H2, CN, SO, H2CS, and CH3CCH, using the IRAM-30m telescope, to study the chemical structure of L1521E. We compared the results to those obtained toward the more evolved and better characterized L1544 pre-stellar core. Based on the IRAM-30m C17O map and N(H2) derived from Herschel/SPIRE data, CO depletion toward L1521E is more significant than suggested by earlier studies, with a lower limit of 4.9+/-1.8 on the CO depletion factor toward the dust peak. The abundances of sulfur-bearing molecules such as C2S, HCS+, C34S, C33S, SO, and H2CS are higher toward L1521E than toward L1544 by factors of ~2-20, which suggests that significant sulfur depletion is taking place during the dynamical evolution of dense cores, from the starless to pre-stellar stage.

Name: Cynthia Saad (P)
Institution: American University of Beirut

Title: Star formation with cosmological initial conditions

Abstract: We conduct a fully self-consistent three-dimensional magneto-hydrodynamical simulation of the formation of the first stars in the Universe. We employ a 12 species chemistry consisting of H, H+, He, He+, He++, e-, H2, H2+,D, D+and HD molecules,in a magnetized primordial prestellar cloud at redshift 100. However, we investigate the redshift range of high density regions form.Our aim is to find if there is a critical magnetic field strength, below which magnetic effects can be ignored. A question is to find out whether the magnetic field will inhibit the formation of a circumstellar disk that can eventually fragment into smaller protostars. It would also be interesting to find the distribution of masses after the accretion process is terminated. In the case of magnetized dark matter haloes, other processes must be taken into consideration such as magnetic braking, angular momentum transport and protostellar jets. So,the expectation is that magnetic field will significantly affect the formationof the early stars as well as their evolution. We will follow the evolution of the protostar several years after its formation. This will allow us to compare the cases with and without magnetic field.

Name: Antoine Verliat (P)
Institution: CEA, Saclay

Title: Disk formation by asymmetrical gravitational collapse

Abstract: We investigate the possibility for a prestellar disk to be formed during the collapse of an initially motionless dense core with non axisymmetric density fluctuations. We perform three-dimensional hydrodynamic simulations of a collapsing prestellar dense core using adaptative mesh refinement. For our initial conditions we consider a spherical dense core with random density perturbations that roughly follow the turbulence spectrum and where all the cells are at rest. The angular momentum calculated in the simulation box referential in relation to the mass center is initially null and conserved during the collapse. The angular momentum calculated in the referential of the disk, in relation to the center of the disk is not conserved due to the non galilean caracter of the referential. We analyse the emerging disk comparing the angular momentum it contains with the one expected from the analytical development. As the angular momentum is not inherited from large scales, we discuss our results looking at the orientation of velocity gradients at different scales.

Name: James Wurster (P)
Institution: University of Exeter

Title: Protostar and disc formation with non-ideal magnetohydrodynamics

Abstract: Magnetic fields are undeniably a critical component of star formation, with the initial strength of the magnetic field ultimately affecting the characteristics of the protostar and of any protostellar disc that forms. Previous studies have shown that strong magnetic fields inhibit disc formation and promote strong, collimated outflows, while weak magnetic fields promote large discs and weak outflows. However, these results assume ideal magnetohydrodynamics (MHD), which is a poor approximation since the majority of the gas in a molecular cloud core is cold, neutral gas. Non-ideal MHD processes account for the motions of charged particles and how they interact with neutral particles. These processes - Ohmic resistivity, ambipolar diffusion and the Hall effect - depend on the local gas properties, magnetic field geometry, and the ionisation fraction. In this talk, I will present smoothed particle radiation non-ideal magnetohydrodynamics simulations of low-mass star and disc formation in the presence of a strong magnetic field. I will first discuss the parameter space in which non-ideal effects have the most influence, with a focus on the initial rotation rate of a molecular cloud core, and the magnetic field strength and orientation; from this study, we can isolate the parameter space in which discs will form, and we can further characterise the disc properties across this parameter space. I will then focus on selected models, and discuss the specific conditions under which a massive protostellar disc can form early in the star formation process (i.e. during the first core phase) in the presence of strong magnetic fields and a realistic cosmic ray ionisation rate; I will show how these results are dependent on the Hall effect. I will finally discuss effect that the non-ideal processes have on the origins of magnetic fields in stars.

Wednesday, June 12, 2019

Name: Bengt Gustafsson (I)
Institution: Uppsala University and Nordita

Title: How odd is the Sun and why?

Abstract: The peculiar chemical composition of the Sun, discovered by Melendez et al. in 2009, when compared with the composition of most Solar twins is still enigmatic. The various explanations that have been proposed are reviewed and discussed in the light of new observations. The power of the possibility proposed by Nordlund that chemical fractionation occurs in the inner proto-solar/planetary nebula is particularly commented on.

Name: Thomas Nordlander (I)
Institution: Australian National University

Title: New light on metal-poor stars

Abstract: I shall give a brief overview of late-type stellar abundance analyses, with a focus on recent progress in non-LTE radiative transfer and the application to metal-poor stars. As an aside, I shall also present recent results from the SkyMapper search for the most metal-poor stars in the Universe and implications for the formation of the first and second generations of stars.

Name: Anish Amrasi (C)
Institution: MPIA

Title: 3D non-LTE solar and stellar abundances

Abstract: Stellar abundance measurements are heavily model dependent, and for late-type stars, and especially for metal-poor late-type stars, the accuracy is often limited by the use of one-dimensional (1D) hydrostatic model atmospheres and the assumption of local thermodynamic equilibrium (LTE). Recently it has become feasible to relax both assumptions simultaneously, performing detailed 3D non-LTE radiative transfer post-processing with the code BALDER, of 3D radiative-hydrodynamical STAGGER simulations of stellar atmospheres. I shall discuss the physics and implementation of this more accurate method and review recent developments, including our latest results for the solar chemical composition, as well as for carbon, oxygen, and iron abundances in the Galactic disk and metal-poor halo and their implications on Galactic chemical evolution.

Name: Salvatore Colombo (C)
Institution: Sorbonne University - Università degli Studi di Palermo

Title: Radiative accretion shocks in classical T Tauri Stars

Abstract: Classical T Tauri Stars (CTTSs) are young stars accreting mass from their circumstellar disks. The material falls onto the star at free-fall velocity and hits the stellar surface, thereby producing shocks that heat the plasma at a few million degrees. Current magnetohydrodynamics (MHD) models of accretion provide a plausible global picture of the phenomenon at work. However, these models suggest that the impact regions may present very complicated structures and dynamics, with wide ranges of temperatures and velocities. In addition, while these models consider radiative energy losses, none of them includes a self-consistent calculation of the radiation effects, through absorption and emission, on the dynamics and energetics of the accretion stream. To understand the role of radiation in the accretion process, we developed a radiation hydrodynamics model of the accreting plasma in the region impacting the stellar surface. The model considers, for the first time, a Non-Local Thermodynamic Equilibrium (NLTE) regime. We found that the radiation arising from the shocked plasma is partially absorbed by the un-shocked part of the accretion column, which is then gradually heated up to a few 10^5 K, thereby forming a precursor region. This may explain the origin of UV fluxes observed in CTTSs which are much larger than expected by current models not including the radiation effects.

Name: Sergio A. Dzib (C)
Institution: Max-Planck-Institute for Radioastronomy

Title: Zooming in to young binary stars with VLBI and measuring their dynamical masse

Abstract: The properties of young multiple systems, such as mass ratio, component masses, and ages, are key observational signatures to probe star-formation theories. However, such deeply embedded stars are hardly accesible to optical telescope, and even the Gaia telescope will only be able to study binary stars with separations above 0.1 arcseconds. As part of an astrometric Very Long Baseline Interferometry (VLBI) program, we have resolved and studied several tight young binaries with typical separations of a few 10 milli-arcseconds or below. Our goal is to better characterize their orbits and measure accurate dynamical masses. In this talk I am going to present our first results (Dzib et al. in prep.), and show that these observations have substantially increased the number of young binaries available to investigate the distributions of component masses and mass ratios in young stars. I will also show that radio astrometry is a key technique that will keep contributing to the understanding of young stars at the early stages of star formation, even in the Gaia era.

Name: Nino Kochiashvili (C)
Institution: Abastumani Observatory, Ilia State University, Georgia

Title: LBVs and Star-Forming Regions in MW

Abstract: P Cyg, a luminous blue variable (LBV), should undergo the next great eruption in the near future according to long-term photometric data. We continue the photometric observations of this star and added other massive stars - hypergiants, WR and massive binaries to our observation program. In most cases, finding a comparison star for them in a field of 10-15 minutes is a big problem. As if the stars are isolated. We decided to explore the environments of these objects. Of course, it is well known that massive stars are not born individually, but in groups. For example, the hypergiant P Cyg is a member of the so-called association Cygnus OB1, which, together with other components and other stellar groups, is part of the star-forming complex Cygnus X. The complex is located on the edge of the galactic spiral arm. Other LBVs in Milky Way are also connected with spiral arms. We are going to discuss the star-forming complexes of Cygnus and Karina-Sagittarius with an emphasis on LBVs and other interesting massive stars in them. These areas are well studied at different wavelengths. The focus will be on the possible role of density waves in star formation.

Name: Mauricio Tapia (C)
Institution: Instituto de Astronomia, UNAM, Ensenada, Mexico

Title: Discovery of an eclipse of a main sequence star by a dense core housing Mol 12, a Class I YSO: The case of a possible star/YSO eclipsing binary

Abstract: As part of a deep near- and mid-infrared imaging survey of young stellar objects (YSOs) within known ammonia cores, we have discovered the phenomenon of a dense dust core housing the Class I YSO Mol 12 eclipsing the light of an early-type star. Both objects probably constitute an eclipsing binary system, as they have nearly identical coordinates and parallaxes as measured by Gaia (DR2) in the case of the star, and by VLBI techniques in the case of the of the water maser associated to the YSO. The light-curve constructed with all the available photometry indicates that the eclipse lasted about 15 years, from 1985 to 2000 and was characterized by a depth in Av of approximately 22 magnitudes, and a near-IR reddening law with a value of the ratio E(J-K)/E(H-K) of approximately 3.4. No further significant variations have been recorded since the year 2002. We also present recent near-IR spectroscopy in order to obtain a better classification of the nature of stellar system.

Name: Raul Jimenez (C)
Institution: ICREA & ICC, University of Barcelona

Title: What will be the next disruption in Cosmology?

Abstract: Aake's contribution to the modeling of stars, and in particular, stellar atmospheres has been groundbreaking and transformational. We learn about cosmology by studying the properties of galaxies, which in turn are made of stars. Most past disruptions in Cosmology have come from modeling stars: dark energy and the current "Hubble tension" that maybe indicative of new physics. I will show in this talk what the next disruption in cosmology may come from and describe in detail how detailed knowledge about how stars from, evolve and "look like" will give us clues on new physics.

Name: Mario Giuseppe Guarcello (P)
Institution: INAF - Osservatorio Astronomico di Palermo

Title: Time resolved X-ray spectral analysis of class II YSOSs in NGC 2264 during optical dips and bursts

Abstract: TBD

Name: Nicolás Medina (P)
Institution: Universidad de Valparaíso

Title: The G305 complex region: The variability view of VVV survey.

Abstract: Time-varying phenomena represent one of the most substantial sources of astrophysical information. Their study is important to identify different astronomical sources, to discover new properties of already known systems, and to map the structure of our galaxy. In this context, I will present how we can extract information from variable objects using more than five years of photometric Ks-band data from Vísta Variables in the Vía Láctea (VVV) survey, using the the methods presented in (Medina et al. 2018) to search and analyze different variable sources in the surrounding of the G305 complex, which is a massive and wide-area Star-Forming Region (SFR), located surrounding the coordinate $\ell = 305^{\circ}.4$, $b= 0^{\circ}.1$, within the Scutum Crux arm of the Milky Way. This complex it is been a high interest region for literature, given the variety of stellar stages that are contained in the surroundings of this SFR, from deeply embedded Young Stellar Objects (YSOs) to young and massive open clusters in the center of this complex, with massive stars and strong stellar winds that affected its interstellar material. Focusing on the identification of YSO, we identified more than 350 objects with a prominent near-infrared variability in the environment of the G305 complex. The selected sources do not exhibit a periodic or semi-periodic behavior, and are sources of young variables in good faith. About 80% of these sources are previously unknown as variable stars.

Thursday, June 13, 2019

Name: Sylvain Bontemps (I)
Institution: Laboratoire d'Astrophysique de Bordeaux / Université de Bordeaux

Title: Recent progresses in our understanding of the formation of high-mass stars
Abstract: TBD

Name: Rolf Kuiper (I)
Institution: University of Tübingen

Title: Modeling Massive Star Formation
Abstract: In the course of their accretion phase, massive (proto)stars impact their natal environment in a variety of feedback effects such as thermal heating, MHD-driven protostellar jets and outflows, radiation forces, photoionization feedback and HII regions as well as stellar winds. Here, I present our most recent simulation results on the efficiency of these feedback processes and if/how they contribute to the upper mass limit of present-day stars. Furthermore, we predict the fragmentation of massive circumstellar accretion disks to be the most natural explanation for the recently observed strong accretion bursts in high-mass star forming regions and the formation of spectroscopic massive binaries.

Name: Jordan Molet (C)
Institution: Laboratoire d'Astrophysique de Bordeaux

Title: Characterization of the best high-mass prestellar core candidate found so far
Abstract: Despite considerable observational efforts over the past 10 years, the very existence of high-mass pre-stellar cores remains a matter of debate. We recall that while high-mass pre-stellar cores are the starting point of the 'turbulent core model' that forms high-mass stars, more dynamical models including the 'competitive accretion model' can skip such a phase. It is just as topical as ever with ALMA which allows now to achieve the spatial resolution necessary to characterise the cores in far away high-mass star forming regions. Very few pre-stellar candidates have been reported and their status is often unclear (see Motte, Bontemps, Louvet 2018). We recently have identified a new, excellent high-mass prestellar core candidate in the W43-MM1 hyper-massive filament, located at a distance of 5.5 kpc (Nony et al. 2018). The region contains numerous 2000 AU massive cores with up to ~100 M⊙ among which one high-mass (60 M⊙) core that does not drive any outflow nor other typical signatures of star formation. To confirm the pre-stellar nature of this core, we have studied its physical conditions and environment through a detailed analysis of its molecular content. We used high spectral and spatial resolution data from ALMA Cycle 2 and Cycle 3 at 230 GHz, covering a total bandwidth of 5 GHz with a 0.5'' (~2400 AU) spatial resolution. We will introduce the technique we developed to obtain automatically a continuum map free of emission lines contamination. With the distribution of the miscellaneous identified molecules, we made a selection of those that are directly associated to the core. Then, the kinetic temperatures and abundances of these molecules are compared to other star-forming regions. Our results tend to confirm that this high-mass core is prestellar in nature and thus a very unique object (Molet et al. 2019). Deep dedicated line surveys are however necessary to confirm that this high-mass core does not harbour a hot corino, like those found toward low-mass class 0s.

Name: Adam Ginsburg (C)
Institution: National Radio Astronomy Observatory

Title: Measuring high-mass protostar masses with disks
Abstract: Disks are a common feature of star formation independent of mass, though Keplerian disks around high-mass stars have been difficult to detect. ALMA's long baselines now provide the opportunity to resolve disks around some of the closest stars. In Orion Source I, the closest high-mass protostar, we have detected new molecular lines of NaCl (salt) and KCl that uniquely trace the circumstellar disk and follow a Keplerian rotation profile. These lines will provide a key tool to measure the masses of young and accreting high-mass protostars, providing a unique means to test theories of high-mass star formation and of the formation of the stellar IMF. I will discuss both the existing measurements of high-mass protostars and the potential to extend these measurements to a larger population.

Name: Nanda Kumar (C)
Institution: Institute of Astrophysics and Space Sciences, Porto

Title: High-mass star formation in the filament-hub paradigm
Abstract: Hubs formed by intersecting interstellar filaments (ISF) naturally render an elongated geometrical configuration where the radiation pressure and gravity do not stand in opposition. The magnetic field structure of ISF and hubs aid in preventing the early fragmentation. I will show that the most luminous protostellar sources are preferentially located in hub-systems, and show how they can elegantly eliminate the classical problems of high-mass star formation.

Name: Patrick Koch (C)
Institution: ASIAA

Title: Zooming in: Magnetized Disk in the High-Mass Star-Forming System W51 e2
Abstract: With increasingly higher resolutions in dust polarization we have resolved the magnetic field structures in the high-mass star-forming system W51 e2 from its 0.5 parsec-scale envelope to its individual cores at a scale of a few mpc. These observations reveal a transition in magnetic field structures from mostly orthogonal to the filamentary envelope axis to smaller-scale field structures that reveal collapsing cores. Additional high-resolution features such as convergence zones and bow-shock shaped field structures from infalling smaller cores hint at a scenario where local collapse happens within larger globally contracting structures. Our latest ALMA Band 6 (230 GHz) dust polarization observations further resolve W51 e2 with an unprecedented resolution of about 500 AU in this source. The detected magnetic field structures display a field morphology and properties that are strikingly similar to a young protostellar source with a flattened envelope and a disk. Despite being different by orders of magnitude in physical scale and densities, our observations show disk-hinting magnetic field structures in a high-mass system that seem identical to those in a low-mass source. Across the different physical scales we showcase new analysis techniques to quantitatively assess the role of the magnetic field from cloud envelope to disk.

Name: Johan van der Walt (C)
Institution: Centre for Space Research, North-West University, South Africa

Title: Masers and high-mass star formation
Abstract: Maser emission associated with young high-mass star forming regions is a common phenomenon. Although the interpretation of maser emission is not as well established as in the case of thermal emission, masers do reveal other aspects of the physical and chemical environment of very young high-mass stars. In this talk I will briefly review the association of masers associated with young high-mass stars, the periodic variability of methanol and OH masers and the possible interpretation thereof, as well as to present results of recent SMA and ALMA observations to understand some aspects of the periodic behaviour of some masers. I will also present recent results on the flaring of methanol and water masers associated with suspected accretion events in two high-mass star forming regions.

Name: Aida Ahmadi (C)
Institution: Max Planck Institute for Astronomy

Title: Disk Kinematics & Fragmentation in High-Mass Star Formation

Abstract: In recent years, differentially rotating disk-like structures have been observed surrounding the most luminous cores, making a case for high-mass star formation being a scaled-up version of low-mass star formation in this context. However, the fragmentation mode and the properties of these disk-like structures have yet to be comprehensively characterised. Using the IRAM NOrthern Extended Millimeter Array (NOEMA) and the IRAM 30-m telescope, the CORE survey has obtained high-resolution (~0.35", 700 AU at 2 kpc) observations of 20 well-known highly luminous star-forming regions in the 1.37 mm wavelength regime in both line and dust continuum emission. I will present our findings on the kinematics of the sample, using the disk tracer CH_3CN. We find rotating structures surrounding the majority of our sample, making a case for disk-mediated accretion in high-mass star formation. We find that different fragmentation processes can contribute to the final stellar mass distribution within a single region, with core fragmentation on large scales and disk fragmentation on smaller spatial scales. We are able to study the Toomre stability of these structures and predict their fate in the disk fragmentation scenario. Furthermore, we use radiation hydrodynamic simulations to test the applied methods and investigate the limits of what current observations can unveil.

Name: Igor Zinchenko (C)

Institution: Institute of Applied Physics of the Russian Academy of Sciences

Title: Episodic accretion and outflows in the S255IR high mass star-forming region

Abstract: High-resolution studies revealed several dense cores in the S255IR area. The most massive one, S255IR-SMA1, harboring 20 solar masses YSO, which is associated with the NIRS3 IR source, exhibited recently a unique burst at various wavelengths and in the maser emission. It is interpreted as an evidence of the disk-mediated accretion event. Our ALMA data reveal a picture of this region in submillimeter continuum and in various molecular lines with the resolution of about 200 AU. They show the structure of the disk around the massive YSO and of the outflows in this area. The disk looks inhomogeneous with a Keplerian rotation. There are at least two outflows originating at the SMA1 and SMA2 cores. The outflow from SMA1 has a wide opening angle. It is surrounded by dense walls, observed in the $C^{34}S$ and CCH lines. This structure may be rotating. There are signs of interaction between the outflowing gas and these walls, which may be created by previous outburst events. Detailed studies of this object may reveal general features of high mass star formation.

Name: Willice Obonyo (C)

Institution: University of Leeds

Title: Massive Protostellar jets

Abstract: Massive young stellar objects (MYSOs) have recently been shown to drive jets whose particles can interact with either the magnetic fields of the jet or ambient medium to emit non-thermal radiation. We report a search for non-thermal radio emission from a sample of 15 MYSOs to establish the prevalence of the emission in the objects. We used their spectrum across the L-, C- and Q-bands along with spectral index maps to characterise their emission. We find that about 50% of the sources show evidence for non-thermal emission with 40% showing clear non-thermal lobes, especially sources of higher bolometric luminosity. All the central cores of the sources are thermal with corresponding mass-loss rates that lie in the range~3e−7 to 7e−6Myr−1. Given the presence of non-thermal lobes in some of the sources and the evidence of non-thermal emission from some spectral index maps, it seems that magnetic fields play a significant role in the jets of massive protostars. Also noted is that some of the sources show evidence of binarity and variability.

Name: Becky Arnold (P)

Institution: University of Sheffield

Title: Quantifying velocity structure in star forming regions

Abstract: Several methods have been devised for quantitatively analysing the spatial structure of star forming regions e.g. the Q parameter (Cartwright and Whitworth 2004, Allison et. al 2009, S Maschberger & Clarke 2011). These methods have been valuable and well used by the field. However there are not similar methods of quantitatively analysing the velocity structure of star forming regions. With the advent of Gaia the field has access to an unprecedented quantity of high quality velocity data. In order to take full advantage of this, new methods are required to quantitatively analyse it. A new method for quantifying and investigating velocity structure in star forming regions will be presented. This method can be applied to data with any number of dimensions, and requires no assumptions about the size or morphology of the region. The method will be applied to simple simulated clusters such as expanding and collapsing Plummer spheres and the results discussed. It will then be demonstrated that the method is robust against high incompleteness and large uncertainties in simulated datasets. To conclude the method will be applied to observational data and the results interpreted.

Name: Yuko Matsushita (P)

Institution: Kyushu University

Title: Detected Both Outflow and Jet Source: MMS 5 / OMC-3 Revealed with ALMA

Abstract: Both high- and low-velocity outflows are occasionally observed around a protostar by molecular line emission. The high-velocity component with a velocity of $\gtrsim 50 - 100$ km/s is called "Extremely High-Velocity (EHV) flow," while the component with a velocity of ~ 10 km/s is simply referred to as "(molecular) outflow." Since these flows are observed only in an early phase of star formation, they are considered to be a pivotal target to clarify the star formation process. This study reports a newly found EHV flow and outflow around MMS 5 in the Orion Molecular Cloud 3 observed with ALMA. The EHV flow is detected with CO J =2–1 and SiO J =5–4 line emissions. CO J =2–1 emission traces both the EHV flow and outflow. In addition, SiO J=5–4 emission, which only traces the EHV flow, and has a considerably collimated structure which includes several knots. The high-velocity collimated component (EHV flow) is located at the root of the V- shaped low-velocity outflow. Dynamical timescale of the EHV flow is smaller than that of the outflow by a factor of ~3. In addition, the axis between the outflow and the EHV flow is different. The flow driving mechanism is discussed in terms of the dynamical timescale and different P.A. between the EHV flow and outflow. We suggest these evidences possibly support the MHD wind model.

Name: Paolo Persi (P)

Institution: IAPS/INAF

Title: Infrared Imaging of high-mass young stellar objects

Abstract: We present deep near- and mid-infrared images of six high-mass young stellar objects (YSOs) in order to help understanding the physical mechanisms of their formation. We have searched for shocked H_2 emission around such massive protostars. All but one of these regions exhibit series of molecular hydrogen emission knots, either in perfect alignment or in more complex configurations. In the case of the Class I object Mol 7, the protostars driving a couple of highly bipolar collimated outflows appear to be members of a binary or multiple system. A similar scenario appears to be the case for Mol 143. The protostar Mol 12 drives a large low-collimated bipolar outflow with a number of H_2 emission nebulosities. In two other methanol cores studied here, we also found shocked molecular hydrogen knots driven by highly embedded YSOs, some of them in clusters. From their near-IR to millimetre-wavelength spectral energy distributions, we derived a number of physical parameters describing these sources, such as extinctions, luminosities, disk masses and accretion rates.

Name: Jianjun Zhou (P)

Institution: Xinjiang Astronomical Observatory, CAS, China

Title: Spatial variations of chemical properties in massive star forming regions

Abstract: We use the MALT90 survey data to derive the abundance distributions of N_2H^+, HCO^+, HCN and HNC for 90 massive star forming clumps, and the distributions of abundance

ratios between them. We studied the spatial variations of the abundances and abundance ratios, and discuss their correlations with H$_2$ column density, temperature and 20cm continuum emission. Firstly, the abundances of N$_2$H$^+$, HCO$^+$, HCN and HNC increase as a function of decreasing column density and increasing temperature. We found that the column densities of these four molecules vary little when the H$_2$ column density vary about one order of magnitude. So the spatial variations of the abundances of these four molecules were dominated by H$_2$ column density. Secondly, the abundance ratios between N$_2$H$^+$, HCO$^+$, HCN, and HNC also display systemic variations as a function of column density. This could be explained by the chemical properties of these four molecules. Thirdly, the sources associated with the 20cm continuum emission could be classified into four types. For the first type of sources, the abundances of these four molecules decrease with increasing 20cm continuum emission flux. For the second type of sources, the abundances of these four molecules increase with increasing 20\,cm continuum emission flux. For the third types of sources, the abundances of these four molecules increase with increasing 20\,cm continuum emission flux when the flux is $\leq$$\sim$10mJy/beam. The abundances of these four molecules decrease with increasing 20\,cm continuum emission flux when the flux is $\geq$$\sim$10mJy/beam. Further analysis suggests that these variations are also dominated by H$_2$ column density. For the fourth type of sources, the abundances of these four molecules have no obvious correlation with 20\,cm continuum emission. We noted that the abundance ratios between these four molecules usually do not show obvious trend as a function of 20\,cm continuum emission flux. Because the spatial variations of the abundances of N$_2$H$^+$, HCO$^+$, HCN an HNC are dominated by H$_2$ column density, it is difficult to use them to extract the chemical properties characterizing the evolution of massive star forming regions.

Name: Annie Zavagno (I)
Institution: Laboratoire d'Astrophysique de Marseille

Title: Ionized regions & Star Formation

Abstract: I will present recent results on the interplay between ionized (HII) regions and star formation observed in their surrounding. I will discuss the role of ionization feedback and how this feedback modifies the properties of the newly formed stars.

Name: Richard Wunsch (I)
Institution: Astronomical Institute, Czech Academy of Sciences

Title: Multiple stellar populations in globular clusters from winds of massive stars

Abstract: It has been found by both spectroscopic and photometric observations that globular clusters (GCs) include two or more populations of stars differing in their chemical composition. Specifically, stars show variability in abundances of light chemical elements and the observed patterns can be understood by assuming that some stars have been formed out of the gas enriched by products of high-temperature hydrogen burning. We develop a model of Rapidly Cooling Shocked Stellar Winds in which the subsequent stellar populations in GCs are formed out of winds of massive stars of the first population. In dense and massive young star clusters, the hot gas originating from wind-wind collisions becomes thermally unstable and forms dense warm gaseous structures that sink into the cluster centre where they accumulate, cool further due to self shielding of the ionising radiation of stars, and form new stars. We use a fast semi-analytic code to follow the evolution of the star cluster during the the first several Myr (before supernovae start to explode), for various combinations of parameters given by stellar evolution and stellar wind models, to identify regions of parameter space where the secondary star formation occurs. Then, we simulate the selected models using 3D radiation-hydrodynamic code. This allows us to explore the interaction of individual stellar winds, the formation of dense warm structures and secondary star formation in detail, and obtain more accurate and better justified results. Furthermore, we synthetically observe the simulations and predict profiles of the recombination lines formed in the ionised gas that would allow tests of the model by observations from radio telescopes.

Name: Morten Andersen (C)
Institution: Gemini Observatory

Title: The formation of massive star clusters and their Initial Mass Function

Abstract: How massive star clusters form and what their Initial Mass Function (IMF) is are topics of great interest in astrophysics. Learning about their formation can teach us of how globular clusters were formed and studying their IMF is closely related to the question of whether the IMF is universal. Here we present results based on high spatial resolution imaging of a Galactic high-mass star cluster caught during its formation. This presents a unique opportunity to study the star formation during the phase where the cluster is still gas dominated. We discuss the stars spatial distribution and what it can tell us about the clusters formation as well as the properties of the stellar content of the cluster. We further discuss the discovery of several potential proto-clusters that may evolve into massive star clusters.

Name: Zeinab Khorrami (C)
Institution: Cardiff University

Title: The IMF in Young Massive Stellar Clusters: do we understand the completeness?

Abstract: Observations of Young Massive Clusters (YMCs) play a central role in star formation research, as they represent the more extreme end of the star formation process. The IMF in these clusters is of particular importance, as any variations from the standard field IMF can hint at changes in the dominant physical processes that regulate the mass of stars during their formation. However, the IMF is very difficult to observe in YMCs, and to correct for the affects of crowding, one needs to work out the completeness limits as a function of mass. This is typically done by inserting artificial stars randomly into the observed image, and seeing how often they can be recovered by the source extraction process. However, we show here that the standard technique for introducing artificial stars in the images is woefully inadequate, underestimating the completeness towards the peak of the IMF by as much as 80%. We introduce a new Monte-Carlo-Markov-Chain technique that does a much better job of estimating completeness, and thus produces more reliable IMF determinations in YMCs. Our study makes use our new “MYOSOTIS” tool, which is designed to make synthetic observations of star cluster simulations.

Name: Christine Allen (C)
Institution: Instituto de Astronomia, Universidad Nacional Autonoma de Mexico

Title: Extremely short dynamical lifetimes of young stellar groups

Abstract: Massive star formation is thought to occur in groups in which the separations beween components are similar. We have studied the dynamical evolution of several such young groups, namely the minicluster Theta1 Ori B, the Orion Trapezium itself, and another 10 massive multiple systems with similar separations among components, known as trapezium-type systems. As initial conditions we used the planar positions, transverse velocities, distances and masses from the best observations in the literature. Unavailable data were modeled by Monte Carlo simulations, within realistic intervals. Our N-body integrations show that the dynamical lifetimes for such systems are extremely short, of the order of 10 to 40 thousand years, and thus much shorter than the evolutionary lifetimes of their components. The end result of the integrations is usually a massive binary, sometimes a triple system. Some hierarchical triples can survive for up to the full integration time, a million years. Non-hierarchical triples survive for only up to 300 thousand years. The binaries end up as field binaries, with properties similar to those of observed wide binaries. We note that even after a comprehensive literature search we found data for only 10 systems likely to be physical multiples with similar member separations. This indicates that such groups are relatively scarce in the field, which is consistent with the very short dynamical lifetimes we found. The implication is that star formation in groups results in dynamically very short-lived systems, which quickly disperse and become indistinguishable from field stars.

Name: Jakob Ward (C)
Institution: Heidelberg University

Title: Not all stars form in clusters - measuring the kinematics of OB associations with Gaia

Abstract: It is often stated that star clusters are the fundamental units of star formation and that most, if not all, stars form in dense stellar clusters. In this monolithic formation scenario, low density OB associations are formed from the expansion of gravitationally-bound star clusters following gas expulsion due to stellar feedback. From N-body simulations, one would expect associations that formed in this manner to continue to exhibit positive radial velocities and elevated levels of anisotropy over 10s of Myr. However, recent theoretical and observational studies suggest that star formation is a hierarchical process, following the fractal nature of natal molecular clouds and allowing the formation of large-scale associations in-situ. Using the Tycho-Gaia Astrometric Solution (TGAS) catalogue, we quantified four key kinematic diagnostics for 18 nearby OB associations in order to determine whether the typical kinematic behaviour of OB associations is consistent with a monolithic star formation scenario. We compared the distributions of each of these diagnostics with those derived from model OB associations with kinematics representative of random motions and expansion, both from a single cluster and from multiple clusters. None of these diagnostics show any evidence of expansion, and the observed kinematics are best represented by a random velocity distribution, favouring a hierarchical formation scenario. With 5-parameter astrometric solutions for over 500 times as many stars and typically an order of magnitude improvement in precision over TGAS, the second Gaia data release (Gaia-DR2) presents a much more nuanced picture of the formation and evolution of OB associations. I will present the exciting new results from the expansion of our study to Gaia-DR2, with which we implement clustering algorithms to independently identify over-densities of OB-type stars before measuring the kinematic properties of over 100 OB associations. I will discuss the implications of these results of these studies with particular emphasis on the unique potential of Gaia to distinguish between the monolithic and hierarchical star formation paradigms.

Name: Anna Rosen (C)
Institution: Harvard-Smithsonian Center for Astrophysics

Title: How Stellar Feedback Limits Accretion onto Massive stars

Abstract: Massive stars play an essential role in the Universe. They are rare, yet the energy and momentum they inject into the interstellar medium with their intense radiation fields dwarfs the contribution by their vastly more numerous low-mass cousins. Massive stars form in magnetized, dense, and cold molecular gas from the gravitational collapse of massive pre-stellar cores located in highly embedded environments. During their formation, feedback from their intense radiation fields, magnetically launched collimated protostellar outflows, and fast, isotropic radiatively driven winds can limit their growth by accretion. In this talk, I will present a series of 3D radiation-magnetohydrodynamic simulations of the collapse of turbulent, massive pre-stellar cores into massive stellar systems that include these feedback mechanisms to demonstrate how stellar feedback can limit accretion onto massive stars. In particular, we find that inclusion of feedback from outflows punches holes in the ISM along the star's polar directions, thereby increasing the size of optically thin regions where radiation can escape while winds shock heat the infalling gas and may eventually shut off accretion onto massive stars.

Name: Jeong-Gyu Kim (C)
Institution: Princeton University

Title: Dispersal of Giant Molecular Clouds by UV Radiation Feedback from Massive Stars

Abstract: UV radiation from newborn massive stars exerts a profound influence on the dynamical evolution of natal molecular clouds by exciting HII regions and driving their expansion. To quantitatively investigate the destructive effects of UV radiation feedback, we perform radiation hydrodynamic simulations of the dispersal of cluster-forming molecular clouds by photoionization and radiation pressure. Our parameter study shows that the cloud destruction takes ~2-10 Myr after the onset of star formation and that the final star formation efficiency increases primarily with the initial surface density of the cloud. Radiation pressure plays a greater role than photoionization in driving outflows and quenching star formation in high surface density clouds. A significant fraction of ionizing and non-ionizing UV photons escape through large, low-density holes created by turbulence. The radial momentum injection rate from thermal and radiation pressure forces is smaller than the spherical case due to momentum cancellation and escape of radiation. We will discuss astronomical implications of our findings.

Name: Sopia Beradze (P)
Institution: Abastumani Astrophysical Observatory, Illia State University

Title: P Cygni as a possible member of an open cluster

Abstract: Hypergiant P Cygni is a rare type of massive stars – Luminous Blue Variables (LBVs). This is a short, about 40000 years, evolutionary stage of massive stars. The star is a member of the association Cygnus OB1 in the star-forming complex Cygnus X. According to earlier studies by Turner and co-authors, P Cygni could be a member of a hypothetical, sparsely populated open cluster. The star lies near the east boundary of this hypothetical cluster. There is another, but known open cluster IC 4996 on the vicinity of P Cygni. The same authors believe that above mentioned two clusters are connected to each other and they could represent a double cluster. As P Cygni is a hypergiant and consequently has very strong and variable stellar wind which obscures the star, so a cluster membership can enable us to determine the age, distance, and reddening of the star relatively precisely. We used new data of different catalogues, for example, PPMXL, 2MASS, GAIA and tried to resolve the problem.

Name: Emmanuel Bratsolis (P)
Institution: University of Athens

Title: The region N83-84-85 of the SMC. Possible supernova explosions and triggered star formation.

Abstract: The region N83-84-85 belongs to the inner wing of the SMC and is of interest because of its OB associations and nebulae. It is evident that there is a correlation between associations like NGC 456, 460 and 465 with the nebulae of ionized gas. We focus on this region because it seems to show a feedback between OB star formation and the physical properties of the interstellar medium. At the same region different molecular clouds and HI shells have been detected. Stellar spectral classification is not only a tool for labeling individual stars but is also useful in studies of stellar population synthesis. Low-dispersion objective prism images have been used and automated methods of detection, extraction and classification have been developed. We find evidence of triggered star formation from massive stars of older to more recent OB associations. Circular arcs constructed by O and B stars have been detected. A study of the population places stars with more recent ages in the groups of the arcs than of their centers. These effects can be explained by supernova explosions. Key words: image processing – star formation – classification – Small Magellanic Cloud – shock waves References Bratsolis E., Bellas-Velidis I., Kontizas E., Pasian F, Dapergolas A., and Smareglia R. 1998, A&AS, 133, 293 Bratsolis E., Kontizas M., and Bellas-Velidis I., 2004, A&A, 423, 919 Bratsolis E., 2005, JASP, 15, 2536 Hatzidimitriou D., Stanimirovic S., Maragoudaki F., Staveley-Smith L., Dapergolas A., and Bratsolis E. 2005, MNRAS, 360, 1171 Livanou, E., Gonidakis, I., Kontizas, E., Klein, U., Kontizas, M., Kester, D., Fukui, Y., Mizuno, N., and Tsalmantza, P., 2007, AJ, 133, 2179

Name: Alejandro Gonzalez-Samaniego (P)
Institution: Instituto de Radioastronomía y Astrofisica, UNAM

Title: How feedback shapes the structural properties of stellar clusters formed within Molecular Clouds

Abstract: It is well known that most stars form in groups or clusters, which in turn form from Molecular Clouds (MC), but it is still not clear how the structural properties of the clusters are affected by the feedback from their massive stars while they are still connected to their parent MCs. Here we present results from hydrodynamical simulations in which we study stellar cluster formation within a MC undergoing global hierarchical collapse, focusing on the effect of feedback from the photoionizing radiation from massive stars. We show that the feedback from the newly formed stars strongly affects the morphology and dynamics of the gas that continues to fall onto the cluster-forming clump. In particular, we find that the resulting stellar sub-clusters (or "groups")

are more extended in simulations that include feedback than the ones obtained in control simulations without feedback, and that infalling motions of the stars forming in the periphery are reduced by this effect. Age gradients in groups can be erased or modified due to the effect of the feedback from massive stars.

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Name: Sarah Jaffa (P)

Institution: University of Hertfordshire

Title: Simulating Young Massive Clusters

Abstract: Young Massive Clusters (YMCs; ages < 100 Myr, masses > 10^4 Msun, radii <~5pc) represent the extremes of the star formation process. These very bright systems have been observed both in our own Galaxy and in other galaxies, but we do not yet have a well-defined model for their formation. The challenge of assembling such a large mass into a single cluster in a short time without the natal cloud being disrupted by feedback has been debated, but simulations to test our theories are generally limited in resolution due to the huge masses involved. In this project, we aim to simulate the possible formation mechanisms of YMCs using Smoothed Particle Hydrodynamics codes capable of resolving the formation of individual stars. This will allow us to test different formation models, examine the role of feedback, and understand whether star formation is halted by gas exhaustion or expulsion.

Name: Nina Sartorio (P)

Institution: INPE - National Institute for Space Sciences

Title: The effect of photoionization feedback in disks of forming massive stars

Abstract: In this talk we present an analysis of the impact photoionizing radiation has on the disks of forming massive stars. In order to that, we rely on a number of simulation preformed with CMacIonize – a Monte Carlo based radiation hydrodynamics code. Ionized regions in the disk plane are found to be either gravitationally trapped or in pressure driven expansion depending on whether or not the size of the ionized region exceeds a critical radius. Trapped Hii regions in the disk plane allow accretion to progress, while expanding Hii regions disrupt the accretion disk preventing the central star from aggregating more mass, thereby setting the star's final mass. We obtain constraints for the luminosities and disks densities that lead to both scenarios and, therefore, under which conditions massive stars can form.

Name: Rebeka Bogner (P)

Institution:

Title: Pre- and protostellar cores in the Rosette Nebula

Abstract: The Herschel satellite with its wavelength coverage could detect massive young stellar objects at all evolutionary stages and was able to detect the precursors of O and B stars. The Rosette Molecular Cloud (RMC) at 1.6 kpc from the Sun is a well-known area: the OB cluster NGC 2244 at the centre is blowing a cavity into it, resulting in an expanding HII region interacting with a high-mass star forming molecular cloud. The cloud has a highly filamentary structure with dense cores covering a wide range of masses. These pre- and protostellar cores were observed by Herschel and key core properties were derived from its data. With the Effelsberg 100m telescope a sample of these cores were observed in NH_3 (1,1) and (2,2) inversion lines. We calculated gas parameters from the ammonia data, which then we compare to the dust properties and investigate their differences according to their distance from NGC 2244 to find possible evidence for triggered star formation.

Friday, June 14, 2019

Name: Diego Turrini (I)
Institution: INAF-IAPS

Title: Giant planets and planetesimals: making an impact on the composition of planetary systems

Abstract: The first few millions of years of the life of planetary systems, when the young stars are surrounded by their protoplanetary disks, is a period extremely difficult to investigate and still limitedly understood. Yet, many fundamental steps of the planetary formation process at this time, among which is the formation of the giant planets. When giant planets appear in protoplanetary disks, their strong gravitational perturbations dynamically and collisionally excite the surrounding planetesimal population. While such effects are often associated to scenarios involving extensive orbital migration, the mass growth of the giant planets is sufficient condition to trigger them. This phase of dynamical and collisional excitation of the planetesimals, therefore, represents a common step in the early life of planetary system hosting giant planets. Here I'll first describe how these processes can help us to constrain the ancient past of the Solar System through their effects in shaping the composition of asteroid Vesta, the most ancient known body in the Solar System. I'll then describe how the same processes, due to their general nature, can shape the characteristics of circumstellar disks and help explain some of their unexpected features emerging from recent observations. Finally, I'll touch upon how the same processes affect the very giant planets that trigger them and how this can impact future observational efforts in compositionally characterize exoplanets.

Name: Jonathan Tan (I)
Institution: Chalmers University and University of Virginia

Title: Inside-Out Planet Formation

Abstract: Inside-Out Planet Formation (IOPF) is a theory for the in situ formation of Systems of Tightly-packed Inner Planets (STIPs). It involves pebble radial drift to the dead zone inner boundary (DZIB), where there is a pressure trap due to the rapid increase in viscosity as gas enters an magnetorotational instability (MRI)-active zone. The DZIB occurs at about 1200K due to thermal ionization of alkali metals. A planet forms from the pebble ring, growing until it is massive enough to open a shallow gap and displace the pressure maximum leading to truncation of its pebble accretion. The DZIB retreats, a new pebble ring forms and the process repeats. I review latest theoretical work and observational tests of this model.

Name: Mario Giuseppe Guarcello (C)
Institution: INAF - Osservatorio Astronomico di Palermo

Title: Photoevaporation and close encounters: How the environment affects the evolution of protoplanetary disks

Abstract: Planets form in protoplanetary disks, after a slow coagulation of solid bodies and accretion of gas occurring over several million years. It has been discussed by several authors that some star forming environments (such as regions hosting massive stars; low-metallicity environments; clusters with high stellar density) can accelerate the dispersion of protoplanetary disks affecting their chance to form planets. The understanding of this environment feedback on disk evolution is thus important to infer in what environments in our Galaxy stars are more likely to form planets. I will present the analysis of the feedback provided by the environment in Cygnus OB2 (the most massive young association within 2 kpc from the Sun) on disk evolution, combining the X-ray data from the Chandra Cygnus OB2 Legacy Project with an extensive set of optical and infrared data. I will show evidence that disk evolution in Cygnus OB2 is seriously affected by externally induced photoevaporation, induced by the intense local UV field characterizing this association, and I will compare the destructive feedback provided by photoevaporation with that of close encounters between members of the association. I will also compare these results with existing studies on star forming environments with a smaller content of massive stars (such as NGC 6611) and with preliminary results on the low metallicity young cluster Dolidze 25, and discuss the need to extend these studies to more extreme environments such as Westerlund 1.

Name: Andrew Winter (C)
Institution: University of Cambridge

Title: Linking galactic scale star formation to planet formation

Abstract: Stellar birth environment can significantly shorten protoplanetary disc (PPD) lifetimes due to the influence of stellar feedback mechanisms. In particular, recent studies have demonstrated that in the solar neighbourhood far and extreme ultraviolet photons from neighbouring massive stars can drive photoevaporative winds from the outer edge of the PPD, significantly reducing the dispersal timescale. Since star formation gives rise to stellar groups with properties that vary over space and time, it follows that the degree to which discs are depleted by external photoevaporation varies similarly. I theoretically quantify the probability density function for stellar birth environments, dependent on the galactic scale primordial gas properties, and link it to the dispersal timescale for PPDs. Applying this general prescription to the central molecular zone of the Milky Way we predict that 70% of PPDs in the region are destroyed within 1 Myr of primordial gas expulsion. My findings hint that we exist in a 'special location' for planet formation, highlighting the importance of externally induced dispersion for understanding planet formation in general.

Name: Yuri Fujii (I)
Institution: Nagoya University

Title: Radiation Hydrodynamic Simulations of the Formation of Circumplanetary Disks

Abstract: Formation of planetary atmospheres and/or regular moons are governed by the gas flow into the vicinity of forming gas giants. Gas around a sufficiently massive planet is thought to form a circumplanetary disk instead of falling directly onto the planet. Recent studies, however, have shown that the circumplanetary gas forms an expanded envelope rather than a thin, rotationally supported Keplerian disk in cases where the gas temperature is very high. Thus, calculating the temperature of the accretion flow properly is important to determine the disk structure. We performed three-dimensional radiation hydrodynamic simulations of the formation of circumplanetary disks with an equation of states that considers effects such as hydrogen dissociation and helium and hydrogen ionization. The region within the deep potential of the planet reached very high temperature regime, however, we observe a disk-like structure to form in our simulations.

Name: Dimitrios Stamatellos (C)
Institution: University of Central Lancashire

Title: Planet formation by disc fragmentation around M dwarfs

Abstract: Direct imaging observations have revealed a population of massive planets (10 times the mass of Jupiter) that orbit around M dwarfs. Such massive planets cannot form by core accretion. We investigate whether disc fragmentation may form these planets. We examine by radiative hydrodynamic simulations the conditions for disc fragmentation in M dwarf discs and the properties of exoplanets formed by this mechanism. We find that a high disc-to-star mass ratio is required (0.3-0.6) for fragmentation to happen, which implies that if fragmentation is responsible for forming these planets it should happen at an early stage. These protoplanets form fast and are initially hot, as expected from fragmenting collapsing gas.

Name: Kevin Baillie (C)
Institution: IMCCE - Paris Observatory

Title: Building the Minimum Mass Solar Nebula

Abstract: Most planetary formation simulations rely on simple protoplanetary disk models evolved from the usual, though inaccurate, Minimum Mass Solar Nebula. Here, we suggest a new consistent way of building a protoplanetary disk from the collapse of the molecular cloud: both the central star and the disk are fed by the collapse and grow jointly. We then model the star physical characteristics based on pre-calculated stellar evolution models. After the collapse, when the cloud initial gas reservoir is empty, the further evolution of the disk and star is mainly driven by the disk viscous spreading, leading to radial structures in the disk: temperature plateaux at the sublimation lines of the dust species and shadowed regions that are not irradiated by the star. These irregularities in the disk surface mass density or midplane temperature may help trap planetary embryos at these locations, eventually selecting the composition of the planet cores. In addition, we redefine the disk timeline and describe the stages that lead to the MMSN model.

Name: Martin Pessah (C)
Institution: Niels Bohr International Academy

Title: Streaming Instability for Particle-size Distributions

Abstract: The streaming instability is thought to play a central role in the early stages of planetesimal formation. Typical conditions for the instability to operate efficiently require gas-to-dust mass ratios of order unity, leading to the formation of overdense filaments on timescales shorter than the radial drift of particles. These ensuing overdense filaments are then argued to undergo gravitational collapse to form asteroid-sized planetesimals, effectively bypassing a number of barriers present in traditional mechanisms. The vast majority of our knowledge about the linear and non-linear regime of this instability has been acquired assuming that the dust is composed of a single-size species. However, any realistic representation of the dust component must involve a grain-size-distribution. We will discuss the results of a systematic study of the streaming instability when a set of dust species is considered.

Name: Sin-iti Sirono (C)
Institution: Nagoya University

Title: Chondrule formation through collisions of planetesimals containing volatile material

Abstract: Chondrules are spherical silicate particles with 0.1-2 mm in size, and occupy a significant (more than 80%) volume fraction of chondrite meteorites. This high abundance of chondrule indicates that chondrule formation is a common event in the early solar nebula. However, the formation scenario is still debating. One of the common events which can lead to chondrule formation is impact between planetesimals (Asphaug et al.2011, Sanders and Scott 2012). However, the size of chondrules has not been explained consistently. Here I propose a new scenario of chondrule formation involving impacts of planetesimals containing volatile materials. This is an analogy to volcanic eruption where quick expansion of water promotes the formation of volcanic ash, whose size range is similar to that of chondrule. Firstly I conducted numerical simulation of planetesimal collisions, and confirmed that enough amount of silicate melt can be produced. Next, the motions of gas and melt are simulated, and it was found that the size range of melt droplets falls within the observed range of chondrules, even if the parameters involved were widely changed.

Name: James Stone (I)
Institution: Princeton University

Title: Using Athena++ to Study Star Formation

Abstract: Computational methods are important tools for addressing many questions in star formation. I will describe recent progress in developing Athena++, a new adaptive mesh refinement (AMR) code with many physics modules designed to enable new studies of star formation. Applications ranging from turbulence and gravitational fragmentation in the ISM to the dynamics of protoplanetary disks will be described. Aake Nordlund has been a pioneer in developing and applying computational methods for star formation, and I will place our efforts in context of his many contributions.

Name: Ake Nordlund (I)
Institution: Niels Bohr Institute and STARPLAN, Copenhagen

Title: Task based computing with the DISPATCH code framework

Abstract: Task based computing promises a path to essentially unlimited scaling in the exascale era, while also offering substantial cost reductions already on current supercomputing experiments, in a range of application fields. One such application field is the modeling of star and planet formation – a context that requires extreme ranges of scales to be covered, in order to avoid having to impose arbitrary initial and boundary conditions. Starting out from observationally well-constrained conditions at scales of tens to hundreds of parsecs, there are about ten orders of magnitude down to the vertical scale heights of protoplanetary disks, and about fifteen orders of magnitude down to the scale heights of rocky planet atmospheres. Simulations covering the whole range of scales are now within reach, using the new high-performance task based simulation framework DISPATCH. DISPATCH uses a hybrid MPI/OpenMP execution model, where a large number of OpenMP tasks are updated semi-independently, under the control of rank-local `dispatchers'. The definition and implementation of a task can vary between experiments, different classes of tasks (mesh based or particles based) can be present in the same experiment, and the nature of a task can even vary with position and time, allowing simple implementation of multiple-domain-multiple-physics experiments, with for example ideal MHD solvers, non-ideal MHD solvers, and particle-in-cell solvers co-existing and collaborating in the same experiment. A feature of decisive importance for the overall performance of the framework is that time steps are determined and applied locally; this allows large reductions in computing time when the allowed time step varies greatly across the computational domain. Other examples include radiative transfer solvers, trace-particle solvers, and sink-particle solvers that operate semi-independently, exchanging data with MHD solvers in the same space domains. The framework allows simple and straightforward implementation of both new and already existing solvers, with performance of existing solvers often augmented when run under the framework, due to more efficient cache usage and vectorization, local time stepping, plus the near linear and in principle unlimited OpenMP and MPI scaling. The framework handles all OpenMP scheduling and all MPI communications, including providing (optionally moving) mesh-based tasks with guard-zone data, and – where needed – data from prolongation and restriction operators. A public domain version of the DISPATCH code framework will be released in connection with the symposium.

Name: Raphaël Mignon-Risse (C)
Institution: AIM, CEA Saclay, France

Title: Hybrid radiative transfer for massive prestellar core collapse

Abstract: Massive stars (>8 solar masses) play a crucial role in the interstellar lifecycle, as they ionize their environment, exert a radiative pressure on it and finally enrich it in metals. Yet, no formation scenario is commonly accepted, oppositely to the low-mass stars. Massive stars still accrete when going onto the main-sequence, hence they start radiating, and at a much higher luminosity as their mass increases. In fact, in a first simple 1D approximation their radiative feedback can stop further accretion (Larson+69). Multidimensional simulations have been able to break this symmetry, and other modes of accretion have emerged like accretion via a disk (Yorke+02) or via Rayleigh-Taylor instabilities (Rosen+16). Hence the radiation processes must be treated accurately. More specifically, the frequency-dependent nature of the radiation has to be captured because the opacity varies on orders of magnitude between the stellar photons and the medium photons, thus it strongly impacts its force and absorption by the surrounding gas (Kuiper+10, Owen+12). In my thesis, I have been coupling two radiative transfer methods in the RAMSES code (Teyssier+02) : the first one is adapted to the direct stellar radiation (RAMSES-RT, Rosdahl+13) and the second one is a correct approximation for absorbed-and-reemitted radiation (Flux-Limited Diffusion, Commerçon+11). I have successfully tested this hybrid approach against benchmarks of an ideal static disk irradiated by a protostar and I have compared my results to Monte-Carlo codes (MCFOST, RADMC-3D). I will show that the hybrid approach brings big

improvements for the gas temperature, the anisotropy of the radiation field and the radiative force. Finally I will present the impact of this approach on the collapse of an isolated massive prestellar core, and more specifically on the disk structure and on the radiative outflows. Collaborators : Matthias González (AIM, CEA Saclay, France), Benoît Commerçon (CRAL, Lyon, France), Joki Rosdahl (CRAL, Lyon, France).

Name: Jon Ramsey (C)

Institution: University of Virginia, Department of Astronomy

Title: DISPATCH: A numerical simulation framework for the exa-scale era. Applications and advantages

Abstract: I will discuss DISPATCH, a relatively new code framework for astrophysical simulations that was built from the ground up for flexibility, high-performance and extreme parallel scaling. I will discuss the unique advantages of DISPATCH and how they are being used to advance our understanding of star and planet formation. In particular, I will present the results and conclusions from past and ongoing scientific investigations using DISPATCH including pebble accretion onto rocky bodies, the 2-component secular gravitational instability, and the launching of protostellar jets.

Name: Maya Petkova (C)

Institution: Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg

Title: Combining SPH and MCRT for the study of ionising stellar feedback

Abstract: Smoothed Particle Hydrodynamics (SPH) is used for modelling the time evolution of gas and the subsequent star formation on size scales ranging from stellar systems to galaxies. As massive stars are formed from the gas, their radiative feedback ionises the surrounding diffuse medium, which in its turn affects the gas dynamics. This behaviour can be accounted for in the computer models by coupling SPH with a Monte Carlo Radiative Transfer (MCRT) code. This talk presents an implementation of live radiation hydrodynamics achieved by combining Phantom (SPH) and CMacIonize (MCRT). The two codes exchange density and ionic fractions information via the use of a Voronoi mesh. We have tested the implementation by modelling the effects of stellar ionising radiation in the ideal case of D-type expansion of an H II region, and achieved good agreement with the existing results in the literature. Furthermore, we have applied our model to more complex and realistic scenario of ionising stellar feedback on stellar cluster scale. The presented code implementation can be used for modelling a broad range of additional astronomical problems involving ionising radiation and hydrodynamics.

Name: Bert Vandenbroucke (C)

Institution: University of St Andrews

Title: The Monte-Carlo radiation hydrodynamics code CMacIonize: summary and recent developments

Abstract: The Monte-Carlo radiation hydrodynamics (RHD) code CMacIonize (Vandenbroucke & Wood, 2018) combines a Monte Carlo photoionisation algorithm with a traditional hydrodynamics solver to perform fully self-consistent RHD simulations of ionised gas surrounding sources of ionising radiation, on a variety of grid types (including co-moving Voronoi grids). It is fully open-source, highly modular and optimised to run on shared-memory parallel systems, making it a powerful tool for large theoretical studies of e.g. massive star formation through disk accretion, or the evolution of the diffuse ionised gas in galaxies. Additionally, the code can also be coupled as a photoionisation library to other hydrodynamics codes. I will briefly introduce the code algorithm and explain the considerations that underlie the design of the code, with a focus on (a) user-friendliness and reproducibility, and (b) parallelisation strategies. I will highlight some recent results obtained using CMacIonize, and outline ongoing work to adapt the code for use on distributed-memory systems.

Name: Andrius Popovas (P)

Institution: RoCS, ITA, Oslo University

Title: Planet formation. The roles of pebble accretion, radiative and convective energy transport

Abstract: (a) Chondrules (1μm - 1cm size particles) accrete fast enough to be the main building blocks of rocky planets. (b) Accretion rates are approximately independent on disk surface density over a range of densities, decreasing surface density is compensated for by faster accretion speeds. (c) Radiative and convective heat transport are crucially important in primordial atmospheres. (d) If the dominant mass fraction of solids lies in mm size particles, this corresponds to ~1.5 million years to grow from a small seed to an Earth-mass planet at 1 AU and ~1 million years to grow a Mars-mass planet at 1.5 AU.

Name: Oliver Lomax (P)

Institution: European Space Agency

Title: Talk: FFTRay: a convolution-based algorithm for radiative transfer calculations

Abstract: We present FFTRay: a convolution-based algorithm for calculating radiation fields in numerical simulations. Radiative transfer is an important component of the star-formation process, and capturing its effect is required in modern simulations. However, calculating radiation fields as a function of both position and direction is computationally challenging. We present a method of approximating the radiation field within a computational domain where the density and emissivity fields are mapped onto a regularly-spaced or hierarchical (octree) gird of N cells. The calculation is performed by convolving these fields with several kernel functions, each of which represent a fraction of the sky covered by a HEALPix pixel. The convolutions are performed using FFTs, allowing the method to scale as NlogN. Moreover, we are able to leverage advanced features of FFT libraries, such as SIMD and GPU instructions, to accelerate the procedure. We benchmark the method by comparing its results with Monte Carlo radiative transfer calculations, noting that FFTRay is orders of magnitude faster.
