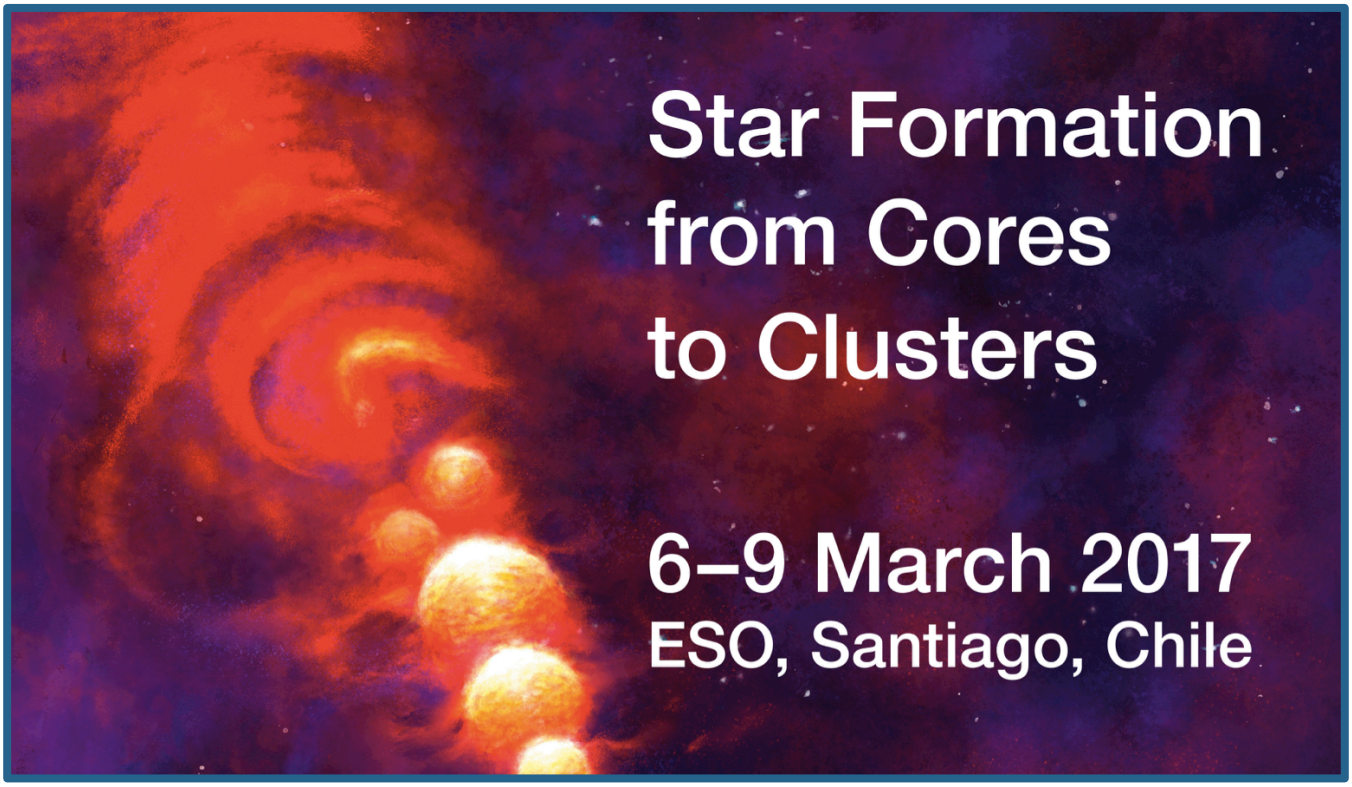

Program and Abstract Book

Program and Abstract Book

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Organizing Committees

Scientific Organizing Committee (SOC)

Fernando Comerón, ESO
Paulo Cortes, NRAO/ALMA
Rebekka Grellmann, University of Cologne
Itziar de Gregorio-Monsalvo, ESO/ALMA
Lewis Knee, NRC Herzberg
Diego Mardones, Universidad de Chile
Koraljka Muzic, CENTRA, University of Lisbon, Portugal
Adele Plunkett, ESO/ALMA
Javier Rodón, Onsala Space Observatory
Satoko Takahashi, NAOJ/ALMA
Leonardo Testi, ESO/INAF-Arcetri
John Tobin, University of Oklahoma

Local Organizing Committee (LOC)

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Antonio Hales, NRAO/ALMA
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Koraljka Muzic, CENTRA, University of Lisbon, Portugal
Adele Plunkett, ESO/ALMA
Satoko Takahashi, NAOJ/ALMA
Willem-Jan de Wit, ESO
María Eugenia Gómez, ESO/Logistics
Paulina Jirón, ESO/Logistics

Program

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10:15	**POSTER FLASH 1**	
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11:00	Cortes, Paulo	The magnetic field in the W43 mini-starburst
11:15	Großschedl, Josefa	The Star Formation Rate and Efficiency maps for Orion
11:30	Kuhn, Michael	Mass Segregation in Star-Forming Regions on Multi-Spatial Scales
11:45	Pagani, Laurent	Multiwavelength study to reveal cloud 3D structure and dust properties
12:00	Soto King, Piera A.	Stellar clustering in the dark filament IRDC 321.706+0.066
12:15	Vazquez-Semadeni, Enrique	Hierarchical Star Cluster Assembly in Globally Collapsing Molecular Clouds
12:30	**LUNCH**	
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14:30	Dunham, Mike (I)	Session 2 Observations Overview
15:00	Boekholt, Tjarda	The Hunter's slingshot: Protostellar ejection from filaments in Orion
15:15	**POSTER FLASH 2**	
15:30	**POSTER SESSION + COFFEE**	
16:15	Busquet, Gemma	Unveiling the L1157-B1 bow-shock structure from optical to millimeter wavelengths
16:30	Commerçon, Benoît	Protostellar disk and outflow formation in low and high-mass dense core collapse
16:45	Dougados, Catherine	ALMA observations of the disk/outflow connection
17:00	De Wit, Willem-Jan	Increased understanding of accretion in massive YSOs
17:15	Zhang, Yichen	Outflow Entrainment and Feedback: A Case Study with HH46/47 Molecular Outflow
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09:30	De Wit, Willem-Jan	Presentation about VLT capabilities
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10:30	**COFFEE**	
11:00	Sakai, Nami (I)	Session 3 Observations Overview
11:30	De Gregorio-Monsalvo, Itziar	The SOLA team: a Star Formation Project to study the Soul of Lupus with ALMA
11:45	Frimann, Søren	Tracing protostellar accretion with chemistry
12:00	Kirk, Helen	A Search for Starless Core Substructure in Ophiuchus
12:15	Maureira, María José	Envelope kinematics of First Core Candidates at 1000 AU scales
12:30	**LUNCH**	
14:00	**DISCUSSION SESSION 1**	
15:00	Rivera Ingraham, Alana	The Switch for High-Mass Star Formation
15:15	Schleicher, Dominik	Can deuteration be used as a chemical clock in protostellar cores
15:30	**POSTER SESSION + COFFEE**	
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17:00	Huelamo, Nuria (I)	Session 4 Observations Overview
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WEDNESDAY		
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09:15	Drass, Holger	Update on the Second Peak of Orion's substellar IMF
09:30	Muzic, Koraljka	Young brown dwarfs: testing star formation across environments
09:45	Riaz, Basmah	First large scale Herbig-Haro jet driven by a proto-brown dwarf
10:00	Santamaria-Miranda, Alejandro	Accretion signatures in the X-Shooter spectrum of the substellar companion to SR 12
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11:30	Saito, Masao (I)	Session 5 Observations Overview
12:00	Girart, Josep Miquel	A young stellar cluster around a massive protostar revealed by ALMA
12:15	Nicholson, Rhana	Supernova enrichment of planetary systems in star clusters
12:30	**LUNCH**	
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14:15	Wright, Nicholas	The Dynamics of Star Clusters and OB Associations
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Talk Abstracts

Monday, March 6, 2017

INVITED TALK Session 1 (Theory Overview)

The Role of Magnetic Fields in Structuring Clouds and Forming Stars

Zhi-Yun Li (University of Virginia, USA)

I will discuss the role of magnetic fields in structuring diffuse ISM and molecular clouds and in forming stars, with emphasis on the distribution of the relative orientation between the field direction as traced by dust polarization and cloud structures and the origin of the magnetically aligned striations.

INVITED TALK Session 1 (Observations Overview)

Review of Molecular Clouds: an Observational Approach

Manuel Fernández López (Instituto Argentino de Radioastronomía, Berazategui, Argentina)

The star formation process involves a wide range of spatial scales, densities and temperatures. Herschel observations of the cold and low density molecular gas extending tens of parsecs, that constitutes the bulk of the molecular clouds of the Milky Way, have shown a network of dense structures in the shape of filaments. These filaments supposedly condense into higher density clumps to form individual stars or stellar clusters. The study of the kinematics of the filaments through single-dish observations suggests the presence of gas flows along the filaments, oscillatory motions due to gravity infall, and the existence of substructure inside filaments that may be threaded by twisted fibers. A few molecular clouds have been mapped with interferometric resolutions bringing more insight into the filament structure.

Compression due to large-scale supersonic flows is the preferred mechanism to explain filament formation although the exact nature of the filaments, their origin and evolution are still not well understood. Determining the turbulence drivers behind the origin of the filaments, the relative importance of turbulence, gravity and magnetic fields on regulating the filament structure and evolution, and providing detailed insight on the substructure inside the filaments are among the current open questions in this research area.

The magnetic field in the W43 mini-starburst

Paulo Cortes (NRAO/ALMA, Santiago, Chile)

Here we present the first results from ALMA observations of 1 mm polarized dust emission towards the W43-MM1 high mass star forming clump. We have detected a highly fragmented filament with source masses ranging from 14M to 312M, where the largest fragment, source A, is believed the most massive proto-stellar core in our Galaxy. We found a smooth, ordered, and detailed polarization pattern throughout the filament which we used to derived magnetic field morphologies and strengths for 12 out of the 15 fragments detected ranging from 0.2 to 9 mG. The dynamical equilibrium of each fragment was evaluated.

The Star Formation Rate and Efficiency maps for Orion A

Josefa Großschedl (University of Vienna, Austria)

The OrionA GMC is a benchmark for studying star formation. Our goal is to construct a map of SFR and SFE (with Herschel) across the entire complex, for which it is critical to have a reliable and complete sample of YSOs. In this work we present a refined catalogue of YSOs, making use of a new deep NIR survey with VISTA, complemented with archival data. The survey allows us to rule out false positives from previous samples (galaxies, cloud edges, etc.). To add new candidates we use MIR data from WISE for areas not covered by Spitzer to get a complete census of the spatial distribution of YSOs.

Mass Segregation in Star-Forming Regions on Multi-Spatial Scales

Michael Kuhn (Universidad de Valparaíso, Chile)

The MYStIX study of 20 nearby star-forming regions reveals diversity in stellar mass segregation. We use the two-point correlation function to statistically test for mass segregation on different spatial scales. Some regions have segregated OB stars, while others do not, and in others segregation exists down to 1.5 solar-mass stars. Mass segregation can occur on scales of 0.1 pc to scales of 1 pc. And, a few cases (notably NGC 1893) exhibit inverse mass segregation. We find no observational evidence for increasing mass segregation with cluster age. Theoretical implications are discussed.

Multiwavelength study to reveal cloud 3D structure and dust properties

Laurent Pagani (Observatoire de Paris & CNRS, France)

The study of low-mass prestellar cores is a difficult task which needs to gather several tools, dust and gas observations, radiative transfer modelling. No single tracer can reveal the physical characteristics of these cores. We show that based on observations of N2H+, and dust from 1 μm to 1 mm, one can hope today to have a faithful 3D description of a dark cloud and its prestellar core. Dust being ill-defined, only the combination of absorption, scattering and emission measurements and modelling can alleviate the degeneracy between temperature, density and emissivity of the dust.

Stellar clustering in the dark filament IRDC 321.706+0.066

Piera A. Soto King (Universidad de La Serena, Chile)

We investigate the star formation process in the infrared dark cloud IRDC 321.706+0.066, where are located three infrared clusters recently discovered by Barbá et al. (2015) using images of the VISTA Variables in the Vía Láctea public survey: La Serena 210, 211 and 212. The aim is to characterize the stellar content of the three clusters and to investigate the star formation sequence in a filamentary dark cloud. We present a new photometric analysis of VVV images, and we use data from others surveys. We confirmed the presence of the three VVV clusters. And also, we propose a new cluster

Hierarchical Star Cluster Assembly in Globally Collapsing Molecular Clouds

Enrique Vazquez-Semadeni (UNAM, IryA, Mexico)

We discuss the mechanism of cluster formation in a numerical simulation of a molecular cloud undergoing global hierarchical collapse. The global collapse implies that the SFR increases over time. The hierarchical nature of the collapse consists of small-scale collapses within larger-scale ones. The large-scale collapses culminate a few Myr later than the small-scale ones and consist of filamentary flows that accrete onto massive central clumps. We discuss the resulting structure of clusters assembled by this flow regime in the clouds.

INVITED TALK Session 2 (Theory Overview)

From the pre-stellar core collapse to the end of the embedded phase

Eduard Vorobyov (University of Vienna, Austria)

The embedded phase of star formation witnesses the birth of stars, the formation of circumstellar disks, and the launch of jets and outflows. It sets the stage for the disk and star evolution in the subsequent optically visible T Tauri phase, largely determining disk and stellar masses and paving the way for planet assembly. This phase is hard to observe and theory can provide valuable insights into the processes that take place in the depth of collapsing clouds.
I will overview processes that are linked with the disk early evolution, such as gravitational instability and its implications, variable protostellar accretion with episodic bursts and its effect on the disk dynamical and chemical evolution, and initial stages of dust growth. The nature of very low luminosity objects (VELLOs) will also be discussed.

INVITED TALK Session 2 (Observations Overview)

Outflows, envelopes, and first conditions of disk formation

Mike Dunham (SUNY Fredonia, NY, USA)

Stars form from the gravitational collapse of dense molecular cloud cores. In the protostellar phase, mass both accretes from the core onto a protostar, likely through an accretion disk, and is ejected in the form of jets and outflows. It is during this protostellar phase that the initial masses of stars and the initial conditions for planet formation are set. Over the past decade, new observational capabilities have provided wide-field single-dish surveys of entire star-forming clouds along with interferometric images at very high angular resolution, giving an unprecedented view of the star formation process. However, we still don't have a complete picture of how ejection, accretion, and disk formation and evolution work together to convert cores into stars. In this talk I will review some of the recent developments on outflows, cores, and disk formation, focusing on observational results aimed at better understanding the interplay between these processes in the formation of stars.

The Hunter's slingshot: Protostellar ejection from filaments in Orion

Tjarda Boekholt (Universidad de Concepción, Chile)

We compare 3 constituents of Orion A (gas, protostars, and pre-main-sequence stars), both morphologically and kinematically, to show the following. Essentially all protostars lie superposed on the Integral Shaped Filament (ISF), while almost all YSOs do not. The fact that protostars move <1 kms relative to the filaments while YSOs move several times faster implies that a “slingshot mechanism” may eject protostars from the dense filamentary cradle. The B-field strengths, compared with the gas mass distribution, indicates that magnetic instabilities may be propagating through the cloud.

Unveiling the L1157-B1 bow-shock structure from optical to millimeter wavelengths

Gemma Busquet (Institut de Ciences de l'Espai (IEEC-CSIC), Barcelona, Spain)

Protostellar shocks play a key role in the chemical evolution of star-forming clouds. They induce large variations of temperature and density, which can activate gas-phase reactions, ionization processes, and evaporation/erosion of dust grains. In this talk, we present high spatial resolution optical images of [SII] and Ha together with long-slit spectra sampling the L1157B1 shock, complemented with NOEMA molecular lines observations. We will discuss the shock properties such as the gas excitation, ionization fraction, and the chemical complexity of the archetypal protostellar shock L1157B1.

Protostellar disk and outflow formation in low and high-mass dense core collapse

Benoît Commerçon (Centre de Recherche Astrophysique de Lyon, France)

I will present the results of magnetised dense cores collapse 3D simulations including ambipolar diffusion with the adaptive-mesh-refinement code RAMSES. The numerical models cover a wide range of initial masses, form one to hundred solar masses, as well as the effect of initial rotation and/or turbulence. I will show how ambipolar diffusion acts on the formation of protostellar disks, which can subsequently launch collimated outflows. I will detail the properties of the disks and outlfows and the similarities between low and high-mass star formation.

ALMA observations of the disk/outflow connection

Catherine Dougados (IPAG, Grenoble)

I will describe in this contribution recent results obtained with ALMA on the origin of the disk/jet/outflow connexion in T Tauri stars. I will first present ALMA observations of the disk associated with the jet source Th 28, which question previous jet rotation measurements in this source and the implications drawn from them. I will then discuss Cycle 2 ALMA observations of the disk and small scale CO outflow associated with the prototypical edge-on HH 30 source. The unprecedented angular resolution of this dataset brings new constraints on the origin of the CO outflows in young stars.

Increased understanding of accretion in massive YSOs

Willem-Jan De Wit (ESO, Chile)

That massive stars up to 20Msol form by disk accretion is by now reasonably well established. We will present the latest observational results for the formation of single and multiple massive YSOs. By means of optical interferometry using the newly commissioned instrument Gravity at the VLT-I, we show the discovery of a young, embedded, 170AU-wide binary and is the most massive and most compact accreting young binary to date. We will also present the results of a multi-site multi-epoch follow-up campaign of the first well studied accretion outburst in a massive YSO.

Outflow Entrainment and Feedback: A Case Study with HH46/47 Molecular Outflow

Yichen Zhang (RIKEN, Woko-shi, Japan)

Our ALMA multi-cycle multi-band observations of HH46/47 outflow show co-existence of entrainment by both wide-angle wind and jet bow-shock and this outflow is at a moment that the former has just become dominant. The estimated outflow mass and strength suggest that it has already strongly affected the core-to-star efficiency to 1/3 at this early stage. The zoom-in observation also reveals multiple wide outflowing shells with positions and shapes smoothly changing over a wide range of velocity, which may be an evidence of episodic eruption not only in jet but also in the wide-angle wind.

Tuesday, March 7, 2017

Presentation about ALMA capabilities

John Carpenter (JAO, Santiago, Chile)

The Atacama Large Millimeter/submillimeter Array (ALMA) has been conducting science observations for the community since October 2011 with the start of Cycle 0. With the deadline for ALMA Cycle 5 proposals upcoming in April, I will report on the status of ALMA, including the opportunities and new capabilities that will be offered Cycle 5. I will also present the anticipated timeline for the roll out of new capabilities as ALMA approaches full operations.

Presentation about VLT capabilities

Willem-Jan De Wit (ESO, Chile)

We will present the capabilities for star formation studies of some appropriate current, and future instruments at ESO's Paranal Observatory. In particular, we will discuss results by means of the the mid-infrared imager and spectrograph VISIR, the soon to be re-installed and cross-dispersed, high resolution, near-IR spectrograph CRIRES, the extreme AO instrument SPHERE, and the spectro-interferometric instruments Gravity (K-band) and MATISSE (M-, L-, N-band).

INVITED TALK Session 3 (Theory Overview)

Prestellar and Protostellar Cores

Stella Offner (UMass Amherst, USA)

I will review current theoretical models for the formation and evolution of dense cores. I will discuss the key physics underlying core properties, stability and collapse. I will report on state-of-the-art numerical calculations and discuss efforts to compare these to observations. Finally, I will summarize remaining open questions.

INVITED TALK Session 3 (Observations Overview)

Role of Centrifugal Barrier in Physics and Chemistry of Disk Formation

Nami Sakai (RIKEN, Saitama, Japan)

Toward a thorough understanding of planet formation in Solar type protostars, one of the most important targets to be explored is formation of a Keplerian disk in the early stage of protostellar evolution. Furthermore, the physical process of the disk formation will significantly affect an initial chemical composition for a protoplanetary disk. We have explored the kinematic structure of the gas associated with the Class 0/I protostar L1527 by using molecular lines of various species. As a result, we have discovered a drastic chemical change at the centrifugal barrier probably due to the accretion shock. Such a phenomenon has not been predicted so far in any chemical models, and its discovery provides us with a new insight into the physical and chemical processes associated with the disk formation. In this talk, I would like to introduce recent progress of disk formation study and its further application to various protostellar sources.

The SOLA team: a Star Formation Project to study the Soul of Lupus with ALMA

Itziar De Gregorio-Monsalvo (ESO/ALMA, Santiago, Chile)

The SOLA team is a multi-national and multi-wavelength collaboration composed by scientists with technical expertise in ALMA and in infrared and optical techniques. The aim of the team is to establish a low-mass star formation scenario based on the Lupus molecular clouds. In this talk I will present our unique catalog of pre-stellar and proto-stellar cores toward Lupus molecular clouds, the results on our latest studies in protoplanetary disks, as well as our ALMA Cycle 3 data aiming at testing the formation mechanism of sub-stellar objects in Lupus molecular clouds.

Tracing protostellar accretion with chemistry

Søren Frimann (Institute of Cosmos Sciences, University of Barcelona, Spain)

Understanding how young stars accrete their mass is an important question of star formation. Specifically, are the accretion rates onto young stars characterised by short intermittent bursts or by a smooth decline from early to late stages? It is difficult to observe bursts directly, hence indirect methods are often used. I will present how CO freeze-out and sublimation chemistry can be used to address this question. The results are derived from numerical simulations (Frimann et al. 2016) and from an observational study towards 21 Perseus protostars (Frimann et al. submitted).

A Search for Starless Core Substructure in Ophiuchus

Helen Kirk (Herzberg Astrophysics, National Research Council of Canada)

Density substructure is expected in evolved starless cores: a single peak to form a protostar, or multiple peaks from fragmentation. Searches for this substructure have had mixed success. In an ALMA survey of Ophiuchus, we find two starless cores with signs of substructure, consistent with simulation predictions. A similar survey in Chameleon (Dunham et al. 2016) had no detections, despite expecting at least two. Our results suggest that Chamleon may lack a more evolved starless cores. Future ALMA observations will better trace the influence of environment on core substructure formation.

Envelope kinematics of First Core Candidates at 1000 AU scales

María José Maureira (Yale University, New Haven, USA)

We use multi-lines observations towards the first cores candidates L1451-mm and Per-bol 58, probing their envelope kinematics and evolutionary state. L1451-mm lines, which show infall and rotation, gave us estimates for the infall rate and central source mass that further support L1451-mm as the most promising first core candidate. Per-bol 58 spectra show two velocity components which can be explained by simulations of a collapsing core, likely just past protostar formation, in which infall is regulated by a combination of turbulence and magnetic fields.

The Switch for High-Mass Star Formation

Alana Rivera Ingraham (ESA, Madrid, Spain)

The Herschel Archive covers regions in a wide range of physical and star-forming conditions across the Galaxy with unprecedented sensitivity. Here we introduce the latests results from an ongoing large-scale project focused on investigating and characterising star formation in the most extreme conditions. In particular, we will present new evidence that suggests that high-mass star formation is initiated under very specific threshold conditions, distinguishing it from low-mass star formation. This evidence will be summarised and discussed in context with theoretical models and simulations.

Can deuteration be used as a chemical clock in protostellar cores

Dominik Schleicher (Universidad de Concepción, Chile)

Measuring deuteration fraction in protostellar cores is considered as an important method for age determinations of protostellar cores, and the high deuteration fraction of up to 10% has been considered as evidence for high ages and strong support via magnetic field. In this talk, I will present 3D magneto-hydrodynamical simulations including the deuteration chemistry to explore how the deuteration fraction depends on the dynamical and chemical conditions. I will show that high deuteration fractions can be obtained under a large set of different conditions.

INVITED TALK Session 4 (Theory Overview)

The theory of the formation of brown dwarfs and low-mass stars

Dimitris Stamatellos (University of Central Lancashire, UK)

More than half of all stars (including brown dwarfs) have masses below 0.2 Msun. The formation mechanism of these objects is uncertain. I will review the four main theories for the formation of low-mass objects: turbulent fragmentation, ejection of protostellar embryos, disc fragmentation, and photo-erosion of prestellar cores. I will discuss the observational predictions of these models regarding the low-mass initial mass function, the brown dwarf desert, and the binary statistics of low-mass stars and brown dwarfs. I will further discuss whether observations may be used to distinguish between different formation mechanisms, and give a few examples of systems that strongly favour a specific formation scenario. Finally, I will argue that it is likely that all mechanisms may play a role in the formation of brown dwarfs and low-mass stars.

INVITED TALK Session 4 (Observations Overview)

The origin of brown dwarfs: Observational studies

Nuria Huélamo (CAB (INTA-CSIC), Spain)

How do brown dwarfs (BDs) form? The formation of substellar objects is still under debate, and several mechanisms have been proposed to explain their origin, e.g. gravoturbulent fragmentation, disk fragmentation or the ejection from a multiple system at very early stages of their evolution. In this talk I will review different observational studies focused on understanding the origin of brown dwarfs: I will describe the main properties of the so-called Very Low Luminosity Objects (VeLLOs), the first hydrostatic cores, and some interesting properties of young BDs that can shed light on their formation mechanism.

Wednesday, March 8, 2017

First submm detection of a disk-bearing young isolated planetary mass object

Amelia Bayo (Universidad de Valparaíso, Chile)

We have very recently obtained band 6 ALMA continuum data of a disk-bearing, very young, free floating planet. The data shows a clear unresolved detection of the source. We have performed radiative transfer modelling of the full SED of the object and disk mass estimates via empirical correlations derived for higher mass central objects. We compare the properties of this unique disk with those recently reported around higher mass (brown dwarfs) young objects in order to infer constraints on its mechanism of formation.

Update on the Second Peak of Orion's substellar IMF

Holger Drass (P. Universidad Católica de Chile)

The Orion Nebular Cluster (ONC) has become the prototype cluster for studying the Initial Mass Function (IMF). In a deep JHK survey of the ONC with HAWK-I we detected a large population of ~900 Brown Dwarfs and Planetary Mass Object candidates presenting a pronounced second peak in the substellar IMF. One of the most obvious issues of this result is the verification of cluster membership. The analysis so far was mainly based on statistical consideration. In this presentation I will show the results from using different high-resolution extinction map to determine the ONC membership.

Young brown dwarfs: testing star formation across environments

Koraljka Muzic (CENTRA, University of Lisbon, Portugal)

SONYC (Substellar Objects in Nearby Young Clusters) is a deep, unbiased imaging and spectroscopic survey designed to provide a census of substellar population in several nearby star forming regions. As a result, the substellar IMF is now well characterized down to 5 - 10 MJup. We are now extending the survey to more distant massive young clusters, characterized by orders of magnitude higher stellar densities and OB star numbers. This new dataset allows us, for the first time, to test the influence that such environments might have on the production of very-low mass objects.

First large scale Herbig-Haro jet driven by a proto-brown dwarf

Basmah Riaz (MPE Garching, Germany)

We report the discovery of a new Herbig-Haro jet, HH1165, driven by a proto-brown dwarf. HH1165 has a projected length of 0.23pc, ten times larger than all known brown dwarf jets. The uniqueness of HH1165 is that it shows the well-known characteristics of a collimated bent C-shape, multiple shock knots, bright reflection nebulosity, and bow-shocks at the jet ends, as seen in parsec-length protostellar HH jets. This discovery demonstrates that large-scale HH jets can be driven by sub-stellar objects, and shows the robustness of models on how jets are launched and interact with the environment.

Accretion signatures in the X-Shooter spectrum of the substellar companion to SR 12

Alejandro Santamaria-Miranda (Universidad de Valparaíso, Chile)

About a dozen substellar companions orbiting young stellar objects at several hundred au have been identified, but it is currently unknown how these objects form. We will present X-shooter spectroscopy of Sr 12 C, a brown dwarf at a separation of 1045 au from the host star. We determine the spectral type, gravity and temperature using model and observed template spectra and we test for accretion using several accretion tracers.We find clear evidence for accretion at a relatively low rate and discuss this result in the context of the formation scenarios that have been proposed for these objects

INVITED TALK Session 5 (Theory Overview)

Multiplicity at early stages of star formation, small clusters

Richard Parker (University of Sheffield, UK)

In this talk I will review the recent theory and simulations of binary star and low-mass cluster formation. I will discuss the various formation mechanisms proposed for binary and multiple star formation, and compare recent simulations to the observed properties of binaries. I will describe efforts to distinguish high-order multiples from low-mass star clusters and how their subsequent evolution may sculpt the binary properties observed in the Galactic field. Finally, I will discuss how the missing physics from current simulations may affect comparisons with observations, and highlight future prospects in this area.

INVITED TALK Session 5 (Observational Overview)

Masao Saito (National Astronomical Observatory of Japan, Japan)

The SOLA (Soul of Lupus with ALMA) project is conducting comprehensive studies of the Lupus Molecular Clouds and their star formation processes covering 10-10^4 AU scale. Our goal is to exploit ALMA and other facilities over a wide wavelength range to establish a prototypical low-mass star forming scenario based on the Lupus region. In the presentation, we will focus on angular momentum in dense cores in a filament, molecular outflows from young stars, and Class 0/I binary survey in Lupus as well as overview of our projects. Our binary survey was conducted in ALMA cycle 2 and achieved at 0.2-0.3 arcsec resolution discovering new binary systems in Lupus. At the same time, we obtained EX Lup, EXor type burst source, data in ALMA Cycle 3.

A young stellar cluster around a massive protostar revealed by ALMA

Josep Miquel Girart (Institut de Ciències de l'Espai (IEEC-CSIC), Spain)

Here we present 1.1 mm ALMA observations at a very high angular resolution of a high mass star forming region. The high angular resolution and high dynamic range allows to reveal a young stellar cluster of low mass YSO near a massive protostellar object. Most of the sources detected has no counterpart at other wavelengths (the IR is dominated by the bright emission of the massive/intermediate young stars, which mask the emission of the low mass YSO). A description of the properties of the low mass YSO will be given (e.g., disks mass distribution, disk sizes).

Supernova enrichment of planetary systems in star clusters

Rhana Nicholson (Liverpool John Moores University, UK)

Short-lived radioactive species have been detected in chondritic meteorites from the early epoch of the Solar system. This implies that the Sun formed in the vicinity of the supernovae of one or more massive stars. Massive stars are more likely to form in massive star clusters (1000 Msun) than lower mass clusters (50-200 Msun). We show that direct enrichment of protoplanetary discs via supernovae occurs as frequently in low mass clusters containing one or two massive stars as in more populous clusters. This significantly relaxes the constraints on the birth environment of the Solar System.

The VLA/ALMA Nascent Disk and Multiplicity (VANDAM) Survey of Orion

John Tobin (University of Oklahoma, USA)

We present highlights and initial results from the VANDAM II: Orion survey where we have observed 330 protostars (Class 0 and I) with ALMA at 850 micron, and we observed a subset with the VLA at 9 mm (100 Class 0, 48 Class I) all at 30 AU resolution. This survey has greater sensitivity to extended disks than the VANDAM-Perseus survey because of the shorter wavelength (850 micron) and has 4x more sources to substantially improve the multiplicity statistics. The results demonstrate the power and utility of unbiased protostar surveys in the characterization of disk formation and multiplicity.

The Dynamics of Star Clusters and OB Associations

Nicholas Wright (Keele University, UK)

The formation and evolution of star clusters is fundamental to our understanding of star formation, the evolution of binary and planetary systems, and the formation of long-lived open and globular clusters. Our understanding of these systems is being revolutionised by new data from Gaia and large-scale RV surveys. I will present multiple kinematic studies of star clusters and OB associations that constrain their kinematic state, reveal evidence for cluster expansion and dispersal, expose considerable kinematic substructure, and provide observations of the disruption of binary systems.

Thursday, March 9, 2017

INVITED TALK Session 6

Variability in star formation: the importance of large data sets

Sami Dib (U. of Atacama, Copiapó, Chile and Starplan, Copenhagen, Denmark)

I will discuss some aspects of the variability in the outcome of the star formation process. In particular, I will focus on the origin of the scatter in the star formation scaling relations in galactic disks and on the variability of the IMF in young star forming regions.

Star formation in the Local Group as seen by low-mass stars

Guido De Marchi (European Space Agency, The Netherlands)

Using HST observations, we have studied over 50,000 low-mass pre-main sequence (PMS) stars in several star-forming regions in the Magellanic Clouds and Milky Way. This is the largest sample of PMS objects, with masses 0.5-4 Msun, metallicities 0.1-1 Zsun, and ages 0.5-30 Myr. I will discuss two important results: low-mass PMS stars are less spatially concentrated than massive stars; mass accretion onto PMS stars depends critically on the environment (metallicity and gas density). We will thoroughly verify these results through GTO imaging and spectroscopic observations with JWST.

VISIONS - VISTA Star Formation Atlas

Stefan Meingast (Institute for Astrophysics, University of Vienna, Austria)

In this talk I will present the new ESO public survey VISIONS. Starting in early 2017 we will use the ESO VISTA survey telescope in a 550 h long programme to map the largest molecular cloud complexes within 500 pc in a multi-epoch program. The survey is optimized for measuring the proper motions of young stellar objects invisible to Gaia and mapping the cloud-structure with extinction. VISIONS will address a series of ISM topics ranging from the connection of dense cores to YSOs and the dynamical evolution of embedded clusters to variations in the reddening law on both small and large scales.

Star formation processes in Nearby Galaxies

Rosita Paladino (INAF-IRA, Bologna, Italy)

The new available observational facilities allow now studies of star formation processes in nearby galaxies with the level of details so far available only for star forming regions of the Galaxy. The statistical study of the properties of giant molecular clouds in different environments are now possible. I will review the current status of these studies, and present recent ALMA observations of a nearby galaxy NGC3627. ALMA observations allow the study of giant molecular clouds properties in the different environments (arms, inter-arms, bar, bar end regions) observable in this galaxies.

Low metallicity molecular clouds with ALMA

Mónica Rubio (Universidad de Chile)

Stars form in molecular clouds. These clouds are dense concentrations of H2 that are traditionally traced in external galaxies using transitions of CO or other, more complex molecules. But dwarf irregular (dIm) galaxies seemingly contradict this fundamental picture. Tracers of recent star formation, such as Halfa or far-ultraviolet (FUV) emission, show that most dwarfs contain young stars and star clusters, but CO observations often yield only upper limits. We will present CO observations with ALMA of star-forming regions at the lowest metallicities dwarf galaxies form SMC to WLM.

Poster Abstracts

Numerical simulations of low mass star formation

Asmita Bhandare (Max Planck Institute for Astronomy, Heidelberg, Germany)

Stars are formed by gravitational collapse of dense cores in magnetized molecular clouds. Details of the earliest epochs of star formation process and protostellar evolution are only vaguely known and strongly depend on the accretion history. Thermodynamical modeling in terms of radiation transport and phase transitions is crucial to identify meaningful results. In this study, we use a gray treatment of radiative transfer coupled with hydrodynamics to simulate Larson's collapse. In spherically symmetric collapse simulations, we investigate properties of prestellar cores in the low mass regime.

Small young clusters in our galaxy as seen in VVV

Jordanka Borissova (Universidad de Valparaíso, Chile)

We will present some recent results of small young clusters in our Galaxy investigation and their connection with the surrounding environment.

Clustering and 10 Myr old stellar aggregates in the Orion OB1 Association

César Briceño (Cerro Tololo Inter-American Observatory, La Serena, Chile)

I will present the results of a photometric and spectroscopic census of the Orion OB1 association, spanning ~180 sq.deg., with emphasis on the off-cloud regions containing somewhat older populations of stars in the age range ~4-10 Myr. With ~2000 confirmed T Tauri stars, this is the largest, most complete sample of low-mass young stars in this important evolutionary stage. We show that the off-cloud stellar population consists of various newly recognized clusters amidst a general low-density background, and that the Orion Nebula Cluster is surrounded by a few sq.deg halo of young stars.

The early stages of planetary mass companions

Claudio Caceres (Universidad Andres Bello, Chile)

In recent years a small number of planetary mass companions candidates (PMCs) at large orbital distances from their host stars has been identified. Their formation mechanism remains unknown, but studying the PMCs that are still in formation is providing some vital clues. I present some results from mm interferometric observations of two PMCs, probing their early stages of evolution.

Energy budget of forming clumps in numerical simulations of collapsing clouds

Vianey Camacho Pérez (Universidad Nacional Autónoma de México)

We analyze the energy balance of clumps and cores in two SPH simulations of collapsing clouds. We find that: (i) the set of clumps with low column-density shows a large scatter around equipartition which, in more than half of the cases, is dominated by external turbulent compressions that assemble them, (ii) clumps lying in filaments tend to appear sub-virial, (iii) high-density cores that exhibit moderate kinetic energy excesses often contain stellar particles, and (iv) cores with kinetic energy excess but no stellar particles are in a state of dispersal.

Star formation in the IR dust bubbles complex S 21-S 24

Cristina Elisabet Cappa (IAR, Conicet, and FCAG, UNLP, Argentina)

We present an analysis of YSOs linked to the IR dust bubble complex S21-S22-S23-S24 of about 12 arcmin in size, which also includes infrared dark clouds and EGOS. The study reveals the presence of many YSOs and their correlation with molecular gas (CO data from APEX) and dust. The YSOs identified in IR point source catalogs indicate that the complex is a very active star forming region with sources in different evolutionary states. Outflow signatures is also investigated. We compare the main parameters of the different sections of the complex in order to characterize the star forming process.

A deep NIR and Optical study on the southern high mass star forming regions RCW 34 and NGC 2626

Robert Czanik (North-West University, Republic of South Africa)

High mass star forming regions that present multiple epochs of star formation are complex environments where the cluster members are inter-connected on each other's evolution. Deep NIR photometry which was obtained with the IRSF telescope are presented of the two HII-regions: RCW 34 and NGC 2626 which both have at least two generations of triggered star formation. The NIR photometry revealed embedded low-mass cluster members with excess emission characteristic to CTTs. Custom extinction laws were derived for each region as well as extinction maps were built using the NICEST method. These low-mass PMS members are identified and characterized using their excess NIR emission, optical photometry and spectroscopy using SALT.

Testing the formation mechanism of sub-stellar objects in Lupus (a SOLA team study)

Itziar De Gregorio-Monsalvo (ESO/ALMA, Santiago, Chile)

The international SOLA team (Soul of Lupus with ALMA) has identified a set of pre- and proto-stellar candidates in Lupus 1 and 3 of substellar nature using 1.1mm ASTE/AzTEC maps and our optical to submillimeter database. We have observed with ALMA the most promising pre- and proto-brown dwarfs candidates. Our aims are to provide insights on how substellar objects form and evolve, from the equivalent to the pre-stellar cores to the Class II stage in the low mass regime of star formation. Our sample comprises 33 pre-stellar objects, 7 Class 0 and I objects, and 22 Class II objects.

Surveying Taurus in the far-infrared

Bill Dent (ALMA, Santiago, Chile)

We present the results from a statistically complete survey of young stars with 24um excess in the Taurus star forming region. The results are based on Herschel PACS and SPIRE photometry, and we investigate trends in the shape of the SEDs from the mid-infrared through to mm wavelengths.

Complex organics in embedded protostellar regions

Maria Drozdovskaya (Universität Bern, Switzerland)

The results from physicochemical simulations will be shown, which model the spatial distribution within protostellar envelopes of solid and gaseous complex organic molecules. For the case of high-mass protostars, the physical model of protostellar core evolution based on the Turbulent Core Model, is adopted and combined with a large gas-grain chemical network. For the case of low-mass protostars, a dynamic semi-analytic collapse model is used in conjunction with the same chemical set up. Hereby, high-mass star-forming regions are contrasted with the low-mass regime.

Complex organic molecules in the molecular outflow G331.512+0.103

Nicolas Duronea (Instituto Argentino de Radioastronomía, La Plata, Argentina)

We used the APEX telescope to look for complex organic molecules that might have been formed by the action of the strong outflow G331.512+0.103 on its molecular surroundings. An analysis of the obtained spectra led us to identify several organic molecules by a plethora of rotational molecular transitions. Some of the detected molecules in G331.512-0.103 are CH3CN, CH3OH, CH3CHO, CH3OCH3, CH3COCH3 and the isomers HCOCH2OH and HCOOCH3). The existence of these molecules indicates a high chemical complexity in the hot core induced by the interaction of the shocks with the primeval cloud.

HH137 and 138: discovering new knots and a molecular outflow with Gemini and APEX

Leticia Ferrero (Observatorio Astronómico de Córdoba - UNC, Argentina)

We present a multi-frequency study of HH 137 and HH 138 using Gemini images and APEX molecular line data, as well as Spitzer images. Several 2.12 micron knots linked to HH137 are identified in the Gemini image. 12CO(3-2), 13CO(3-2), and C18O(3-2) line data reveal the molecular counterpart of HH 137. Spitzer combined images suggest the location of the exciting source of HH 137, almost coincident with a high-density molecular clump detected in C18O. We derive the main physical parameters of the molecular clump and the molecular outflow, and propose a simple scenario for the whole complex.

A Massive Dense Gas Cloud close to the Nucleus of the Seyfert galaxy NGC1068

Ray Furuya (Tokushima University, Japan)

Using the ALMA archival data of both CO(6--5) line and 689 GHz continuum emission towards the archetypical Seyfert galaxy, NGC1068, we identified a distinct dense gas separated by 15pc from the AGN, in projection. The continuum flux gives a gas mass of M_gas ~ 2 x 10^5 Msun and bolometric luminosity of 10^8 Lsun, leading to a star formation rate (SFR) of ~0.1 M_sun/yr. We found that the gas stands a unique position between galactic and extraglactic clouds in the diagrams of SFR vs. gas mass. All the properties may be understood in terms of the turbulence-regulated star formation scenario.

NIR and ALMA imaging of Rosette globulettes

Lauri Haikala (Universidad de Atacama, Copiapó, Chile)

NIR imaging and ALMA arc-second resolution CO, CS and H2CO imaging of two typical Rosette Nebula globulettes is discussed. Velocity structure is observed in the 12CO line whereas the observed CS line widths are are extremely narrow, 0.3kms-1-0.4kms-1, indicating practically no internal motions in the very core. The highest molecular line column densities are detected at the side facing the HII region central cluster. The estimated masses of the globulettes range from 60 to 100 MJupiter (RN88) and 100 to 300MJ (RN122) and thus formation of planetary mass free floating planets is possible.

A sensitive probe of gas in Lupus proto-planetary disks using CN

Antonio Hales (JAO, Santiago, Chile)

We obtained APEX data to do a pilot study to search for gas emission in a sample of protoplanetary disks in the Lupus molecular clouds, using the CN(3-2) line emission at 340 GHz as novel confusion-free probe of the kinematics of disks. Our main aim is to characterize the gas content of disks in the Lupus molecular clouds. The sample comprised eight T Tauris with strong continuum emission at 1.3 mm and with spectral types between K2 and M2. CN is a good tracer of the upper layers of the disk, where most other molecules are photodissociated. We report four (50%) new CN detections.

Ultra-wide pairs and origin of multiplicity in Taurus

Isabelle Joncour (UGA/IPAG, Grenoble, France)

Multiplicity is a key feature in low-mass star-formation. However, its origin is not yet fully understood, even in Taurus that is one of the nearest (145 pc) and best-studied regions. We will present the discovery in Taurus of a new population of ultra-wide pairs (5kAU to 50kAU, hereafter UWPs), (Joncour et al 2017). These UWPs are biased towards higher multiplicity at shorter separation. We suggest that they could be the descendants of the multiple prestellar cores/Class 0 objects and that they may be resulting from a runaway cascade fragmentation of the natal molecular core.

Spectroscopic survey of the low mass population in the star-forming region Lagoon nebula

Venu Kalari (Universidad de Chile)

Using data from the GAIA-ESO spectroscopic survey, we describe the determination of spectroscopic and stellar parameters of circa 400 low-mass members of the Lagoon Nebula. Based on this analysis, we discuss the luminosity/age spread in the H-R diagram, lithium evolution and place in our findings in context of recent theoretical and observational works. We also compare our results with time-series and near-mid infrared data.

Molecular Outflows in Corona Australis

Lewis Knee (NRC Herzberg, Canada) *Absent*

The low mass star forming region associated with the Corona Australis cloud hosts an embedded culture of young stellar objects (YSOs), many of which drive molecular outflows associated with shock-excited (HH-objct) emission-line objects. CO(1-0) mapping from the SEST and CO(3-2) mapping from JCMT are presented and analyzed in the context of identifying outflows and associating them with known YSOs and HH-objects. This region hosts far more molecular outflows than previously thought and resembles in some respects the "burst" of outflow activity associated with the star forming region NGC1333.

Ultraviolet detection of bow shocks in the context of heliosphere numerical models

Jan Kotlarz (Faculty of Physics, University of Warsaw, Poland)

In this work we discuss results of global modeling of the heliosphere regarding the interstellar bow shock, usefulness of these models for the other bow shocks observed in the Universe parameters estimation and bow shocks detection in the UV band.

Numerical Simulations to Obtain Initial Conditions of Protostars Starting From Cluster Scales

Aleksandra Kuznetsova (University of Michigan, USA)

We present the results of a series of numerical simulations using the Athena code aimed at recovering the range of possible initial conditions for protostellar objects starting at cluster scales. With a series of weakly and strongly magnetized runs, we discuss the effects of magnetic fields on the range of possible outcomes for protostars and their immediate environments.

SOLA catalogue: Sub-millimiter and millimiter sources in Lupus

Cristian Lopez (ALMA, Santiago, Chile)

As a key project of the Soul of Lupus with ALMA (SOLA) team, we present the SOLA catalogue, a complete sample of pre-stellar and proto-stellar cores toward Lupus molecular clouds. Lupus I, II, III and IV clouds were observed at 0.87 and 1.1mm with LABOCA and AzTEC bolometers, covering in total 7.5deg^2 on the sky. We found in total 251 sources, and they were classified using their SEDs created including counterparts from optical to far-infrared wavelengths using public databases. The sources were classified as 189 starless, 4 class 0, 7 class I, 49 class II, and 2 class III objects.

Tracing the G331.512+0.103 hot core with CH3CN and CH3OH

Edgar Mendoza (IAG/USP, Sao Paulo, Brazil)

N- and O-bearing molecules trace different physical conditions in hot cores. We observed the G331.512+0.103 hot core with the APEX antenna to study the emission from CH3CN and CH3OH bulks (N. Duronea contribution). All the lines of CH3CN and CH3OH were identified covering the levels Eup=(150-500)K and Eup=(50-400)K, respectively. Radiative analysis indicate rotational temperatures around 100 and 180 K for CH3OH and CH3CN, respectively, as well as that [CH3OH]/[CH3CN]~20. Such hints indicate a rich chemistry activated by thermal processes on the grain surfaces of the G331.512+0.103 hot core.

Hierarchical gravitational fragmentation. I. Collapsing cores within collapsing clouds

Raúl Naranjo-Romero (IRyA - UNAM, Morelia, Mexico)

We investigate the Hierarchical Gravitational Fragmentation scenario through numerical simulations of the prestellar stages of the collapse of a marginally gravitationally unstable isothermal sphere immersed in a strongly gravitationally unstable, uniform background medium. The solution collapses from the outside-in, naturally explaining the observation of extended infall velocities. The core, defined by the radius at which it merges with the background, has a time-variable mass, and evolves along the locus of the ensemble of observed prestellar cores in a plot of M/M_{BE} vs. M, where M

The SuperMALT Project

Sudeep Neupane (Universidad de Chile)

We present the current status of the SuperMALT, a follow up of the MALT90 project which observed ~3200 clumps in 16 molecular lines near 90GHz (mostly, J=1 - 0) using MOPRA telescope. SuperMALT uses APEX telescope to observe a subsample of 76 massive dense clumps at different evolutionary stages (Pre-stellar to HII regions) in higher J transitions (J=3-2 &4-3) of different molecular species (e.g. N2H+, HCO+, HCN, HNC, H13CO+). Combining the low & high J transition line data, we aim to characterize the physical and chemical properties of the clumps as they evolve.

Young Stellar Objects in Orion B identified from the VISTA Orion mini-survey

Monika Petr-Gotzens (ESO, Germany)

I will discuss our search for young stellar objects in the northern part of the Orion molecular cloud B, where we identify almost 200 young stellar objects that coincide or are located close to sites of active star formation. With the total gas mass of the cloud substructures, we calculate local star formation efficiencies, rates, and the star formation density for the star formation sites NGC 2068, NGC 2071, HH24-26. The derived SFEs are similar to those measured for the Orion molecular cloud A, and moreover, the star formation surface density is in excellent agreement with previous findings in other Galactic star-forming regions.

Tracing low-mass star formation in the Large Magellanic Cloud

Monika Petr-Gotzens (ESO, Germany)

Star formation in low metallicity environments is evidently occurring under different conditions than in our Milky Way. Lower metallicity implies a lower dust to gas ratio, most likely leading to less cooling efficiency at high density molecular cores where low mass stars are expected to form. We outline a project that aims to identify the low mass pre-main sequence populations within the Large and Small Magellanic Cloud. We developed an automatic detection algorithm that systematically analyses near-infrared colour-magnitude diagrammes constructed from the VMC (VISTA Magellanic Clouds) public survey data. In this poster we present our first results that show that we are able to detect significant numbers of PMS stars with masses down to ~1.5 solar mass.

Uncovering the protostars in Serpens South with ALMA: continuum sources and their outflow activity

Adele Plunkett (ESO Chile)

The protostellar cluster Serpens South is an appealing case study due several factors: (1) a high protostar fraction; (2) iconic clustered star formation along a filamentary structure; (3) relative proximity to earth. We present a multi-faceted data set acquired from Cycles 1-3 with ALMA, including maps of continuum sources and molecular outflows. Currently, we focus on the census of more than 20 protostars in the cluster center. Among these sources are low-mass objects never before detected in mm-wavelengths, binary/multiple systems previously unresolved, and a strong continuum source driving an episodic outflow.

The current star formation in Orion A: Cores and Filaments

Danae Polychroni (Universidad de Atacama, Copiapó, Chile)

The Orion A molecular cloud, located at 415 pc and spanning some 7 degrees in the night sky, is the massive star forming region nearest to the Sun. As such, it is extensively studied in a variety of wavelengths covering the entire electromagnetic spectrum, most recently with the Herschel Space Telescope. In this talk I will present our study of the low-to-high mass pre-stellar gravitationally bound cores across the cloud, as well as their association to the underlying filamentary structure and the dependence of their properties (mass, temperature etc.) on their local density environment.

Early Versus late type fragmentation in self gravitating cores

Rafeel Riaz (Universidad de Concepción, Chile)

In self gravitating solar mass molecular cores the amplitude of the perturbations and the thermal state of the cores are treated as variable initial conditions. We find that the strength of the perturbations controls both the number of fragments and the proportion of mass accreted by primary versus secondary proto-stellar fragments. Increasing the initial thermal energy in turn leads to dominant mass accretion on primary fragments. Also find that accretion of mass on individual secondary fragments are formed in the later stages of collapse can become more dominant accretor than primaries.

Deuteration in Lupus I

Javier A. Rodón (Onsala Space Observatory, Sweden)

It is known that the deuterium content in star-forming regions is enhanced, and given that the chemical paths that create and destroy a particular deuterated species are not necessarily the same as for others species and depend on the temperature and density of a region, the deuterium content of different species in a given region can be used as a probe of its physical conditions. We probed the deuteration of HCN and HCO+ in the Lupus I main filament, here I will show our preliminary results and what can they tell us about the temperature and density of this cloud.

Properties of massive stellar infalling envelopes

Hugo Saldaño (Observatorio Astronómico de Córdoba, Argentina)

To achieve a better understanding of the high mass star formation, it is necessary to overcome several observational limitations, in particular when the incipient massive young stellar objects are deeply embedded in very dense envelopes. Fortunately, the availably of high sensitivity and angular resolution IR data provided by Herschel allowed us to select a sample of 60 objects. We constructed and modeled the SEDs, and derived properties of the envelopes. We find that they share similar trends with low mass stars, suggesting that both high and low mass stars may form in the same manner.

The Nature of Filament and Prestellar Sources in Lupus I

Satoko Takahashi (Joint ALMA observatory, NAOJ, Chile)

The mechanisms behind the formation of sub-stellar mass sources are key to determine the populations at the low-mass end of the stellar distribution. Here, we present mapping observations toward the Lupus I cloud in C18O(2-1) and 13CO(2-1) obtained with APEX. We have identified a few velocity-coherent filaments. Each contains several substellar mass sources that are also identified in the 1.1mm continuum data (see also SOLA catalogue presentation). We will discuss the velocity structure, fragmentation properties of the identified filaments, and the nature of the detected sources.

A broad view of multiple-star formation

Andrei Tokovinin (CTIO, La Serena, Chile)

A crude description of the processes leading to the formation of binary and multiple stars is given. Typical low-mass binaries are produced by rotational fragmentation of small cores. This mechanism is also viable for solar-mass stars, creating short-period twins, while the majority of multiple systems are generated by turbulent core fragmentation and disk fragmentation. Massive stars and binaries are formed by prolonged accretion in large clusters; their companions form in the circumstellar disks, grow in mass, migrate, and merge, increasing the primary's mass.

Ionisation and the formation of low-mass protostars

James Wurster (University of Exeter, UK)

Molecular clouds are known to have strong magnetic fields and low ionisation rates. Numerical simulations performed with these more realistic conditions yield results closer to those observed, and furthermore, suggest additional observational signatures not yet explored.
I will discuss my simulations of the formation of a single protostar starting from one solar mass of gas; the models include a self-consistent treatment of all three non-ideal MHD processes. My focus will be on how the ionisation parameters and non-ideal MHD processes affect the formation of the protostar and its environment.

Colliding interstellar bubbles and star formation

Lenka Zychova (Masaryk University, Brno, The Czech Repubic)

Using radio and mm surveys, we have found 20 bubbles that show the presence of both atomic and molecular gas and determined their distances, ages, masses, and energies. In our initial study, we identified two pairs of colliding bubbles. At their intersection we found younger and smaller bubbles indicating active star formation. We propose that, by squeezing the interstellar material, collisions of bubbles increase the probability of further star formation. We find that the expansion and collision of bubbles appear to be important mechanisms facilitating star formation in our Galaxy.

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