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The Star Formation Newsletter

The Star Formation Newsletter is a vehicle for fast distribution of information of interest for astronomers working on star and planet formation and molecular clouds. You can submit material for the following sections: *Abstracts of recently accepted papers* (only for papers sent to refereed journals), *Abstracts of recently accepted major reviews* (not standard conference contributions), *Dissertation Abstracts* (presenting abstracts of new Ph.D dissertations), *Meetings* (announcing meetings broadly of interest to the star and planet formation and early solar system community), *New Jobs* (advertising jobs specifically aimed towards persons within the areas of the Newsletter), and *Short Announcements* (where you can inform or request information from the community). Additionally, the Newsletter brings short overview articles on objects of special interest, physical processes or theoretical results, the early solar system, as well as occasional interviews.

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Cover Picture

The image shows and approximately 3 degree wide area of the Taurus clouds. The largest, high-opacity cloud is Barnard 18, which is host to a number of young stars, including IRAS 04239+2436, which drives the giant Herbig-Haro flow HH 300. North is to the right and East is up.

Image courtesy Oliver Czernetz
https://www.astrobin.com/users/OliverCzernetz/

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Abstracts of recently accepted papers

A sensitive λ 3 mm line survey of L483: a broad view of the chemical composition of a core around a Class 0 object

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We present an IRAM 30m line survey of the dense core L483 in the λ 3 mm band. We detected 71 molecules (140 including different isotopologues), most of which are present in the cold and quiescent ambient cloud. Of particular interest are the *cis* isomer of HCOOH, the complex organic molecules $HCOOCH_3$, CH_3OCH_3, and C_2H_5OH, a wide variety of carbon chains, nitrogen oxides like N_2O, and saturated molecules like CH_3SH. In general, fractional molecular abundances in L483 are systematically lower than in TMC-1 (especially for carbon chains), tend to be higher than in L1544 and B1-b, while they are similar to those in L1527. Apart from the overabundance of carbon chains in TMC-1, we find that L483 does not have a marked chemical differentiation with respect to starless/prestellar cores like TMC-1 and L1544, although it does chemically differentiate from Class 0 hot corino sources like IRAS 16293−2422. This fact suggests that the chemical composition of the ambient cloud of some Class 0 sources could be largely inherited from the dark cloud starless/prestellar phase. We also derived isotopic ratios for a variety of molecules, some of which show isotopic anomalies like an extreme depletion in ^{13}C for one of the two isotopologues of c-C_3H_2, a drastic enrichment in ^{18}O for SO and HNCO (SO being also largely enriched in ^{17}O), and different abundances for the two ^{13}C substituted species of C_2H and the two ^{15}N substituted species of N_2H^+. We quantify for the first time the deuterium fractionation for HDCCO and c-C_3D. The detailed chemical characterization of the dense core L483 presented here provides a piece, that together with similar exhaustive characterizations of other low-mass prestellar and protostellar sources, should allow us to understand which are the main factors that regulate the chemical composition of cores along the process of formation of low-mass protostars.

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https://arxiv.org/pdf/1904.06565.pdf

The Origin of [CII] 158um Emission toward the HII Region Complex S235

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Although the $^2P_{3/2} - ^2P_{1/2}$ transition of [C II] at $\lambda \simeq 158\,\mu$m is known to be an excellent tracer of active star formation, we still do not have a complete understanding of where within star formation regions the emission originates. Here, we use *SOFIA* upGREAT observations of [C II] emission toward the H II region complex Sh2-235 (S235) to better understand in detail the origin of [C II] emission. We complement these data with a fully-sampled Green Bank Telescope radio recombination line map tracing the ionized hydrogen gas. About half of the total [C II] emission associated with S235 is spatially coincident with ionized hydrogen gas, although spectroscopic analysis shows **little** evidence that this emission is coming from the ionized hydrogen volume. Velocity-integrated [C II] intensity is strongly correlated with *WISE* 12 μm intensity across the entire complex, indicating that both trace ultra-violet radiation fields. The 22 μm and radio continuum intensities are only correlated with [C II] intensity in the ionized hydrogen portion of the S235 region and the correlations between the [C II] and molecular gas tracers are poor across the region. We

find similar results for emission averaged over a sample of external galaxies, although the strength of the correlations is weaker. Therefore, although many tracers are correlated with the strength of [C II] emission, only *WISE* 12 μm emission is correlated on small-scales of the individual H II region S235 and also has a decent correlation at the scale of entire galaxies. Future studies of a larger sample of Galactic H II regions would help to determine whether these results are truly representative.

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Physical and chemical fingerprint of protostellar disc formation

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Context. The structure and composition of emerging planetary systems are likely strongly influenced by their natal environment within the protoplanetary disc at the time when the star is still gaining mass. It is therefore essential to identify and study the physical processes at play in the gas and dust close to young protostars and investigate the chemical composition of the material that is inherited from the parental cloud.
Aims. The purpose of this paper is to explore and compare the physical and chemical structure of Class I low-mass protostellar sources on protoplanetary disc scales.
Methods. We present a study of the dust and gas emission towards a representative sample of 12 Class I protostars from the Ophiuchus molecular cloud with the Atacama Large Millimeter/submillimeter Array (ALMA). The continuum at 0.87 mm and molecular transitions from $C^{17}O$, $C^{34}S$, $H^{13}CO^+$, CH_3OH, SO_2 , and C_2H were observed at high angular resolution (0.4″, ∼60 au diameter) towards each source. The spectrally and spatially resolved maps reveal the kinematics and the spatial distribution of each species. Moreover, disc and stellar masses are estimated from the continuum flux and position-velocity diagrams, respectively.
Results. Six of the sources show disc-like structures in $C^{17}O$, $C^{34}S$, or $H^{13}CO^+$ emission. Towards the more luminous sources, compact emission and large line widths are seen for transitions of SO_2 that probe warm gas (E_u ∼200 K). In contrast, $C^{17}O$ emission is detected towards the least evolved and less luminous systems. No emission of CH_3OH is detected towards any of the continuum peaks, indicating an absence of warm CH_3OH gas towards these sources.
Conclusions. A trend of increasing stellar mass is observed as the envelope mass decreases. In addition, a power-law relation is seen between the stellar mass and the bolometric luminosity, corresponding to a mass accretion rate of $(2.4 \pm 0.6) \times 10^{-7}$ $M_\odot$ $year^{-1}$ for the Class I sources, with a minimum and maximum value of 7.5×10^{-8} and 7.6×10^{-7} $M_\odot$ $year^{-1}$, respectively. This mass accretion rate is lower than the expected value if the accretion is constant in time and rather points to a scenario of accretion occurring in bursts. The differentiation between $C^{17}O$ and SO_2 suggests that they trace different physical components: $C^{17}O$ traces the densest and colder regions of the disc-envelope system, while SO_2 may be associated with regions of higher temperature, such as accretion shocks. The lack of warm CH_3OH emission suggests that there is no hot-core-like region around any of the sources and that the CH_3OH column density averaged over the disc is low. Finally, the combination of bolometric temperature and luminosity may indicate an evolutionary trend of chemical composition during these early stages.

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Sub-millimeter non-contaminated detection of the disk around TWA 7 by ALMA

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Debris disks can be seen as the left-overs of giant planet formation and the possible nurseries of rocky planets. While M-type stars out-number more massive stars we know very little about the time evolution of their circumstellar disks at ages older than $\sim 10\,$Myr. Sub-millimeter observations are best to provide first order estimates of the available mass reservoir and thus better constrain the evolution of such disks. Here, we present ALMA Cycle 3 Band 7 observations of the debris disk around the M2 star TWA 7, which had been postulated to harbor two spatially separated dust belts, based on unresolved far-infrared and sub-millimeter data. We show that most of the emission at wavelengths longer than $\sim 300\,\mu$m is in fact arising from a contaminant source, most likely a sub-mm galaxy, located at about 6.6 *arcsec* East of TWA 7 (in 2016). Fortunately, the high resolution of our ALMA data allows us to disentangle the contaminant emission from that of the disc and report a significant detection of the disk in the sub-millimeter for the first time with a flux density of 2.1$\pm$0.4 mJy at 870 μm. With this detection, we show that the SED can be reproduced with a single dust belt.

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A survey of C_2H, HCN, and $C^{18}O$ in protoplanetary disks

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Molecular lines observed towards protoplanetary disks carry information about physical and chemical processes associated with planet formation. We present ALMA Band 6 observations of C_2H, HCN, and $C^{18}O$ in a sample of 14 disks spanning a range of ages, stellar luminosities, and stellar masses. Using C_2H and HCN hyperfine structure fitting and HCN/$H^{13}CN$ isotopologue analysis, we extract optical depth, excitation temperature, and column density radial profiles for a subset of disks. C_2H is marginally optically thick ($\tau \sim$ 1–5) and HCN is quite optically thick ($\tau \sim$ 5–10) in the inner 200 AU. The extracted temperatures of both molecules are low (10–30 K), indicative of either sub-thermal emission from the warm disk atmosphere or substantial beam dilution due to chemical substructure. We explore the origins of C_2H morphological diversity in our sample using a series of toy disk models, and find that disk-dependent overlap between regions with high UV fluxes and high atomic carbon abundances can explain a wide range of C_2H emission features (e.g. compact vs. extended and ringed vs. ringless emission). We explore the chemical relationship between C_2H, HCN, and $C^{18}O$ and find a positive correlation between C_2H and HCN fluxes, but no relationship between C_2H or HCN with $C^{18}O$ fluxes. We also see no evidence that C_2H and HCN are enhanced with disk age. C_2H and HCN seem to share a common driver, however more work remains to elucidate the chemical relationship between these molecules and the underlying evolution of C, N, and O chemistries in disks.

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Tiny Grains Shining Bright in the Gaps of Herbig Ae Transitional Discs

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This work presents a study of two Herbig Ae transitional discs, Oph IRS 48 and HD 169142; which both have reported rings in their dust density distributions. We use Keck-II/NIRC2 adaptive optics imaging observations in the L' filter (3.8 μm) to probe the regions of these discs inwards of $\sim$ 20 au from the star. We introduce our method for investigating these transitional discs, which takes a forward modelling approach: making a model of the disc (using the Monte Carlo radiative transfer code RADMC), convolving it with point-spread functions of calibrator stars, and comparing the convolved models with the observational data. The disc surface density parameters are explored with a Monte Carlo Markov Chain technique. Our analysis recovers emission from both of the discs interior to the well known optically thick walls, modelled as a ring of emission at $\sim$ 15 au in Oph IRS 48, and $\sim$ 7 au for HD 169142, and identifies asymmetries in both discs. Given the brightness of the near-symmetric rings compared to the reported companion candidates, we suggest that the reported companion candidates can be interpreted as slightly asymmetric disc emission or illumination.

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ALMA survey of Class II protoplanetary disks in Corona Australis: a young region with low disk masses

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In recent years, the disk populations in a number of young star-forming regions have been surveyed with ALMA. Understanding the disk properties and their correlation with those of the central star is critical to understand planet formation. In particular, a decrease of the average measured disk dust mass with the age of the region has been observed. We conducted high-sensitivity continuum ALMA observations of 43 Class II young stellar objects in CrA at 1.3 mm (230 GHz). The typical spatial resolution is $\sim 0\farcs3$. The continuum fluxes are used to estimate the dust masses of the disks, and a survival analysis is performed to estimate the average dust mass. We also obtained new VLT/X-Shooter spectra for 12 of the objects in our sample. 24 disks are detected, and stringent limits have been put on the average dust mass of the non-detections. Accounting for the upper limits, the average disk mass in CrA is 6±3 $M_\oplus$, significantly lower than that of disks in other young (1–3 Myr) star forming regions (e.g. Lupus) and appears consistent with the 5–10 Myr old Upper Sco. The position of the stars in our sample on the HR diagram, however, seems to confirm that that CrA has age similar to Lupus. Neither external photoevaporation nor a lower than usual stellar mass distribution can explain the low disk masses. On the other hand, a low-mass disk population could be explained if the disks are small, which could happen if the parent cloud has a low temperature or intrinsic angular momentum, or if the the angular momentum of the cloud is removed by some physical mechanism such as magnetic braking. In order to fully explain and understand the dust mass distribution of protoplanetary disks and their evolution, it may also be necessary to take into consideration the initial conditions of star and disk formation process, which may vary from region to region, and affect planet formation.

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Molecular Bullets in A High-mass Protostar

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We present Submillimeter Array (SMA) observations in the CO J = 3–2, SiO J = 5–4 and 8–7, and SO 9_8–8_7 lines, as well as Atacama Pathfinder EXperiment (APEX) observations in the CO J = 6–5 line, of an extremely high-velocity and jet-like outflow in high-mass star-forming region HH 80–81. The outflow is known to contain two prominent molecular bullets, namely B1 and B2, discovered from our previous SMA CO J = 2–1 observations. While B1 is detected in all the CO, SiO, and SO lines, B2 is only detected in CO lines. The CO 3–2/2–1 line ratio in B1 is clearly greater than that in B2. We perform a large velocity gradient analysis of the CO lines and derive a temperature of 70–210 K for B1 and 20–50 K for B2. Taking into account the differences in the velocity, distance from the central source, excitation conditions, and chemistry between the two bullets, we suggest that the bullets are better explained by direct ejections from the innermost vicinity of the central high-mass protostar, and that we are more likely observing the molecular component of a primary wind rather than entrained or swept-up material from the ambient cloud. These findings further support our previous suggestions that the molecular bullets indicate an episodic, disk-mediated accretion in the high-mass star formation process.

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Oscillatory migration of accreting protoplanets driven by a 3D distortion of the gas flow

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Context. The dynamics of a low-mass protoplanet accreting solids is influenced by the heating torque, which was found to suppress inward migration in protoplanetary disks with constant opacities.
Aims. We investigate the differences of the heating torque between disks with constant and temperature-dependent

opacities.
Methods. Interactions of a super-Earth-sized protoplanet with the gas disk are explored using 3D radiation hydrodynamic simulations.
Results. Accretion heating of the protoplanet creates a hot underdense region in the surrounding gas, leading to misalignment of the local density and pressure gradients. As a result, the 3D gas flow is perturbed and some of the streamlines form a retrograde spiral rising above the protoplanet. In the constant-opacity disk, the perturbed flow reaches a steady state and the underdense gas responsible for the heating torque remains distributed in accordance with previous studies. If the opacity is non-uniform, however, the differences in the disk structure can lead to more vigorous streamline distortion and eventually to a flow instability. The underdense gas develops a one-sided asymmetry which circulates around the protoplanet in a retrograde fashion. The heating torque thus strongly oscillates in time and does not on average counteract inward migration.
Conclusions. The torque variations make the radial drift of the protoplanet oscillatory, consisting of short intervals of alternating rapid inward and outward migration. We speculate that transitions between the positive and oscillatory heating torque may occur in specific disk regions susceptible to vertical convection, resulting in the convergent migration of multiple planetary embryos.

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Bok globule CB17: Polarization, extinction and distance

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In this paper, the results obtained from the polarimetric study of a Bok globule CB17 in both optical and submillimeter wavelength are presented. The optical polarimetric observations in R-band (λ = 630 nm, $\Delta\lambda$ = 120 nm) were conducted from 1.04-meter Sampurnanand Telescope, ARIES, Nainital, India on 9th March 2016, while, the sub-mm polarimetric data are taken from the SCUPOL data archive which has been reanalyzed. The contours of Herschel SPIRE 500 μm dust continuum emissions of CB17 (typically a cometary-shaped globule) are overlaid on the DSS image of CB17 along with polarization vectors (optical and submm). The magnetic field strength at the core of the globule is estimated to be 99 μG. Using the Near-Infrared photometric technique and *Gaia* data, the distance to CB17 is found to be 253±43 parsec. A correlation between the various quantities of the globule is also studied. It is observed that the magnetic field in the cloud core as revealed by polarization measurements at the sub-millimeter dust emission is found to be almost aligned along the minor axis of the globule which fits the magnetically regulated star formation model. The misalignment between core-scale magnetic field direction and molecular outflow direction is also found.

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TRAO Survey of Nearby Filamentary Molecular clouds, the Universal Nursery of Stars (TRAO FUNS) I. Dynamics and Chemistry of L1478 in the California Molecular Cloud

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″TRAO FUNS″ is a project to survey Gould Belt's clouds in molecular lines. This paper presents its first results on the central region of the California molecular cloud, L1478. We performed On-The-Fly mapping observations using the Taedeok Radio Astronomy Observatory (TRAO) 14m single dish telescope equipped with a 16 multi-beam array covering ∼1.0 square degree area of this region using $C^{18}O(1-0)$ mainly tracing low density cloud and about 460 square arcminute area using $N_2H^+(1-0)$ mainly tracing dense cores. $CS(2-1)$ and $SO(3_2-2_1)$ were also used simultaneously to map ∼440 square arcminute area of this region. We identified 10 filaments by applying the dendrogram technique to the $C^{18}O$ data-cube and 8 dense N_2H^+ cores by using FellWalker. Basic physical properties of filaments such as mass, length, width, velocity field, and velocity dispersion are derived. It is found that L1478 consists of several filaments with slightly different velocities. Especially the filaments which are supercritical are found to contain dense cores detected in N_2H^+. Comparison of non-thermal velocity dispersions derived from $C^{18}O$ and N_2H^+ for the filaments and dense cores indicates that some of dense cores share similar kinematics with those of the surrounding filaments while several dense cores have different kinematics with those of their filaments. This suggests that the formation mechanism of dense cores and filaments can be different in individual filaments depending on their morphologies and environments.

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A Preferential Attachment Model for the Stellar Initial Mass Function

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Accurate specification of a likelihood function is becoming increasingly difficult in many inference problems in astronomy. As sample sizes resulting from astronomical surveys continue to grow, deficiencies in the likelihood function lead to larger biases in key parameter estimates. These deficiencies result from the oversimplification of the physical processes that generated the data, and from the failure to account for observational limitations. Unfortunately, realistic models often do not yield an analytical form for the likelihood. The estimation of a stellar initial mass function (IMF) is an important example. The stellar IMF is the mass distribution of stars initially formed in a given cluster of stars, a population which is not directly observable due to stellar evolution and other disruptions and observational limitations of the cluster. There are several difficulties with specifying a likelihood in this setting since the physical processes and observational challenges result in measurable masses that cannot legitimately be considered independent draws from an IMF. This work improves inference of the IMF by using an approximate Bayesian computation approach that both accounts for observational and astrophysical effects and incorporates a physically-motivated model for star cluster formation. The methodology is illustrated via a simulation study, demonstrating that the proposed approach can recover the true posterior in realistic situations, and applied to observations from astrophysical simulation data.

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Determining the recurrence timescale of long-lasting YSO outbursts

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We have determined the rate of large accretion events in class I and II young stellar objects (YSOs) by comparing the all-sky digitised photographic plate surveys provided by SuperCOSMOS with the latest data release from *Gaia* (DR2). The long mean baseline of 55 years along with a large sample of class II YSOs (≃15,000) allows us to study approximately 1 million YSO-years. We find 139 objects with $\Delta R \geq 1$ mag, most of which are found at amplitudes between 1 and 3 mag. The majority of YSOs in this group show irregular variability or long-lasting fading events, which is best explained as hot spots due to accretion or by variable extinction. There is a tail of YSOs at $\Delta R \geq 3$ mag and they seem to represent a different population. Surprisingly many objects in this group show high-amplitude irregular variability over timescales shorter than 10 years, in contrast with the view that high-amplitude objects always have long outbursts. However, we find 6 objects that are consistent with undergoing large, long lasting accretion events, 3 of them previously unknown. This yields an outburst recurrence timescale of 112 kyr, with a 68% confidence interval [74 to 180] kyr. This represents the first robust determination of the outburst rate in class II YSOs and shows that YSOs in their planet-forming stage do in fact undergo large accretion events, and with timescales of ≃100,000 years. In addition, we find that outbursts in the class II stage are ≃10 times less frequent than during the class I stage.

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The JCMT BISTRO Survey: The Magnetic Field of the Barnard 1 Star-Forming Region

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We present the POL-2 850 μm linear polarization map of the Barnard 1 clump in the Perseus molecular cloud complex from the B-fields In STar-forming Region Observations (BISTRO) survey at the James Clerk Maxwell Telescope. We find a trend of decreasing polarization fraction as a function of total intensity, which we link to depolarization effects towards higher density regions of the cloud. We then use the polarization data at 850 μm to infer the plane-of-sky orientation of the large-scale magnetic field in Barnard 1. This magnetic field runs North-South across most of the cloud, with the exception of B1-c where it turns more East-West. From the dispersion of polarization angles, we calculate a turbulence correlation length of 5.0 ± 2.5 arcsec (1500 au), and a turbulent-to-total magnetic energy ratio of 0.5 ± 0.3 inside the cloud. We combine this turbulent-to-total magnetic energy ratio with observations of NH_3

molecular lines from the Green Bank Ammonia Survey (GAS) to estimate the strength of the plane-of-sky component of the magnetic field through the Davis-Chandrasekhar-Fermi method. With a plane-of-sky amplitude of 120 ± 60 μG and a criticality criterion $\lambda_c = 3.0 \pm 1.5$, we find that Barnard 1 is a supercritical molecular cloud with a magnetic field nearly dominated by its turbulent component.

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Ultraviolet extinction properties of the 30 Dor Nebula and interpreting observations of starburst clusters

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Recent investigation of the extinction law in 30 Dor and the Tarantula Nebula, at optical and near infrared wavelengths, has revealed a ratio of total to selective extinction $R_V = A_V/E(B-V)$ of about 4.5. This indicates a larger fraction of big grains than in the Galactic diffuse interstellar medium (ISM). Possible origins include coalescence of small grains, small grain growth, selective destruction of small grains, and fresh injection of big grains. From a study of the ultraviolet extinction properties of three massive stars in the 30 Dor Nebula (R 139, R 140, R 145), observed with the International Ultraviolet Explorer, we show that the excess of big grains does not come at the expense of small grains, which are still present and possibly even more abundant. Fresh injection of large grains appears the dominant mechanism. A process able to naturally account for this in environments such as the Tarantula Nebula, where formation of massive stars has been ongoing for over ~ 20 Myr, is the explosion of massive stars as type-II supernovae. The ensuing change in the conditions of the ISM is only temporary, lasting less than ~ 100 Myr, because shattering and shocks will eventually break and destroy the bigger grains. However, this is the only time when star-forming regions are detectable as such in starburst and high-redshift galaxies and we highlight the complexity inherent in interpreting observations of star-forming regions in these environments. If the extinction characteristics are not known properly, any attempts to derive quantitative physical parameters are bound to fail.

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Unveiling molecular clouds toward bipolar HII region G8.14+0.23

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Most recent numerical simulations suggest that bipolar H II regions, powered by O-type stars, can be formed at the interface of two colliding clouds. To observationally understand the birth of O-type stars, we present a detailed multi-wavelength analysis of an area of 1 deg x 1 deg hosting G8.14+0.23 H II region associated with an infrared bipolar nebula (BPN). Based on the radio continuum map, the H II region is excited by at least an O-type star, which is located toward the waist of the BPN. The NANTEN2 ^{13}CO line data reveal the existence of two extended clouds at [9, 14.3] and [15.3, 23.3] km s^{-1} toward the site G8.14+0.23, which are connected in the position-velocity space through a broad-bridge feature at the intermediate velocity range. A "cavity/intensity-depression" feature is evident in the blueshifted cloud, and is spatially matched by the "elongated redshifted cloud". The spatial and velocity connections of the clouds suggest their interaction in the site G8.14+0.23. The analysis of deep near-infrared photometric data reveals the presence of clusters of infrared-excess sources, illustrating ongoing star formation activities in both the clouds. The O-type star is part of the embedded cluster seen in the waist of the BPN, which is observed toward the spatial matching zone of the cavity and the redshifted cloud. The observational results appear to be in reasonable

agreement with the numerical simulations of cloud-cloud collision (CCC), suggesting that the CCC process seems to be responsible for the birth of the O-type star in G8.14+0.23.

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Observational signatures of end-dominated collapse in the S242 filamentary structure

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We present new CO (^{13}CO(1–0) and C^{18}O(1–0)) and CS(2–1) line observations of an elongated filamentary structure (length ∼30 pc) in the star-forming site S242, which were taken with the OSO-20m telescope. One filament's end hosts the S242 H II region, while the other end contains *Planck* cold clumps. Several sub-regions are identified in the filament, and are supersonic with Mach number of 2.7–4.0. The study of the dynamical states shows supercritical nature of the sub-regions (except central part), which could not be supported by a combination of thermal and turbulent motions. Young stellar objects are seen toward the entire filament, but more concentrated toward its ends. Dense molecular cores are observed mainly toward the filament ends, and are close to virial equilibrium. Position-velocity plots trace velocity gradients (∼1 km s^{-1} pc^{-1}) toward both the ends. An oscillatory pattern in velocity is also observed toward the filament, indicating its fragmentation. The collapse timescale of the filament is computed to be ∼3.5 Myr. Using the ^{13}CO data, the structure function in velocity of the filament is found to be very similar as seen in the Musca cloud for lags ∼1–3 pc, and deviates from the Larson's velocity-size relationship. The observed oscillatory pattern in the structure function at higher lags suggests the existence of large-scale and ordered velocity gradients as well as the fragmentation process through accretion along the filament. Considering all the observed results along with their uncertainties, the S242 filament is a very good example of the end-dominated collapse.

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Using Multiwavelength Variability to Explore the Connection between X-ray Emission, the Far-Ultraviolet H2 Bump, and Accretion in T Tauri Stars

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The high-energy radiation fields of T Tauri stars (TTS) should affect the surrounding circumstellar disk, having implications for disk transport and heating. Yet, observational evidence of the effect of high-energy fields on disks is scarce. Here we investigate the connection between X-ray emission and the innermost gas disk by leveraging the variability of TTS. We obtained multiple epochs of coordinated data (taken either simultaneously or within a few hours) of accreting TTS with the *Hubble Space Telescope*, the *Neil Gehrels Swift Observatory*, and the *Chandra X-ray Observatory*. We measured the far-ultraviolet (FUV) H_2 bump feature at 1600 Å, which traces gas < 1 AU from the star; the near-ultraviolet (NUV) emission, from which we extract the accretion luminosity; and also the X-ray luminosity. We do not find a correlation between the FUV H_2 bump and X-ray luminosity. Therefore, an observable tracer of the effect of X-ray ionization in the innermost disk remains elusive. We report a correlation between the FUV H_2 bump and accretion luminosity, linking this feature to the disk surface density. We also see a correlation between the X-ray luminosity and the accretion column density, implying that flaring activity may influence accretion. These results stress the importance of coordinated multiwavelength work to understand TTS.

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Maser Flare Simulations from Oblate and Prolate Clouds

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We investigated, through numerical models, the flaring variability that may arise from the rotation of maser clouds of approximately spheroidal geometry, ranging from strongly oblate to strongly prolate examples. Inversion solutions were obtained for each of these examples over a range of saturation levels from unsaturated to highly saturated. Formal solutions were computed for rotating clouds with many randomly chosen rotation axes, and corresponding averaged maser light curves plotted with statistical information. The dependence of results on the level of saturation and on the degree of deformation from the spherical case were investigated in terms of a variability index and duty cycle. It may be possible to distinguish observationally between flares from oblate and prolate objects. Maser flares from rotation are limited to long timescales (at least a few years) and modest values of the variability index (≤ 100), and can be aperiodic or quasi-periodic. Rotation is therefore not a good model for H_2O variability on timescales of weeks to months, or of truly periodic flares.

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Proper Motions and Shock Wave Dynamics in the HH 7–11 Stellar Jet

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We have used the Hubble Space Telescope to acquire new broad-band and narrow-band images of the optical line emission and red continuum associated with the HH 7–11 stellar jet in the NGC 1333 star formation region. Combining the new narrow-band images of Hα, [OI] λ6300 and [SII] λ6716 allows us to measure electron densities and excitations at each point in the outflow with the spatial resolution of HST, while the I-band image traces out the boundary of the cavity evacuated by the outflow. Comparing these images with those taken $\sim$20 years ago yields high precision proper motions for all the HH objects in the outflow. HH 11 is a bullet-like clump, and emerges from the exciting source SVS 13A towards the Earth at 24 degrees to line of sight. In contrast, HH 8 and HH 10 consist of two rings of shocked gas that show no bulk proper motions even though the emitting gas is blueshifted. The HH 8 rings are expanding with time. These shocks mark places where ambient material located along the path of the jet redirects the outflow. HH 7 consists of multiple shells, and emits strongly in H_2 in what appears to be a terminal bow shock for the outflow, implying that the jet has yet to fully break out of its nascent cloud core. The jet largely fragments into clumps by the time it reaches HH 7. As in the case of HH 110, deflection from ambient material plays a key role in producing observable shock waves in the HH 7–11 outflow.

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An initial overview of the extent and structure of recent star formation within the Serpens Molecular Cloud using Gaia Data Release 2

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The dense clusters within the Serpens Molecular Cloud are among the most active regions of nearby star formation. In this paper, we use Gaia DR2 parallaxes and proper motions to statistically measure ~ 1167 kinematic members of Serpens, few of which were previously identified, to evaluate the star formation history of the complex. The optical members of Serpens are concentrated in three distinct groups located at 380–480 pc; the densest clusters are still highly obscured by optically-thick dust and have few optical members. The total population of young stars and protostars in Serpens is at least 2000 stars, including past surveys that were most sensitive to protostars and disks, and may be far higher. Distances to dark clouds measured from deficits in star counts are consistent with the distances to the optical star clusters. The Serpens Molecular Cloud is seen in the foreground of the Aquila Rift, dark clouds located at 600–700 pc, and behind patchy extinction, here called the Serpens Cirrus, located at ~ 250 pc. Based on the lack of a distributed population of older stars, the star formation rate throughout the Serpens Molecular Cloud increased by at least a factor of 20 within the past ~ 5 Myr. The optically bright stars in Serpens Northeast are visible because their natal molecular cloud has been eroded and not because they were flung outwards from a central factory of star formation. The separation between subclusters of 20–100 pc and the absence of an older population leads to speculation that an external forcing was needed to trigger the active star formation.

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Driving Conditions of Protostellar Outflows in Different Star-Forming Environments

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The evolution of collapsing clouds embedded in different star-forming environments is investigated using three-dimensional non-ideal magnetohydrodynamics simulations considering different cloud metallicities ($Z/Z_\odot = 0$, 10^{-5}, 10^{-4}, 10^{-3}, 10^{-2}, 10^{-1} and 1) and ionisation strengths (C_ζ=0, 0.01, 1 and 10, where C_ζ is a coefficient controlling the ionisation intensity and $C_\zeta = 1$ corresponds to the ionisation strength of nearby star-forming regions). With all combinations of these considered values of $Z/Z_\odot$ and C_ζ, 28 different star-forming environments are prepared and simulated. The cloud evolution in each environment is calculated until the central density reaches $n \approx 10^{16}\,\mathrm{cm}^{-3}$ just before protostar formation, and the outflow driving conditions are derived. An outflow appears when the (first) adiabatic core forms in a magnetically active region where the magnetic field is well coupled with the neutral gas. In cases where outflows are driven, their momentum fluxes are always comparable to the observations of nearby star-forming regions. Thus, these outflows should control the mass growth of the protostars as in the local universe. Roughly, an outflow appears when $Z/Z_\odot > 10^{-4}$ and $C_\zeta \geq 0.01$. It is expected that the transition of the star formation mode from massive stars to normal solar-type stars occurs when the cloud metallicity is enhanced to the range of $Z/Z_\odot \approx 10^{-4}$–$10^{-3}$, above which relatively low-mass stars would preferentially appear as a result of strong mass ejection.

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Sulfur Chemistry in L1157-B1

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The main carrier of sulfur in dense clouds, where it is depleted from the gas phase, remains a mystery. Shock waves in young molecular outflows disrupt the ice mantles and allow us to directly probe the material that is ejected into the gas phase. A comprehensive study of sulfur-bearing species towards L1157-B1, a shocked region along a protostellar outflow, has been carried out as part of the IRAM-30m large program ASAI. The dataset contains over 100 lines of CCS, H_2CS, OCS, SO, SO_2 and isotopologues. The results of these observations are presented, complementing previous studies of sulfur-bearing species in the region. The column densities and fractional abundances of these species are measured and together these species account for 10% of the cosmic sulfur abundance in the region. The gas properties derived from the observations are also presented, demonstrating that sulfur bearing species trace a wide range of different gas conditions in the region.

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Observations of CH_3OH and CH_3CHO in a Sample of Protostellar Outflow Sources

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IRAM 30-m Observations towards eight protostellar outflow sources were taken in the 96–176 GHz range. Transitions of CH_3OH and CH_3CHO were detected in seven of them. The integrated emission of the transitions of each species that fell into the observed frequency range were measured and fit using RADEX and LTE models. Column densities and gas properties inferred from this fitting are presented. The ratio of the A and E-type isomers of CH_3OH indicate that the methanol observed in these outflows was formed on the grain surface. Both species demonstrate a reduction of terminal velocity in their line profiles in faster outflows, indicating destruction in the post-shock gas phase. This destruction, and a near constant ratio of the CH_3OH and CH_3CHO column densities imply it is most likely that CH_3CHO also forms on the grain surface.

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On the origin of very massive stars around NGC 3603

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The formation of the most massive stars in the Universe remains an unsolved problem. Are they able to form in relative isolation in a manner similar to the formation of solar-type stars, or do they necessarily require a clustered environment? In order to shed light on this important question, we study the origin of two very massive stars (VMS): the O2.5If*/WN6 star RFS7 ($\sim$100 $M_\odot$), and the O3.5If* star RFS8 ($\sim$70 $M_\odot$), found within $\approx$ 53 and

58 pc respectively from the Galactic massive young cluster NGC 3603, using *Gaia* data. RFS7 is found to exhibit motions resembling a runaway star from NGC 3603. This is now the most massive runaway star candidate known in the Milky Way. Although RFS8 also appears to move away from the cluster core, it has proper-motion values that appear inconsistent with being a runaway from NGC 3603 at the 3σ level (but with substantial uncertainties due to distance and age). Furthermore, no evidence for a bow-shock or a cluster was found surrounding RFS8 from available near-infrared photometry. In summary, whilst RFS7 is likely a runaway star from NGC 3603, making it the first VMS runaway in the Milky Way, RFS8 is an extremely young (∼2 Myr) VMS, which might also be a runaway, but this would need to be established from future spectroscopic and astrometric observations, as well as precise distances. If RFS8 were still not meeting the criteria for being a runaway from NGC 3603 from such future data, this would have important ramifications for current theories of massive star formation, as well as the way the stellar initial mass function (IMF) is sampled.

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Merged H/H2 and C+/C/CO transitions in the Orion Bar

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High-resolution ALMA images towards the Orion Bar show no discernible offset between the peak of H2 emission in the photodissociation region (PDR) and the 13CO(3-2) and HCO+(4-3) emission in the molecular region. This implies that positions of H2 and CO dissociation fronts are indistinguishable in the limit of ALMA resolution. We use the chemo-dynamical model MARION to show that the ALMA view of the Orion Bar, namely, no appreciable offset between the 13CO(3-2) and HCO+(4-3) peaks, merged H2 and CO dissociation fronts, and high intensity of HCO+(4-3) emission, can only be explained by the ongoing propagation of the dissociation fronts through the molecular cloud, coupled to the dust motion driven by the stellar radiation pressure, and are not reproduced in the model where the dissociation fronts are assumed to be stationary. Modelling line intensities, we demonstrate that after the fronts have merged, the angular separation of the 13CO(3-2) and HCO+(4-3) peaks is indeed unresolvable with the ALMA observations. Our model predictions are consistent with the results of the ALMA observations about the relation of the bright HCO+(4-3) emission to the compressed gas at the border of the PDR in the sense that the theoretical HCO+(4-3) peak does correspond to the gas density enhancement, which naturally appears in the dynamical simulation, and is located near the H2 dissociation front at the illuminated side of the CO dissociation front.

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Massive Young Stellar Objects and Outflow in the Infrared-Dark Cloud G79.3+0.3

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G79.3+0.3 is an infrared dark cloud in the Cygnus-X complex that is home to massive deeply embedded young stellar objects (YSOs). We have produced a submillimeter array (SMA) 1.3 mm continuum image and ^{12}CO line maps of the eastern section of G79.3+0.3 in which we detect five separate YSOs. We have estimated physical parameters for these five YSOs and others in the vicinity of G79.3+0.3 by fitting existing photometry from Spitzer, Herschel, and ground-based telescopes to spectral energy distribution models. Through these model fits we find that the most massive YSOs seen in the SMA 1.3 mm continuum emission have masses in the $5-6\ M_{sun}$ range. One of the SMA sources was observed to power a massive collimated ^{12}CO outflow extending at least 0.94 pc in both directions from the protostar, with a total mass of $0.83\ M_{sun}$ and a dynamical timescale of 23 kyr.

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Development of models for nearby young stellar moving groups: creation, revision, and finalisation of the models

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Lee & Song (2018, Paper 1) developed a tool for calculating Bayesian membership probability for nearby young stellar moving groups (BAMG: Bayesian Analysis of Moving Groups). The study presented the importance of careful construction of models in moving group membership assessment, using β Pictoris moving group as a test case. In this study, we build models for all major nearby young stellar moving groups (NYMGs hereafter) through 4 stages. A set of prototype models is created using members listed in the discovery paper of each group. For each group, suggested members after the discovery of the group are used for revising these prototype models. As these additional members being incorporated, group properties of a NYMG changes, thus membership probabilities change as well. A subset of stars show consistently large membership probabilities regardless of the details of a chosen method for ingesting additional members. Utilising these members, the NYMG models are finalised. The finalised models are applied for evaluating memberships of all claimed candidate members, resulting in a list of bona fide members. The mass function of bona fide members for the entire set of NYMG members indicates that more late-M type members should be identified. In addition, some objects showing a large difference in membership probability between BAMG and BANYAN Σ (Gagne et al. 2018b) are presented and discussed. Memberships of some planet host stars are changed, and it can have a significant influence on the estimated planetary masses.

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The First Two Thousand Years of Star Formation

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Starting from a prestellar core with a size of 1.2×10^4 AU, we calculate the evolution of a gravitationally collapsing core until ~ 2000 yr after protostar formation using a three-dimensional resistive magnetohydrodynamic simulation, in which the protostar is resolved with a spatial resolution of 5.6×10^{-3} AU. Following protostar formation, a rotationally supported disk is formed. Although the disk size is as small as $\sim 2-4$ AU, it remains present until the end of the simulation. Since the magnetic field dissipates and the angular momentum is then not effectively transferred by magnetic effects, the disk surface density gradually increases and spiral arms develop due to gravitational instability. The disk angular momentum is then transferred mainly by gravitational torques, which induce an episodic mass accretion onto the central protostar. The episodic accretion causes a highly time-variable mass ejection (the high-velocity jet) near the disk inner edge, where the magnetic field is well coupled with the neutral gas. As the mass of the central protostar increases, the jet velocity gradually increases and exceeds $\sim 100\,\mathrm{km\,s^{-1}}$. The jet opening angle widens with time at its base, while the jet keeps a very good collimation on the large scale. In addition, a low-velocity outflow is driven from the disk outer edge. A cavity-like structure, a bow shock and several knots, all of which are usually observed in star-forming regions, are produced in the outflowing region.

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Excitation of Planetary Obliquities Through Planet-Disk Interactions

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The tilt of a planet's spin axis off its orbital axis ("obliquity") is a basic physical characteristic that plays a central role in determining the planet's global circulation and energy redistribution. Moreover, recent studies have also highlighted the importance of obliquities in sculpting not only the physical features of exoplanets but also their orbital architectures. It is therefore of key importance to identify and characterize the dominant processes of excitation of non-zero axial tilts. Here we highlight a simple mechanism that operates early on and is likely fundamental for many extrasolar planets and perhaps even Solar System planets. While planets are still forming in the protoplanetary disk, the gravitational potential of the disk induces nodal recession of the orbits. The frequency of this recession decreases as the disk dissipates, and when it crosses the frequency of a planet's spin axis precession, large planetary obliquities may be excited through capture into a secular spin-orbit resonance. We study the conditions for encountering this resonance and calculate the resulting obliquity excitation over a wide range of parameter space. Planets with semi-major axes in the range 0.3 AU $\lesssim$ a $\lesssim$ 2 AU are the most readily affected, but large-a planets can also be impacted. We present a case study of Uranus and Neptune and show that this mechanism likely cannot help explain their high obliquities. While it could have played a role if finely tuned and envisioned to operate in isolation, large-scale obliquity excitation was likely inhibited by gravitational planet-planet perturbations.

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Evolution of young protoclusters embedded in dense massive clumps. A new grid of population synthesis SED models and a new set of L/M evolutionary tracks

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A grid of 20 millions 3–1100 μm SED models is presented for synthetic young clusters embedded in dense clumps. The models depend on four primary parameters: the clump mass $M_{\rm clump}$ and dust temperature $T_{\rm dust}$, the fraction of mass $f_{\rm core}$ locked in dense cores, and the age of the clump $t_{\rm SF}$. We populate the YSO clusters using the IMF from Kroupa (2001) and the YSOs SED models grid of Robitaille et al. (2006). We conduct extensive testing of SED fitting using a simulated dataset and we find that $M_{\rm clump}$ essentially depends on the submillimeter portion of the SED, while $T_{\rm dust}$ is mostly determined from the shape of the SED in the 70–350 μm range. Thanks to the large number of models computed we verify that the combined analysis of L/M, $[8-24]$ and $[24-70]$ colours removes much of the SEDs $f_{\rm core}$–$t_{\rm SF}$ degeneracy. The L/M values are particularly useful to diagnose $f_{\rm core}$. $L/M \leq 1$ identifies protoclusters with $f_{\rm core} \leq 0.1$ and $t_{\rm SF} \lesssim 10^5$ years, while $L/M \geq 10$ excludes $f_{\rm core} \leq 0.1$. We characterize lower limits of L/M where ZAMS stars are not found in models, and we also find models with $L/M \geq 10$ and no ZAMS stars, in which $[8-24] \gtrsim 0.8 \pm 0.1$ independently from $M_{\rm clump}$, temperature and luminosity. This is the first set of synthesis SED models suited to model for embedded and unresolved clusters of YSOs. A set of new evolutionary tracks in the L/M diagram is also presented.

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The Inner Disk and Accretion Flow of the Close Binary DQ Tau

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We present multi-epoch optical and near-infrared (NIR) photometry and spectroscopy of the spectroscopic binary T Tauri star DQ Tau. The photometric monitoring, obtained using SMARTS ANDICAM, recovers the previously-seen correlation between optical flux and the 15.8-day binary orbital period, with blue flux peaks occurring close to most observed periastron passages. For the first time, we find an even more consistent correlation between orbital period and NIR brightness and color. The onset of pulse events in the NIR on average precedes those in the optical by a few days, with the rise usually starting near apastron orbital phase. We further obtained five epochs of spectroscopy using IRTF SpeX, with a wavelength range of 0.8 to 5 microns, and derived spectra of the infrared excess emission. The shape and strength of the excess varies with time, with cooler and weaker characteristic dust emission (T $\sim 1100-1300$ K) over most of the binary orbit, and stronger/warmer dust emission (T $\sim$ 1600 K, indicative of dust sublimation) just before periastron passage. We suggest our results are broadly consistent with predictions of simulations of disk structure and accretion flows around close binaries, with the varying dust emission possibly tracing the evolution of accretion streams falling inwards through a circumbinary disk cavity and feeding the accretion pulses traced by the optical photometry and NIR emission lines. However, our results also show more complicated behavior that is not fully explained by this simple picture, and will require further observations and modeling to fully interpret.

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Rapid destruction of protoplanetary discs due to external photoevaporation in star-forming regions

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We analyse N-body simulations of star-forming regions to investigate the effects of external far and extreme ultra-violet photoevaporation from massive stars on protoplanetary discs. By varying the initial conditions of simulated star-forming regions, such as the spatial distribution, net bulk motion (virial ratio), and density, we investigate which parameters most affect the rate at which discs are dispersed due to external photoevaporation. We find that disc dispersal due to external photoevaporation is faster in highly substructured star-forming regions than in smooth and centrally concentrated regions. Sub-virial star-forming regions undergoing collapse also show higher rates of disc dispersal than regions that are in virial equilibrium or are expanding. In moderately dense ($\sim$100 $M_{\odot}$ pc^{-3}) regions, half of all protoplanetary discs with radii $\geq$100 AU are photoevaporated within 1 Myr, three times faster than is currently suggested by observational studies. Discs in lower-density star-forming regions ($\sim$10 $M_{\odot}$ pc^{-3}) survive for longer, but half are still dispersed on short timescales ($\sim$2 Myr). This demonstrates that the initial conditions of the star forming regions will greatly impact the evolution and lifetime of protoplanetary discs. These results also imply that either gas giant planet formation is extremely rapid and occurs before the gas component of discs is evaporated, or gas giants only form in low-density star-forming regions where no massive stars are present to photoevaporate gas from protoplanetary discs.

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Revealing dust segregation in protoplanetary discs with the help of multi-frequency spectral index maps

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Dust is known to drift and grow in protoplanetary discs, which results in dust segregation over the disc extent. Maps of the spectral index α are a common tool for studying the dust content in protoplanetary discs. The analysis of observationally derived maps reveals significant gradients of the spectral index, confirming that dust evolves in the disc, but a more detailed information about the dust redistribution is required to make inferences about the early stages of dust growth. We calculated the spectral index maps based on the results of numerical hydrodynamical simulations using the `FEOSAD` code, which allows studying a long-term dynamics of a self-gravitating viscous disc populated with coagulating, drifting, and fragmenting dust. Here we demonstrate that values of the spectral index estimated for different wavelength intervals within the far-infrared and radio bands reveal the presence of dust grains of various sizes. Specifically, we show that the disc regions with the maximal spectral index in a specific wavelength interval are the regions with the prevalence of dust grains of a specific size. Thus, a set of spectral index maps derived using different wavelength intervals can be used to recover the dust size-distribution over the disc extent.

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The dispersal of protoplanetary discs I: A new generation of X-ray photoevaporation models

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Photoevaporation of planet forming discs by high energy radiation from the central star is potentially a crucial mechanism for disc evolution and it may play an important role in the formation and evolution of planetary system. We present here a new generation of X-ray photoevaporation models for solar-type stars, based on a new set of hydrodynamical simulations, which account for stellar irradiation via a new, significantly improved, parameterisation of gas temperatures, based on detailed photoionisation and radiation transfer calculations. This is the first of a series of papers aiming at providing a library of models which cover the observed parameter space in stellar and disc mass, metallicity and stellar X-ray properties. We focus here on solar-type stars (0.7 $M_\odot$) with relatively low-mass discs (1% of the stellar mass) and explore the dependence of the wind mass loss rates on stellar X-ray luminosity. We model primordial discs as well as transition discs at various stages of evolution. Our 2D hydrodynamical models are then used to derive simple recipes for the mass loss rates that are suitable for inclusion in one-dimensional disc evolution and/or planet formation models typically employed for population synthesis studies. Line profiles from typical wind diagnostics ([OI] 6300 Å and [NeII] 12.8 μm) are also calculated for our models and found to be roughly in agreement with previous studies. Finally, we perform a population study of transition discs by means of one-dimensional viscous evolution models including our new photoevaporation prescription and find that roughly a half of observed transition discs cavities and accretion rates could be reproduced by our models.

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A tale of two clusters: dynamical history determines disc survival in Tr14 and Tr16 in the Carina Nebula

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Understanding how the birthplace of stars affects planet-forming discs is important for a comprehensive theory of planet formation. Most stars are born in dense star-forming regions where the external influence of other stars, particularly the most massive stars, will affect the survival and enrichment of their planet-forming discs. Simulations suggest that stellar dynamics play a central role in regulating how external feedback affects discs, but comparing models to observations requires an estimate of the initial stellar density in star-forming regions. Structural analyses constrain the amount of dynamical evolution a star-forming region has experienced; regions that maintain substructure and do not show mass segregation are likely dynamically young, and therefore close to their birth density. In this paper, we present a structural analysis of two clusters in the Carina Nebula, Tr14 and Tr16. We show that neither cluster shows evidence for mass segregation or a centrally concentrated morphology, suggesting that both regions are dynamically young. This allows us to compare to simulations from Nicholson et al. (2019) who predict disc survival rates in star-forming regions of different initial densities. The surviving disc fractions in Tr14 and Tr16 are consistent with their predictions (both are $\sim 10\%$), supporting a growing body of evidence that the star-forming environment plays an important role in the survival and enrichment of protoplanetary discs.

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ALMA reveals a pseudo-disc in a proto-brown dwarf

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We present the observational evidence of a pseudo-disc around the proto-brown dwarf Mayrit 1701117, the driving source of the large-scale HH 1165 jet. Our analysis is based on ALMA ^{12}CO (2-1) line and 1.37 mm continuum observations at an angular resolution of $\sim$0.4″. The pseudo-disc is a bright feature in the CO position-velocity diagram (PVD), elongated in a direction perpendicular to the jet axis, with a total (gas+dust) mass of $\sim$0.02 $M_\odot$, size of 165-192 AU, and a velocity spread of $\pm$2 km s^{-1}. The large velocity gradient is a combination of infalling and rotational motions, indicating a contribution from a pseudo-disc and an unresolved inner Keplerian disc. There is weak emission detected in the H_2CO (3-2) and N_2D^+ (3-2) lines. H_2CO emission likely probes the inner Keplerian disc where CO is expected to be frozen, while N_2D^+ possibly originates from an enhanced clump at the outer edge of the pseudo-disc. We have considered various models (core collapse, disc fragmentation, circum-binary disc) that can fit both the observed CO spectrum and the position-velocity offsets. The observed morphology, velocity structure, and the physical dimensions of the pseudo-disc are consistent with the predictions from the core collapse simulations for brown dwarf formation. From the best model fit, we can constrain the age of the proto-brown dwarf system to be $\sim$30,000-40,000 yr. A comparison of the H_2 column density derived from the CO line and 1.37 mm continuum emission indicates that only about 2% of the CO is depleted from the gas phase.

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Massive star formation via torus accretion: the effect of photoionization feedback

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The formation of massive stars is a long standing problem. Although a number of theories of massive star formation exist, ideas appear to converge to a disk-mediated accretion scenario. Here we present radiative hydrodynamic simulations of a star accreting mass via a disk embedded in a torus. We use a Monte Carlo based radiation hydrodynamics code to investigate the impact that ionizing radiation has on the torus. Ionized regions in the torus midplane 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 torus plane allow accretion to progress, while expanding HII regions disrupt the accretion torus preventing the central star from aggregating more mass, thereby setting the star's final mass. We obtain constraints for the luminosities and torus densities that lead to both scenarios.

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ACRONYM III: Radial Velocities for 336 Candidate Young Low-Mass Stars in the Solar Neighborhood, Including 78 Newly Confirmed Young Moving Group Members

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Young, low-mass stars in the solar neighborhood are vital for completing the mass function for nearby, young coeval groups, establishing a more complete census for evolutionary studies, and providing targets for direct-imaging exoplanet and/or disk studies. We present properties derived from high-resolution optical spectra for 336 candidate young nearby, low-mass stars. These include measurements of radial velocities and age diagnostics such as Hα and Li λ6707 equivalent widths. Combining our radial velocities with astrometry from Gaia DR2, we provide full 3D kinematics for the entire sample. We combine the measured spectroscopic youth information with additional age diagnostics (e.g., X-ray and UV fluxes, CMD positions) and kinematics to evaluate potential membership in nearby, young moving groups and associations. We identify 78 objects in our sample as bonafide members of 10 different moving groups, 15 of which are completely new members or have had their group membership reassigned. We also reject 44 previously proposed candidate moving group members. Furthermore, we have newly identified or confirmed the youth of numerous additional stars that do not belong to any currently known group, and find 69 co-moving systems using Gaia DR2 astrometry. We also find evidence that the Carina association is younger than previously thought, with an age similar to the β Pictoris moving group ($\sim$22 Myr).

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Unlocking CO Depletion in Protoplanetary Disks II. Primordial C/H Predictions Inside the CO Snowline

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CO is thought to be the main reservoir of volatile carbon in protoplanetary disks, and thus the primary initial source of carbon in the atmospheres of forming giant planets. However, recent observations of protoplanetary disks point towards low volatile carbon abundances in many systems, including at radii interior to the CO snowline. One potential explanation is that gas phase carbon is chemically reprocessed into less volatile species, which are frozen on dust grain surfaces as ice. This mechanism has the potential to change the primordial C/H ratio in the gas. However, current observations primarily probe the upper layers of the disk. It is not clear if the low volatile carbon abundances extend to the midplane, where planets form. We have run a grid of 198 chemical models, exploring how the chemical reprocessing of CO depends on disk mass, dust grain size distribution, temperature, cosmic ray and X-ray ionization rate, and initial water abundance. Building on our previous work focusing on the warm molecular layer, here we analyze the results for our grid of models in the disk midplane at 12 au. We find that either an ISM level cosmic ray ionization rate or the presence of UV photons due to a low dust surface density are needed to chemically reduce the midplane CO gas abundance by at least an order of magnitude within 1 Myr. In the majority of our models CO does not undergo substantial reprocessing by in situ chemistry and there is little change in the gas phase C/H and C/O ratios over the lifetime of the typical disk. However, in the small sub-set of disks where the disk midplane is subject to a source of ionization or photolysis, the gas phase C/O ratio increases by up to nearly 9 orders of magnitude due to conversion of CO into volatile hydrocarbons.

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Line Ratios Reveal N_2H^+ Emission Originates Above the Midplane in TW Hydrae

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Line ratios for different transitions of the same molecule have long been used as a probe of gas temperature. Here we use ALMA observations of the N_2H^+ J = 1–0 and J = 4–3 lines in the protoplanetary disk around TW Hya to derive the temperature at which these lines emit. We find an averaged temperature of 39 K with a one sigma uncertainty of 2 K for the radial range $0\overset{''}{.}8$–2″, significantly warmer than the expected midplane temperature beyond $0\overset{''}{.}5$ in this disk. We conclude that the N_2H^+ emission in TW Hya is not emitting from near the midplane, but rather from higher in the disk, in a region likely bounded by processes such as photodissociation or chemical reprocessing of CO and N_2 rather than freeze out.

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Virial Ratio: Direct Evaluation from Molecular Cloud Data and the Challenges of Improving Accuracy

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The virial ratio between kinetic and gravitational terms provides key insight into the balance of forces that confine a molecular cloud, but the clumpy and filamentary structures of resolved clouds make it difficult to evaluate this ratio in a consistent way. For clouds with resolved maps of column density as well as a line tracer, we demonstrate that the gravitational energy can be estimated directly from observations in a manner similar to the kinetic energy. This offers improved diagnostic power and consistency. Disentangling a cloud from foreground and background material is a persistent challenge, for which we introduce a strategy based on Abel's transform. We provide proofs of principle using simulated clouds.

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Star-forming regions at the periphery of the supershell surrounding the Cyg OB1 association. II. ISM kinematics and YSOs in the star cluster vdB 130 region

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We present an observational study of small-scale feedback processes operating in the star-forming region located in the wall of the expanding supershell around the Cyg OB1 association. The interstellar gas and dust content and pre-stellar populations in the vicinity of the open star cluster vdB 130 are analysed based on new optical and IR observations performed with the 6-m (3D spectroscopic mapping in the [SII] doublet) and 2.5-m (optical and NIR images) Russian telescopes along with the archival data of *Spitzer* and *Herschel* space telescopes. Analysing ionized gas kinematics and emission spectra, we discovered a compact region with supersonic motions. These motions may be caused either by stellar wind, or a bipolar outflow from a protostellar disc. Young stellar objects were identified and classified in the area under study. Two star-forming regions were identified. One of them is a region of ongoing star formation in the head of the molecular cloud observed there and another one is a burst of star formation in the cloud tail.

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Alignment of a circumbinary disc around an eccentric binary with application to KH 15D

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We analyse the evolution of a mildly inclined circumbinary disc that orbits an eccentric orbit binary by means of smoother particle hydrodynamic (SPH) simulations and linear theory. We show that the alignment process of an initially misaligned circumbinary disc around an eccentric orbit binary is significantly different than around a circular orbit binary and involves tilt oscillations. The more eccentric the binary, the larger the tilt oscillations and the longer it takes to damp these oscillations. A circumbinary disc that is only mildly inclined may increase its inclination by a factor of a few before it moves towards alignment. The results of the SPH simulations agree well with those of linear theory. We investigate the properties of the circumbinary disc/ring around KH 15D. We determine disc properties based on the observational constraints imposed by the changing binary brightness. We find that the inclination is currently at a local minimum and will increase substantially before setting to coplanarity. In addition, the nodal precession is currently near its most rapid rate. The recent observations that show a reappearance of Star B impose constraints on the thickness of the layer of obscuring material. Our results suggest that disc solids have undergone substantial inward drift and settling towards to disc midplane. For disc masses $\sim 0.001 M_\odot$, our model indicates that the level of disc turbulence is low $\alpha \ll 0.001$. Another possibility is that the disc/ring contains little gas.

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Magnetic stability of massive star forming clumps in RCW 106

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The RCW 106 molecular cloud complex is an active massive star-forming region where a ministarburst is taking place. We examined its magnetic structure by near-IR polarimetric observations with the imaging polarimeter SIRPOL on the IRSF 1.4 m telescope. The global magnetic field is nearly parallel to the direction of the Galactic plane and the cloud elongation. We derived the magnetic field strength of $\sim$ 100–1600 μG for 71 clumps with the Davis-Chandrasekhar-Fermi method. We also evaluated the magnetic stability of these clumps and found massive star-forming clumps tend to be magnetically unstable and gravitationally unstable. Therefore, we propose a new criterion to search for massive star-forming clumps. These details suggest that the process enhancing the clump density without an increase of the magnetic flux is essential for the formation of massive stars and the necessity for accreting mass along the magnetic field lines.

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Is there more than meets the eye? Presence and role of submicron grains in debris discs

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The presence of sub-micron grains has been inferred in several debris discs, usually because of a blue colour of the spectrum in scattered light or a pronounced silicate band around 10μm, even though these particles should be blown out by stellar radiation pressure on very short timescales. So far, no fully satisfying explanation has been found for this apparent paradox. We investigate the possibility that the observed abundances of sub-micron grains could be naturally produced in bright debris discs, where the high collisional activity produces them at a rate high enough to partially compensate for their rapid removal. We also investigate to what extent this potential presence of small grains can affect our understanding of some debris disc characteristics. We used a numerical collisional code to follow the collisional evolution of a debris disc down to sub-micron grains far below the limiting blow-out size $s_{\rm blow}$. We considered compact astrosilicates and explored different configurations: A and G stars, cold and warm discs, bright and very bright systems. We then produced synthetic spectra and spectral energy distributions, where we identified and quantified the signature of unbound sub-micron grains.We find that in bright discs (fractional luminosity $\gtrsim$10^{-3}) around A stars, the number of sub-micron grains is always high enough to leave detectable signatures in scattered light where the disc colour becomes blue, and also in the mid-IR ($10 \leq \lambda \leq 20\mu$m), where they boost the disc luminosity by at least a factor of 2 and induce a pronounced silicate solid-state band around 10μm. We also show that with this additional contribution of sub-micron grains, the spectral energy distribution can mimic that of two debris belts separated by a factor of $\sim$ 2 in radial distance. For G stars, the effect of $s \leq s_{\rm blow}$ grains remains limited in the spectra although they dominate the geometrical cross section of the system. We also find that for all considered cases, the halo of small (bound and unbound) grains that extends far beyond the main disc contributes to $\sim$ 50% of the flux up to $\lambda \sim 50\mu$m wavelengths.

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A centrally concentrated sub-solar mass starless core in the Taurus L1495 filamentary complex

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The formation scenario of brown dwarfs is still unclear because observational studies to investigate its initial condition are quite limited. Our systematic survey of nearby low-mass star-forming regions using the Atacama Compact Array (aka Morita array) and the IRAM 30 m telescope in 1.2 mm continuum has identified a centrally concentrated starless condensation with the central H_2 volume density of $\sim 10^6$ cm^{-3}, MC5-N, connected to a narrow (width ∼0.03 pc) filamentary cloud in the Taurus L1495 region. The mass of the core is ∼0.2-0.4 $M_\odot$, which is an order of magnitude smaller than typical low-mass prestellar cores. Taking into account a typical core to star formation efficiency for prestellar cores (∼20-40%) in nearby molecular clouds, brown dwarf(s) or very low-mass star(s) may be going to be formed in this core. We have found possible substructures at the high-density portion of the core, although much higher angular resolution observation is needed to clearly confirm them. The subsequent N_2H^+ and N_2D^+ observations using the Nobeyama 45 m telescope have confirmed the high-deuterium fractionation (∼30%). These dynamically and chemically evolved features indicate that this core is on the verge of proto-brown dwarf or very low-mass star formation and an ideal source to investigate the initial conditions of such low-mass objects via gravitational collapse and/or fragmentation of the filamentary cloud complex.

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On the Mass Function, Multiplicity, and Origins of Wide-Orbit Giant Planets

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A major outstanding question regarding the formation of planetary systems is whether wide-orbit giant planets form differently than close-in giant planets. We aim to establish constraints on two key parameters that are relevant for understanding the formation of wide-orbit planets: 1) the relative mass function and 2) the fraction of systems hosting multiple companions. In this study, we focus on systems with directly imaged substellar companions, and the detection limits on lower-mass bodies within these systems. First, we uniformly derive the mass probability distributions of known companions. We then combine the information contained within the detections and detection limits into a survival analysis statistical framework to estimate the underlying mass function of the parent distribution. Finally, we calculate the probability that each system may host multiple substellar companions. We find that 1) the companion mass distribution is rising steeply toward smaller masses, with a functional form of $N \propto M^{-1.3\pm0.3}$, and consequently, 2) many of these systems likely host additional undetected sub-stellar companions. Combined, these results strongly support the notion that wide-orbit giant planets are formed predominantly via core accretion, similar to the better studied close-in giant planets. Finally, given the steep rise in the relative mass function with decreasing

mass, these results suggest that future deep observations should unveil a greater number of directly imaged planets.

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APEX Observations of the CO Envelope around the Young FUor-type Star V883 Ori

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The accretion-driven outbursts of young FU Orionis-type stars may be a common stage of pre-main sequence evolution and can have a significant impact on the circumstellar environment as it pertains to the growth of solids and eventually planets. This episodic accretion is thought to be sustained by additional gas in-falling from the circumstellar envelope and disk. We present APEX observations of the CO gas in the envelope around V883 Orionis, a young outbursting star. The observations mapped the ^{12}CO (4–3), ^{12}CO (3–2), and ^{13}CO (3–2) lines with the FLASH^{+} instrument and the ^{12}CO (6–5) line with the SEPIA instrument. We detected high signal-to-noise emission extending out to radii >10000 au and calculated integrated fluxes of 1100 Jy km s^{-1} for ^{12}CO (6–5), 2400 Jy km s^{-1} for ^{12}CO (4–3), 1600 Jy km s^{-1} for ^{12}CO (3–2), and 450 Jy km s^{-1} for ^{13}CO (3–2). We used the thermo-chemical code PRODIMO to test several models and find the data are best described by an envelope structure with $M_{\rm env} \approx 0.2$–$0.4\ M_\odot$ and a mass-infall rate of $\dot{M}_{\rm inf} = 1$–$2 \times 10^{-6}\ M_\odot$ yr^{-1}. We infer that the observed envelope and outflow structure around V883 Ori could be caused by multiple outbursts, consistent with episodic accretion.

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The Ophiuchus DIsk Survey Employing ALMA (ODISEA): Disk Dust Mass Distributions across Protostellar Evolutionary Classes

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As protostars evolve from optically-faint/infrared-bright (Class I) sources to optically-bright/infrared-faint (Class II) the solid material in their surrounding disks accumulates into planetesimals and protoplanets. The nearby, young Ophiuchus star-forming region contains hundreds of protostars in a range of evolutionary states. Using the Atacama Large Millimeter Array to observe their millimeter continuum emission, we have measured masses of, or placed strong upper limits on, the dust content of 279 disks. The masses follow a log-normal distribution with a clear trend of decreasing mass from less to more evolved protostellar infrared class. The (logarithmic) mean Class I disk mass, $M = 3.8\,M_\oplus$, is about 5 times greater than the mean Class II disk mass, but the dispersion in each class is so high, $\sigma_{\log M} \simeq 0.8 - 1$, that there is a large overlap between the two distributions. The disk mass distribution of flat-spectrum protostars lies in between Class I and II. In addition, three Class III sources with little to no infrared excess are detected with low disk masses, $M \simeq 0.3\,M_\oplus$.
Despite the clear trend of decreasing disk mass with protostellar evolutionary state in this region, a comparison with surveys of Class II disks in other regions shows that masses do not decrease monotonically with age. This suggests that

the cloud-scale environment may determine the initial disk mass scale or that there is substantial dust regeneration after 1 Myr.

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Enlarging habitable zones around binary stars in hostile environments

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Habitable zones are regions around stars where large bodies of liquid water can be sustained on a planet or satellite. As many stars form in binary systems with non-zero eccentricity, the habitable zones around the component stars of the binary can overlap and be enlarged when the two stars are at periastron (and less often when the stars are at apastron). We perform N-body simulations of the evolution of dense star-forming regions and show that binary systems where the component stars originally have distinct habitable zones can undergo interactions that push the stars closer together, causing the habitable zones to merge and become enlarged. Occasionally, overlapping habitable zones can occur if the component stars move further apart, but the binary becomes more eccentric. Enlargement of habitable zones happens to 1–2 binaries from an average initial total of 352 in each simulated star-forming region, and demonstrates that dense star-forming regions are not always hostile environments for planet formation and evolution.

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Disc formation and fragmentation using radiative non-ideal magnetohydrodynamics

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We investigate the formation and fragmentation of discs using a suite of 3D smoothed particle radiative magnetohydrodynamics simulations. Our models are initialized as 1 $M_\odot$ rotating Bonnor-Ebert spheres that are threaded with a uniform magnetic field. We examine the effect of including ideal and non-ideal magnetic fields, the orientation and strength of the magnetic field, and the initial rotational rate. We follow the gravitational collapse and early evolution of each system until the final classification of the protostellar disc can be determined. Of our 105 models, 41 fragment, 21 form a spiral structure but do not fragment, and another 12 form smooth discs. Fragmentation is more likely to occur for faster initial rotation rates and weaker magnetic fields. For stronger magnetic field strengths, the inclusion of non-ideal MHD promotes disc formation, and several of these models fragment, whereas their ideal MHD counterparts do not. For the models that fragment, there is no correlation between our parameters and where or when the fragmentation occurs. Bipolar outflows are launched in only 17 models, and these models have strong magnetic fields that are initially parallel to the rotation axis. Counter-rotating envelopes form in four slowly rotating, strong-field models including one ideal MHD model indicating they form only in a small fraction of the parameter space investigated.

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G5.89: An Explosive Outflow Powered by a Proto-Stellar Merger?

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The explosive outflows are a newly-discovered family of molecular outflows associated with high-mass star forming regions. Such energetic events are possibly powered by the release of gravitational energy related with the formation of a (proto)stellar merger or a close stellar binary. Here, we present sensitive and high angular resolution observations ($0.85''$) archival CO(J=3-2) observations carried out with the Submillimeter Array (SMA) of the high-mass star forming region G5.89−0.39 that reveal the possible presence of an explosive outflow. We find six well-defined and narrow straight filament-like ejections pointing back approximately to the center of an expanding molecular and ionized shell located at the center of this region. These high velocity (-120 to $+100$ km s^{-1}) filaments follow a Hubble-like velocity law with the radial velocities increasing with the projected distance. The estimated kinematical age of the filaments is about of 1000 yrs, a value similar to the dynamical age found for the expanding ionized shell. G5.89 is the thus the third explosive outflow reported in the galaxy (together with Orion BN-KL and DR21) and argues in favor of the idea that this is a frequent phenomenon. In particular, explosive outflows, in conjunction with runaway stars, demonstrate that dynamical interactions in such groups are a very important ingredient in star formation.

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A transiting exocomet detected in broadband light by TESS in the β Pictoris system

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We search for signs of falling evaporating bodies (FEBs, also known as exocomets) in photometric time series obtained for β Pictoris after fitting and removing its δ Scuti-type pulsation frequencies. Using photometric data obtained by the TESS satellite we determined the pulsational properties of the exoplanet host star β Pictoris through frequency analysis. We then pre-whitened the 54 identified δ Scuti p-modes and investigated the residual photometric time series for the presence of FEBs. We identify three distinct dipping events in the light curve of β Pictoris over a 105-day period. These dips have depths from 0.5 to 2 millimagnitudes and durations of up to 2 days for the largest dip. These dips are asymmetric in nature and are consistent with a model of an evaporating comet with an extended tail crossing the disc of the star. We present the first broadband detections of exocomets crossing the disc of β Pictoris, complementing the predictions made 20 years earlier by Lecavelier Des Etangs et al. (1999). No periodic transits are seen in this time series. These observations confirm the spectroscopic detection of exocomets in calcium H and K lines that have been seen in high resolution spectroscopy

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A Large Catalog of Accurate Distances to Local Molecular Clouds: The Gaia DR2 Edition

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We present a uniform catalog of accurate distances to local molecular clouds informed by the Gaia DR2 data release. Our methodology builds on that of Schlafly et al. 2014. First, we infer the distance and extinction to stars along sightlines towards the clouds using optical and near-infrared photometry. When available, we incorporate knowledge of the stellar distances obtained from Gaia DR2 parallax measurements. We model these per-star distance-extinction estimates as being caused by a dust screen with a 2-D morphology derived from Planck at an unknown distance, which we then fit for using a nested sampling algorithm. We provide updated distances to the Schlafly et al. 2014 sightlines towards the Dame et al. 2001 and Magnani et al. 1985 clouds, finding good agreement with the earlier work. For a subset of 27 clouds, we construct interactive pixelated distance maps to further study detailed cloud structure, and find several clouds which display clear distance gradients and/or are comprised of multiple components. We use these maps to determine robust average distances to these clouds. The characteristic combined uncertainty on our distances is $\approx 5-6\%$, though this can be higher for clouds at farther distances, due to the limitations of our single-cloud model.

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Abstracts of recently accepted major reviews

Submillimeter and Far-Infrared Polarimetric Observations of Magnetic Fields in Star-Forming Regions

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Observations of star-forming regions by the current and upcoming generation of submillimeter polarimeters will shed new light on the evolution of magnetic fields over the cloud-to-core size scales involved in the early stages of the star formation process. Recent wide-area and high-sensitivity polarization observations have drawn attention to the challenges of modeling magnetic field structure of star forming regions, due to variations in dust polarization properties in the interstellar medium. However, these observations also for the first time provide sufficient information to begin to break the degeneracy between polarization efficiency variations and depolarization due to magnetic field sub-beam structure, and thus to accurately infer magnetic field properties in the star-forming interstellar medium. In this article we discuss submillimeter and far-infrared polarization observations of star-forming regions made with single-dish instruments. We summarize past, present and forthcoming single-dish instrumentation, and discuss techniques which have been developed or proposed to interpret polarization observations, both in order to infer the morphology and strength of the magnetic field, and in order to determine the environments in which dust polarization observations reliably trace the magnetic field. We review recent polarimetric observations of molecular clouds, filaments, and starless and protostellar cores, and discuss how the application of the full range of modern analysis techniques to recent observations will advance our understanding of the role played by the magnetic field in the early stages of star formation.

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The Dynamical State of a Young Stellar Cluster

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Ph.D dissertation directed by: Bruce Wilking
Ph.D degree awarded: May 2019

The dynamical state of the young star-forming cluster Rho Ophiuchi is considered, with emphasis on the L1688 cloud. Radial velocities are derived for 32 YSOs, with some being multi-epoch, using Markov-Chain Monte Carlo routines based upon the package *emcee*. Sources are chosen based upon their spectral index to focus on the earlier stages of star formation, in this case, Class I and Flat spectrum objects, and compared with a sample of Class II and III objects from the same embedded cluster. It is found that the radial velocity dispersion for these younger objects is $\Delta v = 2.8 \pm 0.6$ km s^{-1} which is about 2σ higher than the dispersion for Class II and III objects. The implication is that there are either small number statistics at play, or the cluster's dispersion is being increased as an inverse function of the distance from the center of the cluster due to a collapse-and-rebound phase that has been proposed in recent simulations.

https://www.umsl.edu/~physics/files/pdfs/TimothySullivanDissertation1919.pdf

Towards a Complete Study of the Initial Mass Function and Early Kinematics Evolution of the 25 Orionis Stellar Group

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Ph.D dissertation directed by: Carlos Román-Zúñiga & Juan José Downes

Ph.D degree awarded: February 2019

Young stellar aggregates are the laboratories where we study the process by which almost every star in the Galaxy has formed. Most of the young stellar groups break up in at most a few tens of Myr and only a few of them survive as gravitational bound entities to become open clusters. This phenomenon is usually understood as a rapid evolution of young stellar systems when the parental molecular gas is expelled, however, there is also evidence suggesting that these unbound stellar associations are formed in a structured process. To understand how stars are formed and how young stellar systems evolve, it is essential to estimate the total mass of the association, which can be achieved through the analysis of the stellar initial mass function (IMF). Despite many contributions to the study of the IMF, only a few of them over the whole cluster mass range, it is still unclear how it depends on environmental conditions and/or time. Due to its closeness, low extinction, stellar density and evolutionary status, an excellent place to study the IMF, from planetary-mass objects to intermediate/high-mass stars, and the early evolution of a young stellar system that just emerged from its embedded phase, is the 25 Orionis stellar group (25 Ori).

Combining new deep optical photometry from DECam with optical and NIR data from the literature, we selected 1687 member candidates of 25 Ori with I_c-band magnitudes between 5 and 23.3 mag in an area of 1.1° radius. With this sample we derived the system IMF of 25 Ori from 0.012 to 13.1 $M_{\odot}$, which is one of the few IMFs across the entire mass range of a stellar association. The resultant system IMF is well-described by a two-part power-law function and by a tapered power-law form. We also report its best lognormal parameterization. This system IMF do not present significant variations within a radius of about 7 pc, which indicates that the substellar and stellar objects in 25 Ori do not have any preferential spatial distribution. We compared the reported system IMF as well as the BD/star ratio with those of a large diversity of stellar populations and did not find any significant discrepancies, which strongly supports the hypothesis that the star formation mechanism is largely insensitive to environmental conditions.

In order to confirm the membership of each candidate in our sample, we have an ongoing spectroscopic survey using several world-wide facilities. We have obtained high-resolution ($R \sim 22000$) spectra of 77 intermediate/high-mass (1.3-11 $M_{\odot}$) candidates with OAN-SPM/MES and of 1185 intermediate-mass (0.3-5.2 $M_{\odot}$) candidates with SDSS-IV/APOGEE-2. Additionally, we have low-resolution ($R \approx 1000 - 2000$) spectra of 400 low-mass (0.25-0.8 $M_{\odot}$) candidates with MMT/Hectospec, of 172 low-mass (0.09-0.7 $M_{\odot}$) candidates with SDSS-III/BOSS and of 66 brown dwarf (0.01-0.08 $M_{\odot}$) candidates with GTC/OSIRIS. After applying diverse membership criteria, we have so far confirmed 530 members from the spectroscopic sample, out of which 290 lie inside the 25 Ori area and 208 of them are confirmed for the first time. With this sample of confirmed member, plus those in the literature, we estimated that 25 Ori is a 6.5 ± 2.5 Myr old population located at 356 ± 47 pc and presenting a low extinction of 0.29 ± 0.26 mag. Also, we estimated that the 25 Ori mean radial velocity is 20.9 ± 2.0 km s^{-1}. Using these parameters we found that 25 Ori is a dynamically young group without time enough to be relaxed and confirmed that it is, in fact, a gravitationally unbound association that will be part of the Galactic Disk population.

Considering the observed and confirmed members as well as those already confirmed in the literature, the spectroscopic follow-up is ~75% complete, with most of the remaining candidates to be observed with estimated masses around the substellar mass limit. We have ongoing observations to complete the spectroscopic survey of 25 Ori.

https://doi.org/10.5281/zenodo.2598767

Moving ... ??

If you move or your e-mail address changes, please send the editor your new address. If the Newsletter bounces back from an address for three consecutive months, the address is deleted from the mailing list.

Abstract submission deadline

The deadline for submitting abstracts and other submissions is the first day of the month. Abstracts submitted after the deadline will appear in the following month's issue.

Two Postdoctoral Positions on Debris Disks at Friedrich Schiller University, Jena

The Astrophysical Institute and University Observatory (AIU) of the Friedrich Schiller University, Jena, Germany, is seeking two postdoctoral researchers.

The positions are to work in the Research Unit FOR 2285 "Debris Disks in Planetary Systems", funded by the German Research Foundation (DFG). The successful candidates will join the theory group at the AIU. The researchers will benefit from close collaboration with other observational, theory, and laboratory projects of the Research Unit running in Jena, Braunschweig, and Kiel.

One position is part of the Research Unit's project P1 **"Masses and stirring of debris disks."** The main goal of this project is to develop a detailed understanding of the origins of debris disks. The researcher is expected to tackle a challenging "mass problem" identified recently for both debris disks and their protoplanetary disk progenitors. They will also address a related question of what excites the planetesimals in debris disks and when, activating the dust production. Both problems should be investigated by means of analytic work and/or numerical simulations, taking into account a wealth of available observational constraints.

The second position is part of project P3 **"Origin of the warm and hot dust and planetary system architecture."** The successful candidate will work to constrain the occurrence rate and parameters of warm and hot dust disks commonly observed in planetary systems, set up and run simulations for plausible cometary and asteroidal scenarios of dust production, transport and removal, consider implications for the overall architecture of the systems, and make suggestions for future observational tests.

The positions are for three years and can start at any time in the summer or fall 2019. The salary is standard for postdoc positions in Germany (TV-L E13/3–E14/2 of the German federal public service scale) and includes a number of social and family-related benefits. Funding is available for travel, computational resources and relocation expenses.

The applicants should have a strong educational record and hold a doctoral degree or equivalent in physics or astronomy. Previous experience of astronomical research, preferably on debris or protoplanetary disks, exoplanets or planet formation, is required. Proficiency in English is also required.

Applications as a single document in the PDF format should include a CV, a statement of research interests (4 pages max), and the names and contact details of three referees. Please quote "FOR2285/P1" or "FOR2285/P3" in the subject depending on which project is preferred. All applications received by **May 27, 2019** will be given full consideration.

The Friedrich Schiller University is an equal opportunity employer and explicitly encourages women to apply. Disabled persons with equal aptitude, competence and qualification will be given preference.

Applications or enquires about further information should be sent to Prof. Alexander Krivov (krivov@astro.uni-jena.de).

http://www.astro.uni-jena.de/FOR2285

PhD Position on Debris Disks at Friedrich Schiller University, Jena

The Astrophysical Institute and University Observatory (AIU) of the Friedrich Schiller University, Jena, Germany, invites applications for a graduate student position.

The position is to work in the Research Unit FOR 2285 "Debris Disks in Planetary Systems", funded by the German Research Foundation (DFG). The successful candidate will join the theory group at the AIU and will work for the Research Unit's project P2 **"Sculpturing of debris disks by planets and companions."** The project aims at understanding the origin of the observed features in debris disks, such as sharp edges, eccentric offsets, or azimuthal asymmetries. phenomena. Many of these can be attributed to the gravitational influence of alleged but yet unseen planets and companions. The graduate student is expected to utilize a model devised earlier in our group to investigate the disk evolution under the action of secular gravitational perturbations combined with a full collisional cascade and drag forces. The model should be applied to infer possible dynamical histories of the systems, to explore how the parameter variation affects the predicted structure, and to test the predictions against the structure actually observed in selected disks. The researcher will benefit from close collaboration with other observational, theory, and laboratory projects of the Research Unit.

The position is for three years and can start at any time in the summer or fall 2019. The salary is standard for doctoral positions in Germany (1/2 TV-L E13 of the German federal public service scale) and includes a number of social and family-related benefits. Travel funding for short-term visits to collaborators or to attend conferences will be provided. Funding is available for computational resources and the group already has a set of 8 multi-core servers for running simulations. Reimbursement of relocation costs is possible.

The applicant should have a strong educational record and hold a Masters' degree or equivalent in physics or astronomy. Previous experience with numerics and astronomical research, preferably with debris disks and/or orbital dynamics, would be a strong advantage. Proficiency in English is required.

Applications as a single PDF document should include a CV, a brief statement of research interests (1 page max), and the names and contact details of two referees. Please quote "FOR2285/P2" in the subject. All applications received by **June 17, 2019** will be given full consideration.

The Friedrich Schiller University is an equal opportunity employer and explicitly encourages women to apply. Disabled persons with equal aptitude, competence and qualification will be given preference.

Applications or enquiries for further information should be sent to Dr. Torsten Löhne (tloehne@astro.uni-jena.de).

http://www.astro.uni-jena.de/FOR2285

First Stars VI in Concepcion, 01-06 March 2020

Dear colleagues,

we are delighted to announce the First Stars VI conference, which will be held in Concepcion, Chile, from 01-06 March 2020.

http://www.astro.udec.cl/FirstStarsVI/

Scientific rationale:

During the last decade, significant progress has been made towards probing how the first stars, galaxies and black holes have actually formed. Particular highlights include the first detections of gravitational waves as a new window into our Universe, the first detection of a signal from the reionization epoch through the EDGES experiment, as well as the continuous progress in areas such as stellar archeology or the search for the first galaxies. In addition, significant further developments will be expected in the coming years due to future missions such as JWST and the SKA.

The conference aims at discussing the current theoretical and observational status of our understanding of stellar birth throughout cosmic history, the impact of first star and galaxy formation on the subsequent evolution of the Universe, first supernova explosions and chemical enrichment, cosmic reionization, and formation of supermassive black holes. Specific focus is given to current and future space-borne and Earth-bound observational campaigns and their comparison with predictions from state-of-the-art numerical simulations. We will thereby follow up on the previous First Stars conferences (I-V) that were held in Garching in 1999, in Pennsylvania in 2003, in Santa Fe in 2007, in Kyoto in 2012 and in Heidelberg in 2016. The current conference is the first in the series to take place in South America, and aims particularly at establishing closer connections with the observational community in Chile, hosting the worlds largest telescopes and providing significant opportunities in its astronomical community. We encourage especially young researchers and students to attend the conference.

Preliminary program: - Population III stars: formation, IMF, multiplicity and evolution - Transition to second-generation star formation - First supernovae and gamma-ray bursts; Pop. III star fates; abundance patterns at high redshift - Gravitational waves as a new probe of the high-z Universe - Stellar archeology as a powerful probe of the high-z Universe - From the first galaxies to the epoch of reionization - Dwarf galaxies as a potential probe of the early Universe - Formation, growth and observational constraints on the first supermassive black holes - Current and future surveys and observational facilities

Confirmed speakers: - Andrew Bunker, University of Oxford, UK - Elisabetta Caffau,Observatoire de Paris/Meudon, France - Gen Chiaki, Georgia Tech, USA - Tiziana Di Matteo,Carnegie Mellon University, Pittsburg, USA - Anastasia Fialkov, Kavli, Cambridge, UK - Tilman Hartwig, University of Tokyo, Japan - Shingo Hirano, Kyushu University, Kyudai, Japan - Takashi Hosokawa, Kyoto University, Kyoto, Japan - Miho Ishigaki, Tohoku University, Sendai, Japan - Alexander Ji, Carnegie Observatories, Pasadena, USA - Muhammad Latif, United Arab Emirates University - Karin Lind, MPIA, Heidelberg, Germany - Mattias Magg, ITA, Heidelberg, Germany - Takashi Moriya, National Astronomical Observatory of Japan, Japan - Laura Pentericci, Osservatorio Astronomico di Roma, Italy - Stefania Salvadori,University of Florence, Italy - Else Starkenburg, AIP, Postdam, Germany - Ezequiel Treister, Pontificia Universidad Catolica, Chile - Rosa Valiante, Astronomical Observatory of Rome, Italy - Daniel Whalen, University of Portsmouth, UK - John Wise, Georgia Tech, USA

Important deadlines: - Pre-registration: 30 June 2019 - Abstract submission: 31 October 2019 - Notification of speakers: 15 December 2019 - Registration and payment: 01 January 2020 - Begin of conference: 01 March 2020

The venue will be the nice and freely accessible campus of the University of Concepcin close to the city center, including many nearby bars, restaurants, shops and coffee places. The conference itself will take place in the main auditorium of the EmpreUdeC building. Students and postdocs will have the possibility to apply for financial support after the pre-registration. We will provide more information about social events, possible excursions and further activities over the next months. We highly encourage participants to also consider a longer stay, for scientific interactions in Chile, to visit the large observatories or to enjoy the landscapes in Chile, ranging from the big deserts in the North to the beautiful mountain landscapes and glaciers in the South of Chile, as well as potential visits to the Easter Island before or after the conference.

Looking forward to seeing you in Concepcion,

Dominik Schleicher on behalf of the LOC/SOC

UNDERSTANDING THE NEARBY STAR FORMING UNIVERSE WITH JWST

Courmayeur Mont Blanc, Italy - August 26-30 2019

Understanding the way nature assembles matter into stars remains one of the key problems in astrophysics. We know that stars mostly form in clustered systems enshrouded by the densest regions of giant molecular clouds. The process is accompanied by a rich, multi-wavelength phenomenology tracing mass accretion, outflows, radiative energy and momentum feedback into the parental cloud and nearby young stellar objects. The James Webb Space Telescope, with its complement of infrared instrumentation offering an unparalleled combination of sensitivity and diffraction limited performance, will open a new window on the process of star formation. The Birth of Stars and Protoplanetary Systems represents one of the original science drivers of the JWST. Approaching the JWST Call for Proposal for Cycle 1 observations, we invite the community to discuss the potential impact of JWST on our understanding of star formation, also in light of the recent advances enabled by e.g. ALMA and Gaia, and the prospects enabled by the next generation of giant telescopes. The meeting will include invited reviews on the Guaranteed Time and Early Release Science Programs, as well as contributed talks. ESA staff will support a hands-on session on the JWST Exposure Time Calculator and Proposal Tool. Topics include:

- Open Problems in Star Formation
- Protostars and Class 0 objects
- Accretion, disks
- Mass loss, jets and HH objects
- Massive stars, feedback and multiplicity
- Substellar Objects in the field and as companions
- Star formation in the local universe (LMC and beyond)

Confirmed invited speakers

A. Adamo (U. Stockholm)	C. Alves de Oliveira (ESA-STScI)
J. Bally (U. Colorado)	P. Clark (U. Cardiff)
G. de Marchi (ESA-ESTEC)	T. Greene (NASA-Ames)
L. Hillenbrand (Caltech)	K. Hodapp (U. Hawaii)
P. Kalas (U. Berkeley)	M. Krumholz (Australian National U.)
C. F. Manara (ESO)	A. Maury (CEA-Saclay)
M. McCaughrean (ESA-ESTEC)	M. MacGregor (Carnegie)
M. Meixner (STScI)	K. Pontoppidan (STScI)
T. Ray (Dublin IAS)	K. Stapelfeldt (NASA-JPL)
J. Tan (U. Chalmers)	E. Tognelli (U. Pisa)

Science Organizing Committee: J. Bally (Colorado), C. Beichman (JPL), D. Calzetti (UMass), R. Doyon (ESA), D. Gouliermis (HD), T. Henning (MPIA), C.Lada (CFA), M. Meixner (STScI), A. Nota (ESA), M. Robberto (STScI & JHU, SOC Chair), E. Sabbi (ESA, SOC Co-Chair), M. Sirianni (ESA, SOC Co-Chair)

Conference location

The meeting will be held at the futuristic conference center at Pavillon du Mont-Frety (2173m = 7130ft a.s.l.), located at the intermediate station of the newly rebuild SkyWay Monte Bianco. This is the italian leg of the cable car that does the grand-tranvers of Mont Blanc from Courmayeur (Italy) to Chamonix (France). The location offers breathtaking views of Mont Blanc and its glaciers. Hotels and accomodations will be in the village of Courmayeur. The registration fee includes the daily cable-car tickets.

REGISTRATION DEADLINE: June 30, 2019

CONFERENCE WEBSITE: http://www.stsci.edu/institute/conference/unsfjwst2019

Summary of Upcoming Meetings

Exploring the Infrared Universe: The Promise of SPICA
20 - 23 May 2019, Crete, Greece
http://www.spica2019.org

Workshop on Polarization in Protoplanetary Disks and Jets
20 - 24 May 2019, Sant Cugat del Vallès, Catalonia, Spain
http://sites.google.com/view/sant-cugat-forum-astrophysics/next-session

Cloudy Workshop
20 - 24 May 2019, University of Kentucky, USA
http://cloud9.pa.uky.edu/~gary/cloudy/CloudySummerSchool/

Star Clusters: from the Milky Way to the Early Universe
27 - 31 May 2019, Bologna, Italy
http://iausymp351.oas.inaf.it/

Partially Ionised Plasmas in Astrophysics
3 - 7 June 2019, Palma de Mallorca, Spain
http://solar1.uib.es/pipa2019/

Zooming in on Star Formation - A tribute to Åke Nordlund
9 - 14 June 2019, Nafplio, Greece
http://www.nbia.dk/nbia-zoomstarform-2019

From Stars to Planets II: Connecting our Understanding of Star and Planet Formation
17 - 20 June 2019, Gothenburg, Sweden
http://cosmicorigins.space/fstpii

Gaia's View of Pre-Main Sequence Evolution. Linking the T Tauri and Herbig Ae/Be Stars
18 - 21 June 2019, Leeds, UK
https://starry-project.eu/final-conference

Gordon Conference on Origins of Solar Systems: Meteoritical, Spacecraft and Astrophysical Perspectives on the Assembly and Composition of Planets
23 - 28 June 2019
https://www.grc.org/origins-of-solar-systems-conference/2019/

Astrochemistry: From nanometers to megaparsecs - A Symposium in Honour of John H. Black
24 - 28 June 2019, Gothenburg, Sweden
https://www.chalmers.se/en/conference/JHBlacksymp2019/

Smoothed Particle Hydrodynamics International Workshop
25 - 27 June 2019, Exeter, UK
http://spheric2019.co.uk/

Great Barriers in Planet Formation
21 - 26 July 2019 Palm Cove, Australia
https://dustbusters.bitbucket.io/great-barriers-2019/

Summer School Protoplanetary Disks and Planet Formation
5 - 9 August 2019 Copenhagen, Denmark
http://nbia.nbi.ku.dk/nbia-school-2019

Orion Uncovered
26 - 30 August 2019 Leiden, The Netherlands
https://sites.google.com/view/OrionLeiden2019

Understanding the Nearby Star-forming Universe with JCMT
26 - 30 Aug 2019 Courmayeur, Italy
http://www.stsci.edu/institute/conference/unsfjwst2019

Celebrating the first 40 Years of Alexander Tielens' Contribution to Science: The Physics and Chemistry of the ISM
2 - 6 september 2019, Avignon, France https://tielens2019.sciencesconf.org

From Gas to Stars: The Links between Massive Star and Star Cluster Formation
16-20 September 2019 York, UK
https://starformmapper.org/final-conference/

Crete III - Through dark lanes to new stars Celebrating the career of Prof. Charles Lada
23 - 27 September 2019 Crete, Greece
http://crete3.org

The UX Ori type stars and related topics
30 September - 4 October 2019 St. Petersburg, Russia
http://uxors-2019.craocrimea.ru

First Stars VI
1 - 6 March 2020 Concepcion, Chile
http://www.astro.udec.cl/FirstStarsVI/

Linking Dust, Ice, and Gas in Space
19 - 24 April 2020, Capri, Italy
http://frcongressi.net/ecla2020.meet

COOL STARS 21: Cambridge Workshop on Cool Stars, Stellar Systems and the Sun
21 -26 June 2020, Toulouse, France
https://coolstars21.github.io/

The Physics of Star Formation: From Stellar Cores to Galactic Scales
29 June - 3 July 2020 Lyon, France https://cral.univ-lyon1.fr