

THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar/planetary evolution and molecular clouds

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The Star Formation Newsletter

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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.

Newsletter Archive

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List of Contents

Interview	3
Abstracts of Newly Accepted Papers	6
Dissertation Abstracts	41
New Jobs	43
Meetings	44
Summary of Upcoming Meetings	50

Cover Picture

The HII region RCW 32 = Gum 15 is located in the southern constellation Vela at an approximate distance of 1 kpc. It is excited by the early B star HD 74804, which is the brightest star in the image and the most massive member of the cluster Collinder 197. The bright-rimmed cloud to the left in the image, SFO 58, contains an UCHII region with an early B type star, presumably a case of star formation triggered by HD 74804. The image is a composite of H α , B, and R filter exposures obtained at the MPG/ESO 2.2-meter telescope at the La Silla Observatory in Chile. North is up and East is left.

Image courtesy ESO.

Submitting your abstracts

Latex macros for submitting abstracts and dissertation abstracts (by e-mail to reipurth@ifh.hawaii.edu) are appended to each Call for Abstracts. You can also submit via the Newsletter web interface at <http://www2.ifa.hawaii.edu/star-formation/index.cfm>

John Stauffer

in conversation with Bo Reipurth



Q: *Your PhD in 1981 dealt with the nuclei of disk galaxies. But already as a student you published your first of very many papers on the Pleiades. How did your passion for the Pleiades arise?*

A: I was an undergraduate astronomy major at Case Institute of Technology (now part of Case Western Reserve University). One of my professors there was Peter Pesch. Peter liked to tell stories about his life as an observational astronomer. One of those stories concerned a program to obtain photometry of low mass stars in the Pleiades in order to identify its pre-main sequence turn-on point (and resolve a quandary on the age of the Pleiades made famous by George Herbig in a 1962 paper). Peter was granted time for that project at the newly created National Observatory at Kitt Peak several years in a row in the late 1960's - only to be rained out every time. He eventually got the message and had stopped reproposing by the time I took his class in 1972. I became a grad student at Berkeley in 1974, where Harold Weaver was my first advisor. Harold was the epitome of the classically trained astronomer, and from him I tried to absorb lessons in astronomical etiquette and style and the importance of really knowing the literature. Harold also provided me with another link to the Pleiades, because he was son-in-law to R.J. Trumpler, who had executed one of the first proper motion membership studies of the Pleiades. My eventual thesis advisor, though, was Hy Spinrad, who mostly did hi-z science - but Hy introduced me to observing at Kitt Peak and encouraged me to pursue independent research. I figured I would try to follow in Peter's footsteps. I also got time at Kitt Peak, but in my case I had great weather for several observing runs using a newly available, red-sensitive GaAs phototube, and was thus able to begin my career-long "passion" for the Pleiades.

Q: *Your first open cluster papers were primarily based on*

photometry. While at SAO, you began a program of high resolution spectroscopy of low mass stars in open clusters. What prompted that effort?

A: Berkeley was a hot-bed for star-formation science in the 1970's - with Chris McKee, Frank Shu and Nuria Calvet on the theory side, and Len Kuhl, Leo Blitz, Martin Cohen, Stu Vogel and a visiting Steve Strom on the observer side. I spent quite a lot of time at Lick Observatory, at the 120" with Hy or at the smaller telescopes on projects of my own. While observing there, I got to know George Herbig and Bob Kraft (faculty at UCSC), who I would see at the Lick dining room or at the nice library in the 120" dome. So, when I went to SAO as a post-doc, I had a good background of then-current thoughts on PMS evolution as well as knowledge of Bob Kraft's pioneering studies of the rotational velocities of relatively high mass stars in the nearby open clusters using photographic plates. One of my favorite pastimes at SAO was sitting in the the library and reading preprints (before the era of astro-ph). During one such break, I came across an article in the ESO Messenger where Floor van Leeuwen described finding half a dozen Pleiades K dwarfs that were photometric variables with periods less than a day. van Leeuwen interpreted these stars as rapid rotators (due to their youth), but he believed that their variability was a result of their having taken on an ellipsoidal shape - possibly just prior to breaking up into a binary. At the morning tea and cookie gathering the next day, Lee Hartmann (also a recent Case graduate) and I concluded that spots were a much more likely explanation and that the new echelle spectrograph and Reticon detector on the MMT would be a good way to study these stars, and to extend Kraft's open cluster rotation studies to much fainter stars.

We eventually obtained good $v \sin i$ data for large numbers of stars in half a dozen open clusters ranging in age from 50 Myr to 600 Myr, using the MMT as well as the KPNO and CTIO 4m echelle spectrographs. Kraft had only been able to derive $v \sin i$'s down to solar mass (spectral type G1) in the nearest clusters; with these new spectrographs and digital detectors, Lee and I were able to obtain good rotation measurements down to spectral type M3 or slightly later. This let us show that perhaps a third of the low mass stars arrive on the ZAMS as rapid rotators, with rotational velocities up to 150 km/s, whereas the other 2/3 of the stars arrive on the ZAMS rotating much more slowly. Angular momentum loss from winds causes these stars to spin down on a timescale which is shorter for higher mass stars and for more rapidly rotating stars. Our data prompted a new generation of angular momentum evolution models (including features such as saturated winds, disk-locking and core-envelope decoupling) which still form the basic framework for the current generation of models.

Q: *You were involved in the initial set of Cool Stars, Stellar Systems and the Sun Workshops that were organized at SAO in the early 1980's. How did that series come about, and how has it affected your career?*

A: The force behind the Cool Stars workshops, and the chief organizer for many years (and still an active participant and organizer), was Andrea Dupree. Cool Stars 2 and Cool Stars 3 took place while I was at SAO as a postdoc. I was able to present the first results from the Stauffer and Hartmann open cluster rotation program at those meetings. Those talks were very well received because this was exactly the right venue. I quickly realized these people were my astronomical family. I became active in helping to organize the bi-annual meetings, serving on the SOC or LOC on many occasions (and being chair on a few). In addition to Andrea, there was a core group of people who helped shape Cool Stars in its early years and who became friends and collaborators of mine, including Ed Guinan, Dave Soderblom, Mark Giampapa, Fred Vrba, Tom Ayres and Fred Walter. Cool Stars has grown bigger and better with time - expanding to a format with alternating US and European venues beginning with Cool Stars 9 in Florence. Many of my science collaborators are Europeans who I first met at a Cool Stars workshop, most especially David Barrado, who became my first PhD student. I've attended all but a couple of the Cool Stars meetings, and I look forward to each one as a time to catch up with old (and new) friends. Cool Stars 20 will be held in Boston in July 2018, and I will be there, as usual.

Q: *For a while, you also worked on X-ray observations of young clusters? How did that arise?*

A: Bob Stern and I were both in the Bay Area in the late 1980's. Bob was at Lockheed in Palo Alto and I was at NASA Ames in Mountain View, where I worked on the early planning stages for SIRTf (which became Spitzer after it was launched) with Mike Werner. I had met Bob at Berkeley when we were both students. Bob had since then become an expert in solar and stellar X-ray observations, where one of his special interests was the Hyades. Bob and I would see each other moderately often at local Bay Area astronomy gatherings. When Guenter Riegler began the "Long-Term Space Astrophysics" (LTSA) grant program at NASA, Bob urged me to put together an LTSA proposal to support a multi-wavelength study of low mass stars in nearby open clusters, anchored by proposals to obtain ROSAT X-ray data for those clusters. My proposal was approved, and provided a fair amount of money for five years. That grant allowed me to form a small team and hire Charles Prosser as a postdoc - and to pursue a number of projects involving ROSAT. These projects also led to my collaborating and becoming friends with another set of Europeans, including Sofia Randich, Giusi Micela, Roberto Pallavicini, Jurgen Schmitt and Fabio Favata.

Q: *You are the System Scientist for the Spitzer Science Center at Caltech. What does this involve?*

A: In the 1990's, I moved back to SAO to be Project Scientist for a NASA Small Explorer called SWAS (PI: Gary Melnick). In the same division of SAO, Giovanni Fazio led the development of the IRAC camera for SIRTf, and I maintained my ties to SIRTf by being part of that team. SWAS and IRAC gave me a lot of experience in space astronomy and I discovered I liked (and was good at) analysing space data and troubleshooting anomalies. That led to my being hired into the System Scientist position at the Spitzer Science Center by George Helou. My job was essentially to do whatever needed to be done in order to keep Spitzer functioning well. That has entailed everything from debugging IRAC "firmware" prior to launch (when several issues almost led to IRAC being removed from the mission), to figuring out that a pointing drift in Spitzer staring mode photometry was due to a mismatch in how stellar aberration was handled by two different components of the spacecraft, to deriving a new distortion map for IRAC, and to being lead author for Spitzer Senior review proposals.

Q: *Shortly before you moved back to the West coast, you began work with David Barrado on a series of papers involving the ages of open clusters and moving groups. How did that come about?*

A: In the mid-1990's, David and I derived good age estimates for two of the famous IRAS debris disk stars - Beta Pic and Fomalhaut - by identifying low mass companions to those stars and then determining the age of the companions from comparison of their properties to stars in our fiducial set of open clusters. This led us into projects to empirically calibrate PMS theoretical isochrones and eventually to deriving ages for nearby moving groups.

However, while our efforts and those of other groups yielded good relative ages for the nearby open clusters and moving groups, the absolute ages were somewhat poorly constrained. Bildsten's prediction that there should be a sharp, age dependent mass below which lithium would be retained at primordial abundance in young clusters opened up the possibility to obtain good, absolute ages for many nearby clusters. The stars where this signature would be present were quite faint, but fortunately the newly available Keck telescope and LRIS spectrograph brought these stars into reach. David and I soon obtained good S/N spectra of a dozen or more stars in each of the Pleiades and Alpha Per clusters, identified their lithium depletion boundaries, and derived ages of 125 and 90 Myr, respectively, for those two clusters. David and others have subsequently gone on to determine lithium depletion boundary ages for half a dozen more open clusters and moving groups - establishing good benchmark sets of stars to calibrate isochrones and age-activity relations.

Q: *As the leader of a large team you obtained detailed light curves with Spitzer and Corot of young stars in NGC 2264. Not only are these light curves breathtakingly beautiful, but they reveal both accretion events and extinction dips in exquisite detail. Please sum up your key findings.*

A: After Spitzer's cryogen ran out, it continued in the Warm Mission with just the two short wavelength channels of IRAC. With the same total amount of observing time available but now with only one instrument, it became possible to propose much larger programs than had generally been true during the cryo mission. Luisa Rebull, Maria Morales and I managed to get a project approved where our group essentially took over both the French CoRoT telescope (optical imaging) and Spitzer (near IR imaging) for a month to obtain time series photometry of nearly a thousand YSO's in NGC 2264 (the only young cluster observable by CoRoT). A month of continuous, high-cadence, sensitive, space-quality data allowed us to measure YSO variability with much higher fidelity than ever before. New insights (see papers by Cody et al. 2014 and Stauffer et al. 2014, 2015). included showing: (a) that the low mass stars with the highest accretion rates have light curves dominated by short-duration accretion bursts; (b) that stars with extinction dips from disk material near the Keplerian co-rotation radius often switch from periodic (AA Tau-like) dips to stochastic dips; (c) that very narrow flux dips are also present in many CTT light curves, most likely from dust entrained in magnetic accretion columns; and (d) that the dust responsible for these narrow flux dips is likely dominated by large grains.

Q: *Most recently you led another team to use NASA's K2 telescope to obtain light curves for hundreds of stars in each of several young clusters and star-forming regions in order to once again study angular momentum evolution. What can K2 contribute to that topic, and what has your group learned so far?*

A: The only open clusters in the original Kepler field were very distant and old, making them of little use for studies of angular momentum evolution of low mass stars. For me, the best thing that ever happened to the Kepler spacecraft was when its second reaction wheel failed. That resulted in the new K2 mission, and a new ecliptic plane field to observe every 80 days. This has meant that our K2 young-star group (teams led by Luisa and me and by Lynne Hillenbrand and Ann Marie Cody) has been able to obtain exquisite light curves for many hundreds of stars each in the Pleiades, Praesepe and Upper Sco and for dozens of stars in Taurus, the Hyades and rho Oph. The K2 light curves are hugely better than any ground-based program - and they allow determination of rotation periods for nearly 100% of the low mass stars in the younger clusters. If there is a binary, K2 often provides the rotation periods for both stars. The detailed light curve shapes promise

to provide a new way to constrain spot properties as a function of stellar mass and rotation period (Gibor Basri, Maria Morales and Jeff Valenti are working on this topic). Because all of these clusters are nearby and Kepler is very sensitive, the sample of stars with good data covers essentially the whole stellar mass range from high mass stars down to 0.1 Msun. We've discovered a new class of variable star (which we call "scallop shells" - Stauffer et al. 2017, AJ 153, 152); that the components of dM binaries have rotation periods that are both shorter and closer to each other than would be true if drawn at random from their single-star cousins; that ~10 Myr M dwarfs have rotation rates that are strongly correlated with mass - and that the most rapidly rotating M dwarfs at that age are rotating near breakup. Initially for Upper Sco and rho Oph, and just recently for Taurus, K2 has provided the best light curves we are likely to have for many years to come of YSO's exhibiting accretion bursts and AA-Tau type extinction dips (see 2017 and 2018 papers by Ann Marie Cody). It will be a big loss when both Spitzer and K2 stop taking data about a year from now.

Q: *So, after all this - what is the distance to the Pleiades, and why has it generated such controversy?*

A: I believe the true distance is essentially 135 pc, as recently determined from VLBI data (Melis et al. 2014) and corroborated by the new parallax data from Gaia DR1. The distance to the Pleiades had become controversial when the Hipparcos mission estimate of the distance ($r \sim 120$ pc) came out to be 10% closer than most other modern determinations. There is still no consensus as to why the Hipparcos value is so discrepant from the other estimates, and the debate is not completely settled because the DR1 result is viewed as preliminary and possibly subject to significant revision. My hope is that the Gaia DR2 results to be published in April 2018 will finally resolve this question, and then we can simply put this topic behind us. Hipparcos and Gaia have been and are wonderful stellar astronomy missions and their value to the community far outweighs any possible minor mis-step. I am absolutely confident that Gaia DR2 (and later releases) will provide a definitive distance to the Pleiades, and that eventually the Gaia data will provide an accurate 3D map of the individual distances of the Pleiades stars which will allow much more detailed studies of, for example, the impact of spots and magnetic fields on the radii of its low mass members. I have a bottle of wine bet with Gerard van Belle on the topic of the Gaia distance to the Pleiades, so I am anxiously awaiting the DR2 release.

Abstracts of recently accepted papers

The fragmentation criteria in local vertically stratified self-gravitating disk simulations

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Massive circumstellar disks are prone to gravitational instabilities, which trigger the formation of spiral arms that can fragment into bound clumps under the right conditions. Two dimensional simulations of self-gravitating disks are useful starting points for studying fragmentation, allowing for high-resolution simulations of thin disks. However, convergence issues can arise in 2D from various sources. One of these sources is the 2D approximation of self-gravity, which exaggerates the effect of self-gravity on small scales when the potential is not smoothed to account for the assumed vertical extent of the disk. This effect is enhanced by increased resolution, resulting in fragmentation at longer cooling timescales β . If true, it suggests that the 3D simulations of disk fragmentation may not have the same convergence problem and could be used to examine the nature of fragmentation without smoothing self-gravity on scales similar to the disk scale height. To that end, we have carried out local 3D self-gravitating disk simulations with simple β cooling with fixed background irradiation to determine if 3D is necessary to properly describe disk fragmentation. Above a resolution of ~ 40 grid cells per scale height, we find that our simulations converge with respect to the cooling timescale. This result converges in agreement with analytic expectations which place a fragmentation boundary at $\beta_{\text{crit}} = 3$.

Accepted by ApJ

<http://arxiv.org/pdf/1709.00365>

Deuterated methanol on Solar System scale around the HH212 protostar

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Context: Deuterium fractionation is a precious tool to understand the chemical evolution during the process leading to the formation of a Sun-like planetary system.

Aims: Methanol is thought to be mainly formed during the prestellar phase and its deuterated form keeps memory of the conditions at that epoch. Thanks to the unique combination of high angular resolution and sensitivity provided by ALMA, we wish to measure methanol deuteration in the planet formation region around a Class 0 protostar and to understand its origin.

Methods: We mapped both the $^{13}\text{CH}_3\text{OH}$ and CH_2DOH distribution in the inner regions (~ 100 au) of the HH212 system in Orion B. To this end, we used ALMA Cycle 1 and Cycle 4 observations in Band 7 with angular resolution down to $\sim 0.15''$.

Results: We detected 6 lines of $^{13}\text{CH}_3\text{OH}$ and 13 lines of CH_2DOH with upper level energies up to 438 K in temperature units. We derived a rotational temperature of (171 ± 52) K and column densities of $7 \times 10^{16} \text{ cm}^{-2}$ ($^{13}\text{CH}_3\text{OH}$) and $1 \times 10^{17} \text{ cm}^{-2}$ (CH_2DOH), respectively. Consequently, the D/H ratio is $(2.4 \pm 0.4) \times 10^{-2}$, a value lower by an order of magnitude with respect to what was previously measured using single dish telescopes toward protostars located in Perseus. Our findings are consistent with the higher dust temperatures in Orion B with respect to that derived for the Perseus cloud. The emission is tracing a rotating structure extending up to 45 au from the jet axis and elongated by 90 au along the jet axis. So far, the origin of the observed emission appears to be related with the accretion disk. Only higher spatial resolution measurements however, will be able to disentangle between different possible scenarios: disk wind, disk atmosphere, or accretion shocks.

Accepted by Astronomy & Astrophysics Letter

<http://arxiv.org/pdf/1709.04726>

Chemical enrichment of the planet forming region as probed by accretion

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The chemical conditions in the planet forming regions of protoplanetary discs remain difficult to observe directly. Gas accreting from the disc on to the star provides a way to measure the elemental abundances because even refractory species are in an atomic gaseous form. Here we compare the abundance ratios derived from UV lines probing T Tauri accretion streams to simple models of disc evolution. Although the interpretation of line ratios in terms of abundances is highly uncertain, discs with large cavities in mm images tend to have lower Si emission. Since this can naturally be explained by the suppressed accretion of dust, this suggests that abundance variations are at least partially responsible for the variations seen in the line ratios. Our models of disc evolution due to grain growth, radial drift and the flux of volatile species carried as ices on grain surfaces, give rise to a partial sorting of the atomic species based on the volatility of their dominant molecular carriers. This arises because volatiles are left behind at their snow lines while the grains continue to drift. We show that this reproduces the main features seen in the accretion line ratio data, such as C/N ratios that are a few times solar and the correlation between the Si to volatile ratio with mm-flux. We highlight the fact that developing a more robust linkage between line ratios and abundance ratios and acquiring data for larger samples has the potential to cast considerable light on the chemical history of protoplanetary discs.

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<http://arxiv.org/pdf/1709.02391>

New binaries in the ϵ Cha association

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We present Adaptive Optics-aided speckle observations of 47 young stars in the ϵ Cha association, made at the 4-m Southern Astrophysical Research Telescope in the *I*-band. We resolved 10 new binary pairs, 5 previously known binaries and two triple systems, also previously known. In the separation range between 4 and 300 AU, the 30 association members of spectral types G0 and later host 6 binary companions, leading to the raw companion frequency

of 0.010 ± 0.04 per decade of separation, comparable to the main sequence dwarfs in the field. On the other hand, all 5 massive association members of spectral types A and B have companions in this range. We discuss the newly resolved and known binaries in our sample. Observed motions in the triple system ϵ Cha, composed of three similar B9V stars, can be described by tentative orbits with periods 13 and ~ 900 years, and a large mutual inclination.

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<http://arxiv.org/pdf/1709.05044>

CN rings in full protoplanetary disks around young stars as probe of disk structure

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Bright ring-like structure emission of the CN molecule has been observed in protoplanetary disks. We investigate if such structures are due to the morphology of the disk itself or if they are instead an intrinsic feature of CN emission. We also address to which physical and chemical parameters CN is most sensitive, in order to use it as a diagnostic. Using the 2D thermochemical code DALI, a set of disk models are run for different stellar spectra, masses and physical structures. An updated chemical network that accounts for the most relevant CN reactions is adopted. Ring-shaped emission is found to be a common feature of all models: the highest abundance is found in the upper outer regions of the disk, and the column density peaks at 50-70 AU for T Tauri stars with standard accretion rates. The emission profile follows the column density suggesting that optical depth and non-LTE effects are minimal up to the N=3-2 transition. Higher mass disks generally show brighter CN. Higher UV fields, such as appropriate for T Tauri stars with high accretion rates or for Herbig Ae stars or for higher disk flaring, generally result in brighter and larger rings. These trends are due to the main formation paths of CN, which all start with vibrationally excited H₂^{*} molecules, produced through FUV pumping of H₂. The model results compare well with observed disk-integrated CN fluxes and with the observed location of the CN ring in TW Hya. CN rings are produced naturally in protoplanetary disks and do not require a specific underlying disk structure (dust cavity or gap). The strong link between FUV flux and CN emission can provide information on the vertical structure of the disk and on the distribution of dust grains affecting UV penetration, and could help to break some degeneracies in the SED fitting. In contrast with C₂H or c-C₃H₂, the CN flux is not very sensitive to carbon and oxygen depletion.

Accepted by A&A

<https://arxiv.org/pdf/1709.01463.pdf>

A study of dust properties in the inner sub-au region of the Herbig Ae star HD 169142 with VLTI/PIONIER

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An essential step to understanding protoplanetary evolution is the study of disks that contain gaps or inner holes. The pretransitional disk around the Herbig star HD 169142 exhibits multi-gap disk structure, differentiated gas and dust distribution, planet candidates, and near-infrared fading in the past decades, which make it a valuable target for a case study of disk evolution. Using near-infrared interferometric observations with VLTI/PIONIER, we aim to

study the dust properties in the inner sub-au region of the disk in the years 2011–2013, when the object is already in its near-infrared faint state. We first performed simple geometric modeling to characterize the size and shape of the NIR-emitting region. We then performed Monte-Carlo radiative transfer simulations on grids of models and compared the model predictions with the interferometric and photometric observations. We find that the observations are consistent with optically thin gray dust lying at $R_{\text{in}} \sim 0.07$ au, passively heated to $T \sim 1500$ K. Models with sub-micron optically thin dust are excluded because such dust will be heated to much higher temperatures at similar distance. The observations can also be reproduced with a model consisting of optically thick dust at $R_{\text{in}} \sim 0.06$ au, but this model is plausible only if refractory dust species enduring ~ 2400 K exist in the inner disk.

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GMC Collisions As Triggers of Star Formation. IV. The Role of Ambipolar Diffusion

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We investigate the role of ambipolar diffusion (AD) in collisions between magnetized giant molecular clouds (GMCs), which may be an important mechanism for triggering star cluster formation. Three dimensional simulations of GMC collisions are performed using a version of the **Enzo** magnetohydrodynamics code that has been extended to include AD. The resistivities are calculated using the 31-species chemical model of Wu et al. (2015). We find that in the weak-field, $10 \mu\text{G}$ case, AD has only a modest effect on the dynamical evolution during the collision. However, for the stronger-field, $30 \mu\text{G}$ case involving near-critical clouds, AD results in formation of dense cores in regions where collapse is otherwise inhibited. The overall efficiency of formation of cores with $n_{\text{H}} \geq 10^6 \text{ cm}^{-3}$ in these simulations is increases from about 0.2% to 2% once AD is included, comparable to observed values in star-forming GMCs. The gas around these cores typically has relatively slow infall at speeds that are a modest fraction of the free-fall speed.

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<https://arxiv.org/pdf/1706.07032>

ALMA shows that gas reservoirs of star-forming disks over the past 3 billion years are not predominantly molecular

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Cold hydrogen gas is the raw fuel for star formation in galaxies, and its partition into atomic and molecular phases is a key quantity for galaxy evolution. In this Letter, we combine Atacama Large Millimeter/submillimeter Array and Arecibo single-dish observations to estimate the molecular-to-atomic hydrogen mass ratio for massive star-forming galaxies at $z \sim 0.2$ extracted from the HIGHz survey, i.e., some of the most massive gas-rich systems currently known. We show that the balance between atomic and molecular hydrogen in these galaxies is similar to that of local main-sequence disks, implying that atomic hydrogen has been dominating the cold gas mass budget of star-forming galaxies for at least the past three billion years. In addition, despite harboring gas reservoirs that are more typical of objects at the cosmic noon, HIGHz galaxies host regular rotating disks with low gas velocity dispersions suggesting that high total gas fractions do not necessarily drive high turbulence in the interstellar medium.

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Interpretation of a Variable Reflection Nebula Associated with HBC 340 and HBC 341 in NGC 1333

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We present multi-epoch, R -band imaging obtained from the Palomar Transient Factory of a small, fan-shaped reflection nebula in NGC 1333 that experiences prominent brightness fluctuations. Photometry of HBC 340 (K7e) and HBC 341 (M5e), a visual pair of late-type, young stellar objects lying near the apex of the nebula, demonstrates that while both are variable, the former has brightened by more than two magnitudes following a deep local minimum in September 2014. Keck high dispersion ($R \sim 45,000\text{--}66,000$), optical spectroscopy of HBC 340 suggests that the protostar is a spectroscopic binary (HBC 340Aa + HBC 340Ab). Both HBC 340 and HBC 341 exhibit strong $H\alpha$ and forbidden line emission, consistent with accretion and outflow. We conclude that the brightness fluctuations in the reflection nebula represent light echos produced by varying incident radiation emanating from HBC 340. The short-term variability observed in the protostar is attributed to irregular accretion activity, while correlated, dipping behavior on a several hundred day time scale may be due to eclipse-like events caused by orbiting circumstellar material. Archival Hubble Space Telescope imaging of the region reveals a second, faint (F814W ~ 20.3 mag) companion to HBC 340 that lies $1''.02$ (~ 235 AU) east of the protostar. If associated, this probable substellar mass object (20–50 Jupiter masses), HBC 340B, is likely unrelated to the observed brightness variations. The sustained brightening of HBC 340 since late 2014 can be explained by an EXor-like outburst, the recovery from a long duration eclipse event caused by obscuring circumstellar dust, or by the gradual removal of extinguishing material from along the line of sight. Our analysis here favors one of the extinction scenarios.

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IN-SYNC. V. Stellar Kinematics and Dynamics in the Orion A Molecular Cloud.

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The kinematics and dynamics of young stellar populations enable us to test theories of star formation. With this aim, we continue our analysis of the SDSS-III/APOGEE IN-SYNC survey, a high-resolution near-infrared spectroscopic survey of young clusters. We focus on the Orion A star-forming region, for which IN-SYNC obtained spectra of ~ 2700 stars. In Paper IV we used these data to study the young stellar population. Here we study the kinematic properties through radial velocities v_r . The young stellar population remains kinematically associated with the molecular gas, following a ~ 10 km/s gradient along the filament. However, near the center of the region, the v_r distribution is slightly blueshifted and asymmetric; we suggest that this population, which is older, is slightly in the foreground. We find evidence for kinematic subclustering, detecting statistically significant groupings of colocated stars with coherent motions. These are mostly in the lower-density regions of the cloud, while the ONC radial velocities are smoothly distributed, consistent with it being an older, more dynamically evolved cluster. The velocity dispersion σ_v varies along the filament. The ONC appears virialized, or just slightly supervirial, consistent with an old dynamical age. Here there is also some evidence for ongoing expansion, from a v_r -extinction correlation. In the southern filament, σ_v is $\sim 2\text{--}3$ times larger than virial in the L1641N region, where we infer a superposition along the line of sight of stellar

subpopulations, detached from the gas. In contrast, σ_v decreases toward L1641S, where the population is again in agreement with a virial state.

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Observational signatures of cloud-cloud collision in the extended star-forming region S235

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We present a multi-wavelength data analysis of the extended star-forming region S235 (hereafter E-S235), where two molecular clouds are present. In E-S235, using the ^{12}CO (1-0) and ^{13}CO (1-0) line data, a molecular cloud linked with the site “S235main” is traced in a velocity range $[-24, -18]$ km s⁻¹, while the other one containing the sites S235A, S235B, and S235C (hereafter “S235ABC”) is depicted in a velocity range $[-18, -13]$ km s⁻¹. In the velocity space, these two clouds are separated by ~ 4 km s⁻¹, and are interconnected by a lower intensity intermediate velocity emission, tracing a broad bridge feature. In the velocity channel maps, a possible complementary molecular pair at $[-21, -20]$ km s⁻¹ and $[-16, -15]$ km s⁻¹ is also evident. The sites, “S235ABC”, East 1, and South-West are spatially seen in the interface of two clouds. Together, these observed features are consistent with the predictions of numerical models of the cloud-cloud collision (CCC) process, favoring the onset of the CCC in E-S235 about 0.5 Myr ago. Deep UKIDSS near-infrared photometric analysis of point-like sources reveals significant clustering of young stellar populations toward the sites located at the junction, and the “S235main”. The sites, “S235ABC” harbor young compact H II regions having dynamical ages of ~ 0.06 – 0.22 Myr, and these sites (including South-West and East 1) also contain dust clumps (having $M_{clump} \sim 40$ to $635 M_{\odot}$). Our observational findings suggest that the star formation activities (including massive stars) appear to be influenced by the CCC mechanism at the junction.

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Structure and mass segregation in Galactic stellar clusters

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We quantify the structure of a very large number of Galactic open clusters and look for evidence of mass segregation for the most massive stars in the clusters. We characterise the structure and mass segregation ratios of 1276 clusters in the Milky Way Stellar Cluster (MWSC) catalogue containing each at least 40 stars and that are located at a distance of up to ≈ 2 kpc from the Sun. We use an approach based on the calculation of the minimum spanning tree of the clusters, and for each one of them, we calculate the structure parameter \mathcal{Q} and the mass segregation ratio Λ_{MSR} . Our findings indicate that most clusters possess a \mathcal{Q} parameter that falls in the range 0.7–0.8 and are thus neither strongly concentrated nor do they show significant substructure. Only 27% can be considered centrally concentrated with \mathcal{Q} values > 0.8 . Of the 1276 clusters, only 14% show indication of significant mass segregation ($\Lambda_{\text{MSR}} > 1.5$). Furthermore, no correlation is found between the structure of the clusters or the degree of mass segregation with their position in the Galaxy. A comparison of the measured \mathcal{Q} values for the young open clusters in the MWSC to N-body numerical simulations that follow the evolution of the \mathcal{Q} parameter over the first 10 Myrs of the clusters life suggests that the young clusters found in the MWSC catalogue initially possessed local mean volume densities of $\rho_* \approx 10 - 100$

$M_{\odot} \text{ pc}^{-3}$.

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Origin and evolution of magnetic fields in PMS stars : influence of rotation and structural changes

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During stellar evolution, especially in the PMS, stellar structure and rotation evolve significantly causing major changes in the dynamics and global flows of the star. We wish to assess the consequences of these changes on stellar dynamo, internal magnetic field topology and activity level. To do so, we have performed a series of 3D HD and MHD simulations with the ASH code. We choose five different models characterized by the radius of their radiative zone following an evolutionary track computed by a 1D stellar evolution code. These models characterized stellar evolution from 1 Myr to 50 Myr. By introducing a seed magnetic field in the fully convective model and spreading its evolved state through all four remaining cases, we observe systematic variations in the dynamical properties and magnetic field amplitude and topology of the models. The five MHD simulations develop strong dynamo field that can reach equipartition state between the kinetic and magnetic energy and even super-equipartition levels in the faster rotating cases. We find that the magnetic field amplitude increases as it evolves toward the ZAMS. Moreover the magnetic field topology becomes more complex, with a decreasing axisymmetric component and a non-axisymmetric one becoming predominant. The dipolar components decrease as the rotation rate and the size of the radiative core increase. The magnetic fields possess a mixed poloidal-toroidal topology with no obvious dominant component. Moreover the relaxation of the vestige dynamo magnetic field within the radiative core is found to satisfy MHD stability criteria. Hence it does not experience a global reconfiguration but slowly relaxes by retaining its mixed stable poloidal-toroidal topology.

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X-ray photoevaporation's limited success in the formation of planetesimals by the streaming instability

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The streaming instability is often invoked as solution to the fragmentation and drift barriers in planetesimal formation, catalyzing the aggregation of dust on kyr timescales to grow km-sized cores. However there remains a lack of consensus on the physical mechanism(s) responsible for initiating it. One potential avenue is disc photoevaporation, wherein the preferential removal of relatively dust-free gas increases the disc metallicity. Late in the disc lifetime, photoevaporation dominates viscous accretion, creating a gradient in the depleted gas surface density near the location of the gap. This induces a local pressure maximum that collects drifting dust particles, which may then become susceptible to the streaming instability. Using a one-dimensional viscous evolution model of a disc subject to internal X-ray photoevaporation, we explore the efficacy of this process to build planetesimals. Over a range of parameters we find that the amount of dust mass converted into planetesimals is often $<1 M_{\oplus}$ and at most a few M_{\oplus} spread across tens of AU. We conclude that photoevaporation may at best be relevant for the formation of debris discs, rather than a common mechanism for the formation of planetary cores. Our results are in contrast to a recent, similar investigation that considered an FUV-driven photoevaporation model and reported the formation of tens of M_{\oplus} at large (>100 AU) disc radii. The discrepancies are primarily a consequence of the different photoevaporation profiles assumed. Until

observations more tightly constrain photoevaporation models, the relevance of this process to the formation of planets remains uncertain.

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A Survey For Planetary-mass Brown Dwarfs in the Taurus and Perseus Star-forming Regions

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We present the initial results from a survey for planetary-mass brown dwarfs in the Taurus star-forming region. We have identified brown dwarf candidates in Taurus using proper motions and photometry from several ground- and space-based facilities. Through spectroscopy of some of the more promising candidates, we have found 18 new members of Taurus. They have spectral types ranging from mid M to early L and they include the four faintest known members in extinction-corrected K_s , which should have masses as low as $\sim 4\text{--}5 M_{\text{Jup}}$ according to evolutionary models. Two of the coolest new members (M9.25, M9.5) have mid-IR excesses that indicate the presence of disks. Two fainter objects with types of M9-L2 and M9-L3 also have red mid-IR colors relative to photospheres at $\leq L0$, but since the photospheric colors are poorly defined at $>L0$, it is unclear whether they have excesses from disks. We also have obtained spectra of candidate members of the IC 348 and NGC 1333 clusters in Perseus that were identified by Luhman et al. (2016). Eight candidates are found to be probable members, three of which are among the faintest and least-massive known members of the clusters ($\sim 5 M_{\text{Jup}}$).

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Signatures of broken protoplanetary discs in scattered light and in sub-millimetre observations

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Spatially resolved observations of protoplanetary discs are revealing that their inner regions can be warped or broken from the outer disc. A few mechanisms are known to lead to such 3D structures; among them, the interaction with a stellar companion. We perform a 3D SPH simulation of a circumbinary disc misaligned by 60° with respect to the binary orbital plane. The inner disc breaks from the outer regions, precessing as a rigid body, and leading to a complex evolution. As the inner disc precesses, the misalignment angle between the inner and outer discs varies by more than 100° . Different snapshots of the evolution are post-processed with a radiative transfer code, in order to produce observational diagnostics of the process. Even though the simulation was produced for the specific case of a circumbinary disc, most of the observational predictions hold for any disc hosting a precessing inner rim. Synthetic scattered light observations show strong azimuthal asymmetries, where the pattern depends strongly on the misalignment angle between inner and outer disc. The asymmetric illumination of the outer disc leads to azimuthal variations of the temperature structure, in particular in the upper layers, where the cooling time is short. These variations are reflected in asymmetric surface brightness maps of optically thick lines, as CO $J=3-2$. The kinematical information obtained from the gas lines is unique in determining the disc structure. The combination of scattered light images and (sub-)mm lines can distinguish between radial inflow and misaligned inner disc scenarios.

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Interferometric view of the circumstellar envelopes of northern FU Orionis-type stars

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FU Orionis-type objects are pre-main sequence, low-mass stars with large outbursts in visible light that last for several years or decades. They are thought to represent an evolutionary phase during the life of every young star when accretion from the circumstellar disk is enhanced during recurring time periods. These outbursts are able to rapidly build up the star while affecting the physical conditions inside the circumstellar disk and thus the ongoing or future planet formation. In many models infall from a circumstellar envelope seems to be necessary to trigger the outbursts. We characterize the morphology and the physical parameters of the circumstellar material around FU Orionis-type stars using the emission of millimeter wavelength molecular tracers. The high spatial resolution study gives insight into the evolutionary state of the objects, the distribution of parameters in the envelopes and the physical processes forming the environment of these stars.

We observed the J=1–0 rotational transition of ¹³CO and C¹⁸O towards eight northern FU Orionis-type stars (V1057 Cyg, V1515 Cyg, V2492 Cyg, V2493 Cyg, V1735 Cyg, V733 Cep, RNO 1B and RNO 1C) and determine the spatial and velocity structure of the circumstellar gas on the scale of a few thousands of AU. We derive temperatures and envelope masses and discuss the kinematics of the circumstellar material. We detected extended CO emission associated with all our targets. Smaller scale CO clumps were found to be associated with five objects with radii of 2000–5000 AU and masses of 0.02–0.5 M_{\odot} ; these are clearly heated by the central stars. Three of these envelopes are also strongly detected in the 2.7 mm continuum. No central CO clumps were detected around V733 Cep and V710 Cas that can be interpreted as envelopes but there are many other clumps in their environments. Traces of outflow activity were observed towards V1735 Cyg, V733 Cep and V710 Cas.

The diversity of the observed envelopes enables us to set up an evolutionary sequence between the objects. We find their evolutionary state to range from early, embedded Class I stage to late, Class II-type objects with very low-mass circumstellar material. We also find evidence of larger scale circumstellar material influencing the detected spectral features in the environment of our targets. These results reinforce the idea of FU Orionis-type stars as representatives of a transitory stage between embedded Class I young stellar objects and classical T-Tauri stars.

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The wind and the magnetospheric accretion onto the T Tauri star S Coronae Australis at sub-au resolution

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To investigate the inner regions of protoplanetary discs, we performed near-infrared interferometric observations of the classical T Tauri binary system S CrA. We present the first VLTI-GRAVITY high spectral resolution ($R \sim 4000$) observations of a classical T Tauri binary, S CrA (composed of S CrA N and S CrA S and separated by $\sim 1.4''$), combining the four 8m telescopes in dual-field mode. Our observations in the near-infrared K-band continuum reveal a disc around each binary component, with similar half-flux radii of about 0.1 au at $d \sim 130$ pc, inclinations ($i = 28 \pm 3^\circ$ and $i = 22 \pm 6^\circ$),

and position angles ($PA=0^\circ\pm 6^\circ$ and $PA=-2^\circ\pm 12^\circ$), suggesting that they formed from the fragmentation of a common disc. The S CrA N spectrum shows bright He I and Br γ line emission exhibiting inverse P Cygni profiles, typically associated with infalling gas. The continuum-compensated Br γ line visibilities of S CrA N show the presence of a compact Br γ emitting region whose radius is about ~ 0.06 au, which is twice as big as the truncation radius. This component is mostly tracing a wind. Moreover, a slight radius change between the blue- and red-shifted Br γ line components is marginally detected. The presence of an inverse P Cygni profile in the He I and Br γ lines, along with the tentative detection of a slightly larger size of the blue-shifted Br γ line component, hint at the simultaneous presence of a wind and magnetospheric accretion in S CrA N.

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Effect of Angular Momentum Alignment and Strong Magnetic Fields on the Formation of Protostellar Disks

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Star forming molecular clouds are observed to be both highly magnetized and turbulent. Consequently the formation of protostellar disks is largely dependent on the complex interaction between gravity, magnetic fields, and turbulence. Studies of non-turbulent protostellar disk formation with realistic magnetic fields have shown that these fields are efficient in removing angular momentum from the forming disks, preventing their formation. However, once turbulence is included, disks can form in even highly magnetized clouds, although the precise mechanism remains uncertain. Here we present several high resolution simulations of turbulent, realistically magnetized, high-mass molecular clouds with both aligned and random turbulence to study the role that turbulence, misalignment, and magnetic fields have on the formation of protostellar disks. We find that when the turbulence is artificially aligned so that the angular momentum is parallel to the initial uniform field, no rotationally supported disks are formed, regardless of the initial turbulent energy. We conclude that turbulence and the associated misalignment between the angular momentum and the magnetic field are crucial in the formation of protostellar disks in the presence of realistic magnetic fields.

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Fragmentation of Filamentary Cloud Permeated by Perpendicular Magnetic Field

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We examine the linear stability of an isothermal filamentary cloud permeated by a perpendicular magnetic field. Our model cloud is assumed to be supported by gas pressure against the self-gravity in the unperturbed state. For simplicity, the density distribution is assumed to be symmetric around the axis. Also for simplicity, the initial magnetic field is assumed to be uniform and turbulence is not taken into account. The perturbation equation is formulated to be an eigenvalue problem. The growth rate is obtained as a function of the wavenumber for fragmentation along the axis and the magnetic field strength. The growth rate depends critically on the outer boundary. If the displacement vanishes in the region very far from the cloud axis (fixed boundary), cloud fragmentation is suppressed by a moderate magnetic field, which means the plasma beta is below 1.67 on the cloud axis. If the displacement is constant along the magnetic field in the region very far from the cloud, the cloud is unstable even when the magnetic field is infinitely strong. The cloud is deformed by circulation in the plane perpendicular to the magnetic field. The unstable mode is

not likely to induce dynamical collapse, since it is excited even when the whole cloud is magnetically subcritical. For both the boundary conditions the magnetic field increases the wavelength of the most unstable mode. We find that the magnetic force suppresses compression perpendicular to the magnetic field especially in the region of low density.

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How do stars gain their mass? A JCMT/SCUBA-2 Transient Survey of Protostars in Nearby Star Forming Regions

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Most protostars have luminosities that are fainter than expected from steady accretion over the protostellar lifetime. The solution to this problem may lie in episodic mass accretion – prolonged periods of very low accretion punctuated by short bursts of rapid accretion. However, the timescale and amplitude for variability at the protostellar phase is almost entirely unconstrained. In *A JCMT/SCUBA-2 Transient Survey of Protostars in Nearby Star Forming Regions*, we are monitoring monthly with SCUBA-2 the sub-mm emission in eight fields within nearby (< 500 pc) star forming regions to measure the accretion variability of protostars. The total survey area of ~ 1.6 sq.deg. includes ~ 105 peaks with peaks brighter than 0.5 Jy/beam (43 associated with embedded protostars or disks) and 237 peaks of 0.125–0.5 Jy/beam (50 with embedded protostars or disks). Each field has enough bright peaks for flux calibration relative to other peaks in the same field, which improves upon the nominal flux calibration uncertainties of sub-mm observations to reach a precision of $\sim 2 - 3\%$ rms, and also provides quantified confidence in any measured variability. The timescales and amplitudes of any sub-mm variation will then be converted into variations in accretion rate and subsequently used to infer the physical causes of the variability. This survey is the first dedicated survey for sub-mm variability and complements other transient surveys at optical and near-IR wavelengths, which are not sensitive to accretion variability of deeply embedded protostars.

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Early Science with the Large Millimetre Telescope: Fragmentation of molecular clumps in the Galaxy

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Sensitive, imaging observations of the 1.1 mm dust continuum emission from a 1 deg² area collected with the AzTEC bolometer camera on the Large Millimeter Telescope are presented. A catalog of 1545 compact sources is constructed based on a Wiener-optimization filter. These sources are linked to larger clump structures identified in the Bolocam Galactic Plane Survey. Hydrogen column densities are calculated for all sources and mass and mean volume densities are derived for the subset of sources for which kinematic distances can be assigned. The AzTEC sources are localized, high density peaks within the massive clumps of molecular clouds and comprise 5–15% of the clump mass. We examine the role of the gravitational instability in generating these fragments by comparing the mass of embedded AzTEC sources to the Jeans' mass of the parent BGPS object. For sources with distances less than 6 kpc the fragment masses

are comparable to the clump Jeans' mass, despite having isothermal Mach numbers between 1.6 and 7.2. AzTEC sources linked to ultra-compact HII regions have mass surface densities greater than the critical value implied by the mass-size relationship of infrared dark clouds with high mass star formation while AzTEC sources associated with Class II methanol masers have mass surface densities greater than 0.7 g cm^{-2} that approaches the proposed threshold required to form massive stars.

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Gas dynamics in the inner few AU around the Herbig B[e] star MWC297: Indications of a disk wind from kinematic modeling and velocity-resolved interferometric imaging

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Circumstellar accretion disks and outflows play an important role in star formation. By studying the continuum and $\text{Br}\gamma$ -emitting region of the Herbig B[e] star MWC297 with high-spectral- and high-spatial resolution we aim to gain insight into the wind-launching mechanisms in young stars.

We present near-infrared AMBER ($R = 12,000$) and CRILES ($R = 100,000$) observations of the Herbig B[e] star MWC297 in the hydrogen $\text{Br}\gamma$ -line. Using the VLTI unit telescopes, we obtained a uv -coverage suitable for aperture synthesis imaging. We interpret our velocity-resolved images as well as the derived two-dimensional photocenter displacement vectors, and fit kinematic models to our visibility and phase data in order to constrain the gas velocity field on sub-AU scales.

The measured continuum visibilities constrain the orientation of the near-infrared-emitting dust disk, where we determine that the disk major axis is oriented along a position angle of $\sim 99.6 \pm 4.8^\circ$. The near-infrared continuum emission is $\sim 3.6\times$ more compact than the expected dust-sublimation radius, possibly indicating the presence of highly refractory dust grains or optically thick gas emission in the inner disk. Our velocity-resolved channel maps and moment maps reveal the motion of the $\text{Br}\gamma$ -emitting gas in six velocity channels, marking the first time that kinematic effects in the sub-AU inner regions of a protoplanetary disk could be directly imaged. We find a rotation-dominated velocity field, where the blue- and red-shifted emissions are displaced along a position angle of $24^\circ \pm 3^\circ$ and the approaching part of the disk is offset west of the star. The visibility drop in the line as well as the strong non-zero phase signals can be modeled reasonably well assuming a Keplerian velocity field, although this model is not able to explain the 3σ difference that we measure between the position angle of the line photocenters and the position angle of the dust disk. We find that the fit can be improved by adding an outflowing component to the velocity field, as inspired by a magneto-centrifugal disk-wind scenario.

This study combines spectroscopy, spectroastrometry, and high-spectral dispersion interferometric, providing yet the tightest constraints on the distribution and kinematics of $\text{Br}\gamma$ -emitting gas in the inner few AU around a young star. All observables can be modeled assuming a disk wind scenario. Our simulations show that adding a poloidal velocity component causes the perceived system axis to shift, offering a powerful new diagnostic for detecting non-Keplerian velocity components in other systems.

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On the inner disk structure of MWC480: evidence for asymmetries?

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Studying the physical conditions structuring the young circumstellar disks is required for understanding the onset of planet formation. Of particular interest is the protoplanetary disk surrounding the Herbig star MWC480. The structure and properties of the circumstellar disk of MWC480 are studied by infrared interferometry and interpreted from a modeling approach. New observations are driving this study, in particular some recent Very Large Telescope Interferometer (VLTI)/MIDI data acquired in December 2013. Our one-component disk model could not reproduce simultaneously all our data: the Spectral Energy Distribution, the near-infrared Keck Interferometer data and the mid-infrared data obtained with the MIDI instrument. In order to explain all measurements, one possibility is to add an asymmetry in our one-component disk model with the assumption that the structure of the disk of MWC480 has not varied with time. Several scenarios are tested, and the one considering the presence of an azimuthal bright feature in the inner component of the disk model provides a better fit of the data. (In this study, we assumed that the size of the outer disk of MWC480 to be 20 au since most of the near and mid-IR emissions come from below 20 au. In our previous study (Jamialahmadi et al. 2015), we adopted an outer radius of 80 au, which is consistent with the value found by previous studies based on mm observations).

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Simulating the Exoplanet Yield of a Space-based MIR Interferometer Based on Kepler Statistics

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Aims: We predict the exoplanet yield of a space-based mid-infrared nulling interferometer using Monte-Carlo simulations. We quantify the number and properties of detectable exoplanets and identify those target stars that have the highest or most complete detection rate. We investigate how changes in the underlying technical assumptions and uncertainties in the underlying planet population impact the scientific return.

Methods: We simulate 2'000 exoplanetary systems, based on planet occurrence statistics from *Kepler*, with randomly orientated orbits and uniformly distributed albedos around each of 326 nearby ($d < 20$ pc) stars. Assuming thermal equilibrium and blackbody emission, together with the limiting spatial resolution and sensitivity of our simulated instrument in three specific bands (5.6, 10.0, and 15.0 μm), we quantify the number of detectable exoplanets as a function of their radii and equilibrium temperatures.

Results: $\sim 315_{-77}^{+113}$ exoplanets (with radii $0.5 R_{\text{Earth}} \leq R_{\text{p}} \leq 6 R_{\text{Earth}}$) could be detected in at least one and half of them in all three bands during ~ 0.52 years of mission time assuming throughputs 3.5 times worse than those for the *JWST* and $\sim 40\%$ overheads. Accounting for stellar leakage and (unknown) exozodiacal light, the discovery phase of the mission very likely requires 2 – 3 years in total. The uncertainties in planet yield are dominated by uncertainties in the underlying planet population, but the distribution of the Bond albedos also has a significant impact. Roughly 50% of the detected planets orbit M stars, which also have the highest planet yield per star; the other 50% FGK stars, which show a higher completeness in the detectability. ~ 85 planets could be habitable ($0.5 R_{\text{Earth}} \leq R_{\text{p}} \leq 1.75 R_{\text{Earth}}$ and $200 \text{ K} \leq T_{\text{eq}} \leq 450 \text{ K}$) and are prime targets for spectroscopic observations in a second mission phase. Comparing these results to those for a large optical/NIR telescope we find that a MIR interferometer would detect more planets and the number of planets depends less strongly on the wavelength. **Conclusions:** An optimized space-based nulling interferometer operating in the mid-infrared would deliver an unprecedented dataset for the characterization of (small) nearby exoplanets including dozens of potentially habitable worlds.

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Distortion of Magnetic Fields in a Starless Core II: 3D Magnetic Field Structure of FeSt 1-457

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Three dimensional (3D) magnetic field information on molecular clouds and cores is important for revealing their kinematical stability (magnetic support) against gravity which is fundamental for studying the initial conditions of star formation. In the present study, the 3D magnetic field structure of the dense starless core FeSt 1-457 is determined based on the near-infrared polarimetric observations of the dichroic polarization of background stars and simple 3D modeling. With an obtained angle of line-of-sight magnetic inclination axis θ_{inc} of $45^\circ \pm 10^\circ$ and previously determined plane-of-sky magnetic field strength B_{pol} of $23.8 \pm 12.1 \mu\text{G}$, the total magnetic field strength for FeSt 1-457 is derived to be $33.7 \pm 18.0 \mu\text{G}$. The critical mass of FeSt 1-457, evaluated using both magnetic and thermal/turbulent support is $M_{\text{cr}} = 3.70 \pm 0.92 M_{\odot}$, which is identical to the observed core mass, $M_{\text{core}} = 3.55 \pm 0.75 M_{\odot}$. We thus conclude that the stability of FeSt 1-457 is in a condition close to the critical state. Without infalling gas motion and no associated young stars, the core is regarded to be in the earliest stage of star formation, i.e., the stage just before the onset of dynamical collapse following the attainment of a supercritical condition. These properties would make FeSt 1-457 one of the best starless cores for future studies of the initial conditions of star formation.

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Do planets remember how they formed?

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One of the most directly observable features of a transiting multi-planet system is their size-ordering when ranked in orbital separation. Kepler has revealed a rich diversity of outcomes, from perfectly ordered systems, like Kepler-80, to ostensibly disordered systems, like Kepler-20. Under the hypothesis that systems are born via preferred formation pathways, one might reasonably expect non-random size-orderings reflecting these processes. However, subsequent dynamical evolution, often chaotic and turbulent in nature, may erode this information and so here we ask - do systems remember how they formed? To address this, we devise a model to define the entropy of a planetary system's size-ordering, by first comparing differences between neighboring planets and then extending to accommodate differences across the chain. We derive closed-form solutions for many of the micro state occupancies and provide public code with look-up tables to compute entropy for up to ten-planet systems. All three proposed entropy definitions exhibit the expected property that their credible interval increases with respect to a proxy for time. We find that the observed Kepler multis display a highly significant deficit in entropy compared to a randomly generated population. Incorporating a filter for systems deemed likely to be dynamically packed, we show that this result is robust against the possibility of missing planets too. Put together, our work establishes that Kepler systems do indeed remember something of their younger years and highlights the value of information theory for exoplanetary science.

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Modelling of mid-infrared interferometric signature of hot exozodiacal dust emission

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Hot exozodiacal dust emission was detected in recent surveys around two dozen main sequence stars at distances of less than 1 au using H and K band interferometry. Due to the high contrast as well as the small angular distance between the circumstellar dust and the star, direct observation of this dust component is challenging. An alternative way to explore the hot exozodiacal dust is provided by mid-infrared interferometry. We analyze the L, M and N band interferometric signature of this emission in order to find stronger constraints for the properties and the origin of the hot exozodiacal dust. Considering the parameters of nine debris disc systems derived previously, we model the discs in each of these bands. We find that the M band possesses the best conditions to detect hot dust emission, closely followed by L and N bands. The hot dust in three systems – HD 22484 (10 Tau), HD 102647 (β Leo) and HD 177724 (ζ Aql) — shows a strong signal in the visibility functions which may even allow one to constrain the dust location. In particular, observations in the mid-infrared could help to determine whether the dust piles up at the sublimation radius or is located at radii up to 1 au. In addition, we explore observations of the hot exozodiacal dust with the upcoming mid-infrared interferometer MATISSE at the Very Large Telescope Interferometer (VLTI).

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Kinematics and Structure of Star-forming Regions: Insights from Cold Collapse Models

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The origin of the observed morphological and kinematic substructure of young star forming regions is a matter of debate. We offer a new analysis of data from simulations of globally gravitationally collapsing clouds of progenitor gas to answer questions about sub-structured star formation in the context of cold collapse. As a specific example, we compare our models to recent radial velocity survey data from the IN-SYNC survey of Orion and new observations of dense gas kinematics, and offer possible interpretations of kinematic and morphological signatures in the region. In the context of our model, we find the frequently-observed hub-filament morphology of the gas naturally arises during gravitational evolution, as well as the dynamically-distinct kinematic substructure of stars. We emphasize that the global and not just the local gravitational potential plays an important role in determining the dynamics of both clusters and filaments.

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Gas and dust in the star-forming region ρ Oph A: II. The gas in the PDR and in the dense cores

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We investigate to what degree local physical and chemical conditions are related to the evolutionary status of various objects in star-forming media. ρ Oph A displays the entire sequence of low-mass star formation in a small volume of space. Using spectrophotometric line maps of H₂, H₂O, NH₃, N₂H⁺, O₂, OI, CO, and CS, we examine the distribution of the atomic and molecular gas in this dense molecular core. The physical parameters of these species are derived, as are their relative abundances in ρ Oph A. Using radiative transfer models, we examine the infall status of the cold dense cores from their resolved line profiles of the ground state lines of H₂O and NH₃, where for the latter no contamination from the VLA 1623 outflow is observed and line overlap of the hyperfine components is explicitly taken into account. The stratified structure of this photon dominated region (PDR), seen edge-on, is clearly displayed. Polycyclic aromatic hydrocarbons (PAHs) and OI are seen throughout the region around the exciting star S1. At the interface to the molecular core 0.05 pc away, atomic hydrogen is rapidly converted into H₂, whereas OI protrudes further into the molecular core. This provides oxygen atoms for the gas-phase formation of O₂ in the core SM1, where $X(\text{O}_2) \sim 5 \times 10^{-8}$. There, the ratio of the O₂ to H₂O abundance [$X(\text{H}_2\text{O}) \sim 5 \times 10^{-9}$] is significantly higher than unity. Away from the core, O₂ experiences a dramatic decrease due to increasing H₂O formation. Outside the molecular core, on the far side as seen from S1, the intense radiation from the 0.5 pc distant early B-type star HD147889 destroys the molecules. Towards the dark core SM1, the observed abundance ratio $X(\text{O}_2)/X(\text{H}_2\text{O}) > 1$, which suggests that this object is extremely young, which would explain why O₂ is such an elusive molecule outside the solar system.

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Formation of wide binaries by turbulent fragmentation

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Understanding the formation of wide binary systems of very low mass stars ($M \leq 0.1$ Msun) is challenging. The most obvious route is via widely separated low-mass collapsing fragments produced through turbulent fragmentation of a molecular core. However, close binaries/multiples from disk fragmentation can also evolve to wide binaries over a few initial crossing times of the stellar cluster through tidal evolution. Finding an isolated low mass wide binary system in the earliest stage of formation, before tidal evolution could occur, would prove that turbulent fragmentation is a viable mechanism for (very) low mass wide binaries. Here we report high resolution ALMA observations of a known wide-separation protostellar binary, showing that each component has a circumstellar disk. The system is too young to have evolved from a close binary and the disk axes are misaligned, providing strong support for the turbulent fragmentation model. Masses of both stars are derived from the Keplerian rotation of the disks; both are very low mass stars.

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Analytical core mass function (CMF) from filaments: Under which circumstances can filament fragmentation reproduce the CMF?

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Observations suggest that star formation in filamentary molecular clouds occurs in a two-step process, with the formation of filaments preceding that of prestellar cores and stars. Here, we apply the gravo-turbulent fragmentation theory of Hennebelle & Chabrier 08, 09, 13 to a filamentary environment, taking into account magnetic support. We discuss the induced geometrical effect on the cores, with a transition from 3D geometry at small scales to 1D at large ones. The model predicts the fragmentation behavior of a filament for a given mass per unit length (MpL) and level of magnetization. This CMF for individual filaments is then convolved with the distribution of filaments to obtain the final system CMF. The model yields two major results: (i) the filamentary geometry naturally induces a hierarchical fragmentation process, first into groups of cores, separated by a length equal to a few filament Jeans lengths, i.e. a few times the filament width. These groups then fragment into individual cores. (ii) Non-magnetized filaments with high MpL are found to fragment excessively, at odd with observations. This is resolved by taking into account the magnetic field treated simply as additional pressure support). The present theory suggests two complementary modes of star formation: while small (spherical or filamentary) structures will collapse directly into prestellar cores, according to the standard Hennebelle-Chabrier theory, the large (filamentary) ones, the dominant population according to observations, will follow the afore-described two-step process.

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The optical+infrared L dwarf spectral sequence of young planetary-mass objects in the Upper Scorpius association

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We present the results of photometric and spectroscopic follow-ups of the lowest mass member candidates in the nearest OB association, Upper Scorpius (5–10 Myr; 145 ± 17 pc), with the Gran Telescopio de Canarias (GTC) and European Southern Observatory (ESO) Very Large Telescope (VLT). We confirm the membership of the large majority (>80%) of the candidates selected originally photometrically and astrometrically based on their spectroscopic features, weak equivalent widths of gravity-sensitive doublets, and radial velocities. Confirmed members follow a sequence over a wide magnitude range ($J=17.0$ – 19.3 mag) in several colour-magnitude diagrams with optical, near-, and mid-infrared photometry, and have near-infrared spectral types in the L1–L7 interval with likely masses below 15 Jupiter masses. We find that optical spectral types tend to be earlier than near-infrared spectral types by a few subclasses for spectral types later than M9. We investigate the behaviour of spectral indices defined in the literature as a function of spectral type and gravity by comparison with values reported in the literature for young and old dwarfs. We also derive effective temperatures in the 1900–1600K from fits of synthetic model-atmosphere spectra to the observed photometry but we caution the procedure carries large uncertainties. We determine bolometric corrections for young L dwarfs with ages of ~ 5 –10 Myr (Upper Sco association) and find them similar in the J-band but larger by 0.1–0.4 mag in the K-band with respect to field L dwarfs. Finally, we discovered two faint young L dwarfs, VISTAJ1607–2146 (L4.5) and VISTAJ1611–2215 (L5) that have H emission and possible flux excesses at $4.5 \mu\text{m}$, pointing towards the presence of accretion from a disk onto the central objects of mass below ~ 15 Jupiter masses at the age of 5–10 Myr.

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Diffuse Ionized Gas in the Milky Way Disk

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We analyze the diffuse ionized gas (DIG) in the first Galactic quadrant from $\ell = 18^\circ$ to 40° using radio recombination line (RRL) data from the Green Bank Telescope. These data allow us to distinguish DIG emission from H II region emission and thus study the diffuse gas essentially unaffected by confusion from discrete sources. We find that the DIG has two dominant velocity components, one centered around 100 km s^{-1} associated with the luminous H II region W43, and the other centered around 45 km s^{-1} not associated with any large H II region. Our analysis suggests that the two velocity components near W43 may be caused by non-circular streaming motions originating near the end of the Galactic bar. At lower Galactic longitudes, the two velocities may instead arise from gas at two distinct distances from the Sun, with the most likely distances being $\sim 6 \text{ kpc}$ for the 100 km s^{-1} component and $\sim 12 \text{ kpc}$ for the 45 km s^{-1} component. We show that the intensity of diffuse *Spitzer* GLIMPSE $8.0 \mu\text{m}$ emission caused by excitation of polyaromatic hydrocarbons (PAHs) is correlated with both the locations of discrete H II regions and the intensity of the RRL emission from the DIG. This implies that the soft ultra-violet photons responsible for creating the infrared emission have a similar origin as the harder ultra-violet photons required for the RRL emission. The $8.0 \mu\text{m}$ emission increases with RRL intensity but flattens out for directions with the most intense RRL emission, suggesting that PAHs are partially destroyed by the energetic radiation field at these locations.

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Massive outflows driven by magnetic effects in star-forming clouds with high mass accretion rates

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The relation between the mass accretion rate onto the circumstellar disc and the rate of mass ejection by magnetically driven winds is investigated using three-dimensional magnetohydrodynamics simulations. Using a spherical cloud core with a varying ratio of thermal to gravitational energy, which determines the mass accretion rate onto the disc, to define the initial conditions, the outflow propagation for approximately 10^4 yr after protostar formation is then calculated for several cloud cores. The mass ejection rate and accretion rate are comparable only when the magnetic energy of the initial cloud core is comparable to the gravitational energy. Consequently, in strongly magnetised clouds a higher mass accretion rate naturally produces both massive protostars and massive outflows. The simulated outflow mass, momentum, kinetic energy and momentum flux agree well with observations, indicating that massive stars form through the same mechanism as low-mass stars but require a significantly strong magnetic field to launch massive outflows.

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Molecular gas in debris disks around young A-type stars

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According to the current paradigm of circumstellar disk evolution, gas-rich primordial disks evolve into gas-poor debris disks composed of second-generation dust. To explore the transition between these phases, we searched for ^{12}CO , ^{13}CO , and C^{18}O emission in seven dust-rich debris disks around young A-type stars, using ALMA in Band 6. We discovered molecular gas in three debris disks. In all these disks, the ^{12}CO line was optically thick, highlighting the importance of less abundant molecules in reliable mass estimates. Supplementing our target list by literature data, we compiled a volume-limited sample of dust-rich debris disks around young A-type stars within 150 pc. We obtained a CO detection rate of 11/16 above a ^{12}CO $J=2-1$ line luminosity threshold of $\sim 1.4 \times 10^4$ Jy km s⁻¹ pc² in the sample. This high incidence implies that the presence of CO gas in bright debris disks around young A-type stars is likely more the rule than the exception. Interestingly, dust-rich debris disks around young FG-type stars exhibit, with the same detectability threshold as for A-type stars, significantly lower gas incidence. While the transition from protoplanetary to debris phase is associated with a drop of dust content, our results exhibit a large spread in the CO mass in our debris sample, with peak values comparable to those in protoplanetary Herbig Ae disks. In the particularly CO-rich debris systems the gas may have primordial origin, characteristic of a hybrid disk.

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Electron Heating and Saturation of Self-regulating Magnetorotational Instability in Protoplanetary Disks

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Magnetorotational instability (MRI) has a potential to generate the vigorous turbulence in protoplanetary disks, although its turbulence strength and accretion stress remains debatable because of the uncertainty of MRI with low ionization fraction. We focus on the heating of electrons by strong electric fields which amplifies nonideal magnetohydrodynamic effects. The heated electrons frequently collide with and stick to dust grains, which in turn decreases the ionization fraction and is expected to weaken the turbulent motion driven by MRI. In order to quantitatively investigate the nonlinear evolution of MRI including the electron heating, we perform magnetohydrodynamical simulation with the unstratified shearing box. We introduce a simple analytic resistivity model depending on the current density by mimicking resistivity given by the calculation of ionization. Our simulation confirms that the electron heating suppresses magnetic turbulence when the electron heating occurs with low current density. We find a clear correlation between magnetic stress and its current density, which means that the magnetic stress is proportional to the squared current density. When the turbulent motion is completely suppressed, laminar accretion flow is caused by ordered magnetic field. We give an analytical description of the laminar state by using a solution of linear perturbation equations with resistivity. We also propose a formula that successfully predicts the accretion stress in the presence of

the electron heating.

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The star-forming complex LMC-N79 as a future rival to 30 Doradus

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Within the early Universe, ‘extreme’ star formation may have been the norm rather than the exception. Super Star Clusters (SSCs; $M_{\star} \geq 10^5 M_{\odot}$) are thought to be the modern-day analogs of globular clusters, relics of a cosmic time ($z \geq 2$) when the Universe was filled with vigorously star-forming systems. The giant HII region 30 Doradus in the Large Magellanic Cloud (LMC) is often regarded as a benchmark for studies of extreme star formation. Here, we report the discovery of a massive embedded star forming complex spanning ~ 500 pc in the unexplored southwest region of the LMC, which manifests itself as a younger, embedded twin of 30 Doradus. Previously known as N79, this region has a star formation efficiency exceeding that of 30 Doradus by a factor of ~ 2 as measured over the past ≤ 0.5 Myr. Moreover, at the heart of N79 lies the most luminous infrared (IR) compact source discovered with large-scale IR surveys of the LMC and Milky Way, possibly a precursor to the central SSC of 30 Doradus, R136. The discovery of a nearby candidate SSC may provide invaluable information to understand how extreme star formation proceeds in the current and high-redshift Universe.

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Impact of Protostellar Outflows on Turbulence and Star Formation Efficiency in Magnetized Dense Cores

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The star-forming efficiency of dense gas is thought to be set within cores by outflow and radiative feedback. We use magneto-hydrodynamic simulations to investigate the relation between protostellar outflow evolution, turbulence and star formation efficiency. We model the collapse and evolution of isolated dense cores for $\gtrsim 0.5$ Myr including the effects of turbulence, radiation transfer, and both radiation and outflow feedback from forming protostars. We show that outflows drive and maintain turbulence in the core environment even with strong initial fields. The star-formation efficiency decreases with increasing field strength, and the final efficiencies are 15–40%. The Stage 0 lifetime, during which the protostellar mass is less than the dense envelope, increases proportionally with the initial magnetic field strength and ranges from ~ 0.1 – 0.4 Myr. The average accretion rate is well-represented by a tapered turbulent core model, which is a function of the final protostellar mass and is independent of the magnetic field strength. By tagging material launched in the outflow, we demonstrate that the outflow entrains about 3 times the actual launched gas mass, a ratio that remains roughly constant in time regardless of the initial magnetic field strength. However, turbulent driving increases for stronger fields since momentum is more efficiently imparted to non-outflow material. The protostellar outflow momentum is highest during the first 0.1 Myr and declines thereafter by a factor of $\gtrsim 10$ as

the accretion rate diminishes.

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ALMA observations of the archetypal “hot core” that isn’t: Orion KL

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We present sensitive high angular resolution ($\sim 0.1'' - 0.3''$) continuum ALMA observations of the archetypal hot core located in Orion-KL. The observations were made in five different spectral bands (bands 3, 6, 7, 8, and 9) covering a very broad range of frequencies (149 – 658 GHz). Apart of the well-know millimeter emitting objects located in this region (Orion Source I and BN), we report the first submillimeter detection of three compact continuum sources (ALMA 1-3) in the vicinities of the Orion-KL hot molecular core. These three continuum objects have spectral indices between 1.47 to 1.56, and brightness temperatures between 100 to 200 K at 658 GHz suggesting that we are seeing moderate optically thick dust emission with possible grain growth. However, as these objects are not associated with warm molecular gas, and some of them are farther out from the molecular core, we thus conclude that they cannot heat the molecular core. This result favours the hypothesis that the hot molecular core in Orion-KL core is heated externally.

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Was Planet 9 captured in the Sun’s natal star-forming region?

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The presence of an unseen ‘Planet 9’ on the outskirts of the Solar system has been invoked to explain the unexpected clustering of the orbits of several Edgeworth–Kuiper Belt Objects. We use N -body simulations to investigate the probability that Planet 9 was a free-floating planet (FFLOP) that was captured by the Sun in its birth star-formation environment. We find that only 1 – 6 per cent of FFLOPs are ensnared by stars, even with the most optimal initial conditions for capture in star-forming regions (one FFLOP per star, and highly correlated stellar velocities to facilitate capture). Depending on the initial conditions of the star-forming regions, only 5 – 10 of 10 000 planets are captured onto orbits that lie within the constraints for Planet 9. When we apply an additional environmental constraint for Solar system formation – namely the injection of short-lived radioisotopes into the Sun’s protoplanetary disc from supernovae – we find that the probability for the capture of Planet 9 to be almost zero.

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Millimeter Spectral Indices and Dust Trapping By Planets in Brown Dwarf Disks

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Disks around brown dwarfs (BDs) are excellent laboratories to study the first steps of planet formation in cold and low-mass disk conditions. The radial-drift velocities of dust particles in BD disks are higher than in disks around more massive stars. Therefore, BD disks are expected to be more depleted in millimeter-sized grains compared to disks around T Tauri or Herbig Ae/Be stars. However, recent millimeter observations of BD disks revealed low millimeter spectral indices, indicating the presence of large grains in these disks and challenging models of dust evolution. We present 3 mm photometric observations carried out with the IRAM/Plateau de Bure Interferometer (PdBI) of three BD disks in the Taurus star forming region, which have been observed with ALMA at 0.89 mm. The disks were not resolved and only one was detected with enough confidence ($\sim 3.5\sigma$) with PdBI. Based on these observations, we obtain the values and lower limits of the spectral index and find low values ($\alpha_{\text{mm}} \lesssim 3.0$). We compare these observations in the context of particle trapping by an embedded planet, a promising mechanism to explain the observational signatures in more massive and warmer disks. We find, however, that this model cannot reproduce the current millimeter observations for BD disks, and multiple-strong pressure bumps globally distributed in the disk remain as a favorable scenario to explain observations. Alternative possibilities are that the gas masses in BD disk are very low ($\sim 2 \times 10^{-3} M_{\text{Jup}}$) such that the millimeter grains are decoupled and do not drift, or fast growth of fluffy aggregates.

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Medium resolution near-infrared spectroscopy of Massive Young Stellar Objects

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We present medium-resolution ($R \sim 7000$) near-infrared echelle spectroscopic data for 36 MYSOs drawn from the Red MSX Source (RMS) survey. This is the largest sample observed at this resolution at these wavelengths of MYSOs to date. The spectra are characterized mostly by emission from hydrogen recombination lines and accretion diagnostic lines. One MYSO shows photospheric H I absorption, a comparison with spectral standards indicates that the star is an A type star with a low surface gravity, implying that the MYSOs are probably swollen, as also suggested by evolutionary calculations. An investigation of the Br γ line profiles shows that most are in pure emission, while $13 \pm 5\%$ display P Cygni profiles, indicative of outflow, while less than $8 \pm 4\%$ have inverse P Cygni profiles, indicative of infall. These values are comparable with investigations into the optically bright Herbig Be stars, but not with those of Herbig Ae and T Tauri stars, consistent with the notion that the more massive stars undergo accretion in a different fashion than lower mass objects which are undergoing magnetospheric accretion. Accretion luminosities and rates as derived from the Br γ line luminosities agree with results for lower mass sources, providing tentative evidence for massive star formation theories based on scaling of low-mass scenarios. We present Br γ /Br12 line profile ratios exploiting the fact that optical depth effects can be traced as a function of Doppler shift across the lines. These show that the winds of MYSOs in this sample are nearly equally split between constant, accelerating, and decelerating velocity structures.

There are no trends between the types of features we see and bolometric luminosities or near-infrared colours.

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The ALMA Early Science View of FUor/EXor objects. IV. Misaligned Outflows in the Complex Star-forming Environment of V1647 Ori and McNeil’s Nebula

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We present Atacama Large Millimeter/sub-millimeter Array (ALMA) observations of the star-forming environment surrounding V1647 Ori, an outbursting FUor/EXor pre-MS star. Dust continuum and the ($J = 2-1$) ^{12}CO , ^{13}CO , C^{18}O molecular emission lines were observed to characterize the V1647 Ori circumstellar disc and any large scale molecular features present. We detect continuum emission from the circumstellar disc and determine a radius $r = 40$ au, inclination $i = 17^{\circ}_{-9}^{+6}$ and total disc mass of M_{disk} of $\sim 0.1 M_{\odot}$. We do not identify any disc structures associated with nearby companions, massive planets or fragmentation. The molecular cloud environment surrounding V1647 Ori is both structured and complex. We confirm the presence of an excavated cavity north of V1647 Ori and have identified dense material at the base of the optical reflection nebula (McNeil’s Nebula) that is actively shaping its surrounding environment. Two distinct outflows have been detected with dynamical ages of $\sim 11,700$ and $17,200$ years. These outflows are misaligned suggesting disc precession over ~ 5500 years as a result of anisotropic accretion events is responsible. The collimated outflows exhibit velocities of $\sim 2 \text{ km s}^{-1}$, similar in velocity to that of other FUor objects presented in this series but significantly slower than previous observations and model predictions. The V1647 Ori system is seemingly connected by an “arm” of material to a large unresolved structure located $\sim 20''$ to the west. The complex environment surrounding V1647 Ori suggests it is in the early stages of star formation which may relate to its classification as both an FUor and EXor type object.

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X-Shooter observations of low-mass stars in the η Chamaeleontis association

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The nearby η Chamaeleontis association is a collection of 4–10 Myr old stars with a disk fraction of 35–45%. In this study, the broad wavelength coverage of VLT/X-Shooter is used to measure the stellar and mass accretion properties of 15 low mass stars in the η Chamaeleontis association. For each star, the observed spectrum is fitted with a non-accreting stellar template and an accretion spectrum obtained from assuming a plane-parallel hydrogen slab. Five of the eight stars with an IR disk excess show excess UV emission, indicating ongoing accretion. The accretion rates measured here are similar to those obtained from previous measurements of excess UV emission, but tend to be higher than past measurements from $H\alpha$ modeling. The mass accretion rates are consistent with those of other young star forming regions.

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Star formation history of Canis Major OB1 - II. A bimodal X-ray population revealed by XMM-Newton

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The Canis Major OB1 Association has an intriguing scenario of star formation, especially in the region called Canis Major R1 (CMa R1) traditionally assigned to a reflection nebula, but in reality an ionized region. This work is focused on the young stellar population associated to CMa R1, for which our previous results from *ROSAT*, optical and near-infrared data had revealed two stellar groups with different ages, suggesting a possible mixing of populations originated from distinct star-formation episodes. The X-ray data allow the detected sources to be characterized according to hardness ratios, light curves and spectra. Estimates of mass and age were obtained from the *2MASS* catalogue, and used to define a complete subsample of stellar counterparts, for statistical purposes. A catalogue of 387 *XMM-Newton* sources is provided, 78% being confirmed as members or probable members of the CMa R1 association. Flares (or similar events) were observed for 13 sources, and the spectra of 21 bright sources could be fitted by a thermal plasma model. Mean values of fits parameters were used to estimate X-ray luminosities. We found a minimum value of $\log(L_X[\text{erg/s}]) = 29.43$, indicating that our sample of low-mass stars ($M_\star \leq 0.5M_\odot$), being faint X-ray emitters, is incomplete. Among the 250 objects selected as our complete subsample (defining our “best sample”), 171 are found to the East of the cloud, near Z CMa and dense molecular gas, 50% of them being young (< 5 Myr) and 30% being older (> 10 Myr). The opposite happens to the West, near GU CMa, in areas lacking molecular gas: among 79 objects, 30% are young and 50% are older. These findings confirm that a first episode of distributed star formation occurred in the whole studied region ~ 10 Myr ago and dispersed the molecular gas, while a second, localized episode (< 5 Myr) took place in the regions where molecular gas is still present.

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Very Large Array Ammonia Observations of the HH 111/HH 121 Protostellar System: a Detection of a New Source With a Peculiar Chemistry

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We present the results of Very Large Array NH_3 (J, K) = (1, 1) and (2, 2) observations of the HH 111/HH 121 protostellar system. HH 111, with a spectacular collimated optical jet, is one of the most well-known Herbig-Haro objects. We report the detection of a new source ($\text{NH}_3\text{-S}$) in the vicinity of HH 111/HH 121 (~ 0.03 pc from the HH 111 jet source) in two epochs of the ammonia observations. This constitutes the first detection of this source, in a region which has been thoroughly covered previously by both continuum and spectral line interferometric observations. We study the kinematic and physical properties of HH 111 and the newly discovered $\text{NH}_3\text{-S}$. We also use HCO^+ and HCN ($J = 4-3$) data obtained with the James Clerk Maxwell Telescope and archival Atacama Large Millimeter/submillimeter Array ^{13}CO , ^{12}CO , and C^{18}O ($J = 2-1$), N_2D^+ ($J = 3-2$), and ^{13}CS ($J = 5-4$) data to gain insight into the nature of $\text{NH}_3\text{-S}$. The chemical structure of $\text{NH}_3\text{-S}$ shows evidence for “selective freeze-out”, an inherent characteristic of dense cold cores. The inner part of $\text{NH}_3\text{-S}$ shows subsonic non-thermal velocity dispersions indicating a “coherent core”, while they increase in the direction of the jets. Archival near- to far-infrared data show no indication of any embedded source in $\text{NH}_3\text{-S}$. The properties of $\text{NH}_3\text{-S}$ and its location in the infrared dark cloud suggest that it is a starless core located in a turbulent medium with turbulence induced by Herbig-Haro jets and associated outflows. More data is needed to fully understand the physical and chemical properties of $\text{NH}_3\text{-S}$ and if/how its evolution is affected by nearby jets.

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Expelled grains from an unseen parent body around AU Mic

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Recent observations of the edge-on debris disk of AU Mic have revealed asymmetric, fast outward-moving arch-like structures above the disk midplane. Although asymmetries are frequent in debris disks, no model can readily explain the characteristics of these features. We present a model aiming to reproduce the dynamics of these structures, more specifically their high projected speeds and their apparent position. We test the hypothesis of dust emitted by a point source and then expelled from the system by the strong stellar wind of this young, M-type star. In this model, we make the assumption that the dust grains follow the same dynamics as the structures, i.e. they are not local density enhancements. We perform numerical simulations of test particle trajectories to explore the available parameter space, in particular the radial location R_0 of the dust producing parent body and the size of the dust grains as parameterized by the value of β (ratio of stellar wind and radiation pressure forces over gravitation). We consider both the case of a static and an orbiting parent body. We find that, for all considered scenarios (static or moving parent body), there is always a set of (R_0, β) parameters able to fit the observed features. The common characteristics of these solutions is that they all require a high value of β , of around 6. This means that the star is probably very active and the grains composing the structures are sub-micronic, in order for observable grains to reach such high β values. As for the location of the hypothetical parent body, we find it to be closer-in than the planetesimal belt, around 8 ± 2 au (orbiting case) or 28 ± 7 au (static case). A nearly periodic process of dust emission appears, of 2 years in the orbiting scenario, and 7 years in the static case. We show that the scenario of sequential dust releases by an unseen, point-source parent body is able to explain the radial behaviour of the observed structures. We predict the evolution of the structures to help future observations to discriminate between the different parent body configurations that have been considered. In the orbiting parent body scenario, we expect new structures to appear on the northwest side of the disk in the coming years.

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Formation of stellar clusters

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We investigate the triggering of star formation and the formation of stellar clusters in molecular clouds that form as the ISM passes through spiral shocks. The spiral shock compresses gas into ~ 100 pc long main star formation ridge, where clusters forming every 5-10 pc along the merger ridge. We use a gravitational potential based cluster finding algorithm, which extracts individual clusters, calculates their physical properties and traces cluster evolution over multiple time steps. Final cluster masses at the end of simulation range between 1000 and 30000 M_{\odot} with their characteristic half-mass radii between 0.1 pc and 2 pc. These clusters form by gathering material from 10-20 pc size scales. Clusters also show a mass - specific angular momentum relation, where more massive clusters have larger specific angular momentum due to the larger size scales, and hence angular momentum from which they gather their mass. The evolution shows that more massive clusters experiences hierarchical merging process, which increases stellar age spreads up to 2-3 Myr. Less massive clusters appear to grow by gathering nearby recently formed sinks, while more massive clusters with their large global gravitational potentials are increasing their mass growth from gas accretion.

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ALMA 1.3 Millimeter Map of the HD 95086 System

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Planets and minor bodies such as asteroids, Kuiper-belt objects and comets are integral components of a planetary system. Interactions among them leave clues about the formation process of a planetary system. The signature of such interactions is most prominent through observations of its debris disk at millimeter wavelengths where emission is dominated by the population of large grains that stay close to their parent bodies. Here we present ALMA 1.3 mm observations of HD 95086, a young early-type star that hosts a directly imaged giant planet b and a massive debris disk with both asteroid- and Kuiper-belt analogs. The location of the Kuiper-belt analog is resolved for the first time. The system can be depicted as a broad ($\Delta R/R_0.84$), inclined ($30^{\circ} \pm 3^{\circ}$) ring with millimeter emission peaked at 200 ± 6

au from the star. The 1.3 mm disk emission is consistent with a broad disk with sharp boundaries from 106 ± 6 to 320 ± 20 au with a surface density distribution described by a power law with an index of -0.5 ± 0.2 . Our deep ALMA map also reveals a bright source located near the edge of the ring, whose brightness at 1.3 mm and potential spectral energy distribution are consistent with it being a luminous star-forming galaxy at high redshift. We set constraints on the orbital properties of planet b assuming co-planarity with the observed disk.

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Observability of Forming Planets and their Circumplanetary Disks I. – Parameter Study for ALMA

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We present mock observations of forming planets with ALMA. The possible detections of circumplanetary disks (CPDs) were investigated around planets of Saturn, 1, 3, 5, and 10 Jupiter-masses that are placed at 5.2 AU from their star. The radiative, three dimensional hydrodynamic simulations were then post-processed with RADMC3D and the ALMA Observation Simulator. We found that even though the CPDs are too small to be resolved, they are hot due to the accreting planet in the optically thick limit, therefore the best chance to detect them with continuum observations in this case is at the shortest ALMA wavelengths, such as Band 9 (440 microns). Similar fluxes were found in the case of Saturn and Jupiter-mass planets, as for the 10 M_{Jup} gas-giant, due to temperature weighted optical depth effects: when no deep gap is carved, the planet region is blanketed by the optically thick circumstellar disk leading to a less efficient cooling there. A test was made for a 52 AU orbital separation, showed that optically thin CPDs are also detectable in band 7 but they need longer integration times (>5hrs). Comparing the gap profiles of the same simulation at various ALMA bands and the hydro simulation confirmed that they change significantly, first because the gap is wider at longer wavelengths due to decreasing optical depth; second, the beam convolution makes the gap shallower and at least 25% narrower. Therefore, caution has to be made when estimating planet masses based on ALMA continuum observations of gaps.

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ALMA discovery of a rotating SO/SO₂ flow in HH212. A possible MHD disk wind ?

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We wish to put tight constraints on the possible contribution of an MHD disk wind (DW) to the HH212 molecular jet. We use ALMA Cycle 4 to map the inner outflow at $0.13'' \sim 60$ au resolution, and compare with synthetic predictions for DW models. We identify in SO/SO₂ a rotating flow wider and slower than the axial SiO jet. The broad outflow cavity seen in C³⁴S is not carved by a fast wide-angle wind but by this slower agent. Rotation signatures may be fitted by a DW of moderate lever arm launched out to ~ 40 au, with SiO tracing dust-free streamlines from 0.05-0.3 au. If indeed a DW, it could limit the core-to-star efficiency to $\leq 50\%$.

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Kinetic temperature of massive star-forming molecular clumps measured with formaldehyde. III. The Orion molecular cloud 1

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We mapped the kinetic temperature structure of the Orion molecular cloud 1 (OMC-1) with para-H₂CO ($J_{K_a K_c} = 3_{03-2_{02}}, 3_{22-2_{21}}$, and $3_{21-2_{20}}$) using the APEX 12 m telescope. This is compared with the temperatures derived from the ratio of the NH₃ (2,2)/(1,1) inversion lines and the dust emission. Using the RADEX non-LTE model, we derive the gas kinetic temperature modeling the measured averaged line ratios of para-H₂CO $3_{22-2_{21}}/3_{03-2_{02}}$ and $3_{21-2_{20}}/3_{03-2_{02}}$. The gas kinetic temperatures derived from the para-H₂CO line ratios are warm, ranging from 30 to >200 K with an average of 62 ± 2 K at a spatial density of 10^5 cm^{-3} . These temperatures are higher than those obtained from NH₃ (2,2)/(1,1) and CH₃CCH (6-5) in the OMC-1 region. The gas kinetic temperatures derived from para-H₂CO agree with those obtained from warm dust components measured in the mid infrared (MIR), which indicates that the para-H₂CO (3-2) ratios trace dense and warm gas. The cold dust components measured in the far infrared (FIR) are consistent with those measured with NH₃ (2,2)/(1,1) and the CH₃CCH (6-5) line series. With dust at MIR wavelengths and para-H₂CO (3-2) on one side, and dust at FIR wavelengths, NH₃ (2,2)/(1,1), and CH₃CCH (6-5) on the other, dust and gas temperatures appear to be equivalent in the dense gas ($n(\text{H}_2) > 10^4 \text{ cm}^{-3}$) of the OMC-1 region, but provide a bimodal distribution, one more directly related to star formation than the other. The non-thermal velocity dispersions of para-H₂CO are positively correlated with the gas kinetic temperatures in regions of strong non-thermal motion (Mach number > 2.5) of the OMC-1, implying that the higher temperature traced by para-H₂CO is related to turbulence on a ~ 0.06 pc scale. Combining the temperature measurements with para-H₂CO and NH₃ (2,2)/(1,1) line ratios, we find direct evidence for the dense gas along the northern part of the OMC-1 10 km s^{-1} filament heated by radiation from the central Orion nebula.

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A Detached Protostellar Disk around a $\sim 0.2 M_{\odot}$ protostar in a Possible Site of a Multiple Star Formation in a Dynamical Environment in Taurus

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We report ALMA observations in 0.87 mm continuum and ^{12}CO ($J = 3-2$) toward a very low-luminosity ($<0.1 L_{\odot}$) protostar, which is deeply embedded in one of the densest core, MC27/L1521F, in Taurus with an indication of multiple star formation in a highly dynamical environment. The beam size corresponds to ~ 20 AU, and we have clearly detected blueshifted/redshifted gas in ^{12}CO associated with the protostar. The spatial/velocity distributions of the gas show there is a rotating disk with a size scale of ~ 10 AU, a disk mass of $\sim 10^{-4} M_{\odot}$ and a central stellar mass of $\sim 0.2 M_{\odot}$. The observed disk seems to be detached from the surrounding dense gas although it is still embedded at the center of the core whose density is $\sim 10^6 \text{ cm}^{-3}$. The current low outflow activity and the very-low luminosity indicate that the mass accretion rate onto the protostar is extremely low in spite of a very early stage of star formation. We may be witnessing the final stage of the formation of $\sim 0.2 M_{\odot}$ protostar. However, we cannot explain the observed low-luminosity with the standard pre-main-sequence evolutionary track, unless we assume cold accretion with an extremely small initial radius of the protostar ($\sim 0.65 R_{\odot}$). These facts may challenge our current understanding of the low-mass star formation, in particular, the mass accretion process onto the protostar and the circumstellar disk.

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The *Gaia*-ESO Survey and CSI 2264: Substructures, disks, and sequential star formation in the young open cluster NGC 2264

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Reconstructing the structure and history of young clusters is pivotal to understanding the mechanisms and timescales of early stellar evolution and planet formation. Recent studies suggest that star clusters often exhibit a hierarchical structure, possibly resulting from several star formation episodes occurring sequentially rather than a monolithic cloud

collapse. We aim to explore the structure of the open cluster and star-forming region NGC 2264 (~ 3 Myr), which is one of the youngest, richest and most accessible star clusters in the local spiral arm of our Galaxy; we link the spatial distribution of cluster members to other stellar properties such as age and evolutionary stage to probe the star formation history within the region. We combined spectroscopic data obtained as part of the *Gaia*-ESO Survey (GES) with multi-wavelength photometric data from the Coordinated Synoptic Investigation of NGC 2264 (CSI 2264) campaign. We examined a sample of 655 cluster members, with masses between 0.2 and 1.8 M_{\odot} and including both disk-bearing and disk-free young stars. We used T_{eff} estimates from GES and g, r, i photometry from CSI 2264 to derive individual extinction and stellar parameters. We find a significant age spread of 4–5 Myr among cluster members. Disk-bearing objects are statistically associated with younger isochronal ages than disk-free sources. The cluster has a hierarchical structure, with two main blocks along its latitudinal extension. The northern half develops around the O-type binary star S Mon; the southern half, close to the tip of the Cone Nebula, contains the most embedded regions of NGC 2264, populated mainly by objects with disks and ongoing accretion. The median ages of objects at different locations within the cluster, and the spatial distribution of disked and non-disked sources, suggest that star formation began in the north of the cluster, over 5 Myr ago, and was ignited in its southern region a few Myr later. Star formation is likely still ongoing in the most embedded regions of the cluster, while the outer regions host a widespread population of more evolved objects; these may be the result of an earlier star formation episode followed by outward migration on timescales of a few Myr. We find a detectable lag between the typical age of disk-bearing objects and that of accreting objects in the inner regions of NGC 2264: the first tend to be older than the second, but younger than disk-free sources at similar locations within the cluster. This supports earlier findings that the characteristic timescales of disk accretion are shorter than those of disk dispersal, and smaller than the average age of NGC 2264 (i.e., $\lesssim 3$ Myr). At the same time, we note that disks in the north of the cluster tend to be shorter-lived (~ 2.5 Myr) than elsewhere; this may reflect the impact of massive stars within the region (notably S Mon), that trigger rapid disk dispersal. Our results, consistent with earlier studies on NGC 2264 and other young clusters, support the idea of a star formation process that takes place sequentially over a prolonged span in a given region. A complete understanding of the dynamics of formation and evolution of star clusters requires accurate astrometric and kinematic characterization of its population; significant advance in this field is foreseen in the upcoming years thanks to the ongoing *Gaia* mission, coupled with extensive ground-based surveys like GES.

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ATLASGAL — properties of a complete sample of Galactic clumps

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ATLASGAL is an unbiased 870 μm submillimetre survey of the inner Galactic plane. It provides a large and systematic inventory of all massive, dense clumps in the Galaxy ($>1000 M_{\odot}$) and includes representative samples of all embedded stages of high-mass star formation. Here we present the first detailed census of the properties (velocities, distances, luminosities and masses) and spatial distribution of a complete sample of ~ 8000 dense clumps located in the Galactic

disk. We derive highly reliable velocities and distances to $\sim 97\%$ of the sample and use mid- and far-infrared survey data to develop an evolutionary classification scheme that we apply to the whole sample. Comparing the evolutionary subsamples reveals trends for increasing dust temperatures, luminosities and line-widths as a function of evolution indicating that the feedback from the embedded proto-clusters is having a significant impact on the structure and dynamics of their natal clumps. We find 88 per cent are already associated with star formation at some level. We also find the clump mass to be independent of evolution suggesting that the clumps form with the majority of their mass in-situ. We estimate the statistical lifetime of the quiescent stage to be $\sim 5 \times 10^4$ yr for clump masses $\sim 1000 M_\odot$ decreasing to $\sim 1 \times 10^4$ yr for clump masses $> 10000 M_\odot$. We find a strong correlation between the fraction of clumps associated with massive stars and peak column density. The fraction is initially small at low column densities but reaching 100 per cent for column densities above 10^{23} cm^{-2} ; there are no clumps with column density clumps above this value that are not already associated with massive star formation. All of the evidence is consistent with a dynamic view of star formation wherein the clumps form rapidly and are initially very unstable so that star formation quickly ensues.

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The formation of mini-Neptunes

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Mini-Neptunes seem to be common planets. In this work we investigate the possible formation histories and predicted occurrence rates of mini-Neptunes assuming the planets form beyond the iceline. We consider pebble and planetesimal accretion accounting for envelope enrichment and two different opacity conditions. We find that the formation of mini-Neptunes is a relatively frequent output when envelope enrichment by volatiles is included, and that there is a “sweet spot” for mini-Neptune formation with a relatively low solid accretion rate of $\sim 10^{-6}$ Earth masses per year. This rate is typical for low/intermediate-mass protoplanetary disks and/or disks with low metallicities. With pebble accretion, envelope enrichment and high opacity favor the formation of mini-Neptunes, with more efficient formation at large semi-major axes (~ 30 AU) and low disk viscosity. For planetesimal accretion, such planets can form also without enrichment, with the opacity being a key aspect in the growth history and favorable formation location. Finally, we show that the formation of Neptune-like planets remains a challenge for planet formation theories.

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CO emission tracing a warp or radial flow within $\lesssim 100$ au in the HD 100546 protoplanetary disk

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We present spatially resolved Atacama Large Millimeter/submillimeter Array (ALMA) images of ^{12}CO $J = 3 - 2$ emission from the protoplanetary disk around the Herbig Ae star, HD 100546. We expand upon earlier analyses of this data and model the spatially-resolved kinematic structure of the CO emission. Assuming a velocity profile which prescribes a flat or flared emitting surface in Keplerian rotation, we uncover significant residuals with a peak of $\approx 7\delta v$, where $\delta v = 0.21 \text{ km s}^{-1}$ is the width of a single spectral resolution element. The shape and extent of the residuals reveal the possible presence of a severely warped and twisted inner disk extending to at most 100 au. Adapting the model to include a misaligned inner gas disk with (i) an inclination almost edge-on to the line of sight, and (ii) a

position angle almost orthogonal to that of the outer disk reduces the residuals to $< 3\delta v$. However, these findings are contrasted by recent VLT/SPHERE, MagAO/GPI, and VLTI/PIONIER observations of HD 100546 that show no evidence of a severely misaligned inner *dust* disk down to spatial scales of ~ 1 au. An alternative explanation for the observed kinematics are fast radial flows mediated by (proto)planets. Inclusion of a radial velocity component at close to free-fall speeds and inwards of ≈ 50 au results in residuals of $\approx 4\delta v$. Hence, the model including a radial velocity component only does not reproduce the data as well as that including a twisted and misaligned inner gas disk. Molecular emission data at a higher spatial resolution (of order 10 au) are required to further constrain the kinematics within $\lesssim 100$ au. HD 100546 joins several other protoplanetary disks for which high spectral resolution molecular emission shows that the gas velocity structure cannot be described by a purely Keplerian velocity profile with a universal inclination and position angle. Regardless of the process, the most likely cause is the presence of an unseen planetary companion.

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Methanol formation in TW Hya and future prospects for detecting larger complex molecules in disks with ALMA

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Gas-phase methanol was recently detected in a protoplanetary disk for the first time with ALMA. The peak abundance and distribution of methanol observed in TW Hya differed from that predicted by chemical models. Here, the chemistry of methanol gas and ice is calculated using a physical model tailored for TW Hya with the aim to contrast the results with the recent detection in this source. New pathways for the formation of larger complex molecules (e.g., ethylene glycol) are included in an updated chemical model, as well as the fragmentation of methanol ice upon photodesorption. It is found that including fragmentation upon photodesorption improves the agreement between the peak abundance reached in the chemical models with that observed in TW Hya ($\sim 10^{11}$ with respect to H_2); however, the model predicts that the peak in emission resides a factor of 2-3 farther out in the disk than the ALMA images. Reasons for the persistent differences in the gas-phase methanol distribution between models and the observations of TW Hya are discussed. These include the location of the ice reservoir which may coincide with the compact mm-dust disk ($\lesssim 60$ au) and sources of gas-phase methanol which have not yet been considered in models. The possibility of detecting larger molecules with ALMA is also explored. Calculations of the rotational spectra of complex molecules other than methanol using a parametric model constrained by the TW Hya observations suggest that the detection of individual emission lines of complex molecules with ALMA remains challenging. However, the signal-to-noise ratio can be enhanced via stacking of multiple transitions which have similar upper energy levels.

Accepted by IAUS 332 Astrochemistry VII conference proceedings

<https://arxiv.org/pdf/1710.01219>

Two-Dimensional Molecular Gas and ongoing star formation around H II region Sh2-104

Jin-Long Xu¹, Ye Xu^{2,3}, Naiping Yu¹, Chuan-peng Zhang¹, Xiao-Lan Liu¹, Jun-Jie Wang¹, Chang-chun Ning⁴, Bing-Gang Ju³ and Guo-Yin Zhang¹

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We performed a multiwavelength study towards HII region Sh2-104. New maps of $^{12}\text{CO } J=1-0$ and $^{13}\text{CO } J=1-0$ were obtained from the Purple Mountain Observatory (PMO) 13.7 m radio telescope. Sh2-104 displays a double-ring

structure. The outer ring with a radius of 4.4 pc is dominated by $12\ \mu\text{m}$, $500\ \mu\text{m}$, $^{12}\text{CO } J=1-0$, and $^{13}\text{CO } J=1-0$ emission, while the inner ring with a radius of 2.9 pc is dominated by $22\ \mu\text{m}$ and 21 cm emission. We did not detect CO emission inside the outer ring. The north-east portion of the outer ring is blueshifted, while the south-west portion is redshifted. The present observations have provided evidence that the collected outer ring around Sh2-104 is a two-dimensional structure. From the column density map constructed by the Hi-GAL survey data, we extract 21 clumps. About 90% of all the clumps will form low-mass stars. A power-law fit to the clumps yields $M = 281 M_{\odot}(r/\text{pc})^{1.31}$. The selected YSOs are associated with the collected material on the edge of Sh2-104. The derived dynamical age of Sh2-104 is 1.6×10^6 yr. Compared the Sh2-104 dynamical age with the YSOs timescale and the fragmentation time of the molecular ring, we further confirm that collect-and-collapse process operates in this region, indicating a positive feedback from a massive star for surrounding gas.

Accepted by ApJ

<http://arxiv.org/pdf/1709.08779>

Pebble Accretion in Turbulent Protoplanetary Disks

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It has been realized in recent years that the accretion of pebble-sized dust particles onto planetary cores is an important mode of core growth, which enables the formation of giant planets at large distances and assists planet formation in general. The pebble accretion theory is built upon the orbit theory of dust particles in a laminar protoplanetary disk (PPD). For sufficiently large core mass (in the ‘‘Hill regime’’), essentially all particles of appropriate sizes entering the Hill sphere can be captured. However, the outer regions of PPDs are expected to be weakly turbulent due to the magnetorotational instability (MRI), where turbulent stirring of particle orbits may affect the efficiency of pebble accretion. We conduct shearing-box simulations of pebble accretion with different levels of MRI turbulence (strongly turbulent assuming ideal magnetohydrodynamics, weakly turbulent in the presence of ambipolar diffusion, and laminar) and different core masses to test the efficiency of pebble accretion at a microphysical level. We find that accretion remains efficient for marginally coupled particles (dimensionless stopping time $\tau_s \sim 0.1-1$) even in the presence of strong MRI turbulence. Though more dust particles are brought toward the core by the turbulence, this effect is largely canceled by a reduction in accretion probability. As a result, the overall effect of turbulence on the accretion rate is mainly reflected in the changes in the thickness of the dust layer. On the other hand, we find that the efficiency of pebble accretion for strongly coupled particles (down to $\tau_s \sim 0.01$) can be modestly reduced by strong turbulence for low-mass cores.

Accepted by ApJ

<http://arxiv.org/pdf/1709.03530>

The JCMT Transient Survey: Detection of sub-mm variability in a Class I protostar EC 53 in Serpens Main

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During the protostellar phase of stellar evolution, accretion onto the star is expected to be variable, but this suspected variability has been difficult to detect because protostars are deeply embedded. In this paper, we describe a sub-mm luminosity burst of the Class I protostar EC 53 in Serpens Main, the first variable found during our dedicated JCMT/SCUBA-2 monitoring program of eight nearby star-forming regions. EC 53 remained quiescent for the first 6 months of our survey, from February to August 2016. The sub-mm emission began to brighten in September 2016, reached a peak brightness of 1.5 times the faint state, and has been decaying slowly since February 2017. The change in sub-mm brightness is interpreted as dust heating in the envelope, generated by a luminosity increase of the protostar of a factor of ≥ 4 . The 850 μm lightcurve resembles the historical *K*-band lightcurve, which varies by a factor of ~ 6 with a 543 period and is interpreted as accretion variability excited by interactions between the accretion disk and a close binary system. The predictable detections of accretion variability observed at both near-infrared and sub-mm wavelengths make the system a unique test-bed, enabling us to capture the moment of the accretion burst and to study the consequences of the outburst on the protostellar disk and envelope.

Accepted by ApJ

<https://arxiv.org/pdf/1709.04096>

Detection of a new methanol maser line with ALMA

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Aims. We investigated the structure and kinematics of the gaseous disk and outflows around the massive YSO S255 NIRS3 in the S255IR-SMA1 dense clump.

Methods. Observations of the S255IR region were carried out with ALMA at two epochs in the compact and extended configurations.

Results. We serendipitously detected a new, never predicted, bright maser line at about 349.1 GHz, which most probably represents the $\text{CH}_3\text{OH } 14_1 - 14_0 \text{ A}^{-+}$ transition. The emission covers most of the 6.7 GHz methanol maser emission area of almost $1''$ and shows a velocity gradient in the same sense as the disk rotation. No variability was found in the time interval of several months. The emission is classified as Class II maser and probably originates in a ring at a distance of several hundred AU from the central star.

Accepted by Astronomy & Astrophysics

<https://arxiv.org/pdf/1709.08889>

Dissertation Abstracts

On the Evolutionary Pathways of Stars and Extrasolar Planets

Trevor David



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Ph.D dissertation directed by: Lynne Hillenbrand

Ph.D degree awarded: August 2017

In this thesis, I present several studies aimed at determining the evolutionary states of stars and the planets that orbit them. Multiple approaches are undertaken to determine the physical parameters of stars over a wide range of masses, and in the process I evaluate current theoretical models which are commonly used to indirectly determine the properties of stars and planets.

Chapter II concerns the ages of nearby stars more massive than the Sun. These stars, because they are bright and young (less than 1 Gyr) on the average, constitute attractive targets for surveys aiming to directly capture light from planets in wide orbits. The precise masses of directly imaged companions are important for constraining star and planet formation theories, but rely critically on the host star ages. I show that sky-projected rotational velocity is a vital parameter in age-determination for intermediate-mass stars. Rapid rotation induces large pole-to-equator gradients in the photospheric temperature and surface gravity, such that a star seen pole-on appears hotter and higher gravity (and thus younger) than a star with identical properties seen edge-on. I use intermediate-band photometry centered on the hydrogen Balmer series and projected rotational velocities to determine atmospheric parameters and ages for approximately 3500 nearby stars with masses in the range of 1-10 solar masses. I validate the method using four open clusters, in the process finding ages for α Persei and the Hyades that are younger at ~ 70 Myr and older at ~ 830 Myr, respectively, than canonical values.

In Chapters III through V, I present orbital solutions and fundamental parameters for eclipsing binaries (EBs), newly discovered from the K2 mission, in the Pleiades open cluster (125 Myr) and the Upper Scorpius OB association (5-10 Myr). EBs, particularly those in coeval stellar populations, are valuable benchmarks for evaluating evolutionary models. Such benchmarks are particularly rare at low masses and young ages, and my work has increased the sample by 80% for stars less massive than the Sun and younger than 150 Myr. By jointly fitting eclipse observations and radial velocity measurements, one can directly determine the masses and radii of stars in an EB with percent-level precision. I use newly determined masses and radii to demonstrate a systematic temperature offset of approximately 200 K between empirical relations and model predictions. This result is in agreement with literature on the temperature

suppression observed in low-mass stars, believed to be related to magnetic activity and inhibited convection. I show that stellar ages determined from the mass-radius diagram appear systematically older than those determined for the same stars in a Hertzsprung-Russell (H-R) diagram. A precise distance determination for the Pleiades EB HCG 76 is in agreement with the literature consensus and formally excludes the now discredited trigonometric measurement from Hipparcos. The orbital periods, eccentricities, and stellar spin periods determined from K2 photometry are compared with theoretical expectations from tidal dissipation. In Chapter VI, I present preliminary results on more recently discovered EBs in Upper Scorpius, and updated interpretations of previously published systems. I use the combined data to pave the way for an empirical pre-main-sequence mass-radius relation over a broad range of masses and determine an age of Upper Scorpius which is intermediate to the canonical age (3-5 Myr, as derived from low-mass pre-main-sequence stars) and a more recent estimate (9-13 Myr, as derived from intermediate-mass stars) from H-R diagram analyses.

In Chapter VII, I present observations of the low-mass pre-main-sequence star RIK-210. This star shows a variable eclipse-like signature, which persisted through 78 days of K2 photometry but was apparently absent in archival photometry. Follow-up observations demonstrate that RIK-210 is a single star with no massive companion orbiting at the period of the eclipse-like signature. The flux diminutions are in phase with the stellar rotation, behavior seen in some young stars that are periodically obscured by an accretion disk, but RIK-210 lacks such a protoplanetary disk. I consider various explanations for the observations and favor a model in which charged dust is trapped in a rigidly-rotating magnetosphere. The source of such dust could be from one or more close-in planets or residual planet-forming material drifting in towards the star.

In Chapter VIII I present the discovery and characterization of K2-33 b, a Neptune-sized planet closely orbiting a low-mass star in Upper Scorpius and one of the youngest exoplanets currently known. K2-33 b provides evidence that planets with substantial gaseous envelopes can be found close to their stars shortly after dispersal of the primordial protoplanetary disk. Given the planet's age (5-10 Myr), in situ formation or migration through the protoplanetary disk are the only plausible formation scenarios. K2-33 b is unusually large in size when compared to planets with similar orbital periods around low-mass field stars. I interpret this as tentative evidence that the planet is still contracting, experiencing photoevaporative atmospheric mass-loss, or both. In Chapter IX I present preliminary results from a study aimed at determining the prevalence of close-in planets at the epoch of primordial disk dispersal. Using K2 photometry for hundreds of pre-main-sequence stars in Upper Scorpius I search for transiting planets, assess survey completeness, and determine the occurrence rates or upper limits to such rates for large planets in close orbits around low-mass stars. With the singular detection of K2-33 b, I determine a rate of close-in Neptune- to Jupiter-sized planets higher than that for low-mass field stars but in closer agreement with the rate for sub-Neptune planets. Given the extreme youth of K2-33 b, I tentatively interpret these results as an indication that the planet is a progenitor of the abundant class of close-in sub-Neptunes.

Considered collectively, my results highlight the importance of benchmark systems. Nearly all branches of astrophysics are reliant in some regard on stellar evolutionary models, but the magnitude and sense of any particular systematic offset contained in these models is often poorly understood. Eclipsing binaries and planets located in stellar clusters provide firm anchors to theoretical models aiming to predict the evolution of such objects. The need for benchmarks and model calibration is particularly acute at young ages, when stars and planets are rapidly evolving and where theoretical evolutionary models are highly uncertain. While statistical studies of large populations can yield far-reaching results that move fields forward, it is the detailed characterization of individual systems that often reveal salient clues about the inaccuracies of assumptions underlying larger scale studies. Benchmark systems, whether they are clusters, eclipsing binaries, or well-characterized planets, offer the best path forward in refining our understanding of the evolution of stars and planets.

<http://thesis.library.caltech.edu/10435/>

New Jobs

Postdoctoral Research Position in Young Stars @Caltech

Applications are solicited for appointment as a Postdoctoral Scholar in Astronomy/Astrophysics at Caltech, collaborating with Lynne Hillenbrand. The successful candidate will be knowledgeable regarding the stellar populations in nearby molecular clouds and young star clusters, and expected to work on populating a young stellar objects database from both published literature and primary catalogs. The ability to further develop features within the python-based relational database (which runs within a PostgreSQL + Django + HTML framework) is also expected. In addition to the primary project, the postdoc will have the opportunity to pursue collaborative and/or independent research on topics related to circumstellar disks and pre-main sequence stellar evolution. Caltech's observational facilities include the W.M. Keck Observatory (WMKO) and the Palomar Observatory.

The application package should include a CV, a publication list, a *brief* summary of research interests and experience, contact information for at least three individuals familiar with the applicant's record, and an indication of the earliest possible start date. This position is available **immediately** for an initial two-year appointment; renewal for a third year is possible. Salary will be commensurate with experience, and competitive with other similar positions.

Please send inquiries and materials to Lynne Hillenbrand (lah@astro.caltech.edu). Consideration of applications will begin around 15 October but the position will remain open until filled.

Caltech is an equal opportunity employer and all qualified applicants will receive consideration for employment – without regard to any personal characteristic.

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.

Meetings

FIRST ANNOUNCEMENT

The Wonders of Star Formation **A tribute to Hans Zinnecker**

3 - 7 September 2018 Edinburgh, Scotland

RATIONALE:

This meeting will celebrate the many and varied contributions that Hans Zinnecker has made to the study of star formation during his long and active career, and the inspiration that working with Hans has given countless astronomers both young and old. Understanding how stars form continues to be one of the most compelling problems in astrophysics, and a new generation of instruments is set to maintain the excitement of this field into the foreseeable future. We will explore the key observations, theories, their contradictions and limitations and the steps being taken to overcome them, in the beautiful city of Edinburgh, where Hans was a postdoc 35 years ago. The aim will be to chart the progress that has been made since then, to identify the problems that still need to be addressed, and how best to go about solving them. We hope you will join us and help make this a memorable meeting.

VENUE:

The conference will be held at the John McIntyre Conference Centre, which is located on Edinburgh University's Pollock Halls campus.

ACCOMMODATION:

Accommodation is available in the John McIntyre Conference Centre. There are also many hotels, guest-houses and AirBnBs in the city, but participants are advised to book early, since Edinburgh is a popular tourist destination, particularly at this time of year.

SCIENTIFIC ORGANIZING COMMITTEE:

John Bally, Cathie Clarke, Mark McCaughrean, Bo Reipurth, Ken Rice, Dimitris Stamatellos, Stefanie Walch, Anthony Whitworth (chair), Harold Yorke.

REGISTRATION:

Early registration (before April 30, 2018): £290
Late registration (April 30 to July 31, 2018): £310
Abstract submission: Up to June 15, 2018 (decisions by July 6)

WEBSITE:

<http://events.ph.ed.ac.uk/star-formation>

Cosmic Rays: the salt of the star formation recipe

2-4 May 2018

Department of Physics and Astronomy, University of Florence, Arcetri – Italy

Cosmic rays are a key ingredient in many fields of Astrophysics and in particular in star formation, but despite their great relevance our understanding is still relatively incomplete. Thanks to the data delivered by the new generation of radio and (sub)millimeter telescopes, we have now the opportunity of attaining a comprehensive knowledge about the **role of cosmic rays in the physics and chemistry of the interstellar medium**, hence about the processes leading to star and planet formation. Observations are needed to constrain the multiple aspects of the proposed theoretical models and models are required to properly interpret observations. Despite the importance of cosmic rays in star formation, the interplay between observers, chemical modellers, and theoreticians is still missing. Therefore, the proposed workshop has the goal of bringing together experts in theory and simulations of cosmic-ray propagation, astrochemists, and observers to share ideas, discuss about recent and present results, and identify the key challenges regarding the chemistry and the physics of cosmic rays for the near future.

The discussion arising from this workshop will settle the ground for a more efficient exploitation of the current facilities (Radionet facilities as NOEMA, IRAM 30m, APEX, Effelsberg, LOFAR, VLBI; and other such as ALMA and VLA). We stress that **we expect not only participants who already work on cosmic rays, but also experts on different aspects of star formation with the aim of make everyone aware about the relevance of cosmic rays in their respective research.**

Specific science topics

- Role of cosmic rays in star and planet formation
- Cosmic-ray fingerprints in different environments
- Impact of cosmic rays on the formation of interstellar molecules: observations, models, and laboratory experiments
- Cosmic-ray factories: local acceleration in protostellar shocks
- Cosmic rays and the origin of Life: ISM, comets, planets, and early Earth

Invited speakers already confirmed

Elena Amato (INAF-OAA), Anabella Araudo (Astronomical Institute of Prague), Paola Caselli (MPE), Jan Forbrich (U. Hertfordshire), Stefano Gabici (APC), Daniele Galli (INAF-OAA), Philipp Girichidis (Leibniz-Institut), Guillaume Gronoff (NASA), Izaskun Jiménez-Serra (QMUL), Alexandre Marcowith (LUPM), Jesús Martín-Pintado (INTA-CSIC), Guillermo Muñoz-Caro (INTA-CSIC), David Neufeld (JHU), Elisabetta Palumbo (INAF-OACT)

Scientific Organizing Committee

Marco Padovani (INAF-OAA, co-chair), Víctor M. Rivilla (INAF-OAA, co-chair), Patrick Hennebelle (CEA/IRFU/SAP), Ana López-Sepulcre (IRAM/IPAG), Leonardo Testi (ESO/INAF-OAA), Serena Viti (UCL)

More detailed information and registration instructions are published on the conference website:

<https://www.arcetri.astro.it/cosmicrays/>

We invite you to register for this conference and we look forward to your contributions.

Marco Padovani and Víctor M. Rivilla on behalf of the SOC and the LOC.

FIRST ANNOUNCEMENT

Interstellar: The Matter

14-18 May 2018, Cozumel, Mexico

CONTACT:

ism2018@correo.nucleares.unam.mx

<http://bigbang.nucleares.unam.mx/astroplasmas/interstellar-the-matter/>

IMPORTANT DATES:

First announcement: September 29th, 2017

Second announcement: December 4th, 2017

Third announcement: February 4th, 2017

Abstract submission dead line: March 4th, 2018

Final program list and final announcement: Abril 4th, 2018

Conference: May 14-18, 2018

ABOUT THE CONFERENCE:

The matter between stars has a rich and complex structure across a vast range of scales. The physical properties of this interstellar medium (ISM) are controlled by the interplay of several mechanisms, such as turbulence, magnetic fields, and the feedback from stars and protostars. The ISM is constantly providing the material and conditions to form new stars, and at the same time is affected and enriched by those that already exist. In the past decades there have been great advances in the understanding of the ISM, from observations, theory and simulations. The aim of this conference is to bring together experts in a broad range of areas of research, to summarize the recent progress and to prepare for the new challenges that the new generation of observatories will bring.

TOPICS TO BE COVERED:

The main topics that will be covered are:

ISM dynamics and chemistry

Winds and outflows

Star formation and magnetic fields

Turbulence

ORGANIZERS:

Scientific Organizing Committee (SOC):

Fred Adams (University of Michigan, USA); Guillem Anglada (Instituto de Astrofísica de Andalucía, Spain); Jorge Cantó (IA, UNAM, Mexico); Salvador Curiel (IA, UNAM, Mexico); Alejandro Esquivel, Co-Chair (ICN, UNAM, Mexico); Elisabete M. de Gouveia Dal Pino (Universidade de Sao Paulo, Brazil); Susana Lizano (IRyA, UNAM, Mexico); Alberto Noriega-Crespo (Space Telescope Science Institute, USA); Alejandro Raga (ICN, UNAM, Mexico); Luis Felipe Rodríguez (IRyA, UNAM, Mexico); Ary Rodríguez-González, Co-chair (ICN, UNAM, Mexico); Jose Maria Torrelles (Institut de Ciències de l'Espai, Spain); David Williams (University College London, UK); Luis Zapata Co-Chair (IRyA, UNAM, Mexico)

Local Organizing Committee (LOC):

Ary Rodríguez-González, Co-Chair (ICN, UNAM, Mexico); Alejandro Esquivel, Co-chair (ICN, UNAM, Mexico); Luis Zapata, Co-chair (IRyA, UNAM, Mexico); Salvador Curiel (IA, UNAM, Mexico); Liliانا Hernández-Martínez (ICN, UNAM, Mexico); Juan C. Toledo-Roy (ICN, UNAM, Mexico); Pablo Velázquez (ICN, UNAM, Mexico)

ALMA North America-Taiwan Joint Conference
**Magnetic Fields or Turbulence: Which is the critical factor for the
formation of stars and planetary disks?**
6-9 February 2018, National Tsing-Hua University, Taiwan

The unprecedented high sensitivity of ALMA provides the best opportunity so far to resolve one of the most debated questions in star formation: whether magnetic fields or turbulence play a critical role? Since ALMA has been producing magnetic field measurements for a few years, a conference in Taiwan will promote discussion on this important question. A group of established as well as young and upcoming researchers will present reviews, new results from ALMA, and important complementary observations from other telescopes, including SMA, BLAST-pol, HAWC+ on SOFIA, etc.

While the focus of this conference is on magnetic fields and turbulence, astronomers are welcome to present related work on star formation studies. Participants with divergent background will be sought for discussion of the conference topic.

Confirmed invited speakers:

Shantanu Basu - Blakesley Burkhart - Dick Crutcher - Edith Falgarone - Laura Fissel - Chat Hall - Hua-Bai Li - Zhi-Yun Li - Hanyu Baobab Liu - Susana Lizano - Anaelle Maury - Thushara Pillai - Qizhou Zhang

<http://events.asiaa.sinica.edu.tw/workshop/20180206/>

Science with the Atacama Pathfinder Experiment (APEX2018)
March 11-14, 2018, Schloss Ringberg, Tegernsee, Germany

Now more than 12 years in operation, the Atacama Pathfinder Experiment (APEX) 12 m submillimeter telescope has significantly contributed to a wide variety of submillimeter astronomy science areas, ranging from the discoveries of new molecules to large and deep imaging of the submillimeter sky.

Since 2012, the Ringberg APEX workshops bring together APEX users working on a wide range of exciting results covering the Solar System to distant galaxies in the early Universe. APEX2018 aims at presenting new science results and to looking into new science opportunities for the next years.

Earlier this year, the partners signed another extension of APEX operations to 2022. This extension comes with upgrades of the antenna itself as well as the commissioning of new instruments, including new large cameras for wide-field continuum imaging and new heterodyne instruments highly complementary to ALMA.

While ALMA operation is in full swing, APEX is strengthening its role not only as pathfinder for studying large source samples and spatial scales to prepare detailed high angular resolution ALMA follow ups, but also as fast response instruments to complement new results from ALMA. Furthermore, APEX ensures southern hemisphere access for submillimeter projects complementing archival Herschel research as well as new SOFIA science.

The conference venue Ringberg Castle provides a unique setting for in depth discussions on current and future science with APEX. In particular, sessions on new scientific results, on synergies with other observatories and on the exploitation of the upcoming new APEX capabilities are envisioned.

The castle can accommodate about 60-70 participants. Updates on the registration and submission of abstracts will be given on the workshop website:

<https://events.mpifr-bonn.mpg.de/indico/event/58/>

SPF2: Star and Planet Formation in the Southwest

March 12-16, 2018, Biosphere 2 Center, Oracle, AZ, USA

SUMMARY:

The Southwestern US is rich with astronomers working in the fields of star and planet formation. This conference will feature pedagogical reviews, invited topical talks, and numerous contributed talks by junior scientists. A primary goal of this meeting is to highlight the contributions of post-doc and graduate student attendees. Attendees from any geographic region are welcome. This meeting will foster extended, unstructured discussion and interaction between the senior review speakers and other attendees. The meeting will be held at the Biosphere 2 Center, in Oracle, AZ, just North of Tucson. This unique venue includes both meeting rooms and on-site lodging, making this an intimate setting for informal science discussions. This meeting will have a special emphasis on disks, along with breakout sessions on ALMA, JWST, GMT, and Computing Methods.

REGISTRATION:

Conference registration will open in late September, hosted through NRAO at: <http://tinyurl.com/spf2018>. Registration is limited to 100. Please note that registration and abstract submission are separate processes. Your spot is not guaranteed until you have registered and paid. Registration for graduate students has been heavily subsidized to encourage attendance. Early bird pricing goes until Nov. 1st. Registration ends on February 1st.

CONTRIBUTED TALKS AND POSTERS:

We have reserved ample time in the schedule for short contributed talks. Post-doc and graduate student attendees will be given preference. There will also be a poster hall located near the dining area. The abstract submission deadline is Dec. 15th.

LODGING AND LOCATION:

All participants will stay on location at the biosphere. The housing consists of private or shared rooms with separate bathrooms in shared houses with living areas and kitchens. Most meals will be provided onsite and are covered by the registration fee, but attendees must cover their own housing. Rooms are \$79 a night and can be paid upon arrival via credit card. We will facilitate room sharing arrangements.

TRAVEL:

Oracle, AZ is a little over an hour away from the Tucson International Airport. We can help you book shared transportation from the airport. Participants may also fly into Phoenix International Airport, which is about two hours drive. Because of the travel time, we recommend against booking very early morning departures.

SOC:

Phil Armitage (CU Boulder), Andrea Isella (Rice), Kaitlin Kratter (Co-Chair, UA), Adam Kraus (UT Austin), Hui Li (LANL), Rebecca Martin (UNLV), Joan Najita (NOAO), Stella Offner (UT Austin), Paola Pinilla (Co-Chair, UA), Lisa Prato (Lowell), Evgenya Shkolnik (ASU), Andrew Youdin (UA).

Invited Speakers:

Matthew Bate (Exeter), Myriam Benisty (U. Chile / Grenoble), John Carpenter (JAO / NRAO), Eugene Chiang (Berkeley), Ilse Cleeves (CfA), Cornelis Dullemond (ITA Heidelberg), Scott Gaudi (OSU), Meredith Hughes (Wesleyan), Helen Kirk (NRC), Brenda Matthews (NRC), Ilaria Pascucci (UA), John Tobin (Oklahoma), Alycia Weinberger (Carnegie), Jonathan Williams (Hawaii), Zhaohuan Zhu (UNLV).

SPONSORS:

This meeting is made possible by generous contributions from: Steward Observatory, NRAO, CSES/ LANL, Lowell Observatory, Rice University, and ASU.

Please direct all questions to: spfconf@as.arizona.edu

Web: <http://tinyurl.com/spf2018>

We look forward to welcoming you to Tucson!

Kaitlin Kratter & Paola Pinilla (Co-chairs) on behalf of the SOC.

Take a Closer Look: The innermost region of protoplanetary discs and its connection to the origin of planets

October 15-19, 2018
ESO-HQ, Garching b. München, Germany

Recent discoveries of close-in planets around main sequence and even pre-main sequence stars raise a number of questions about the formation of planetary systems. Their formation and migration history must be directly linked to the conditions within the inner regions of their progenitor protoplanetary discs. These sites also play a key role in star-disc interactions. Studies probing this important region require the use of innovative techniques and a wide range of instruments. This workshop will address a number of topics related to the inner disc, including the morphology and composition of the innermost disc regions, star-disc interaction, and theories that describe the evolution of the innermost disc regions and the formation of close-in planets.

Specifically, the workshop will cover the following themes:

- Observations of the innermost regions of disks ($< 0.1 - 1$ au, with near-IR interferometry, adaptive optics, spectroscopic techniques, space-based diffraction limited telescopes such as HST and JWST in the future)
- Modeling of the inner disk (structure of the inner gas disk, disk walls, effects of magnetic fields)
- Observations and theoretical predictions of processes happening at the inner disk-star interface (e.g., magnetic fields, accretion, jets)
- Observations of exo-planets close to the central star (hot Jupiters, transits . . .)
- Theoretical predictions to explain the origin of planets detected close to the stars

Confirmed speakers: Andrea Banzatti (Arizona), Christine Chen (STScI), Mario Flock (Caltech), Kevin France (Boulder), Rebeca García López (DIAS Dublin), Scott Gregory (St. Andrews), Raphaëlle Haywood (CfA), Stefan Kraus (Exeter), Alexis Matter (OCA Nice), Melissa McClure (ESO/UvA), Chris Ormel (University of Amsterdam, UvA), Suzanne Ramsay (ESO), Giovanni Rosotti (IoA Cambridge), Somayeh Sheikhezami (IPM Tehran), Laura Venuti (INAF-Palermo)

SOC: G. Hussain (ESO, chair), M. Benisty, (Grenoble), T. Birnstiel (LMU), J. Bouvier (Grenoble), N. Calvet (Michigan), F. Ciesla (Chicago), B. Ercolano (LMU), B. Lopez (Nice), A. Natta (DIAS), C.F. Manara (ESO, organizer), P.C. Schneider (Hamburg, organizer)

Conference email: tcl2018@eso.org

For further information, please see the conference website at:
<https://www.eso.org/sci/meetings/2018/tcl2018.html>

Summary of Upcoming Meetings

The Initial Mass Function: From Top to Bottom

10 November 2017, London, UK

<https://rasimf2017.wordpress.com>

Exoplanets and Planet Formation

11 - 15 December 2017, Shang Hai, China

<https://indico.leeinst.sjtu.edu.cn/event/25/>

Star Formation and Young Stars in Cygnus

31 Jan - 2 Feb 2018, Keele, UK

<http://www.astro.keele.ac.uk/cygnus>

Magnetic Fields or Turbulence: Which is the critical factor for the formation of stars and planetary disks?

6 - 9 February 2018, Hsinchu, Taiwan

<http://events.asiaa.sinica.edu.tw/workshop/20180206/index.php>

Water during planet formation and evolution 2018

12-16 February 2016, Zürich, Switzerland

<https://waterzurich.github.io/>

Star and Planet Formation in the Southwest 2 (SPF2)

12 - 16 March 2018, Oracle, Arizona, USA

<http://tinyurl.com/spf2018>

Cosmic Rays: the salt of the star formation recipe

2 - 4 May 2018, Florence, Italy

<http://www.arcetri.astro.it/cosmicrays>

EPoS 2018 The Early Phase of Star Formation - Archetypes

13 - 18 May 2018, Ringberg Castle, Tegernsee, Germany

<http://www.mpia.de/homes/stein/EPoS/epos.php>

Interstellar: The Matter

14 - 18 May 2018, Cozumel, Mexico

<http://bigbang.nucleares.unam.mx/astroplasmas/interstellar-the-matter>

The Olympian Symposium 2018: Gas and stars from milli- to mega- parsecs

28 May - 1 June 2018, Mt. Olympus, Greece

<http://www.olympiansymposium.org>

Astrochemistry: Past, Present, and Future

10 - 13 July, 2018, Pasadena, USA

<http://www.cfa.harvard.edu/events/2018/astrochem18>

Cool Stars 20: Cambridge Workshop on Cool Stars, Stellar Systems and the Sun

29 July - 3 August 2018, Cambridge/Boston, USA

<http://www.coolstars20.com>

The Wonders of Star Formation

3 - 7 September 2018, Edinburgh, Scotland

<http://events.ph.ed.ac.uk/star-formation>