THE STAR FORMATION NEWSLETTER

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

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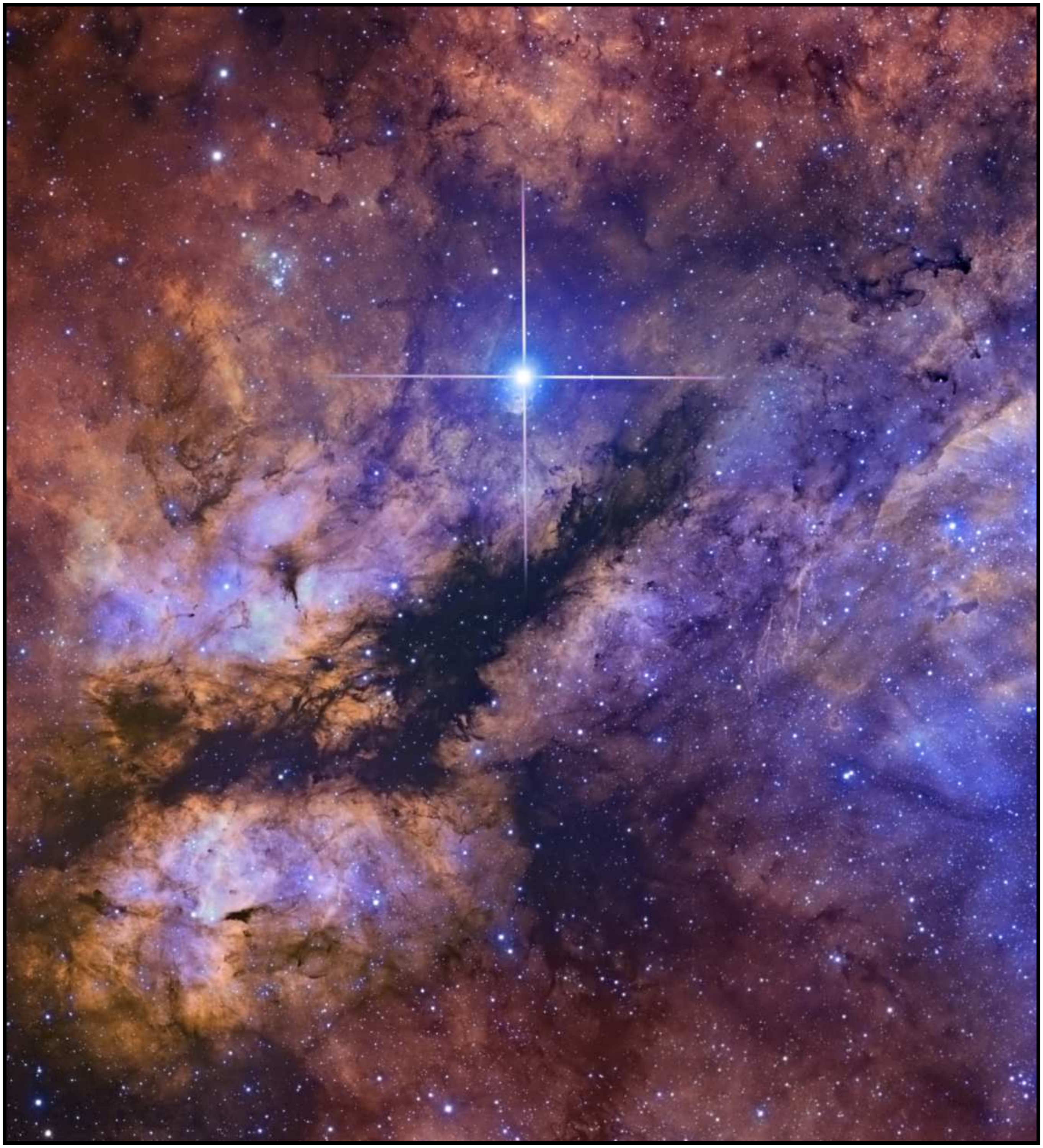

The Star Formation Newsletter

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

Newsletter Archive

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Cover Picture

IC 1318 is an HII region in Cygnus divided into three parts, A, B, and C. The figure shows the two parts B and C, bifurcated by the dark cloud L889. The distance to IC 1318 is uncertain, but is assumed to be about 1.5 kpc. The bright star in the foreground is γ Cygni.

Image courtesy of Steve Mazlin
http://www.fourthdimensionastroimaging.com

Submitting your abstracts

Latex macros for submitting abstracts and dissertation abstracts (by e-mail to reipurth@ifa.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 Black

in conversation with Bo Reipurth

Q: *In 1973, while you were still a PhD student, you and Alex Dalgarno published a highly cited paper on the cosmic abundance of deuterium. What were the key insights?*

A: It's interesting that you bring up this paper, because there is so much background hidden behind the strict four-page limit on a *Letter* at that time. The hope was to measure the interstellar deuterium abundance because primordial deuterium constrains cosmological parameters (baryon mass density, number of neutrino species, etc.) through the theory of Big Bang Nucleosynthesis. The early *Copernicus* observations of ultraviolet absorption lines of H_2 and HD required detailed models of the chemistry and structure of diffuse interstellar clouds, because the molecular abundances must vary strongly with depth. We extracted only a loose constraint on D/H, but rich insight into the importance of depth-dependent models. These were among the first attempts to describe in detail what we now call photodissociation regions (PDR). It also became clear that cosmic-ray ionization drives part of the rich chemical activity (oxygen into OH and water) while ultraviolet starlight controls other aspects (atomic carbon into CH, the H_2/H ratio). Interstellar absorption spectroscopy, astrochemistry, and cosmic ray interactions have been persistent themes in my work ever since.

Q: *That same year you, again with Alex, also published a paper on the formation of CH in interstellar clouds. How have these results held up with time?*

A: The key suggestion of a radiative association process, $C^+ + H_2 \rightarrow CH_2^+ + \gamma$, has held up well. Subsequent detailed models with Alex and later with Ewine van Dishoeck demonstrated good quantitative agreement with observed column densities of C^+, CH, C_2, and H_2 in diffuse molecular clouds. Ewine and I then tried to extend absorption line observations to thicker lines of sight, in order to see the transition from translucent, starlight-driven chemistry to the cold, dark limit in dense molecular clouds. CH remains a good indirect tracer of molecular hydrogen.

I tried to learn everything about the CH molecule. This led me to try to detect the microwave lines of CH near 3 GHz frequency in Comet Kohoutek in 1974 with the Harvard 25 meter radio telescope. This comet (1973f) had been discovered well in advance of its perihelion passage so there was time to prepare. At first, the idea was to use the comet as a spectroscopic source for determining the frequencies of the three ground-state Λ-doubling transitions, because these were not well measured. In retrospect that would have been impossible given the weakness of the lines and the narrow bandwidth of the spectrometer. Fortunately, in the meantime, Olof Rydbeck and his team at Onsala Space Observatory detected the CH lines in interstellar clouds and published accurate rest frequencies. Our detection of one line in the comet was at the 10σ level. Coincidentally, Onsala, Sweden, has been my home for the last twenty-four years.

Q: *A few years later you and Alex wrote a paper on how molecular hydrogen in diffuse clouds absorbs ultraviolet radiation, and you predicted how the resulting fluorescence should lead to the emission of infrared photons.*

A: This was the original focus of my PhD thesis. We found that the depth-dependent attenuation of the ultraviolet starlight and the rest of the interstellar chemistry were crucial to understanding the stratified structure of the atomic/molecular transition zone. A diffuse interstellar cloud is just a low-flux version of the photodissociation regions (PDR) that dominate the infrared emission from luminous star-forming regions.

Q: *In 1977 you and Alex developed a model of the Zeta Ophiuchi diffuse cloud to take advantage of the UV line data from the Copernicus satellite. What were the main ingredients in this model?*

A: The backbone of such a PDR model is the treatment of the depth-dependence of the ultraviolet absorption by H_2 in a self-consistent way with its formation and destruction. Approximately 15% of the ultraviolet line absorptions lead to dissociation of the molecule while the rest produce the UV fluorescence and infrared cascade. The overall yield is around three IR photons for every UV photon absorbed. The other processes that excite H_2, such as inelastic collisions with other atoms and molecules, are included. The populations of all the states of H_2 are computed by solving a system of rate equations. Thus the calculated column densities, state-by-state in H_2, could be compared directly with the observations from the Princeton spectrometer on *Copernicus*. The ion chemistry related to the abundances of HD and OH was also included, along with the ionization equilibria of several atomic species. We also tried to assess the heating and cooling processes in the gas, in order to account for the temperatures suggested by the populations of the lowest states of H_2. At the time, the diffuse molecular cloud toward ζ Oph was the best studied region, based on the classic study by George Herbig (1968).

Our knowledge of chemical processes and the amount of observational data both increased rapidly during the following decade, so that Ewine van Dishoeck and I were able to expand and improve this comprehensive approach to cloud models. This was explained in several long papers in the late 1980s, including our detailed investigation of the photochemistry of carbon monoxide. We tried very hard to test the models against **all** of the available observations and to predict new observables; as a result, the referee of our 1986 paper even allowed us to keep the word "comprehensive" in the title.

In parallel with the work on models, we extended absorption spectroscopy to thicker translucent clouds, that is sightlines toward early type stars with visual extinction greater than 3 magnitudes. We reported surveys of CH, CN, CH^+, and C_2 molecules. As Ewine and I had shown earlier, the rotational populations in C_2 could be used to infer the density and temperature in these regions.

The chemical networks in these models made rather specific predictions about the abundances of unseen molecules like H_3^+, OH^+, H_2O^+, H_3O^+, HCl^+, and H_2Cl^+. It has been very exciting to witness the later discoveries of all of these molecular ions.

Q: *Interstellar absorption spectroscopy has taken you even further afield, hasn't it?*

A: That's right. When it became clear that the UV absorption by H_2 was so widespread in the Milky Way, it was tempting to look for molecular lines in QSO absorption spectra at high redshift. A redshift of $z > 2$ puts the far-ultraviolet lines within the comfort zone of a ground-based telescope. Marc Aaronson, Chris McKee, and I searched for the H_2 fingerprint in published lists of QSO absorption lines in 1974. In 1985, Levshakov and Varshalovich identified the telltale pattern in a line list and in 1988 Craig Foltz, Fred Chaffee, and I confirmed their identification with better observations and a direct comparison with simulated spectra at $z = 2.8$ toward PKS $0528-250$. It has been gratifying to see the enormous progress in this area in recent years. Patrick Petitjean and collaborators have assembled a large sample of molecular absorbers at high redshift. Some of these systems even have detectable HD and CO. It was also possible to follow up on a suggestion by Rodger Thompson that measurements of highly redshifted H_2 could be sensitive to a possible cosmological variation of the ratio of masses of electron and proton. During the last few years, I have been fortunate to be part of Sebastien Muller's program to study molecular absorption at $z = 0.89$ toward a gravitationally lensed QSO. We confirmed that the temperature of the cosmic microwave background does indeed scale as $(1 + z)$. There is now a long list of measured molecular column densities (including isotope ratios). I confess I am slightly surprised that the chemistry at $z = 0.89$ is so similar to what we see in translucent clouds in the Milky Way.

Q: *In the late 1980s you and Ewine van Dishoeck re-visited the question of the fluorescent excitation of interstellar H_2 in an important paper that is still today highly cited. What were the new insights?*

A: This was spurred by the advances in infrared astronomy in the decade 1977-1987, which included observations of H_2 emission in a variety of sources. In some cases, the signature of fluorescence was evident. Perhaps the paper is still cited because we presented tables of predicted line fluxes and scaling formulae that could be simply applied to infrared spectra. I was fortunate to learn about infrared astronomy from a pioneer, Ed Ney, and the talented people around him at the University of Minnesota, during my time there, 1975-1978.

Q: *What are your current interests?*

A: I am very interested in the spectroscopy of mass-losing stars. The Atacama Large Millimeter/submillimeter Array (ALMA) provides very sensitive, broad-band line surveys with good angular resolution. I like to explore complicated excitation processes of molecules in which the infrared radiation of the star competes with collisions in controlling the line emission that emerges at millimeter and submillimeter wavelengths. With ALMA and with the optical/infrared interferometer at the ESO Very Large Telescope, it is also possible now to resolve central components of atomic and molecular line emission that lie well inside the dust-forming zones of evolved, mass-losing stars. I'm hopeful that the studies of these extended chromospheres will lead to a better understanding of conditions in the regions where winds are launched and solids begin to condense. I am working on simple models to unify the description of visible, infrared, and mm-wave emission-line regions for this purpose.

Some of your earlier questions remind me that models of thermal and fluorescent infrared emission should also be combined with models of H_2 exposed to hot electrons (tens of eV) that come from interactions with cosmic rays or X-rays. There are some hints of electron-excited H_2 emission in the disks around young stellar objects. I am also curious whether the IR fluorescence of H_2 might be detectable from a cold, dark cloud (or circumstellar envelope), as a measure of the response to starlight at its surface and to cosmic-ray-induced ultraviolet radiation in its interior.

Finally, I still hope to pursue a serious, non-astronomical hobby someday.

Abstracts of recently accepted papers

A Swift view of X-ray and UV radiation in the planet-forming T-Tauri system PDS 70

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PDS 70 is a ∼5 Myr old star with a gas and dust disc in which several proto-planets have been discovered. We present the first UV detection of the system along with X-ray observations taken with the *Neil Gehrels Swift Observatory* satellite. PDS 70 has an X-ray flux of 3.4×10^{-13} erg cm^{-2} s^{-1} in the 0.3–10.0 keV range, and UV flux (U band) of 3.5×10^{-13} erg cm^{-2} s^{-1} . At the distance of 113.4 pc determined from Gaia DR2 this gives luminosities of 5.2×10^{29} erg s^{-1} and 5.4×10^{29} erg s^{-1} respectively. The X-ray luminosity is consistent with coronal emission from a rapidly rotating star close to the log $\frac{L_{\rm X}}{L_{\rm bol}} \sim -3$ saturation limit. We find the UV luminosity is much lower than would be expected if the star were still accreting disc material and suggest that the observed UV emission is coronal in origin.

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http://arxiv.org/pdf/1911.00297

Simultaneous photometric and spectral analysis of a new outburst of V1686 Cyg

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We present an analysis of the optical observations of Herbig AeBe star V1686 Cyg, which is associated with a small isolated star-forming region around HAeBe star BD+40°4124. We observed this star as a part of our project of young eruptive stars investigation. Observations were held on 2.6m telescope of Byurakan Observatory from 2015 to 2017. For this period we obtained V1686 Cyg direct images and 14 medium- and low-resolution spectra. In the course of observations we noticed that this star underwent a not-typical brightness outburst. After data reduction we found that the full rise and decline of V1686 Cyg brightness had almost 3 magnitudes amplitude and lasted about 3 months. We were also able to trace the changes of the stellar spectrum during the outburst, which are correlated with the photometric variations.

Accepted by Research in Astronomy and Astrophysics

http://arxiv.org/pdf/1912.01262

Modeling the accretion disk around the high-mass protostar GGD 27-MM1

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Recent high-angular resolution ($\simeq 40$ mas) ALMA observations at 1.14 mm resolve a compact ($R \simeq 200$ au) flattened dust structure perpendicular to the HH 80–81 jet emanating from the GGD 27-MM1 high-mass protostar, making it a robust candidate for a true accretion disk. The jet/disk system (HH 80–81/GGD 27-MM1) resembles those found in association with low- and intermediate-mass protostars. We present radiative transfer models that fit the 1.14 mm ALMA dust image of this disk which allow us to obtain its physical parameters and predict its density and temperature structure. Our results indicate that this accretion disk is compact ($R_{\rm disk}\simeq$ 170 au) and massive ($\simeq 5$ $M_\odot$), about 20% of the stellar mass of $\simeq 20$ $M_\odot$. We estimate the total dynamical mass of the star-disk system from the molecular line emission finding a range between 21 and 30 $M_\odot$, which is consistent with our model. We fit the density and temperature structures found by our model with power law functions. These results suggest that accretion disks around massive stars are more massive and hotter than their low-mass siblings, but they still are quite stable. We also compare the temperature distribution in the GGD 27–MM1 disk with that found in low- and intermediate-mass stars and discuss possible implications on the water snow line. We have also carried out a study of the distance based on Gaia DR2 data and the population of young stellar objects (YSOs) in this region, and from the extinction maps. We conclude that the source distance is within 1.2 and 1.4 kpc, closer than what was derived in previous studies (1.7 kpc).

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https://arxiv.org/pdf/1911.12398.pdf

Uncovering a 260 pc wide, 35 Myr old filamentary relic of star formation

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Several recent studies have shown that the Vela OB2 region hosts a complex constellation of sub-populations with ages in the range 10 to 50 Myr. Such populations might represent the best example of the outcome of clustered star formation in Giant Molecular clouds (GMC). We use Gaia DR2 data over an area of 40◦ radius around the open cluster Collinder 135 to extend the study of the stellar populations of the Vela OB2 region over an area of several hundreds of parsecs on sky. Detailed clustering algorithms combined with the exquisite astrometric quality of the GAIA catalogue allow us to detect a new cluster named BBJ 1 that shows the same age as NGC 2547 (30 to 35 Myr), but located at a distance of 260 pc from it. Deeper investigation of the region via clustering in 5D parameter space and in the colour-magnitude diagram allows us to detect a filamentary structure of stars that bridges the two clusters. Given the extent in space of such structure (260 pc) and the young age ($\sim$35 Myr), we exclude that such population originates by the same mechanism responsible to create tidal streams around older clusters. Even if we miss a complete picture of the 3D motion of the studied stellar structure because of the lack of accurate radial velocity measurements, we propose that such structure represent the detection of a 35 Myr old outcome of a mechanism of filamentary star formation in a GMC.

Accepted by MNRAS

http://arxiv.org/pdf/1911.05709

The Forgotten Quadrant Survey. ^{12}CO and ^{13}CO (1–0) survey of the Galactic Plane in the range $220^\circ < l < 240^\circ$ $-2\overset{\circ}{.}5 < b < 0^\circ$

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We present the Forgotten Quadrant Survey (FQS), an ESO large project that used the 12m antenna of the Arizona Radio Observatory to map the Galactic Plane in the range $220° < l < 240°$ and $-2\overset{\circ}{.}5 < b < 0°$, both in ^{12}CO(1–0) and ^{13}CO(1–0), at a spectral resolution of 0.65 km s^{-1} and 0.26 km s^{-1}. Our dataset allows us to easily identify how the molecular dense gas is organised at different spatial scales: from the giant clouds with their denser filamentary networks, down to the clumps and cores that host the newborn stars and to obtain reliable estimates of their key physical parameters. We present the first release of the FQS data and discuss their quality. Spectra with 0.65 km s^{-1} velocity channels have a noise ranging from 0.8 K to 1.3 K for ^{12}CO(1–0) and from 0.3 K to 0.6 K for ^{13}CO(1–0). In this paper, we used the ^{12}CO(1–0) spectral cubes to produce a catalogue of 263 molecular clouds. This is the first selfconsistent, statistical catalogue of molecular clouds of the outer Galaxy, obtained with a subarcminute spatial resolution and therefore able to detect not only the classical giant molecular clouds, but also the small clouds and to resolve the cloud structure at the subparsec scale up to a distance of a few kpc. We found two classes of objects: structures with size above a few parsecs that are typical molecular clouds and may be self-gravitating, and subparsec structures that cannot be in gravitational equilibrium and are likely transient or confined by external pressure. We used the ratio between the Herschel H_2 column density and the integrated intensity of the CO lines to calculate the CO conversion factor and we found mean values of $(3.3\pm1.4)\times10^{20}$ cm^{-2} (K km s^{-1})$^{-1}$ and $(1.2\pm0.4)\times10^{21}$ cm^{-2} (K km s^{-1})$^{-1}$, for ^{12}CO(1–0) and ^{13}CO(1–0), respectively.

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http://arxiv.org/pdf/1911.11545

Astrochemistry as a tool to follow the protostellar evolution: the Class I stage

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The latest developments in astrochemistry have shown how some molecular species can be used as a tool to study the early stages of the solar-type star formation process. Among them, the more relevant species are the interstellar complex organic molecules (iCOMs) and the deuterated molecules. Their analysis give us information on the present and past history of protostellar objects. Among the protostellar evolutionary stages, Class I protostars represent a perfect laboratory in which to study the initial conditions for the planet formation process. Indeed, from a physical point of view, the Class I stage is the bridge between the Class 0 phase, dominated by the accretion process, and the protoplanetary disk phase, when planets form. Despite their importance, few observations of Class I protostars exist and very little is known about their chemical content. In this paper we review the (few) existing observations of iCOMs and deuterated species in Class I protostars. In addition, we present new observations of deuterated cyanoacetylene and thioformaldehyde towards the Class I protostar SVS13-A. These new observations allow us to better understand the physical and chemical structure of SVS13-A and compare the cyanoacetylene and thioformaldehyde deuteration with other sources in different evolutionary phases.

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The dry and carbon poor inner disk of TW Hya: evidence for a massive icy dust trap

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Gas giants accrete their envelopes from the gas and dust of proto-planetary disks, so it is important to determine the composition of the inner few AU, where most giant planets are expected to form. We aim to constrain the elemental carbon and oxygen abundance in the inner disk ($R < 2.3$ AU) of TW Hya and compare with the outer disk ($R > 2.3$ AU) where carbon and oxygen appear underabundant by a factor of $\sim$50. Archival infrared observations of TW Hya are compared with a detailed thermo-chemical model, DALI. The inner disk gas mass and elemental C and O abundances are varied to fit the infrared CO, H_2 and H_2O line fluxes. Best fitting models have an inner disk that has a gas mass of $2 \times 10^{-4}\ M_{\odot}$ with C/H $\approx 3 \times 10^{-6}$ and O/H $\approx 6 \times 10^{-6}$. The elemental oxygen and carbon abundances of the inner disk are $\sim$50 times underabundant compared to the ISM and are consistent with those found in the outer disk. The uniformly low volatile abundances imply that the inner disk is not enriched by ices on drifting bodies that evaporate. This indicates that drifting grains are stopped in a dust trap outside the water ice line. Such a dust trap would also form a cavity as seen in high resolution sub-millimeter continuum observations. If CO is the major carbon carrier in the ices, dust needs to be trapped efficiently outside the CO ice line of $\sim$20 AU. This would imply that the shallow sub-millimeter rings in the TW Hya disk outside of 20 AU correspond to very efficient dust traps. The more likely scenario is that more than 98% of the CO has been converted into less volatile species, e.g. CO_2 and CH_3OH. A giant planet forming in the inner disk would be accreting gas with low carbon and oxygen abundances as well as very little icy dust, potentially leading to a planet atmosphere with strongly substellar C/H and O/H ratios.

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http://arxiv.org/pdf/1911.11152

Jupiter formed as a pebble pile around the N_2 ice line

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The region around the H_2O ice line, due to its higher surface density, seems to be the ideal location to form planets. The core of Jupiter, as well as the cores of close in gas giants are thus thought to form in this region of the disk. Actually constraining the formation location of individual planets has proven to be difficult, however. We aim to use the Nitrogen abundance in Jupiter, which is around 4 times solar, in combination with *Juno* constraints on the total mass of heavy elements in Jupiter, to narrow down its formation scenario. Different pathways of enrichment of Jupiter's atmosphere, such as the accretion of enriched gas, pebbles or planetesimals are considered and their implications for the oxygen abundance of Jupiter is discussed. The super solar Nitrogen abundance in Jupiter necessitates the accretion of extra N_2 from the proto-solar nebula. The only location of the disk that this can happen is outside, or just inside the N_2 ice line. These constraints favor a pebble accretion origin of Jupiter, both from the composition as well as from a planet formation perspective. We predict that Jupiter's oxygen abundance is between 3.6 and 4.5 times solar.

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VLBI observations of the G25.65+1.05 water maser superburst

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This paper reports observations of a 22 GHz water maser 'superburst' in the G25.65+1.05 massive star forming region, conducted in response to an alert from the Maser Monitoring Organisation (M2O). Very long baseline interferometry (VLBI) observations using the European VLBI Network (EVN) recorded a maser flux density of 1.2×10^4 Jy. The superburst was investigated in the spectral, structural and temporal domains and its cause was determined to be an increase in maser path length generated by the superposition of multiple maser emitting regions aligning in the line of sight to the observer. This conclusion was based on the location of the bursting maser in the context of the star forming region, its complex structure, and its rapid onset and decay.

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The dynamically young outflow of the Class 0 protostar Cha-MMS1

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On the basis of its low luminosity, its chemical composition, and the absence of a large-scale outflow, the dense core Cha-MMS1 located in the Chamaeleon I molecular cloud was proposed as a first hydrostatic core (FHSC) candidate a decade ago. Our goal is to test this hypothesis by searching for a slow, compact outflow driven by Cha-MMS1 that would match the predictions of MHD simulations for this short phase of star formation. We use the Atacama Large Millimetre/submillimetre Array (ALMA) to map Cha-MMS1 at high angular resolution in CO 3–2 and ^{13}CO 3–2 as well as in continuum emission. We report the detection of a bipolar outflow emanating from the central core, along a (projected) direction roughly parallel to the filament in which Cha-MMS1 is embedded and perpendicular to the large-scale magnetic field. The morphology of the outflow indicates that its axis lies close to the plane of the sky. We measure velocities corrected for inclination of more than 90 km s^{-1} which is clearly incompatible with the expected properties of a FHSC outflow. Several properties of the outflow are determined and compared to previous studies of Class 0 and Class I protostars. The outflow of Cha-MMS1 has a much smaller momentum force than the outflows of other Class 0 protostars. In addition, we find a dynamical age of 200–3000yr indicating that Cha-MMS1 might be one of the youngest ever observed Class 0 protostars. While the existence of the outflow suggests the presence of a disk, no disk is detected in continuum emission and we derive an upper limit of 55 au to its radius. We conclude that

Cha-MMS1 has already gone through the FHSC phase and is a young Class 0 protostar, but it has not brought its outflow to full power yet.

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Variable warm dust around the Herbig Ae star HD 169142: Birth of a ring?

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The Herbig Ae star HD 169142 is known to have a gaseous disk with a large inner hole, and also a photometrically variable inner dust component in the sub-au region. Following up our previous analysis, we further studied the temporal evolution of inner dust around HD 169142, which may provide information on the evolution from late-stage protoplanetary disks to debris disks. We used near-infrared interferometric observations obtained with VLTI/PIONIER to constrain the dust distribution at three epochs spanning six years. We also studied the photometric variability of HD 169142 using our optical-infrared observations and archival data. Our results indicate that a dust ring at $\sim$0.3 au formed at some time between 2013 and 2018, and then faded (but did not completely disappear) by 2019. The short-term variability resembles that observed in extreme debris disks, and is likely related to short-lived dust of secondary origin, though variable shadowing from the inner ring could be an alternative interpretation. If confirmed, this is the first direct detection of secondary dust production inside a protoplanetary disk.

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Evidence of a substellar companion to AB Dor C

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Studies of fundamental parameters of very low-mass objects are indispensable to provide tests of stellar evolution models that are used to derive theoretical masses of brown dwarfs and planets. However, only objects with dynamically determined masses and precise photometry can effectively evaluate the predictions of stellar models. AB Dor C (0.090 $M_\odot$) has become a prime benchmark for calibration of theoretical evolutionary models of low-mass young stars. One of the ambiguities remaining in AB Dor C is the possible binary nature of this star. We observed AB Dor C with the VLTI/AMBER instrument in low-resolution mode at the J, H and K bands. The interferometric observables at the K-band are compatible with a binary brown dwarf system with tentative components AB Dor Ca/Cb with a K-band flux ratio of 5$\pm$1% and a separation of 38$\pm$1 mas. This implies theoretical masses of 0.072$\pm$0.013 $M_\odot$ and 0.013$\pm$0.001 $M_\odot$ for each component, near the hydrogen-burning limit for AB Dor Ca, and near the deuterium-burning limit, straddling the boundary between brown dwarfs and giant planets, for AB Dor Cb. The possible binarity of AB Dor C alleviates the disagreement between observed magnitudes and theoretical mass-luminosity relationships.

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ALMA Observations of the Extraordinary Carina Pillars: HH 901/902

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We present Atacama Large Millimeter/Submillimeter Array (ALMA) 1.3 mm continuum and $C^{18}O(2-1)$, $N_2D^+(3-2)$, $^{13}CS(5-4)$, and $^{12}CO(2-1)$ line sensitive and high angular resolution ($\sim 0.3''$) observations of the famous carina pillars and protostellar objects HH 901/902. Our observations reveal for the first time, the bipolar CO outflows and the dusty disks (plus envelopes) that are energizing the extended and irradiated HH objects far from the pillars. We find that the masses of the disks+envelopes are about 0.1 $M_\odot$ and of the bipolar outflows are between 10^{-3} - 10^{-4} $M_\odot$, which suggests that they could be low- or maybe intermediate- mass protostars. Moreover, we suggest that these young low-mass stars are likely embedded Class 0/I protostars with high-accretion rates. We also show the kinematics of the gas in the pillars together with their respective gas masses (0.1 – 0.2 $M_\odot$). We estimate that the pillars will be photo-evaporated in 10^4 to 10^5 years by the massive and luminous stars located in the Trumpler 14 cluster. Finally, given the short photo-evaporated timescales and that the protostars in these pillars are still very embedded, we suggest that the disks inside of the pillars will be quickly affected by the radiation of the massive stars, forming proplyds, like those observed in Orion.

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New insights in giant molecular cloud hosting S147/S153 complex: signatures of interacting clouds

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In order to understand the formation of massive OB stars, we report a multi-wavelength observational study of a giant molecular cloud hosting the S147/S153 complex (size $\sim$90 pc $\times$ 50 pc). The selected complex is located in the Perseus arm, and contains at least five HII regions (S147, S148, S149, S152, and S153) powered by massive OB stars having dynamical ages of $\sim$0.2–0.6 Myr. The Canadian Galactic Plane Survey ^{12}CO line data (beam size $\sim 100''.4$) trace the complex in a velocity range of [-59, -43] km s^{-1}, and also reveal the presence of two molecular cloud components around -54 and -49 km s^{-1} in the direction of the complex. Signatures of the interaction/collision between these extended cloud components are investigated through their spatial and velocity connections. These outcomes suggest the collision of these molecular cloud components about 1.6 Myr ago. Based on the observed overlapping zones of the two clouds, the collision axis appears to be parallel to the line-of-sight. Deep near-infrared photometric analysis of point-like sources shows the distribution of infrared-excess sources in the direction of the overlapping zones of the molecular cloud components, where all the HII regions are also spatially located. All elements put together, the birth of massive OB stars and embedded infrared-excess sources seems to be triggered by two colliding molecular clouds in the selected site. High resolution observations of dense gas tracer will be required to further confirm the proposed scenario.

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Cloudlet capture by Transitional Disk and FU Orionis stars

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After its formation, a young star spends some time traversing the molecular cloud complex in which it was born. It is therefore not unlikely that, well after the initial cloud collapse event which produced the star, it will encounter one or more low mass cloud fragments, which we call "cloudlets" to distinguish them from full-fledged molecular clouds. Some of this cloudlet material may accrete onto the star+disk system, while other material may fly by in a hyperbolic orbit. In contrast to the original cloud collapse event, this process will be a "cloudlet flyby" and/or "cloudlet capture" event: A Bondi-Hoyle-Lyttleton type accretion event, driven by the relative velocity between the star and the cloudlet. As we will show in this paper, if the cloudlet is small enough and has an impact parameter similar or less than $GM_\star/{v_\infty}^2$ (with v_∞ being the approach velocity), such a flyby and/or capture event would lead to arc-shaped or tail-shaped reflection nebulosity near the star. Those shapes of reflection nebulosity can be seen around several transitional disks and FU Orionis stars. Although the masses in the those arcs appears to be much less than the disk masses in these sources, we speculate that higher-mass cloudlet capture events may also happen occasionally. If so, they may lead to the tilting of the outer disk, because the newly infalling matter will have an angular momentum orientation entirely unrelated to that of the disk. This may be one possible explanation for the highly warped/tilted inner/outer disk geometries found in several transitional disks. We also speculate that such events, if massive enough, may lead to FU Orionis outbursts.

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Multi-planet disc interactions in binary systems

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We investigate the evolution of a multi–planet–disc system orbiting one component of a binary star system. The planet–disc system is initially coplanar but misaligned to the binary orbital plane. The planets are assumed to be giants that open gaps in the disc. We first study the role of the disc in shaping the mutual evolution of the two planets using a secular model for low initial tilt. In general we find that the planets and the disc do not remain coplanar, in agreement with Lubow & Martin (2016) for the single planet case. Instead, the planets and the disc undergo tilt oscillations. A high mass disc between the two planets causes the planets and the disc to nodally precess at the same average rate but they are generally misaligned. The amplitude of the tilt oscillations between the planets is larger while the disc is present. We then consider higher initial tilts using hydrodynamical simulations and explore the possibility of the formation of eccentric Kozai-Lidov (KL) planets. We find that the inner planet's orbit undergoes eccentricity growth for a large range of disc masses and initial misalignments. For a low disc mass and large initial misalignment both planets and the disc can undergo KL oscillations. Furthermore, we find that sufficiently massive discs can cause the inner planet to increase its inclination beyond 90° and therefore to orbit the binary in a retrograde fashion. The results have important implications for the explanation of very eccentric planets and retrograde planets observed in multi-planet systems.

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Disks Around T Tauri Stars with SPHERE (DARTTS-S) II: Twenty-one new polarimetric images of young stellar disks

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Near-IR polarimetric images of protoplanetary disks provide the ability to characterize sub-structures that are potentially due to the interaction with (forming) planets. The available census is, however, strongly biased toward massive disks around old stars. The DARTTS program aims at alleviating this bias by imaging a large number of T Tauri stars with diverse properties. DARTTS-S employs VLT/SPHERE to image the polarized scattered light from disks. In parallel, DARTTS-A is providing ALMA images of the same targets for a comparison of different dust components. In this work, we present new SPHERE images of 21 circumstellar disks, which is the largest sample of this time yet to be released. A re-calculation of some relevant stellar and disk properties following Gaia DR2 is also performed. The targets of this work are significantly younger than those published thus far with polarimetric NIR imaging. Scattered light is unambiguously resolved in 11 targets while some polarized unresolved signal is detected in 3 additional sources. Some disk sub-structures are detected. However, the paucity of spirals and shadows from this sample reinforces the trend for which these NIR features are associated with Herbig stars, either because older or more massive. Furthermore, disk rings that are apparent in ALMA observations of some targets do not appear to have corresponding detections with SPHERE. Inner cavities larger than 15 au are also absent from our images despite being expected from the SED. On the other hand, 3 objects show extended filaments at larger scale that are indicative of strong interaction with the surrounding medium. All but one of the undetected disks are best explained by their limited size (approximately 20 au) and the high occurrence of stellar companions in these sources suggest an important role in limiting the disk size. One undetected disk is massive and very large at millimeter wavelengths implying it is self-shadowed in the near-IR. This work paves the way towards a more complete and less biased sample of scattered-light observations, which is required to interpret how disk features evolve throughout the disk lifetime.

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NGTS clusters survey. I. Rotation in the young benchmark open cluster Blanco 1

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We determine rotation periods for 127 stars in the $\sim$115 Myr old Blanco 1 open cluster using $\sim$200 days of photometric monitoring with the Next Generation Transit Survey (NGTS). These stars span F5–M3 spectral types ($1.2 \gtrsim M \gtrsim 0.3\ M_{\odot}$) and increase the number of known rotation periods in Blanco 1 by a factor of four. We determine rotation periods using three methods: Gaussian process (GP) regression, generalised autocorrelation (G-ACF) and Lomb-Scargle (LS) periodograms, and find that GPs and G-ACF are more applicable to evolving spot modulation patterns. Between mid-F and mid-K spectral types, single stars follow a well-defined rotation sequence from $\sim$2 to 10 days, whereas stars in photometric multiple systems typically rotate faster. This may suggest that the presence of a moderate-to-high mass ratio companion inhibits angular momentum loss mechanisms during the early pre-main sequence, and this signature has not been erased at $\sim$100 Myr. The majority of mid-F to mid-K stars display evolving modulation

patterns, whereas most M stars show stable modulation signals. This morphological change coincides with the shift from a well-defined rotation sequence (mid-F to mid-K stars) to a broad rotation period distribution (late-K and M stars). Finally, we compare our rotation results for Blanco 1 to the similarly-aged Pleiades: the single star populations in both clusters possess consistent rotation period distributions, which suggests that the angular momentum evolution of stars follows a well-defined pathway that is, at least for mid-F to mid-K stars, strongly imprinted by ∼100 Myr.

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Searching for further evidence for cloud-cloud collisions in L1188

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In order to search for further observational evidence of cloud-cloud collisions in one of the promising candidates, L1188, we carried out observations of multiple molecular lines toward the intersection region of the two nearly orthogonal filamentary molecular clouds in L1188. Based on these observations, we find two parallel filamentary structures, both of which have at least two velocity components being connected with broad bridging features. We also found a spatially complementary distribution between the two molecular clouds, as well as enhanced ^{13}CO emission and ^{12}CO self-absorption toward their abutting regions. At the most blueshifted velocities, we unveil a 1 pc-long arc ubiquitously showing ^{12}CO line wings. We discover two 22 GHz water masers, which are the first maser detections in L1188. An analysis of line ratios at a linear resolution of 0.2 pc suggests that L1188 is characterised by kinetic temperatures of 13–23 K and H_2 number densities of 10^3–$10^{3.6}$ cm^{-3}. On the basis of previous theoretical predictions and simulations, we suggest that these observational features can be naturally explained by the scenario of a cloud-cloud collision in L1188, although an additional contribution of stellar feedback from low-mass young stellar objects cannot be ruled out.

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Short and long term near-infrared spectroscopic variability of eruptive protostars from VVV

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Numerous eruptive variable young stellar objects (YSOs), mostly Class I systems, were recently detected by the near-infrared Vista Variables in the Via Lactea (VVV) survey. We present an exploratory near-infrared spectroscopic variability study of 14 eruptive YSOs. The variations were sampled over 1-day and 1 to 2-year intervals and analysed in combination with VVV light curves. CO overtone absorption features are observed on 3 objects with FUor-like spectra: all show deeper absorption when they are brighter. This implies stronger emission from the circumstellar disc with a steeper vertical temperature gradient when the accretion rate is higher. This confirms the nature of fast VVV FUor-like events, in line with the accepted picture for classical FUors. The absence of Brγ emission in a FUor-like object declining to pre-outburst brightness suggests that reconstruction of the stellar magnetic field is a slow process. Within the 1-day timescale, 60% of H_2-emitting YSOs show significant but modest variation, and 2/6 sources have large variations in Brγ. Over year-long timescales, H_2 flux variations remain modest despite up to 1.8 mag variation in K_s. This indicates that emission from the molecular outflow usually arises further from the protostar and is unaffected by relatively large changes in accretion rate on year-long timescales. Two objects show signs of on/off magnetospheric accretion traced by Brγ emission. In addition, a 60% inter-night brightening of the H_2 outflow is detected in one YSO.

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HCN/HNC intensity ratio: a new chemical thermometer for the molecular ISM

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Context. The gas kinetic temperature (T_K) determines the physical and chemical evolution of the Interestellar Medium (ISM). However, obtaining reliable T_K estimates usually requires expensive observations including the combination of multi-line analysis and dedicated radiative transfer calculations.
Aims. This work explores the use of HCN and HNC observations, and particularly its I(HCN)/I(HNC) intensity ratio of their J=1–0 lines, as direct probe of the gas kinetic temperature in the molecular ISM.
Methods. We obtained a new set of large-scale observations of both HCN and HNC (1–0) lines along the Integral Shape Filament (ISF) in Orion. In combination with ancillary gas and dust temperature measurements, we find a systematic temperature dependence of the observed I(HCN)/I(HNC) intensity ratio across our maps. Additional comparisons with chemical models demonstrate that these observed I(HCN)/I(HNC) variations are driven by the effective destruction and isomerization mechanisms of HNC under low energy barriers.
Results. The observed variations of I(HCN)/I(HNC) with T_K can be described with a two-part linear function. This empirical calibration is then used to create a temperature map of the entire ISF. Comparisons with similar dust temperature measurements in this cloud, as well as in other regions and galactic surveys, validate this simple technique to obtain direct estimates of the gas kinetic temperature in a wide range of physical conditions and scales with an optimal working range between 15 K $\leq T_K \leq$ 40 K.
Conclusions. Both observations and models demonstrate the strong sensitivity of the I(HCN)/I(HNC) ratio to the gas kinetic temper- ature. Since these lines are easily obtained in observations of local and extragalactic sources, our results highlight the potential use of this observable as new chemical thermometer for the ISM.

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AVIATOR: Morphological object reconstruction in 3D. An application to dense cores

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Reconstructing 3D distributions from their 2D projections is a ubiquitous problem in various scientific fields, particularly so in observational astronomy. In this work, we present a new approach to solving this problem: a Vienna inverse-Abel-transform based object reconstruction algorithm AVIATOR. The reconstruction that it performs is based on the assumption that the distribution along the line of sight is similar to the distribution in the plane of projection, which requires a morphological analysis of the structures in the projected image. The output of the AVIATOR algorithm is an estimate of the 3D distribution in the form of a reconstruction volume that is calculated without the problematic requirements that commonly occur in other reconstruction methods such as symmetry in the plane of projection or modelling of radial profiles. We demonstrate the robustness of the technique to different geometries,

density profiles, and noise by applying the AVIATOR algorithm to several model objects. In addition, the algorithm is applied to real data: We reconstruct the density and temperature distributions of two dense molecular cloud cores and find that they are in excellent agreement with profiles reported in the literature. The AVIATOR algorithm is thus capable of reconstructing 3D distributions of physical quantities consistently using an intuitive set of assumptions.

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Multiple nitrogen reservoirs in a protoplanetary disk at the epoch of comet and giant planet formation

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The isotopic ratio of nitrogen measured in primitive Solar System bodies shows a broad range of values, the origin of which remains unknown. One key question is whether these isotopic reservoirs of nitrogen predate the comet formation stage or are posterior to it. Another central question is elucidating the processes that can produce the observed variations in the $^{14}N/^{15}N$ isotopic ratio. Disks that orbit pre-main-sequence stars provide unique opportunities for observing the chemical content of analogs of the protosolar nebula and therefore for building a comprehensive scenario for the origin of nitrogen in the Solar System and in planet-forming disks. We present spectrally and spatially resolved observations of the hyperfine structure of the 4–3 rotational transition of HCN and its main isotopologs $H^{13}CN$ and $HC^{15}N$ in the disk orbiting the 8 Myr old T Tauri star TW Hya. The spatially averaged HCN/$H^{13}CN$ and HCN/$HC^{15}N$ abundance ratios are 86±4 and 223±21, respectively. The latter value is significantly lower than the CN:$C^{15}N$ ratio 323±30 in this disk and thus provides the first evidence that two isotopic reservoirs of nitrogen are present in a disk at the stage of giant planet and comet formation. Furthermore, we find clear evidence for an increase in the ratio of HCN to $HC^{15}N$ with radius. The ratio in the outer disk is 339±28, in excellent agreement with direct measurements in the local interstellar medium, and with the bulk nitrogen isotopic ratio predicted from galactic evolution calculations. In the comet formation region at $r = 20$ au, the ratio is a factor ∼3 lower, 121±11. This radial increase qualitatively agrees with the scenario in which selective photodissociation of N_2 is the dominant fractionation process. However, our isotopic ratios and kinetic temperature of the HCN-emitting layers quantitatively disagree with models of nitrogen chemistry in disks.

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First Resolved Scattered-Light Images of Four Debris Disks in Scorpius-Centaurus with the Gemini Planet Imager

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We present the first spatially resolved scattered-light images of four debris disks around members of the Scorpius-Centaurus (Sco-Cen) OB Association with high-contrast imaging and polarimetry using the Gemini Planet Imager (GPI). All four disks are resolved for the first time in polarized light and one disk is also detected in total intensity. The three disks imaged around HD 111161, HD 143675, and HD 145560 are symmetric in both morphology and brightness distribution. The three systems span a range of inclinations and radial extents. The disk imaged around HD 98363 shows indications of asymmetries in morphology and brightness distribution, with some structural similarities to the HD 106906 planet-disk system. Uniquely, HD 98363 has a wide co-moving stellar companion Wray 15-788 with a recently resolved disk with very different morphological properties. HD 98363 A/B is the first binary debris disk system with two spatially resolved disks. All four targets have been observed with ALMA, and their continuum fluxes range from one non-detection to one of the brightest disks in the region. With the new results, a total of 15 A/F-stars in Sco-Cen have resolved scattered light debris disks, and approximately half of these systems exhibit some form of asymmetry. Combining the GPI disk structure results with information from the literature on millimeter fluxes and imaged planets reveals a diversity of disk properties in this young population. Overall, the four newly resolved disks contribute to the census of disk structures measured around A/F-stars at this important stage in the development of planetary systems.

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Late encounter events as source of disks and spiral structures. Forming second generation disks

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Observations of arc-like structures and luminosity bursts of stars > 1 Myr in age indicate that at least some stars undergo late infall events. We investigate scenarios of replenishing the mass reservoir around a star via capturing and infalling events of cloudlets. We carried out a total of 24 three-dimensional hydrodynamical simulations of cloudlet encounters with a Herbig star of mass 2.5 $M_\odot$ using the moving-mesh code AREPO. To account for the two possibilities of a star or a cloudlet traveling through the interstellar medium (ISM), we put either the star or the cloudlet at rest with respect to the background gas. For absent cooling in the adiabatic runs, almost none of the cloudlet gas is captured as a result of high thermal pressure. However, second-generation disks easily form when accounting for cooling of the gas. The disk radii range from several 100 au to ∼1000 au and associated arc-like structures up to 10^4 au in length form around the star for runs with and without stellar irradiation. Consistent with angular momentum conservation, the arcs and disks are larger for larger impact parameters. Accounting for turbulence in the cloudlet only mildly changes the model outcome. In the case of the star being at rest with the background gas, the disk formation and mass replenishment process is more pronounced and the associated arc-shaped streamers are longer lived. The results of our models confirm that late encounter events lead to the formation of transitional disks associated with arc-shaped structures such as observed for AB Aurigae or HD 100546. In addition, we find that second-generation disks and their associated filamentary arms are longer lived ($> 10^5$ yrs) in infall events, when the star is at rest with the background gas.

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The Formation and Evolution of Wide-orbit Stellar Multiples in Magnetized Clouds

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Stars rarely form in isolation. Nearly half of the stars in the Milky Way have a companion, and this fraction increases in star- forming regions. However, why some dense cores and filaments form bound pairs while others form single stars remains unclear. We present a set of three-dimensional, gravo-magnetohydrodynamic simulations of turbulent star-forming clouds, aimed at understanding the formation and evolution of multiple-star systems formed through large scale (10^3 AU) turbulent fragmentation. We investigate three global magnetic field strengths, with global mass-to-flux ratios of $\mu_\phi = 2$, 8, and 32. The initial separations of protostars in multiples depends on the global magnetic field strength, with stronger magnetic fields (e.g., $\mu_\phi = 2$) suppressing fragmentation on smaller scales. The overall multiplicity fraction (MF) is between 0.4 - 0.6 for our strong and intermediate magnetic field strengths, which is in agreement with observations. The weak field case has a lower fraction. The MF is relatively constant throughout

the simulations, even though stellar densities increase as collapse continues. While the MF rarely exceeds 60% in all three simulations, over 80% of all protostars are part of a binary system at some point. We additionally find that the distribution of binary spin mis-alignment angles is consistent with a randomized distribution. In all three simulations, several binaries originate with wide separations and dynamically evolve to $\sim 10^2$ AU separations. We show that a simple model of mass accretion and dynamical friction with the gas can explain this orbital evolution.

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The circumstellar environment around the embedded protostar EC 53

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EC53 is an embedded protostar with quasi-periodic emission in the near-IR and sub-mm. We use ALMA high-resolution observations of continuum and molecular line emission to describe the circumstellar environment of EC 53. The continuum image reveals a disk with a flux that suggests a mass of 0.075 $M_\odot$, much less than the estimated mass in the envelope, and an in-band spectral index that indicates grain growth to centimeter sizes. Molecular lines trace the outflow cavity walls, infalling and rotating envelope, and/or the Keplerian disk. The rotation profile of the $C^{17}O$ 3–2 line emission cannot isolate the Keplerian motion clearly although the lower limit of the protostellar mass can be calculated as 0.3 ± 0.1 $M_\odot$ if the Keplerian motion is adopted. The weak CH_3OH emission, which is anti-correlated with the HCO^+ 4–3 line emission, indicates that the water snow line is more extended than what expected from the current luminosity, attesting to bygone outburst events. The extended snow line may persist for longer at the disk surface because the lower density increases the freeze-out timescale of methanol and water.

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Numerical Simulation and Completeness Survey of Bubbles in the Taurus and Perseus Molecular Clouds

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Previous studies have analyzed the energy injection into the interstellar matter due to molecular bubbles. They found that the total kinetic energies of bubbles are comparable to, or even larger than, those of outflows but still less than the gravitational potential and turbulence energies of the hosting clouds. We examined the possibility that previous studies underestimated the energy injection due to being unable to detect dim or incomplete bubbles. We simulated typical molecular bubbles and inserted them into the ^{13}CO Five College Radio Astronomical Observatory maps of the Taurus and Perseus Molecular Clouds. We determined bubble identification completeness by applying the same procedures to both simulated and real data sets. We proposed a detectability function for both the Taurus and Perseus molecular clouds based on a multivariate approach. In Taurus, bubbles with kinetic energy less than $\sim 1 \times 10^{44}$ erg are likely to be missed. We found that the total missing kinetic energy in Taurus is less than a couple of 10^{44} erg, which only accounts for around 0.2% of the total kinetic energy of identified bubbles. In Perseus, bubbles with kinetic

energy less than $\sim 2 \times 10^{44}$ erg are likely to be missed. We found that the total missing kinetic energy in Perseus is less than 10^{45} erg, which only accounts for around 1% of the total kinetic energy of identified bubbles. We thus conclude that previous manual bubble identification routines used in Taurus and Perseus can be considered to be energetically complete. Therefore, we confirm that energy injection from dynamic structures, namely outflows and bubbles, produced by star formation feedback are sufficient to sustain turbulence at a spatial scale from$\sim$0.1 to $\sim$2.8 pc.

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Aggregate Growth and Internal structures of Chondrite Parent Bodies Forming from Dense Clumps

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Major components of chondrites are chondrules and matrix. Measurements of the volatile abundance in Semarkona chondrules suggest that chondrules formed in a dense clump that had a higher solid density than the gas density in the solar nebula. We investigate collisions between chondrules and matrix in the surface region of dense clumps using fluffy aggregate growth models. Our simulations show that the collisional growth of aggregates composed of chondrules and matrix takes place in the clumps well before they experience gravitational collapse. The internal structure of chondrite parent bodies (CPBs) can be thereby determined by aggregate growth. We find that the aggregate growth generates two scales within CPBs. The first scale is involved with the small scale distribution of chondrules and determined by the early growth stage, where chondrules accrete aggregates composed of matrix grains. This accretion can reproduce the thickness of the matrix layer around chondrules found in chondrites. The other scale is related to the large scale distribution of chondrules. Its properties (e.g., the abundance of chondrules and the overall size) depend on the gas motion within the clump, which is parameterized in this work. Our work thus suggests that the internal structure of CPBs may provide important clues about their formation conditions and mechanisms.

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NaCo polarimetric observations of Sz 91 transitional disk: a remarkable case of dust filtering

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We present polarized light observations of the transitional disk around Sz 91 acquired with VLT/NaCo at H (1.7μm) and K_s (2.2μm) bands. We resolve the disk and detect polarized emission up to ∼0."5 (∼80 au) along with a central cavity at both bands. We computed a radiative transfer model that accounts for the main characteristics of the polarized observations. We found that the emission is best explained by small, porous grains distributed in a disk with a ∼45 au cavity. Previous ALMA observations have revealed a large sub-mm cavity (∼83 au) and extended gas emission from the innermost (<16 au) regions up to almost 400 au from the star. Dynamical clearing by multiple low-mass planets arises as the most probable mechanism for the origin of Sz 91's peculiar structure. Using new L' band ADI observations we can rule out companions more massive than $M_p \geq 8\ M_{\rm Jup}$ beyond 45 au assuming hot-start models. The disk is clearly asymmetric in polarized light along the minor axis, with the north side brighter than the south side. Differences in position angle between the disk observed at sub-mm wavelengths with ALMA and our NaCo observations were found. This suggests that the disk around Sz 91 could be highly structured. Higher signal-to-noise near-IR and sub-mm observations are needed to confirm the existence of such structures and to improve the current understanding in the origin of transitional disks.

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Shadowing and multiple rings in the protoplanetary disk of HD 139614

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Shadows in scattered light images of protoplanetary disks are a common feature and support the presence of warps or misalignments between disk regions. These warps are possibly due to an inclined (sub-)stellar companion embedded in the disk. We study the morphology of the protoplanetary disk around the Herbig Ae star HD 139614 based on the first scattered light observations of this disk, which we model with the radiative transfer code MCMax3D. We obtained *J*- and *H*-band observations in polarized scattered light with VLT/SPHERE that show strong azimuthal asymmetries. In the outer disk, beyond ∼30 au, a broad shadow spans a range of ∼240° in position angle, in the East. A bright ring at ∼16 au also shows an azimuthally asymmetric brightness, with the faintest side roughly coincidental with the brightest region of the outer disk. Additionally, two arcs are detected at ∼34 au and ∼50 au. We created a simple 4-zone approximation to a warped disk model of HD 139614 in order to qualitatively reproduce these features. The location and misalignment of the disk components were constrained from the shape and location of the shadows they cast. We find that the shadow on the outer disk covers a range of position angle too wide to be explained by a single inner misaligned component. Our model requires a minimum of two separate misaligned zones — or a continuously warped region — to cast this broad shadow on the outer disk. A small misalignment of ∼4° between adjacent components can reproduce most of the observed shadow features. Multiple misaligned disk zones, potentially mimicing a warp, can explain the observed broad shadows in the HD 139614 disk. A planetary mass companion in the disk, located on an inclined orbit, could be responsible for such a feature and for the dust depleted gap responsible for a dip in the SED.

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SUBARU Near-Infrared Imaging Polarimetry of Misaligned Disks Around SR24 Hierarchical Triple System

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The SR24 multi-star system hosts both circumprimary and circumsecondary disks, which are strongly misaligned from each other. The circumsecondary disk is circumbinary in nature. Interestingly, both disks are interacting, and they possibly rotate in opposite directions. To investigate the nature of this unique twin disk system, we present $0\farcs1$ resolution near-infrared polarized intensity images of the circumstellar structures around SR24, obtained with HiCIAO mounted on the Subaru 8.2 m telescope. Both the circumprimary disk and the circumsecondary disk are resolved and have elongated features. While the position angle of the major axis and radius of the NIR polarization disk around SR24S are 55° and 137 au, respectively, those around SR24N are 110° and 34 au, respectively. As an overall morphology, the circumprimary disk around SR24S shows strong asymmetry, whereas the circumsecondary disk around SR24N shows relatively strong symmetry. Our NIR observations confirm the previous claim that the circumprimary and circumsecondary disks are misaligned from each other. Both the circumprimary and circumsecondary disks show similar structures in ^{12}CO observations in terms of its size and elongation direction. This consistency is because both NIR and ^{12}CO are tracing surface layers of the flared disks. As the radius of the polarization disk around SR24N is roughly consistent with the size of the outer Roche lobe, it is natural to interpret the polarization disk around SR24N as a circumbinary disk surrounding the SR24Nb-Nc system.

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Flyby-induced misalignments in planet-hosting discs

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We now have several observational examples of misaligned broken protoplanetary discs, where the disc inner regions are strongly misaligned with respect to the outer disc. Current models suggest that this disc structure can be generated with an internal misaligned companion (stellar or planetary), but the occurrence rate of these currently unobserved companions remains unknown. Here we explore whether a strong misalignment between the inner and outer disc can be formed without such a companion. We consider a disc that has an existing gap — essentially separating the disc into two regions — and use a flyby to disturb the discs, leading to a misalignment. Despite considering the most optimistic parameters for this scenario, we find maximum misalignments between the inner and outer disc of $\sim$45° and that these misalignments are short-lived. We thus conclude that the currently observed misaligned discs must harbour internal, misaligned companions.

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The Gemini Planet Imager Exoplanet Survey: Dynamical Mass of the Exoplanet β Pictoris b from Combined Direct Imaging and Astrometry

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We present new observations of the planet β Pictoris b from 2018 with GPI, the first GPI observations following conjunction. Based on these new measurements, we perform a joint orbit fit to the available relative astrometry from ground-based imaging, the Hipparcos Intermediate Astrometric Data (IAD), and the Gaia DR2 position, and demonstrate how to incorporate the IAD into direct imaging orbit fits. We find a mass consistent with predictions of hot-start evolutionary models and previous works following similar methods, though with larger uncertainties: $12.8^{+5.3}_{-3.2}$ $M_{\rm Jup}$. Our eccentricity determination of $0.12^{+0.04}_{-0.03}$ disfavors circular orbits. We consider orbit fits to several different imaging datasets, and find generally similar posteriors on the mass for each combination of imaging data. Our analysis underscores the importance of performing joint fits to the absolute and relative astrometry simultaneously, given the strong covariance between orbital elements. Time of conjunction is well constrained within 2.8 days of 2017 September 13, with the star behind the planet's Hill sphere between 2017 April 11 and 2018 February 16 ($\pm$18 days). Following the recent radial velocity detection of a second planet in the system, β Pic c, we perform additional two-planet fits combining relative astrometry, absolute astrometry, and stellar radial velocities. These joint fits find a significantly smaller mass for the imaged planet β Pic b, of 8.0$\pm$2.6 $M_{\rm Jup}$, in a somewhat more circular orbit. We expect future ground-based observations to further constrain the visual orbit and mass of the planet in advance of the release of Gaia DR4.

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The jet/counterjet symmetry of the HH 212 outflow

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We present Spitzer (IRAC) images observations and a VLT 2.1 μm image of the HH 212 outflow. We find that this outflow has a strong symmetry, with jet/counterjet knot pairs with $\Delta x < 1''$ position offsets. We deduce that the jet/counterjet knots are ejected with time differences $\Delta\tau_0 \sim 6$ yr and velocity differences $\Delta v_0 \sim 2$ km s^{-1}. We also analyze the deviations of the knot positions perpendicular to the outflow axis, and interpret them in terms of a binary orbital motion of the outflow source. Through this model, we deduce a ~ 0.7 M$_\odot$ mass for the outflow source, and a separation of ~ 80 AU between the components of the binary (assuming equal masses for the two components). Finally, using the IRAC data and the VLT 2.1 μm image we have measured the proper motion velocities, obtaining values from 50 to 170 km s^{-1}.

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Kinematic study of the molecular gas associated with two cometary globules in Sh2-236

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Cometary globules, dense molecular gas structures exposed to the UV radiation, are found inside HII regions. Understanding the nature and origin of these structures through a kinematic study of the molecular gas is useful to advance in our knowledge of the interplay between radiation and molecular gas. Using ASTE we carried out molecular observations towards two cometary globules (Sim129 and Sim130) in the HII region Sh2-236. We mapped two regions

with the ^{12}CO J=3–2 and HCO$^+$ J=4–3 lines. Additionally, two single pointings of C_2H (N=4–3), HNC and HCN J=4–3 were observed. We combined our observations with public infrared and optical data to analyse the distribution and kinematics of the gas. We found kinematic signatures of infalling gas in the ^{12}CO J=3–2 and C_2H J=4–3 spectra towards Sim129 . We detected HCO$^+$, HCN, and HNC J=4–3 only towards Sim130. The HCN/HNC integrated ratio of about 3 found in Sim130 suggests that the possible star formation activity within the globule has not yet ionized the gas. The location of NVSS 052255+33315, which peaks towards the brightest border of the globule, supports this scenario. The non-detection of these molecules towards Sim129 could be due to the radiation arising from the star formation activity inside this globule. The ubiquitous presence of the C_2H molecule towards both globules shows the action of nearby O-B stars irradiating their external layers. Based on mid-infrared emission, we identified two new structures: a region of diffuse emission (R1) located, in projection, in front of the head of Sim129, and a pillar-like feature (P1) placed besides Sim130. Based on ^{12}CO J=3–2, we found molecular gas associated with Sim129, Sim130, R1 and P1 at radial velocities of −1.5, −11, +10, and +4 km s^{-1}, respectively. Therefore, while Sim129 and P1 are located at the far side of the shell, Sim130 is placed at the near side, consistent with earlier results.

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The density gradient inside molecular-gas clumps as a booster of their star formation activity

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Star-forming regions presenting a density gradient experience a higher star formation rate than if they were of uniform density. We refer to the ratio between the star formation rate of a spherical centrally-concentrated gas clump and the star formation rate that this clump would experience if it were of uniform density as the magnification factor ζ. We map ζ as a function of clump mass, radius, initial volume density profile and star formation time-span. For clumps with a steep density profile (i.e. power-law slope ranging from −3 to −4, as observed in some high-density regions of Galactic molecular clouds), we find the star formation rate to be at least an order of magnitude higher than its top-hat equivalent. This implies that such clumps experience faster and more efficient star formation than expected based on their mean free-fall time. This also implies that measurements of the star formation efficiency per free-fall time of clumps based on their global properties, namely, mass, mean volume density and star formation rate, present wide fluctuations. These reflect the diversity in the density profile of star-forming clumps, not necessarily variations in the physics of star formation. Steep density profiles inside star-cluster progenitors may be instrumental in the formation of multiple stellar populations, such as those routinely observed in old globular clusters.

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Resolving the FU Ori System with ALMA: Interacting Twin Disks?

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FU Orionis objects are low-mass pre-main sequence stars characterized by dramatic outbursts of several magnitudes in brightness. These outbursts are linked to episodic accretion events in which stars gain a significant portion of their mass. The physical processes behind these accretion events are not yet well understood. The archetypical FU Ori system, FU Orionis, is composed of two young stars with detected gas and dust emission. The continuum emitting regions have not been resolved until now. Here, we present 1.3 mm observations of the FU Ori binary system with ALMA. The disks are resolved at 40 mas resolution. Radiative transfer modeling shows that the emission from FU Ori north (primary) is consistent with a dust disk with a characteristic radius of ∼11 au. The ratio between major and minor axes shows that the inclination of the disk is ∼37 deg. FU Ori south is consistent with a dust disk of similar inclination and size. Assuming the binary orbit shares the same inclination angle as the disks, the deprojected distance between north and south components is 0.″6, i.e. ∼250 au. Maps of ^{12}CO emission show a complex kinematic environment with signatures disk rotation at the location of the northern component, and also (to a lesser extent) for FU Ori south. The revised disk geometry allows us to update FU Ori accretion models (Zhu et al.), yielding a stellar mass and mass accretion rate of FU Ori north of 0.6 $M_\odot$ and 3.8×10^{-5} $M_\odot$ yr^{-1}, respectively.

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A Survey for High-Mass Eclipsing Binaries

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We report results from a search for galactic high-mass eclipsing binaries. The photometric monitoring campaign was performed in Sloan r and i with the robotic twin refractor RoBoTT at the Universitätssternwarte Bochum in Chile and complemented by Johnson UBV data. Comparison with the SIMBAD database reveals 260 variable high-mass stars. Based on well-sampled light curves we discovered 35 new eclipsing high-mass systems and confirm the properties of six previously known systems. For all objects, we provide the first light curves and determine orbital periods through the Lafler-Kinman algorithm. Apart from GSC 08173-0018 and Pismis 24-13 ($P = 19.47\,d$ and $20.14\,d$) and the exceptional short-period system TYC 6561-1765-1 ($P = 0.71\,d$), all systems have orbital periods between 1 and 9 days. We model the light curves of 26 systems within the framework of the Roche geometry and calculate fundamental parameters for each system component. The Roche lobe analysis indicates that 14 systems have a detached geometry while 12 systems have a semi-detached geometry; seven of them are near-contact systems. The deduced mass ratios $q = M_2/M_1$ reach from 0.4 to 1.0 with an average value of 0.8. The similarity of masses suggests that these high-mass binaries were created during the star formation process rather than by tidal capture.

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The young stellar content of the giant HII regions M8, G333.6−0.2, and NGC6357 with VLT/KMOS

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Context. The identification and characterisation of populations of young massive stars in (giant) HII regions provides important constraints on i) the formation process of massive stars and their early feedback on the environment, and ii) the initial conditions for population synthesis models predicting the evolution of ensembles of stars.
Aims. We identify and characterise the stellar populations of the following young giant HII regions: M8, G333.6−0.2,

and NGC6357.
Methods. We acquired *H*- and *K*-band spectra of around 200 stars using The *K*-band KMOS on the ESO Very Large Telescope. The targets for M8 and NGC6357 were selected from the MYStIX project, which combines X-ray observations with near-infrared and mid-infrared data. For G333.6−0.2, the sample selection is based on the near-infrared colours combined with X-ray data. We introduce an automatic spectral classification method in order to obtain temperatures and luminosities for the observed stars. We analyse the stellar populations using their photometric, astrometric, and spectroscopic properties and compared the position of the stars in the Hertzprung-Russell diagram with stellar evolution models to constrain their ages and mass ranges.
Results. We confirm the presence of candidate ionising sources in the three regions and report new ones, including the first spectroscopically identified O stars in G333.6−0.2. In M8 and NGC6357, two populations are identified: i) OB main-sequence stars ($M > 5\ M_\odot$) and ii) pre-main sequence stars ($M \approx 0.5$–$5\ M_\odot$). The ages of the clusters are ∼1–3 Myr, <3 Myr, and ∼0.5–3 Myr for M8, G333.6−0.2, and NGC6357, respectively. We show that MYStIX selected targets have >90% probability of being members of the HII region, whereas a selection based on near infrared (NIR) colours leads to a membership probability of only ∼70%.

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Autonomous Gaussian decomposition of the Galactic Ring Survey. I. Global statistics and properties of the ^{13}CO emission data

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The analysis of large molecular line surveys of the Galactic plane is essential for our understanding of the gas kinematics on Galactic scales and, in particular, its link with the formation and evolution of dense structures in the interstellar medium. An approximation of the emission peaks with Gaussian functions allows for an efficient and straightforward extraction of useful physical information contained in the shape and Doppler-shifted frequency of the emission lines contained in these enormous data sets. In this work, we present an overview and the first results of a Gaussian decomposition of the entire Galactic Ring Survey (GRS) ^{13}CO $(1-0)$ data that consists of about 2.3 million spectra. We performed the decomposition with the fully automated GaussPy+ algorithm and fitted about 4.6 million Gaussian components to the GRS spectra. These decomposition results enable novel and unexplored ways to interpret and study the gas velocity structure. We discuss the statistics of the fit components and relations between the fitted intensities, velocity centroids, and velocity dispersions. We find that the magnitude of the velocity dispersion values increase towards the inner Galaxy and around the Galactic midplane, which we speculate is partly due to the influence of the Galactic bar and regions with higher non-thermal motions located in the midplane, respectively. We also used our decomposition results to infer global properties of the gas emission and find that the number of fit components used per spectrum is indicative of the amount of structure along the line of sight. We find that the emission lines from regions located on the far side of the Galaxy show increased velocity dispersion values, which are likely due to beam averaging effects. We demonstrate how this trend has the potential to aid in characterising Galactic structure by disentangling emission that belongs to the nearby Aquila Rift molecular cloud from emission that is more likely associated with the Perseus and Outer spiral arms. With this work, we also make our entire decomposition results available.

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ALMA and ROSINA detections of phosphorus-bearing molecules: the interstellar thread between star-forming regions and comets

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To understand how Phosphorus-bearing molecules are formed in star-forming regions, we have analysed ALMA observations of PN and PO towards the massive star-forming region AFGL 5142, combined with a new analysis of the data of the comet 67P/Churyumov-Gerasimenko taken with the ROSINA instrument onboard Rosetta. The ALMA maps show that the emission of PN and PO arises from several spots associated with low-velocity gas with narrow linewidths in the cavity walls of a bipolar outflow. PO is more abundant than PN in most of the spots, with the PO/PN ratio increasing as a function of the distance to the protostar. Our data favor a formation scenario in which shocks sputter phosphorus from the surface of dust grains, and gas-phase photochemistry induced by UV photons from the protostar allows efficient formation of the two species in the cavity walls. Our analysis of the ROSINA data has revealed that PO is the main carrier of P in the comet, with PO/PN>10. Since comets may have delivered a significant amount of prebiotic material to the early Earth, this finding suggests that PO could contribute significantly to the phosphorus reservoir during the dawn of our planet. There is evidence that PO was already in the cometary ices prior to the birth of the Sun, so the chemical budget of the comet might be inherited from the natal environment of the Solar System, which is thought to be a stellar cluster including also massive stars.

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Global axisymmetric simulations of photoevaporation and magnetically driven protoplanetary disk winds

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Photoevaporation and magnetically driven winds are two independent mechanisms to remove mass from protoplanetary disks. In addition to accretion, the effect of these two principles acting concurrently could be significant and the transition between those two has not been extensively studied and quantified in the literature yet. In order to contribute to the understanding of disk winds, we present the phenomena emerging in the framework of two-dimensional axisymmetric, non-ideal magnetohydrodynamic simulations including EUV-/ X-ray driven photoevaporation. Of particular interest are the examination of the transition region between photoevaporation and magnetically driven wind, the possibility of emerging magneto-centrifugal wind effects, as well as the morphology of the wind itself depending on the strength of the magnetic field. We use the PLUTO code in a 2.5D axisymmetric configuration with additional treatment of EUV-/ X-ray heating and dynamic ohmic diffusion based on a semi-analytical chemical model. We identify the transition between both outflow types to occur for values of the initial plasma beta $\beta \leq 10^7$, while magnetically driven winds generally outperform photoevaporation for stronger fields. In our simulations we observe irregular and asymmetric outflows for stronger magnetic fields. In the weak field regime the photoevaporation rates are slightly lowered by perturbations of the gas density in the inner regions of the disk. Overall, our results predict a wind with a lever arm smaller than 1.5, consistent with a hot magneto-thermal wind. Stronger accretion flows are present for values of $\beta < 10^7$.

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Massive Star Formation via the Collapse of Subvirial and Virialized Turbulent Massive Cores

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Similar to their low-mass counterparts, massive stars likely form via the collapse of pre-stellar molecular cores. Recent observations suggest that most massive cores are subvirial (i.e., not supported by turbulence) and therefore are likely unstable to gravitational collapse. Here we perform radiation hydrodynamic simulations to follow the collapse of turbulent massive pre-stellar cores with subvirial and virialized initial conditions to explore how their dynamic state affects the formation of massive stars and core fragmentation into companion stars. We find that subvirial cores undergo rapid monolithic collapse resulting in higher accretion rates at early times as compared to the collapse of virialized cores that have the same physical properties. In contrast, we find that virialized cores undergo a slower, gradual collapse and significant turbulent fragmentation at early times resulting in numerous companion stars. In the absence of strong magnetic fields and protostellar outflows we find that the faster growth rate of massive stars that are born out of subvirial cores leads to an increase in the radiative heating of the core thereby further suppressing fragmentation at early times when turbulent fragmentation occurs for virialized cores. Regardless of initial condition, we find that the massive accretion disks that form around massive stars dominant the accretion flow onto the star at late times and eventually become gravitationally unstable and fragment to form companion stars at late times.

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Spiral arms in the proto-planetary disc HD100453 detected with ALMA: evidence for binary-disc interaction and a vertical temperature gradient

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Scattered light high-resolution imaging of the proto-planetary disc orbiting HD100453 shows two symmetric spiral arms, possibly launched by an external stellar companion. In this paper we present new, sensitive high-resolution ($\sim$30 mas) Band 7 ALMA observations of this source. This is the first source where we find counterparts in the sub-mm continuum to both scattered light spirals. The CO J=3–2 emission line also shows two spiral arms; in this case they can be traced over a more extended radial range, indicating that the southern spiral arm connects to the companion position. This is clear evidence that the companion is responsible for launching the spirals. The pitch angle of the sub-millimeter continuum spirals ($\sim 6^\circ$) is lower than the one in scattered light ($\sim 16^\circ$). We show that

hydrodynamical simulations of binary-disc interaction can account for the difference in pitch angle only if one takes into account that the midplane is colder than the upper layers of the disc, as expected for the case of externally irradiated discs.

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Physical Properties of the star-forming clusters in NGC 6334

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We have studied the high-mass star-forming complex NGC 6334 with ALMA in the continuum emission at a frequency of 87.6 GHz, achieving a spatial resolution of 1300 au. Detecting 142 compact sources distributed over the whole observed area, we then used machine learning algorithms to group the compact cores in different clusters. A total of four main clusters were identified: NGC 6334-E, NGC 6334-I, NGC 6334-I(N) and NGC 6334-I(NW). The typical separations between cluster members (4000–12000 au) together with the core masses (0.2–100 $M_\odot$) are in agreement with turbulent fragmentation at scales of 0.1 pc. We find that the CMFs (core mass functions) show an excess of massive cores compared to the IMF. Typical uncertainties in temperature or unresolved multiplicity may mimic the observed excess of massive cores. Evidence of mass segregation in NGC 6334-I and NGC 6334-I(N), with the most massive cores located closer to the center, was found. Correlations between the physical properties of the clusters and their evolutionary stage were searched for, and found to show a larger separation between cores in the more evolved clusters, favouring the role of gas expulsion and stellar ejection over time. From these results, we suggest that NGC 6334-I(N) was primordially segregated, while NGC 6334-I may have become mass-segregated over time due to dynamical effects. Finally, the lack of massive cores in the most evolved cluster suggests that the gas reservoir may be already exhausted, while the less evolved clusters still have access to a larger gas mass reservoir. In general, the fragmentation in NGC 6334 at large scales (about 1 pc) is governed by turbulent pressure, while at smaller scales (a few hundred au), thermal pressure regulates the fragmentation process.

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Demographics of disks around young very low-mass stars and brown dwarfs in Lupus

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We present new 890 μm continuum ALMA observations of 5 brown dwarfs (BDs) with infrared excess in Lupus I and III – which, in combination with 4 BDs previously observed, allowed us to study the mm properties of the full known BD disk population of one star-forming region. Emission is detected in 5 out of the 9 BD disks. Dust disk mass, brightness profiles and characteristic sizes of the BD population are inferred from continuum flux and modeling of the observations. Only one source is marginally resolved, allowing for the determination of its disk characteristic size. We conduct a demographic comparison between the properties of disks around BDs and stars in Lupus. Due to the small sample size, we cannot confirm or disprove if the disk mass over stellar mass ratio drops for BDs, as suggested for Ophiuchus. Nevertheless, we find that all detected BD disks have an estimated dust mass between 0.2 and 3.2 $M_\oplus$; these results suggest that the measured solid masses in BD disks can not explain the observed exoplanet population, analogous to earlier findings on disks around more massive stars. Combined with the low estimated accretion rates, and assuming that the mm-continuum emission is a reliable proxy for the total disk mass, we derive ratios of $\dot{M}_{\rm acc}/M_{\rm disk}$

significantly lower than in disks around more massive stars. If confirmed with more accurate measurements of disk gas masses, this result could imply a qualitatively different relationship between disk masses and inward gas transport in BD disks.

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Photometric and spectroscopic study of 5 pre-main sequence stars in the vicinity of NGC 7129

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We present results from long-term optical photometric and spectroscopic observations of 5 pre-main sequence stars, located in the vicinity of the bight nebula NGC 7129. We obtained *UBVRI* photometric observations in the field centered on the star V391 Cep, north-west of the bright nebula NGC 7129. Our multicolor CCD observations spanned the period from February 1998 to November 2016. At the time of our photometric monitoring, a total of thirteen medium-resolution optical spectra of the stars were obtained. The results from our photometric study show that all stars exhibit strong variability in all optical passbands. Long-term light curves of the five stars indicate the typical of classical T Tauri stars variations in brightness with large amplitudes. We did not find any reliable periodicity in the brightness variations of all five stars. The results from spectral observations showed that all studied stars can be classified as a classical T Tauri stars with reach emission line spectra and strong variability in the profiles and intensity of emission lines.

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Time-resolved photometry of the young dipper RX J1604.3-2130A: Unveiling the structure and mass transport through the innermost disk

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RX J1604.3-2130A is a young, dipper-type, variable star in the Upper Scorpius association, suspected to have an inclined inner disk, with respect to its face-on outer disk. We aim to study the eclipses to constrain the inner disk properties. We used time-resolved photometry from the Rapid Eye Mount telescope and Kepler 2 data to study the multi-wavelength variability, and archival optical and infrared data to track accretion, rotation, and changes in disk structure. The observations reveal details of the structure and matter transport through the inner disk. The eclipses show 5d quasi-periodicity, with the phase drifting in time and some periods showing increased/decreased eclipse depth and frequency. Dips are consistent with extinction by slightly processed dust grains in an inclined, irregularly-shaped inner disk locked to the star through two relatively stable accretion structures. The grains are located near the dust sublimation radius ($\sim$0.06 au) at the corotation radius, and can explain the shadows observed in the outer disk. The total mass (gas and dust) required to produce the eclipses and shadows is a few % of a Ceres mass. Such an amount of mass is accreted/replenished by accretion in days to weeks, which explains the variability from period to period. Spitzer and WISE infrared variability reveal variations in the dust content in the innermost disk on a timescale of a few years, which is consistent with small imbalances (compared to the stellar accretion rate) in the matter transport

from the outer to the inner disk. A decrease in the accretion rate is observed at the times of less eclipsing variability and low mid-IR fluxes, confirming this picture. The v$sini$=16 km/s confirms that the star cannot be aligned with the outer disk, but is likely close to equator-on and to be aligned with the inner disk. This anomalous orientation is a challenge for standard theories of protoplanetary disk formation.

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https://arxiv.org/pdf/1911.04938.pdf

X-ray Emission and Disk Irradiation of HL Tau and HD 100546

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We present new X-ray observations of the optically-obscured protostar HL Tau and the intermediate mass Herbig Be star HD 100546. Both objects are surrounded by spectacular disks showing complex morphology including rings and gaps that may have been sculpted by protoplanets. HL Tau was detected as a variable hard X-ray source by Chandra, typical of late-type magnetically-active coronal sources. No extended X-ray emission was seen along the HL Tau jet, or along the jet of the T Tauri binary system XZ Tau located 23 arcsecs to its east. In contrast, HD 100546 was detected by XMM-Newton as a soft X-ray source with no short-term (<1 day) variability. Its X-ray properties are remarkably similar to the Herbig stars AB Aur and HD 163296, strongly suggesting that their X-ray emission arises from the same mechanism and is intrinsic to the Herbig stars themselves, not due to unseen late-type companions. We consider several possible emission mechanisms and conclude that the X-ray properties of HD 100546 are consistent with an accretion shock origin, but higher resolution grating spectra capable of providing information on individual emission lines are needed to more reliably distinguish between accretion shocks and alternatives. We show that X-ray ionization and heating are mainly confined to the upper disk layers in both HL Tau and HD 100546, and any exoplanets near the midplane at distances >1 au are well-shielded from X-rays produced by the central star.

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The Mean Magnetic Field Strength of CI Tau

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We present a blind comparison of two methods to measure the mean surface magnetic field strength of the classical T Tauri star CI Tau based on Zeeman broadening of sensitive spectral lines. Our approach takes advantage of the greater Zeeman broadening at near-infrared compared to optical wavelengths. We analyze a high signal-to-noise, high spectral resolution spectrum from 1.5–2.5um observed with IGRINS (Immersion GRating INfrared Spectrometer) on the Discovery Channel Telescope. Both stellar parameterization with MoogStokes (which assumes an uniform magnetic field) and modeling with SYNTHMAG (which includes a distribution of magnetic field strengths) yield consistent measurements for the mean magnetic field strength of CI Tau is B of $\sim$2.2 kG. This value is typical compared with measurements for other young T Tauri stars and provides an important contribution to the existing sample given it is the only known developed planetary system hosted by a young classical T Tauri star. Moreover, we potentially identify an interesting and suggestive trend when plotting the effective temperature and the mean magnetic field strength of T Tauri stars. While a larger sample is needed for confirmation, this trend appears only for a subset of the sample, which may have implications regarding the magnetic field generation.

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ALMA view of the $^{12}C/^{13}C$ isotopic ratio in starburst galaxies

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We derive molecular-gas-phase $^{12}C/^{13}C$ isotope ratios for the central few hundred parsecs of the three nearby starburst galaxies NGC 253, NGC 1068, and NGC 4945 making use of the $\lambda \sim 3$ mm ^{12}CN and ^{13}CN $N = 1$–0 lines in the ALMA Band 3. The $^{12}C/^{13}C$ isotopic ratios derived from the ratios of these lines range from 30 to 67 with an average of 41.6 ± 0.2 in NGC 253, from 24 to 62 with an average of 38.3 ± 0.4 in NGC 1068, and from 6 to 44 with an average of 16.9 ± 0.3 in NGC 4945. The highest $^{12}C/^{13}C$ isotopic ratios are determined in some of the outskirts of the nuclear regions of the three starburst galaxies. The lowest ratios are associated with the northeastern and southwestern molecular peaks of NGC 253, the northeastern and southwestern edge of the mapped region in NGC 1068, and the very center of NGC 4945. In the case of NGC 1068, the measured ratios suggest inflow from the outer part of NGC 1068 into the circum-nuclear disk through both the halo and the bar. Low $^{12}C/^{13}C$ isotopic ratios in the central regions of these starburst galaxies indicate the presence of highly processed material.

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Exploring the Grain Properties in the Disk of HL Tau with an Evolutionary Model

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We model the ALMA and VLA millimeter radial profiles of the disk around HL Tau to constrain the properties of the dust grains. We adopt the disk evolutionary models of Lynden-Bell & Pringle and calculate their temperature and density structure and emission. These disks are heated by the internal viscosity and irradiated by the central star and a warm envelope. We consider a dust size distribution $n(a)da \propto a^{-3.5}da$, and vary the maximum grain size in the atmosphere and the midplane, $a_{\rm max} = 100$ μm, 1 mm, and 1cm. We also include dust settling and vary the dust-to-gas mass ratio from 1 to 9 times the ISM value. We find that the models that can fit the observed level of emission along the profiles at all wavelengths have an atmosphere with a maximum grain size $a_{\rm max} = 100$ μm, and a midplane with $a_{\rm max} = 1$ cm. The disk substructure, with a deficit of emission in the gaps, can be due to dust properties in these regions that are different from those in the rings. We test an opacity effect (different $a_{\rm max}$) and a dust mass deficit

(smaller dust-to-gas mass ratio) in the gaps. We find that the emission profiles are better reproduced by models with a dust deficit in the gaps, although a combined effect is also possible. These models have a global dust-to-gas mass ratio twice the ISM value, needed to reach the level of emission of the 7.8 mm VLA profile.

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Long lived dust rings around HD169142

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Recent ALMA observations of the protoplanetary disc around HD 169142 reveal a peculiar structure made of concentric dusty rings: a main ring at ∼20 au, a triple system of rings at ∼55-75 au in millimetric continuum emission and a perturbed gas surface density from the ^{12}CO,^{13}CO and $C^{18}O$ (J=2-1) surface brightness profile. In this Letter, we perform three-dimensional numerical simulations and radiative transfer modeling exploring the possibility that two giant planets interacting with the disc and orbiting in resonant locking can be responsible for the origin of the observed dust inner rings structure. We find that in this configuration the dust structure is actually long lived while the gas mass of the disc is accreted onto the star and the giant planets, emptying the inner region. In addition, we also find that the innermost planet is located at the inner edge of the dust ring, and can accrete mass from the disc, generating a signature in the dust ring shape that can be observed in mm ALMA observations.

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Chemical and kinematic structure of extremely high-velocity molecular jets in the Serpens Main star-forming region

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Context. Outflows are one of the first signposts of ongoing star formation. The fastest molecular component of protostellar outflows, extremely high-velocity (EHV) molecular jets, are still puzzling since they are seen only rarely. As they originate deep inside the embedded protostar-disk system, they provide vital information about the outflow-launching process in the earliest stages.

Aim. The first aim is to analyze the interaction between the EHV jet and the slow outflow by comparing their outflow force content. The second aim is to analyze the chemical composition of the different outflow velocity components and to reveal the spatial location of molecules.

Methods. The Atacama Large Millimeter/submillimeter Array (ALMA) 3 mm (Band 3) and 1.3 mm (Band 6) observations of five outflow sources at 0.3 – 0.6 arcsec(130 – 260 au) resolution in the Serpens Main cloud are presented.

Observations of CO, SiO, H_2CO, and HCN reveal the kinematic and chemical structure of those flows. The following three velocity components are distinguished: the slow and the fast wing, and the EHV jet.

Results. Out of five sources, three have the EHV component. The comparison of outflow forces reveals that only the EHV jet in the youngest source, Ser-emb 8 (N), has enough momentum to power the slow outflow. The SiO abundance is generally enhanced with velocity, while HCN is present in the slow and the fast wing, but disappears in the EHV jet. For Ser-emb 8 (N), HCN and SiO show a bow-shock shaped structure surrounding one of the EHV peaks, thus suggesting sideways ejection creating secondary shocks upon interaction with the surroundings. Also, the SiO abundance in the EHV gas decreases with distance from this protostar, whereas it increases in the fast wing. H_2CO is mostly associated with low-velocity gas, but, surprisingly, it also appears in one of the bullets in the Ser-emb 8 (N) EHV jet. No complex organic molecules are found to be associated with the outflows.

Conclusions. The high detection rate suggests that the presence of the EHV jet may be more common than previously expected. The EHV jet alone does not contain enough outflow force to explain the entirety of the outflowing gas. The origin and temporal evolution of the abundances of SiO, HCN, and H_2CO through high-temperature chemistry are discussed. The data are consistent with a low C/O ratio in the EHV gas versus a high C/O ratio in the fast and slow wings.

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Temperature profiles of young disk-like structures: The case of IRAS 16293A

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Temperature is a crucial parameter in circumstellar disk evolution and planet formation because it governs the resistance of the gas to gravitational instability and sets the chemical composition of the planet-forming material. We set out to determine the gas temperature of the young disk-like structure around the Class 0 protostar IRAS 16293–2422A. We used Atacama Large Millimeter/submillimeter Array (ALMA) observations of multiple H_2CS $J = 7 - 6$ and $J = 10 - 9$ lines from the Protostellar Interferometric Line Survey (PILS) to create a temperature map for the inner ∼200 AU of the disk-like structure. This molecule is a particularly useful temperature probe because transitions between energy levels with different K_a quantum numbers operate only through collisions. Based on the H_2CS line ratios, the temperature is between ∼100–175 K in the inner ∼150 AU, and drops to ∼75 K at ∼200 AU. At the current resolution ($0.5''$ ∼70 AU), no jump is seen in the temperature at the disk–envelope interface. The temperature structure derived from H_2CS is consistent with envelope temperature profiles that constrain the temperature from 1000 AU scales down to ∼100 AU, but does not follow the temperature rise seen in these profiles at smaller radii. Higher angular resolution observations of optically thin temperature tracers are needed to establish whether cooling by gas-phase water, the presence of a putative disk, or the dust optical depth influences the gas temperature at $\lesssim$100 AU scales. The temperature at 100 AU is higher in IRAS 16293A than in the embedded Class 0/I disk L1527, consistent with the higher luminosity of the former.

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Multiwavelength Polarimetry of the Filamentary Cloud IC5146: II. Magnetic Field Structures

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The IC5146 cloud is a nearby star-forming region in Cygnus, consisting of molecular gas filaments in a variety of evolutionary stages. We used optical and near-infrared polarization data toward the IC5146 cloud, reported in the first paper of this series, to reveal the magnetic fields in this cloud. Using the newly released Gaia data, we found that the IC5146 cloud may contain two separate clouds: a first cloud, including the densest main filament at a distance of ∼600 pc, and a second cloud, associated with the Cocoon Nebula at a distance of ∼800 pc. The spatially averaged *H*-band polarization map revealed a well-ordered magnetic field morphology, with the polarization segments perpendicular to the main filament but parallel to the nearby sub-filaments, consistent with models assuming that the magnetic field is regulating cloud evolution. We estimated the magnetic field strength using the Davis-Chandrasekhar-Fermi method, and found that the magnetic field strength scales with volume density with a power-law index of ∼0.5 in the density range from $N_{\mathrm{H_2}} \sim 10$ to 3000 cm^{-3}, which indicates an anisotropic cloud contraction with a preferred direction along the magnetic field. In addition, the mass-to-flux ratio of the cloud gradually changes from subcritical to supercritical from the cloud envelope to the deep regions. These features are consistent with strong magnetic field star-formation models and suggest that the magnetic field is important in regulating the evolution of the IC5146 cloud.

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Measurements of Low Temperature Rate Coefficients for the Reaction of CH with CH_2O and Application to Dark Cloud and AGB Stellar Wind Models.

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Rate coefficients have been measured for the reaction of CH radicals with formaldehyde, CH_2O, over the temperature range 31 - 133 K using a pulsed Laval nozzle apparatus combined with pulsed laser photolysis and laser induced fluorescence spectroscopy. The rate coefficients are very large and display a distinct decrease with decreasing temperature below 70 K, although classical collision rate theory fails to reproduce this temperature dependence. The measured rate coefficients have been parameterized and used as input for astrochemical models for both dark cloud and AGB stellar outflow scenarios. The models predict a distinct change (up to a factor of two) in the abundance of ketene, H_2CCO, which is the major expected molecular product of the CH + CH_2O reaction.

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Morphological signatures induced by dust back reaction in discs with an embedded planet

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Recent observations have revealed a gallery of substructures in the dust component of nearby protoplanetary discs, including rings, gaps, spiral arms, and lopsided concentrations. One interpretation of these substructures is the existence of embedded planets. Not until recently, however, most of the modelling effort to interpret these observations ignored the dust back reaction to the gas. In this work, we conduct local-shearing-sheet simulations for an isothermal, inviscid, non-self-gravitating, razor-thin dusty disc with a planet on a fixed circular orbit. We systematically examine the parameter space spanned by planet mass ($0.1M_{\rm th} \leq M_{\rm p} \leq 1M_{\rm th}$, where $M_{\rm th}$ is the thermal mass), dimensionless stopping time ($10^{-3} \leq \tau_{\rm s} \leq 1$), and solid abundance ($0 < Z \leq 1$). We find that when the dust particles are tightly coupled to the gas ($\tau_{\rm s} < 0.1$), the spiral arms are less open and the gap driven by the planet becomes deeper with increasing Z, consistent with a reduced speed of sound in the approximation of a single dust-gas mixture. By contrast, when the dust particles are marginally coupled ($0.1 \lesssim \tau_{\rm s} \lesssim 1$), the spiral structure is insensitive to Z and the gap structure in the gas can become significantly skewed and unidentifiable. When the latter occurs, the pressure maximum radially outside of the planet is weakened or even extinguished, and hence dust filtration by a low-mass ($M_{\rm p} < M_{\rm th}$) planet could be reduced or eliminated. Finally, we find that the gap edges where the dust particles are accumulated as well as the lopsided large-scale vortices driven by a massive planet, if any, are unstable, and they are broken into numerous small-scale dust-gas vortices.

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Dense Cores, Filaments and Outflows in the S255IR Region of High Mass Star Formation

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We investigate at a high angular resolution the spatial and kinematic structure of the S255IR high mass star-forming region, which demonstrated recently the first disk-mediated accretion burst in the massive young stellar object. The observations were performed with ALMA in Band 7 at an angular resolution $\sim 0\farcs1$, which corresponds to $\sim$ 180 AU. The 0.9 mm continuum, $C^{34}S$(7–6) and CCH $N = 4-3$ data show a presence of very narrow ($\sim$ 1000 AU), very dense ($n \sim 10^7$ cm^{-3}) and warm filamentary structures in this area. At least some of them represent apparently dense walls around the high velocity molecular outflow with a wide opening angle from the S255IR-SMA1 core, which is associated with the NIRS3 YSO. This wide-angle outflow surrounds a narrow jet. At the ends of the molecular outflow there are shocks, traced in the SiO(8–7) emission. The SiO abundance there is enhanced by at least 3 orders of magnitude. The CO(3–2) and SiO(8–7) data show a collimated and extended high velocity outflow from another dense core in this area, SMA2. The outflow is bent and consists of a chain of knots, which may indicate periodic ejections possibly arising from a binary system consisting of low or intermediate mass protostars. The $C^{34}S$ emission shows evidence of rotation of the parent core. Finally, we detected two new low mass compact cores in this area (designated as SMM1 and SMM2), which may represent prestellar objects.

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New Jobs

15 Double-degree PhD fellowships in proto-planetary disk and exoplanet research

The fellowships are part of the Marie Sklodowska-Curie Innovative Training Network (ITN) CHAMELEON – 'virtual laboratories for exoplanets and planet forming disks', which combines the expertise of eight European research institutes (Universities of St Andrews, Groningen, Copenhagen, Edinburgh, Leuven and Antwerp, the Max-Planck Institute in Heidelberg and the Netherlands Institute for Space Research) to cover relevant aspects of this complex modelling task, joining the expertise in protoplanetary disks and exoplanetary atmospheres, including observation and interpretation. The network will consist of 15 Early Stage Researchers (PhD students) and the respective supervisors and local research groups. Deadline for applying is February 3, 2020. Starting date is September 1, 2020 or as soon as possible thereafter. Students of all nationalities are welcomed. A detailed description of all the 15 announced PhD fellowships of the network is listed at http://chameleon.wp.st-andrews.ac.uk/recruitment/.

Postdoctoral Position in Star Formation Studies

Applications are invited for a two-year postdoctoral position in star formation studies at The University of Western Ontario. The successful applicant will work with Prof. Shantanu Basu, and experience with computational simulations of present-day star formation or first stars in the universe is preferred.

The applications will be assessed by the background and research interests of the candidate and the synergy of possible research with the Basu group. To apply, please send a cover letter, a cv including a publication list and list of references, and a brief description of research experience and interests, to basu@uwo.ca. Applications will be considered from 3 January, 2020.

A description of ongoing research projects in the group and a list of recent publications can be obtained from http://physics.uwo.ca/~basu/.

Postdoc Position in Star Formation

The Department of Astronomy at the College of Liberal Arts and Sciences is seeking a Post-doctoral Associate in star formation. This position will be working in a project on the formation of the initial mass function led by Dr. Adam Ginsburg and Dr. Elizabeth Lada in the Department of Astronomy.

The applicant must have PhD in astrophysics by the date of appointment. Experience with radio and millimeter data reduction, infrared stellar photometry, and/or stellar population synthesis modeling is preferred. This position will be initially awarded for one year, and, contingent upon strong performance and conduct and availability of funds, may be renewed on a year-to-year contract for up to three years. The salary is competitive and commensurate with qualifications and experience, and includes a full benefits package.

Minimum Qualifications: PhD in astrophysics by the date of appointment.

Preferred Qualifications: Experience with radio and millimeter data reduction, infrared stellar photometry, and/or stellar population synthesis modeling is preferred.

Application Instructions: For full consideration, applications must be submitted online at http://apply.interfolio.com/71803 and must include: (1) a short (limited to three pages) statement of scientific interests, (2) a CV including list of publications, (3) and the names and email addresses for three references must be provided on the application. After initial review, applicants who are chosen to receive further consideration will be asked to request confidential letters of recommendation from the references.

For full consideration, applications should be submitted by January 15, and a decision will be made by February 28, 2020. The position can start as soon as March 1, 2020, but no later than September 1, 2020. For additional information you may address your specific questions to Adam Ginsburg at adamginsburg@ufl.edu.

All candidates for employment are subject to a pre-employment screening which includes a review of criminal records, reference checks, and verification of education.

The selected candidate will be required to provide an official transcript to the hiring department upon hire. A transcript will not be considered 'official' if a designation of 'Issued to Student' is visible. Degrees earned from an educational institution outside of the United States require evaluation by a professional credentialing service provider approved by the National Association of Credential Evaluation Services (NACES), which can be found at http://www.naces.org/.

The University of Florida is an equal opportunity institution dedicated to building a broadly diverse and inclusive faculty and staff. Searches are conducted in accordance with Florida's Sunshine Law. If an accommodation due to disability is needed in order to apply for this position, please call (352) 392-2477 or the Florida Relay System at (800) 955-8771 (TDD).

https://apply.interfolio.com/71803

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.

Star Formation: From Clouds to Discs
A Tribute to the Career of Lee Hartmann

17 - 20 August 2020, Malahide, Ireland

The Dublin Institute for Advanced Studies is proud to announce the upcoming conference **"Star Formation: From Clouds to Discs - A Tribute to the Career of Lee Hartmann"**. It will be held on 17^{th}-20^{th} August, 2020, in Malahide, County Dublin, Ireland.

Scientific Rationale:

Star formation involves many physical processes, scales, and different types of objects, the origin of which are subject to intense debate. How do molecular clouds form and how do they evolve? What are the key processes that define the initial stellar mass function? What are the physical properties of small stellar groups, as well as stellar clusters? How do accretion discs evolve to allow grain growth and planet formation? How is angular momentum redistributed with time from molecular cloud scales down to those of individual stars? What can we learn from episodic accretion and outflow? What is the role of stellar feedback in the rapid dispersal of the parent cloud, as well as in sequential star formation? Our understanding of how stars are born to their dispersal as young moving groups has grown enormously in the last decade. In part this is due to new facilities like ALMA and space observatories such as Herschel and GAIA, but also increasingly more powerful and realistic simulations of the processes involved.

This conference will celebrate the career of Lee Hartmann, who has made enormous contributions to our field during his productive life. For over 3 decades Lee has been a leading pioneer in characterizing the physics of molecular clouds, stars and planet formation. His scientific breadth and impact can be seen in his studies on molecular cloud formation and cloud lifetimes. This has led to a change in our paradigm of star formation towards more rapid evolution. He has been among the first to recognize the importance of accretion and magnetic fields in the phenomena observed in young stars, and has led ground-breaking efforts characterizing these effects. As a tribute to Lee, but also recognizing that we stand on the threshold of a new era with the arrival of JWST, E-ELT and SKA, it is appropriate to take stock of the most fascinating developments in our field, emphasizing those areas where Lee has made significant contributions.

Scientific Organizing Committee:

Javier Ballesteros-Paredes (Co-Chair, UNAM, Mexico), John Bally (U. of Colorado Boulder, USA), Ian Bonnell (U. of St. Andrews, UK), Jerome Bouvier (IPAG, France), Andreas Burkert (LMU, Germany), Nuria Calvet (U. of Michigan, USA), Suzan Edwards (Smith College, USA), Bruce Elmegreen (IBM Research Division, USA), Catherine Espaillat (Boston U., USA), Thomas Henning (MPIA, Germany), Tom Ray (Co-Chair, DIAS, Ireland), Leonardo Testi (ESO, Germany).

Local Organizing Committee:

Alessio Caratti o Garatti, Eileen Flood, Pauline McGinnis, Simon Purser, Devaraj Rangaswamy (all of DIAS, Ireland).

Registration and abstract submission will open on 3^{rd} February, 2020.

For more details, please see: https://www.dias.ie/cloudstodiscs/

Call for Review Proposals: Protostars & Planets VII
Deadline April 1, 2020

Kyoto, April 1 (Thu) - 7 (Wed), 2021

The Protostars Planets series has served the community for more than three decades with state-of-the-art compilations of the current knowledge in the fields of star and planet formation. The previous volume PPVI was published in 2014. Since then, the field of Protostars & Planets has advanced significantly. The next Protostars & Planets conference will take place in Kyoto, Japan, April 1-7, 2021. For more details about the schedule and location, please visit the conference website: http://ppvii.org.

A primary outcome of the conference will be a book of review articles as *"Protostars and Planets VII"*. This announcement is a call for proposals for review chapters in the book and associated talks. **The organizers have defined rules in the submission of proposals, such as "one proposal per person" rule, please refer to the website.** Since the organizers would like to have sufficient time to evaluate the proposals, we ask you to submit proposals by April 1, 2020. The respective deadlines and dates are the following:

Dec. 13, 2019 (this announcement): Call for review chapters and talk proposals
Apr. 1, 2020 (15:00JST): Deadline for the submission of proposals
Oct. 1, 2020: Decision on review chapters and talks
Oct. 1, 2020: Start of registration
Dec. 1, 2020: End of early registration
Feb. 1, 2021: Submission of extended skeleton papers
Mar. 1, 2021: Submission of the final review article
Apr. 1, 2021: Start of PP7 meeting

Scientific Advisory Committee:
João Alves (Austria), Philippe André (France), Isabelle Baraffe (UK), John Carpenter (Chile), Paola Caselli (Germany), Wen-Ping Chen (Taiwan), Kees Dullemond (Germany), Tristan Guillot (France), Alyssa Goodman (USA), Lynne Hillenbrand (USA), Thomas Henning (Germany), Shigeru Ida (Japan), Doug Johnstone (Canada), Inga Kamp (Netherlands), Mark Krumholz (Australia), Jeong-Eun Lee (Korea), Victoria Meadows (USA), Michael Meyer (USA), Richard Nelson (UK), Toshikazu Onishi (Japan), Eve Ostriker (USA), Ilaria Pascucci (USA), Yasuhito Sekine (Japan), Shogo Tachibana (Japan), Mario Tafalla (Spain), Ewine van Dishoeck (Netherland), and Jonathan Williams (USA)

List of Editors:
Shu-ichiro Inutsuka (Nagoya University), Motohide Tamura (University of Tokyo), Yuri Aikawa (University of Tokyo), Takayuki Muto (Kogakuin University), and Kengo Tomida (Osaka University)

AIP Thinkshop on Protoplanetary Disk Chemodynamics

11 - 15 May 2020, Leibnitz Institute for Astrophysics Potsdam, Germany

More information/registration at: https://meetings.aip.de/event/1

Protoplanetary disk dynamics are crucial in defining the ecosystem for planet formation. The shift away from turbulence as the main agent for driving disk evolution towards disk winds has recently gained momentum in the community.

At the same time, both the absence of significant levels of turbulence and the presence of large-scale outflows are gaining observational support. Yet, we are still lacking clear diagnostics for magnetic fields during the T Tauri phase.

The task of extracting useful knowledge about the conditions in planet-forming disks, for instance from molecular-line ALMA data, is paramount. It demands an approach based on forward modelling combined with synthetic observation to understand the relevant dynamical and chemical processes shaping the detected emission features.

Highlighting recent developments, we aim to orient the workshop around this chemo-dynamical link with a special focus on the potential role played by magnetic fields.

Wheel of Star Formation: A conference dedicated to Prof. Jan Palouš

Prague, 14-18th September 2020

https://janfest2020.asu.cas.cz

Dear colleagues,

We would like to announce the forthcoming conference, "Wheel of Star Formation", to be held in Prague in September 2020. This meeting will celebrate the lifetime work and contributions to astronomy of Professor Jan Palouš.

A key area of Jan's research is the gas cycle in galaxies, in particular how star formation influences their evolution. With the advance of new instruments and computational facilities, in recent years there have been many unexpected discoveries from observations and increasingly sophisticated simulations. This brings a desire to think anew about these topics, and try to connect these sometimes conflicting findings with the greater picture of star formation as a major element in the evolution of the Universe. The goal of the meeting is to gather researchers actively working in the field, to present and discuss the latest advances and discoveries, as well as identify the important questions and initiate discussions on their solution strategies. The topics that will be covered in particular are:

- Clusters of galaxies
- Inflow into galaxies
- Formation of molecular clouds, stars, and star clusters
- Stellar kinematics, dynamics, and feedback
- The evolution of structures in the ISM
- Gas loss from galaxies

The meeting will be five days of contributed and invited talks and posters (14th-18th September 2020).

Pre-registration is now open : https://janfest2020.asu.cas.cz/page/registration

Pre-registration can be cancelled at any time. Further announcements will be sent regarding the dates for registration and abstract submission in due course.

The conference will take place in the Refectory Hall of the Conference and Social Centre "House for Professed" located in the historical centre of Prague. It is a beautiful baroque hall that can accommodate up to 160 people. More information can be found on the conference web site.

We look forward to welcoming you to Prague !

On behalf of Janfest2020 Organisers

The Sharpest Eyes on the Sky:
A 2020 vision for high angular resolution astronomy
April 20-24th 2020, University of Exeter, UK

Dear colleagues,

We invite you to join us at the University of Exeter, UK for our conference on high angular resolution astronomy. The conference will focus on discussing the latest scientific results obtained with optical interferometry and other high angular resolution imaging techniques (ALMA, SPHERE, GPI, ...). There will be presentations on operational aspects, ongoing and future instrumentation development activities at CHARA and VLTI, and opportunities to discuss synergies between facilities.

We are charging a fee of GBP (£) 95 per delegate (with financial support from ERC project "ImagePlanetFormDiscs" and the University of Exeter). This cost covers all conference events for the delegate including a ticket for the conference dinner and attendance at one of two excursions we are offering for the Wednesday afternoon. For more information as well as details of how to register your attendance and submit a talk/poster abstract, please visit the conference website at: http://sites.exeter.ac.uk/sharpesteyes2020/

Please note that the deadline for registration and abstract submission is March 6th 2020.

Confirmed Invited Speakers: Arnaud Cassan (IAP Paris, France), Mercedes Filho (University of Porto, Portugal), Violeta Games (University of Leiden, Netherlands), Tyler Gardner (University of Michigan, USA), Doug Gies (Georgia State University, USA), Susanne Hoefner (Uppsala University, Sweden), Evgenia Koumpia (University of Leeds, UK), Jacques Kluska (University of Leuven, Belgium), Sylvestre Lacour (Observatoire de Paris, France), Keiichi Ohnaka (University of Antofagasta, Chile)

Scientific Organisers: Fabien Baron (Georgia State University, USA), Claire Davies (University of Exeter, UK), Sebastian Hoenig (University of Southampton, UK), Stefan Kraus (University of Exeter, UK), Antoine Mérand (European Southern Observatory, Germany), Claudia Paladini (European Southern Observatory, Chile), Rachael Roettenbacher (Yale University, USA), Gail Schaefer (CHARA Array, USA).

Abstract submission deadline

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

Summary of Upcoming Meetings

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

Interstellar Shocks School
22 - 27 March 2020, Les Houches, France
https://www.sciencesconf.org/browse/conference/?confid=8899

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

AIP Thinkshop on Protoplanetary Disk Chemodynamics
11 - 15 May 2020, Leibnitz Institute for Astrophysics Potsdam, Germany
https://meetings.aip.de/event/1

Planet Formation: From Dust Coagulation to Final Orbital Assembly
1 - 26 June 2020, Munich, Germany
http://www.munich-iapp.de/planetformation

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

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

Illuminating the Dusty Universe: A Tribute to the Work of Bruce Draine
6 - 10 July 2020, Florence, Italy
https://web.astro.princeton.edu/IlluminatingTheDusty Universe

The Early Phase of Star Formation
12 - 17 July 2020, Ringberg, Germany
http://www.mpia.de/homes/stein/EPoS/2020/2020.php

Star Formation: From Clouds to Discs - A Tribute to the Career of Lee Hartmann
17 - 20 August 2020, Malahide, Ireland
https://www.dias.ie/cloudstodiscs/

Star Formation in Different Environments 2020
24 - 28 August 2020, Quy Nhon, Vietnam
http://icisequynhon.com/conferences/sfde/

Planetary Science: The Young Solar System
6 - 12 September 2020, Quy Nhon, Vietnam
http://www.icisequynhon.com/conferences/planetary_science/

Wheel of Star Formation: A conference dedicated to Prof. Jan Palouš
14 - 18 September 2020, Prague, Czech Republic
https://janfest2020.asu.cas.cz

Conditions and Impact of Star Formation - Across Times and Scales
28 September - 2 October 2020, Chile
https://astro.uni-koeln.de/symposium-star-formation-2020.html

From Clouds to Planets II: The Astrochemical Link
28 September - 2 October 2020, Berlin, Germany
https://events.mpe.mpg.de/event/12/

The Aftermath of a Revolution: Planet Formation Five Years after HL Tau
7 - 11 December 2020, Chile
https://www.eso.org/sci/meetings/2020/hltau2020.html

Protostars & Planets VII
1 - 7 April 2021, Kyoto, Japan
http://www.ppvii.org

Short Announcements

100th Anniversary of George Herbig

George Herbig was born on January 2, 1920. He was one of the great figures of 20th century astronomy, and when he passed away at age 93, he had succeeded, in a career spanning more than 70 years, to build the foundation upon which our present-day understanding of star birth and young stars rests. His pioneering studies of the T Tauri stars were synthesized in his famous 1962 review, which sparked a general awareness and interest in the nature of young low-mass stars. His identification of intermediate-mass young stars, the Herbig Ae/Be stars, has led to thousands of detailed studies, and his recognition that Herbig-Haro objects move supersonically away from embedded young stars led to an understanding of bipolar outflows from young stars. His 1977 paper on the FU Orionis phenomenon established that early stellar evolution is not a steady progression, but is punctuated by violent episodes. At an age when most people retire, Herbig and his students embarked on a series of observational studies of very young clusters of stars, which supported the idea that star formation in clusters proceeds over an extended period, with low-mass stars forming first, until the birth of massive stars suddenly destroys the stellar cradle and brings further star formation to a rapid halt. Herbig was a brilliant trailblazer, who found and lit the way that he knew future generations would continue to explore.

A scientific biography of George Herbig can be downloaded from http://ifa.hawaii.edu/SP1

The book discusses the circumstances of Herbig's main achievements and puts them into the context of current results. The following lists the chapters of the book:

1 The Budding Astronomer
2 T Tauri Stars
3 Herbig-Haro Objects
4 The Herbig Ae/Be Stars
5 FUors and EXors
6 Clustered Star Formation
7 The Interstellar Medium
8 Molecular Spectroscopy
9 Variable and Exotic Stars
10 From Astronomer to Professor
11 Instruments and Telescopes
12 Closing Remarks

Bo Reipurth