THE STAR FORMATION NEWSLETTER

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The Star Formation Newsletter

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

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Cover Picture

Westerlund 1 is a young massive cluster containing numerous massive stars, including evolved stars like red supergiants and Wolf-Rayet stars. It is located toward the southern constellation Ara at a distance of 4-5 kpc. The image is from the VST Photometric Hα Survey of the Southern Galactic Plane and Bulge (VPHAS+) carried out by ESO.

Image courtesy VPHAS+/Nick Wright.

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

Abstracts of recently accepted papers

Infrared Detection of Abundant CS in the Hot Core AFGL 2591 at High Spectral Resolution with SOFIA/EXES

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We have performed a 5-8 μm spectral line survey of the hot molecular core associated with the massive protostar AFGL 2591, using the Echelon-Cross-Echelle Spectrograph (EXES) on the Stratospheric Observatory for Infrared Astronomy (SOFIA). We have supplemented these data with a ground based study in the atmospheric M band around 4.5 μm using the iSHELL instrument on the Infrared Telescope Facility (IRTF), and the full N band window from 8-13 μm using the Texas Echelon Cross Echelle Spectrograph (TEXES) on the IRTF.
Here we present the first detection of ro-vibrational transitions of CS in this source. The absorption lines are centred on average around -10 kms^{-1} and the line widths of CS compare well with the hot component of ^{13}CO (around 10 kms^{-1}). Temperatures for CS, hot ^{13}CO and ^{12}CO v=1-2 agree well and are around 700 K. We derive a CS abundance of 8×10^{-3} and 2×10^{-6} with respect to CO and H_2 respectively. This enhanced CS abundance with respect to the surrounding cloud (1×10^{-8}) may reflect sublimation of H_2S ice followed by gas-phase reactions to form CS.
Transitions are in LTE and we derive a density of $>10^7$ cm^{-3}, which corresponds to an absorbing region of $<0.04''$. EXES observations of CS are likely to probe deeply into the hot core, to the base of the outflow. Submillimeter and infrared observations trace different components of the hot core as revealed by the difference in systemic velocities, line widths and temperatures, as well as the CS abundance.

Accepted by ApJL

Dynamics of multiple protoplanets embedded in gas/pebble disks and its dependence on Σ and ν parameters

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Protoplanets of Super-Earth sizes may get trapped in convergence zones for planetary migration and form gas giants there. These growing planets undergo accretion heating, which triggers a hot-trail effect that can reverse migration directions, increase eccentricities and prevent resonant captures (Chrenko et al. 2017). We study populations of embryos accreting pebbles using Fargo-Thorin 2D hydrocode.
We find that embryos in a disk with high surface density ($\Sigma_0 = 990$ g cm^{-2}) undergo 'unsuccessful' two-body encounters which do not lead to a merger. Only when a 3rd protoplanet arrives to the convergence zone, three-body encounters lead to mergers. For a low-viscosity disk ($\nu = 5 \times 10^{13}$ cm^2 s^{-1}) a massive coorbital is a possible outcome, for which a pebble isolation develops and the coorbital is stabilised. For more massive protoplanets (5 $M_\oplus$), the convergence radius is located further out, in the ice-giant zone. After a series of encounters, there is an evolution driven by a dynamical

torque of a tadpole region, which is systematically repeated several times, until the coorbital configuration is disrupted and planets merge. This may be a pathway how to solve the problem that coorbitals often form in simulations but they are not observed in nature.
In contrast, the joint evolution of 120 low-mass protoplanets (0.1 $M_\oplus$) reveals completely different dynamics. The evolution is no longer smooth, but rather a random walk. This is because the spiral arms, developed in the gas disk due to Lindblad resonances, overlap with each other and affect not only a single protoplanet but several in the surroundings. Our hydrodynamical simulations may have important implications for N-body simulations of planetary migration that use simplified torque prescriptions and are thus unable to capture protoplanet dynamics in its full glory.

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http://arxiv.org/pdf/1810.03385

Photoevaporation of Molecular Clouds in Regions of Massive Star Formation as Revealed Through H_2 and Brγ Emission

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We examine new and pre-existing wide-field, continuum-corrected, narrowband images in H_2 1–0 S(1) and Brγ of three regions of massive star formation: IC 1396, Cygnus OB2, and Carina. These regions contain a variety of globules, pillars, and sheets, so we can quantify how the spatial profiles of emission lines behave in photodissociation regions (PDRs) that differ in their radiation fields and geometries. We have measured 450 spatial profiles of H_2 and Brγ along interfaces between HII regions and PDRs. Brγ traces photoevaporative flows from the PDRs, and this emission declines more rapidly with distance as the radius of curvature of the interface decreases, in agreement with models. As noted previously, H_2 emission peaks deeper into the cloud relative to Brγ, where the molecular gas absorbs far-UV radiation from nearby O-stars. Although PDRs in IC 1396, Cygnus OB2, and Carina experience orders of magnitude different levels of ionizing flux and have markedly differing geometries, all the PDRs have spatial offsets between Brγ and H_2 on the order of 10^{17} cm. There is a weak negative correlation between the offset size and the intensity of ionizing radiation and a positive correlation with the radius of curvature of the cloud. We can reproduce both the size of the offsets and the dependencies of the offsets on these other variables with simple photoevaporative flow models. Both Brγ and H_2 1–0 S(1) will undoubtedly be targeted in future JWST observations of PDRs, so this work can serve as a guide to interpreting these images.

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Evidence for a massive dust-trapping vortex connected to spirals. Multi-wavelength analysis of the HD 135344B protoplanetary disk

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Context. Spiral arms, rings and large scale asymmetries are structures observed in high resolution observations of protoplanetary disks, and it appears that some of the disks showing spiral arms in scattered light also show asymmetries in millimeter-sized dust. HD 135344B is one such disk. Planets are invoked as the origin of these structures, but no planet has been observed so far and upper limits are becoming more stringent with time.
Aims. We want to investigate the nature of the asymmetric structure in the HD 135344B disk in order to understand the origin of the spirals and of the asymmetry seen in this disk. Ultimately, we aim to understand whether or not one or more planets are needed to explain such structures.
*Methods.*We present new ALMA sub-0.1″ resolution observations at optically thin wavelengths ($\lambda = 2.8$ mm and 1.9 mm) of the HD 135344B disk. The high spatial resolution allows us to unambiguously characterize the mm-dust morphology of the disk. The low optical depth of continuum emission probes the bulk of the dust content of the vortex. Moreover, we have combined the new observations with archival data at shorter wavelengths to perform a multi-wavelength analysis and to obtain information about the dust distribution and properties inside the observed asymmetry.
*Results.*We resolve the asymmetric disk into a symmetric ring + asymmetric crescent, and observe that: (1) the spectral index strongly decreases at the centre of the vortex, consistent with the presence of large grains; (2) for the first time, an azimuthal shift of the peak of the vortex with wavelength is observed; (3) the azimuthal width of the vortex decreases at longer wavelengths, as expected for dust traps. These features allow to confirm the nature of the asymmetry as a vortex. Finally, under the assumption of optically thin emission, a lower limit to the total mass of the vortex is $0.3 M_{\rm Jupiter}$. Considering the uncertainties involved in this estimate, it is possible that the actual mass of the vortex is higher and possibly within the required values ($\sim 4\,{\rm M_{Jupiter}}$) to launch spiral arms similar to those observed in scattered light. If this is the case, the explaining the morphology does not require an outer planet.

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https://arxiv.org/pdf/1809.04160.pdf

The physical and chemical properties of the ρ ophiuchi A dense core

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The physical and chemical properties of the ρ Ophiuchi A core were studied using 1.3 mm continuum and molecular lines such as $C^{18}O$, $C^{17}O$, CH_3OH and H_2CO observed with the Submillimeter Array (SMA). The continuum and $C^{18}O$ data were combined with the single-dish data obtained with the IRAM 30m telescope and the James Clerk Maxwell Telescope (JCMT), respectively. The combined 1.3 mm continuum map reveals three major sources, SM1, SM1N and VLA1623 embedded in the extended emission running along the north-south direction, and two additional compact condensations in the continuum ridge connecting SM1 and VLA1623. The spatial distribution of the $C^{18}O$ emission is significantly different from that of the continuum emission; the $C^{18}O$ emission is enhanced at the eastern and western edges of the continuum ridge, with its peak brightness temperature of 40–50 K. This supports the picture that the ρ-Oph A core is heated externally from the nearby stars Oph S1 and HD147889. In contrast, the $C^{18}O$ intensity is lower than 15–20 K at the center of the ridge where the continuum emission is bright. The $C^{18}O$ abundance decreases inside the ridge, and shows anti-correlation with the N_2H^+ abundance. However, both $C^{18}O$ and N_2H^+ show strong depletion at the Class 0 protostar VLA1623, implying that the dense gas surrounding VLA1623 is colder than the freeze-out temperature of N_2. The blue- and red-shifted components of CH_3OH and H_2CO lines are seen at SM1, suggesting outflow activity of embedded source in SM1, although the spatial distributions do not show clear bipolarity.

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https://arxiv.org/pdf/1810.08226.pdf

Binary planet formation by gas-assisted encounters of planetary embryos

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We present radiation hydrodynamic simulations in which binary planets form by close encounters in a system of several super-Earth embryos. The embryos are embedded in a protoplanetary disk consisting of gas and pebbles and evolve in a region where the disk structure supports convergent migration due to Type I torques. As the embryos accrete pebbles, they become heated and thus affected by the thermal torque (Benítez-Llambay et al. 2015) and the hot-trail effect (Chrenko et al. 2017) which excites orbital eccentricities. Motivated by findings of Eklund & Masset (2017), we assume the hot-trail effect operates also vertically and reduces the efficiency of inclination damping. Non-zero inclinations allow the embryos to become closely packed and also vertically stirred within the convergence zone. Subsequently, close encounters of two embryos assisted by the disk gravity can form transient binary planets which quickly dissolve. Binary planets with a longer lifetime $\sim 10^4$ yr form in 3-body interactions of a transient pair with one of the remaining embryos. The separation of binary components generally decreases in subsequent encounters and due to pebble accretion until the binary merges, forming a giant planet core. We provide an order-of-magnitude estimate of the expected occurrence rate of binary planets, yielding one binary planet per ≈ 2–5×10^4 planetary systems. Therefore, although rare, the binary planets may exist in exoplanetary systems and they should be systematically searched for.

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The viscous evolution of circumstellar discs in young star clusters

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Stars with circumstellar disks may form in environments with high stellar and gas densities which affects the disks through processes like truncation from dynamical encounters, ram pressure stripping, and external photoevaporation. Circumstellar disks also undergo viscous evolution which leads to disk expansion. Previous work indicates that dynamical truncation and viscous evolution play a major role in determining circumstellar disk size and mass distributions. However, it remains unclear under what circumstances each of these two processes dominates. Here we present results of simulations of young stellar clusters taking viscous evolution and dynamical truncations into account. We model the embedded phase of the clusters by adding leftover gas as a background potential which can be present through the whole evolution of the cluster, or expelled after 1 Myr. We compare our simulation results to actual observations of disk sizes, disk masses, and accretion rates in star forming regions. We argue that the relative importance of dynamical truncations and the viscous evolution of the disks changes with time and cluster density. Viscous evolution causes the importance of dynamical encounters to increase in time, but the encounters cease soon after the expulsion of the leftover gas. For the clusters simulated in this work, viscous growth dominates the evolution of the disks.

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Investigating inner and large scale physical environments of IRAS 17008-4040 and IRAS 17009-4042 toward $l = 345.5$ deg, $b = 0.3$ deg

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We present a multi-wavelength observational study of IRAS 17008-4040 and IRAS 17009-4042 to probe the star-formation (SF) mechanisms operational in both the sites. Each IRAS site is embedded within a massive ATLASGAL 870 μm clump ($\sim$2430–2900 $M_\odot$), and several parsec-scale filaments at 160 μm are radially directed toward these clumps (at $T_d \sim$25–32 K). The analysis of the *Spitzer* and VVV photometric data depicts a group of infrared-excess sources toward both the clumps, suggesting the ongoing SF activities. In each IRAS site, high-resolution GMRT radio maps at 0.61 and 1.28 GHz confirm the presence of H II regions, which are powered by B-type stars. In the site IRAS 17008-4040, a previously known O-star candidate without an H II region is identified as an infrared counterpart of the 6.7 GHz methanol maser emission (i.e. IRcmme). Based on the VLT/NACO adaptive-optics L′ image (resolution ∼0.1 arcsec), the source IRcmme is resolved into two objects (i.e. IRcmme1 and IRcmme2) within a scale of 900 AU that are found to be associated with the ALMA core G345.50M. IRcmme1 is characterized as the main accreting HMPO candidate before the onset of an ultracompact H II region. In the site IRAS 17009-4042, the 1.28 GHz map has resolved two radio sources that were previously reported as a single radio peak. Altogether, in each IRAS site, the junction of the filaments (i.e. massive clump) is investigated with the cluster of infrared-excess sources and the ongoing massive SF. These evidences are consistent with the "hub-filament" systems as proposed by Myers (2009).

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colorbluehttps://arxiv.org/pdf/1810.07448.pdf

Analysis of colour and polarimetric variability of RW Aur A in 2010–2018

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Results of $UBVRIJHKLM$ photometry and VRI polarimetry of a young star RW Aur A observed during unprecedented long and deep (up to $\Delta V \approx 5\,$mag) dimming events in 2010–11 and 2014–18 are presented. The polarization degree p of RW Aur A at this period has reached 30 per cent in the I band. As in the case of UX Ori type stars (UXORs), the so-called 'bluing effect' in the colour–magnitude V versus $V-R_{\rm c}$, $V-I_{\rm c}$ diagrams of the star and a strong anticorrelation between p and brightness were observed. But the duration and the amplitude of the eclipses as well as the value and orientation of polarization vector in our case differ significantly from that of UXORs. We concluded that the dimmings of RW Aur A occurred due to eclipses of the star and inner regions of its disc by the axisymmetric dust structure located above the disc and created by the disc wind. Taking into account both scattering and absorption of stellar light by the circumstellar dust, we explain some features of the light curve and the polarization degree – magnitude dependence. We found that near the period of minimal brightness mass-loss rate of the dusty wind was $> 10^{-9}\,{\rm M}_\odot\,{\rm yr}^{-1}$.

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Distances and Kinematics of Gould Belt Star-Forming Regions with Gaia DR2 results

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We present an analysis of the astrometric results from Gaia second data release (DR2) to Young Stellar Objects (YSOs) in star-forming regions related to the Gould Belt. These regions are Barnard 59, Lupus 1 to 4, Chamaeleon I and II, ϵ-Chamaeleontis, the Cepheus flare, IC 5146 and Corona Australis. The mean distance to the YSOs in each region are consistent with earlier estimations, though a significant improvement to the final errors was obtained. The mean distances to the star-forming regions were used to fit an ellipsoid of size $(358\pm7)\times(316\pm13)\times(70\pm4)$ pc, and centered at $(X_0, Y_0, Z_0) = (-82\pm15, 39\pm7, -25\pm4)$ pc, consistent with recently determined parameter of the Gould Belt. The mean proper motions were combined with radial velocities from the literature to obtain the three dimensional motion of the star-forming regions, which are consistent with a general expansion of the Gould Belt. We estimate that this expansion is occurring at a velocity of 2.5 ± 0.1 km s^{-1}. This is the first time that YSOs motions are used to investigate the kinematic of the Gould Belt. As an interesting side result, we also identified stars with

large peculiar velocities.

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Gravitational instabilities in a protosolar-like disc III: molecular line detection and sensitivities

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At the time of formation, protoplanetary discs likely contain a comparable mass to their host protostars. As a result, gravitational instabilities (GIs) are expected to play a pivotal role in the early phases of disc evolution. However, as these young objects are heavily embedded, confirmation of GIs has remained elusive. Therefore, we use the radiative transfer code LIME to produce line images of a 0.17 $M_{\odot}$ self-gravitating protosolar-like disc. We note the limitations of using LIME and explore methods to improve upon the default gridding. We synthesise noiseless observations to determine the sensitivities required to detect the spiral flux, and find that the line flux distribution does not necessarily correlate to the abundance density distribution; hence performing radiative transfer calculations is imperative. Moreover, the spiral features are seen in absorption, due to the GI-heated midplane and high extinction, which could be indicative of GI activity. If a small beamsize and appropriate molecular line are used then spatially resolving spirals in a protosolar-like disc should be possible with ALMA for an on-source time of 30 hr. Spectrally resolving non-axisymmetric structure takes only a tenth as long for a reasonable noise level, but attributing this structure to GI-induced activity would be tentative. Finally, we find that identifying finger-like features in PV diagrams of nearly edge-on discs, which are a direct indicator of spirals, is feasible with an on-source time of 19 hr, and hence likely offers the most promising means of confirming GI-driven spiral structure in young, embedded protoplanetary discs.

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A New Look at T Tauri Star Forbidden Lines: MHD Driven Winds from the Inner Disk

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Magnetohydrodynamic (MHD) and photoevaporative winds are thought to play an important role in the evolution and dispersal of planet-forming disks. We report the first high-resolution ($\Delta v \sim 6$ km s^{-1}) analysis of [S II] λ4068, [O I] λ5577, and [O I] λ6300 lines from a sample of 48 T Tauri stars. Following Simon et al. (2016), we decompose them into three kinematic components: a high-velocity component (HVC) associated with jets, and a low-velocity narrow (LVC-NC) and broad (LVC-BC) components. We confirm previous findings that many LVCs are blueshifted by more than 1.5 km s^{-1} thus most likely trace a slow disk wind. We further show that the profiles of individual components are similar in the three lines. We find that most LVC-BC and NC line ratios are explained by thermally excited gas with temperatures between 5,000–10,000 K and electron densities $\sim 10^7$–10^8 cm^{-3}. The HVC ratios are better reproduced by shock models with a pre-shock H number density of $\sim 10^6$–10^7 cm^{-3}. Using these physical properties, we estimate $\dot{M}_{\rm wind}/\dot{M}_{\rm acc}$ for the LVC and $\dot{M}_{\rm jet}/\dot{M}_{\rm acc}$ for the HVC. In agreement with previous work, the mass carried out in jets is modest compared to the accretion rate. With the likely assumption that the NC wind height is larger than the BC, the LVC-BC $\dot{M}_{\rm wind}/\dot{M}_{\rm acc}$ is found to be higher than the LVC-NC. These results suggest that most of the mass loss occurs close to the central star, within a few au, through an MHD driven wind. Depending on the wind height, MHD winds might play a major role in the evolution of the disk mass.

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Evolution of protoplanetary disks from their taxonomy in scattered light: spirals, rings, cavities, and shadows

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The variety of observed protoplanetary disks in polarimetric light motivates a taxonomical study to constrain their evolution and establish the current framework of this type of observations. We classified 58 disks with available polarimetric observations into six major categories (Ring, Spiral, Giant, Rim, Faint, and Small disks) based on their appearance in scattered light. We re-calculated the stellar and disk properties from the newly available GAIA DR2 and related these properties with the disk categories. More than a half of our sample shows disk sub-structures. For the remaining sources, the absence of detected features is due to their faintness, to their small size, or to the disk geometry. Faint disks are typically found around young stars and typically host no cavity. There is a possible dichotomy in the near-IR excess of sources with spiral-disks (high) and ring-disks (low). Like spirals, shadows are associated with a high near-IR excess. If we account for the pre-main sequence evolutionary timescale of stars with different mass, spiral arms are likely associated to old disks. We also found a loose, shallow declining trend for the disk dust mass with time. Protoplanetary disks may form sub-structures like rings very early in their evolution but their detectability in scattered light is limited to relatively old sources (more than 5 Myr) where the recurrently detected disk cavities allow to illuminate the outer disk. The shallow decrease of disk mass with time might be due to a selection effect, where disks observed thus far in scattered light are typically massive, bright transition disks with longer lifetime than most disks. Our study points toward spirals and shadows being generated by planets of fraction-to-few Jupiter masses that leave their (observed) imprint on both the inner disk near the star and the outer disk cavity.

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ALMA detects a radial disk wind in DG Tau

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Aims. We aim to use the high spatial resolution of the Atacama Large Millimeter/submillimeter Array (ALMA) to map the flow pattern of molecular gas near DG Tau and its disk, a young stellar object driving a jet and a molecular outflow.
Methods. We use observations from ALMA in the $J = 2$–1 transition of ^{12}CO, ^{13}CO, and $C^{18}O$ to study the Keplerian disk of DG Tau and outflows that may be related to the disk and the jet.
Results. We find a new wind component flowing radially at a steep angle ($\sim 25°$ from the vertical) above the disk with a velocity of ~ 3.1 km s^{-1}. It continues the trend of decreasing velocity for increasing distance from the jet axis ("onion-like velocity structure").
Conclusions. The new component is located close to the protostellar disk surface and may be related to photoevaporative winds.

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Temperature spectra of interstellar dust grains heated by cosmic-rays II: dark cloud cores

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Cosmic-ray (CR) induced heating of whole interstellar grains is an important desorption mechanism for grain surface molecules in interstellar molecular clouds. This study aims to provide a detailed temperature spectra for such CR-induced heating. For this, olivine grains with radius of 0.05, 0.1 and 0.2 μm shielded by interstellar gas with isotropic column densities characteristic to dark cores were considered. The accumulation of an ice mantle of increasing thickness was taken into account. The CR energy spectra was obtained for these column densities for 32 cosmic-ray constituents. We calculated the frequencies with which a CR nucleus with a known energy hits a grain, depositing a certain amount of energy. As a result, we obtain the energy and temperature spectra for grains affected by CR hits. This allows to improve the existing approaches on CR-induced whole-grain heating in astrochemical modeling.

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Impacts of dust feedback on a dust ring induced by a planet in a protoplanetary disk

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When a planet forms a deep gap in a protoplanetary disk, dust grains cannot pass through the gap. As a consequence, the density of the dust grains can increase up to the same level of the density of the gas at the outer edge. The feedback on the gas from the drifting dust grains is not negligible, in such a dusty region. We carried out two-dimensional two-fluid (gas and dust) hydrodynamic simulations. We found that when the radial flow of the dust grains across the gap is halted, a broad ring of the dust grains can be formed because of the dust feedback and the diffusion of the dust grains. The minimum mass of the planet to form the broad dust ring is consistent with the pebble-isolation mass, in the parameter range of our simulations. The broad ring of the dust grains is good environment for the formation of the protoplanetary solid core. If the ring is formed in the disk around the sun-like star at $\sim$2 AU, a massive solid core ($\sim$50 $M_\oplus$) can be formed within the ring, which may be connected to the formation of Hot Jupiters holding a massive solid core such as HD 149026b. In the disk of the dwarf star, a number of Earth-sized planets can be formed within the dust ring around $\sim$0.5 AU, which potentially explain the planet system made of multiple Earth-sized planets around the dwarf star such as TRAPPIST-1.

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Distortion of Magnetic Fields in a Starless Core V: Near-infrared and Submillimeter Polarization in FeSt 1-457

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The relationship between submillimeter (submm) dust emission polarization and near-infrared (NIR) H-band polarization produced by dust dichroic extinction was studied for the cold starless dense core FeSt 1-457. The distribution of polarization angles (90°-rotated for submm) and degrees were found to be very different between at submm and NIR wavelengths. The mean polarization angles for FeSt 1-457 at submm and NIR wavelengths are $132.1^\circ \pm 22.0^\circ$ and $2.7^\circ \pm 16.2^\circ$, respectively. The correlation between P_H and A_V was found to be linear from outermost regions to relatively dense line of sight of $A_V \approx 25$ mag, indicating that NIR polarization reflects overall polarization (magnetic field) structure of the core at least in this density range. The flat P_H/A_V versus A_V correlations were confirmed, and the polarization efficiency was found to be comparable to the observational upper limit (Jones 1989). On the other hand, as reported by Alves et al., submm polarization degrees show clear linearly decreasing trend against A_V from $A_V \approx 20$ mag to the densest center ($A_V \approx 41$ mag), appearing as "polarization hole" structure. The power law index for the $P_{\rm submm}$ versus A_V relationship was obtained to be ≈ -1, indicating that the alignment for the submm sensitive dust is lost. These very different polarization distributions at submm and NIR wavelengths suggest that (1) there is different radiation environment at these wavelengths or (2) submm-sensitive dust is localized or the combination of them.

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Extremely Dense Cores associated with Chandra Sources in Ophiuchus A: Forming Brown Dwarfs Unveiled?

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On the basis of various data such as ALMA, JVLA, Chandra, *Herschel*, and *Spitzer*, we confirmed that two protostellar candidates in Oph-A are bona fide protostars or proto-brown dwarfs (proto-BDs) in extremely early evolutionary stages. Both objects are barely visible across infrared (IR, i.e., near-IR to far-IR) bands. The physical nature of the cores is very similar to that expected in first hydrostatic cores (FHSCs), objects theoretically predicted in the evolutionary phase prior to stellar core formation with gas densities of $\sim 10^{11-12}$ cm^{-3}. This suggests that the evolutionary stage is close to the FHSC formation phase. The two objects are associated with faint X-ray sources, suggesting that they are in very early phase of stellar core formation with magnetic activity. In addition, we found the CO outflow components around both sources which may originate from the young outflows driven by these sources. The masses of these objects are calculated to be $\sim$0.01–0.03 $M_\odot$ from the dust continuum emission. Their physical properties are consistent with that expected from the numerical model of forming brown dwarfs. These facts (the X-ray detection, CO outflow association, and FHSC-like spectral energy distributions) strongly indicate that the two objects are proto-BDs or will be in the very early phase of protostars which will evolve more massive protostars if they gain enough mass from the surroundings. The ages of these two objects are likely to be within $\sim 10^3$ years after the protostellar core (or second core) formation, taking into account the outflow dynamical times ($\lesssim$500 yrs).

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A Spatially Resolved AU-scale Inner Disk around DM Tau

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We present Atacama Large Millimeter/submillimeter Array (ALMA) observations of the dust continuum emission at 1.3 mm and ^{12}CO J=2–1 line emission of the transitional disk around DM Tau. DM Tau's disk is thought to possess a dust-free inner cavity inside a few au, from the absence of near-infrared excess on its spectral energy distribution (SED). Previous submillimeter observations were, however, unable to detect the cavity; instead, a dust ring ∼20 au in radius was seen. The excellent angular resolution achieved in the new ALMA observations, 43 × 31 mas, allows discovery of a 4 au radius inner dust ring, confirming previous SED modeling results. This inner ring is symmetric in continuum emission, but asymmetric in ^{12}CO emission. The known (outer) dust ring at ∼20 au is recovered and shows azimuthal asymmetry with a strong-weak side contrast of ∼1.3. The gap between these two rings is depleted by a factor of ∼40 in dust emission relative to the outer ring. An extended outer dust disk is revealed, separated from the outer ring by another gap. The location of the inner ring is comparable to that of the main asteroid belt in the solar system. As a disk with a "proto-asteroid belt," the DM Tau system offers valuable clues to disk evolution and planet formation in the terrestrial planet forming region.

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The Role of Gravity in Producing Power-Law Mass Functions

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Numerical simulations of star formation have found that a power-law mass function can develop at high masses. In a previous paper, we employed isothermal simulations which created large numbers of sinks over a large range in masses to show that the power law exponent of the mass function, $dN/d\log M \propto M^{\Gamma}$, asymptotically and accurately approaches $\Gamma = --1$. Simple analytic models show that such a power law can develop if the mass accretion rate $\dot{M} \propto M^2$, as in Bondi-Hoyle accretion; however, the sink mass accretion rates in the simulations show significant departures from this relation. In this paper we show that the expected accretion rate dependence is more closely realized provided the gravitating mass is taken to be the sum of the sink mass and the mass in the near environment. This reconciles the observed mass functions with the accretion rate dependencies, and demonstrates that power-law upper mass functions are essentially the result of gravitational focusing, a mechanism present in, for example, the competitive accretion model.

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Gaps and Rings in an ALMA Survey of Disks in the Taurus Star-forming Region

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Rings are the most frequently revealed substructure in ALMA dust observations of protoplanetary disks, but their origin is still hotly debated. In this paper, we identify dust substructures in 12 disks and measure their properties to investigate how they form. This subsample of disks is selected from a high-resolution ($\sim 0.12''$) ALMA 1.33 mm survey of 32 disks in the Taurus star-forming region, which was designed to cover a wide range of sub-mm brightness and to be unbiased to previously known substructures. While axisymmetric rings and gaps are common within our sample, spiral patterns and high contrast azimuthal asymmetries are not detected. Fits of disk models to the visibilities lead to estimates of the location and shape of gaps and rings, the flux in each disk component, and the size of the disk. The dust substructures occur across a wide range of stellar mass and disk brightness. Disks with multiple rings tend to be more massive and more extended. The correlation between gap locations and widths, the intensity contrast between rings and gaps, and the separations of rings and gaps could all be explained if most gaps are opened by low-mass planets (super-Earths and Neptunes) in the condition of low disk turbulence ($\alpha = 10^{-4}$). The gap locations are not well correlated with the expected locations of CO and N_2 ice lines, so condensation fronts are unlikely to be a universal mechanism to create gaps and rings, though they may play a role in some cases.

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Lack of high-mass prestellar cores in the starless MDCs of NGC6334

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Two families of models compete to explain the formation of high-mass stars. The quasi-static models predict the existence of high-mass pre-stellar cores sustained by a high degree of turbulence while competitive accretion models predict that high-mass proto-stellar cores evolve from low/intermediate mass proto-stellar cores in dynamic environments. We present ALMA (1.4 mm continuum emission and ^{12}CO emission line) and MOPRA (HCO^+, $H^{13}CO^+$ and N_2H^+ molecular line emissions) observations of a sample of 9 starless massive dense cores (MDCs) discovered in a recent Herschel/HOBYS study that have masses and sizes ($\sim$110 $M_\odot$ and $r \sim 0.1$ pc, respectively) similar to the initial conditions used in the quasi-static models. The MOPRA molecular line features show that 3 of the starless MDCs are subvirialized with $\alpha_{\rm vir} \sim 0.35$, and 4 MDCs show sign of collapse. Our ALMA observations, on the other hand, show very little fragmentation within the MDCs whereas the observations resolve the Jeans length ($\lambda_{\rm Jeans} \sim 0.03$ pc) and are sensitive to the Jeans mass ($M_{\rm Jeans} \sim 0.65\ M_\odot$) in the 9 starless MDCs. Only two of the starless MDCs host compact continuum sources, whose fluxes correspond to $< 3\ M_\odot$ fragments. Therefore the mass reservoir of the MDCs has not yet been accreted onto compact objects, and most of the emission is filtered out by the interferometer. These observations do not support the quasi-static models for high-mass star formation since no high-mass pre-stellar core is found in NGC6334. The competitive accretion models, on the other hand, predict a level of fragmentation much higher than what we observe.

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Chasing discs around O-type (proto)stars - ALMA evidence for an SiO disc and disc wind from G17.64+0.16

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We present high angular resolution 0.2 arcsec continuum and molecular emission line Atacama Large Millimeter/submillimeter Array (ALMA) observations of G17.64+0.16 in Band 6 (220GHz) taken as part of a campaign in search of circumstellar discs around (proto)-O-stars. At a resolution of 400au the main continuum core is essentially unresolved and isolated from other strong and compact emission peaks. At a resolution of 400au the main continuum core is essentially unresolved and isolated from other strong and compact emission peaks. We detect SiO (5-4) emission that is marginally resolved and elongated in a direction perpendicular to the large-scale outflow seen in the ^{1}3CO (2-1) line using the main ALMA array in conjunction with the Atacama Compact Array (ACA). Morphologically, the SiO appears to represent a disc-like structure. Using parametric models we show that the position-velocity profile of the SiO is consistent with the Keplerian rotation of a disc around an object between 10-30Mo in mass, only if there is also radial expansion from a separate structure. The radial motion component can be interpreted as a disc wind from the disc surface. Models with a central stellar object mass between 20 and 30Mo are the most consistent with the stellar luminosity (1x10^5 Lo) and indicative of an O-type star. The H30a millimetre recombination line (231.9GHz) is also detected, but spatially unresolved, and is indicative of a very compact, hot, ionised region co-spatial with the dust continuum core. Accounting for all observables, we suggest that G17.64 is consistent with a O-type young stellar object in the final stages of protostellar assembly, driving a wind, but that has not yet developed into a compact HII region. The existance and detection of the disc in G17.64 is likely related to its isolated and possibly more evolved nature, traits which may underpin discs in similar sources.

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Characterizing young protostellar disks with the CALYPSO IRAM-PdBI survey: large Class 0 disks are rare

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Understanding the formation mechanisms of protoplanetary disks and multiple systems and also their pristine properties are key questions for modern astrophysics. The youngest disks are embedded in rotating infalling protostellar envelopes, and their properties have largely remained unconstrained up to now.
We aim to observe the youngest protostars with a spatial resolution that is high enough to resolve and characterize the progenitors of protoplanetary disks. This can only be achieved using submillimeter and millimeter interferometric facilities. In the framework of the IRAM Plateau de Bure Interferometer survey CALYPSO, we have obtained subarcsecond observations of the dust continuum emission at 231 GHz and 94 GHz for a sample of 16 solar-type Class 0 protostars.
In an attempt to identify disk-like structures embedded at small scales in the protostellar envelopes, we modeled the dust continuum emission visibility profiles using Plummer-like envelope models and envelope models that include additional Gaussian disk-like components.
Our analysis shows that in the CALYPSO sample, less than 25% of the Class 0 protostars may harbor resolved disk-like dust continuum structures at radii $>$ 60 au. Including all available literature constraints on Class 0 disks at subarcsecond scales, we show that our results are representative: most ($>$ 72% in a sample of 25 protostars) Class 0 protostellar disks are small and emerge only at radii $<$ 60 au. We find a multiplicity fraction of the CALYPSO protostars $\gtrsim$57% $\pm$ 10% at the scales 100–5000 au, which generally agrees with the multiplicity properties of Class I protostars at similar scales.
We compare our observational constraints on the disk size distribution in Class 0 protostars to the typical disk properties from protostellar formation models. If Class 0 protostars contain similar rotational energy as is currently estimated for prestellar cores, then hydrodynamical models of protostellar collapse systematically predict a high occurrence of large disks. Our observations suggest that these are rarely observed, however. Because they reduce the centrifugal radius and produce a disk size distribution that peaks at radii $<$ 100 au during the main accretion phase, magnetized models of rotating protostellar collapse are favored by our observations.

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ALMA Reveals a Misaligned Inner Gas Disk inside the Large Cavity of a Transitional Disk

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Pairs of azimuthal intensity decrements at near symmetric locations have been seen in a number of protoplanetary disks. They are most commonly interpreted as the two shadows cast by a highly misaligned inner disk. Direct evidence of such an inner disk, however, remain largely illusive, except in rare cases. In 2012, a pair of such shadows were discovered in scattered light observations of the near face-on disk around 2MASS J16042165−2130284, a transitional object with a cavity ∼60 AU in radius. The star itself is a 'dipper', with quasi-periodic dimming events on its light curve, commonly hypothesized as caused by extinctions by transiting dusty structures in the inner disk. Here, we report the detection of a gas disk inside the cavity using ALMA observations with $\sim0\farcs2$ angular resolution. A twisted butterfly pattern is found in the moment 1 map of CO (3–2) emission line towards the center, which is the key signature of a high misalignment between the inner and outer disks. In addition, the counterparts of the shadows are seen in both dust continuum emission and gas emission maps, consistent with these regions being cooler than their surroundings. Our findings strongly support the hypothesized misaligned-inner-disk origin of the shadows in the J1604−2130 disk. Finally, the inclination of inner disk would be close to $-45°$ in contrast with $45°$; it is possible that its internal asymmetric structures cause the variations on the light curve of the host star.

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Spectro-astrometry of the pre-transitional star LkCa 15 does not reveal an accreting planet but extended Hα emission

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Context: The detection of forming planets in protoplanetary disks around young stars remains elusive, and state-of-the-art observational techniques provide somewhat ambiguous results. The pre-transitional T Tauri star LkCa 15 is an excellent example. It has been reported that it could host three planets; candidate planet b is in the process of formation, as inferred from its Hα emission. However, a more recent work casts doubts on the planetary nature of the previous detections.
Aims: We test the potential of spectro-astrometry in Hα as an alternative observational technique to detect forming planets around young stars, taking LkCa 15 as a reference case.
Methods: LkCa 15 was observed with the ISIS spectrograph at the 4.2m William Herschel Telescope (WHT). The slit was oriented towards the last reported position of LkCa 15 b (parallel direction) and 90° from that (perpendicular). The photocenter and full width half maximum (FWHM) of the Gaussians fitting the spatial distribution at Hα and the adjacent continuum were measured. A well-known binary (GU CMa) was used as a calibrator to test the spectro-astrometric performance of ISIS/WHT.
Results: A consistent spectro-astrometric signature is recovered for GU CMa. However, the photocenter shift predicted for LkCa 15 b is not detected, but the FWHM in Hα is broader than in the continuum for both slit positions. Our simulations show that the photocenter and FWHM observations cannot be explained simultaneously by an accreting planet, but the lack of photocenter shift alone could still be consistent with an emitting planet with contrast > 5.5

mags in Hα or < 6 mag in the adjacent continuum. In turn, both spectro-astrometric observations are naturally reproduced from a roughly symmetric Hα emitting region centered on the star and extent comparable to the orbit originally attributed to the planet at several au.
Conclusions: The extended Hα emission around LkCa 15 could be related to a variable disk wind, but additional multi-epoch data and detailed modeling are necessary to understand its physical nature. Optical spectro-astrometry carried out with mid-size telescopes is capable of probing small-scale structures in relatively faint young stars that are not easily accessible with state-of-the-art instrumentation mounted on larger telescopes. Therefore, spectro-astrometry in Hα is able to test the presence of accreting planets and can be used as a complementary technique to survey planet formation in circumstellar disks.

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Constraining the period of the ringed secondary companion to the young star J1407 with photographic plates

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Context. The 16 Myr old star 1SWASP J140747.93−394542.6 (V1400 Cen) underwent a series of complex eclipses in May 2007, interpreted as the transit of a giant Hill sphere filling debris ring system around a secondary companion, J1407b. No other eclipses have since been detected, although other measurements have constrained but not uniquely determined the orbital period of J1407b. Finding another eclipse towards J1407 will help determine the orbital period of the system, the geometry of the proposed ring system and enable planning of further observations to characterize the material within these putative rings.
Aims. We carry out a search for other eclipses in photometric data of J1407 with the aim of constraining the orbital period of J1407b.
Methods. We present photometry from archival photographic plates from the Harvard DASCH survey, and Bamberg and Sonneberg Observatories, in order to place additional constraints on the orbital period of J1407b by searching for other dimming and eclipse events. Using a visual inspection of all 387 plates and a period-folding algorithm we performed a search for other eclipses in these data sets.
Results. We find no other deep eclipses in the data spanning from 1890 to 1990, nor in recent time-series photometry from 2012–2018.
Conclusions. We rule out a large fraction of putative orbital periods for J1407b from 5 to 20 years. These limits are still marginally consistent with a large Hill sphere filling ring system surrounding a brown dwarf companion in a bound elliptical orbit about J1407. Issues with the stability of any rings combined with the lack of detection of another eclipse, suggests that J1407b may not be bound to J1407.

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Is the ring inside or outside the planet?: The effect of planet migration on dust rings

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Planet migration in protoplanetary discs plays an important role in the longer term evolution of planetary systems, yet we currently have no direct observational test to determine if a planet is migrating in its gaseous disc. We explore the formation and evolution of dust rings — now commonly observed in protoplanetary discs by ALMA — in the presence of relatively low mass (12–60 Earth masses) migrating planets. Through two dimensional hydrodynamical simulations using gas and dust we find that the importance of perturbations in the pressure profile interior and exterior to the planet varies for different particle sizes. For small sizes a dust enhancement occurs interior to the planet, whereas it is exterior to it for large particles. The transition between these two behaviours happens when the dust drift velocity is comparable to the planet migration velocity. We predict that an observational signature of a migrating planet consists of a significant outwards shift of an observed midplane dust ring as the wavelength is increased.

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A Centimeter-wave Study of Methanol and Ammonia Isotopologues in Sgr B2(N): Physical and chemical differentiation between two hot cores

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We present new radio-frequency interferometric maps of emission from the $^{14}NH_3$, $^{15}NH_3$, and $^{14}NH_2D$ isotopologues of ammonia, and the $^{12}CH_3OH$ and $^{13}CH_3OH$ isotopologues of methanol toward Sgr B2(N). With a resolution of $\sim 3''$ (0.1 pc), we are able to spatially resolve emission from two hot cores in this source and separate it from absorption against the compact HII regions in this area. The first (N1) is the well-known $v = 64$ km s^{-1} core, and the second (N2) is a core $6''$ to the north at $v = 73$ km s^{-1}. Using emission from $^{15}NH_3$, and hyperfine satellites of $^{14}NH_3$ metastable transitions we estimate the $^{14}NH_3$ column densities of these sources and compare them to those of $^{14}NH_2D$. We find that the ammonia deuteration fraction of N_2 is roughly 10–20 times higher than in N1. We also measure an $[^{15}NH_3/^{14}NH_3]$ abundance ratio that is apparently 2–3 times higher in N2 than N1, which could indicate a correspondingly higher degree of nitrogen fractionation in N2. In addition, we find that N2 has a factor of 7 higher methanol abundance than N1. Together, these abundance signatures suggest that N2 is a younger source, for which species characteristic of grain chemistry at low temperatures are currently being actively liberated from ice mantles, and have not yet reached chemical equilibrium in the warm gas phase. The high D abundance and possible high ^{15}N abundance in NH_3 found in N2 are interesting for studying the potential interstellar origin of abundances in primitive solar system material.

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The Dense Gas Fraction in Galactic Center Clouds

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We present an analysis of gas densities in the central R=300 parsecs of the Milky Way, focusing on three clouds: GCM−0.02−0.07 (the 50 km s^{-1} cloud), GCM−0.13−0.08 (the 20 km s^{-1} cloud), and GCM0.25+0.01 (the "Brick"). Densities are determined using observations of the J = (3–2), (4–3), (5–4), (10–9), (18–17), (19–18), (21–20), and (24–23) transitions of the molecule HC_3N. We find evidence of at least two excitation regimes for HC_3N and constrain the low-excitation component to have a density less than 10^4 cm^{-3} and the high-excitation component to have a density between 10^5 and 10^6 cm^{-3}. This is much less than densities of 10^7 cm^{-3} that are found in Sgr B2, the most actively star-forming cloud in the Galactic center. This is consistent with the requirement of a higher density threshold for star formation in the Galactic center than is typical in the Galactic disk. We are also able to constrain the column density of each component in order to determine the mass fraction of 'dense' ($n > 10^5$ cm^{-3}) gas for these clouds. We find that this is ∼15% for all three clouds. Applying the results of our models to ratios of the (10–9) and (3–2) line across the entire central R=300 pc, we find that the fraction of gas with $n > 10^4$ cm^{-3} increases inward of a radius of ∼140 pc, consistent with the predictions of recent models for the gas dynamics in this region. Our observations show that HC3N is an excellent molecule for probing the density structure of clouds in the Galactic center.

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Magnetic Field Structure in Spheroidal Star-Forming Clouds

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A model of magnetic field structure is presented to help test the prevalence of flux freezing in star-forming clouds of various shapes, orientations, and degrees of central concentration, and to estimate their magnetic field strength. The model is based on weak-field flux freezing in centrally condensed Plummer spheres and spheroids of oblate and prolate shape. For a spheroid of given density contrast, aspect ratio, and inclination, the model estimates the local field strength and direction, and the global field pattern of hourglass shape. Comparisons with a polarization simulation indicate typical angle agreement within 1 - 10 degrees. Scalable analytic expressions are given to match observed polarization patterns, and to provide inputs to radiative transfer codes for more accurate predictions. The model may apply to polarization observations of dense cores, elongated filamentary clouds, and magnetized circumstellar disks.

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Star Cluster Detection and Characterization using Generalized Parzen Density Estimation

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Star cluster studies hold the key to understanding star formation, stellar evolution, and origin of galaxies. The detection and characterization of clusters depend on the underlying background density and the cluster richness. We examine the ability of the Parzen Density Estimation (a.k.a. Parzen Windows) method, which is a generalization of the well-known Star Count method, to detect clusters and measure their properties. We apply it on a range of simulated and real star fields, considering square and circular windows, with and without Gaussian kernel smoothing.

Our method successfully identifies clusters and we suggest an optimal standard deviation of the Gaussian Parzen window for obtaining the best estimates of these parameters. Finally, we demonstrate that the Parzen Windows with Gaussian kernels are able to detect small clusters in regions of relatively high background density where the Star Count method fails.

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Detection of a high-mass prestellar core candidate in W43-MM1

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Aims. To constrain the physical processes that lead to the birth of high-mass stars it is mandatory to study the very first stages of their formation. We search for high-mass analogs of low-mass prestellar cores in W43-MM1.
Methods. We conducted a 1.3 mm ALMA mosaic of the complete W43-MM1 cloud, which has revealed numerous cores with ∼2000 au FWHM sizes. We investigated the nature of cores located at the tip of the main filament, where the clustering is minimum. We used the continuum emission to measure the core masses and the $^{13}CS(5–4)$ line emission to estimate their turbulence level. We also investigated the prestellar or protostellar nature of these cores by searching for outflow signatures traced by CO(2–1) and SiO(5–4) line emission, and for molecular complexity typical of embedded hot cores.
Results. Two high-mass cores of ∼1300 au diameter and ∼60 $M_\odot$ mass are observed to be turbulent but gravitationally bound. One drives outflows and is associated with a hot core. The other core, W43-MM1#6, does not yet reveal any star formation activity and thus is an excellent high-mass prestellar core candidate.

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Turbulent action at a distance due to stellar feedback in magnetized clouds

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A fundamental property of molecular clouds is that they are turbulent, but how this turbulence is generated and maintained is unknown. One possibility is that stars forming within the cloud regenerate turbulence via their outflows, winds and radiation ('feedback'). However, disentangling motions created by feedback from the initial cloud turbulence is challenging. Here, we confront the relationship between stellar feedback and turbulence by identifying and separating the local and global impact of stellar winds. We analyse magnetohydrodynamic simulations in which we track wind material as it interacts with the ambient cloud. By distinguishing between launched material, gas entrained by the wind and pristine gas we show energy is transferred away from the sources via magnetic waves excited by the expanding wind shells. This action at a distance enhances the fraction of stirring motion compared with compressing motion and produces a flatter velocity power spectrum. We conclude that stellar feedback accounts for significant energy transfer within molecular cloudsan impact enhanced by magnetic waves, which have previously been neglected by observations. Overall, stellar feedback can partially offset global turbulence dissipation.

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SMA line observations of the CH_3OH-maser outflow in DR21(OH)

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We present a (sub)millimeter line survey of the methanol maser outflow located in the massive star-forming region DR21(OH) carried out with the Submillimeter Array (SMA) at 217/227 GHz and 337/347 GHz. We find transitions from several molecules towards the maser outflow such as CH_3OH, H_2CS, $C^{17}O$, $H^{13}CO^+$ and $C^{34}S$. However, with the present observations, we cannot discard the possibility that some of the observed species such as $C^{17}O$, $C^{34}S$, and H_2CS, might be instead associated with the compact and dusty continuum sources located in the MM2 region. Given that most of transitions correspond to methanol lines, we have computed a rotational diagram with CASSIS and a LTE synthetic spectra with XCLASS for the detected methanol lines in order to estimate the rotational temperature and column density in small solid angle of the outflow where enough lines are present. We obtain a rotational temperature of 28 ± 2.5K and a column density of $6.0 \pm 0.9 \times 10^{15}$ cm^{-2}. These values are comparable to those column densities/rotational temperatures reported in outflows emanating from low-mass stars. Extreme and moderate physical conditions to excite the maser and thermal emission coexist within the CH_3OH flow. Finally, we do not detect any complex molecules associated with the flow, e.g., CH3OCHO, (CH3)2CO, and CH_3CH_2CN.

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HAZMAT. IV. Flares and Superflares on Young M Stars in the Far Ultraviolet

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M stars are powerful emitters of far-ultraviolet light. Over long timescales, a significant, possibly dominant, fraction of this emission is produced by stellar flares. Characterizing this emission is critical to understanding the atmospheres of the stars producing it and the atmospheric evolution of the orbiting planets subjected to it. Ultraviolet emission is known to be elevated for several hundred million years after M stars form. Whether the same is true of ultraviolet flare activity is a key concern for the evolution of exoplanet atmospheres. Hubble Space Telescope (HST) observations by the HAZMAT program (HAbitable Zones and M dwarf Activity across Time) detected 18 flares on young (40 Myr) early M stars in the Tucana-Horologium association over 10 h of observations, ten having energy $> 10^{30}$ erg. These imply flares on young M stars are 100–1000× more energetic than those occurring at the same rate on "inactive," field-age M dwarfs. However, when energies are are normalized by quiescent emission there is no statistical difference between the young and field-age samples. The most energetic flare observed, dubbed the "Hazflare," emitted an energy of $10^{32.1}$ erg in the FUV, 30× more energetic than any stellar flare previously observed in the FUV with HST's COS or STIS spectrographs. It was accompanied by 15,500±400 K blackbody emission bright enough to designate it a superflare ($E > 10^{33}$ erg), with an estimated bolometric energy of $10^{33.6^{+0.1}_{-0.2}}$ erg. This blackbody emitted 18^{+2}_{-1}% of its flux in the FUV (912–1700 Å) where molecules are generally most sensitive to photolysis. Such hot superflares in young, early M stars could play an important role in the evolution of nascent planetary atmospheres.

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Identification of V735 Sgr as an Active Herbig Ae/Be Object

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V735 Sgr was known as an enigmatic star with rapid brightness variations. Long-term OGLE photometry, brightness measurements in infrared bands, and recently obtained moderate resolution spectrum from the 6.5-m Magellan telescope show that this star is an active young stellar object of Herbig Ae/Be type.

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Making the Planetary Material Diversity During the Early Assembling of the Solar System

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Chondritic meteorites, the building blocks of terrestrial planets, are made of an out-of-equilibrium assemblage of solids formed at high and low temperatures, either in our Solar system or previous generations of stars. This was considered for decades to result from large scale transport processes in the Sun's isolated accretion disk. However, mounting evidences suggest that refractory inclusions in chondrites formed contemporaneously with the disk building. Here we numerically investigate, using a 1D model and several physical and chemical processes, the formation and transport of rocky materials during the collapse of the Sun's parent cloud and the consequent Solar Nebula assembling. The interplay between the cloud collapse, the dynamics of gas and dust, vaporization, recondensation and thermal processing of different species in the disk, results in a local mixing of solids with different thermal histories. Moreover, our results also explains the overabundance of refractory materials far from the Sun and their short formation timescales, during the first tens of kyr of the Sun, corresponding to class 0–I, opening new windows into the origin of the compositional diversity of chondrites.

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Variable Outer Disk Shadowing Around the Dipper Star RX J1604.3-2130

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Low brightness dips have been recently observed in images of protoplanetary disks, and they are believed to be shadows by the inner disk. We present VLT/SPHERE polarimetric differential imaging of the transition disk around the dipper star RX J1604.3-2130. We gathered 11 epochs that cover a large temporal baseline, to search for variability over timescales of years, months, weeks, and days. Our observations unambiguously reveal two dips along an almost face-on narrow ring (with a width of ∼20 au), and the location of the peak of this ring is at ∼65 au. The ring lies inside the ring-like structure observed with ALMA, which peaks at ∼83 au. This segregation can result from particle trapping in pressure bumps, potentially due to planet(s). We find that the dips are variable, both in morphology and in position. The eastern dip, at a position angle (PA) of ∼83.7±13.7°, has an amplitude that varies between 40% to 90%, and its angular width varies from 10° to 34°. The western dip, at a PA of ∼265.90±13.0°, is more variable, with amplitude and width variations of 31% to 95% and 12° to 53°, respectively. The separation between the dips is 178.3°±14.5°, corresponding to a large misalignment between the inner and outer disk, supporting the classification of J1604 as an aperiodic dipper. The variability indicates that the innermost regions are highly dynamic, possibly due to a massive companion or to a complex magnetic field topology.

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Gemini, SOFIA, and ATCA Reveal Very Young, Massive Protostars in the Collapsing Molecular Cloud BYF 73

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We present multi-wavelength data on the globally infalling molecular cloud/protostellar cluster BYF 73. These include new far-infrared (FIR) spectral line and continuum data from the Stratospheric Observatory for Infrared Astronomy's (SOFIA's) Far-Infrared Field-Imaging Line Spectrometer (FIFI-LS), mid-infrared (MIR) observations with the Thermal-Region Camera Spectrograph (T-ReCS) camera on Gemini-South, and 3mm continuum data from the Australia Telescope Compact Array (ATCA), plus archival data from *Spitzer*/Infrared Array Camera (IRAC), and *Herschel*/Photodetecting Array Camera and Spectrometer (PACS) and Spectral and Photometric Imaging Receiver (SPIRE). The FIFI-LS spectroscopy in [O I]λ63 μm, [O III]λ88 μm, [O I]λ145 μm, and [C II]λ158 μm highlights different gas environments in and between the dense molecular cloud and H II region. The photo-dissociation region (PDR) between the cloud and H II region is best traced by [O I]λ145 μm and may have density $>10^{10}$ m^{-3}, but the observed $\lambda145\mu$m/$\lambda63\mu$m and $\lambda63\mu$m/$\lambda158\mu$m line ratios in the densest gas are well outside model values. The H II region is well-traced by [C II], with the $\lambda158\mu$m/$\lambda145\mu$m line ratio, indicating a density of $10^{8.5}$ m^{-3} and a relatively weak ionizing radiation field, $1.5 \lesssim \log(G/G_0) \lesssim 2$. The T-ReCS data reveal eight protostellar objects in the cloud, of which six appear deeply embedded ($A_V > 30^m$ or more) near the cloud's center. MIR 2 has the most massive core at $\sim240\,M_\odot$, more massive than all the others combined by up to tenfold, with no obvious gas outflow, negligible cooling line emission, and ∼3–8% of its $4.7\times10^3\,L_\odot$ luminosity originating from the release of gravitational potential energy. MIR 2's dynamical age may be as little as 7000 years. This fact, and the cloud's total embedded stellar mass being far less than its gas mass, confirm BYF 73's relatively early stage of evolution.

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Pebble dynamics and accretion onto rocky planets. II. Radiative models

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We investigate the effects of radiative energy transfer on a series of nested-grid, high-resolution hydrodynamic simulations of gas and particle dynamics in the vicinity of an Earth-mass planetary embryo. We include heating due to the accretion of solids and the subsequent convective motions. Using a constant embryo surface temperature, we show that radiative energy transport results in a tendency to reduce the entropy in the primordial atmosphere, but this tendency is alleviated by an increase in the strength of convective energy transport, triggered by a correspondingly increased super-adiabatic temperature gradient. As a consequence, the amplitude of the convective motions increase by roughly an order of magnitude in the vicinity of the embryo. In the cases investigated here, where the optical depth towards the disk surface is larger than unity, the reduction of the temperature in the outer parts of the Hill sphere relative to cases without radiative energy transport is only ∼100K, while the mass density increase is on the order of a factor of two in the inner parts of the Hill sphere. Our results demonstrate that, unless unrealistically low dust opacities are assumed, radiative cooling in the context of primordial rocky planet atmospheres can only become important after the disk surface density has dropped significantly below minimum-mass-solar-nebula values.

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MALT90 molecular content on high-mass IR-dark clumps

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High mass stars form in groups or clusters in dense molecular clumps with sizes of 1 pc and masses of 200 $M_\odot$. Infrared-dark clumps and the individual cores within them with sizes <0.1pc and masses <100 $M_\odot$ are important laboratories for high-mass star formation in order to study the initial conditions. We investigate the physical and chemical properties of high-mass clumps in order to better understand the early evolutionary stages and find targets that show star formation signs such as infall motions or outflows. We selected the high-mass clumps from ATLASGAL survey that were identified as dark at 8/24 μm wavelengths. We used MALT90 Survey data which provides a molecular line set (HCO^+, HNC, HCN, N_2H^+, $H^{13}CO^+$, $HN^{13}C$, SiO) to investigate the physical and chemical conditions in early stages of star formation. Eleven sources have significant SiOdetection (over 3σ) which usually indicates outflow activity. Thirteen sources are found with blue profiles in both or either HCO^+ and/or HNC lines and clump mass infall rates are estimated to be in the range of 0.2×10^{-3} $M_\odot yr^{-1}$ − 1.8×10^{-2} $M_\odot yr^{-1}$. The excitation temperature is obtained as < 24 K for all sources. The column densities for optically thin lines of $H^{13}CO^+$ and $HN^{13}C$ are in the range of 0.4-8.8($\times 10^{12}$) cm^{-2}, and 0.9-11.9($\times 10^{12}$) cm^{-2}, respectively, while it is in the range of 0.1-7.5 ($\times 10^{14}$) cm^{-2} for HCO^+ and HNC lines. The column densities for N_2H^+ were ranging between 4.4-275.7($\times 10^{12}$) cm^{-2} as expected from cold dense regions. Large line widths of N_2H^+ might indicate turbulence and large line widths of HCO^+, HNC, and SiO indicate outflow activities. Mean optical depths are 20.32, and 23.19 for optically thick HCO^+ and HCN lines, and 0.39 and 0.45 for their optically thin isotopologues $H^{13}CO^+$ and $HN^{13}C$, respectively. This study reveals the physical and chemical properties of 30 high-mass IR-dark clumps and the interesting targets among them based on their emission line morphology and kinematics.

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A Lagrangian Model for Dust Evolution in Protoplanetary Disks: Formation of Wet and Dry Planetesimals at Different Stellar Masses

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We introduce a new Lagrangian smooth-particle method to model the growth and drift of pebbles in protoplanetary disks. The Lagrangian nature of the model makes it especially suited to follow characteristics of individual (groups of) particles, such as their composition. In this work we focus on the water content of solid particles. Planetesimal formation via streaming instability is taken into account, partly based on previous results on streaming instability outside the water snowline that were presented in Schoonenberg & Ormel (2017). We validate our model by reproducing earlier results from the literature and apply our model to steady-state viscous gas disks (with constant gas accretion rate) around stars with different masses. We also present various other models where we explore the effects of pebble accretion, the fragmentation velocity threshold, the global metallicity of the disk, and a time-dependent gas accretion rate. We find that planetesimals preferentially form in a local annulus outside the water snowline, at early times in the lifetime of the disk ($\lesssim 10^5$ yr), when the pebble mass fluxes are high enough to trigger the streaming instability. During this first phase in the planet formation process, the snowline location hardly changes due to slow viscous evolution, and we conclude that assuming a constant gas accretion rate is justified in this first stage. The efficiency of converting the solids reservoir of the disk to planetesimals depends on the location of the water snowline. Cooler disks with a closer-in water snowline are more efficient at producing planetesimals than hotter disks where the water snowline is located further away from the star. Therefore, low-mass stars tend to form planetesimals more efficiently, but any correlation may be overshadowed by the spread in disk properties.

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NU Ori: a hierarchical triple system with a strongly magnetic B-type star

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NU Ori is a massive spectroscopic and visual binary in the Orion Nebula Cluster, with 4 components: Aa, Ab, B, and C. The B0.5 primary (Aa) is one of the most massive B-type stars reported to host a magnetic field. We report the detection of a spectroscopic contribution from the C component in high-resolution ESPaDOnS spectra, which is also detected in a Very Large Telescope Interferometer (VLTI) dataset. Radial velocity (RV) measurements of the inner binary (designated Aab) yield an orbital period of 14.3027(7) d. The orbit of the third component (designated C) was constrained using both RVs and interferometry. We find C to be on a mildly eccentric 476(1) d orbit. Thanks to spectral disentangling of mean line profiles obtained via least-squares deconvolution we show that the Zeeman Stokes V signature is clearly associated with C, rather than Aa as previously assumed. The physical parameters of the stars were constrained using both orbital and evolutionary models, yielding $M_{\rm Aa} = 14.9 \pm 0.5\ M_\odot$, $M_{\rm Ab} = 3.9 \pm 0.7\ M_\odot$, and $M_{\rm C} = 7.8 \pm 0.7\ M_\odot$. The rotational period obtained from longitudinal magnetic field $\langle B_z \rangle$ measurements is $P_{\rm rot} = 1.09468(7)$ d, consistent with previous results. Modeling of $\langle B_z \rangle$ indicates a surface dipole magnetic field strength of $\sim$8 kG. NU Ori C has a magnetic field strength, rotational velocity, and luminosity similar to many other stars exhibiting magnetospheric Hα emission, and we find marginal evidence of emission at the expected level ($\sim$1% of the continuum).

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Rings and gaps in protoplanetary disks: planets or snowlines?

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High resolution ALMA observations of protoplanetary disks have revealed that many, if not all primordial disks consist of ring-like dust structures. The origin of these dust rings remains unclear, but a common explanation is the presence of planetary companions that have cleared gaps along their orbit and trapped the dust at the gap edge. A signature of this scenario is a decrease of gas density inside these gaps. In recent work, Isella et al. 2016 derived drops in gas density consistent with Saturn-mass planets inside the gaps in the HD163296 disk through spatially resolved CO isotopologue observations. However, as CO abundance and temperature depends on a large range of factors, the interpretation of CO emission is non-trivial. We use the physical-chemical code DALI to show that the gas temperature increases inside dust density gaps, implying that any gaps in the gas, if present, would have to be much deeper, consistent with planet masses higher than a Jupiter mass. Furthermore, we show that a model with increased grain growth at certain radii, as expected at a snowline, can reproduce the dust rings in HD163296 equally well without the need for companions. This scenario can explain both younger and older disks with observed gaps, as gaps have been seen in systems as young <1 Myr. While the origin of the rings in HD163296 remains unclear, these modeling results demonstrate that care has to be taken when interpreting CO emission in protoplanetary disk observations.

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The magnetic fields of intermediate-mass T Tauri stars : I. Magnetic detections and fundamental stellar parameters

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Context. The origin of the fossil magnetic fields detected in 5 to 10% of intermediate-mass main sequence stars is still highly debated.
Aims. We want to bring observational constraints to a large population of intermediate-mass pre-main sequence (PMS) stars in order to test the theory that convective-dynamo fields generated during the PMS phases of stellar evolution can occasionally relax into fossil fields on the main sequence.
Methods. Using distance estimations, photometric measurements, and spectropolarimetric data from HARPSpol and ESPaDOnS of 38 intermediate-mass PMS stars, we determined fundamental stellar parameters ($T_{\rm eff}$, L and $v \sin i$)

and measured surface magnetic field characteristics (including detection limits for non-detections, and longitudinal fields and basic topologies for positive detections). Using PMS evolutionary models, we determined the mass, radius, and internal structure of these stars. We compared different PMS models to check that our determinations were not model-dependent. We then compared the magnetic characteristics of our sample accounting for their stellar parameters and internal structures.
Results. We detect magnetic fields in about half of our sample. About 90% of the magnetic stars have outer convective envelopes larger than ∼25% of the stellar radii, and heavier than ∼2% of the stellar mass. Going to higher mass, we find that the magnetic incidence in intermediate-mass stars drops very quickly, within a time-scale of the order of few times 0.1 Myr. Finally, we propose that intermediate-mass T Tauri stars with large convective envelopes, close to the fully convective limit, have complex fields and that their dipole component strengths may decrease as the sizes of their convective envelopes decrease, similar to lower-mass T Tauri stars.

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How do disks and planetary systems in high-mass open clusters differ from those around field stars?

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Only star clusters that are sufficiently compact and massive survive largely unharmed beyond 10 Myr. However, their compactness means a high stellar density which can lead to strong gravitational interactions between the stars. As young stars are often initially surrounded by protoplanetary disks and later on potentially by planetary systems, the question arises to what degree these strong gravitational interactions influence planet formation and the properties of planetary systems. Here, we perform simulations of the evolution of compact high-mass clusters like Trumpler 14 and Westerlund 2 from the embedded to the gas-free phase and study the influence of stellar interactions. We concentrate on the development of the mean disk size in these environments. Our simulations show that in high-mass open clusters $80-90\%$ of all disks/planetary systems should be smaller than 50 AU just due to the strong stellar interactions in these environments. Already in the initial phases, 3-4 close fly-bys lead to typical disk sizes within the range of 18-27 AU. Afterwards, the disk sizes are altered only to a small extent. Our findings agree with the recent observation that the disk sizes in the once dense environment of the Upper Scorpio OB association, NGC 2362, and h/χPersei are at least three times smaller in size than, for example, in Taurus. We conclude that the observed planetary systems in high-mass open clusters should also be on average smaller than those found around field stars; in particular, planets on wide orbits are expected to be extremely rare in such environments.

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http://arxiv.org/pdf/1810.04453

Physical and Chemical Conditions of the Protostellar Envelope and the Protoplanetary Disk in HL Tau

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We report our SMA observations of the Class I-II protostar HL Tau in the ^{13}CO (2–1), C^{18}O (2–1), SO(5_6–4_5), and the 1.3 mm dust-continuum emission and our analyses of the ALMA long baseline data of the HCO$^+$ (1–0) emission. The 1.3 mm continuum emission observed with the SMA shows compact ($\sim0''.8 \times 0''.5$) and extended ($\sim6''.5 \times 4''.3$) components, tracing the protoplanetary disk and the protostellar envelope, respectively. The ^{13}CO, C^{18}O, and HCO$^+$

show a compact (~ 200 AU) component at velocities higher than 3 km s^{-1} from the systemic velocity and an extended (~ 1000 AU) component at the lower velocities. The high-velocity component traces the Keplerian rotating disk, and the low-velocity component traces the infalling envelope. The HCO^+ high-velocity component is fitted with a Keplerian disk model with a central stellar mass of 1.4 $M_\odot$. The radial intensity profiles of the ^{13}CO and $C^{18}O$ along the disk major axis are fitted with a disk+envelope model, and the gas masses of the disk and envelope are estimated to be 2–40 $\times 10^{-4}$ $M_\odot$ and 2.9×10^{-3} $M_\odot$, respectively. The disk dust mass has been estimated to be 1–3 $\times 10^{-3}$ $M_\odot$ in the literature. Thus, our estimated disk gas mass suggests that the gas-to-dust mass ratio in the disk is <10, a factor of ten lower than the estimated ratio in the envelope. We discuss the possible gas depletion or CO depletion in the planet-forming candidate HL Tau in the context of disk and envelope evolution.

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https://arxiv.org/pdf/1810.13081

NGC 1893: a young open cluster rich in multi-type variable stars

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In this work, we have studied the variable stars in the young open cluster NGC 1893 based on a multi-year photometric survey covering a sky area around the cluster up to $31' \times 31'$ wide. More than 23 000 images in the V band taken from January 2008 to February 2017 with different telescopes, complemented with 90 images in the B band in 2014 and 2017, were reduced, and light curves were derived in V for 5653 stars. By analyzing these light curves, we detected 147 variable stars (85 of them being new discoveries), including 110 periodic variables, 15 eclipsing binaries and 22 non-periodic variables. Proper motions, radial velocities, color-magnitude and two-color diagrams were used to identify the cluster membership of these variable stars, resulting in 84 members. Periodic variable members were then classified into different variability types, mainly according to their magnitudes and to their periods of variability, as well as to their positions in the Hertzsprung-Russell diagram for the early-type stars. As a result, among main-sequence periodic variable members, we identified five β Cep candidates, seven slowly pulsating B-type candidates, and thirteen fast-rotating pulsating B-type (FaRPB) candidates (one of which is a confirmed classical Be star). While most of the FaRPB stars display properties similar to the ones discovered in NGC 3766 by Mowlavi et al. (2013), five of them have periods below 0.1 d, contrary to expectations. Additional observations, including spectroscopic, are called for to further characterize these stars. We also find a binary candidate harboring a δ-Scuti candidate.

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Diffusion and Concentration of Solids in the Dead Zone of a Protoplanetary Disk

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The streaming instability is a promising mechanism to drive the formation of planetesimals in protoplanetary disks. To trigger this process, it has been argued that sedimentation of solids onto the mid-plane needs to be efficient and therefore that a quiescent gaseous environment is required. It is often suggested that dead-zone or disk-wind structure created by non-ideal magnetohydrodynamical (MHD) effects meets this requirement. However, simulations have shown that the midplane of a dead zone is not completely quiescent. In order to examine the concentration of solids in such an environment, we use the local-shearing-box approximation to simulate a particle-gas system with an Ohmic dead zone including mutual drag force between the gas and the solids. We systematically compare the evolution of the system with ideal or non-ideal MHD, with or without back-reaction drag force from particles on gas, and with varying solid abundances. Similar to previous investigations of dead zone dynamics, we find that particles of dimensionless stopping time $\tau_s = 0.1$ do not sediment appreciably more than those in ideal magneto-rotational turbulence, resulting in a vertical scale height an order of magnitude larger than in a laminar disk. Contrary to the expectation that this should curb the formation of planetesimals, we nevertheless find that strong clumping of solids still occurs in the dead zone when solid abundances are similar to the critical value for a laminar environment. This can be explained by the weak radial diffusion of particles near the mid-plane. The results imply that the sedimentation of particles to the mid-plane is not a necessary criterion for the formation of planetesimals by the streaming instability.

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Planck Cold Clumps in the λ Orionis Complex. II. Environmental Effects on Core Formation

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Based on the 850 μm dust continuum data from SCUBA-2 at James Clerk Maxwell Telescope (JCMT), we compare overall properties of Planck Galactic Cold Clumps (PGCCs) in the λ Orionis cloud to those of PGCCs in the Orion

A and B clouds. The Orion A and B clouds are well known active star-forming regions, while the λ Orionis cloud has a different environment as a consequence of the interaction with a prominent OB association and a giant H II region. PGCCs in the λ Orionis cloud have higher dust temperatures ($T_d = 16.13 \pm 0.15$ K) and lower values of dust emissivity spectral index ($\beta = 1.65 \pm 0.02$) than PGCCs in the Orion A ($T_d = 13.79 \pm 0.21$ K, $\beta = 2.07 \pm 0.03$) and Orion B ($T_d = 13.82 \pm 0.19$ K, $\beta = 1.96 \pm 0.02$) clouds. We find 119 sub-structures within the 40 detected PGCCs and identify them as cores. Of total 119 cores, 15 cores are discovered in the λ Orionis cloud, while 74 and 30 cores are found in the Orion A and B clouds, respectively. The cores in the λ Orionis cloud show much lower mean values of size R = 0.08 pc, column density $N(H_2) = (9.5 \pm 1.2) \times 10^{22}$ cm^{-2}, number density $n(H_2) = (2.9 \pm 0.4) \times 10^5$ cm^{-3}, and mass $M_{core} = 1.0 \pm 0.3$ M$_\odot$ compared to the cores in the Orion A (R = 0.11 pc, $N(H_2) = (2.3 \pm 0.3) \times 10^{23}$ cm^{-2}, $n(H_2) = (3.8 \pm 0.5) \times 10^5$ cm^{-3}, and $M_{core} = 2.4 \pm 0.3$ M$_\odot$) and Orion B (R = 0.16 pc, $N(H_2) = (3.8 \pm 0.4) \times 10^{23}$ cm^{-2}, $n(H_2) = (15.6 \pm 1.8) \times 10^5$ cm^{-3}, and $M_{core}= 2.7 \pm 0.3$ M$_\odot$) clouds. These core properties in the λ Orionis cloud can be attributed to the photodissociation and external heating by the nearby H II region, which may prevent the PGCCs from forming gravitationally bound structures and eventually disperse them. These results support the idea of negative stellar feedback on core formation.

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http://arxiv.org/pdf/1805.05738
http://iopscience.iop.org/article/10.3847/1538-4365/aac2e0/pdf

3D mapping of young stars in the solar neighbourhood with Gaia DR2

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We study the three dimensional arrangement of young stars in the solar neighbourhood using the second release of the Gaia mission (Gaia DR2) and we provide a new, original view of the spatial configuration of the star forming regions within 500 pc from the Sun. By smoothing the star distribution through a gaussian filter, we construct three dimensional density maps for early-type stars (upper-main sequence, UMS) and pre-main sequence (PMS) sources. The PMS and the UMS samples are selected through a combination of photometric and astrometric criteria. A side product of the analysis is a three dimensional, *G*-band extinction map, which we use to correct our colour-magnitude diagram for extinction and reddening. Both density maps show three prominent structures, Scorpius-Centaurus, Orion, and Vela. The PMS map shows a plethora of lower mass star forming regions, such as Taurus, Perseus, Cepheus, Cassiopeia, and Lacerta, which are less visible in the UMS map, due to the lack of large numbers of bright, early-type stars. We report the finding of a candidate new open cluster towards $l, b \sim 218.^\circ5, -2^\circ$, which could be related to the Orion star forming complex. We estimate ages for the PMS sample and we study the distribution of PMS stars as a function of their age. We find that younger stars cluster in dense, compact clumps, and are surrounded by older sources, whose distribution is instead more diffuse. The youngest groups that we find are mainly located in Scorpius-Centaurus, Orion, Vela, and Taurus. Cepheus, Cassiopeia, and Lacerta are instead more evolved and less numerous. Finally, we find that the three dimensional density maps show no evidence for the existence of the ring-like structure which is usually referred to as the Gould Belt.

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Catching the Birth of a Dark Molecular Cloud for the First Time

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The majority of hydrogen in the interstellar medium (ISM) is in atomic form. The transition from atoms to molecules and, in particular, the formation of the H_2 molecule, is a key step in cosmic structure formation en route to stars. Quantifying H_2 formation in space is difficult, due to the confusion in the emission of atomic hydrogen (HI) and the lack of a H_2 signal from the cold ISM. Here we present the discovery of a rare, isolated dark cloud currently undergoing H_2 formation, as evidenced by a prominent "ring" of HI self-absorption. Through a combined analysis of HI narrow self-absorption, CO emission, dust emission, and extinction, we directly measured, for the first time, the [HI]/[H2] abundance varying from 2% to 0.2%, within one region. These measured HI abundances are orders of magnitude higher than usually assumed initial conditions for protoplanetary disk models. None of the fast cloud formation model could produce such low atomic hydrogen abundance. We derived a cloud formation timescale of 6×10^6 years, consistent with the global Galactic star formation rate, and favoring the classical star formation picture over fast star formation models. Our measurements also help constrain the H_2 formation rate, under various ISM conditions.

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http://arxiv.org/pdf/1810.10758

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The origin of protostellar jets in the ALMA era From modeling to observations

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Ph.D dissertation directed by: Sylvie Cabrit and Guillaume Pineau des Forêts
Ph.D degree awarded: October 2018

The question of angular momentum extraction from protoplanetary disks (hereafter PPDs) is fundamental in understanding the accretion process in young stars and the formation conditions of planets. Pioneering semi-analytical work, followed by a growing body of magnetohydrodynamic (MHD) simulations, have shown that when a significant vertical magnetic field is present, MHD disk winds (hereafter MHD-DWs) can develop and extract some or all of the angular momentum flux required for accretion. The aim of this PhD thesis is to exploit the unprecedented capabilities provided by ALMA to clarify the accretion-ejection process in protostars. This goal is achieved following three approaches. 1) Comparison of MHD-DW models with the kinematics of HH 212 jet observed by ALMA at high angular resolution. I report the discovery of a rotating SO/SO_2 wind consistent with a MHD-DWs launched out to $\sim$40 au with SiO tracing dust-free streamlines launched from 0.05-0.3 au. 2) Analytical and numerical study of the interaction between a pulsating inner jet embedded in a stationary disk wind. Observational signatures are identified from the morphology and the kinematics of bow-shock shells. 3) Chemical signatures of a jet launched inside the dust sublimation radius ($\sim$0.2 au). I show that despite the strong X-FUV field and the absence of dust, molecules like SiO or CO can form efficiently from a small fraction of H_2. This scenario will be confronted with JWST observations.

http://www.theses.fr/s165881

New Jobs

Chalmers Astronomy & Astrophysics PhD Positions in Galaxy, Star and Planet Formation

Several PhD positions are advertised as part of the Chalmers Astronomy & Astrophysics PhD program. The overall range of topics spans from galaxy formation and evolution to ISM, star & planet formation, exoplanets and astrochemistry, from both observational and theoretical perspectives. There are opportunities to work with faculty supervisors Susanne Aalto, Kirsten Knusden, Carina Person, Jonathan Tan and Wouter Vlemmings within the Astronomy & Plasma Physics (AoP) Division. AoP has close connection to the Onsala Space Observatory (OSO) Division, both of which are hosted within the Department of Space, Earth and Environment (SEE) at Chalmers University of Technology. Physically, we are situated at both the OSO in Onsala and at the main Johanneberg campus in Gothenburg.

Local resources include access to substantial high-performance computing, as well as telescope access via OSO and membership of the European Southern Observatory (ESO). In particular, OSO hosts the Nordic ALMA Regional Center (ARC) node.

More information about specific PhD topics are given at the program website, below.

Starting dates are negotiable, depending on the particular project, but are expected to be during 2019. The starting salary for PhD positions is approximately 30,000 SEK per month. Expected duration is 4 years (max 5 years). A 10% salary increase is given following a successful licentiate defence, normally completed after 2 years. The positions also come with generous fringe benefits, including health insurance, retirement benefits, eligibility for parental leave, etc.

The deadline for applications and all letters of recommendation is 5th December 2018.

Program website:
http://www.chalmers.se/en/departments/see/research/Astronomy-and-Plasma-Physics/PhD-Program/Pages/default.as

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Ph.D. and post-doctoral positions at Nicolaus Copernicus University in Toruń, Poland

Star-Forming Regions in the Outer Galaxy

The Faculty of Physics, Astronomy and Informatics at the Nicolaus Copernicus University in Toruń, Poland, invites applications for a 3-year post-doctoral research fellow and two 3-year Ph.D. candidates in studies of star-forming regions in the Outer Galaxy. The aim is to characterize gas and dust properties of star-forming regions in a variety of environments within our Galaxy and to create a 'template' to interpret emission from star-forming regions in more distant, younger galaxies. The post involves working on the project funded by the Foundation for Polish Science within the First TEAM program awarded to Dr. Agata Karska in the Toruń Center for Astronomy. The project is supported and will be carried out in a close collaboration with researchers from University of Copenhagen, NASA Goddard Space Flight Center, and Space Telescope Science Institute.

Ph.D. I A complete census of protostars in the outer Galaxy star-forming regions using sub-mm dense gas tracers and maser emission at radio wavelengths.
Ph.D. II Properties of warm and hot gas using spectral mapping at infrared.
The candidates applying for the positions should have a strong motivation for pursuing Ph.D. studies, have a Master-level degree in physics or astronomy, good knowledge of written and spoken English, and at least basic programming skills. The Ph.D. stipends in the project are 3500 PLN (820 euro) / month for 3 years. Additional funding options and extension to the 4th year are possible as part of a regular Ph.D. program at Nicolaus Copernicus University. See also: https://euraxess.ec.europa.eu/jobs/342149.

Post-doc Cold gas reservoir and chemical complexity of star-forming regions. The candidates applying for the position should have a PhD in physics or astronomy, or in a related field awarded not earlier than in 2013, and good knowledge of written and spoken English. Motivation to work in a young, developing research team and to co-advise undergraduate and Master level students will be welcomed. Prior experience with interferometer data will be a strong asset. The gross salary is 15000 PLN (3500 euro) / month for 3 years. Multiple options for additional funding are in place for strongly motivated young researchers in Poland.

All interested candidates should send their curriculum vitae, list of publications, a cover letter outlining their research interests and motivation to join the project, and arrange for up to three letters of reference. Applications received before **November 23**, 2018 will be given full consideration, but will continue to be accepted until the positions are filled. Please send questions regarding the post, applications and reference letters to: agata.karska@umk.pl. The appointments are expected to start on February 1, 2019, but a later date may be negotiated.

Postdoctoral Fellowship in Star- and Planet formation, Astrochemistry at Leiden Observatory

A 3-year postdoctoral fellowship is available within the Molecular Astrophysics group of Prof. dr. E.F. van Dishoeck located at Leiden Observatory, the Netherlands. The postdoc will be part of an international team studying the physical and chemical evolution from collapsing cores to planet-forming disks and exoplanets centered around ALMA and (guaranteed time) JWST data.

The postdoc is expected to co-supervise PhD or MSc students and is encouraged to also pursue a personal research program. The position can start anytime in fall 2019.

Candidates with an observational and/or modeling background in astrochemistry, star formation, circumstellar disks, submillimeter/ infrared spectroscopy, or planet formation are encouraged to apply.

Applications should include a curriculum vitae, publication list, and a brief statement of research experience and interests, and arrange for at least three letters of reference to be uploaded at
http://jobs.strw.leidenuniv.nl/2018/dishoeckPD/

Leiden Observatory is a lively institute carrying out observational, interpretative and theoretical research in the fields of the star and planet formation, laboratory astrophysics, galactic structure, the formation, dynamics and evolution of (high-redshift) galaxies and their nuclei, and cosmology. Leiden is a charming city located close to a major international airport.

Review of applications will start on December 1 2018.

Research Assistantship in High-Mass Star Formation

The research group of Dr. Hofner at New Mexico Tech (NMT) in Socorro, New Mexico, has an opening for a Physics/Astronomy graduate student to work on a 3-year NSF-funded project in the field of high-mass star formation. Most of the research will be based on ALMA and VLA spectral line and continuum observations. A Master-level degree in Physics or Astronomy is required for this position, and the successful candidate is expected to obtain a PhD degree in Physics/Astrophysics at NMT from this work. For further details please inquire with Dr. Hofner, email: peter.hofner@nmt.edu.

Post-doctoral position in protoplanetary discs and planet formation

The Department of Physics & Astronomy at the University of Leicester invites applications for a post-doctoral Research Associate in Theoretical Astrophysics. This appointment is funded by a European Research Council (ERC) grant awarded to Dr Richard Alexander, and will initially be for a period of two years, with the possibility of extension depending on progress and funding considerations.

The project (BuildingPlanS) will use large suites of numerical simulations to link the architectures of observed exoplanet systems to their formation in protoplanetary discs. The successful applicant will be expected to carry out independent and collaborative research for this project, and will also have opportunities to collaborate more widely within the department (whose existing theoretical research programme includes star and planet formation, AGN physics, accretion discs, galactic dynamics & dark matter). We are therefore particularly interested in candidates with expertise in protoplanetary discs, planet formation and migration, or numerical hydrodynamics, but all applicants with a strong background in theoretical astrophysics are encouraged to apply.

Applicants must have a PhD in astrophysics (or a related discipline), or expect to be awarded a PhD before taking up the position. The position is available from early 2019, but the starting date can be flexible. The salary scale is £34,189 to £39,609, depending on experience. The successful applicant will have access to substantial expenses for relocation, travel and computing equipment, as well as extensive access to high-performance computing facilities.

Applications should be submitted electronically, via
https://jobs.le.ac.uk/vacancies/508/research-associate-in-theoretical-astrophysics.html
Informal enquiries should be directed to Dr Richard Alexander (richard.alexander@leicester.ac.uk). All applications received by December 19th 2018 will be given full consideration.

Virginia Cosmic Origins Postdoctoral Positions

The University of Virginia (UVA) invites applications for Postdoctoral Research Associate positions as part of the interdisciplinary Virginia Initiative on Cosmic Origins (VICO).

The incumbents will lead an ambitious, independent research programs related to Cosmic Origins science, expected to align with the wide range of research at UVA, as well as at the National Radio Astronomy Observatory (NRAO) on the grounds of the University. The relevant themes include star formation, planet formation and evolution, planetary science, astrochemistry and astrobiology, from both theoretical and observational perspectives. See www.cosmicorigins.space for more information.

The Postdoctoral Research Associates will participate in departmental activities and promote collaboration both within VICO and with its partner institutes, Chalmers University of Technology, Gothenburg, Sweden and the Center for Astrochemical Studies at the Max Planck Institute for Extraterrestrial Physics (MPE), Garching, Germany.

There are three types of research programs: 1) Cosmic Origins Program; (2) Virginia-Chalmers Cosmic Origins Program; (3) Virginia-MPE Cosmic Origins Program (funding pending for this cycle). Applicants should indicate in their cover letter if they have preferences among these research programs.

All positions will start at UVA and are initially a one-year appointment, with renewal for an additional two one-year increments for the position, contingent upon satisfactory performance and available funding, and an additional three one-year increments for the Virginia-Chalmers and Virginia-MPE positions, contingent upon satisfactory performance and available funding (Years 3 and 4 would be at Chalmers or MPE).

Applicants are required to have a Ph.D. in astrophysics, astrochemistry, astrobiology or related disciplines by the appointment start date.

To apply, visit http://jobs.virginia.edu and search on Posting Number 0624333. Complete a Candidate Profile online and electronically attach as a single PDF document as "Other 1": cover letter; curriculum vitae; list of publications; summary of previous and current research (limited to 3 pages, including references); research proposal (limited to 3 pages text plus up to 2 pages of references/figures). Applicants should also arrange for 3 letters of recommendation to be submitted to vico-postdoc@virginia.edu. Review of applications will begin on December 15, 2018; however, the position will remain open until filled.

A competitive salary and benefits package is offered at the University of Virginia. The positions also include travel funds and opportunities for dissemination, networking, and international collaboration.

Questions about the position may be directed to: Eric Herbst (eh2ef@virginia.edu), Jonathan Tan (jct6e@virginia.edu) or Ilse Cleeves (lic3f@virginia.edu). Additional information on the research can be found at http://cosmicorigins.space/

Questions regarding the application process in Jobs@UVA should be directed to: Richard Haverstrom, (rkh6j@.EDU).

The University of Virginia is fundamentally committed to increasing the diversity of its faculty and staff. UVA is an affirmative action and equal opportunity employer. We welcome nominations of and applications from women, members of minority groups, veterans and individuals with disabilities. We also welcome others who would bring additional dimensions of diversity to the university's research and teaching mission. We believe diversity is excellence expressing itself through every person's perspectives and lived experiences.

Deadline: 5th December 2018, with review of applications beginning 15th December 2018

VICO URL: http://cosmicorigins.space/

Application URL:

https://jobs.virginia.edu/applicants/jsp/shared/frameset/Frameset.jsp?time=1540046240031

New Horizons in Planetary Systems

Understanding planetary systems from protoplanetary disks through to the solar system, exoplanets and debris disks
13-17 May 2019 – Victoria, British Columbia, Canada

Registration and abstract submission are now open for the science conference New Horizons in Planetary Systems. The meeting is jointly organized by NRC Herzberg and NRAO as part of their roles within the North American ALMA Science Center (NAASC) and will have a broad scope, including planetary systems in formation within protoplanetary disks, minor objects in the solar system, debris disks and exoplanets. Experts will be asked to provide insights from all these fields to enhance our understanding of how planets form and evolve. Although it is organized by the NAASC, the meeting is not ALMA-centric, with a strong focus on the impact of the New Horizons mission flyby of a Kuiper Belt Object in January 2019, as well as experts from the Transiting Exoplanet Survey Satellite and other facilities, who will be asked to provide a multi-chromatic picture of the current understanding in their fields. Invited speakers have been asked to provide broadly accessible talks.

The meeting will be held at the Victoria Conference Centre in the heart of picturesque Victoria, British Columbia, on Canada's Pacific coast. Local attractions include whale watching, wine tours, the world-famous Butchart Gardens, and the Dominion Astrophysical Observatory. Excellent beaches, diving, camping and hiking are all within a day's drive from Victoria.

Invited speakers
Diana Dragomir (MIT Kavli Institute): TESS early results
Brett Gladman (UBC): theory of planet formation
Grant Kennedy (Warwick): debris disk constraints on planet formation
Heather Knutson (Caltech): exoplanet atmospheric composition
Emmanuel Lellouch (Obs de Paris): solar system objects, constraints on formation
Karin berg (Harvard): protoplanetary disk composition and chemistry
John Spencer (SWRI): New Horizons KBO flyby: first results
Geronimo Villaneuva (NASA Goddard): cometary chemistry and early planet formation
Zhaohuan Zhu (UNLV): Protoplanetary disk composition/chemistry

Registration
Registration is now open. There is a hard cap on meeting attendance of 250 participants. Registrants interested in the meeting once the cap is reached will be placed on a waitlist.

Financial Assistance
Travel support as well as childcare support will be available for those who need financial assistance to attend. For more information, see the meeting website: http://go.nrao.edu/NewHorizons

Public Talk
The New Horizons mission and the flybys of Pluto and 2014 MU 69 will be the focus of a public talk Tuesday evening by Deputy Mission Scientist Kelsi Singer (SWRI).

Territory Acknowledgement
We acknowledge with respect the Lkwungen-speaking peoples on whose traditional territory the New Horizons in Planetary Systems meeting is being held, and the Songhees, Esquimalt and WSÁNEĆ peoples whose historical relationships with the land continue to this day.

Important Deadlines in 2019
February 1: abstract submission deadline, applications due for travel and childcare support
February 22: contributed talk selection and travel support finalized, participants notified

March 1: registration deadline, late registration (or waitlist)
April 12: final registration deadline, late poster abstract submission deadline

Web: http://go.nrao.edu/NewHorizons
Facebook: https://www.facebook.com/vicplanetsys
Twitter: #VicPlanetSys
Email: Dr. Brenda Matthews, LOC Chair (newhorizons@nrao.edu)

Download the conference poster at http://astroherzberg.org/wp-content/uploads/2018/10/new_horizons_poster.pdf

Zooming in on star formation

9-14 June 2019, Nafplio, Greece

The conference will be a venue to celebrate the rich career of Prof. Ake Nordlund (Niels Bohr Institute & Starplan, Copenhagen Denmark) and his numerous contributions to the field. The program will also include sessions related to other fields in which Ake is very active, namely the modeling of stellar/solar atmospheres, numerical code development, and planet formation.

Registration: You can register by going to the webpage of the conference and select "Registration" and you should be able to modify the registration form until 15th February 2018. Only abstracts submitted before this date will be considered for an oral contribution by the SOC. The registration will be considered complete only after the payment of the registration fees (the link to the payment portal will be provided shortly)

Accommodation: we made arrangements with local hotels and obtained discounts on their rates. Please consult the "Accommodation" section for more information on how to book a room in one of these hotels. Nafplio is a very popular destination and we recommend you do an early booking.

Additional information on transport, excursions, activities for children, and public outreach activities will be updated on the conference webpage. Please keep an eye on this if it is of interest to you.

http://www.nbia.dk/nbia-zoomstarform-2019

Dusting the Universe

March 4-8, 2019 – The University of Arizona, Tucson, AZ

The advent of modern infrared and sub-mm facilities has revolutionized studies of dust in a wide range of astrophysical environments. Simultaneously, there have been many theoretical advances in understanding the composition, physical nature, and evolution of dust. It is thus timely to bring together the observational and theoretical communities to share what we know about dust in the universe over a wide range of cosmic time and discuss efficient strategies to exploit the science capabilities of our powerful current and future facilities, such as SOFIA, ALMA, LMT, JWST, and OST.

Topics to be covered:

• Dust chemical composition, grain structure and size distribution

• Dust formation and destruction mechanisms

• Modelling dust emission and attenuation in galaxies near and far: dust mass, dust temperature, dust and stars geometry

• Dust, gas, metallicity, and star formation: scaling relations between global properties

• Dust emission and absorption features as tools to learn about the source of radiation: stellar populations and AGN

Registration opens in the next few weeks.

https://www.noao.edu/meetings/dust2019/

Spectroscopy with SOFIA: new results & future opportunities

Schloss Ringberg, Tegernsee, Germany, January 20–23, 2019

Building on the success of the 2015/17 Ringberg meetings on spectroscopy with SOFIA at which about 70 participants discussed SOFIA results ranging from nearby star formation to the interstellar medium in nearby galaxies, SOFIA2019 aims at presenting new science results and looking into future science opportunities for the next years enabled by new instrumentation.

Several instruments on SOFIA allow unique spectroscopic studies of the physics and chemistry of the interstellar medium: 4GREAT and upGREAT cover with high spectral resolution selected FIR-windows between 0.5 and 4.7 THz (63–600 μm), which includes important ground state transitions from hydrides and the major interstellar medium cooling lines from [CII] and [OI], the latter even with arrays of 14 and 7 pixels, respectively. In larger fields, these lines can be probed with the FIFI-LS integral field spectrometer (50–200 μm) at lower spectral resolution, while EXES covers even shorter wavelengths (from 4.5–28.3 μm), again with high spectral resolution, including the important H2 rotational transitions. The forthcoming third generation instrument HIRMES will cover 25–120 μm continuously with resolution of 10000–100000.

Given the rapid progress in instrument development, resulting in continuous upgrades and extensions of the existing detectors, as well as new science projects, it is timely to discuss new results from SOFIA and to look into science opportunities for the coming years, particularly in the area of FIR spectroscopy.

The conference venue, Ringberg Castle, will provide a unique setting for in-depth discussions on current and future unique science with SOFIA. In particular, sessions on new scientific results, on synergies with other observatories, and on new instruments enabling new science are envisioned. Registration at the workshop website is now open:

https://events.mpifr-bonn.mpg.de/indico/event/87/

Astrowin19 - Winter School on Astronomy
Hyderabad, India, February 19-23, 2019

A five-day winter school on astronomy for senior undergraduate students and graduate students. Hands-on workshops will be emphasized along with lectures delivered by leading practitioners in the field. Only 70 spaces are open to students from all countries.

Lecture topics include star formation, stellar magnetism, and gravitational waves. Hands-on sessions will cover Athena++ simulations, modeling the initial mass function, and analysis of LIGO data.

The venue is the Birla Science Centre, in the heart of historic Hyderabad, India.
Website: https://astrowin19.wixsite.com/astrowin19.

This is an inclusive winter school that emphasizes regional and gender equity and encourages cultural exchange and awareness between students from different countries. We value the role of informal interactions among participants and the consequent mentoring of students by senior scientists. Application deadline 15 Dec 2018.

Confirmed invited speakers:

Kengo Tomida (Osaka, Japan)
Mousumi Das (IIAP, India)
Shantanu Basu (Western, Canada)
Gregg Wade (RMC, Canada)
Ajith Parameswaran (ICTS, India)

Summary of Upcoming Meetings

Planet Formation and Evolution
27 February - 1 March 2019, Rostock, Germany
http://pfe2019.stat.physik.uni-rostock.de

Dusting the Universe
4 - 8 March 2019, Tucson, USA
http://www.noao.edu/meetings/dust2019/

New Quests in Stellar Astrophysocs IV. Astrochemistry, astrobiology and the Orign of Life
31 March - 5 April 2019, Puerto Vallarta, mexico
http://www.inaoep.mx/puerto19

New Horizons in Planetary Systems
13 - 17 May 2019 - Victoria, Canada
http://go.nrao.edu/NewHorizons

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

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

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

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

Abstract submission deadline

The deadline for submitting abstracts and other submissions is the first day of the month.