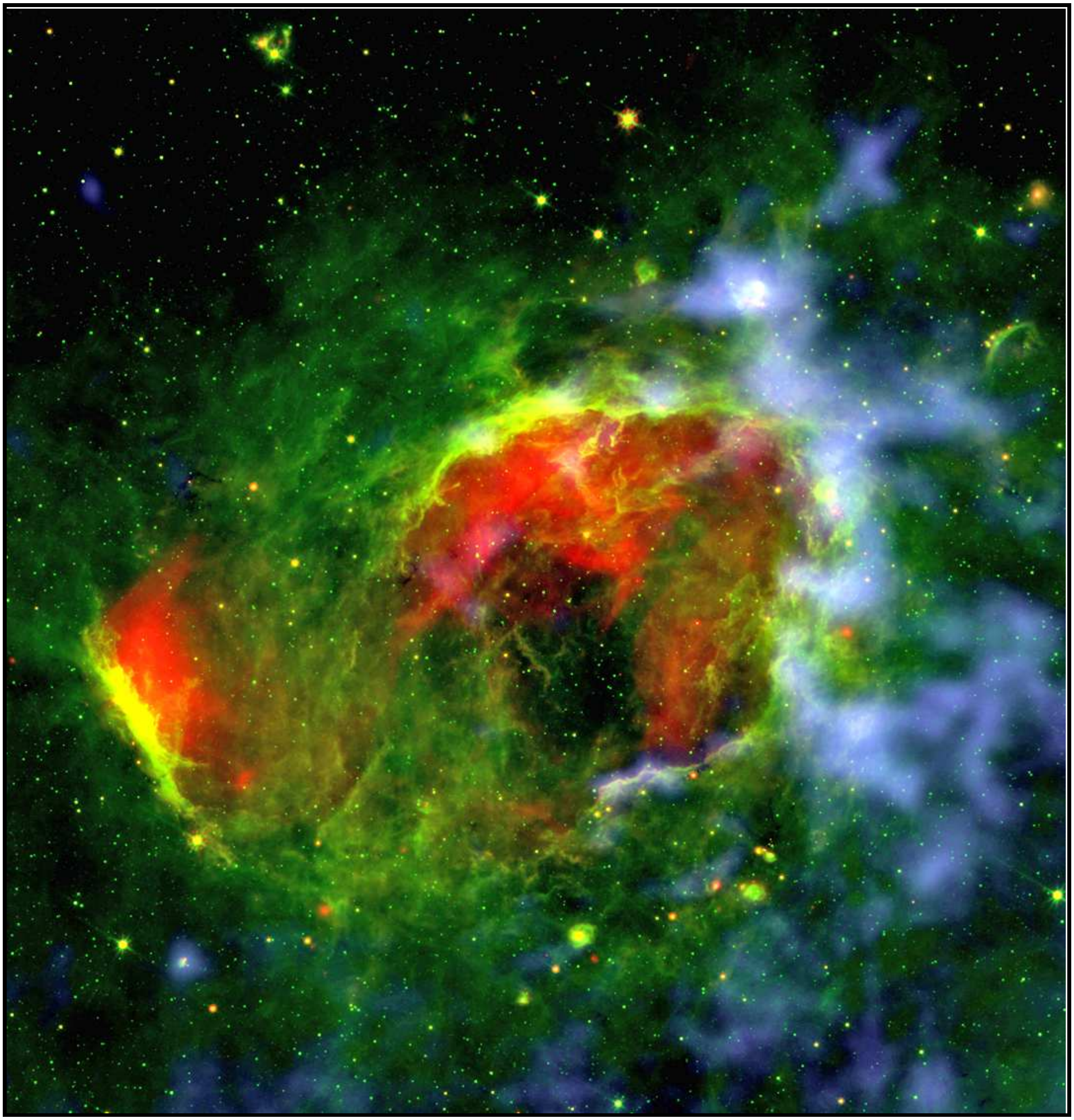
THE STAR FORMATION NEWSLETTER

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

No. 295 — 18 July 2017 Editor: Bo Reipurth (reipurth@ifa.hawaii.edu)



The Star Formation Newsletter

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

Newsletter Archive

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Cover Picture

The N107 bubble is one of the largest bubbles discovered in the GLIMPSE survey made with Spitzer of the Galactic plane and listed in a catalogue by Churchwell et al. (2006). The bubble is likely a classical HII region located at a kinematical distance of 3.6 kpc and has a diameter of about 12 pc. Red corresponds to 24 μm continuum, green to 8 μm continuum and blue to ^{13}CO (J = 1-0) line integrated over the radial velocities of 38.5 to 47.6 km/s.

Image courtesy V. Sidorin et al. (2014).

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

Molecular outflow launched beyond the disk edge

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One of the long-standing problems of star formation is the excess of angular momentum of the parent molecular cloud. In the classical picture, a fraction of angular momentum of the circumstellar material is removed by the magneto-centrifugally driven disk wind that is launched from a wide region throughout the disk. In this work, we investigate the kinematics in the envelope-disk transition zone of the Class I object BHB07-11, in the B59 core. For this purpose, we used the Atacama Large Millimeter/submillimeter Array in extended configuration to observe the thermal dust continuum emission ($\lambda_0 \sim 1.3$ mm) and molecular lines (CO, $C^{18}O$ and H_2CO), which are suitable tracers of disk, envelope, and outflow dynamics at a spatial resolution of ~ 30 AU. We report a bipolar outflow that was launched at symmetric positions with respect to the disk ($\sim$80 AU in radius), but was concentrated at a distance of 90–130 AU from the disk center. The two outflow lobes had a conical shape and the gas inside was accelerating. The large offset of the launching position coincided with the landing site of the infall materials from the extended spiral structure (seen in dust) onto the disk. This indicates that bipolar outflows are efficiently launched within a narrow region outside the disk edge. We also identify a sharp transition in the gas kinematics across the tip of the spiral structure, which pinpoints the location of the so-called centrifugal barrier.

Accepted by Astronomy & Astrophysics Letters

https://arxiv.org/pdf/1707.01501

High-resolution TNG spectra of T Tauri stars: near-IR GIANO observations of the young variables XZ Tau and DR Tau

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We aim to characterise the star-disk interaction region in T Tauri stars that show photometric and spectroscopic variability. We used the GIANO instrument at the Telescopio Nazionale Galileo to obtain near-infrared high-resolution spectra (R$\sim$ 50,000) of XZ Tau and DR Tau, which are two actively accreting T Tauri stars classified as EXors. Equivalent widths and profiles of the observed features are used to derive information on the properties of the inner disk, the accretion columns, and the winds. Both sources display composite HI line profiles, where contributions from both accreting gas and high-velocity winds can be recognised. These lines are progressively more symmetric and

narrower with increasing upper energy which may be interpreted in terms of two components with different decrements or imputed to self-absorption effects. XZ Tau is observed in a relatively high state of activity with respect to literature observations. The variation of the HeI 1.08μm line blue-shifted absorption, in particular, suggests that the inner wind has undergone a dramatic change in its velocity structure, connected with a recent accretion event. DR Tau has a more stable wind as its HeI 1.08μm absorption does not show variations with time in spite of strong variability of the emission component. The IR veiling in the two sources can be interpreted as due to blackbody emission at temperatures of 1600 K and 2300 K for XZ Tau and DR Tau, respectively, with emitting areas $\sim$ 30 times larger than the central star. While for XZ Tau these conditions are consistent with emission from the inner rim of the dusty disk, the fairly high temperature inferred for DR Tau might suggest that its veiling originates from a thick gaseous disk located within the dust sublimation radius. Strong and broad metallic lines, mainly from CI and FeI, are detected in XZ Tau, similar to those observed in other EXor sources during burst phases. At variance, DR Tau shows weaker and narrower metallic lines, despite its larger accretion luminosity. This suggests that accretion is not the only driver of metallic line excitation. The presented observations demonstrate the potential of wide-band, high-resolution near-IR spectroscopy to simultaneously probe the different phenomena that occur in the interaction region between the stellar magnetosphere and the accretion disk, thus providing hints on how these two structures are linked to each other.

Accepted by A&A

https://arxiv.org/pdf/1706.05447

Exploring dust around HD142527 down to 0.025" / 4au using SPHERE/ZIMPOL

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We have observed the protoplanetary disk of the well-known young Herbig star HD 142527 using ZIMPOL Polarimetric Differential Imaging with the VBB (Very Broad Band, $\sim$ 600-900nm) filter. We obtained two datasets in May 2015 and March 2016. Our data allow us to explore dust scattering around the star down to a radius of $\sim$0.025 *arcsec* ($\sim$ 4au). The well-known outer disk is clearly detected, at higher resolution than before, and shows previously unknown sub-structures, including spirals going inwards into the cavity. Close to the star, dust scattering is detected at high signal-to-noise ratio, but it is unclear whether the signal represents the inner disk, which has been linked to the two prominent local minima in the scattering of the outer disk, interpreted as shadows. An interpretation of an inclined inner disk combined with a dust halo is compatible with both our and previous observations, but other arrangements of the dust cannot be ruled out. Dust scattering is also present within the large gap between ∼30 and ∼140au. The comparison of the two datasets suggests rapid evolution of the inner regions of the disk, potentially driven by the interaction with the close-in M-dwarf companion, around which no polarimetric signal is detected.

Accepted by Astrophysical Journal

https://arxiv.org/pdf/1705.09680

Gap and rings carved by vortices in protoplanetary dust

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Large-scale vortices in protoplanetary disks are thought to form and survive for long periods of time. Hence, they can significantly change the global disk evolution and particularly the distribution of the solid particles embedded in the gas, possibly explaining asymmetries and dust concentrations recently observed at sub-millimeter and millimeter wavelengths. We investigate the spatial distribution of dust grains using a simple model of protoplanetary disk hosted by a giant gaseous vortex. We explore the dependence of the results on grain size and deduce possible consequences and predictions for observations of the dust thermal emission at sub-millimeter and millimeter wavelengths. Global 2D simulations with a bi-fluid code are used to follow the evolution of a single population of solid particles aerodynamically coupled to the gas. Possible observational signatures of the dust thermal emission are obtained using simulators of ALMA and ngVLA observations. We find that a giant vortex not only captures dust grains with Stokes number $St < 1$ but can also affect the distribution of larger grains (with $St \sim 1$) carving a gap associated to a ring composed of incompletely trapped particles. The results are presented for different particle size and associated to their possible signatures in disk observations. Gap clearing in the dust spatial distribution could be due to the interaction with a giant gaseous vortex and their associated spiral waves, without the gravitational assistance of a planet. Hence, strong dust concentrations at short sub-mm wavelengths associated with a gap and an irregular ring at longer mm and cm wavelengths could indicate the presence of an unseen gaseous vortex.

Accepted by A&A

http://arxiv.org/pdf/1706.07131

The Young L Dwarf 2MASS J11193254−1137466 is a Planetary-Mass Binary

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We have discovered that the extremely red, low-gravity L7 dwarf 2MASS J11193254−1137466 is a $0''\!.14$ (3.6 AU) binary using Keck laser guide star adaptive optics imaging. 2MASS J11193254−1137466 has previously been identified as a likely member of the TW Hydrae Association (TWA). Using our updated photometric distance and proper motion, a kinematic analysis based on the BANYAN II model gives an 82% probability of TWA membership. At TWA's 10±3 Myr age and using hot-start evolutionary models, 2MASS J11193254−1137466AB is a pair of $3.7^{+1.2}_{-0.9}$ $M_{\rm Jup}$ brown dwarfs, making it the lowest-mass binary discovered to date. We estimate an orbital period of 90^{+80}_{-50} years. One component is marginally brighter in K band but fainter in J band, making this a probable flux-reversal binary, the first discovered with such a young age. We also imaged the spectrally similar TWA L7 dwarf WISEA J114724.10−204021.3 with Keck and found no sign of binarity. Our evolutionary model-derived $T_{\rm eff}$ estimate for WISEA J114724.10−204021.3 is ≈230 K higher than for 2MASS J11193254−1137466AB, at odds with their spectral similarity. This discrepancy

suggests that WISEA J114724.10−204021.3 may actually be a tight binary with masses and temperatures very similar to 2MASS J11193254−1137466AB, or further supporting the idea that near-infrared spectra of young ultracool dwarfs are shaped by factors other than temperature and gravity. 2MASS J11193254−1137466AB will be an essential benchmark for testing evolutionary and atmospheric models in the young planetary-mass regime.

Accepted by ApJL

http://arxiv.org/pdf/1706.01883

X-shooter spectroscopy of young stellar objects in Lupus: Lithium, iron, and barium elemental abundances

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With the purpose of performing a homogeneous determination of elemental abundances for members of the Lupus T association, we analyzed three chemical elements: lithium, iron, and barium. The aims were: 1) to derive the lithium abundance for the almost complete sample ($\sim 90\%$) of known class II stars in the Lupus I, II, III, and IV clouds; 2) to perform chemical tagging of a region where few iron abundance measurements have been obtained in the past, and no determination of the barium content has been done up to now. We also investigated possible barium enhancement at the very young age of the region, as this element has become increasingly interesting in the last few years following the evidence of barium over-abundance in young clusters, the origin of which is still unknown. Using the X-shooter spectrograph mounted on the Unit 2 (UT2) at the Very Large Telescope (VLT), we analyzed the spectra of 89 cluster members, both class II (82) and class III (7) stars. We measured the strength of the lithium line at $\lambda 6707.8\,\text{Å}$ and derived the abundance of this element through equivalent width measurements and curves of growth. For six class II stars we also derived the iron and barium abundances using the spectral synthesis method and the code MOOG. The veiling contribution was taken into account in the abundance analysis for all three elements. We find a dispersion in the strength of the lithium line at low effective temperatures and identify three targets with severe Li depletion. The nuclear age inferred for these highly lithium-depleted stars is around 15 Myr, which exceeds by an order of magnitude the isochronal one. We derive a nearly solar metallicity for the members whose spectra could be analyzed. We find that Ba is over-abundant by ~ 0.7 dex with respect to the Sun. Since current theoretical models cannot reproduce this abundance pattern, we investigated whether this unusually large Ba content might be related to effects due to stellar parameters, stellar activity, and accretion. We are unable to firmly assess whether the dispersion in the lithium content we observe is a consequence of an age spread. As in other star-forming regions, no metal-rich members are found in Lupus, giving support to a recent hypothesis that the iron abundance distribution of most of the nearby young regions could be the result of a common and widespread star formation episode involving the Galactic thin disk. Among the possible causes or sources for Ba enhancement examined here, none is sufficient to account for the over-abundance of this element at a ~ 0.7 dex level.

Accepted by A&A

http://arxiv.org/pdf/1706.09684

Triggering Collapse of the Presolar Dense Cloud Core and Injecting Short-Lived Radioisotopes with a Shock Wave. V. Nonisothermal Collapse Regime

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Recent meteoritical analyses support an initial abundance of the short-lived radioisotope ^{60}Fe that may be high enough to require nucleosynthesis in a core collapse supernova, followed by rapid incorporation into primitive meteoritical components, rather than a scenario where such isotopes were inherited from a well-mixed region of a giant molecular cloud polluted by a variety of supernovae remnants and massive star winds. This paper continues to explore the former scenario, by calculating three dimensional, adaptive mesh refinement, hydrodynamical code (FLASH 2.5) models of the self-gravitational, dynamical collapse of a molecular cloud core that has been struck by a thin shock front with a speed of 40 km/sec, leading to the injection of shock front matter into the collapsing cloud through the formation of Rayleigh-Taylor fingers at the shock-cloud intersection. These models extend the previous work into the nonisothermal collapse regime using a polytropic approximation to represent compressional heating in the optically thick protostar. The models show that the injection efficiencies of shock front material are enhanced compared to previous models, which were not carried into the nonisothermal regime and so did not reach such high densities. The new models, combined with the recent estimates of initial ^{60}Fe abundances, imply that the supernova triggering and injection scenario remains as a plausible explanation for the origin of the short-lived radioisotopes involved in the formation of our solar system.

Accepted by Astrophysical Journal

https://home.dtm.ciw.edu/users/boss/ftp/triggerV.pdf

Probing changes of dust properties along a chain of solar-type prestellar and protostellar cores in Taurus with NIKA

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The characterization of dust properties in the interstellar medium (ISM) is key for understanding the physics and chemistry of star formation. Mass estimates are crucial to determine gravitational collapse conditions for the birth of new stellar objects in molecular clouds. However, most of these estimates rely on dust models that need further observational constraints to capture the relevant parameters variations depending on the local environment: from clouds to prestellar and protostellar cores.
We present results of a new study of dust emissivity changes based on millimeter (mm) continuum data obtained with the NIKA camera at the IRAM-30m telescope. Observing dust emission at 1.15 mm and 2 mm allows us to constrain the dust emissivity index, β, in the Rayleigh-Jeans tail of the dust spectral energy distribution (SED) far from its peak emission, where the contribution of other parameters (i.e. dust temperature) is more important. Focusing on the Taurus molecular cloud, one of the most famous low-mass star-forming regions in the Gould Belt, we analyze the emission properties of several distinct objects in the B213 filament. This sub-parsec size region is of particular interest since it is characterized by the presence of a collection of evolutionary stages of early star formation: three prestellar cores, two Class-0/I protostellar cores and one Class-II object. We are therefore able to compare dust properties among a sequence of sources that likely derive from the same parent filament.
By means of the ratio of the two NIKA channel-maps, we show that in the Rayleigh-Jeans approximation, $\beta_{\rm RJ}$ varies among the objects: it decreases from prestellar cores ($\beta_{\rm RJ}\sim2$) to protostellar cores ($\beta_{\rm RJ}\sim1$) and the Class-II object ($\beta_{\rm RJ}\sim0$). For one prestellar and two protostellar cores, we produce a robust study using available *Herschel* data to constrain the dust temperature of the sources. By using the Abel transform inversion technique we get accurate radial temperature profiles that allow us to obtain radial β profiles. We find systematic spatial variations of β in the protostellar cores that is not observed in the prestellar core. While in the former case β decreases toward the center (with β varying between 1 and 2), in the latter it remains constant ($\beta = 2.4 \pm 0.3$). Moreover, the dust emissivity index appears anticorrelated with the dust temperature. We discuss the implication of these results in terms of dust grain evolution between pre- and protostellar cores.

Accepted by Astronomy & Astrophysics

https://arxiv.org/pdf/1706.08407

Magnetic fields in circumstellar disks: The potential of Zeeman observations

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Context. Recent high angular resolution polarimetric continuum observations of circumstellar disks provide new insights into their magnetic field. However, direct constraints are limited to the plane of sky component of the magnetic field. Observations of Zeeman split spectral lines are a potential approach to enhance these insights by providing complementary information.
Aims. We investigate which constraints for magnetic fields in circumstellar disks can be obtained from Zeeman observations of the 113 GHz CN lines. Furthermore, we analyze the requirements to perform these observations and their dependence on selected quantities.
Methods. We simulate the Zeeman splitting with the radiative transfer (RT) code POLARIS (Reissl et al. 2016) extended by our Zeeman splitting RT extension ZRAD (Brauer et al. 2017), which is based on the line RT code Mol3D (Ober et al. 2015).
Results. We find that Zeeman observations of the 113 GHz CN lines provide significant insights into the magnetic field of circumstellar disks. However, with the capabilities of recent and upcoming instrument/observatories, even spatially unresolved observations would be challenging. Nevertheless, these observations are feasible for the most massive disks with a strong magnetic field and high abundance of CN/H. The most restrictive quantity is the magnetic field strength, which should be at least in the order of $\sim$1 mG. In addition, the inclination of the disk should be around 60° to preserve the ability to derive the line-of-sight (LOS) magnetic field strength and to obtain a sufficiently high circularly polarized flux. Finally, we simulate the RT of a circumbinary disk model based on a magnetohydrodynamic

(MHD) simulation. We find that our analysis of the magnetic field is still applicable. However, owing to their lower circularly polarized emission, Zeeman observations of circumbinary disks with a significant separation between their stellar components ($r_{\rm star} \sim 10$ AU) are more challenging if compared to circumstellar disks with a single star.

Accepted by Astronomy & Astrophysics

https://arxiv.org/pdf/1706.09732

The L1157-B1 astrochemical laboratory: testing the origin of DCN

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Context. L1157-B1 is the brightest shocked region of the large-scale molecular outflow. It is considered the prototype of the so-called chemically rich active outflows, being the perfect laboratory to study how shocks affect the molecular gas content. Specifically, several deuterated molecules have previously been detected with the IRAM 30 m telescope, most of them formed on grain mantles and then released into the gas phase due to the passage of the shock.
Aims. We aim to observationally investigate the role of the different chemical processes at work that lead to formation of the DCN and compare it with HDCO, the two deuterated molecules imaged with an interferometer, and test the predictions of the chemical models for their formation.
Methods. We performed high-angular-resolution observations toward L1157-B1 with the IRAM NOEMA interferometer of the DCN (2–1) and $H^{13}CN$ (2–1) lines to compute the deuterated fraction, $D_{\rm frac}$(HCN), and compare it with previously reported $D_{\rm frac}$ of other molecular species.
Results. We detected emission of DCN (2–1) and $H^{13}CN$ (2–1) arising from L1157-B1 shock. The deuterated fraction $D_{\rm frac}$(HCN) is $\sim 4 \times 10^{-3}$ and given the associated uncertainties, we did not find significant variations across the bow-shock structure. Contrary to HDCO, whose emission delineates the region of impact between the fast jet and the ambient material, DCN is more widespread and not limited to the impact region. This is consistent with the idea that gas-phase chemistry is playing a major role in the deuteration of HCN in the head of the bow-shock, where HDCO is undetected as it is a product of grain-surface chemistry. The spectra of DCN and $H^{13}CN$ match the spectral signature of the outflow cavity walls, suggesting that their emission results from shocked gas. The analysis of the time-dependent gas-grain chemical model UCL_CHEM coupled with a parametric C-type shock model shows that the observed deuterated fraction $D_{\rm frac}$(HCN) is reached during the post-shock phase, when the gas is at $T = 80$ K, matching the dynamical timescale of the B1 shock, around ∼1100 years.
Conclusions. Our results indicate that the presence of DCN in L1157-B1 is a combination of gas-phase chemistry that produces the widespread DCN emission, dominating especially in the head of the bow-shock, and sputtering from grain mantles toward the jet impact region, that can be efficient close to the brightest DCN clumps B1a.

Accepted by Astronomy and Astrophysics

https://arxiv.org/pdf/1706.08834

NH_3 (1_0-0_0) in the pre-stellar core L1544

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Pre-stellar cores represent the initial conditions in the process of star and planet formation, therefore it is important to study their physical and chemical structure. Because of their volatility, nitrogen-bearing molecules are key to study the dense and cold gas present in pre-stellar cores. The NH_3 rotational transition detected with *Herschel*-HIFI provides a unique combination of sensitivity and spectral resolution to further investigate physical and chemical processes in pre-stellar cores. Here we present the velocity-resolved *Herschel*-HIFI observations of the ortho-$NH_3(1_0$-$0_0)$ line at 572 GHz and study the abundance profile of ammonia across the pre-stellar core L1544 to test current theories of its physical and chemical structure. Recently calculated collisional coefficients have been included in our non-LTE radiative transfer code to reproduce *Herschel* observations. A gas-grain chemical model, including spin-state chemistry and applied to the (static) physical structure of L1544 is also used to infer the abundance profile of ortho-NH_3. The hyperfine structure of ortho-$NH_3(1_0$-$0_0)$ is resolved for the first time in space. All the hyperfine components are strongly self-absorbed. The profile can be reproduced if the core is contracting in quasi-equilibrium, consistent with previous work, and if the NH_3 abundance is slightly rising toward the core centre, as deduced from previous interferometric observations of para-NH_3(1,1). The chemical model overestimates the NH_3 abundance at radii between $\simeq$ 4000 and 15000 AU by about two orders of magnitude and underestimates the abundance toward the core centre by more than one order of magnitude. Our observations show that chemical models applied to static clouds have problems in reproducing NH_3 observations.

Accepted by A&A Letters

http://arxiv.org/pdf/1706.03063

Eccentricity excitation and merging of planetary embryos heated by pebble accretion

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Context. Planetary embryos can continue to grow by pebble accretion until they become giant planet cores. Simultaneously, these embryos mutually interact and also migrate due to torques arising from the protoplanetary disk.
Aims. Our aim is to investigate how pebble accretion alters the orbital evolution of embryos undergoing the Type-I migration. In particular, we study whether they establish resonant chains, whether these chains are prone to instabilities and if giant planet cores form through embryo merging, thus occurring more rapidly than by pebble accretion alone.
Methods. For the first time, we perform self-consistent global-scale radiative hydrodynamic simulations of a two-fluid protoplanetary disk consisting of gas and pebbles, the latter being accreted by embedded embryos. Accretion heating, along with other radiative processes, is accounted for to correctly model the Type-I migration.
Results. We track the evolution of four super-Earth-like embryos, initially located in a region where the disk structure allows for a convergent migration. Generally, embryo merging is facilitated by rapidly increasing embryo masses and breaks the otherwise oligarchic growth. Moreover, we find that the orbital eccentricity of each embryo is considerably excited ($\approx$0.03) due to the presence of an asymmetric underdense lobe of gas, a so-called 'hot trail', produced by accretion heating of the embryo's vicinity. Eccentric orbits lead the embryos to frequent close encounters and make resonant locking more difficult.

Conclusions. Embryo merging typically produces one massive core ($\gtrsim$10 $M_{\rm E}$) in our simulations, orbiting near 10 AU. Pebble accretion is naturally accompanied by occurrence of eccentric orbits which should be considered in future efforts to explain the structure of exoplanetary systems.

Accepted by A&A

http://arxiv.org/pdf/1706.06329

Variable $H^{13}CO^+$ Emission in the IM Lup Disk: X-ray Driven Time-Dependent Chemistry?

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We report the first detection of a substantial brightening event in an isotopologue of a key molecular ion, HCO^+, within a protoplanetary disk of a T Tauri star. The $H^{13}CO^+$ $J = 3$–2 rotational transition was observed three times toward IM Lup between July 2014 and May 2015 with the Atacama Large Millimeter Array. The first two observations show similar spectrally integrated line and continuum fluxes, while the third observation shows a doubling in the disk integrated $J = 3$–2 line flux compared to the continuum, which does not change between the three epochs. We explore models of an X-ray active star irradiating the disk via stellar flares, and find that the optically thin $H^{13}CO^+$ emission variation can potentially be explained via X-ray driven chemistry temporarily enhancing the HCO^+ abundance in the upper layers of the disk atmosphere during large or prolonged flaring events. If the HCO^+ enhancement is indeed caused by a X-ray flare, future observations should be able to spatially resolve these events and potentially enable us to watch the chemical aftermath of the high-energy stellar radiation propagating across the face of protoplanetary disks, providing a new pathway to explore ionization physics and chemistry, including electron density, in disks.

Accepted by ApJL

http://arxiv.org/pdf/1706.00833

The molecular cloud S242: physical environment and star formation activities

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We present a multi-wavelength study to probe the star formation (SF) processes on a larger scale ($\sim$1°.05 × 0°.56) around the S242 site. The S242 molecular cloud is depicted in a velocity range from −3.25 to 4.55 km s^{-1} and has spatially elongated appearance. Based on the virial analysis, the cloud is prone to gravitational collapse. The cloud harbors an elongated filamentary structure (EFS; length $\sim$25 pc) evident in the *Herschel* column density map and the EFS has an observed mass per unit length of $\sim$200 $M_\odot$ pc^{-1} exceeding the critical value of $\sim$16 $M_\odot$ pc^{-1} (at T = 10 K). The EFS contains a chain of *Herschel* clumps (M_{clump} $\sim$150 to 1020 $M_\odot$), revealing the evidence of fragmentation along its length. The most massive clumps are observed at both the EFS ends, while the S242 H II region is located at one EFS end. Based on the radio continuum maps at 1.28 and 1.4 GHz, the S242 H II region is ionized by a B0.5V–B0V type star and has a dynamical age of $\sim$0.5 Myr. The photometric 1–5 μm data analysis of point-like sources traces young stellar objects (YSOs) toward the EFS and the clusters of YSOs are exclusively found at both the EFS ends, revealing the SF activities. Considering the spatial presence of massive clumps and YSO clusters at both the EFS ends, the observed results are consistent with the prediction of a SF scenario of the end-dominated collapse driven by the higher accelerations of gas.

Accepted by the Astrophysical Journal

http://xxx.lanl.gov/pdf/1707.00395

Hub-filament system in IRAS 05480+2545: young stellar cluster and 6.7 GHz methanol maser

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To probe the star formation (SF) process, we present a multi-wavelength study of IRAS 05480+2545 (hereafter I05480+2545). Analysis of *Herschel* data reveals a massive clump (M_{clump} ∼1875 $M_\odot$; peak $N(H_2)$ ∼4.8×10^{22} cm^{-2}; A_V ∼51 mag) containing the 6.7 GHz methanol maser and I05480+2545, which is also depicted in a temperature range of 18–26 K. Several noticeable parsec-scale filaments are detected in the *Herschel* 250 μm image and seem to be radially directed to the massive clump. It resembles more of a "hub-filament" system. Deeply embedded young stellar objects (YSOs) have been identified using the 1–5 μm photometric data, and a significant fraction of YSOs and their clustering are spatially found toward the massive clump, revealing the intense SF activities. An infrared counterpart (IRc) of the maser is investigated in the *Spitzer* 3.6–4.5 μm images. The IRc does not appear point-like source and is most likely associated with the molecular outflow. Based on the 1.4 GHz and Hα continuum images, the ionized emission is absent toward the IRc, indicating that the massive clump harbors an early phase of massive protostar before the onset of an ultracompact H II region. Together, the I05480+2545 is embedded in a very similar "hub-filament" system to those seen in Rosette Molecular Cloud. The outcome of the present work indicates the role of filaments in the formation of the massive star-forming clump and cluster of YSOs, which might help channel material to the central hub configuration and the clump/core.

Accepted by The Astrophysical Journal

http://xxx.lanl.gov/pdf/1706.03714

The evolution of Giant Molecular Filaments

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In recent years there has been a growing interest in studying giant molecular filaments (GMFs), which are extremely elongated (more than 100pc in length) giant molecular clouds (GMCs). They are often seen as inter-arm features in external spiral galaxies, but have been tentatively associated with spiral arms when viewed in the Milky Way. In this paper, we study the time evolution of GMFs in a high-resolution section of a spiral galaxy simulation, and their link with spiral arm GMCs and star formation, over a period of 11Myrs. The GMFs generally survive the inter-arm passage, although they are subject to a number of processes (e.g. star formation, stellar feedback and differential rotation) which can break the giant filamentary structure into smaller sections. The GMFs are not gravitationally bound clouds as a whole, but are, to some extent, confined by external pressure. Once they reach the spiral arms, the GMFs tend to evolve into more substructured spiral arm GMCs, suggesting that GMFs may be precursors to arm GMCs. Here, they become incorporated into the more complex and almost continuum molecular medium that makes up the gaseous spiral arm. Instead of retaining a clear filamentary shape, their shapes are distorted both by their climb up the spiral potential and their interaction with the gas within the spiral arm. The GMFs do tend to become aligned with the spiral arms just before they enter them (when they reach the minimum of the spiral potential), which could account for the observations of GMFs in the Milky Way.

Accepted by MNRAS

https://arxiv.org/pdf/1706.05421

The Flying Saucer: Tomography of the thermal and density gas structure of an edge-on protoplanetary disk.

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Context: Determining the gas density and temperature structures of protoplanetary disks is a fundamental task in order to constrain planet formation theories. This is a challenging procedure and most determinations are based on model-dependent assumptions.
Aims: We attempt a direct determination of the radial and vertical temperature structure of the Flying Saucer disk, thanks to its favorable inclination of 90 degrees.
Methods: We present a method based on the tomographic study of an edge-on disk. Using ALMA, we observe at $0.5''$ resolution the Flying Saucer in CO J=2-1 and CS J=5-4. This edge-on disk appears in silhouette against the CO J=2-1 emission from background molecular clouds in ρ Oph. The combination of velocity gradients due to the Keplerian rotation of the disk and intensity variations in the CO background as a function of velocity provide a direct measure of the gas temperature as a function of radius and height above the disk mid-plane.
Results: The overall thermal structure is consistent with model predictions, with a cold ($< 15 - 12$ K) CO-depleted mid-plane and a warmer disk atmosphere. However, we find evidence for CO gas along the mid-plane beyond a radius of about 200 au, coincident with a change of grain properties. Such behavior is expected in the case of efficient rise of UV penetration re-heating the disk and thus allowing CO thermal desorption or favoring direct CO photo-desorption. CO is also detected at up to 3-4 scale heights, while CS is confined to around 1 scale height above the mid-plane. The limits of the method due to finite spatial and spectral resolutions are also discussed.
Conclusions: This method appears to be a very promising way to determine the gas structure of planet-forming disks, provided that the molecular data have an angular resolution which is high enough, on the order of $0.3 - 0.1''$ at the distance of the nearest star-forming regions.

Accepted by Astronomy and Astrophysics

https://arxiv.org/pdf/1706.02608.pdf

An Incipient Debris Disk in the Chamaeleon I Cloud

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The point at which a protoplanetary disk becomes a debris disk is difficult to identify. To better understand this, here

we study the ∼40 AU separation binary T 54 in the Chamaeleon I cloud. We derive a K5 spectral type for T 54 A (which dominates the emission of the system) and an age of ∼2 Myr. However, the dust disk properties of T 54 are consistent with those of debris disks seen around older and earlier-type stars. At the same time, T 54 has evidence of gas remaining in the disk as indicated by [Ne II], [Ne III], and [O I] line detections. We model the spectral energy distribution of T 54 and estimate that $\sim 3\times10^{-3}$ M_{Earth} of small dust grains (<0.25 μm) are present in an optically thin circumbinary disk along with at least $\sim 3\times10^{-7}$ M_{Earth} of larger (>10 μm) grains within a circumprimary disk. Assuming a solar-like mixture, we use Ne line luminosities to place a minimum limit on the gas mass of the disk ($\sim 3\times10^{-4}$ M_{Earth}) and derive a gas-to-dust mass ratio of ∼0.1. We do not detect substantial accretion, but we do see Hα in emission in one epoch, suggestive that there may be intermittent dumping of small amounts of matter onto the star. Considering the low dust mass, the presence of gas, and young age of T 54, we conclude that this system is on the bridge between the protoplanetary and debris disk stages.

Accepted by ApJ

http://arxiv.org/pdf/1706.05032

A survey for planetary-mass brown dwarfs in the Chamaeleon I star-forming region

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We have performed a search for planetary-mass brown dwarfs in the Chamaeleon I star-forming region using proper motions and photometry measured from optical and infrared images from the Spitzer Space Telescope, the Hubble Space Telescope, and ground-based facilities. Through near-infrared spectroscopy at Gemini Observatory, we have confirmed six of the candidates as new late-type members of Chamaeleon I >M7.75. One of these objects, Cha J11110675−7636030, has the faintest extinction-corrected M_K among known members, which corresponds to a mass of 3–6 $M_{\rm Jup}$ according to evolutionary models. That object and two other new members have redder mid-IR colors than young photospheres at <M9.5, which may indicate the presence of disks. However, since those objects may be later than M9.5 and the mid-IR colors of young photospheres are ill-defined at those types, we cannot determine conclusively whether color excesses from disks are present. If Cha J11110675−7636030 does have a disk, it would be a contender for the least-massive known brown dwarf with a disk. Since the new brown dwarfs that we have found extend below our completeness limit of 6–10 $M_{\rm Jup}$, deeper observations are needed to measure the minimum mass of the initial mass function in Chamaeleon I.

Accepted by AJ

http://arxiv.org/pdf/1706.00058

Gravitational instabilities in a protosolar-like disc II: continuum emission and mass estimates

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Gravitational instabilities (GIs) are most likely a fundamental process during the early stages of protoplanetary disc formation. Recently, there have been detections of spiral features in young, embedded objects that appear consistent with GI-driven structure. It is crucial to perform hydrodynamic and radiative transfer simulations of gravitationally unstable discs in order to assess the validity of GIs in such objects, and constrain optimal targets for future observations. We utilise the radiative transfer code LIME to produce continuum emission maps of a $0.17\,M_{\odot}$ self-gravitating protosolar-like disc. We note the limitations of using LIME as is and explore methods to improve upon the default gridding. We use CASA to produce synthetic observations of 270 continuum emission maps generated across different frequencies, inclinations and dust opacities. We find that the spiral structure of our protosolar-like disc model is distinguishable across the majority of our parameter space after 1 hour of observation, and is especially prominent at 230 GHz due to the favourable combination of angular resolution and sensitivity. Disc mass derived from the observations is sensitive to the assumed dust opacities and temperatures, and therefore can be underestimated by a factor of at least 30 at 850 GHz and 2.5 at 90 GHz. As a result, this effect could retrospectively validate GIs in discs previously thought not massive enough to be gravitationally unstable, which could have a significant impact on the understanding of the formation and evolution of protoplanetary discs.

Accepted by MNRAS

https://arxiv.org/pdf/1706.00254

The complexity of Orion: an ALMA view. II. gGg′–Ethylene Glycol and Acetic Acid

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We report the first detection and high angular resolution ($1.8'' \times 1.1''$) imaging of acetic acid (CH_3COOH) and gGg′–ethylene glycol (gGg′$(CH_2OH)_2$) towards the Orion Kleinmann–Low nebula. The observations were carried out at ∼1.3mm with ALMA during Cycle 2. A notable result is that the spatial distribution of the acetic acid and ethylene glycol emission differs from that of the other O-bearing molecules within Orion-KL. Indeed, while the typical emission of O-bearing species harbors a morphology associated with a "V-shape" linking the Hot Core region to the Compact Ridge (with an extension towards the BN object), that of acetic acid and ethylene glycol mainly peaks at about $2''$ southwest from the hot core region (near sources I and n). We find that the measured CH_3COOH:aGg′$(CH_2OH)_2$ and CH_3COOH:gGg′$(CH_2OH)_2$ ratios differ from the ones measured towards the low-mass protostar IRAS 16293–2422 by more than one order of magnitude. Our best hypothesis to explain these findings is that CH_3COOH, aGg′$(CH_2OH)_2$ and gGg′$(CH_2OH)_2$ are formed on the icy-surface of grains and then released into the gas-phase, via co-desorption with water, due to a bullet of matter ejected during the explosive event that occurred in the heart of the Nebula about 500-700 years ago.

Accepted by A&A Letters

https://arxiv.org/pdf/1707.01741

The formation of giant planets in wide orbits by photoevaporation-synchronised migration

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The discovery of giant planets in wide orbits represents a major challenge for planet formation theory. In the standard core accretion paradigm planets are expected to form at radial distances $\lesssim$20 au in order to form massive cores (with masses $\gtrsim$10 $M_\oplus$) able to trigger the gaseous runaway growth before the dissipation of the disc. This has encouraged authors to find modifications of the standard scenario as well as alternative theories like the formation of planets by gravitational instabilities in the disc to explain the existence of giant planets in wide orbits. However, there is not yet consensus on how these systems are formed. In this letter, we present a new natural mechanism for the formation of giant planets in wide orbits within the core accretion paradigm. If photoevaporation is considered, after a few Myr of viscous evolution a gap in the gaseous disc is opened. We found that, under particular circumstances planet migration becomes synchronised with the evolution of the gap, which results in an efficient outward planet migration. This mechanism is found to allow the formation of giant planets with masses $M_\mathrm{p} \gtrsim 1$ M_Jup in wide stable orbits as large as ~130 au from the central star.

Accepted by MNRAS Letters

http://arxiv.org/pdf/1706.03420

First detection of THz water maser in NGC7538-IRS1 with SOFIA and new 22 GHz e-MERLIN maps

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The formation of massive stars is still not well understood. Accumulating a large amount of mass infalling within a single entity in spite of radiation pressure is possible if, among several other conditions, enough thermal energy is released. Despite numerous water line observations, with the Herschel Space Observatory, in most of the sources observations were not able to trace the emission from the hot core around the newly forming protostellar object. We want to probe the physical conditions and water abundance in the inner layers of the host protostellar object NGC7538-IRS1 using a highly excited H2O line. Water maser models predict that several THz water masers should be detectable in these objects. We present SOFIA observations of the o-H2O 8(2,7)-7(3,4) line at 1296.41106 GHz and a 6(1,6)-5(2,3) 22 GHz e-MERLIN map of the region (first-ever 22 GHz images made after the e-MERLIN upgrade). In order to be able to constrain the nature of the emission - thermal or maser - we use near-simultaneous observations of the 22 GHz water maser performed with the Effelsberg radiotelescope and e-MERLIN. A thermal water model using the RATRAN radiative transfer code is presented based on HIFI pointed observations. Molecular water abundances are derived for the hot core. The H2O 8(2,7)- 7(3,4) line is detected toward NGC7538-IRS1 with one feature at the source velocity (-57.7 km/s) and another one at -48.4 km/s. We propose that the emission at the source velocity is consistent with thermal excitation and is excited in the innermost part of the IRS1a massive protostellar object's closest circumstellar environment. The other emission is very likely the first detection of a water THz maser line, pumped by shocks due to IRS1b outflow, in a star-forming region. Assuming thermal excitation of the THz line, the water abundance in NGC7538-IRS1's hot core is estimated to be 5.2x10^{-5} with respect to H2.

Accepted by A&A

https://arxiv.org/pdf/1706.06390

Direct evidence of multiple reservoirs of volatile nitrogen in a protosolar nebula analogue

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Isotopic ratios are keys to understanding the origin and early evolution of the solar system in the context of Galactic nucleosynthesis. The large range of measured $^{14}N/^{15}N$ isotopic ratios in the solar system reflects distinct reservoirs of nitrogen whose origins remain to be determined. We have directly measured a $C^{14}N/C^{15}N$ abundance ratio of 323±30 in the disk orbiting the nearby young star TW Hya. This value, which is in good agreement with nitrogen isotopic ratios measured for prestellar cores, likely reflects the primary present-day reservoir of nitrogen in the solar neighbourhood. These results support models invoking novae as primary ^{15}N sources as well as outward migration of the Sun over its lifetime, and suggest that comets sampled a secondary, ^{15}N-rich reservoir during solar system formation.

Accepted by A&A

https://arxiv.org/pdf/1706.10095

Disk-driven rotating bipolar outflow in Orion Source I

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One of the outstanding problems in star formation theory concerns the transfer of angular momentum so that mass can accrete onto a newly born young stellar object (YSO). From a theoretical standpoint, outflows and jets are predicted to play an essential role in the transfer of angular momentum and their rotations have been reported for both low- and high-mass YSOs. However, little quantitative discussion on outflow launching mechanisms has been presented for high-mass YSOs due to a lack of observational data. Here we present a clear signature of rotation in the bipolar outflow driven by Orion Source I, a high-mass YSO candidate, using the Atacama Large Millimeter/Submillimeter Array (ALMA). A rotational transition of silicon monoxide ($Si^{18}O$) reveals a velocity gradient perpendicular to the outflow axis, which is consistent with that of the circumstellar disk traced by a high excitation water line. The launching radii and outward velocity of the outflow are estimated to be >10 au and 10 km s^{-1}, respectively. These parameters rule out the possibility that the observed outflow is produced by the entrainment of a high-velocity jet, and that contributions from the stellar wind or X-wind, which have smaller launching radii, are significant in the case of Source I. Thus these results provide convincing evidence of a rotating outflow directly driven by the magneto-centrifugal disk wind launched by a high-mass YSO candidate.

Accepted by Nature Astronomy

http://www.nature.com/articles/s41550-017-0146

Simulating radiative feedback and star cluster formation in GMCs: II. Mass dependence of cloud destruction and cluster properties

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The process of radiative feedback in Giant Molecular Clouds (GMCs) is an important mechanism for limiting star cluster formation through the heating and ionization of the surrounding gas. We explore the degree to which radiative feedback affects early ($\lesssim$5 Myr) cluster formation in GMCs having masses that range from 10^{4-6} $M_{\odot}$ using the FLASH code. The inclusion of radiative feedback lowers the efficiency of cluster formation by 20–50% relative to hydrodynamic simulations. Two models in particular — 5×10^4 and 10^5 $M_{\odot}$ — show the largest suppression of the cluster formation efficiency, corresponding to a factor of ∼2. For these clouds only, the internal energy, a measure of the energy injected by radiative feedback, exceeds the gravitational potential for a significant amount of time. We find a clear relation between the maximum cluster mass, $M_{\rm cl,max}$, formed in a GMC of mass $M_{\rm GMC}$; $M_{\rm cl,max} \propto {M_{\rm GMC}}^{0.81}$. This scaling result suggests that young globular clusters at the necessary scale of 10^6 $M_{\odot}$ form within host GMCs of masses near $\sim 5 \times 10^7$ $M_{\odot}$. We compare simulated cluster mass distributions to the observed embedded cluster mass function ($d\log(N)/d\log(M) \propto M^{\beta}$ where $\beta = -1$) and find good agreement ($\beta = -0.99 \pm 0.14$) only for simulations including radiative feedback, indicating this process is important in controlling the growth of young clusters. However, the high star formation efficiencies, which range from 16–21%, and high star formation rates compared to locally observed regions suggest other feedback mechanisms are also important during the formation and growth of stellar clusters.

Accepted by MNRAS

http://arxiv.org/pdf/1706.00477

Unveiling the Role of the Magnetic Field at the Smallest Scales of Star Formation

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We report Atacama Large Millimeter/submillimeter Array (ALMA) observations of polarized dust emission from the protostellar source Ser-emb 8 at a linear resolution of 140 AU. Assuming models of dust-grain alignment hold, the observed polarization pattern gives a projected view of the magnetic field structure in this source. Contrary to expectations based on models of strongly magnetized star formation, the magnetic field in Ser-emb 8 does not exhibit an hourglass morphology. Combining the new ALMA data with previous observational studies, we can connect magnetic field structure from protostellar core ($\sim$80,000 AU) to disk ($\sim$100 AU) scales. We compare our observations with four magnetohydrodynamic gravo-turbulence simulations made with the AREPO code that have initial conditions ranging from super-Alfvénic (weakly magnetized) to sub-Alfvénic (strongly magnetized). These simulations achieve the spatial dynamic range necessary to resolve the collapse of protostars from the parsec scale of star-forming clouds down to the $\sim$100 AU scale probed by ALMA. Only in the very strongly magnetized simulation do we see both the preservation of the field direction from cloud to disk scales and an hourglass-shaped field at $<$1000 AU scales. We conduct an analysis of the relative orientation of the magnetic field and the density structure in both the Ser-emb 8 ALMA observations and the synthetic observations of the four AREPO simulations. We conclude that the Ser-emb 8 data are most similar to the weakly magnetized simulations, which exhibit random alignment, in contrast to the

strongly magnetized simulation, where the magnetic field plays a role in shaping the density structure in the source. In the weak-field case, it is turbulence—not the magnetic field—that shapes the material that forms the protostar, highlighting the dominant role that turbulence can play across many orders of magnitude in spatial scale.

Published in the Astrophysical Journal Letters

Open-access ApJL: http://iopscience.iop.org/article/10.3847/2041-8213/aa71b7
arXiv pre-print: https://arxiv.org/pdf/1706.03806

ALMA observations of dust polarization and molecular line emission from the Class 0 protostellar source Serpens SMM1

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We present high angular resolution dust polarization and molecular line observations carried out with the Atacama Large Millimeter/submillimeter Array (ALMA) toward the Class 0 protostar Serpens SMM1. By complementing these observations with new polarization observations from the Submillimeter Array (SMA) and archival data from the Combined Array for Research in Millimeter-wave Astronomy (CARMA) and the James Clerk Maxwell Telescopes (JCMT), we can compare the magnetic field orientations at different spatial scales. We find major changes in the magnetic field orientation between large (~ 0.1 pc) scales—where the magnetic field is oriented E–W, perpendicular to the major axis of the dusty filament where SMM1 is embedded—and the intermediate and small scales probed by CARMA (~ 1000 AU resolution), the SMA (~ 350 AU resolution), and ALMA (~ 140 AU resolution). The ALMA maps reveal that the redshifted lobe of the bipolar outflow is shaping the magnetic field in SMM1 on the southeast side of the source; however, on the northwestern side and elsewhere in the source, low velocity shocks may be causing the observed chaotic magnetic field pattern. High-spatial-resolution continuum and spectral-line observations also reveal a tight (~ 130 AU) protobinary system in SMM1-b, the eastern component of which is launching an extremely high-velocity, one-sided jet visible in both CO J=2-1 and SiO J=5-4; however, that jet does not appear to be shaping the magnetic field. These observations show that with the sensitivity and resolution of ALMA, we can now begin to understand the role that feedback (e.g., from protostellar outflows) plays in shaping the magnetic field in very young, star-forming sources like SMM1.

Accepted for publication in the Astrophysical Journal

http://arxiv.org/pdf/1707.03827

Effect of dust radial drift on viscous evolution of gaseous disk

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The total amount of dust (or "metallicity") and the dust distribution in protoplanetary disks are crucial for planet formation. Dust grains radially drift due to gas–dust friction, and the gas is affected by the feedback from dust grains. We investigate the effects of the feedback from dust grains on the viscous evolution of the gas, taking into account the vertical dust settling. The feedback from the grains pushes the gas outward. When the grains are small and the dust-to-gas mass ratio is much smaller than unity, the radial drift velocity is reduced by the feedback effect but the gas still drifts inward. When the grains are sufficiently large or piled-up, the feedback is so effective that forces the gas flows outward. Although the dust feedback is affected by dust settling, we found that the 2D approximation reasonably reproduces the vertical averaged flux of gas and dust. We also performed the 2D two-fluid hydrodynamic simulations to examine the effect of the feedback from the grains on the evolution of the gas disk. We show that when the feedback is effective, the gas flows outward and the gas density at the region within ∼10 AU is significantly depleted. As a result, the dust-to-gas mass ratio at the inner radii may significantly excess unity, providing the environment where planetesimals are easily formed via, e.g., streaming instability. We also show that a simplified 1D model well reproduces the results of the 2D two-fluid simulations, which would be useful for future studies.

Accepted by ApJ

http://arxiv.org/pdf/1706.08975

Distortion of Magnetic Fields in a Starless Core: Near-Infrared Polarimetry of FeSt 1-457

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Magnetic fields are believed to play an important role in controlling the stability and contraction of dense condensations of gas and dust leading to the formation of stars and planetary systems. In the present study, the magnetic field of FeSt 1-457, a cold starless molecular cloud core, was mapped on the basis of the polarized near-infrared light from 185 background stars after being dichroically absorbed by dust aligned with the magnetic field in the core. A distinct "hourglass-shaped" magnetic field was identified in the region of the core, which was interpreted as the first evidence of a magnetic field structure distorted by mass condensation in a starless core. The steep curvature of the magnetic field lines obtained in the present study indicates that the distortion was mainly created during the formation phase of the dense core. The derived mass-to-magnetic flux ratio indicates that the core is in a magnetically supercritical state. However, the stability of the core can be considered to be in a nearly critical state if the additional contributions from the thermal and turbulent support are included. Further diffusion of the magnetic field and/or turbulent dissipation would cause the onset of dynamical collapse of the core. The geometrical relationship between the direction of the magnetic field lines and the elongation of the core was found to be in good agreement with the theoretical predictions for the formation of Sun-like stars under the influence of a magnetic field.

Accepted by Astrophysical Journal

https://arxiv.org/abs/1707.00720

The evidence of radio polarization induced by the radiative grain alignment and self-scattering of dust grains in a protoplanetary disk

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The mechanisms causing millimeter-wave polarization in protoplanetary disks are under debate. To disentangle the polarization mechanisms, we observe the protoplanetary disk around HL Tau at 3.1 mm with the Atacama Large Millimeter/submillimeter Array (ALMA), which had polarization detected with CARMA at 1.3 mm. We successfully detect the ring-like azimuthal polarized emission at 3.1 mm. This indicates that dust grains are aligned with the major axis being in the azimuthal direction, which is consistent with the theory of radiative alignment of elongated dust grains, where the major axis of dust grains is perpendicular to the radiation flux. Furthermore, the morphology of the polarization vectors at 3.1 mm is completely different from those at 1.3 mm. We interpret that the polarization at 3.1 mm to be dominated by the grain alignment with the radiative flux producing azimuthal polarization vectors, while the self-scattering dominates at 1.3 mm and produces the polarization vectors parallel to the minor axis of the disk. By modeling the total polarization fraction with a single grain population model, the maximum grain size is constrained to be 100 μm, which is smaller than the previous predictions based on the spectral index between ALMA at 3 mm and VLA at 7 mm.

Accepted by ApJL

https://arxiv.org/pdf/1707.01612

The TWA 3 Young Triple System: Orbits, Disks, Evolution

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We have characterized the spectroscopic orbit of the TWA 3A binary and provide preliminary families of probable solutions for the TWA 3A visual orbit as well as for the wide TWA 3A–B orbit. TWA 3 is a hierarchical triple located at 34 pc in the ∼10 Myr old TW Hya association. The wide component separation is 1.”55; the close pair was first identified as a possible binary almost 20 years ago. We initially identified the 35-day period orbital solution using high-

resolution infrared spectroscopy which angularly resolved the A and B components. We then refined the preliminary orbit by combining the infrared data with a re-analysis of our high-resolution optical spectroscopy. The orbital period from the combined spectroscopic solution is ∼35 days, the eccentricity is ∼0.63, and the mass ratio is ∼0.84; although this high mass ratio would suggest that optical spectroscopy alone should be sufficient to identify the orbital solution, the presence of the tertiary B component likely introduced confusion in the blended optical spectra. Using millimeter imaging from the literature, we also estimate the inclinations of the stellar orbital planes with respect to the TWA 3A circumbinary disk inclination and find that all three planes are likely misaligned by at least ∼30 degrees. The TWA 3A spectroscopic binary components have spectral types of M4.0 and M4.5; TWA 3B is an M3. We speculate that the system formed as a triple, is bound, and that its properties were shaped by dynamical interactions between the inclined orbits and disk.

Accepted by ApJ

Kinematics of the Optically Visible YSOs Toward the Orion B Molecular Cloud

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We present results from high resolution optical spectra toward 66 young stars in the Orion B molecular cloud to study their kinematics and other properties. Observations of the Hα and Li I 6707 Å lines are used to check membership and accretion properties. While the stellar radial velocities of in NGC 2068 and L1622 show good agreement with that of the molecular gas, many of the stars in NGC 2024 show a considerable offset. This could be a signature of either expansion of the cluster, high degree of the ejection of the stars from the cluster through the dynamical interaction, or the acceleration of the gas due to stellar feedback.

Accepted by ApJ

http://arxiv.org/pdf/1707.01115

A Rotating Protostellar Jet Launched from the Innermost Disk of HH 212

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The central problem in forming a star is the angular momentum in the circumstellar disk which prevents material from falling into the central stellar core. An attractive solution to the "angular momentum problem" appears to be the ubiquitous (low-velocity and poorly-collimated) molecular outflows and (high-velocity and highly-collimated) protostellar jets accompanying the earliest phase of star formation that remove angular momentum at a range of disk radii. Previous observations suggested that outflowing material carries away the excess angular momentum via magneto-centrifugally driven winds from the surfaces of circumstellar disks down to $\sim$ 10 AU scales, allowing the material in the outer disk to transport to the inner disk. Here we show that highly collimated protostellar jets remove the residual angular momenta at the $\sim$ 0.05 AU scale, enabling the material in the innermost region of the disk to accrete toward the central protostar. This is supported by the rotation of the jet measured down to $\sim$ 10 AU from the protostar in the HH 212 protostellar system. The measurement implies a jet launching radius of $\sim 0.05^{+0.05}_{-0.02}$ AU on the disk, based on the magneto-centrifugal theory of jet production, which connects the properties of the jet measured at large distances to those at its base through energy and angular momentum conservation.

Accepted by Nature Astronomy

https://www.nature.com/articles/s41550-017-0152
http://arxiv.org/pdf/1706.06343

First Detection of Equatorial Dark Dust Lane in a Protostellar Disk at Submillimeter Wavelength

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In the earliest (so-called "Class 0") phase of sunlike (low-mass) star formation, circumstellar disks are expected to form, feeding the protostars. However, such disks are difficult to resolve spatially because of their small sizes. Moreover, there are theoretical difficulties in producing such disks in the earliest phase, due to the retarding effects of magnetic fields on the rotating, collapsing material (so-called "magnetic braking"). With the Atacama Large Millimeter/submillimeter Array (ALMA), it becomes possible to uncover such disks and study them in detail. HH 212 is a very young protostellar system. With ALMA, we not only detect but also spatially resolve its disk in dust emission at submillimeter wavelength. The disk is nearly edge-on and has a radius of ~ 60 AU. Interestingly, it shows a prominent equatorial dark lane sandwiched between two brighter features, due to relatively low temperature and high optical depth near the disk midplane. For the first time, this dark lane is seen at submillimeter wavelength, producing a "hamburger"-shaped appearance that is reminiscent of the scattered-light image of an edge-on disk in optical and near infrared. Our observations open up an exciting possibility of directly detecting and characterizing small disks around the youngest protostars through high-resolution imaging with ALMA, which provides strong constraints on theories of disk formation.

Accepted by Science Advances

http://advances.sciencemag.org/content/3/4/e1602935
http://arxiv.org/pdf/1704.08962

Formation and Atmosphere of Complex Organic Molecules of the HH 212 Protostellar Disk

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HH 212 is a nearby (400 pc) Class 0 protostellar system recently found to host a "hamburger"-shaped dusty disk with a radius of ~ 60 AU, deeply embedded in an infalling-rotating flattened envelope. We have spatially resolved this envelope-disk system with the Atacama Large Millimeter/submillimeter Array at up to ~ 16 AU ($0\rlap{.}''04$) resolution. The envelope is detected in HCO^+ J=4-3 down to the dusty disk. Complex organic molecules (COMs) and doubly deuterated formaldehyde (D_2CO) are detected above and below the dusty disk within ~ 40 AU of the central protostar. The COMs are methanol (CH_3OH), deuterated methanol (CH_2DOH), methyl mercaptan (CH_3SH), and formamide (NH_2CHO, a prebiotic precursor). We have modeled the gas kinematics in HCO^+ and COMs, and found a centrifugal barrier at a radius of ~ 44 AU, within which a Keplerian rotating disk is formed. This indicates that HCO^+ traces the infalling-rotating envelope down to centrifugal barrier and COMs trace the atmosphere of a Keplerian rotating disk within the centrifugal barrier. The COMs are spatially resolved for the first time, both radially and vertically, in the atmosphere of a disk in the earliest, Class 0 phase of star formation. Our spatially resolved observations of COMs favor their formation in the disk rather than a rapidly infalling (warm) inner envelope. The abundances and spatial distributions of the COMs provide strong constraints on models of their formation and transport in low-mass star formation.

Accepted by ApJ

http://arxiv.org/pdf/1706.06041

A new study of the chemical structure of the Horsehead nebula: the influence of grain-surface chemistry

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A wide variety of molecules have recently been detected in the Horsehead nebula photodissociation region (PDR) suggesting that: (i) gas-phase and grain chemistries should both contribute to the formation of organic molecules, and (ii) far-ultraviolet (FUV) photodesorption may explain the release into the gas phase of grain surface species. In order to tackle these specific problems and more generally in order to better constrain the chemical structure of these types of environments we present a study of the Horsehead nebula gas-grain chemistry. To do so we used the 1D astrochemical gas-grain code Nautilus with an appropriate physical structure computed with the Meudon PDR Code and compared our modeled outcomes with published observations and with previously modeled results when available. The use of a large set of chemical reactions coupled with the time-dependent code Nautilus allows us to reproduce most of the observations well, including those of the first detections in a PDR of the organic molecules HCOOH, CH_2CO, CH_3CHO and CH_3CCH, which are mostly associated with hot cores. We also provide some abundance predictions for other molecules of interest. Understanding the chemistry behind the detection of these organic molecules is crucial to better constrain the environments these molecules can probe.

Accepted by A&A

http://arxiv.org/pdf/1706.00454

The Link between Magnetic-field Orientations and Star Formation Rates

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Understanding star formation rates (SFR) is a central goal of modern star-formation models, which mainly involve gravity, turbulence and, in some cases, magnetic fields (B-fields). However, a connection between B-fields and SFR has never been observed. Here, a comparison between the surveys of SFR and a study of cloud-field alignment - which revealed a bimodal (parallel or perpendicular) alignment - shows consistently lower SFR per solar mass for clouds almost perpendicular to the B-fields. This is evidence of B-fields being a primary regulator of SFR. The perpendicular alignment possesses a significantly higher magnetic flux than the parallel alignment and thus a stronger support of the gas against self-gravity. This results in overall lower masses of the fragmented components, which are in agreement with the lower SFR.

Accepted by Nature Astronomy

https://www.nature.com/articles/s41550-017-0158
http://arxiv.org/pdf/1706.08452

An ALMA Survey of CO isotopologue emission from Protoplanetary Disks in Chamaeleon I

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The mass of a protoplanetary disk limits the formation and future growth of any planet. Masses of protoplanetary disks are usually calculated from measurements of the dust continuum emission by assuming an interstellar gas-to-dust ratio. To investigate the utility of CO as an alternate probe of disk mass, we use ALMA to survey ^{13}CO and C^{18}O $J = 3$–2 line emission from a sample of 93 protoplanetary disks around stars and brown dwarfs with masses from 0.03–2 $M_\odot$ in the nearby Chamaeleon I star-forming region. We detect ^{13}CO emission from 17 sources and C^{18}O from only one source. Gas masses for disks are then estimated by comparing the CO line luminosities to results from published disk models that include CO freeze-out and isotope-selective photodissociation. Under the assumption of a typical ISM CO-to-H$_2$ ratios of 10^{-4}, the resulting gas masses are implausibly low, with an average gas mass of $\sim$0.05 $M_{\rm Jup}$ as inferred from the average flux of stacked ^{13}CO lines. The low gas masses and gas-to-dust ratios for Cha I disks are both consistent with similar results from disks in the Lupus star-forming region. The faint CO line emission may instead be explained if disks have much higher gas masses, but freeze-out of CO or complex C-bearing molecules is underestimated in disk models. The conversion of CO flux to CO gas mass also suffers from uncertainties in disk structures, which could affect gas temperatures. CO emission lines will only be a good tracer of the disk mass when models for C and CO depletion are confirmed to be accurate.

Accepted by ApJ

http://arxiv.org/pdf/1706.03320

The JCMT Transient Survey: Data Reduction and Calibration Methods

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Though there has been a significant amount of work investigating the early stages of low-mass star formation in recent years, the evolution of the mass assembly rate onto the central protostar remains largely unconstrained. Examining in depth the variation in this rate is critical to understanding the physics of star formation. Instabilities in the outer and inner circumstellar disk can lead to episodic outbursts. Observing these brightness variations at infrared or submillimetre wavelengths sets constraints on the current accretion models. The JCMT Transient Survey is a three-year project dedicated to studying the continuum variability of deeply embedded protostars in eight nearby star-forming regions at a one month cadence. We use the SCUBA-2 instrument to simultaneously observe these regions at wavelengths of 450 μm and 850 μm. In this paper, we present the data reduction techniques, image alignment procedures, and relative flux calibration methods for 850 μm data. We compare the properties and locations of bright, compact emission sources fitted with Gaussians over time. Doing so, we achieve a spatial alignment of better than 1" between the repeated observations and an uncertainty of 2-3% in the relative peak brightness of significant, localised emission. This combination of imaging performance is unprecedented in ground-based, single dish submillimetre observations. Finally, we identify a few sources that show possible and confirmed brightness variations. These sources will be closely monitored and presented in further detail in additional studies throughout the duration of the survey.

Accepted by The Astrophysical Journal

https://arxiv.org/pdf/1706.01897

Using binary statistics in Taurus-Auriga to distinguish between brown dwarf formation processes

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Whether BDs form as stars through gravitational collapse ("star-like") or BDs and some very low-mass stars constitute a separate population which form alongside stars comparable to the population of planets, e.g. through circumstellar disk ("peripheral") fragmentation, is one of the key questions of the star-formation problem. For young stars in Taurus-Auriga the binary fraction is large with little dependence on primary mass above $\sim 0.2\ M_\odot$, while for BDs it is <10%. We investigate a case in which BDs in Taurus formed dominantly through peripheral fragmentation. The decline of the binary frequency in the transition region between star-like and peripheral formation is modelled. A dynamical population synthesis model is employed in which stellar binary formation is universal. Peripheral objects form separately in circumstellar disks with a distinctive initial mass function (IMF), own orbital parameter distributions for binaries and a low binary fraction. A small amount of dynamical processing of the stellar component is accounted for as appropriate for the low-density Taurus-Auriga embedded clusters. The binary fraction declines strongly between the mass-limits for star-like and peripheral formation. The location of characteristic features and the steepness depend on these mass-limits. Such a trend might be unique to low density regions hosting dynamically unprocessed binary populations. The existence of a strong decline in the binary fraction – primary mass diagram will become verifiable in future surveys on BD and VLMS binarity in the Taurus-Auriga star forming region. It is a test of the (non-)continuity of star formation along the mass-scale, the separateness of the stellar and BD populations and the dominant formation channel for BDs and BD binaries in regions of low stellar density hosting dynamically unprocessed populations.

Accepted by A&A

http://arxiv.org/pdf/1706.01464

Angular Momentum Evolution of Young Stars in the Nearby Scorpius-Centaurus OB Association

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We report the results of a study of archival SuperWASP light curves for stars in Scorpius-Centaurus (Sco-Cen), the nearest OB association. We use SuperWASP time-series photometry to extract rotation periods for 189 candidate members of the Sco-Cen complex, and verify that 162 of those are members of the classic Sco-Cen subgroups of Upper Scorpius (US), Upper Centaurus-Lupus (UCL), and Lower Centaurus-Crux (LCC). This study provides the first measurements of rotation periods explicitly for large samples of pre-main sequence (pre-MS) stars spanning the UCL and LCC subgroups. Our final sample of 157 well-characterized pre-MS stars spans ages of ∼10–20 Myr, spectral types of ∼F3–M0, and masses of $M \approx 0.3$–$1.5\ M_\odot^{\rm N}$. For this sample, we find a distribution of stellar rotation periods with a median of $P_{\rm rot} \approx 2.4$ days, overall range of $0.2 < P_{\rm rot} < 8$ days, and a fairly well-defined mass-dependent upper envelope of rotation periods. This distribution of periods is consistent with recently developed stellar angular

momentum evolution models. These data are significant because they represent an undersampled age range and the number of measurable rotation periods is large compared to recent studies of other regions. We also search for new examples of eclipsing disk or ring systems analogous to 1SWASP J140747.93−394542.6 ("J1407", V1400 Cen), but find none. Our survey yielded five eclipsing binaries, but only one appears to be physically associated with the Sco-Cen complex. V2394 Oph is a heavily reddened ($A_V \approx 5$ mag) massive contact binary in the LDN 1689 cloud whose Gaia astrometry is clearly consistent with kinematic membership with the Ophiuchus star-forming region.

Accepted by ApJ

http://arxiv.org/pdf/1706.06105

ALMA observations of N83C in the early stage of star formation in the Small Magellanic Cloud

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We have performed Atacama Large Millimeter/submillimeter Array (ALMA) observations in ^{12}CO($J = 2-1$), ^{13}CO($J = 2-1$), C^{18}O($J = 2-1$), ^{12}CO($J = 3-2$), ^{13}CO($J = 3-2$), and CS($J = 7-6$) lines toward the active star-forming region N83C in the Small Magellanic Cloud (SMC), whose metallicity is $\sim 1/5$ of the Milky Way (MW). The ALMA observations first reveal sub-pc scale molecular structures in ^{12}CO($J = 2-1$) and ^{13}CO($J = 2-1$) emission. We found strong CO peaks associated with young stellar objects (YSOs) identified by the *Spitzer* Space Telescope, and also found that overall molecular gas is distributed along the edge of the neighboring HII region. We derived a gas density of $\sim 10^4$ cm^{-3} in molecular clouds associated with YSOs based on the virial mass estimated from ^{12}CO($J = 2-1$) emission. This high gas density is presumably due to the effect of the HII region under the low-metallicity (accordingly small-dust content) environment in the SMC; far-UV radiation from the HII region can easily penetrate and photo-dissociate the outer layer of ^{12}CO molecules in the molecular clouds, and thus only the innermost parts of the molecular clouds are observed even in ^{12}CO emission. We obtained the CO-to-H_2 conversion factor $X_{\rm CO}$ of $\sim 8 \times 10^{20}$ cm^{-2} (K km s^{-1})$^{-1}$ in N83C based on virial masses and CO luminosities, which is four times larger than that in the MW, 2×10^{20} cm^{-2} (K km s^{-1})$^{-1}$. We also discuss the difference in the nature between two high-mass YSOs, each of which is associated with a molecular clump with a mass of about a few $\times 10^3 M_\odot$.

Accepted by Astrophysical Journal

https://arxiv.org/pdf/1706.04871

Centrifugally driven winds from protostellar accretion discs. I - Formulation and initial results

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Protostellar discs play an important role in star formation, acting as the primary mass reservoir for accretion onto young stars and regulating the extent to which angular momentum and gas is released back into stellar nurseries through the launching of powerful disc winds. In this study, we explore how disc structure relates to the properties of the wind-launching region, mapping out the regions of protostellar discs where wind launching could be viable. We combine a series of 1.5D semi-analytic, steady-state, vertical disc-wind solutions into a radially extended 1+1.5D model, incorporating all three diffusion mechanisms (Ohm, Hall and ambipolar). We observe that the majority of mass outflow via disc winds occurs over a radial width of a fraction of an astronomical unit, with outflow rates attenuating rapidly on either side. We also find that the mass accretion rate, magnetic field strength and surface density profile each have significant effects on both the location of the wind-launching region and the ejection/accretion ratio $\dot{M}_{\rm out}/\dot{M}_{\rm in}$. Increasing either the accretion rate or the magnetic field strength corresponds to a shift of the wind-launching region to smaller radii and a decrease in $\dot{M}_{\rm out}/\dot{M}_{\rm in}$, while increasing the surface density corresponds to launching regions at larger radii with increased $\dot{M}_{\rm out}/\dot{M}_{\rm in}$. Finally, we discover a class of disc winds containing an ineffective launching configuration at intermediate radii, leading to two radially separated regions of wind launching and diminished $\dot{M}_{\rm out}/\dot{M}_{\rm in}$. We find that the wind locations and ejection/accretion ratio are consistent with current observational and theoretical estimates.

Accepted by MNRAS

https://arxiv.org/pdf/1707.01088.pdf

Spatial distribution of star formation related to ionized regions throughout the inner Galactic plane

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We present a comprehensive statistical analysis of star-forming objects located in the vicinities of 1 360 bubble structures throughout the Galactic Plane and their local environments. The compilation of ∼70 000 star-forming sources, found in the proximity of the ionized (HII) regions and detected in both Hi-GAL and GLIMPSE surveys, provided a broad overview of the different evolutionary stages of star-formation in bubbles, from prestellar objects to

more evolved young stellar objects (YSOs). Surface density maps of star-forming objects clearly reveal an evolutionary trend where more evolved star-forming objects (Class II YSO candidates) are found spatially located near the center, while younger star-forming objects are found at the edge of the bubbles. We derived dynamic ages for a subsample of 182 H II regions for which kinematic distances and radio continuum flux measurements were available. We detect approximately 80% more star-forming sources per unit area in the direction of bubbles than in the surrounding fields. We estimate the clump formation efficiency (CFE) of Hi-GAL clumps in the direction of the shell of the bubbles to be $\sim 10\%$, around twice the value of the CFE in fields that are not affected by feedback effects. We find that the higher values of CFE are mostly due to the higher CFE of protostellar clumps, in particular in younger bubbles, whose density of the bubble shells is higher. We argue that the formation rate from prestellar to protostellar phase is probably higher during the early stages of the (H II) bubble expansion. Furthermore, we also find a higher fraction of massive YSOs (MYSOs) in bubbles at the early stages of expansion (< 2 Myr) than older bubbles. Evaluation of the fragmentation time inside the shell of bubbles advocates the preexistence of clumps in the medium before the bubble expansion in order to explain the formation of MYSOs in the youngest H II regions (< 1 Myr), as supported by numerical simulations. Approximately 23% of the Hi-GAL clumps are found located in the direction of a bubble, with 15% for prestellar clumps and 41% for protostellar clumps. We argue that the high fraction of protostellar clumps may be due to the acceleration of the star-formation process cause by the feedback of the (HII) bubbles.

Accepted by Astronomy and Astrophysics

https://arxiv.org/pdf/1705.09877.pdf

Detection of the HC_3NH^+ and $HCNH^+$ ions in the L1544 pre-stellar core

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The L1544 pre-stellar core was observed as part of the ASAI (Astrochemical Surveys At IRAM) Large Program. We report the first detection in a pre-stellar core of the $HCNH^+$ and HC_3NH^+ ions. The high spectral resolution of the observations allows to resolve the hyperfine structure of $HCNH^+$. Local thermodynamic equilibrium analysis leads to derive a column density equal to $(2.0 \pm 0.2) \times 10^{13}$ cm^{-2} for $HCNH^+$ and $(1.5 \pm 0.5) \times 10^{11}$ cm^{-2} for HC_3NH^+. We also present non-LTE analysis of five transitions of HC_3N, three transitions of $H^{13}CN$ and one transition of $HN^{13}C$, all of them linked to the chemistry of $HCNH^+$ and HC_3NH^+. We computed for HC_3N, HCN, and HNC a column density of $(2.0 \pm 0.4) \times 10^{13}$ cm^{-2}, $(3.6 \pm 0.9) \times 10^{14}$ cm^{-2}, and $(3.0 \pm 1.0) \times 10^{14}$ cm^{-2}, respectively. We used the gas-grain chemical code Nautilus to predict the abundances all these species across the pre-stellar core. Comparison of the observations with the model predictions suggests that the emission from $HCNH^+$ and HC_3NH^+ originates in the external layer where non-thermal desorption of other species was previously observed. The observed abundance of both ionic species ($[HCNH^+] \approx 3 \times 10^{-10}$ and $[HC_3NH^+] \approx [1.5–3.0] \times 10^{-12}$, with respect to H_2) cannot be reproduced at the same time by the chemical modelling, within the error bars of the observations only. We discuss the possible reasons for the discrepancy and suggest that the current chemical models are not fully accurate or complete. However, the modelled abundances are within a factor of three consistent with the observations, considering a late stage of the evolution of the pre-stellar core, compatible with previous observations.

Accepted by MNRAS

http://arxiv.org/pdf/1706.00647

The chemistry of episodic accretion in embedded objects. 2D radiation thermo-chemical models of the post-burst phase.

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Episodic accretion is an important process in the evolution of young stars and their environment. The observed strong luminosity bursts of young stellar objects likely have a long lasting impact on the chemical evolution of the disk and envelope structure. We want to investigate observational signatures of the chemical evolution in the post-burst phase for embedded sources. With such signatures it is possible to identify targets that experienced a recent luminosity burst. We present a new model for episodic accretion chemistry based on the 2D, radiation thermo-chemical disk code ProDiMo. We have extended ProDiMo with a proper treatment for envelope structures. For a representative Class I model, we calculated the chemical abundances in the post-burst phase and produced synthetic observables like intensity maps and radial profiles. During a burst many chemical species, like CO, sublimate from the dust surfaces. As the burst ends they freeze out again (post-burst phase). This freeze-out happens from inside-out due to the radial density gradient in the disk and envelope structure. This inside-out freeze-out produces clear observational signatures in spectral line emission, like rings and distinct features in the slope of radial intensity profiles. We fitted synthetic C18O J=2-1 observations with single and two component fits and find that post-burst images are much better matched by the latter. Comparing the quality of such fits allows identification of post-burst targets in a model-independent way. Our models confirm that it is possible to identify post-burst objects from spatially resolved CO observations. However, to derive proper statistics, like frequencies of bursts, from observations it is important to consider aspects like the inclination and structure of the target and also dust properties as those have a significant impact on the freeze-out timescale.

Accepted by A&A

https://arxiv.org/pdf/1705.03946

Proper motions of collimated jets from intermediate-mass protostars in the Carina Nebula

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We present proper motion measurements of 37 jets and HH objects in the Carina Nebula measured in two epochs of Hα images obtained $\sim$ 10 yrs apart with *HST*/ACS. Transverse velocities in all but one jet are faster than $\gtrsim$25 km s^{-1}, confirming that the jet-like Hα features identified by Smith et al. (2010) trace outflowing gas. Proper motions constrain the location of the jet-driving source and provide kinematic confirmation of the intermediate-mass protostars that we identify for 20/37 jets. Jet velocities do not correlate with the estimated protostar mass and embedded driving sources do not have slower jets. Instead, transverse velocities (median $\sim$ 75 km s^{-1}) are similar to those in jets from low-mass stars. Assuming a constant velocity since launch, we compute jet dynamical ages (median $\sim 10^4$ yr). If continuous emission from inner jets traces the duration of the most recent accretion bursts, then these episodes are sustained longer (median $\sim$ 700 yr) than the typical decay time of an FU Orionis outburst. These jets can carry appreciable momentum that may be injected into the surrounding environment. The resulting outflow force, dP/dt, lies between that measured in low- and high-mass sources, despite the very different observational tracers used. Smooth scaling of the outflow force argues for a common physical process underlying outflows from protostars of all masses. This latest kinematic result adds to a growing body of evidence that intermediate-mass star formation proceeds like a scaled-up version of the formation of low-mass stars.

Accepted by MNRAS

https://arxiv.org/pdf/1706.04657

ALMA Observations of the Young Substellar Binary System 2M1207

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We present ALMA observations of the 2M1207 system, a young binary made of a brown dwarf with a planetary-mass companion at a projected separation of about 40 au. We detect emission from dust continuum at 0.89 mm and from the $J = 3$–2 rotational transition of CO from a very compact disk around the young brown dwarf. The small radius found for this brown dwarf disk may be due to truncation from the tidal interaction with the planetary-mass companion. Under the assumption of optically thin dust emission, we estimated a dust mass of 0.1 $M_\oplus$ for the 2M1207A disk, and a 3σ upper limit of $\sim$1 $M_{\rm Moon}$ for dust surrounding 2M1207b, which is the tightest upper limit obtained so far for the mass of dust particles surrounding a young planetary-mass companion. We discuss the impact of this and other non-detections of young planetary-mass companions for models of planet formation, which predict the presence of circum-planetary material surrounding these objects.

Accepted by AJ

http://arxiv.org/pdf/1706.03708

Deep imaging search for planets forming in the TW Hya protoplanetary disk with the Keck/NIRC2 vortex coronagraph

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Distinct gap features in the nearest protoplanetary disk, TW Hya (distance of 59.5±0.9 pc), may be signposts of ongoing planet formation. We performed long-exposure thermal infrared coronagraphic imaging observations to search for accreting planets especially within dust gaps previously detected in scattered light and submm-wave thermal emission. Three nights of observations with the Keck/NIRC2 vortex coronagraph in L′ (3.4–4.1 μm) did not reveal any statistically significant point sources. We thereby set strict upper limits on the masses of non-accreting planets. In the four most prominent disk gaps at 24, 41, 47, and 88 au, we obtain upper mass limits of 1.6–2.3, 1.1–1.6, 1.1–1.5, and 1.0–1.2 Jupiter masses ($M_{\rm J}$) assuming an age range of 7–10 Myr for TW Hya. These limits correspond to the contrast at 95% completeness (true positive fraction of 0.95) with a 1% chance of a false positive within 1″ of the star. We also approximate an upper limit on the product of planet mass and planetary accretion rate of $M_{\rm p}\dot{M} \lesssim 10^{-8} M_{\rm J}{}^2/{\rm yr}$

implying that any putative ∼0.1 M_J planet, which could be responsible for opening the 24 au gap, is presently accreting at rates insufficient to build up a Jupiter mass within TW Hya's pre-main sequence lifetime.

Accepted by AJ

http://arxiv.org/pdf/1706.07489

A deep decrease event in the brightness of the PMS star V350 Cep

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New photometric data from CCD $UBVRI$ observations of the PMS star V350 Cep during the period from March 2014 to May 2017 are presented. In the period April-May 2016 we registered a deep fades event in the brightness of the star with amplitudes $\Delta I = 1.75$ mag, $\Delta R = 1.69$ mag, $\Delta V = 1.77$ mag and $\Delta B = 2.16$ mag. Simultaneously with the fades in the brightness, the change in the star's color indices has been observed. V350 Cep indicates the typical for stars of UXor type "blueing effect" during the deep minimum of brightness. During the second half of 2016 V350 Cep restores its brightness to a level close to the maximum. Since the star has been studied as a possible FUor object in previous studies, the possible cause of the deep decline is a decrease in the accretion rate. Another possible cause is obscuration from clumps of dust orbiting at the vicinity of the star.

Accepted by Bulgarian Astronomical Journal

http://arxiv.org/pdf/1706.01076

All-sky Co-moving Recovery Of Nearby Young Members. (ACRONYM) II: The Beta Pictoris Moving Group

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We confirm 66 low-mass stellar and brown dwarf systems (K7–M9) plus 19 visual or spectroscopic companions of the β Pictoris Moving Group (BPMG). Of these, 41 are new discoveries, increasing the known low-mass members by 45%. We also add four objects to the 14 known with masses predicted to be less than 0.07 $M_\odot$. Our efficient photometric+kinematic selection process identified 104 low-mass candidates which we observed with ground-based spectroscopy. We collected infrared observations of the latest spectral types (>M5) to search for low gravity objects. These and all <M5 candidates were observed with high-resolution optical spectrographs to measure the radial velocities and youth indicators, such as lithium absorption and Hα emission, needed to confirm BPMG membership, achieving a 63% confirmation rate. We also compiled the most complete census of the BPMG membership with which we tested the efficiency and false-membership assignments using our selection and confirmation criteria. We assess a group age of 22±6 Myr using the new census, consistent with past estimates. With the now densely sampled lithium depletion boundary, we resolve the broadening of the boundary by either an age spread or astrophysical influences on lithium burning rates. We find that 69% of the now known members with AFGKM primaries are M stars, nearing the expected value of 75%. However, the new IMF for the BPMG shows a deficit of 0.2–0.3 $M_\odot$ stars by a factor of approximately 2. We expect that the AFGK census of the BPMG is also incomplete, probably due to biases of searches towards the nearest stars.

Accepted by AJ

http://arxiv.org/pdf/1706.04556

Temperature structure and kinematics of the IRDC G035.39-00.33

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Aims. Infrared dark clouds represent the earliest stages of high-mass star formation. Detailed observations of their physical conditions on all physical scales are required to improve our understanding of their role in fueling star formation.
Methods. We investigate the large-scale structure of the IRDC G035.39–00.33, probing the dense gas with the classical ammonia thermometer. This allows us to put reliable constraints on the temperature of the extended, pc-scale dense gas reservoir and to probe the magnitude of its non-thermal motions. Available far-infrared observations can be used in tandem with the observed ammonia emission to estimate the total gas mass contained in G035.39–00.33.
Results. We identify a main velocity component as a prominent filament, manifested as an ammonia emission intensity ridge spanning more than 6 pc, consistent with the previous studies on the Northern part of the cloud. A number of additional line-of-sight components are found, and a large scale, linear velocity gradient of ∼0.2 km $s^{-1}pc^{-1}$ is found along the ridge of the IRDC. In contrast to the dust temperature map, an ammonia-derived kinetic temperature map, presented for the entirety of the cloud, reveals local temperature enhancements towards the massive protostellar cores. We show that without properly accounting for the line of sight contamination, the dust temperature is 2-3 K larger than the gas temperature measured with NH_3.
Conclusions. While both the large scale kinematics and temperature structure are consistent with that of starless dark filaments, the kinetic gas temperature profile on smaller scales is suggestive of tracing the heating mechanism coincident with the locations of massive protostellar cores.

Accepted by A&A

https://arxiv.org/pdf/1706.08903

Early Solar System irradiation quantified by linked vanadium and beryllium isotope variations in meteorites

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X-ray emission in young stellar objects (YSOs) is orders of magnitude more intense than in main sequence stars[1,2], suggestive of cosmic ray irradiation of surrounding accretion disks. Protoplanetary disk irradiation has been detected around YSOs by HERSCHEL[3]. In our solar system, short-lived ^{10}Be (half-life = 1.39 My[4]), which cannot be produced by stellar nucleosynthesis, was discovered in the oldest solar system solids, the calcium-aluminium-rich inclusions (CAIs)[5]. The high ^{10}Be abundance, as well as detection of other irradiation tracers[6,7], suggest ^{10}Be likely originates from cosmic ray irradiation caused by solar flares[8]. Nevertheless, the nature of these flares (gradual or impulsive), the target (gas or dust), and the duration and location of irradiation remain unknown. Here we use the vanadium isotopic composition, together with initial ^{10}Be abundance to quantify irradiation conditions in the early Solar System[9]. For the

initial ^{10}Be abundances recorded in CAIs, ^{50}V excesses of a few per mil relative to chondrites have been predicted[10,11]. We report ^{50}V excesses in CAIs up to 4.4 per mil that co-vary with ^{10}Be abundance. Their co-variation dictates that excess ^{50}V and ^{10}Be were synthesised through irradiation of refractory dust. Modelling of the production rate of ^{50}V and ^{10}Be demonstrates that the dust was exposed to solar cosmic rays produced by gradual flares for less than 300 years at about 0.1 au from the protoSun.

Accepted by Nature Astronomy

https://arxiv.org/pdf/1705.01808

Planet-disc interaction in laminar and turbulent discs

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In weakly ionized discs turbulence can be generated through the vertical shear instability (VSI). Embedded planets feel a stochastic component in the torques acting on them which can impact their migration. In this work we study the interplay between a growing planet embedded in a protoplanetary disc and the VSI-turbulence. We performed a series of three-dimensional hydrodynamical simulations for locally isothermal discs with embedded planets in the mass range from 5 to 100 Earth masses. We study planets embedded in an inviscid disc that is VSI unstable, becomes turbulent and generates angular momentum transport with an effective $\alpha = 5 \times 10^{-4}$. This is compared to the corresponding viscous disc using exactly this α-value.
In general we find that the planets have only a weak impact on the disc turbulence. Only for the largest planet (100 $M_\oplus$) the turbulent activity becomes enhanced inside of the planet. The depth and width of a gap created by the more massive planets (30,100 $M_\oplus$) in the turbulent disc equal exactly that of the corresponding viscous case, leading to very similar torque strengths acting on the planet, with small stochastic fluctuations for the VSI disc. At the gap edges vortices are generated that are stronger and longer lived in the VSI disc. Low mass planets (with $M_\mathrm{p} \leq 10\ M_\oplus$) do not open gaps in the disc in both cases but generate for the turbulent disc an over-density behind the planet that exerts a significant negative torque. This can boost the inward migration in VSI turbulent discs well above the Type I rate.
Due to the finite turbulence level in realistic three-dimensional discs the gap depth will always be limited and migration will not stall in inviscid discs.

Accepted by A&A

http://arxiv.org/pdf/1706.04354

First Detection of $HC_5{}^{15}N$ in the Interstellar Medium

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We report the first detection of $HC_5{}^{15}N$ with the $J = 9 - 8$ rotational line from the cyanopolyyne peak in Taurus Molecular Cloud-1 (TMC-1 CP) using the 45-m radio telescope of the Nobeyama Radio Observatory. The column density of $HC_5{}^{15}N$ is derived to be $(1.9 \pm 0.5) \times 10^{11}$ cm^{-2} (1σ). We apply the double isotope method to derive the $^{14}N/^{15}N$ ratios of HC_5N and HC_3N in TMC-1 CP. The $^{14}N/^{15}N$ ratios are calculated to be 344 ± 53 and 257 ± 54 for HC_5N and HC_3N, respectively. The $^{14}N/^{15}N$ ratio of HC_5N is lower than the elemental ratio in the local interstellar medium (~ 440) and slightly higher than that of HC_3N in TMC-1 CP. Since HC_3N is formed via the neutral-neutral reaction between C_2H_2 and CN, the slightly higher $^{14}N/^{15}N$ ratio of HC_5N may support our previous suggestions that the main formation mechanism of HC_5N is the ion-molecule reactions between hydrocarbon ions ($C_5H_n^+$) and nitrogen atoms.

Accepted by PASJ letter

https://arxiv.org/pdf/1706.08662

Observations of Cyanopolyynes toward Four High-Mass Star-Forming Regions Containing Hot Cores

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We carried out line survey observations at the 26−30 GHz band toward the four high-mass star-forming regions containing hot cores, G10.30-0.15, G12.89+0.49, G16.86-2.16, and G28.28-0.36, with the Robert C. Byrd Green Bank Telescope. We have detected HC_5N from all of the sources, and HC_7N from the three sources, except for G10.30-0.15. We further conducted observations of HC_5N at the 42−46 GHz and 82−103 GHz bands toward the three sources, G12.89+0.49, G16.86-2.16, and G28.28-0.36, with the Nobeyama 45 m radio telescope. The rotational lines of HC_5N with the high excitation energies ($E_u/k \sim 63 - 100$ K), which are hardly excited in the cold dark clouds, have been detected from the three sources. The rotational temperatures of HC_5N are found to be $\sim 13 - 20$ K in the three sources. The detection of the lines with the high excitation energies and the derived rotational temperatures indicate that HC_5N exists in the warm gas within 0.07−0.1 pc radii around massive young stellar objects. The column densities of HC_5N in the three sources are derived to be $(\sim 2.0 - 2.8) \times 10^{13}$ cm^{-2}. We compare the ratios between $N(HC_5N)$ the column density of HC_5N and $W(CH_3OH)$ the integrated intensity of the thermal CH_3OH emission line among the three high-mass star-forming regions. We found a possibility of the chemical differentiation in the three high-mass star-forming regions; G28.28-0.36 shows the largest $N(HC_5N)/W(CH_3OH)$ ratio of $> 8.0 \times 10^{14}$ in units of (K km s^{-1})$^{-1}$ cm^{-2}, while G12.89+0.49 and G16.86-2.16 show the smaller values ($\sim 2 \times 10^{13}$).

Accepted by ApJ

https://arxiv.org/pdf/1706.02465

Chemical complexity induced by efficient ice evaporation in the Barnard 5 molecular cloud

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Cold gas-phase water has recently been detected in a cold dark cloud, Barnard 5 located in the Perseus complex, by targeting methanol peaks as signposts for ice mantle evaporation. Observed morphology and abundances of methanol and water are consistent with a transient non-thermal evaporation process only affecting the outermost ice mantle layers, possibly triggering a more complex chemistry. We present the detection of the Complex Organic Molecules (COMs) acetaldehyde (CH_3CHO) and methyl formate (CH_3OCHO) as well as formic acid (HCOOH) and ketene (CH_2CO), and the tentative detection of di-methyl ether (CH_3OCH_3) towards the methanol hotspot of Barnard 5 located between two dense cores using the single dish OSO 20m, IRAM 30m, and NRO 45m telescopes. The high energy *cis-* conformer of formic acid is detected, suggesting that formic acid is mostly formed at the surface of interstellar grains and then evaporated. The detection of multiple transitions for each species allows us to constrain their abundances through LTE and non-LTE methods. All the considered COMs show similar abundances between ~ 1 and ~ 10 % relative to methanol depending on the assumed excitation temperature. The non-detection of glycolaldehyde, an isomer of methyl formate, with a [glycolaldehyde]/[methyl formate] abundance ratio lower than 6 %, favours gas phase formation pathways triggered by methanol evaporation. According to their excitation temperatures derived in massive hot cores, formic acid, ketene, and acetaldehyde have been designated as "lukewarm" COMs whereas methyl formate and di-methyl ether were defined as "warm" species. Comparison with previous observations of other types of sources confirms that "lukewarm" and "warm" COMs show similar abundances in low-density cold gas whereas the "warm" COMs tend to be more abundant than the "lukewarm" species in warm protostellar cores. This abundance evolution suggests either that "warm" COMs are indeed mostly formed in protostellar environments and/or that "lukewarm" COMs are efficiently depleted by increased hydrogenation efficiency around protostars.

Accepted by Astronomy and Astrophysics

https://arxiv.org/pdf/1706.01368

Pulsed Accretion in the T Tauri Binary TWA 3A

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TWA 3A is the most recent addition to a small group of young binary systems that both actively accrete from a circumbinary disk and have spectroscopic orbital solutions. As such, it provides a unique opportunity to test binary accretion theory in a well-constrained setting. To examine TWA 3A's time-variable accretion behavior, we have conducted a two-year, optical photometric monitoring campaign, obtaining dense orbital phase coverage ($\sim$20 observations per orbit) for $\sim$15 orbital periods. From U-band measurements we derive the time-dependent binary mass accretion rate, finding bursts of accretion near each periastron passage. On average, these enhanced accretion events evolve over orbital phases 0.85 to 1.05, reaching their peak at periastron. The specific accretion rate increases above the quiescent value by a factor of $\sim$4 on average but the peak can be as high as an order of magnitude in a given orbit. The phase dependence and amplitude of TWA 3A accretion is in good agreement with numerical simulations of binary accretion with similar orbital parameters. In these simulations, periastron accretion bursts are fueled by periodic streams of material from the circumbinary disk that are driven by the binary orbit. We find that TWA 3A's average accretion behavior is remarkably similar to DQ Tau, another T Tauri binary with similar orbital parameters, but with significantly less variability from orbit to orbit. This is only the second clear case of orbital-phase-dependent accretion in a T Tauri binary.

Accepted by ApJL

https://arxiv.org/pdf/1706.07073
http://iopscience.iop.org/article/10.3847/2041-8213/aa75cb

Massive 70 μm quiet clumps I: evidence of embedded low/intermediate-mass star formation activity

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Massive clumps, prior to the formation of any visible protostars, are the best candidates to search for the elusive massive starless cores. In this work we investigate the dust and gas properties of massive clumps selected to be 70 μm quiet, therefore good starless candidates. Our sample of 18 clumps has masses $300 < M < 3000\ M_\odot$, radius $0.54 < R < 1.00$ pc, surface densities $\Sigma > 0.05$ g cm^{-2} and luminosity/mass ratio $L/M < 0.3$. We show that half of these 70 μm quiet clumps embed faint 24 μm sources. Comparison with GLIMPSE counterparts shows that 5 clumps embed young stars of intermediate stellar mass up to $\sim$5.5 $M_\odot$. We study the clump dynamics with observations of N_2H^+ (1–0), HNC (1–0) and HCO^+ (1–0) made with the IRAM 30m telescope. Seven clumps have blue-shifted spectra compatible with infall signatures, for which we estimate a mass accretion rate $0.04 < \dot{M} < 2.0 \times 10^{-3}\ M_\odot\ \mathrm{yr}^{-1}$, comparable with values found in high-mass protostellar regions, and free-fall time of the order of $t_{\rm ff} = 3 \times 10^5$ yr. The only appreciable difference we find between objects with and without embedded 24 μm sources is that the infall rate appears to increase from 24 μm dark to 24 μm bright objects. We conclude that all 70 μm quiet objects have similar properties on clump scales, independently of the presence of an embedded protostar. Based on our data we speculate that the majority, if not all of these clumps may already embed faint, low-mass protostellar cores. If these clumps are to form massive stars, this must occur after the formation of these lower mass stars.

Accepted by MNRAS

http://arxiv.org/pdf/1706.00432

A Millimeter Continuum Size-Luminosity Relationship for Protoplanetary Disks

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We present a sub-arcsecond resolution survey of the 340 GHz dust continuum emission from 50 nearby protoplanetary disks, based on new and archival observations with the Submillimeter Array. The observed visibility data were modeled with a simple prescription for the radial surface brightness profile. The results were used to extract intuitive, empirical estimates of the emission "size" for each disk, $R_{\rm eff}$, defined as the radius that encircles a fixed fraction of the total continuum luminosity, $L_{\rm mm}$. We find a significant correlation between the sizes and luminosities, such that $R_{\rm eff} \propto {L_{\rm mm}}^0.5$, providing a confirmation and quantitative characterization of a putative trend that was noted previously. This correlation suggests that these disks have roughly the same average surface brightness interior to their given effective radius, $\sim$0.2 Jy arcsec^{-2} (or 8 K in brightness temperature). The same trend remains, but the 0.2dex of dispersion perpendicular to this relation essentially disappears, when we account for the irradiation environment of each disk with a crude approximation of the dust temperatures based on the stellar host luminosities. We consider two (not mutually exclusive) explanations for the origin of this size-luminosity relationship. Simple models of the growth and migration of disk solids can account for the observed trend for a reasonable range of initial conditions, but only on timescales that are much shorter than the nominal ages present in the sample. An alternative scenario invokes optically thick emission concentrated on unresolved scales, with filling factors of a few tens of percent, that are perhaps manifestations of localized particle traps.

Accepted by ApJ

http://arxiv.org/pdf/1706.08977

An 80 au cavity in the disk around HD 34282

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Context: Large cavities in disks are important testing grounds for the mechanisms proposed to drive disk evolution and dispersion, such as dynamical clearing by planets and photo-evaporation.
Aims: We aim to resolve the large cavity in the disk around HD 34282, such as has been predicted by previous studies modeling the spectral energy distribution.
Methods: Using ALMA band 7 observations we study HD 34282 with a spatial resolution of 0.10" 0.17" at 345 GHz.
Results: We resolve the disk around HD 34282 into a ring between 0.24 and 1.15" (78^{+7}_{-11} and 374^{+33}_{-54} au adopting a distance of 325^{+29}_{-47} pc). The emission in this ring shows azimuthal asymmetry centered at a radial distance of 0.46" and a position angle of 135 degrees and an azimuthal FWHM of 51 degrees. We detect CO emission both inside the disk cavity and as far out as 2.7 times the radial extent of the dust emission.
Conclusions: Both the large disk cavity and the azimuthal structure in the disk around HD 34282 can be explained by the presence of a 50 $M_{\rm jup}$ brown dwarf companion at a separation of $\approx$ 0.1".

Accepted by Astronomy & Astrophysics

https://arxiv.org/pdf/1707.01688

Improving the thin-disk models of circumstellar disk evolution. The 2+1-dimensional model

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Context. Circumstellar disks of gas and dust are naturally formed from contracting pre-stellar molecular cores during the star formation process. To study various dynamical and chemical processes that take place in circumstellar disks prior to their dissipation and transition to debris disks, the appropriate numerical models capable of studying the long-term disk chemodynamical evolution are required.
Aims. We aim at improving the frequently used two-dimensional hydrodynamical model for disk evolution in the thin- disk limit by employing a better calculation of the disk thermal balance and adding a reconstruction of the disk vertical structure. Together with the hydrodynamical processes, the thermal evolution is of great importance since it influences the strength of gravitational instability and the chemical evolution of the disk.
Methods. We present a new 2+1-dimensional numerical hydrodynamics model of circumstellar disk evolution, in which the thin-disk model is complemented with the procedure for calculating the vertical distributions of gas volume density and temperature in the disk. The reconstruction of the disk vertical structure is performed at every time step via the solution of the time-dependent radiative transfer equations coupled to the equation of the vertical hydrostatic equilibrium.
Results. We perform a detailed comparison between circumstellar disks produced with our previous 2D model and with the improved 2+1D approach. The structure and evolution of resulting disks, including the differences in temperatures, densities, disk masses and protostellar accretion rates, are discussed in detail.
Conclusions. The new 2+1D model yields systematically colder disks, while the in-falling parental clouds are warmer. Both effects act to increase the strength of disk gravitational instability and, as a result, the number of gravitationally bound fragments that form in the disk via gravitational fragmentation as compared to the purely 2D thin-disk simulations with a simplified thermal balance calculation. The presented method has a low time overhead as compared to the purely 2D models and is particularly suited for the long-term simulations of circumstellar disks including compact chemical reaction networks.

Accepted by Astronomy and Astrophysics

https://arxiv.org/pdf/1706.00401

Disc truncation in embedded star clusters: Dynamical encounters versus face-on accretion

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Observations indicate that the dispersal of protoplanetary discs in star clusters occurs on time scales of about 5 Myr. Several processes are thought to be responsible for this disc dispersal. Here we compare two of these processes: dynamical encounters and interaction with the interstellar medium, which includes face-on accretion and ram pressure stripping. We perform simulations of embedded star clusters with parameterisations for both processes to determine the environment in which either of these processes is dominant. We find that face-on accretion, including ram pressure stripping, is the dominant disc truncation process if the fraction of the total cluster mass in stars is $\lesssim$30% regardless of the cluster mass and radius. Dynamical encounters require stellar densities $\gtrsim 10^4$ pc^{-3} combined with a mass fraction in stars of $\approx$90% to become the dominant process. Our results show that during the embedded phase of the cluster, the truncation of the discs is dominated by face-on accretion and dynamical encounters become dominant when the intra-cluster gas has been expelled. As a result of face-on accretion the protoplanetary discs become compact and their surface density increases. In contrast, dynamical encounters lead to discs that are less massive and remain larger.

Accepted by A&A

http://arxiv.org/pdf/1706.07048

Generation of inclined protoplanetary discs and misaligned planets through mass accretion I: Coplanar secondary discs

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We study the three-dimensional evolution of a viscous protoplanetary disc which accretes gas material from a second protoplanetary disc during a close encounter in an embedded star cluster. The aim is to investigate the capability of the mass accretion scenario to generate strongly inclined gaseous discs which could later form misaligned planets. We use smoothed particle hydrodynamics to study mass transfer and disc inclination for passing stars and circumstellar discs with different masses. We explore different orbital configurations to find the parameter space which allows significant disc inclination generation. Thies et al. (2011) suggested that significant disc inclination and disc or planetary system shrinkage can generally be produced by the accretion of external gas material with a different angular momentum. We found that this condition can be fullfilled for a large range of gas mass and angular momentum. For all encounters, mass accretion from the secondary disc increases with decreasing mass of the secondary proto-star. Thus, higher disc inclinations can be attained for lower secondary stellar masses. Variations of the secondary disc's orientation relative to the orbital plane can alter the disc evolution significantly. The results taken together show that mass accretion can change the three-dimensional disc orientation significantly resulting in strongly inclined discs. In combination with the gravitational interaction between the two star-disc systems, this scenario is relevant for explaining the formation of highly inclined discs which could later form misaligned planets.

Accepted by MNRAS

http://arxiv.org/pdf/1706.09905

Concentrating small particles in protoplanetary disks through the streaming instability

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Laboratory experiments indicate that direct growth of silicate grains via mutual collisions can only produce particles up to roughly millimeters in size. On the other hand, recent simulations of the streaming instability have shown that mm/cm-sized particles require an excessively high metallicity for dense filaments to emerge. Using a numerical algorithm for stiff mutual drag force, we perform simulations of small particles with significantly higher resolutions and longer simulation times than in previous investigations. We find that particles of dimensionless stopping time $\tau_s = 10^{-2}$ and 10^{-3} – representing cm- and mm-sized particles interior of the water ice line – concentrate themselves via the streaming instability at a solid abundance of a few percent. We thus revise a previously published critical solid abundance curve for the regime of $\tau_s \ll 1$. The solid density in the concentrated regions reaches values higher than the Roche density, indicating that direct collapse of particles down to mm sizes into planetesimals is possible. Our results hence bridge the gap in particle size between direct dust growth limited by bouncing and the streaming instability.

Accepted by Astronomy and Astrophysics

https://arxiv.org/pdf/1611.07014

Abstracts of recently accepted major reviews

High-mass star and massive cluster formation in the Milky Way

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This review gives the state-of-the-art knowledge of high-mass star and massive cluster formation, gained from ambitious observational surveys, which acknowledge the multi-scale characteristics of these processes. After a brief overview of theoretical models and main open issues, we present observational searches for the evolutionary phases of high-mass star formation, first among high-luminosity sources and more recently among young massive protostars and the elusive high-mass prestellar cores. We then introduce the most likely evolutionary scenario for high-mass star formation, which emphasizes the link of high-mass star formation to massive cloud and cluster formation. Finally, we introduce the first attempts to search for variations of the star formation activity and cluster formation in molecular cloud complexes, in the most extreme star-forming sites, and across the Milky Way. The combination of Galactic plane surveys and high-angular resolution images with submillimeter facilities such as ALMA are prerequisites to make significant progresses in the forthcoming decade.

Accepted by Annual Review of Astronomy and Astrophysics

https://arxiv.org/pdf/1706.00118

Research Fellow in Astrophysics–Star Formation

The School of Physics & Astronomy is seeking an ambitious Research Fellow to work on observational studies of the formation of massive stars and star clusters.

Applications are invited for an active researcher in the area of star formation, including astrochemistry. The fellow will work with Dr. Claudia Cyganowski and collaborators on high-resolution (sub)millimetre and radio-wavelength observations of massive star-forming regions (including ALMA, Submillimeter Array, and Karl G. Jansky Very Large Array data). Candidates with experience in (sub)millimetre interferometric data analysis, astrochemistry, and/or spectral modelling are encouraged to apply.

The School of Physics & Astronomy offers a young, vibrant and modern work environment. Astrophysics research in St Andrews combines theoretical, numerical and observational research in star formation, protoplanetary discs, extra-solar planets, stellar magnetic activity, star-planet interaction, gravitational lensing, active galactic nuclei, galaxy dynamics and cosmology.

The successful candidate should have a PhD in astronomy, astrophysics, or a closely related field by the appointment start date, with experience in (sub)millimetre/radio interferometry and/or astrochemical or spectral modelling. The position is available immediately for an initial period of one year, with possible extension subject to grant funding and performance, and is in collaboration with Dr. Claudia Cyganowski. The position is funded by an STFC consolidated grant and includes funds for high performance computing and travel. Benefits include medical coverage by the National Health Service.

Informal enquiries to Claudia Cyganowski, e-mail: cc243@st-andrews.ac.uk.

Candidates should send a CV, publication list, and a brief statement of research experience and interests, and arrange for three letters of reference to be provided.

Closing Date: 31 July 2017

We encourage applicants to apply online at www.vacancies.st-andrews.ac.uk/welcome.aspx, however if you are unable to do this, please call +44 (0)1334 462571 for an application pack.

Please quote ref: AR1956SB

The University of St Andrews is a charity registered in Scotland (No SC013532).

Postdoctoral Research Position on Computational Astrophysics of Planet Formation

Applications are invited for a postdoctoral research position in the Computational Astrophysics Group at the Seoul National University (SNU), Korea to work in the areas of dynamics of protoplantary disks, planet formation, star formation and feedback, etc. The successful candidate will work in collaboration with Prof. Woong-Tae Kim at the SNU (http://astro.snu.ac.kr/∼wkim) and Dr. Dimitris Stamatellos in the Jeremiah Horrocks Institute for Mathematics at the University of Central Lancashire, UK (http://www.star.uclan.ac.uk/∼dstamatellos).

Applicants must hold a PhD in astronomy or a related field by the start date of the appointment. The appointment will begin in September 1, 2017, but the starting date is flexible. Appointment is initially for two years, with extension to a third year possible.

Applicants should send their curriculum vitae, list of publications, a description of current and future research interests, and arrange for two letters of recommendation to be sent directly to Prof. Woong-Tae Kim at wkim@astro.snu.ac.kr. Applications received before July 31, 2017 will receive full consideration, but the position will remain open until filled. Further inquiries about the position are welcome and can be obtained by email.

Moving ... ??

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

Star formation in Different Environments: From Local Clouds to Galaxies

ICISE, Quy Nhon, Vietnam, 6-12 August, 2017 (bootcamp: 4,5 August 2017)

Building upon the success of the SFDE16 conference held in ICISE, Quy Nhon, Vietnam, we will get together again in 2017 to discuss about the recent progress in star formation from local clouds to distant galaxies. The conference will highlight the recent advances in wide-field and high resolution surveys and detail numerical simulations of star formation in different environments, from individual star to galaxy systems. The idea is to search for a universal picture of star formation across all scales and also identify the characteristics of each individual scale. The goal of the conference is to share the different views from different research communities by balancing contributions from different categories and to encourage collaborations between researchers across the Globe. Depending on the demand, we might continue as SFDExSeries in the next years. Focus group meetings also allow more specific topic discussion. Ample time is set aside to encourage discussions and collaboration.

Topics

Local star formation, SF in the Milky Way molecular clouds, ISM, stellar feedback, cluster formation, massive SF, galactic center, Nearby galaxies, Environmental effect, interacting galaxies, High-z (including primordial star formation), Connecting all scales of SF and the universal processes of star formation

Registration We are still accepting participants for poster presentation and participation only.

Registration fee is 350 USD (early bird) or 420 USD (normal) Accommodation + meal (breakfast, lunch, dinner) fee for the entire conference duration (6 nights) is 450 USD for a single room and 315 USD per person for a double room.

INVITED SPEAKERS

Susanne Aalto (Chalmers, SE); Pierre Cox (ALMA JAO, CL); Neal Evans (UTexas, US); Christoph Federrath (ANU, AU); Yu Gao (PMO, CN); Bunyo Hatsukade (NAOJ, JP); Jacqueline Hodge (Leiden, NL); Jens Kauffmann (MpifR, DE); Kohno Kotaro (Tokyo Univ., JP); Alex Lazarian (Wisconsin, US); Elisabeth Mills (San Jose, US); Tomoharu Oka (Keio Univ., JP); Sachiko Onodera (Meisei, JP); Ralph Pudritz (McMaster, JP); Chelsea Sharon (McMaster, CA); Naoki Yoshida (Kavli IPMU, JP); Cara Battersby (CfA, US)

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Francoise Combes (Observatoire de Paris, FR); Daisuke Iono (NAOJ, JP); Bruce Elmegreen (IBM, US); Daniel Espada (NAOJ, JP); Jens Kauffmann (MpifR, DE); Guinevere Kauffmann (MPIA, DE); Woong-Tae Kim (SNU, KR); Mark Krumholz (ANU, AU); Adam Leroy (Ohio State University, US); Satoki Matsushita (ASIAA, TW, Co-Chair); Frederique Motte (Grenoble university, FR); Fumitaka Nakamura (NAOJ, JP, Co-Chair); Quang Nguyen-Luong (KASI, KR); Christine Wilson (McMaster University, CA)

LOCAL ORGANIZING COMMITTEE

Fumitaka Nakamura (NAOJ, Japan); Quang Nguyen-Luong (KASI, Korea); Jean Tran Thanh Van (ICISE, Vietnam); Tran Thanh Son (ICISE, Vietnam)

Website

http://rencontresduvietnam.org/conferences/2017/sfde2017/

Program

http://rencontresduvietnam.org/conferences//2017/sfde2017/?page_id=389

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

28 May - 1 June 2018 • Paralia Katerini, Mt. Olympus, Greece

The overall view of star formation and interstellar medium studies has been significantly populated with the new remarkable observational data delivered in the age of ALMA. Theoretical investigations have also advanced with unprecedented simulation tools that allow the magneto-hydrodynamical and chemical evolution of the ISM from milli- to mega- parsec scales to be examined. The aim of the conference is to bring together the theoretical, computational and observational scientific communities to address and discuss the star formation and the ISM in this new era.

Our sessions will include discussions on:

the physics and chemistry of the ISM at different scales and metallicities • the role of the galactic environment in the star formation process • the star formation process from low- to high- mass stars • the ISM in starbursts, (U)LIRGs, mergers, AGNs • the formation and evolution of star clusters • the role played by feedback, turbulence and magnetic fields in the evolution of the ISM • the importance of cosmic rays regulating the (thermo-)dynamics and chemical composition of the ISM • how line observations and chemical modelling bridge star formation across scales

The meeting will be held from Monday 28th of May to Friday 1st of June 2018 at the five-star Mediterranean Village Hotel & Spa. This is the third Olympian Symposium, following two successful meetings in 2014 (on Star Formation) and 2015 (on Cosmology and the Epoch of Reionization).

We recommend you to sign up for updates about our meeting via the OS2018 webpage. The call for abstract submission and the opening of registration will occur on September 4, 2017.

Scientific Organizing Committee:

Thomas Bisbas (Florida; Co-chair) • Maria Drozdovskaya (Bern; Co-chair) • Cara Battersby (CfA) • Philipp Girichidis (Heidelberg) • Thomas Haworth (Imperial) • Jonathan Tan (Florida) • Stefanie Walch (Cologne)

Confirmed Invited Speakers:

Crystal Brogan (NRAO) • James Dale (Hertfordshire) • Neal Evans (Texas) • Alvaro Hacar (Leiden) • Nick Indriolo (STScI) • Mark Krumholz (ANU) • Eve Ostriker (Princeton) • Serena Viti (UCL) • Naoki Watanabe (Hokkaido)

Local Organizing Committee: Olympian Centre for Astrophysics

Website: http://www.olympiansymposium.org/

Contact: symposium2018@olympiancfa.org

First announcement

70 years of Stellar Associations

Byurakan Observatory, Armenia, 25-27 September 2017

In 1947, Viktor Ambartsumian published the first paper dedicated to the existence of young stars, entitled 'The Stellar Associations and Astrophysics'. Considering the dynamical characteristics of the newfound star systems, which he called stellar associations, he arrived at the conclusion that these systems have positive energy and are therefore disintegrating systems, not older than about 10^7 years. Although seven decades ago few were ready to believe in the existence of young stars, the field of star formation is today one of the main research areas in Astrophysics, sitting at the crossroads of Galaxy formation and evolution and planet formation.

After seventy years, Byurakan Observatory commemorates this discovery by organizing a conference dedicated to the studies of stellar associations, young stars, and early stellar evolution. The current data and views on star formation, including those obtained with space missions, will be presented and discussed. One should take into account that the imminent Gaia second data release (in April 2018) is likely to substantially change our understanding of the origins of clusters and associations.

Immediately after the conference, a small one-day workshop is planned, where the future programs and projects in the field of stellar research for medium and small size telescopes will be discussed. For the participants of the conference, excursions to the historical sights of Armenia and of the city of Yerevan will be organized.

SOC:

Joao Alves, University of Vienna (co-chair)

Tigran Magakian, Byurakan Observatory (co-chair)

John Bally, University of Colorado

Claude Bertout, Observatoire de Paris

Vladimir Grinin, Pulkovo Observatory

Haik Harutyunian, Byurakan Observatory

Charles Lada, Harvard-Smithsonian Center for Astrophysics

Important Deadlines

01.07.2017 First announcement and webpage; call for abstracts and registration

10.08.2017 Abstract submission and registration deadline

20.08.2017 Accepting abstracts and selection of participants

10.09.2017 Final program and list of participants; abstracts available online

10.09.2017 Accommodation reservation deadline

15.09.2017 Final announcement with practical information

3.12.2017 Submission of papers for the proceedings deadline

Registration fee: no fee

Accommodation:

Some participants can stay in the observatory hotel (free of charge, but the number of rooms is limited). Also participants can stay in the nearby "Northern Star" hotel in the Byurakan village or, by their choice, in Yerevan, where the great variety of hotels and hostels are available. Additional information will be given in the web page. Transportation between Yerevan and the Observatory will be organized.

Contact address: tigmag@sci.am

Web link: www.bao.am/assoc70

Invited speakers will be announced in the web page of the Conference as they are confirmed

Summary of Upcoming Meetings

Measuring Star Formation in the Radio, Millimetre, and Submillimetre
24 - 26 July 2017, Manchester, United Kingdom
http://www.alma.ac.uk/index.php/meetings/uk-arc-node-meetings/106-measuring-star-formation-in-the-radio-mill

Star Formation in Different Environments: From Local Clouds to Galaxies
6 - 12 August 2017, Quy Nhon, Vietnam
http://rencontresduvietnam.org/conferences/2017/sfde2017/

Cosmic Dust
14 - 18 August 2017, Mitaka, Japan
https://www.cps-jp.org/~dust/

Ages^2: Taking stellar ages to the next power
18 - 22 September 2017, Elba, Italy
http://www.stsci.edu/institute/conference/ages2017

Planet Formation and Evolution 2017
25 - 27 September 2017, Jena, Germany
http://www.astro.uni-jena.de/~pfe2017

The Initial Mass Function: From Top to Bottom
10 November 2017, London, UK
https://rasimf2017.wordpress.com

Exoplanets and Planet Formation
11 - 15 December 2017, Shang Hai, China
https://indico.leeinst.sjtu.edu.cn/event/25/

Magnetic Fields or Turbulence: Which is the critical factor for the formation of stars and planetary disks?
6 - 9 February 2018, Hsinchu, Taiwan
http://events.asiaa.sinica.edu.tw/workshop/20180206/index.php

EPoS 2018 The Early Phase of Star Formation - Archetypes
13 - 18 May 2018, Ringberg Castle, Tegernsee, Germany
http://www.mpia.de/homes/stein/EPoS/epos.php

The Olympian Symposium 2018: Gas and stars from milli- to mega- parsecs
28 May - 1 June 2018, Mt. Olympus, Greece
http://www.olympiansymposium.org

Cool Stars 20: Cambridge Workshop on Cool Stars, Stellar Systems and the Sun
29 July - 3 August 2018, Cambridge/Boston, USA
http://www.coolstars20.com

Short Announcements

The 2017 Release of Cloudy

G.J. Ferland; M. Chatzikos; F. Guzman; M.L. Lykins; P.A.M. van Hoof; R.J.R. Williams; N.P. Abel; N.R. Badnell; F.P. Keenan; R.L. Porter; P.C. Stancil

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We describe the 2017 release of the spectral synthesis code Cloudy. A major development since the previous release has been exporting the atomic data into external data files. This greatly simplifies updates and maintenance of the data. Many large datasets have been incorporated with the result that we can now predict well over an order of magnitude more emission lines when all databases are fully used. The use of such large datasets is not realistic for most calculations due to the time and memory needs, and we describe the limited subset of data we use by default. Despite the fact that we now predict significantly more lines than the previous Cloudy release, this version is faster because of optimization of memory access patterns and other tuning. The size and use of the databases can easily be adjusted in the command-line interface. We give examples of the accuracy limits using small models, and the performance requirements of large complete models. We summarize several advances in the H- and He-like iso-electronic sequences. We use our complete collisional-radiative models of the ionization of these one and two-electron ions to establish the highest density for which the coronal or interstellar medium (ISM) approximation works, and the lowest density where Saha or local thermodynamic equilibrium can be assumed. The coronal approximation fails at surprisingly low densities for collisional ionization equilibrium but is valid to higher densities for photoionized gas clouds. Many other improvements to the physics have been made and are described. These include the treatment of isotropic continuum sources such as the cosmic microwave background (CMB) in the reported output, and the ability to follow the evolution of cooling non-equilibrium clouds.

Submitted to Revista Mexicana, comments welcome

http://adsabs.harvard.edu/pdf/2017arXiv170510877F