THE STAR FORMATION NEWSLETTER

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

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The Star Formation Newsletter

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

Newsletter Archive

www.ifa.hawaii.edu/users/reipurth/newsletter.htm

List of Contents

Cover Picture

The L1495 cloud in Taurus contains many small groupings of young low-mass stars. The image shows the region around V1096 Tau, seen as a nebulous star near the center of the image, and the small compact group of young stars seen further to the south, including CW Tau, V773 Tau, and FM Tau. The red nebulous object is Herbig-Haro object HH 827.

Image courtesy Adam Block
http://adamblockphotos.com
http://caelumobservatory.com

Submitting your abstracts

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

Editorial

Do we still need a Star Formation Newsletter?

This is a fair question. It's 2020, and there is an abundance of services that will filter the astro-ph river into a manageable number of papers on a specific topic. Why continue with the Star Formation Newsletter (SFN)? In October 1992, Bo Reipurth introduced the SFN, the first electronic newsletter in Astronomy, to allow easy distribution of abstracts of the recent papers in the field. Back then, one would need to physically go to the local library, sit down, and read about the field's latest results. Over the following 28 years, Bo created much more than a list of monthly Abstracts; he created a community. The SFN has been connecting astronomers working on star and planet formation across the planet since 1992 and is today the authoritative reference for the latest in Star and Planet Formation research, from Abstracts and Reviews listings to Perspectives, from the latest Jobs and Meetings listings to community Announcements. The section "Interviews" is now the de facto community legacy's repository: describing inspiring scientific life achievements and the human story behind them.

After 333 months at the helm of the successful SFN, Bo has asked me to become the editor. The thought of leading the SFN is exciting and honoring but also terrifying. How does one follow Bo and how not to drop the ball? Bo was transparent about the challenges, and I accepted, with joy and fear, the editor's role from SFN 334. The immediate plan is to transition the SFN into a sustainable web page, where the various sections of the SFN will become readily accessible web pages. In some future, I would like to include a new section on resources for the community, like a curated list of high-quality star and planet formation illustrations and images to be used in teaching and presentations, among other ideas.

An essential goal of the SFN is to welcome young researchers into the field, help them navigate the community, and inspire them to make their mark. A paradox in today's incredibly easy access to large amounts of information is PhD students' hyper-specialization. In part, this is a structural problem arising from what is expected from young researchers to succeed. The SFN web will minimize this drawback and avoid dividing the SFN into sub-fields to expose the reader to a broader view, following Bo's original design. Given the current information growth, this will be difficult to tread, but the spirit will be kept.

Finally, the SFN is done by the community and for the community. I invite anyone to contribute to the content and the design of the SFN. All ideas are welcome. I plan to put together a group of Contributing Editors and an Editorial Advisory Board to strengthen and guide the SFN through the 2020s. This transition will take some time, so the current submission platform and the PDF file will be with us a little longer. The SFN mailing list will be hosted at the University of Vienna, under the new General Data Protection Regulation (GDPR) of the European Union. You will be able to opt-in/out easily and register via a web interface of the University.

I thank Bo for the trust and wish him a wonderful retirement from the 333 months he dedicated to the SFN. My wish for the SFN is to allow it to grow, with your help, as a useful reference for the Star and Planet Formation community.

João Alves
Vienna, October 2020

Tom Dame

in conversation with Bo Reipurth

Q: *What was the topic of your 1983 PhD, and who was your advisor?*

A: For my thesis work I was fortunate to be in the right place at the right time. Just after passing my qualifying exams, I was contacted by Pat Thaddeus who told me about the little radio telescope that he was building on the roof of the physics building on the Columbia campus. Pat was a brilliant and inspiring scientist who sold me on the importance of the work right away. Several of his graduate students, including Gordon Chin, Hong-Ih Cong, and Richard Cohen, had been working hard for the previous few years on building the 1.2 m telescope, so by the time I joined the group it was ready to begin large-scale CO surveys of the Galaxy. My thesis was entitled "Molecular Clouds and Galactic Spiral Structure" and dealt with some subjects which at the time were very controversial: the confinement of molecular clouds to the spiral arms and their lifetimes. Based on modeling of the spiral features evident in my CO survey of the first Galactic quadrant, I argued that molecular clouds were tightly confined to the arms and so couldn't live longer than a spiral arm crossing time of a few 10^7 years. Since then, interferometric CO surveys of many external spirals have shown that molecular clouds are indeed excellent tracers of spiral structure.

Q: *Your first paper with Pat Thaddeus presented a CO survey of the first Galactic quadrant with 1 degree angular resolution. How and why did you carry out such a survey?*

A: That 1985 paper presented the first of our so-called "superbeam" surveys for which we degraded the telescope's angular resolution by offsetting the pointing through a square raster of points separated by a beam width ($\sim$1/8 deg) during an observation; it bore some resemblance to modern day on-the-fly mapping except that our Data General Nova minicomputer was not up to the task of saving every data sample. It might seem crazy to degrade the resolution of the world's smallest radio telescope, but the technique allowed us to well sample large areas of the sky very rapidly, and the angular resolution was still more than adequate for comparison with the high-energy gamma ray surveys that were being obtained around the same time by the SAS-II and COS-B satellites. Pat and I collaborated with the COS-B group on such a comparison (Lebrun et al. 1983) that provided the first gamma-ray calibration of the CO-to-H_2 conversion factor - what we unimaginatively named the "X factor" in the paper.

Q: *A few years later you and a team of collaborators presented a composite survey of the entire Milky Way. This was something of a revolution in millimeter astronomy, and the paper has been cited over 800 times. What were the key conclusions?*

A: Even though that 1987 paper was cited so many times, I suspect that most older researchers today have forgotten about it and most younger ones have never heard of it. That's because the '87 whole-Galaxy survey was superseded by a higher-resolution version that we published in 2001; the former survey was a composite of 0.5° "superbeam" surveys while the latter was largely beam width sampled. Both journal papers included unique 5-page foldouts displaying the whole-Galaxy *lb* and *lv* maps and in both cases we put those same maps on wall posters that were widely distributed. Because our research group – along with the northern 1.2 m telescope – moved from Columbia to CfA in 1986, the former survey is generally called the Columbia CO survey and the latter one the CfA survey. Together these two surveys incorporate the data from most of the 24 people who have obtained their PhDs with the northern and southern 1.2 m telescopes.

Thanks to the superbeam technique, we were able to get our first look at the molecular Milky Way 15 years earlier than would otherwise have been possible. Owing to its wide latitude coverage, the Columbia survey was especially valuable for studying local molecular clouds. We cataloged 23 within 1 kpc of the Sun, plotted their locations on the Galactic plane, and used them to determine the mean molecular surface density and scale height in the solar neighborhood. It was reassuring that these direct measurements agreed well with values obtained for the inner Galaxy using kinematic distances and axisymmetric modeling.

Q: *In 1986 you and your colleagues published a paper on the largest molecular clouds in the first Galactic quadrant, aiming to characterize their distribution and properties. What did you learn?*

A: This was an early attempt to decompose the CO emission in the first quadrant into its component clouds. We focused on the few dozen largest and brightest objects, what we called "complexes", because they were the best defined and I knew from my thesis work that such objects contained most of the molecular mass. Unlike the many subsequent attempts that relied on programs such as clumpfind, this analysis was largely done by hand, particularly when it came to resolving the kinematic distance ambiguity. We had an appendix which gave a "lawyer's brief" of evidence for each cloud supporting either the near or far distance.

I think this work was important because it broke a longstanding stalemate as to whether the apparent spiral structure in *lv* diagrams was due to velocity or gas density variations along the line of sight. Very influential work by W. Butler Burton in the early 1970s had shown that in the case of 21 cm *lv* diagrams, the apparent spiral structure might be just "kinematic illusions" produced by density wave streaming motions. In our case we definitely had real, well-defined objects, and we were able to locate them one by one on the Galactic plane, and they lined up nicely along the spiral arms. We also confirmed and extended the radius-linewidth relation of Larson to much higher cloud masses and showed that the clouds were in approximate virial equilibrium.

Q: *Besides the Milky Way, the 1.2 m telescopes also obtained the first complete CO surveys of the LMC and M31. Can you tell us about those surveys?*

A: The Magellanic Clouds, along with the Galactic center, were prime targets for the second 1.2 m telescope, which was built and tested on the roof of the Goddard Institute for Space Studies in New York City before being transported to CTIO in Chile in 1982. Certainly the most spectacular discovery of the LMC survey was the enormous concentration of molecular clouds extending south from the giant HII region 30 Doradus for nearly 2400 pc and containing about 60 million solar masses of molecular gas. There is really nothing comparable to that structure in the Milky Way. Perhaps it is the solid body rotation of the LMC that allows such structures to form. We found that individual GMCs in the LMC were similar to those in the Milky Way, except that they were about 6 times fainter in CO, suggesting that the CO luminosity in a galaxy scales roughly with its metallicity.

Our complete CO survey of M31 was the most difficult ever undertaken with either of the 1.2 m telescopes. Beam dilution and velocity gradients across our 1.7 kpc beam resulted in extremely weak ($\sim$0.01 K) and broad (50-100 km s^{-1}) lines that required exceptionally flat baselines for detection. Only mm-wave observing aficionados will appreciate this, but we developed a unique azimuth-switching technique in which we slightly adjusted the elevation of the OFF after every switching cycle to cancel out any accumulated ON-OFF power to that point in the scan. This active feedback technique balanced the ON-OFF powers to one part in 10^5 and yielded spectra that almost did not require baseline removal. Although we could not resolve individual clouds, we obtained robust results on the molecular radial distribution. We found that beyond a radius of $\sim$8 kpc M31 and the Milky Way have comparable amounts of gas, both atomic and molecular, and both have central gas holes. We suggested that the essential difference between the two galaxies may be the larger size of the hole in M31 ($\sim$8 kpc) compared with that in the Milky Way ($\sim$3 kpc).

Q: *In 2001 you published, together with Dap Hartmann and Pat Thaddeus, your magnum opus, a new complete CO survey of the molecular clouds in the Milky Way. With almost 1500 citations, this study evidently has been highly influential. Please tell us about the survey.*

A: This was our second whole-Galaxy CO survey, already mentioned earlier. The many citations to this paper are largely owing to the fact that molecular clouds, along with their associated dust and star formation, influence the large-scale Galactic emission in every major wavelength band. In many cases, our CO survey provides the crucial third dimension of velocity or kinematic distance that is lacking in continuum surveys such as those in gamma rays and the infrared. Much of my work in recent years has been in collaboration with astronomers studying the Galaxy at other wavelengths. I'm proud of the fact that our small telescopes, largely operated by students for about $25K per year, have provided data that were essential for the interpretation of satellite surveys costing tens to hundreds of millions of dollars.

Q: *In the past decade or so you and Pat have discovered two new spiral arm structures in the Milky Way. How did these discoveries come about and what are their significance?*

A: During my thesis work I developed a great familiarity with and, some would say, bizarre fondness for 21 cm and CO longitude-velocity diagrams. My feeling is that any gaseous spiral feature must be evident in the *lv* diagram–essentially the raw data of a spectral line survey–otherwise it's crazy to think that it is going to suddenly appear after a complex transformation into the plane of the Galaxy. I spotted the far-side counterpart of the long-known "Expanding 3-kpc Arm" while preparing a review talk on CO spiral structure for the June 2008 AAS meeting. I was trying to make *lv* diagrams that showed the CO spiral structure most clearly when the so-called "Far 3-kpc Arm" revealed itself. I was a bit skeptical at first, but subsequently calculated that all of its physical characteristics closely matched those of the near-side Expanding Arm. My review talk turned into a report on this new spiral feature, which was very exciting and fun. Scott Tremaine called it the first direct evidence for a two-fold symmetry in the Galaxy.

Oddly enough, I came upon the Outer Scutum-Centaurus Arm in a similar manner – while preparing a review talk for an ESO conference in Chile. In this case the arm was first visible only in 21 cm emission. Since it was located a few degrees above the plane in the distant outer Galaxy, no CO survey had covered the region. Concerned that the arm might be considered a "kinematic illusion" of the sort discussed earlier, Pat and I began very sensitive CO observations of the structure with the CfA telescope. We concentrated on HI peaks and ultimately found molecular clouds at about a dozen locations along the arm. Molecular clouds are so rare in the distant outer Galaxy that these detections strongly supported the idea that this was a major spiral arm structure. In our 2011 paper, we argued that it was most likely the far end of the mighty Sct-Cen arm, which originates at the end of the central bar before spiraling through the first and fourth quadrants and then back around to the first quadrant again in the outer Galaxy. This result too argued for a degree of Galactic symmetry, since the Outer Sct-Cen arm appears to be the distant counterpart of the Perseus spiral arm in the third quadrant.

Q: *What are you currently focused on?*

A: Both 1.2 m telescopes are still in operation, the northern one just a few years shy of its 50th anniversary. The CfA telescope recently completed a very long-term project to map the entire northern sky in CO. This was a background observing project for about a decade, and most of the data were obtained at night and on weekends by several generations of Harvard undergraduate observers. I'm working now on the final reduction and publication of this massive survey. I think Pat, who passed away in 2017, would have agreed that completion of that survey is an appropriate endpoint to what he called the "zeroth-order experiment", to determine the overall distribution of molecular gas in the Milky Way. Accordingly, over the past year or so we have been tuning the telescope to other molecules of interest, most notably HCN at 89 GHz. Extragalactic observers have long favored this high dipole moment molecule for tracing dense gas (Gao & Solomon 2004), but interpretation of their data has been stymied by the lack of nearby Galactic clouds that have been mapped in HCN. Completing such maps is an ideal project for our telescope, so we are currently planning modifications to our receiver that will double its sensitivity at the HCN line while maintaining its current sensitivity at CO.

Besides such observing projects and other collaborations involving our surveys, I've been very excited to be involved in the BeSSeL maser survey led by Mark Reid at the CfA. This project has recently completed a five-year run on the Very Long Baseline Array during which highly accurate parallaxes and proper motions were measured for about 200 molecular masers associated with very young high-mass stars (Reid et al. 2019). One of my main roles in the project has been to pick out maser targets based on their locations in the *lv* diagram and their potential for clarifying the structure of particular spiral arms. Having struggled throughout my career to locate the Galactic spiral arms using kinematic distances, it's thrilling to finally be pinning down the arms with such high precision. I can hardly wait to see results start to come in from the southern counterpart of BeSSeL, which is scheduled to start soon using an array of telescopes in Australia and New Zealand.

Abstracts of recently accepted papers

Gravitoviscous Protoplanetary Discs with a Dust Component. IV. Disc Outer Edges, Spectral Indices, and Opacity Gaps

Vitaly Akimkin[1], Eduard Vorobyov[2,3], Yaroslav Pavlyuchenkov[1] and Olga Stoyanovskaya[4,5]

[1] Institute of Astronomy, Russian Academy of Sciences, Pyatnitskaya str. 48, 119017, Russia; [2] University of Vienna, Department of Astrophysics, Vienna, 1180, Austria; [3] Research Institute of Physics, Southern Federal University, Rostov-on-Don, 344090 Russia; [4] Lavrentiev Institute of Hydrodynamics, Siberian Branch of Russian Academy of Sciences, Lavrentieva ave. 15, 630090, Russia; [5] Novosibirsk State University, Novosibirsk, 630090 Russia

E-mail contact: akimkin *at* inasan.ru

The crucial initial step in planet formation is the agglomeration of micron-sized dust into macroscopic aggregates. This phase is likely to happen very early during the protostellar disc formation, which is characterised by active gas dynamics. We present numerical simulations of protostellar/protoplanetary disc long-term evolution, which includes gas dynamics with self-gravity in the thin-disc limit, and bidisperse dust grain evolution due to coagulation, fragmentation, and drift through the gas. We show that the decrease of the grain size to the disc periphery leads to sharp outer edges in dust millimetre emission, which are explained by a drop in dust opacity coefficient rather than by dust surface density variations. These visible outer edges are at the location where average grain size $\approx \lambda/2\pi$, where λ is the observational wavelength, so discs typically look more compact at longer wavelengths if dust size decreases outwards. This allows a simple recipe for reconstructing grain sizes in disc outer regions. Discs may look larger at longer wavelengths if grain size does not reach $\lambda/2\pi$ for some wavelength. Disc visible sizes evolve non-monotonically over the first million years and differ from dust and gas physical sizes by factor of a few. We compare our model with recent observation data on gas and dust disc sizes, far-infrared fluxes and spectral indices of protoplanetary discs in Lupus. We also show that non-monotonic variations of the grain size in radial direction can cause wavelength-dependent opacity gaps, which are not associated with any physical gaps in the dust density distribution.

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https://arxiv.org/pdf/2010.06566

Hints for icy pebble migration feeding an oxygen-rich chemistry in the inner planet-forming region of disks

Andrea Banzatti[1,2], Ilaria Pascucci[2,3], Arthur D. Bosman[4], Paola Pinilla[5], Colette Salyk[6], Greg J. Herczeg[7], Klaus M. Pontoppidan[8], Ivan Vazquez[1], Andrew Watkins[1], Sebastiaan Krijt[9,3,10], Nathan Hendler[2] and Feng Long[11]

[1] Department of Physics, Texas State University, 749 N Comanche Street, San Marcos, TX 78666, USA; [2] Department of Planetary Sciences, University of Arizona, 1629 East University Boulevard, Tucson, AZ 85721, USA; [3] Earths in Other Solar Systems Team, NASA Nexus for Exoplanet System Science; [4] Department of Astronomy, University of Michigan, 1085 S. University Ave, Ann Arbor, MI 48109; [5] Max-Planck-Institut für Astronomie, Königstuh l17, 69117 Heidelberg, Germany; [6] Department of Physics and Astronomy, Vassar College, 124 Raymond Avenue, Poughkeepsie, NY 12604, USA; [7] Kavli Institute for Astronomy and Astrophysics, Peking University, Beijing 100871, China; [8] Space Telescope Science Institute 3700 San Martin Drive Baltimore, MD 21218, USA; [9] Department of Astronomy, The University of Arizona, 933 North Cherry Avenue, Tucson, AZ 85721, USA; [10] Hubble Fellow; [11] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA

E-mail contact: banzatti *at* txstate.edu

We present a synergic study of protoplanetary disks to investigate links between inner disk gas molecules and the large-scale migration of solid pebbles. The sample includes 63 disks where two types of measurements are available: *i)* spatially-resolved disk images revealing the radial distribution of disk pebbles (mm-cm dust grains), from millimeter observations with ALMA or the SMA, and *ii)* infrared molecular emission spectra as observed with *Spitzer*. The line flux ratios of H_2O with HCN, C_2H_2, and CO_2 all anti-correlate with the dust disk radius R_{dust}, expanding previous results found by Najita et al. (2013) for HCN/H_2O and the dust disk mass. By normalization with the dependence on accretion luminosity common to all molecules, only the H_2O luminosity maintains a detectable anti-correlation with disk radius, suggesting that the strongest underlying relation is between H_2O and R_{dust}. If R_{dust} is set by large-scale pebble drift, and if molecular luminosities trace the elemental budgets of inner disk warm gas, these results can be naturally explained with scenarios where the inner disk chemistry is fed by sublimation of oxygen-rich icy pebbles migrating inward from the outer disk. Anti-correlations are also detected between all molecular luminosities and the infrared index n_{13-30}, which is sensitive to the presence and size of an inner disk dust cavity. Overall, these relations suggest a physical interconnection between dust and gas evolution both locally and across disk scales. We discuss fundamental predictions to test this interpretation and study the interplay between pebble drift, inner disk depletion, and the chemistry of planet-forming material.

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https://arxiv.org/pdf/2009.13525

Gravity and rotation drag the magnetic field in high-mass star formation

H. Beuther[1], J.D. Soler[1], H. Linz[1], Th. Henning[1], C. Gieser[1], R. Kuiper[2], W. Vlemmings[3], P. Hennebelle[4], S. Feng[5], R. Smith[6] and A. Ahmadi[7]

[1] Max Planck Institute for Astronomy, Königstuhl 17, 69117 Heidelberg, Germany; [2] Institute of Astronomy and Astrophysics, University of Tübingen, Auf der Morgenstelle 10, D-72076 Tübingen, Germany; [3] Department of Earth and Space Sciences Chalmers University of Technology, Onsala Space Observatory, 439 92, Onsala, Sweden; [4] AIM, CEA, CNRS, Universite Paris-Saclay, Universite Paris Diderot, Sorbonne Paris Cite, 91191 Gif-sur-Yvette, France; [5] Chinese Academy of Sciences Key Laboratory of FAST, National Astronomical Observatory of China, Datun Road 20, Chaoyang, Bejing, 100012, P. R. China; [6] Jodrell Bank Centre for Astrophysics, Department of Physics and Astronomy, University of Manchester, Oxford Road, Manchester M13 9PL, UK; [7] Leiden University, Niels Bohrweg 2, 2333 CA Leiden, Netherlands

E-mail contact: beuther *at* mpia.de

The formation of hot stars out of the cold interstellar medium lies at the heart of astrophysical research. Understanding the importance of magnetic fields during star formation remains a major challenge. With the advent of the Atacama Large Millimeter Array, the potential to study magnetic fields by polarization observations has tremendously progressed. However, the major question remains how much magnetic fields shape the star formation process or whether gravity is largely dominating. Here, we show that for the high-mass star-forming region G327.3 the magnetic field morphology appears to be dominantly shaped by the gravitational contraction of the central massive gas core where the star formation proceeds. We find that in the outer parts of the region, the magnetic field is directed toward the gravitational center of the region. Filamentary structures feeding the central core exhibit U-shaped magnetic field morphologies directed toward the gravitational center as well, again showing the gravitational drag toward the center. The inner part then shows rotational signatures, potentially associated with an embedded disk, and there the magnetic field morphology appears to be rotationally dominated. Hence, our results demonstrate that for this region gravity and rotation are dominating the dynamics and shaping the magnetic field morphology.

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https://www2.mpia-hd.mpg.de/homes/beuther/papers.html

Observations of the Onset of Complex Organic Molecule Formation in Interstellar Ices

Laurie E. U. Chu[1], Klaus W. Hodapp[1] and Adwin Boogert[2]

[1] Institute for Astronomy, 640 N. Auhoku Pl. #209, Hilo, HI 96720 USA; [2] Institute for Astronomy, 2680 Woodlawn Dr., Honolulu, HI 96822 USA

E-mail contact: lurban *at* hawaii.edu

Isolated dense molecular cores are investigated to study the onset of complex organic molecule formation in interstellar ice. Sampling three cores with ongoing formation of low-mass stars (B59, B335, and L483) and one starless core (L694-

2) we sample lines of sight to nine background stars and five young stellar objects (YSOs; A_K ∼0.5 - 4.7). Spectra of these stars from 2-5 μm with NASA's Infrared Telescope Facility (IRTF) simultaneously display signatures from the cores of H_2O (3.0 μm), CH_3OH (C-H stretching mode, 3.53 μm) and CO (4.67 μm) ices. The CO ice is traced by nine stars in which five show a long wavelength wing due to a mixture of CO with polar ice (CO_r), presumably CH_3OH. Two of these sight lines also show independent detections of CH_3OH. For these we find the ratio of the CH_3OH:CO_r is 0.55±0.06 and 0.73±0.07 from L483 and L694-2, respectively. The detections of both CO and CH_3OH for the first time through lines of sight toward background stars observationally constrains the conversion of CO into CH_3OH ice. Along the lines of sight most of the CO exists in the gas phase and ≤15% of the CO is frozen out. However, CH_3OH ice is abundant with respect to CO (∼50%) and exists mainly as a CH_3OH-rich CO ice layer. Only a small fraction of the lines of sight contains CH_3OH ice, presumably that with the highest density. The high conversion of CO to CH_3OH can explain the abundances of CH_3OH ice found in later stage Class 1 low mass YSO envelopes (CH_3OH:CO_r 0.5-0.6). For high mass YSOs and one Class 0 YSO this ratio varies significantly implying local variations can affect the ice formation. The large CH_3OH ice abundance indicates that the formation of complex organic molecules is likely during the pre-stellar phase in cold environments without higher energy particle interactions (e.g. cosmic rays).

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SiO emission as a probe of Cloud-Cloud Collisions in Infrared Dark Clouds

G. Cosentino[1], I. Jiménez-Serra[2], J.D. Henshaw[3], P. Caselli[4], S. Viti[5], A.T. Barnes[6], J.C. Tan[1,7], F. Fontani[8] and B. Wu[9]

[1] Space, Earth and Environment Department, Chalmers University of Technology, SE-412 96 Gothenburg, Sweden; [2] Centro de Astrobiología (CSIC/INTA), Ctra. de Torrejón a Ajalvir km 4, Madrid, Spain; [3] Max Planck Institute for Astronomy, Königstuhl 17, D-69117 Heidelberg, Germany; [4] Max Planck Institute for Extraterrestrial Physics, Giessenbachstrasse 1, 85748 Garching bei München, Germany; [5] Department of Physics and Astronomy, University College London, Gower Street, London WC1E6BT, UK; [6] Argelander-Institut für Astronomie, Universität Bonn, Auf dem Hügel 71, 53121, Bonn, Germany; [7] Department of Astronomy, University of Virginia, 530 McCormick Road Charlottesville, 22904-4325 USA; [8] INAF Osservatorio Astronomico di Arcetri, Largo E. Fermi 5, 50125 Florence, Italy; [9] National Astronomical Observatory of Japan, Yubinbango 181-8588 Tokio, Mitaka, Osawa 2-21-1, Japan

E-mail contact: giuliana.cosentino *at* chalmers.se

Infrared Dark Clouds (IRDCs) are very dense and highly extincted regions that host the initial conditions of star and stellar cluster formation. It is crucial to study the kinematics and molecular content of IRDCs to test their formation mechanism and ultimately characterise these initial conditions. We have obtained high-sensitivity Silicon Monoxide, SiO(2-1), emission maps toward the six IRDCs, G018.82−00.28, G019.27+00.07, G028.53−00.25, G028.67+00.13, G038.95−00.47 and G053.11+00.05 (cloud A, B, D, E, I and J, respectively), using the 30-m antenna at the Instituto de Radioastronomía Millimétrica (IRAM30m). We have investigated the SiO spatial distribution and kinematic structure across the six clouds to look for signatures of cloud-cloud collision events that may have formed the IRDCs and triggered star formation within them. Toward clouds A, B, D, I and J we detect spatially compact SiO emission with broad line profiles which are spatially coincident with massive cores. Toward the IRDCs A and I, we report an additional SiO component that shows narrow line profiles and that is widespread across quiescent regions. Finally, we do not detect any significant SiO emission toward cloud E. We suggest that the broad and compact SiO emission detected toward the clouds is likely associated with ongoing star formation activity within the IRDCs. However, the additional narrow and widespread SiO emission detected toward cloud A and I may have originated from the collision between the IRDCs and flows of molecular gas pushed toward the clouds by nearby HII regions.

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Chemical evolution during the formation of a protoplanetary disk

A. Coutens[1], B. Commerçon[2] and V. Wakelam[1]

[1] Laboratoire d'Astrophysique de Bordeaux, Univ. Bordeaux, CNRS, B18N, allée Geoffroy Saint-Hilaire, 33615 Pessac, France; [2] Centre de Recherche Astrophysique de Lyon UMR5574, ENS de Lyon, Univ. Lyon1, CNRS, Université de

Lyon, 69007 Lyon, France

E-mail contact: audrey.coutens *at* u-bordeaux.fr

The chemical composition of protoplanetary disks is expected to impact the composition of the forming planets. Characterizing the diversity of chemical composition in disks and the physicochemical factors that lead to this diversity is consequently of high interest. The aim of this study is to investigate the chemical evolution from the prestellar phase to the formation of the disk, and to determine the impact that the chemical composition of the cold and dense core has on the final composition of the disk. We performed 3D nonideal magneto-hydrodynamic (MHD) simulations of a dense core collapse using the adaptive-mesh-refinement RAMSES code. For each particle ending in the young rotationally supported disk, we ran chemical simulations with the three-phase gas-grain chemistry code Nautilus. Two different sets of initial abundances, which are characteristic of cold cores, were considered. The final distributions of the abundances of common species were compared to each other, as well as with the initial abundances of the cold core. We find that the spatial distributions of molecules reflect their sensitivity to the temperature distribution. The main carriers of the chemical elements in the disk are usually the same as the ones in the cold core, except for the S-bearing species, where HS is replaced by H_2S_3, and the P-bearing species, where atomic P leads to the formation of PO, PN, HCP, and CP. However, the abundances of less abundant species change over time. This is especially the case for "large" complex organic molecules (COMs) such as CH_3CHO, CH_3NH_2, CH_3OCH_3, and $HCOOCH_3$ which see their abundances significantly increase during the collapse. These COMs often present similar abundances in the disk despite significantly different abundances in the cold core. In contrast, the abundances of many radicals decrease with time. A significant number of species still show the same abundances in the cold core and the disk, which indicates efficient formation of these molecules in the cold core. This includes H_2O, H_2CO, HNCO, and "small" COMs such as CH_3OH, CH_3CN, and NH_2CHO. We computed the MHD resistivities within the disk for the full gas–grain chemical evolution and find results in qualitative agreement with the literature assuming simpler chemical networks. In conclusion, the chemical content of prestellar cores is expected to affect the chemical composition of disks. The impact is more or less important depending on the type of species. Users of stand-alone chemical models of disks should pay special attention to the initial abundances they choose.

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Time-Variable Radio Recombination Line Emission in W49A

C. G. DePree[1], D. J. Wilner[2], L. E. Kristensen[3,2], R. Galván-Madrid[4], W. M. Goss[5], R. S. Klessen[6,7], M.-M. Mac Low[7,8], T. Peters[10], A. Robinson[1], M. Rao[1] and S. Sloman[1]

[1] Department of Physics & Astronomy, Agnes Scott College, Decatur, GA, United States; [2] Center for Astrophysics ; [3] Harvard & Smithsonian, Cambridge, MA, United States; [4] Niels Bohr Institute & Centre for Star and Planet Formation, Copenhagen University, Denmark; [5] Instituto de Radioastronomía y Astrofísica (IRyA), UNAM, Morelia, Michoacán, Mexico; [6] National Radio Astronomy Observatory, Socorro, NM, United States; [7] Universität Heidelberg, Zentrum für Astronomie, Institut für Theoretische Astrophysik, Heidelberg, Germany; [8] Universität Heidelberg, Interdisziplinäres Zentrum für Wissenschaftliches Rechnen, Heidelberg, Germany; [9] Department of Astrophysics, American Museum of Natural History, New York, NY, USA; [10] Center for Computational Astrophysics, Flatiron Institute, New York, NY, United States

E-mail contact: cdepree *at* agnesscott.edu

We present new Jansky Very Large Array (VLA) images of the central region of the W49A star-forming region at 3.6 cm and at 7 mm at resolutions of 0.15″ (1650 au) and 0.04″ (440 au), respectively. The 3.6 cm data reveal new morphological detail in the ultracompact HII region population, as well as several previously unknown and unresolved sources. In particular, source A shows elongated, edge-brightened, bipolar lobes, indicative of a collimated outflow, and source E is resolved into three spherical components. We also present VLA observations of radio recombination lines at 3.6 cm and 7 mm, and IRAM Northern Extended Millimeter Array (NOEMA) observations at 1.2 mm. Three of the smallest ultracompact HII regions (sources A, B2 and G2) all show broad kinematic linewidths, with ΔV_{FWHM} >40 km s^{-1}. A multi-line analysis indicates that broad linewidths remain after correcting for pressure broadening effects, suggesting the presence of supersonic flows. Substantial changes in linewidth over the 21 year time baseline at both 3.6 cm and 7 mm are found for source G2. At 3.6 cm, the linewidth of G2 changed from 31.7±1.8 km s^{-1} to 55.6±2.7 km s^{-1}, an increase of +23.9±3.4 km s^{-1}. The G2 source was previously reported to have shown

a 3.6 cm continuum flux density decrease of 40% between 1994 and 2015. This source sits near the center of a very young bipolar outflow whose variability may have produced these changes.

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New insights in the HII region G18.88−0.49: hub-filament system and accreting filaments

L. K. Dewangan[1], D. K. Ojha[2], Saurabh Sharma[3], S. del Palacio[4], N. K. Bhadari[1,5] and A. Das[6]

[1] Physical Research Laboratory, Navrangpura, Ahmedabad - 380 009, India.; [2] Department of Astronomy and Astrophysics, Tata Institute of Fundamental Research, Homi Bhabha Road, Mumbai - 400005, India.; [3] Aryabhatta Research Institute of Observational Sciences (ARIES), Manora Peak, Nainital, 263002, India.; [4] Instituto Argentino de Radioastronomía (CCT La Plata, CONICET; CICPBA; UNLP), C.C.5, (1894) Villa Elisa, Buenos Aires, Argentina.; [5] Indian Institute of Technology Gandhinagar Palaj, Gandhinagar, 382355, India.; [6] University of Hyderabad, Hyderabad - 500046, India.

E-mail contact: lokeshd *at* prl.res.in

We present an analysis of multi-wavelength observations of an area of 0.27 deg × 0.27 deg around the Galactic H II region G18.88−0.49, which is powered by an O-type star (age $\sim 10^5$ years). The *Herschel* column density map reveals a shell-like feature of extension ∼12 pc × 7 pc and mass $\sim 2.9 \times 10^4$ $M_\odot$ around the H II region; its existence is further confirmed by the distribution of molecular (^{12}CO, ^{13}CO, C^{18}O, and NH_3) gas at [60, 70] km s^{-1}. Four subregions are studied toward this shell-like feature, and show a mass range of ~ 0.8–10.5×10^3 $M_\odot$. These subregions associated with dense gas are dominated by non-thermal pressure and supersonic non-thermal motions. The shell-like feature is associated with the H II region, Class I protostars, and a massive protostar candidate, illustrating the ongoing early phases of star formation (including massive stars). The massive protostar is found toward the position of the 6.7 GHz methanol maser, and is associated with outflow activity. Five parsec-scale filaments are identified in the column density and molecular maps, and appear to be radially directed to the dense parts of the shell-like feature. This configuration is referred to as a “hub-filament" system. Significant velocity gradients (0.8–1.8 km s^{-1} pc^{-1}) are observed along each filament, suggesting that the molecular gas flows towards the central hub along the filaments. Overall, our observational findings favor a global non-isotropic collapse scenario as discussed in Motte et al. (2018), which can explain the observed morphology and star formation in and around G18.88−0.49.

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The structure and characteristic scales of molecular clouds

Sami Dib[1], Sylvain Bontemps[1], Nicola Schneider[2], Davide Elia[3], Volker Ossenkopf-Okada[2], Mohsen Shadmehri[4], Doris Arzoumanian[5], Frédérique Motte[6], Mark Heyer[7], Åke Nordlund[8] and Bilal Ladjelate[9]

[1] Laboratoire d’Astrophysique de Bordeaux, Université de Bordeaux, CNRS, B18N, allée Geoffroy Saint-Hilaire, 33615, Pessac, France; [2] I. Physikalisches Institut, Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Germany; [3] Istituto di Astrofisica e Planetologia Spazialli, INAF, via Fosso del Cavaliere 100, Roma, 00133, Italy; [4] Department of Physics, Faculty of Sciences, Golestan University, Gorgan 49138-15739, Iran; [5] nstituto de Astrofísica e Ciências do Espaço, Universidade do Porto, CAUP, Rua das Estrelas, PT4150-762, Porto, Portugal; [6] Institut de Planétologie et d’Astrophysique de Grenoble, Université Grenoble Alpes, CNRS, Grenoble, France; [7] Department of Astronomy, University of Massachusetts, Amherst, MA 01003, USA; [8] Centre for Star and Planet Formation, the Niels Bohr Institute and the Natural History Museum of Denmark, University of Copenhagen, Øster Voldgade 5-7, DK-1350, Denmark; [9] Instituto de Radioastronomía Milimétrica, IRAM Avenida Divina Pastora 7, Local 20, 18012, Granada, Spain

E-mail contact: sami.dib *at* gmail.com

The structure of molecular clouds holds important clues on the physical processes that lead to their formation and subsequent dynamical evolution. While it is well established that turbulence imprints a self-similar structure to the clouds, other processes, such as gravity and stellar feedback, can break their scale-free nature. The break of selfsimilarity can manifest itself in the existence of characteristic scales that stand out from the underlying structure generated by turbulent motions. In this work, we investigate the structure of the Cygnus-X North and the Polaris Flare molecular clouds which represent two extremes in terms of their star formation activity. We characterize the structure of the clouds using the delta-variance (Δ-variance) spectrum. In the Polaris Flare, the structure of the cloud is self-similar over more than one order of magnitude in spatial scales. In contrast, the Δ-variance spectrum of Cygnus-X North exhibits an excess and a plateau on physical scales of $\approx 0.5 - 1.2$ pc. In order to explain the observations for Cygnus-X North, we use synthetic maps in which we overlay populations of discrete structures on top of a fractal Brownian motion (fBm) image. The properties of these structures such as their major axis sizes, aspect ratios, and column density contrasts with the fBm image are randomly drawn from parameterized distribution functions. We are able to show that under plausible assumptions, it is possible to reproduce a Δ-variance spectrum that resembles the one of the Cygnus-X North region. We also use a "reverse engineering" approach in which we extract the compact structures in the Cygnus-X North cloud and re-inject them on an fBm map. The calculated Δ-variance spectrum using this approach deviates from the observations and is an indication that the range of characteristic scales ($\approx 0.5 - 1.2$ pc) observed in Cygnus-X North is not only due to the existence of compact sources, but is a signature of the whole population of structures that exist in the cloud, including more extended and elongated structures

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The First Extensive Spectroscopic Study of Young Stars in the North America and Pelican Nebulae Region

Min Fang[1], Lynne A. Hillenbrand[1], Jinyoung Serena Kim[2], Krzysztof Findeisen[3], Gregory J. Herczeg[4], John M. Carpenter[5], Luisa M. Rebull[6] and Hongchi Wang[7]

[1] Department of Astronomy, California Institute of Technology, Pasadena CA 91125; [2] Department of Astronomy, University of Arizona, 933 North Cherry Avenue, Tucson, AZ 85721, USA; [3] University of Washington, Department of Astronomy, Seattle, WA, 98195, U.S.A; [4] Kavli Institute for Astronomy and Astrophysics, Peking University, Yiheyuan 5, Haidian Qu, 100871 Beijing, China; [5] Joint ALMA Observatory, Alonso de Cordova 3107 Vitacura, Santiago, Chile; [6] Infrared Science Archive (IRSA), IPAC, 1200 E. California Blvd., California Institute of Technology, Pasadena, CA 91125, USA; [7] Purple Mountain Observatory and Key Laboratory of Radio Astronomy, Chinese Academy of Sciences, 2 West Beijing Road, 210008 Nanjing, China

E-mail contact: mfang.cn *at* gmail.com

We present a spectroscopic survey of over 3400 potential members in the North America and Pelican nebulae (NAP) using several low-resolution (R≈1300-2000) spectrographs: Palomar/Norris, WIYN/HYDRA, Keck/DEIMOS, and MMT/Hectospec. We identify 580 young stars as likely members of the NAP region based on criteria involving infrared excess, Li I 6708 absorption, X-ray emission, parallax, and proper motions. The spectral types of individual spectra are derived by fitting them with templates that are either empirical spectra of pre-main sequence stars, or model atmospheres. The templates are artificially veiled, and a best-fit combination of spectral type and veiling parameter is derived for each star. We use the spectral types with archival photometry to derive V-band extinction and stellar luminosity. From the H-R diagram, the median age of the young stars is about 1 Myr, with a luminosity dispersion of ∼0.3–0.4 dex. We investigate the photometric variability of the spectroscopic member sample using ZTF data, and conclude that photometric variability, while present, does not significantly contribute to the luminosity dispersion. While larger than the formal errors, the luminosity dispersion is smaller than if veiling were not taken into account in our spectral typing process. The measured ages of stellar kinematic groups, combined with inferred ages for embedded stellar populations revealed by Spitzer, suggests a sequential history of star formation in the NAP region.

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The chemical structure of young high-mass star-forming clumps: (II) parsec-scale CO depletion and deuterium fraction of HCO^+

S. Feng[1,2,3], D. Li[1,4], P. Caselli[5], F. Du[6,7], Y. Lin[8], O. Sipilä[5], H. Beuther[9], Patricio Sanhueza[3], K.

Tatematsu[10,11], S. Y. Liu[2], Q. Zhang[12], Y. Wang[9], T. Hogge[13], I. Jimenez-Serra[14], X. Lu[3], T. Liu[15], K. Wang[16], Z. Y. Zhang[17], S. Zahorecz[3,18], G. Li[19], H. B. Liu[2] and J. Yuan[1]

[1] National Astronomical Observatories, Chinese Academy of Science, Beijing 100101, People's Republic of China; [2] Academia Sinica Institute of Astronomy and Astrophysics, No.1, Section 4, Roosevelt Road, Taipei 10617, Taiwan, Republic of China; [3] National Astronomical Observatory of Japan, National Institutes of Natural Sciences, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan; [4] NAOC-UKZN Computational Astrophysics Centre, University of KwaZulu-Natal, Durban 4000, South Africa; [5] Max-Planck-Institut für Extraterrestrische Physik, Gießenbachstraße 1, D-85748, Garching bei München, Germany; [6] Purple Mountain Observatory and Key Laboratory of Radio Astronomy, Chinese Academy of Sciences, Nanjing 210023, People's Republic of China; [7] School of Astronomy and Space Science, University of Science and Technology of China, Hefei 230026, People's Republic of China; [8] Max Planck Institute for Radio Astronomy, Auf dem Hügel 69, D-53121 Bonn, Germany; [9] Max-Planck-Institut für Astronomie, Königstuhl 17, D-69117, Heidelberg, Germany; [10] Nobeyama Radio Observatory, National Astronomical Observatory of Japan, National Institutes of Natural Sciences, Nobeyama, Minamimaki, Minamisaku, Nagano 384-1305, Japan; [11] Department of Astronomical Science, SOKENDAI (The Graduate University for Advanced Studies), 2-21-1 Osawa, Mitaka, Tokyo, 181-8588, Japan; [12] Center for Astrophysics; [13] Harvard and Smithsonian, 60 Garden Street, Cambridge, MA 02138, USA; [14] Institute for Astrophysical Research, Boston University, Boston, MA 02215, USA; [15] Centro de Astrobiología (CSIC, INTA), Ctra. de Torrejón a Ajalvir km. 4, Torrejón de Ardoz, E-28850 Madrid, Spain; [16] Shanghai Astronomical Observatory, Chinese Academy of Sciences, 80 Nandan Road, Shanghai 200030, People's Republic of China; [17] Kavli Institute for Astronomy and Astrophysics, Peking University, 5 Yiheyuan Road, Haidian District, Beijing 100871, People's Republic of China; [18] School of Astronomy and Space Science, Nanjing University, 163 Xianlin Avenue, Nanjing 210023, People's Republic of China; [19] Department of Physical Science, Graduate School of Science, Osaka Prefecture University, 1-1 Gakuen-cho,Naka-ku, Sakai, Osaka 599-8531, Japan

E-mail contact: siyi.s.feng *at* gmail.com

The physical and chemical properties of cold and dense molecular clouds are key to understanding how stars form. Using the IRAM 30 m and NRO 45 m telescopes, we carried out a Multiwavelength line-Imaging survey of the 70 μm dark and bright clOuds (MIAO). At a linear resolution of 0.1–0.5 pc, this work presents a detailed study of parsec-scale CO depletion and HCO^+ deuterium (D-) fractionation toward four sources (G 11.38+0.81, G 15.22-0.43, G 14.49-0.13, and G 34.74-0.12) included in our full sample. In each source with T $<$ 20 K and $n_{\rm H} \sim 10^4$–$10^5\,{\rm cm^{-3}}$, we compared pairs of neighboring 70 μm bright and dark clumps and found that (1) the H_2 column density and dust temperature of each source show strong spatial anticorrelation; (2) the spatial distribution of CO isotopologue lines and dense gas tracers, such as 1–0 lines of $H^{13}CO^+$ and DCO^+, are anticorrelated; (3) the abundance ratio between $C^{18}O$ and DCO^+ shows a strong correlation with the source temperature; (4) both the $C^{18}O$ depletion factor and D-fraction of HCO^+ show a robust decrease from younger clumps to more evolved clumps by a factor of more than 3; and (5) preliminary chemical modeling indicates chemical ages of our sources are $\sim 8 \times 10^4$ yr, which is comparable to their free-fall timescales and smaller than their contraction timescales, indicating that our sources are likely dynamically and chemically young.

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Hydrodynamical simulations of protoplanetary disks including irradiation of stellar photons. I. Resolution study for Vertical Shear Instability (VSI)

Lizxandra Flores-Rivera[1], Mario Flock[1] and Ryohei Nakatani[2]

[1] Max Planck Institute for Astronomy, Germany; [2] RIKEN, Japan

E-mail contact: flores *at* mpia.de

In recent years hydrodynamical (HD) models have become important to describe the gas kinematics in protoplanetary disks, especially in combination with models of photoevaporation and/or magnetic-driven winds. Our aim is to investigate how the Vertical Shear Instability (VSI) could influence the thermally-driven winds on the surface of protoplanetary disks. In this first part of the project, we focus on diagnosing the conditions of the VSI at the highest numerical resolution ever recorded and allude at what resolution per scale height we obtain convergence. At the same time, we want to investigate the vertical extent of VSI activity. Finally, we determine the regions where EUV, FUV

and X-Rays are dominant in the disk. We perform global HD simulations using the PLUTO code. We adopt a global isothermal accretion disk setup, 2.5D (2 dimensions, 3 components) which covers a radial domain from 0.5 to 5.0 and an approximately full meridional extension. Our simulation runs cover a resolution from 12 to 203 cells per scale height. We determine the 50 cells per scale height to be the lower limit to resolve the VSI. For higher resolutions, greater than 50 cells per scale height, we observe the convergence for the saturation level of the kinetic energy. We are also able to identify the growth of the 'body' modes, with higher growth rate for higher resolution. Full energy saturation and a turbulent steady state is reached after 70 local orbits. We determine the location of the EUV-heated region defined by the radial column density to be 10^{19} cm^{-2} located at H_R ∼9.7 and the FUV/X-Rays-heated boundary layer defined to be 10^{22} cm^{-2} located at H_R ∼6.2, making it necessary to introduce the need of a hot atmosphere. For the first time, we report the presence of small scale vortices in the r-Z plane, between the characteristic layers of large scale vertical velocity motions. Such vortices could lead to dust concentration, promoting grain growth. Our results highlight the importance to combine photoevaporation processes in the future high-resolution studies of the turbulence and accretion processes in disks.

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Lupus DANCe. Census of stars and 6D structure with Gaia-DR2 data

P.A.B. Galli[1], H. Bouy[1], J. Olivares[1], N. Miret-Roig[1], R.G. Vieira[2], L.M. Sarro[3], D. Barrado[4], A. Berihuete[5], C. Bertout[6], E. Bertin[6] and J.C. Cuillandre[7]

[1] Laboratoire d'Astrophysique de Bordeaux, Univ. Bordeaux, CNRS, B18N, allée Geoffroy Saint-Hillaire, F-33615 Pessac, France; [2] Departamento de Física, Universidade Federal de Sergipe, São Cristóvão, SE, Brazil; [3] Depto. de Inteligencia Artificial, UNED, Juan del Rosal, 16, 28040 Madrid, Spain; [4] Centro de Astrobiología, Depto. de Astrofísica, INTA-CSIC, ESAC Campus, Camino Bajo del Castillo s/n, 28692 Villanueva de la Cañada, Madrid, Spain; [5] Dept. Statistics and Operations Research, University of Cádiz, Campus Universitario Río San Pedro s/n, 11510 Puerto Real, Cádiz, Spain; [6] Institut d'Astrophysique de Paris, CNRS UMR 7095 and UPMC, 98bis bd Arago, 75014 Paris, France; [7] AIM Paris Saclay, CNRS/INSU, CEA/Irfu, Université Paris Diderot, Orme des Merisiers, France

E-mail contact: phillip.galli *at* u-bordeaux.fr

Context: Lupus is recognised as one of the closest star-forming regions, but the lack of trigonometric parallaxes in the pre-*Gaia* era hampered many studies on the kinematic properties of this region and led to incomplete censuses of its stellar population.
Aims: We use the second data release of the *Gaia* space mission combined with published ancillary radial velocity data to revise the census of stars and investigate the 6D structure of the Lupus complex.
Methods: We performed a new membership analysis of the Lupus association based on astrometric and photometric data over a field of 160 deg^2 around the main molecular clouds of the complex and compared the properties of the various subgroups in this region.
Results: We identified 137 high-probability members of the Lupus association of young stars, including 47 stars that had never been reported as members before. Many of the historically known stars associated with the Lupus region identified in previous studies are more likely to be field stars or members of the adjacent Scorpius-Centaurus association. Our new sample of members covers the magnitude and mass range from $G \simeq 8$ to $G \simeq 18$ mag and from 0.03 to 2.4 $M_{\odot}$, respectively. We compared the kinematic properties of the stars projected towards the molecular clouds Lupus 1 to 6 and showed that these subgroups are located at roughly the same distance (about 160 pc) and move with the same spatial velocity. Our age estimates inferred from stellar models show that the Lupus subgroups are coeval (with median ages ranging from about 1 to 3 Myr). The Lupus association appears to be younger than the population of young stars in the Corona-Australis star-forming region recently investigated by our team using a similar methodology. The initial mass function of the Lupus association inferred from the distribution of spectral types shows little variation compared to other star-forming regions.
Conclusions: In this paper, we provide an updated sample of cluster members based on *Gaia* data and construct the most complete picture of the 3D structure and 3D space motion of the Lupus complex.

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A photoionized accretion disk around a young high-mass star

Andres E. Guzman[1], Paricio Sanhueza[1,2], Luis Zapata[3], Guido Garay[4] and Luis Felipe Rodriguez[3]

[1] National Astronomical Observatory of Japan, National Institutes of Natural Sciences, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan; [2] Department of Astronomical Sciences, SOKENDAI (The Graduate University for Advanced Studies), 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan; [3] Instituto de Radioastronomía y Astrofísica, Universidad Nacional Autónoma de México, P.O. Box 3-72, 58090, Morelia, Michoacán, México; [4] Departamento de Astronomía, Universidad de Chile, Camino el Observatorio 1515, Las Condes, Santiago, Chile

E-mail contact: andres.guzman *at* nao.ac.jp

We present high spatial resolution (52 au) observations of the high-mass young stellar object (HMYSO) G345.4938+01.4677 made using the Atacama Large Millimeter/sub-millimeter Array (ALMA). This O-type HMYSO is located at 2.38 kpc and it is associated with a luminosity of $1.5 \times 10^5 L_\odot$. We detect circumstellar emission from the H38β hydrogen recombination line showing a compact structure rotating perpendicularly to the previously detected radio jet. We interpret this emission as tracing a photo-ionized accretion disk around the HMYSO. While this disk-like structure seems currently too small to sustain continued accretion, the data present direct observational evidence of how disks can effectively survive the photo-ionization feedback from young high-mass stars. We also report the detection of a low-mass young stellar object in the vicinity of the HMYSO and suggest that it forms a high-mass and low-mass star binary system.

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APEX-SEPIA660 Early Science: Gas at densities above 10^7 cm^{-3} towards OMC-1

A. Hacar[1,2], M. R. Hogerheijde[1,3], D. Harsono[4], S. Portegies Zwart[1], C. De Breuck[5], K. Torstensson[5], W. Boland[6], A. M. Baryshev[6], R. Hesper[6], J. Barkhof[6], J. Adema[6], M. E. Bekema[6], A. Koops[6], A. Khudchenko[6] and R. Stark[7]

[1] Leiden Observatory, Leiden University, P.O. Box 9513, 2300-RA Leiden, The Netherlands; [2] University of Vienna, Department of Astrophysics, Türkenschanzstrasse 17, 1180 Vienna, Austria; [3] Anton Pannekoek Institute for Astonomy, University of Amsterdam, the Netherlands; [4] Institute of Astronomy and Astrophysics, Academia Sinica, No.1, Sec. 4, Roosevelt Rd, Taipei 10617, Taiwan, R.O.C.; [5] European Southern Observatory, Karl Schwarzschild Strasse 2, 85748 Garching, Germany; [6] Netherlands Research School for Astronomy (NOVA), Kapteyn Astronomical Institute, Landleven 12, 9747 AD Groningen, The Netherlands; [7] Netherlands Research School for Astronomy (NOVA), Leiden Observatory, Leiden University, P.O. Box 9513, 2300-RA Leiden, The Netherlands

E-mail contact: alvaro.hacar *at* univie.ac.at

Context: The star formation rates and stellar densities found in young massive clusters suggest that these stellar systems originate from gas at densities n(H_2)=10^7 cm^{-3}. Until today, however, the physical characterization of this ultra high density material remains largely unconstrained in observations.
Aims. We investigated the density properties of the star-forming gas in the OMC-1 region located in the vicinity of the Orion Nebula Cluster (ONC).
Methods: We mapped the molecular emission at 652 GHz in OMC-1 as part of the APEX-SEPIA660 Early Science.
Results: We detect bright and extended N_2H^+ (J=7-6) line emission along the entire OMC-1 region. Comparisons with previous ALMA data of the (J=1-0) transition and radiative transfer models indicate that the line intensities observed in this N_2H^+ (7-6) line are produced by large mass reservoirs of gas at densities n(H_2)=10^7 cm^{-3}.
Conclusions: The first detection of this N_2H^+ (7-6) line at parsec-scales demonstrates the extreme density conditions of the star- forming gas in young massive clusters such as the ONC. Our results highlight the unique combination of sensitivity and mapping capabilities of the new SEPIA660 receiver for the study of the ISM properties at high frequencies.

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Misaligned Twin Molecular Outflows From Class-0 Proto-stellar Binary System VLA 1623A Unveiled by ALMA

Chihomi Hara[1,2,3], Ryohei Kawabe[2,3,4], Fumitaka Nakamura[2,3,4], Naomi Hirano[5], Shigehisa Takakuwa[6], Yoshito Shimajiri[2], Takeshi Kamazaki[2], James Di Francesco[7], Masahiro N. Machida[8], Motohide Tamura[3], Kazuya Saigo[2], Tomoaki Matsumoto[9] and Kengo Tomida[10]

[1] NEC Coorporation, Fuchu, Tokyo 183-8501, Japan; [2] National Astronomical Observatory of Japan, Mitaka, Tokyo 181-8588, Japan; [3] Department of Astronomy, The University of Tokyo, 7-3-1, Hongo, Bunkyo-ku, Tokyo, 113-0033, Japan; [4] The Graduate University for Advanced Studies (SOKENDAI), 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan; [5] Academia Sinica Institute of Astronomy and Astrophysics, 11F of Astronomy-Mathematics Building, AS/NTU, No.1, Sec. 4, Roosevelt Rd, Taipei, 10617, Taiwan; [6] Department of Physics and Astronomy, Graduate School of Science and Engineering, Kagoshima University, 1-21-35 Korimoto, Kagoshima, Kagoshima 890-0065, Japan; [7] NRC Herzberg Inst of Astrophysics, 5071 W Saanich Rd, Victoria BC V9E 2E7, British Columbia, Canada; [8] Department of Earth and Planetary Science, Faculty of Science, Kyushu University, Motooka 744 , Nishi-ku, Fukuoka 819-0395, Japan; [9] aculty of Sustainability Studies, Hosei University,Fujimi, Chiyoda-ku, Tokyo 102-8160, Japan; [10] Astronomical Institute, Tohoku University, Sendai, Miyagi 980-8578, Japan

E-mail contact: fumitaka.nakamura *at* nao.ac.jp

We present the results of ALMA observations toward the low-mass Class-0 binary system, VLA 1623Aab in the Ophiuchus molecular cloud in ^{12}CO, ^{13}CO, and C^{18}O(2–1) lines. Our ^{12}CO (J=2–1) data reveal that the VLA 1623 outflow consists of twin spatially overlapped outflows/jets. The redshifted northwestern jet exhibits the three cycles of wiggle with a spatial period of 1360pm10 au, corresponding to a time period of 180 yr. The wiggle-like structure is also found in the position-velocity (PV) diagram, showing an amplitude in velocity of about 0.9 km s^{-1}. Both the period and the velocity amplitude of the wiggle are roughly consistent with those expected from the binary parameters, i.e., the orbital period (460pm20 yr) and the Keplerian velocity (2.2 km s^{-1}). Our ^{13}CO and C^{18}O images reveal the nature of the dense gas in the two cm/mm sources, VLA 1623-B and -W, and its relation to the outflows, and strongly support the previous interpretation that both are shocked cloudlets. The driving sources of the twin molecular outflows are, therefore, likely to be within the VLA 1623Aab binary. The axes of the two molecular outflows are estimated to be inclined by 70° from each other across the plane of sky, implying that the associated protostellar disks are also misaligned by 70°. Such a misalignment, together with a small binary separation of 34 au in the one of the youngest protobinary systems known, is difficult to explain by models of disk fragmentation in quiescent environments. Instead, other effects such as turbulence probably play roles in misaligning the disks.

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CMZoom II: Catalog of Compact Submillimeter Dust Continuum Sources in the Milky Way's Central Molecular Zone

H Perry Hatchfield[1], Cara Battersby[1,2], Eric Keto[2], Daniel Walker[1,3,4], Ashley Barnes[5], Daniel Callanan[2,6], Adam Ginsburg[7], Jonathan D. Henshaw[8], Jens Kauffmann[9], J. M. Diederik Kruijssen[10], Steve N. Longmore[6], Xing Lu[4], Elisabeth A. C. Mills[11], Thushara Pillai[12], Qizhou Zhang[13], John Bally[14], Natalie Butterfield[15], Yanett A. Contreras[16], Luis C. Ho[17,18], J[19], Nimesh Patel[2] and Volker Tolls[2]

[1] University of Connecticut, Department of Physics, 196A Auditorium Road, Unit 3046, Storrs, CT 06269, USA; [2] Center for Astrophysics, Harvard & Smithsonian, MS-78, 60 Garden Street, Cambridge, MA 02138, USA; [3] Joint ALMA Observatory, Alonso de Córdova 3107, Vitacura, Santiago, Chile; [4] National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo, 181-8588, Japan; [5] Argelander-Institut für Astronomie, Universität Bonn, Auf dem Hügel 71, D-53121, Bonn, DE, Germany; [6] Astrophysics Research Institute, Liverpool John Moores University, 146 Brownlow Hill, Liverpool L3 5RF, UK; [7] University of Florida Department of Astronomy, Bryant Space Science Center, Gainesville, FL, 32611, USA; [8] Max-Planck-Institute for Astronomy, Koenigstuhl 17, D-69117 Heidelberg, Germany; [9] Haystack Observatory, Massachusetts Institute of Technology, 99 Millstone Road, Westford, MA 01886, USA; [10] Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg, Mönchhofstraße 12-14, D-69120 Heidelberg, Germany; [11] Department of Physics and Astronomy, University of Kansas, 1251 Wescoe Hall Drive, Lawrence, KS 66045, USA; [12] Boston University Astronomy Department, 725 Commonwealth Avenue, Boston, MA 02215, USA; [13] Center for Astrophysics, Harvard & Smithsonian, MS-42, 60 Garden Street, Cambridge, MA 02138, USA; [14] CASA, University of Colorado, 389-UCB, Boulder, CO 80309, USA; [15] Green Bank Observatory, 155

Observatory Road, P.O. Box 2, Green Bank, WV 24944, USA; [16] Leiden Observatory, Leiden University, P.O. Box 9513, NL 2300 RA Leiden, The Netherlands; [17] Kavli Institute for Astronomy and Astrophysics, Peking University, Beijing 100871, People's Republic of China; [18] Department of Astronomy, School of Physics, Peking University, Beijing 100871, People's Republic of China; [19] National Radio Astronomy Observatory, 1003 Lopezville Road, Socorro, NM 87801, USA

E-mail contact: h.hatchfield *at* uconn.edu

In this paper we present the *CMZoom* Survey's catalog of compact sources ($\leq$ 10 arcsec, $\sim$0.4pc) within the CentralMolecular Zone (CMZ). *CMZoom* is a Submillimeter Array (SMA) large program designed to provide a complete and unbiased map of all high column density gas ($N(H_2) \geq 10^{23}$ cm^{-2}) of the innermost 500pc of the Galaxy in the 1.3mm dust continuum. We generate both a robust catalog designed to reduce spurious source detections, and a second catalog with higher completeness, both generated using a pruned dendrogram. In the robust catalog, we report 285 compact sources, or 816 in the high completeness catalog. These sources have effective radii between 0.04-0.4 pc, and are the potential progenitors of star clusters. The masses for both catalogs are dominated by the Sagittarius B2 cloud complex, where masses are likely unreliable due to free-free contamination, uncertain dust temperatures, and line-of-sight confusion. Given the survey selection and completeness, we predict that our robust catalog accounts for more than $\sim$99% of compact substructure capable of forming high mass stars in the CMZ. This catalog provides a crucial foundation for future studies of high mass star formation in the Milky Way's Galactic Center.

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Transport, destruction and growth of pebbles in the gas envelope of a protoplanet

Anders Johansen[1] and Åke Nordlund[2]

[1] Lund Observatory, Lund University and GLOBE Institute, University of Copenhagen; [2] Niels Bohr Institute, University of Copenhagen

E-mail contact: Anders.Johansen *at* sund.ku.dk

We analyse the size evolution of pebbles accreted into the gaseous envelope of a protoplanet growing in a protoplanetary disc, taking into account collisions driven by the relative sedimentation speed as well as the convective gas motion. Using a simple estimate of the convective gas speed based on the pebble accretion luminosity, we find that the speed of the convective gas is higher than the sedimentation speed for all particles smaller than 1 mm. This implies that both pebbles and pebble fragments are strongly affected by the convective gas motion and will be transported by large-scale convection cells both towards and away from the protoplanet's surface. We present a simple scheme for evolving the characteristic size of the pebbles, taking into account the effects of erosion, mass transfer and fragmentation. Including the downwards motion of convective cells for the transport of pebbles with an initial radius of 1 millimeter, we find pebble sizes between 100 microns and 1 millimeter near the surface of the protoplanet. These sizes are generally amenable to accretion at the base of the convection flow. Small protoplanets far from the star (> 30 AU) nevertheless erode their pebbles to sizes below 10 microns; future hydrodynamical simulations will be needed to determine whether such small fragments can detach from the convection flow and become accreted by the protoplanet.

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Resolved star formation in the metal poor star-forming region Magellanic Bridge C

V. M. Kalari[1,2], M. Rubio[2], Hugo P. Saldaño[3] and Alberto D. Bolatto[4]

[1] Gemini Observatory, Southern Operations Center, c/o AURA, Casilla 603, La Serena, Chile; [2] Departamento de Astronomia, Universidad de Chile, Casilla 36-D, Santiago, Chile; [3] Observatorio Astronómico, Universidad Nacional de Córdoba, Córdoba, Argentina; [4] Department of Astronomy, University of Maryland, College Park, MD 20742, USA

E-mail contact: vkalari *at* gemini.edu

Magellanic Bridge C (MB-C) is a metal-poor ($\sim 1/5\, Z_{\odot}$) low-density star-forming region located 59 kpc away in the Magellanic Bridge, offering a resolved view of the star formation process in conditions different to the Galaxy. From

Atacama Large Millimetre Array CO (1-0) observations, we detect molecular clumps associated to candidate young stellar objects (YSOs), pre-main sequence (PMS) stars, and filamentary structure identified in far-infrared imaging. YSOs and PMS stars form in molecular gas having densities between 17–200 $M_\odot\,\mathrm{pc}^{-2}$, and have ages between $\lesssim$0.1–3 Myr. YSO candidates in MB-C have lower extinction than their Galactic counterparts. Otherwise, our results suggest that the properties and morphologies of molecular clumps, YSOs, and PMS stars in MB-C present no patent differences with respect to their Galactic counterparts, tentatively alluding that the bottleneck to forming stars in regions similar to MB-C is the conversion of atomic gas to molecular.

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Mapping the H_2D^+ and N_2H^+ emission towards prestellar cores. Testing dynamical models of the collapse using gas tracers

E. Koumpia[1], L. Evans[2,3], J. Di Francesco[4], F. F. S. van der Tak[5,6] and R. D. Oudmaijer[1]

[1] School of Physics & Astronomy, University of Leeds, Woodhouse Lane, LS2 9JT Leeds, UK; [2] IRAP, Université de Toulouse, CNRS, UPS, CNES, F-31400 Toulouse, France; [3] INAF-Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5,I-50125, Florence, Italy; [4] Herzberg Astronomy and Astrophysics Research Centre, National Research Council of Canada, Victoria, BC, Canada; [5] SRON Netherlands Institute for Space Research, Landleven 12, 9747 AD Groningen, The Netherlands; [6] Kapteyn Astronomical Institute, University of Groningen, The Netherlands

E-mail contact: ev.koumpia *at* gmail.com

The study of prestellar cores is critical as they set the initial conditions in star formation and determine the final mass of the stellar object. To date, several hypotheses are describing their gravitational collapse. We perform detailed line analysis and modelling of H_2D^+ 110 -111 and N_2H^+ 4-3 emission at 372 GHz, using 2'x2' maps (JCMT). Our goal is to test the most prominent dynamical models by comparing the modelled gas kinematics and spatial distribution (H_2D^+ and N_2H^+) with observations towards four prestellar (L1544, L183, L694-2, L1517B) and one protostellar core (L1521f). We perform a detailed non-LTE radiative transfer modelling using RATRAN, where we compare the predicted spatial distribution and line profiles of H_2D^+ and N_2H^+ with observations towards all cores. To do so, we adopt the physical structure for each core predicted by three different dynamical models taken from literature: Quasi-Equilibrium Bonnor-Ebert Sphere (QE-BES), Singular Isothermal Sphere (SIS), and Larson-Penston (LP) flow. Our analysis provides an updated picture of the physical structure of prestellar cores. We find that the SIS model can be clearly excluded in explaining the gas emission towards the cores, but a larger sample is required to differentiate clearly between the LP flow, the QE-BES and the static models. All models of collapse underestimate the intensity of the gas emission by up to several factors towards the only protostellar core in our sample, indicating that different dynamics take place in different evolutionary core stages. If the LP model is confirmed towards a larger sample of prestellar cores, it would indicate that they may form by compression or accretion of gas from larger scales. If the QE-BES model is confirmed, it means that quasi hydrostatic cores can exist within turbulent ISM.

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Supernovae in the Orion: the missing link in the star forming history of the region

Marina Kounkel[1]

[1] Western Washington University

E-mail contact: Marina.Kounkel *at* wwu.edu

The Orion Complex is a notable star forming region, that it is fragmented into several different populations that have substantial difference in their phase space. I propose a model that attempts to explain the how the Complex has evolved to this current configuration. In this model, the large scale expansion can be attributable to a supernova that has exploded 6 Myr ago. The remnant of which can be seen as Barnard's loop, as the center of the expansion is consistent with the geometrical center of the HII bubble. This is similar to the HII bubble and the ballistic expansion that is associated with λ Ori, a region which has also been a site of an ancient supernova. Assuming that the Orion Complex has originally been forming as one long filament spanning from the bottom of Orion A to ψ^2 Ori (or, potentially, as far as λ Ori), Barnard's loop supernova could have split the cloud, which lead to the formation of Orion C & D. Furthermore, the shockwave that has propagated into the filament could have swept along the gas through several pc, which lead to the formation of the singularly most massive cluster in the Solar Neighborhood, the ONC. I also discuss other related nearby events, such as the formation of the Monogem ring, and various runaways that have been ejected from the Orion Complex.

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Untangling the Galaxy. II. Structure within 3 kpc

Marina Kounkel[1], Kevin Covey[1] and Keivan Stassun[2]

[1] Western Washington University; [2] Vanderbilt University

E-mail contact: Marina.Kounkel *at* wwu.edu

We present the results of the hierarchical clustering analysis of the *Gaia* DR2 data to search for clusters, co-moving groups, and other stellar structures. The current paper builds on the sample from the previous work, extending it in distance from 1 kpc to 3 kpc, increasing the number of identified structures up to 8292. To aid in the analysis of the population properties, we developed a neural network called Auriga to robustly estimate the age, extinction, and distance of a stellar group based on the input photometry and parallaxes of the individual members. We apply Auriga to derive the properties of not only the structures found in this paper, but also previously identified open clusters. Through this work, we examine the temporal structure of the spiral arms. Specifically, we find that the Sagittarius arm has moved by >500 pc in the last 100 Myr, and the Perseus arm has been experiencing a relative lull in star formation activity over the last 25 Myr. We confirm the findings from the previous paper on the transient nature of the spiral arms, with the timescale of transition of a few 100 Myr. Finally, we find a peculiar $\sim$1 Gyr old stream of stars that appears to be heliocentric. It is unclear what is the origin of it.

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Makemake + Sedna: A Continuum Radiation Transport and Photoionization Framework for Astrophysical Newtonian Fluid Dynamics

Rolf Kuiper[1], Harold W. Yorke[2] and Andrea Mignone[3]

[1] Institut für Astronomie und Astrophysik, Universität Tübingen, Auf der Morgenstelle 10, D-72076 Tübingen, Germany; [2] SOFIA Science Center, Universities Space Research Association (USRA), M/S 232-12, Moffett Field, CA 94035-1000, USA; [3] Dipartimento di Fisica Generale, Universita di Torino, via Pietro Giuria 1, 10125 Torino, Italy

E-mail contact: rolf.kuiper *at* uni-tuebingen.de

Astrophysical fluid flow studies often encompass a wide range of physical processes to account for the complexity of the system under consideration. In addition to gravity, a proper treatment of thermodynamic processes via continuum radiation transport and/or photoionization is becoming the state of the art.
We present a major update of our continuum radiation transport module, MAKEMAKE, and a newly developed module for photoionization, SEDNA, coupled to the magnetohydrodynamics code PLUTO. These extensions are currently not publicly available; access can be granted on a case-by-case basis.
We explain the theoretical background of the equations solved, elaborate on the numerical layout, and present a comprehensive test suite for radiation–ionization hydrodynamics. The grid based radiation and ionization modules support static one-dimensional, two-dimensional, and three-dimensional grids in Cartesian, cylindrical, and spherical coordinates. Each module splits the radiation field into two components, one originating directly from a point source – solved using a ray-tracing scheme – and a diffuse component – solved with a three-dimensional flux-limited diffusion (FLD) solver. The FLD solver for the continuum radiation transport makes use of either the equilibrium one-temperature approach or the linearization two-temperature approach. The FLD solver for the photoionization module enables accounting for the temporal evolution of the radiation field from direct recombination of free electrons into the hydrogen ground state as an alternative to the on-the-spot approximation.

A brief overview of completed and ongoing scientific studies is given to explicitly illustrate the multipurpose nature of the numerical framework presented.

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The physical parameters of clumps associated with class I methanol masers

Dmitry A. Ladeyschikov[1], James S. Urquhart[2], Andrey M. Sobolev[1], Shari L. Breen[3] and Olga S. Bayandina[4]

[1] Ural Federal University, 51 Lenin Str., 620051 Ekaterinburg, Russia; [2] Centre for Astrophysics and Planetary Science, University of Kent, Canterbury CT2 7NH, UK; [3] SKA Organisation, Jodrell Bank Observatory, SK11 9DL, UK; [4] Joint Institute for VLBI ERIC Oude Hoogeveensedijk 4, 7991 PD Dwingeloo, The Netherlands

E-mail contact: dmitry.ladeyschikov *at* urfu.ru

We present a study of the association between class I methanol masers and cold dust clumps from the ATLASGAL survey. It was found that almost 100% of class I methanol masers are associated with objects listed in the ATLASGAL compact source catalog. We find a statistically significant difference in the flux density, luminosity, number and column density and temperature distributions of ATLASGAL sources associated with 95/44 GHz methanol masers compared with those ATLASGAL sources devoid of 95 GHz methanol masers. The masers tend to arise in clumps with higher densities, luminosities and temperatures compared with both the full sample of the ATLASGAL clumps, as well as the sample of ATLASGAL sources that were cross-matched with positions previously searched for methanol masers but with no detections. Comparison between the peak position of ATLASGAL clumps and the interferometric positions of the associated class I and II methanol masers reveals that class I masers are generally located at larger physical distances from the peak submillimetre emission than class II masers. We conclude that the tight association between ATLASGAL sources and class I methanol masers may be used as a link toward understanding the conditions of the pumping of these masers and evolutionary stages at which they appear.

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A statistical analysis of dust polarization properties in ALMA observations of Class 0 protostellar cores

Valentin J. M. Le Gouellec[1,2], Anaëlle J. Maury[2,3], Vincent Guillet[4,5], Charles L. H. Hull[6,7,11], Josep Miquel Girart[8,9], Antoine Verliat[2], Raphaël Mignon-Risse[2,10], Valeska Valdivia[2], Patrick Hennebelle[2], Matthias Gonzàlez[2,10] and Fabien Louvet[2]

[1] European Southern Observatory, Alonso de Córdova 3107, Vitacura, Casilla 19001, Santiago , Chile; [2] Université Paris-Saclay, CNRS, CEA, Astrophysique, Instrumentation et Modélisation de Paris-Saclay, 91191, Gif-sur-Yvette, France; [3] Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA; [4] Université Paris-Saclay, CNRS, Institut d'astrophysique spatiale, 91405, Orsay, France; [5] Laboratoire Univers et Particules de Montpellier, Université de Montpellier, CNRS/IN2P3, CC 72, Place Eugene Bataillon, 34095, Montpellier Cedex 5, France; [6] National Astronomical Observatory of Japan, NAOJ Chile, Alonso de Cordova 3788, Office 61B, 7630422, Vitacura, Santiago, Chile; [7] Joint ALMA Observatory, Alonso de Cordova 3107, Vitacura, Santiago, Chile; [8] Institut de Ciències de l'Espai (ICE-CSIC), Campus UAB, Carrer de Can Magrans S/N, E-08193 Cerdanyola del Valles, Catalonia, Spain; [9] Institut d'Estudis Espacials de Catalunya, E-08030 Barcelona, Catalonia, Spain; [10] Universié de Paris, AIM, F-91191, Gif-sur-Yvette, France; [11] NAOJ Fellow

E-mail contact: valentin.le.gouellec *at* gmail.com

Recent observational progress has challenged the dust grain-alignment theories used to explain the polarized dust emission routinely observed in star-forming cores. In an effort to improve our understanding of the dust grain alignment mechanism(s), we have gathered a dozen ALMA maps of (sub)millimeter-wavelength polarized dust emission from Class 0 protostars, and carried out a comprehensive statistical analysis of dust polarization quantities. We analyze the statistical properties of the polarization fraction $\mathcal{P}_{\rm frac}$ and dispersion of polarization position angles $\mathcal{S}$. More specifically, we investigate the relationship between $\mathcal{S}$ and P_{frac} as well as the evolution of the product S$\times$P$_{frac}$

as a function of the column density of the gas in the protostellar envelopes. We compare the observed trends with those found in polarization observations of dust in the interstellar medium and in synthetic observations of non-ideal magneto-hydrodynamic (MHD) simulations of protostellar cores. We find a significant $\mathcal{S} \propto \mathcal{P}_{\rm frac}{}^{-0.79}$ correlation in the polarized dust emission from protostellar envelopes seen with ALMA; the power-law index differs significantly from the one observed by *Planck* in star-forming clouds. The product $S{\times}P_{frac}$, which is sensitive to the dust grain alignment efficiency, is approximately constant across three orders of magnitude in envelope column density (from $N_{H_2} = 10^{22}\,{\rm cm}^{-2}$ to $N_{H_2} = 10^{25}\,{\rm cm}^{-2}$, with a mean value of $0.36^{+0.10}_{-0.17}$. This suggests that the grain alignment mechanism producing the bulk of the polarized dust emission in star-forming cores may not depend systematically on the local conditions such as local gas density. However, in the lowest-luminosity sources in our sample, we find a hint of less efficient dust grain alignment with increasing column density. Our observations and their comparison with synthetic observations of MHD models suggest that the total intensity versus the polarized dust are distributed at different intrinsic spatial scales, which can affect the statistics from the ALMA observations, for example by producing artificially high $\mathcal{P}_{\rm frac}$. Finally, synthetic observations of MHD models implementing radiative alignment torques (RATs) show that the statistical estimator $\mathcal{S} \times \mathcal{P}_{\rm frac}$ is sensitive to the strength of the radiation field in the core. Moreover, we find that the simulations with a uniform perfect alignment (PA) of dust grains yield on average much higher $S{\times}P_{frac}$ values than those implementing RATs; the ALMA values lie among those predicted by PA, and are significantly higher than the ones obtained with RATs, especially at large column densities. Ultimately, our results suggest dust alignment mechanism(s) are efficient at producing dust polarized emission in the various local conditions typical of Class 0 protostars. The grain alignment efficiency found in these objects seems to be higher than the efficiency produced by the standard RAT alignment of paramagnetic grains. Further study will be needed to understand how more efficient grain alignment via, e.g., different irradiation conditions, dust grain characteristics, or additional grain alignment mechanisms can reproduce the observations.

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Young Faithful: The Eruptions of EC 53 as It Cycles through Filling and Draining the Inner Disk

Yong-Hee Lee[1], Doug Johnstone[2,3], Jeong-Eun Lee[1], Gregory Herczeg[4,5], Steve Mairs[6], Watson Varricatt[7], Klaus W. Hodapp[7], Tim Naylor[8], Carlos Contreras Peña[8], Giseon Baek[1], Martin Haas[9] and Rolf Chini[9,10]

[1] School of Space Research and Institute of Natural Sciences, Kyung Hee University, 1732 Deogyeong-daero, Giheung-gu, Yongin-si, Gyeonggi-do 446-701, Korea; [2] Department of Physics and Astronomy, University of Victoria, Victoria, BC, V8P 1A1, Canada; [3] NRC Herzberg Astronomy and Astrophysics, 5071 West Saanich Rd, Victoria, BC, V9E 2E7, Canada; [4] Kavli Institute for Astronomy and Astrophysics, Peking University, Yiheyuan 5, Haidian Qu, 100871 Beijing, China; [5] Department of Astronomy, Peking University, Yiheyuan 5, Haidian Qu, 100871 Beijing, China; [6] East Asian Observatory, 660 N. A'ohōkū Place, Hilo, HI 96720, USA; [7] Institute for Astronomy, University of Hawaii, 640 N. A'ohoku Place, Hilo, HI 96720, USA; [8] School of Physics, Astrophysics Group, University of Exeter, Stocker Road, Exeter EX4 4QL, UK; [9] Astronomisches Institut, Ruhr-Universität Bochum, Universitätsstraße 150, 44801 Bochum, Germany; [10] Instituto de Astronomia, Universidad Catolica del Norte, Avenida Angamos 0610, Antofagasta, Chile

E-mail contact: ieehee *at* khu.ac.kr

While young stellar objects sometimes undergo bursts of accretion, these bursts usually occur sporadically, making them challenging to study observationally and to explain theoretically. We build a schematic description of cyclical bursts of the young stellar object EC 53 using near-IR and sub-mm monitoring obtained over six cycles, each lasting ≈ 530 days. EC 53 brightens over 0.12 yr by 0.3 mag at 850 μm, 2 mag at 3.35 μm, and 1.5 mag at near-IR wavelengths, to a maximum luminosity consistent with an accretion rate of $\sim 8 \times 10^{-6}$ M$_\odot$ yr^{-1}. The emission then decays with an e-folding timescale of ≈ 0.74 yr until the accretion rate is $\sim 1 \times 10^{-6}$ M$_\odot$ yr^{-1}. The next eruption then occurs, likely triggered by the buildup of $\sim 5 \times 10^{-6}$ M$_\odot$ of mass in the inner disk, enough that it becomes unstable and drains onto the star. Just before outburst, when the disk is almost replenished, the near-IR colors become redder, indicating an increase in the geometrical height of the disk by this mass buildup. The reddening disappears soon after the initial burst, as much of the mass is drained from the disk. We quantify physical parameters related to the accretion process in EC 53 by assuming an α-disk formulation, constrained by the observed disk properties and accretion rate. While

we can only speculate about the possible trigger for these faithful eruptions, we hope that our quantified schematic will motivate theorists to test the hypothesized mechanisms that could cause the cyclical buildup and draining of mass in the inner disk.

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The ALMA Survey of 70 μm Dark High-mass Clumps in Early Stages (ASHES). II: Molecular Outflows in the Extreme Early Stages of Protocluster Formation

Shanghuo Li[1,2,3,4], Patricio Sanhueza[5,6], Qizhou Zhang[2], Fumitaka Nakamura[5,6], Xing Lu[5], Junzhi Wang[1], Tie Liu[1], Ken'ichi Tatematsu[5], James M. Jackson[7], Andrea Silva[5], Andrés E. Guzmán[5], Takeshi Sakai[8], Natsuko Izumi[5,9], Daniel Tafoya[10], Fei Li[1,3], Yanett Contreras[11], Kaho Morii[12] and Kee-Tae Kim[13]

[1] Shanghai Astronomical Observatory, Chinese Academy of Sciences, 80 Nandan Road, Shanghai 200030, China; [2] CfA, 60 Garden Street, Cambridge, MA 02138, USA; [3] University of Chinese Academy of Sciences, 19A Yuquanlu, Beijing 100049, China; [4] KASI, 776 Daedeokdae-ro, Yuseong-gu, Daejeon 34055, Republic of Korea; [5] National Astronomical Observatory of Japan, National Institutes of Natural Sciences, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan; [6] Department of Astronomical Science, SOKENDAI (The Graduate University for Advanced Studies), 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan; [7] SOFIA Science Center, USRA, NASA Ames Research Center, Moffett Field CA 94045, USA; [8] Graduate School of Informatics and Engineering, The University of Electro-Communications, Chofu, Tokyo 182-8585, Japan.; [9] College of Science, Ibaraki University, 2-1-1 Bunkyo, Mito, Ibaraki 310-8512, Japan; [10] Department of Space, Earth and Environment, Chalmers University of Technology, Onsala Space Observatory, 439 92 Onsala, Sweden; [11] Leiden Observatory, PO Box 9513, NL-2300 RA Leiden, the Netherlands; [12] Department of Astronomy, Graduate School of Science, The University of Tokyo, 2-21-1, Osawa, Mitaka, Tokyo 181-0015, Japan; [13] University of Science and Technology, 217 Gajeong-ro, Yuseong-gu, Daejeon 34113, Republic of Korea

E-mail contact: shanghuo.li *at* gmail.com

We present a study of outflows at extremely early stages of high-mass star formation obtained from the ALMA Survey of 70 μm dark High-mass clumps in Early Stages (ASHES). Twelve massive 3.6−70 μm dark prestellar clump candidates were observed with the Atacama Large Millimeter/submillimeter Array (ALMA) in Band 6. Forty-three outflows are identified toward 41 out of 301 dense cores using the CO and SiO emission lines, yielding a detection rate of 14%. We discover 6 episodic molecular outflows associated with low- to high-mass cores, indicating that episodic outflows (and therefore episodic accretion) begin at extremely early stages of protostellar evolution for a range of core masses. The time span between consecutive ejection events is much smaller than those found in more evolved stages, which indicates that the ejection episodicity timescale is likely not constant over time. The estimated outflow dynamical timescale appears to increase with core masses, which likely indicates that more massive cores have longer accretion timescales than less massive cores. The lower accretion rates in these 70 μm dark objects compared to the more evolved protostars indicate that the accretion rates increase with time. The total outflow energy rate is smaller than the turbulent energy dissipation rate, which suggests that outflow induced turbulence cannot sustain the internal clump turbulence at the current epoch. We often detect thermal SiO emission within these 70 μm dark clumps that is unrelated to CO outflows. This SiO emission could be produced by collisions, intersection flows, undetected protostars, or other motions.

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The role of collision speed, cloud density, and turbulence in the formation of young massive clusters via cloud-cloud collisions

Kong You Liow[1] and Clare L. Dobbs[1]

[1] School of Physics and Astronomy, University of Exeter, Stocker Road, Exeter EX4 4QL, UK

E-mail contact: kl457 *at* exeter.ac.uk

Young massive clusters (YMCs) are recently formed astronomical objects with unusually high star formation rates. We propose the collision of giant molecular clouds (GMCs) as a likely formation mechanism of YMCs, consistent with the

YMC conveyor-belt formation mode concluded by other authors. We conducted smoothed particle hydrodynamical simulations of cloud-cloud collisions and explored the effect of the clouds collision speed, initial cloud density, and the level of cloud turbulence on the global star formation rate and the properties of the clusters formed from the collision. We show that greater collision speed, greater initial cloud density and lower turbulence increase the overall star formation rate and produce clusters with greater cluster mass. In general, collisions with relative velocity ≥ 25 km/s, initial cloud density ≥ 250 cm^{-3}, and turbulence of ≈ 2.5 km/s can produce massive clusters with properties resembling the observed Milky Way YMCs.

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The SOFIA Massive (SOMA) Star Formation Survey. III. From Intermediate- to High-Mass Protostars

Mengyao Liu[1], Jonathan C. Tan[2,1], James M. De Buizer[3], Yichen Zhang[4], Emily Moser[5], Maria T. Beltrán[6], Jan E. Staff[7], Kei E. I. Tanaka[8], Barbara Whitney[9], Viviana Rosero[10], Yao-Lun Yang[1] and Rubén Fedriani[2]

[1] Dept. of Astronomy, University of Virginia, Charlottesville, Virginia 22904, USA; [2] Dept. of Space, Earth & Environment, Chalmers University of Technology, 412 93 Gothenburg, Sweden; [3] SOFIA-USRA, NASA Ames Research Center, MS 232-12, Moffett Field, CA 94035, USA; [4] Star and Planet Formation Laboratory, RIKEN Cluster for Pioneering Research, Wako, Saitama 351-0198, Japan; [5] Dept. of Astronomy, Cornell University, Ithaca, NY 14853, USA; [6] INAF-Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, I-50125 Firenze, Italy; [7] College of Science and Math, University of Virgin Islands, St. Thomas, United States Virgin Islands 00802; [8] ALMA Project, NAOJ, Mitaka, Tokyo 181-8588, Japan; [9] Dept. of Astronomy, University of Wisconsin-Madison, 475 N. Charter St, Madison, WI 53706, USA; [10] NRAO, 1003 Lópezville Rd., Socorro, NM 87801, USA

E-mail contact: ml7hc *at* virginia.edu

We present $\sim 10-40\,\mu$m *SOFIA*-FORCAST images of 14 intermediate-mass protostar candidates as part of the *SOFIA* Massive (SOMA) Star Formation Survey. We build spectral energy distributions (SEDs), also utilizing archival *Spitzer*, *Herschel* and *IRAS* data. We then fit the SEDs with radiative transfer (RT) models of Zhang & Tan (2018), based on Turbulent Core Accretion theory, to estimate key protostellar properties. With the addition of these intermediate-mass sources, SOMA protostars span luminosities from $\sim 10^2-10^6\,L_\odot$, current protostellar masses from $\sim 0.5-30\,M_\odot$ and ambient clump mass surface densities, $\Sigma_{\rm cl}$ from $0.1-3\,{\rm g\,cm^{-2}}$. A wide range of evolutionary states of the individual protostars and of the protocluster environments are also probed. We have also considered about 50 protostars identified in Infrared Dark Clouds and expected to be at the earliest stages of their evolution. With this global sample, most of the evolutionary stages of high- and intermediate-mass protostars are probed. From the best fitting models, there is no evidence of a threshold value of protocluster clump mass surface density being needed to form protostars up to $\sim 25\,M_\odot$. However, to form more massive protostars, there is tentative evidence that $\Sigma_{\rm cl}$ needs to be $\gtrsim 1\,{\rm g\,cm^{-2}}$. We discuss how this is consistent with expectations from core accretion models that include internal feedback from the forming massive star.

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ALMA observations and modeling of the rotating outflow in Orion Source I

J. A. López-Vázquez[1], Luis A. Zapata[1], Susana Lizano[1] and Jorge Cantó[2]

[1] Instituto de Radioastronomía y Astrofísica, Universidad Nacional Autónoma de México, Apartado Postal 3-72, 58089 Morelia, Michoacán, México; [2] Instituto de Astronomía, Universidad Nacional Autónoma de México, Apartado Postal 70-264, 04510, CDMX, México

E-mail contact: j.lopez *at* irya.unam.mx

We present ^{29}SiO(J=8–7) ν=0, SiS (J=19–18) ν=0, and ^{28}SiO (J=8–7) ν=1 molecular line archive observations made with the Atacama Large Millimeter/Submillimeter Array (ALMA) of the molecular outflow associated with Orion Source I. The observations show velocity asymmetries about the flow axis which are interpreted as outflow rotation.

We find that the rotation velocity (∼4–8 km s^{-1}) decreases with the vertical distance to the disk. In contrast, the cylindrical radius (∼100–300 au), the expansion velocity (∼2–15 km s^{-1}), and the axial velocity v_z (∼-1–10 km s^{-1}) increase with the vertical distance. The mass estimated of the molecular outflow $M_{outflow}$ ∼0.66–1.3 $M_\odot$. Given a kinematic time ∼130 yr, this implies a mass loss rate $\dot{M}_{outflow} \sim 5.1 - 10 \times 10^{-3}$ $M_\odot$ yr^{-1}. This massive outflow sets important contraints on disk wind models. We compare the observations with a model of a shell produced by the interaction between an anisotropic stellar wind and an Ulrich accretion flow that corresponds to a rotating molecular envelope in collapse. We find that the model cylindrical radii are consistent with the ^{29}SiO(J=8–7) ν=0 data. The expansion velocities and the axial velocities of the model are similar the observed values, except close to the disk ($z \sim \pm150$ au) for the expansion velocity. Nevertheless, the rotation velocities of the model are a factor ∼3–10 lower than the observed values. We conclude that the Ulrich flow alone cannot explain the rotation observed and other possibilities should be explored, like the inclusion of the angular momentum of a disk wind.

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Failed and delayed protostellar outflows with high mass accretion rates

Masahiro N. Machida[1] and Takashi Hosokawa[2]

[1] Department of Earth and Planetary Sciences, Faculty of Sciences, Kyushu University, Fukuoka, Fukuoka, Japan; [2] Department of Physics, Graduate School of Science, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan

E-mail contact: machida.masahiro.018 *at* m.kyushu-u.ac.jp

The evolution of protostellar outflows is investigated under different mass accretion rates in the range $\sim 10^{-5}$–$10^{-2}\,M_\odot\,yr^{-1}$ with three-dimensional magnetohydrodynamic simulations. A powerful outflow always appears in strongly magnetized clouds with $B_0 > B_{0,cr} = 10^{-4}(M_{cl}/100\,M_\odot)\,G$, where M_{cl} is the cloud mass. When a cloud has a weaker magnetic field, the outflow does not evolve promptly with a high mass accretion rate. In some cases with moderate magnetic fields B_0 slightly smaller than $B_{0,cr}$, the outflow growth is suppressed or delayed until the infalling envelope dissipates and the ram pressure around the protostellar system is significantly reduced. In such an environment, the outflow begins to grow and reaches a large distance only during the late accretion phase. On the other hand, the protostellar outflow fails to evolve and is finally collapsed by the strong ram pressure when a massive ($> 100 M_\odot$) initial cloud is weakly magnetized with $B_0 < 100\,\mu$G. The failed outflow creates a toroidal structure that is supported by magnetic pressure and encloses the protostar and disk system. Our results indicate that high-mass stars form only in strongly magnetized clouds, if all high-mass protostars possess a clear outflow. If we would observe either very weak or no outflow around evolved protostars, it means that strong magnetic fields are not necessarily required for high-mass star formation. In any case, we can constrain the high-mass star formation process from observations of outflows.

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Exploring the nature of compact radio sources associated to UCHII regions

J.M. Masqué[1], L.F. Rodríguez[2,3], S.A. Dzib[4], S.N. Medina[4], L. Loinard[2], M.A. Trinidad[1], S.E. Kurtz[2] and C. A Rodríguez-Rico[1]

[1] Departamento de Astronomía, Universidad de Guanajuato, Apdo. Postal 144, 36000 Guanajuato, México; [2] Instituto de Radioastronomía y Astrofísica, UNAM, Morelia 58089, México; [3] Mesoamerican Center for Theoretical Physics, Universidad Autónoma de Chiapas, Carretera Emiliano Zapata Km. 4, Real del Bosque (Terán), 29050 Tuxtla Gutiérrez, Chiapas, México; [4] Max Planck Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany

E-mail contact: jmasque *at* astro.ugto.mx

We present Very Large Array 7 mm continuum observations of four Ultra-Compact (UC)HII regions, observed previously at 1.3 cm, in order to investigate the nature of the compact radio sources associated with these regions. We detected a total of seven compact radio sources, four of them with thermal emission, and two compact radio sources have clear non-thermal emission. The thermal emission is consistent with the presence of an ionized envelope, either static (i.e., trapped in the gravitational radius of an associated massive star) or flowing away (i.e., a photo-evaporative flow). On the other hand, the nature of the non-thermal sources remains unclear and several possibilities are pro-

posed. The possibility that most of these compact radio sources are photo-evaporating objects and the remaining ones more-evolved objects is consistent with previous studies on UCHII regions.

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ALMA observations of envelopes around first hydrostatic core candidates

María José Maureira[1,2], Héctor G. Arce[1], Michael M. Dunham[3,4], Diego Mardones[5,2], Andrés E. Guzmán[6], Jaime E. Pineda[2] and Tyler L. Bourke[7,3]

[1] Astronomy Department, Yale University, New Haven, CT 06511, USA; [2] Max-Planck-Institut für extraterrestrische Physik (MPE), Giessenbachstr. 1, D-85741 Garching, Germany; [3] Center for Astrophysics ; [4] Harvard & Smithsonian, Cambridge, MA 02138, USA; [5] Department of Physics, State University of New York Fredonia, Fredonia, New York 14063, USA; [6] Dept. de Astronomía, Universidad de Chile, Casilla 36-D, Santiago, Chile; [7] National Astronomical Observatory of Japan, National Institutes of Natural Sciences, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan

E-mail contact: maureira *at* mpe.mpg.de

We present ALMA 3 mm molecular line and continuum observations with a resolution of 3.5" towards five first hydrostatic core (FHSC) candidates (L1451-mm, Per-bolo 58, Per-bolo 45, L1448-IRS2E and Cha-MMS1). Our goal is to characterize their envelopes and identify the most promising sources that could be bona fide FHSCs. We identify two candidates which are consistent with an extremely young evolutionary state (L1451-mm and Cha-MMS1), with L1451-mm being the most promising FHSC candidate. Although our envelope observations cannot rule out Cha-MMS1 as a FHSC yet, the properties of its CO outflow and SED published in recent studies are in better agreement with the predictions for a young protostar. For the remaining three sources, our observations favor a prestellar nature for Per-bolo 45 and rule out the rest as FHSC candidates. Per-bolo 58 is fully consistent with being a Class 0, while L1448 IRS2E shows no emission of high-density tracers (NH2D and N2H+) at the location of the previously identified compact continuum source, which is also undetected in our observations. Thus we argue that there is no embedded source at the presumptive location of the FHSC candidate L1448 IRS2E. We propose instead, that what was thought to be emission from the presumed L1448 IRS2E outflow corresponds to outflow emission from a nearby Class 0 system, deflected by the dense ambient material. We compare the properties of the FHSC candidates studied in this work and the literature, which shows that L1451-mm appears as possibly the youngest source with a confirmed outflow.

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Carbon depletion observed inside T Tauri inner rims: Formation of icy, kilometer size planetesimals by 1 Myr

M. K. McClure[1]

[1] Marie Curie Postdoctoral Fellow, Anton Pannekoek Institute for Astronomy, Universiteit van Amsterdam, Science Park 904, 1098 XH Amsterdam, Netherlands

E-mail contact: mcclure *at* strw.leidenuniv.nl

Context: The carbon content of protoplanetary disks is an important parameter to characterize planets formed at different disk radii. There is some evidence from far-infrared and submillimeter observations that gas in the outer disk is depleted in carbon, with a cor- responding enhancement of carbon-rich ices at the disk midplane. Observations of the carbon content inside of the inner sublimation rim could confirm how much carbon remains locked in kilometer size bodies in the disk.
Aims: I aim to determine the density, temperature, and carbon abundance inside the disk dust sublimation rim in a set of T Tauri stars with full protoplanetary disks.
Methods: Using medium-resolution, near-infrared (0.8 to 2.5 μm) spectra and the new GAIA DR 2 distances, I self-consistently determine the stellar, extinction, veiling, and accretion properties of the 26 stars in my sample. From these values, and non-accreting T Tauri spectral templates, I extract the inner disk excess of the target stars from their observed spectra . Then I identify a series of C0 recombination lines in 18 of these disks and use the CHIANTI atomic line database with an optically thin slab model to constrain the average ne, Te, and nC for these lines in the five disks with a complete set of lines. By comparing these values with other slab models of the inner disk using the

Cloudy photoionization code, I also constrain nH and the carbon abundance, XC , and hence the amount of carbon 'missing' from the slab. For one disk, DR Tau, I use relative abundances for the accretion stream from the literature to also determine XS i and XN .
Results: The inner disks modeled here are extremely dense ($n_H \sim 10^{16}$ cm^{-3}), warm ($T_e \sim 4500$ K), and moderately ionized ($\log X_e \sim 3.3$). Three of the five modeled disks show robust carbon depletion up to a factor of 42 relative to the solar value. I discuss multiple ways in which the 'missing' carbon could be locked out of the accreting gas. Given the high-density inner disk gas, evidence for radial drift, and lack of obvious gaps in these three systems, their carbon depletion is most consistent with the 'missing' carbon being sequestered in kilometer size bodies. For DR Tau, nitrogen and silicon are also depleted by factors of 45 and 4, respectively, suggesting that the kilometer size bodies into which the grains are locked were formed beyond the N2 snowline. I explore briefly what improvements in the models and observations are needed to better address this topic in the future.

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Measuring the atomic composition of planetary building blocks

Melissa McClure[1], Carsten Dominik[2] and Mihkel Kama[3]

[1] Leiden Observatory, Leiden University, P.O. Box 9513, NL-2300 RA Leiden, The Netherlands; [2] Anton Pannekoek Institute for Astronomy, University of Amsterdam, Science Park 904 1098 XH Amsterdam, Netherlands; [3] Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, UK

E-mail contact: mcclure *at* strw.leidenuniv.nl

Context: Volatile molecules are critical to terrestrial planetary habitability, yet they are difficult to observe directly where planets form at the midplanes of protoplanetary disks. It is unclear whether the inner ?1 AU of disks are volatile-poor or if this region is resupplied with ice-rich dust from colder disk regions. Dust traps at radial pressure maxima bounding disk gaps can cut off the inner disk from these types of volatile reservoirs. However, the trap retention efficiency and atomic composition of trapped dust have not been measured.
Aims: We present a new technique to measure the absolute atomic abundances in the gas accreting onto T Tauri stars and infer the bulk atomic composition and distribution of midplane solids that have been retained in the disk around the young star TW Hya. Methods. We identify near-infrared atomic line emission from gas-phase material inside the dust sublimation rim of TW Hya. Gaus- sian decomposition of the strongest H Paschen lines isolates the inner disk hydrogen emission. We measure several key elemental abundances, relative to hydrogen, using a chemical photoionization model and infer dust retention in the disk. With a 1D transport model, we determine approximate radial locations and retention efficiencies of dust traps for different elements.
Results: Volatile and refractory elements are depleted from TW Hya's hot gas by factors of ?102 and up to 105, respectively. The abundances of the trapped solids are consistent with a combination of primitive Solar System bodies. Dust traps beyond the CO and N2 snowline cumulatively sequester 96% of the total dust flux, while the trap at 2 AU, near the H2 O snowline, retains 3%. The high depletions of Si, Mg, and Ca are explained by a third trap at 0.3 AU with >95% dust retention.
Conclusion: TW Hya sports a significant volatile reservoir rich in C- and N-ices in its outer submillimeter ring structure. However, unless the inner disk was enhanced in C by earlier radial transport, typical C destruction mechanisms and the lack of a C resupply should leave the terrestrial planet-forming region of TW Hya 'dry' and carbon-poor. Any planets that form within the silicate dust trap at 0.3 AU could resemble Earth in terms of the degree of their volatile depletion.

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Dust trapping around Lagrangian points in protoplanetary disks

Matías Montesinos[1,2,3], Juan Garrido-Deutelmoser[4,3], Johan Olofsson[1,3], Cristian A. Giuppone[5], Jorge Cuadra[6,3], Amelia Bayo[1,3], Mario Sucerquia[1,3] and Nicolás Cuello[7]

[1] Instituto de Física y Astronomía, Universidad de Valparaíso, Chile; [2] Chinese Academy of Sciences South America Center for Astronomy, National Astronomical Observatories, CAS, Beijing 100012, China; [3] Núcleo Milenio de For-

mación Planetaria (NPF), Chile; [4] Instituto de Astrofísica, Pontificia Universidad Católica de Chile, Santiago, Chile; [5] Universidad Nacional de Córdoba, Observatorio Astronómico - IATE. Laprida 854, 5000 Córdoba, Argentina; [6] Departamento de Ciencias, Facultad de Artes Liberales, Universidad Adolfo Ibáñez, Av. Padre Hurtado 750, Viña del Mar, Chile; [7] Univ. Grenoble Alpes, CNRS, IPAG, F-38000 Grenoble, France

E-mail contact: matias.montesinos *at* uv.cl

Trojans are defined as objects that share the orbit of a planet at the stable Lagrangian points L_4 and L_5. In the Solar System, these bodies show a broad size distribution ranging from micrometer(μm) to centimeter(cm) particles (Trojan dust) and up to kilometer (km) rocks (Trojan asteroids). It has also been theorized that earth-like Trojans may be formed in extra-solar systems. The Trojan formation mechanism is still under debate, especially theories involving the effects of dissipative forces from a viscous gaseous environment. We perform hydro-simulations to follow the evolution of a protoplanetary disk with an embedded 1–10 Jupiter-mass planet. On top of the gaseous disk, we set a distribution of μm–cm dust particles interacting with the gas. This allows us to follow dust dynamics as solids get trapped around the Lagrangian points of the planet. We show that large vortices generated at the Lagrangian points are responsible for dust accumulation, where the leading Lagrangian point L_4 traps a larger amount of submillimeter (submm) particles than the trailing L_5, which traps mostly mm–cm particles. However, the total bulk mass, with typical values of $\sim M_{\rm moon}$, is more significant in L_5 than in L_4, in contrast to what is observed in the current Solar System a few gigayears later. Furthermore, the migration of the planet does not seem to affect the reported asymmetry between L_4 and L_5. The main initial mass reservoir for Trojan dust lies in the same co-orbital path of the planet, while dust migrating from the outer region (due to drag) contributes very little to its final mass, imposing strong mass constraints for the in situ formation scenario of Trojan planets.

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ALMA Observations of Giant Molecular Clouds in M33. II. Triggered High-mass Star Formation by Multiple Gas Colliding Events at the NGC 604 Complex

Kazuyuki Muraoka[1], Hiroshi Kondo[1], Kazuki Tokuda[1,2], Atsushi Nishimura[1], Rie E. Miura[2], Sachiko Onodera[3], Nario Kuno[4,5], Sarolta Zahorecz[1,2], Kisetsu Tsuge[6], Hidetoshi Sano[2], Shinji Fujita[1], Toshikazu Onishi[1], Kazuya Saigo[2], Kengo Tachihara[6], Yasuo Fukui[6,7] and Akiko Kawamura[2]

[1] Department of Physical Science, Graduate School of Science, Osaka Prefecture University, 1-1 Gakuen-cho, Naka-ku, Sakai, Osaka 599-8531, Japan; [2] National Astronomical Observatory of Japan, National Institutes of Natural Science, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan; [3] Meisei University, 2-1-1 Hodokubo, Hino, Tokyo 191-0042, Japan; [4] Department of Physics, Graduate School of Pure and Applied Sciences, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8577, Japan; [5] Tomonaga Center for the History of the Universe, University of Tsukuba, Tsukuba, Ibaraki 305-8571, Japan; [6] Department of Physics, Nagoya University, Chikusa-ku, Nagoya 464-8602, Japan; [7] Institute for Advanced Research, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8601, Japan

E-mail contact: kmuraoka *at* p.s.osakafu-u.ac.jp

We present the results of ALMA observations in ^{12}CO($J = 2-1$), ^{13}CO($J = 2-1$), and C^{18}O($J = 2-1$) lines and 1.3 mm continuum emission toward a massive ($\sim 10^6\,M_\odot$) giant molecular cloud associated with the giant H II region NGC 604 in one of the nearest spiral galaxy M33 at an angular resolution of 0".44 × 0".27 (1.8 pc × 1.1 pc). The ^{12}CO and ^{13}CO images show highly complicated molecular structures composed of a lot of filaments and shells whose lengths are $5-20$ pc. We found three 1.3 mm continuum sources as dense clumps at edges of two shells and also at an intersection of several filaments. We examined the velocity structures of ^{12}CO($J = 2-1$) emission in the shells and filaments containing dense clumps, and concluded that expansion of the H II regions cannot explain the formation of such dense cores. Alternatively, we suggest that cloud–cloud collisions induced by an external H I gas flow and the galactic rotation compressed the molecular material into dense filaments/shells as ongoing high-mass star formation sites. We propose that multiple gas converging/colliding events with a velocity of a few tens km s^{-1} are necessary to build up NGC 604, the most significant cluster-forming complex in the Local Group of galaxies.

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The dipper light curve of V715 Per: is there dust in the magnetosphere?

Erick Nagel[1] **and Jerome Bouvier**[2]

[1] Departamento de Astronomía, Universidad de Guanajuato, Callejón de Jalisco S/N,Guanajuato,Gto,36240,México;
[2] IPAG, Université Grenoble Alpes 38000 Grenoble, France

E-mail contact: e.nagel *at* ugto.mx

The dipper optical light curves in young stellar objects are commonly interpreted as partial or total occultation of the stellar radiation by dust surrounding the star.

In this work, we analyze the amplitude of the optical light curve of V715 Per, located in the young star forming region IC 348. Observations gathered over the years suggest that the light curve can be explained by dust extinction events.

In our model, the dust is distributed inside the magnetosphere according to the strength of the stellar magnetic field. The dust distribution is modulated by the vertical component of the field, whose axis is misaligned with respect to the rotational axis. We include a model for the evaporation of the dust reaching the magnetosphere in order to consistently calculate its distribution.

For V715 Per, there is dust in the optically thick warp at the disk truncation radius. We suggest that the optical light curve is explained by extinction caused by dust reaching inside the magnetosphere. The dust distribution is optically thin and due to the high temperature and low density, it cannot survive for a long time. However because the grains rapidly move towards the stellar surface and the sublimation is not instantaneous, there is a layer of dust covering the magnetosphere responsible for the extinction.

Dust surviving the harsh conditions of the magnetospheric accretion flow may be responsible for some of the dipper light curves.

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A new parameterization of the star formation rate-dense gas mass relation: embracing gas density gradients

G. Parmentier[1] **and A. Pasquali**[1]

[1] Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg, Mönchhofstr. 12-14, D-69120 Heidelberg, Germany

E-mail contact: gparm *at* ari.uni-heidelberg.de

It is well-established that a gas density gradient inside molecular clouds and clumps raises their star formation rate compared to what they would experience from a gas reservoir of uniform density. This effect should be observed in the relation between dense-gas mass M_{dg} and star formation rate SFR of molecular clouds and clumps, with steeper gas density gradients yielding higher SFR/M_{dg} ratios. The content of this paper is two-fold. Firstly, we build on the notion of magnification factor introduced by Parmentier (2019) to redefine the dense-gas relation (i.e. the relation between M_{dg} and SFR). Not only does the SFR/M_{dg} ratio depend on the mean free-fall time of the gas and on its (intrinsic) star formation efficiency per free-fall time, it also depends on the logarithmic slope $-p$ of the gas density profile and on the relative extent of the constant-density region at the clump center. Secondly, we show that nearby molecular clouds follow the newly-defined dense-gas relation, provided that their dense-gas mass is defined based on a volume density criterion. We also find the same trend for the dense molecular clouds of the Central Molecular Zone (CMZ) of the Galaxy, although this one is scaled down by a factor of 10 compared to nearby clouds. The respective locii of both nearby and CMZ clouds in the $(p, SFR/M_{dg})$ parameter space is discussed.

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The brown dwarf population in the star forming region NGC2264

Samuel Pearson[1], Aleks Scholz[1], Paula S Teixeira[1], Koraljka Muzic[2] and Jochen Eisloffel[3]

[1] SUPA, School of Physics & Astronomy, University of St Andrews, North Haugh, St Andrews, KY16 9SS, United Kingdom; [2] CENTRA, Faculdade de Ciencias, Universidade de Lisboa, Ed. C8, Campo Grande, 1749-016 Lisboa, Portugal; [3] Thuüringer Landessternwarte, Sternwarte 5, D-07778 Tautenburg, Germany

E-mail contact: sp246 *at* st-andrews.ac.uk

The brown dwarf population in the canonical star forming region NGC2264 is so far poorly explored. We present a deep, multi-wavelength, multi-epoch survey of the star forming cluster NGC2264, aimed to identify young brown dwarf candidates in this region. Using criteria including optical/near-infrared colours, variability, *Spitzer* mid-infrared colour excess, extinction, and *Gaia* parallax and proper motion (in order of relevance), we select 902 faint red sources with indicators of youth. Within this sample we identify 429 brown dwarf candidates based on their infrared colours. The brown dwarf candidates are estimated to span a mass range from 0.01 to 0.08 $M_{\odot}$. We find rotation periods for 44 sources, 15 of which are brown dwarf candidates, ranging from 3.6 hours to 6.5 days. A subset of 38 brown dwarf candidates show high level irregular variability indicative of ongoing disc accretion, similar to the behaviour of young stars.

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From the CMF to the IMF: Beyond the Core-Collapse Model

V.-M. Pelkonen[1], P. Padoan[1,2], T. Haugbolle[3], A. Nordlund[1]

[1] Institut de Ciències del Cosmos, Universitat de Barcelona, Spain; [2] ICREA, Spain; [3] Niels Bohr Institute, University of Copenhagen;

E-mail contact: s.pfalzner *at* fz-juelich.de

Observations have indicated that the prestellar core mass function (CMF) is similar to the stellar initial mass function (IMF), except for an offset towards larger masses. This has led to the idea that there is a one-to-one relation between cores and stars, such that the whole stellar mass reservoir is contained in a gravitationally-bound prestellar core, as postulated by the core-collapse model, and assumed in recent theoretical models of the stellar IMF. We test the validity of this assumption by comparing the final mass of stars with the mass of their progenitor cores in a high-resolution star-formation simulation that generates a realistic IMF under physical conditions characteristic of observed molecular clouds. Using a definition of bound cores similar to previous works we obtain a CMF that converges with increasing numerical resolution. We find that the CMF and the IMF are closely related in a statistical sense only; for any individual star there is only a weak correlation between the progenitor core mass and the final stellar mass. In particular, for high mass stars only a small fraction of the final stellar mass comes from the progenitor core, and even for low mass stars the fraction is highly variable, with a median fraction of only about 50%. We conclude that the core-collapse scenario and related models for the origin of the IMF are incomplete.

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Oumuamuas passing through molecular clouds

Susanne Pfalzner[1,2], Melvyn B. Davies[3], Giorgi Kokaia[3] and Michele Bannister[4]

[1] Jülich Supercomputing Center, Forschungszentrum Jülich, 52428 Jülich, Germany; [2] Max Planck Institute for Radio Astronomy, Auf dem Hügel 69, 53121 Bonn, Germany; [3] Lund Observatory, Department of Astronomy and Theoretical Physics, Box 43, SE-221 00 Lund, Sweden; [4] School of Physical and Chemical Sciences — Te Kura Matū, University of Canterbury, Private Bag 4800, Christchurch 8140, New Zealand

E-mail contact: s.pfalzner *at* fz-juelich.de

The detections of 1I/Oumuamua and 2I/Borisov within just two years demonstrate impressively that interstellar objects (ISOs) must be common in the Milky Way. Once released from their parent system, these ISOs travel for Gyr through interstellar space. While often imagined as empty, interstellar space contains gas and dust most prominent in the form of molecular clouds. Performing numerical simulations, we test how often ISOs cross such molecular clouds. We find that the ISOs pass amazingly often through molecular clouds. In the solar neighbourhood, ISOs typically spend 0.1-0.2% of their journey inside molecular clouds, for relative slow ISOs (< 5 km/s) this can increase to 1-2%, equivalent to 10 - 20 Myr per Gyr. Thus the dynamically youngest ISOs spend the longest time in molecular clouds. In other words, molecular clouds must mainly contain relatively young ISOs (< 1-2 Gyr). Thus the half-life of the seeding process by ISOs is substantially shorter than a stellar lifetime. The actual amount of time spent in MCs decreases with distance to the Galactic Centre. We find that ISOs pass so often through MCs that backtracing their path to find their parent star beyond 250 Myr seems beyond the point. Besides, we give a first estimate of the ISO density depending on the galactic centre distance based on the stellar distribution.

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Magnetized filamentary gas flows feeding the young embedded cluster in Serpens South

Thushara G.S. Pillai[1,2], Dan P. Clemens[1], Stefan Reissl[3], Philip C. Myers[4], Jens Kauffmann[5], Enrique Lopez-Rodriguez[6], Felipe O. Alves[7], Gabriel A.P. Franco[8], Jonathan Henshaw[9], Karl M. Merten[2], Fumitaka Nakamura[10], Daniel Seifried[11], Koji Sugitani[12] and Helmut Wiesemeyer[2]

[1] Institute for Astrophysical Research, Boston University, 725 Commonwealth Avenue, Boston MA, 02215, USA; [2] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany; [3] Universität Heidelberg, Zentrum für Astronomie, Institut für Theoretische Astrophysik, Albert-Ueberle-Str. 2, 69120 Heidelberg, Germany; [4] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138 USA; [5] Haystack Observatory, Massachusetts Institute of Technology, Westford, MA 01886, USA; [6] SOFIA Science Center, NASA Ames Research Center, Moffett Field, CA 94035, USA; [7] Max-Planck-Institut für extraterrestrische Physik, Giessenbachstr. 1, 85748 Garching, Germany; [8] Departamento de Física - ICEx - UFMG, Caixa Postal 702, 30.123-970 Belo Horizonte, Brazil; [9] Max-Planck-Institute for Astronomy, Koenigstuhl 17, 69117 Heidelberg, Germany; [10] National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan; [11] Universität zu Köln, I. Physikalisches Institut, Zülpicher Str. 77, 50937 Köln, Germany; [12] Graduate School of Natural Sciences, Nagoya City University, Mizuho-ku, Nagoya, Aichi 467-8501, Japan

E-mail contact: tpillai.astro *at* gmail.com

Observations indicate that molecular clouds are strongly magnetized, and that magnetic fields influence the formation of stars. A key observation supporting the conclusion that molecular clouds are significantly magnetized is that the orientation of their internal structure is closely related to that of the magnetic field. At low column densities the structure aligns parallel with the field, whereas at higher column densities, the gas structure is typically oriented perpendicular to magnetic fields, with a transition at visual extinctions $A_V \geq 3$ mag. Here we use far-infrared polarimetric observations from the HAWC+ polarimeter on SOFIA to report the discovery of a further transition in relative orientation, i.e., a return to parallel alignment at $A_V \geq 21$ mag in parts of the Serpens South cloud. This transition appears to be caused by gas flow and indicates that magnetic supercriticality sets in near $A_V \geq 21$ mag, allowing gravitational collapse and star cluster formation to occur even in the presence of relatively strong magnetic fields.

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A "head/tail" plasmon model with a Hubble law velocity profile

A. C. Raga[1], A. Rodriguez-Gonzalez[1], L. Hernandez-Ramirez[1], J. Canto[2] and A. Castellanos-Ramirez[2]

[1] ICN, UNAM, Mexico; [2] IA, UNAM, Mexico

E-mail contact: raga *at* nucleares.unam.mx

We present a model of a hypersonic, collimated, "single pulse" outflow, produced by an event with an ejection velocity that first grows, reaches a peak, and then decreases again to zero velocity in a finite time (simultaneously, the ejection

density can have an arbitrary time-variability). We obtain a flow with a leading "head" and a trailing "tail' that for times greater than the width of the pulse develops a linear, "Hubble law" velocity vs. position. We present an analytic model for a simple pulse with a parabolic ejection velocity vs. time and time-independent mass-loss rate, and compare it to an axisymmetric gasdynamic simulation with parameters appropriate for fast knots in planetary nebulae. This "head/tail plasmon" flow might be applicable to other high-velocity clumps with "Hubble law" tails.

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https://bigbang.nucleares.unam.mx/astroplasmas/

First sample of N_2H^+ nitrogen isotopic ratio measurements in low-mass protostars

Elena Redaelli[1], Luca Bizzocchi[1] and Paola Caselli[1]

[1] Max Planck for Extraterrestrial Physics, Giessenbachstrasse 1, D-85749 Garching bei Muenchen, Germany

E-mail contact: eredaelli *at* mpe.mpg.de

Context. The nitrogen isotopic ratio is considered an important diagnostic tool of the star formation process, and N_2H^+ is particularly important because it is directly linked to molecular nitrogen N_2. However, theoretical models still lack to provide an exhaustive explanation for the observed $^{14}N/^{15}N$ values.
Aims. Recent theoretical works suggest that the $^{14}N/^{15}N$ behaviour is dominated by two competing reactions that destroy N_2H^+: dissociative recombination and reaction with CO. When CO is depleted from the gas phase, if N_2H^+ recombination rate is lower with respect to the $N^{15}NH^+$ one, the rarer isotopologue is destroyed faster. In prestellar cores, due to a combination of low temperatures and high densities, most CO is frozen in ices onto the dust grains, leading to high levels of depletion. On the contrary, in protostellar cores, where temperature are higher, CO ices evaporate back to the gas phase. This implies that the N_2H^+ isotopic ratio in protostellar cores should be lower than the one in prestellar cores, and consistent with the elemental value of ≈ 440. We aim to test this hypothesis, producing the first sample of $N_2H^+/N^{15}NH^+$ measurements in low mass protostars.
Methods. We observe the N_2H^+ and $N^{15}NH^+$ lowest rotational transition towards six young stellar objects in Perseus and Taurus molecular clouds. We model the spectra with a custom `python` code using a constant $T_{\rm ex}$ approach to fit the observations. We discuss in appendix the validity of this hypothesis. The derived column densities are used to compute the nitrogen isotopic ratios.
Results. Our analysis yields an average of $^{14}N/^{15}N|_{\rm pro} = 420 \pm 15$ in the protostellar sample. This is consistent with the protosolar value of 440, and significantly lower than the average value previously obtained in a sample of prestellar objects.
Conclusions. Our results are in agreement with the hypothesis that, when CO is depleted from the gas-phase, dissociative recombinations with free electrons destroy $N^{15}NH^+$ faster than N_2H^+, leading to high isotopic ratios in prestellar cores, where carbon monoxide is frozen onto dust grains.

Accepted by A&A

NGC 7538 IRS1 - An O Star Driving an Ionized Jet and Giant N-S Outflow

G. Sandell[1], M. Wright[2], R. Güsten[3], H. Wiesemeyer[3], N. Reyes[3], B. Mookerjea[4] and S. Corder[5]

[1] Institute for Astronomy, University of Hawaii, Hilo, HI 96720, USA; [2] Radio Astronomy Laboratory, University of California, Berkeley, CA 94720, USA; [3] Max Planck Institut für Radioastronomie, Auf dem Hg̈el 69, 53121 Bonn, Germany; [4] Tata Institute of Fundamental Research, Homi Bhabha Road, Mumbai 400005, India; [5] ALMA, Av Apoquindo 3946 Piso 19, Las Condes, Santiago, Chile

E-mail contact: gsandell *at* hawaii.edu

NGC 7538 IRS 1 is a very young embedded O star driving an ionized jet and accreting mass with an accretion rate $>10^{-4}$ $M_\odot$/year, which is quenching the hypercompact HII region. We use SOFIA GREAT data, Herschel PACS and SPIRE archive data, SOFIA FORCAST archive data, Onsala 20m and CARMA data, and JCMT archive data to determine the properties of the O star and its outflow. IRS 1 appears to be a single O-star with a bolometric luminosity $> 1 \times 10^5$ $l_\odot$, i.e. spectral type O7 or earlier. We find that IRS 1 drives a large molecular outflow with the blue-shifted northern outflow lobe extending to ∼ 280 arcsec or 3.6 pc from IRS 1. Near IRS 1 the outflow is well aligned with the ionized jet. The dynamical time scale of the outflow is $\sim 1.3 \times 10^5$ yr. The total outflow mass

is ~ 130 $M_\odot$. We determine a mass outflow rate of 1.0 $\times 10^{-3}$ $M_\odot yr^{-1}$, roughly consistent with the observed mass accretion rate. We observe strong high velocity [C II] emission in the outflow, confirming that strong UV radiation from IRS 1 escapes into the outflow lobes and is ionizing the gas. Many O stars may form like low mass stars, but with a higher accretion rate and in a denser environment. As long as the accretion stays high enough to quench the HII region, the star will continue to grow. When the accretion rate drops, the HII region will rapidly start to expand.

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FEEDBACK: a SOFIA Legacy Program to Study Stellar Feedback in Regions of Massive Star Formation

N. Schneider[1], R. Simon[1], C. Guevara[1], C. Buchbender[1], R.D. Higgins[1], Y. Okada[1], J. Stutzki[1], R. Guesten[2], L.D. Anderson[3], J. Bally[4], H. Beuther[5], L. Bonne[6], S. Bontemps[6], E. Chambers[7], T. Csengeri[6], U.U. Graf[1], A. Gusdorf[8], K. Jacobs[1], M. Justen[1], S. Kabanovic[1], R. Karim[9], M. Luisi[3], K. Menten[2], M. Mertens[1], B. Mookerjea[10], V. Ossenkopf-Okada[1], C. Pabst[11], M.W. Pound[9], H. Richter[12], N. Reyes[2], O. Ricken[2], M. Roellig[1], D. Russeil[13], A. Sanchez-Monge[1], G. Sandell[14], M. Tiwari[9], H. Wiesemeyer[2], M. Wolfire[9], F. Wyrowski[2], A. Zavagno[13] and A.G.G.M. Tielens[9,11]

[1] I. Physik. Institut, University of Cologne, Germany; [2] MPIfR Bonn, Germany; [3] Dep. of Physics and Astronomy, West Virginia University, USA; [4] Center for Astrophysics and Space Astronomy, University of Colorado, USA; [5] MPA, Heidelberg, Germany; [6] LAB, University of Bordeaux, France; [7] USRA/SOFIA, NASA Ames Research Center, USA; [8] LPENS, Sorbonne Universite, Paris, France; [9] Department of Astronomy, University of Maryland, USA; [10] Tata Institute of Fundamental Research, Mumbai, India; [11] Leiden Observatory, Leiden University, The Netherlands; [12] DLR, Berlin, Germany; [13] Aix Marseille Universite, LAM, Marseille, France; [14] Institute for Astronomy, University of Hawaii, USA

E-mail contact: nschneid *at* ph1.uni-koeln.de

FEEDBACK is a SOFIA (Stratospheric Observatory for Infrared Astronomy) legacy program dedicated to study the interaction of massive stars with their environment. It performs a survey of 11 galactic high mass star forming regions in the 158 μm (1.9 THz) line of [C II] and the 63 μm (4.7 THz) line of [O I]. We employ the 14 pixel Low frequency Array (LFA) and 7 pixel High Frequency Array (HFA) upGREAT heterodyne instrument to spectrally resolve (0.24 MHz) these far-infrared fine structure lines. With a total observing time of 96h, we will cover ~6700 arcmin^2 at 14.1$''$ angular resolution for the [C II] line and 6.3$''$ for the [O I] line. The observations started in spring 2019 (Cycle 7). Our aim is to understand the dynamics in regions dominated by different feedback processes from massive stars such as stellar winds, thermal expansion, and radiation pressure, and to quantify the mechanical energy injection and radiative heating efficiency. This is an important science topic because feedback of massive stars on their environment regulates the physical conditions and sets the emission characteristics in the interstellar medium (ISM), influences the star formation activity through molecular cloud dissolution and compression processes, and drives the evolution of the ISM in galaxies. The [C II] line provides the kinematics of the gas and is one of the dominant cooling lines of gas for low to moderate densities and UV fields. The [O I] line traces warm and high-density gas, excited in photodissociations regions with a strong UV field or by shocks. The source sample spans a broad range in stellar characteristics from single OB stars, to small groups of O stars, to rich young stellar clusters, to ministarburst complexes. It contains well-known targets such as Aquila, the Cygnus X region, M16, M17, NGC7538, NGC6334, Vela, and W43 as well as a selection of H II region bubbles, namely RCW49, RCW79, and RCW120. These [C II] maps, together with the less explored [O I] 63 μm line, provide an outstanding database for the community. They will be made publically available and will trigger further studies and follow-up observations.

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https://iopscience.iop.org/journal/1538-3873
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Constraining the Chemical Signatures and the Outburst Mechanism of the Class 0 Protostar HOPS 383

Rajeeb Sharma[1], John J. Tobin[2], Patrick D. Sheehan[2], S. Thomas Megeath[3], William J. Fischer[4], Jes K. Jørgensen[5], Emily J. Safron[6] and ZSofia Nagy[7]

[1] Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, 440 W. Brooks Street, Norman, OK, 73019, USA; [2] National Radio Astronomy Observatory, Charlottesville, VA, 22901, USA; [3] Ritter Astrophysical Observatory, Department of Physics and Astronomy, University of Toledo, Toledo, OH, USA; [4] Space Telescope Science Institute, Baltimore, MD, USA; [5] Niels Bohr Institute, University of Copenhagen, Øster Voldgade 5-7, DK-1350, Copenhagen K, Denmark; [6] Department of Physics and Astronomy, Louisiana State University, Baton Rouge, LA, USA; [7] Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, H-1121 Budapest, Konkoly Thege út 15–17, Hungary

E-mail contact: rajeeb.sharma-1 *at* ou.edu

We present observations toward HOPS 383, the first known outbursting Class 0 protostar located within the Orion molecular cloud using ALMA, VLA, and SMA. The SMA observations reveal envelope scale continuum and molecular line emission surrounding HOPS 383 at 0.85 mm, 1.1 mm, and 1.3 mm.The images show that HCO^+ and $H^{13}CO^+$ peaks on or near the continuum, while N_2H^+ is reduced at the same position. This reflects the underlying chemistry where CO evaporating close to the protostar destroys N_2H^+ while forming HCO^+. We also observe the molecular outflow traced by ^{12}CO ($J = 2 \rightarrow 1$) and ($J = 3 \rightarrow 2$). A disk is resolved in the ALMA 0.87 mm dust continuum, orthogonal to the outflow direction, with an apparent radius of ∼62 AU. Radiative transfer modeling of the continuum gives disk masses of 0.02 $M_\odot$ when fit to the ALMA visibilities. The models including VLA 8 mm data indicate that the disk mass could be up to a factor of 10 larger due to lower dust opacity at longer wavelengths. The disk temperature and surface density profiles from the modeling, and an assumed protostar mass of 0.5 $M_\odot$ suggest that the Toomre Q parameter < 1 before the outburst, making gravitational instability a viable mechanism to explain outbursts at an early age if the disk is sufficiently massive.

Accepted by ApJ

https://arxiv.org/pdf/2010.05939.pdf

Investigating episodic accretion in a very low-mass young stellar object

Camille Stock[1,2], Alessio Caratti o Garatti[1,3], Pauline McGinnis[1], Rebeca Garcia Lopez[1,3], Simone Antoniucci[4], Ruben Fedriani[5] and Tom P. Ray[1,2]

[1] Dublin Institute for Advanced Studies (DIAS), School of Cosmic Physics, Astronomy and Astrophysics Section, 31 Fitzwilliam Place, Dublin 2, Ireland; [2] School of Physics, Trinity College Dublin, College Green, Dublin 2, Ireland; [3] School of Physics, University College Dublin, Belfield, Dublin 4, Ireland; [4] INAF, Osservatorio Astronomico di Roma, via di Frascati 33, 00040 Monte Porzio Catone, Italy; [5] Department of Space, Earth & Environment, Chalmers University of Technology, 412 93 Gothenburg, Sweden

E-mail contact: cstock *at* cp.dias.ie

Very low-mass Class I protostars have been investigated very little thus far. Variability of these young stellar objects (YSOs) and whether or not they are capable of strong episodic accretion is also left relatively unstudied. We investigate accretion variability in IRS 54 (YLW52), a Class I very low-mass protostar with a mass of $M_\star \sim 0.1 - 0.2\,M_\odot$. We obtained spectroscopic and photometric data with VLT/ISAAC and VLT/SINFONI in the near-infrared (J, H, and K bands) across four epochs (2005, 2010, 2013, and 2014). We used accretion-tracing lines (Paβ and Brγ) and outflow-tracing lines (H_2 and [FeII]) to examine physical properties and kinematics of the object. A large increase in luminosity was found between the 2005 and 2013 epochs of more than 1 magnitude in the K band, followed in 2014 by a steep decrease. Consistently, the mass accretion rate ($\dot{M}_{acc}$) rose by an order of magnitude from $\sim 10^{-8}$ $M_\odot\,yr^{-1}$ to $\sim 10^{-7}\,M_\odot\,yr^{-1}$ between the two early epochs. The visual extinction (A_V) has also increased from ~ 15 mag in 2005 to ~ 24 mag in 2013. This rise in A_V in tandem with the increase in $\dot{M}_{acc}$ is explained by the lifting up of a large amount of dust from the disc of IRS 54, following the augmented accretion and ejection activity in the YSO, which intersects our line of sight due to the almost edge-on geometry of the disc. Because of the strength and timescales involved in this dramatic increase, this event is believed to have been an accretion burst possibly similar to bursts of EXor-type objects. IRS 54 is the lowest mass Class I source observed to have an accretion burst of this type, and

therefore potentially one of the lowest mass EXor-type objects known so far.

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https://arxiv.org/pdf/2009.12281

Planet migration, resonant locking and accretion streams in PDS70: Comparing models and data

Claudia Toci[1,2], Giuseppe Lodato[1], Valentin Christiaens[3], Davide Fedele[4], Christophe Pinte[3], Daniel J. Price[3] and Leonardo Testi[5]

[1] Dipartimento di Fisica, Universitá degli Studi di Milano, Via Celoria 16, 20133 Milano MI, Italy; [2] INAF OA Brera, via Brera 28, 20121, Milano MI, Italy; [3] School of Physics and Astronomy, Monash University, VIC 3800, Australia; [4] INAF OA Arcetri, Largo Enrico Fermi 5, 50125 Firenze FI; [5] European Southern Observatory, Karl-Schwarzschild-Strasse 2, 85748 Garching bei Munchen, Germany

E-mail contact: claudia.toci *at* inaf.it

The disc surrounding PDS 70, with two directly imaged embedded giant planets, is an ideal laboratory to study planet-disc interaction. We present three-dimensional smoothed particle hydrodynamics simulations of the system. In our simulations, planets, which are free to migrate and accrete mass, end up in a locked resonant configuration that is dynamically stable. We show that features observed at infrared (scattered light) and millimetre (thermal continuum) wavelengths are naturally explained by the accretion stream onto the outer planet, without requiring a circumplanetary disc around planet c. We post-processed our near-infrared synthetic images in order to account for observational biases known to affect high-contrast images. Our successful reproduction of the observations indicates that planet-disc dynamical interactions alone are sufficient to explain the observations of PDS 70.

Accepted by MNRAS

https://arxiv.org/pdf/2009.11893

2x ALMA related PhD positions in Vienna (EMERGE ERC-StG)

The Department of Astrophysics at the University of Vienna is offering 2xPhD positions at the Interstellar Medium Astrophysics group of Dr. Alvaro Hacar. We seek an outstanding candidates to work on high-mass star formation studies using ALMA interferometric observations as part of the new EMERGE ERC-StG project ().

PhD#1 - ALMA observations of complex fiber networks (ERC funds)

High-mass stars drive the physical and chemical evolution of the Universe. However, the connection of these massive objects with the initial properties of their gas embryos remains largely controversial.

Large-scale molecular surveys have demonstrated the existence of a new and fundamental filamentary gas unit, the so-called fibers. Fibers play a pivotal role in the star-formation process. Fibers are the first objects decoupled from the turbulent cascade and the first gas structures dominated by gravity inside clouds. Fibers also fragment and form most of the stars in the solar neighbourhood. Recent Atacama Large Millimeter Array (ALMA) observations have identified complex fiber networks as the birthplace of high-mass stars in regions such as Orion. The discovery of these fiber systems opens a new route to investigate the origin of some of the most massive stars and clusters in our Galaxy.

As part of the new EMERGE ERC-StG project this PhD work will explore a novel large-scale ALMA survey of massive fiber networks extracted from its public archive. By developing a new set of state-of-the-art analysis techniques, this PhD research will characterise the statistical properties of these new fiber systems (mass, internal kinematics, spatial distribution) across the Milky Way. In its main scientific goal, this project aims to investigate how multi-scale phenomena in complex fiber networks such as collisions, mergers, and self-gravity determine the initial conditions for the formation of high-mass stars.

PhD#2 - A dynamical origin of the IMF (potentially funded via VISESS fellowship)

Most of the stars in the Universe are formed following a precise mass distribution known as the Initial Mass Function (IMF). Still, the origin of this stellar mass distribution is one of the major open questions in astrophysics.

Different surveys in nearby clouds suggest that the IMF may be originated from a pre-existing distribution of dense gas clumps, namely, the Core Mass Function (CMF). The connection between the IMF and CMF implies a direct and uniform conversion between the initial (cores) and final (stars) gas masses with constant efficiency. This static description also assumes the cores as single objects isolated from their environment. On the contrary, recent observations demonstrate that most dense cores are originated inside filaments. The fragmentation process of these filaments connects the cores with their environments and provides with a more dynamical environment than previously thought.

For the first time, this PhD project aims to connect the physical evolution of the gas during the entire formation process of cores and stars in different mass regimes. Using ALMA observations of large core populations in clouds such as Orion, this project will statistically characterise the gas fragmentation, accretion, and collapse processes at scales of $> 10^5$ AU (filaments), $\sim 10^4$ (cores) and 100 AU (disks + stars). This project aims to provide a first dynamical description of the conversion of gas (CMF) and stars (IMF). This PhD project will be carried out in collaboration with the EMERGE ERC-StG team.

Both PhDs will join the new **Vienna International School of Earth and Space Sciences (VISESS)**
website: https://visess.univie.ac.at/
More info + application form: https://jobregister.aas.org/ad/2bb56b58
Application deadline: November 15, 2020
Questions? email: alvaro.hacar@univie.ac.at

Star Formation in the Local Galaxy with Gaia and VISIONS 2 PhD positions in Vienna

The Department of Astrophysics of the University of Vienna is offering 2 PhD positions in Star Formation in the Local Galaxy with ESA Gaia and VISIONS (http://visions.univie.ac.at) an ESO Large Public Survey led by the group of Prof. João Alves. When completed, in 2021, VISIONS will be the most sensitive and complete NIR survey of local star formation and will feed the next generation of telescopes (e.g., ELT) with new targets for star and planet formation studies. Together with Gaia, VISIONS will reveal the 3D dynamics of the nearby stellar nurseries, as well as of the clouds spawning them, allowing the community to explore resolved star formation in a robust, large, and contextual manner, from cloud formation to the build-up of the Milky Way field population. The goal of these PhD projects is centered on a fundamental ISM measurement, yet to be made, namely its 3D motion.

The two PhD projects offered are:
PhD 1: The 3D space motion of the local Interstellar Medium (4 years, fully funded)
PhD 2: The origin and evolution of the Radcliffe Wave (4 years, fully funded)

Both PhDs will join the new Vienna International School of Earth and Space Sciences (VISESS)
website: https://visess.univie.ac.at/
More info + application form: https://jobregister.aas.org/ad/2bb56b58
Application deadline: November 15, 2020
Questions? email: joao.alves@univie.ac.at

ECOGAL hires a postdoctoral associate to decipher magnetic fields in star-forming cores

The ERC synergy project 'ECOGAL: Understanding our Galactic ecosystem - From the disk of the Milky Way to the formation sites of stars and planets' aims at building a unifying predictive model of star and planet formation in the Milky Way and to understand the Galaxy as a complex dynamically evolving ecosystem. Several large research groups are now hiring across Europe (PIs Hennebelle, Klessen, Testi, Molinari - a project led jointly by CEA Saclay, Heidelberg University, INAF Rome, and ESO Garching).

The team at CEA-Saclay is seeking candidates to participate to the scientific exploitation of interferometric polarization datasets. A significant fraction of the work during the first year will be dedicated to the testing and validation of polarization observations carried out with the IRAM/NOEMA observatory, a capability development currently supported by the ECOGAL/MagneticYSOs efforts. This program will produce a rich dataset probing the millimeter polarized dust emission in a sample of protostars: the postdoctoral research fellow will be leading the scientific analysis with the aim to characterize the magnetic field properties in young star-forming cores (with comparison to synthetic observations of MHD models produced in the consortium). Our team was one of the very first to show that the very young disks around the first star embryos (Class 0 protostars) are so compact that it is absolutely necessary to consider star formation scenarios including the dynamic role of the magnetic field. The CEA teams are also pioneers in the observation of magnetic fields at work during the initial phases of star formation: thanks to the combination of interferometric observations and numerical models, we have recently obtained the first observational proof of the efficiency of magnetic braking to regulate the formation of stars and their disks. The ECOGAL observations and models will allow us to further investigate the dynamic role of the magnetic field and its coupling with dust.

The Astrophysics department of CEA is a major astrophysics laboratory located on the campus of the Paris-Saclay University, about 20 km south-west of Paris. The appointment will be for a period of two to three years, depending on the evolution of the project and data collection timelines. The position includes comprehensive benefits such as transportation and lunch subsidies, as well as a generous travel allowance.

As data is expected to start being collected in the coming months, the successful candidate is expected to start activities in the Spring 2021 timeframe. Flexible starting dates could be accommodated: don't let incompatible timelines stop you from applying if you are highly motivated to come work with us, contact us with your questions !

Applicants should have a PhD in astronomy, astrophysics, or a closely related field. Previous experiences in analysis of datasets from star-forming structures, and expertize in submillimetre/radio interferometric observations, especially in interferometric polarization techniques, will be considered as assets. We also encourage female/under-represented community applications. Applications will be handled according to CEA rules and procedures. Applicants should send a CV, list of publications, brief statement of research interests and relevant expertise for the job to Dr. Analle Maury (anaelle.maury@cea.fr) by November 1st.

https://jobregister.aas.org/ad/5e7aa1bf

McLaughlin Postdoctoral Fellowship

The University of Michigan Department of Astronomy invites applications for its McLaughlin Postdoctoral Fellowship.

The Department of Astronomy has a strong emphasis in star and planet formation research, as well as exoplanet detection and characterization.

Fellows are afforded the opportunity to construct and pursue an independent research program in an energetic and diverse research environment. The Department has guaranteed access to the 6.5 Magellan telescopes in Chile, the 1.2m and 2.4m MDM telescopes in Arizona, the NOEMA sub-mm interferometer in France, and the Swift UV/X-ray/Gamma-ray telescope. Observational and theoretical efforts within the department span topics including exoplanets, young stars, galaxy groups and clusters, galaxy evolution, cosmology, black holes and neutron stars, transient events, and time-domain astronomy, dark matter, and dark energy. Instrumentation efforts are also ongoing within the Department.

The salary for the fellowship will start at 69,000 USD, with an annual research stipend of 6,000 USD. A full benefits package is included.

Fellowships will commence in September 2021, the expected term is three years, dependent on performance and funding. Applicants need to have completed a Ph. D. in astronomy, physics, or a closely related field prior to the start of the fellowship. Applicants should send a cover letter, statement of past research, statement of proposed research, CV, and publications list (with three 'key' papers specifically highlighted) to mclfellows@umich.edu. Letters from three references are also required and should be sent to the same address. Applications that are complete by December 1, 2020, will receive full attention.

We encourage applications from people holding any identity(ies) that have been traditionally underrepresented in the field of astronomy.

To learn more about our research interests please visit https://lsa.umich.edu/astro/research/stars-exoplanets.html or contact any member of our program.

Post-doctoral research positions in exoplanet science at the University of Michigan

The Department of Astronomy at the University of Michigan welcomes applications for post-doctoral positions to join the Formation and Evolution of Planetary Systems research group (https://sites.lsa.umich.edu/feps/). Applications are especially welcome in the areas of high contrast imaging, exoplanet detection/spectral characterization, and infrared instrumentation (especially detector expertise), as well as exoplanet population statistics, and planet formation. Our lab is involved in a funded effort to develop new mid-infrared detectors for use with adaptive optics on large ground-based telescopes. Successful applicants will have access to departmental facilities such as the Magellan telescopes, the MDM Observatories, NOEMA, SWIFT, high performance computing clusters, and other facilities (please see http://www.lsa.umich.edu/astro/). Members of the research team have a chance to collaborate on on-going projects (such as planned observations with the James Webb Space Telescope), and work with students (if appropriate). Interdisciplinary collaborations with the Departments of Astronomy, Physics, Earth Sciences, as well as Climate and Space Sciences, are supported through the Michigan Institute for Research in Astrophysics. The University of Michigan is recognized as a top academic employer and Ann Arbor, Michigan is routinely recognized for its high quality of life. Please send a cover letter, CV, description of research accomplishments and plans (suggested length 8 pages total), list of publications, and arrange for three letters of recommendation to be sent directly to Professor Michael R. Meyer at mrmeyer@umich.edu by 4 January 2020 for full consideration. We encourage applications from people holding any identity(ies) that have been traditionally underrepresented in the field of astronomy. The Department of Astronomy has a specific commitment to enhance diversity, equity, and inclusion within our department, and the field (https://sites.google.com/umich.edu/astro-dei).

Postdoctoral Position in Exoplanets, Sub-Stellar Objects or Planet Formation - Cornell University

Applications are invited for a postdoctoral position at Cornell University. The successful candidate will work with Professor Ray Jayawardhana and his collaborators on observational and analytical studies of extra-solar planets and related topics such as sub-stellar objects and planet formation. Spectroscopic and photometric characterization of exoplanets is of particular interest. Prof. Jayawardhana's research group currently includes two postdocs and two graduate students.

Group members lead a recently accepted Large Program at the Gemini Observatory focused on high-resolution spectroscopy of exoplanet atmospheres. The program plans to observe 50+ targets, spanning a range of properties, over the next three years. Prof. Jayawardhana is also on the JWST/NIRISS science team, with 200 hours of GTO dedicated to exoplanet characterization. In addition, team members use data from TESS, Kepler, CHEOPS, Subaru, Keck, VLT, CFHT, and other major observatories.

The position is for two years, with extension to a third year possible, and comes with a competitive salary and funds for research expenses. Start date is flexible, ideally between January-September 2021.

Applicants should send their curriculum vitae, a description of research interests and plans and a list of publications, and should arrange for three letters of recommendation to be sent directly to Lynda Sovocool (lmk3@cornell.edu). All materials should be submitted electronically to her e-mail address. Applications are accepted until the position is filled, and those received before December 1, 2020 will receive full consideration. Early expressions of interest and inquiries are encouraged, and should be made to rayjay@cornell.edu Candidates interested in applying for a Klarman Fellowship (https://as.cornell.edu/klarman-postdoctoral-fellowships) at Cornell, or bringing other independent fellowships to Cornell, are also encouraged to contact Prof. Jayawardhana.

Application deadline: December 1, 2020

More information: https://astro.cornell.edu/ray-jayawardhana

https://astro.cornell.edu/

Chalmers Cosmic Origins Fellowships

Applications are invited for several postdoctoral fellowships at Chalmers University of Technology (Gothenburg, Sweden) and partner institutes as part of the Chalmers Initiative on Cosmic Origins (CICO):

1) Chalmers Cosmic Origins Fellowship: One or more positions are 3-year fellowships at Chalmers;

2) Chalmers-UVA Cosmic Origins Fellowship: One fellowship is part of the Chalmers-UVA fellowship that is a 4-year position, shared between Chalmers (2 years) and Dept. of Astronomy, Univ. of Virginia, Charlottesville, VA, USA (2 years).

A successful applicant will lead an ambitious, independent research program related to Cosmic Origins science, expected to align with the wide range of research at Chalmers and partner institutes. Relevant themes include galaxy formation and evolution, ISM, astrochemistry, star cluster formation, high- and low-mass star formation, astrochemistry and planet formation and evolution, from both theoretical and observational perspectives. See www.cosmicorigins.space for more information.

http://cosmicorigins.space/job-openings
https://jobregister.aas.org/ad/12f4d49a
Application deadline: December 15th, 2020

Virginia Cosmic Origins Fellowships

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

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

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

There are two types of research programs being advertised this year: 1) Virginia Cosmic Origins Program; (2) Virginia-Chalmers Cosmic Origins Program. Applicants should indicate in their cover letter if they have preferences among these research programs.

http://cosmicorigins.space/job-openings
https://jobregister.aas.org/ad/ea51cd16
Application deadline: December 15, 2020

Tenure-track Assistant Professor Faculty Position in Star Formation

The Department of Physics and Astronomy at Rice University invites applications for a tenure-track faculty position in astronomy in the general field of galactic star formation, including the formation and evolution of planetary systems. We seek an outstanding theoretical, observational, or computational astronomer whose research will complement and extend existing activities in these areas within the Department. In addition to developing an independent and vigorous research program, the successful applicant will be expected to teach, on average, one undergraduate or graduate course each semester, and contribute to the service missions of the Department and University. The Department anticipates making the appointment at the assistant professor level. A Ph.D. in astronomy/astrophysics or related field is required.

Applications for this position must be submitted electronically at http://jobs.rice.edu/postings/24588. Applicants will be required to submit the following: (1) cover letter; (2) curriculum vitae; (3) statement of research; (4) statement on teaching, mentoring, and outreach; (5) PDF copies of up to three publications; and (6) the names, affiliations, and email addresses of three professional references. Rice University is committed to a culturally diverse intellectual community. In this spirit, we particularly welcome applications from all genders and members of historically underrepresented groups who exemplify diverse cultural experiences and who are especially qualified to mentor and advise all members of our diverse student population. We will begin reviewing applications on December 1, 2020. To receive full consideration, all application materials must be received by January 1, 2021. The appointment is expected to begin in July 2021.

Rice University is an Equal Opportunity Employer with a commitment to diversity at all levels and considers for employment qualified applicants without regard to race, color, religion, age, sex, sexual orientation, gender identity, national or ethnic origin, genetic information, disability, or protected veteran status. We encourage applicants from diverse backgrounds to apply.

Meetings

Protostars and Planets VII

Dear Scientists interested in Protostars and Planets VII,

We sincerely hope that all of you remain safe. We would like to announce the rescheduling of the Protostars and Planets VII Conference at Kyoto. Since the COVID-19 Pandemic still strongly affects the international travel, we decided to postpone the conference by approximately one year. The new conference dates are from 21st to 27th of March, 2022. See for current schedule: http://ppvii.org/schedule/index.html

We are looking forward to seeing you at Kyoto in March 2022.

Best wishes, Shu-ichiro Inutsuka, on behalf of PP7 Editors

Planetesimal Formation Meeting - A Virtual Workshop

We are happy to announce a virtual interdisciplinary workshop on planetesimal formation via the streaming instability that explores the connection to protoplanetary disc observations and the Solar System minor bodies.

17-20 November 2020

https://michiellambrechts.bitbucket.io/pfmeet.html

Main organisers: Michiel Lambrechts and Anders Johansen

SOC:
Pablo Benitez-Llambay
Anders Johansen
Michiel Lambrechts
Jake Simon
Kelsi Singer

Summary of Upcoming Meetings

Check the websites of these meetings for the latest information on how they are affected by Covid-19

Threats from the Surroundings – VIRTUAL MEETING
10 - 12 November 2020
http://www.eso.org/sci/meetings/2020/tfts2020.html

Planetesimal Formation Meeting - A Virtual Workshop 17 - 20 November 2020
https://michiellambrechts.bitbucket.io/pfmeet.html

Five Years after HL Tau: A New Era in Planet Formation – VIRTUAL MEETING
7 - 11 December 2020
https://www.eso.org/sci/meetings/2020/hltau2020.html

Gordon Conference on Origins of Solar Systems
19 - 25 June 2021, MA, USA
https://www.grc.org/origins-of-solar-systems-conference/2021

Cool Stars, Stellar Systems, and the Sun 21
5 - 9 July 2021, Toulouse, France
https://coolstars21.github.io/

Star Formation: From Clouds to Discs - A Tribute to the Career of Lee Hartmann
16 - 19 August 2021, Malahide, Ireland
https://www.dias.ie/cloudstodiscs/

Chemical Processes in Solar-type Star Forming Regions
13 - 17 September 2021, Torino, Italy
https://sites.google.com/inaf.it/aco-conference

Wheel of Star Formation: A conference dedicated to Prof. Jan Palouš
20 - 24 September 2020, Prague, Czech Republic
https://janfest2020.asu.cas.cz

Protostars & Planets VII
21 - 27 March 2022, Kyoto, Japan
http://www.ppvii.org

The Physics of Star Formation: From Stellar Cores to Galactic Scales
∼June - July 2022, Lyon, France
http:/staratlyon.univ-lyon1.fr/en

Short Announcements

Fizeau exchange visitors program in optical interferometry - call for applications - European Interferometry Initiative

The Fizeau exchange visitors program in optical interferometry funds (travel and accommodation) visits of researchers to an institute of his/her choice (within the European Community) to perform collaborative work and training on one of the active topics of the European Interferometry Initiative. The visits will typically last for one month, and strengthen the network of astronomers engaged in technical, scientific and training work on optical/infrared interferometry. The program is open for all levels of astronomers (Ph.D. students to tenured staff), with priority given to PhD students and young postdocs. Non-EU based missions will only be funded if considered essential by the Fizeau Committee. From January 2021 onwards, applications to travel to VLTI Expertise Centres are priority, given the new financial rules applying to the programme. Applicants are strongly encouraged to seek also partial support from their home or host institutions.

The deadline for applications is November 15. Fellowships can be awarded for missions to be carried out between mid January 2021 and July 2021!

Further informations and application forms can be found at: www.european-interferometry.eu

The program is funded by OPTICON/H2020.

Please distribute this message also to potentially interested colleagues outside of your community!

Looking forward to your applications,
Josef Hron & Péter Ábrahám
(for the European Interferometry Initiative)