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Abstracts of recently accepted papers

Spitzer Spectroscopy of the Circumprimary Disk in the Binary Brown Dwarf 2MASS J04414489+2301513

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Using the *Spitzer* Infrared Spectrograph, we have performed mid-infrared spectroscopy on the young binary brown dwarf 2MASS J04414489+2301513 (15 AU) in the Taurus star-forming region. The spectrum exhibits excess continuum emission that likely arises from a circumstellar disk around the primary. Silicate emission is not detected in these data, indicating the presence of significant grain growth. This is one of the few brown dwarf disks at such a young age ($\sim$ 1 Myr) that has been found to lack silicate emission. To quantitatively constrain the properties of the disk, we have compared the spectral energy distribution of 2MASS J04414489+2301513 to the predictions of our vertical structure codes for irradiated accretion disks. Our models suggest that the remaining atmospheric grains of moderately depleted layers may have grown to a size of $\gtrsim$5 μm. In addition, our model fits indicate an outer radius of 0.2–0.3 AU for the disk. The small size of this circumprimary disk could be due to truncation by the secondary. The absence of an outer disk containing a reservoir of small, primordial grains, combined with a weak turbulent mechanism, may be responsible for the advanced grain growth in this disk.

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http://arxiv.org/abs/1012.0022

X-ray impact on the protoplanetary disks around T Tauri stars

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T Tauri stars have X-ray luminosities ranging from $L_{\rm X} = 10^{28} - 10^{32}\,{\rm erg\,s^{-1}}$. These luminosities are similar to UV luminosities ($L_{\rm UV} \sim 10^{30} - 10^{31}{\rm erg\,s^{-1}}$) and therefore X-rays are expected to affect the physics and chemistry of the upper layers of their surrounding protoplanetary disks. The effects and importance of X-rays on the chemical and hydrostatic structure of protoplanetary disks are investigated, species tracing X-ray irradiation (for $L_{\rm X} \geq 10^{29}{\rm erg\,s^{-1}}$) are identified and predictions for [O I], [C II] and [N II] fine structure line fluxes are provided. We have implemented X-ray physics and chemistry into the chemo-physical disk code ProDiMo. We include Coulomb heating and H_2 ionization as heating processes and primary and secondary ionization due to X-rays in the chemistry. X-rays heat up the gas causing it to expand in the optically thin surface layers. Neutral molecular species are not much affected in their abundance and spatial distribution, but charged species such as N^+, OH^+, H_2O^+ and H_3O^+ show enhanced abundances in the disk surface. Coulomb heating by X-rays changes the vertical structure of the disk, yielding temperatures of $\sim$ 8 000 K out to distances of 50 AU. The chemical structure is altered by the high electron abundance in the gas in the disk surface, causing an efficient ion-molecule chemistry. The products of this, OH^+, H_2O^+ and H_3O^+, are of great interest for observations of low-mass young stellar objects with the Herschel Space Observatory. [O I] (at 63 and 145 μm) and [C II] (at 158 μm) fine structure emission are only affected for $L_{\rm X} > 10^{30}$ erg s^{-1}.

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http://arxiv.org/abs/1011.5623

Dissecting the Moth: Discovery of an off-centered ring in the HD 61005 debris disk with high-resolution imaging

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The debris disk known as 'The Moth' is named after its unusually asymmetric surface brightness distribution. It is located around the ~90 Myr old G8V star HD 61005 at 34.5 pc and has previously been imaged by the HST at 1.1 and 0.6 microns. Polarimetric observations suggested that the circumstellar material consists of two distinct components, a nearly edge-on disk or ring, and a swept-back feature, the result of interaction with the interstellar medium. We resolve both components at unprecedented resolution with VLT/NACO H-band imaging. Using optimized angular differential imaging techniques to remove the light of the star, we reveal the disk component as a distinct narrow ring at inclination $i = 84.3 \pm 1.0°$. We determine a semi-major axis of $a = 61.25 \pm 0.85$ AU and an eccentricity of $e = 0.045 \pm 0.015$, assuming that periastron is located along the apparent disk major axis. Therefore, the ring center is offset from the star by at least 2.75 ± 0.85 AU. The offset, together with a relatively steep inner rim, could indicate a planetary companion that perturbs the remnant planetesimal belt. From our imaging data we set upper mass limits for companions that exclude any object above the deuterium-burning limit for separations down to 0.3". The ring shows a strong brightness asymmetry along both the major and minor axis. A brighter front side could indicate forward-scattering grains, while the brightness difference between the NE and SW components can be only partly explained by the ring center offset, suggesting additional density enhancements on one side of the ring. The swept-back component appears as two streamers originating near the NE and SW edges of the debris ring.

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The outburst of an embedded low-mass YSO in L1641

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Context: Strong outbursts in very young and embedded protostars are rare and not yet fully understood. They are believed to originate from an increase in the mass accretion rate ($\dot{M}_{acc}$) onto the source.
Aims: We report the discovery of a strong outburst in a low-mass embedded young stellar object (YSO), namely 2MASS-J05424848-0816347 or [CTF93]216-2, as well as its photometric and spectroscopic follow-up.
Methods: Using near- to mid-IR photometry and NIR low-resolution spectroscopy, we monitor the outburst, deriving its magnitude, duration, as well as the enhanced accretion luminosity and mass accretion rate.
Results: [CTF93]216-2 increased in brightness by $\sim$4.6, 4.0, 3.8, and 1.9 mag in the J, H, K_s bands and at 24 μm, respectively, corresponding to an L_{bol} increase of $\sim 20\,L_\odot$. Its early spectrum, probably taken soon after the outburst, displays a steep almost featureless continuum, with strong CO band heads and H_2O broad-band absorption features, and Brγ line in emission. A later spectrum reveals more absorption features, allowing us to estimate $T_{\rm eff}\sim 3200$ K, $M_*\sim 0.25\,M_\odot$, and $\dot{M}_{acc}\sim 1.2\times10^{-6}\,M_\odot\,yr^{-1}$. This makes it one of the lowest mass YSOs with a strong outburst so far discovered.

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Preprints can be obtained from
http://www.aanda.org/articles/aa/pdf/forth/aa16146-10.pdf
http://arxiv.org/abs/1012.0281

A Magnetized Jet from a Massive Protostar

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Synchrotron emission is commonly found in relativistic jets from active galactic nuclei (AGNs) and microquasars, but so far its presence in jets from young stellar objects (YSOs) has not been proved. Here, we present evidence of polarized synchrotron emission arising from the jet of a YSO. The apparent magnetic field, with strength of $\sim$0.2 milligauss, is parallel to the jet axis, and the polarization degree increases toward the jet edges, as expected for a confining helical magnetic field configuration. These characteristics are similar to those found in AGN jets, hinting at a common origin of all astrophysical jets.

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Gravitational fragmentation in turbulent primordial gas and the initial mass function of Population III stars

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We report results from numerical simulations of star formation in the early universe that focus on the dynamical behavior of metal-free gas under different initial and environmental conditions. In particular we investigate the role of turbulence, which is thought to ubiquitously accompany the collapse of high-redshift halos. We distinguish between two main cases: the birth of Population III.1 stars – those which form in the pristine halos unaffected by prior star formation – and the formation of Population III.2 stars – those forming in halos where the gas has an increased ionization fraction. We find that turbulent primordial gas is highly susceptible to fragmentation in both cases, even for turbulence in the subsonic regime, i.e. for rms velocity dispersions as low as 20 percent of the sound speed. Fragmentation is more vigorous and more widespread in pristine halos compared to pre-ionized ones. If such levels of turbulent motions were indeed present in star-forming minihalos, Pop III.1 stars would be on average of somewhat lower mass, and form in larger groups, than Pop III.2 stars. We find that fragment masses cover over two orders of magnitude, suggesting that the Population III initial mass function may have been much broader than previously thought. This prompts the need for a large, high-resolution study of the formation of dark matter minihalos that is capable of resolving the turbulent flows in the gas at the moment when the baryons become self-gravitating. This would help to determine the applicability of our results to primordial star formation.

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Searching for Jet Rotation in Class 0/I Sources observed with GEMINI/GNIRS

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In recent years, there has been a number of detections of gradients in the radial velocity profile across jets from young stars. The significance of these results is considerable. They may be interpreted as a signature of jet rotation about its symmetry axis, thereby representing the only existing observational indications supporting the theory that jets extract angular momentum from star-disk systems. However, the possibility that we are indeed observing jet rotation in pre-main sequence systems is undergoing active debate. To test the validity of a rotation argument, we must extend the survey to a larger sample, including younger sources. We present the latest results of a radial velocity analysis on jets from Class 0 and I sources, using high resolution data from the infrared spectrograph GNIRS on GEMINI South. We obtained infrared spectra protostellar jets HH 34, HH 111-H, HH 212 NK1 and SK1. The [Fe II] emission was unresolved in all cases and so Doppler shifts across the jet width could not be accessed. The H_2 emission was resolved in all cases except HH 34. Doppler profiles across the molecular emission were obtained, and gradients in radial velocity of typically $3\,km\,s^{-1}$ identified. Agreement with previous studies implies they may be interpreted as jet rotation, leading to toroidal velocity and angular momentum flux estimates of $1.5\,km\,s^{-1}$ and $1{\times}10^{-5}\ M_\odot\,yr^{-1}\,AU\,km\,s^{-1}$ respectively. However, caution is needed. For example, emission is asymmetric across the jets from HH 212 suggesting a more complex interpretation is warranted. Furthermore, observations for HH 212 and HH 111-H are conducted far from the source implying external influences are more likely to confuse the intrinsic flow kinematics. These observations demonstrate the difficulty of conducting this study from the ground, and highlight the necessity for high angular resolution via adaptive optics or space-based facilities.

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Bipolar Molecular Outflows and Hot Cores in GLIMPSE Extended Green Objects (EGOs)

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We present high angular resolution Submillimeter Array (SMA) and Combined Array for Research in Millimeter-wave Astronomy (CARMA) observations of two GLIMPSE Extended Green Objects (EGOs)–massive young stellar object (MYSO) outflow candidates identified based on their extended 4.5 μm emission in *Spitzer* images. The mm observations reveal bipolar molecular outflows, traced by high-velocity ^{12}CO(2-1) and HCO^+(1-0) emission, coincident with the 4.5 μm lobes in both sources. SiO(2-1) emission confirms that the extended 4.5 μm emission traces active outflows. A single dominant outflow is identified in each EGO, with tentative evidence for multiple flows in one source (G11.92−0.61). The outflow driving sources are compact millimeter continuum cores, which exhibit hot-core spectral line emission and are associated with 6.7 GHz Class II CH_3OH masers. G11.92−0.61 is associated with at least three compact cores: the outflow driving source, and two cores that are largely devoid of line emission. In contrast, G19.01−0.03 appears as a single MYSO. The difference in multiplicity, the comparative weakness of its hot core emission, and the dominance of its extended envelope of molecular gas all suggest that G19.01−0.03 may be in an earlier evolutionary stage than G11.92−0.61. Modeling of the G19.01−0.03 spectral energy distribution suggests that a central (proto)star (M $\sim$10 $M_\odot$) has formed in the compact mm core (M_{gas} $\sim$12-16$M_\odot$), and that accretion is ongoing at a rate of $\sim$$10^{-3}$ $M_\odot$ year^{-1}. Our observations confirm that these EGOs are young MYSOs driving massive bipolar molecular outflows, and demonstrate that considerable chemical and evolutionary diversity are present within the EGO sample.

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Atlas and Catalog of Dark Clouds Based on the 2 Micron All Sky Survey

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This paper presents an atlas and catalog of dark clouds derived based on the 2 Micron All Sky Survey Point Source Catalog (2MASS PSC). Color excess maps of $E(J-H)$ and $E(H-K_S)$ as well as extinction maps of A_J, A_H, and A_{K_S} covering all of the sky have been produced at the $1'$ grid with a changing angular resolution ($1'$–$12'$) depending on the regions in the sky. Maps drawn at the lower $15'$ grid with a fixed 1 deg resolution were also derived for various sets of the threshold magnitudes in the J, H, and K_S bands to estimate the background star colors and star densities needed to derive the color excess and extinction maps. The maps obtained in this work are presented on various scales in a series of figures that can be used as an atlas of dark clouds for general research purposes. On the basis of the $E(J-H)$ and A_J maps drawn at the $1'$ grid, we have carried out a systematic survey for dark clouds all over the sky. In total, we identified 7614 dark clouds, and measured the coordinates, extents, and A_V values for each of them. We also searched for their counterparts in the previously published catalog of dark clouds based on the optical photographic plates DSS Dobashi et al. (2005, PASJ, 57, S1). These cloud parameters including the information of the counterparts are compiled into a new catalog of dark clouds.
The atlas and catalog organized in this paper mainly trace relatively dense regions in dark clouds revealing a number of dense cloud cores leading to star formation, while those presented by Dobashi et al. (2005) based on the optical database are more suited to trace less dense regions and to reveal the global extents of dark clouds. These two datasets are complementary, and all together, they are useful to picture the structures of dark clouds in various density ranges.

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http://darkclouds.u-gakugei.ac.jp/index.html

A *Spitzer* IRS Study of Infrared Variability in Transitional and Pre-Transitional Disks around T Tauri Stars

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We present a *Spitzer* IRS study of variability in 14 T Tauri stars in the Taurus and Chamaeleon star-forming regions. The sample is composed of transitional and pre-transitional objects which contain holes and gaps in their disks. We detect variability between 5–38 μm in all but two of our objects on timescales of 2–3 years. Most of the variability observed can be classified as seesaw behavior, whereby the emission at shorter wavelengths varies inversely with the emission at longer wavelengths. For many of the objects we can reasonably reproduce the observed variability using irradiated disk models, particularly by changing the height of the inner disk wall by $\sim$20%. When the inner wall is taller, the emission at the shorter wavelengths is higher since the inner wall dominates the emission at 2–8 μm. The taller inner wall casts a larger shadow on the outer disk wall, leading to less emission at wavelengths beyond 20 μm where the outer wall dominates. We discuss how the possible presence of planets in these disks could lead to warps which cause changes in the height of the inner wall. We also find that crystalline silicates are common in the outer disks of our objects and that in the four disks in the sample with the most crystalline silicates, variability on timescales of 1 week is present. In addition to explaining the infrared variability described above, planets can create shocks and collisions which can crystallize the dust and lead to short timescale variability.

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Protostellar collapse and fragmentation using an MHD GADGET

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Although the influence of magnetic fields is regarded as vital in the star formation process, only a few magnetohydrodynamics (MHD) simulations have been performed on this subject within the smoothed particle hydrodynamics method. This is largely due to the unsatisfactory treatment of non-vanishing divergence of the magnetic field. Recently smoothed particle magnetohydrodynamics (SPMHD) simulations based on Euler potentials have proven to be successful in treating MHD collapse and fragmentation problems, however these methods are known to have some intrinsic difficulties. We have performed SPMHD simulations based on a traditional approach evolving the magnetic field itself using the induction equation. To account for the numerical divergence, we have chosen an approach that subtracts the effects of numerical divergence from the force equation, and additionally we employ artificial magnetic

dissipation as a regularization scheme.We apply this realization of SPMHD to a widely known setup, a variation of the 'Boss and Bodenheimer standard isothermal test case', to study the impact of the magnetic fields on collapse and fragmentation. In our simulations, we concentrate on setups, where the initial magnetic field is parallel to the rotation axis. We examine different field strengths and compare our results to other findings reported in the literature. We are able to confirm specific results found elsewhere, namely the delayed onset of star formation for strong fields, accompanied by the tendency to form only single stars. We also find that the 'magnetic cushioning effect', where the magnetic field is wound up to form a 'cushion' between the binary, aids binary fragmentation in a case where previously only formation of a single protostar was expected.

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Effect of FIR Fluxes on Constraining Properties of YSOs

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Young Stellar Objects (YSOs) in the early evolutionary stages are very embedded, and thus they emit most of their energy at long wavelengths such as far-infrared (FIR) and submillimeter (Submm). Therefore, the FIR observational data are very important to classify the accurate evolutionary stages of these embedded YSOs, and to better constrain their physical parameters in the dust continuum modeling. We selected 28 YSOs, which were detected in the AKARI Far-Infrared Surveyor (FIS), from the Spitzer c2d legacy YSO catalogs to test the effect of FIR fluxes on the classification of their evolutionary stages and on the constraining of envelope properties, internal luminosity, and UV strength of the Interstellar Radiation Field (ISRF). According to our test, one can mis-classify the evolutionary stages of YSOs, especially the very embedded ones if the FIR fluxes are not included. In addition, the total amount of heating of YSOs can be underestimated without the FIR observational data.

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Inclination-angle of the outflow in IRAS 05553+1631: A method to correct the projection effect

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A mapping study of IRAS 05553+1631 was performed with ^{12}CO J=3-2 and ^{13}CO J=2-1 lines observed by the KOSMA 3 m-telescope. A core with a size of 0.65 pc and with a LTE mass of 120 $M_\odot$ was defined by the mapping with ^{13}CO J=2-1 line. We have identified a bipolar outflow with ^{12}CO J=3-2. For accuracy in the calculation of outflow parameters, overcoming the projection effect is important. We propose a new method to directly calculate the inclination-angle θ. We establish two basic equations with the help of outflow contour diagram and finally obtain the "angle function" and the "angle equation" to derive θ. We apply our method to the outflow of IRAS 05553+1631, finding that θ_{blue} is 73° and θ_{red} is 78°. Compared to the parameters initially estimated under an assumption of 45° inclination-angle, the newly derived parameters are changed with different factors. For instance, the timescales for the blue and the red lobes are reduced by 0.31 and 0.21, respectively. Larger influences apply to mechanical luminosity, driving force, and mass-loss rate. The comparisons between parameters before and after the correction show that the effect of the inclination-angle cannot be neglected.

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Formation of collapsing cores in subcritical magnetic clouds: three-dimensional MHD simulations with ambipolar diffusion

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We employ the three-dimensional magnetohydrodynamic simulation including ambipolar diffusion to study the gravitationally-driven fragmentation of subcritical molecular clouds, in which the gravitational fragmentation is stabilized as long as magnetic flux-freezing applies. The simulations show that the cores in an initially subcritical cloud generally develop gradually over an ambipolar diffusion time, which is about a few $\times 10^7$ years in a typical molecular cloud. On the other hand, the formation of collapsing cores in subcritical clouds is accelerated by supersonic nonlinear flows. Our parameter study demonstrates that core formation occurs faster as the strength of the initial flow speed in the cloud increases. We found that the core formation time is roughly proportional to the inverse of the square root of the enhanced density created by the supersonic nonlinear flows. The density dependence is similar to that derived in quasistatically contracting magnetically supported clouds, although the core formation conditions are created by the nonlinear flows in our simulations. We have also found that the accelerated formation time is not strongly dependent on the initial strength of the magnetic field if the cloud is highly subcritical. Our simulation shows that the core formation time in our model subcritical clouds is several $\times 10^6$ years, due to the presence of large-scale supersonic flows (~ 3 times sound speed). Once a collapsing core forms, the density, velocity, and magnetic field structure of the core does not strongly depend on the initial strength of the velocity fluctuation. The infall velocities of the cores are subsonic and the magnetic field lines show weak hourglass shapes.

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http://th.nao.ac.jp/∼kudoh/kudohbasu2010/kudohbasu2010.pdf

Evidence for Dynamically Important Magnetic Fields in Molecular Clouds

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Recent observational evidence that magnetic fields are dynamically important in molecular clouds, compared to self-gravity and turbulence, is reviewed and illustrated with data from the NGC 2024 region. One piece of evidence, turbulence anisotropy, was found in the diffuse envelope of a cloud (Av ~ 1; Heyer et al. 2008); our data further suggests turbulence anisotropy in the cloud (Av > 7) and even near the cloud core (Av ~ 100). The data also shows that magnetic fields can channel gravitational contraction even for a region with super-critical N(H2)/2Blos ratio (the ratio between the observed column density and two times the line-of-sight observed field strength), a parameter which has been widely used by observers to estimate core mass-to-flux ratios. Although the mass-to-flux ratio is constant under the flux-freezing condition, we show that N(H2)/2Blos grows with time if gravitational contraction is anisotropic due to magnetic fields.

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Infall and outflow detections in a massive core JCMT 18354-0649S

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We present a high-resolution study of a massive dense core JCMT 18354-0649S with the Submillimeter Array. The

core is mapped with continuum emission at 1.3 mm, and molecular lines including CH_3OH (5_{23}–4_{13}) and HCN (3–2). The dust core detected in the compact configuration has a mass of 47 $M_\odot$ and a diameter of 2 arcsec (0.06 pc), which is further resolved into three condensations with a total mass of 42 $M_\odot$ under higher spatial resolution. The HCN (3–2) line exhibits asymmetric profile consistent with infall signature. The infall rate is estimated to be 2.0×10^{-3} $M_\odot$·yr^{-1}. The high velocity HCN (3-2) line wings present an outflow with three lobes. Their total mass is 12 $M_\odot$ and total momentum is 121 $M_\odot$·km s^{-1}, respectively. Analysis shows that the N-bearing molecules especially HCN can trace both inflow and outflow.

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SiO outflows in high-mass star forming regions: A potential chemical clock?

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Context: Some theoretical models propose that O-B stars form via accretion, in a similar fashion to low-mass stars. Jet-driven molecular outflows play an important role in this scenario, and their study can help to understand the process of high-mass star formation and the different evolutionary phases involved.
Aims: Observations towards low-mass protostars so far favour an evolutionary picture in which jets are always associated with Class 0 objects while more evolved Class I/II objects show less evidence of powerful jets. The present study aims at checking whether an analogous picture can be found in the high-mass case.
Methods: The IRAM 30-m telescope (Spain) has been used to perform single-pointing SiO(2–1) and (3–2) observations towards a sample of 57 high-mass molecular clumps in different evolutionary stages. Continuum data at different wavelengths, from mid-IR to 1.2 mm, have been gathered to build the spectral energy distributions of all the clumps and estimate their bolometric luminosities.
Results: SiO emission at high velocities, characteristic of molecular jets, is detected in 88% of our sources, a very high detection rate indicating that there is ongoing star formation activity in most of the sources of our sample. The SiO(2–1) luminosity drops with $L_{\rm bol}/M$, which suggests that jet activity declines as time evolves. This represents the first clear evidence of a decrease of SiO outflow luminosity with time in a homogeneous sample of high-mass molecular clumps in different evolutionary stages. The SiO(3–2) to SiO(2–1) integrated intensity ratio shows only minor changes with evolutionary state.

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http://www.arcetri.astro.it/~starform/preprints/sepulcre_03.pdf

Protostellar collapse of magneto-turbulent cloud cores: shape during collapse and outflow formation

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We investigate protostellar collapse of molecular cloud cores by numerical simulations, taking into account turbulence and magnetic fields. By using the adaptive mesh refinement technique, the collapse is followed over a wide dynamic range from the scale of a turbulent cloud core to that of the first core. The cloud core is lumpy in the low density region owing to the turbulence, while it has a smooth density distribution in the dense region produced by the collapse. The shape of the dense region depends mainly on the mass of the cloud core; a massive cloud core tends to be prolate while a less massive cloud core tends to be oblate. In both cases, anisotropy of the dense region increases during the isothermal

collapse ($n \lesssim 10^{11}\,\mathrm{cm}^{-3}$). The minor axis of the dense region is always oriented parallel to the local magnetic field. All the models eventually yield spherical first cores ($n \gtrsim 10^{13}\,\mathrm{cm}^{-3}$) supported mainly by the thermal pressure. Most of turbulent cloud cores exhibit protostellar outflows around the first cores. These outflows are classified into two types, bipolar and spiral flows, according to the morphology of the associated magnetic field. Bipolar flow often appears in the less massive cloud core. The rotation axis of the first core is oriented parallel to the local magnetic field for bipolar flow, while the orientation of the rotation axis from the global magnetic field depends on the magnetic field strength. In spiral flow, the rotation axis is not aligned with the local magnetic field.

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The thermal structure and the location of the snow line in the protosolar nebula: axisymmetric models with full 3-D radiative transfer

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The precise location of the water ice condensation front ('snow line') in the protosolar nebula has been a debate for a long time. Its importance stems from the expected substantial jump in the abundance of solids beyond the snow line, which is conducive to planet formation, and from the higher 'stickiness' in collisions of ice-coated dust grains, which may help the process of coagulation of dust and the formation of planetesimals. In an optically thin nebula, the location of the snow line is easily calculated to be around 3 AU, subject to brightness variations of the young Sun. However, in its first 5 to 10 million years, the solar nebula was optically thick, implying a smaller snowline radius due to shielding from direct sunlight, but also a larger radius because of viscous heating. Several models have attempted to treat these opposing effects. However, until recently treatments beyond an approximate 1+1D radiative transfer were unfeasible. We revisit the problem with a fully self-consistent 3D treatment in an axisymmetric disk model, including a density-dependent treatment of the dust and ice sublimation. We find that the location of the snow line is very sensitive to the opacities of the dust grains and the mass accretion rate of the disk. We show that previous approximate treatments are quite efficient at determining the location of the snow line if the energy budget is locally dominated by viscous accretion. Using this result we derive an analytic estimate of the location of the snow line that compares very well with results from this and previous studies. Using solar abundances of the elements we compute the abundance of dust and ice and find that the expected jump in solid surface density at the snow line is smaller than previously assumed. We further show that in the inner few AU the refractory species are also partly evaporated, leading to a significantly smaller solid state surface density in the regions where the rocky planets were formed.

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Methanol and water masers in IRAS 20126+4104: The distance, the disk, and the jet

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Context. Knowledge of the distance to high-mass star forming regions is crucial to obtain accurate luminosity and mass estimates of young OB-type (proto)stars and thus better constrain their nature and age. IRAS 20126+4104 is a

special case, being the best candidate of a high-mass (proto)star surrounded by an accretion disk. Such a fact may be used to set constraints on theories of high-mass star formation, but requires confirmation that the mass and luminosity of IRAS 20126+4104 are indeed typical of a B0.5 star, which in turn requires an accurate estimate of the distance.
Aims. The goal of our study is twofold: to determine the distance to IRAS 20126+4104, using the parallax of H_2O masers associated with the source, and unveil the 3D velocity field of the disk, through proper motion measurements of the 6.7 GHz CH_3OH masers. At the same time, we can also obtain an estimate of the systemic velocity in the plane of the sky of the disk+star system.
Methods. We used the Very Long Baseline Array and the European VLBI Network to observe the 22.2 GHz H_2O and 6.7 GHz CH_3OH masers in IRAS 20126+4104 at a number of epochs suitably distributed in time. The absolute positions of the maser features were established with respect to reference quasars, which allowed us to derive absolute proper motions.
Results. From the parallax of the H_2O masers we obtain a distance of 1.64 ± 0.05 kpc, which is very similar to the value adopted so far in the literature (1.7 kpc) and confirms that IRAS 20126+4104 is a high-mass (proto)star. From the CH_3OH masers we derive the component in the plane of the sky of the systemic velocity of the disk+star system (-16 km s^{-1} in right-ascension and $+7.6$ km s^{-1} in declination). Accurate knowledge of the distance and systemic velocity allows us to improve on the model fit to the H_2O maser jet presented in a previous study. Finally, we identify two groups of CH_3OH maser features, one undergoing rotation in the disk and possibly distributed along a narrow ring centered on the star, the other characterised by relative proper motions indicating that the features are moving away from the disk, perpendicular to it. We speculate that the latter group might be tracing the disk material marginally entrained by the jet.
Conclusions. VLBI multi-epoch observations with phase referencing are confirmed to be an excellent tool for distance determinations and for the investigation of the structure and 3D velocity field within a few 100 AU from newly born high-mass stars.

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http://www.arcetri.astro.it/~starform/preprints/mosca_05.pdf

The Star Formation Rate of Supersonic MHD Turbulence

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This work presents a new physical model of the star formation rate (SFR), which is verified with an unprecedented set of large numerical simulations of driven, supersonic, self-gravitating, magneto-hydrodynamic (MHD) turbulence, where collapsing cores are captured with accreting sink particles. The model depends on the relative importance of gravitational, turbulent, magnetic, and thermal energies, expressed through the virial parameter, $\alpha_{\rm vir}$, the rms sonic Mach number, $\mathcal{M}_{\rm S,0}$, and the ratio of mean gas pressure to mean magnetic pressure, β_0. The SFR is predicted to decrease with increasing $\alpha_{\rm vir}$ (stronger turbulence relative to gravity), to increase with increasing $\mathcal{M}_{\rm S,0}$ (for constant values of $\alpha_{\rm vir}$), and to depend weakly on β_0 for values typical of star forming regions ($\mathcal{M}_{\rm S,0} \approx$ 4-20 and $\beta_0 \approx$ 1-20). In the unrealistic limit of $\beta_0 \to \infty$, that is in the complete absence of a magnetic field, the SFR increases approximately by a factor of three, which shows the importance of magnetic fields in the star formation process, even when they are relatively weak (super-Alfvénic turbulence). The star-formation simulations used to test the model result in an approximately constant SFR, after an initial transient phase. The dependence of the SFR on the virial parameter is shown to agree very well with the theoretical predictions.

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Tracing kinematical and physical asymmetries in the jet from DG Tau B

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Context: Stellar jets from young stars can be highly asymmetric and have multiple velocity components.
Aims: To clarify the origin of jet asymmetries and constrain the launch mechanism we study, as a test case, the physical and kinematical structure of the prototypical asymmetric flow emitted by DG Tau B.
Methods: The analysis of deep, high spectral resolution observations taken at the KECK telescope allows us to infer the properties and the spatial distribution of the velocity components in the two jet lobes. From selected line ratios we derive the gas physical conditions (the electron and total density, n_e and n_H, the ionisation fraction, x_e, and the temperature, T_e), as a function of both distance from the source and gas velocity. The presence of dust grains in the jet is investigated by estimating the gas-phase abundance of calcium with respect to its solar value.
Results: The detected lines show broad velocity profiles at the base of the jet (up to $\sim$100 km s^{-1}) where up to three velocity components are detected. At 5” from the source, however, only the denser and more excited high velocity components survive and the lines are narrower ($\sim$10-30 km s^{-1}). The jet is strongly asymmetric both in velocity and in its physical structure. The red lobe, which is slower ($\sim$140 km s^{-1}) and more collimated (opening angle: $\alpha\sim$3-4°), presents low ionisation fractions ($x_e\sim$0.1-0.4) and temperatures ($T_e<5\,10^3$ K), while the total density is up to $\sim2.5\,10^4$ cm^{-3}. The blue lobe, faster ($\sim$-320 km s^{-1}) and less collimated ($\alpha\sim$14°), is also less dense ($n_H\sim10^4$ cm^{-3}) but highly excited (T_e up to $\sim5\,10^4$ K and x_e up to 0.9). The estimated mass loss rate turns out to be similar in the two lobes ($\sim$6-8 10^{-9} $M_\odot$ yr^{-1}), while the flux of linear momentum is 3 times higher in the blue one ($\sim2.5\,10^{-7}$ $M_\odot$ yr^{-1} km s^{-1}). Calcium is strongly depleted with respect to its solar abundance, indicating that the jet contains dust grains. The depletion is lower for higher velocities, consistent with dust destruction by shocks.
Conclusions: The similar mass loss rate in the two lobes suggests that the ejection power is comparable on the two sides of the system, as expected from a magneto-centrifugal ejection mechanism, and that the observed asymmetries are due to different mass load and propagation properties in an inhomogeneous environment. The presence of dust grains implies that the jet is generated from a region of the disk extending beyond the dust sublimation radius.

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The density variance – Mach number relation in supersonic, isothermal turbulence

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We examine the relation between the density variance and the mean-square Mach number in supersonic, isothermal turbulence, assumed in several recent analytic models of the star formation process. From a series of calculations of supersonic, hydrodynamic turbulence driven using purely solenoidal Fourier modes, we find that the ‘standard’ relationship between the variance in the log of density and the Mach number squared, i.e., $\sigma^2_{\ln\rho/\bar{\rho}} = \ln\left(1 + b^2\mathcal{M}^2\right)$, with $b = 1/3$ is a good fit to the numerical results in the supersonic regime up to at least Mach 20, similar to previous determinations at lower Mach numbers. While direct measurements of the variance in linear density are found to be severely underestimated by finite resolution effects, it is possible to infer the linear density variance via the assumption of log-normality in the Probability Distribution Function. The inferred relationship with Mach number, consistent with $\sigma_{\rho/\bar{\rho}} \approx b\mathcal{M}$ with $b = 1/3$, is, however, significantly shallower than observational determinations of the relationship in the Taurus Molecular Cloud and IC5146 (both consistent with $b \approx 0.5$), implying that additional physics such as gravity is important in these clouds and/or that turbulent driving in the ISM contains a significant compressive component. Magnetic fields are not found to change this picture significantly, in general reducing the measured variances and thus worsening the discrepancy with observations.

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Outflows, Accretion, and Clustered Protostellar Cores around a Forming O Star

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We present a Submillimeter Array study in the 1.3 mm waveband of the NGC 7538 IRS 1–3 massive star-forming region. The brightest core in the mm continuum map, MM1, harbors the IRS 1 young O star. The core has a gas temperature of about 245 K and shows spatially unresolved emission in complex organic molecules, all typical of a hot molecular core. Toward MM1, redshifted absorption is seen in molecular lines with different energies above the ground state. This absorption probes inward motion of the dense gas toward the central young O star, and the estimated mass accretion rate reaches 10^{-3} $M_{\odot}\,\mathrm{yr}^{-1}$. Multiple outflows are seen in the CO and ^{13}CO maps. The gas mass of 50 $M_{\odot}$ and mass outflow rate of 2.5×10^{-3} $M_{\odot}\,\mathrm{yr}^{-1}$ measured in CO line wings are dominated by the MM1 outflow, which is most likely driven by a fast wide-angle wind. Apart from MM1, we discover eight new dusty cores, MM2–9, within a projected distance of 0.35 pc from MM1. These cores show no counterpart in infrared or radio continuum emission, while seven of them appear to be forming intermediate- to high-mass stars. This manifests a deeply embedded star-forming component of the parent cloud of IRS 1–3. Apparently we are observing a Trapezium system in formation, and the system is presumably surrounded by a cluster of lower mass stars.

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X-shooter observations of the accreting brown dwarf J053825.4-024241

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We present the first observations of a probable brown dwarf, obtained with the new spectrograph X-shooter mounted on the UT2@VLT. The target (2MASS J053825.4-024241) is a 0.06 $\mathrm{M}_{\odot}$ object in the star-formation region σ Ori. The X-shooter spectrum covers simultaneously the whole range from UV to NIR (300-2500 nm). The J053825.4-024241 spectrum is rich in emission lines that are typical of accreting young object and clearly shows the Balmer jump. Moreover, many photospheric atomic and molecular absorption lines yield the spectral type and confirm that the object is young. We compute the mass accretion rate from all available observed accretion diagnostics. We find that there is a large spread in the $\dot{M}_{acc}$ values (up to a factor 40) that is not caused by variability; some of this spread may be intrinsic, i.e., owing to different physical conditions of the emitting region for the same $\dot{M}_{acc}$. However, within the large error bars all $\dot{M}_{acc}$ measurements agree, and the mean value is $\log\dot{M}_{acc} \sim -9.86 \pm 0.45$ $\mathrm{M}_{\odot}$/y. The hydrogen Balmer lines are clearly detected up to $n = 25$. Their ratios suggest that the emitting region is cold ($\mathrm{T} \sim 2000 - 3000$ K), dense and in thermal equilibrium (LTE), and that the lines are optically thick up to $n \sim 21$. We briefly discuss the implications of this result for magnetospheric accretion models.

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Observing dust settling and coagulation in circumstellar discs: Selected constraints from high resolution imaging

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Circumstellar discs are expected to be the nursery of planets. Grain growth within such discs is the first step in the planet formation process in the core-accretion gas-capture scenario. We aim at providing selected criteria on observational quantities derived from multi-wavelength imaging observations that allow to identify dust grain growth and settling. We define a wide-ranged parameter space of discs in various states of their evolution. Using a parametrised model set-up and radiative transfer techniques we compute multi-wavelength images of discs at different inclinations. Using millimetre and sub-millimetre images we are in the position to constrain the process of dust grain growth and sedimentation. However, the degeneracy between parameters prohibit the same achievement using near- to mid-infrared images. Using face-on observations in the N and Q Band, the sedimentation height can be constrained.

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Identifying star clusters in a field: A comparison of different algorithms

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Star clusters are often hard to find, as they may lie in a dense field of background objects or, because in the case of embedded clusters, they are surrounded by a more dispersed population of young stars. This paper discusses four algorithms that have been developed to identify clusters as stellar density enhancements in a field, namely stellar density maps from star counts, the nearest neighbour method and the Voronoi tessellation, and the separation of minimum spanning trees. These methods are tested and compared to each other by applying them to artificial clusters of different sizes and morphologies. While distinct centrally concentrated clusters are detected by all methods, clusters with low overdensity or highly hierarchical structure are only reliably detected by methods with inherent smoothing (star counts and nearest neighbour method). Furthermore, the algorithms differ strongly in computation time and additional parameters they provide. Therefore, the method to choose primarily depends on the size and character of the investigated area and the purpose of the study.

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The lower limits of disc fragmentation and the prospects for observing fragmenting discs

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A large fraction of brown dwarfs and low-mass hydrogen-burning stars may form by gravitational fragmentation of protostellar discs. We explore the conditions for disc fragmentation and we find that they are satisfied when a disc is large enough ($\gtrsim$ 100 AU) so that its outer regions can cool efficiently, *and* it has enough mass to be gravitationally unstable, at such radii. We perform radiative hydrodynamic simulations and show that even a disc with mass 0.25 $M_\odot$ and size 100 AU fragments. The disc mass, radius, and the ratio of disc-to-star mass ($M_D/M_\star \approx 0.36$) are smaller than in previous studies (Stamatellos & Whitworth 2009a). We find that fragmenting discs drastically decrease in

mass and size within a few 10^4 yr of their formation, since a fraction of their mass, especially outside ~ 100 AU is consumed by the new stars and brown dwarfs that form. Fragmenting discs end up with masses $\sim 0.001 - 0.1$ $M_\odot$, and sizes $\sim 20 - 100$ AU. On the other hand, discs that are marginally stable evolve on a viscous timescale, thus living longer ($\sim 1 - 10$ Myr). We produce simulated images of fragmenting discs and find that observing discs that are undergoing fragmentation is possible using current (e.g. IRAM-PdBI) and future (e.g. ALMA) interferometers, but highly improbable due to the short duration of this process. Comparison with observations shows that many observed discs may be remnants of discs that have fragmented at an earlier stage. However, there are only a few candidates that are possibly massive and large enough to currently be gravitationally unstable. The rarity of massive ($\gtrsim 0.2$ $M_\odot$), extended ($\gtrsim 100$ AU) discs indicates either that such discs are highly transient (i.e. form, increase in mass becoming gravitationally unstable due to infall of material from the surrounding envelope, and quickly fragment), or that their formation is suppressed (e.g. by magnetic fields). We conclude that current observations of early-stage discs cannot exclude the mechanism of disc fragmentation.

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http://www.astro.cf.ac.uk/pub/Dimitrios.Stamatellos/Publications.html

Carbon-Chain and Organic Molecules around Very Low-Luminosity Protostellar Objects of L1521F-IRS and IRAM 04191+1522

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We have observed dense gas around the Very Low-Luminosity Objects (VeLLOs) L1521F-IRS and IRAM 04191+1522 in carbon-chain and organic molecular lines with the Nobeyama 45 m telescope. Towards L1521F-IRS, carbon-chain lines of CH_3CCH (5_0–4_0), C_4H ($\frac{17}{2}$–$\frac{15}{2}$), and C_3H_2 (2_{12}–1_{01}) are 1.5 - 3.5 times stronger than those towards IRAM 04191+1522, and the abundances of the carbon-chain molecules towards L1521F-IRS are 2 to 5 times higher than those towards IRAM 04191+1522. Mapping observations of these carbon-chain molecular lines show that in L1521F the peak positions of these carbon-chain molecular lines are different from each other and there is no emission peak towards the VeLLO position, while in IRAM 04191+1522 these carbon-chain lines are as weak as the detection limits except for the C_3H_2 line. The observed chemical differentiation between L1521F and IRAM 04191+1522 suggests that the evolutionary stage of L1521F-IRS is younger than that of IRAM 04191+1522, consistent with the extent of the associated outflows seen in the ^{13}CO (1–0) line. The non-detection of the organic molecular lines of CH_3OH (6_{-2}–7_{-1} E) and CH_3CN (6_0–5_0) implies that the warm ($\sim$ 100 K) molecular-desorbing region heated by the central protostar is smaller than $\sim$ 100 AU towards L1521F-IRS and IRAM 04191+1522, suggesting the young age of these VeLLOs. We propose that the chemical status of surrounding dense gas can be used to trace the evolutionary stages of VeLLOs.

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Exposed Long-lifetime First-core; A New Model of First Cores Based on Radiation Hydrodynamics

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A first adiabatic core is a transient object formed in the early phase of star formation. The observation of a first core is believed to be difficult because of its short lifetime and low luminosity. On the basis of radiation hydrodynamic simulations, we propose a novel theoretical model of first cores, Exposed Long-lifetime First core (ELF). In the very low-mass molecular core, the first core evolves slowly and lives longer than 10,000 years because the accretion rate is considerably low. The evolution of ELFs is different from that of ordinary first cores because radiation cooling

has a significant effect there. We also carry out radiation transfer calculation of dust-continuum emission from ELFs to predict their observational properties. ELFs have slightly fainter but similar SEDs to ordinary first cores in radio wavelengths, therefore they can be observed. Although the probabilities that such low mass cores become gravitationally unstable and start to collapse are low, we still can expect that a considerable number of ELFs can be formed because there are many low-mass molecular cloud cores in star-forming regions that can be progenitors of ELFs.

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Chemical abundances in the protoplanetary disk LV 2 (Orion): clues to the causes of the abundance anomaly in H II regions

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Optical integral field spectroscopy of the archetype protoplanetary disk LV 2 in the Orion Nebula is presented, taken with the VLT FLAMES/Argus fibre array. The detection of recombination lines of C II and O II from this class of objects is reported, and the lines are utilized as abundance diagnostics. The study is complemented with the analysis of *HST* Faint Object Spectrograph ultraviolet and optical spectra of the target contained within the Argus field of view. By subtracting the local nebula background the intrinsic spectrum of the proplyd is obtained and its elemental composition is derived for the first time. The proplyd is found to be overabundant in carbon, oxygen and neon compared to the Orion Nebula and the sun.
The simultaneous coverage over LV 2 of the C III] λ1908 and [O III] λ5007 collisionally excited lines (CELs) and C II and O II recombination lines (RLs) has enabled us to measure the abundances of C^{2+} and O^{2+} for LV 2 with both sets of lines. The two methods yield consistent results for the intrinsic proplyd spectrum, but not for the proplyd spectrum contaminated by the generic nebula spectrum, thus providing one example where the long-standing abundance anomaly plaguing metallicity studies of H II regions has been resolved. These results would indicate that the standard forbidden-line methods used in the derivation of light metal abundances in H II regions in our own and other galaxies underestimate the true gas metallicity.

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Impact of grain evolution on the chemical structure of protoplanetary disks

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We study the impact of dust evolution in a protoplanetary disk around a T Tauri star on the disk chemical composition. For the first time we utilize a comprehensive model of dust evolution which includes growth, fragmentation and sedimentation. Specific attention is paid to the influence of grain evolution on the penetration of the UV field in the disk. A chemical model that includes a comprehensive set of gas phase and grain surface chemical reactions is used to simulate the chemical structure of the disk. The main effect of the grain evolution on the disk chemical composition comes from sedimentation, and, to a lesser degree, from the reduction of the total grain surface area. The net effect of grain growth is suppressed by the fragmentation process which maintains a population of small grains, dominating the total grain surface area. We consider three models of dust properties. In model GS both growth and sedimentation are taken into account. In models A5 and A4 all grains are assumed to have the same size (10^{-5} cm and 10^{-4} cm, respectively) with constant gas-to-dust mass ratio of 100. Like in previous studies, the "three-layer" pattern (cold

midplane, warm molecular layer, and hot atmosphere) in the disk chemical structure is preserved in all models, but shifted closer to the midplane in models with increased grain size (GS and A4). Unlike other similar studies, we find that in models GS and A4 column densities of most gas-phase species are enhanced by 1–3 orders of magnitude relative to those in a model with pristine dust (A5), while column densities of their surface counterparts are decreased. We show that column densities of certain species, like C_2H, $HC_{2n+1}N$ ($n = 0 - 3$), H_2O and some other molecules, as well as the C_2H_2/HCN abundance ratio, which are accessible with Herschel and ALMA, can be used as observational tracers of early stages of the grain evolution process in protoplanetary disks.

Accepted by The Astrophysical Journal

http://arxiv.org/abs/1011.4420

Millimeter Imaging of the β Pictoris Debris Disk: Evidence for a Planetesimal Belt

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We present observations at 1.3 millimeters wavelength of the β Pictoris debris disk with beam size 4.3×2.6 arcsec (83×50 AU) from the Submillimeter Array. The emission shows two peaks separated by $\sim 7''$ along the disk plane, which we interpret as a highly inclined dust ring or belt. A simple model constrains the belt center to 94 ± 8 AU, close to the prominent break in slope of the optical scattered light. We identify this region as the location as the main reservoir of dust producing planetesimals in the disk.

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http://arxiv.org/abs/1012.2313

Abstracts of recently accepted major reviews

Chemistry in Protoplanetary Disks

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Protoplanetary disks (PPDs) surrounding young stars are short-lived ($\sim$ 0.3-10 Myr), compact ($\sim$ 10-1000 AU) rotating reservoirs of gas and dust. PPDs are believed to be birthplaces of planetary systems, where tiny grains are assembled into pebbles, then rocks, planetesimals, and eventually planets, asteroids, and comets. Strong variations of physical conditions (temperature, density, ionization rate, UV/X-rays intensities) make a variety of chemical processes active in disks, producing simple molecules in the gas phase and complex polyatomic (organic) species on the surfaces of dust particles. In this entry, we summarize the major modern observational methods and theoretical paradigms used to investigate disk chemical composition and evolution, and present the most important results. Future research directions that will become possible with the advent of the Atacama Large Millimeter Array (ALMA) and other forthcoming observational facilities are also discussed.

Accepted as pre-final chapter to be published in Encyclopedia of Astrobiology by Gargaud, M.; Cernicharo, J.; Viso, M.; Cleaves II, H.J.; Pinti, D.; Amils, R.; Kobayashi, K.; Irvine, W.M. (Eds.), Springer, 2011 (ISBN: 978-3-642-11279-9)

http://adsabs.harvard.edu/abs/2010arXiv1011.4770S

Postdoctoral Position in Computational Astrophysics with focus on Star and Planet Formation Processes

The Centre for Star and Planet Formation at the University of Copenhagen is opening a postdoctoral position in the field of computational astrophysics focusing on star and planet formation processes. The Centre for Star and Planet Formation is a research centre for astronomy, astrophysics and cosmochemistry funded by the Danish National Research Foundation and located at the Natural History Museum of Denmark. The main research theme of the centre is to explore the origin and evolution of planetary systems using a multidisciplinary approach.

Additional information is available at http://starplan.net/career/postdoctoral-position-star-and-planet-formation.

Closing date: January 15, 2011.

Two Early Stage Researcher Positions, Astrochemistry Group at Strathclyde University (part of the Marie Curie ITN LASSIE (http://www.lassie-itn.eu))

1. Observational Astrochemistry (Fixed Term for 24 months)

This project, entitled: 'Combined Gas-Ice Mapping on 1000 AU Scales of Star-Forming and Pre-Stellar Cores' will utilise our unique set of AKARI IR and JCMT / IRAM sub-mm observational data to produce maps of up to 28 star-forming and pre-stellar cores, showing the spatial abundance distribution of solid H2O CO and CO2, comparing this to the spatial distribution of gases in the same regions. The aim is to build a clear picture, commensurate with observational constraints, of the chemical networks that lead to the plethora of molecules observed in star-forming regions. You will have the opportunity to marry your observational work with experimental and theoretical work undertaken elsewhere in the network.

2. Theoretical Chemistry (Fixed-term for 36 months) 24 Months based at Department of Physics, University of Strathclyde 12 Months based at Department of Chemistry, University of Gothenburg

This project entitled: 'Modelling the Physical and Chemical Behaviour of Amorphous Solid Water: an Interstellar Ice Analog' aims to build a clear picture on the molecular level, looking in particular at the role of hydrogen bonding in the physical and chemical behaviour of thin-films of ASW, to elucidate how they govern the chemical evolution of star-forming regions. During the first 12 months of the project you will be based at the University of Strathclyde, with Dr Helen Fraser, and will utilise an exiting molecular dynamics code, and apply state-of the art techniques to develop long time- and length- scale simulations of amorphous solid water (ASW) to look at the effects of temperature on the ASW structure and a process called pore collapse. The post will be based for the second 12 month period in Gothenburg, with Prof. Gunar Nyman and Dr Stefan Andersson where you will focus on using state of the chemical reactions dynamics calculations, alongside an existing photochemistry code, to study the chemical reactions that can result in ASW in interstellar space, whether induced by heating (and pore collapse) or by UV photons. The final 12 months will be based at Strathclyde, and will involve coupling the findings of the theoretical chemical calculations into astrochemical networks, according to our existing knowledge (from elsewhere in the network) of observational and laboratory determined constraints on the chemical processes in interstellar ices.

Candidates for these challenging and rewarding positions must have a Masters Degree or equivalent in Chemistry, Physics, Astronomy, Maths or a related Engineering field, obtained within the past four years, and demonstrate experience (e.g. with a Masters research project) in at least one of the following areas: observational astronomy; chemical physics; physical chemistry; surface science; computational chemistry or theoretical astrochemistry and astrophysics. In addition at the time of appointment, applicants should meet the eligibility requirements of the Marie Curie Initial Training Network (see links below for full details).

The successful candidate must commence the appointment by 1st February 2011.

For an application pack and full details of both posts visit http://www.mis.strath.ac.uk/Personnel/open/r842010.htm (Observational Astrochemistry) http://www.mis.strath.ac.uk/Personnel/open/r852010.htm (Theoretical Astrochemistry) or contact Human Resources, University of Strathclyde, Glasgow G1 1XQ. Tel. 0141 553 4133, quoting ref: JA/R85/2010 or JA/R84/2010.

Closing date: 14th December 2010 (though applicants wishing to apply after this date should contact Dr Fraser in the first instance)

We value diversity and welcome applications from all sections of the community.

Postdoctoral position on Turbulence and Star Formation

The Centro de Radioastronomia y Astrofisica (CRyA) of the Universidad Nacional Autonoma de Mexico (UNAM) invites applications for a postdoctoral position in Astrophysics, to work with the Interstellar Turbulence group, led by Prof. Enrique Vazquez-Semadeni. Preference will be given to candidates with an expertise in the field of Computational Star Formation, although candidates in related fields are welcome to apply. The position is for one year, but can be extended for another year.

The successful candidate is expected to carry out original research in the theory of gravitational collapse in turbulent media and star formation, from the numerical and analytical viewpoints, and its connection to observations. The CRyA is located in the beautiful city of Morelia, 300 km west of Mexico City, with direct flights from Mexico City, Houston, Los Angeles, and Chicago. CRyA members have access to the San Pedro Martir National Astronomical Observatory near Ensenada, Baja California. Astronomers at Mexican institutions have competitive access to the EVLA, the VLBA, and in the near future to ALMA, via a collaboration with the USA National Radio Astronomy Observatoty. The Interstellar Turbulence group has a 34-core cluster on site and is in the process of acquiring a new, 180-core machine in the next few months. It also has access to UNAM's supercomputer, KanBalam (an HP CP 4000 with 1360 cores, rated at 7.1 TFlops with 3 Tbytes of memory and 160 Tbytes of storage). The CRyA provides funds for publishing, and limited support for traveling. Although work can be carried out in English, knowledge of, or willingness to learn Spanish is highly recommended.

Candidates must send a complete curriculum vitae including a full list of publications, as well as a statement of previous experience and current and future professional interests, and arrange for three recommendation letters to be sent to Prof. Vazquez-Semadeni by January 31st 2011, at the lastest. Unsigned material can be sent by e-mail; letters can be sent by e-mail (scanned) or by courier. Please do not use regular mail.

Please send applications and inquiries to

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PhD position in high-mass star formation research at the SRON laboratory in Groningen (The Netherlands)

Dr. Floris van der Tak has a PhD studentship available in his group studying the physics of the interstellar medium and the formation of stars. The project is to analyze images and spectra of Galactic star-forming regions at submillimeter wavelengths. The bulk of the observational material will come from Guaranteed Time Key Programs on the Herschel Space Observatory, launched May 2009. Supplementary data will come from ground-based telescopes such as JCMT, APEX and interferometers such as IRAM, SMA and ALMA. The data will be used to measure physical parameters such as temperatures and densities of the regions, and also to infer their chemical composition. By comparing these quantities to model calculations, we hope to achieve a better understanding of how stars form.

The study is expected to lead to a PhD degree within a period of four years, and will be carried out at SRON, the Netherlands Institute for Space Research. Being the PI institute of HIFI, one of the instruments onboard Herschel, SRON offers a direct link to the instrument team, so that the student can make the most of the data. The project is being carried out in collaboration with researchers at other institutes in Europe and North America and the selected student will have opportunities to spend periods working with other members of the Key Program teams. In the first years of the project, the student will participate in several research schools, both in the Netherlands and abroad. Participation in University courses and/or teaching activities is allowed but not required. In the final years of the project, the student will have the opportunity to present his/her research at international meetings.

The group of Floris van der Tak collaborates closely with staff and students of the astronomy department of the University of Groningen. This ”Kapteyn Institute” is a flourishing research facility with about 20 staff members and about 50 students from all over the world. Groningen is a lively student town with about 180000 inhabitants and plenty of social and cultural opportunities.

Applications should include a curriculum vitae, an academic transcript including an indication of the (expected) date of the award of a MSc (master) degree or equivalent, two reference letters, and a summary of undergraduate research projects carried out and how they fit into the student’s aims for PhD research. If English or Dutch is not the student’s native language, the reference letters should include an assessment of the English level (written and oral) of the student. All materials should arrive via email, FAX, or regular post by February 1, 2011, addressed to Dr. F.F.S. van der Tak at SRON, Landleven 12 9747 AD Groningen, The Netherlands. More information can be obtained by emailing Dr. van der Tak at vdtak *at* sron.nl.

Employment of this full-time position is by NWO (The Netherlands Organization for Scientific Research) and will be for a period of 4 years. The gross salary will grow from Euro 2037 per month in the first year to Euro 2610 per month in the fourth year on a full-time basis.

NWO has good secondary employment conditions such as:

- An end of year bonus of 8,33% of the gross yearly salary
- At least 42 days of vacation leave a year on full-time basis
- An excellent pension scheme
- Options for (additional) personal development
- Excellent facilities for parental leave
- A holiday allowance of 8% of the gross yearly salary

The Star Formation Newsletter is a vehicle for fast distribution of information of interest for astronomers working on star 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).

Latex macros for submitting abstracts and dissertation abstracts (by e-mail to reipurth@ifa.hawaii.edu) are appended to each issue of the newsletter. You can also submit via the Newsletter web interface at http://www2.ifa.hawaii.edu/star-formation/index.cfm
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The Star Formation Newsletter is available on the World Wide Web at http://www.ifa.hawaii.edu/users/reipurth/newsletter.htm.

Moving ... ??

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