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Abstracts of recently accepted papers

A Search for Star-Disk Interaction Among the Strongest X-ray Flaring Stars in the Orion Nebula Cluster

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The Chandra Orion Ultradeep Project observed hundreds of young, low-mass stars undergoing highly energetic X-ray flare events. The 32 most powerful cases have been modeled with the result that the magnetic structures responsible for these flares can be many stellar radii in extent. In this paper, we model the observed spectral energy distributions of these 32 stars in order to determine, in detail for each star, whether there is circumstellar disk material situated in sufficient proximity to the stellar surface for interaction with the large magnetic loops inferred from the observed X-ray flares. Our spectral energy distributions span the wavelength range 0.3–8 μm (plus 24 μm for some stars), allowing us to constrain the presence of dusty circumstellar material out to $\gtrsim$10 AU from the stellar surface in most cases. For 24 of the 32 stars in our sample the available data are sufficient to constrain the location of the inner edge of the dusty disks. Six of these (25%) have spectral energy distributions consistent with inner disks within reach of the observed magnetic loops. Another four stars may have gas disks interior to the dust disk and extending within reach of the magnetic loops, but we cannot confirm this with the available data. The remaining 14 stars (58%) appear to have no significant disk material within reach of the large flaring loops. Thus, up to $\sim$ 40% of the sample stars exhibit energetic X-ray flares that possibly arise from a magnetic star-disk interaction, and the remainder are evidently associated with extremely large, free-standing magnetic loops anchored only to the stellar surface.

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http://aps.arxiv.org/abs/1005.2128

Predicted Colors And Flux Densities Of Protostars In The Herschel Pacs And Spire Filters

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Upcoming surveys with the Herschel Space Observatory will yield far-IR photometry of large samples of young stellar objects, which will require careful interpretation. We investigate the color and luminosity diagnostics based on Herschel broad-band filters to identify and discern the properties of protostars. We compute a grid of 2,016 protostars in various physical configurations and present the expected flux densities and flux density ratios for this grid of protostars. These provide useful constraints on the range of colors and fluxes of protostar in the Herschel filters. We find that Herschel data alone is likely a useful diagnostic of the envelope properties of young stars.

Accepted by A&A Herschel special letters issue.

http://arxiv.org/abs/1005.2404

Discovery of a Young L Dwarf Binary, SDSS J224953.47+004404.6AB

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We report discovery of a young 0.32 arcsec L dwarf binary, SDSS J2249+0044AB, found as the result of a Keck laser guide star adaptive optics imaging survey of young field brown dwarfs. Weak K, Na, and FeH features as well as strong VO absorption in the integrated-light J-band spectrum indicate a low surface gravity and hence young age for the system. From spatially resolved K-band spectra we determine spectral types of L3 $\pm$ 0.5 and L5 $\pm$ 1 for components A and B, respectively. SDSS J2249+0044A is spectrally very similar to G196-3B, an L3 companion to a young M2.5 field dwarf. Thus, we adopt 100 Myr (the age estimate of the G196-3 system) as the age of SDSS J2249+0044AB, but ages of 12–790 Myr are possible. By comparing our photometry to the absolute magnitudes of G196-3B, we estimate a distance to SDSS J2249+0044AB of 54 $\pm$ 16 pc and infer a projected separation of 17 $\pm$ 5 AU for the binary. Comparison of the luminosities to evolutionary models at an age of 100 Myr yields masses of 0.029 $\pm$ 0.006 and $0.022^{+0.006}_{-0.009} M_{\odot}$ for SDSS J2249+0044A and B, respectively. Over the possible ages of the system (12–790 Myr), the mass of SDSS J2249+0044A could range from 0.011 to 0.070 $M_{\odot}$ and the mass of SDSS J2249+0044B could range from 0.009 to 0.065 $M_{\odot}$. Evolutionary models predict that either component could be burning deuterium, which could result in a mass ratio as low as 0.4, or alternatively, a reversal in the luminosities of the binary. We find a likely proper motion companion, GSC 00568-01752, which lies 48.9 arcsec away (a projected separation of 2600 AU) and has Sloan Digital Sky Survey and Two Micron All Sky Survey colors consistent with an early M dwarf. We calculate a photometric distance to GSC 00568-01752 of 53 $\pm$ 15 pc, in good agreement with our distance estimate for SDSS J2249+0044AB. The space motion of SDSS J2249+0044AB shows no obvious coincidence with known young moving groups, though radial velocity and parallax measurements are necessary to refine our analysis. The unusually red near-IR colors, young age, and low masses of the binary make it an important template for studying planetary-mass objects found by direct imaging surveys.

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The physical properties of the dust in the RCW 120 HII region as seen by Herschel

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Context. RCW 120 is a well-studied, nearby Galactic HII region with ongoing star formation in its surroundings. Previous work has shown that it displays a bubble morphology at mid-infrared wavelengths and has a massive layer of collected neutral material seen at sub-mm wavelengths. Given the well-defined photo-dissociation region (PDR) boundary and collected layer, it is an excellent laboratory to study the "collect and collapse" process of triggered star formation. Using Herschel Space Observatory data at 100, 160, 250, 350, and 500 micron, in combination with Spitzer and APEX-LABOCA data, we can for the first time map the entire spectral energy distribution of an HII region at high angular resolution.
Aims. We seek a better understanding of RCW120 and its local environment by analysing its dust temperature distribution. Additionally, we wish to understand how the dust emissivity index, beta, is related to the dust temperature.
Methods. We determine dust temperatures in selected regions of the RCW 120 field by fitting their spectral energy distribution (SED), derived using aperture photometry. Additionally, we fit the SED extracted from a grid of positions to create a temperature map.
Results. We find a gradient in dust temperature, ranging from >30 K in the interior of RCW 120, to ∼20K for the material collected in the PDR, to ∼10K toward local infrared dark clouds and cold filaments. Our results suggest that RCW 120 is in the process of destroying the PDR delineating its bubble morphology. The leaked radiation from its interior may influence the creation of the next generation of stars. We find support for an anti-correlation between the fitted temperature and beta, in rough agreement with what has been found previously. The extended wavelength coverage of the Herschel data greatly increases the reliability of this result.

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Initial highlights from the *Herschel* Gould Belt survey

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We summarize the first results from the Gould Belt survey, obtained toward the Aquila Rift and Polaris Flare regions during the 'science demonstration phase' of *Herschel*. Our 70–500 μm images taken in parallel mode with the SPIRE and PACS cameras reveal a wealth of filamentary structure, as well as numerous dense cores embedded in the filaments. Between ~ 350 and 500 prestellar cores and ~ 45–60 Class 0 protostars can be identified in the Aquila field, while ~ 300 unbound starless cores and no protostars are observed in the Polaris field. The prestellar core mass function (CMF) derived for the Aquila region bears a strong resemblance to the stellar initial mass function (IMF), already confirming the close connection between the CMF and the IMF with much better statistics than earlier studies. Comparing and contrasting our *Herschel* results in Aquila and Polaris, we propose an observationally-driven scenario for core formation according to which complex networks of long, thin filaments form first within molecular clouds, and then the densest filaments fragment into a number of prestellar cores via gravitational instability.

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From high-mass starless cores to high-mass protostellar objects

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Aims: Our aim is to understand the evolutionary sequence of high-mass star formation from the earliest evolutionary stage of high-mass starless cores, via high-mass cores with embedded low- to intermediate-mass objects, to finally high-mass protostellar objects.
Methods: Herschel far-infrared PACS and SPIRE observations are combined with existing data at longer and shorter wavelengths to characterize the spectral and physical evolution of massive star-forming regions.
Results: The new Herschel images spectacularly show the evolution of the youngest and cold high-mass star-forming regions from mid-infrared shadows on the Wien-side of the spectral energy distribution (SED), via structures almost lost in the background emission around 100mum, to strong emission sources at the Rayleigh-Jeans tail. Fits of the SEDs for four exemplary regions covering evolutionary stages from high-mass starless cores to high-mass protostellar objects reveal that the youngest regions can be fitted by single-component black-bodies with temperatures on the order of 17K. More evolved regions show mid-infrared excess emission from an additional warmer component, which

however barely contributes to the total luminosities for the youngest regions. Exceptionally low values of the ratio between bolometric and submm luminosity additionally support the youth of the infrared-dark sources.
Conclusions: The Herschel observations reveal the spectral and physical properties of young high-mass star-forming regions in detail. The data clearly outline the evolutionary sequence in the images and SEDs. Future work on larger samples as well as incorporating full radiative transfer calculations will characterize the physical nature at the onset of massive star formation in even more depth.

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http://www.mpia-hd.mpg.de/homes/beuther/papers.html

Who Pulled the Trigger: a Supernova or an AGB Star?

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The short-lived radioisotope ^{60}Fe requires production in a core collapse supernova or AGB star immediately before its incorporation into the earliest solar system solids. Shock waves from a somewhat distant supernova, or a relatively nearby AGB star, have the right speeds to simultaneously trigger the collapse of a dense molecular cloud core and to inject shock wave material into the resulting protostar. A new set of FLASH2.5 adaptive mesh refinement hydrodynamical models shows that the injection efficiency depends sensitively on the assumed shock thickness and density. Supernova shock waves appear to be thin enough to inject the amount of shock wave material necessary to match the short-lived radioisotope abundances measured for primitive meteorites. Planetary nebula shock waves from AGB stars, however, appear to be too thick to achieve the required injection efficiencies. These models imply that a supernova pulled the trigger that led to the formation of our solar system.

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Giant Planet Formation by Disk Instability: A Comparison Simulation With An Improved Radiative Scheme

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There has been disagreement currently about whether cooling in protoplanetary disks can be sufficiently fast to induce the formation of gas giant protoplanets via gravitational instabilities. Simulations by our own group and others indicate that this method of planet formation does not work for disks around young, low- mass stars inside several tens of AU, while simulations by other groups show fragmentation into protoplanetary clumps in this region. To allow direct comparison in hopes of isolating the cause of the differences, we here present a high resolution three-dimensional hydrodynamics simulation of a protoplanetary disk, where the disk model, initial perturbation, and simulation conditions are essentially identical to those used in a set of simulations by Boss. As in earlier papers by the same author, Boss (2007, hereafter B07) purports to show that cooling is fast enough to produce protoplanetary clumps. Here, we evolve the same B07 disk using an improved version of one of our own radiative schemes and find that the disk does not fragment in our code but instead quickly settles into a state with only low amplitude nonaxisymmetric structure, which persists for at least several outer disk rotations. We see no rapid radiative or convective cooling. We conclude that the differences in results are due to different treatments of regions at and above the disk photosphere, and we explain at least one way in which the scheme in B07 may lead to artificially fast cooling.

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Distribution of refractory and volatile elements in CoRoT exoplanet host stars

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The relative distribution of abundances of refractory, intermediate, and volatile elements in stars with planets can be an important tool for investigating the internal migration of a giant planet. This migration can lead to the accretion of planetesimals and the selective enrichment of the star with these elements. We report on a spectroscopic determination of the atmospheric parameters and chemical abundances of the parent stars in transiting planets CoRoT-2b and CoRoT-4b. Adding data for CoRoT-3 and CoRoT-5 from the literature, we find a flat distribution of the relative abundances as a function of their condensation temperatures. For CoRoT-2, the relatively high lithium abundance and intensity of its Li I resonance line permit us to propose an age of 120 Myr, making this stars one of the youngest stars with planets to date. We introduce a new methodology to investigate a relation between the abundances of these stars and the internal migration of their planets. By simulating the internal migration of a planet in a disk formed only by planetesimals, we are able, for the first time, to separate the stellar fractions of refractory, intermediate, and volatile rich planetesimals accreting onto the central star. Intermediate and volatile element fractions enriching the star are similar and much larger than those of pure refractory ones. This result is opposite to what has been considered in the literature for the accreting self-enrichment processes of stars with planets. We also show that these results are highly dependent on the model adopted for the disk distribution regions in terms of refractory, intermediate, and also volatile elements and other parameters considered. We note however, that this self-enrichment mechanism is only efficient during the first 20 – 30 Myr or later in the lifetime of the disk when the surface convection layers of the central star for the first time attain its minimum size configuration.

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Triggered star formation and Young Stellar Population in Bright-Rimmed Cloud SFO 38

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We have investigated the young stellar population in and around SFO 38, one of the massive globules located in the northern part of the Galactic H II region IC 1396, using the *Spitzer* IRAC and MIPS observations (3.6 to 24 μm) and followed up with ground based optical photometric and spectroscopic observations. Based on the IRAC and MIPS colors and Hα emission we identify $\sim$45 Young Stellar Objects (Classes 0/I/II) and 13 probable Pre Main Sequence Candidates. We derive the spectral types (mostly K- and M-type stars), effective temperatures and individual extinction of the relatively bright and optically visible Class II objects. Most of the Class II objects show variable Hα emission as well as optical and near-infrared photometric variability which confirm their "*youth*". Based on optical photometry and theoretical isochrones, we estimate the spread in stellar ages to be between 1–8 Myr with a median age of 3 Myr and a mass distribution of 0.3–2.2 $M_\odot$ with a median value around 0.5 $M_\odot$. Using the width of the Hα emission line measured at 10% peak intensity, we derive the mass accretion rates of individual objects to be between 10^{-10} to 10^{-8} $M_\odot$/yr. From the continuum-subtracted Hα line image, we find that the Hα emission of the globule is not spatially symmetric with respect to the O type ionizing star HD 206267 and the interstellar extinction towards the globule is also anomalous. We clearly detect an enhanced concentration of YSOs closer to the southern rim of SFO 38 and identify an evolutionary sequence of YSOs from the rim to the dense core of the cloud, with most of the Class II objects located at the bright rim. The YSOs appear to be aligned along two different directions towards the O6.5V type star HD 206267 and the B0V type star HD 206773. This is consistent with the Radiation Driven Implosion (RDI) model for triggered star formation. Further the apparent speed of sequential star formation is consistent with the speed of propagation of shocks in dense globules as derived from numerical simulations of RDI.

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The role of magnetic reconnection on jet/accretion disk systems

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It was proposed earlier that the relativistic ejections observed in microquasars could be produced by violent magnetic reconnection episodes at the inner disk coronal region (de Gouveia Dal Pino & Lazarian 2005). Here we revisit this model, which employs a standard accretion disk description and fast magnetic reconnection theory, and discuss the role of magnetic reconnection and associated heating and particle acceleration in different jet/disk accretion systems, namely young stellar objects (YSOs), microquasars, and active galactic nuclei (AGNs). In microquasars and AGNs, violent reconnection episodes between the magnetic field lines of the inner disk region and those that are anchored in the black hole are able to heat the coronal/disk gas and accelerate the plasma to relativistic velocities through a diffusive first-order Fermi-like process within the reconnection site that will produce intermittent relativistic ejections or plasmons. The resulting power-law electron distribution is compatible with the synchrotron radio spectrum observed during the outbursts of these sources. A diagram of the magnetic energy rate released by violent reconnection as a function of the black hole (BH) mass spanning 10^9 orders of magnitude shows that the magnetic reconnection power is more than sufficient to explain the observed radio luminosities of the outbursts from microquasars to low luminous AGNs. In addition, the magnetic reconnection events cause the heating of the coronal gas, which can be conducted back to the disk to enhance its thermal soft x-ray emission as observed during outbursts in microquasars. The decay of the hard x-ray emission right after a radio flare could also be explained in this model due to the escape of relativistic electrons with the evolving jet outburst. In the case of YSOs a similar magnetic configuration can be reached that could possibly produce observed x-ray flares in some sources and provide the heating at the jet launching base, but only if violent magnetic reconnection events occur with episodic, very short-duration accretion rates which are $\sim 100-1000$ times larger than the typical average accretion rates expected for more evolved (TTauri) YSOs.

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Small-scale structure in the Rosette molecular cloud revealed by *Herschel*

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We present a preliminary analysis of the small-scale structure found in new 70-520 μum continuum maps of the Rosette molecular cloud (RMC), obtained with the SPIRE and PACS instruments of the *Herschel* Space Observatory. We find 473 clumps within the RMC using a new structure identification algorithm, with sizes up to ∼1.0 pc in diameter. A comparison with recent *Spitzer* maps reveals that 371 clumps are "starless" (without an associated young stellar object), while 102 are "protostellar". Using the respective values of dust temperature, we determine the clumps have masses (M_C) over the range -0.75 $\leq$ log (M_C/M$_\odot$) $\leq$ 2.50. Linear fits to the high-mass tails of the resulting clump mass spectra (CMS) have slopes that are consistent with those found for high-mass clumps identified in CO emission by other groups.

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The Bolocam Galactic Plane Survey – III. Characterizing Physical Properties of Massive Star-Forming Regions in the Gemini OB1 Molecular Cloud

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We present the 1.1 millimeter Bolocam Galactic Plane Survey (BGPS) observations of the Gemini OB1 molecular cloud complex, and targeted NH_3 observations of the BGPS sources. When paired with molecular spectroscopy of a dense gas tracer, millimeter observations yield physical properties such as masses, radii, mean densities, kinetic temperatures and line widths. We detect 34 distinct BGPS sources above $5\sigma = 0.37$ Jy beam^{-1} with corresponding 5σ detections in the NH_3(1,1) transition. Eight of the objects show water maser emission (20%). We find a mean millimeter source FWHM of 1.12 pc, and a mean gas kinetic temperature of 20 K for the sample of 34 BGPS sources with detections in the NH_3(1,1) line. The observed NH_3 line widths are dominated by non-thermal motions, typically found to be a few times the thermal sound speed expected for the derived kinetic temperature. We calculate the mass for each source from the millimeter flux assuming the sources are isothermal and find a mean isothermal mass within a 120" aperture of 230 ± 180 M$_\odot$. We find a total mass of 8,400 M$_\odot$ for all BGPS sources in the Gemini OB1 molecular cloud, representing 6.5% of the cloud mass. By comparing the millimeter isothermal mass to the virial mass within a radius equal to the mm source size calculated from the NH_3 line widths, we find a mean virial parameter (M_{vir}/M_{iso}) of 1.0±0.9 for the sample. We find mean values for the distributions of column densities of 1.0×10^{22} cm^{-2} for H_2, and 3.0×10^{14} cm^{-2} for NH_3, giving a mean NH_3 abundance of 3.0×10^{-8} relative to H_2. We find volume-averaged densities on the order of $10^3 - 10^4$ cm^{-3}. The sizes and densities suggest that in the Gem OB 1 region the BGPS is detecting the clumps from which stellar clusters form, rather than smaller, higher density cores where single stars or small multiple systems form.

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Unveiling the Structure of Pre-Transitional Disks

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In the past few years, several disks with inner holes that are relatively empty of small dust grains have been detected and are known as transitional disks. Recently, *Spitzer* has identified a new class of "pre-transitional disks" with gaps based on near-infrared photometry and mid-infrared spectra; these objects have an optically thick inner disk separated from an optically thick outer disk by an optically thin disk gap. A near-infrared spectrum provided the first confirmation of a gap in the pre-transitional disk of LkCa 15 by verifying that the near-infrared excess emission in this object was due to an optically thick inner disk. Here we investigate the difference between the nature of the inner regions of transitional and pre-transitional disks using the same veiling-based technique to extract the near-infrared excess emission above the stellar photosphere. However, in this work we use detailed disk models to fit the excess continua as opposed to the simple blackbody fits used previously. We show that the near-infrared excess emission of the previously identified pre-transitional disks of LkCa 15 and UX Tau A in the Taurus cloud as well as the newly identified pre-transitional disk of ROX 44 in Ophiuchus can be fit with an inner disk wall located at the dust destruction radius. We also present detailed modeling of the broad-band spectral energy distributions of these objects, taking into account the effect of shadowing by the inner disk on the outer disk, but considering the finite size of the star, unlike other recent treatments. The near-infrared excess continua of these three pre-transitional disks, which can be explained by optically thick inner disks, are significantly different from that of the transitional disks of GM Aur, whose near-infrared excess continuum can be reproduced by emission from sub-micron-sized optically thin dust, and DM Tau, whose near-infrared spectrum is consistent with a disk hole that is relatively free of small dust. The structure of pre-transitional disks may be a sign of young planets forming in these disks and future studies of pre-transitional disks will provide constraints to aid in theoretical modeling of planet formation.

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Herschel/PACS Imaging of Protostars in the HH 1–2 Outflow Complex

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We present 70 and 160 μm *Herschel* science demonstration images of a field in the Orion A molecular cloud that contains the prototypical Herbig-Haro objects HH 1 and 2, obtained with the Photodetector Array Camera and Spectrometer (PACS). These observations demonstrate *Herschel*'s unprecedented ability to study the rich population of protostars in the Orion molecular clouds at the wavelengths where they emit most of their luminosity. The four protostars previously identified by *Spitzer* 3.6–40 μm imaging and spectroscopy are detected in the 70 μm band, and three are clearly detected at 160 μm. We measure photometry of the protostars in the PACS bands and assemble their spectral energy distributions (SEDs) from 1 to 870 μm with these data, *Spitzer* spectra and photometry, 2MASS data, and APEX sub-mm data. The SEDs are fit to models generated with radiative transfer codes. From these fits we can constrain the fundamental properties of the protostars. We find luminosities in the range 12–84 $L_\odot$ and envelope densities spanning over two orders of magnitude. This implies that the four protostars have a wide range of envelope infall rates and evolutionary states: two have dense, infalling envelopes, while the other two have only residual envelopes. We also show the highly irregular and filamentary structure of the cold dust and gas surrounding the protostars as traced at 160 μm.

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Disentangling protostellar evolutionary stages in clustered environments using *Spitzer*-IRS spectra and comprehensive SED modeling

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When studying the evolutionary stages of protostars that form in clusters, the role of any intracluster medium cannot be neglected. High foreground extinction can lead to situations where young stellar objects (YSOs) appear to be in earlier evolutionary stages than they actually are, particularly when using simple criteria like spectral indices. To address this issue, we have assembled detailed SED characterizations of a sample of 56 *Spitzer*-identified candidate YSOs in the clusters NGC 2264 and IC 348. For these, we use spectra obtained with the Infrared Spectrograph onboard the *Spitzer* Space Telescope and ancillary multi-wavelength photometry. The primary aim is twofold: 1) to discuss the role of spectral features, particularly those due to ices and silicates, in determining a YSO's evolutionary stage, and 2) to perform comprehensive modeling of spectral energy distributions (SEDs) enhanced by the IRS data. The SEDs consist of ancillary optical-to-submillimeter multi-wavelength data as well as an accurate description of the

9.7 μm silicate feature and of the mid-infrared continuum derived from line-free parts of the IRS spectra. We find that using this approach, we can distinguish genuine protostars in the cluster from T Tauri stars masquerading as protostars due to external foreground extinction. Our results underline the importance of photometric data in the far-infrared/submillimeter wavelength range, at sufficiently high angular resolution to more accurately classify cluster members. Such observations are becoming possible now with the advent of the *Herschel* Space Observatory.

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Molecular Hydrogen Emission from the Boundaries of the Taurus Molecular Cloud

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We report Spitzer Space Telescope observations of the four lowest rotational transitions of H_2 in three portions of the boundary of the Taurus molecular cloud. Emission in the two lowest transitions, S(0) and S(1), was detected in almost all pointing directions, while the S(2) and S(3) lines were marginally detected only after further averaging of data. The widespread detection of lines coming from levels 510 K and 1016 K above the molecular ground state is indicative of gas at a temperature of at least 200 K containing column densities 1 to 5 $\times$ 10^{18} cm^{-2} of H_2. For the region with the simplest geometry, we have used the Meudon PDR code to model the chemistry, radiative transfer, and excitation of molecular hydrogen. We conclude that models with acceptable values of the UV interstellar radiation field can reproduce the amount of H_2 in the lowest excited state, but cannot account for the degree of excitation of the H_2. The unexpectedly high degree of excitation of the H_2 in the boundary layer of a molecular cloud, which cannot be explained by the presence of stellar sources, points to an enhanced heating rate which may be result of e.g. dissipation of turbulence. We have in one boundary region been able to obtain the ortho to para H_2 ratio, which by modeling and possible detection of the S(2) and S(3) lines has a range $1.0 \geq \mathrm{OPR} \geq 0.15$, although this result must be treated with caution. The fact that the ortho to para ratio is lower than that expected for equilibrium at the gas kinetic temperature may be indicative of circulation of material from cold, purely molecular regions into the boundary layer, possibly due to turbulent diffusion. The explanation of these data may thus be suggestive of processes that are having a significant effect on the structure and evolution of molecular clouds and the star formation that takes place within them.

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The absence of sub-minute periodicity in classical T Tauri stars

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Classical T Tauri stars (CTTS) are young, late-type objects, that still accrete matter from a circumstellar disk. Analytical treatments and numerical simulations predict instabilities of the accretion shock on the stellar surface. We search for variability on timescales below a few minutes in the CTTS TW Hya and AA Tau. TW Hya was observed with SALTICAM on the Southern African Large Telescope (SALT) in narrow-band filters around the Balmer jump. The observations were performed in slit mode, which provides a time resolution of about 0.1 s. For AA Tau we obtained observations with OPTIMA, a single photon-counting device with even better time resolution. Small-scale variability typically lasts a few seconds, however, no significant periodicity is detected. We place a 99% confidence upper limit on the pulsed fraction of the lightcurves. The relative amplitude is below 0.001 for TW Hya in the frequency range 0.02-3 Hz in the 340 nm filter and 0.1-3 Hz in the 380 nm filter. The corresponding value for AA Tau is an amplitude of 0.005 for 0.02-50 Hz. The relevant timescales indicate that shock instabilites should not be seen directly in our

optical and UV observations, but the predicted oscialltions would induce observable variations in the reddening. We discuss how the magnetic field could stabilise the accretion shock.

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Herschel observations of embedded protostellar clusters in the Rosette Molecular Cloud

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The Herschel OB young stellar objects survey (HOBYS) has observed the Rosette molecular cloud, providing an unprecedented view of its star formation activity. These new far-infrared data reveal a population of compact young stellar objects whose physical properties we aim to characterise. We compiled a sample of protostars and their spectral energy distributions that covers the near-infrared to submillimetre wavelength range. These were used to constrain key properties in the protostellar evolution, bolometric luminosity, and envelope mass and to build an evolutionary diagram. Several clusters are distinguished including the cloud centre, the embedded clusters in the vicinity of luminous infrared sources, and the interaction region. The analysed protostellar population in Rosette ranges from 0.1 to about 15 $M_\odot$ with luminosities between 1 and 150 $L_\odot$, which extends the evolutionary diagram from low-mass protostars into the high-mass regime. Some sources lack counterparts at near- to mid-infrared wavelengths, indicating extreme youth. The central cluster and the Phelps & Lada 7 cluster appear less evolved than the remainder of the analysed protostellar population. For the central cluster, we find indications that about 25% of the protostars classified as Class I from near- to mid-infrared data are actually candidate Class 0 objects. As a showcase for protostellar evolution, we analysed four protostars of low- to intermediate-mass in a single dense core, and they represent different evolutionary stages from Class 0 to Class I. Their mid- to far-infrared spectral slopes flatten towards the Class I stage, and the 160 to 70 μm flux ratio is greatest for the presumed Class 0 source. This shows that the Herschel observations characterise the earliest stages of protostellar evolution in detail.

A&A Letters Special Issue for Herschel first results

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The seeds of star formation in the filamentary infrared-dark cloud G011.11-0.12

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Infrared-dark clouds (IRDCs) are the precursors to massive stars and stellar clusters. G011.11-0.12 is a well-studied filamentary IRDC, though, to date, the absence of far-infrared data with sufficient spatial resolution has limited the understanding of the structure and star-formation activity. We use Herschel to study the embedded population of young pre- and protostellar cores in this IRDC. We examine the cloud structure, which appears in absorption at short wavelength and in emission at longer wavelength. We derive the properties of the massive cores from the spectral energy distributions of bright far-infrared point sources detected with the PACS instrument aboard Herschel. We report on the detection and characterization of pre- and protostellar cores in a massive filamentary infrared-dark cloud

G011.11-0.12 using PACS. We characterize 18 cores directly associated with the filament, two of which have masses over 50 Msun, making them the best candidates to become massive stars in G011.11-0.12. These cores are likely at various stages of protostar formation, showing elevated temperature (<T>∼ 22 K) with respect to the ambient gas reservoir. The core masses (<M>∼ 24 Msun) are small compared to that in the cold filament. The mean core separation is 0.9 pc, well in excess of the Jeans length in the filament. We confirm that star formation in IRDCs is underway and diverse, and IRDCs have the capability of forming massive stars and clusters.

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Extreme active molecular jets in L1448C

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The protostellar jet driven by L1448C was observed in the SiO J=8–7 and CO J=3–2 lines and 350 GHz dust continuum at ∼1 arcsec resolution with the Submillimeter Array (SMA). A narrow jet from the northern source L1448C(N) was observed in the SiO and the high-velocity CO. The jet consists of a chain of emission knots with an inter-knot spacing of ∼2 arcsec (500 AU) and a semi-periodic velocity variation. These knots are likely to be the internal bow shocks in the jet beam that were formed due to the periodic variation of the ejection velocity with a period of ∼15—20 yr. The innermost pair of knots, which are significant in the SiO map but barely seen in the CO, are located at ∼1 arcsec (250 AU) from the central source, L1448C(N). Since the dynamical time scale for the innermost pair is only ∼10 yr, SiO may have been formed in the protostellar wind through the gas-phase reaction, or been formed on the dust grain and directly released into the gas phase by means of shocks. It is found that the jet is extremely active with a mechanical luminosity of ∼7 $L_\odot$, which is comparable to the bolometric luminosity of the central source (7.5 $L_\odot$). The mass accretion rate onto the protostar derived from the mass-loss rate is $\sim 10^{-5}$ $M_\odot$ yr^{-1}. Such a high mass accretion rate suggests that the mass and the age of the central star are 0.03–0.09 $M_\odot$ and (4–12)$\times 10^3$ yr, respectively, implying that the central star is in the very early stage of protostellar evolution. The low-velocity CO emission delineates two V-shaped shells with a common apex at L1448C(N). The kinematics of these shells are reproduced by the model of a wide opening angle wind. The co-existence of the highly-collimated jets and the wide-opening angle shells can be explained by the "unified X-wind model" in which highly-collimated jet components correspond to the on-axis density enhancement of the wide-opening angle wind. The CO J=3–2 map also revealed the second outflow driven by the southern source L1448C(S) located at ∼8.3 arcsec (2000 AU) from L1448C(N). Although L1448C(S) is brighter than L1448C(N) in the mid-IR bands, the momentum flux of the outflow from L1448C(S) is two or three orders of magnitude smaller than that of the L1448C(N) outflow. It is likely that the evolution of L1448C(S) has been strongly affected by the powerful outflow from L1448C(N).

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Herschel-SPIRE spectroscopy of G29.96-0.02: fitting the full SED

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We use the SPIRE Fourier-Transform Spectrometer (FTS) on-board the ESA *Herschel* Space Telescope to analyse the submillimetre spectrum of the Ultra-compact HII region G29.96-0.02. Spectral lines from species including ^{13}CO, CO, [CI], and [NII] are detected. A sparse map of the [NII] emission shows at least one other HII region neighbouring the clump containing the UCHII. The FTS spectra are combined with ISO SWS and LWS spectra and fluxes from the literature to present a detailed spectrum of the source spanning three orders of magnitude in wavelength. The quality of the spectrum longwards of 100 μm allows us to fit a single temperature greybody with temperature 80.3 ± 0.6 K and dust emissivity index 1.73 ± 0.02, an accuracy rarely obtained with previous instruments. We estimate a mass of 1500 $M_\odot$ for the clump containing the HII region. The clump's bolometeric luminosity of 4×10^6 $L_\odot$ is comparable to, or slightly greater than, the known O-star powering the UCHII region.

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Ring-like features around young B stars

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Aims: To investigate the nature of two targets namely IRAS20293+3952 and IRAS05358+3843, which display, well defined H_2 emission rings around young intermediate mass stars.
Methods: Hi-Res deconvolution of finely sampled 3.6–8.0 μm Spitzer-IRAC images of IRAS20293+3952 and IRAS05358+3843 are carried out. Continuum-subtracted 2.122 μm H_2 1-0 S(1) narrow-band images of both targets and HK band spectrum of two main stars in IRAS20293+3952 is presented. The Spectral energy distibutions (SED) of the stars enclosed in the H_2 rings are constructed using photometry from the literature and combining with newly obtained Spitzer-MIPS 70 μm photometry. The SEDs are modelled using a popular grid of radiative transfer models to obtain estimates of the star, disk and envelope physical parameters.
Results: The Hi-Res processed Spitzer-IRAC images and the the continuum-subtracted narrow-band images reveal ring-like structures surrounding isolated young B-type stars. The modelling attributes a mass and age of $\sim$7 $M_\odot$ and $\sim$0.1 Myr respectively to the young stars, in agreement with other observational indicators. The HK band spectra of I20293 display the Brackett series of HI recombination lines, localised on the young star in this source. The ring around I20293 appears as a single well defined ellipse with the inner parts shining brightly in the Spitzer broad band images and the outer parts displaying strong H_2 emission. In the source I05358, at least two ring's are found, one circumscribing the other. The emission in the Spitzer bands and the H_2 emission are mostly coincident for the inner ring. The outer ring is visible partly in the Spitzer bands and partly in H_2 emission. The rings in both the sources, I20293 and I05358, have diameters of $\sim$25000-30000 AU. The envelope sizes estimated by the SED modelling is consistent with the size of the rings estimated using the imaging data. The spectrum of H_2 ring in I20293 is suggestive of flourescent excitation. In the source I05358, the inner ring display a combination of PAH and H_2 line emission with excess PAH emission closer to the star.

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Scattered H-alpha emission from a large translucent cloud G294-24

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We study an undocumented large translucent cloud, detected by means of its enhanced radiation on the SHASSA (Southern H-Alpha Sky Survey Atlas) survey. We consider whether its excess surface brightness can be explained by light scattered off the dust grains in the cloud, or whether emission from in situ ionized gas is required. In addition, we aim to determine the temperature of dust, the mass of the cloud, and its possible star formation activity.

We compare the observed H-alpha surface brightness of the cloud with predictions of a radiative transfer model. We use the WHAM (Wisconsin H-Alpha Mapper) survey as a source for the Galactic H-alpha interstellar radiation field illuminating the cloud. Visual extinction through the cloud is derived using 2MASS J, H, and K band photometry. We use far-IR ISOSS (ISO Serendipitous Survey), IRAS, and DIRBE data to study the thermal emission of dust. The LAB (The Leiden/Argentine/Bonn Galactic HI Survey) is used to study 21cm HI emission associated with the cloud.

Radiative transfer calculations of the Galactic diffuse H-alpha radiation indicate that the surface brightness of the cloud can be explained solely by radiation scattered off dust particles in the cloud. The maximum visual extinction through the cloud is about 1.2mag. The cloud is found to be associated with 21cm HI emission at a velocity of about -9 km/s. The total mass of the cloud is about 550-1000 solar masses . There is no sign of star formation in this cloud. The distance of the cloud is estimated from the Hipparcos data to be about 100 pc.

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The structured environments of embedded star-forming cores. PACS and SPIRE mapping of the enigmatic outflow source UYSO 1.

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The intermediate-mass star-forming core UYSO 1 has previously been found to exhibit intriguing features. While deeply embedded and previously only identified by means of its (sub-)millimetre emission, it drives two powerful, dynamically young, molecular outflows. Although the process of star formation has obviously started, the chemical composition is still pristine. We present Herschel PACS and SPIRE continuum data of this presumably very young region. The now complete coverage of the spectral energy peak allows us to precisely constrain the elevated temperature of 26 − 28 K for the main bulge of gas associated with UYSO1, which is located at the interface between the hot HII region Sh 2-297 and the cold dark nebula LDN 1657A. Furthermore, the data identify cooler compact far-infrared sources of just a few solar masses, hidden in this neighbouring dark cloud.

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The CO luminosity and CO-H_2 conversion factor of diffuse ISM: does CO emission trace dense molecular gas?

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In this paper, we wish to separate and quantify the CO luminosity and CO-H_2 conversion factor applicable to diffuse but partially-molecular ISM when H_2 and CO are present but C^+ is the dominant form of gas-phase carbon.

We discuss galactic lines of sight observed in HI, HCO^+ and CO where CO emission is present but the intervening

clouds are diffuse (locally $A_V \lesssim 1$ mag) with relatively small CO column densities $N_{CO} \lesssim 2 \times 10^{16}$ cm^{-2}. We separate the atomic and molecular fractions statistically using E_{B-V} as a gauge of the total gas column density and compare N_{H_2} to the observed CO brightness.

Although there are H_2-bearing regions where CO emission is too faint to be detected, the mean ratio of integrated CO brightness to N_{H_2} for diffuse ISM does not differ from the usual value of $1\,K\,km\,s^{-1}$ of integrated CO brightness per 2×10^{20} H_2 cm^{-2} . Moreover, the luminosity of diffuse CO viewed perpendicular to the galactic plane is 2/3 that seen at the Solar galactic radius in surveys of CO emission near the galactic plane.

Commonality of the CO-H_2 conversion factors in diffuse and dark clouds can be understood from considerations of radiative transfer and CO chemistry. There is unavoidable confusion between CO emission from diffuse and dark gas and misattribution of CO emission from diffuse to dark or giant molecular clouds. The character of the ISM is different from what has been believed if CO and H_2 that have been attributed to molecular clouds on the verge of star formation are actually in more tenuous, gravitationally-unbound diffuse gas.

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Gas in Protoplanetary Systems (GASPS) I. First results

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Context. Circumstellar discs are ubiquitous around young stars, but rapidly dissipate their gas and dust on timescales of a few Myr. The Herschel space observatory allows for the study of the warm disc atmosphere, using far-infrared spectroscopy to measure gas content and excitation conditions, and far-IR photometry to constrain the dust distribution.
Aims. We aim to detect and characterize the gas content of circumstellar discs in four targets as part of the Herschel science demonstration phase.
Methods. We carried out sensitive medium resolution spectroscopy and high sensitivity photometry at lambda 60-190 μm using the Photodetector Array Camera and Spectrometer instrument on the Herschel space observatory.
Results. We detect [OI] 63 μm emission from the young stars HD 169142, TW Hydrae, and RECX 15, but not HD 181327. No other lines, including [CII] 158 and [OI] 145, are significantly detected. All four stars are detected in photometry at 70 and 160 μm. Extensive models are presented in associated papers.

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Gas in the protoplanetary disc of HD 169142: *Herschel*'s view

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In an effort to simultaneously study the gas and dust components of the disc surrounding the young Herbig Ae star HD 169142, we present far-IR observations obtained with the PACS instrument onboard the *Herschel* Space Observatory. This work is part of the Open Time Key Project GASPS, which is aimed at studying the evolution of protoplanetary discs. To constrain the gas properties in the outer disc, we observed the star at several key gas-lines, including [OI] 63.2 and 145.5 μm, [CII] 157.7 μm, CO 72.8 and 90.2 μm, and o-H_2O 78.7 and 179.5 μm. We only detect the [OI] 63.2 μm line in our spectra, and derive upper limits for the other lines. We complement our data set with PACS photometry and $^{12/13}$CO data obtained with the Submillimeter Array. Furthermore, we derive accurate stellar parameters from optical spectra and UV to mm photometry. We model the dust continuum with the 3D radiative transfer code MCFOST and use this model as an input to analyse the gas lines with the thermo-chemical code ProDiMo. Our dataset is consistent with a simple model in which the gas and dust are well-mixed in a disc with a continuous structure between 20 and 200 AU, but this is not a unique solution. Our modelling effort allows us to constrain the gas-to-dust mass ratio as well as the relative abundance of the PAHs in the disc by simultaneously fitting the lines of several species that originate in different regions. Our results are inconsistent with a gas-poor disc with a large UV excess; a gas mass of $5.0 \pm 2.0 \times 10^{-3}$ $M_\odot$ is still present in this disc, in agreement with earlier CO observations.

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Will soon appear on astro-ph

Filamentary structures and compact objects in the Aquila and Polaris clouds observed by *Herschel*

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Our PACS and SPIRE images of the Aquila Rift and part of the Polaris Flare regions, taken during the science demonstration phase of *Herschel* discovered fascinating, omnipresent filamentary structures that appear to be physically related to compact cores. We briefly describe a new multi-scale, multi-wavelength source extraction method used to detect objects and measure their parameters in our *Herschel* images. All of the extracted starless cores (541 in Aquila and 302 in Polaris) appear to form in the long and very narrow filaments. With its combination of the far-IR resolution and sensitivity, *Herschel directly* reveals the filaments in which the dense cores are embedded; the filaments are resolved and have deconvolved widths of $\sim$ 35" in Aquila and $\sim$ 59" in Polaris ($\sim$ 9000 AU in both regions). Our first results of observations with *Herschel* enable us to suggest that in general dense cores may originate in a process of fragmentation of complex networks of long, thin filaments, likely formed as a result of an interplay between gravity, interstellar turbulence, and magnetic fields. To unravel the roles of the processes, one has to obtain additional kinematic and polarization information; these follow-up observations are planned.

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Locating the planetesimals belts in the multiple-planet systems HD 128311, HD 202206, HD 82943 and HR 8799

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In addition to the Sun, six other stars are known to harbor multiple planets and debris disks: HD 69830, HD 38529, HD 128311, HD 202206, HD 82943 and HR 8799. In this paper we set constraints on the location of the dust-producing planetesimals around the latter four systems. We use a radiative transfer model to analyze the spectral energy distributions of the dust disks (including two new *Spitzer IRS* spectra presented in this paper), and a dynamical model to assess the long-term stability of the planetesimals' orbits. As members of a small group of stars that show evidence of harboring a multiple planets and planetesimals, their study can help us learn about the diversity of planetary systems.

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Revising the kinematics of 12 GHz CH3OH masers towards W3(OH)

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We derive accurate proper motions of the CH_3OH 12 GHz masers towards the W3(OH) UC HII region, employing seven epochs of VLBA observations spanning a time interval of about 10 yr. The achieved velocity accuracy is of the order of 0.1 km s^{-1}, adequate to precisely measure the relative velocities of most of the 12 GHz masers in W3(OH), with amplitude varying in the range 0.3–3 km s^{-1}. Towards W3(OH), the most intense 12 GHz masers concentrate in a small area towards the north (the northern clump) of the UC HII region. We have compared the proper motions of the CH_3OH 12 GHz masers with those (derived from literature data) of the OH 6035 MHz masers, emitting from the same region of the methanol masers. In the northern clump, the two maser emissions emerge from nearby (but likely distinct) cloudlets of masing gas with, in general, a rather smooth variation of line-of-sight and sky-projected velocities, which suggests some connection of the environments and kinematics traced by both maser types. The conical outflow model, previously proposed to account for the 12 GHz maser kinematics in the northern clump, does not reproduce the new, accurate measurements of 12 GHz maser proper motions and has to be rejected. We focus on the subset of 12 GHz masers of the northern clump belonging to the "linear structure at P.A. = 130^0–140^0", whose regular variation of LSR velocities with position presents evidence for some ordered motion. We show that the 3-dimensional velocities of this "linear distribution" of 12 GHz masers can be well fitted considering a flat, rotating disk, seen almost edge-on.

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Initial highlights of the HOBYS Key Program, the Herschel imaging survey of OB young stellar objects

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We present the initial highlights of the HOBYS Key Program, which are based on *Herschel* images of the Rosette molecular complex and maps of the RCW120 H II region. Using both SPIRE at 250/350/500 μm and PACS at 70/160 μm or 100/160 μm, the HOBYS survey provides an unbiased and complete census of intermediate- to high-mass young stellar objects, some of which are not detected by *Spitzer*. Key core properties, such as bolometric luminosity and mass (as derived from spectral energy distributions), are used to constrain their evolutionary stages. We identify a handful of high-mass prestellar cores and show that their lifetimes could be shorter in the Rosette molecular complex than in nearby low-mass star-forming regions. We also quantify the impact of expanding H II regions on the star formation process acting in both Rosette and RCW 120.

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Soon on astro-ph http://arxiv.org/find/all/1/AND+au:+Motte+ti:+HOBYS/0/1/0/all/0/1

A cold complex chemistry toward the low-mass protostar B1-b: evidence for complex molecule production in ice

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Gas-phase complex organic molecules have been detected toward a range of high- and low-mass star-forming regions at abundances which cannot be explained by any known gas-phase chemistry. Recent laboratory experiments show that UV irradiation of CH_3OH-rich ices may be an important mechanism for producing complex molecules and releasing them into the gas-phase. To test this ice formation scenario we mapped the B1-b dust core and nearby protostar in CH_3OH gas using the IRAM 30m telescope to identify locations of efficient non-thermal ice desorption. We find three CH_3OH abundance peaks tracing two outflows and a quiescent region on the side of the core facing the protostar. The CH_3OH gas has a rotational temperature of ~10 K at all locations. The quiescent CH_3OH abundance peak and one outflow position were searched for complex molecules. Narrow, 0.6-0.8 km s^{-1} wide, $HCOOCH_3$ and CH_3CHO lines originating in cold gas are clearly detected, CH_3OCH_3 is tentatively detected and C_2H_5OH and $HOCH_2CHO$ are undetected toward the quiescent core, while no complex molecular lines were found toward the outflow. The core abundances with respect to CH_3OH are ~2.3% and 1.1% for $HCOOCH_3$ and CH_3CHO, respectively, and the upper limits are 0.7–1.1%, which is similar to most other low-mass sources. The observed complex molecule characteristics toward B1-b and the pre-dominance of HCO-bearing species suggest a cold ice (below 25 K, the sublimation temperature of CO) formation pathway followed by non-thermal desorption through e.g. UV photons traveling through outflow cavities. The observed complex gas composition together with the lack of any evidence of warm gas-phase chemistry thus provide clear evidence of efficient complex molecule formation in cold interstellar ices.

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The sequence of low and high mass star formation in the young stellar cluster IRAS 19343+2026

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BVRIJHK photometry, *Spitzer*-GLIMPSE photometry and *HK* band spectroscopy were used to study the stellar content of IRAS 19343+2026, a (proto)star/cluster candidate, located close to the Galactic plane. The data suggest that IRAS 19343+2026 is a rich cluster associated with a massive protostar of 7.6 $M_\odot$ with an age of $\sim 10^5$ yr. Three point sources in the vicinity of the far-infrared (FIR) peak are also found to be early B type stars. The remaining (predominantly low mass) members of the cluster are best represented by a 1 - 3 Myr pre-main-sequence (PMS) population. *HK* band spectra of two bright and five faint point sources in the cluster confirm that the results obtained from the photometry are good representations of their young stellar object (YSO) nature. Thus, IRAS 19343+2026 is a young cluster with at least four early B-type stars classified as young (10^4 - 10^5 yr), that are surrounded by a somewhat older (1 - 3 Myr) population of low mass YSOs. Together, these results argue for a scenario in which low mass stars form prior to massive stars in a cluster forming environment. We compute the Initial Mass Function (IMF) for this cluster using the *K*-band luminosity function; the slope of the IMF is shallower than predicted by the Salpeter's mass function. The cluster mass, $M_{\rm total}$, is estimated to be in the range $\sim$ 307 $M_\odot$ (from the data completeness limit) - 585 $M_\odot$ (extrapolated down to the brown dwarf limit, assuming a certain IMF).

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A Spitzer Survey of Protoplanetary Disk Dust in the Young Serpens Cloud: How do Dust Characteristics Evolve with Time?

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We present *Spitzer* IRS mid-infrared (5–35 μm) spectra of a complete flux-limited sample ($\geq$ 3 mJy at 8 μm) of young stellar object (YSO) candidates selected on the basis of their infrared colors in the Serpens Molecular Cloud. Spectra of 147 sources are presented and classified. Background stars (with slope consistent with a reddened stellar spectrum and silicate features in absorption), galaxies (with redshifted PAH features) and a planetary nebula (with high ionization lines) amount to 22% of contamination in this sample, leaving 115 true YSOs. Sources with rising spectra and ice absorption features, classified as embedded Stage I protostars, amount to 18% of the sample. The remaining 82% (94) of the disk sources are analyzed in terms of spectral energy distribution shapes, PAHs and silicate features. The presence, strength and shape of these silicate features are used to infer disk properties for these systems. About 8% of the disks have 30/13 μm flux ratios consistent with cold disks with inner holes or gaps, and 3% of the disks show PAH emission. Comparison with models indicates that dust grains in the surface of these disks have sizes of at least a few μm. The 20 μm silicate feature is sometimes seen in absence of the 10 μm feature, which may be indicative of very small holes in these disks. No significant difference is found in the distribution of silicate feature shapes and strengths between sources in clusters and in the field. Moreover, the results in Serpens are compared with other well-studied samples: the c2d IRS sample distributed over 5 clouds and a large sample of disks in the Taurus

star-forming region. The remarkably similar distributions of silicate feature characteristics in samples with different environment and median ages – if significant – imply that the dust population in the disk surface results from an equilibrium between dust growth and destructive collision processes that are maintained over a few million years for any YSO population irrespective of environment.

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Self-Correlation Analysis of the Photometric Variability of T Tauri Stars. II. A Survey

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We have used Fourier and self-correlation analysis to study the photometric time variability of 162 T Tauri stars and related objects, including Herbig Ae/Be stars. Many show periodic variability, presumably due to rotation of a spotted star in most cases. For the non-periodic stars, we have estimated an upper limit to the periodic variability. We have also analyzed 26 stars suspected to have periods longer than 10 days. Of these 26 stars, at least 14 have periods significantly longer than 10 days; their variability may be due to processes in the disc, or the effect of a companion, since most (but not all) T Tauri stars have rotational periods less than this value. For a few of the rotational variables, namely AA Tau, DK Tau, DL Tau, DN Tau, GK Tau, GM Aur, Rox 29, V1121 Oph, V410 Tau, and V649 Ori, we have found long-term variability of the amplitude, presumably due to activity cycles; the time scales are 1500-4000 days.

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Results from DROXO. III. Observation, source list and X-ray properties of sources detected in the "Deep Rho Ophiuchi XMM-Newton Observation"

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X-rays from very young stars are powerful probes to investigate the mechanisms at work in the very first stages of the star formation and the origin of X-ray emission in very young stars. We present results from a 500 ks long observation of the Rho Ophiuchi cloud with a XMM-Newton large program named DROXO, aiming at studying the X-ray emission of deeply embedded young stellar objects (YSOs). The data acquired during the DROXO program were reduced with SAS software, and filtered in time and energy to improve the signal to noise of detected sources; light curves and spectra were obtained. We detected 111 sources, 61 of them associated with ρ Ophiuchi YSOs as identified from infrared observations with ISOCAM. Specifically, we detected 9 out of 11 Class I objects, 31 out of 48 Class II and 15 out 16 Class III objects. Six objects out of 21 classified Class III candidates are also detected. At the same time we suggest that 15 Class III candidates that remain undetected at $\log L_x$ [erg/s] < 28.3 are not related to the cloud population. The global detection rate is $\sim 64\%$. We have achieved a flux sensitivity of $\sim 5 \cdot 10^{-15}$ erg s^{-1} cm^{-2}. The L_X to L_{bol} ratio shows saturation at a value of ~ -3.5 for stars with $T_{eff} \leq 5000$ K or 0.7 M$\odot$ as observed in the Orion Nebula. The plasma temperatures and the spectrum absorption show a decline with YSO class, with Class I YSOs being hotter and more absorbed than Class II and III YSOs. In one star (GY 266) with infrared

counterpart in 2MASS and Spitzer catalogs we have detected a soft excess in the X-ray spectrum, which is best fitted by a cold thermal component less absorbed than the main thermal component of the plasma. This soft component hints at plasma heated by shocks due to jets outside the dense circumstellar material.

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Internal dynamics and membership of NGC 3603 Young Cluster from microarcsecond astrometry

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We have analyzed two epochs of HST/WFPC2 observations of the young Galactic starburst cluster in NGC 3603 with the aim to study its internal dynamics and stellar population. Relative proper motions measured over 10.15 yrs of more than 800 stars enable us to distinguish cluster members from field stars. The best-fitting isochrone yields A_V=4.6-4.7 mag, a distance of 6.6 to 6.9 kpc, and an age of 1 Myr for NGC 3603 Young Cluster (NYC). We identify pre-main sequence / main sequence transition stars located in the short-lived radiative-convective gap, which in the NYC occurs in the mass range 3.5 to 3.8 $M_\odot$. We also identify a sparse population of stars with an age of 4 Myr, which appear to be the lower mass counterparts to previously discovered blue supergiants located in the giant HII region NGC 3603. For the first time we are able to measure the internal velocity dispersion of a starburst cluster from 234 stars with $I < 18.5$ mag to $\sigma_{\rm pm1D} = 141 \pm 27\mu$as yr^{-1} ($4.5 \pm 0.8$ km s^{-1} at a distance of 6.75 kpc). As stars with masses between 1.7 and 9 $M_\odot$ all exhibit the same velocity dispersion, the cluster stars have not yet reached equipartition of kinetic energy (i.e. the cluster is not in virial equilibrium). The results highlight the power of combining high-precision astrometry and photometry, and emphasize the rôle of NYC as a benchmark object for testing stellar evolution models and dynamical models for young clusters and as a template for extragalactic starburst clusters.

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Physical properties of the Sh2-104 H II region as seen by *Herschel*

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Context: Sh2-104 is a Galactic H II region with a bubble morphology, detected at optical and radio wavelengths. It is considered the first observational confirmation of the collect-and-collapse model of triggered star-formation.
Aims: We aim to analyze the dust and gas properties of the Sh2-104 region to better constrain its effect on local future generations of stars. In addition, we investigate the relationship between the dust emissivity index β and the dust temperature, T_{dust}.
Methods: Using *Herschel* PACS and SPIRE images at 100, 160, 250, 350 and 500 μm we determine T_{dust} and β throughout Sh2-104, fitting the spectral energy distributions (SEDs) obtained from aperture photometry. With the SPIRE Fourier transform spectrometer (FTS) we obtained spectra at different positions in the Sh2-104 region. We detect J-ladders of ^{12}CO and ^{13}CO, with which we derive the gas temperature and column density. We also detect proxies of ionizing flux as the [NII] $^3P_1 -^3 P_0$ and [CI] $^3P_2 -^3 P_1$ transitions.
Results: We find an average value of $\beta \sim 1.5$ throughout Sh2-104, as well as a T_{dust} difference between the photodissociation region (PDR, ~ 25 K) and the interior (~ 40 K) of the bubble. We recover the anti-correlation between β and

dust temperature reported numerous times in the literature. The relative isotopologue abundances of CO appear to be enhanced above the standard ISM values, but the obtained value is very preliminary and is still affected by large uncertainties.

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Three-dimensional molecular line transfer: A simulated star-forming region

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We present the first non-LTE, co-moving frame molecular line calculations of a star-forming cluster simulated using smoothed particle hydrodynamics (SPH), from which we derive high-resolution synthetic observations. We have resampled a particle representation onto an adaptive mesh and self-consistently solved the equations of statistical equilibrium in the co-moving frame, using TORUS, a three-dimensional adaptive mesh refined (AMR) radiative transfer (RT) code. We verified the applicability of the code to the conditions of the SPH simulation by testing its output against other codes. We find that the level populations obtained for optically thick and thin scenarios closely match the ensemble average of the other codes. We have used the code to obtain non-LTE level populations of multiple molecular species throughout the cluster and have created three-dimensional velocity-resolved spatial maps of the emergent intensity. Line profiles of cores traced by N_2H^+ (1-0) are compared to probes of low density gas, ^{13}CO (1-0) and $C^{18}O$ (1-0) surrounding the cores along the line of sight. The relative differences of the line-centre velocities are shown to be small compared to the velocity dispersion, matching recent observations. We conclude that one cannot reject competitive accretion as a viable theory of star formation based on observed velocity profiles.

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Molecular Outflows within the Filamentary Infrared Dark Cloud G34.43+0.24

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We present molecular line observations, made with angular resolutions of ~20 arcsec, toward the filamentary infrared dark cloud G34.43+0.24 using the APEX [$CO(3 \rightarrow 2)$, $^{13}CO(3 \rightarrow 2)$, $C^{18}O(3 \rightarrow 2)$ and $CS(7 \rightarrow 6)$ transitions], Nobeyama 45 m [$CS(2 \rightarrow 1)$, $SiO(2 \rightarrow 1)$, $C^{34}S(2 \rightarrow 1)$, $HCO^+(1 \rightarrow 0)$, $H^{13}CO^+(1 \rightarrow 0)$ and $CH_3OH(2 \rightarrow 1)$ transitions] , and SEST [$CS(2 \rightarrow 1)$ and $C^{18}O(2 \rightarrow 1)$ transitions] telescopes. We find that the spatial distribution of the molecular emission is similar to that of the dust continuum emission observed with 11 arcsec resolution showing a filamentary structure and four cores. The cores have local thermodynamic equilibrium masses ranging from 3.3×10^2 – 1.5×10^3 $M_\odot$ and virial masses from $1.1 \times 10^3 - 1.5 \times 10^3$ $M_\odot$, molecular hydrogen densities between 1.8×10^4 and 3.9×10^5 cm^{-3}, and column densities $> 2.0 \times 10^{22}$ cm^{-2}; values characteristics of massive star forming cores. The $^{13}CO(3 \rightarrow 2)$ profile observed toward the most massive core reveals a blue profile indicating that the core is undergoing large–scale inward motion with an average infall velocity of 1.3 km s^{-1} and a mass infall rate of 1.8×10^{-3} $M_\odot$ yr^{-1}. We report the discovery of a molecular outflow toward the northernmost core thought to be in a very early stage of evolution. We also detect the presence of high velocity gas toward each of the other three cores, giving support to the hypothesis that the excess 4.5 μm emission ("green fuzzies") detected toward these cores is due to shocked gas. The molecular outflows are massive and energetic, with masses ranging from 25 – 80 $M_\odot$, momentum $2.3 - 6.9 \times 10^2$ $M_\odot$ km s^{-1}, and kinetic energies $1.1 - 3.6 \times 10^3$ $M_\odot$ km^2 s^{-2}; indicating that they are driven by luminous, high-mass young stellar objects.

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VLBI study of maser kinematics in high-mass SFRs. I. G16.59–0.05

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Aims. To study the high-mass star-forming process, we started a large project to unveil the gas kinematics close to young stellar objects (YSOs) through the Very Long Baseline Interferometry (VLBI) of maser associations. By comparing the high spatial resolution maser data that traces the inner kinematics of the (proto)stellar cocoon with interferometric thermal data that traces the large-scale environment of the hot molecular core (HMC) harboring the (proto)stars, we can investigate the nature and identify the sources of large-scale motions. The present paper focuses on the high-mass, star-forming region G16.59–0.05. *Methods.* Using the VLBA and the EVN arrays, we conducted phase-referenced observations of the three most powerful maser species in G16.59–0.05: H_2O at 22.2 GHz (4 epochs), CH_3OH at 6.7 GHz (3 epochs), and OH at 1.665 GHz (1 epoch). In addition, we performed high-resolution ($\geq 0\farcs1$), high-sensitivity (< 0.1 mJy) VLA observations of the radio continuum emission from the star-forming region at 1.3 and 3.6 cm. *Results.* This is the first work to report accurate measurements of the *relative* proper motions of the 6.7 GHz CH_3OH masers. The different spatial and 3-D velocity distributions clearly indicate that the 22 GHz water and 6.7 GHz methanol masers trace different kinematic environments. The bipolar distribution of 6.7 GHz maser line of sight velocities and the regular pattern of observed proper motions suggest that these masers are tracing rotation around a central mass of about 35 $M_\odot$. The flattened spatial distribution of the 6.7 GHz masers, oriented NW–SE, suggests that they can originate in a disk/toroid rotating around the massive YSO that drives the ^{12}CO (2–1) outflow, oriented NE–SW, observed on an arcsec scale. The extended, radio continuum source observed close to the 6.7 GHz masers could be excited by a wide-angle wind emitted from the YSO associated with the methanol masers, and such a wind has proven to be energetic enough to drive the NE–SW ^{12}CO (2–1) outflow. The H_2O masers are distributed across a region offset about $0\farcs5$ to the NW of the CH_3OH masers, in the same area as where the emission of high-density molecular tracers, typical of HMCs, was detected. We postulate that a distinct YSO, possibly in an earlier evolutionary phase than what excites the methanol masers, is responsible for the excitation of the water masers and the HMC molecular lines.

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VLBI study of maser kinematics in high-mass SFRs. II. G23.01–0.41

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Aims. We performed a detailed study of maser and radio continuum emission toward the high-mass star-forming region G23.01–0.41. This study aims at improving our knowledge of the high-mass star-forming process by comparing the gas kinematics near a newly born young stellar object (YSO), analyzed through high spatial resolution maser data, with the large-scale environment of its native hot molecular core (HMC), identified in previous interferometric observations of thermal continuum and molecular lines. *Methods.* Using the VLBA and the EVN arrays, we conducted phase-referenced observations of the three most powerful maser species in G23.01–0.41: H_2O at 22.2 GHz (4 epochs), CH_3OH at 6.7 GHz (3 epochs), and OH at 1.665 GHz (1 epoch). In addition, we performed high-resolution ($\geq 0\farcs1$), high-sensitivity (< 0.1 mJy) VLA observations of the radio continuum emission from the HMC at 1.3 and 3.6 cm. *Results.* We have detected H_2O, CH_3OH, and OH maser emission clustered within 2000 AU from the center of a flattened HMC, oriented SE–NW, from which emerges a massive ^{12}CO outflow, elongated NE–SW, extended up to the pc-scale. Although the three maser species show a clearly different spatial and velocity distribution and sample

distinct environments around the massive YSO, the spatial symmetry and velocity field of each maser specie can be explained in terms of expansion from a common center, which possibly denotes the position of the YSO driving the maser motion. Water masers trace both a fast shock (up to 50 km s^{-1}) closer to the YSO, powered by a wide-angle wind, and a slower (20 km s^{-1}) bipolar jet, at the base of the large-scale outflow. Because the compact free-free emission is found offset from the putative location of the YSO along a direction consistent with that of the maser jet axis, we interpret the radio continuum in terms of a thermal jet. The velocity field of methanol masers can be explained in terms of a composition of slow (4 km s^{-1} in amplitude) motions of radial expansion and rotation about an axis approximately parallel to the maser jet. Finally, the distribution of line-of-sight velocities of the hydroxyl masers suggests that they can trace gas less dense ($n_{H_2} \leq 10^6$ cm^{-3}) and more distant from the YSO than that traced by the water and methanol masers, which is expanding toward the observer. A few pairs of OH masers, with different circular polarization, are well aligned in position on the sky and we interpret them as Zeeman pairs. From Zeeman splitting, the derived typical values of the magnetic field are of a few mG.

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Spatially resolved detection of crystallized water ice in a T Tauri object

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We search for frozen water and its processing around young stellar objects (YSOs of class I/II). We try to detect potential, regional differences in water ice evolution within YSOs, which is relevant to understanding the chemical structure of the progenitors of protoplanetary systems and the evolution of solid materials. Water plays an important role as a reaction bed for rich chemistry and is an indispensable requirement for life as known on Earth. We present our analysis of NAOS-CONICA/VLT spectroscopy of water ice at 3um for the TTauri star YLW 16A in the rho-Ophiuchi molecular cloud. We obtained spectra for different regions of the circumstellar environment. The observed absorption profiles are deconvolved with the mass extinction profiles of amorphous and crystallized ice measured in laboratory. We take into account both absorption and scattering by ice grains. Water ice in YLW 16A is detected with optical depths of between tau=1.8 and tau=2.5. The profiles that are measured can be fitted predominantly by the extinction profiles of small grains (0.1um - 0.3um) with a small contribution from large grains. However, an unambiguous trace of grain growth cannot be found. We detected crystallized water ice spectra that have their origin in different regions of the circumstellar environment of the TTauri star YLW 16A. The crystallinity increases in the upper layers of the circumstellar disk, while only amorphous grains exist in the bipolar envelope. As in studies of silicate grains in TTauri objects, the higher crystallinity in the upper layers of the outer disk regions implies that water ice crystallizes and remains crystallized close to the disk atmosphere where water ice is shielded against hard irradiation.

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A Comparative Study of High-mass Cluster Forming Clumps

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Aims: We have searched for star formation activity (mainly infall and outflow signatures) in a sample of high-mass molecular clumps ($M > 100$ $M_{\odot}$) in different evolutionary stages and with a wide range of surface densities, with the aim of looking for evolutionary trends and testing observationally recent theoretical models which predict the need for a minimum surface density to form high-mass stars.
Methods: Our sample has been selected from single-dish 1.2 mm continuum surveys and is composed of 48 massive molecular clumps, of which 29 are IR-loud and 19 are IR-dark. Each of these has been mapped in the HCO^+(1–

0), HCN(1–0) and $C^{18}O$(2–1) transitions with the IRAM-30m telescope on Pico Veleta (Spain). We derive basic parameters (mass, momentum, kinetic energy) for the clumps and their associated outflows and examine the HCO^+(1–0) line profiles for evidence of infall or expansion.
Results: Molecular outflows have been detected in 75% of our targets from the presence of high-velocity wings in the HCO^+(1–0) spectra. These are equally frequent and massive (between ∼1 and ∼100 $M_\odot$) in IR-dark and IR-loud clumps, implying similar levels of star formation activity in both kinds of objects. A surface density threshold at $\Sigma = 0.3$ g cm^{-2} has been found above which the outflow detection rate increases significantly and the outflows are on average more massive. The infall detection rate in our sample is low, but significantly higher in the IR-dark sub-sample. Our clump mass estimates using the mm dust emission and $C^{18}O$(2–1) are sensitive to the temperature, but assuming a value of 15 K for the IR-dark sub-sample, we find evidence that $C^{18}O$ is depleted by a factor ∼4.5. The HCO^+(1–0) to HCN(1–0) integrated intensity ratios measured reveal a greater dispersion about the mean value in the IR-dark sub-sample than in the IR-loud by a factor of about 5. We find that a considerable number of IR-dark sources are self-absorbed in HCN(1–0) suggesting that radiative transport effects in the ground state transitions have an important influence on the integrated intensity ratio.
Conclusions: Our results indicate that, in terms of outflow frequency and energetics, both IR-dark and IR-loud molecular clumps present equivalent signatures of star formation activity, and that the formation of high-mass stars requires sufficiently high clump surface densities. The higher infall detection rate measured for the IR-dark subsample suggests that these objects could be associated with the onset of star formation.

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Hier ist wahrhaftig ein Loch im Himmel - The NGC 1999 dark globule is not a globule

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The NGC 1999 reflection nebula features a dark patch with a size of ∼10,000 AU, which has been interpreted as a small, dense foreground globule and possible site of imminent star formation. We present *Herschel* PACS far-infrared 70 and 160 μm maps, which reveal a flux deficit at the location of the globule. We estimate the globule mass needed to produce such an absorption feature to be a few tenths to a few $M_\odot$. Inspired by this *Herschel* observation, we obtained APEX LABOCA and SABOCA submillimeter continuum maps, and Magellan PANIC near–infrared images of the region. We do not detect a submillimer source at the location of the *Herschel* flux decrement; furthermore our observations place an upper limit on the mass of the globule of $\sim 2.4 \cdot 10^{-2}\,M_\odot$. Indeed, the submillimeter maps appear to show a flux depression as well. Furthermore, the near–infrared images detect faint background stars that are less affected by extinction inside the dark patch than in its surroundings. We suggest that the dark patch is in fact a hole or cavity in the material producing the NGC 1999 reflection nebula, excavated by protostellar jets from the V 380 Ori multiple system.

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Tidally induced brown dwarf and planet formation in circumstellar discs

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Most stars are born in clusters and the resulting gravitational interactions between cluster members may significantly affect the evolution of circumstellar discs and therefore the formation of planets and brown dwarfs. Recent findings suggest that tidal perturbations of typical circumstellar discs due to close encounters may inhibit rather than trigger disc fragmentation and so would seem to rule out planet formation by external tidal stimuli. However, the disc models in these calculations were restricted to disc radii of 40 AU and disc masses below 0.1 $M_\odot$. Here we show that even modest encounters can trigger fragmentation around 100 AU in the sorts of massive ($\sim 0.5\,M_\odot$), extended ($\geq 100\,$AU) discs that are observed around young stars. Tidal perturbation alone can do this, no disc-disc collision is required. We also show that very-low-mass binary systems can form through the interaction of objects in the disc. In our computations, otherwise non-fragmenting massive discs, once perturbed, fragment into several objects between about 0.01 and 0.1 $M_\odot$, i.e. over the whole brown dwarf mass range. Typically these orbit on highly eccentric orbits or are even ejected. While probably not suitable for the formation of Jupiter- or Neptune-type planets, our scenario provides a possible formation mechanism for brown dwarfs and very massive planets which, interestingly, leads to a mass distribution consistent with the canonical substellar IMF. As a minor outcome, a possible explanation for the origin of misaligned extrasolar planetary systems is discussed.

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http://arxiv.org/abs/1005.3017 (preprint)
http://www.astro.uni-bonn.de/~webaiub/english/downloads.php (movies)

Statistical Analysis of Water Masers in Star Forming Regions: Cepheus A and W75 N

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We have done a statistical analysis of Very Long Baseline Array (VLBA) data of water masers in the star-forming

regions (SFRs) Cepheus A and W75 N, using correlation functions to study the spatial clustering and Doppler-velocity distribution of these masers. Two-point spatial correlation functions show a characteristic scale size for clusters of water maser spots $\lesssim 1$ AU, similar to the values found in other SFRs. This suggests that the scale for water maser excitation tends to be $\lesssim 1$ AU. Velocity correlation functions show power-law dependences with indices that can be explained by regular velocity fields, such as expansion and/or rotation. These velocity fields are similar to those indicated by the water maser proper-motion measurements; therefore, the velocity correlation functions appear to reveal the organized motion of water maser spots on scales larger than 1 AU.

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Water abundance variations around high-mass protostars: HIFI observations of the DR21 region

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Context Water is a key molecule in the star formation process, but its spatial distribution in star-forming regions is not well known.
Aims We study the distribution of dust continuum and H_2O and ^{13}CO line emission in DR21, a luminous star-forming region with a powerful outflow and a compact H II region.
Methods *Herschel*-HIFI spectra near 1100 GHz show narrow ^{13}CO 10−9 emission and H_2O $1_{11} - 0_{00}$ absorption from the dense core and broad emission from the outflow in both lines. The H_2O line also shows absorption by a foreground cloud known from ground-based observations of low-J CO lines.
Results The dust continuum emission is extended over 36″ FWHM, while the ^{13}CO and H_2O lines are confined to ≈24″ or less. The foreground absorption appears to peak further North than the other components. Radiative transfer models indicate very low abundances of $\sim 2\times10^{-10}$ for H_2O and $\sim 8\times10^{-7}$ for ^{13}CO in the dense core, and higher H_2O abundances of $\sim 4\times10^{-9}$ in the foreground cloud and $\sim 7\times10^{-7}$ in the outflow.
Conclusions The high H_2O abundance in the warm outflow is probably due to the evaporation of water-rich icy grain mantles, while the H_2O abundance is kept down by freeze-out in the dense core and by photodissociation in the foreground cloud.

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http://arxiv.org/abs/1005.2903

Dust, Ice, and Gas In Time (DIGIT) Herschel program first results: A full PACS-SED scan of the gas line emission in protostar DK Cha

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We aim to study the composition and energetics of the circumstellar material of DK Cha, an intermediate-mass star in transition from an embedded configuration to a star plus disk stage, during this pivotal stage of its evolution. Using the Range Scan mode of PACS on the Herschel Space Observatory, we obtained a spectrum of DK Cha from 55 to 210 μm as part of the DIGIT Key Program. Almost 50 molecular and atomic lines were detected, many more than the 7 lines detected in ISO-LWS. Nearly the entire ladder of CO from J=14-13 to 38-37 ($E_u/k = 4080$ K), water from

levels as excited as $J_{K_{-1}K_{+1}} = 7_{07}$ ($E_u/k = 843$ K), and OH lines up to $E_u/k = 290$ K were detected. The continuum emission in our PACS SED scan matches the flux expected by a model consisting of a star, a surrounding disk of 0.03 $M_\odot$, and an envelope of a similar mass, supporting the suggestion that the object is emerging from its main accretion stage. Molecular, atomic, and ionic emission lines in the far-infrared reveal the outflow's influence on the envelope. The inferred hot gas may be photon-heated, but some emission may be caused by C-shocks in the walls of the outflow cavity.

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Sub-Keplerian accretion onto circumstellar disks

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Context. Models of the formation, evolution and photoevaporation of circumstellar disks are an essential ingredient in many theories of the formation of planetary systems. The ratio of disk mass over stellar mass in the circumstellar phase of a disk is for a large part determined by the angular momentum of the original cloud core from which the system was formed. While full 3D or 2D axisymmetric hydrodynamical models of accretion onto the disk automatically treat all aspects of angular momentum, this is not so trivial for 1D and semi-2D viscous disk models.
Aims. Since 1D and semi-2D disk models are still very useful for long-term evolutionary modelling of disks with relatively little numerical effort, we investigate how the 2D nature of accretion affects the formation and evolution of the disk in such models. A proper treatment of this problem requires a correction for the sub-Keplerian velocity at which accretion takes place.
Methods. We develop an update of our semi-2D time-dependent disk evolution model to properly treat the effects of sub-Keplerian accretion. The new model also accounts for the effects of the vertical extent of the disk on the accretion streamlines from the envelope.
Results. The disks produced with the new method are smaller than those obtained previously, but their mass is mostly unchanged. The new disks are a few degrees warmer in the outer parts, so they contain less solid CO. Otherwise, the results for ices are unaffected. The 2D treatment of the accretion results in material accreting at larger radii, so a smaller fraction comes close enough to the star for amorphous silicates to be thermally annealed into crystalline form. The lower crystalline abundances thus predicted correspond more closely to observed abundances than did earlier model predictions. We argue that thermal annealing followed by radial mixing must be responsible for at least part of the observed crystalline material.

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A *Herschel* study of the properties of starless cores in the Polaris Flare dark cloud region using PACS and SPIRE

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The Polaris Flare cloud region contains a great deal of extended emission. It is at high declination and high Galactic latitude. It was previously seen strongly in IRAS Cirrus emission at 100 microns. We have detected it with both PACS and SPIRE on *Herschel*. We see filamentary and low-level structure. We identify the five densest cores within this structure. We present the results of a temperature, mass and density analysis of these cores. We compare their

observed masses to their virial masses, and see that in all cases the observed masses lie close to the lower end of the range of estimated virial masses. Therefore, we cannot say whether they are gravitationally bound prestellar cores. Nevertheless, these are the best candidates to be potential prestellar cores in the Polaris cloud region.

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http://lanl.arxiv.org/abs/1005.2519

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).

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The Role of Magnetic Fields in the Pre-Main Sequence Evolution of Solar Type Stars

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Ph.D degree awarded: March 2010

T Tauri stars, being pre-main sequence and solar mass, tell us in essence what our Sun was like when it was very young. T Tauri stars and their protoplanetary disks are ideal astrophysical laboratories for studying the solar system when planets were forming. At the same time, there is no astrophysical laboratory like the present-day Sun for studying in detail the microphysics needed to understand processes involved in early stellar evolution. Specifically, a goal of this work is to understand the role of large-scale structures in stellar magnetic fields. We begin with a general overview of star formation and stellar evolution, focusing on the role of magnetic fields in these processes. Under the broad aegis of star formation and evolution, the remainder of this work aims to methodically explore methods of identifying groups of young stars, star-disk interaction, and a new solar-calibrated pre-main sequence angular momentum loss model. In summary, we begin with a broad focus on a group of young stars, then examine more closely the interaction of young stars with their disks via the stellar magnetic field, and finally we assess other ways in which the field can affect stellar evolution. In searching for a coeval group of young stars, we find the quite surprising result that the particular young trio of stars in question apparently formed separately from any known association or star forming region in the vicinity. Turning then to a well-studied group of million year old stars, the Orion Nebula Cluster, we seek to determine whether a group of young stars' magnetospheres are linked to circumstellar disks. In the majority of cases, we found that large-scale loops do not intersect disk material. This leads naturally into the question of how such large structures then could affect stellar evolution if not via star-disk interaction. We invoke solar physics to relate solar flare flux to corresponding CME mass in order to begin calibration of a stellar CME mass loss rate, the first effort in this field to-date.

INAF – ARCETRI ASTROPHYSICAL OBSERVATORY
Florence (ITALY)

International Post-Doctoral Fellowship

The INAF – Arcetri Astrophysical Observatory (Florence) intends to award a post-doctoral fellowship in the field of star formation. The fellow will be part of the Star Formation Group, whose observational and theoretical activities cover the dynamical state of clouds/cores, the formation and early evolution of stars, and the investigation of circumstellar disks and jets/outflows from young stellar objects.

The fellow is expected to focus his/her activity on observations of OB star forming regions. In particular, he/she will participate in the investigation of high-mass star formation in the Galaxy by means of large scale surveys at (sub)mm and IR wavelengths performed with APEX and HERSCHEL. The applicant is also expected to complement these data with more focused, higher angular resolution observations of selected regions by means of currently available instruments and, in the near future, with ALMA. Experience with radio single-dish and interferometric observations and data analysis is requested, from centimeter to sub-millimeter wavelengths.

Applicants must have a Ph.D. or equivalent at the starting date of the fellowship. The gross yearly salary will be 33,000 Euro. The fellowship will be granted for two years, conditional to a positive evaluation of the research activity carried out during the first year, and will not entail social benefits or medical insurance. No special application forms are required. The applicants should send a **curriculum vitae**, a **list of publications**, and a **short (1 page) research plan** to the above submission address, and should arrange for **two letters of recommendation** to be sent separately to the same address. E-mail submission is accepted. Applications should arrive in Arcetri no later than July 31, 2010. The starting date will be as early as possible but is negotiable.

Application deadline: July 31, 2010

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Two postgraduate positions in star formation at the Dublin Institute for Advanced Studies

The School of Cosmic Physics at the Dublin Institute for Advanced Studies (DIAS) is offering two postgraduate positions. The students will work in the star formation group with Dr. Aleks Scholz and Prof. Tom Ray. Funding is available for 4 years, starting in fall 2010. The funding includes a stipendium, postgraduate fees, as well as travel support. DIAS is involved in projects with access to the leading ground- and space-based facilities, including ESO-VLT, Subaru, Gemini, Keck, Spitzer, Herschel, SMA, and JCMT.

The students will work on the interpretation of observations of young stellar objects, their disks and outflows. An undergraduate degree in physics or astronomy as well as a background and interest in observational astronomy are mandatory. Programming skills and experience with astronomical data analysis are beneficial. The deadline for applications is the 15th of July 2010. Interested students are encouraged to send a brief statement of intent and a curriculum vitae to Dr. Aleks Scholz, aleks *at* cp.dias.ie, School of Cosmic Physics, Dublin Institute for Advanced Studies, 31 Fitzwilliam Place, Dublin 2, Ireland. Email submissions are preferred.

Post-Doctoral Position in Infrared Astronomy - The University of Western Ontario

Applications are invited for a postdoctoral position in infrared astronomy in the Department of Physics and Astronomy at The University of Western Ontario. The successful candidate will pursue projects with Dr. Peeters involving observational infrared astronomy and independent research. These projects will primarily be related to the study of PAHs and dust in various environments, with an emphasis on (galactic and extragalactic) star-forming regions and PDRs, and will utilize Spitzer and Herschel observations.

Candidates should have a PhD in astronomy, astrophysics, or physics. A preference will be given to candidates with a strong background in IR, FIR and/or sub-millimeter astronomy and experience in astronomical data reduction.

The astronomy group at Western has recently expanded and focuses on research in planetary science, star formation, stars, nearby galaxies, and AGNs. The successful candidate will be encouraged to interact with other faculty and to take an active role in mentoring our growing group of graduate students. Affiliation with a Canadian university allows researchers to apply for Canadian time on telescopes including CFHT, Gemini, JCMT, and E-VLA.

The appointment is for 2 years with the possibility of renewal for one year subject to satisfactory performance and the availability of funds. The starting date is September 2010 or as soon as possible thereafter. Applicants should send (preferably electronically) a cover letter, CV, a statement of research interests, and arrange for three letters of recommendation to be send directly to Dr. Peeters by June 20, 2010. The University of Western Ontario is committed to employment equity.

Submit To:
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The University of Western Ontario,
Department of Physics and Astronomy, PAB213,
1151 Richmond St,
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Email Submission Address: epeeters *at* uwo.ca

Postdoctoral fellowships at SIM

The Laboratory for Systems, Instrumentation and Modeling in Science and Technology for Space and the Environment (SIM) is a key space sciences research unit in Portugal with strong activities in astronomical instrumentation and astrophysics. The SIM laboratory has a national scope with offices in Lisbon and Porto. Our instrumentation activities include leading the Portuguese participation in the ESA/GAIA satellite and in the ESO/GRAVITY experiment; we participate in the ESO/ESPRESSO spectrograph. R&D in image reconstruction, adaptive optics and astrophotonics is also undertaken. Our astrophysical activities range from star and planet formation to black-hole physics, including models and observations. Projects interfacing astrophysics and Earth climate are also starting.

The infrastructures completely allocated to the center include a data processing center with 160 xeon processor cores and 100TB of disk, an optical instrument control interferometer, vacuum and cryogenic facilities.

We seek postdoctoral fellows to strengthen our activities. The fellows are expected to integrate in the team, with large research liberty, international collaborations being strongly supported. The recruiting priorities are:

Lisbon offices: Astronomical instrumentation and data processing, planets, astrophysical exploitation of GAIA, namely in the fields of: a) structure and evolution the Milkyway; b) star clusters and c) stellar variability.

Porto offices: star and planet formation (theory and observations); high angular resolution techniques (interferometry, adaptive optics) and astrophotonics.

Applications will be received immediately, with closing deadline the 31st of June 2010. Starting dates for contracts range from 1st of October 2010 to 3Q 2011. Contract durations are for 3 years renewable for a second 3 year period. Applicants should send a curriculum vitae (including list of publications) and a description of research interests (2 pages max.). Inquiries as well as the applications should be directed to: Antonio Amorim (Antonio.Amorim *at* sim.fc.ul.pt) Lisbon offices or Paulo Garcia (pgarcia *at* fe.up.pt) Porto offices.