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Abstracts of recently accepted papers

V1647 Orionis: Reinvigorated Accretion and the Re-Appearance of McNeil's Nebula

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In late 2003, the young eruptive variable star V1647 Orionis optically brightened by over 5 mag, stayed bright for around 26 months, and then declined to its pre-outburst level. In 2008 August, the star was reported to have unexpectedly brightened yet again and we herein present the first detailed observations of this new outburst. Photometrically, the star is now as bright as it ever was following the 2003 eruption. Spectroscopically, a pronounced P Cygni profile is again seen in Hα with an absorption trough extending to $\sim$700 km s^{-1}. In the near-infrared, the spectrum now possesses very weak CO overtone bandhead absorption in contrast to the strong bandhead emission seen soon after the 2003 event. Water vapor absorption is also much stronger than previously seen. We discuss the current outburst below and relate it to the earlier event.

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Numerical Simulations of a Protostellar Outflow Colliding with a Dense Molecular Cloud

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High-resolution SiO observations of the NGC 1333 IRAS 4A star-forming region show a highly collimated outflow with a substantial deflection. The deflection has been suggested to be caused by the interactions of the outflow and a dense cloud core. To investigate the deflection process of protostellar outflows, we carry out three-dimensional hydrodynamic simulations of the collision of an outflow with a dense cloud. Assuming a power-law-type density distribution of the obstructing cloud, the numerical experiments show that the deflection angle is mainly determined by the impact

parameter and the density contrast between the outflow and the cloud. The deflection angle is, however, relatively insensitive to the velocity of the outflow. Using a numerical model with physical conditions that are particularly suitable for the IRAS 4A system, we produce a column-density image and a position-velocity diagram along the outflow which are consistent with the observations. Based on our numerical simulations, if we assume that the initial density and the velocity of the outflow are $\sim$10 cm^{-3} and $\sim$70 km s^{-1}, respectively, the densities of the dense core and ambient medium in the IRAS 4A system are most likely to be $\sim 10^5$ cm^{-3} and $\sim 10^2$ cm^{-3}, respectively. We, therefore, demonstrate through numerical simulations that the directional variability of the IRAS 4A outflow can be explained reasonably well using the collision model.

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Three-Dimensional Simulations of Kelvin-Helmholtz Instability in Settled Dust Layers in Protoplanetary Disks

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As dust settles in a protoplanetary disk, a vertical shear develops because the dust-rich gas in the midplane orbits at a rate closer to true Keplerian than the slower-moving dust-depleted gas above and below. A classical analysis (neglecting the Coriolis force and differential rotation) predicts that Kelvin-Helmholtz instability occurs when the Richardson number of the stratified shear flow is below roughly one-quarter. However, earlier numerical studies showed that the Coriolis force makes layers more unstable, whereas horizontal shear may stabilize the layers. Simulations with a three-dimensional spectral code were used to investigate these opposing influences on the instability in order to resolve whether such layers can ever reach the dense enough conditions for the onset of gravitational instability. I confirm that the Coriolis force, in the absence of radial shear, does indeed make dust layers more unstable, however the instability sets in at high spatial wavenumber for thicker layers. When radial shear is introduced, the onset of instability depends on the amplitude of perturbations: small amplitude perturbations are sheared to high wavenumber where further growth is damped; whereas larger amplitude perturbations grow to magnitudes that disrupt the dust layer. However, this critical amplitude decreases sharply for thinner, more unstable layers. In three-dimensional simulations of unstable layers, turbulence mixes the dust and gas, creating thicker, more stable layers. I find that layers with minimum Richardson numbers in the approximate range 0.2-0.4 are stable in simulations with horizontal shear.

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Magnetically-Regulated Fragmentation Induced by Nonlinear Flows and Ambipolar Diffusion

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We present a parameter study of simulations of fragmentation regulated by gravity, magnetic fields, ambipolar diffusion, and nonlinear flows. The thin-sheet approximation is employed with periodic lateral boundary conditions, and the nonlinear flow field ("turbulence") is allowed to freely decay. In agreement with previous results in the literature, our results show that the onset of runaway collapse (formation of the first star) in subcritical clouds is significantly accelerated by nonlinear flows in which a large-scale wave mode dominates the power spectrum. In addition, we find that a power spectrum with equal energy on all scales also accelerates collapse, but by a lesser amount. For a highly super-Alfvénic initial velocity field with most power on the largest scales, the collapse occurs promptly during the initial compression wave. However, for trans-Alfvénic perturbations, a subcritical magnetic field causes a rebound from the initial compression, and the system undergoes several oscillations before runaway collapse occurs. Models

that undergo prompt collapse have highly supersonic infall motions at the core boundaries. Cores in magnetically subcritical models with trans-Alfvénic initial perturbations also pick up significant systematic speeds by inheriting motions associated with magnetically-driven oscillations. Core mass distributions are much broader than in models with small-amplitude initial perturbations, although the disturbed structure of cores that form due to nonlinear flows does not guarantee subsequent monolithic collapse. Our simulations also demonstrate that significant power can (if present initially) be maintained with negligible dissipation in large-scale compressive modes of a magnetic thin sheet, in the limit of perfect flux freezing.

Accepted by New Astronomy

http://www.astro.uwo.ca/∼basu/pb.htm, and arXiv:0810.0783

A Deep Look into the Cores of Young Clusters - I. σ-Orionis

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Context. Nearby young clusters are privileged places to study the star formation history. Over the last decade, the σ-Orionis cluster has been a prime location for the study of young very low mass stars, substellar and isolated planetary mass objects and the determination of the initial mass function.
Aims. To extend previous studies of this association to its core, we searched for ultracool members and new multiple systems within the $1.5' \times 1.5'$ central region of the cluster.
Methods. We obtained deep multi-conjugate adaptive optics (MCAO) images of the core of the σ-Orionis cluster with the prototype MCAO facility MAD at the VLT using the H and K_S filters. These images allow us to detect companions fainter by $\Delta H \approx 5$ mag as close as $0.2''$ on a typical source with H=14.5 mag. These images were complemented by archival SofI -K_S band images and Spitzer IRAC and MIPS mid-infrared images.
Results. We report the detection of 2 new visual multiple systems, one being a candidate binary proplyd and the other one a low mass companion to the massive star σ Ori E. Of the 36 sources detected in the images, 25 have a H-band luminosity lower than the expected planetary mass limit for members, and $H - K_S$ color consistent with the latest theoretical isochrones. Nine objects have additional *Spitzer* photometry and spectral energy distribution consistent with them being cluster members. One of them has a spectral energy distribution from H to 3.6 μm consistent with that of a 5.5 $M_{\rm Jup}$ cluster member. Complementary NTT/SofI and *Spitzer* photometry allow us to confirm the nature and membership of two L-dwarf planetary mass candidates.

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The Inevitable Future of the Starless Core Barnard 68

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Dense, small molecular cloud cores have been identified as the direct progenitors of stars. One of the best studied examples is Barnard 68 which is considered a prototype stable, spherical gas core, confined by a diffuse high-pressure environment. Observations of its radial density structure however indicate that Barnard 68 should be gravitationally unstable and collapsing which appears to be inconsistent with its inferred long lifetime and stability. We argue that

Barnard 68 is currently experiencing a fatal collision with another small core which will lead to gravitational collapse. Despite the fact that this system is still in an early phase of interaction, our numerical simulations imply that the future gravitational collapse is already detectable in the outer surface density structure of the globule which mimicks the profile of a gravitationally unstable Bonnor-Ebert sphere. Within the next 200,000 years Barnard 68 will condense into a low-mass solar-type star(s), formed in isolation, and surrounded by diffuse, hot interstellar gas. As witnessed in situ for Barnard 68, core mergers might in general play an important role in triggering star formation and shaping the molecular core mass distribution and by that also the stellar initial mass function.

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http://adsabs.harvard.edu/abs/2008arXiv0809.1457B

Mid-Infrared Extinction Mapping of Infrared Dark Clouds: Probing the Initial Conditions for Massive Stars and Star Clusters

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Infrared Dark Clouds (IRDCs) are cold, dense regions of giant molecular clouds that are opaque at wavelengths $\sim 10\mu$m or more and thus appear dark against the diffuse Galactic background emission. They are thought to be the progenitors of massive stars and star clusters. We use 8 μm imaging data from *Spitzer* GLIMPSE to make extinction maps of 10 IRDCs, selected to be relatively nearby and massive. The extinction mapping technique requires construction of a model of the Galactic IR background intensity behind the cloud, which is achieved by correcting for foreground emission and then interpolating from the surrounding regions. The correction for foreground emission can be quite large, up to $\sim 50\%$ for clouds at ~ 5 kpc distance, thus restricting the utility of this technique to relatively nearby clouds. We investigate three methods for the interpolation, finding systematic differences at about the 10% level, which, for fiducial dust models, corresponds to a mass surface density $\Sigma = 0.013\,\mathrm{g\,cm^{-2}}$, above which we conclude this extinction mapping technique attains validity. We examine the probability distribution function of Σ in IRDCs. From a qualitative comparison with numerical simulations of astrophysical turbulence, many clouds appear to have relatively narrow distributions suggesting relatively low (< 5) Mach numbers and/or dynamically strong magnetic fields. Given cloud kinematic distances, we derive cloud masses. Rathborne, Jackson & Simon identified cores within the clouds and measured their masses via mm dust emission. For 43 cores, we compare these mass estimates with those derived from our extinction mapping, finding good agreement: typically factors of $\lesssim$2 difference for individual cores and an average systematic offset of $\lesssim$10% for the adopted fiducial assumptions of each method. We find tentative evidence for a systematic variation of these mass ratios as a function of core density, which is consistent with models of ice mantle formation on dust grains and subsequent grain growth by coagulation, and/or with a temperature decrease in the densest cores.

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http://www.astro.ufl.edu/~jt/publications.html

High Angular Resolution Radio Observations of the HL/XZ Tau Region: Mapping the 50 AU Protoplanetary Disk around HL Tau and Resolving XZ Tau S into a 13 AU Binary

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We present new 7 mm and archive 1.3 cm high angular resolution observations of the HL/XZ Tau region made with the VLA. At 7 mm, the emission from HL Tau seems to be arising in a clumpy disk with radius of order 25 AU. The 1.3 cm emission from XZ Tau shows the emission from a binary system with 0.3 arcsec (42 AU) separation, known from previous optical/IR observations. However, at 7 mm, the southern radio component resolves into a binary with 0.09 arcsec (13 AU) separation, suggesting that XZ Tau is actually a triple star system. We suggest that the remarkable ejection of gas from the XZ Tau system observed with the HST may be related to a periastron passage of this newly discovered close binary system.

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A Pulsed, Precessing Jet in Cepheus A

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We present near-infrared H_2, radio CO, and thermal infrared observations of the nearby massive star-forming region Cepheus A (Cep A). From H_2 bow shocks arranged along four distinct jet axes, we infer that the massive protostellar source HW2 drives a pulsed, precessing jet that has changed its orientation by about 45° in roughly 10^4 years. The current HW2 radio jet represents the most recent event in this time series of eruptions. This scenario is consistent with the recent discovery of a disk around HW2, perpendicular to the current jet orientation, and with the presence of companions at projected distances comparable to the disk radius. We propose that the Cep A system formed by the disk-assisted capture of a sibling star by HW2. We present a numerical model of a 15 $M_\odot$ star with a circumstellar disk, orbited by a companion in an inclined, eccentric orbit. Close passages of the companion through or near the disk result in periods of enhanced accretion and mass loss, as well as forced precession of the disk and associated orientation changes in the jet. The observations reveal a second powerful outflow that emerges from radio source HW3c or HW3d. This flow is associated with blueshifted CO emission and a faint H_2 bow shock to the east, and with HH 168 to the west. A collision between the flows from HW2 and HW3c/d may be responsible for X-ray and radio continuum emission in Cep A West.

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Binarity of Transit Host Stars – Implications on Planetary Parameters

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Context. Straight-forward derivation of planetary parameters can only be achieved in transiting planetary systems. However, planetary attributes such as radius and mass strongly depend on stellar host parameters. Discovering a transit host star to be multiple leads to a necessary revision of the derived stellar and planetary parameters.
Aims. Based on our observations of 14 transiting exoplanet hosts, we derive parameters of the individual components of three transit host stars (WASP-2, TrES-2, and TrES-4) which we detected to be binaries. Two of these have not been known to be multiple before. Parameters of the corresponding exoplanets are revised.
Methods. High-resolution “Lucky Imaging” with AstraLux at the 2.2 m Calar Alto telescope provided near diffraction limited images in i' and z' passbands. These results have been combined with existing planetary data in order to recalibrate planetary attributes.
Results. Despite the faintness (Δmag$\sim$4) of the discovered stellar companions to TrES-2, TrES-4, and WASP-2, light-curve deduced parameters change by up to more than 1σ. We discuss a possible relation between binary separation and planetary properties, which—if confirmed—could hint at the influence of binarity on the planet formation process.

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Spitzer Spectroscopy of Circumstellar Disks in the 5 Myr Old Upper Scorpius OB Association

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We present mid-infrared spectra between 5.2 and 38 μm for 26 disk-bearing members of the ∼5 Myr old Upper Scorpius OB association obtained with the Infrared Spectrograph (IRS) onboard the *Spitzer* Space Telescope. We find clear evidence for changes in the spectral characteristics of dust emission between the early (B+A) and late-type (K+M) infrared excess stars. The early-type members exhibit featureless continuum excesses that become apparent redward of ∼8 μm. In contrast, 10 and 20 μm silicate features or PAH emission are present in all but one of the late-type excess members of Upper Scorpius. The strength of silicate emission among late-type Upper Scorpius members is spectral type dependent, with the most prominent features being associated with K5–M2 type stars. By fitting the spectral energy distributions (SED) of a representative sample of low-mass stars with accretion disk models, we find that the SEDs are consistent with models having inner disk radii ranging from ∼0.2 to 1.2 AU. Complementary high resolution ($R \sim 33,000$) optical ($\lambda\lambda$4800–9200) spectra for the Upper Scorpius excess stars were examined for signatures of gaseous accretion. Of the 35 infrared excess stars identified in Upper Scorpius, only 7 (all late-type) exhibit definitive signatures of accretion. Mass accretion rates for these stars were estimated to range from 10^{-11} to $10^{-8.9}$ $M_\odot$ yr^{-1}. Compared to Class II sources in Taurus-Auriga, the disk population in Upper Scorpius exhibits reduced levels of near and mid-infrared excess emission and an order of magnitude lower mass accretion rates. These results suggest that the disk structure has changed significantly over the 2–4 Myr in age separating these two stellar populations. The ubiquity of depleted inner disks in the Upper Scorpius excess sample implies that such disks are a common evolutionary pathway that persists for some time.

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An analytic column density profile to fit prestellar cores

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We present a new analytical three-parameter formula to fit observed column density profiles of prestellar cores. It represents a line-of-sight integral through a spherically symmetric or disc-like isothermal cloud. The underlying model resembles the Bonnor-Ebert model in that it features a flat central region leading into a power-law decline $\propto r^{-2}$ in density, and a well-defined outer radius. However, we do not assume that the cloud is in equilibrium, and can instead make qualitative statements about its dynamical state (expansion, equilibrium, collapse) using the size of the flat region as a proxy. Instead of having temperature as a fitting parameter, our model includes it as input, and thus avoids possible inconsistencies. It is significantly easier to fit to observational data than the Bonnor-Ebert sphere. We apply this model to L1689B and B68. We show that L1689B cannot be in equilibrium but instead appears to be collapsing, while our model verifies that B68 is not far from being a hydrostatic object.

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Resolved 24.5 micron emission from massive young stellar objects

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Massive young stellar objects (MYSO) are surrounded by massive dusty envelopes, whose physical structure and geometry are determined by the star formation process. Our principal aim is to establish the density structure of MYSO envelopes on scales of ∼1000 AU. This constitutes an increase of a factor ∼10 in angular resolution compared to similar studies performed in the (sub)mm. We have obtained diffraction-limited (0.6 arcsec) 24.5 μm images (field of view of 40 *arcsec* × 30 *arcsec*) of 14 well-known massive star formation regions with the COMICS instrument mounted on the 8.2 meter Subaru telescope. We construct azimuthally averaged intensity profiles of the resolved MYSO envelopes and build spectral energy distributions (SEDs) from archival data and the COMICS 24.5 μm flux density. The SEDs range from near-infrared to millimeter wavelengths. Self-consistent 1-D radiative transfer models described by a density dependence of the form $n(r) \propto r^{-p}$ are used to simultaneously compare the intensity profiles and SEDs to model predictions. The images reveal the presence of discrete MYSO sources which are resolved on arcsecond scales, and, to first-order, the observed emission is circular on the sky. For many sources, the spherical models are capable of satisfactorily reproducing the 24.5 μm intensity profile, the 24.5 μm flux density, the 9.7 μm silicate absorption feature, and the submm emission. They are described by density distributions with $p = 1.0 \pm 0.25$. Such distributions are shallower than those found on larger scales probed with single-dish (sub)mm studies. Other sources have density laws that are shallower/steeper than $p = 1.0$ and there is evidence that these are viewed near edge-on or near face-on respectively. In these cases spherical models fail to provide good fits to the data. The images also reveal a diffuse component tracing somewhat larger scale structures, particularly visible in the regions S 140, AFGL 2136, IRAS 20126+4104, Mon R2, and Cep A. We find a flattening of the MYSO density law going from scales probed with single-dish submm observations down to scales of ∼1000 AU probed with the observations presented here. We propose that this may be evidence of rotational support of the envelope. This finding will be explored further in a future paper using 2-D axisymmetric radiative transfer models.

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Star formation around RCW 120, the perfect bubble

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Context: This study deals with the star formation triggered by H II regions.

Aims: We wish to take advantage of the very simple morphology of RCW 120 –a perfect bubble – to understand the mechanisms triggering star formation around an H II region and to establish what kind of stars are formed there.

Methods: We present 870 μm observations of RCW 120, obtained with the APEX-LABOCA camera. These show the distribution of cold dust, and thus of neutral material. We use Spitzer-MIPS observations at 24 μm and 70 μm to detect the young stellar objects present in this region and to estimate their evolutionary stages.

Results: A layer of dense neutral material surrounds the entire H II region, having been swept up during the region's expansion. This layer has a mass greater than 2000 $M_\odot$ and is fragmented, with massive fragments elongated along the ionization front (IF). We measured the 24 μm flux of 138 sources. Of these, 39 are Class I or flat-spectrum young stellar objects (YSOs) observed in the direction of the collected layer. We show that several triggering mechanisms are acting simultaneously in the swept-up shell, where they form a second generation of stars. No massive YSOs are detected. However, a massive, compact 870 μm core lies adjacent to the IF. A 70 μm source with no 24 μm counterpart is detected at the same position. This source is a likely candidate for a Class 0 YSO. Also at 24 μm, we detect a chain of about ten regularly spaced Class I or flat spectrum sources, parallel to the IF, in the direction of the most massive fragment. We suggest that the formation of these YSOs is the result of Jeans gravitational instabilities in the collected layer. Finally, the 870 μm emission, the 24 μm emission, and the Hα emission show the existence of an extended and partially ionized photodissociation region around RCW 120. This demonstrates the long-distance influence of the H II region upon its surrounding medium.

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anonymous ftp: ftp://ftp.oamp.fr/ldeharve/1337.pdf

Giant HH Flows in L1228: A Second Look

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We present second epoch narrow band Hα and [S II] images of the giant Herbig-Haro flows HH199 and HH200 in the L1228 molecular cloud. Proper motions for several members of the HH200 flow were determined by comparing the new images to similar narrow band images taken thirteen years earlier. Based on our measurements, the HH200 flow is inclined by 15 degrees to the plane of the sky and has a steady, fixed outflow axis with P.A. = 49 degrees. There is a general non-linear decline in the proper motions with increasing distance from the source, and it appears that successive eruption episodes have cleared out a relatively free channel through the L1228 cloud. The bright knot HH200B6 is located at the end of the channel along the edge of L1228, and appears to be tracing the location where the outflow erupts from the cloud. We did not detect any proper motions for HH200B6, and suggest that it is the plug of material that has been bored out by the cumulative effects of numerous eruptions along a steady outflow axis. The proper motions combined with the spacing of the HH200 knots along the flow axis are consistent with a velocity variable outflow which erupts periodically on time scales of order 600 years. The relatively small size of the knots combined with the large proper motions and derived bowshock speeds would seem to rule out the presence of a less collimated wind component. We also discuss the HH199 flow, which is radically different from HH200. The members of the HH199 flow exhibited large changes in morphology and emission, and were not suitable for determining proper motions. The HH200 and HH199 flows appear to be opposite ends of the spectrum of giant HH flows.

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Dense Cores in Perseus: The Influence of Stellar Content and Cluster Environment

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We present the chemistry, temperature, and dynamical state of a sample of 193 dense cores or core candidates in the Perseus Molecular cloud and compare the properties of cores associated with young stars and clusters with those which are not. The combination of our NH3 and CCS observations with previous millimeter, sub-millimeter, and Spitzer data available for this cloud enable us both to determine core properties precisely and to accurately classify cores as starless or protostellar. The properties of cores in different cluster environments and before-and-after star formation provide important constraints on simulations of star-formation, particularly under the paradigm that the essence of star formation is set by the turbulent formation of prestellar cores. We separate the influence of stellar content from that of cluster environment and find that cores within clusters have (1) higher kinetic temperatures and (2) lower fractional abundances of CCS and NH3. Cores associated with protostars have (1) slightly higher kinetic temperatures (2) higher NH3 excitation temperatures), (3) are at higher column density, have (4) slightly more non-thermal/turbulent NH3 linewidths, have (5) higher masses and have (6) lower fractional abundance of CCS. We find that neither cluster environment nor protostellar content makes a significant difference to the dynamical state of cores as estimated by the virial parameter – most cores in each category are gravitationally bound. Overall, cluster environment and protostellar content have a smaller influence on the properties of the cores than is typically assumed, and the variation within categories is larger than the differences between categories.

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Global MHD simulations of stratified and turbulent protoplanetary discs. II. Dust settling

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The aim of this paper is to study the vertical profile of small dust particles in protoplanetary discs in which angular momentum transport is due to MHD turbulence driven by the magnetorotational instability. We consider particle sizes that range from approximately 1 micron up to a few millimeters. We use a grid–based MHD code to perform global two-fluid simulations of turbulent protoplanetary discs which contain dust grains of various sizes. In quasi–steady state, the gravitational settling of dust particles is balanced by turbulent diffusion. Simple and standard models of this process fail to describe accurately the vertical profile of the dust density. The disagreement is larger for small dust particles (of a few microns in size), especially in the disc upper layers ($Z > 3H$, where H is the scale-height). Here there can be orders of magnitude in the disagreement between the simple model predictions and the simulation results. This is because MHD turbulence is not homogeneous in accretion discs, since velocity fluctuations increase significantly in the disc upper layer where a strongly magnetized corona develops. We provide an alternative model that gives a better fit to the simulations. In this model, dust particles are diffused away from the midplane by MHD turbulence, but the diffusion coefficient varies vertically and is everywhere proportional to the square of the local turbulent vertical velocity fluctuations. The spatial distribution of dust particles can be used to trace the properties of MHD turbulence in protoplanetary discs, such as the amplitude of the velocity fluctuations. In the future, detailed and direct comparison between numerical simulations and observations should prove a useful tool for constraining the properties of turbulence in protoplanetary discs.

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Near-Infrared Circular Polarimetry and Correlation Diagrams in the Orion BN/KL Region: Contribution of Dichroic Extinction

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We present a deep circular polarization image of the Orion BN/KL nebula in the Ks band and correlations of circular polarization, linear polarization, and H-Ks color representing extinction. The image of circular polarization clearly reveals the quadrupolar structure around the massive star IRc2, rather than BN. H-Ks color is well correlated with circular polarization. A simple relation between dichroic extinction, color excess, circular and linear polarization is derived. The observed correlation between the Stokes parameters and the color excess agrees with the derived

relation, and suggests a major contribution of dichroic extinction to the production of circular polarization in this region, indicating the wide existence of aligned grains.

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A Role for Self-Gravity at Multiple Length Scales in the Process of Star Formation

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Self-gravity plays a decisive role in the final stages of star formation, where dense cores (size ∼0.1 parsecs) inside molecular clouds collapse to form star-plus-disk systems. But self-gravity's role at earlier times (and on larger length scales, such as ∼1 parsec) is unclear; some molecular cloud simulations that do not include self-gravity suggest that 'turbulent fragmentation' alone is sufficient to create a mass distribution of dense cores that resembles, and sets, the stellar initial mass function. Here we report a 'dendrogram' (hierarchical tree-diagram) analysis that reveals that self-gravity plays a significant role over the full range of possible scales traced by ^{13}CO observations in the L1448 molecular cloud, but not everywhere in the observed region. In particular, more than 90 per cent of the compact 'pre-stellar cores' traced by peaks of dust emission are projected on the sky within one of the dendrogram's self-gravitating 'leaves'. As these peaks mark the locations of already-forming stars, or of those probably about to form, a self-gravitating cocoon seems a critical condition for their existence. Turbulent fragmentation simulations without self-gravity–even of unmagnetized isothermal material–can yield mass and velocity power spectra very similar to what is observed in clouds like L1448. But a dendrogram of such a simulation shows that nearly all the gas in it (much more than in the observations) appears to be self-gravitating. A potentially significant role for gravity in 'non-self-gravitating' simulations suggests inconsistency in simulation assumptions and output, and that it is necessary to include self-gravity in any realistic simulation of the star-formation process on subparsec scales.

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Spitzer-IRAC GLIMPSE of high mass protostellar objects. II SED modelling of a bonafide sample

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In a previous work (paper I) a sample of 380 HMPO targets was studied using the GLIMPSE point source catalog and images. Colour-magnitude analysis of the point sources resulted in the identification of infrared counterparts (IRC) of the (sub)mm cores of HMPO candidates which were considered bonafide targets.
We aim to estimate and analyse the physical properties of the infrared counterparts of HMPOs by comparing their spectral energy distributions (SED) with those predicted by radiative transfer accretion models of YSOs.
The SED of 68 IRC's are extended beyond the GLIMPSE photometry to the possible limits, from the near-infrared to the millimetre wavelengths by using the 2MASS, GLIMPSE version 2.0 catalogs, MSX, IRAS and some single dish (and interferometric) (sub)mm data. An online SED fitting tool that uses 2D radiative transfer accretion models of YSOs is employed to fit the observed SED to obtain various physical parameters.
The SED of IRC's were fitted by models of massive protostars with a range of masses between 5–42 $M_\odot$ and ages between 10^3 and 10^6 years. The median mass and age are $10 M_\odot$ and 10^4yr's. The observed data favours protostars of

low effective temperatures (4000-1000K) with correspondingly large effective photospheres (2-200$R_\odot$) for the observed luminosities. The envelopes are large with a mean size of ∼0.2-0.3 pc and show a distribution that is very similar to the distribution of the sizes of 8μm nebulae discussed in Paper I. The estimated envelope accretion rates are high with a mean value of $10^{-3} M_\odot$/yr and show a power law dependence to mass with an exponent of 2, suggesting spherical accretion at those scales. Disks are found to exist in most of the sources with a mean mass of $10^{-1.4\pm0.7}\ M_\odot$.
The observed infrared-millimetre SED of the infrared counterparts of HMPOs are successfully explained with an YSO accretion model. The modelled sources mostly represent proto-B stars although some of them could become O stars in future. We demonstrate that many of these results may represent a realistic picture of massive star formation, despite some of the results which may be an effect of the assumptions within the models.

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http://www.astro.up.pt/investigacao/ficheiros/2009_AA_Grave.pdf

iVINE - Ionization in the parallel tree/SPH code VINE: First results on the observed age-spread around O-stars

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We present a three-dimensional, fully parallelized, efficient implementation of ionizing ultraviolet (UV) radiation for smoothed particle hydrodynamics (SPH) including self-gravity. Our method is based on the SPH/TREE code VINE. We therefore call it iVINE (for Ionization + VINE). This approach allows detailed high-resolution studies of the effects of ionizing radiation from, for example, young massive stars on their turbulent parental molecular clouds. In this paper, we describe the concept and the numerical implementation of the radiative transfer for a plane-parallel geometry and we discuss several test cases demonstrating the efficiency and accuracy of the new method. As a first application, we study the radiatively driven implosion of marginally stable molecular clouds at various distances of a strong UV source and show that they are driven into gravitational collapse. The resulting cores are very compact and dense exactly as it is observed in clustered environments. Our simulations indicate that the time of triggered collapse depends on the distance of the core from the UV source. Clouds closer to the source collapse several 105yr earlier than more distant clouds. This effect can explain the observed age spread in OB associations where stars closer to the source are found to be younger. We discuss possible uncertainties in the observational derivation of shock front velocities due to early stripping of protostellar envelopes by ionizing radiation.

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Driving Turbulence and Triggering Star Formation by Ionizing Radiation

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We present high resolution simulations on the impact of ionizing radiation of massive O-stars on the surrounding turbulent interstellar medium (ISM). The simulations are performed with the newly developed software iVINE which combines ionization with smoothed particle hydrodynamics (SPH) and gravitational forces. We show that radiation from hot stars penetrates the ISM, efficiently heats cold low density gas and amplifies over-densities seeded by the initial turbulence. The formation of observed pillar-like structures in star forming regions (e.g. in M16) can be explained by this scenario. At the tip of the pillars gravitational collapse can be induced, eventually leading to the formation of low mass stars. Detailed analysis of the evolution of the turbulent spectra shows that UV-radiation of O-stars indeed provides an excellent mechanism to sustain and even drive turbulence in the parental molecular cloud.

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A New Approach for Probing Circumbinary Disks

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Circumbinary disks are considered to exist in a wide variety of astrophysical objects, e.g., young binary stars, protoplanetary systems, and massive binary black hole systems in active galactic nuclei (AGNs). However, there is no definite evidence for the circumbinary disk except for some in a few young binary star systems. In this Letter, we study possible oscillation modes in circumbinary disks around eccentric and circular binaries. We find that prograde, nonaxisymmetric waves are induced in the inner part of the circumbinary disk by the tidal potential of the binary. Such waves would cause variabilities in emission line profiles from circumbinary disks. Because of prograde precession of the waves, the distance between each component of the binary and the inner edge of the circumbinary disk varies with the beat period between the precession period of the wave and the binary orbital period. As a result, light curves from the circumbinary disks are also expected to vary with the same period. The current study thus provides a new method to detect circumbinary disks in various astrophysical systems.

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Measuring tiny mass accretion rates onto young brown dwarfs

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We present low-resolution Keck I/LRIS spectra spanning from 3200–9000 Å of nine young brown dwarfs and three low-mass stars in the TW Hya Association and in Upper Sco. The optical spectral types of the brown dwarfs range from M5.5-M8.75, though two have near-IR spectral types of early L-dwarfs. We report new accretion rates derived from excess Balmer continuum emission for the low-mass stars TW Hya and Hen 3-600A and the brown dwarfs 2MASS J12073347-3932540, UScoCTIO 128, SSSPM J1102-3431, UScoJ160606.29-233513.3, DENIS-P J160603.9-205644, and Oph J162225-240515B, and upper limits on accretion for the low-mass star Hen 3-600B and the brown dwarfs UScoCTIO 112, Oph J162225-240515A, and USco J160723.82-221102.0. For the six brown dwarfs in our sample that are faintest at short wavelengths, the accretion luminosity or upper limit is measurable only when the image is binned over large wavelength intervals. This method extends our sensivity to accretion rate down to $\sim 10^{-13}\ M_\odot\ yr^{-1}$ for brown dwarfs. Since the ability to measure an accretion rate from excess Balmer continuum emission depends on the contrast between excess continuum emission and the underlying photosphere, for objects with earlier spectral types the upper limit on accretion rate is much higher. Absolute uncertainties in our accretion rate measurements of $\sim 3-5$ include uncertainty in accretion models, brown dwarf masses, and distance. The accretion rate of 2×10^{-12} $M_\odot$ yr^{-1} onto 2MASS J12073347-3932540 is within 15% of two previous measurements, despite large changes in the Hα flux.

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Dispersion of Magnetic Fields in Molecular Clouds. I

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We describe a method for determining the dispersion of magnetic field vectors about large-scale fields in turbulent molecular clouds. The method is designed to avoid inaccurate estimates of magnetohydrodynamic or turbulent dispersion - and help avoiding inaccurate estimates of field strengths - due to large-scale, non-turbulent field structure when using the well-known method of Chandrasekhar and Fermi. Our method also provides accurate, independent estimates of the turbulent to large-scale magnetic field strength ratio. We discuss applications to the molecular clouds OMC-1, M17, and DR21(Main).

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The Variable Reflection Nebula Cepheus A East

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We report K'-band imaging observations of the reflection nebula associated with Cepheus A East covering the time interval from 1990 to 2004. Over this time the reflection nebula shows variations of flux distribution, which we interpret as the effect of inhomogeneous and varying extinction in the light path from the illuminating source HW2 to the reflection nebula. The obscuring material is located within typical distances of approximately 10 AU from the illuminating source.

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Detection of Water Ice Grains on the Surface of the Circumstellar Disk Around HD 142527

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Coronagraphic imaging for the Herbig Ae star, HD 142527, was performed using the Coronagraphic Imager with Adaptive Optics (CIAO) on the 8.2 m Subaru Telescope. The images were obtained in the H2O ice filter (λ = 3.08 μm) using adaptive optics (AO), and in the L' band without AO. Combining these data with previous observational results in the H and K bands, we derived the spectra of the scattered light from the circumstellar disk around HD 142527 and detected an H_2O ice absorption feature in the spectra. This result can be explained by the presence of silicate and H_2O ice grains of $\sim$1 μm in size, according to the prediction model by Inoue et al. This grain size is consistent with previous observational study by Fukagawa et al. and Fujiwara et al. The present result demonstrates that high-resolution imaging of disk-scattered light in the ice band is useful for detecting H_2O ice grain distributions

in circumstellar disks.

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Star Formation at Very Low Metallicity. IV. Fragmentation Does Not Depend on Metallicity for Cold Initial Conditions

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Primordial star formation appears to result in stars at least an order of magnitude more massive than modern star formation. It has been proposed that the transition from primordial to modern initial mass functions occurs due to the onset of effective metal line cooling at a metallicity $Z/Z_{\odot} = 10^{-3.5}$. However, these simulations neglected molecular hydrogen cooling. We perform simulations using the same initial conditions, but including molecular cooling, using a complex network that follows molecular hydrogen formation and also directly follows carbon monoxide and water. We find that molecular hydrogen cooling allows roughly equivalent fragmentation to proceed even at zero metallicity for these initial conditions. The apparent transition just represents the point where metal line cooling becomes more important than molecular cooling. In all cases, the fragments are massive enough to be consistent with models of primordial stellar masses, suggesting that the transition to the modern initial mass function may be determined by other physics such as dust formation. We conclude that such additional cooling mechanisms, combined with the exact initial conditions produced by cosmological collapse are likely more important than metal line cooling in determining the initial mass function, and thus that there is unlikely to be a sharp transition in the initial mass function at $Z/Z_{\odot} = 10^{-3.5}$.

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On the evolution of the molecular line profiles induced by the propagation of C-shock waves

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We present the first results of the expected variations of the molecular line emission arising from material recently affected by C-shocks (shock precursors). Our parametric model of the structure of C-shocks has been coupled with a radiative transfer code to calculate the molecular excitation and line profiles of shock tracers such as SiO, and of ion and neutral molecules such as $H^{13}CO^{+}$ and $HN^{13}C$, as the shock propagates through the unperturbed medium. Our results show that the SiO emission arising from the early stage of the magnetic precursor typically has very narrow line profiles slightly shifted in velocity with respect to the ambient cloud. This narrow emission is generated in the region where the bulk of the ion fluid has already slipped to larger velocities in the precursor as observed toward the young L1448-mm outflow. This strongly suggests that the detection of narrow SiO emission and of an ion enhancement in young shocks, is produced by the magnetic precursor of C-shocks. In addition, our model shows that the different velocity components observed toward this outflow can be explained by the coexistence of different shocks at different evolutionary stages, within the same beam of the single-dish observations.

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Modification of Angular Velocity by Inhomogeneous Magnetorotational Instability Growth in Protoplanetary Disks

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We have investigated evolution of magnetorotational instability (MRI) in protoplanetary disks that have radially nonuniform magnetic field such that stable and unstable regions coexist initially, and found that a zone in which the disk gas rotates with a super-Keplerian velocity emerges as a result of the nonuniformly growing MRI turbulence. We have carried out two-dimensional resistive magnetohydrodynamic simulations with a shearing box model. We found that if the spatially averaged magnetic Reynolds number, which is determined by widths of the stable and unstable regions in the initial conditions and values of the resistivity, is smaller than unity, the original Keplerian shear flow is transformed to the quasi-steady flow such that more flattened (rigid rotation in extreme cases) velocity profile emerges locally and the outer part of the profile tends to be super-Keplerian. Angular momentum and mass transfer due to temporally generated MRI turbulence in the initially unstable region is responsible for the transformation. In the local super-Keplerian region, migrations due to aerodynamic gas drag and tidal interaction with disk gas are reversed. The simulation setting corresponds to the regions near the outer and inner edges of a global MRI dead zone in a disk. Therefore, the outer edge of dead zone, as well as the inner edge, would be favorable sites to accumulate dust particles to form planetesimals and retain planetary embryos against Type I migration.

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High Resolution Mid-Infrared Spectroscopy of NGC 7538 IRS 1: Probing Chemistry in a Massive Young Stellar Object

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We present high resolution (R = 75,000–100,000) mid-infrared spectra of the high-mass embedded young star IRS 1 in the NGC 7538 star-forming region. Absorption lines from many rotational states of C_2H_2, $^{13}C^{12}CH_2$, CH_3, CH_4, NH_3, HCN, HNCO, and CS are seen. The gas temperature, column density, covering factor, line width, and Doppler shift for each molecule are derived. All molecules were fit with two velocity components between –54 and –63 km/s. We find high column densities ($\sim 10^{16}$ cm^{-2}) for all the observed molecules compared to values previously reported and present new results for CH_3 and HNCO. Several physical and chemical models are considered. The favored model involves a nearly edge-on disk around a massive star. Radiation from dust in the inner disk passes through the disk atmosphere, where large molecular column densities can produce the observed absorption line spectrum.

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Tracing the young massive high-eccentricity binary system θ^1 Orionis C through periastron passage

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Context: The nearby high-mass star binary system θ^1Ori C is the brightest and most massive of the Trapezium OB stars at the core of the Orion Nebula Cluster, and it represents a perfect laboratory to determine the fundamental parameters of young hot stars and to constrain the distance of the Orion Trapezium Cluster.
Aims: By tracing the orbital motion of the θ^1Ori C components, we aim to refine the dynamical orbit of this important binary system.
Methods: Between January 2007 and March 2008, we observed θ^1Ori C with VLTI/AMBER near-infrared (H- and K-band) long-baseline interferometry, as well as with bispectrum speckle interferometry with the ESO 3.6 m and the BTA 6 m telescopes (B'- and V'-band). Combining AMBER data taken with three different 3-telescope array configurations, we reconstructed the first VLTI/AMBER closure-phase aperture synthesis image, showing the θ^1Ori C system with a resolution of ~ 2 mas. To extract the astrometric data from our spectrally dispersed AMBER data, we employed a new algorithm, which fits the wavelength-differential visibility and closure phase modulations along the H- and K-band and is insensitive to calibration errors induced, for instance, by changing atmospheric conditions.
Results: Our new astrometric measurements show that the companion has nearly completed one orbital revolution since its discovery in 1997. The derived orbital elements imply a short-period ($P \approx 11.3$ yr) and high-eccentricity orbit ($e \approx 0.6$) with periastron passage around 2002.6. The new orbit is consistent with recently published radial velocity measurements, from which we can also derive the first direct constraints on the mass ratio of the binary components. We employ various methods to derive the system mass ($M_{\text{system}} = 44 \pm 7\ M_{\odot}$) and the dynamical distance ($d = 410 \pm 20$ pc), which is in remarkably good agreement with recently published trigonometric parallax measurements obtained with radio interferometry.

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The Formation of Massive Star Systems by Accretion

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Massive stars produce so much light that the radiation pressure they exert on the gas and dust around them is stronger than their gravitational attraction, a condition that has long been expected to prevent them from growing by accretion. We present three-dimensional radiation-hydrodynamic simulations of the collapse of a massive prestellar core and find that radiation pressure does not halt accretion. Instead, gravitational and Rayleigh-Taylor instabilities channel gas onto the star system through non-axisymmetric disks and filaments that self-shield against radiation, while allowing radiation to escape through optically-thin bubbles. Gravitational instabilities cause the disk to fragment and form a massive companion to the primary star. Radiation pressure does not limit stellar masses, but the instabilities that allow accretion to continue lead to small multiple systems.

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http://www.ucolick.org/∼krumholz/publications.html
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Grain Growth and Density Distribution of the Youngest Protostellar Systems

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We present dust opacity spectral indexes (β) of the youngest protostellar systems (so-called Class 0 sources), L1448 IRS 2, L1448 IRS 3, and L1157, obtained between the $\lambda = 1.3$ mm and 2.7 mm continua, using the Combined Array for Research in Millimeter-wave Astronomy (CARMA). The unprecedented compact configuration and image fidelity of CARMA allow a better detection of the dust continuum emission from Class 0 sources, with a less serious missing flux problem normally associated with interferometry. Through visibility-modeling at both $\lambda = 1.3$ mm and 2.7 mm simultaneously, as well as image- and visibility-comparison, we show that β of the three Class 0 sources are around or smaller than 1, indicating that dust grains have already significantly grown at the Class 0 stage. In addition, we find a radial dependence of β, which implies faster grain growth in the denser central regions and/or dust segregation. Density distributions of the Class 0 sources are also addressed by visibility-modeling.

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Combined Effects of Tidal and Rotational Distortions on the Equilibrium Configuration of Low-Mass, Pre-Main Sequence Stars

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Context. In close binary systems, the axial rotation and the mutual tidal forces of the component stars deform each other and destroy their spherical symmetry by means of the respective disturbing potentials.
Aims. We present new models for low-mass, pre-main sequence stars that include the combined distortion effects of tidal and rotational forces on the equilibrium configuration of stars. Using our theoretical results, we aim at investigating the effects of interaction between tides and rotation on the stellar structure and evolution.
Methods. The Kippenhahn & Thomas (1970, in Stellar Rotation, ed. A. Slettebak) approximation, along with the Clairaut-Legendre expansion for the gravitational potential of a self-gravitating body, is used to take the effects of tidal and rotational distortions on the stellar configuration into account.
Results. We obtained values of internal structure constants for low-mass, pre-main sequence stars from stellar evolutionary models that consider the combined effects of rotation and tidal forces due to a companion star. We also derived a new expression for the rotational inertia of a tidally and rotationally distorted star. Our values corresponding to standard models (with no distortions) are compatible with those available in literature. Our distorted models were successfully used to analyze the eclipsing binary system EK Cep, reproducing the stellar radii, effective temperature ratio, lithium depletion, rotational velocities, and the apsidal motion rate in the age interval of 15.5-16.7 Myr.
Conclusions. In the low-mass range, the assumption that harmonics greater than j=2 can be neglected seems not to be fully justified, although it is widely used when analyzing the apsidal motion of binary systems. The non-standard evolutionary tracks are cooler than the standard ones, mainly for low-mass stars. Distorted models predict more mass-concentrated stars at the zero-age main-sequence than standard models.

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Resonance Trapping in Protoplanetary Disks. I. Coplanar Systems

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Mean-motion resonances (MMRs) are likely to play an important role both during and after the lifetime of a protostellar gas disk. We study the dynamical evolution and stability of planetary systems containing two giant planets on circular orbits near a 2:1 resonance and closer. We find that by having the outer planet migrate inward, the two planets can capture into either the 2:1, 5:3, or 3:2 MMR. We use direct numerical integrations of $\sim$1000 systems in which the planets are initially locked into one of these resonances and allowed to evolve for up to $\sim 10^7$ yr. We find that the final eccentricity distribution in systems which ultimately become unstable gives a good fit to observed exoplanets. Next, we integrate $\sim$500 two-planet systems in which the outer planet is driven to continuously migrate inward, resonantly capturing the inner planet; the systems are evolved until either instability sets in or the planets reach the star. We find that although the 5:3 resonance rapidly becomes unstable under migration, the 2:1 and 3:2 are very stable. Thus the lack of observed exoplanets in resonances closer than 2:1, if it continues to hold up, may be a primordial signature of the planet formation process.

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Triggered Star Formation on the Border of the Orion-Eridanus Superbubble

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A census of classical T Tauri stars and Herbig Ae/Be stars has been performed around the Orion-Eridanus Superbubble which is ionized and created by the Ori OB1 association. This sample is used to study the spatial distribution of newborn stars, hence the recent star formation sequence, in the region that includes two giant molecular clouds (Orion A and B) and additional smaller clouds (NGC 2149, GN 05.51.4, VdB 64, the Crossbones, the Northern Filament, LDN 1551, LDN 1558, and LDN 1563). Most of the molecular clouds are located on the border of the Superbubble, and associated with Hα filaments and star formation activity, except the Northern Filament which is probably located outside the Superbubble. This suggests that while star formation progresses from the oldest Ori OB1a subgroup to 1b, 1c and 1d, the Superbubble compresses and initiates starbirth in clouds such as NGC 2149, GN 05.51.4, VdB 64, and the Crossbones, which are located more than one hundred pc away from the center of the Superbubble, and even in clouds some two hundred pc away, i.e., in LDN 1551, LDN 1558, and LDN 1563. A superbubble appears to have potentially a long-range influence in triggering next-generation star formation in an OB association.

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A Shocking Solar Nebula?

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It has been suggested that shock waves in the solar nebula formed the high temperature materials observed in meteorites and comets. It is shown that the temperatures at the inner rim of the solar nebula could have been high enough over a sufficient length of time to produce chondrules, CAIs, refractory dust grains and other high-temperature materials observed in comets and meteorites.

The solar bipolar jet flow may have produced an enrichment of ^{16}O in the solar nebula over time and the chondrule oxygen isotopic reservoirs are possibly due to temporal changes in the relative position of the inner edge of the solar nebula and the subsequent strength of the solar bipolar jet flow. As such, nebula heating models, such as the shock model, are not required to explain the formation of most high-temperature chondritic components

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NICEST, a near-infrared color excess method tailored to small-scale structures

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Observational data and theoretical calculations show that significant small-scale substructures are present in dark molecular clouds. These inhomogeneities can provide useful clues to the physical conditions inside the clouds, but can also severely bias extinction measurements. We present nicest, a novel method to account and correct for inhomogeneities in molecular cloud extinction studies. The method, tested against numerical simulations, removes almost completely the biases introduced by sub-pixel structures and by the contamination of foreground stars. We applied nicest to 2MASS data of the Pipe molecular complex. The map thereby obtained shows significantly higher (up to 0.41 mag in A_K) extinction peaks than the standard nicer (Lombardi & Schneider 2001, A&A, 373, 359) map. This first application confirms that substructures in nearby molecular clouds, if not accounted for, can significantly bias extinction measurements in regions with $A_K > 1$ mag; the effect, moreover, is expected to increase in more distant molecular clouds, because of the poorer physical resolution achievable.

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The nature of HH 223 from long-slit spectroscopy

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HH 223 is a knotty, wiggling nebular emission of $\sim 30''$ length found in the L723 star-forming region. It lies projected onto the largest blueshifted lobe of the cuadrupolar CO outflow powered by a low-mass YSO system embedded in the core of L723. We analysed the physical conditions and kinematics along HH 223 with the aim of disentangling whether the emission arises from shock-excited, supersonic gas characteristic of a stellar jet, or is only tracing the wall cavity excavated by the CO outflow. We performed long-slit optical spectroscopy along HH 223, crossing all the bright knots (A to E) and part of the low-brightness emission nebula (F filament). One spectrum of each knot, suitable to characterize the nature of its emission, was obtained. The physical conditions and the radial velocity of the HH 223 emission along the slits were also sampled at smaller scale (0.6") than the knot sizes. The spectra of all the HH 223 knots appear as those of the intermediate/high excitation Herbig-Haro objects. The emission is supersonic, with blueshifted peak velocities ranging from -60 to -130 km s^{-1}. Reliable variations in the kinematics and physical conditions at smaller scale that the knot sizes are also found. The properties of the HH 223 emission derived from the spectroscopy confirm the HH nature of the object, the supersonic optical outflow most probably also being powered by the YSOs embedded in the L723 core.

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http://www.am.ub.es/~rosario/hh223_longslit_v2a.pdf

Discovery of a Wide Binary Brown Dwarf Born in Isolation

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During a survey for stars with disks in the Taurus star-forming region using the *Spitzer Space Telescope*, we have discovered a pair of young brown dwarfs, FU Tau A and B, in the Barnard 215 dark cloud. They have a projected angular separation of 5.7″, corresponding to 800 AU at the distance of Taurus. To assess the nature of these two objects, we have obtained spectra of them and constructed spectral energy distributions. Both sources are young (∼1 Myr) according to their Hα emission, gravity-sensitive spectral features, and mid-infrared excess emission. The proper motion of FU Tau A provides additional evidence of its membership in Taurus. We measure spectral types of M7.25 and M9.25 for FU Tau A and B, respectively, which correspond to masses of ∼0.05 and ∼0.015 M according to the evolutionary models of Chabrier and Baraffe. FU Tau A is significantly overluminous relative to an isochrone passing through FU Tau B and relative to other members of Taurus near its spectral type, which may indicate that it is an unresolved binary. FU Tau A and B are likely to be components of a binary system based on the low probability (∼3 $\times 10^{-4}$) that Taurus would produce two unrelated brown dwarfs with a projected separation of $a \leq 6''$. Barnard 215 contains only one other young star and is in a remote area of Taurus, making FU Tau A and B the first spectroscopically confirmed brown dwarfs discovered forming in isolation rather than in a stellar cluster or aggregate. Because they were born in isolation and comprise a weakly bound binary, dynamical interactions with stars could not have played a role in their formation, and thus are not essential for the birth of brown dwarfs.

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Molecular hydrogen in the disk of the Herbig Ae star HD 97048

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We present high-resolution spectroscopic mid-infrared observations of the circumstellar disk around the Herbig Ae star HD 97048 obtained with the *VLT Imager and Spectrometer for the mid-InfraRed (VISIR)*. We conducted observations of mid-infrared pure rotational lines of molecular hydrogen (H_2) as a tracer of warm gas in the disk surface layers. In a previous paper, we reported the detection of the S(1) pure rotational line of H_2 at 17.035 μm and argued it is arising from the inner regions of the disk around the star. We used *VISIR* on the VLT for a more comprehensive study based on complementary observations of the other mid-infrared molecular transitions, namely S(2) and S(4) at 12.278 μm and 8.025 μm respectively, to investigate the physical properties of the molecular gas in the circumstellar disk around HD 97048. We do not detect neither the S(2) line nor the S(4) H_2 line from the disk of HD 97048, but we derive upper limits on the integrated line fluxes which allows us to estimate an upper limit on the gas excitation temperature, $T_{ex} < 570$ K. This limit on the temperature is consistent with the assumptions previously used in the analysis of the S(1) line, and allows us to set stronger contraints on the mass of warm gas in the inner regions of the disk. Indeed, we estimate the mass of warm gas to be lower than 0.1 $M_{\rm Jup}$. We also discuss the probable physical mechanisms which could be responsible of the excitation of H_2 in the disk of HD 97048.

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The molecular emission of the irradiated star forming core ahead of HH 80N

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We present a Berkeley-Illinois-Maryland Association (BIMA) Array molecular survey of the star forming core ahead of HH 80N, the optically obscured northern counterpart of the Herbig-Haro objects HH 80/81. Continuum emission at 1.4 mm and 8 μm is detected at the center of the core, which confirms the presence of an embedded very young stellar object in the core. All detected molecular species arise in a ring-like structure, which is most clearly traced by CS (2–1) emission. This molecular ring suggests that strong molecular depletion occurs in the inner part of the core (at a radius of $\simeq 0.1$ pc and densities higher than $\sim 5 \times 10^4$ cm^{-3}). Despite of the overall morphology and kinematic similarity between the different species, there is significant molecular differentiation along the ring-like structure. The analysis of the chemistry along the core shows that part of this differentiation may be caused by the UV irradiation of the nearby HH 80N object, that illuminates the part of the core facing HH 80N, which results in an abundance enhancement of some of the detected species.

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Probing the role of protostellar feedback in clustered star formation : Mapping outflows in the collapsing protocluster NGC 2264-C

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Context The role played by protostellar feedback in clustered star formation is still a matter of debate. In particular, protostellar outflows have been proposed as a source of turbulence in cluster-forming clumps, which may provide support against global collapse for several free-fall times.

Aims Here, we seek to test the above hypothesis in the case of the well-documented NGC 2264-C protocluster, by quantifying the amount of turbulence and support injected in the surrounding medium by protostellar outflows.

Methods Using the HERA heterodyne array on the IRAM 30m telescope, we carried out an extensive mapping of NGC 2264-C in the three molecular line transitions ^{12}CO(2–1), ^{13}CO(2–1), and C^{18}O(2–1).

Results We found widespread high-velocity ^{12}CO emission, testifying to the presence of eleven outflow lobes, closely linked to the compact millimeter continuum sources previously detected in the protocluster. We carried out a detailed analysis of the dynamical parameters of these outflows, including a quantitative evaluation of the overall momentum flux injected in the cluster-forming clump. These dynamical parameters were compared to the gravitational and turbulent properties of the clump.

Conclusions We show that the population of protostellar outflows identified in NGC 2264-C are likely to contribute a significant fraction of the observed turbulence but cannot efficiently support the protocluster against global collapse. Gravity appears to largely dominate the dynamics of the NGC 2264-C clump at the present time. It is however possible that an increase in the star formation rate during the further evolution of the protocluster will trigger sufficient outflows to finally halt the contraction of the cloud.

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MBM 12: young protoplanetary discs at high galactic latitude

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We present Spitzer infrared observations to constrain disc and dust evolution in young T Tauri stars in MBM 12, a star-forming cloud at high latitude with an age of 2 Myr and a distance of 275 pc. The region contains 12 T Tauri systems, with primary spectral types between K3 and M6; 5 are weak-line and the rest classical T Tauri stars. Of the 8 stars that are detected with MIPS (spectral types between K3 and M5), only 1 lacks an IR excess - the other 7 all have an IR excess that can be attributed to a disc. This means that in MBM 12, for the detected spectral types K3-M5, we have a very high disc fraction rate, about 90%. Furthermore, 3 of those 7 excess sources are candidate transitional discs. The IRS spectra are analysed with the newly developed two-layer temperature distribution (TLTD) spectral decomposition method. For the 7 T Tauri stars with a detected IR excess, we analyse their solid-state features to derive dust properties such as mass-averaged grain size, composition and crystallinity. The mass-averaged grain size we determine from the 10 micron feature has a wide range, between 0.4 and 6 μm. This grain size is much smaller in the longer-wavelength region: between 0.1 and 1.5 μm. We find a spatial gradient in the forsterite to enstatite range, with more enstatite present in the warmer regions. The fact that we see a radial dependence of the dust properties indicates that radial mixing is not very efficient in the discs of these young T Tauri stars. The sources that have the least amount of disc flaring have the largest grain sizes, pointing to dust settling. A comparison between the objects with companions closer than 400 AU ('binaries') and those with wider or no companions ('singles'), shows that disc evolution already starts to differentiate between both groups at an age of 2 Myr: the excess at 30 μm is a factor 3 larger for the 'single' group. The SED analysis shows that the discs in MBM 12, in general, undergo rapid inner disc clearing, while the binary sources have faster disc evolution. The dust grains seem to evolve independently from the stellar properties, but are mildly related to disc properties such as flaring and accretion rates.

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Detection of Star Formation in the Unusually Cold Giant Molecular Cloud G216

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The giant molecular cloud G216-2.5, also known as Maddalena's cloud or the Maddalena-Thaddeus cloud, is distinguished by an unusual combination of high gas mass ($1 - 6 \times 10^5$ M$_\odot$), low kinetic temperatures (10 K), and the lack of bright far infrared emission. Although star formation has been detected in neighboring satellite clouds, little evidence for star formation has been found in the main body of this cloud. Using a combination of mid-infrared observations with the IRAC and MIPS instruments onboard the *Spitzer* space telescope, and near-IR images taken with the Flamingos camera on the KPNO 2.1-meter, we identify a population of 41 young stars with disks and 33 protostars in the center of the cloud. Most of the young stellar objects are coincident with a filamentary structure of dense gas detected in CS ($2 \rightarrow 1$). These observations show that the main body of G216 is actively forming stars, although at a low stellar density comparable to that found in the Taurus cloud.

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for paper http://astro1.physics.utoledo.edu/∼megeath/mt_stm.pdf
for table http://astro1.physics.utoledo.edu/∼megeath/mt_stm_table.pdf

Photodesorption of ices I: CO, N_2 and CO_2

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A longstanding problem in astrochemistry is how molecules can be maintained in the gas phase in dense inter- and circumstellar regions at temperatures well below their thermal desorption values. Photodesorption is a non-thermal desorption mechanism, which may explain the small amounts of observed cold gas in cloud cores and disk mid-planes. This study aims to determine the UV photodesorption yields and to constrain the photodesorption mechanisms of three astrochemically relevant ices: CO, N_2 and CO_2. In addition, the possibility of co-desorption in mixed and layered CO:N_2 ices is explored. The UV photodesorption of ices is studied experimentally under ultra high vacuum conditions and at astrochemically relevant temperatures (15 – 60 K) using a hydrogen discharge lamp (7–10.5 eV). The ice desorption is monitored by reflection absorption infrared spectroscopy of the ice and simultaneous mass spectrometry of the desorbed molecules. Both the UV photodesorption yield per incident photon and the photodesorption mechanism are highly molecule specific. The CO photodesorbs without dissociation from the surface layer of the ice, and N_2, which lacks a dipole allowed electronic transition in the wavelength range of the lamp, has a photodesorption yield that is more than an order of magnitude lower. This yield increases significantly due to co-desorption when N_2 is mixed in with, or layered on top of, CO ice. CO_2 photodesorbs through dissociation and subsequent recombination from the top 10 layers of the ice. At low temperatures (15 – 18 K), the derived photodesorption yields are $2.7(\pm1.3) \times 10^{-3}$ and $< 2 \times 10^{-4}$ molecules photon^{-1} for pure CO and N_2, respectively. The CO_2 photodesorption yield is $1.2(\pm0.7) \times 10^{-3} \times (1 - e^{-(x/2.9(\pm1.1))}) + 1.1(\pm0.7) \times 10^{-3} \times (1 - e^{-(x/4.6(\pm2.2))})$ molecules photon^{-1}, where x is the ice thickness in monolayers and the two parts of the expression represent a CO_2 and a CO photodesorption pathway, respectively. At higher temperatures, the CO ice photodesorption yield decreases, while that of CO_2 increases.

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Photodesorption of Ices II: H_2O and D_2O

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Gaseous H_2O has been detected in several cold astrophysical environments, where the observed abundances cannot be explained by thermal desorption of H_2O ice or by H_2O gas phase formation. These observations hence suggest an efficient non-thermal ice desorption mechanism. Here, we present experimentally determined UV photodesorption yields of H_2O and D_2O ice and deduce their photodesorption mechanism. The ice photodesorption is studied under ultra high vacuum conditions and at astrochemically relevant temperatures (18–100 K) using a hydrogen discharge lamp (7-10.5 eV), which simulates the interstellar UV field. The ice desorption during irradiation is monitored using reflection absorption infrared spectroscopy of the ice and simultaneous mass spectrometry of the desorbed species. The photodesorption yield per incident photon, $Y_{\rm pd}(T, x)$, is identical for H_2O and D_2O and its dependence on ice thickness and temperature is described empirically by $Y_{\rm pd}(T, x) = Y_{\rm pd}(T, x > 8)(1 - e^{-x/l(T)})$ where x is the ice thickness in monolayers (ML) and $l(T)$ a temperature dependent ice diffusion parameter that varies between ~1.3 ML at 30 K and 3.0 ML at 100 K. For thick ices the yield is linearly dependent on temperature due to increased diffusion of ice species such that $Y_{\rm pd}(T, x > 8) = 10^{-3}\,(1.3 + 0.032 \times T)$ UV photon^{-1}, with a 60% uncertainty for the absolute yield. The increased diffusion also results in an increasing H_2O:OH desorption product ratio with temperature from 0.7:1.0 at 20 K to 2.0:1.2 at 100 K. The yield does not depend on the substrate, the UV photon flux or the UV fluence. The yield is also independent on the initial ice structure since UV photons efficiently amorphize H_2O ice. The results are consistent with theoretical predictions of H_2O photodesorption at low temperatures and partly in agreement with a previous experimental study. Applying the experimentally determined yield to a Herbig Ae/Be star+disk model provides an estimate of the amount of gas phase H_2O that may be observed by e.g. *Herschel* in an example astrophysical environment. The model shows that UV photodesorption of ices increases the H_2O content by orders of magnitude in the disk surface region compared to models where non-thermal desorption is ignored.

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A formation scenario of young stellar groups in the region of the Scorpio Centaurus OB association

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The main objective of this work is to investigate the role played by Lower Centaurus Crux (LCC) and Upper Centaurus Lupus (UCL), both subcomponent of the Scorpio Centaurus OB association (Sco-Cen), in the formation of the groups β Pictoris, TW Hydrae and the η Chamaeleontis cluster. The dynamical evolution of all the stellar groups involved and of the bubbles and shells blown by LCC and UCL are calculated and followed from the past to the present. This leads to a formation scenario in which:

a) the groups β Pictoris, TW Hydrae were formed in the wake of the shells created by LCC and UCL;

b) the young cluster η Chamaeleontis was born as a consequence of the collision of the shells of LCC and UCL;

c) the formation of Upper Scorpius (US), the other main subcomponent of the Sco-Cen association, may have been started by the same process that created η Chamaeleontis.

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Multiwavelength Signatures of Magnetic Activity from Young Stellar Objects in the LkHα 101 Cluster

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We describe the results of our multiwavelength observing campaign on the young stellar objects in the LkHα 101 cluster. Our simultaneous X-ray and multifrequency radio observations are unique in providing simultaneous constraints on short-timescale variability at both wavelengths as well as constraints on the thermal or nonthermal nature of radio emission from young stars. Focussing on radio-emitting objects and the multiwavelength data obtained for them, we find that multifrequency radio data indicate nonthermal emission even in objects with infrared evidence for disks. We find radio variability on timescales of decades, days, and hours. About half of the objects with X-ray and radio detections were variable at X-ray wavelengths, despite lacking large-scale flares or large variations. Variability appears to be a bigger factor affecting radio emission than X-ray emission. A star with infrared evidence for a disk, [BW88] 3, was observed in the decay phase of radio flare. In this object and another ([BW88] 1), we find an inverse correlation between radio flux and spectral index, which contrasts with behavior seen in the Sun and active stars. We interpret this behavior as the repopulation of the hardest energy electrons due to particle acceleration. A radio and X-ray source lacking an infrared counterpart, [BW88] 1, may be near the substellar limit; its radio properties are similar to other cluster members, but its much higher radio to X-ray luminosity ratio is reminiscent of behavior in nearby very low-mass stars/brown dwarfs. We find no correspondence between signatures of particle acceleration and those of plasma heating, both time-averaged and time-variable. The lack of correlated temporal variability in multiwavelength behavior, the breakdown of multiwavelength correlations of time-averaged luminosities, and the optical thickness of X-ray emitting material at radio wavelengths support the idea that radio and X-ray emission on young stars are physically and/or energetically distinct.

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On the width and shape of the corotation region for low-mass planets

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We study the coorbital flow for embedded, low mass planets. We provide a simple semi-analytic model for the corotation region, which is subsequently compared to high resolution numerical simulations. The model is used to derive an expression for the half-width of the horseshoe region, $x_{\rm s}$, which in the limit of zero softening is given by $x_{\rm s}/r_{\rm p} = 1.68(q/h)^{1/2}$, where q is the planet to central star mass ratio, h is the disc aspect ratio and $r_{\rm p}$ the orbital radius. This is in very good agreement with the same quantity measured from simulations. This result is used to show that horseshoe drag is about an order of magnitude larger than the linear corotation torque in the zero softening limit. Thus the horseshoe drag, the sign of which depends on the gradient of specific vorticity, is important for estimates of the total torque acting on the planet. We further show that phenomena, such as the Lindblad wakes, with a radial separation from corotation of $\sim$ a pressure scale height H can affect $x_{\rm s}$, even though for low-mass planets $x_{\rm s} \ll H$. The effect is to distort streamlines and to reduce $x_{\rm s}$ through the action of a back pressure. This effect is reduced for smaller gravitational softening parameters and planets of higher mass, for which $x_{\rm s}$ becomes comparable to H.

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On corotation torques, horseshoe drag and the possibility of sustained stalled or outward protoplanetary migration

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We study the torque on low mass protoplanets on fixed circular orbits, embedded in a protoplanetary disc in the isothermal limit. We consider a wide range of surface density distributions including cases where the surface density increases smoothly outwards. We perform both linear disc response calculations and non linear numerical simulations. We consider a large range of viscosities, including the inviscid limit, as well as a range of protoplanet mass ratios, with special emphasis on the coorbital region and the corotation torque acting between disc and protoplanet.

For low mass protoplanets and large viscosity the corotation torque behaves as expected from linear theory. However, when the viscosity becomes small enough to enable horseshoe turns to occur, the linear corotation torque exists only temporarily after insertion of a planet into the disc, being replaced by the horseshoe drag first discussed by Ward. This happens after a time that is equal to the horseshoe libration period reduced by a factor amounting to about twice the disc aspect ratio. This torque scales with the radial gradient of specific vorticity, as does the linear torque, but we find it to be many times larger. If the viscosity is large enough for viscous diffusion across the coorbital region to occur within a libration period, we find that the horseshoe drag may be sustained. If not, the corotation torque saturates leaving only the linear Lindblad torques. As the magnitude of the non linear coorbital torque (horseshoe drag) is always found to be larger than the linear torque, we find that the sign of the total torque may change even for for mildly positive surface density gradients. In combination with a kinematic viscosity large enough to keep the torque from saturating, strong sustained deviations from linear theory and outward or stalled migration may occur in such cases.

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GGD 27: X-rays from a Massive Protostar with an Outflow

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We report the discovery of a cluster of Class I protostars in GGD 27. One of these protostars is the previously known, centrally located, GGD 27-ILL, which powers a massive bipolar outflow. We show that GGD 27-ILL, which is known to be the bright infrared (IR) source, IRAS 18162-2048, and a compact radio continuum source, is also the newly

discovered hard X-ray source, GGD 27-X. The observations were made with the ACIS instrument on the *Chandra* X-ray Observatory. The X-rays from GGD 27-X are variable when compared with 4 years earlier, with an unabsorbed 2-10 keV X-ray luminosity in this observation of 1.5-12 $\times$ 10^{31} erg s^{-1} and a plasma temperature of $\geq 10^7$ K. The X-rays are probably associated with the underlying B0 star (rather than outflowing material), providing a rare glimpse in hard X-rays of an optically obscured massive protostar with an outflow. The X-ray luminosity and spectrum appear to be consistent with stars of its type in other star formation regions. Several other variable X-ray sources are also detected in the IR cluster that contains GGD 27-X. We also discuss another nearby cluster. In each of the clusters there is an object that is X-ray hard, highly absorbed at low energies, in a blank optical/IR/radio field, and variable in X-ray intensity by a factor of $\geq$ 10 on a timescale of 4 years. These latter objects may arise from more recent episodes of star formation or may be "hidden" Class III sources.

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Physical and chemical conditions in methanol maser selected hot-cores and UCHII regions

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We present the results of a targeted 3-mm spectral line survey towards the eighty-three 6.67 GHz methanol maser selected star forming clumps observed by Purcell et al. (2006). In addition to the previously reported measurements of HCO^+ (1−0), $H^{13}CO^+$ (1−0), and CH_3CN (5−4) & (6−5), we used the Mopra antenna to detect emission lines of N_2H^+ (1−0), HCN (1−0) and HNC (1−0) towards 82/83 clumps (99 per cent), and CH_3OH (2−1) towards 78/83 clumps (94 per cent).

The molecular line data have been used to derive virial and LTE masses, rotational temperatures and chemical abundances in the clumps, and these properties have been compared between sub-samples associated with different indicators of evolution. The greatest differences are found between clumps associated with 8.6 GHz radio emission, indicating the presence of an Ultra-Compact HII region, and 'isolated' masers (without associated radio emission), and between clumps exhibiting CH_3CN emission and those without. In particular, thermal CH_3OH is found to be brighter and more abundant in Ultra-Compact HII (UCHII) regions and in sources with detected CH_3CN, and may constitute a crude molecular clock in single dish observations.

Clumps associated with 8.6 GHz radio emission tend to be more massive *and* more luminous than clumps without radio emission. This is likely because the most massive clumps evolve so rapidly that a Hyper-Compact HII or UCHII region is the first visible tracer of star-formation.

The gas-mass to sub-mm/IR luminosity relation for the combined sample was found to be $L \propto M^{0.68}$, considerably shallower than expected for massive main-sequence stars. This implies that the mass of the clumps is comparable to, or greater than the mass of the stellar content.

We find also that the mass of the hot core is correlated with the mass of the clump in which it is embedded.

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Submillimeter Array Observations of the Molecular Outflow in High-mass Star-forming Region G240.31+0.07

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We present Submillimeter Array observations toward the $10^{4.7}$ $L_\odot$ star-forming region G240.31+0.07, in the $J = 2$–1 transition of ^{12}CO and ^{13}CO and at 1.3 mm continuum, as well as the ^{12}CO and ^{13}CO observations from the Caltech Submillimeter Observatory to recover the extended emission filtered out by the interferometer. Maps of the ^{12}CO and ^{13}CO emission show a bipolar, wide-angle, quasi-parabolic molecular outflow, roughly coincident with an IR nebula revealed by the *Spitzer* 3.6 and 4.5 μm emission. The outflow has ~ 98 $M_\odot$ molecular gas, making it one of the most massive molecular outflows known, and resulting in a very high mass-loss rate of 4.1×10^{-3} $M_\odot yr^{-1}$ over a dynamical timescale of 2.4×10^4 yr. The 1.3 mm continuum observations with a $4'' \times 3''$ beam reveal a flattened dusty envelope of ~ 150 $M_\odot$, which is further resolved with a $1.2'' \times 1''$ beam into three dense cores with a total mass of ~ 40 $M_\odot$. The central mm core, showing evidence of active star formation, approximately coincides with the geometric center of the bipolar outflow thus most likely harbors the powering source of the outflow. Overall our observations provide the best case to date of a well-defined wide-angle molecular outflow in a $> 10^4$ $L_\odot$ star-forming region. The outflow is morphologically and kinematically similar to low-mass protostellar outflows but has two to three orders of magnitude greater mass, momentum, and energy, and is apparently driven by an underlying wide-angle wind, hence further supports that high-mass stars up to late-O types, even in a crowded clustering environment, can form as a scaled-up version of low-mass star formation.

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Properties of Protostars in the Elephant Trunk in the Globule IC 1396A

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Extremely red objects, identified in the early *Spitzer Space Telescope* observations of the bright-rimmed globule IC 1396A and photometrically classified as Class I protostars and Class II T Tauri stars based on their mid-infrared (mid-IR) colors, were spectroscopically observed at 5.5-38 μm (*Spitzer* Infrared Spectrograph), at the 22 GHz water maser frequency (National Radio Astronomy Observatory Green Bank Telescope), and in the optical (Palomar Hale 5 m) to confirm their nature and further elucidate their properties. The sources photometrically identified as Class I, including IC 1396A:α, γ, δ, ϵ, and ζ, are confirmed as objects dominated by accretion luminosity from dense envelopes, with accretion rates 1-10 $\times 10^{-6}$ $M_\odot$ yr^{-1} and present stellar masses 0.1-2 $M_\odot$. The Class I sources have extremely red continua, still rising at 38 μm, with a deep silicate absorption at 9-11 μm, weaker silicate absorption around 18 μm, and weak ice features including CO_2 at 15.2 μm and H_2O at 6 μm. The ice/silicate absorption ratio in the envelope is exceptionally low for the IC 1396A protostars, compared to those in nearby star-forming regions, suggesting that the envelope chemistry is altered by the radiation field or globule pressure. Only one 22 GHz water maser was detected in IC 1396A; it is coincident with a faint mid-IR source, offset from near the luminous Class I protostar IC 1396A:γ. The maser source, IC 1396A:γ_b , has luminosity less than 0.1 $L_\odot$, the first H_2O maser from such a low-luminosity object. Two near-infrared (NIR) H_2 knots on opposite sides of IC 1396A:γ reveal a jet, with an axis clearly distinct from the H_2O maser of IC 1396A:γ_b . The objects photometrically classified as Class II, including IC 1396A:β, θ, Two Micron All Sky Survey (2MASS)J 21364964+5722270, 2MASSJ 21362507+5727502, LkHα 349c, Tr 37 11-2146, and Tr 37 11-2037, are confirmed as stars with warm, luminous disks, with a silicate emission feature at 9-11 μm, and bright Hα emission; therefore, they are young, disk-bearing, classical T Tauri stars. The disk properties change significantly with source luminosity: low-mass (G-K) stars have prominent 9-11 emission features due to amorphous silicates while

higher-mass (A-F) stars have weaker features requiring abundant crystalline silicates. A mineralogical model that fits the wide- and low-amplitude silicate feature of IC 1396A:θ requires small grains of crystalline olivine (11.3 μm peak) and another material to to explain its 9.1 μm peak; reasonable fits are obtained with a phyllosilicate, quartz, or relatively large (greater than 10 μm) amorphous olivine grains. The distribution of Class I sources is concentrated within the molecular globule, while the Class II sources are more widely scattered. Combined with the spectral results, this suggests two phases of star formation, the first (4 Myr ago) leading to the widespread Class II sources and the central O star of IC 1396 and the second (less than 1 Myr ago) occurring within the globule. The recent phase was likely triggered by the wind and radiation of the central O star of the IC 1396 H II region.

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Discovery of an old photoevaporating disk in sigma Orionis

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The photoevaporation of circumstellar disks is a powerful process in the disk dissipation at the origin of the Orion proplyds. This Letter reports the first detection of a photoevaporating disk in the final but long-lasting phase of its evolution. The disk is associated to a low-mass T Tauri member of the sigma Orionis Cluster. It is characterized by a very low (if any) accretion rate and by a tenuous ($\sim 10^{-9}$ M$_\odot$/yr) photoevaporation wind, which is unambiguously detected in the optical spectrum of the object. The wind emits strong forbidden lines of [SII] and [NII] because the low-mass star is close to a powerful source of ionizing photons, the O9.5 star sigma Ori.

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Long-wavelength observations of debris discs around sun-like stars

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Context. Tracing the evolution of debris discs is essential for our understanding of planetary system architectures.While the evolution of their inner discs has been recently studied with the Spitzer Space Telescope at mid- to far-infrared wavelengths, the outer discs are best characterised by sensitive millimetre observations.
Aims. The goal of our study is to understand the evolution timescale of circumstellar debris discs, and the physical mechanisms responsible for such evolution around solar-type stars. In addition, we perform a detailed characterisation of the detected debris discs.
Methods. Two deep surveys of circumstellar discs around solar-type stars at different ages were carried out at 350 ?m with the CSO and at 1.2 mm with the IRAM 30-m telescope. The dust disc masses were computed from the millimetre emission, where the discs are optically thin. Theoretically, the mass of the disc is expected to decrease with time. In order to test this hypothesis, we performed the generalised Kendall?s tau correlation and three different two-sample tests. A characterisation of the detected debris discs has been obtained by computing the collision and Poynting-Robertson timescales and by modelling the spectral energy distribution.
Results. The Kendall?s tau correlation yields a probability of 76% that the mass of debris discs and their age are correlated. Similarly, the three two-sample tests give a probability between 70 and 83% that younger and older debris systems belong to different parent populations in terms of dust mass. We detected submillimetre/millimetre emission

from six debris discs, enabling a detailed SED modelling.
Conclusions. Our results on the correlation and evolution of dust mass as a function of age are conditioned by the sensitivity limit of our survey. Deeper millimetre observations are needed to confirm the evolution of debris material around solar-like stars. In the case of the detected discs, the comparison between collision and Poynting-Robertson timescales supports the hypothesis that these discs are collision dominated. All detected debris disc systems show the inner part evacuated from small micron-sized grains.

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Near-Infrared Imaging Polarimetry of S106 Cluster-Forming Region with Sirpol

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We present the results of wide-field JHK_S polarimetry toward the H II region S106 using the Infrared Survey Facility telescope. Our polarimetry data revealed an extended (up to $\sim 5'$) polarized nebula over S106. We confirmed the position of the illuminating source of most of the nebula as consistent with S106 IRS 4 through an analysis of polarization vectors. The bright portion of the polarized intensity is consistent with the red wing component of the molecular gas. Diffuse polarized intensity emission is distributed along the north-south molecular gas lanes. We found the interaction region between the radiation from S106 IRS 4 and the dense gas. In addition, we also discovered two small polarization nebulae, SIRN 1 and SIRN 2, associated with a young stellar object (YSO). Aperture polarimetry of point-like sources in this region was carried out for the first time. The regional magnetic field structures were derived using point-like source aperture polarimetry, and the magnetic field structure position angle around the cluster region in S106 was found to be $\sim 120°$. The magnetic fields in the cluster region, however, have three types of position angles: $\sim 20°$, $\sim 80°$, and $\sim 120°$. The present magnetic field structures are consistent with results obtained by submillimeter continuum observations. We found that the magnetic field direction in the dense gas region is not consistent with that of the low-density gas region.

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The spatial distribution of stars in open clusters

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The analysis of the distribution of stars in open clusters may yield important information on the star formation process and early dynamical evolution of stellar clusters. Here we address this issue by systematically characterizing the internal spatial structure of 16 open clusters in the Milky Way spanning a wide range of ages. Cluster stars have been selected from a membership probability analysis based on a non-parametric method that uses both positions and proper motions and does not make any a priori assumption on the underlying distributions. The internal structure is then characterized by means of the minimum spanning tree method (Q parameter), King profile fitting, and the correlation dimension (Dc) for those clusters with fractal patterns. On average, clusters with fractal-like structure are younger than those exhibiting radial star density profiles and an apparent trend between Q and age is observed in agreement with previous ideas about the dynamical evolution of the internal spatial structure of stellar clusters. However, some new results are obtained from a more detailed analysis: (a) a clear correlation between Q and the concentration parameter of the King model for those cluster with radial density profiles, (b) the presence of spatial substructure in clusters as old as 100 Myr, and (c) a significant correlation between fractal dimension and age for those

clusters with internal substructure. Moreover, the lowest fractal dimensions seem to be considerably smaller than the average value measured in galactic molecular cloud complexes.

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Silica in Protoplanetary Disks

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Mid-infrared spectra of a few T Tauri stars (TTS) taken with the Infrared Spectrograph on board the *Spitzer Space Telescope* show prominent narrow emission features indicating silica (crystalline silicon dioxide). Silica is not a major constituent of the interstellar medium; therefore, any silica present in the circumstellar protoplanetary disks of TTS must be largely the result of processing of primitive dust material in the disks surrouding these stars. We model the silica emission features in our spectra using the opacities of various polymorphs of silica and their amorphous versions computed from earth-based laboratory measurements. This modeling indicates that the two polymorphs of silica, tridymite and cristobalite, which form at successively higher temperatures and low pressures, are the dominant forms of silica in the TTS of our sample. These high-temperature, low-pressure polymorphs of silica present in protoplanetary disks are consistent with a grain composed mostly of tridymite named Ada found in the cometary dust samples collected from the STARDUST mission to Comet 81P/Wild 2. The silica in these protoplanetary disks may arise from incongruent melting of enstatite or from incongruent melting of amorphous pyroxene, the latter being analogous to the former. The high temperatures of $\sim$ 1200-1300 K and rapid cooling required to crystallize tridymite or cristobalite set constraints on the mechanisms that could have formed the silica in these protoplanetary disks, suggestive of processing of these grains during the transient heating events hypothesized to create chondrules.

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The Gas Temperature of Starless Cores in Perseus

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In this paper, we study the determinants of starless core temperatures in the Perseus molecular cloud. We use NH_3 (1,1) and (2,2) observations to derive core temperatures ($T_{\rm kin}$) and data from the COMPLETE Survey of Star-Forming Regions and the c2d *Spitzer* Legacy Survey for observations of the other core and molecular cloud properties. The kinetic temperature distribution probed by NH_3 is in the fairly narrow range of $\sim$ 9-15 K. We find that cores within the clusters IC348 and NGC1333 are significantly warmer than "field" starless cores, and $T_{\rm kin}$ is higher within regions of larger extinction-derived column density. Starless cores in the field are warmer when they are closer to Class 0/I protostars, but this effect is not seen for those cores in clusters. For field starless cores, $T_{\rm kin}$ is higher in regions in which the ^{13}CO line width and the 1.1 mm flux from the core are larger, and $T_{\rm kin}$ is lower when the the peak column

density within the core and average volume density of the core are larger. There is no correlation between $T_{\rm kin}$ and ^{13}CO line width, 1.1 mm flux, density, or peak column density for those cores in clusters. The temperature of the cloud material along the line of sight to the core, as measured by CO or far-infrared emission from dust, is positively correlated with core temperature when considering the collection of cores in the field and in clusters, but this effect is not apparent when the two subsamples of cores are considered separately.

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X-ray Emission from the FU Orionis Star V1735 Cygni

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The variable star V1735 Cyg (= Elias 1-12) lies in the IC 5146 dark cloud and is a member of the class of FU Orionis objects whose dramatic optical brightenings are thought to be linked to episodic accretion. We report the first X-ray detections of V1735 Cyg and a deeply-embedded class I protostar lying 24″ to its northeast. X-ray spectra obtained with EPIC on *XMM-Newton* reveal very high-temperature plasma (kT > 5 keV) in both objects, but no large flares. Such hard X-ray emission is not anticipated from accretion shocks and is a signature of magnetic processes. We place these new results into the context of what is presently known about the X-ray properties of FU Orionis stars and other accreting young stellar objects.

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Disk Winds Driven by Magnetorotational Instability and Dispersal of Protoplanetary Disks

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By performing local three-dimensional MHD simulations of stratified accretion disks, we investigate disk winds driven by MHD turbulence. Initially weak vertical magnetic fields are effectively amplified by magnetorotational instability and winding due to differential rotation. Large-scale channel flows develop most effectively at 1.5-2 times the scale heights where the magnetic pressure is comparable to but slightly smaller than the gas pressure. The breakup of these channel flows drives structured disk winds by transporting the Poynting flux to the gas. These features are universally observed in the simulations of various initial fields. This disk wind process should play an essential role in the dynamical evaporation of protoplanetary disks. The breakup of channel flows also excites the momentum fluxes associated with Alfvnic and (magneto-)sonic waves toward the midplane, which possibly contribute to the sedimentation of small dust grains in protoplanetary disks.

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The intermediate-mass embedded cluster GM 24 revisited: New infrared and radio observations

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New and archived high-resolution infrared (1 to 20 μm) and radio continuum images of the isolated embedded cluster and associated compact HII region, GM 24, are presented and measured photometrically. The nucleus of the complex is Irs 3, or IRAS 17136-3617, located at the densest part of the molecular cloud. This object is composed of at least three compact near-infrared sources (A, B and C) that are the most luminous and massive young stellar components and provide most of the ionizing energy to the cometary-shaped radio HII region. The 3.6 cm radio map shows a complex structure with an extended emission peak and two very compact components very close to Irs 3A. Large inhomogeneities in the dust density within the nebula cause considerably different morphologies in the observed emission of hydrogen recombination lines, namely Paβ, Brγ and Brα. No H_2 line emission at 2.12 μm was detected. The embedded infrared cluster is found to contain more than 100 members within a radius of around 40″, which corresponds to 0.39 pc. The total stellar mass is estimated to be $\geq 250 M_{\odot}$. The extinction to the nearby edge of the cluster is determined to be $A_V = 13$, though a number of sources, including Irs 3, are reddened by $A_V > 50$. A fraction of near-IR sources, mainly in the periphery of the cluster, are main sequence A - B-type stars while a large fraction ($\sim$ 50%) of the detected members show significant IR excesses, including several Class I young stellar objects with luminosities ranging from a few solar luminosities near our sensitivity limit, to 1.5×10^5 $L_{\odot}$, the derived luminosity of Irs 3.

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Effects of Radionuclides on the Ionization State of Protoplanetary Disks and Dense Cloud Cores

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We comprehensively reinvestigate the ionization rates by radionuclides with the newest data on the abundance of the nuclides for the primitive solar nebula distinguishing the ionization rates of a hydrogen molecule, ζ^{H_2}, from those of a helium atom $\zeta^{He} \approx 0.84\zeta^{H_2}$. The ionization rates by ^{232}Th, ^{235}U, and ^{238}U become an order of magnitude larger than in the previous work of Umebayashi & Nakano by including all the energy released in the decay series, and these nuclides contribute about 20% of the total ionization rate by the long-lived radionuclides, 1.4 $\times 10^{-22}$ s^{-1} for a hydrogen molecule. The rest (80%) is contributed by ^{40}K. Among the short-lived radionuclides which are extinct in the present solar system, ^{26}Al is the dominant ionization source with the rate (7-10) $\times$ 10^{-19} s^{-1}, overwhelming the long-lived nuclides. In addition, ^{60}Fe and ^{36}Cl are more efficient than the long-lived nuclides though at least 10 times more inefficient than ^{26}Al. The helium abundance in the primitive solar nebula is significantly lower than in the present interstellar medium. We obtain a simple formula which transforms the ionization rates into those for the other values of the helium abundance. Ionization by radionuclides is quite inefficient when the mean dust size is greater than about 1 cm. Using these ionization rates, we investigate the ionization state for some configurations of the clouds. With an improved attenuation law of cosmic rays in geometrically thin disks, we find that the dead zones in protoplanetary disks are significantly larger than those obtained in the previous work.

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Chemical stratification in the Orion Bar: JCMT Spectral Legacy Survey observations

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Context. Photon-dominated regions (PDRs) are expected to show a layered structure in molecular abundances and emerging line emission, which is sensitive to the physical structure of the region as well as the UV radiation illuminating it.

Aims. We aim to study this layering in the Orion Bar, a prototypical nearby PDR with a favorable edge-on geometry.

Methods. We present new maps of 2 arcmin ×2 arcmin fields at 14 arcsec–23 arcsec resolution toward the Orion Bar in the SO 8_8–9_9, H_2CO 5_{15}–4_{14}, ^{13}CO 3–2, C_2H $4_{9/2}$–$3_{7/2}$ and $4_{7/2}$–$3_{5/2}$, $C^{18}O$ 2–1 and HCN 3–2 transitions.

Results. The data reveal a clear chemical stratification pattern. The C_2H emission peaks close to the ionization front, followed by H_2CO and SO, while $C^{18}O$, HCN and ^{13}CO peak deeper into the cloud. A simple PDR model reproduces the observed stratification, although the SO emission is predicted to peak much deeper into the cloud than observed while the H_2CO peak is predicted to peak closer to the ionization front than observed. In addition, the predicted SO abundance is higher than observed while the H_2CO abundance is lower than observed.

Conclusions. The discrepancies between the models and observations indicate that more sophisticated models, including production of H_2CO through grain surface chemistry, are needed to quantitatively match the observations of this region.

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Physical properties of Southern infrared dark clouds

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Context. What are the mechanisms by which massive stars form? What are the initial conditions for these processes? It is commonly assumed that cold and dense Infrared Dark Clouds (IRDCs) likely represent the birth sites massive stars. Therefore, this class of objects gets increasing attention, and their analysis offers the opportunity to tackle the above mentioned questions.

Aims. To enlarge the sample of well-characterised IRDCs in the southern hemisphere, where ALMA will play a major role in the near future, we have set up a program to study the gas and dust of southern infrared dark clouds. The present paper aims at characterizing the continuuum properties of this sample of IRDCs.

Methods. We cross-correlated 1.2 mm continuum data from SIMBA@SEST with Spitzer/GLIMPSE images to establish the connection between emission sources at millimeter wavelengths and the IRDCs we see at 8 μm in absorption against the bright PAH background. Analysing the dust emission and extinction leads to a determination of masses and column densities, which are important quantities in characterizing the initial conditions of massive star formation. We also evaluated the limitations of the emission and extinction methods.

Results. The morphology of the 1.2 mm continuum emission is in all cases in close agreement with the mid-infrared extinction. The total masses of the IRDCs were found to range from 150 to 1150 $M_\odot$ (emission data) and from 300 to 1750 $M_\odot$ (extinction data). We derived peak column densities between 0.9 and 4.6 $\times 10^{22}$ cm^{-2} (emission data) and 2.1 and 5.4 $\times 10^{22}$ cm^{-2} (extinction data). We demonstrate that the extinction method fails for very high extinction values (and column densities) beyond A_V values of roughly 75 mag according to the Weingartner & Draine (2001) extinction relation $R_V = 5.5$ model B (around 200 mag when following the common Mathis (1990) extinction calibration). By taking the spatial resolution effects into account and restoring the column densities derived from the dust emission back to a linear resolution of 0.01 pc, peak column densities of $3-19$ $\times 10^{23}$ cm^{-2} are obtained, much higher than typical values for low-mass cores.

Conclusions. The derived column densities, taking into account the spatial resolution effects, are beyond the column density threshold of 3.0 $\times 10^{23}$ cm^{-2} required by theoretical considerations for massive star formation. We conclude that the values for column densities derived for the selected IRDC sample make these objects excellent candidates for objects in the earliest stages of massive star formation.

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Variable Evolved Stars and Young Stellar Objects Discovered in the Large Magellanic Cloud Using the *SAGE* Survey

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We present initial results and source lists of variable sources in the Large Magellanic Cloud (LMC) for which we detect thermal infrared variability from the *Surveying the Agents of a Galaxy's Evolution* (*SAGE*) survey, which had two epochs of photometry separated by 3 months. The *SAGE* survey mapped a 7° × 7° region of the LMC using the Infrared Array Camera (IRAC) and the MIPS instruments on board *Spitzer*. Variable sources are identified using a combination of the IRAC 3.6, 4.5, 5.8, 8.0 μm bands and the MIPS 24 μm bands. An error-weighted flux difference between the two epochs is used to assess the variability. Of the ∼3 million sources detected at both epochs, we find ∼2000 variable sources for which we provide electronic catalogs. Most of the variable sources can be classified as asymptotic giant branch (AGB) stars. A large fraction (>66%) of the extreme AGB stars are variable and only smaller fractions of carbon-rich (6.1%) and oxygen-rich (2.0%) stars are detected as variable sources. We also detect a population of variable young stellar object candidates.

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Multiple Outflows and Protostars in Barnard 1
II. Deep Optical and Near Infrared Images

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We have used deep optical (Hα and [S II]) and near-IR (H_2 and K_S) images and catalogs of protostars based on optical and infrared data to follow up the observations of Walawender et al. 2005 and examine the protostellar outflow population in the Barnard 1 (B1) dark cloud. The deep images presented here link shocks at the low extinction periphery of the cloud to an outflow system which bisects the confused core of B1. In addition, we find that a deeply embedded infrared shock, previously identified as a protostar, is likely the impact of a flow on a submillimeter clump. In all, we detail nine outflow systems in this cloud, eight of which have clearly identified source protostars.

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Crystalline Silicates and Dust Processing in the Protoplanetary Disks of the Taurus Young Cluster

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We characterize the crystalline-silicate content and spatial distribution of small dust grains in a large sample of protoplanetary disks in the Taurus-Auriga young cluster, using the *Spitzer Space Telescope* mid-IR spectra. In turn we use the results to analyze the evolution of structure and composition of these 1-2 Myr old disks around Solar- and later-type young stars, and test the standard models of dust processing which result in the conversion of originally amorphous dust into minerals. We find strong evidence of evolution of the dust-crystalline mass fraction in parallel with that of the structure of the disks, in the sense that increasing crystalline mass fraction is strongly linked to dust settling to the disk midplane. We also confirm that the crystalline silicates are confined to small radii, $r < \sim 10$ AU. However, we see no significant correlation of crystalline mass fraction with stellar mass or luminosity, stellar-accretion rate, disk mass, or disk/star mass ratio, as would be expected in the standard models of dust processing based upon photoevaporation and condensation close to the central star, accretion-heating-driven annealing at $r < \sim 1$ AU, or spiral-shock heating at $r < \sim 10$ AU, with or without effective large-scale radial mixing mechanisms. Either another grain-crystallizing mechanism dominates over these, or another process must be at work within the disks to erase the correlations they produce. We propose one of each sort that seems to be worth further investigation, namely X-ray heating and annealing of dust grains, and modulation of disk structure by giant-planetary formation and migration.

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Fragmentation at the Earliest Phase of Massive Star Formation

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We present 1.3mm continuum and spectral line images of two massive molecular clumps P1 and P2 in the G28.34+0.06 region with the Submillimeter Array. While the two clumps contain masses of 1000 and 880 $M_\odot$, respectively, P1 has a luminosity $< 10^2$ $L_\odot$, and a lower gas temperature and smaller line width than P2. Thus, P1 appears to be at a much earlier stage of massive star formation than P2. The high resolution SMA observations reveal two distinctive cores in P2 with masses of 97 and 49 $M_\odot$, respectively. The 4 GHz spectral bandpass captures line emission from CO isotopologues, SO, CH_3OH, and CH_3CN, similar to hot molecular cores harboring massive young stars. The P1 clump, on the other hand, is resolved into five cores along the filament with masses from 22 to 64 $M_\odot$ and an average projected separation of 0.19 pc. Except ^{12}CO, no molecular line emission is detected toward the P1 cores at a 1σ rms of 0.1 K. Since strong ^{12}CO and $C^{18}O$ emissions are seen with the single dish telescope at a resolution of $11''$, the non-detection of these lines with the SMA indicates a depletion factor upto 10^3. While the spatial resolution of the SMA is better than the expected Jeans length, the masses in P1 cores are much larger than the thermal Jeans mass, indicating the importance of turbulence and/or magnetic fields in cloud fragmentation. The hierarchical structures in the P1 region provide a glimpse of the initial phase of massive star and cluster formation.

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The Minimum Jeans Mass, Brown Dwarf Companion IMF, and Predictions for Detection of Y-Type Dwarfs

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Cool L- and T-type objects were discovered first as companions to stars in 1988 and 1995, respectively. A certain example of the even cooler Y-type spectral class ($T_{\rm eff} < \sim$500 K) has not been seen. Recent infrared-imaging observations of stars and brown dwarfs indicate that substellar companions with large semi-major axes and with masses less than the brown dwarf/giant planet dividing line ($\sim$13.5 $M_{\rm J}$) are rare. Theoretical considerations of the Jeans mass fragmentation of molecular clouds are consistent with this minimum mass cutoff and also with the semi-major axis (hundreds of AU) characteristic of the lowest mass imaged companions. As a consequence, Y-class companions with large semi-major axes should be scarce around stars <2 Gyr old, and also around substellar primaries of all ages. By focusing on brown dwarf companions to young stellar primaries, it is possible to derive a first estimate of the brown dwarf IMF over the entire range of brown dwarf masses (13 $M_{\rm J}$ to 79 $M_{\rm J}$) – the number of companion brown dwarfs is proportional to the mass to the -1.2 ± 0.2 power.

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MOST photometry of the enigmatic PMS pulsator HD 142666

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Context. Modeling of pre-main sequence (PMS) stars through asteroseismology of PMS p-mode pulsators has only recently become possible, and spacebased photometry is one of the important sources of data for these efforts. We present precise photometry of the pulsating Herbig Ae star HD 142666 obtained in two consecutive years with the MOST (Microvariability & Oscilations of STars) satellite.
Aims. Previously, only a single pulsation period was known for HD 142666. The MOST photometry reveals that HD 142666 is multi-periodic. However, the unique identification of pulsation frequencies is complicated by the presence of irregular variability caused by the star's circumstellar dust disk. The two light curves obtained with MOST in 2006 and 2007 provided data of unprecedented quality to study the pulsations in HD 142666 and also to monitor the circumstellar variability.
Methods. Frequency analysis was performed using the routine SIGSPEC and the results from the 2006 and 2007 campaigns were then compared to each other with the software CINDERELLA to identify frequencies common to both light curves. The correlated frequencies were then submitted to an asteroseismic analysis.
Results. We attribute 12 frequencies to pulsation. Model fits to the three frequencies with the highest amplitudes lie well outside the uncertainty box for the star's position in the HR diagram based on published values. Some of the frequencies appear to be rotationally split modes.
Conclusions. The models suggest that either (1) the published estimate of the luminosity of HD 142666, based on a relation between circumstellar disk radius and stellar luminosity, is too high and/or (2) additional physics such as mass accretion may be needed in our models to accurately fit both the observed frequencies and HD 142666's position in the HR diagram.

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An Infrared and Optical View of Young Eruptive Stars

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Young eruptive stars (FU Orionis- and EX Lupi-type objects) form a small, but remarkable subgroup of pre-main sequence stars. They are characterized by eruptions which may increase the brightness of the system by as much as a factor of 100. Outbursts probably correspond to increased accretion from the circumstellar disk to the star. In my dissertation I present the detailed analysis of three young eruptive stars using ground-based and space-borne observations at optical and infrared wavelengths.

The outburst of OO Serpentis between 1995 and 2006. OO Ser is a deeply embedded young star that produced an eruption in 1995. Using archival (ISO, Spitzer) and new observations, I constructed the light curves of the star at ten different infrared wavelengths. My results show that the eruption caused brightening in the whole infrared regime, which is followed by a slow, wavelength-independent fading. The fading is still ongoing and the star will probably not return to quiescence before 2011. The timescale of the outburst is shorter than that of typical FU Ori-type objects, but longer than that of EX Lupi-type stars. Based on the spectral energy distribution, OO Ser seems to be an early Class I object with an age of $< 10^5$ yr. In accordance with outburst models, the star is probably surrounded by an accretion disk and a dense envelope. Due to the shorter timescales, outburst models developed for FU Ori-type stars can only work for OO Ser if the viscosity of the circumstellar disk is set to an order of magnitude larger value than usual for FU Ori objects.

The 2004–2006 outburst and environment of V1647 Orionis. V1647 Ori is a premain sequence star that suddenly brightened up in less than 4 months, reaching its peak brightness in 2004 February. I participated in a monitoring program, in which we obtained $VR_CI_CJHK_s$-band observations. After reaching its peak brightness, the star was fading very slowly. Then, in 2005 October it suddenly faded back to its quiescence level. The timescale of the outburst and the moderate increase in bolometric luminosity suggest that V1647 Ori differs both from FU Ori- and EX Lupi-type objects. By calculating the time delay between the brightness variations of the star and a nebular position, I deduced the geometry of the system. The near-infrared color maps of the nebula suggest that the star is surrounded by a disk and an extended nebula.

High-resolution polarimetry of Parsamian 21. Parsamian 21 is an FU Orionis-type object consisting of a central star and an extended reflection nebula. We obtained high spatial resolution adaptive optics assisted near-infrared direct and polarimetric observations with the NACO instrument at ESO's Very Large Telescope. I complemented these measurements with archival Hubble, Spitzer and ISO data. The results revealed that (1) the star is probably indeed an FU Orionis-type object; (2) the star is not associated with any known rich cluster of young stars; (3) the star is surrounded by an edge-on disk, and a circumstellar envelope with a polar cavity; (4) the disk seems to be flat and extends from at least 48 to 360 AU from the star; (5) the spectral energy distribution can be successfully modeled with a circumstellar disk and an envelope; (6) within the framework of an evolutionary sequence of FU Ori-type stars, Parsamian 21 seems to be an intermediate-aged object.

Post-doctoral position in modeling of the physics and chemistry of the interstellar medium - Laboratory Univers et Theories - Paris Observatory

In the context of the ASTRONET project STARFORMAT, LUTH and LERMA invite applications for a postdoctoral position to develop a 2D Photodissociaton Region code. This next generation PDR code will be used to interpret HERSCHEL observations in star forming regions.

Thanks to higher spatial and spectral resolutions of new instruments, as HERSCHEL and multi-wavelength studies, the interaction between UV radiation field and interstellar matter, induced photo-chemistry and coupling between gas and dust can be studied with unprecedented depth. Interpretations of chemical abundances in the presence of UV radiation field rely on state of the art PDR codes. Presently, most of these codes are 1D and stationary. Such a geometry does not allow scientists to simulate a variety of physical conditions, such as (e.g.) edge on PDRs or spherical clouds illuminated by a close star. The objectives of this project is to develop a 2D PDR code using an ellipsoidal geometry illuminated by any external radiation field. Such a geometry permits modeling of interstellar clouds from spheres to plan-parallel geometry illuminated by a unidirectional radiation field (produced by a star) plus an isotropic radiation field.

To this end, the candidate will work in collaboration with the LUTH - ISM team, Jacques Le Bourlot, Evelyne Roueff and Franck Le Petit who developed the Meudon PDR code. The present 1D code treats in details the microphysics of PDRs and new algorithms concerning radiative transfer have been recently introduced. Most of the challenge is to develop the radiative transfer equation on an orthogonal polynomial base adapted to the new geometry to bring the mathematical system to a set of differential equations with boundary conditions. The new 2D PDR code, will then be used to compute chemical structure of simulated cloud cores computed by MHD simulations in partnership with Patrick Hennebelle - LERMA, in the frame of the STARFORMAT project. It will then be used to interpret HERSCHEL observations from the key programs the ISM team is participating in.

Prospective applicants are encouraged to contact us by e-mail for further information. The position is expected to start in the early fall of 2009. It is funded for two years. Some expertise on numerical analysis and software development skills is required. Applicants should send a CV, a publication list and a brief research statement, either electronically or by regular mail, and arrange for three letters of reference to reach us by March 1, 2009. Late applications will continue to receive attention until the position is filled.

Opportunity for Assistant Professor Fellowship, Stockholm

To strengthen the star & planet formation research at the department of Astronomy, Stockholm University, we are looking for talented researchers interested in applying together with us for a personal 4 year fellowship from the (VR), with a possible extension to 5 years. To be eligible for this fellowship your PhD should typically be more recent than April 2004 (with some exceptions, e.g. due to parental leave), and you are normally expected to have at least two years of postdoc experience. With the fellowship you will be employed as assistant professor with about 20% teaching/departemental duties (25% if the department agrees to pay a 5th year). It also comes with a personal research budget. The fellowship is prestigious, with only some 30 granted each year for all of the natural sciences in Sweden, and at most one in astronomy. The decision on the fellowship will be taken by the Swedish National Research Council late 2009, and the position could start any time during 2010.

The star & planet formation research at Stockholm University is mostly observational, using facilities such as ESO/VLT, APEX, and involvement in Herschel and ALMA. Theoretical/computational work mainly deals with disc-planet interaction and the structure of HII regions. We are also part of the Stockholm University graduate school in Astrobiology, a truly crossdisciplinary collaboration with the departments of physics, geology and molecular biology. We are interested in researchers working observationally and/or theoretically on star formation, planet formation/exo-planets, and/or astrobiology.

Since the actual application to the research council has to be done jointly with the institute (with a deadline in April), we invite those interested in applying to contact one of us before March 1. Please include a CV. You can also contact us for more information: Göran Olofsson (olofsson *at* astro.su.se) or Garrelt Mellema (garrelt *at* astro.su.se).

Postdoctoral position in the study of Star Formation with Herschel

A post-doctoral position is available in the 'Star and Planetary Formation' group at the Istituto di Fisica dello Spazio Interplanetario (IFSI-INAF, Rome), in the framework of the group activities for the HERSCHEL mission. This fellowship is funded by the Italian Space Agency (ASI).

The IFSI 'Star and Planetary Formation' actively participates to the consortia of the three focal plane instruments of the HERSCHEL satellite: SPIRE, PACS and HIFI. The group is involved in many of the Guarantee Time (GT) and Open Time (OT) Key Projects of the mission. In particular the group co-leads the GT Key Project 'Gould Belt: A wide-field Herschel photometric survey of nearby star-forming cloud complexes' and leads the HIGAL OT Key Project for the photometric galactic plane survey.

The selected candidate is expected to carry out and develop research activity in the field of the Star Formation science related to the observations with the Herschel Satellite and with other ancillary and archive data. In addition the candidate will be encouraged to develop analitic and theoretical skills toward the interpretation of the data. The winner will participate to all the Herschel activities of the group.

The Candidates must have experience with infrared/submillimeter astrophysics and with Star Formation/Interstellar Medium scientific topics. Experience with IR Astronomy Space Instrumentation will be considered as a plus.

The fellowship is expected to have the duration of one year, with a renewal for other two years subject to a positive evaluation of the research activity carried out during the first year. The gross yearly salary will be in the range 28000 - 33000 depending on the capabilities and experience of the selected candidate.

The applicants should send (either electronically, mail or via FAX) a Curriculum Vitae, a statement of research interests and a list of publications. They should also arrange for three letters of references to be sent independently at the address below.

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Anna Maria Di Giorgio: anna.digiorgio *at* ifsi-roma.inaf.it

The deadline for submission of applications is February 28th 2009. Candidate could be invited to have an interview on their activity.

Post-doctoral positions in Saclay and Marseille (FRANCE)

Two post-doctoral positions (one in Saclay and one in Marseille) are offered to work on massive star formation in the Galaxy. Details about the positions can be found at: http://www.obs.u-bordeaux1.fr/radio/SBontemps/probes/

The deadline for sending applications is extended to March 15 2009.

Structure Formation in Astrophysics

Edited by Gilles Chabrier

These are the proceedings of a conference held in Chamonix in May 2007. The basis of the conference was a recognition that the formation of structure in astrophysical objects share many underlying physical mechanisms. Hence a valuable symbiosis can be developed when people working in the seemingly different fields of galaxy formation, star formation, and planet formation get together. Instead of a multitude of short individual presentations, the book contains a set of major and authoritative reviews in a textbook format, written by teams of authors with sometimes discrepant views, thus providing a window into not only areas of consensus, but also into the issues that currently divide opinion. Chapters presenting observational results precede chapters discussing theoretical concepts and methods. The following lists the chapters in the book.

Part 1. Physical Processes and Numerical Methods Common to Structure Formations in Astrophysics

The Physics of Turbulence *E. Léêque*
The Numerical Simulation of Turbulence *W. Schmidt*
Numerical Methods for Radiation Magnetohydrodynamics in Astrophysics *R. Klein & J. Stone*
The Role of Jets in the Formation of Planets, Stars, and Galaxies *R.E. Pudritz, R. Banerjee, & R. Ouyed*
Advanced Numerical Methods in Astriphysical Fluid Dynamics *A. Hujeirat & F. Heitsch*

Part 2. Structure and Star Formation in the Primordial Universe

New Frontiers in Cosmology and Galaxy Formation: Challenges for the Future *R. Ellis & J. Silk*
Galaxy Formation Physics *T. Abel, G. Bryan, & R. Teyssier*
First Stars: Formation, Evolution and Feedback Effects *V. Bromm, A. Ferrara, & A. Heger*

Part 3. Contemporary Star and Brown Dwarf Formation

Diffuse Interstellar medium and the Formation of Molecular Clouds *P. Hennebelle, M.-M. Mac Low, & E. Vazquez-Semadeni*
The Formation of Distributed and Clustered Stars in Molecular Clouds *S.T. Megeath, Z.-Y. Li, & A. Nordlund*
The Formation and Evolution of Prestellar Cores *P. André, S. Basu, & S. Inutsuka*
Models for the Formation of Massive Stars *M.R. Krumholz & I.A. Bonnell*

Part 4. Protoplanetary Disks and Planet Formation

Observational Properties of Disks and Young Stellar Objects *G. Duchene, F. Menard, J. Muzerolle, & S. Mohanty*
Structure and Dynamics of Protoplanetary Disks *C.P. Dullemond, R.H. Durisen, & J.C.B. Papaloizou*
Planet Formation and Evolution: Theory and Observations *Y. Alibert, I. Baraffe, W. Benz, G. Laughlin, & S. Udry*
Planet Formation: Assembling the Puzzle *G. Wurm & T. Guillot*

Part 5: Summary

Open Issues in Small- and Large-Scale Structure Formation *R.S. Klessen & M.-M. Mac Low*
A Final Word *E.E. Salpeter*

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http://www.cambridge.org/catalogue/catalogue.asp?isbn=9780521887793

From Disks to Planets: Learning from Starlight 2009 EARA workshop 16-20 March 2009

Our goal is to connect observers, theorists, and modelers of early stellar evolution, protoplanetary disks, and planet-hosting stars to stimulate discussion regarding the contribution and effects of starlight on the evolution of circumstellar disks.

All participants will receive office space and have internet access to conduct work. Funding for accommodation is available upon request.

Confirmed keynote speakers:

Cathie Clarke, IoA, Cambridge, UK
John Carpenter, Caltech, USA
Leo Girardi, INAF, Padova, IT
Greg Herczeg, MPE, Germany
Inga Kamp, Kapteyn Institute, NL
Bruno Mern, ESAC, ESA
Michael Meyer, ETH Zurich, CH
Ramiro de la Reza, National Observatory, BR
Stephane Udry, Observatoire de Geneve, CH
Andrew Youdin, CITA, Canada

http://www.lorentzcenter.nl/lc/web/2009/341/info.php3?wsid=341

YOUNG STARS, BROWN DWARFS, AND PROTOPLANETARY DISKS

IAU XXVII General Assembly - Special Session 7

Dates: Tuesday, 11 August 2009 - Friday, 14 August 2009

Location: Rio de Janeiro, Brazil

Web site: http://www.fisica.ufmg.br/ss7iau09/

Important date: The travel grant application and the abstract submission will be opened until March 1st, 2009.

Scientific Program: Properties of circumstellar disks; Accretion in brown dwarfs, T Tauri stars and Herbig Ae/Be stars; The role of magnetic fields and high-energy phenomena in young stellar objects, and their effects on protoplanetary disks; Jets and outflows from young stars. The angular momentum transport throughout pre-main sequence evolution; Planet formation and evolution; Brown dwarf and star formation and early evolution. The role of binary and multiple systems in PMS evolution and planet evolution.

Scientific Organizing Committee: Silvia Alencar (Co-chair, Brazil); Nuria Calvet (USA); Gilles Chabrier (France); Francesca D'Antona (Italy); Eric Feigelson (USA); Jane Gregorio-Hetem (Co-chair, Brazil); Sergei Lamzin (Russia); Susana Lizano (Mexico); Robert Mathieu (USA); Thierry Montmerle (France); Antonella Natta (Italy); Bo Reipurth (USA); Hsien Shang (Taiwan); Michael Sterzik (Chile); Ewine van Dishoeck (Netherlands); Hans Zinnecker (Germany).

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

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

The Star Formation Newsletter is available on the World Wide Web at http://www.ifa.hawaii.edu/users/reipurth/newsletter.htm.

Moving ... ??

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