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Abstracts of recently accepted papers

The 2004–2006 outburst and environment of V1647 Ori

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We studied the brightness and spectral evolution of the young eruptive star V1647 Ori during its recent outburst in the period 2004 February – 2006 Sep. We performed a photometric follow–up in the bands V, R_C, I_C, J, H, K_s as well as visible and near-IR spectroscopy. The main results derived from combining our data with those published by other authors are as follows: The brightness of V1647 Ori stayed more than 4 mag above the pre-outburst level until 2005 October when it started a rapid fading. In the high state we found a periodic component in the optical light curves with a period of 56 days. The delay between variations of the star and variations in the brightness of clump of nearby nebulosity corresponds to an angle of $61^o \pm 14^o$ between the axis of the nebula and the line of sight. The overall appearance of the infrared and optical spectra did not change in the period March 2004 – March 2005, though a steady decrease of HI emission line fluxes could be observed. In 2006 May, in the quiescent phase, the HeI 1.083 μm line was observed in emission, contrary to its deep blueshifted absorption observed during the outburst. The $J - H$ and $H - K_s$ color maps of the infrared nebula reveal an envelope around the star whose largest extension is about $18''$ (0.03 pc). The color distribution of the infrared nebula suggests reddening of the scattered light inside a thick circumstellar disk. Comparison of the K_s and Hα images of McNeil's Nebula, the conical nebulosity illuminated by V1647 Ori, shows that HH 22A, the Spitzer infrared source and the bright clump C of the nebula may be unrelated objects. We show that the observed properties of V1647 Ori could be interpreted in the framework of the thermal instability models of Bell et al. (1995). V1647 Ori might belong to a new class of young eruptive stars, defined by relatively short timescales, recurrent outbursts, modest increase in bolometric luminosity and accretion rate, and an evolutionary state earlier than that of typical EXors.

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Cold CO Gas in Protoplanetary Disks

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In a disk around DM Tau, previous observation of ^{13}CO ($J = 2 - 1$ and $1 - 0$ transitions) derived the ^{13}CO gas temperature of $\sim 13 - 20$K, which is lower than the sublimation temperature of CO (20 K). We argue that the

existence of such cold CO can be explained by a vertical mixing of disk material. As the gas is transported from a warm layer to a cold layer, CO is depleted onto dust grains with a timescale of $\sim 10^3$ yr. Because of the steep temperature gradient in the vertical direction, an observable amount of CO is still in the gas phase when the fluid parcel reaches the layer of ~ 13 K. Apparent temperature of CO decreases as the maximum grain size increases from μm-size to mm-size.

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Massive Binaries in High-Mass Star-forming Regions: A Multiepoch Radial Velocity Survey of Embedded O Stars

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We present the first multiepoch radial velocity study of embedded young massive stars using near-infrared spectra obtained with ISAAC mounted at the ESO Very Large Telescope, with the aim of detecting massive binaries. Our 16 targets are located in high-mass star-forming regions, and many of them are associated with known ultracompact H II regions, whose young age ensures that dynamic evolution of the clusters did not influence the intrinsic binarity rate. We identify two stars with about 90 km s^{-1} velocity differences between two epochs, proving the presence of close massive binaries. The fact that two out of the 16 observed stars are binary systems suggests that at least 20% of the young massive stars are formed in close multiple systems, but may also be consistent with most, if not all, young massive stars being binaries. In addition, we show that the radial velocity dispersion of the full sample is about 35 km s^{-1}, significantly larger than our estimated uncertainty (25 km s^{-1}). This finding is consistent with similar measurements of the young massive cluster 30 Dor, which might have a high intrinsic binary rate. Furthermore, we argue that virial cluster masses derived from the radial velocity dispersion of young massive stars may intrinsically overestimate the cluster mass due to the presence of binaries.

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First Detection of an H_2CO 6 cm Maser Flare: A Burst in IRAS 18566+0408

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We report the discovery of a short-duration (less than 3 months) outburst of the H_2CO 6 cm maser in IRAS 18566+0408 (G37.55+0.20). During the flare, the peak flux density of the maser increased by a factor of 4; after less than a month, it decayed to the preflare value. This is the first detection of a short, burstlike variability of an H_2CO 6 cm maser. The maser shows an asymmetric line profile that is consistent with the superposition of two Gaussian components. We did not detect a change in the velocity or the line width of the Gaussian components during the flare. If the two Gaussian components trace two separate maser regions, then very likely an event outside the maser gas triggered simultaneous flares at two different locations.

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Near-IR imaging of Galactic massive clusters: Westerlund 2

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Most stars in the Galaxy were formed in massive clusters. To understand nature's favorite mode of star formation and the initial stages of the life of most stars one needs to characterize the youngest and resolved massive clusters in the Milky Way. Unfortunately young massive clusters are challenging observational targets as they are rare, hence found at large distances, are still embedded in their parental molecular cloud, and are swamped by relatively bright nebulae. In this paper we propose to use deep subarcsec resolution NIR data to derive the basic parameters of the unstudied population of massive cluster Westerlund 2. We present deep JHK_s images (~ 0.6" seeing) and photometry of Westerlund 2. This is the most complete photometric census of the cluster's population to date. We detect a total of 4701, 5724, and 5397 sources in the J, H, and K_s bands respectively. By comparison with main-sequence and pre-main-sequence model tracks we determine an average visual extinction toward the cluster of 5.8 mag, a likely distance of 2.8 kpc, and an age of 2.0 ± 0.3 Myr for the core of the cluster. Although we have the sensitivity to reach beyond the Hydrogen burning limit in the cluster we are only complete to about 1 $M_{\odot}$ due to source confusion. We find no evidence for a top-heavy MF, and the slope of the derived mass function is -1.20 ± 0.16. Based on the extrapolation of a field IMF, we roughly estimate the total mass of the cluster to be about 10^4 $M_{\odot}$. We find compelling evidence for mass segregation in this cluster.

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http://www.astro.up.pt/investigacao/ficheiros/175.pdf

Massive star formation via high accretion rates and early disk-driven outflows

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We present an investigation of massive star formation that results from the gravitational collapse of massive, magnetized molecular cloud cores. We investigate this by means of highly resolved, numerical simulations of initial magnetized Bonnor-Ebert-Spheres that undergo collapse and cooling. By comparing three different cases - an isothermal collapse, a collapse with radiative cooling, and a magnetized collapse - we show that massive stars assemble quickly with mass accretion rates exceeding $10^{-3}\, M_{\odot}\, \mathrm{yr}^{-1}$. We confirm that the mass accretion during the collapsing phase is much more efficient than predicted by selfsimilar collapse solutions, i.e. $\dot{M} \sim c^3/G$. We find that during protostellar assembly the mass accretion reaches $20 - 100\, c^3/G$. Furthermore, we determined the self-consistent structure of bipolar outflows that are produced in our three dimensional magnetized collapse simulations. These outflows produce cavities out of which radiation pressure can be released, thereby reducing the limitations on the final mass of massive stars formed by gravitational collapse. Moreover, we argue that the extraction of angular momentum by disk-threaded magnetic fields and/or by the appearance of bars with spiral arms significantly enhance the mass accretion rate, thereby helping the massive protostar to assemble more quickly.

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The Protostar in the massive Infrared Dark Cloud IRDC18223-3

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At the onset of high-mass star formation, accreting protostars are deeply embedded in massive cores made of gas and dust. Their spectral energy distribution is still dominated by the cold dust and rises steeply from near-to far-infrared wavelengths. The young massive star-forming region IRDC 18223-3 is a prototypical Infrared-Dark-Cloud with a compact mm continuum core that shows no protostellar emission below 8 μm. However, based on outflow tracers, early star formation activity was previously inferred for this region. Here, we present recent Spitzer observations from the MIPSGAL survey that identify the central protostellar object for the first time at 24 and 70 μm. Combining the mid- to far-infrared data with previous mm continuum observations and the upper limits below 8 μm, one can infer physical properties of the central source. At least two components with constant gas mass M and dust temperature T are necessary: one cold component ($\sim$15 K and $\sim$576 $M_\odot$) that contains most of the mass and luminosity, and one warmer component ($\geq$51 K and $\geq$0.01 $M_\odot$) to explain the 24 μm data. The integrated luminosity of $\sim$177 $L_\odot$ can be used to constrain additional parameters of the embedded protostar from the turbulent core accretion model for massive star formation. The data of IRDC 18223-3 are consistent with a massive gas core harboring a low-mass protostellar seed of still less than half a solar mass with high accretion rates of the order $10^{-4}\,M_\odot\,yr^{-1}$. In the framework of this model, the embedded protostar is destined to become a massive star at the end of its formation processes.

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http://www.mpia.de/homes/beuther/papers.html

Deviations from He I Case B Recombination Theory and Extinction Corrections in the Orion Nebula

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We are engaged in a comprehensive program to find reliable elemental abundances in and probe the physical structure of the Orion Nebula, the brightest and best-resolved H II region. In the course of developing a robust extinction correction covering our optical and UV FOS and STIS observations, we examined the decrement within various series of He I lines. The decrements of the $2^3S - n^3P$, $2^3P - n^3S$, and $3^3S - n^3P$ series are not in accord with case B recombination theory. None of these anomalous He I decrements can be explained by extinction, indicating the presence of additional radiative transfer effects in He I lines ranging from the near-IR to the near-UV. CLOUDY photoionization equilibrium models including radiative transfer are developed to predict the observed He I decrements, and the quantitative agreement is quite remarkable. Following from these results, select He I lines are combined with H I and [O II] lines and stellar extinction data to validate a new normalizable analytic expression for the wavelength dependence of the extinction. In so doing, the He^+/H^+ abundance is also derived.

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The Internal Energy for Molecular Hydrogen in Gravitationally Unstable Protoplanetary Disks

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The gas equation of state may be one of the critical factors for the disk instability theory of gas giant planet formation. This letter addresses the treatment of H_2 in hydrodynamical simulations of gravitationally unstable disks. In our discussion, we point out possible consequences of erroneous specific internal energy relations, approximate specific internal energy relations with discontinuities, and assumptions of constant Γ_1. In addition, we consider whether the ortho/para ratio for H_2 in protoplanetary disks should be treated dynamically as if the species are in equilibrium. Preliminary simulations indicate that the correct treatment is particularly critical for the study of gravitational instability when T = 30-50 K.

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Collapse and Fragmentation of Molecular Cloud Cores. IX. Magnetic Braking of Initially Filamentary Clouds.

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The collapse and fragmentation of initially filamentary, magnetic molecular clouds is calculated in three dimensions with a gravitational, radiative hydrodynamics code. The code includes magnetic field effects in an approximate manner: magnetic pressure, tension, braking, and ambipolar diffusion are all modelled. The parameters varied are the ratio of the ambipolar diffusion time to the free fall time at the center of the filamentary cloud (t_{ad}/t_{ff} = 10, 20, or $10^6 \sim \infty$), the cloud's reference magnetic field strength (B_{oi} = 0, 200, or 300 microgauss – the latter two values leading to magnetically subcritical clouds), the ratio of rotational to gravitational energy of the filament (10^{-4} or 10^{-2}), and the efficiency of magnetic braking (represented by a factor f_{mb} = 0, 10^{-4}, or 10^{-3}). Three types of outcomes are observed: direct collapse and fragmentation into a multiple protostar system (models with $B_{oi} = 0$), periodic contraction and expansion without collapse (models with $t_{ad}/t_{ff} = 10^6$), or periodic contraction and expansion leading eventually to collapse on a time scale of $\sim$ 6 to 12 t_{ff} (all other models). Because the computational grid is a finite volume sphere, the expanding clouds bounce off the spherical boundary and re-collapse toward the center of the spherical grid, leading to the periodic formation of shocked regions where the infalling gas collides with itself, forming dense layers susceptible to sustained collapse and eventual fragmentation. While the models begin their evolution at rest except for the assumed solid-body rotation, they develop weakly supersonic velocity fields as a result of the rebounding prior to collapse. The models show that magnetically-supported clouds subject to magnetic braking can undergo dynamic collapse leading to protostellar fragmentation on scales of 10 AU to 100 AU, consistent with typical binary star separations.

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25 Orionis: A kinematically distinct 10 Myr old group in Orion OB1a

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We report here on the photometric and kinematic properties of a well defined group of nearly 200 low-mass pre-main sequence stars, concentrated within $\sim 1^\circ$ of the early-B star 25 Ori, in the Orion OB1a sub-association. We refer to this stellar aggregate as the 25 Orionis group. The group also harbors the Herbig Ae/Be star V346 Ori and a dozen other early type stars with photometry, parallaxes, and some with IR excess emission, consistent with group

membership. The number of high and low-mass stars is in agreement with expectations from a standard Initial Mass Function. The velocity distribution for the young stars in 25 Ori shows a narrow peak centered at $19.7\,\mathrm{km\,s^{-1}}$, very close to the velocity of the star 25 Ori. This velocity peak is offset $\sim -10\,\mathrm{km\,s^{-1}}$ from the velocity characterizing the younger stars of the Ori OB1b sub-association, and $-4\,\mathrm{km\,s^{-1}}$ from the velocity of more widely spread young stars of the Ori OB1a population near the σ Ori cluster; this result provides new and compelling evidence that the 25 Ori group is a distinct kinematic entity, and that considerable space and velocity structure is present in the Ori OB1a sub-association. The low-mass members follow a well defined band in the color-magnitude diagram, consistent with an isochronal age of $\sim 7-10$ Myr, depending on the assumed evolutionary model. The $\sim 2\times$ drop in the overall Li I equivalent widths and accretion fraction between the younger Ori OB1b and the 25 Ori group, is consistent with the later being significantly older, independent of the absolute age calibration.
The highest density of members is located near the star 25 Ori, but the actual extent of the cluster cannot be well constrained with our present data. In a simple-minded kinematic evolution scenario, the 25 Ori group may represent the evolved counterpart of a younger aggregate like the σ Ori cluster.
The 25 Ori stellar aggregate is the most populous ~ 10 Myr sample yet known within 500 pc, setting it as an excellent laboratory to study the evolution of solar-like stars and protoplanetary disks.

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The Spitzer c2d Survey of Nearby Dense Cores. IV. Revealing the Embedded Cluster in B59

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Infrared images of the dark cloud core B59 were obtained with the Spitzer Space Telescope as part of the "Cores to Disks" Legacy Science project. Photometry from 3.6-70μm indicates at least 20 candidate low-mass young stars near the core, more than doubling the previously known population. Out of this group, 13 are located within 0.1 pc in projection of the molecular gas peak, where a new embedded source is detected. Spectral energy distributions span the range from small excesses above photospheric levels to rising in the mid-infrared. One other embedded object, probably associated with the millimeter source B59-MMS1, with a bolometric luminosity $L_{bol} \sim 2L_{\odot}$, has extended structure at 3.6 and 4.5μm, possibly tracing the edges of an outflow cavity. The measured extinction through the central part of the core is $A_V \gtrsim 45$ mag. The B59 core is producing young stars with a high efficiency.

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The young stellar population in M17 revealed by *Chandra*

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We report here results from a *Chandra* ACIS observation of the stellar populations in and around the Messier 17 HII region. The field reveals 886 sources with observed X-ray luminosities (uncorrected for absorption) between $\sim 29.3 < \log L_x < 32.8$ ergs s^{-1}, 771 of which have stellar counterparts in infrared images. In addition to comprehensive tables of X-ray source properties, several results are presented:

1. The X-ray Luminosity Function is calibrated to that of the Orion Nebula Cluster population to infer a total population of roughly 8000–10,000 stars in M17, one-third lying in the central NGC 6618 cluster.

2. About 40% of the ACIS sources are heavily obscured with $A_V > 10$ mag. Some are concentrated around well-studied star-forming regions—IRS 5/UC1, the Kleinmann-Wright Object, and M17-North—but most are distributed across the field. As previously shown, star formation appears to be widely distributed in the molecular clouds. X-ray emission is detected from 64 of the hundreds of Class I protostar candidates that can be identified by near- and mid-infrared colors. These constitute the most likely protostar candidates known in M17.

3. The spatial distribution of X-ray stars is complex: in addition to the central NGC 6618 cluster and well-known embedded groups, we find a new embedded cluster (designated M17-X), a 2 pc-long arc of young stars along the southwest edge of the M17 HII region, and 0.1 pc substructure within various populations. These structures may indicate that the populations are dynamically young.

4. All (14/14) of the known O stars but only about half (19/34) of the known B0–B3 stars in the M17 field are detected. These stars exhibit the long-reported correlation between X-ray and bolometric luminosities of $L_x \sim 10^{-7} L_{bol}$. While many O and early B stars show the soft X-ray emission expected from microshocks in their winds or moderately hard emission that could be caused by magnetically channeled wind shocks, six of these stars exhibit very hard thermal plasma components ($kT > 4$ keV) that may be due to colliding wind binaries. More than 100 candidate new OB stars are found, including 28 X-ray detected intermediate- and high-mass protostar candidates with infrared excesses.

5. Only a small fraction (perhaps 10%) of X-ray selected high- and intermediate-mass stars exhibit K-band emitting protoplanetary disks, providing further evidence that inner disks evolve very rapidly around more massive stars.

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http://arxiv.org/abs/astro-ph/0612590
http://www.astro.psu.edu/users/patb/M17/paper.pdf

The Separation/Period Gap in the Distribution of Extrasolar Planets around Stars with Masses M $\geq$ 1.2 M$_\odot$

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The evidence for a shortage of exosolar planets with semimajor axes -1.1 $\leq \log(a/AU) \leq -0.2$ is investigated. It is shown that this valley results from a gap in the radial distribution of planets, orbiting stars with masses $M_* \geq 1.2 M_\odot$

(the high-mass sample, HMS). No underabundance is found for planets orbiting stars with smaller masses. The observational data also indicate that within the HMS population it is preferentially the more massive planets with $M\sin(i) \geq 0.8M_J$ that are missing. Monte-Carlo simulations of planet formation and migration are presented that reproduce the observed shortage of planets in the observed radius regime. A dependence on the disk depletion timescale $\tau_{\rm dep}$ is found. The gap is more pronounced for $\tau_{\rm dep} = 10^6 - 10^7$ yrs than for $\tau_{\rm dep} = 3\times10^6 - 3\times10^7$ yrs. This might explain the observed trend with stellar mass if disks around stars with masses $M_* \geq 1.2M_\odot$ have shorter depletion timescales than those around less massive stars. Possible reasons for such a dependence are a decrease of disk size and an increase of stellar EUV flux with stellar mass.

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Optical spectroscopy of close companions to nearby Herbig Ae/Be and T Tauri stars

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We present VLT-FORS2 optical (5700 - 9400 Å) spectroscopy of close ($r < 1.5$”) companions to three nearby (d < 200 pc) Herbig Ae/Be stars (HD 144432, HD 150193, KK Oph) and one T Tauri star (S CrA). We report the detection of Li I (6707 Å) in absorption and emission lines (H_α, Ca II triplet) in the spectra of the companions. Our observations strongly suggest that the companions are physically associated pre-main-sequence stars. The spectral type derived for the companions is K5Ve for HD 144432 B, F9Ve for HD 150193 B, and G6Ve for KK Oph B. S CrA A and B were observed simultaneously. The spatially resolved spectra indicate that S CrA A (primary, north) is a G star and that S CrA B (secondary, south) is a K star. Using photometry from the literature and estimations of the R and I magnitude derived from the spectra, we localized primaries and companions in the HR diagram, derived their masses and assuming coevality constrained the age of the systems. KK Oph B (7 Myr) and S CrA B (2 Myr) are actively accreting T Tauri stars and are very likely surrounded by disks. HD 150193 B (10 Myr) and HD 144432 B (8 Myr) are weak-line T Tauri stars. Three of the four systems studied (HD 144432, HD 150193, KK Oph) have ages > 7 Myr. These systems retained their disks for a longer time than typical of a young star. Our results suggest that binarity may be a key issue in understanding the lifetime of disks.

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Evidence of Stellar-driven Outflows from the Classical T Tauri Star RY Tau

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RY Tau is a rapidly rotating classical T Tauri star observed close to edge-on. The combination of new HST/STIS observations obtained in 2001 with HST/GHRS archive data from 1993 has allowed us to get, for the first time, information on the thermal structure and velocity of the wind. The repeated observations of the Si III] and C III] lines show a lack of changes with time on the blue side of the profile (dominated by the wind contribution). Very high temperature plasma (log $T_e = 4.8$) is detected at densities of $9.5 \leq \log n_e$ (cm^{-3}) ≤ 10.2 associated with the wind. The emitting volumes are $\sim (0.35R_\odot)^3$, suggesting a stellar origin. The wind kinematics derived from the profiles (Si III], C III], and [O II]) does not satisfy the theoretical predictions of MHD centrifugally driven disk winds. The profiles' asymmetry, large velocity dispersions, and small variability as well as the small emitting volumes are best explained if the wind is produced by the contributions of several outflows from atmospheric open-field structures like those observed in the Sun.

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Dust Coagulation and Settling in Layered Protoplanetary Disks

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Previous models of dust growth in protoplanetary disks considered either uniformly laminar or turbulent disks. This Letter explores how dust growth occurs in a layered protoplanetary disk in which the magnetorotational instability (MRI) generates turbulence only on the surface layers of a disk. Two cases are considered: a completely laminar dead zone and a dead zone in which turbulence is "stirred up" from the MRI acting above. It is found that dust is depleted from high altitudes in layered disks faster than in uniformly laminar or turbulent disks. This is a result of the accelerated growth of particles in the turbulent regions and their storage in the laminar lower levels where they escape energetic collisions that would result in disruption. Thus, the regions of a protoplanetary disk above a dead zone would become rapidly depleted in small dust grains, whereas the outer regions will maintain a small dust population at all heights due to the disruptive collisions and vertical mixing from turbulence. This structure is similar to that inferred for disks around TW Hydra, GM Auriga, DM Tau, and CoKu Tau/4, which are depleted in dust close to the star but are optically thick at larger heliocentric distances.

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Simulating planet migration in globally evolving disks

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Context. Numerical simulations of planet-disk interactions are usually performed with hydro-codes that - because they consider only an annulus of the disk, over a 2D grid - cannot take into account the global evolution of the disk. However, the global evolution governs type II planetary migration, so that the accuracy of the planetary evolution can be questioned.

Aims. To develop an algorithm that models the local planet-disk interactions together with the global viscous evolution of the disk.

Methods. We surround the usual 2D grid with a 1D grid ranging over the real extension of the disk. The 1D and 2D grids are coupled at their common boundaries via ghost rings, paying particular attention to the fluxes at the interface, especially the flux of angular momentum carried by waves. The computation is done in the frame centered on the center of mass to ensure angular momentum conservation.

Results. The global evolution of the disk and the local planet-disk interactions are both well described and the feedback of one on the other can be studied with this algorithm, for a negligible additional computing cost with respect to the usual algorithms.

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Tidal Barrier and the Asymptotic Mass of Proto Gas-Giant Planets

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The extrasolar planets found with radial velocity surveys have masses ranging from several Earth to several Jupiter masses. According to the conventional sequential accretion scenario, these planets acquired super-earth cores prior to the onset of efficient gas accretion with rates that rapidly increase with their masses. In weak-line T-Tauri disks, mass accretion onto protoplanetary cores may eventually be quenched by a global depletion of gas, as in the case of Uranus and Neptune. However, such a mechanism is unlikely to have stalled the growth of some known planetary systems which contain relatively low-mass and close-in planets along with more massive and longer period companions. Here, we suggest a potential solution for this conundrum. In general, supersonic infall of surrounding gas onto a protoplanet is only possible interior to both of its Bondi and Roche radii. At a critical mass, a protoplanet's Bondi and Roche radii are equal to the disk thickness. Above this mass, the protoplanets' tidal perturbation induces the formation of a gap. Although the disk gas may continue to diffuse into the gap, the azimuthal flux across the protoplanets' Roche lobe is quenched. Using two different schemes, we present the results of numerical simulations and analysis to show that the accretion rate increases rapidly with the ratio of the protoplanet's Roche to Bondi radii or equivalently to the disk thickness. In regions with low geometric aspect ratios, gas accretion is quenched with relatively low protoplanetary masses. This effect is important for determining the gas-giant planets' mass function, the distribution of their masses within multiple planet systems around solar type stars, and for suppressing the emergence of gas-giants around low mass stars. Finally, we find that the accretion rate into the protoplanets' Roche lobe declines gradually on a characteristic timescale of a few Myr. During this final stage, the protracted decline in the accretion flow across their Roche lobe and onto their protoplanetary disks may lead to the formation and retention of their regular satellites.

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Chemistry in disks I - Deep search for N_2H^+ in the protoplanetary disks around LkCa 15, MWC 480, and DM Tau.

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Aims: To constrain the ionization fraction in protoplanetary disks, we present new high-sensitivity interferometric observations of N_2H^+ in three disks surrounding DM Tau, LkCa 15, and MWC 480.
Methods: We used the IRAM PdBI array to observe the N_2H^+ J=1-0 line and applied a χ^2-minimization technique to estimate corresponding column densities. These values are compared, together with HCO^+ column densities, to results of a steady-state disk model with a vertical temperature gradient coupled to gas-grain chemistry.
Results: We report two N_2H^+ detections for LkCa 15 and DM Tau at the 5σ level and an upper limit for MWC 480. The column density derived from the data for LkCa 15 is much lower than previously reported. The $[N_2H^+/HCO^+]$ ratio is on the order of 0.02–0.03. So far, HCO^+ remains the most abundant observed molecular ion in disks.
Conclusions: All the observed values generally agree with the modelled column densities of disks at an evolutionary stage of a few million years (within the uncertainty limits), but the radial distribution of the molecules is not reproduced well. The low inferred concentration of N_2H^+ in three disks around low-mass and intermediate-mass young stars implies that this ion is not a sensitive tracer of the overall disk ionization fraction.

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On the formation of terrestrial planets in hot-Jupiter systems

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Context. There are numerous extrasolar giant planets which orbit close to their central stars. These "hot-Jupiters" probably formed in the outer, cooler regions of their protoplanetary disks, and migrated inward to $\sim$0.1 AU. Since these giant planets must have migrated through their inner systems at an early time, it is uncertain whether they could have formed or retained terrestrial planets.

Aims. We present a series of calculations aimed at examining how an inner system of planetesimals/protoplanets,

undergoing terrestrial planet formation, evolves under the influence of a giant planet undergoing inward type II migration through the region bounded between 5-0.1 AU.

Methods. We have previously simulated the effect of gas giant planet migration on an inner system protoplanet/planetesimal disk using a N-body code which included gas drag and a prescribed migration rate. We update our calculations here with an improved model that incorporates a viscously evolving gas disk, annular gap and inner-cavity formation due to the gravitational field of the giant planet, and self-consistent evolution of the giant's orbit.

Results. We find that $\gtrsim$60% of the solids disk survives by being scattered by the giant planet into external orbits. Planetesimals are scattered outward almost as efficiently as protoplanets, resulting in the regeneration of a solids disk where dynamical friction is strong and terrestrial planet formation is able to resume. A simulation that was extended for a few Myr after the migration of the giant planet halted at 0.1 AU, resulted in an apparently stable planet of $\sim$2 $M_\oplus$ forming in the habitable zone. Migration-induced mixing of volatile-rich material from beyond the "snowline" into the inner disk regions means that terrestrial planets that form there are likely to be water-rich.

Conclusions. We predict that hot-Jupiter systems are likely to harbor water-abundant terrestrial planets in their habitable zones. These planets may be detected by future planet search missions.

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The Effect of Internal Dissipation and Surface Irradiation on the Structure of Disks and the Location of the Snow Line around Sun-like Stars

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In theory of accretion disks, angular momentum and mass transfer are associated with the generation of energy through viscous dissipation. In the construction of SED models of protostellar disks, the stellar irradiation is usually assumed to be the dominant heating source. Here we construct a new set of self-consistent analytical disk models by taking into account both sources of thermal energy and the thermal structure of the disk across the midplane. We deduce a set of general formulae for the relationship between the mass accretion rate and the surface density profile. We apply it to determine the structure of protostellar disks under a state of steady accretion and derive the radial distribution of surface density and midplane temperature. The incorporation of the viscous heating in our model reduces the disk flaring angle and leads to lower photospheric temperatures than previously thought. Around T Tauri stars, the snow line can evolve from outside 10 AU during FU Orionis outbursts, to 2 AU during the quasi-steady accretion phase, to 0.7 AU when the accretion rate falls to about $10^{-9} M_\odot$ yr^{-1}, and finally reexpand beyond 2.2 AU during the protostellar-to-debris disk transition. The nonmonotonous evolution of the snow line may lead to the observed isotopic composition of water on both Venus and Earth. We also infer the presence of a marginally opaque, isothermal region with a surface density distribution similar to that of the MSN model. With a 40% higher temperature than that in the region immediately within, this transition may lead to an upturn in the SEDs in the MIR (24-70 μm) wavelength range. The optically thin, outermost regions of the disk have a shallow surface density profile of the dust that is consistent with millimeter observations of spatially resolved disks.

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Are gas-phase models of interstellar chemistry tenable? The case of methanol

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We consider the case of methanol production in cold dark clouds, also known as quiescent cores, for which recent work shows that a purely gas-phase synthesis is unlikely to produce a sufficient amount to explain the observational

fractional abundance of $\simeq 10^{-9}$ Moreover, recent experiments appear to confirm a previous hypothesis that methanol can be formed on cold grain surfaces by the hydrogenation of CO via successive reactions with hydrogen atoms. In this paper we consider two ways of including the surface formation of methanol into chemical models of cold dark clouds. First, we use a gas-phase model and artificially include the surface formation of methanol in the same manner that the formation of molecular hydrogen is included. Secondly, we utilize a gas-grain code with a new mechanism for desorption following exothermic chemical reactions on grain surfaces. The latter method can reproduce the observed fractional abundance of gas-phase methanol and many other gas-phase species in the well-studied cold dark cloud TMC1-CP but the best fit to the observational data occurs at times significantly later than at ages estimated from gas-phase models.

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The Signature of Primordial Grain Growth in the Polarized Light of the AU Microscopii Debris Disk

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We have used the Hubble Space Telescope Advanced Camera for Surveys coronagraph to make the first polarization maps of the AU Microscopii debris disk. The polarization rises from 5% at 20 AU to 40% at 80 AU. The polarization is perpendicular to the disk, indicating that the scattered light originates from micron-sized grains in an optically thin disk. Disk models show that interior to the "birth ring" (40-50 AU) there is a hole in the dust distribution where micron-sized dust is depleted by a factor of more than 300. The disk is collision dominated, and grains that fall inward due to drag forces undergo a destructive collision. The presence of this hole implies that the localized enhancements in surface brightness that occur at projected radii interior to the birth ring are caused by nonaxisymmetric structures in the outer disk. The grains exhibit strong forward scattering and high polarization. Spherical grains composed of conventional materials cannot reproduce these optical properties. A Mie/Maxwell-Garnett analysis demands highly porous (91%-94%) particles. In the inner solar system, porous particles form in cometary dust, where the sublimation of ices leaves a "bird's nest" of refractory material. In AU Mic, the grain porosity may be primordial, because the dust birth ring lies beyond the ice sublimation point. The observed porosities span the range of values implied by laboratory studies of particle coagulation by ballistic cluster-cluster aggregation. To avoid compactification, the upper size limit for the parent bodies is in the decimeter range, in agreement with theoretical predictions based on collisional lifetime arguments. Consequently, AU Mic may exhibit the signature of the primordial agglomeration process whereby interstellar grains first assembled to form macroscopic objects.

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Collisional dust avalanches in debris discs

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We quantitatively investigate how collisional avalanches may develop in debris discs as the result of the initial breakup of a planetesimal or comet-like object, triggering a collisional chain reaction due to outward escaping small dust grains. We use a specifically developed numerical code that follows both the spatial distribution of the dust grains and the evolution of their size-frequency distribution due to collisions. We investigate how strongly avalanche propagation depends on different parameters (e.g., amount of dust released in the initial breakup, collisional properties of dust

grains, and their distribution in the disc). Our simulations show that avalanches evolve on timescales of ~ 1000 years, propagating outwards following a spiral-like pattern, and that their amplitude exponentially depends on the number density of dust grains in the system. We estimate the probability of witnessing an avalanche event as a function of disc densities, for a gas-free case around an A-type star, and find that features created by avalanche propagation can lead to observable asymmetries for dusty systems with a β Pictoris-like dust content or higher. Characteristic observable features include: (i) a brightness asymmetry of the two sides for a disc viewed edge-on, and (ii) a one-armed open spiral or a lumpy structure in the case of face-on orientation. A possible system in which avalanche-induced structures might have been observed is the edge-on seen debris disc around HD 32297, which displays a strong luminosity difference between its two sides.

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On the circum(sub)stellar environment of brown dwarfs in Taurus

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Aims : We want to investigate whether brown dwarfs (BDs) form like stars or are ejected embryos. We study the presence of disks around BDs in the Taurus cloud, and discuss implications for substellar formation models. Methods : We use photometric measurements from the visible to the far infrared to determine the spectral energy distributions (SEDs) of Taurus BDs. Results: We use Spitzer color indices, Halpha as an accretion indicator, and model fits to the SEDs in order to estimate physical parameters of the disks around these BDs. We study the spatial distribution of BDs with and without disks across the Taurus aggregates, and we find that BDs with and without disks are not distributed regularly across the Taurus cloud. Conclusions: We find that 48%+/- 14% of Taurus BDs have a circumstellar disk signature, a ratio similar to recent results from previous authors in other regions. We fit the SEDs and find that none of the disks around BDs in Taurus can be fitted convincingly with a flaring index beta = 0, indicating that heating by the central object is efficient and that the disks we observe retain a significant amount of gas. We find that BDs with disks are proportionally more numerous in the northern Taurus filament, possibly the youngest filament. We do not find such a clear segregation for classical T Tauri stars (CTTS) and weak-lined T Tauri stars (WTTS), suggesting that, in addition to the effects of evolution, any segregation effects could be related to the mass of the object. A by-product of our study is to propose a recalibration of the Barrado y Navascues & Martin (2003) accretion limit in the substellar domain. The global shape of the limit fits our data points if it is raised by a factor 1.25-1.30.

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Star formation in Perseus: II. SEDs, classification and lifetimes

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Context: Hatchell et al. (2005) (Paper I) published a submillimetre continuum map of the Perseus molecular cloud, detecting the starless and protostellar cores within it.

Aims: To determine the evolutionary stage of each submm core in Perseus, and investigate the lifetimes of these phases.

Method: We compile spectral energy distributions (SEDs) from 2MASS (1–2 μm), Spitzer IRAC (3.6, 4.5, 5.8, 8.0 μm), Michelle (11 and 18 μm), IRAS (12, 25, 60, 100 μm), SCUBA (450 and 850 μm) and Bolocam(1100 μm) data. Sources are classified starless/protostellar on the basis of infrared and/or outflow detections and Class I/Class 0 on the basis of $T_{\rm bol}$, $L_{\rm bol}/L_{\rm smm}$ and $F_{3.6}/F_{850}$. In order to investigate the dependence of these evolutionary indicators on mass, we construct radiative transfer models of Class 0 sources.

Results: Of the submm cores, 56/103 (54%) are confirmed protostars on the basis of infrared emission or molecular outflows. Of these, 22 are classified Class 1 on the basis of three evolutionary indicators, 34 are Class 0, and the remaining 47 are assumed starless. Perseus contains a much greater fraction of Class 0 sources than either Taurus or Rho Oph. We derive estimates for the correlation between bolometric luminosity and envelope mass for Class I and Class 0 sources.

Conclusions: Comparing the protostellar with the T Tauri population, the lifetime of the protostellar phase in Perseus is 0.25–0.67 Myr(95% confidence limits). The relative lifetime of the Class 0 and Class 1 phases are similar, confirming the results of Visser et al. (2002) in isolated cores. We find that for the same source geometry but different masses, evolutionary indicators such as $T_{\rm bol}$ vary their value. It is therefore not always appropriate to use a fixed threshold to separate Class 0 and Class I sources. More modelling is required to determine the observational characteristics of the Class 0/Class I boundary over a range of masses.

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http://www.astro.ex.ac.uk/people/hatchell/publications.html

On the structure of the turbulent interstellar atomic hydrogen. I- Physical characteristics, influence and nature of turbulence in a thermally bistable flow

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We study in some details the statistical properties of the turbulent 2-phase interstellar atomic gas. We present high resolution bidimensional numerical simulations of the interstellar atomic hydrogen which describe it over 3 to 4 orders of magnitude in spatial scales. The simulations produce naturally small scale structures having either large or small column density. It is tempting to propose that the former are connected to the tiny small scale structures observed in the ISM. We compute the mass spectrum of CNM structures and find that $\mathcal{N}(M)dM \propto M^{-1.7}dM$, which is remarkably similar to the mass spectrum inferred for the CO clumps. We propose a theoretical explanation based on a formalism inspired from the Press & Schecter (1974) approach and used the fact that the turbulence within WNM is subsonic. This theory predicts $\mathcal{N}(M) \propto M^{-5/3}$ in 2D and $\mathcal{N}(M) \propto M^{-16/9}$ in 3D. We compute the velocity and the density power-spectra and conclude that, although the latter is rather flat, as observed in supersonic isothermal simulations, the former follows the Kolmogorov prediction and is dominated by its solenoidal component. This is due to the bistable nature of the flow which produces large density fluctuations even when the rms Mach number (of WNM) is not large. We also find that, whereas the energy at large scales is mainly in the WNM, at smaller scales, it is dominated by the kinetic energy of the CNM fragments. We find that turbulence in a thermally bistable flow like the atomic interstellar hydrogen, is somehow different from turbulence in a supersonic isothermal gas. In a companion paper, we compare the numerical results with atomic hydrogen observations and show that the simulations well reproduce various observational features.

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On the structure of the turbulent interstellar atomic hydrogen. II- First comparison between observation and theory
Are the characteristics of molecular clouds determined early in the turbulent 2-phase atomic gas?

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It is necessary to understand the dynamics of the atomic gas to use complex modeling and to carry out detailed comparisons between theoretical models and observations. In a companion paper, we present high resolution bidimensional numerical simulations of the interstellar atomic hydrogen. Here, we further characterize these simulations and we compare our results with various observations. We give statistics of the column density and velocity along the line of sight and show that they compare favorably with observations of high-latitude lines of sight. We compute synthetic HI spectra and qualitatively discuss the information that could be inferred if these spectra were observed. Finally, we extract CNM clouds and study their physical properties finding strong similarities with real clouds. In particular, we find that the clouds follow Larson-type relations, i.e $M \propto L^{\gamma}$, where $\gamma \simeq 1.7$ (we speculate that in 3D, $\gamma \simeq 2.5$) and $\sqrt{< \delta v^2 >} \propto L^{0.4}$. We also find that the distribution, $\mathcal{N}(N)$, of the column density, N, of the CNM structures formed in the simulation follows $\mathcal{N}(N) \propto N^{-1.2}$ which is marginally compatible with the observational result obtained by Heiles & Troland (2005). From the mass-size relation and the mass spectrum, we derive an exponent for the column density distribution close to the value obtained in the numerical simulation. We conclude that the simulations reproduce various observational features reasonably well. An important implication suggested by our results is that the "turbulence" within the cold interstellar atomic gas is mainly the result of individual long living cloudlet (confined by an external warm medium) motions rather than supersonic turbulence within nearly isothermal clouds. Another important aspect is that the CNM structures produced in the simulation present various physical characteristics that are similar to the characteristics of the molecular clouds. This raises the question as to whether the physical properties of the molecular clouds are determined at a very early stage, before the gas becomes molecular.

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Direct imaging of the young spectroscopic binary HD 160934

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We report on the direct detection of a close companion to HD 160934, a young active star, SB1 spectroscopic binary, and suggested member of the AB Doradus moving group. High angular resolution at the Calar Alto 2.2m telescope was achieved by means of the Lucky Imaging technique, allowing direct imaging close to the diffraction limit in the SDSS z' band. Our results are combined with pre-discovery HST archive data, own UBVRI broadband photometry, published JHK magnitudes, and available radial velocity measurements to constrain the physical properties of the HD 160934 close binary. We suggest that the direct detection may be identical to the spectroscopically discovered companion.

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Constraints on the Formation of the Planet in HD 188753

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The claimed discovery of a Jupiter-mass planet in the close triple-star system HD 188753 poses a problem for planet formation theory. A circumstellar disk around the planet's parent star would be truncated close to the star, leaving little material available for planet formation. In this paper we attempt to model a protoplanetary disk around HD 188753A using a fairly simple α-disk model, exploring a range of parameters constrained by observations of T Tauri-type stars. The disk is truncated to within 1.5-2.7 AU, depending on model parameters. We find that the in situ formation of the planet around HD 188753A is implausible.

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The distance to the Orion Nebula Cluster

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The distance to the Orion Nebula Cluster (ONC) is estimated using the rotational properties of its low-mass pre main-sequence (PMS) stars. Rotation periods, projected equatorial velocities and distance-dependent radius estimates are used to form an observational $\sin i$ distribution (where i is the axial inclination), which is modelled to obtain the distance estimate. A distance of 440 ± 34 pc is found from a sample of 74 PMS stars with spectral types between G6 and M2, but this falls to 392 ± 32 pc when PMS stars with accretion discs are excluded on the basis of their near-infrared excess. Since the radii of accreting stars are more uncertain and probably systematically underestimated, then this closer distance is preferred. The quoted uncertainties include statistical errors and uncertainties due to a number of systematic effects including binarity and inclination bias. This method is geometric and independent of stellar evolution models, though does rely on the assumption of random axial orientations and the Cohen & Kuhi (1979) effective temperature scale for PMS stars. The new distance is consistent with, although lower and more precise, than most previous ONC distance estimates. A closer ONC distance implies smaller luminosities and an increased age based on the positions of PMS stars in the Hertzsprung-Russell diagram.

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The Keele-Exeter young cluster survey: I. Low mass pre-main sequence stars in NGC 2169

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We have used $R_C I_C$ CCD photometry from the Isaac Newton telescope and intermediate resolution spectroscopy from the Gemini North telescope to identify and characterise low-mass ($0.15 < M/M_\odot < 1.3$) pre-main sequence stars in the young open cluster NGC 2169. Isochrone fitting to the high- and low-mass populations yields an intrinsic distance modulus of $10.13^{+0.06}_{-0.09}$ mag and a model-dependent age of 9 ± 2 Myr. Compared with the nearby, kinematically defined groups of a similar age, NGC 2169 has a large low-mass population which potentially offers a more precise statistical investigation of several aspects of star formation and early stellar evolution. By modelling the distribution of low-mass stars in the I_C versus $R_C - I_C$ diagram we find that any age spread among cluster members has a Gaussian full width at half maximum ≤ 2.5 Myr. A young age and small age spread (< 10 Myr) are supported by the lack of significant lithium depletion in the vast majority of cluster members. There is no clear evidence for accretion or warm circumstellar dust in the low-mass members of NGC 2169, bolstering the idea that strong accretion has ceased and inner discs have dispersed in almost all low-mass stars by ages of 10 Myr.

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PROSAC: A Submillimeter Array Survey of Low-Mass Protostars
I. Overview of Program: Envelopes, Disks, Outflows and Hot Cores

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This paper presents a large spectral line and continuum survey of 8 deeply embedded, low-mass protostellar cores using the Submillimeter Array. Each source was observed with three different spectral settings, to include high excitation lines of some of the most common molecular species, CO, HCO^+, CS, SO, H_2CO, CH_3OH and SiO. Line emission from 11 molecular species (including isotopologues) originating from warm and dense gas have been imaged at high angular resolution (1–3″; typically corresponding to 200–600 AU scales) together with continuum emission at 230 GHz (1.3 mm) and 345 GHz (0.8 mm). Compact continuum emission is observed for all sources which likely originates in marginally optically thick circumstellar disks, with typical lower limits to their masses of 0.1 $M_\odot$ (1–10% of the masses of their envelopes) and having a dust opacity law, $\kappa_\nu \propto \nu^\beta$, with $\beta \approx 1$. Prominent outflows are present in CO 2–1 observations in all sources, extending over most of the interferometer field of view. Most outflows are highly collimated. Significant differences are seen in their morphologies, however, with some showing more jet-like structure and others seemingly tracing material in the outflow cavity walls. The most diffuse outflows are found in the sources with the lowest ratios of disk-to-envelope mass, and it is suggested that these sources are in a phase where accretion of matter from the envelope has almost finished and the remainder of the envelope material is being dispersed by the outflows. Other characteristic dynamical signatures are found with inverse P Cygni profiles indicative of infalling motions seen in the ^{13}CO 2–1 lines toward NGC 1333-IRAS4A and NGC 1333-IRAS4B. Outflow-induced shocks are present on all scales in the protostellar environments and are most clearly traced by the emission of CH_3OH in NGC 1333-IRAS4A and NGC 1333-IRAS4B. These observations suggest that the emission of CH_3OH and H_2CO from these proposed "hot corinos" are related to the shocks caused by the protostellar outflows. One source, NGC 1333-IRAS2A, stands out as the only one remaining with evidence for hot, compact CH_3OH emission coincident with the embedded protostar.

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Searching for gas-rich disks around T Tauri stars in Lupus

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Aims. We characterize the molecular environment of classical T Tauri stars in Lupus observed with the Spitzer Space Telescope in our search for gas-rich disks toward these sources.

Methods. Submillimeter observations of ^{12}CO, ^{13}CO, and C^{18}O in the J=3-2 and 2-1 lines were obtained with the James Clerk Maxwell Telescope toward a sample of 21 T Tauri stars with disks in the Lupus molecular clouds. Pointings at the sources and at selected off-positions are presented in order to disentangle material associated with disks from ambient cloud material.

Results. One source, IM Lup (Sz 82), was found with the double-peaked ^{12}CO and ^{13}CO profiles characteristic of a large rotating gas disk. The inclination of the disk is found to be $\sim 20°$, with an outer radius of 400-700 AU. For most other sources, including GQ Lup with its substellar companion, the single-dish ^{12}CO lines are dominated by extended cloud emission with a complex velocity structure. No evidence of molecular outflows is found. Due to dense circumstellar material, compact C^{18}O emission was detected toward only two sources. Future searches for gas-rich disks in Lupus should either use interferometers or perform very deep single-dish integrations in dense gas tracers to separate the cloud and disk emission.

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On the nature of clumps in debris disks

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The azimuthal substructure observed in some debris disks, as exemplified by ϵ Eridani, is usually attributed to resonances with embedded planets. In a standard scenario, the Poynting-Robertson force, possibly enhanced by the stellar wind drag, is responsible for the delivery of dust from outer regions of the disk to locations of external mean-motion planetary resonances; the captured particles then create characteristic "clumps". Alternatively, it has been suggested that the observed features in systems like ϵ Eri may stem from populations of planetesimals that have been captured in resonances with the planet, such as Plutinos and Trojans in the solar system. A large fraction of dust produced by these bodies would stay locked in the same resonance, creating the dusty clumps. To investigate both scenarios and their applicability limits for a wide range of stars, planets, disk densities, and planetesimal families we construct simple analytic models for both scenarios. In particular, we show that the first scenario works for disks with the pole-on optical depths below about $\sim 10^{-4} - 10^{-5}$. Above this optical depth level, the first scenario will generate a narrow resonant ring with a hardly visible azimuthal structure, rather than clumps. It is slightly more efficient for more luminous/massive stars, more massive planets, and planets with smaller orbital radii, but all these dependencies are weak. The efficiency of the second scenario is proportional to the mass of the resonant planetesimal family, as example, a family with a total mass of ~ 0.01 to 0.1 Earth masses could be sufficient to account for the clumps of ϵ Eridani. The brightness of the clumps produced by the second scenario increases with the decreasing luminosity of the star, increasing planetary mass, and decreasing orbital radius of the planet. All these dependencies are much stronger than in the first scenario. Models of the second scenario are quantitatively more uncertain than those of the first one, because they are very sensitive to poorly known properties of the collisional grinding process.

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HH 212: SMA Observations of a Remarkable Protostellar Jet

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HH 212 is a nearby (460 pc) protostellar jet discovered in H_2 powered by a Class 0 source, IRAS 05413-0104, in the L1630 cloud of Orion. It is highly collimated and symmetric with matched pairs of bow shocks on either side of the source. We have mapped it in 850 μm continuum, SiO ($J = 8-7$), CO ($J = 3-2$), SO ($N_J = 8_9 - 7_8$), HCO^+ ($J = 4-3$), and $H^{13}CO^+$ ($J = 4-3$) emission simultaneously at $\sim 1''$ resolution with the Submillimeter Array (SMA). Thermal dust emission is seen in continuum around the source, mainly arising from an inner envelope (i.e., the inner part of a previously seen flattened envelope) and a possible disk. The inner envelope is also seen with rotation in CO, HCO^+, and probably SO. Like H_2 emission, CO and SiO emission are seen along the jet axis but extending closer to the source, tracing the bow shocks with a broad range of velocities and the continuous structures in between. SO emission is seen only around the source, forming a jetlike structure extending along the jet axis from the source, likely tracing the jet near the launching region. The jet is episodic and bending. It may also be slightly precessing as the jetlike SO structure shows a slight S-shaped symmetry about the source. A hint of jet rotation is also seen across the jet axis. Internal outflow shells are seen in CO and HCO^+, associated with the bow shocks in the inner part of the jet. The bases of the HCO^+ shells are seen with a hint of rotation similar to that seen in the inner envelope, probably consisted mainly of the material extended from the inner envelope and even the possible disk. The bases of the outflow shells are also seen in $H^{13}CO^+$ and even the continuum, probably tracing the dense material extended from around the same regions. Outflow shells are also seen in CO surrounding the jet extending out from the H_2 nebulae seen around the source.

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Chandra Observations of the Eagle Nebula. I. Embedded Young Stellar Objects near the Pillars of Creation

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We present and analyze the first high-resolution X-ray images ever obtained of the Eagle Nebula star-forming region. On 2001 July 30 the Chandra X-Ray Observatory obtained a 78 ks image of the Eagle Nebula (M16) that includes the core of the young galactic cluster NGC 6611 and the dark columns of dust and cold molecular gas in M16 known as the "Pillars of Creation". We find a total of 1101 X-ray sources in the $17' \times 17'$ ACIS-I field of view. Most of the X-ray sources are low-mass pre-main-sequence or high-mass main-sequence stars in this young cluster. A handful of hard X-ray sources in the pillars are spatially coincident with deeply embedded young stellar objects seen in high-resolution near-infrared images recently obtained with the VLT (McCaughrean & Andersen). In this paper, we focus on the 40 X-ray sources in and around pillars 1-4 at the heart of the Eagle Nebula. None of the X-ray sources are associated with the evaporating gaseous globules (EGGs) first observed by Hester and coworkers in HST WFPC2 images of M16, implying either that the EGGs do not contain protostars or that the protostars have not yet become X-ray active. Eight X-ray counts are coincident with the Herbig-Haro object HH 216, implying $\log L_X \approx 30.0$.

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Time-dependent H_2 formation and protonation in diffuse clouds

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Aims. To demonstrate the time-approach to equilibrium of H_2-formation and protonation in models of diffuse or H I interstellar gas clouds previously published by the author.

Methods. The microscopic equations of H_2-formation and protonation are integrated numerically over time in such a manner that the overall structures evolve self-consistently under benign conditions.

Results. The equilibrium H_2 formation timescale in an H I cloud with N(H) $\approx 4 \times 10^{20}$ cm^{-2} is $1{-}3 \times 10^7$ yr, nearly independent of the assumed density or H_2 formation rate on grains, etc. Attempts to speed up the evolution of the H_2-fraction would require densities well beyond the range usually considered typical of diffuse gas. The calculations suggest that, under benign, quiescent conditions, H_2 in the diffuse ISM formation of H_2 is favored in larger regions having moderate density, consistent with the rather high mean kinetic temperatures measured in H_2, 70-80 K. Formation of H_3^+ is essentially complete when H_2-formation equilibrates but the final abundance of H_3^+ appears more nearly at the very last instant. Chemistry in a weakly-molecular gas has particular properties so that the abundance patterns change appreciably as gas becomes more fully molecular, either in model sequences or with time in a single model. One manifestation of this is that the predicted abundance of H_3^+ is much more weakly dependent on the cosmic-ray ionization rate when $n(H_2)/n(H) \lesssim 0.05$. In general, high abundances of H_3^+ do not enhance the abundances of other species (e.g. HCO^+) but late-time OH formation proceeds most vigourously in more diffuse regions having modest density, extinction and H_2 fraction and somewhat higher fractional ionization, suggesting that atypically high OH/H_2 abundance ratios might be found optically in diffuse clouds having modest extinction.

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Observations of Herbig Ae Disks with Nulling Interferometry

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We present the results of 10 micron nulling interferometric observations of 13 Herbig Ae stars using the Magellan I (Baade) and the MMT 6.5 m telescopes. A portion of the observations was completed with the adaptive secondary at the MMT. We have conclusively spatially resolved 3 of the 13 stars, HD 100546, AB Aur, and HD 179218, the latter two recently resolved using adaptive optics in combination with nulling interferometry. For the resolved objects we find that the 10 micron emitting regions have a spatial extent of 15-30 AU in diameter. We also have some evidence for resolved emission surrounding an additional 2 stars (V892 Tau and R CrA). For those objects in our study with mid-IR SEDs classifications from Meeus et al. (2001), we find that the Group I objects (those with constant to increasing mid-IR flux) are more likely to be resolved, within our limited sample. This trend is evident in correlations in the inferred disk sizes vs. the sub-millimeter SED slope and disk size vs. fractional infrared luminosity of the systems. We explore the spatial distribution and orientation of the warm dust in the resolved systems and constrain physical models which are consistent with their observational signatures.

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Accretion to Stars with Non-Dipole Magnetic Fields

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Disc accretion to a rotating star with a non-dipole magnetic field is investigated for the first time in full three-dimensional (3D) magnetohydrodynamic (MHD) simulations. We investigated the cases of (1) pure dipole, (2) pure quadrupole, and (3) dipole plus quadrupole fields. The quadrupole magnetic moment $\mathbf{D}$ is taken to be parallel to the dipole magnetic moment $\boldsymbol{\mu}$, and both are inclined relative to the spin axis of the star $\boldsymbol{\Omega}$ at an angle Θ. Simulations have shown that in each case the structure of the funnel streams and associated hot spots on the surface of the star have specific features connected with the magnetic field configuration. In the pure dipole case matter accretes in two funnel streams which form two arch-like spots near the magnetic poles. In the case of a pure quadrupole field, most of the matter flows through the quadrupole "belt" forming a ring-shaped hot region on the magnetic equator. In the case of a dipole plus quadrupole field, magnetic flux in the northern magnetic hemisphere is larger than that in the southern, and the quadrupole belt and the ring are displaced to the south. The stronger the quadrupole, the closer the ring is to the magnetic equator. At sufficiently large Θ, matter also flows to the south pole, forming a hot spot near the pole. The light curves have a variety of different features which makes it difficult to derive the magnetic field configuration from the light curves. There are specific features which are different in cases of dipole and quadrupole dominated magnetic field: (1) Angular momentum flow between the star and disc is more efficient in the case of the dipole field; (2) Hot spots are hotter and brighter in case of the dipole field because the matter accelerates over a longer distance compared with the flow in a quadrupole case.

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On the Luminosity of Young Jupiters

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Traditional thermal evolution models of giant planets employ arbitrary initial conditions selected more for computational expediency than physical accuracy. Since the initial conditions are eventually forgotten by the evolving planet, this approach is valid for mature planets, if not young ones. To explore the evolution at young ages of jovian mass planets, we have employed model planets created by one implementation of the core-accretion mechanism as initial conditions for evolutionary calculations. The luminosities and early cooling rates of young planets are highly sensitive to their internal entropies, which depend on the formation mechanism and are highly model dependent. As a result of the accretion shock through which most of the planetary mass is processed, we find lower initial internal entropies than commonly assumed in published evolution tracks. Consequently, young Jovian planets are smaller, cooler, and several to 100 times less luminous than predicted by earlier models. Furthermore, the time interval during which the young Jupiters are fainter than expected depends on the mass of planet. Jupiter mass planets ($1M_J$) align with the conventional model luminosity in as little at 20 million years, but $10M_J$ planets can take up to 1 billion years to match commonly cited luminosities, given our implementation of the core-accretion mechanism. If our assumptions, especially including our treatment of the accretion shock, are correct and if extrasolar Jovian planets indeed form with low entropy, then young Jovian planets are substantially fainter at young ages than currently believed. Furthermore, early evolution tracks should be regarded as uncertain for much longer than the commonly quoted 10^6 yr. These results have important consequences both for detection strategies and for assigning masses to young Jovian planets based on observed luminosities.

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GQ Lup B Visible and Near-Infrared Photometric Analysis

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We have reanalyzed archival HST and Subaru data of the recently discovered planetary mass companion (PMC) GQ Lup B. With these we produce the first R- and I-band photometry of the companion and fit a radius and effective temperature using detailed model atmospheres. We find an effective temperature of 2335 ± 100 K, a radius of 0.38 ± 0.05 $R_\odot$;, and a luminosity of $\log(L/L_\odot)$ = -2.42 ± 0.07 (at 140 pc). Since we fit wavelengths that span most of the emitted radiation from GQ Lup, this luminosity estimate is robust, with uncertainty dominated by the distance uncertainty (± 50 pc). The radius obtained for 140 pc (0.38 $R_\odot$) is significantly larger than the one originally derived and larger than model predictions. The mass of the object is much more model-dependent than the radiative properties, but for the Gaia dusty models we find a mass between $10M_{Jup}$ and $20M_{Jup}$, in the range of the brown dwarf and PMC deuterium-burning boundary. Assuming a distance of 140 pc, observations fit to 1 σ the Baraffe evolution model for an $15M_{Jup}$ brown dwarf. Additionally, the F606W photometric band is significantly overluminous compared to model predictions and other brown dwarfs. Such overluminosity could be explained by a bright Hα emission from chromospheric activity, interaction with another undetected companion, or accretion. Assuming that GQ Lup B has a bright Hα emission line, its Hα emission strength is $10^{-1.71\pm0.10}$ L_{bol}, significantly larger than field late-type dwarfs. GQ Lup B might be strongly accreting and might still be in its formation phase.

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Protostellar Outflow-Driven Turbulence

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Protostellar outflows crisscross the regions of star cluster formation, stirring turbulence and altering the evolution of the forming cluster. We model the stirring of turbulent motions by protostellar outflows, building on an observation that

the scaling law of supersonic turbulence implies a momentum cascade analogous to the energy cascade in Kolmogorov turbulence. We then generalize this model to account for a diversity of outflow strengths, and for outflow collimation, both of which enhance turbulence. For a single value of its coupling coefficient the model is consistent with turbulence simulations by Li & Nakamura and, plausibly, with observations of the NGC 1333 cluster-forming region. Outflow-driven turbulence is strong enough to stall collapse in cluster-forming regions for several crossing times, relieving the mismatch between star formation and turbulent decay rates. The predicted line-width-size scaling implies radial density indices between -1 and -2 for regions supported by outflow-driven turbulence, with a tendency for steeper profiles in regions that are more massive or have higher column densities.

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A Dynamical Origin for Early Mass Segregation in Young Star Clusters

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Some young star clusters show a degree of mass segregation that is inconsistent with the effects of standard two-body relaxation from an initially unsegregated system without substructure, in virial equilibrium, and it is unclear whether current cluster formation models can account for this degree of initial segregation in clusters of significant mass. In this Letter we demonstrate that mergers of small clumps that are initially mass segregated, or in which mass segregation can be produced by two-body relaxation before they merge, generically lead to larger systems that inherit the progenitor clumps' segregation. We conclude that clusters formed in this way are naturally mass segregated, accounting for the anomalous observations and suggesting that this process of prompt mass segregation due to initial clumping should be taken into account in models of cluster formation and dynamics.

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Kinematics and Chemistry of the Hot Molecular Core in G34.26+0.15 at High Resolution

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We present high angular resolution ($\sim 1''$) multi-tracer spectral line observations toward the hot core associated with G34.26+0.15 between 87–109 GHz. We have mapped emission from (i) complex nitrogen- and oxygen-rich molecules like CH_3OH, HC_3N, CH_3CH_2CN, NH_2CHO, CH_3OCH_3, $HCOOCH_3$; (ii) sulfur-bearing molecules like OCS, SO and SO_2; and (iii) the recombination line H53β.

The high angular resolution enables us to directly probe the hot molecular core associated with G34.26+0.15 at spatial scales of 0.018 pc. At this resolution we find no evidence for the hot core being internally heated. The continuum peak detected at $\lambda = 2.8$ mm is consistent with the free-free emission from component C of the ultracompact HII region. Velocity structure and morphology outlined by the different tracers suggest that the hot core is primarily energized by component C. Emission from the N- and O-bearing molecules peak at different positions within the innermost regions of the core; none are coincident with the continuum peak. Lack of high resolution complementary datasets makes it difficult to understand whether thedifferent peaks correspond to separate hot cores, which are not resolved by the present data, or manifestations of the temperature and density structure within a single core.

Based on the brightness temperatures of optically thick lines in our sample, we estimate the kinetic temperature of the inner regions of the HMC to be 160 ± 30 K. Comparison of the observed abundances of the different species in G34.26+0.15 with existing models does not produce a consistent picture. There are uncertainties due to: (i) the unavailability of temperature and density distribution of the mapped region within the hot core, (ii) typical assumption of centrally peaked temperature distribution for a hot core with an accreting protostar at the center, by the chemical

models, an aspect not applicable to externally heated hot cores like G34.26+0.15 and (iii) inadequate knowledge about the formation mechanism of many of the complex molecules.

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Dust coagulation in protoplanetary disks: porosity matters

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Context. Sticking of colliding dust particles through van der Waals forces is the first stage in the grain growth process in protoplanetary disks, eventually leading to the formation of comets, asteroids and planets. A key aspect of the collisional evolution is the coupling between dust and gas motions, which depends on the internal structure (porosity) of aggregates.

Aims. To quantify the importance of the internal structure on the collisional evolution of particles, and to create a new coagulation model to investigate the difference between porous and compact coagulation in the context of a turbulent protoplanetary disk.

Methods. We have developed simple prescriptions for the collisional evolution of porosity of grain-aggregates in grain-grain collisions. Three regimes can then be distinguished: "hit-and-stick" at low velocities, with an increase in porosity; compaction at intermediate velocities, with a decrease of porosity; and fragmentation at high velocities. This study has been restricted to physical regimes where fragmentation is unimportant. The temporal evolution has been followed using a Monte Carlo coagulation code.

Results. This collision model is applied to the conditions of the (gas dominated) protoplanetary disk, with an $\alpha_{\rm T}$ parameter characterising the turbulent viscosity. We can discern three different stages in the particle growth process. Initially, growth is driven by Brownian motion and the relatively low velocities involved lead to a rapid increase in porosity of the growing aggregate. The subsequent second stage is characterised by much higher, turbulent driven velocities and the particles compact. As they compact, their mass-to-surface area increases and eventually they enter the third stage, the settling out to the mid-plane. We find that when compared to standard, compact models of coagulation, porous growth delays the onset of settling, because the surface area-to-mass ratio is higher, a consequence of the build-up of porosity during the initial stages. As a result, particles grow orders of magnitudes larger in mass before they rain-out to the mid-plane. Depending on the precise value of $\alpha_{\rm T}$ and on the position in the nebula, aggregates can grow to (porous) sizes of ~ 10 cm in a few thousand years. We also find that collisional energies are higher than in the limited PCA/CCA fractal models, thereby allowing aggregates to restructure. It is concluded that the microphysics of collisions plays a key role in the growth process.

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The young stellar cluster associated with IRAS 09149-4743

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Context. We present the results of a near-infrared survey of the young stellar cluster associated with IRAS 09149-4743, a member of the Vela Molecular Ridge.

Aims. The main purpose of this survey is to study the cluster members and find the ionizing sources of the associated HII region.

Methods. Infrared photometry of 62 stars located in the crowded parts of the cluster is given in the J, H, and K bands. Colour-colour and colour-magnitude diagrams are drawn to obtain an estimate of their spectral type and reddening.

Results. Three main sources are identified as candidates to ionize the HII region: a star located at the centre of the cluster, inside the IRAS error ellipse; a second star, member of a small "subcluster" situated 1.1′ to the southeast of the former; and a third object, showing very high colour indices, which indicate visual extinction over 20 mag. Dereddened J magnitudes suggest that the former two stars probably are the main ionizing sources, whereas the latter is too reddened to allow a reliable estimate of its spectral type by photometric methods.

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Population III Star Formation in a ΛCDM Universe. I. The Effect of Formation Redshift and Environment on Protostellar Accretion Rate

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We perform 12 extremely high resolution adaptive mesh refinement cosmological simulations of Population III star formation in a ΛCDM universe, varying the box size and large-scale structure, to understand systematic effects in the formation of primordial protostellar cores. We find results that are qualitatively similar to those of previous groups. We observe that in the absence of a photodissociating ultraviolet background, the threshold halo mass for formation of a Population III protostar does not evolve significantly with time in the redshift range studied (33 > z > 19) but exhibits substantial scatter ($1.5 < M_{vir}/10^5 M_\odot < 7$) due to different halo assembly histories: halos that assembled more slowly develop cooling cores at lower mass than those that assemble more rapidly, in agreement with previous work. We do, however, observe significant evolution in the accretion rates of Population III protostars with redshift, with objects that form later having higher maximum accretion rates ($\dot{m} \simeq 10^{-4} M_\odot yr^{-1}$ at z = 33 and $\simeq 10^{-2} M_\odot yr^{-1}$ at z = 20). This can be explained by considering the evolving virial properties of the halos with redshift and the physics of molecular hydrogen formation at low densities. Our result implies that the inferred mass distribution of Population III stars is broader than previously thought and may evolve with redshift. Finally, we observe that our collapsing protostellar cloud cores do not fragment, consistent with previous results, which suggests that Population III stars that form in halos of mass $10^5 - 10^6 M_\odot$ always form in isolation.

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A three-dimensional numerical method for modelling weakly ionized plasmas

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Astrophysical fluids under the influence of magnetic fields are often subjected to single-fluid or two-fluid approximations. In the case of weakly ionized plasmas however, this can be inappropriate due to distinct responses from the multiple constituent species to both collisional and non-collisional forces. As a result, in dense molecular clouds and proto-stellar accretion discs for instance, the conductivity of the plasma may be highly anisotropic leading to phenomena such as Hall and ambipolar diffusion strongly influencing the dynamics.

Diffusive processes are known to restrict the stability of conventional numerical schemes which are not implicit in nature. Furthermore, recent work establishes that a large Hall term can impose an additional severe stability limit on standard explicit schemes. Following a previous paper which presented the one-dimensional case, we describe a fully three-dimensional method which relaxes the normal restrictions on explicit schemes for multifluid processes. This is achieved by applying the little known Super TimeStepping technique to the symmetric (ambipolar) component of the evolution operator for the magnetic field in the local plasma rest-frame, and the new Hall Diffusion Scheme to the skew-symmetric (Hall) component.

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Dust accretion onto high-mass planets

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Aims. We study the accretion of dust particles of various sizes onto embedded massive gas giant planets, where we take into account the structure of the gas disk due to the presence of the planet. The accretion rate of solids is important for the structure of giant planets: it determines the growth rate of the solid core that may be present as well as their final enrichment in solids.

Methods. We use the RODEO hydrodynamics solver to solve the flow equations for the gas, together with a particle approach for the dust. The solver for the particles' equations of motion is implicit with respect to the drag force, which allows us to treat the whole dust size spectrum.

Results. We find that dust accretion is limited to the smallest particle sizes. The largest particles get trapped in outer mean-motion resonances with the planet, while particles of intermediate size are pushed away from the orbit of the planet by the density structure in the gas disk. Only particles smaller than approximately $s_{\rm max} = 10$ μm may accrete on a planet with the mass of Jupiter. For a ten times less massive planet $s_{\rm max} = 100$ μm. The strongly reduced accretion of dust makes it very hard to enrich a newly formed giant planet in solids.

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Star formation in a clustered environment around the UCHII region in IRAS 20293+3952

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We aim at studying the cluster environment surrounding the UCHII region in IRAS 20293+3952, a region in the first stages of formation of a cluster around a high-mass star. BIMA and VLA were used to observe the 3 mm continuum, N_2H^+ (1–0), NH_3 (1,1), NH_3 (2,2), and CH_3OH (2–1) emission of the surroundings of the UCHII region. We studied the kinematics of the region and computed the rotational temperature and column density maps by fitting the hyperfine structure of N_2H^+ and NH_3. The dense gas traced by N_2H^+ and NH_3 shows two different clouds, a main cloud to the east of the UCHII region, of ∼0.5 pc and ∼250 $M_\odot$, and a western cloud, of ∼0.15 pc and ∼30 $M_\odot$. The dust emission reveals two strong components in the northern side of the main cloud, BIMA 1 and BIMA 2, associated with YSOs driving molecular outflows, and two fainter components in the southern side, BIMA 3 and BIMA 4, with no signs of star forming activity. Regarding the CH_3OH, we found strong emission in a fork-like structure associated with outflow B, as well as emission associated with outflow A. The YSOs associated with the dense gas seem to have a diversity of age and properties. The rotational temperature is higher in the northern side of the main cloud, around 22 K, where there are most of the YSOs, than in the southern side, around 16 K. There is strong chemical differentiation in the region, since we determined low values of the NH_3/N_2H^+ ratio, ∼50, associated with YSOs in the north of the main cloud, and high values, up to 300, associated with cores with no detected YSOs, in the south of the main cloud. Such a chemical differentiation is likely due to abundance/depletion effects. Finally, interaction between the different sources in the region is important. First, the UCHII region is interacting with the main cloud, heating it and enhancing the CN (1–0) emission. Second, outflow A seems to be excavating a cavity and heating its walls. Third, outflow B is interacting with the BIMA 4 core, likely producing the deflection of the outflow and illuminating a clump located ∼0.2 pc to the northeast of the shock. We conclude that the star formation process in IRAS 20293+3952 is not obviously associated with interactions, but seems to take place where density is highest.

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Investigating star formation in the young open cluster NGC 6383

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Context. By studying young open clusters, the mechanisms important for star formation over several Myr can be examined. For example, accretion rate as a function of rotational velocity can be investigated. Similarly, sequential star formation triggered by massive stars with high mass-loss rates can be studied in detail.

Aims. We identified and characterized probable members of NGC 6383, as well as determined cluster parameters.

Methods. New Strömgren *uvby* CCD photometry, obtained by us, is presented. This new data, together with Johnson UBV and 2MASS data in the NIR, was used to investigate characteristics of pre- as well as zero age main sequence cluster members.

Results. We present Strömgren *uvby* CCD photometry for 272 stars in the field of NGC 6383 and derive its reddening, $E(b-y) = 0.21(4)$ mag, as well as distance, d = 1.7(3) kpc from the Sun. Several stars with NIR excess and objects in the domain of the classical Herbig Ae/Be and T Tauri stars were detected. Two previously known variables were identified as rapidly-rotating PMS stars. The field population is clearly separated from the probable members in the color-magnitude diagram.

Conclusions. NGC 6383 is a young open cluster, with an age of less than 4 Myr, undergoing continuous star formation. True pre-main sequence members might be found down to absolute magnitudes of +6 mag, with a variety of rotational velocities and stellar activities.

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Numerical Viscosity and the Survival of Gas Giant Protoplanets in Disk Simulations

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We present three-dimensional hydrodynamic simulations of a gravitationally unstable protoplanetary disk model under the condition of local isothermality. Ordinarily, local isothermality precludes the need for an artificial viscosity (AV) scheme to mediate shocks. Without AV, the disk evolves violently, shredding into dense (although short-lived) clumps. When we introduce our AV treatment in the momentum equation, but without heating due to irreversible compression, our grid-based simulations begin to resemble smoothed particle hydrodynamics (SPH) calculations, where clumps are more likely to survive many orbits. In fact, the standard SPH viscosity appears comparable in strength to the AV that leads to clump longevity in our code. This sensitivity to one numerical parameter suggests extreme caution in interpreting simulations by any code in which long-lived gaseous protoplanetary bodies appear.

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High-resolution simulations of the final assembly of Earth-like planets 2: water delivery and planetary habitability

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The water content and habitability of terrestrial planets are determined during their final assembly, from perhaps a hundred 1000-km "planetary embryos" and a swarm of billions of 1-10 km "planetesimals." During this process, we assume that water-rich material is accreted by terrestrial planets via impacts of water-rich bodies that originate

in the outer asteroid region. We present analysis of water delivery and planetary habitability in five high-resolution simulations containing about ten times more particles than in previous simulations. These simulations formed 15 terrestrial planets from 0.4 to 2.6 Earth masses, including five planets in the habitable zone. Every planet from each simulation accreted at least the Earth's current water budget; most accreted several times that amount (assuming no impact depletion). Each planet accreted at least five water-rich embryos and planetesimals from past 2.5 AU; most accreted 10-20 water-rich bodies.

We present a new model for water delivery to terrestrial planets in dynamically calm systems, with low-eccentricity or low-mass giant planets – such systems may be very common in the Galaxy. We suggest that water is accreted in comparable amounts from a few planetary embryos in a ″hit or miss″ way and from millions of planetesimals in a statistically robust process. Variations in water content are likely to be caused by fluctuations in the number of water-rich embryos accreted, as well as from systematic effects such as planetary mass and location, and giant planet properties.

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Organic Chemistry in the Dark Clouds L1448 and L183: A Unique Grain Mantle Composition

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We present high-sensitivity observations of the complex organic molecules (COMs) CH_3OH, C_2H_5OH, $HCOOCH_3$, HCOOH, and H_2CO and of SiO toward the quiescent dark cloud L183 and the molecular outflow L1448-mm. We have not detected C_2H_5OH, $HCOOCH_3$, or SiO in L183 or in the quiescent gas of L1448-mm. The abundances of CH_3OH, H_2CO, and SiO are enhanced by factors of 4-20 in the shock precursor component, and those of CH_3OH and SiO by 3 and 4 orders of magnitude in the shocked gas, without substantial changes (less than a factor of 2) in the abundances of C_2H_5OH and $HCOOCH_3$ relative to that of CH_3OH. The large enhancements of SiO and CH_3OH can be explained by the shock ejection of an important fraction of the grain mantle material into the gas phase. Our upper limits to the C_2H_5OH/CH_3OH and $HCOOCH_3/CH_3OH$ ratios are consistent with the rather constant ratios measured in hot cores and Galactic center clouds. However, the upper limits to the $HCOOCH_3/CH_3OH$ and $HCOOH/CH_3OH$ ratios are at least 1 order of magnitude smaller than those found in "hot corinos" surrounding low-mass protostars. We speculate that the observed abundances of COMs in different objects are consistent with a sort of "universal" grain mantle composition that is locally changed by the processes of low-mass star formation.

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Interpreting Spectral Energy Distributions from Young Stellar Objects. II. Fitting observed SEDs using a large grid of pre-computed models

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We present a method to analyze the spectral energy distributions (SEDs) of young stellar objects (YSOs). Our approach is to fit data with pre-computed 2-D radiation transfer models spanning a large region of parameter space. This allows us to determine not only a single set of physical parameter values but the entire range of values consistent with the multi-wavelength observations of a given source. In this way we hope to avoid any over-interpretation when modeling a set of data. We have constructed spectral energy distributions from optical to sub-mm wavelengths, including new *Spitzer* IRAC and MIPS photometry, for 30 young and spatially resolved sources in the Taurus-Auriga star-forming region. We demonstrate fitting model SEDs to these sources, and find that we correctly identify the evolutionary stage and physical parameters found from previous independent studies, such as disk mass, disk accretion rate, and stellar temperature. We also explore how fluxes at various wavelengths help to constrain physical parameters, and show examples of degeneracies that can occur when fitting SEDs. A web-based version of this tool is available to the community (http://www.astro.wisc.edu/protostars)

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http://www.astro.wisc.edu/protostars

A deep XMM-Newton X-ray observation of the Chamaeleon I dark cloud

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Context. Low-mass stars are known to exhibit strong X-ray emission during the early stages of evolution. Nearby star forming regions are ideal targets to study the X-ray properties of pre-main sequence stars.

Aims. A deep XMM-Newton exposure is used to investigate X-ray properties of the pre-main sequence population of the Chamaeleon I star forming region.

Methods. The northern-eastern fringe of the Chameleon I dark cloud was observed with XMM-Newton, revisiting a region observed with ROSAT 15 years ago. Centered on the extended X-ray source CHXR 49 we are able to resolve it into three major contributing components and to analyse their spectral properties. Furthermore, the deep exposure allows not only the detection of numerous, previously unknown X-ray sources, but also the investigation of variability and the study of the X-ray properties for the brighter targets in the field. We use EPIC spectra, to determine X-ray brightness, coronal temperatures and emission measures for these sources, compare the properties of classical and weak-line T Tauri stars and make a comparison with results from the ROSAT observation.

Results. X-ray properties of T Tauri stars in Cha I are presented. The XMM-Newton images resolve some previously blended X-ray sources, confirm several possible ones and detect many new X-ray targets, resulting in the most comprehensive list with 71 X-ray sources in the northern Cha I dark cloud. The analysis of medium resolution spectra shows an overlapping distribution of spectral properties for classical and weak-line T Tauri stars, with the X-ray brighter stars having hotter coronae and a higher $L_{\rm X}/L_{\rm bol}$ ratio. X-ray luminosity correlates with bolometric luminosity, whereas the $L_{\rm X}/L_{\rm bol}$ ratio is slightly lower for the classical T Tauri stars. Large flares as well as a low iron and a high neon abundance are found in both types of T Tauri stars. Abundance pattern, plasma temperatures and emission measure distributions during quiescent phases are attributed to a high level of magnetic activity as the dominant source of their X-ray emission.

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The Magnetospheric Gap and the Accumulation of Giant Planets Close to a Star

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The bunching of giant planets at a distance of several stellar radii may be explained by the disruption of the inner part of the disk by the magnetosphere of the star during the T Tauri stage of evolution. The rotating magnetic field of the star gives rise to a low density magnetospheric gap where stellar migration is strongly suppressed. We performed full 3D magnetohydrodynamic simulations of the disk-magnetosphere interaction and examined conditions for which the magnetospheric gap is "empty", by changing the misalignment angle between magnetic and rotational axes of the star, Θ, and by lowering the adiabatic index γ, which mocks up the effect of heat conductivity and cooling. Our simulations show that for a wide range of plausible conditions the gap is essentially empty. However, in the case of large misalignment angles Θ, part of the funnel stream is located in the equatorial plane and the gap is not empty.

Furthermore, if the adiabatic index is small ($\gamma \sim 1.1$) and the rotational and magnetic axes are almost aligned, then matter penetrates through the magnetosphere due to 3D instabilities forming high-density equatorial funnels. For these two limits there is appreciable matter density in the equatorial plane of the disk so that a planet may migrate into the star.

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Spitzer Observations of the Giant Molecular Cloud W3

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We present new images of the giant molecular cloud W3 obtained with the Infrared Array Camera (IRAC) and the Multiband Imaging Photometer for Spitzer (MIPS) on board the Spitzer Space Telescope. The images encompass the star forming regions W3 Main, W3(OH), and a region that we refer to as the Central Cluster, which encloses the emission nebula IC 1795. We present a star count analysis of the point sources detected in W3. The star count analysis shows that the stellar population of the Central Cluster, when compared to that in the background, contains an over density of sources. The Central Cluster also contains an excess of sources with colors consistent with Class II young stellar objects (YSOs). An analysis of the color-color diagrams also reveals a large number of Class II YSOs in the Central Cluster. Our results suggest that an earlier epoch of star formation created the Central Cluster, created a cavity, and triggered the active star formation in the W3 Main and W3(OH) regions. We also detect a new outflow and its candidate exciting star.

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Past and Present Star Formation in the SMC: NGC 346 and Its Neighborhood

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In the quest to understand how star formation occurs and propagates in the low-metallicity environment of the Small Magellanic Cloud (SMC), we acquired deep F555W ($\sim$V) and F814W ($\sim$I) Hubble Space Telescope ACS images of the young and massive star-forming region NGC 346. These images and their photometric analysis provide us with a snapshot of the star formation history of the region. We find evidence for star formation extending from ≈ 10 Gyr in the past until ≈ 150 Myr in the field of the SMC. The youngest stellar population ($\sim 3 \pm 1$ Myr) is associated with the NGC 346 cluster. It includes a rich component of low-mass pre-main-sequence stars mainly concentrated in a number of subclusters spatially colocated with CO clumps previously detected by Rubio and coworkers. Within our analysis uncertainties, these subclusters appear coeval with each other. The most massive stars appear concentrated in the central subclusters, indicating possible mass segregation. A number of embedded clusters are also observed. This finding, combined with the overall wealth of dust and gas, could imply that star formation is still active. An intermediate-age star cluster, BS 90, formed $\sim 4.3 \pm 0.1$ Gyr ago, is also present in the region. Thus, this region of

the SMC has supported star formation with varying levels of intensity over much of the cosmic time.

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Ionization of Polycyclic Aromatic Hydrocarbon Molecules around Herbig Ae/Be Environment

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We present our recent results on the mid-infrared N-band spectroscopy of the Herbig Ae/Be system MWC1080 using the Cooled Mid-Infrared Camera and Spectrometer (COMICS) on board the 8m Subaru Telescope. The MWC1080 has a geometry such that the diffuse nebulous structures surround the central Herbig B0 type star. We focus on the properties of polycyclic aromatic hydrocarbons (PAHs) and PAH-like species, which are thought to be the carriers of the unidentified infrared (UIR) bands in such environments. A series of UIR bands at 8.6, 11.0, 11.2, and 12.7μm is detected throughout the system and we find a clear increase in the UIR 11.0μm/11.2μm ratio in the vicinity of the central star. Since the UIR 11.0μm feature is attributed to a solo-CH out-of-plane wagging mode of cationic PAHs while the UIR 11.2μm feature to a solo-CH out-of-plane bending mode of neutral PAHs, the large 11.0μm/11.2μm ratio directly indicates a promotion of the positive ionization of PAHs near the central star.

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The influence of stochastic density fluctuations on the infrared emissions of interstellar dark clouds

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We investigate the effects of stochastic density fluctuations on the dust temperatures and the resulting infrared (IR) emission spectra of interstellar clouds as an extension of preceding investigations by Hegmann & Kegel. We consider absorption and scattering by dust grains in spherical clouds which are, on average, homogeneous but have a fluctuating density. The spatial variation of the density is described by means of a Markov process. This clump model introduces two parameters: the correlation length l_n and the Gaussian width σ_n of the density fluctuations. As the intensity $I_{\lambda,n}$ inherits the randomness of the density n, the ordinary radiative transfer equation has to be replaced by a generalized transfer equation of Fokker-Planck type.

In the first part, we investigate the influence of our model parameters on the radiative transport in the ultraviolet (UV) and use the results to calculate the dust temperature in radiative equilibrium. Afterwards, the IR emission of the dust is modelled for the same set of clump parameters.

We find that the presence of clumps decreases the effective extinction and therefore leads to substantial differences in UV illumination and dust temperatures, compared with the homogeneous case. Because of the distribution of dust temperatures, the presence of clumps also affects the IR emission and thus possible observations.

In the second part, we use a fit with two blackbody spectra to determine the cloud dust mass from our synthetic IR fluxes. It is shown that in a clumpy environment the overall dust mass is generally underestimated. This effect correlates with the degree of cloud fragmentation.

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Silicate Dust in Evolved Protoplanetary Disks: Growth, Sedimentation, and Accretion

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We present the Spitzer IRS spectra for 33 young stars in Tr 37 and NGC 7160. The sample includes the high- and intermediate-mass stars with MIPS 24 microns excess, the only known active accretor in the 12 Myr-old cluster NGC 7160, and 19 low-mass stars with disks in the 4 Myr-old cluster Tr 37. We examine the 10 microns silicate feature, present in the whole sample of low-mass star and in 3 of the high- and intermediate-mass targets, and we find that PAH emission is detectable only in the Herbig Be star. We analyze the composition and size of the warm photospheric silicate grains by fitting the 10 microns silicate feature, and study the possible correlations between the silicate characteristics and the stellar and disk properties (age, SED slope, accretion rate, spectral type). We find indications of dust settling with age and of the effect of turbulent enrichment of the disk atmosphere with large grains. Crystalline grains are only small contributors to the total silicate mass in all disks, and do not seem to correlate with any other property, except maybe binarity. We also observe that spectra with very weak silicate emission are at least 3 times more frequent among M stars than among earlier spectral types, which may be an evidence of inner disk evolution. Finally, we find that 5 of the high- and intermediate-mass stars have SEDs and IRS spectra consistent with debris disk models involving planet formation, which could indicate debris disk formation at ages as early as 4 Myr.

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Hard X-rays and Fluorescent Iron Emission from the Embedded Infrared Cluster in NGC 2071

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We present first results of *XMM-Newton* X-ray observations of the infrared cluster lying near the NGC 2071 reflection nebula in the Orion B region. This cluster is of interest because it is one of the closest regions known to harbor embedded high-mass stars. We report the discovery of hard X-ray emission from the dense central NGC 2071-IR subgroup which contains at least three high-mass young stellar objects (NGC 2071 IRS-1, IRS-2, and IRS-3). A prominent X-ray source is detected within $1''$ of the infrared source IRS-1, which is thought to drive a powerful bipolar molecular outflow. The X-ray spectrum of this source is quite unusual compared to the optically thin plasma spectra normally observed in young stellar objects (YSOs). The spectrum is characterized by a hard broad-band continuum plus an exceptionally broad emission line at $\approx$6.4 keV from neutral or near-neutral iron. The fluorescent Fe line likely originates in cold material near the embedded star (i.e. a disk or envelope) that is irradiated by the hard heavily-absorbed X-ray source.

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Preprints: http://xxx.lanl.gov/abs/astro-ph/0612563

Tracing high energy radiation with molecular lines near deeply embedded protostars

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Submillimeter lines of CN, NO, CO+ and SO+, and upper limits on SH+ and N2O are observed with the James Clerk Maxwell Telescope in two high-mass and up to nine low-mass young stellar objects and compared with chemical models. It is found that constant fractional abundances derived from radiative transfer modeling of the line strengths are x(CN)   a few x 10^{-11}-10^{-8}, x(NO) $\sim 10^{-9}$-10^{-8} and x(CO+) $\sim 10^{-12}$-10^{-10}. SO+ has abundances of a few x 10^{-11} in the high-mass objects and upper limits of $\sim 10^{-12}$-10^{-11} in the low-mass sources. All abundances are up to 1-2 orders of magnitude higher if the molecular emission is assumed to originate mainly from the inner region (< 1000 AU) of the envelope. For high-mass sources, the CN, SO+ and CO+ abundances and abundance ratios are best explained by an enhanced far-ultraviolet (FUV) field impacting gas at temperatures of a few hundred K. The observed column densities require that this region of enhanced FUV has scales comparable to the observing beam, such as in a geometry in which the enhanced FUV irradiates outflow walls. For low-mass sources, the required temperatures within the FUV models of T > 300 K are much higher than found in models, so that an X-ray enhanced region close to the protostar (r < 500 AU) is more plausible. Gas-phase chemical models produce more NO than observed, suggesting an additional reduction mechanism not included in current models. The observed CN, CO+ and SO+ abundances can be explained with either enhanced X-rays or FUV fields from the central source. High-mass sources likely have low opacity regions that allow the FUV photons to reach large distances from the central source. X-rays are suggested to be more effective than FUV fields in the low-mass sources. The observed abundances imply X-ray fluxes for the Class 0 objects of $L_X \sim 10^{29}$-10^{31} erg s^{-1}, comparable to those observed from low-mass Class I protostars. Spatially resolved data are needed to clearly distinguish the effects of FUV and X-rays for individual species.

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astro-ph/0608393

Gas and dust condensations and a peculiar class 0 object in the Lupus 3 star forming cloud

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The Lupus 3 molecular cloud has been surveyed for dense gas and dust cores and embedded objects in radio ($H^{13}CO^+$ $J = 1{-}0$ line and 1.2 mm continuum) and infrared ($JHK_sL'MN$ bands and H_2 $v = 1{-}0$ s(1) line) wavelengths. These observations unveil a filamentary cloud, three dense cores, an embedded mm-wave source (MMS), and an associated elongated object in the K band. The properties of the 3 dense cores are $M = 3.5$–5.6 $M_\odot$, $R = 0.04$–0.06 pc, and $n(H_2) = (1.0$–$3.9) \times 10^5$ cm^{-3}, similar properties to those in Taurus. Two of these 3 objects are likely to be prestellar cores while the other one exhibits ongoing star formation. The spectral energy distribution (SED) analysis of the MMS shows that it is a remarkably cold class 0 object with molecular outflow detected in the CO ($J = 3{-}2$) line, and peculiarly with near-IR detections. From the estimated low bolometric temperature (39.5 K), faint bolometric luminosity (0.16 $L_\odot$), and sufficiently large envelope mass (0.52 $M_\odot$), the MMS is expected to be in a very early phase ($\sim 10^4$ yr) of mass accretion. The K-band elongated feature appears to be scattered light originated from the embedded central object of the MMS seen through the outflow cavity opening toward HH 78 on the near side as shown by the blue-shifted CO wings. The MMS has been also detected by the Spitzer Space Telescope (SST), and its near-IR images exhibit butterfly-shaped nebulosity emission as scattered light through the bipolar cavities in contrast to that in the K band. Together with the SST and NTT JHK photometric data, the observed SED has a short-wavelength

cutoff suggesting a low effective temperature (< 1400 K) of the central object.

Accepted by ApJ

http://harbor.scitec.kobe-u.ac.jp/~tatihara/research.html

Imaging Scattered Light from the Youngest Protostars in L1448: Signatures of Outflows

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We present deep IRAC images that highlight the scattered light emission around many of the youngest protostars, the so-called Class 0 sources, in L1448. By comparison of the data with a Monte Carlo radiative transfer code (Whitney 2003a), we demonstrate for the first time that the observed infrared light from these objects is consistent with scattered light from the central protostar. The scattered light escapes out the cavity, carved by molecular outflows, in the circumstellar envelope. In particular, we observe prominent scattered light nebulae associated with the Class 0 sources: L1448-mm, L1448 IRS 2, and 3B, as well as a Class I source: IRS 3A. We use a grid of models with probable protostellar properties to generate model spectral energy distributions (SEDs) and images for bands sensitive to this scattered light: J, H, Ks, and *Spitzer* IRAC bands. By simultaneously fitting SEDs and images of the outflow cavities, we are able to model geometric parameters, i.e. inclination angle and opening angle, and loosely constrain physical parameters. The opening angle may be an important indicator of the evolutionary state of a source. We compare our results for Class 0 sources to similar studies of Class I sources. There may be a transition phase from Class 0 to Class I when a source has an opening angle between 20^o to 30^o. It is important to note that while the best fit model image and SED do not fully describe the sources, the fits generally describe the circumstellar structure of Class 0 sources in L1448.

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Turbulent Mixing and the Dead Zone in Protostellar Disks

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We investigate the conditions for the presence of a magnetically inactive dead zone in protostellar disks, using 3-D shearing-box MHD calculations including vertical stratification, Ohmic resistivity and time-dependent ionization chemistry. Activity driven by the magnetorotational instability fills the whole thickness of the disk at 5 AU, provided cosmic ray ionization is present, small grains are absent and the gas-phase metal abundance is sufficiently high. At 1 AU the larger column density of 1700 g/cm^2 means the midplane is shielded from ionizing particles and remains magnetorotationally stable even under the most favorable conditions considered. Nevertheless the dead zone is effectively eliminated. Turbulence mixes free charges into the interior as they recombine, leading to a slight coupling of the midplane gas to the magnetic fields. Weak, large-scale radial fields diffuse to the midplane where they are sheared out to produce stronger azimuthal fields. The resulting midplane accretion stresses are just a few times less than in the surface layers on average.

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Dense core compression and fragmentation induced by the scattering of hydromagnetic waves

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We have performed 2D hydromagnetic simulations with an adaptive mesh refinement code to examine the response of a pre-existing initially spherical dense core to a non-linear fast-mode wave. One key parameter is the ratio of the wavelength to the initial core radius. If that ratio is large and the wave amplitude is sufficient, significant compression of the core occurs, as envisaged by Myers & Lazarian (1998) in their "turbulent cooling flow" picture. For smaller values of that ratio, an initial value of the ratio of the thermal pressure to magnetic pressure of 0.2, and sufficiently large wave amplitude, the scattering induces the production of dense substructure in the core. This substructure may be related to that detected in the dense core associated with the cyanopolyyne peak in TMC-1. Our simulations also show that short-wavelength waves, contrary to large-wavelength waves, do not confine dense cores.

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An X-Ray Census of Young Stars in the Massive Southern Star-forming Complex NGC 6357

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We present the first high spatial resolution X-ray study of the massive star-forming region NGC 6357, obtained in a 38 ks Chandra/ACIS observation. Inside the brightest constituent of this large H II region complex is the massive open cluster Pismis 24. It contains two of the brightest and bluest stars known, yet remains poorly studied; only a handful of optically bright stellar members have been identified. We investigate the cluster extent and initial mass function and detect $\sim$ 800 X-ray sources with a limiting sensitivity of $\sim 10^{30}$ ergs s^{-1}; this provides the first reliable probe of the rich intermediate-mass and low-mass population of this massive cluster, increasing the number of known members from optical study by a factor of $\sim$ 50. The high-luminosity end ($\log L_h$ [2-8 keV] $\geq$ 30.3 ergs s^{-1}) of the observed X-ray luminosity function in NGC 6357 is clearly consistent with a power-law relation as seen in the Orion Nebula Cluster and Cepheus B, yielding the first estimate of NGC 6357's total cluster population, a few times the known Orion population. We investigate the structure of the cluster, finding small-scale substructures superposed on a spherical cluster with 6 pc extent, and discuss its relationship to the nebular morphology. The long-standing L_X - $10^{-7} L_{bol}$ correlation for O stars is confirmed. Twenty-four candidate O stars and one possible new obscured massive YSO or Wolf-Rayet star are presented. Many cluster members are estimated to be intermediate-mass stars from available infrared photometry (assuming an age of $\sim$ 1 Myr), but only a few exhibit K-band excess. We report the first detection of X-ray emission from an evaporating gaseous globule at the tip of a molecular pillar; this source is likely a B0-B2 protostar.

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The Abundance of Carbon Dioxide Ice in the Quiescent Intracloud Medium

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We present new observations with the Infrared Spectrograph on board the Spitzer Space Telescope of the solid-CO_2 absorption feature near 15μm in the spectra of eight field stars behind the Taurus complex of dark clouds. Solid CO_2 is detected in six lines of sight. New results are combined with previous data to investigate the correlation of CO_2 column density with those of other major ice constituents (H_2O and CO) and with extinction. CO_2 is shown to display a "threshold extinction" effect, i.e., a minimum extinction ($A_0 = 4.3 \pm 1.0$ mag) required for detection, behavior similar to that previously reported for H_2O and CO. We find a particularly tight correlation through the origin between $N(CO_2)$ and $N(H_2O)$, confirming that these species form in tandem and coexist in the same (polar) ice layer on the grains. The observed composition of the mantles is broadly consistent with the predictions of photochemical models with diffusive surface chemistry proposed by Ruffle & Herbst. Comparison of our results for Taurus with published data for Serpens indicates significant differences in ice composition consistent with enhanced CO_2 production in the latter cloud. Our results also place constraints on the distribution of elemental oxygen between ices and other potential reservoirs. Assuming a constant $N(H)$ to extinction ratio, we show that $\sim 65\%$ of the solar O abundance is accounted for by summing the contributions of ices ($\sim 26\%$), refractory dust ($\sim 30\%$) and gas-phase CO ($\sim 9\%$). If the Sun is an appropriate standard for the interstellar medium, the "missing" oxygen may reside in atomic O I gas and/or (undetected) O_2 within the ices.

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Nonradial Oscillations on a PreMain-Sequence Star

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We show that the modes observed on the pulsating premain-sequence (PMS) star NGC 6383 170 can be interpreted as a combination of radial and nonradial p-modes. Using a dense grid of PMS models and oscillation spectra, we have identified models that match the observed oscillation spectrum within 1σ of the frequency uncertainties and are consistent with the star's position in the H-R diagram.

Published by The Astrophysical Journal (Vol. 655, p. 342)

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

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6.7 GHz Methanol Masers: Properties, Associations and Tracers of Galactic Structure

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Ph.D degree awarded: January 2007

The 6.7 GHz transition of methanol is the strongest of methanol masers, and is the second strongest maser transition ever observed in the Milky Way. There is strong theoretical and observational evidence that the masers trace an early phase of massive star formation. The lack of association of these masers with other astronomical objects such as low-mass young stellar objects (YSOs) and late type stars, and their high brightness temperatures makes them excellent tools to detect and study massive star formation across our Galaxy. The preponderance of massive stars along the spiral arms of galaxies also imply the potential utility of these methanol masers to study the spiral structure of our Galaxy.

In this dissertation, we present a study of 6.7 GHz methanol masers and their properties based on the Arecibo Methanol Maser Galactic Plane Survey (AMGPS), a sensitive blind survey carried out with the Arecibo radio telescope. To carry out this study, we built a receiver for Arecibo that could process signals between 6 and 8 GHz. The high sensitivity of the cooled receiver and the large collecting area of Arecibo made AMGPS the most sensitive blind survey to date for 6.7 GHz methanol masers, and resulted in the detection of 86 methanol masers, 48 of which are new detections.

The distribution of methanol masers as a function of Galactic latitude and the statistics of their multi-wavelength counterparts show our data to be consistent with the hypothesis of 6.7 GHz methanol masers being associated with massive YSOs. Using the detection statistics of AMGPS, we estimate the minimum number of methanol masers in the Galaxy to be 1125. The $l - v$ diagram of the AMGPS sample shows the tangent point of the Carina-Sagittarius spiral arm to be around 49.6°, and suggests occurrence of massive star formation along the extension of the Crux-Scutum arm. A Gaussian component analysis of methanol masers shows the mean line-width to be 0.38 km s^{-1} which is more a factor of two larger than what is reported in the literature. We also find no evidence that faint methanol masers have different properties than their bright counterparts.

Moving ... ??

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Transformational Science with ALMA: Through Disks to Stars and Planets

On June 22-24, 2007, the North American ALMA Science Center at NRAO and the University of Virginia will sponsor a workshop in Charlottesville, Virginia entitled "Transformational Science with ALMA: Through Disks to Stars and Planets". The focus of the meeting will be to discuss how ALMA will impact our understanding in several key areas of disk formation and evolution including:

* Cores, Fragmentation and the Earliest Observable Stages of Protostellar Disks

* The Disk-Envelope-Outflow Connection

* Low and High Mass Disk Structure

* Disk Chemistry, Kinematics, Isotopic Anomalies, Grain Growth, and Sedimentation

* Flaring, Spiral Density Waves, Turbulence, Magnetic Fields in Protostellar Disks

* Debris Disks

* Planet Formation: Fragmentation and Gaps

* Synergy between ALMA and Upcoming Optical, Infrared, and Radio Facilities

It is our hope that the meeting will generate extensive discussion and new ideas of how ALMA may be used to transform our understanding of protostellar and protoplanetary disks. Toward this goal we are inviting very few speakers in the traditional sense, but instead are requesting abstract proposals to give a talk either from a set of "wish list" topics or an alternative ALMA focused disk topic of your choice. More information is available at **http://www.cv.nrao.edu/naasc/disk07.html**. Pre-registration is now available and abstract submission will begin Jan. 2 until March 1, 2007.

Astronomy in the submillimeter and far infrared domains with the Herschel Space Observatory.

a Les Houches winter school
23 April 2007 – 4 May 2007

The Herschel Space Observatory will be launched by the European Space Agency in mid 2008. This satellite and its instruments have been prepared by ESA and instrument consortia from many countries, with support from NASA. Herschel will completely open the domain of submillimeter and far infrared wavelengths to astronomy. In order to distribute information and knowledge on the Herschel project, we are organizing a winter school in Les Houches, from April 23 to May 4, 2007. This school is open to all astronomers, but especially dedicated to students and young post-docs. The format of the school is organized such as providing ample time for training using the software tools specially prepared for preparing and analysing the observations, as well as for discussions and presentations of results. The main scientific domains which will benefit from Herschel observations will be presented by experts in the fields.

Registration will be opened very soon. As the assistance is limited, we encourage interested persons to register rapidly once the registration site opens. Applications will be received until 15th of March, 2007. The inscription fees including the lectures book are 150 Euros + full boarding (803 Euros)

For more details and to register on-line, consult our web page : http://aramis.obspm.fr/ houches/ or contact one of us (laurent.pagani@obspm.fr, maryvonne.gerin@lra.ens.fr)

2007 Origins of Solar Systems

The 2007 Gordon Research Conference on Origins of Solar Systems will be held at Mt. Holyoke College in South Hadley, MA on 8-13 July 2007. This unique interdisciplinary meeting includes astronomers and astrophysicists interested in star and planet formation, planetary scientists and meteoriticists interested in the early history of the Solar System, and plasma and life scientists. This meeting is much broader than most conferences and many fruitful research collaborations have been initiated at Gordon conferences, encouraged by the relaxed pace of the meeting.

If you would like to attend a meeting which is not packed solid with talks, but has a limited number of overview talks; if you would enjoy spending extended time reading posters (or would like to have plenty of time for people to look at your poster and even speak with you); and if you might like participating in evening beverage sessions with colleagues from a wide variety of backgrounds, this is the meeting for you.

The preliminary scientific program is now available on the web at **www.grc.org**. Information on registration, travel, and accomodations is also available at that site.

The Chair and Vice-Chair of the 2007 Origins of Solar Systems conference are Lee Hartmann (Michigan) and Sara Russell (Natural History Museum, London). Please contact us (lhartm@umich.edu, sara.russell@nhm.ac.uk) if you have any questions.

1st Announcement: 2007 Berkeley Conference on High Contrast Imaging

In the Spirit of Bernard Lyot: The Direct Detection of Planets & Circumstellar Disks in the 21st Century

http://www.lyot2007.org/

Berkeley, California

June 04-08, 2007

This is a 5-day international conference that aims to bring together instrumentalists and research scientists endeavoring to directly detect extrasolar planets and circumstellar disks. We nickname it "The Spirit of Lyot" to highlight the theme of technical innovation and scientific drive that is the legacy of Bernard Lyot.

The conference will be held on the scenic University of California, Berkeley, campus, which is 30 minutes by underground rail from San Francisco. Nearby airports are San Francisco International (SFO) and Oakland (OAK).

PRE-REGISTRATION: If you would like to receive future announcements by e-mail, please send a short message to lyot@berkeley.edu. If you would like to present a contributed talk or poster, please let us know, and include a tentative title or description.

PROPOSED PROGRAM:

Monday, June 04 - The legacy of Bernard Lyot - The coronagraph tree of life - Advances in solar coronagraphy - Planet formation & evolution - Planet migration & stability

Tuesday, June 05 - Properties of known extrasolar planets - Contemporary coronagraphy - space & ground - Coronagraph theory & innovation

Wednesday, June 06 - Wavefront control, observing techniques & methods - Theory of cool atmospheres - Direct detection of extrasolar planets & brown dwarfs

Thursday, June 07 - Observational properties of circumstellar disks - Poster oral summaries - Future instruments & telescopes - ground & space

Friday, June 08 - Strategic planning, science priorities & funding - AAAC Exoplanet Task Force (NASA / DOE / NRC) - Panel discussion

Scientific Organizing Committee: Gael Chauvin, Mark Clampin, James Graham, Olivier Guyon, Garth Illingworth, Paul Kalas, Bruce Macintosh, Mark Marley, Karl Stapelfeldt