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Abstracts of recently accepted papers

ISO spectroscopy of disks around Herbig Ae/Be stars

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We have investigated the infrared spectra of all 46 Herbig Ae/Be stars for which spectroscopic data is available in the ISO data archive. Our quantitative analysis of these spectra focusses on the emission bands at 3.3,6.2, "7.7", 8.6 and 11.2 micron, linked to polycyclic aromatic hydrocarbons (PAHs), the nanodiamond-related features at 3.4 and 3.5 micron, the amorphous 10 micron silicate band and the crystalline silicate band at 11.3 micron. We have detected PAH emission in 57% of the Herbig stars in our sample. Although for most of these sources the PAH spectra are similar, there are clear examples of differences in the PAH spectra within our sample which can be explained by differencesin PAH size, chemistry and/or ionization. Amorphous silicate emission was detected in the spectra of 52% of the sample stars, amorphous silicate absorption in 13%. We have detected crystalline silicate emission in 11 stars (24% of our sample), of which four (9%) also display strong PAH emission. We have classified the sample sources according to the strength of their mid-IR energy distribution. The systems with stronger mid-infared (20–100 μm) excesses relative to their near-infrared (1–5 μm) excess display significantly more PAH emission than those with weaker mid-infrared excesses. There are no strong differences in the behaviour of the silicate feature between both groups. This provides strong observational support for the disk models by Dullemond et al., 2001, in which systems with a flaring disk geometry display a strong mid-infrared excess, whereas those with disks that are strongly shadowed by the puffed-up inner rim of the disk only display modest amounts of mid-infrared emission. Since the silicates are expected to be produced mainly in the warm inner disk regions, no strong differences in silicate behaviour are expected between the two groups. In contrast to this, the PAH emission is expected to be produced mainly in the part of the disk atmosphere that is directly exposed to radiation from the central star. In this model, self-shadowed disks should display weaker PAH emission than flared disks, consistent with our observations.

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http://arxiv.org/abs/astro-ph/0406050

The effects of X-ray photoionization and heating on the structure of circumstellar discs

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We present the results of a theoretical study investigating the effects of photoionization and heating by X-rays on discs around low-mass stars. In particular we address the question of whether or not X-rays can drive a disc wind. First, we construct a 1-dimensional "quasi-hydrostatic" model, which solves for the vertical structure introduced by X-ray heating. We consider uniform X-ray illumination of the disc, but the X-ray fluxes required to heat the disc significantly are much greater than those seen by recent observations. When the model is extended to consider heating from a central X-ray source we find that the 1-dimensional model is only valid very close to the star. We extend

our analysis to consider a simple 2-dimensional model, treating the disc as a two-layered structure and solving for its density profile self-consistently. For T Tauri stars we are able to set a crude upper limit on the mass-loss rate that can be driven by X-ray photoevaporation, with a value of $\simeq 10^{-13}$g cm^{-2} s^{-1}. Our model is designed to maximise this value, and most likely over-estimates it significantly. However we still find a mass-loss rate which is less than that found in studies of ultraviolet photoevaporation. We conclude that in the presence of a significant UV field, X-ray driven disc winds are unlikely to play a significant role in the evolution of discs around low-mass stars.

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Preprint available at `http://www.ast.cam.ac.uk/~rda/publications.html` or `astro-ph/0406643`

Adsorption of CO on amorphous water-ice surfaces

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We present the results of classical trajectory calculations of the adsorption of thermal CO on the surface of compact amorphous water ice, with a view to understanding the processes governing the growth and destruction of icy mantles on dust grains in star-forming regions and interpreting solid CO infrared spectra. The calculations are performed at normal incidence, for $E_i = 0.01$ eV (116 K) and surface temperature $T_s = 90$ K. The calculations predict high adsorption probabilities (~ 1), with the adsorbed CO molecules having potential energies ranging from –0.15 to –0.04 eV with an average energy of –0.094 eV. In all the adsorbing trajectories, CO sits on top of the surface. No case of CO diffusion inside the ice or into a surface valley with restricted access was seen. Geometry minimizations suggest that the maximum potential energy of adsorbed CO (– 0.155 eV) occurs when CO interacts with a "dangling OH" group, associated with the 2152 cm^{-1} band seen in laboratory solid-state CO spectra. We show that relatively few "dangling OH" groups are present on the amorphous ice surface, potentially explaining the absence of this feature in astronomical spectra. CO also interacts with "bonded OH" groups, which we associate with the 2139 cm^{-1} infrared feature of solid CO. Our results for CO adsorption on amorphous ice are compared with those previously obtained for CO adsorption to crystalline ice. The implications of the spectroscopic assignments are discussed in terms of the solid-CO infrared spectra observed in interstellar regions. Using the Frenkel model, the lifetime τ for which CO may remain adsorbed at the surface is calculated. At temperatures relevant to the interstellar medium, i.e. 10 K, it is longer than the age of the universe, but decreases dramatically with increasing T_s, such that at $T_s = 90$ K, $\tau = 300$ ns. The pre-exponential factor τ_ν used in the Frenkel model is found to be 0.95 ± 0.02 ps. These data are compared to recent experimental results. The astrophysical implications of these calculations are discussed, with particular reference to the CO binding sites identified on amorphous ice surfaces, their adsorption energies, probabilities and lifetimes.

Accepted by Astronomy & Astrophysics

`http://www.strw.leidenuniv.nl/~ewine/coice.pdf`

Outflow-Infall Interactions in Early Star Formation and their Impact on the Mass-Assembling Process in L1228

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New high resolution molecular line and continuum millimeter interferometer observations of the environment within 10^4 AU of the low-mass protostar IRAS 20582+7724, in the L1228 dark cloud, enable a detailed study of the molecular outflow near the protostellar source, the circumstellar envelope, and the outflow-envelope interaction. In ^{12}CO(1-0) and ^{13}CO(1-0) maps a wide-angle molecular outflow has been imaged to within less than 1000 AU of the 2.7 mm continuum emission associated with IRAS 20582+7724. The morphology and kinematics are consistent with entrainment of the gas by an underlying wind that has both a wide-angle *and* a collimated component. The HCO$^+$(1-0), HNC(1-0), and

CS(2-1) lines are sensitive to infall motions and trace an elongated circumstellar envelope perpendicular to the outflow axis. Together the morphology, kinematics, and energetics of both the outflow and infalling circumstellar envelope suggest that the outflow has excavated wide-angle cavities in the envelope and thereby constrained the infall region to a limited volume outside the outflow lobes. In the IRAS 20582+7724 system, outflow-envelope interactions evidently have an important effect on the mass-assembling process. In addition, our multi-molecular line data show that the outflow has affected the chemical composition of the gaseous environment surrounding the protostar, through the shock-enhancement of different molecular species.

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Preprint available at: http://www.astro.caltech.edu/∼harce/papers/

A High Spatial Resolution Infrared View of the T Tauri Multiple System

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We present the results of our monitoring study of the IR photometric and spectroscopic variability of the T Tau multiple system. We also present data on the apparent position of T Tau S with respect to T Tau N, and two new spatially resolved observations of the T Tau Sa-Sb binary. T Tau N has not varied by more than 0.2 magnitudes in K and L′ flux during the 8 years of our observations, though its Brγ and Brα emission line fluxes have varied by nearly a factor of four during this time. For the unresolved T Tau S system, we have derived a 20 year light curve based on our images and on measurements available in the literature. T Tau S varies by 2-3 magnitudes in K and L′-band brightness in a "redder when faint" manner, consistent with changes along the line of sight in the amount of material that follows an ISM extinction law. Absorption in the 3.05μm water-ice feature is seen only in the spectra of T Tau S and it displays variations in depth and profile. H_2 (2.12μm) emission is also detected only at the position of T Tau S; the H_2, Brγ and Brα emission line fluxes also vary. We have found that the apparent positions of T Tau S with respect to T Tau N and T Tau Sb with respect to Sa are consistent with gravitationally bound orbital motion. The possible orbits of the T Tau S binary imply that Sa is likely the most massive component in this young triple. A reanalysis of the motion of the radio source associated with T Tau S provides no evidence for an ejection event in the T Tau system.

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Preprints available at: astroph/0406337 (low resolution figures)
or http://ftp.gemini.edu/staff/tbeck/preprints/Beck_TTau_2004.ps (high resolution figures)

The Dense Molecular Cores in the IRAS 21391+5802 region

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We present a detailed kinematical study and modeling of the emission of the molecular cores at ambient velocities surrounding IRAS 21391+5802, an intermediate-mass protostar embedded in IC 1396N. The high-density gas emission is found in association with three dense cores associated with the YSOs BIMA 1, BIMA 2, and BIMA 3. The CS (J=5→4) and CH_3OH (J=5_{-1} →4_{-1}) emission around BIMA 1 has been modeled by considering a spatially infinitely thin ring seen edge-on by the observer. From the model we find that CS is detected over a wider radii range than CH_3OH. A bipolar outflow is detected in the CS (J=2→1) line centered near BIMA 1. This outflow could be powered by a yet undetected YSO, BIMA 1W, or alternatively could be part of the BIMA 1 molecular outflow. The CS and CH_3OH emission associated with the intermediate-mass protostar BIMA 2 is highly perturbed by the bipolar outflow even at cloud velocities, confirming that the protostar is in a very active stage of mass loss. For YSO BIMA 3 the lack of outflow and of clear evidence of infall suggests that both outflow and infall are weaker than in BIMA 1, and that BIMA 3 is probably a more evolved object.

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Preprint available at http://www.arcetri.astro.it/∼mbeltran/i21391-core.ps

Sub-arcsecond sub-mm continuum observations of Orion-KL

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We present the first 865 μm continuum image with sub-arcsecond resolution obtained with the Submillimeter Array. These data resolve the Orion-KL region into the hot core, the nearby radio source I, the sub-mm counterpart to the infrared source n (radio source L), and new sub-mm continuum sources. The radio to submillimeter emission from source I may be modeled as either the result of proton-electron free-free emission that is optically thick to ~ 100 GHz plus dust emission that accounts for the majority of the submillimeter flux, or H^- free-free emission that gives rise to a power-law spectrum with power-law index of ~ 1.6. The latter model would indicate similar physical conditions as found in the inner circumstellar environment of Mira variable stars. Future sub-arcsecond observations at shorter sub-mm wavelengths should easily discriminate between these two possibilities. The sub-mm continuum emission toward source n can be interpreted in the framework of emission from an accretion disk.

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Preprints available at http://cfa-www.harvard.edu/∼hbeuther/

Collimated molecular jets from high-mass young stars: IRAS 18151-1208

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Recent near-IR images of massive star forming regions have revealed two collimated jets in the IRAS 18151-1208 region, one of which is almost a parsec in length (Varricatt et al.). Follow-up high-spectral-resolution echelle spectroscopy and 2-dimensional “integral field” spectroscopy of the associated molecular shock features are presented here. From these data kinematic information and excitation maps are extracted, which show that the two jets are morphologically, kinematically and energetically similar to their counterparts from low mass protostars. The close association between the H_2 emission features and the high-velocity CO emission presented by Beuther et al. also suggests that the CO represents gas entrained by these two very collimated jets. From the mass and momentum of the molecular gas, and the luminosity of the H_2 features, it is clear that the flows must be powered by massive sources. To all intents and purposes, the molecular jets appear to be scaled-up versions of low-mass YSO jets. Collectively, the observations add further support to the idea that massive stars are formed through vigorous disk accretion, and that, while in their earliest stages of evolution, massive protostars drive collimated jets.

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Preprints available from http://www.jach.hawaii.edu/∼cdavis/

Resolved Inner Disks around Herbig Ae/Be Stars

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We have observed 14 Herbig Ae/Be sources with the long-baseline near-IR Palomar Testbed Interferometer. All except two sources are resolved at 2.2 μm, with angular sizes generally < 5 mas. We determine the size scales and orientations of the 2.2 μm emission using various models: uniform disks, Gaussians, uniform rings, flat accretion disks with inner holes, and flared disks with puffed-up inner rims. Although it is difficult to distinguish different radial distributions, we are able to place firm constraints on the inclinations of most sources; 7 objects display significantly inclined morphologies. The inner disk inclinations derived from our near-IR data are generally compatible with the outer disk geometries inferred from millimeter interferometric observations, implying that HAEBE disks are not significantly warped. Using the derived inner disk sizes and inclinations, we compute the spectral energy distributions for two simple physical disk models, and compare these with observed SEDs compiled from the literature and new near-IR photometry. While geometrically flat accretion disk models are consistent with the data for the earliest spectral types in our sample (MWC 297, V1685 Cyg, and MWC 1080), the later-type sources are explained better through models incorporating puffed-up inner disk walls. The different inner disk geometries may indicate different accretion mechanisms for early and late-type Herbig Ae/Be stars.

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An X-ray census of young stars in the Chamaeleon I North cloud

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Sensitive X-ray imaging surveys provide a new and effective tool to establish the census of pre-main sequence (PMS) stars in nearby young stellar clusters. We report here a deep *Chandra* $X-ray\ Observatory$ observation of PMS stars in the Chamaeleon I North cloud, achieving a limiting luminosity of $\log L_t \simeq 27$ erg s^{-1} ($0.5-8$ keV band) in a 0.8×0.8 pc region. Of the 107 X-ray sources, 37 are associated with Galactic stars of which 27 are previously recognized cloud members. These include three PMS brown dwarfs; the protostellar brown dwarf ISO 192 has a particularly high level of magnetic activity. Follow-up optical photometry and spectroscopy establishes that 9-10 of the *Chandra* sources are probably magnetically active background stars. Several previously proposed cloud members are also inferred to be interlopers due to the absence of X-ray emission at the level expected from the $\log L_t - K$ correlation. No new X-ray discovered stars were confidently found despite the high sensitivity.

From these findings, we argue that the sample of 27 PMS cloud members in the *Chandra* field is uncontaminated and complete down to $K = 12$ or $M \simeq 0.1$ M$_{o}dot$. The initial mass function (IMF) derived from our sample is deficient in $0.1-0.3$ M$_\odot$ stars compared to the IMF of the rich Orion Nebula Cluster and other Galactic populations. We can not discriminate whether this is due to different star formation processes, mass segregation, or dynamical ejection of lower mass stars.

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The paper is available with full figures at http://www.astro.psu.edu/users/edf/ChaIN.pdf

Simultaneous *Chandra* and *VLA* Observations of Young Stars and Protostars in ρ Ophiuchus Cloud Core A

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A 96-ks *Chandra* X-ray observation of ρ Ophiuchus cloud core A detected 87 sources, of which 60 were identified with counterparts at other wavelengths. The X-ray detections include 12 of 14 known classical T Tauri stars (CTTS) in the field, 15 of 17 known weak-lined TTS (WTTS), and 4 of 15 brown dwarf candidates. The X-ray detections are characterized by hard, heavily absorbed emission. Most X-ray detections have visual extinctions in the range $A_V \approx$ 10 - 20 mag, but several sources with visual absorptions as high as $A_V \approx 40 - 56$ mag were detected. The mean photon energy of a typical source is $\langle E \rangle \approx 3$ keV, and more than half of the detections are variable. Prominent X-ray flares were detected in the unusual close binary system Oph S1, the X-ray bright WTTS DoAr 21, and the brown dwarf candidate GY 31 (M5.5). Time-resolved spectroscopic analysis of the DoAr 21 flare clearly reveals a sequence of secondary flares during the decay phase which may have reheated the plasma. We find that the X-ray luminosity distributions and spectral hardnesses of CTTS and WTTS are similar. We also conclude that the X-ray emission of detected brown-dwarf candidates is less luminous than T Tauri stars, but spectroscopically similar.

Simultaneous multifrequency *VLA* observations detected 31 radio sources at 6 cm, of which ten were also detected by *Chandra*. We report new radio detections of the optically invisible IR source WLY 2-11 and the faint Hα emission line star Elias 24 (class II). We confirm circular polarization in Oph S1 and report a new detection of circular polarization in DoAr 21. We find no evidence that X-ray and radio luminosities are correlated in the small sample of TTS detected simultaneously with *Chandra* and the *VLA*.

We describe a new non-parametric method for estimating X-ray spectral properties from unbinned photon event lists that is applicable to both faint and bright X-ray sources. The method is used to generate f_X, $\log T$ and L_X light curves. In addition, we provide a publically-available electronic database containing multi-wavelength data for 345 known X-ray, IR, and radio sources in the core A region.

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Chandra observations of the massive star-forming region S106: X-ray emission from the embedded massive protostellar object IRS 4

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We present *Chandra* observations of the massive star-forming region S106, a prominent H II region in Cygnus, associated with an extended molecular cloud and a young cluster. The nebula is excited by a single young massive star located at the center of the molecular cloud and the embedded cluster. The prominence of the cluster in the *Chandra* observation presented here confirms its youth and allows some of its members to be studied in more detail. We detect X-ray emission from the young massive central source S106 IRS 4, the deeply embedded central object which drives the bipolar nebula with a mass loss rate approximately 1–2 orders of magnitude higher than main sequence stars of comparable luminosity. Still, on the basis of its wind momentum flux the X-ray luminosity of S106 IRS 4 is comparable to the values observed in more evolved (main sequence and giant) massive stars, suggesting that the same process which is responsible for the observed X-ray emission from older massive stars is already at work at these early stages.

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The Disk Wind in Young Binaries and the Origin of the Cyclic Activity of Young Stars

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We present results of numerical modeling of the cyclic brightness modulation in the young binary systems with the eccentric orbits and low-mass secondary components. It is suggested that the system components accrete the matter from the remnant of the protostellar cloud and, according to the current models, the low-mass companion is the main accretor. Brightness variations of the primary is due to the periodical extinction variations on the line-of-sight caused by the disk wind of the secondary and a common envelope it produces. A matter distribution in the envelope has been calculated in the ballistic approach.

When calculating the optical effects due to the dust component of the disk wind, we adopt the dust to gas mass ratio 1:100 as in the interstellar medium and the optical parameters of the circumstellar dust typical for the young stars. Calculations showed that in the young binaries with the elliptic orbits theoretical light curves demonstrated the more variety of shapes comparing with the case of the circular orbits. In this case parameters of the photometric minima (their depth, duration and the shape of light curves) depend not only on the disk wind parameters and an inclination of the binary orbit to the line-of-sight but also on the longitude of the periastron. A modulation of the scattered radiation of the common envelope with a phase of the orbital period has been investigated in the single scattering approach. It is shown that an amplitude of the modulation is maximal when the system is seen edge-on and has also a non-zero value in the binaries observed pole-on. Possible applications of the theory to the young stellar objects are discussed. In particular, an attention is payed to a resemblance of the light curves in some models with light curves of some objects suspected as candidates to FUORs.

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X-ray Study of the Intermediate-Mass Young Stars Herbig Ae/Be Stars

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We present the *ASCA* results of intermediate-mass pre-main-sequence stars (PMSs), or Herbig Ae/Be stars (HAeBes). Among the 35 *ASCA* pointed-sources, we detect 11 plausible X-ray counterparts. X-ray luminosities of the detected sources in the 0.5–10 keV band are in the range of log L_{rmX} $sim30-32$ ergs s^{-1}, which is systematically higher than those of low-mass PMSs. This fact suggests that the contribution of a possible low-mass companion is not large. Most of the bright sources show significant time variation, particularly, two HAeBes - MWC 297 and TY CrA - exhibit flare-like events with long decay timescales (e-folding time $\sim 10-60$ ksec). These flare shapes are similar to those of low-mass PMSs. The X-ray spectra are successfully reproduced by an absorbed one or two-temperature thin-thermal plasma model. The temperatures are in the range of $kT \sim 1-5$ keV, which are significantly higher than those of main-sequence OB stars ($kT < 1$ keV). These X-ray properties are not explained by wind driven shocks, but are more likely due to magnetic activity. On the other hand, the plasma temperature rises as absorption column density increases, or as HAeBes ascend to earlier phases. The X-ray luminosity reduces after stellar age of a few$\times10^6$ years. X-ray activity may be related to stellar evolution. The age of the activity decay is apparently near the termination of jet or outflow activity. We thus hypothesize that magnetic activity originates from the interaction of the large scale magnetic fields coupled to the circumstellar disk. We also discuss differences in X-ray properties between HAeBes and main-sequence OB stars.

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Subaru K band Spectroscopy of Low-mass Protostars in Taurus

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We present K band spectra of five Class I objects in the Taurus molecular cloud. The high-sensitivity and high-spatial resolution observations using the Subaru Telescope enabled us to detect the emission lines of Brγ and H_2 in four and two objects, respectively, and photospheric absorption lines in two objects. From the absorption lines, the effective temperature, stellar luminosity, and the amount of veiling were estimated for the two objects (IRAS 04016+2610 and IRAS 04248+2612). We conclude that the amount of circumstellar emission is much higher in IRAS 04016 (r_K = 7–10) than IRAS 04248 ($r_K \sim 2$), while the stellar properties are similar between the two objects. Apart from the stellar spectra, the nebular spectra were obtained for IRAS 04016 and IRAS 04248. The reflection nebulae of the Class I objects were verified from a spectroscopic viewpoint for the first time: we found that the nebular spectra are explained as the scattered light from the central YSOs with the difference of the line of sight extinction between the star and nebula, $\Delta A_V \sim$2–9 mag.

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An Extinction Threshold for Protostellar Cores in Ophiuchus

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We have observed continuum emission at $\lambda = 850\,\mu$m over $\sim$4 square degrees of the Ophiuchus star-forming cloud using SCUBA on the JCMT, producing a submillimetre continuum map twenty times larger than previous Ophiuchus surveys. Our sensitivity is $40\,\mathrm{mJy\,beam^{-1}}$, a factor of $\sim$2 less sensitive than earlier maps. Using an automated identification algorithm, we detect 100 candidate objects. Only two new objects are detected outside the boundary of previous maps, despite the much wider area surveyed. We compare the submillimetre continuum map with a map of visual extinction across the Ophiuchus cloud derived using a combination of 2MASS and R-band data. The total mass in submillimetre objects is ≈ 50 $M_\odot$ compared with ≈ 2000 $M_\odot$ in observed cloud mass estimated from the extinction. The submillimetre objects represent only 2.5% of the cloud mass. A clear association is seen between the locations of detected submillimetre objects and high visual extinction, with no objects detected at $A_V < 7$ magnitudes. Using the extinction map, we estimate pressures within the cloud from $P/k \approx 2 \times 10^5\,\mathrm{cm^{-3}\,K}$ in the less-extincted regions to $P/k \approx 2 \times 10^6\,\mathrm{cm^{-3}\,K}$ at the cloud centre. Given our sensitivities, cold ($T_d \approx 15\,$K) clumps supported by thermal pressure, had they existed, should have been detected throughout the majority of the map. Such objects may not be present at low A_V because they may form only where $A_V > 15$, by some mechanism (e.g., loss of non-thermal support).

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The Size Distribution of Kuiper Belt Objects

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We describe analytical and numerical collisional evolution calculations for the size distribution of icy bodies in the Kuiper Belt. For a wide range of bulk properties, initial masses, and orbital parameters, our results yield power-law

cumulative size distributions, $N_C \propto r^{-q}$, with $q_L \approx 3.5$ for large bodies with radii, $r \geq$ 10–100 km, and $q_s \approx$ 2.5–3 for small bodies with radii, $r \leq$ 0.1–1 km. The transition between the two power laws occurs at a break radius, $r_b \approx$ 1–30 km. The break radius is more sensitive to the initial mass in the Kuiper Belt and the amount of stirring by Neptune than the bulk properties of individual Kuiper Belt objects (KBOs). Comparisons with observations indicate that most models can explain the observed sky surface density $\sigma(m)$ of KBOs for red magnitudes $R \approx$ 22–27. For $R \leq 22$ and $R \geq 28$, the model $\sigma(m)$ is sensitive to the amount of stirring by Neptune, suggesting that the size distribution of icy planets in the outer solar system provides independent constraints on the formation of Neptune.

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An unbiased search for the signatures of protostars in the ρ Ophiuchi A Molecular Cloud: I. Near-infrared observations

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We present an unbiased search for molecular hydrogen emission in the L1688 cloud within the ρ Ophiuchi molecular cloud complex. Our near-infrared survey covers a connected region of extent 35' × 35'. We detect several new H_2 flows but the total number of detected outflows is low and is consistent with the paucity of Class 0 and Class 1 sources in the molecular cloud. From the spatial distribution, their collimation and the individual shapes of the bow shocks, we suggest possible candidates for the outflow sources. Most of the candidate driving sources are deeply embedded in dense cores of the molecular cloud. A very young outflow arises from the newly discovered Class 0 source MMS 126. Two major outflows in the NE–SW direction arise from the YLW 15 and YLW 16 Class I sources. Three additional outflows, which both extend over several arcminutes, arise from the Class I sources YLW 31 and YLW 52. Flow directions are generally NE–SW, perpendicular to the elongation directions of the cloud filaments. The apparent extents of molecular flows are related to either the widths of cloud filaments or to the separation between filaments. The estimated jet power needed to continuously drive and excite the detected portions of the shocked H_2 outflows lies in the range 0.02 –0.2 $L_\odot$. Given the critical dependence on the environment, however, the total sizes and powers of the outflows may be considerably larger.

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Embedded Star Clusters in the W51 Giant Molecular Cloud

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We present sub-arcsecond (0.35″-0.9″), near-infrared J,H,K band photometric observations of six fields along the W51 Giant Molecular Cloud (W51 GMC). Our observations reveal four new, embedded clusters and provide a new high-resolution (0.35″) view of the W51IRS2 (G49.5-0.4) region. The cluster associated with G48.9-0.3 is found to be a double cluster enclosed in a nest of near-infrared nebulosity. We construct stellar surface density maps for four major clusters in the W51 GMC. These unveil the underlying hierarchical structure. Color-color and color-magnitude diagrams for each of these clusters show clear differences in the embedded stellar populations and indicate the relative ages of these clusters. In particular, the clusters associated with the HII regions G48.9-0.3 and G49.0-0.3 are found to have a high fraction of YSOs and are therefore considered the youngest of all the near-infrared clusters in the W51 GMC. The estimated masses of the individual clusters, when summed, yield a total stellar mass of $\sim 10^4\,M_\odot$ in the W51 GMC, implying a star formation efficiency of 5-10%. These results in comparision with the CO observations of the W51 GMC, suggest for the first time, that star formation in the W51 GMC is likely triggered by a galactic spiral

density wave.

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The structure of Onsala 1 star forming region

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We present new high-sensitivity high-resolution mm-wave observations of the Onsala 1 ultra-compact HII region that bring to light the internal structure of this massive star forming cloud. The 1.2 mm continuum map obtained with the IRAM 30-m radiotelescope (∼11″ resolution) shows a centrally peaked condensation of 1′ size (∼0.5 pc at the assumed distance of 1.8 kpc) which has been further investigated at higher resolution in the 3 mm continuum and in the emission lines of $H^{13}CO^+$ J=1–0 and SiO J=2–1 with the IRAM Plateau de Bure interferometer. The 3 mm data, with a resolution of ∼5″×4″, displays a unresolved continuum source at the peak of the extended 1.2 mm emission and closely associated with the ultra-compact HII region. The $H^{13}CO^+$ map traces the central condensation in good agreement with previous NH_3 maps of Zheng et al.1985. However, the velocity field of this central condensation, which was previously thought to arise in a rapidly rotating structure, is better explained in terms of the dense and compact component of a bipolar outflow. This interpretation is confirmed by SiO and CO observations of the full region. In fact, our new SiO data unveils the presence of multiple (at least 4) outflows in the region. In particular, there is an important center of outflow activity in the region at about 1′ north of the UCHII region. Indeed the different outflows are related to different members of the Onsala 1 cluster. The data presented here support a scenario in which the phases of massive star formation begin much later in the evolution of a cluster and/or UCHII region last for much longer than 10^5yrs.

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preprints: ftp://ftp.astro.up.pt/pub/preprints/160.pdf

A Catalog of CH_3OH $7_0 - 6_1$ A^+ Maser Sources in Massive Star Forming Regions

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We present a Very Large Array survey of 44 massive star forming regions in the 44 GHz $7_0 - 6_1$ A^+ methanol transition; 37 fields showed maser emission. Thirty-one sources were also observed in the 23 GHz $9_2 - 10_1$ A^+ methanol line; two fields showed maser emission. Although the 44 GHz line is a class I maser, we find a large number of these masers in relatively close association with HII regions and water masers. Several sources show strong evidence for a correlation between 44 GHz masers and shocked molecular gas, supporting the interpretation that molecular outflows may give rise to class I maser emission. We provide maser positions with arcsecond accuracy which not only locate the masers with respect to other star formation phenomena, but also provide, for the stronger masers, phase referencing sources that can be used to calibrate future 7 mm (44 GHz) observations of these regions.

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Deep 3.8 μm Observations of the Trapezium Cluster

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We present deep 3.8 μm $L^{'}$ imaging observations of the Trapezium cluster in Orion obtained with the ESO VLT. We use these observations to: 1) search for infrared excess emission and evidence for protoplanetary disks associated with the faint, substellar population of this young cluster, and 2) investigate the nature and extent of a recently discovered population of deeply embedded sources located in dense molecular gas behind the cluster. We detected 38 $L^{'}$ sources with substellar luminosities. In addition, we detected 24 $L^{'}$ sources that were spectroscopically classified as substellar objects in previous studies. Examining the infrared colors of all these sources we determine an infrared excess fraction of 50 ± 20 % from the $JHK_sL^{'}$ colors for both the luminosity selected and spectroscopically selected substellar samples. This finding confirms the presence of infrared excess, likely due to circumstellar disks, around a significant fraction of the cluster's substellar population, consistent with the indications of earlier observations obtained at shorter (JHK_s) wavelengths. Our deep $L^{'}$ imaging survey also provides new information concerning the deeply embedded population of young objects located in the molecular cloud behind the cluster and revealed in an earlier L band imaging survey of the region. In particular, our present $L^{'}$ survey doubles the number of sources in the cluster region known to possess extremely red $K-L$ colors. These objects exhibit $K-L^{'}$ colors indicative of deeply buried, possibly protostellar, objects that likely mark the site of the most recent and ongoing star formation in the region. We find the surface density distribution of the deeply embedded population to follow that of the background molecular ridge and to be highly structured, consisting of a string of at least 5 significant subclusters. These subclusters may represent the primordial building blocks out of which the cluster was and perhaps still is being assembled. These observations may thus provide insights into the early stages of cluster formation and appear consistent with recent simulations that suggest that the Trapezium cluster may have formed from numerous but small primordial subclusters.

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See http://cfa-www.harvard.edu/∼clada/preprints.html for full resolution figures or astro-ph/0406326.

The G9.62+0.19–F Hot Molecular Core – The Infrared View on Very Young Massive Stars

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We present the results of an extensive infrared study of the massive star–forming region G9.62+0.19. The data cover information from broad– and narrow–band filters in the wavelength range from 1 to 19 μm and are obtained with ESO's near– and thermal infrared camera ISAAC at the VLT and with the mid–infrared cameras TIMMI2 (La Silla, ESO) and SpectroCam-10 (Mt. Palomar). The high sensitivity and resolution provided by these facilities revealed intriguing new details of this star–forming region and especially about the embedded hot molecular core (HMC) – component F. We analyse the newly found infrared sub–structure of four objects in this HMC region.
While one of these objects (F2) is probably a foreground field star, the nature of the brightest object in the near–infrared there (F1) remains somewhat enigmatic. Our new astrometry proves that this object is not coincident with the peak of the molecular line emission of the HMC, but displaced by ~ 1.7 arcsecs which translates to nearly 10000 AU on a linear scale. On the basis of the available data we estimate this object to be an additional embedded object with a dense dust shell. Very near the HMC location we find L' band emission which strongly rises in flux towards longer wavelengths. We presume that this emission (F4) arises from the envelope of the HMC which is known to be associated with a molecular outflow roughly aligned along the line of sight. Thus, the clearing effect of this outflow causes strong deviations from spherical symmetry which might allow infrared emission from the HMC to escape through the outflow cavities. This presents the first direct detection of an HMC at a wavelength as short as 3.8 μm. At 11.7 μm and 18.75 μm, the HMC counterpart F4 ultimately proves to be the most luminous IR source within the G9.62+0.19–F region. In addition, within the entire G9.62+0.19 complex our narrow–band data and the K band imaging polarimetry reveal

well–defined regions of enhanced Brγ and H_2 emission as well as a sector where a large contribution comes from scattered light. In combination with high–resolution radio data we make predictions about the extinction within this star–forming region which clarifies why some of the associated ultracompact HII regions are not visible in the near–infrared.
Our investigations show the complexity of massive star formation in full grandeur, but they also demonstrate that the related problems can be tackled by observations using the new generation of infrared cameras.

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Since this preprint contains several colour figures, it is advisable to visit the following website to get a high-resolution version of it: http://www.tls-tautenburg.de/research/tls-research/papers/linz/G9.62.html

Massive planets in FU Orionis discs: implications for thermal instability models

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FU Orionis are young stellar objects undergoing episodes of enhanced luminosity, which are generally ascribed to a sudden increase of mass accretion rate in the surrounding protostellar disc. Models invoking a thermal instability in the disc are able to reproduce many features of the outburst, but cannot explain the rapid rise time-scale observed in many cases. Here we explore the possibility (originally suggested by Clarke & Syer 1996) that the thermal instability is triggered away from the disc inner edge (at a distance of $\approx 10R_{\odot}$ from the central protostar) due to the presence of a massive planet embedded in the disc. We have constructed simple, one-dimensional, time-dependent models of the disc evolution, taking into account both the interaction between the disc and the planet, and the thermal evolution of the disc. We are indeed able to reproduce rapid rise outbursts (with rise time-scale ≈ 1 yr), with a planet mass $M_{\rm s} = 10 - 15 M_{\rm Jupiter}$. We show that the luminosity and the duration of the outbursts are increasing functions of planet mass. We also show that the inward migration of the planet is significantly slowed once it reaches the radius where it is able to trigger FU Orionis outbursts, thus suggesting that a single planet may be involved in triggering several outbursts.

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On the alignment of Classical T Tauri stars with the magnetic field in the Taurus-Auriga molecular cloud

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In this paper we readdress the issue of the alignment of Classical T Tauri stars (CTTS) with the magnetic field in the Taurus-Auriga molecular cloud. Previous studies have claimed that the jet axis of active young stellar objects (YSO), projected in the plane of the sky, is aligned preferentially along the projected direction of the local magnetic field. We re-examine this issue in view of the numerous high angular resolution images of circumstellar disks and micro-jets now available. The images show that T Tauri stars as a group are oriented randomly with respect to the local magnetic field, contrary to previous claims. This indicates that the magnetic field may play a lesser role in the final stages of collapse of an individual prestellar core than previously envisioned. The current database also suggests that a subsample of CTTS with resolved disks but without observations of bright and extended outflows have a tendency to align perpendicularly to the magnetic field. We discuss the possibility that this may trace a less favorable topology, e.g., quadrupolar, for the magnetic field in the inner disk, resulting in a weaker collimated outflow.

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Preprint is available at **astro-ph/0407075** and also at the following URL: http://www-laog.obs.ujf-grenoble.fr by clicking first on "activites" and then on "formation stellaire".

The Formation and Evolution of Planetary Systems: First Results from a Spitzer Legacy Science Program

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We present 3-160 μm photometry obtained with the IRAC and MIPS instruments for the first five targets from the Spitzer Legacy Science Program “Formation and Evolution of Planetary Systems” and 4-35 μm spectro-photometry obtained with the IRS for two sources. We discuss in detail our observations of the debris disks surrounding HD 105 (G0V, 30 $\pm$10 Myr) and HD 150706 (G3V, $\sim$ 700 $\pm$300 Myr). For HD 105, possible interpretations include large bodies clearing the dust inside of 45 AU or a reservoir of gas capable of sculpting the dust distribution. The disk surrounding HD 150706 also exhibits evidence of a large inner hole in its dust distribution. Of the four survey targets without previously detected IR excess, spanning ages 30 Myr to 3 Gyr, the new detection of excess in just one system of intermediate age suggests a variety of initial conditions or divergent evolutionary paths for debris disk systems orbiting solar-type stars.

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Preprints can be obtained on–line at http://feps.as.arizona.edu or http://xxx.lanl.gov/abs/astro-ph/0406301.

The Giant Molecular Cloud associated with RCW 106 : A 1.2 mm continuum mapping study

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We have mapped the dust continuum emission from the molecular cloud covering a region of 28 pc×94 pc associated with the well-known H II region RCW 106 at 1.2 mm using SIMBA on SEST. The observations, having an HPBW of 24″ (0.4 pc), reveal 95 `clumps`, of which about 50% have MSX associations and only 20% have IRAS associations. Owing to the higher sensitivity to colder dust and higher angular resolution the present observations identify new emission features and also show that most of the IRAS sources in this region consist of multiple dust emission peaks. The detected millimeter sources (MMS) include on one end the exotic MMS5 (associated with IRAS 16183-4958, one of the brightest infrared sources in our Galaxy) and the bright (and presumably cold) source MMS54, with no IRAS or MSX associations on the other end. Around 10% of the sources are associated with signposts of high mass star formation activity. Assuming a uniform dust temperature of 20 K we estimate the total mass of the GMC associated with RCW 106 to be $\sim 10^5$ M$_\odot$. The constituent millimeter `clumps` cover a range of masses and radii between 40 to 10^4 M$_\odot$ and 0.3 to 1.9 pc. Densities of the clumps range between (0.5-6) 10^4 cm^{-3}. We have decomposed the continuum emission into `gaussian` and `arbitrary shaped clumps` using the two independent structure analysis tools `gaussclumps` and `clumpfind` respectively. The `clump` mass spectrum was found to have an index α of 1.6 ± 0.3, independent of the decomposition algorithm used. The index of the mass spectrum for the mass and length scales covered here are consistent with results derived from large scale CO observations.

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The Pleiades mass function : models versus observations

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Two stellar-dynamical models of binary-rich embedded proto-Orion-Nebula-type clusters that evolve to Pleiades-like clusters are studied with an emphasis on comparing the stellar mass function with observational constraints. By the age of the Pleiades (about 100 Myr) both models show a similar degree of mass segregation which also agrees with observational constraints. This thus indicates that the Pleiades is well relaxed and that it is suffering from severe amnesia. It is found that the initial mass function (IMF) must have been indistinguishable from the standard or Galactic-field IMF for stars with mass $m \lesssim 2\,M_\odot$, provided the Pleiades precursor had a central density of about $10^{4.8}$ stars/pc^3. A denser model with $10^{5.8}$ stars/pc^3 also leads to reasonable agreement with observational constraints, but owing to the shorter relaxation time of the embedded cluster it evolves through energy equipartition to a mass-segregated condition just prior to residual-gas expulsion. This model consequently preferentially loses low-mass stars and brown dwarfs (BDs), but the effect is not very pronounced. The empirical data indicate that the Pleiades IMF may have been steeper than the Salpeter for stars with $m \gtrsim 2\,M_\odot$.

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Excitation of Molecular Material Near the Young Stellar Object LkHα 234 in NGC 7129

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With the *Spitzer*-IRS we have obtained the first mid-IR spectroscopy of NGC 7129, in the unusually strong outflow and in a ridge of H_2 emission near the Herbig Be star LkHα 234. The UV radiation field strength is estimated from PAH band intensities in the H_2 ridge, and found to be comparable to that of NGC 7023. From the rotational H_2 emission lines we have deduced aperture average excitation temperatures and column densities in the two regions, finding the H_2 ridge values to be consistent with pumping by UV fluorescence, but also comparable to warm-gas regions of Cep A that form H_2 in non-dissociative C-shocks. The H_2 emission in the outflow is consistent with formation by collisional excitation in J-shocks, with shock velocities of $10 - 30$ km sec^{-1}. A photodissociating component may be present in the outflow, by similarity of S(0) line intensities in both regions. There is no indication of warm dust in the outflow. We also present the first 16 μm imaging of a Galactic nebula using the unique imaging capabilities of the IRS, and combine with ground-based 2.12 μm (H_2 $1-0$ S(1)) imaging. Candidate pre-main sequence objects are clearly evident in these data. We also find extended emission not previously observed around the young B star BD $+65^\circ 1638$, $\sim 22''$ across, clearly showing that the region is not free of material as otherwise inferred by recent high angular resolution mapping at submillimeter wavelengths. The presence of this material complicates interpretation of the surrounding CO cavity and origin(s) of the PDR, and further spectroscopic observations are needed to characterize its nature.

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A Study of the RNO 129 Star Forming Group

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The compact star-forming group RNO 129 in the L 1228 cloud is analyzed. For the several nebulae and HH objects forming this group, new images and results of slit and integral-field spectroscopy are presented. Several new HH objects were found, including two small HH knots inside the bright reflection nebula. The central star of this nebula is double and can be the source of at least one collimated outflow. Certain features in the spectrum of the nebula suggests its similarity to NGC 2261.

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The X-ray emission from Young Stellar Objects in the ρ Ophiuchi cloud core as seen by XMM-Newton

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We observed the main core F of the ρ Ophiuchi cloud, an active star-forming region located at $d \sim 140$ pc, using *XMM-Newton* with an exposure of 33 ks. We detect 87 X-ray sources within the 30 arcmin diameter field-of-view of the *EPIC* imaging detector array. We cross-correlate the positions of *XMM-Newton* X-ray sources with previous X-ray and infrared (IR) catalogs: 25 previously unknown X-ray sources are found from our observation; 43 X-ray sources are detected by both *XMM-Newton* and *Chandra*; 68 *XMM-Newton* X-ray sources have 2MASS near-IR counterparts. We show that *XMM-Newton* and *Chandra* have comparable sensitivity for point source detection when the exposure time is set to ~ 30 ks for both. We detect X-ray emission from 7 Class I sources, 26 Class II sources, and 17 Class III sources. The X-ray detection rate of Class I sources is very high (64 %), which is consistent with previous *Chandra* observations in this area. We propose that 15 X-ray sources are new class III candidates, which doubles the number of known Class III sources, and helps to complete the census of YSOs in this area. We also detect X-ray emission from two young bona fide brown dwarfs, GY310 and GY141, out of three known in the field of view. GY141 appears brighter by nearly two orders of magnitude than in the *Chandra* observation. We extract X-ray light curves and spectra from these YSOs, and find some of them showed weak X-ray flares. We observed an X-ray flare from the bona fide brown dwarf GY310. We find as in the previous *Chandra* observation of this region that Class I sources tend to have higher temperatures and heavier X-ray absorptions than Class II and III sources.

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The Hot Core–Ultracompact H II Connection in G10.47+0.03

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We present infrared imaging and spectroscopic data of the complex massive star-forming region G10.47+0.03. The detection of seven mid-infrared (MIR) sources in our field combined with a sensitive Ks/ISAAC image allows to establish a very accurate astrometry, at the level of $0.3''$. Two MIR sources are found to be coincident with two ultracompact H II regions (UCH IIs) within our astrometric accuracy. Another MIR source lies very close to three other UCH II regions and to the hot molecular core (HMC) in G10.47+0.03. Spectroscopy of two of the most interesting MIR sources allows to identify the location and spectral type of the ionizing sources. We discuss in detail the relationship between the HMC, the UCH II regions and the nearby MIR source. The nature of the other MIR sources is also investigated.

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Models for the IR cavity of HH 46/47

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We have modeled the limb-brightened cavity seen in the new Spitzer IR images of the SW lobe of HH 46/47 as the bow shock driven by an outflow from a young, low mass star. We present models in which the outflow is a perfectly collimated, straight jet, in which we have a precessing jet, and finally a model in which the outflow takes the form of a latitude-dependent wind. We study cases in which the outflow moves into a constant density cloud and into a stratified cloud. We find that the best agreement with the observed cavity is obtained for the precessing jet in a stratified cloud. However, the "straight jet" (travelling in a stratified cloud) also gives cavity shapes close to the observed one. The "latitude-dependent wind" model that we have computed gives cavity shapes which are substantially wider than the observed cavity. We therefore conclude that the cavity seen in the Spitzer observations of the SW lobe of the HH 46/47 outflow do not seem to imply the presence of a "latitude-dependent wind", as it can be modeled successfully with a "perfectly collimated jet" model.

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Dust diffusion, sedimentation, and gravitational instabilities in protoplanetary disks

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We derive the diffusion coefficient D of dust under the conditions of a protostellar disk. A reliable estimate of this quantity is essential for the transport, especially the sedimentation, of dust particles in the disk environment. In contrast to earlier treatments, the diffusion coefficient is derived on the basis of a mean field theory which allows a reliable determination of D. In the course of this derivation, we used two different turbulence models. We applied the diffusion coefficient in order to calculate how dust grains sediment and how a dust sub-disk develops. Starting from the physical conditions in the sub-disk, we discuss gravitational instabilities of this structure.

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The Circumstellar Environment of the Early B Protostar G192.16–3.84 and the Discovery of a Low-Mass, Protostellar Core

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We have observed the massive star forming region associated with the early B protostar G192.16–3.84 in NH_3(1,1), 22.2 GHz H_2O masers, 1.3 cm continuum emission, and at 850 μm. The dense gas associated with G192.16 is clumpy, optically thin, and has a mass of 0.9 $M_\odot$. The NH_3 core is gravitationally unstable which may signal that the outflow phase of this system is coming to an end. Water masers trace an ionized jet 0.8″ (1600 AU at a distance of 2 kpc) north of G192.16. Masers are also located within 500 AU of G192.16, their velocity distribution is consistent with but does not strongly support the interpretation that the maser emission arises in a 1000 AU rotating disk centered on G192.16. Roughly 30″ south of G192.16 (0.3 pc) is a compact, optically thick (τ = 1.2) NH_3 core (called G192 S3) with an estimated mass of 2.6 $M_\odot$. Based on the presence of 850 μm and 1.2 mm continuum emission, G192 S3

probably harbors a very young, low-mass protostar or proto-cluster. The dense gas in the G192 S3 core is likely to be gravitationally bound and may represent the next site of star formation in this region.

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Available on the web at http://www.aoc.nrao.edu/∼dshepher/science.shtml/g192.nh3.h2o.ps.gz

New Perspectives on the X-ray Emission of HD 104237 and Other Nearby Herbig Ae/Be Stars from XMM-Newton and Chandra

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The origin of the X-ray emission from Herbig Ae/Be stars is not yet known. These intermediate mass pre-main sequence stars lie on radiative tracks and are not expected to emit X-rays via solar-like magnetic processes, nor are their winds powerful enough to produce X-rays by radiative wind shocks as in more massive O-type stars. The emission could originate in unseen low-mass companions, or it may be intrinsic to the Herbig stars themselves if they still have primordial magnetic fields or can sustain magnetic activity via a nonsolar dynamo.

We present new X-ray observations of the nearby Herbig Ae star HD 104237 (= DX Cha) with *XMM-Newton*, whose objective is to clarify the origin of the emission. Several X-ray emission lines are clearly visible in the CCD spectra, including the high-temperature Fe Kα complex. The emission can be accurately modeled as a multi-temperature thermal plasma with cool (kT $<$ 1 keV) and hot (kT $\gtrsim$ 3 keV) components. The presence of a hot component is compelling evidence that the X-rays originate in magnetically confined plasma, either in the Herbig star itself or in the corona of an as yet unseen late-type companion. The X-ray temperatures and luminosity (log L_X = 30.5 ergs s^{-1}) are within the range expected for a T Tauri companion, but high resolution *Chandra* and *HST* images constrain the separation of a putative companion to $<1''$. We place these new results into broader context by comparing the X-ray and bolometric luminosities of a sample of nearby Herbig stars with those of T Tauri stars and classical main-sequence Be stars. We also test the predictions of a model that attributes the X-ray emission of Herbig stars to magnetic activity that is sustained by a shear-powered dynamo.

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Preprints: http://xxx.lanl.gov/abs/astro-ph/0405450

Influence of UV radiation from a massive YSO on the chemistry of its envelope

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We have studied the influence of far ultraviolet (UV) radiation ($6< h\nu < 13.6$ eV) from a massive young stellar object (YSO) on the chemistry of its own envelope by extending the models of Doty et al. (2002) to include a central source of UV radiation. The models are applied to the massive star-forming region AFGL 2591 for different inner UV field strengths. Depth-dependent abundance profiles for several molecules are presented and discussed. We predict enhanced column densities for more than 30 species, especially radicals and ions. Comparison between observations and models is improved with a moderate UV field incident on the inner envelope, corresponding to an enhancement factor $G_0 \approx$ 10–100 at 200 AU from the star with an optical depth $\tau \approx$ 15–17. The chemical networks of various species are explored. Subtle differences are found compared with traditional models of Photon Dominated Regions (PDRs) because of the higher temperatures and higher gas-phase H_2O abundance caused by evaporation of ices in the inner region. In particular, the CN/HCN ratio is not a sensitive tracer of the inner UV field, in contrast with the situation for normal PDRs: for low UV fields, the extra CN reacts with H_2 in the inner dense and warm region and produces more HCN. It is found that the CH^+ abundance is strongly enhanced and grows steadily with increasing UV field. In addition, the ratio CH^+/CH is increased by a factor of 10^3–10^5 depending on the inner UV flux. High-J lines of molecules like CN and HCN are most sensitive to the inner dense region where UV radiation plays a role. Thus, even though the total column density affected by UV photons is small, comparison of high-J and low-J lines can selectively trace and distinguish the inner UV field from the outer one. In addition, future Herschel-HIFI observations of hydrides can sensitively probe the inner UV field

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A highly collimated, extremely high velocity outflow in Taurus

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We present the first case of a highly collimated, extremely high velocity bipolar outflow in Taurus. It is powered by the low-luminosity (0.4 $L_\odot$) source IRAS 04166+2706 and contains gas accelerated up to 50 km s^{-1} with respect to the ambient cloud both toward the blue and the red (uncorrected for projection). At the highest velocities, the outflow collimation factor exceeds 20, and the gas displays a very high degree of spatial symmetry. This very fast gas presents multiple maxima, and most likely arises from the acceleration of ambient material by a time-variable jet-like stellar wind. When scaled for luminosity, the outflow parameters of IRAS 04166 are comparable to those of other extremely high velocity outflows like L1448, indicating that even the very quiescent star-formation mode of Taurus can produce objects powering very high energy flows ($L_{mec}/L_* > 0.15$).

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Star Formation on the Move?

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Recent models of star formation suggest that the mass of a star is largely determined by its history of motion through its natal molecular cloud. Such motions may be observable in the early stages of star formation. We have looked for the relative shifts of line-center velocity in low (^{13}CO (1–0) and $C^{18}O$ (1–0)) and high (N_2H^+ (1–0)) density tracers towards a sample of 42 low mass star-forming cores. Our results indicate that any motions of the high-density cores, with respect to their low-density envelopes, are very small (≤ 0.1 km/s) compared to the motions expected from models of ballistic movement. We therefore conclude that isolated cores do not generally move ballistically with respect to their surrounding envelopes.

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Preprint available at: http://sadu.cfa.harvard.edu:8080/ms.ps

V1647 Ori (IRAS 05436-0007) in Outburst: the First Three Months

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We report on photometric (BVRIJHK) and low dispersion spectroscopic observations of V1647 Ori, the star that drives McNeil's Nebula, between 10 February and 7 May 2004. The star is photometrically variable atop a general decline in brightness of about 0.3-0.4 magnitudes during these 87 days. The spectra are featureless, aside from Hα and the Ca II infrared triplet in emission, and a Na I D absorption feature. The Ca II triplet line ratios are typical of young stellar objects. The Hα equivalent width may be modulated on a period of about 60 days. The post-outburst extinction appears to be less than 7 mag. The data are suggestive of an FU Orionis-like event, but further monitoring will be needed to definitively characterize the outburst.

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Preprints may be downlaoded from http://www.astro.sunysb.edu/fwalter/PUBS/V1647Ori.ps

Probing Pre-Protostellar Cores with Formaldehyde

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We present maps of the 6 cm and 1.3 mm transitions of H_2CO toward three cold, dense pre-protostellar cores: L1498, L1512, and L1544. The 6 cm transition is a unique probe of high density gas at low temperature. However, our models unequivocally indicate that H_2CO is depleted in the interiors of PPCs, and depletion significantly affects how H_2CO probes the earliest stages of star formation. Multi-stage, self-consistent models, including gas–dust energetics, of both H_2CO transitions are presented, and the implications of the results are discussed

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http://xxx.lanl.gov/abs/astro-ph/0406530

A Cluster of 1.3 Centimeter Continuum Sources in OMC1 South

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We present sensitive 1.3 cm radio continuum observations of the region OMC1 South (OMC-1S) in Orion using the Very Large Array in its B configuration. We detect eleven radio sources clustered in a $30'' \times 30''$ region, of which only three had been detected previously at radio wavelengths in deep 3.6 cm observations. The eight new radio sources are compact ($\theta_s \leq 0\rlap{.}''1$) and we set lower limits to their spectral indices, $\alpha > 0.8 \pm 0.3$ (with $S_\nu \propto \nu^\alpha$), that suggest that they may be optically-thick H II regions. However, one of the new sources exhibits significant circular polarization, indicating that gyrosynchrotron emission with large positive spectral indices may be an alternative explanation. Furthermore, we find that four other sources are associated with infrared sources of low bolometric luminosity that cannot drive an H II region. Finally, two of the sources previously detected at 3.6-cm are angularly resolved in the 1.3 cm image and their major axes have position angles that align well with large scale outflows emanating from OMC-1S. The radio source 143-353 has a major axis with a position angle consistent with those of the HH 202 and HH 528 flows, while the radio source 134-411 has a major axis with a position angle consistent with that of the low-velocity molecular outflow associated with the far-infrared source FIR 4.

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Abstracts of recently accepted major reviews

VLBI Water Maser Proper Motion Measurements in Star-Forming Regions

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We review some of the recent water maser proper motion measurements in star-forming regions performed through VLBI multi-epoch observations. These observations are starting to reveal exciting perspectives, providing the full kinematics of the gas within the outflows/circumstellar disks around YSOs at scales of AUs, discovering new phenomena (e.g., isotropic mass ejections, water maser "micro-structures" exhibiting remarkable coherent and well ordered spatio-kinematical behavior at AU scale), and opening new, puzzling questions related to the early stellar evolution.

Accepted by Ap&SS

ftp://ftp.ieec.fcr.es/ieec/astrofisica/torrelles/TPGAU.ps.gz

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, not reviews nor conference notes), *Dissertation Abstracts* (presenting abstracts of new Ph.D dissertations), *Meetings* (announcing meetings broadly of interest to the star formation and interstellar medium community), *New Books* (giving details of books relevant for the same community), *New Jobs* (advertising jobs specifically aimed towards persons within our specialty), and *Short Announcements* (where you can inform or request information from the community).

Latex macros for submitting abstracts and dissertation abstracts are appended to each issue of the newsletter.

The Star Formation Newsletter is available on the World Wide Web at http://www.ifa.hawaii.edu/~reipurth or at http://www.eso.org/gen-fac/pubs/starform/ .

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Dissertation Abstracts

Signatures of Planets in Circumstellar Debris Disks

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Ph.D dissertation directed by: Renu Malhotra

Ph.D degree awarded: June 2004

Main sequence stars are commonly surrounded by debris disks, composed of cold dust continuously replenished by a reservoir of undetected dust-producing planetesimals. In the outer Solar System, Kuiper Belt (KB) objects produce dust by mutual or interstellar grain collisions.

The orbital evolution of KB dust has been numerically modeled. Its equilibrium radial density distribution can be accurately estimated even though there are inherent uncertainties in the prediction of structure, owing to the chaotic dynamics of dust orbital evolution imposed by resonant gravitational perturbations of the planets. The particle size distribution of dust is greatly changed from the distribution at production, as a result of radiation forces and the perturbations of the planets. The contribution of KB dust to the population of interplanetary dust particles collected at Earth may be as low as a few percent.

Gravitational scattering by giant planets creates an outflow of large grains. We quantify the characteristics of this large-particle outflow in different planetary architectures, discuss its implications for exo-planetary debris disks, and for the interpretation of in-situ dust detection experiments in space probes traveling in the outer Solar System. These outflows may contribute to the clearing of circumstellar debris in planetary systems, affecting the particle size distribution of their local ISM.

In anticipation of future observations of unresolved debris disks with *Spitzer*, we are interested in studying how the structure carved by planets affects the shape of the disk's spectral energy distribution (SED), and consequently if the SED can be used to infer the presence of planets. We numerically calculate the equilibrium spatial density distributions and SEDs of dust disks originated by an outer belt of planetesimals (35–50 AU) in the presence of different planetary configurations, and for a representative sample of chemical compositions. The dynamical models are needed to estimate the enhancement of particles near the mean motion resonances with the planets, and to determine how many particles drift inside the planet's orbit. Based on the SEDs and predicted *Spitzer* colors we discuss what types of planetary systems can be distinguishable from one another.

We are pleased to announce IAU Symposium 231 on:

Astrochemistry throughout the Universe:
Recent Successes and Current Challenges

August 29 - September 2, 2005
Asilomar, California

http://asilomar.caltech.edu/

This meeting is the 5'th in a series of IAU Symposia on Astrochemistry, following the 1985 Goa, 1991 Brazil, 1996 Leiden and 1999 Korea symposia. The main goal of the meeting is to bring together observers, theoreticians, and experimentalists from different communities to discuss the many different aspects of our rapidly developing field. The Scientific Organizing Committee is formed by the IAU Working Group on Astrochemistry of IAU Commission 34/Division VI (Interstellar Medium), whereas the Local Organizing Committee is led by the California Institute for Technology.

Topics include:

- Molecules in diffuse clouds and pre-stellar cores
- Basic molecular processes: gas-phase and gas-grain interactions
- Physics and chemistry of star-forming regions: hot cores, shocks, PDRs
- Chemistry in protoplanetary disks
- Solar system connection: comets, meteorites, IDPs, atmospheres of exo-planets
- Extragalactic star formation: chemistry from high z to the present
- Special sessions on recent results

The meeting will take place at the Asilomar Conference Grounds near Monterey, at a beautiful stretch of Northern California Pacific Coast, providing a very stimulating and pleasant environment for the meeting. Please visit the Website at http://asilomar.caltech.edu/ to view many pictures of the surroundings and obtain more information on the meeting. Also, you can help us to reach a large interdisciplinary audience by distributing this annnouncement to other interested colleagues within or outside your institute.

We look forward to see many of you in Asilomar in 2005! Don't forget to bookmark the Website and note the dates in your agenda. The next announcement containing the list of invited speakers will be sent in September 2004.

On behalf of the SOC:	On behalf of the LOC:
Ewine van Dishoeck (chair) Eric Herbst (secretary)	Tom Phillips (chair)