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Abstracts of recently accepted papers

Observations and modeling of the inner disk region of T Tauri stars

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We present observations of four T Tauri stars using long baseline infrared interferometry from the Palomar Testbed Interferometer. The target sources, T Tau N, SU Aur, RY Tau and DR Tau, are all known to be surrounded by dusty circumstellar disks. The observations directly trace the inner regions (<1 AU) of the disk and can be used to constrain the physical properties of this material. For three of the sources observed, the infrared emission is clearly resolved. We first use geometric models to characterize the emission region size, which ranges from 0.04 to 0.3 AU in radius. We then use Monte Carlo radiation transfer models of accretion disks to jointly model the spectral energy distribution and the interferometric observations with disk models including accretion and scattering. With these models, we are able to reproduce the data set with extended emission arising from structures larger than 10 milliarcseconds contributing less than 6% of the K band emission, consistent with there being little or no envelope remaining for these Class II sources ($d\log(\lambda F_\lambda)/d\log\lambda \approx$ -2 to 0 in the infrared). The radiation transfer models have inner radii for the dust similar to the geometric models; however, for RY Tau emission from gas within the inner dust radius contributes significantly to the model flux and visibility at infrared wavelengths. The main conclusion of our modeling is that emission from inner gas disks (between the magnetic truncation radius and the dust destruction radius) can be a significant component in the inner disk flux for sources with large inner dust radii.

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Preprint available at http://spider.ipac.caltech.edu/staff/rla/ApJ2005.pdf

Collapse and Fragmentation of Molecular Cloud Cores. VIII. Magnetically-Supported Infinite Sheets

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The collapse and fragmentation of initially sheet-like, magnetic molecular clouds is calculated in three dimensions with a gravitational, radiative hydrodynamics code. The code includes a crude representation of magnetic field effects and ambipolar diffusion, through the magnetic pressure and magnetic tension approximations, and a simple parameterization based on previous magnetohydrodynamical calculations, respectively. The computational volume is a spherical portion of an initially isothermal, infinite sheet of self-gravitating gas, symmetric about its midplane, with the portion of the cloud exterior to the spherical volume being represented through its effect on the gravitational

potential inside the spherical volume. The gas layer is initially in hydrostatic equilibrium, but with a mass equal to or greater than the critical mass ($\sim 1 M_\odot$) for the growth of gravitational instability. The magnetic field pressure acts to further stabilize the initial cloud. Over 10^6 active grid points are employed in the models, sufficient to resolve the Jeans length and so avoid artificial fragmentation. The parameters varied are the ratio of the ambipolar diffusion time to the midplane free fall time (10 or 20), the cloud's reference magnetic field strength (100 or 200 microgauss, corresponding to initially magnetically supercritical or subcritical clouds, respectively), the ratio of rotational to gravitational energy of the sheet (0.0 or 0.01), and the form of the initial density perturbation applied to the infinite sheet. Three types of outcomes are observed: formation of one or two protostars near the edge of the spherical volume, formation of a protostar near (but not at) the center of the cloud, or formation of a rotating ring near the center of the cloud, which appears likely to fragment into two or more protostars. Flow speeds of ~ 0.1 km s^{-1} are generated as the sheet begins to break-up into collapsing protostars. The forming protostars are separated by distances approximately equal to the cloud diameter, consistent with the spacing predicted by the linear theory of the gravitational stability of an infinite sheet.

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Preprint available at http://www.ciw.edu/boss/ftp/coresviii

Star formation in RCW 108: triggered or spontaneous?

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We present visible, near infrared, and mm-wave observations of RCW 108, a molecular cloud complex in the Ara OB1 association that is being eroded by the energetic radiation of two O-type stars in the nearby cluster NGC 6193. The western part of the RCW108 molecular cloud, for which we derive a mass of $\sim$ 8000 M$_\odot$, contains an embedded compact HII region, IRAS 16362-4845, ionized by an aggregate of early-type stars for which we estimate a mass of $\sim$ 210 M$_\odot$. The spectral type of the earliest star is O9, as confirmed by the visible spectrum of the compact HII region. We notice a lack of stars later than A0 in the aggregate, at least having the moderate reddenings that are common among its B-type stars, and we speculate that this might be a consequence of the extreme youth of the aggregate. We also note the existence of a dense ionized clump ($n > 10^4$ cm^{-3}) appearing near the main ionizing star of the compact HII region. We examine the distribution of stars displaying infrared excesses projected across the molecular cloud. While many of them are located in the densest ($n \sim 10^{4-5}$ cm^{-3}) area of the molecular cloud near the position of IRAS 16362-4845, we also find a group concentrating towards the edge of the cloud that faces NGC 6193, as well as some other stars beyond the edge of the molecular cloud. The intense ionizing radiation field by the O stars in NGC 6193 is a clear candidate trigger of star formation in the molecular cloud, and we suggest that the existence and arrangement of stars in this region of the molecular cloud supports a scenario in which their formation may be a consequence of this. However, infrared excess stars are also present in some areas of the opposite side of the cloud, where no obvious candidate external trigger is identified. The existence of such tracers of recent star formation scattered across the more massive molecular cloud associated with IRAS 16362-4845, and the low star formation efficiency that we derive, indicate that it is in a state to still form stars. This is in contrast to the less massive cloud ($\sim$ 660 M$_\odot$) close to NGC 6193, which seems to be more evolved and mostly already recycled into stars, and whose internal kinematics show hints of having been perturbed by the presence of the massive stars formed out of it.

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`http://www.eso.org/~fcomeron/rcw108.ps.gz`

The dependence of protoplanet migration rates on coorbital torques

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We investigate the migration rates of high-mass protoplanets embedded in accretion discs via two and three-dimensional hydrodynamical simulations. The simulations follow the planet's radial motion and employ a nested-grid code that allows for high resolution close to the planet. We concentrate on the possible role of the coorbital torques in affecting migration rates. We analyse two cases: (a) a Jupiter-mass planet in a low-mass disc and (b) a Saturn-mass planet in a high-mass disc. The gap in case (a) is much cleaner than in case (b). Planet migration in case (b) is much more susceptible to coorbital torques than in case (a). We find that the coorbital torques in both cases do not depend sensitively on whether the planet is allowed to migrate through the disc or is held on a fixed orbit. We also examine the dependence of the planet's migration rate on the numerical resolution near the planet. For case (a), numerical convergence is relatively easy to obtain, even when including torques arising from deep within the planet's Hill sphere, since the gas mass contained within the Hill sphere is much less than the planet's mass. The migration rate in this case is numerically on order of the Type II migration rate and much smaller than the Type I rate, if the disc has 0.01 solar-masses inside 26 AU. Torques from within the Hill sphere provide a substantial opposing contribution to the migration rate. In case (b), the gas mass within the Hill sphere is larger than the planet's mass and convergence is more difficult to obtain. Torques arising from within the Hill sphere are strong, but nearly cancel. Any inaccuracies in the calculation of the torques introduced by grid discretization can introduce spurious torques. If the torques within the Hill sphere are ignored, convergence is more easily achieved but the migration rate is artificially large. At our highest resolution, the migration rate for case (b) is much less than the Type I rate, but somewhat larger than the Type II rate.

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The paper is available as an Astro-ph preprint at
`http://arxiv.org/abs/astro-ph/0411705`

Dust coagulation in protoplanetary disks: a rapid depletion of small grains

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We model the process of dust coagulation in protoplanetary disks and calculate how it affects their observational appearance. Our model involves the detailed solution of the coagulation equation at every location in the disk. At regular time intervals we feed the resulting 3-D dust distribution functions into a continuum radiative transfer code to obtain spectral energy distributions. We find that, even if only the very basic – and well understood – coagulation mechanisms are included, the process of grain growth is much too quick to be consistent with infrared observations of T Tauri disks. Small grains are removed so efficiently that, long before the disk reaches an age of 10^6 years typical of T Tauri stars, the SED shows only very weak infrared excess. This is inconsistent with observed SEDs of most classical T Tauri stars. Small grains somehow need to be replenished, for instance by aggregate fragmentation through high-speed collisions. A very simplified calculation shows that when aggregate fragmentation is included, a quasi-stationary grain size distribution is obtained in which growth and fragmentation are in equilibrium. This quasi-stationary state may last 10^6 years or even longer, dependent on the circumstances in the disk, and may bring the time scales into the right regime. If this is indeed the case, or if other processes are responsible for the replenishment of small grains, then the typical grain sizes inferred from infrared spectral features of T Tauri disks do not necessarily reflect the age of the system (small grains → young, larger grains → older), as is often proposed. Indeed, there is evidence reported in the literature that the typical inferred grain sizes do not correlate with the age of the star. Instead, it is more likely that the typical grain sizes found in T Tauri star (and Herbig Ae/Be star and Brown Dwarf) disks reflect the state of the disk in some more complicated way, e.g. the strength of the turbulence, the amount of dust mass transformed into planetesimals, the amount of gas lost via evaporation etc. A simple evolutionary scenario in which grains slowly grow

from pristine 0.1μm grains to larger grains over a period of a few Myr is most likely incorrect.

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A Hybrid Scenario for Gas Giant Planet Formation in Rings

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The core-accretion mechanism for gas giant formation may be too slow to create all observed gas giant planets during reasonable gas disk lifetimes, but it has yet to be firmly established that the disk instability model can produce permanent bound gaseous protoplanets under realistic conditions. Based on our recent simulations of gravitational instabilities in disks around young stars, we suggest that, even if instabilities due to disk self-gravity do not produce gaseous protoplanets directly, they may create persistent dense rings that are conducive to accelerated growth of gas giants through core accretion. The rings occur at and near the boundary between stable and unstable regions of the disk and appear to be produced by resonances with discrete spiral modes on the unstable side.

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http://arxiv.org/abs/astro-ph/0312611
http://westworld.astro.indiana.edu/Publications/dcmp04.pdf

Extended emission associated with young HII regions

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We have used the Australia Telescope Compact Array (ATCA) to make observations of a sample of eight young ultra-compact HII regions, selected on the basis that they have associated class II methanol maser emission. We have made observations sensitive to both compact and extended structures and find both to be present in most sources. The scale of the extended emission in our sample is in general less than that observed towards samples based on *IRAS* properties, or large single-dish flux densities. Our observations are consistent with a scenario where extended and compact radio continuum emission coexists within HII regions for a significant period of time.

We suggest that these observations are consistent with a model where HII evolution takes place within hierarchically structured molecular clouds. This model is the subject of a companion paper (Shabala et al. 2005) and addresses both the association between compact and extended emission and UCHII region lifetime problem.

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The Stellar Content of Obscured Galactic Giant HII Regions V: G333.1–0.4

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We present high angular resolution near–infrared images of the obscured Galactic Giant HII (GHII) region G333.1–0.4 in which we detect an OB star cluster. For G333.1–0.4, we find OB stars and other massive objects in very early evolutionary stages, possibly still accreting. We obtained K–band spectra of three stars; two show O type photospheric features, while the third has no photospheric features but does show CO 2.3 μm band–head emission. This object is at least as hot as an early B type star based on its intrinsic luminosity and is surrounded by a circumstellar disc/envelope which produces near infrared excess emission. A number of other relatively bright cluster members also display excess emission in the K–band, indicative of disks/envelopes around young massive stars. Based upon the O star photometry and spectroscopy, the distance to the cluster is 2.6 ± 0.4 kpc, similar to a recently derived kinematic (near side) value. The slope of the K–band luminosity function is similar to those found in other young clusters. The mass function slope is more uncertain, and we find $-1.3 \pm 0.2 < \Gamma < -1.1 \pm 0.2$- for stars with M > 5 $M_{\odot}$ where the upper an lower limits are calculated independently for different assumptions regarding the excess emission of the individual massive stars. The number of Lyman continuum photons derived from the contribution of all massive stars in the cluster is $0.2 \times 10^{50}\ s^{-1} < NLyc < 1.9 \times 10^{50}\ s^{-1}$. The integrated cluster mass is $1.0 \times 10^{3}\ M_{\odot} < M_{cluster} < 1.3 \times 10^{3}\ M_{\odot}$.

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Search for massive protostellar candidates in the southern hemisphere: I. Association with dense gas

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We have observed two rotational transitions of both CS and $C^{17}O$, and the 1.2 mm continuum emission towards a sample of 130 high-mass protostellar candidates with $\delta < -30°$. This work represents the first step of the extension to the southern hemisphere of a project started more than a decade ago aimed at the identification of massive protostellar candidates. Following the same approach adopted for sources with $\delta \geq -30°$, we have selected from the IRAS Point Source Catalogue 429 sources which potentially are compact molecular clouds on the basis of their IR colours. The sample has then been divided into two groups according to the colour indices [25−12] and [60−12]: the 298 sources with [25−12]≥0.57 and [60−12]≥1.30 have been called *High* sources, the remaining 131 have been called *Low* sources. In this paper, we check the association with dense gas and dust in 130 *Low* sources. We have obtained a detection rate of $\sim$ 85% in CS, demonstrating a tight association of the sources with dense molecular clumps. Among the sources detected in CS, $\sim$ 76% have also been detected in $C^{17}O$ and $\sim$ 93% in the 1.2 mm continuum. Millimeter-continuum maps show the presence of clumps with diameters in the range $0.2 - 2$ pc and masses from a few $M_{\odot}$ to $10^5 M_{\odot}$; H_2 volume densities computed from CS line ratios lie between $\sim 10^{4.5}$ and $10^{5.5}$ cm^{-3}. The bolometric luminosities of the sources, derived from IRAS data, are in the range $10^3 - 10^6\ L_{\odot}$, consistent with embedded high-mass objects. Based on our results and those found in the literature for other samples of high-mass young stellar objects, we conclude that our sources are massive objects in a very early evolutionary stage, probably prior to the formation of an HII region. We propose a scenario in which *High* and *Low* sources are both made of a massive clump hosting a high-mass protostellar candidate and a nearby stellar cluster. The difference might be due to the fact that the 12 μm IRAS flux, the best discriminant between the two groups, is dominated by the emission from the cluster in *Lows* and from the massive protostellar object in *Highs*.

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http://www.arcetri.astro.it/~starform/preprints/fontani_4.ps.gz

Star formation in globules in IC 1396

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We present a large-scale study of the IC 1396 region using new deep NIR and optical images, complemented by 2MASS data. For ten globules in IC 1396 we determine (H-K, J-H) colour-colour diagrams and identify the young stellar population. Five of these globules contain a rich population of reddened objects, most of them probably young stellar objects. Two new HH objects (HH 865 and HH 864) could be identified by means of [SII] emission, one of them a parsec-scale flow. Using star counts based on 2MASS data we create an extinction map of the whole region. This map is used to identify 25 globules and to estimate their mass. The globule masses show a significant increase with the distance from the exciting O6.5V star HD 206267. We explain this correlation by the enhanced radiation pressure close to this star, leading to evaporation of the nearby clouds and hence smaller globule masses. We see evidence that the radiation from HD 206267 has a major impact on the star formation activity in these globules.

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Chemical evolution in the environment of intermediate mass young stellar objects: NGC 7129 – FIRS 2 and LkHα 234

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We have carried out a molecular survey of the Class 0 IM protostar NGC 7129 – FIRS 2 (hereafter FIRS 2) and the Herbig Be star LkHα 234 with the aim of studying the chemical evolution of the envelopes of intermediate-mass (IM) young stellar objects (YSOs). The two objects have similar luminosities (∼500 $L_\odot$) and are located in the same molecular cloud which minimizes the chemical differences due to different stellar masses or initial cloud conditions. Moreover, since they are located at the same distance, we have the same spatial resolution in both objects. A total of 17 molecular species (including rare isotopes) have been observed in both objects and the structure of their envelopes and outflows has been determined with unprecedent detail.

Our results show that the protostellar envelopes are dispersed and warmed up during the evolution of the YSO into a pre-main sequence star. In fact, the envelope mass decreases by a factor >5 from FIRS 2 to LkHα 234, while the kinetic temperature increases from ∼13 K to 28 K. On the other hand, there is no molecular outflow associated with LkHα 234. The molecular outflow seems to stop before the star becomes visible.

These physical changes strongly affect the chemistry of their envelopes. The N_2H^+ and NH_3 abundances seem to be quite similar in the two objects. However, the $H^{13}CO^+$ abundance is a factor of ∼3 lower in the densest part of FIRS 2 than in LkHα 234, very likely because of depletion. In contrast, the SiO abundance is larger by a factor of ∼100 in FIRS 2 than in LkHα 234. CS presents complex behavior since its emission arises in different envelope components (outflow, cold envelope, hot core) and could also suffer from depletion. The CH_3OH and H_2CO column densities are very similar in FIRS 2 and LkHα 234 which implies that the beam-averaged abundances are a factor >5 larger in LkHα 234 than in FIRS 2. The same is found for the PDR tracers CN and HCN which have similar column densities in both objects. Finally, complex behavior is found for the deuterated compounds. While the $DCO^+/H^{13}CO^+$ ratio decreases by a factor of ∼4 from FIRS 2 to LkHα 234, the D_2CO/H_2CO ratios is within a factor 1.5 in both objects. The detection of a warm CH_3CN component with T_k>63 K shows the existence of a hot core in FIRS 2. Thus far, only a handful of hot cores have been detected in low and intermediate mass stars.

Based on our results in FIRS 2 and LkHα 234, we propose some abundance ratios that can be used as chemical clocks for the envelopes of IM YSOs. The SiO/CS, CN/N_2H^+, HCN/N_2H^+, DCO^+/HCO^+ and D_2CO/DCO^+ ratios are good diagnostics of the protostellar evolutionary stage.

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H^+ + H Scattering and Ambipolar Diffusion Heating

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We report new and highly accurate quantum mechanical calculations of the astrophysically interesting scattering of H^+ by H atoms. The effects of the quantum indistinguishability of the two protons are treated consistently throughout, including the calculation of the momentum transfer cross section where elastic scattering and charge transfer cannot be separated at low energies. We are able to resolve the numerous oscillations in the energy variation of the angle-integrated cross sections. With decreasing energy below 1 eV, the oscillations grow in amplitude until a smooth approximately $1/v^2$ dependence on velocity is reached below 10^{-5} eV. The $1/v$ behavior, traditionally associated with a constant Langevin rate coefficient, is never realized down to the lowest energy calculated (10^{-10} eV). We use the momentum-transfer cross section to calculate accurately the transport rate-coefficient that characterizes the drag force between ionic and neutral fluids and the strength of ambipolar diffusion heating for temperatures and ion-neutral drift speeds relevant for astrophysical applications. An early fit of this rate coefficient by Draine (1980) is sustained except at low energies. The application of these results to the role of ambipolar diffusion in heating jets from young stellar objects is discussed.

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Evolution of HII Regions inside Hot Molecular Cores

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We study the evolution of HII regions inside accreting hot molecular cores (HMCs). The HII regions are being pushed by a strong stellar wind from a massive young star at the center. We consider a range of pressures characteristic of HMCs. We find that thermal conductivity reduces to a thin shell the bubble of hot shocked stellar wind so that the expansion of the HII region is driven by the momentum of the stellar wind. The HII region can expand beyond the boundary of the HMC at $\sim$ 0.1 pc, in $t \lesssim 5 \times 10^4$ yr. Just before reaching the HMC boundary, it has equatorial emission measures $EM_{eq} \sim 3 \times 10^7\,\mathrm{cm}^{-6}$ pc, characteristic of ultracompact HII regions. In fact, these ionized regions will evolve from hypercompact to ultracompact HII regions as they expand inside the HMC. We also study the effect of the magnitude of the thermal conductivity coefficient on the evolution of the shocked stellar wind shell and calculate its hard X ray emission. Due to the oscillating cooling instability of the shell, the X ray emission is variable. This work addresses the birth and evolution of HII regions inside the HMCs where massive stars are born.

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The Disk Atmospheres of Three Herbig Ae/Be Stars

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We present infrared (IR) spectrophotometry ($R \simeq 180$) of three Herbig Ae/Be stars surrounded by possible protoplanetary disks: HD 150193, HD100546 and HD 179218. We construct a mid-IR spectral energy distributions (SED) for each object by using 7.6 – 13.2 μm HIFOGS spectra, 2.4 – 45 μm spectrophotometry from the *ISO* SWS, the 12, 25, 60, and 100 μm photometric points from IRAS, and for HD 179218, photometric bolometric data points from the Mt.

Lemmon Observing Facility. The SEDs are modeled by using an expanded version of the chigol97 two-layer, radiative and hydrostatic equilibrium, passive disk. This expanded version includes the emission from Mg-pure crystalline olivine (forsterite) grains in the disk surface layer. Each of the three objects studied vary in the amount of crystals evident from their spectrophotometry. HD 150193 contains no crystals while HD 100546 and HD 179218 respectively show evidence of having crystalline silicates in the surface layers of their disks. We find that the inner region of HD100546 has a 37% higher crystalline-to-amorphous silicate ratio in its inner disk region ($\leq$ 5 AU) compared to the outer disk region, while the inner disk region of HD 179218 has a 84% higher crystalline-to-amorphous silicate ratio in its inner disk region ($\leq$ 5 AU) compared to the outer region. All three objects are best-fit using a grain size distribution power law which falls as $a^{-3.5}$. HD 150193 is best-fit by a small disk ($\sim$ 5 AU in radius) while HD 100546 and HD 179218 are best fit by larger disks ($\sim$ 150 AU in radius). Furthermore, HD 100546's disk flares larger than compared to HD 150193 (25% more at 5 AU) and HD 179218 (80% more at 5 AU). We discuss the implications of our results and compare them with other modeling efforts.

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An S-shaped outflow from IRAS 03256+3055 in NGC 1333

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The IRAS source 03256+3055 in the NGC 1333 star forming region is associated with extended sub-millimeter emission of complex morphology, showing multiple clumps. One of these is found to coincide with the driving source of a bipolar jet of S-shaped morphology seen in the emission lines of Hα and [SII] as well as in the H_2 emission lines in the *K*-band. Detailed images of the driving source at the wavelengths of Hα and [SII] and in the *I*, *J*, *H*, and *K*-bands as well as a *K*-band spectrum and polarimetry are discussed. The near-infrared morphology is characterized by a combination of line emission from the jet and scattered light from a source with a steep continuum spectrum. The morphology and proper motion of the jet are discussed in the context of a binary system with a precessing disk. We conclude that the molecular core associated with IRAS 03256+3055 consists of several clumps, only one of which shows evidence of recent star formation at optical and near-infrared wavelengths. We also briefly discuss a second, newly found near-infrared source associated with a compact sub-millimeter continuum source near IRAS 03256+3055, and conclude that this source may be physically unrelated the cluster of molecular clumps.

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8–13 μm spectroscopy of YSOs: Evolution of the silicate feature

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Silicate features arising from material around pre-main sequence stars are useful probes of the star and planet formation process. In order to investigate possible connections between dust processing and disk properties, 8–13 μm spectra of 34 young stars, exhibiting a range of circumstellar environments and including spectral types A to M, were obtained using the Long Wavelength Spectrometer at the W. M. Keck Observatory. The broad 9.7 μm amorphous silicate (Si-O

stretching) feature which dominates this wavelength regime evolves from absorption in young, embedded sources, to emission in optically revealed stars, and to complete absence in older "debris" disk systems for both low- and intermediate-mass stars. This is similar to the evolutionary pattern seen in ISO observations of high/intermediate-mass YSOs. The peak wavelength and FWHM are centered about 9.7 μm and $\sim$2.3 μm, respectively, corresponding to amorphous olivine, with a larger spread in FWHM for embedded sources and in peak wavelength for disks. In a few of our objects that have been previously identified as class I low-mass YSOs, the observed silicate feature is more complex, with absorption near 9.5 μm and emission peaking around 10 μm. Although most of the emission spectra show broad classical features attributed to amorphous silicates, small variations in the shape/strength may be linked to dust processing, including grain growth and/or silicate crystallization. For some of the Herbig Ae stars in the sample, the broad emission feature has an additional bump near 11.3 μm, similar to the emission from crystalline forsterite seen in comets and the debris disk β Pictoris. Only one of the low-mass stars, Hen 3-600A, and one Herbig Ae star, HD 179218 clearly show strong, narrow emission near 11.3 μm. We study quantitatively the evidence for evolutionary trends in the 8–13 μm spectra through a variety of spectral shape diagnostics. Based on the lack of correlation between these diagnostics and broad-band infrared luminosity characteristics for silicate emission sources we conclude that although spectral signatures of dust processing are present, they can not be connected clearly to disk evolutionary stage (for optically thick disks) or optical depth (for optically thin disks). The diagnostics of silicate absorption features (other than the central wavelength of the feature), however, are tightly correlated with optical depth and thus do not probe silicate grain properties.

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How Protostellar Outflows Help Massive Stars Form

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We consider the effects of an outflow on radiation escaping from the infalling envelope around a massive protostar. Using numerical radiative transfer calculations, we show that outflows with properties comparable to those observed around massive stars lead to significant anisotropy in the stellar radiation field, which greatly reduces the radiation pressure experienced by gas in the infalling envelope. This means that radiation pressure is a much less significant barrier to massive star formation than has previously been thought.

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Discovery of multi-seeded multi-mode formation of embedded clusters in the Rosette Molecular Complex

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An investigation based on data from the spatially complete 2MASS Survey reveals that a remarkable burst of clustered star formation is taking place throughout the south-east quadrant of the Rosette Molecular Cloud. Compact clusters are forming in a multi-seeded mode, in parallel and at various places. In addition, sparse aggregates of embedded young stars are extensively distributed. In this study, we report the primary results and implications for high-mass and clustered star formation in giant molecular clouds. In particular, we incorporate for the first time the birth of medium to low-mass stars into the scenario of sequential formation of OB clusters. Following the emergence of the young OB cluster NGC 2244, a variety of manifestations of forming clusters of medium to high mass appear in the vicinity of the swept-up layer of the HII region as well as further into the molecular cloud. The embedded clusters

appear to form in a structured manner, which suggests they follow tracks laid out by the decay of macroturbulence. We address the possible origins of the turbulence. This leads us to propose a tree model to interpret the neat spatial distribution of clusters within a large section of the Rosette complex. Prominent new generation OB clusters are identified at the root of the tree pattern.

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3-D Kinematics of the HH 110 jet

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We present new results on the kinematics of the jet HH 110. New proper motion measurements have been calculated from [SII] CCD images obtained with a time baseline of nearly fifteen years. HH 110 proper motions show a strong asymmetry with respect to the outflow axis, with a general trend of pointing towards the west of the axis direction. Spatial velocities have been obtained by combining the proper motions and radial velocities from Fabry-Pérot data. Velocities decrease by a factor ~ 3 over a distance of $\sim 10^{18}$ cm, much shorter than the distances expected for the braking caused by the jet/environment interaction. Our results show evidence of an anomalously strong interaction between the outflow and the surrounding environment, and are compatible with the scenario in which HH 110 emerges from a deflection in a jet/cloud collision.

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http://www.am.ub.es/∼robert/ISMpub.html

Adaptive Optics Imaging of the AU Microscopii Circumstellar Disk: Evidence for Dynamical Evolution

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We present an H-band image of the light scattered from circumstellar dust around the nearby (10 pc) young M star AU Microscopii (AU Mic, GJ 803, HD 197481), obtained with the Keck adaptive optics system. We resolve the disk both vertically and radially, tracing it over 17–60 AU from the star. Our AU Mic observations thus offer the possibility to probe at high spatial resolution (0.04 arcsec or 0.4 AU per resolution element) for morphological signatures of the debris disk on Solar-System scales. Various sub-structures (dust clumps and gaps) in the AU Mic disk may point to the existence of orbiting planets. No planets are seen in our H-band image down to a limiting mass of 1 $M_{\rm Jup}$ at >20 AU, although the existence of smaller planets can not be excluded from the current data. Modeling of the disk surface brightness distribution at H-band and R-band, in conjunction with the optical to sub-millimeter spectral energy distribution, allows us to constrain the disk geometry and the dust grain properties. We confirm the nearly edge-on orientation of the disk inferred from previous observations, and deduce an inner clearing radius ≤10 AU. We find evidence for a lack of small grains in the inner (<60 AU) disk, either as a result of primordial disk evolution, or because of destruction by Poynting-Robertson and/or corpuscular drag. A change in the power-law index of the surface brightness profile is observed near 33 AU, similar to a feature known in the profile of the β Pic circumstellar debris disk. By comparing the time scales for inter-particle collisions and Poynting-Robertson drag between the two

systems, we argue that the breaks are linked to one of these two processes.

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The prestellar and protostellar population of R Coronae Australis

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We present 450 and 850 μm maps of R Coronae Australis. We compare the maps to previous surveys of the region, and shed new light on the previously unknown nature of the protostellar sources at the centre of the cloud. We clarify the nature of two millimetre sources previously discovered in lower resolution data. We identify one new Class 0 protostar that we label SMM 1B, and we measure the envelope masses of a number of more evolved protostars. We identify two new prestellar cores that we call SMM 1A and SMM 6.

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The prominent dust emission feature near 8.9 μm in four HII regions

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We present a mid-infrared study of four HII regions based on the combination of ISO-SWS observations with spatial information from SpectroCam10 images and long-slit spectra. We report a prominent broad emission feature near 8.9 μm. The peak position and width of this feature does not resemble known PAH or dust emission features. Its spatial distribution is analyzed for two HII regions and is clearly distinct from that of the PAH emission features, being more similar to that of the ionized gas and especially to the spatial distribution of the dust continuum at 15 μm. Thus, the carrier of this band likely resides within the HII region. Possible carriers of this feature are highlighted.

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Ices in the edge-on disk CRBR 2422.8-3423: Spitzer spectroscopy and Monte Carlo radiative transfer modeling

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We present 5.2-37.2 μm spectroscopy of the edge-on circumstellar disk CRBR 2422.8-3423 obtained using the InfraRed Spectrograph (IRS) of the Spitzer Space Telescope. The IRS spectrum is combined with ground-based 3-5 μm spectroscopy to obtain a complete inventory of solid state material present along the line of sight toward the source. Archival JHK_s imaging as well as 350 μm CSO mapping, 850 μm SCUBA mapping and 3 mm OVRO interferometry is used to obtain a set of spectro-photometric data covering 1.2–3000 μm. The ices observed toward CRBR 2422.8-3423 are compared to archival ISOCAM-CVF 5-16 μm ice spectra of other nearby sources within 2 arcminutes. We model the object with a 2D axisymmetric (effectively 3D) Monte Carlo radiative transfer code using all the available observations to constrain the source geometry and dust composition. In particular, the location of the observed ices in the disk and envelope material is included in the model. It is found that the model disk, assuming a standard flaring structure, is too warm to contain the very large observed column density of pure CO ice, but is possibly responsible for up to 50% of the water, CO_2 and minor ice species. In particular the 6.85 μm band, tentatively due to NH_4^+, exhibits a prominent red wing, indicating a significant contribution from warm ice in the disk. The shape of the CO_2 bending mode suggests an interaction with up to 20% of the CO ice. It is argued that the pure CO ice is located in the dense core Oph-F in front of the source seen in the submillimeter imaging, with the CO gas in the core highly depleted. Up to 50% of the CO ice embedded in water or CO_2 ice (no more than 20% of the total amount of CO) may still be located in the disk, assuming constant abundances of these types of CO ice throughout the system. Discrepancies among the strength of different water ice bands are discussed. Specifically, the observed water ice libration band located at 11–13 μm is significantly weaker than that of the model. The model is used to predict which circumstances are most favourable for direct observations of ices in edge-on circumstellar disks. Ice bands will in general be deepest for inclinations similar to the disk opening angle, i.e. $\sim 70^\circ$, except for very tenuous disks. Due to the high optical depths of typical disk mid-planes, ice absorption bands will often probe warmer ice located in the upper layers of nearly edge-on disks. The ratios between different ice bands are found to vary by up to an order of magnitude depending on disk inclination due to radiative transfer effects caused by the 2D structure of the disk. Ratios between ice bands of the same species can therefore be used to constrain the location of the ices in a circumstellar disk.

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On the linear analysis of unstable radiative shocks

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We study the stability properties of strong hydrodynamic shocks and their associated radiative cooling layers. We explore a range of conditions which covers both molecular and atomic gas impacting against a rigid wall. Through a linear analysis employing a cooling function of the form $\Lambda \propto \rho^\beta T^\alpha$ and a specific heat ratio of γ, we determine the overstability regime in the parameter space consisting of α, β and γ. In general, if α is sufficiently low, the fundamental mode leads to long wavelength growing oscillations. For the fundamental mode, we find that values of γ corresponding to molecular hydrodynamics lead to a significantly restricted instability range for α in comparison to the shocks in a monatomic medium. The conditions for the growth of higher order modes, however, are relatively unchanged. This predicts that certain molecular shocks are prone to display signatures of small-scale rapid variability. Dissociative shocks, however, can be subject to a large-scale overstability if subsequent molecule formation in the cooling layer abruptly increases the cooling rate. In contrast to the dynamical rippling overstability, the cooling overstability is suppressed for a sufficiently low specific heat ratio.

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Discovery of CO gas in the inner disk of TW Hydrae

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We report the detection of ro-vibrationally excited CO emission from the inner disk of the classical T Tauri star (cTTS) TW Hya. We observe $\approx 6 \times 10^{21}$grams of CO gas with a rotational temperature of 430 $\pm$ 40 K. The linearity of the excitation plot suggests that the CO is optically thin. Atypical for cTTSs, hot CO was not detected, implying that TW Hya has cleared its inner disk region out to a radial distance of ≈ 0.5 AU. We discuss implications for the structure of the disk as it relates to replenishment and planet formation.

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Protostars and Outflows in the NGC 7538 - IRS 9 Cloud Core

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New high resolution observations of HCO^+ J=1→0, $H^{13}CN$ J=1→0, SO $2_2 \rightarrow 1_1$, and continuum with BIMA at 3.4 mm show that the NGC 7538 - IRS 9 cloud core is a site of active ongoing star formation. Our observations reveal at least three young bipolar molecular outflows, all $\sim$ 10,000 − 20,000 years old. IRS 9 drives a bipolar, extreme high velocity outflow observed nearly pole on. South of IRS 9 we find a cold, protostellar condensation with a size of $\sim 14'' \times 6''$ with a mass > 250 M$_\odot$. This is the center of one of the outflows and shows deep, red-shifted self absorption in HCO^+, suggesting that there is a protostar embedded in the core, still in a phase of active accretion. This source is not detected in the far infrared, suggesting that the luminosity $< 10^4$ L$_\odot$; yet the mass of the outflow is ~ 60 M$_\odot$. The red-shifted HCO^+ self-absorption profiles observed toward the southern protostar and IRS 9 predict accretion rates of a few times 10^{-4} to 10^{-3} M$_\odot$ yr^{-1}. Deep VLA continuum observations at 3.6 cm show that IRS 9 coincides with a faint thermal VLA source, but no other young star in the IRS 9 region has any detectable free-free emission at a level of ~ 60 μJy at 3.6 cm. The HCO^+ abundance is significantly enhanced in the hot IRS 9 outflow. A direct comparison of mass estimates from HCO^+ and CO for the well-characterized red-shifted IRS 9 outflow predicts an HCO^+ enhancement of more than a factor of 30, or $[HCO^+/H_2] \geq 6\ 10^{-8}$.

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An atomic and molecular database for analysis of submillimetre line observations

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Atomic and molecular data for the transitions of a number of astrophysically interesting species are summarized, including energy levels, statistical weights, Einstein *A*-coefficients and collisional rate coefficients. Available collisional data from quantum chemical calculations and experiments are extrapolated to higher energies (up to $E/k \sim 1000$ K). These data, which are made publically available through the WWW at `http://www.strw.leidenuniv.nl/~moldata`, are essential input for non-LTE line radiative transfer programs. An online version of a computer program for performing statistical equilibrium calculations is also made available as part of the database. Comparisons of calculated emission lines using different sets of collisional rate coefficients are presented. This database should form an important tool in analyzing observations from current and future (sub)millimetre and infrared telescopes.

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www.astro.su.se/~fredrik/papers.html (astro-ph/0411110)

Millimeter observations and modeling of the AB Aurigae system

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We present the results of millimeter observations and a suitable chemical and radiative transfer model of the AB Aurigae (HD 31293) circumstellar disk and surrounding envelope. The integral molecular content of this system is studied by observing CO, $C^{18}O$, CS, HCO^+, DCO^+, H_2CO, HCN, HNC, and SiO rotational lines with the IRAM 30-m antenna, while the disk is mapped in the HCO^+(1-0) transition with the Plateau de Bure interferometer. Using a flared disk model with a vertical temperature gradient and an isothermal spherical envelope model with a shadowed midplane and two unshielded cones together with a gas-grain chemical network, time-dependent abundances of observationally important molecules are calculated. Then a 2D non-LTE line radiative transfer code is applied to compute excitation temperatures of several rotational transitions of HCO^+, CO, $C^{18}O$, and CS molecules. We synthesize the HCO^+(1-0) interferometric map along with single-dish CO(2-1), $C^{18}O$(2-1), HCO^+(1-0), HCO^+(3-2), CS(2-1), and CS(5-4) spectra and compared them with the observations. Our disk model successfully reproduces observed interferometric HCO^+(1-0) data, thereby constraining the following disk properties: (1) the inclination angle $\iota = 17^{+6}_{-3} degr$, (2) the position angle $\phi = 80 \pm 30 degr$, (3) the size $R_{\rm out} = 400 \pm 200$ AU, (4) the mass $M_{\rm disk} = 1.3 \cdot 10^{-2}\, M_\odot$ (with a factor of ~ 7 uncertainty), and (5) that the disk is in Keplerian rotation. Furthermore, indirect evidence for a local inhomogeneity of the envelope at 600 AU is found. The single-dish spectra are synthesized for three different cases, namely, for the disk model, for the envelope model, and for their combination. An overall reasonable agreement between all modeled and acquired line intensities, widths, and profiles is achieved for the latter model, with the exception of the CS(5-4) data that require presence of high density clumpy structures in the model. This allows to constrain the physical structure of the AB Aur inner envelope: (1) its mass-average temperature is about 35 ± 14 K, (2) the density goes inversely down with the radius, $\rho \propto r^{-1.0\pm0.3}$, starting from an initial value $n_0 \approx 3.9 \cdot 10^5$ cm^{-3} at 400 AU, and (3) the mass of the shielded region within 2 200 AU is about $4 \cdot 10^{-3}\, M_\odot$ (the latter two quantities are uncertain by a factor of ~ 7). Also, evolutionary nature and lifetime for dispersal of the AB Aur system and Herbig Ae/Be systems in general are discussed.

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Discovery of Two Very Low-Mass Binaries: Final Results of an Adaptive Optics Survey of Nearby M6.0-M7.5 Stars

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We present updated results of a high-resolution, magnitude limited ($K_s < 12$ mag) imaging survey of nearby low-mass M6.0-M7.5 field stars. The observations were carried out using adaptive optics at the Gemini North, VLT, Keck II, and Subaru telescopes. Our sample of 36 stars consists predominantly of nearby (≤ 30 pc) field stars, 5 of which we have resolved as binaries. Two of the binary systems, 2MASSI J0429184-312356 and 2MASSI J1847034+552243, are presented here for the first time. All 5 discovered binary systems have separations between 0.08-0.53 arcsec (2 - 9 AU) with similar mass ratios (q > 0.8, $\Delta K_s < 1$ mag). This result supports the hypothesis that wide (a > 20 AU) very low-mass ($M_{tot} < 0.19\, M_\odot$) binary systems are rare. The projected semimajor axis distribution of these systems peak at ~ 5 AU and we report a sensitivity-corrected binary fraction of 9^{+4}_{-3}% for stars with primaries of spectral type M6.0-M7.5 with separations ≥ 3 AU and mass ratios q ≥ 0.6. Within these instrumental sensitivities, these results support the overall trend that both the semimajor axis distribution and binary fraction are a function of the mass of the primary star and decrease with decreasing primary mass. These observations provide important constraints for low-mass binary star formation theories.

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Hydrodynamic simulations of molecular outflows driven by slow-precessing protostellar jets

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We present hydrodynamic simulations of molecular outflows driven by jets with a long period of precession, motivated by observations of arc-like features and S-symmetry in outflows associated with young stars. We simulate images of not only H_2 vibrational and CO rotational emission lines, but also of atomic emission. The density cross section displays a jaw-like cavity, independent of precession rate. In molecular hydrogen, however, we find ordered chains of bow shocks and meandering streamers which contrast with the chaotic structure produced by jets in rapid precession. A feature particularly dominant in atomic emission is a stagnant point in the flow that remains near the inlet and alters shape and brightness as the jet skims by. Under the present conditions, slow jet precession yields a relatively high fraction of mass accelerated to high speeds, as also attested to in simulated CO line profiles. Many outflow structures, characterised by HH 222 (continuous ribbon), HH 240 (asymmetric chains of bow shocks) and RNO 43N (protruding cavities), are probably related to the slow precession model.

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Iron Fluorescent Line Emission from Young Stellar Objects in the Orion Nebula

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We present the result of a systematic search for the iron Kα fluorescent line at ~ 6.4 keV among 1616 X-ray sources detected by ultra-deep *Chandra* observations of the Orion Nebula Cluster and the obscured Orion Molecular Cloud 1 population as part of the *Chandra* Orion Ultra-deep Project (COUP). Seven sources are identified to have an excess emission at ~ 6.4 keV among 127 control sample sources with significant counts in the 6.0–9.0 keV band. These seven sources are young stellar objects (YSOs) characterized by intense flare-like flux variations, thermal spectra, and near-infrared (NIR) counterparts. The observed equivalent widths of the line cannot be attributed to the fluorescence by interstellar or circumstellar matter along the line of sight. The X-ray spectral fits and NIR colors of the 6.4 keV sources show that these sources have X-ray absorption of $> 1{\times}10^{22}$ cm^{-2} and NIR excess emission, which is not expected when the fluorescence occurs at the stellar photosphere. We therefore conclude that the iron fluorescent line of YSOs arises from reflection off of circumstellar disks, which are irradiated by the hard X-ray continuum emission of magnetic reconnection flares.

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Turbulence in Class 0 and Class I protostellar envelopes

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We estimate the levels of turbulence in the envelopes of Class 0 and I protostars using a model based on measurements of the peak separation of double-peaked asymmetric line profiles. We use observations of 20 protostars of both Class 0 & I taken in the HCO^+(J=3→2) line that show the classic double-peaked profile. We find that some Class 0 sources show high levels of turbulence whilst others demonstrate much lower levels. In Class I protostars we find predominantly low levels of turbulence. The observations are consistent with a scenario in which Class 0 protostars form in a variety of environments and subsequently evolve into Class I protostars. The data do not appear to be consistent with a recently proposed scenario in which Class 0 protostars can only form in extreme environments.

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Preprint available at astro-ph/0412219

An Alternate Estimate of the Mass of Dust in Cassiopeia A

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Recent observations of sub-millimeter continuum emission toward supernova remnants (SNR) have raised the question of whether such emission is caused by dust within the SNR itself or along the line-of-sight. Here we make a comparison of the image of sub-mm emission from dust with the integrated $J = 1-0$ line emission from interstellar ^{13}CO toward the SNR Cassiopeia A based on existing data. The cm and mm synchrotron emission from Cas A has a rather symmetric, ring-like structure whereas both the sub-mm continuum and interstellar ^{13}CO line emission are located mostly toward the south of the SNR. There is positional agreement for 3 of 6 maxima found in ^{13}CO line and sub-mm continuum emission, with the weakest feature near the center of Cas A and the other two features near the southeast and west edges of the SNR. For these three maxima, a comparison of masses determined from dust and ^{13}CO data shows good agreement if we use the 450 μm dust absorption coefficient typical for diffuse clouds. There is also good agreement between the sub-mm dust temperature and the gas kinetic temperature from CO and NH_3. For the remaining sub-mm continuum peaks, one is outside the forward shock of the SNR. For the other two, one was not mapped in ^{13}CO; for the other there is no ^{13}CO emission. HI absorption covers all of Cas A, but the HI column density may be too small to account for the sub-mm dust emission. Thus it is possible that one, or perhaps two of these sub-mm continuum peaks are located inside the SNR. From lower resolution maps in CO lines, the SE and W features are the edges of extended clouds. Toward the cloud centers, the CO emission is more intense, but there appears to be less sub-mm dust emission. The differences between CO and sub-mm images may be caused a combination of the techniques used to produce the sub-mm maps and changes in cloud properties from center to edge.

Accepted by A& A

Abstracts of papers in Nature and Science

Because of embargoes on preprints for Nature and Science, abstracts for these two journals will be accepted for papers that have already been published

Stellar encounters as the origin of distant solar system objects in highly eccentric orbits

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The Kuiper Belt extends from the orbit of Neptune at 30 AU to an abrupt outer edge at 50 AU from the Sun. Beyond the edge is a sparse population of objects with large orbital eccentricities. Neptune shapes the dynamics of these objects, but the recently discovered planet 2003 VB12 (Sedna) has an eccentric orbit with a perihelion distance, 70 AU, far beyond Neptune's gravitational influence. Although influences from passing stars can create the Kuiper Belt's outer edge and can scatter objects into large, eccentric orbits, no model currently explains the properties of Sedna. Here we show that a passing star probably scattered Sedna from the Kuiper Belt into its observed orbit. The likelihood that a planet at 60-80 AU can be scattered into Sedna's orbit is roughly 50%; this estimate depends critically on the geometry of the flyby. Even more interesting, though, is the roughly 10outer disk of the passing star. Most captures have very high inclination orbits; detection of these objects would confirm the presence of extrasolar planets in our own Solar System.

Nature, vol. 432, p. 598 (2004)

Animations and text available at astro-ph/0412030 and at

`http://cfa-www.harvard.edu/~kenyon/pf/sedna/`

Moving ... ??

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

New Jobs

Three Post-doctoral Positions at ETH Zurich, Switzerland

Protoplanetary Disks and Planet Formation

Pending budgetary approval, up to three new postdoctoral positions are expected to be available at ETH Zurich in 2005 as part of a new multidisciplinary initiative in Planetary Science. This initiative will first focus on *the formation of planets* and will bring together the ETH Departments of Physics and Earth Sciences and research groups at the Universities of Zurich and Bern. The new appointments will work in the following areas:

1. Physical processes that occur in circumstellar disks, including the effects of protostellar magnetic activity on disks and the interaction of molecules and dust with high-energy radiation. Experience with modeling chemical reactions in stellar disks and millimeter and submillimeter observations would be valuable.

2. The combined collisional growth and hydrodynamical evolution of planetary systems and the late time growth and resulting internal structure of terrestrial planets, in collaboration with the research groups of Ben Moore (University of Zurich) and Willy Benz (University of Bern). Experience with dynamics, geophysics, computational techniques and parallel algorithms would be valuable.

Salaries will be approximately CHF 72,000 - 90,000 (about USD 60,000 - 75,000), depending on experience, and the appointments will be renewable for up to three years, starting around October 1 2005.

Available computational resources include the 288-processor zBox and the future 400-processor zBox2 at the University of Zurich, and a new 64-processor fast-connection Beowulf cluster at the ETH Institute for Astronomy. Switzerland has full access to all ESO/ESA observational facilities.

Applications for these positions should be sent in uncompressed PDF format to aurelio@phys.ethz.ch with subject heading "Planet formation postdocs". Applications are invited from all nationalities and should consist of a CV, publication list, and a brief description of past and proposed research (maximum 3 pages each). Applicants should also arrange for three letters of reference to be sent electronically to the same address. The deadline for receipt of both is January 10 2005.

Two PhD student positions at the University of Exeter, United Kingdom

Deadline for application: **January 15, 2005**

The Astrophysics Group in the School of Physics at the University of Exeter will have at least two PhD positions available starting October 2005. The PhD projects will likely be in the field of *galactic star formation* (either observational or theoretical projects). However, students interested in projects in extragalactic star formation or observations of high-redshift galaxies will also be considered.

More information about the Astrophysics Group at Exeter can be found at:

http://www.astro.ex.ac.uk/

and from the group's personal web pages that can be reached from:

http://www.astro.ex.ac.uk/group/contacts.html

Candidates interesting in applying should, in the first instance, contact Dr Matthew Bate, email: mbate@astro.ex.ac.uk. We also encourage our colleagues to circulate this announcment to any students who they think may wish to apply.

Applications received before **JANUARY 15, 2005** will receive full consideration.

Assistant/Associate Professor, College of Science, The University of Arizona

The University of Arizona (UA) seeks applicants for a tenure-track faculty position in astrobiology, specializing in research relating to *the origins of stars, planets and life*. UA, with the NOAO, recently became a member of NASA's Astrobiology Institute, and founded an interdisciplinary center for astrobiology, Life And Planets Astrobiology Center (LAPLACE; see the website, www.laplace.arizona.edu).

Appointment will be in one or more Departments within the College of Science. LAPLACE activities are currently focused in Astronomy/ Steward Observatory (http://www.as.arizona.edu), Chemistry (http://www.chem.arizona.edu), Planetary Sciences/Lunar and Planetary Laboratory (http://www.lpl.arizona.edu) and is being extended to other College of Science departments.

UA has active programs in optical/infrared/sub-millimeter astronomy, planetary exploration, astrochemistry and theoretical astrophysics. On-going programs relevant to astrobiology include:

- optical/infrared observations at the MMT (6.5-m), Magellan (6.5-m), the Large Binocular Telescope (2 x 8.4-m) and several smaller telescopes; mm-wave observations at the Arizona Radio Observatory facilities on Mt. Graham (10-m) and Kitt Peak (12-m);

- active involvement in NASA space telescope programs such as Spitzer Space Telescope, the James Webb Space Telescope and the Terrestrial Planet Finder;

-solar system exploration including the Cassini-Huygens Mission to Saturn and Mars missions such the Phoenix Mission scheduled for launch in 2007;

- extensive laboratory and computational programs in astrobiological and astrochemical research, including high resolution molecular spectroscopy, gas-phase chemical kinetics and bioorganic chemistry; state-of-the-art Nuclear Magnetic Resonance (NMR), mass spectroscopy facilities are available.

NOTE: The department is seeking an individual who is able to work with diverse students and colleagues, and who has experience with a variety of teaching methods and curricular perspectives.

Ph.D. in Astronomy, Chemistry, Physics, Planetary Science or an astrobiology-related field required.

Although all applicants with research interests in astrobiology will be considered, we are particularly interested in applicants with expertise in:

- theoretical astrochemistry and the interstellar medium; - theoretical and/or computational studies of planet formation and dynamical evolution; and - sub-mm/radio observational studies of molecular clouds and star formation.

Please mail statement of interest, curriculum vitae (including list of publications and descriptions of current and proposed research) and the names of three references to:

Dr. Anna Spitz
Steward Observatory
The University of Arizona
933 N. Cherry Ave.
Tucson, AZ 85721, USA.

NOTE: No email applications will be accepted.

http://www.uacareertrack.com/applicants/jsp/shared/frameset/Frameset.jsp?time=1101850902038

New Books

The Formation of Stars

Steven W. Stahler and Francesco Palla

This book presents a detailed examination of our current understanding of star formation, and as such fills a major gap in the scientific literature. At 850 pages the book is massive, and covers in great detail the physical processes that lead from molecular clouds through the collapse phase to protostars and pre-main sequence stars. The book contains 20 chapters, which are divided into 6 sections:

I. Star Formation in Our Galaxy
1. Overview
2. The Interstellar Medium
3. Molecular Clouds
4. Young Stellar Systems

II. Physical Processes in Molecular Clouds
5. Molecular Transitions: Basic Physics
6. Molecular Transitions: Applications
7. Heating and Cooling
8. Cloud Thermal Structure

III. From Clouds to Stars
9. Cloud Equilibrium and Stability
10. The Collapse of Dense Cores
11. Protostars
12. Multiple Star Formation

IV. Environmental Impact of Young Stars
13. Jets and Molecular Outflows
14. Interstellar Masers
15. Effects of Massive Stars

V. Pre-Main Sequence Stars
16. Quasi-Static Contraction
17. T Tauri Stars
18. Herbig Ae/Be Stars

VI. A Universe of Stars
19. Star Formation on the Galactic Scale
20. The Physical Problem: A Second Look

As the field of star formation progresses and the pace and volume of research steadily increase, the need to bring an overview to graduate students becomes increasingly pressing. Graduate courses on the interstellar medium are common, and excellent textbooks on the physics and chemistry of the interstellar medium exist. But no single book covers the subject of star formation. This book fills the gap, indeed it presents much more material than can be accomodated in a typical graduate course. The authors list those chapters and sections which they suggest may convey the more essential information to the students. Each chapter is followed by a brief summary, and a list of suggested additional reading which directs the reader to key papers in the field.

A text book on, say, stellar structure will be covering a mature subject where all the principal issues have been solved, and such a book can therefore give very firm answers to most of the questions discussed. Star formation, in contrast, is a young subject, and many problems have not yet found their final solution. Still, a core of fundamental results has been built up, which is unlikely to change significantly even as new results appear. The authors make it clear when an issue has not yet been fully understood, and point out when observations and theory diverge. Rather than presenting every popular model, the authors have selected interpretations of data that fit into a unified, coherent picture as they see it. Inevitably, not every reader may agree with everything in the book. The book thus reflects the active and ongoing nature of research in star formation.

ISBN 3-527-40559-3, 852 pages, published 2004
Softbound US$89.95, (hardbound copies are also available)

The book was published November 4 in Germany and is available now in Europe. Copies will arrive in the US, Asia, etc in January.

The book may be pre-ordered (from any country) through Amazon.com or directly from

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For those who attend the meeting of the American Astronomical Society in San Diego Jan 9-13, the book will be on display there.

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/ .

The Origin of Stars

Michael D. Smith

This book offers an overview of the field of star formation as it currently stands. It can be read by a wider audience, including readers beyond the circles of professional astronomers. However, many scientists, especially in adjacent fields like meteoritics and planetary science, will also find it an excellent introduction to the subject. It will serve admirably as a textbook for an undergraduate course in star formation. The book covers the full range of early stellar evolution, from the formation and properties of molecular clouds to protostars and pre-main sequence stars and clustered star formation. The author uses equations where they are needed, but explains them so that readers without a background in mathematics can follow and appreciate the arguments. The book emphasizes ideas and processes, while at the same time extensive references are made to observations. This is a welcome addition to the literature.

The book is divided into the following 13 chapters:

1. Introduction
2. The Physics and Chemistry
3. The Clouds
4. Cloud Formation, Evolution and Destruction
5. Turbulence
6. The Collapse
7. Magnetic Mediation
8. The Birth
9. The Young Stars
10. Jets and Outflows
11. Massive Stars
12. The Distributions
13. Cosmological Star Formation

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Meteorites

A Petrologic, Chemical and Isotopic Synthesis

Robert Hutchison

This book gives an overview of our current understanding of meteorites based on laboratory studies. Major advances in the field of meteoritics have taken place in recent years, partly through the development of increasingly sophisticated measuring techniques, and partly through the wealth of new specimens, in particular from Antarctica. The author has specifically tried to make the book understandable to scientists without training in mineralogy and other topics that are second nature to meteoriticists. With the growing links between star formation and the early Solar Nebula, astronomers increasingly need to understand the results derived from meteorites, and this book helps to make meteoritics accessible to scientists in related fields.

The book contains the following chapters:

1. Introduction
2. The chondrites: chemistry and classification
3. The components of chondrites
4. Petrography of the chondrites I: carbonaceous chondrites
5. Petrography of the chondrites II: non-carbonaceous chondrites
6. Time in the evolution of chondrites
7. Origin of chondrites and their components
8. Differentiated meteorites I: primitive achondrintes, ureilites
9. Differentiated meteorites II: asteroidal, lunar and Martian basaltic meteorites
10. Differentiated meteorites III: iron and stony iron meteorites
11. Parent body processes and petrogenetic associations
12. Origin of Solar System planets: a meteoriticist's view

ISBN 0 521 47010 2 hardback. 506 pages. US$135

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Fax: 1-845-353-4141

Meetings

The 2005 Gordon Conference on the Origins of Solar Systems

Joseph Nuth[1] and Lee Hartmann[2]

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The next Origins of Solar Systems Gordon Conference will be held at Connecticut College in New London, Connecticut from June 26 through July 1, 2005. The theme of the conference will be dynamic processes that control the formation and evolution of planetary systems. The Conference is organized around a series of nine sessions, beginning Sunday evening, each outlining specific topics via presentations by several invited speakers. Adequate time will be allocated for group discussions at each of the formal sessions, while more informal discussion among individual participants is facilitated by long afternoon breaks taken between lunch and dinner. Joseph Nuth of NASAs Goddard Space Flight Center and Lee Hartmann of Harvard-Smithsonian Center for Astrophysics will organize this years conference. Please direct any suggestions for invited presentations to Joe Nuth [301-286-9467 or nuth@gsfc.nasa.gov] and send abstracts for potential poster presentations to Lee Hartmann at hartmann@cfa.harvard.edu. A preliminary schedule of invited presentations will appear on the Gordon Conference Website that will be advertised in the February 1, 2005 Issue of Science. Applications for participation in the conference as well as a description of the conference facility and directions for potential attendees will also be posted on the Gordon Conference website.

Additional Info in February 1 Issue of Science

The 68th Annual Meeting of the Meteoritical Society

September 12 - 16, 2005, in Gatlinburg, Tennessee

For further information, please refer to the first announcement at:

http://www.lpi.usra.edu/meetings/metsoc2005/

To subscribe to a mailing list to receive updates, reminders and any special announcements relating to the meeting vial e-mail, please submit an Indication of Interest (available at the conference Web site) by January 15, 2005.

Further details regarding the program, topics for discussion, opportunities for participation, as well as guidelines for abstract and poster preparation, will be included in the second announcement that will be available on the meeting Web site in April 2005.