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## *Abstracts of recently accepted papers*

### **Long-term evolution of FU Orionis objects at infrared wavelengths**

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We investigate the brightness evolution of 7 FU Orionis systems in the 1–100  $\mu\text{m}$  wavelength range using data from the *Infrared Space Observatory* (ISO). The ISO measurements were supplemented with 2MASS and MSX observations performed in the same years as the ISO mission (1995–98). The spectral energy distributions (SEDs) based on these data points were compared with earlier ones derived from the IRAS photometry as well as from ground-based observations carried out around the epoch 1983. In 3 cases (Z CMa, Parsamian 21, V1331 Cyg) no difference between the two epochs was seen within the measurement uncertainties. V1057 Cyg, V1515 Cyg and V1735 Cyg have become fainter at near-infrared wavelengths while V346 Nor has become slightly brighter. V1057 Cyg exhibits a similar flux change also in the mid-infrared. At  $\lambda \geq 60 \mu\text{m}$  most of the sources remained constant; only V346 Nor seems to fade. Our data on the long-term evolution of V1057 Cyg agree with the model predictions of Kenyon & Hartmann (1991) and Turner et al. (1997) at near- and mid-infrared wavelengths, but disagree at  $\lambda > 25 \mu\text{m}$ . We discuss if this observational result at far-infrared wavelengths could be understood in the framework of the existing models.

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astro-ph/0408048

### **A Search for H<sub>2</sub>CO 6 cm Emission toward Young Massive Stellar Objects**

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A survey for H<sub>2</sub>CO 6 cm emission toward young massive stellar objects has been conducted using the 305 m Arecibo Telescope. We report detection of emission toward IRAS 18566+0408, only the fifth source in the Galaxy known to show H<sub>2</sub>CO 6 cm emission. A cross-scan shows that the size of the emitting region is smaller than the C-Band Arecibo half-power beamwidth (i.e.,  $\theta_s < 1'$ ). We detect extended H<sub>2</sub>CO 6 cm absorption around and toward the emitter position. We detect H<sub>2</sub>CO 6 cm absorption features toward all 15 sources observed. Three of the sources exhibit complex absorption profiles that could be due to absorption partially filled by emission.

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<http://www.journals.uchicago.edu/ApJ/future.html>

## Deep Near Infrared Imaging toward Vela Molecular Ridge C 1: A Remarkable Embedded Cluster in RCW 36

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We present deep near-infrared ( $J, H, K_S$ ) images toward an embedded cluster which lies in a  $C^{18}O$  clump in the cloud C of the Vela Molecular Ridge. This cluster has at least  $\sim 350$  members and a radius of  $\sim 0.5$  pc. The stellar surface number density is approximately  $3000$  stars  $\text{pc}^{-2}$  in the central  $0.1 \text{ pc} \times 0.1 \text{ pc}$  region of the cluster. This is much higher than most of the young clusters within 1 kpc of the Sun. From the comparison of the luminosity function and near-infrared excess fraction with those of other embedded clusters, we estimate that the age of this cluster is approximately 2-3 Myr. This cluster exhibits an excess of brighter stars in its central region, from which we conclude that the more massive stars are located near the cluster center.

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## Star count analysis of the interstellar matter in the region of L1251

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We studied the ISM distribution in and around the star forming cloud L1251 with optical star counts. A careful calculation with a maximum likelihood based statistical approach resulted in  $B, V, R, I$  extinction distributions from the star count maps. A distance of  $330 \pm 30$  pc was derived. The extinction maps revealed an elongated dense cloud with a bow shock at its eastern side. We estimated a Mach number of  $M \approx 2$  for the bow shock. A variation of the apparent dust properties is detected, i.e. the  $R_V = A_V/E_{B-V}$  total to selective extinction ratio varies from 3 to 5.5, peaking at the densest part of L1251. The spatial structure of the head of L1251 is well modelled with a Schuster-sphere (i.e.  $n=5$  polytropic sphere). The observed radial distribution of mass fits the model with high accuracy out to 2.5 pc distance from the assumed center. Unexpectedly, the distribution of  $NH_3$  1.3 cm line widths is also well matched by the Schuster solution even in the tail of the cloud. Since the elongated head-tail structure of L1251 is far from the spherical symmetry the good fit of the linewidths in the tail makes it reasonable to assume that the present cloud structure has been formed by isothermal contraction.

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## Spectroscopy of Very Low Mass Stars and Brown Dwarfs in IC 2391: Lithium depletion and $H\alpha$ emission

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We have obtained intermediate-resolution optical spectroscopy of 44 candidate very low mass members of the nearby

young open cluster IC 2391. Of these, 26 spectra are totally new, 14 were already analyzed in a previous paper and another four are in common. These spectra, taken at the Cerro Tololo 4-meter and Magellan I and II telescopes, allow us to confirm 33 of them as likely cluster members, based on their spectral types, presence of Li, and H $\alpha$  emission. Among these new cluster members is CTIO-160 (M7), the first IC 2391 candidate to satisfy all criteria for being a substellar member of the cluster, including detection of the Li 6708A doublet. With the enlarged membership, we are able to locate the lithium depletion boundary of the cluster more reliably than in the past. Based on comparison to several theoretical models, we derive an age of  $50\pm 5$  Myr for IC 2391. We also estimate new ages for the Alpha Per and Pleiades clusters; our ages are  $85\pm 10$  Myr and  $130\pm 20$  Myr, respectively. We derive an estimate of the initial mass function of IC 2391 that extends to below the substellar limit, and compare it to those of other well-studied young open clusters. The index of the power law mass function for IC 2391 is  $\alpha=0.96\pm 0.12$ , valid in the range 0.5 to  $0.072 M_{\odot}$ .

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<http://xxx.unizar.es/abs/astro-ph/0406436>

## A new Classical T Tauri object at the sub-stellar boundary in Chamaeleon II

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We have obtained low- and medium-resolution optical spectra of 20 candidate young low-mass stars and brown dwarfs in the nearby Chamaeleon II dark cloud, using the Magellan Baade telescope. We analyze these data in conjunction with near-infrared photometry from the 2-Micron All Sky Survey. We find that one target, [VCE2001] C41, exhibits broad H $\alpha$  emission as well as a variety of forbidden emission lines. These signatures are usually associated with accretion and outflow in young stars and brown dwarfs. Our spectra of C41 also reveal LiI in absorption and allow us to derive a spectral type of M5.5 for it. Therefore, we propose that C41 is a classical T Tauri object near the sub-stellar boundary. Thirteen other targets in our sample have continuum spectra without intrinsic absorption or emission features, and are difficult to characterize. They may be background giants or foreground field stars not associated with the cloud or embedded protostars, and need further investigation. The six remaining candidates, with moderate reddening, are likely to be older field dwarfs, given their spectral types, lack of lithium and H $\alpha$ .

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## How special is the Solar System?

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Most mechanisms proposed for the formation of planets are modified versions of the mechanism proposed for the solar system. Here we argue that, in terms of those planetary systems which have been observed, the case for the solar system being a typical planetary system has yet to be established. We consider the possibility that most observed planetary systems have been formed in some quite different way. If so, it may be that none of the observed planetary systems is likely to harbour an earth-like planet.

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# High-spatial-resolution CN and CS observations of two regions of massive star formation

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Molecular line CN, CS and mm continuum observations of two intermediate- to high-mass star-forming regions – IRAS 20293+3952 and IRAS 19410+2336 – obtained with the Plateau de Bure Interferometer at high spatial resolution reveal interesting characteristics of the gas and dust emission. In spite of the expectation that the CN and CS morphology might closely follow the dense gas traced by the dust continuum, both molecules avoid the most central cores. Comparing the relative line strengths of various CN hyperfine components, this appears not to be an opacity effect but to be due to chemical and physical effects. The CN data also indicate enhanced emission toward the different molecular outflows in the region. Regarding CS, avoiding the central cores can be due to high optical depth, but the data also show that the CS emission is nearly always associated with the outflows of the region. Therefore, neither CS nor CN appear well suited for dense gas and disk studies in these two sources, and we recommend the use of different molecules for future massive disk studies. An analysis of the 1 and 3 mm continuum fluxes toward IRAS 20293+3952 reveals that the dust opacity index  $\beta$  is lower than the canonical value of 2. Tentatively, we identify a decreasing gradient of  $\beta$  from the edge of the core to the core center. This could be due to increasing optical depth toward the core center and/or grain growth within the densest cores and potential central disks. We detect 3 mm continuum emission toward the collimated outflow emanating from IRAS 20293+3952. The spectral index of  $\alpha \sim 0.8$  in this region is consistent with standard models for collimated ionized winds.

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Preprints available at: <http://cfa-www.harvard.edu/~hbeuther>

## Spectroscopic monitoring of the Herbig Ae star HD 104237

### I. Multiperiodic stellar oscillations

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We present the results of multisite observations spanning two years of the pre-main-sequence Herbig Ae star HD 104237. The star was observed in high resolution spectroscopy ( $R \geq 35000$ ) for a total of 157.3 hours of effective exposure time, over 42 nights, corresponding to a data base of 1888 individual echelle spectra. We confirm that the HD 104237 system includes a spectroscopic binary, whose primary component HD 104237 A is pulsating. The resulting high quality radial velocity curve allows us to detect for the first time by spectroscopic means multiperiodic oscillations in a pre-main sequence star. Five different modes are detected with very high confidence, with frequencies ranging between 28.5 and 35.6 d<sup>-1</sup>, typical of  $\delta$  Scuti pulsations; an additional 3 frequencies have been extracted from the data, but with a lower level of confidence. The pattern of frequencies indicates that at least some of the detected modes are non-radial. The precise orbit determination and the measurement of the double line spectroscopic binary observed around periastron enabled us to determine a mass ratio of  $1.29 \pm 0.02$  between the primary and the secondary; based on the primary mass of  $2.2 \pm 0.1 M_{\odot}$  we conclude that the secondary HD 104237 B should have a mass of  $1.7 \pm 0.1 M_{\odot}$  and lie outside the pre-main sequence instability strip towards later spectral types. A search for pulsations in the radial velocity curve of the much weaker secondary component was not conclusive at this stage. The location of the primary in the HR diagram and its position with respect to recent pre-main sequence evolutionary tracks and isochrones implies a location of the secondary indicative of spectral type K3.

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## Methane Abundance Variations toward the Massive Protostar NGC 7538 : IRS9

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Absorption and emission lines originating from the  $\nu_3$  C-H stretching manifold of gas phase CH<sub>4</sub> were discovered in the high resolution ( $R=25,000$ ) infrared L band spectrum along the line of sight toward NGC 7538 : IRS9. These observations provide a diagnostic of the complex dynamics and chemistry in a massive star forming region. The line shapes resemble P Cygni profiles with the absorption and emission components shifted by  $\sim 7 \text{ km s}^{-1}$  with respect to the systemic velocity. Similar velocity components were observed in CO at  $4.7 \mu\text{m}$ , but in contrast to CH<sub>4</sub>, the CO shows deep absorption due to a high velocity outflow as well as absorption at the systemic velocity due to the cold outer envelope. It is concluded that the gas phase CH<sub>4</sub> abundance varies by an order of magnitude in this line of sight: it is low in the envelope and the outflow ( $X[\text{CH}_4] < 0.4 \times 10^{-6}$ ), and at least a factor of 10 larger in the central core. The discovery of solid CH<sub>4</sub> in independent ground and space based data sets shows that methane is nearly entirely frozen onto grains in the envelope. It thus appears that CH<sub>4</sub> is formed by grain surface reactions, evaporates into the gas phase in the warm inner regions of protostellar cores and is efficiently destroyed in shocks related to outflows.

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## Complex molecules in the hot core of the low mass protostar NGC1333-IRAS4A

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We report the detection of complex molecules (HCOOCH<sub>3</sub>, HCOOH and CH<sub>3</sub>CN), signposts of a “hot core” like region, toward the low mass, Class 0 source NGC1333-IRAS4A. This is the second low mass protostar where such complex molecules have been searched for and reported, the other source being IRAS16293–2422. It is therefore likely that compact (few tens of AUs) regions of dense and warm gas, where the chemistry is dominated by the evaporation of grain mantles, and where complex molecules are found, are common in low mass Class 0 sources. Given that the chemical formation timescale is much shorter than the gas hot core crossing time, it is not clear whether the reported complex molecules are formed on the grain surfaces (first generation molecules) or in the warm gas by reactions involving the evaporated mantle constituents (second generation molecules). We do not find evidence for large differences in the molecular abundances, normalized to the formaldehyde abundance, between the two solar type protostars, suggesting perhaps a common origin.

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## Collapse and Fragmentation in Finite Sheets

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We present two-dimensional simulations of finite, self-gravitating gaseous sheets. Unlike the case of infinite sheets, such configurations do not constitute equilibrium states but instead are subject to global collapse unless countered by pressure forces or rotation. The initial effect of finite geometry is to promote concentrations of material at the edges of the sheet. If the sheet is not perfectly circular, gravitational focussing results in enhanced concentrations of mass. In the second-most simple geometry, that of an elliptical outer boundary, the general result is collapse to a filamentary structure with the densest concentrations of mass at the ends of the filament. We suggest that these simple calculations have interesting implications for the gravitational evolution of overall molecular cloud structure, envisioning that such clouds might originate as roughly sheetlike sections of gas accumulated as a result of large-scale flows in the local interstellar medium. We show some examples of local clouds with overall filamentary shape and denser concentrations of mass and star clusters near the ends of the overall extended structure, suggestive of our simple ellipse collapse calculations. We suggest that cluster-forming gas is often concentrated as a result of gravity acting on irregular boundaries; this mechanism can result in very rapid infall of gas which may be of importance to the formation of massive stars. This picture suggests that much of the supersonic “turbulence” observed in molecular clouds might be gravitationally-generated. Our results may provide impetus for further theoretical explorations of global gravitational effects in molecular clouds and their implications for generating the substructure needed for fragmentation into stars and clusters.

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<http://cfa-www.harvard.edu/cfa/youngstars/>

## The nature of the KW object

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The KW object which has been one of the most puzzling infrared sources for three decades has been resolved into a system of two early B-type stars with a projected separation of 2600 AU. While the more luminous component shows a huge IR excess due to circumstellar dust, the fainter one displays X-ray emission. The system is deeply embedded ( $A_V \sim 24$  mag) in the molecular cloud M17SW and associated with an IR reflection nebula. A radiative transfer model of the spectral energy distribution of the IR excess object requires a stellar source of  $5.1 \cdot 10^3 L_\odot$  – equivalent to B0 star – surrounded by  $10 M_\odot$  of circumstellar material. The KW object is associated with a small cluster of about 150 red stars. The stellar density within 0.1 pc is  $> 2.4 \cdot 10^3 \text{pc}^{-3}$ . From all new evidence, we suggest that the KW object is one of the youngest, most deeply embedded Herbig Be stars known to date.

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## Multiple protostellar systems. I. A deep near infrared survey of Taurus and Ophiuchus protostellar objects.

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We performed a deep infrared imaging survey of 63 embedded young stellar objects (YSOs) located in the Taurus and Ophiuchus clouds to search for companions. The sample includes Class I and flat infrared spectrum protostellar objects. We find 17 companions physically bound to 15 YSOs with angular separations in the range 0.8-10 arcsec (110–1400 AU) and derive a companion star fraction of  $23\pm 9\%$  and  $29\pm 7\%$  for embedded YSOs in Taurus and Ophiuchus, respectively, about twice as large as that found among G dwarfs in the solar neighborhood. Therefore, binary and multiple protostellar systems are a very frequent outcome of the fragmentation of prestellar cores. In spite of different properties of the clouds and especially of the prestellar cores, the fraction of wide companions,  $27\pm 6\%$  for the combined sample, is identical in the two star-forming regions. This suggests that the frequency and properties of wide multiple protostellar systems are not very sensitive to specific initial conditions. Comparing the companion star fraction of the youngest YSOs still surrounded by extended envelopes to that of more evolved YSOs, we find evidence for a possible evolution of the fraction of wide multiple systems, which seems to decrease by a factor of about 2 on a timescale of  $\sim 10^5$  yr. For the first time, it is possible to confront the result of a multiplicity survey of a nearly complete population of embedded YSOs at an age of  $\sim 10^5$  yr to numerical simulations of molecular cloud collapse which, after a few free fall times, reach this evolutionary stage. Somewhat contrary to model predictions, we do not find evidence for a sub-clustering of embedded sources at this stage on a scale of a few 100 AU that could be related to the formation of small-N protostellar clusters. Possible interpretations for this discrepancy are discussed.

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## Discovery of new 19.9-GHz methanol masers in star forming regions

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We have used the NASA Tidbinbilla 70-m antenna to search for emission from the  $2_1-3_0$  E (19.9-GHz) transition of methanol. The search was targeted towards 22 star formation regions which exhibit maser emission in the 107.0-GHz  $3_1-4_0$  A<sup>+</sup> methanol transition, as well as in the 6.6-GHz  $5_1-6_0$  A<sup>+</sup> transition characteristic of class II methanol maser sources. A total of 7 sources were detected in the  $2_1-3_0$  E transition, 6 of these being new detections. Many of the new detections are weak ( $\lesssim 0.5$  Jy), however, they appear to be weak masers rather than thermal or quasi-thermal emission.

We find a strong correlation between sources which exhibit 19.9-GHz methanol masers and those which both have the class II methanol masers projected against radio continuum emission and have associated 6035-MHz OH masers. This suggests that the 19.9-GHz methanol masers arise in very specific physical conditions, probably associated with a particular evolutionary phase. In the model of Cragg, Sobolev & Godfrey (2002) these observations are consistent with gas temperatures of 50 K, dust temperatures of 150-200 K and gas densities of  $10^{6.5} - 10^{7.5}$  cm<sup>-3</sup>.

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## Generalized Collapse Solutions with Nonzero Initial Velocities for Star Formation in Molecular Cloud Cores

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Motivated by recent observations that show starless molecular cloud cores exhibit subsonic inward velocities, we revisit the collapse problem for polytropic gaseous spheres. In particular, we provide a generalized treatment of protostellar collapse in the spherical limit and find semi-analytic (self-similar) solutions, corresponding numerical solutions, and purely analytic calculations of the mass infall rates (the three approaches are in good agreement). This study focuses on collapse solutions that exhibit nonzero inward velocities at large radii, as observed in molecular cloud cores, and extends previous work in four ways: (1) The initial conditions allow nonzero initial inward velocity. (2) The starting states can exceed the density of hydrostatic equilibrium so that the collapse itself can provide the observed inward motions. (3) We consider different equations of state, especially those that are softer than isothermal. (4) We consider dynamic equations of state that are different from the effective equation of state that produces the initial density distribution. This work determines the infall rates over a wide range of parameter space, as characterized by four variables: the initial inward velocity  $v_\infty$ , the overdensity  $\Lambda$  of the initial state, the index  $\Gamma$  of the static equation of state, and the index  $\gamma$  of the dynamic equation of state. For the range of parameter space applicable to observed cores, the resulting infall rate is about a factor of two larger than found in previous theoretical studies (those with hydrostatic initial conditions and  $v_\infty = 0$ ).

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## The weak-line T Tauri star V410 Tau. II. A flaring star

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We show that V410 Tau, a weak-line T Tauri star, is a flaring star. This result comes from an intensive, coordinated monitoring campaign carried out in November 2001 at visible and X-ray wavelength ranges. It is confirmed by previous, isolated observations found in the literature. Flares tend to occur mainly around the star's minimum brightness, when the most active regions face us.

We report on the strongest flare detected up to now on this star, for which we have obtained simultaneous visible Strömgren photometry and intermediate resolution spectroscopy. We derive decay times from 3 to 0.7 hours at several wavelengths for the continuum in the 3600-5600 Å range. We estimate the energy involved in this and the other flares for which we have good time sampling, and conclude that the strongest event, at least, could have important consequences for the matter in the surroundings of the star. If similar events took place on the young Sun and lasted for several Myr, they could explain the anomalous abundances of elemental isotopes found in some meteorites. They could have also contributed to eliminate part of the primary atmospheres of the planet embryos and would have provided enough energy for the melting of solid iron-magnesium silicates, a process that may explain the presence of chondrules in chondritic meteorites.

High resolution spectroscopy of the  $H_\alpha$  emission line in the quiescent states of V410 Tau enables us to study the variability of the broad component. We suggest that this component is related to microflaring activity, such as the one observed on more evolved, magnetically-active stars. The large velocities and the energy associated with this component support this hypothesis.

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<http://www.iaa.es/~matilde/V410.II.ps.gz>

## Heating Protoplanetary Disk Atmospheres

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We calculate the thermal-chemical structure of the gaseous atmospheres of the inner disks of T Tauri stars, starting from the density and dust temperature distributions derived by D'Alessio et al. (1999). Due to processes such as X-ray irradiation or mechanical heating of the surface layers, the gas temperature at the very top of the disk atmosphere in the neighborhood of 1 AU is greater than 5000 K. Deep down, it drops rapidly into the range of the dust temperature, i.e., several hundred Kelvin. In between these upper hot and lower cool layers, there is a transition zone with gas temperatures in the range 500-2000 K. The thickness and location of this warm region depends on the strength of the surface heating. This region also manifests the basic chemical transitions of H going into H<sub>2</sub> and of C<sup>+</sup> and C going into CO. It is remarkable that, even though the H<sub>2</sub> transition begins first (higher up), it does not go to completion until after CO does. Consequently, there is a reasonably thick layer of warm CO which is predominantly atomic H. This thermal-chemical structure is favorable to the excitation of the fundamental and overtone bands of CO because of the large rate coefficients for vibrational excitation in H + CO as opposed to H<sub>2</sub> + CO collisions. This conclusion is supported by the recent observations of the fundamental band transitions in most T Tauri stars. We also argue that layered atmospheres of inner T Tauri disks may play an important role in understanding the observations of H<sub>2</sub> UV fluorescence pumped from excited vibrational levels of that molecule. Possible candidates for surface heating include the interaction of a wind with the upper layers of the disk and dissipation of hydromagnetic waves generated by mechanical disturbances close to the midplane, e.g., by the Balbus-Hawley instability. Detailed modeling of the observations have the potential to reveal the nature of the mechanical surface heating that we model phenomenologically in these calculations and to help understand the nature of the gas in protoplanetary disks.

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## Clumpy filaments of the Chamaeleon I cloud: C<sup>18</sup>O mapping with the SEST

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The Chamaeleon I dark cloud (Cha I) has been mapped in C<sup>18</sup>O (1-0) with an angular resolution of 1' using the SEST telescope. The large scale structures previously observed with lower spatial resolution in the cloud turn into a network of clumpy filaments. The automatic Clumpfind routine developed by Williams et al. 1994 is used to identify individual clumps in a consistent way. Altogether 71 clumps were found and the total mass of these clumps is 230 Mo. The dense 'cores' detected with the NANTEN telescope (Mizuno et al. 1999) and the very cold cores detected in the ISOPHOT serendipity survey (Toth et al. 2000) form parts of these filaments but decompose into numerous 'clumps'. The filaments are preferentially oriented at right angles to the large-scale magnetic field in the region. We discuss the cloud structure, the physical characteristics of the clumps and the distribution of young stars. The observed clump mass spectrum is compared with the predictions of the turbulent fragmentation model of Padoan & Nordlund 2002. An agreement is found if fragmentation has been driven by very large-scale hypersonic turbulence, and if it has had time to dissipate into modestly supersonic turbulence in the interclump gas by the present time. According to numerical simulations, large-scale turbulence should have resulted in filamentary structures as seen in Cha I. The well-oriented magnetic field does not, however, support this picture, but suggest magnetically steered large-scale collapse. The origin of filaments and clumps in Cha I is thus controversial. A possible solution is that the characterization of the driving turbulence fails and in fact different processes have been effective on small and large scales in this cloud.

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## LkH $\alpha$ -101 and the Young Cluster in NGC 1579

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The central region of the dark cloud L1482 is illuminated by LkH $\alpha$ -101, a heavily reddened ( $A_V \approx 10$  mag) high-luminosity ( $\geq 8 \times 10^3 L_\odot$ ) star having an unusual emission-line spectrum plus a featureless continuum. About 35 much fainter (mostly between  $R = 16$  and  $>21$ ) H $\alpha$  emitters have been found in the cloud. Their color-magnitude distribution suggests a median age of about 0.5 Myr, with considerable dispersion. There are also at least 5 bright B-type stars in the cloud, presumably of about the same age; none show the peculiarities expected of HAeBe stars. De-reddened, their apparent  $V$  magnitudes lead to a distance of about 700 pc.

Radio observations suggest that the optical object LkH $\alpha$ -101 is in fact a hot star surrounded by a small HII region, both inside an optically-thick dust shell. The level of ionization inferred from the shape of the radio continuum corresponds to a Lyman continuum luminosity appropriate for an early B-type ZAMS star. The  $V - I$  color is consistent with a heavily reddened star of that type. However, the optical spectrum does not conform to this expectation: the absorption lines of an OB star are not detected. Also, the [OIII] lines of an HII region are absent, possibly because those upper levels are collisionally deexcited at high densities.

There are several distinct contributors to the optical spectrum of LkH $\alpha$ -101. The H $\alpha$  emission line is very strong, with wings extending to about  $\pm 1700$  km s $^{-1}$ , which could be produced by a thin overlying layer of hot electron scatterers. There is no sign of P Cyg-type mass ejection. Lines of SiII are narrower, while the many FeII lines are still narrower and are double with a splitting of about 20 km s $^{-1}$ . Lines of [FeII], [OI], [SII] are similarly sharp but are single, at the same velocity as the FeII average. Tuthill et al. (2002) inferred, from  $K$ -band interferometry, that the central source is actually a small horseshoe-shaped arc about 0.05 arcsec (35 AU) across. A tipped annulus of that size in rotation about a 15  $M_\odot$  star would produce double spectrum lines having about the splitting observed for FeII.

The totality of observational evidence encourages the belief that LkH $\alpha$ -101 is a massive star caught in an early evolutionary state.

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## Radiative Transfer and Starless Cores

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We develop a method of analyzing radio frequency spectral line observations to derive data on the temperature, density, velocity, and molecular abundance of the emitting gas. The method incorporates a radiative transfer code with a new technique for handling overlapping hyperfine emission lines within the accelerated lambda iteration algorithm and a heuristic search algorithm based on simulated annealing. We apply this method to new observations of Diaz in three Lynds clouds thought to be starless cores in the first stages of star formation and determine their density structure. A comparison of the gas densities derived from the molecular line emission and the millimeter dust emission suggests that the required dust mass opacity is about  $\kappa_{1.3\text{mm}} = 0.04$  cm $^2$  g $^{-1}$ , consistent with models of dust grains that have opacities enhanced by ice mantles and fluffy aggregates.

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## Core-Accretion Model Predicts Few Jovian-Mass Planets Orbiting Red Dwarfs

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The favored theoretical explanation for giant planet formation – in both our solar system and others – is the core accretion model (although it still has some serious difficulties). In this scenario, planetesimals accumulate to build up planetary cores, which then accrete nebular gas. With current opacity estimates for protoplanetary envelopes, this model predicts the formation of Jupiter-mass planets in 2–3 Myr at 5 AU around solar-mass stars, provided that the surface density of solids is enhanced over that of the minimum-mass solar nebula (by a factor of a few). Working within the core-accretion paradigm, this paper presents theoretical calculations which show that the formation of Jupiter-mass planets orbiting M dwarf stars is seriously inhibited at all radial locations (in sharp contrast to solar-type stars). Planet detection programs sensitive to companions of M dwarfs will test this prediction in the near future.

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## Evolution of Chemistry and Molecular Line Profile during Protostellar Collapse

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Understanding the chemical evolution in star-forming cores is a necessary pre-condition to correctly assess physical conditions when using molecular emission. We follow the evolution of chemistry and molecular line profiles through the entire star formation process, including a self-consistent treatment of dynamics, dust continuum radiative transfer, gas energetics, chemistry, molecular excitation, and line radiative transfer. In particular, the chemical code follows a gas parcel as it falls toward the center, passing through regimes of density, dust temperature, and gas temperature that are changing both because of the motion of the parcel and the evolving luminosity of the central source. We combine a sequence of Bonnor-Ebert spheres and the inside-out collapse model to describe dynamics from the pre-protostellar stage to later stages. The overall structures of abundance profiles show complex behavior that can be understood as interactions between freeze-out and evaporation of molecules. We find that the presence or absence of gas-phase CO has a tremendous effect on the less abundant species. In addition, the ambient radiation field and the grain properties have important effects on the chemical evolution, and the variations in abundance have strong effects on the predicted emission line profiles. Multi-transition and multi-position observations are necessary to constrain the parameters and interpret observations correctly in terms of physical conditions. Good spatial and spectral resolution is also important in distinguishing evolutionary stages.

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## Photoevaporated Disks around Massive Young stars

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We present a parametric model of an isothermal photoevaporating wind from a Keplerian disk around a young massive star. The wind is produced by high energy photons ( $h\nu > 13.6$  eV) from the massive central star that ionize and heat the material of the circumstellar disk, as discussed several years ago by Hollenbach et al. (1994). The model gives the velocity and density structure of the ionized winds. Because of its simplicity, it is very useful to explore the physical conditions of this type of winds. The model can also describe the photoevaporation of disks around low mass young stars. We obtain the free-free continuum emission of the photoevaporated flows and compare with the spectral energy distribution of the known bipolar sources MWC 349 A and NGC 7538 IRS1.

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## Directions of Outflows, Disks, Magnetic Fields, and Rotation of YSOs in Collapsing Molecular Cloud Cores

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The collapse of slowly rotating molecular cloud cores threaded by magnetic fields is investigated by high-resolution numerical simulation. Outflow formation in the collapsing cloud cores is also followed. In the models examined, the cloud core and parent cloud rotate rigidly and are initially threaded by a uniform magnetic field. The simulations show that the cloud core collapses along the magnetic field lines. The magnetic field in the dense region of the cloud core rotates faster than that of the parent cloud as a consequence of spin-up of the central region during the collapse. The cloud core exhibits significant precession of the rotation axis, magnetic field, and disk orientation, with precession highest in the models with low initial field strength ( $\leq 20 \mu\text{G}$ ). Precession in models with initial fields of  $\sim 40 \mu\text{G}$  is suppressed by strong magnetic braking. Magnetic braking transfers angular momentum from the central region and acts more strongly on the component of angular momentum oriented perpendicular to the magnetic field. After the formation of an adiabatic core, outflow is ejected along the local magnetic field lines. Strong magnetic braking associated with the outflow causes the direction of angular momentum to converge with that of the local magnetic field, resulting in the convergence of the local magnetic field, angular momentum, outflow, and disk orientation by the outflow formation phase. The magnetic field of a young star is inclined at an angle of no more than  $30^\circ$  from that of the parent cloud at initial field strengths of  $\sim 20 \mu\text{G}$ , while at an initial field strength of  $\sim 40 \mu\text{G}$ , the magnetic field of the young star is well aligned with that of the parent cloud.

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<http://meric.i.hosei.ac.jp/~matsu/outflow04/>

## A Radio and Mid-Infrared Survey of Northern Bright-Rimmed Clouds

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We have carried out an archival radio, optical and infrared wavelength imaging survey of 44 Bright-Rimmed Clouds (BRCs) using the NRAO/VLA Sky Survey (NVSS) archive, images from the Digitised Sky Survey (DSS) and the Midcourse Space eXperiment (MSX). The data characterise the physical properties of the Ionised Boundary Layer (IBL) of the BRCs. We have classified the radio detections as: that associated with the ionised cloud rims; that associated with possible embedded Young Stellar Objects (YSOs); and that unlikely to be associated with the clouds at all. The stars responsible for ionising each cloud are identified and a comparison of the expected ionising flux to that measured at the cloud rims is presented. A total of 25 clouds display 20 cm radio continuum emission that is associated with their bright optical rims. The ionising photon flux illuminating these clouds, the ionised gas pressure and the electron density of the IBL are determined. We derive internal molecular pressures for 9 clouds using molecular

line data from the literature and compare these pressures to the IBL pressures to determine the pressure balance of the clouds. We find three clouds in which the pressure exerted by their IBLs is much greater than that measured in the internal molecular material. A comparison of external pressures around the remaining clouds to a global mean internal pressure shows that the majority of clouds can be expected to be in pressure equilibrium with their IBLs and hence are likely to be currently shocked by photoionisation shocks. We identify one source which shows 20 cm emission consistent with that of an embedded high-mass YSO and confirm its association with a known infrared stellar cluster. This embedded cluster is shown to contain early-type B stars, implying that at least some BRCs are intimately involved in intermediate to high mass star formation.

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## Is the Cepheus E Outflow driven by a Class 0 Protostar?

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New early release observations of the Cepheus E outflow and its embedded source, obtained with the Spitzer Space Telescope, are presented. We show that the driving source is detected in all 4 IRAC bands, which suggests that traditional Class 0 classification, although essentially correct, needs to accommodate the new high sensitivity infrared arrays and their ability to detect deeply embedded sources, thus we have determined a slope of the mid infrared spectral energy distribution to be  $a = 5 \pm 1$  using only the IRAC fluxes. The IRAC, MIPS 24 and  $70\mu\text{m}$  new photometric points are consistent with a spectral energy distribution dominated by a cold, dense envelope surrounding the protostar. The Cep E outflow displays a very similar morphology in the near and mid-infrared wavelengths and is detected at  $24\mu\text{m}$ . The interface between the dense molecular gas (where Cep E lies) and less dense interstellar medium, is well traced by the emission at 8 and  $24\mu\text{m}$ , and is one of the most exotic features of the new IRAC and MIPS images. IRS observations of the North lobe of the flow confirm that most of the emission is due to the excitation of pure  $\text{H}_2$  rotational transitions arising from a relatively cold ( $T_{ex} \sim 700$  K) and dense ( $6.4 \times 10^4$  cc) molecular gas.

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## A New Look at Stellar Outflows: Spitzer Observations of the Herbig-Haro 46/47 System

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We present the early release observations of the HH 46/47 system and HH 46 IRS1 source, taken with the three instruments aboard the Spitzer Space Telescope. The optically invisible SW lobe, driven by the HH 47C bow shock is revealed in full detail by the IRAC images, and displays a “loop” like morphology. Both of the mid-infrared outflow lobes are narrower than those of CO flow. We believe that the combination of emission by  $\text{H}_2$  rotational lines (S(11)-S(4)) and some atomic lines, which fall within the IRAC passbands, are responsible for the bulk of the observed

emission, although contributions from the 3.3, 6.2 and 7.7 $\mu\text{m}$  PAH emission bands can not be ruled out. Weak spectral features corresponding to these emitters are present in the IRS spectrum of the HH 47A bow shock. The spectrum of HH 46 IRS1 shows remarkable similarities to those of high-mass protostars, which include the presence of H<sub>2</sub>O, CO<sub>2</sub>, CH<sub>4</sub>, and possibly NH<sub>3</sub>, CH<sub>3</sub>OH, and NH<sub>4</sub><sup>+</sup> ices. The high ice abundances and the lack of signs of thermal processing indicate that these ices in the envelope are well shielded from the powerful outflow and its cavity. Emission from the Bok Globule at 24 $\mu\text{m}$  is detected and displays a similar structure to that observed at 8 $\mu\text{m}$ .

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## Mapping ices in protostellar environments on 1000 AU scales: Methanol-rich ice in the envelope of Serpens SMM 4

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We present VLT-ISAAC *L*-band spectroscopy toward 10 stars in SVS 4, a 30 $\text{arcsec} \times 45\text{arcsec}$  dense cluster of pre-main sequence stars deeply embedded in the Serpens star forming cloud. The ISAAC spectra are combined with archival imaging from UKIRT and ISOCAM to derive accurate extinctions toward the SVS 4 stars. The data are then used to construct a spatial map of the distribution of ice in front of the cluster stars with an average angular resolution of 6 arcsec or 1500 AU, three orders of magnitude better than previous maps. We show that water ice is present throughout the region and confirm the presence of methanol ice with an abundance of up to 25% relative to water. It is shown that methanol ice maintains a very high abundance relative to H<sub>2</sub> throughout SVS 4, but drops by at least an order of magnitude only 75 $\text{arcsec}$  away from SVS 4. The maps indicate that some of the lines of sight toward the SVS 4 stars pass through the outer envelope of the class 0 protostar SMM 4. The abundance of water ice relative to the refractory dust component shows a sudden increase by 90% to  $(1.7 \pm 0.2) \times 10^{-4}$  relative to H<sub>2</sub> at a distance of 5 000 AU to the center of SMM 4. The water ice abundance outside the jump remains constant at  $(9 \pm 1) \times 10^{-5}$ . We suggest that this is an indication of a significantly enhanced ice formation efficiency in the envelopes of protostars. The depletion of volatile molecules in the envelope of SMM 4 is discussed. In particular, it is found that up to 2/3 of the depleted CO is converted into CO<sub>2</sub> and CH<sub>3</sub>OH in the ice. Therefore, only 1/3 of the CO originally frozen out will return to the gas phase as CO upon warmup.

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## Sharpless 170 and the surrounding interstellar medium

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Sharpless 170 is a diffuse HII region ionized by a single main sequence O-star located near the periphery of a small dense molecular cloud at a distance of  $\sim 2$  kpc. We describe wide-field observations of the region in the radio continuum, in HI and CO-lines, and in the far-infrared which delineate the major ionized, atomic, molecular and dust components of the gas affected by the exciting star. From the thermal continuum emission we estimate the mass of ionized gas at  $\sim 350M_{\odot}$  within a radius of  $\sim 7\text{pc}$ . The HI ( $\lambda 21$  cm) and far-infrared observations show an extended low-density atomic component, of  $\sim 1000M_{\odot}$ , within an irregular boundary surrounding the ionized gas of mean radius  $\sim 10$  pc. Mean densities in the HI and HII are similar, in the range 9–16 nucleons  $\text{cm}^{-3}$ . CO emission shows a molecular cloud of  $\sim 1150M_{\odot}$  within an area 6pc $\times$ 4pc with densities  $\sim 2000$  nucleons  $\text{cm}^{-3}$ . A compact infrared component coincides with the cloud. The exciting star is located on the near side of the cloud, just inside the southern periphery.

Sh170 is an example of a young HII region with the ionized gas, seen in H $\alpha$  emission, streaming outward in the manner of a “champagne flow”. Although the observed velocities of the HI are close to the mean velocity of the CO cloud, the morphology of the associated atomic hydrogen closely resembles that seen in the surrounds of other young HII regions which show clear evidence of expansion of their HI. We propose that much of the HI is a diffuse dissociation zone beyond the ionization front, in directions from the star within a wide annulus, approximately transverse to the line-of-sight, between the dense photon-bounded region on the far side of the star and the density-bounded ionized flow region on the near side. In this view, much of the associated atomic gas, like the ionized gas, has been eroded from the molecular cloud in a small fraction ( $\leq 10\%$ ) of the star’s main sequence lifetime.

Accepted by Astronomy and Astrophysics

## Variability in the stellar initial mass function at high mass: coalescence models for starburst clusters

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A coalescence model using the observed properties of pre-stellar condensations (PSCs) shows how an initially steep IMF that might be characteristic of primordial cloud fragmentation can change into a Salpeter IMF or shallower IMF in a cluster of normal density after one dynamical time, even if the PSCs are collapsing on their own dynamical time. The model suggests that top-heavy IMFs in some starburst clusters originate with PSC coalescence.

Accepted by MNRAS

<http://xxx.lanl.gov/astro-ph/0407120>

## Free-Free Radio Emission from Young Stellar Objects

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We calculate the cm wavelength free-free emission of the jets of young stellar objects (YSOs) with the x-wind model enhanced by a variety of physical processes. Using parameters characteristic of a Class I YSO with a mass-loss rate  $\sim 10^{-6} M_{\odot} \text{yr}^{-1}$ , we obtain a 3.6-cm map and a spectral index that compare well with high-spatial resolution observations of L1551 IRS5. Models with lower mass loss rates, appropriate for Class II YSOs with revealed optical jets, produce radio jets that are too weak to be detected at current sensitivity levels. In addition to demonstrating the consistency of the density distribution of the x-wind model with observations, we are able to obtain information on the processes that heat and ionize the inner jet, i.e., X-ray ionization and shock heating and ionization.

Accepted by ApJ Letters

## The secrets of the nearest starburst cluster: I. VLT/ISAAC Photometry of NGC 3603

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VLT/ISAAC *JHKL* photometry with sub-arcsecond resolution of the dense, massive starburst cluster NGC 3603 YC forming the core of the NGC 3603 giant molecular cloud is analysed to reveal characteristics of the stellar population in unprecedented detail. The colour-magnitude plane features a strong pre-main sequence/main sequence (PMS/MS) transition region including the PMS/MS transition point, and reveals a secondary sequence for the first time in a nearby young starburst cluster. Arguments for a possible binary nature of this sequence are given. The resolved PMS/MS transition region allows isochrone fitting below the hydrogen burning turn-on in NGC 3603 YC, yielding an independent estimate of global cluster parameters. A distance modulus of 13.9 mag equivalent to  $d = 6.0 \pm 0.3$  kpc is derived, as well as a line-of-sight extinction of  $A_V = 4.5 \pm 0.6$  towards PMS stars in the cluster center. The interpretation of a binary candidate sequence suggests a single age of 1 Myr for NGC 3603 YC, providing evidence for a single burst of star formation without the need to employ an age spread in the PMS population, as argued for in earlier studies. Disk fractions are derived from *L*-band excesses, indicating a radial increase in the disk frequency from 20 to 40% from the core to the cluster outskirts. The low disk fraction in the cluster core as compared to the 42% *L*-band excess fraction found for massive stars in the Trapezium cluster of a comparably young age indicates strong photoevaporation in the cluster center. The estimated binary fraction of 30% as well as the low disk fraction suggest strong impacts on low-mass star formation due to stellar interactions in the dense starburst. The significant differences between NGC 3603 YC and less dense and massive young star clusters in the Milky Way reveal the importance to use local starbursts as templates for massive extragalactic star formation.

Accepted by the Astronomical Journal

## Magnetically-controlled Spasmodic Accretion during Star Formation: I. Formulation of the Problem and Method of Solution

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We formulate the problem of the late accretion phase of the evolution of an isothermal magnetic disk surrounding a forming star. The evolution is described by the six-fluid MHD equations, accounting for the presence of neutrals, atomic & molecular ions, electrons, and neutral, positively and negatively charged grains. Only the electron fluid is assumed to be attached to the magnetic field, in order to investigate the effect of the detachment of the ions from the magnetic field lines that begins at densities as low as  $10^8 \text{ cm}^{-3}$ . The “central sink approximation” is used to circumvent the problem of describing the evolution inside the opaque central region for densities greater than  $10^{11} \text{ cm}^{-3}$ . In this way, the structure and evolution of the isothermal disk surrounding the forming star can be studied at late times without having to implement the numerically costly radiative transfer required by the physics of the opaque core. The mass and magnetic flux accumulating in the forming star are calculated, as are their effects on the structure & evolution of the surrounding disk.

The numerical method of solution first uses an adaptive grid and later, after a central region a few AUs in radius becomes opaque, switches to a stationary but nonuniform grid with a central sink cell. It also involves an implicit time integrator; an advective difference scheme that possesses the transportive property; a second-order difference approximation of forces inside a cell; an integral approximation of the gravitational and magnetic fields; and tensor artificial viscosity that permits an accurate investigation of the formation and evolution of shocks in the neutral fluid.

Accepted by Ap.J.

## Magnetically-controlled Spasmodic Accretion during Star Formation: II. Results

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The problem of the late accretion phase of the evolution of an axisymmetric, isothermal magnetic disk surrounding a

forming star has been formulated in a companion paper. The “central sink approximation” is used to circumvent the problem of describing the evolution inside the opaque central region for densities greater than  $10^{11} \text{ cm}^{-3}$  and radii smaller than a few AUs. Only the electrons are assumed to be attached to the magnetic field lines, and the effects of both negatively and positively charged grains are accounted for.

After a mass of  $0.1 M_{\odot}$  accumulates in the central cell (forming star), a series of magnetically driven outflows and associated outward propagating shocks form in a quasi-periodic fashion. As a result, mass accretion onto the protostar occurs in magnetically controlled bursts. We refer to this process as spasmodic accretion. The shocks propagate outward with supermagnetosonic speeds. The period of dissipation and revival of the outflow decreases in time, as the mass accumulated in the central sink increases. We evaluate the contribution of ambipolar diffusion to the resolution of the magnetic flux problem of star formation during the accretion phase, and we find it to be very significant although not sufficient to resolve the entire problem yet. Ohmic dissipation is completely negligible in the disk during this phase of the evolution. The protostellar disk is found to be stable against interchange-like instabilities, despite the fact that the mass-to-flux ratio has temporary local maxima.

Accepted by Ap.J.

## Ambipolar-diffusion Timescale, Star-formation Timescale, and the Ages of Molecular Clouds: Is there a Discrepancy?

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We re-examine critically the estimates of the duration of different phases of star formation and the lifetimes of molecular clouds, based on the ages of T-Tauri stars, age spreads of stars in clusters, and statistics of pre-stellar cores. We show that all available observational data are consistent with lifetimes of molecular clouds comparable to  $\approx 10^7$  yr, as well as with the predictions of the theory of self-initiated, ambipolar-diffusion -controlled star formation. We conclude that there exists no observational support for either “young” molecular clouds or “rapid” star formation.

Accepted by Ap.J.

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/>.

## *New Jobs*

### **INAF - Osservatorio Astronomico di Palermo Giuseppe S. Vaiana**

#### **Marie Curie Fellowships Closing date: 20 October 2004**

INAF - Osservatorio Astronomico di Palermo (OAPA) Giuseppe S. Vaiana will appoint one fellow in the area of Astrophysics under the European Commission's Marie Curie Actions Host Fellowship - Transfer of Knowledge programme "The Influence of Stellar High Energy Radiation on Planetary Atmospheres". The selected fellow will work in one of the following areas:

1. X-ray emission from very young and/or active stars, focusing on the determination of high energy emission and flare frequency.
2. X-ray emission and stellar population, through a detailed study of galactic models and characterization in terms of activity of selected fields.
3. Interaction of X-ray emission with planetary atmospheres.

Depending on the need of the institute, one additional position could be covered from the list of selected candidates. The first fellowship has to start before the end of February 2005.

Candidates should have a PhD or at least four years of full-time research experience at postgraduate level in a relevant field. In any case the candidate cannot have more than ten years of research experience.

The applicant must be national of a Member State of the European Community (other than Italy) or an Associated State, or otherwise residing in the Community or in an Associated State for at least four years out of the last five years (except Italy). Candidates should not have been resident in Italy for more than 12 months in the three years prior to selection. Candidates from third countries, could be considered, but subjected to formal approval by the European Commission. In the case of a researcher holding more than one nationality including the Italian one, (s)he could apply if (s)he has not resided in Italy during the previous 5 years. As an exception to the general rule, an Italian citizen can apply if (s)he can provide evidence testifying that (s)he has legally resided and had his/her main activity in a third country for at least four out of the last five years immediately prior to his/her appointment.

Gross salary, including all compulsory deductions under Italian legislation, is fixed at 3889.25 Euro per month plus a mobility allowance for the duration of the contract, which is expected to last for 24 months.

Female candidates are explicitly encouraged to apply.

Applications should include 1. Documents certifying the doctoral degree or a four years of full time research experience.  
2. Statement of compliance with the eligibility requirements relative to the citizenship or residence.

3. Curriculum Vitae.

4. Publication list.

5. Description of applicant's research interests/program with the indication of which area(s) of research, (s)he is interested in working on, selected among those listed above.

6. Two letters of recommendation.

Documents 1,2,3,4,5 should be signed by the candidate.

All documents should arrive by 20 October 2004 at:

INAF - Osservatorio Astronomico di Palermo

Marie Curie Fellowship Selection

Piazza del Parlamento 1

I-90134 Palermo, Italy

For further information contact: Giusi Micela - [giusi@astropa.unipa.it](mailto:giusi@astropa.unipa.it) or <http://www.astropa.unipa.it/ISHERPA>

## *Meetings*

We are pleased to announce IAU Symposium 227 on:

### MASSIVE STAR BIRTH: A CROSSROADS OF ASTROPHYSICS

May 16–20 2005  
Acireale (Catania), Italy

<http://www.arcetri.astro.it/iaus227>

#### *Scientific Organizing Committee*

Ed Churchwell (USA) - Co-Chair; Peter S. Conti (USA) - Co-Chair; Philippe Eenens (Belgium/Mexico); Marcello Felli (Italy); Yasuo Fukui (Japan); Guido Garay (Chile); Suzana Lizano (Mexico); Malcolm Walmsley (Italy); Hans Zinnecker (Germany).

#### *Local Organizing Committee*

Marcello Felli (Italy) Chair; Riccardo Cesaroni (Italy); Corrado Trigilio (Italy); Grazia Umana (Italy).

#### *Co-Editors of Proceedings*

M. Walmsley and E. Churchwell

This IAU sponsored symposium will consider Massive Star Formation (MSF) from the perspective of their gas and dust ENVIRONMENTS, the physics of their FORMATION, their initial phases of EVOLUTION, and their connections to STAR BIRTH CLUSTERS. We will bring together astronomers from several disparate communities: interstellar medium, stellar astrophysics, stellar dynamics, and star formation in galaxies. Observations from a wide range of energies will be considered, including X-rays, optical, IR, and radio wavelengths. Related theoretical studies will be included, as will new and relevant data from the SPITZER mission.

We believe that: a better understanding of the problems of MSF can be achieved; an assessment of where we are in solving those problems will result; ideas for future programs to attack remaining issues will follow.

Unlike other fields of stellar astrophysics, MSF is nearly entirely hidden from view in the visible but amenable to observation at hard X-Ray, IR, mm, and radio wavelengths. These observations typically deal with the surrounding ionized medium and the natal dust clouds from which the properties of the

underlying newly born stars need to be inferred. This conference will specifically consider massive star birth processes in terms of the evolution of the newly born stellar object and that of its environment.

Two competing hypotheses have been proposed for massive star birth; accretion of ambient gas in molecular cores and mergers of intermediate mass protostars. In this meeting, we plan to assess the observational and theoretical evidence of the role of these two processes, as well as to discuss issues such as the evolutionary sequence from Starless Molecular Cores, to Hot Molecular Cores, to Hypercompact HII regions, to Ultracompact HII regions, to Classical HII regions.

We also plan to address other important topics outlined in the program below.

#### **ORGANIZATION OF THE SYMPOSIUM**

The symposium will consist of four and one-half days of meetings, from 08:30 to 18:30, with two one-half hour coffee breaks and three hours for lunch. Invited Talks of 30 minutes length each and Contributed Talks of 20 minutes length each will be scheduled. Posters will provide an important

part of the presentations. The following draft of the program with the tentative Invited Talks is given to provide a framework of the main threads of the conference. The topics listed already have tentative speakers associated but they have not all been contacted as yet. Contributed talks are welcomed.

#### **OUTLINE OF PROGRAM**

##### *I. Introductory Framework*

The Role of Massive Stars in Astrophysics; Orion, The Nearest MS Birth Region; MS Birth in the Galactic Center

*II. Star Birth Sequence: The Natal Precursors*

Initial Conditions for MS Birth; Ices as Tracers of MS Birth; Chemistry of the Molecular Cores; The Role of Magnetic Fields on MSF; Hot Molecular Cores; Formation of Discs; The Disc-Jet Connection; Dissipation of Stellar Disks; Hypercompact HII Regions; Radio Observations of UCHII Regions; Spitzer Observations of MSF Regions

*III. Star Birth Sequence: The Stars*

Stellar Evolution Before the ZAMS; Protostellar SEDs and IR Colors; Accretion Processes; Binary Mergers; Massive Star Outflows; Jets from YSOs; Chandra Observations of MSF; X-Ray Studies of MSF; Parameters of ZAMS Stars; Parameters of Massive YSOs; Winds in ZAMS O Stars

*IV. Star Birth in a Cluster Environment*

Clustered Massive Star Birth; Cluster Formation in Molecular Clouds; Molecular Cores/Clusters in the MCs; Turbulence and Star Birth; Infrared Studies of Newly Formed Clusters; IR Observations of UC HII Regions; Protoclusters: Massive Star Birth; NIR Studies of GHII Region Clusters; Super Star Clusters: Implication for MSF; Upper Mass Limit in Clusters; Population III stars

*V. Conference Summary: What have we learned? What are the main unsolved problems? Where do we go from here?*

Natal Molecular Clouds; Massive Star Birth Sequence; Star Birth in Clusters

**ACCOMMODATION**

The Symposium will be hosted in the Congress Center “La Perla Ionica” (<http://www.laperlaionica.com/ITA/homepage.htm>) in Sicily (Italy), in the town of Acireale, close to Catania. The place is a quiet and pleasant resort on the Ionic Coast, not far from Taormina and at the foot of the Etna Volcano. The Congress Center offers a range of room rates.

**IAU GRANTS**

A limited number of IAU grants for individual participants will be available. The IAU grants can be used primarily for room and board of candidates unable to provide this by themselves. The application form for an IAU grant can be found in <http://www.iau.org/IAU/Activities/meetings/travappl.html> and should be submitted by e-mail, FAX, or regular mail to:

Ed Churchwell  
Washburn Observatory, University of Wisconsin-Madison  
475 North Charter Street, Madison, Wisconsin 53706  
U.S.A.  
FAX: +1-608-263-6386 - ([churchwell@astro.wisc.edu](mailto:churchwell@astro.wisc.edu))

The deadline for application to an IAU grant is November 30 2004.

**REGISTRATION**

Registration is possible through the symposium web site <http://www.arcetri.astro.it/iaus227>  
The registration fee will be 200 Euro to be paid in cash upon arrival at the meeting.

**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.