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# *Abstracts of recently accepted papers*

## The infrared void in the Lupus dark clouds revisited: A polarimetric approach

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The results of B-band CCD imaging linear polarimetry obtained for stars from the *Hipparcos* catalogue are used to re-examine the distribution of the local interstellar medium towards the *IRAS* 100-$\mu$m emission void in the Lupus dark clouds. The analysis of the obtained parallax-polarization diagram assigns to the dark cloud Lupus 1 a distance between 130 and 150 pc and assures the existence of a low column density region coincident to the observed infrared void. Moreover, there are clear indications of the existence of absorbing material at distances closer than 60–100 pc, which may be associated to the interface boundary between the Local Bubble and its neighbourhood Loop I superbubble.

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## Birth and fate of hot-Neptune planets

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This paper presents a consistent description of the formation and the subsequent evolution of gaseous planets, with special attention to short-period, low-mass hot-Neptune planets characteristic of $\mu$ Ara-like systems. We show that core accretion including migration and disk evolution and subsequent evolution taking into account irradiation and evaporation provide a viable formation mechanism for this type of strongly irradiated light planets. At an orbital distance $a \simeq 0.1$ AU, this revised core accretion model leads to the formation of planets with total masses ranging from $\sim 14$ $M_{earth}$ (0.044 $M_{jup}$) to $\sim 400$ $M_{earth}$ (1.25 $M_{jup}$). The newly born planets have a dense core of $\sim 6$ $M_{earth}$, independent of the total mass, and heavy element enrichments in the envelope, $M_{\rm Z,env}/M_{\rm env}$, varying from 10% to 80% from the largest to the smallest planets. We examine the dependence of the evolution of the born planet on the evaporation rate due to the incident XUV stellar flux. In order to reach a $\mu$ Ara-like mass ($\sim 14$ $M_{earth}$) after $\sim 1$ Gyr, the initial planet mass must range from 166 $M_{earth}$ ($\sim 0.52$ $M_{jup}$) to about 20 $M_{earth}$, for evaporation rates varying by 2 orders of magnitude, corresponding to 90% to 20% mass loss during evolution. The presence of a core and heavy elements in the envelope affects appreciably the structure and the evolution of the planet and yields $\sim 8\% - 9\%$ difference in radius compared to coreless objects of solar composition for Saturn-mass planets. These combinations of evaporation rates and internal compositions translate into different detection probabilities, and thus different statistical distributions for hot-Neptunes and hot-Jupiters. These calculations provide an observable diagnostic, namely a mass-radius-age relationship to distinguish between the present core-accretion-evaporation model and the alternative colliding core scenario for the formation of hot-Neptunes.

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*For preprints via ftp or WWW*: astro-ph/0512091

## Neutral carbon and CO emission in the core and the halo of dark cloud Barnard 5

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*Aims.* The physical conditions and chemical structure in the dark cloud of Barnard 5 and its surrounding atomic halo is studied. The impact of the halo on the line emission emerging from the molecular cloud is investigated.

*Methods.* We present observations of the [CI] $^3P_1 \rightarrow ^3P_0$ transition of neutral carbon and the low-$J$ transitions of $^{12}$CO and $^{13}$CO. The CO maps extend from the core ($A_v \gtrsim 7$) to the northern cloud edge and into the halo ($A_v \lesssim 1$). They are complemented by deeply integrated [CI] spectra made along a 1D cut of similar extent. Escape probability and photon-dominated region (PDR) models are employed to interpret the observations.

*Results.* $^{12}$CO and $^{13}$CO are detected in the cloud and the halo, while [CI] is detected only toward the molecular cloud. This occurs even though the neutral carbon column density is $\gtrsim 5$ times larger than the CO column density in the halo, but it can be understood in terms of excitation. The [CI] excitation is governed by collisions even at the low halo densities, while the CO excitation is dominated by the absorption of line photons emitted by the nearby molecular cloud. The upper limit on the neutral carbon column density in the halo is $6 \times 10^{15}\,\mathrm{cm}^{-2}$.

The PDR studies show that even small column densities of $H_2$ and CO, such as those in the B5 halo, can significantly change the [CI] and CO line emission (pre-shielding). Since this effect decreases the [CI] intensity and increases the CO intensity, the largest impact is noted for the [CI]/CO line ratios. For the B5 cloud, a PDR model with a molecular hydrogen column density of $\sim 6 \times 10^{19}\,\mathrm{cm}^{-2}$ in the halo matches the observed [CI]/CO line ratios best. Models with no pre-shielding, in contrast, suggest high gas densities that are in conflict with independently derived densities. The PDR models with a $\chi < 1$ demonstrate that the [CI]/CO ratios cannot be attributed solely to a reduced FUV field.

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http://www.edpsciences.org/articles/aa/pdf/forthpdf/aa3580-05_forth.pdf

## Caught in the Act: The Onset of Massive Star Formation

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Combining mid-infrared data from the *Spitzer Space Telescope* with cold gas and dust emission observations from the Plateau de Bure Interferometer, we characterize the infrared dark cloud IRDC 18223-3 at high spatial resolution. The millimeter continuum data reveal a massive $\sim 184 M_\odot$ gas core with a projected size of 28,000 AU that has no associated protostellar mid-infrared counterpart. However, the detection of 4.5 $\mu$m emission at the edge of the core indicates early outflow activity, which is supported by broad CO and CS spectral line-wing emission. Moreover, systematically increasing $N_2H^+(1-0)$ line width toward the millimeter core center can be interpreted as additional evidence for early star formation. Furthermore, the $N_2H^+(1-0)$ line emission reveals a less massive secondary core that could be in an evolutionary stage prior to any star formation activity.

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## Dynamical Masses for Low-Mass Pre-Main-Sequence Stars: A Preliminary Physical Orbit for HD 98800 B

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We report on Keck Interferometer observations of the double-lined binary (B) component of the quadruple pre-main-sequence (PMS) system HD 98800. With these interferometric observations, combined with astrometric measurements made by the *Hubble Space Telescope* (*HST*) Fine Guidance Sensors (FGS) and published radial velocity observations, we have estimated preliminary visual and physical orbits of the HD 98800 B subsystem. Our orbit model calls for an inclination of $66.8^\circ \pm 3.2^\circ$ and allows us to infer the masses and luminosities of the individual components. In particular we find component masses of $0.699 \pm 0.064$ and $0.582 \pm 0.051 M_\odot$ for the Ba (primary) and Bb (secondary) components, respectively. Spectral energy distribution (SED) modeling of the B subsystem suggests that the B circumstellar material is a source of extinction along the line of sight to the B components. This seems to corroborate a conjecture by Tokovinin that the B subsystem is viewed through circumbinary material, but it raises important questions a bout the morphology of that circumbinary material. Our modeling of the subsystem component SEDs finds temperatures and luminosities in agreement with previous studies, and coupled with the component mass estimates allows for comparison with PMS models in the low-mass regime with few empirical constraints. Solar abundance models seem to underpredict the inferred component temperatures and luminosities, while assuming slightly subsolar abundances brings the models and observations into better agreement. The current preliminary orbit does not yet place significant constraints on existing PMS stellar models, but prospects for additional observations improving the orbit model and component parameters are very good.

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## Gas Giant Protoplanets Formed by Disk Instability in Binary Star Systems

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Roughly half of nearby primary stars are members of binary or multiple systems, so the question of whether or not they can support the formation of planetary systems similar to our own is an important one in the search for life outside our solar system. Previous theoretical work has suggested that binary star systems might not be able to permit the formation of gas giant planets, because of the heating associated with shock fronts driven in the stars' protoplanetary disks by tidal forces during the periodic close encounters between the two stars. As a result, the disks could become too hot for icy bodies to exist, thereby preventing giant planet formation by the core accretion mechanism, and too hot for giant planets to form by the disk instability mechanism. However, gas giant planets have been discovered in orbit around a number of stars that are members of binary or triple star systems, with binary semimajor axes ranging from $\sim 12$ to over 1000 AU. We present here a suite of three dimensional radiative gravitational hydrodynamics models suggesting that binary stars may be quite capable of forming planetary systems similar to our own. One difference between the new and previous calculations is the inclusion of artificial viscosity in the previous work, leading to significant conversion of disk kinetic energy into thermal energy in shock fronts and elsewhere. New models are presented showing how vigorous artificial viscosity can help to suppress clump formation. The new models with binary companions do not employ any explicit artificial viscosity, and also include the third (vertical) dimension in the hydrodynamic calculations, allowing for transient phases of convective cooling. The new calculations of the evolution of initially marginally gravitationally stable disks show that the presence of a binary star companion may actually help to trigger the formation of dense clumps that could become giant planets. Earth-like planets would form much later in the inner disk regions by the traditional collisional accumulation of progressively larger, solid bodies. We also show that in models without binary companions, which begin their evolution as gravitationally stable disks, the disks evolve to form dense rings, which then break-up into self-gravitating clumps. These latter models suggest that the evolution of any self-gravitating disk with sufficient mass to form gas giant planets is likely to lead to a period of disk instability, even in the absence of a trigger such as a binary star companion.

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## Linking the collisional history of the main asteroid belt to its dynamical excitation and depletion

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The main belt is believed to have originally contained an Earth mass or more of material, enough to allow the asteroids to accrete on relatively short timescales. The present-day main belt, however, only contains $\sim 5 \times 10^{-4}$ Earth masses. Numerical simulations suggest that this mass loss can be explained by the dynamical depletion of main belt material via gravitational perturbations from planetary embryos and a newly-formed Jupiter. To explore this scenario, we combined dynamical results from Petit et al. [Petit, J. Morbidelli, A., Chambers, J., 2001. The primordial excitation and clearing of the asteroid belt. Icarus 153, 338-347] with a collisional evolution code capable of tracking how the main belt undergoes comminution and dynamical depletion over 4.6 Gyr [Bottke, W.F., Durda, D., Nesvorny, D., Jedicke, R., Morbidelli, A., Vokrouhlický, D., Levison, H., 2005. The fossilized size distribution of the main asteroid belt. Icarus 175, 111-140]. Our results were constrained by the main belt's size-frequency distribution, the number of asteroid families produced by disruption events from diameter $D > 100$ km parent bodies over the last 3-4 Gyr, the presence of a single large impact crater on Vesta's intact basaltic crust, and the relatively constant lunar and terrestrial impactor flux over the last 3 Gyr. We used our model to set limits on the initial size of the main belt as well as Jupiter's formation time. We find the most likely formation time for Jupiter was $3.3 \pm 2.6$ Myr after the onset of fragmentation in the main belt. These results are consistent with the estimated mean disk lifetime of 3 Myr predicted by Haisch et al. [Haisch, K.E., Lada, E.A., Lada, C.J., 2001. Disk frequencies and lifetimes in young clusters. Astrophys. J. 553, L153-L156]. The post-accretion main belt population, in the form of diameter $D \leq 1000$ km planetesimals, was likely to have been $160 \pm 40$ times the current main belt's mass. This corresponds to 0.06-0.1 Earth masses, only a small fraction of the total mass thought to have existed in the main belt zone during planet formation. The remaining mass was most likely taken up by planetary embryos formed in the same region. Our results suggest that numerous $D > 200$ km planetesimals disrupted early in Solar System history, but only a small fraction of their fragments survived the dynamical depletion event described above. We believe this may explain the limited presence of iron-rich M-type, olivine-rich A-type, and non-Vesta V-type asteroids in the main belt today. The collisional lifetimes determined for main belt asteroids agree with the cosmic ray exposure ages of stony meteorites and are consistent with the limited collisional evolution detected among large Koronis family members. Using the same model, we investigated the near-Earth object (NEO) population. We show the shape of the NEO size distribution is a reflection of the main belt population, with main belt asteroids driven to resonances by Yarkovsky thermal forces. We used our model of the NEO population over the last 3 Gyr, which is consistent with the current population determined by telescopic and satellite data, to explore whether the majority of small craters ($D < 0.1 - 1$ km) formed on Mercury, the Moon, and Mars were produced by primary impacts or by secondary impacts generated by ejecta from large craters. Our results suggest that most small craters formed on these worlds were a by-product of secondary rather than primary impacts.

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## The Effects of Metallicity and Grain Size on Gravitational Instabilities in Protoplanetary Disks

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Observational studies show that the probability of finding gas giant planets around a star increases with the star's metallicity. Our latest simulations of disks undergoing gravitational instabilities (GIs) with realistic radiative cooling indicate that protoplanetary disks with lower metallicity generally cool faster and thus show stronger overall GI-activity. More importantly, the global cooling times in our simulations are too long for disk fragmentation to occur, and the disks do not fragment into dense protoplanetary clumps. Our results suggest that direct gas giant planet formation via disk instabilities is unlikely to be the mechanism that produced most observed planets. Nevertheless, GIs may still play an important role in a hybrid scenario, compatible with the observed metallicity trend, where structure created by GIs accelerates planet formation by core accretion.

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## $H_2$ active jets in the near IR as a probe of protostellar evolution

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We present an in-depth near-IR analysis of a sample of $H_2$ outflows from young embedded sources to compare the physical properties and cooling mechanisms of the different flows. The sample comprises 23 outflows driven by Class 0 and I sources having low-intermediate luminosity. We have obtained narrow band images in $H_2$ 2.12 $\mu$m and [FeII] 1.64 $\mu$m and spectroscopic observations in the range 1-2.5 $\mu$m. From [FeII] images we detected spots of ionized gas in ∼74% of the outflows which in some cases indicate the presence of embedded HH-like objects. $H_2$ line ratios have been used to estimate the visual extinction and average temperature of the molecular gas. $A_v$ values range from ∼2 to ∼15 mag; average temperatures range between ∼2000 and ∼4000 K. In several knots, however, a stratification of temperatures is found with maximum values up to 5000 K. Such a stratification is more commonly observed in those knots which also show [FeII] emission, while a thermalized gas at a single temperature is generally found in knots emitting only in molecular lines. Combining narrow band imaging ($H_2$, 2.12 $\mu$m and [FeII], 1.64 $\mu$m) with the parameters derived from the spectroscopic analysis, we are able to measure the total luminosity of the $H_2$ and [FeII] shocked regions ($L_{H_2}$ and $L_{[FeII]}$) in each flow. $H_2$ is the major NIR coolant with an average $L_{H_2}/L_{[FeII]}$ ratio of $\sim 10^2$. We find that ∼83% of the sources have a $L_{H_2}/L_{bol}$ ratio ∼0.04, irrespective of the Class of the driving source, while a smaller group of sources (mostly Class I) have $L_{H_2}/L_{bol}$ an order of magnitude smaller. Such a separation reveals the non-homogeneous behaviour of Class I, where sources with very different outflow activity can be found. This is consistent with other studies showing that among Class I one can find objects with different accretion properties, and it demonstrates that the $H_2$ power in the jet can be a powerful tool to identify the most active sources among the objects of this class.

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http://www.mporzio.astro.it/∼bruni/publ.html

## A new radial system of dark globules in Monoceros

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*Aims.* We analyze the LBN 978 HII region in order to study the HII/molecular cloud interaction.
*Methods.* We used the IAC-80 telescope to image the region with narrow-band filters and the Very Large Array to obtain a radio continuum map at 3.6 cm. We also used the DSS2 red images and the NRAO VLA Sky Survey at 20 cm.

*Results.* We have discovered a new radial system of dark globules associated with the LBN 978 HII region, containing a group of at least eight cometary bright-rimmed globules with the same morphological type. The brightest source is also detected in the radio continuum. Analysis of optical and radio emission suggest that this object is photoionized by HD 47432, the central star of the LBN 978 HII region.

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## A *Spitzer* Study of Dusty Disks around Nearby, Young Stars

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We have obtained *Spitzer Space Telescope* MIPS (Multiband Imaging Photometer for *Spitzer*) observations of 39 A- through M-type dwarfs, with estimated ages between 12 and 600 Myr; IRAC observations for a subset of 11 stars; and follow-up CSO SHARC II 350 $\mu$m observations for a subset of two stars. None of the objects observed with IRAC possess infrared excesses at $3.6-8.0\mu$m; however, seven objects observed with MIPS possess 24 and/or 70 $\mu$m excesses. Four objects ($\kappa$ Phe, HD 92945, HD 119124, and AU Mic), with estimated ages $12-200$ Myr, possess strong 70 $\mu$m excesses, $\geq 100\%$ larger than their predicted photospheres, and no 24 $\mu$m excesses, suggesting that the dust grains in these systems are cold. One object (HD 112429) possesses moderate 24 and 70 $\mu$m excesses with a color temperature, $T_{gr} = 100$ K. Two objects ($\alpha^1$ Lib and HD 177724) possess such strong 24 $\mu$m excesses that their 12, 24, and 70 $\mu$m fluxes cannot be self-consistently modeled using a modified blackbody despite a 70 $\mu$m excess $> 2$ times greater than the photosphere around $\alpha^1$ Lib. The strong 24 $\mu$m excesses may be the result of emission in spectral features, as observed toward the Hale-Bopp star HD 69830.

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## Protostars, Dust Globules, and a Herbig-Haro Object in the LMC Superbubble N51D

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Using *Spitzer Space Telescope* and *Hubble Space Telescope* observations of the superbubble N51D, we have identified three young stellar objects (YSOs) in dust globules and made the first detection of a Herbig-Haro object outside the Galaxy. The spectral energy distributions of these YSOs suggest young massive stars with disk, envelope, and outflow cavities. The interstellar conditions are used to assess whether the star formation was spontaneous or induced by external pressure.

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## The Evolution of the Water Distribution in a Viscous Protoplanetary Disk

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Astronomical observations have shown that protoplanetary disks are dynamic objects through which mass is transported and accreted by the central star. This transport causes the disks to decrease in mass and cool over time, and such evolution is expected to have occurred in our own solar nebula. Age dating of meteorite constituents shows that their creation, evolution, and accumulation occupied several Myr, and over this time disk properties would evolve significantly. Moreover, on this timescale, solid particles decouple from the gas in the disk and their evolution follows a different path. It is in this context that we must understand how our own solar nebula evolved and what effects this evolution had on the primitive materials contained within it. Here we present a model which tracks how the distribution of water changes in an evolving disk as the water-bearing species experience condensation, accretion, transport, collisional destruction, and vaporization. Because solids are transported in a disk at different rates depending on their sizes, the motions will lead to water being concentrated in some regions of a disk and depleted in others. These enhancements and depletions are consistent with the conditions needed to explain some aspects of the chemistry of chondritic meteorites and formation of giant planets. The levels of concentration and depletion, as well as their locations, depend strongly on the combined effects of the gaseous disk evolution, the formation of rapidly migrating rubble, and the growth of immobile planetesimals. Understanding how these processes operate simultaneously is critical to developing our models for meteorite parent body formation in the solar system and giant planet formation throughout the galaxy. We present examples of evolution under a range of plausible assumptions and demonstrate how the chemical evolution of the inner region of a protoplanetary disk is intimately connected to the physical processes which occur in the outer regions.

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## Evidence for $J$- and $H$-Band Excess in Classical T Tauri Stars and the Implications for Disk Structure and Estimated Ages

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We argue that classical T Tauri stars (CTTSs) possess significant nonphotospheric excess in the $J$ and $H$ bands (1.25 and 1.66 $\mu$m, respectively). We first show that normalizing the spectral energy distributions (SEDs) of CTTSs to the $J$ band leads to a poor fit of the optical fluxes (which are systematically overestimated), while normalizing the SEDs to the $I_C$ band (0.8 $\mu$m) produces a better fit to the optical bands and in many cases reveals the presence of a considerable excess at $J$ and $H$. Near-infrared spectroscopic veiling measurements from the literature support this result. We find that $J$- and $H$-band excesses correlate well with the $K$-band (2.2 $\mu$m) excess and that the $J-K$ and $H-K$ colors of the excess emission are consistent with that of a blackbody at the dust sublimation temperature ($\sim 1500-2000$ K). We propose that this near-IR excess originates at a hot inner rim, analogous to those suggested to explain the "near-IR bump" in the SEDs of Herbig Ae/Be stars. To test our hypothesis, we use the model presented by Dullemond and coworkers to fit the photometry data between 0.5 and 24 $\mu$m of 10 CTTSs associated with the Chamaeleon II molecular cloud. We find that simple models that include luminosities calculated from $I_C$-band magnitudes and an inner rim may account for the reported $J$- and $H$-band excesses. The models that best fit the data are those in which the inner radius of the disk is larger than expected for a rim in thermal equilibrium with the photospheric radiation field alone. In particular, we find that large inner rims are necessary to account for the mid-infrared fluxes ($3.6-8.0\mu$m) obtained by the *Spitzer Space Telescope* (*Spitzer*). The large radius could be explained if, as proposed by D'Alessio and colleagues, the UV radiation from the accretion shock significantly affects the sizes of the inner holes in disks around CTTSs. Finally, we argue that deriving the stellar luminosities of CTTSs by making bolometric corrections to the $J$-band fluxes, which is the "standard" procedure for obtaining CTTS luminosities, systematically overestimates these luminosities. The overestimated luminosities translate into underestimated ages when the stars are placed in the

H-R diagram. Thus, the results presented herein have important implications for the dissipation timescale of inner accretion disks.

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## Adaptive Optics Assisted Near-Infrared Spectroscopy of SVS 13 and its Jet

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We present long-slit H- and K-band spectroscopy of the low-mass outflow source SVS 13, obtained with the adaptive-optics assisted imager-spectrometer *NACO* on the *VLT*. With a spatial resolution of <0.25" and a pixel scale of 0.027" we precisely establish the relative offsets of $H_2$, [Fe II], CO, HI and NaI components from the source continuum. The $H_2$ and [Fe II] peaks are clearly associated with the jet, while the CO, HI and NaI peaks are spatially unresolved and coincident with the source, as is expected for emission associated with accretion processes. The $H_2$ profile along the slit is resolved into multiple components, which increase in size though decrease in intensity with distance from the source. This trend might be consistent with thermal expansion of packets of gas ejected during periods of increased accretion activity. Indeed, for the brightest component nearest the source, proper motion measurements indicate a tangential velocity of 0.028"/year. It therefore seems unlikely that this emission peak is associated with a stationary zone of warm gas at the base of the jet. However, the same can not be said for the [Fe II] peak, for which we see no evidence for motion downwind, even though radial velocity measurements indicate that the emission is associated with higher jet velocities. We postulate that the [Fe II] could be associated with a collimation shock at the base of the jet.

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http://www.jach.hawaii.edu/∼cdavis/

## Direct detection of a magnetic field in the innermost regions of an accretion disk

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Models predict that magnetic fields play a crucial role in the physics of astrophysical accretion disks and their associated winds and jets. For example, the rotation of the disk twists around the rotation axis the initially vertical magnetic field, which responds by slowing down the plasma in the disk and by causing it to fall towards the central star. The magnetic energy flux produced in this process points away from the disk, pushing the surface plasma outwards, leading to a wind from the disk and sometimes a collimated jet. But these predictions have hitherto not been supported by observations. Here we report the direct detection of the magnetic field in the core of the protostellar accretion disk FU Orionis. The surface field reaches strengths of about 1 kG close to the centre of the disk, and it includes a significant azimuthal component, in good agreement with recent models. But we find that the field is very filamentary and slows down the disk plasma much more than models predict, which may explain why FU Ori fails to collimate its wind into a jet.

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## 51 Eri and GJ 3305: A 10-15 Myr old binary star system at 30 parsecs

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Following the suggestion of Zuckerman et al. (2001, ApJ, 562, L87), we consider the evidence that 51 Eri (spectral type F0) and GJ 3305 (M0), historically classified as unrelated main sequence stars in the solar neighborhood, are instead a wide physical binary system and members of the young $\beta$ Pic moving group (BPMG). The BPMG is the nearest ($d < 50$ pc) of several groups of young stars with ages around 10 Myr that are kinematically convergent with the Oph-Sco-Cen Association (OSCA), the nearest OB star association. Combining SAAO optical photometry, Hobby-Eberly Telescope high-resolution spectroscopy, *Chandra* X-ray data, and UCAC2 catalog kinematics, we confirm with high confidence that the system is indeed extremely young. GJ 3305 itself exhibits very strong magnetic activity but has rapidly depleted most of its lithium. The 51 Eri/GJ 3305 system is the westernmost known member of the OSCA, lying 110 pc from the main subgroups. The system is similar to the BPMG wide binary HD 172555/CD $-64°1208$ and the HD 104237 quintet, suggesting that dynamically fragile multiple systems can survive the turbulent environments of their natal giant molecular cloud complexes, while still being imparted high dispersion velocities. Nearby young systems such as these are excellent targets for evolved circumstellar disk and planetary studies, having stellar ages comparable to that of the late phases of planet formation.

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## Massive stars and the energy balance of the interstellar medium. II. The 35 solar mass star and a solution to the "missing wind problem"

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We continue our numerical analysis of the morphological and energetic influence of massive stars on their ambient interstellar medium for a 35 $M_{\odot}$ star that evolves from the main sequence through red supergiant and Wolf-Rayet phases, until it ultimately explodes as a supernova. We find that structure formation in the circumstellar gas during the early main-sequence evolution occurs as in the 60 $M_{\odot}$ case but is much less pronounced because of the lower mechanical wind luminosity of the star. Since on the other hand the shell-like structure of the H II region is largely preserved, effects that rely on this symmetry become more important. At the end of the stellar lifetime 1% of the energy released as Lyman continuum radiation and stellar wind has been transferred to the circumstellar gas. From this fraction 10% is kinetic energy of bulk motion, 36% is thermal energy, and the remaining 54% is ionization energy of hydrogen. The sweeping up of the slow red supergiant wind by the fast Wolf-Rayet wind produces remarkable morphological structures and emission signatures, which are compared with existing observations of the Wolf-Rayet bubble S308, whose central star has probably evolved in a manner very similar to our model star. Our model reproduces the correct order of magnitude of observed X-ray luminosity, the temperature of the emitting plasma as well as the limb brightening of the intensity profile. This is remarkable, because current analytical and numerical models of Wolf-Rayet bubbles fail to consistently explain these features. A key result is that almost the entire X-ray emission in this stage comes from the shell of red supergiant wind swept up by the shocked Wolf-Rayet wind rather than from the shocked Wolf-Rayet wind itself as hitherto assumed and modeled. This offers a possible solution to what is called the "missing wind problem" of Wolf-Rayet bubbles.

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## Trans-ethyl methyl ether in space – A new look at a complex molecule in selected hot core regions

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An extensive search for the complex molecule trans-ethyl methyl ether towards several hot core regions has been performed. Using the IRAM 30 m telescope and the SEST 15 m we looked at several frequencies where trans-ethyl methyl ether has strong transitions, as well as lines which are particularly sensitive to the physical conditions in which the molecule can be found. We included G34.26, NGC 6334(I), Orion KL, and W51e2 which have previously been proven to have a rich chemistry of complex molecules. Our observations cannot confirm the tentative Orion KL detection made by Charnley et al. (2001) within their stated column density limits, but we confirm the existence of the trans-ethyl methyl ether towards W51e2 with a column density of $2 \times 10^{14}$ $cm^{-2}$. The dimethyl ether/methanol ratio of 0.6 as well as the newly found ethyl methyl ether/ethanol ratio of 0.13 indicate relative high abundances of ethers toward W51e2. Furthermore, the observation of ethyl methyl ether also confirms the importance of ethanol as a grain mantle constituent. We present new upper limits of around $8 \times 10^{13}$ $cm^{-2}$ for the column densities of the molecule toward Orion KL, G34.26, NGC 6334(I) and estimate the column density towards SgrB2(N) to be of the same order. The W51e2 observations are discussed in more detail.

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## Dynamical decay of a massive multiple system in Orion KL?

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We present absolute astrometry of 35 radio sources in the Orion Trapezium and Becklin-Neugebauer/Kleinman-Low regions, obtained from Very Large Array archival observations collected over a period of 15 years. By averaging the results for all the sources, we estimate the mean absolute proper motion of Orion to be –in Galactic coordinates– $\mu_\ell \cos b = +2.1 \pm 0.2$ mas $yr^{-1}$; $\mu_b = -0.1 \pm 0.2$ mas $yr^{-1}$. These values agree remarkably well with those expected from the differential rotation of the Milky Way. Subtraction of this mean motion from the individual measurements allows us to register all proper motions to the rest frame of the Orion nebula, and identify radio sources with large residual velocities. In the KL region, we find three sources in this situation: the BN object, the radio source I, and the radio counterpart of the infrared source n. All three objects appear to be moving away from a common point where they must all have been located about 500 years ago. This suggests that all three sources were originally part of a multiple massive stellar system that recently disintegrated as a result of a close dynamical

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## Near-infrared imaging polarimetry of dusty young stars

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We have carried out JHK polarimetric observations of eleven dusty young stars, by using the polarimeter module IR-

POL2 with the near-IR camera UIST on the 3.8-m United Kingdom Infrared Telescope (UKIRT). Our sample targeted systems for which UKIRT-resolvable discs had been predicted by model fits to their spectral energy distributions. Our observations have confirmed the presence of extended polarized emission around TW Hya and around HD 169142. HD 150193 and HD 142666 show the largest polarization values among our sample, but no extended structure was resolved. By combining our observations with HST coronographic data from the literature, we derive the J- and H-band intrinsic polarization radial dependences of TW Hya's disc. We find the disc's polarizing efficiency is higher at H than at J, and we confirm that the J- and H-band percentage polarizations are reasonably constant with radius in the region between 0.9 and 1.3 arcseconds from the star. We find that the objects for which we have detected extended polarizations are those for which previous modelling has suggested the presence of flared discs, which are predicted to be brighter than flat discs and thus would be easier to detect polarimetrically.

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## The Pre–Main-Sequence Population of L988

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L988 is a large ($\sim 0.5^o \times 0.7^o$) dark cloud complex at about 600 pc that contains several bright pre–main-sequence objects (V1331 Cyg, LkH$\alpha$-321), but this paper deals in detail only with a small region on its eastern edge, near the HAeBe star LkH$\alpha$-324. That star, and its distant companion LkH$\alpha$-324SE, lie at the apex of a V-shaped area apparently excavated from the edge of L988, and are the brightest members of a small cluster containing about 50 H$\alpha$-emission stars. A median age of about 0.6 Myr (with large dispersion) is inferred from its color-magnitude diagram, constructed from $VRI$ photometry to $V = 22$. Keck HIRES spectra show that LkH$\alpha$-324SE is probably also an HAeBe. Its image is nonstellar, and within 3 arcsec to the northwest are three condensations having complex [S II] and [O I] profiles, and radial velocities up to $-200$ km s$^{-1}$. They probably originate in an outflow from LkH$\alpha$-324SE. A bright Ap star with strong Si II lines is embedded in the heavy obscuration $8'$ to the west. It illuminates a small reflection nebulosity, has several faint H$\alpha$-emitters nearby, and shares the radial velocity of L988, so clearly it was formed in that cloud. It demonstrates again that such chemical peculiarities can be established very early in young stars of moderate mass.

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## Resolution requirements for simulating gravitational fragmentation using SPH

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Jeans showed analytically that, in an infinite uniform-density isothermal gas, plane-wave perturbations collapse to dense sheets if their wavelength, $\lambda$, satisfies $\lambda > \lambda_{\rm JEANS} = (\pi a^2/G\rho_0)^{1/2}$ (where $a$ is the isothermal sound speed and $\rho_0$ is the unperturbed density); in contrast, perturbations with smaller $\lambda$ oscillate about the uniform density state. Here we show that Smoothed Particle Hydrodynamics reproduces these results well, even when the diameters of the SPH particles are twice the wavelength of the perturbation. Our simulations are performed in 3-D with initially settled (i.e. non-crystalline) distributions of particles. Therefore there exists the seed noise for artificial fragmentation, but it does not occur. We conclude that, although there may be – as with any numerical scheme – 'skeletons in the SPH cupboard', a propensity to fragment artificially is evidently not one of them.

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## SiO $J$=5–4 in the HH 211 protostellar jet imaged with the SMA

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We have mapped the SiO $J$=5–4 line at 217 GHz from the HH$\dot{2}$11 molecular outflow with the Submillimeter Array (SMA). The high resolution map ($1.6'' \times 0.9''$) shows that the SiO $J$=5–4 emission comes from the central narrow jet along the outflow axis with a width of $\sim$0.8″ ($\sim$250 AU) FWHM. The SiO jet consists of a chain of knots separated by 3–4″ ($\sim$1000 AU) and most of the SiO knots have counterparts in shocked $H_2$ emission seen in a new, deep VLT near-infrared image of the outflow. A new, innermost pair of knots are discovered at just $\pm 2''$ from the central star. The line ratio between the SiO $J$=5–4 data and upper limits from the SiO $J$=1–0 data of Chandler & Richer (2001) suggests that these knots have a temperature in excess of 300–500 K and a density of $(0.5\text{–}1) \times 10^7\,\mathrm{cm}^{-3}$. The radial velocity measured for these knots is $\sim 30\,\mathrm{km\,s}^{-1}$, comparable to the maximum velocity seen in the entire jet. The high temperature, high density, and velocity structure observed in this pair of SiO knots suggest that they are closely related to the primary jet launched close to the protostar.

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## A spectral study of the HH12 object

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One of the brightest Herbig-Haro objects HH12 is studied with a multi-pupil spectrograph. The maps of line intensities are presented, where nine knots are separated. Overall, the H$\alpha$ emission dominates in the knots with the exception of two of them (C and M), which have higher intensity of [SII] emission and, consequently, a lower level of excitation. The mean value of the electron temperature in the object is 6700 K. It is shown that the radial velocity of the object is small, which suggests that it moves mainly in the plane of the sky. The probable source of HH12 is also discussed.

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## Terrestrial Planet Formation I. The Transition from Oligarchic Growth to Chaotic Growth

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We use a hybrid, multiannulus, $n$-body–coagulation code to investigate the growth of km-sized planetesimals at 0.4–2 AU around a solar-type star. After a short runaway growth phase, protoplanets with masses of $\sim 10^{26}$ g and larger form throughout the grid. When (i) the mass in these 'oligarchs' is roughly comparable to the mass in planetesimals and (ii) the surface density in oligarchs exceeds 2–3 g cm$^{-2}$ at 1 AU, strong dynamical interactions among oligarchs produce a high merger rate which leads to the formation of several terrestrial planets. In disks with lower surface density, milder interactions produce several lower mass planets. In all disks, the planet formation timescale is $\sim$ 10–100 Myr, similar to estimates derived from the cratering record and radiometric data.

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## ROTSE Observations of the Young Cluster IC 348

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CCD observations of stars in the young cluster IC 348 were obtained from 2004 August to 2005 January with the 0.45 m ROTSE-IIId robotic reflecting telescope at the Turkish National Observatory site, Bakirlitepe, Turkey. The timing analysis of selected stars whose X-ray counterparts were detected by the *Chandra X-Ray Observatory* were studied. The time series of stars were searched for rotational periodicity by using different period-search methods. Thirty-five stars were found to be periodic with periods ranging from 0.74 to 32.3 days. Eighteen of the 35 periodic stars were new detections. Four of the new detections were classical T Tauri stars (CTTSs), and the others were weak-line T Tauri stars (WTTSs) or G-type (or unknown spectral class) stars. In this study, we confirmed the stability of rotation periods of TTSs. The periods obtained by Cohen et al. and us were different by 1%. We also confirmed the 3.24 hr pulsation period of H254, which is a $\delta$ Scuti-type star as noted by Ripepi et al., but the other periods detected by them were not found. We examined the correlation between X-ray luminosity and rotation period for our sample of TTSs. There is a decline in the rotation period with X-ray luminosity for late-type TTSs.

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## *Spitzer* Mid-Infrared Spectroscopy of Ices Toward Extincted Background Stars

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A powerful way to observe directly the solid state inventory of dense molecular clouds is by infrared spectroscopy of background stars. We present *Spitzer*/IRS 5-20 $\mu$m spectra of ices toward stars behind the Serpens and Taurus molecular clouds, probing visual extinctions of 10-34 mag. These data provide the first complete inventory of solid-state material in dense clouds before star formation begins. The spectra show prominent 6.0 and 6.85 $\mu$m bands. In contrast to some young stellar objects (YSOs), most ($\sim$75%) of the 6.0 $\mu$m band is explained by the bending mode of pure $H_2O$ ice. In realistic mixtures this number increases to 85%, because the peak strength of the $H_2O$ bending mode is very sensitive to the molecular environment. The strength of the 6.85 $\mu$m band is comparable to what is observed toward YSOs. Thus, the production of the carrier of this band does not depend on the energetic input of a nearby source. The spectra show large abundances of CO and $CO_2$ (20-40% with respect to $H_2O$ ice). Compared to YSOs, the band profile of the 15 $\mu$m $CO_2$ bending mode lacks the signatures of crystallization, confirming the cold, pristine nature of these lines of sight. After the dominant species are removed, there are residuals that suggest the presence of minor species such as HCOOH and possibly $NH_3$. Clearly, models of star formation should begin with dust models already coated with a fairly complex mixture of ices.

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## The Youngest Stellar clusters
## Clusters associated with massive protostellar candidates

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We report on the identification of 54 embedded clusters around 217 massive protostellar candidates of which 34 clusters are new detections. The embedded clusters are identified as stellar surface density enhancements in the 2 $\mu$m All Sky Survey (2MASS) data. Because the clusters are all associated with massive stars in their earliest evolutionary stage, the clusters should also be in an early stage of evolution. Thus the properties of these clusters should reflect properties associated with their formation rather than their evolution. For each cluster, we estimate the mass, the morphological type, the photometry and extinction. The clusters in our study, by their association with massive protostars and massive outflows, reinstate the notion that massive stars begin to form after the first generation of low mass stars have completed their accretion phase. Further, the observed high gas densities and accretion rates at the centers of these clusters is consistent with the hypothesis that high mass stars form by continuing accretion onto low mass stars.

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## Multiseeded Multimode Formation of Embedded Clusters in the Rosette Molecular Complex: Structured Star Formation Toward the Southeastern Boundary

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The Rosette Molecular Complex contains embedded clusters with diverse properties and origins. We have previously explored the shell mode of formation in the north (regions A and B) and the massive concentrations in the ridge (region C). Here we explore star formation toward the south of the complex, region D, based on data from the spatially complete Two Micron All Sky Survey. We find that stars are forming prolifically throughout this region in a highly structured mode, with both clusters and loose aggregates detected. The most prominent cluster (region D1) lies in the north-center. This cluster is over 20 pc to the south of the Monoceros Ridge, the interface of the emerging young OB cluster NGC 2244 with its ambient molecular clouds. In addition, there are several branches stemming from AFGL 961 in region C and extending to the southeastern boundary of the cloud. We invoke a tree model to interpret this pattern, corresponding to probable tracks of abrupt turbulent excitation and subsequent decay. Alternatively, we discuss gravoturbulent collapse scenarios based on numerical simulations. Relative stellar ages and gas flow directions will differentiate between these mechanisms.

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## Locking of the Rotation of Disk-Accreting Magnetized Stars

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We investigate the rotational equilibrium state of disk-accreting magnetized stars using axisymmetric magnetohydrodynamic (MHD) simulations. In this "locked" state, the spin-up torque balances the spin-down torque so that the net average torque on the star is zero. We investigated two types of initial conditions: (I) a relatively weak stellar magnetic field and a high coronal density and (II) a stronger stellar field and a lower coronal density. We observed that for both initial conditions the rotation of the star is locked to the rotation of the disk. In the second case, the radial field lines carry significant angular momentum out of the star. However, this did not appreciably change the condition for locking of the rotation of the star. We find that in the equilibrium state the corotation radius $r_{co}$ is related to the magnetospheric radius $r_A$ as $r_{co}/r_A \approx 1.2 - 1.3$ for case I and $r_{co}/r_A \approx 1.4 - 1.5$ for case II. We estimated periods of rotation in the equilibrium state for classical T Tauri stars, dwarf novae, and X-ray millisecond pulsars.

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## The very low-mass population of the Corona Australis and Chamaeleon II star forming regions

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We present the results of a deep optical survey in the Corona Australis and Chamaeleon II star forming regions. Our optical photometry is combined with available near- and mid-infrared photometry to identify very low-mass candidate members in these dark clouds. In our Chamaeleon II field, only one object exhibits clear H$\alpha$ emission, but the discrepancy between its optical and near-infrared colours suggests that it might be a foreground star. We also identify two objects without H$\alpha$ emission that could be planetary mass members of Chamaeleon II. In Corona Australis, we find ten stars and three brown dwarf candidates in the Coronet cluster. Five of our new members are identified with ISOCAM sources. Only two of them have a mid-infrared excess, indicating the presence of an accretion disk. On the other hand, one brown dwarf candidate has a faint close companion, seen only in our deepest *I*-band image. For many of the candidates in both clouds, membership could not be inferred from their H$\alpha$ emission or near-infrared colours; these objects need spectroscopic confirmation of their status.

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## Gas Flow Across Gaps in Protoplanetary Disks

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We analyze the gas accretion flow through a planet-produced gap in a protoplanetary disk. We adopt the alpha disk model and ignore effects of planetary migration. We develop a semi-analytic, one-dimensional model that accounts for the effects of the planet as a mass sink and also carry out two-dimensional hydrodynamical simulations of a planet embedded in a disk. The predictions of the mass flow rate through the gap based on the semi-analytic model generally agree with the hydrodynamical simulations at the 25% level. Through these models, we are able to explore steady state disk structures and over large spatial ranges. The presence of an accreting $\sim 1M_J$ planet significantly lowers the density of the disk within a region of several times the planet's orbital radius. The mass flow rate across the gap (and onto the central star) is typically 10% to 25% of the mass accretion rate outside the orbit of the planet, for planet-to-star mass ratios that range from $5 \times 10^{-5}$ to $1 \times 10^{-3}$.

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## VLBI Observations of the Water Masers Near LkH$\alpha$ 234 and BD +40 4124

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I present observations made with the National Radio Astronomy Observatory's Very Large Array and Very Long Baseline Array of the water masers near the candidate Herbig Ae/Be star V1318 Cygni S (V1318S) in the vicinity of the Herbig Ae/Be star BD +40 4124 and near the Herbig Ae/Be star LkH$\alpha$ 234. The water masers are not found to be associated with either of the Herbig Ae/Be stars dominant in the optical but with other embedded sources. The masers appear to form in the outflows from these sources, some of which have been detected in radio continuum by other authors. The water masers near BD +40 4124 are found to be associated with the star V1318S, itself a candidate Herbig Ae/Be star. The water masers imaged with very long baseline interferometry resolutions near LkH$\alpha$ 234 are found to be associated with the continuum sources LkH$\alpha$ 234-VLA 2 and LkH$\alpha$ 234-VLA 3B. I do not detect maser

emission from LkH$\alpha$ 234-VLA1. It is likely that the water maser emission originally thought to be associated with Herbig Ae/Be stars is in fact hosted by embedded young stellar objects, is linked to their outflowing jets, and is not found in their disks.

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## The IMF and star formation history of the stellar clusters in the Vela D cloud

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We present the results of a Near-Infrared deep photometric survey of a sample of six embedded star clusters in the Vela-D molecular cloud, all associated with luminous ($\sim 10^3$ $L_\odot$) IRAS sources. The clusters are unlikely to be older than a few $10^6$ yrs, since all are still associated with molecular gas. We employed the fact that all clusters lie at the same distance and were observed with the same instrumental setting to derive their properties in a consistent way, being affected by the same instrumental and observational biases. We extracted the clusters' $K$ Luminosity Functions and developed a simple method to correct them for extinction, based on colour-magnitude diagrams. The reliability of the method has been tested by constructing synthetic clusters from theoretical tracks for pre-main sequence stars and a standard Initial Mass Function. The clusters' Initial Mass Functions have been derived from the dereddened $K$ Luminosity Functions by adopting a set of pre-main sequence evolutionary tracks and assuming coeval star formation. All clusters are small ($\sim 100$ members) and compact (radius $\sim 0.1-0.2$ pc); their most massive stars are intermediate-mass ($\sim 2-10$ $M_\odot$) ones. The dereddened $K$ Luminosity Functions are likely to arise from the same distribution, suggesting that the selected clusters have quite similar Initial Mass Functions and star formation histories. The Initial Mass Functions are consistent with those derived for field stars and clusters. Adding them together we found that the "global" Initial Mass Function appears steeper at the high-mass end and exhibits a drop-off at $\sim 10$ $M_\odot$. In fact, a standard Initial Mass Function would predict a star with $M > 22.5$ $M_\odot$ within one of the clusters, which is not found. Hence, either high-mass stars need larger clusters to be formed, or the Initial Mass Function of the single clusters is steeper at the high-mass end because of the physical conditions in the parental gas.

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## Effects of Type I Migration on Terrestrial Planet Formation

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Planetary embryos embedded in a gas disk suffer a decay in semimajor axis–type I migration–due to the asymmetric torques produced by the interior and exterior wakes raised by the body. This presents a challenge for standard oligarchic approaches to forming the terrestrial planets, as the timescale to grow the progenitor objects near 1 AU is longer than that for them to decay into the Sun. In this paper we investigate the middle and late stages of oligarchic growth using both semianalytic methods (based on Thommes and coworkers) and $N$-body integrations and vary gas properties such as dissipation timescale in different models of the protoplanetary disk. We conclude that even for near-nominal migration efficiencies and gas dissipation timescales of 1 Myr, it is possible to maintain sufficient mass in the terrestrial region to form Earth and Venus if the disk mass is enhanced by factors of $\sim 2-4$ over the minimum-mass model. The resulting configurations differ in several ways from the initial conditions used in previous simulations of the final stages of terrestrial accretion, chiefly in (1) larger interembryo spacings, (2) larger embryo masses, and (3) up to $\sim 0.4 M_\oplus$ of material left in the form of planetesimals when the gas vanishes. The systems we produce are reasonably stable for $\sim 100$ Myr and therefore require an external source to stir up the embryos sufficiently to produce final systems resembling the terrestrial planets.

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## Multi-Generational Star Formation in L1551

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The L1551 molecular cloud, unlike most of the Taurus Molecular Complex, is undergoing a long and sustained period of relatively high efficiency star formation. It contains two small clusters of Class 0 and I protostars, as well as a halo of more evolved Class II and III YSOs, indicating a current and at least one past burst of star formation. We present here new, sensitive maps of 850 and 450 $\mu$m dust emission covering most of the L1551 cloud, new CO J=2-1 data of the molecular cloud, and a new, deep, optical image of [SII] emission (6730Å). We have detected all of the previously known Class 0 and I YSOs in L1551, and no new ones. Compact sub-millimetre emitters are concentrated in two sub-clusters: IRS5 and L1551NE, and the HL Tauri group. Both stellar groups show significant extended emission and outflow/jet activity. A jet, terminating at HH 265 and with a very weak associated molecular outflow, may originate from LkH$\alpha$ 358, or from a binary companion to another member of the HL Tauri group. Several Herbig Haro objects associated with IRS5/NE were clearly detected in the sub-mm, as were faint ridges of emission tracing outflow cavity walls. We confirm a large-scale molecular outflow originating from NE parallel to that from IRS5, and suggest that the "hollow shell" morphology is more likely due to two interacting outflows. The origin of the E-W flow east of HH 102 is undetermined. We confirm the presence of a prestellar core (L1551-MC) of mass 2-3 $M_\odot$ north-west of IRS5. The next generation cluster may be forming in this core. The L1551 cloud appears cometary in morphology, and appears to be illuminated and eroded from the direction of Orion, perhaps explaining the multiple episodes of star formation in this cloud.

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http://www.jach.hawaii.edu/~gms/l1551/l1551-apj641.pdf –or– astro-ph/0512351

## Dynamical Shake-up of Planetary Systems. I. Embryo Trapping and Induced Collisions by the Sweeping Secular Resonance and Embryo-Disk Tidal Interaction

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We analyze the orbital evolution of terrestrial planetary embryos after oligarchic growth, including the effect of the sweeping Jupiter secular resonance combined with tidal drag during the depletion of the protoplanetary gas disk. Previous studies show that the orbits of isolated embryos become unstable through long-term gravitational interaction. However, the planetary systems formed as a result of giant impacts are generally very eccentric, unlike our solar system. Although mechanisms that damp the eccentricity have been proposed, such mechanisms not only damp the eccentricity of embryos strongly but also prevent their orbital crossing and planetary growth. This dilemma can be solved if the protoplanetary collisions occur in an environment where the damping is still working. We consider the stage of gas depletion after the formation of a Jupiter-like planet in the disk. The gas depletion changes the gravitational potential and causes the sweeping of a secular resonance. We find that the secular resonance passes through the terrestrial region from outside to inside, that the resonance excites the eccentricities of isolated embryos, and that it leads to orbit crossing. Because the remnant disk is still present in this stage, the gas drag due to tidal interaction is still effective. The tidal drag effectively damps the eccentricities of the fully grown embryos. This process allows the system to form circular orbits analogous to our solar system. We also find that the tidal drag induces the decay of the semimajor axes of the embryos. As a result of balance between damping and excitation of eccentricity, the embryos migrate along with the secular resonance. This "secular resonance trapping" can lead to rapid collisions and mergers

among the embryos as they migrate from the outer to the inner region, concurrent with the disk depletion. Since the induced migration is strongest near the Jovian orbit, the final terrestrial planets tend to be concentrated in a relatively small region ($< 2$ AU). We suggest that this mechanism may be the origin of the severe present-day mass depletion of the asteroid belt.

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## An explicit scheme for multifluid magnetohydrodynamics

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When modeling astrophysical fluid flows, it is often appropriate to discard the canonical magnetohydrodynamic approximation thereby freeing the magnetic field to diffuse with respect to the bulk velocity field. As a consequence, however, the induction equation can become problematic to solve via standard explicit techniques. In particular, the Hall diffusion term admits fast-moving whistler waves which can impose a vanishing timestep limit.

Within an explicit differencing framework, a multifluid scheme for weakly ionised plasmas is presented which relies upon a new approach to integrating the induction equation efficiently. The first component of this approach is a relatively unknown method of accelerating the integration of parabolic systems by enforcing stability over large compound timesteps rather than over each of the constituent substeps. This method, Super Time Stepping, proves to be very effective in applying a part of the Hall term up to a known critical value. The excess of the Hall term above this critical value is then included via a new scheme for pure Hall diffusion.

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## Near-infrared line spectropolarimetry of hot massive stars

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In order to study the inner parts of the circumstellar material around optically faint infrared bright objects, we present the first medium-resolution spectropolarimetric data taken in the near-infrared. In this paper, we discuss Pa$\beta$ line data of GL 490, a well-known embedded massive young stellar object, and of MWC 349A and MWC 342, two optically faint stars that are proposed to be in the pre-main-sequence phase of evolution. As a check on the method, the classical Be star $\zeta$ Tau, known to display line polarization changes at optical wavelengths, was observed as well. Three of our targets show a 'line effect' across Pa$\beta$. For $\zeta$ Tau and MWC 349A, this line effect is due to depolarization by a circumstellar electron-scattering disc. In both cases, the position angle of the polarization is consistent with that of the larger scale discs imaged at other wavelengths, validating infrared spectropolarimetry as a means to detect flattening on small scales. The tentative detection of a rotation in the polarization position angle at Pa$\beta$ in the embedded massive young stellar object GL 490 suggests the presence of a small-scale rotating accretion disc with an inner hole – similar to those recently discovered at optical wavelengths in Herbig Ae and T Tauri stars.

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## Submillimeter emission from the hot molecular jet HH 211

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We observed the HH 211 jet in the submillimeter continuum and the CO(3–2) and SiO(8–7) transitions with the Submillimeter Array. The continuum source detected at the center of the outflow shows an elongated morphology, perpendicular to the direction of the outflow axis. The high-velocity emission of both molecules shows a knotty and highly collimated structure. The SiO(8–7) emission at the base of the outflow, close to the driving source, spans a wide range of velocities, from $-20$ up to 40 km s$^{-1}$. This suggests that a wide-angle wind may be the driving mechanism of the HH 211 outflow. For distances $\geq 5''$ ($\sim$ 1500 AU) from the driving source, emission from both transitions follows a Hubble-law behavior, with SiO(8–7) reaching higher velocities than CO(3–2), and being located upstream of the CO(3–2) knots. This indicates that the SiO(8–7) emission is likely tracing entrained gas very close to the primary jet, while the CO(3–2) is tracing less dense entrained gas. From the SiO(5–4) data of Hirano et al. we find that the SiO(8–7)/SiO(5–4) brightness temperature ratio along the jet decreases for knots far from the driving source. This is consistent with the density decreasing along the jet, from (3–10)$\times10^6$ cm$^{-3}$ at 500 AU to (0.8–4)$\times10^6$ cm$^{-3}$ at 5000 AU from the driving source.

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## A $CH_3CN$ and $HCO^+$ survey towards southern methanol masers.

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We present the initial results of a 3-mm spectral line survey towards 83 methanol maser selected massive star-forming regions. Here we report observations of the J = 5 − 4 and 6 − 5 rotational transitions of methyl cyanide ($CH_3CN$) and the J = 1 − 0 transition of $HCO^+$ and $H^{13}CO^+$.

$CH_3CN$ emission is detected in 58 sources (70 % of our sample). We estimate the temperature and column density for 37 of these using the rotational diagram method. The temperatures we derive range from 28 − 166 K, and are lower than previously reported temperatures, derived from higher J transitions. We find that $CH_3CN$ is brighter and more commonly detected towards ultra-compact HII (UCHII) regions than towards isolated maser sources. Detection of $CH_3CN$ towards isolated maser sources strongly suggests that these objects are internally heated and that $CH_3CN$ is excited prior to the UCHII phase of massive star-formation.

$HCO^+$ is detected towards 82 sources (99 % of our sample), many of which exhibit asymmetric line profiles compared to $H^{13}CO^+$. Skewed profiles are indicative of inward or outward motions, however, we find approximately equal numbers of red and blue-skewed profiles among all classes. Column densities are derived from an analysis of the $HCO^+$ and $H^{13}CO^+$ line profiles.

80 sources have mid-infrared counterparts: 68 seen in emission and 12 seen in absorption as 'dark clouds'. Seven of the twelve dark clouds exhibit asymmetric $HCO^+$ profiles, six of which are skewed to the blue, indicating infalling motions. $CH_3CN$ is also common in dark clouds, where it has a 90 % detection rate.

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http://www.phys.unsw.edu.au/~crp/papers/cpurcell_2005.pdf

## CO J=6–5 observations of TW Hya with the SMA

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We present the first images of the 691.473 GHz CO J=6–5 line in a protoplanetary disk, obtained along with the 690 GHz dust continuum, toward the classical T Tauri star TW Hya using the Submillimeter Array. Imaging in the CO J=6–5 line reveals a rotating disk, consistent with previous observations of CO J=3–2 and 2–1 lines. Using an irradiated accretion disk model and 2D Monte Carlo radiative transfer, we find that additional surface heating is needed to fit simultaneously the absolute and relative intensities of the CO J=6–5, 3–2 and 2–1 lines. In particular, the vertical gas temperature gradient in the disk must be steeper than that of the dust, mostly likely because the CO emission lines probe nearer to the surface of the disk. We have used an idealized X-ray heating model to fit the line profiles of CO J=2–1 and 3–2 with $\chi^2$ analysis, and the prediction of this model yields CO J=6–5 emission consistent with the observations.

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## The influence of the Mach number on the stability of radiative shocks

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We study the stability properties of hydrodynamic shocks with finite Mach numbers. The linear analysis supplements previous analyses which took the strong shock limit. We derive the linearised equations for a general specific heat ratio as well as temperature and density power-law cooling functions, corresponding to a range of conditions relevant to interstellar atomic and molecular cooling processes. Boundary conditions corresponding to a return to the upstream temperature ($R = 1$) and to a cold wall ($R = 0$) are investigated. We find that for Mach number $M > 5$, the strong shock overstability limits are not significantly modified. For $M < 3$, however, shocks are considerably more stable for most cases. In general, as the shock weakens, the critical values of the temperature power-law index (below which shocks are overstable) are reduced for the overtones more than for the fundamental, which signifies a change in basic behaviour. In the $R=0$ scenario, however, we find that the overstability regime and growth rate of the fundamental mode are increased when cooling is under local thermodynamic equilibrium. We provide a possible explanation for the results in terms of a stabilising influence provided downstream but a destabilising effect associated with the shock front. We conclude that the regime of overstability for interstellar atomic shocks is well represented by the strong shock limit unless the upstream gas is hot. Although molecular shocks can be overstable to overtones, the magnetic field provides a significant stabilising influence.

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## Discovery of an M4 Spectroscopic Binary in Upper Scorpius: A Calibration Point for Young Low-Mass Evolutionary Models

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We report the discovery of a new low-mass spectroscopic (SB2) stellar binary system in the star-forming region of Upper Scorpius. This object, UScoCTIO 5, was discovered by Ardila and coworkers, who assigned it a spectral class of M4. A Keck I HIRES spectrum revealed it to be double-lined, and we then carried out a program at several observatories to determine its orbit. The orbital period is 34 days, and the eccentricity is nearly 0.3. The importance of such a discovery is that it can be used to help calibrate evolutionary models at low masses and young ages. This is one of the outstanding problems in the study of formation mechanisms and initial mass functions at low masses. The orbit allows us to place a lower limit of $0.64 \pm 0.02 M_\odot$ on the total system mass. The components appear to be of almost equal mass. We are able to show that this mass is significantly higher than predicted by evolutionary models for an object of this luminosity and age, in agreement with other recent results. More precise determination of the temperature and surface gravity of the components would be helpful in further solidifying this conclusion.

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## Evolving structures of star-forming clusters

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Understanding the formation and evolution of young star clusters requires quantitative statistical measures of their structure. We investigate the structures of observed and modelled star-forming clusters. By considering the different evolutionary classes in the observations and the temporal evolution in models of gravoturbulent fragmentation, we study the temporal evolution of the cluster structures. We apply different statistical methods, in particular the normalised mean correlation length and the minimum spanning tree technique. We refine the normalisation of the clustering parameters by defining the area using the normalised convex hull of the objects and investigate the effect of two-dimensional projection of three-dimensional clusters. We introduce a new measure $\xi$ for the elongation of a cluster. It is defined as the ratio of the cluster radius determined by an enclosing circle to the cluster radius derived from the normalised convex hull. The mean separation of young stars increases with the evolutionary class, reflecting the expansion of the cluster. The clustering parameters of the model clusters correspond in many cases well to those from observed ones, especially when the $\xi$ values are similar. No correlation of the clustering parameters with the turbulent environment of the molecular cloud is found, indicating that possible influences of the environment on the clustering behaviour are quickly smoothed out by the stellar velocity dispersion. The temporal evolution of the clustering parameters shows that the star cluster builds up from several subclusters and evolves to a more centrally concentrated cluster, while the cluster expands slower than new stars are formed.

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## The IMF of the field population of 30 Doradus

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The star-formation history and IMF of the field population of the 30 Doradus super-association is determined using Wide Field Imager photometry. The cluster NGC 2070 and the OB association LH104 are also studied and used for comparison. The star-formation history of the 30 Doradus super-association appears to be characterized by a large increase in star-formation activity 10 Myr to 20 Myr ago. This seems to be the case across the whole eastern half of the LMC as demonstrated by the ages of stellar populations as far away as 30 Doradus and Shapley's Constellation III. Star-formation appears to be occurring at a constant rate in the field and in loose associations, and in bursts in the clusters. The field IMF is found to have almost the exact Salpeter slope in the range $7M_{\odot} \leq M \leq 40M_{\odot}$, at odds with previous claims. We find that, for objects with more complex star-formation histories, Be stars and selective incompleteness strongly affect the determination of the IMF for $M > 40M_{\odot}$, naturally explaining the observed deviation of the high mass IMF slope from the Salpeter value. The present work supports the idea of a universal IMF.

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## Spectroscopic Abundance Analysis of Dwarfs in the Young Open Cluster IC 4665

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We report a detailed spectroscopic abundance analysis for a sample of 18 F-K dwarfs of the young open cluster IC 4665. Stellar parameters and element abundances of Li, O, Mg, Si, Ca, Ti, Cr, Fe, and Ni have been derived using the spectroscopic synthesis tool SME (Spectroscopy Made Easy). Within the measurement uncertainties the iron abundance is uniform, with a standard deviation of 0.04 dex. No correlation is found between the iron abundance and the mass of the stellar convective zone or between the Li abundance and the Fe abundance. In other words, our results do not reveal any signature of accretion and therefore do not support the scenario that stars with planets (SWPs) acquire their on-average higher metallicity compared to field stars via accretion of metal-rich planetary material. Instead, the higher metallicity of SWPs may simply reflect the fact that planetary formation is more efficient in high-metallicity environs. However, since so many details of the planetary system formation processes remain poorly understood, further studies are needed for a final settlement of the problem of the high metallicity of SWPs. The standard deviation of [Fe/H] deduced from our observations, taken as an upper limit on the metallicity dispersion among the IC 4665 member stars, has been used to constrain protoplanetary disk evolution, terrestrial and giant planets formation, and evolution processes. The total reservoir of heavy elements retained by the nascent disks is limited, and high retention efficiency of planet-building material is supported. Under modest surface density, gas giant planets are expected to form in locally enhanced regions or start efficient gas accretion when they only have a small core of a few Earth masses. Our results do not support the possibility that the migration of gas giants and the circularization of terrestrial planets' orbits are regulated by their interaction with a residual population of planetesimals and dust particles.

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## High-Mass Starless Cores

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We report the identification of a sample of potential high-mass starless cores (HMSCs). The cores were discovered by comparing images of fields containing candidate high-mass protostellar objects (HMPOs) at 1.2 mm and mid-infrared (MIR; 8.3 $\mu$m) wavelengths. While the HMPOs are detected at both wavelengths, several cores emitting at 1.2 mm in the same fields show absorption or no emission at the MIR wavelength. We argue that the absorption is caused by cold dust. The estimated masses of a few times $10^2 - 10^3 M_\odot$ and the lack of IR emission suggest that they may be massive cold cores in a prestellar phase, which could form massive stars. Ammonia observations indicate smaller velocity dispersions and lower rotation temperatures compared with HMPOs and ultracompact H II regions, suggesting a quiescent prestellar stage. We propose that these newly discovered cores are good candidates for the HMSC stage in high-mass star formation. This sample of cores will allow us to study the high-mass star and cluster formation processes at the earliest evolutionary stages.

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## Identifying Primordial Substructure in NGC2264

**Paula S. Teixeira[1,2], Charles J. Lada[1], Erick T. Young[3], Massimo Marengo[1], August Muench[1], James Muzerolle[3], Nick Siegler[3], George Rieke[3], Lee Hartmann[4], S. Thomas Megeath[1] and Giovanni Fazio[1]**

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We present new *Spitzer* Space Telescope observations of the young cluster NGC 2264. Observations at 24 $\mu$m with the Multiband Imaging Photometer has enabled us to identify the most highly embedded and youngest objects in NGC 2264. This letter reports on one particular region of NGC 2264 where bright 24 $\mu$m sources are spatially configured in curious linear structures with quasi-uniform separations. The majority of these sources ($\sim$60%) are found to be protostellar in nature with Class I spectral energy distributions. Comparison of their spatial distribution with submillimeter data from Wolf-Chase et al. (2003) and millimeter data from Peretto et al. (2005) shows a close correlation between the dust filaments and the linear spatial configurations of the protostars, indicating that star formation is occurring primarily within dense dusty filaments. Finally, the quasi-uniform separations of the protostars are found to be comparable in magnitude to the expected Jeans length suggesting thermal fragmentation of the dense filamentary material.

Accepted by Astrophysical Journal Letters

http://xxx.lanl.gov/abs/astro-ph/0511732
http://cfa-www.harvard.edu/∼pteixeir/
http://cfa-www.harvard.edu/∼clada/preprints.html

## Mopra Observations of G305.2+0.2: Massive Star Formation at Different Evolutionary Stages?

**Andrew J. Walsh[1] and Michael G. Burton[1]**

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We have successfully used a new on-the-fly mapping technique with the Mopra radiotelescope to image G305.2+0.2 in transitions of CO, $HCO^+$, $N_2H^+$, $CH_3CN$ and $CH_3OH$. All these species appear to be concentrated towards the infrared-quiet methanol maser site G305A (G305.21+0.21). We suggest that this region contains an extremely deeply embedded site of massive star formation, with comparable qualities to the low mass Class 0 stage. The infrared-bright methanol maser site G305B (G305.21+0.20) also exhibits emission in all the mapped transitions, but always at a lower level. We suggest this is because it harbours a site of massive star formation older and more developed than G305.21+0.21. All transitions appear to be extended beyond the size of the Mopra beam (30″). CO and $HCO^+$ line wings are suggestive of an outflow in the region, but the spatial resolution of these data is insufficient to

identify the powering source. A narrow-lined (1.6 km s$^{-1}$ compared to a typical line FWHM of 6.4 km s$^{-1}$) $N_2H^+$ source (G305SW) is found 90$''$ to the south-west of the main star forming centres, which does not correspond to any $CH_3CN$ or $CH_3OH$ source, nor does it correspond well to CO or $HCO^+$ emission in the vicinity. We suggest this may be a massive, cold, quiescent and possibly prestellar core.

Accepted by MNRAS

Preprint available at: http://astro.phys.unsw.edu.au/~awalsh/G305_Mopra.ps

## Connecting Dense Gas Tracers of Star Formation in our Galaxy to High-z Star Formation

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Observations have revealed prodigious amounts of star formation in starburst galaxies as traced by dust and molecular emission, even at large redshifts. Recent work shows that for both nearby spiral galaxies and distant starbursts, the global star formation rate, as indicated by the infrared luminosity, has a tight and almost linear correlation with the amount of dense gas as traced by the luminosity of HCN. Our surveys of Galactic dense cores in HCN 1−0 emission show that this correlation continues to a much smaller scale, with nearly the same ratio of infrared luminosity to HCN luminosity found over 7-8 orders of magnitude in $L_{IR}$, with a lower cutoff around $10^{4.5}$ $L_\odot$ of infrared luminosity. The linear correlation suggests that we may understand distant star formation in terms of the known properties of local star-forming regions. Both the correlation and the luminosity cutoff can be explained if the basic unit of star formation in galaxies is a dense core, similar to those studied in our Galaxy.

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astro-ph/0511424

## Two-dimensional models of layered protoplanetary discs - II. The effect of a residual viscosity in the dead zone.

**R. Wünsch[1,3], A. Gawryszczak[1], H. Klahr[2] and M. Różyczka[1]**

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We study axisymmetric models of layered protoplanetary discs taking radiative transfer effects into account, and allowing for a residual viscosity in the dead zone. We also explore the effect of different viscosity prescriptions. In addition to the ring instability reported in the first paper of the series we find an oscillatory instability of the dead zone, accompanied by variations of the accretion rate onto the central star. We provide a simplified analytical description explaining the mechanism of the oscillations. Finally, we find that the residual viscosity enables stationary accretion in large regions of layered discs. Based on results obtained with the help of a simple 1-D hydrocode we identify these regions, and discuss conditions in which layered discs can give rise to FU Orionis phenomena.

Accepted by MNRAS

http://arXiv.org/abs/astro-ph/0512402

## In Search of Circumstellar Disks Around Young Massive Stars

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We present 7 mm, 1.3 cm and 3.6 cm continuum observations made with the Very Large Array toward a sample of ten luminous IRAS sources that are believed to be regions of massive star formation. We detect compact 7 mm emission in four of these objects: IRAS 18089-1732(1), IRAS 18182-1433, IRAS 18264-1152 and IRAS 18308-0841 and for the first time find that these IRAS sources are associated with double or triple radio sources separated by a few arcseconds. We discuss the characteristics of these sources based mostly on their spectral indices and find that their nature is diverse. Some features indicate that the 7 mm emission is dominated by dust from disks or envelopes. Toward other components the 7 mm emission appears to be dominated by free-free radiation, both from ionized outflows or from optically thick H II regions. Furthermore, there is evidence of synchrotron contamination in some of these sources. Finally, we found that the sources associated with ionized outflows, or thermal jets are correlated with $CH_3OH$ masers. The precise determination of the nature of these objects requires additional multifrequency observations at high angular resolution. The 3.6 cm continuum observations also revealed seven UCHII regions in the vicinity of the sources IRAS 18089-1732(1) and two more in the source IRAS 18182-1433. We show that the small photoionized nebulae of these UCHII regions are produced by early B-type stars.

Accepted by The Astronomical Journal

arXiv:astro-ph/0510761

## Microlensing of Circumstellar Disks

**Zheng Zheng[1] and Brice Ménard[1]**

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We investigate the microlensing effects on a source star surrounded by a circumstellar disk, as a function of wavelength. The microlensing light curve of the system encodes the geometry and surface brightness profile of the disk. In the mid- and far-infrared, the emission of the system is dominated by the thermal emission from the cold dusty disk. For a system located at the Galactic center, we find typical magnifications to be of order $10\% - 20\%$ or higher, depending on the disk surface brightness profile, and the event lasts over 1 yr. At around 20 $\mu$m, where the emission for the star and the disk are comparable, the difference in the emission areas results in a chromatic microlensing event. Finally, in the near-infrared and visible, where the emission of the star dominates, the fraction of star light directly reflected by the disk slightly modifies the light curve of the system, which is no longer that of a point source. In each case, the corresponding light curve can be used to probe some of the disk properties. A fraction of $10^{-3}$ to $10^{-2}$ of optical microlensing events are expected to be associated with circumstellar disk systems. We show that the lensing signal of the disk can be detected with sparse follow-up observations of the next generation space telescopes. While direct imaging studies of circumstellar disks are limited to the solar neighborhood, this microlensing technique can probe very distant disk systems living in various environments and has the potential to reveal a larger diversity of circumstellar disks.

Published by The Astrophysical Journal (Vol. 635, p. 599)

# Postdoctoral Positions in Star Formation

The Zentrum für Astronomie Heidelberg (ZAH, Centre for Astronomy Heidelberg) invites applications for two or three postdoctoral research positions in numerical star-formation studies, astrophysical jets and ISM dynamics. The successful candidates will work with Prof. R. Klessen in the newly established star-formation group at the Institute for Theoretical Astrophysics, and are expected to carry out independent research programmes as well as collaborate with members of the ZAH and colleagues at the other institutes in Heidelberg on ongoing projects. Current projects include

(a) numerical modelling of star and star-cluster formation in turbulent molecular clouds,

(b) studying the interaction between protostellar jets and interstellar turbulence (in collaboration with C. Fendt, Max Planck Institute for Astronomy, Heidelberg), and

(c) formation and evolution of protostellar disks in dense star clusters (with W. Kley, University of Tübingen).

The ZAH is part of Heidelberg University and consists of three institutes: the Institute for Theoretical Astrophysics, the Astronomisches Rechen-Institut and the Landessternwarte Königstuhl. Heidelberg also is home to the Max Planck Institutes for Astronomy and Nuclear Physics. The region thus offers a rich and stimulating environment for astrophysical research and unique opportunities for collaborations in virtually all fields of modern astronomy and astrophysics, ranging from star and planet formation, the interstellar medium, to the formation and evolution of galaxies and the large-scale structure of the universe. The ZAH is involved in large telescope projects (e.g. LBT) and future space missions (GAIA), and features excellent local computing facilities as well as access to large supercomputers.

Applicants should hold a PhD in astronomy, astrophysics, or a closely related field. A strong background in star formation, jet physics or astrophysical fluid dynamics as well as experience with modern numerical modelling techniques are desirable. The initial appointment is for 2 years with the possibility for an extension by one year. The salary is on the German civil service level. Reviewing of applications will begin January 31, 2006 and will continue until the post is filled.

Applicants should submit their curriculum vitae, a list of publications, and a brief statement of research interests to the address given below, and arrange for three letters of references to be sent to the same address. Heidelberg University is an equal opportunity employer and particularly encourages applications from women.

Address:
Institut für Theoretische Astrophysik
Zentrum für Astronomie Heidelberg
Attn.: Prof. R. Klessen
Albert-Überle-Str. 2
D-69120 Heidelberg, Germany

e-mail submission and inquiries: rklessen@ita.uni-heidelberg.de URL1: http://www.ita.uni-heidelberg.de/ URL2: http://www.ita.uni-heidelberg.de/∼ralf Closing date: 01/31/2006

# Marie Curie Fellowship in Simulations of Jets from Young Stars JETSET Project

This position will be based in the Astronomy & Astrophysics Section of the Dublin Institute for Advanced Studies (DIAS) for a period of up to 3 years. DIAS is the coordinating node for the Marie Curie Research Training Network JETSET (www.jetsets.org) as well as the largest Irish computational Grid project Cosmogrid (www.cosmogrid.ie). The present position is focused on computational modelling of outflows from young stars utilising Grid technology. It is intended that the candidate will develop tools to derive synthetic atomic and molecular line data from simulations for direct comparison with observation. Implementation of more complex physics, including radiative transfer and the presence of multi-fluids, into existing AMR codes is planned. The successful candidate will have access to large computing resources and expertise within Cosmogrid, as well as additional computing power from the new Irish Centre for High End Computing (www.ichec.ie).

Application Procedure

Applications should include a Curriculum Vita, a short statement of research interests, and the names of 3 referees. They should be sent electronically to: lery@cp.dias.ie AND eflood@cp.dias.ie. Inquiries should be directed to Thibaut Lery, Tel: +353-1-6621333 E-mail: lery@cp.dias.ie. The deadline for receipt of applications is 31st January 2006.

Application Policy

Some recruitment restrictions, in accordance with EU Marie Curie RTN policy, apply (see the job advertisement at www.jetsets.org). JETSET is committed to equal opportunity/affirmative action and women are particularly encouraged to apply.

## Postdoctoral Position in Star Formation

Applications are invited for a postdoctoral position at the Astrophysical Institute Potsdam in Germany. The successful candidate will work in the group of Dr. Hans Zinnecker on observational studies of star formation, ranging from extrasolar planets to extragalactic starbursts. He/she can pursue independent research.

The Astrophysical Institute Potsdam (AIP) is one of the major German research institutes for astronomy and astrophysics, located in a historic city in the outskirts of Berlin. Research interests at the AIP cover a wide variety of theoretical and observational astrophysics, including solar physics and the solar-stellar connection, star formation and the interstellar medium, magnetohydrodynamics, the formation and evolution of galaxies and AGN, and the large scale structure of the universe. The AIP is involved in large telescope projects, in particular in the LBT in Arizona, as well as in the development of astronomical instrumentation, in particular for integral field spectroscopy (e.g. PMAS for the Calar Alto Observatory and MUSE for the VLT). The AIP is also a partner in the ARENA infrastructure network, related to astronomy at Dome C in Antarctica. Finally the AIP features excellent computer facilities and access to large supercomputers.

Applicants should hold a PhD in astronomy and/or astrophysics and should have a strong interest in modern observations (e.g. at VLT/VLTI or equivalent). Experience with complex data reduction, especially in interferometry, would be advantageous. The initial appointment is for 2-3 years, depending on experience, with yearly extensions up to a maximum of 6 years. The salary is on the German civil service level. Reviewing of applications will begin Jan 16, 2006 and will continue until the post is filled.

Applicants should submit to the address below a curriculum vitae, a list of publications, a brief statement of research interests, and arrange for three letters of references from people familiar with the work of the candidate. The AIP is an equal opportunity employer and particularly encourages applications from women.

contact: Dr. Hans Zinnecker, hzinnecker@aip.de

Astrophysical Institute Potsdam
An der Sternwarte 16,
D-14482 Potsdam, Germany
Fax (49)-331-7499-429
Institute homepage: www.aip.de
Email submission address: cbiering@aip.de
Closing date for receipt of applications: 1/15/2006

## Postdoc Position at Ecole Normale Superieure - CRAL, Lyon, France

## Multi-dimensional numerical simulations of hydrodynamical processes in stellar interiors

A two year postdoctoral research position (no teaching) will be available starting in the fall 2006 in the Astrophysics group of Ecole Normale Superieure in Lyon. Our group has various activities in the fields of stellar physics and hydrodynamics, star formation and stellar pulsations (cf http://www.ens-lyon.fr and http://www-obs.univ-lyon1.fr/recherche/equipes/ens_fr.html). For this postdoc position, our main interest is the developement of multi-dimensional numerical simulations applied to hydrodynamical processes characteristic of star formation and evolution (convection, turbulence, instabilities, oscillations, etc...). The candidate can carry out a personal research program but is expected to participate actively in the development of a multi-D hydrodynamical code devoted to the analysis of convection, turbulence, instabilities, transport processes in stellar interiors.

We are looking especially for candidates with strong background in fluid dynamics and/or numerical analysis. A good experience in multi-D hydrodynamical simulations is also highly desirable. Experiences in the development and/or use of implicit methods will be appreciated.

The candidate will interact with faculties of our group, (I. Baraffe, G. Chabrier, and others) and of the Physics department at ENS (E. Leveque, B. Castaing) as well as with graduate students.

Applicants are invited to send their application material, including a curriculum vita, a list of publications, a detailed summary of past, current and planned research, and letters of recommendation, by email (preferentially) or post to:

I. Baraffe
Ecole Normale Superieure, CRAL
46 allee d'Italie
69007 Lyon, France
email: ibaraffe@ens-lyon.fr

Details on the position can be asked directly by email to I. Baraffe. The closing date for application is February 15, 2006.

## 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 Books*

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*Meetings*

## MASSIVE STARS From Pop III and GRBs to the Milky Way

The Space Telescope Science Institute is announcing that the topic of its next May Symposium will be:

MASSIVE STARS From Pop III and GRBs to the Milky Way

The Symposium will take place at STScI May 8 - 11, 2006, with registration and reception on May 7, from 4 to 7 pm.

The Symposium will cover topics in the general areas of: The formation of massive stars (both Pop III and in the galaxies); Massive stellar clusters; The evolution of massive stars; The end of life of massive stars (including SNe, GRBs, Ultra-luminous X-Ray sources, etc.); Environmental impacts (feedback, chemical evolution, etc., for both Pop III and galactic objects). The Symposium will consist primarily of invited talks, but there is room for a few contributed talks. Those interested in presenting a contributed talk should send a title and an abstract before December 15, 2005, to the Symposium Administrative Coordinator, Quin Gryce (gryce@stsci.edu). Registration information will be posted on the STScI Web page shortly.

Looking forward to seeing you at STScI,

The Organizing Committee

# Workshop on Physical Processes in Circumstellar Disks around Young Stars

## September 18-23 2006

## Vidago Palace, Portugal

## http://www.astro.up.pt/disks2006

**Submitted by: Paulo J.V. Garcia**

Electronic mail: disks2006@astro.up.pt

**Scientific Rationale**

Circumstellar disks surrounding pre-main sequence stars across the mass spectrum are extremely rich astrophysical systems, and may now be probed by a wide variety of observational techniques. The radiation field from the central object influences their evolution, chemistry and geometry. The interaction of the disk and it's wind with the stellar magnetosphere and wind adds further complexity. The radiation field, protostellar wind, gravitational instabilities, and turbulent transport of angular momentum all affect the ability of the dust and gas to collect and form planets.

The extraordinary complexity of circumstellar disks has created a interdisciplinary field in which it has become increasingly important for researchers working on different aspects of the observations and theories to develop a more unified view. One of the goals of the workshop, therefore, is to facilitate a productive interaction between the different disciplines by devoting ample time to reviews that are both in-depth and pedagogical. The workshop will focus on the evolution of young disks from their formation through the initial stages of planet building and planet-gas interaction.

It is our goal to maximize the interaction between the attendants and to foster an atmosphere conducive to discussion. Ample free time will be available for this purpose, and contributed talks on open issues are especially encouraged. The workshop will be limited to around 60 attendants.

**Reviews**

The reviews are 3h-4.5h long allowing in-depth presentation and discussions.

"Observations of disks across mass and time" by Antonella Natta
"Gas processes" by David Hollenbach
"Disk chemistry" by Edwin Bergin
"Disk hydrodynamics" by Richard H. Durisen
"MHD dynamics of protostellar disks" by Steve Balbus
"Disk-star-wind interactions" by Arieh Konigl
"Structure and emission of protoplanetary disks" by Nuria Calvet
"Dust processing and mineralogy in protoplanetary accretion disks" by Thomas Henning

**Short talks slots & posters**

There will be around 20 slots available for short (20 min.) talks. The SOC will give preference to talks addressing unsolved questions & problems over talks presenting recent work or work in progress. Space will be made available for posters.

**Important dates**

December 1st 2005 First announcement
February 1st 2006 Second announcement
March 1st 2006 Contributed talks/posters abstract submission deadline
April 1st 2006 Notification of contributed speakers selected by SOC
April 30th 2006 Deadline for room reservation and registration