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Abstracts of recently accepted papers

Magnetically Controlled Outflows from Hot Jupiters

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Recent observations that indicate that some extrasolar planets observed in transit can experience mass loss from their surfaces. Motivated by these findings, this paper considers outflows from Hot Jupiters in the regime where the flow is controlled by magnetic fields. Given the mass loss rates estimated from current observations — and from theoretical arguments — magnetic fields will dominate the flow provided that field strength near the planet is greater than ~ 1 gauss, comparable to the surface fields of the Sun and Jupiter. The problem can be separated into an inner regime, near the planet, where the outflow is launched, and an outer regime where the flow follows (primarily) stellar field lines and interacts with the stellar wind. This paper concentrates on the flow in the inner regime. For a dipole planetary field with a spatially constant background contribution, we construct a set of orthogonal coordinates that follow the field lines and determine the corresponding differential operators. Under the assumption of isothermal flow, we analytically find the conditions required for escaping material to pass smoothly through the sonic transition, and then estimate the mass outflow rates. These magnetically controlled outflows differ significantly from previous spherical models: The outflow rates are somewhat smaller, typically $\dot{M} \sim 10^9$ g/s, and the flow is launched primarily from the polar regions of the planet. In addition, if the stellar wind is strong enough, the flow could be reversed and the planet could gain mass from the star.

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Radial Structure in the TW Hya Circumstellar Disk

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We present new near-infrared interferometric data from the CHARA array and the Keck Interferometer on the circumstellar disk of the young star, TW Hya, a proposed "transition disk." We use these data, as well as previously published, spatially resolved data at 10 μm and 7 mm, to constrain disk models based on a standard flared disk structure. We find that we can match the interferometry data sets and the overall spectral energy distribution with a three-component model, which combines elements at spatial scales proposed by previous studies: optically thin, emission nearest the star, an inner optically thick ring of emission at roughly 0.5 AU followed by an opacity gap and, finally, an outer optically thick disk starting at $\sim$4 AU. The model demonstrates that the constraints imposed by the spatially resolved data can be met with a physically plausible disk but this requires a disk containing not only an inner gap in the optically thick disk as previously suggested, but also a gap between the inner and outer optically thick disks. Our model is consistent with the suggestion by Calvet et al. of a planet with an orbital radius of a few AU. We discuss the implications of an opacity gap within the optically thick disk.

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http://iopscience.iop.org/0004-637X/728/2/96/

Star Formation in the Gulf of Mexico

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We present an optical/infrared study of the dense molecular cloud, L935, dubbed "The Gulf of Mexico", which separates the North America and the Pelican nebulae, and we demonstrate that this area is a very active star forming region. A wide-field imaging study with interference filters has revealed 35 new Herbig-Haro objects in the Gulf of Mexico. A grism survey has identified 41 Hα emission-line stars, 30 of them new. A small cluster of partly embedded pre-main sequence stars is located around the known LkHα 185-189 group of stars, which includes the recently erupting FUor HBC 722.

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CSO Bolocam 1.1mm Continuum Mapping of the Braid Nebula Star Formation Region in Cygnus OB7

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We present a 1.1 mm map of the Braid Nebula star formation region in Cygnus OB7 taken using Bolocam on the Caltech Submillimeter Observatory. Within the one square degree covered by the map, we have detected 55 cold dust clumps all of which are new detections. A number of these clumps are coincident with *IRAS* point-sources although the majority are not. Some of the previously studied optical/near-IR sources are detected at 1.1 mm. We estimate total dust/gas masses for the 55 clumps together with peak visual extinctions. We conclude that over the whole region, approximately 20% of the clumps are associated with *IRAS* sources suggesting that these are protostellar objects. The remain 80% are classed as starless clumps. In addition, both FU Orionis-like objects in the field, the Braid-Star and HH 381 IRS, are associated with strong mm emission. This implies that FU Orionis eruptions can occur at very early stages of pre-main sequence life. Finally, we determine that the cumulative clump mass function for the region is very similar to that found in both the Perseus and ρ Ophiuchus star forming

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Single peaked CO emission line profiles from the inner regions of protoplanetary disks

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The study of warm molecular gas in the inner region (<10 AU) of circumstellar disks around young stars is of significant importance to understand how planets are forming. This inner zone of disks can now be explored in unprecedented detail with the high spectral (R=100000) and spatial resolution spectrometer CRIRES at the VLT. This paper investigates a set of disks that show CO ro-vibrational v=1-0 4.7 micron emission line profiles characterized by a single, narrow peak and a broad base extending to >50 km/s, not readily explained by just Keplerian motions of gas in the inner disk. The line profiles are very symmetric, have high line/continuum ratios and have central velocity shifts of <5 km/s relative to the stellar radial velocity. The disks in this subsample are accreting onto their central stars at high rates relative to the parent sample. All disks show CO lines from v=2, suggesting that the lines are excited, at least in part, by UV fluorescence. Analysis of their spatial distribution shows that the lines are formed within a few AU of the central star. It is concluded that these broad centrally peaked line profiles are inconsistent with the double peaked profiles expected from just an inclined disk in Keplerian rotation. Alternative non-Keplerian line formation mechanisms are discussed, including thermally and magnetically launched winds and funnel flows. The most likely interpretation is that these profiles originate from a combination of emission from the inner part (<a few AU) of a circumstellar disk, perhaps with enhanced turbulence, and a slow moving disk wind, launched by either EUV emission or soft X-rays.

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The Influence of Deuteration and Turbulent Diffusion on the Observed D/H Ratio

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The influence of turbulent mixing on the chemistry of the interstellar medium has so far received little attention. Previous studies of this effect have suggested that it might play an important role in mixing the various phases of the interstellar medium. In this paper we examine the potential effects of turbulent diffusion on the deuterium chemistry within molecular clouds. We find that such mixing acts to reduce the efficiency of deuteration in these clouds by increasing the ionization fraction and reducing freeze-out of heavy molecules. This leads to lower abundances for many deuterated species. We also examine the influence of turbulent mixing on the transition from atomic hydrogen to H_2 and from atomic deuterium to HD near the cloud edge. We find that including turbulent diffusion in our models serves to push these transitions deeper into the cloud and helps maintain a higher atomic fraction throughout the cloud envelope. Based on these findings, we propose a new process to account for the significant scatter in the observed atomic D/H ratio for galactic sightlines extending beyond the Local Bubble. Although several mechanisms have been put forward to explain this scatter, they are unable to fully account for the range in values. We suggest a scenario in which turbulent mixing of atomic and molecular gas at the edges of molecular clouds causes the observed atomic D/H ratio to vary by a factor of $\sim$2.

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Triggered star formation at the borders of the H II region Sh 2-217

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This paper is part of our ongoing study of star formation at the borders of Galactic H II regions. In this paper we report our observations and analysis of Sharpless 217 (Sh 2-217).

We study stars and gas in and around H II regions to see if the various physical parameters derived from the data (such as column densities, masses, sizes, and timescales) are consistent with the predictions of a simple model of the collect-and-collapse mechanism. This should indicate whether stars forming in molecular gas at the borders of the H II regions could have been triggered by the expansion of the ionized gas.

We observed the emission of various molecules and transitions towards Sh 2-217, and obtained both near-infrared photometry in the H and K bands, and near-infrared images in [Fe II] and H_2 narrow-band filters of the stars in a molecular condensation at the edge of the H II region, where an UC H II region is also located. For the atomic and ionized hydrogen gas we used literature data.

Several molecular condensations are found on the borders of Sh 2-217 and both behind and in front of the ionized emission. We find signs of star formation (an UC H II region, outflows, and water masers). The masses of the larger molecular condensations, derived from ^{13}CO-data, are $\gtrsim 330 - 1100$ M$_\odot$, while smaller clumps or cores within them have up to several tens of solar masses. The morphology of the atomic and molecular gas associated with Sh 2-217, especially the condensations of molecular gas on its border, and the presence of star forming activity within them, is strongly indicative of being the result of star formation triggered by the expansion of the ionized region, following the collect-and-collapse scenario. Application of a simple model illustrates that the present radii of both Sh 2-217 and the UC H II region, the masses of the condensations, and the timescales needed to sweep up these amounts of gas and allow massive stars to form in them, are consistent with the model predictions.

We show that it is highly plausible that the expansion of Sh 2-217 has swept-up the ambient interstellar medium, and that it has taken about 4 Myr to reach its present radius. About 1 Myr ago, the most massive gas condensation became unstable and produced a cluster of stars. The most massive of these stars give rise to the UC H II region, which took about 0.5 Myr to reach its present size.

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Exposing the gas braking mechanism of the β Pictoris disk

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Ever since the discovery of the edge-on circumstellar disk around β Pictoris, a standing question has been why the gas observed against the star in absorption is not rapidly expelled by the strong radiation pressure from the star. A solution to the puzzle has been suggested to be that the neutral elements that experience the radiation force also are rapidly ionized, and so are only able to accelerate to an average limiting velocity $v_{\rm ion}$. Once ionized, the elements are rapidly braked by C II, which is observed to be at least 20× overabundant in the disk with respect to other species. A prediction from this scenario is that different neutral elements should reach different $v_{\rm ion}$, depending on the ionization thresholds and strengths of driving line transitions. In particular, neutral Fe and Na are predicted to reach the radial velocities 0.5 and 3.3 km s^{-1}, respectively, before being ionized. In this paper, we study the absorption profiles of Fe and Na from the circumstellar gas disk around β Pic, as obtained by HARPS at the ESO 3.6 m telescope. We find that the Fe and Na velocity profiles are indeed shifted with respect to each other, confirming the model. The absence of an extended blue wing in the profile of Na, however, indicates that there must be some additional braking on the neutrals.

We explore the possibility that the ion gas (dominated by C II) can brake the neutrals, and conclude that about 2–5× more C than previously estimated is needed for the predicted line profile to be consistent with the observed one.

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Rotation of the NGC 1333 IRAS 4A2 Protostellar Jet

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The bipolar jet of the NGC 1333 IRAS 4A2 protostar shows a velocity gradient in the direction perpendicular to the jet axis. This lateral velocity gradient can be seen throughout the jet imaged in a silicon monoxide line, 2500–8700 AU from the driving source, and is consistent with the rotation of the accretion disk. If this gradient is caused by the rotation of the jet around its axis, the average specific angular momentum is about 1.5×10^{21} cm^2 s^{-1}. Comparison of the kinematics between the jet and the disk suggests that the jet-launching region on the disk has a radius of about 2 AU, which supports the disk-wind models. The angular momentum transported away by the jet seems to be large enough for the protostar to accrete matter from the disk, confirming the crucial role of jets in the early phase of star formation process.

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Mass and Magnetic Distributions in Self Gravitating Super Alfvénic Turbulence with AMR

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In this work, we present the mass and magnetic distributions found in a recent Adaptive Mesh Refinement (AMR) MHD simulation of supersonic, super-Alfvénic, self gravitating turbulence. Power law tails are found in both mass density and magnetic field probability density functions, with $P(\rho) \propto \rho^{-1.6}$ and $P(B) \propto B^{-2.7}$. A power law relationship is also found between magnetic field strength and density, with $B \propto \rho^{0.5}$, throughout the collapsing gas. The mass distribution of gravitationally bound cores is shown to be in excellent agreement with recent observation of prestellar cores. The mass to flux distribution of cores is also found to be in excellent agreement with recent Zeeman splitting measurements. We also compare the relationship between velocity dispersion and density to the same cores, and find an increasing relationship between the two, with $\sigma \propto n^{0.25}$, also in agreement with the observations. We then estimate the potential effects of ambipolar diffusion in our cores and find that due to the weakness of the magnetic field in our simulation, the inclusion of ambipolar diffusion in our simulation will not cause significant alterations of the flow dynamics.

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News on two jets in Lupus 3

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Context: Jets from solar type and low-mass stars are typical manifestations of stellar youth. Shocks along these jets produce visible, generally fast-moving Herbig-Haro objects whose proper motions are easily measured in nearby star forming regions using images taken just a few years apart. Herbig-Haro objects have now been observed in association with objects close to the substellar boundary.
Aims: We present second-epoch observations of the central area of the Lupus 3 star forming region that include two of its most interesting Herbig-Haro systems. One is HH 228, produced by the classical T Tauri star Th 28 (=Sz 102), whereas the other is HH 600 and has its origin in the very low-mass star Par-Lup3-4.
Method: Narrow-band imaging through filters centered respectively on the Hα and the [SII] lines has been obtained with the FORS2 instrument at the Very Large Telescope (VLT) in mid-2010. The images obtained are compared to others obtained in early 2003, which led to the discovery of HH 600.
Results: New Herbig-Haro objects associated with Th 28 are found at large distances from it, representing an extension of the HH 228 jet to a projected distance of 0.32 pc from Th 28. The farthest Herbig-Haro object is HH 989, whose possible relationship with Th 28 had been already suggested in a previous study but is now kinematically confirmed. We find other likely Herbig-Haro objects whose proper motions make less obvious the connection with Th 28, but which may be caused by oblique shocks near the outer walls of its jet. Regarding the HH 600 jet, the knot discovered by us in 2003 to the southeast of Par-Lup3-4 is found to have clearly moved and faded. Using high resolution spectroscopy obtained in 2003 and the proper motion that we can measure now, we determine a spatial velocity of 170 ± 30 km s^{-1}. The northeastern jet is found to have grown in prominence in the intervening years. The possible relationship of other Herbig-Haro objects in the region with Th 28, Par-Lup3-4, and other young stellar objects in the area is discussed.

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http://www.eso.org/∼fcomeron/hh_228.pdf

Modelling Circumbinary Gas Flows in Close T Tauri Binaries

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Young close binaries open central gaps in the surrounding circumbinary accretion disc, but the stellar components may still gain mass from gas crossing through the gap. It is not well understood how this process operates and how the stellar components are affected by such inflows. Our main goal is to investigate how gas accretion takes place and evolves in close T Tauri binary systems. In particular, we model the accretion flows around two close T Tauri binaries, V4046 Sgr and DQ Tau, both showing periodic changes in emission lines, although their orbital characteristics are very different. In order to derive the density and velocity maps of the circumbinary material, we employ two-dimensional hydrodynamic simulations with a locally isothermal equation of state. The flow patterns become quasi-stable after a few orbits in the frame co-rotating with the system. Gas flows across the circumbinary gap through the co-rotating Lagrangian points, and local circumstellar discs develop around both components. Spiral density patterns develop in the circumbinary disc that transport angular momentum efficiently. Mass is preferentially channelled towards the primary and its circumstellar disc is more massive than the disc around the secondary. We also compare the derived density distribution to observed line profile variability. The line profile variability tracing the gas flows in the central cavity shows clear similarities with the corresponding observed line profile variability in V4046 Sgr, but only when the local circumstellar disc emission was excluded. Closer to the stars normal magnetospheric accretion may dominate while further out the dynamic accretion process outlined here dominates. Periodic changes in the accretion rates onto the stars can explain the outbursts of line emission observed in eccentric systems such as DQ Tau.

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Why are most molecular clouds not gravitationally bound?

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The most recent observational evidence seems to indicate that giant molecular clouds are predominantly gravitationally unbound objects. In this paper we show that this is a natural consequence of a scenario in which cloud-cloud collisions and stellar feedback regulate the internal velocity dispersion of the gas, and so prevent global gravitational forces from becoming dominant. Thus, while the molecular gas is for the most part gravitationally unbound, local regions within the denser parts of the gas (within the clouds) do become bound and are able to form stars. We find that the observations, in terms of distributions of virial parameters and cloud structures, can be well modelled provided that the star formation efficiency in these bound regions is of order 5 - 10 percent. We also find that in this picture the constituent gas of individual molecular clouds changes over relatively short time scales, typically a few Myr.

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The effect of dust cooling on low-metallicity star-forming clouds

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The theory for the formation of the first population of stars (Pop III) predicts a IMF composed predominantly of high-mass stars, in contrast to the present-day IMF, which tends to yield stars with masses less than 1 $M_\odot$. The leading theory for the transition in the characteristic stellar mass predicts that the cause is the extra cooling provided by increasing metallicity and in particular the cooling provided at high densities by dust. The aim of this work is to test whether dust cooling can lead to fragmentation and be responsible for this transition. To investigate this, we make use of high-resolution hydrodynamic simulations. We follow the thermodynamic evolution of the gas by solving the full thermal energy equation, and also track the evolution of the dust temperature and the chemical evolution of the gas. We model clouds with different metallicities, and determine the properties of the cloud at the point at which it undergoes gravitational fragmentation. We follow the further collapse to scales of an AU when we replace very dense, gravitationally bound, and collapsing regions by a simple and nongaseous object, a sink particle.
Our results suggest that for metallicities as small as $10^{-5}Z_\odot$, dust cooling produces low-mass fragments and hence can potentially enable the formation of low mass stars. We conclude that dust cooling affects the fragmentation of low-metallicity gas clouds and plays an important role in shaping the stellar IMF even at these very low metallicities. We find that the characteristic fragment mass increases with decreasing metallicity, but find no evidence for a sudden transition in the behaviour of the IMF within the range of metallicites examined in our present study.

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A Mid-Infrared Census of Star Formation Activity in Bolocam Galactic Plane Survey Sources

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We present the results of a search for mid-infrared signs of star formation activity in the 1.1 mm sources in the Bolocam Galactic Plane Survey (BGPS). We have correlated the BGPS catalog with available mid-IR Galactic plane catalogs based on the *Spitzer Space Telescope* GLIMPSE legacy survey and the *Midcourse Space Experiment* (*MSX*) Galactic plane survey. We find that 44% (3,712 of 8,358) of the BGPS sources contain at least one mid-IR source, including 2,457 of 5,067 (49%) within the area where all surveys overlap ($10° < \ell < 65°$). Accounting for chance alignments between the BGPS and mid-IR sources, we conservatively estimate that 20% of the BPGS sources within the area where all surveys overlap show signs of active star formation. We separate the BGPS sources into four groups based on their probability of star formation activity. Extended Green Objects (EGOs) and Red *MSX* Sources (RMS) make up the highest probability group, while the lowest probability group is comprised of "starless" BGPS sources which were not matched to any mid-IR sources. The mean 1.1 mm flux of each group increases with increasing probability of active star formation. We also find that the "starless" BGPS sources are the most compact, while the sources with the highest probability of star formation activity are on average more extended with large skirts of emission. A subsample of 280 BGPS sources with known distances demonstrates that mass and mean H_2 column density also increase with probability of star formation activity.

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A High Mass Dusty Disk Candidate: The Case of IRAS 18151-1208

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Many questions remain regarding the properties of disks around massive prototstars. Here we present the observations of a high mass protostellar object including an elongated dust continuum structure perpendicular to the outflow. Submillimeter Array 230 GHz line and continuum observations of the high mass protostellar object IRAS 18151-1208 along with single dish IRAM 30m observations afford us high spatial resolution (0.8") as well as recovery of the extended emission that gets filtered out by the interferometer. The observations of ^{12}CO confirm the outflow direction to be in the southeast-northwest direction, and the 1.3 mm continuum exhibits an elongation in the direction perpendicular to the outflow. We model the physical parameters of the elongated structure by simultaneously fitting the observed spectral energy distribution (SED) and the brightness profile along the major axis using the 3D Radiative Transfer code MC3D. Assuming a density profile similar to that of a low mass disk, we can also reproduce the observations of this high mass protostellar object. This is achieved by using the same density distribution and flaring parameters as were used in the low mass case, and scaling up the size parameters that successfully modeled the circumstellar disk of several T Tauri stars. We also calculate that a region within the inner 30 AU of such a high mass disk is stable under the Toomre criterion. While we do not rule out other scenarios, we show here that the observations in the high mass regime are consistent with a scaled up version of a low mass disk. Implications on high mass star formation are discussed.

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A new Jeans resolution criterion for (M)HD simulations of self-gravitating gas: Application to magnetic field amplification by gravity-driven turbulence

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Cosmic structure formation is characterized by the complex interplay between gravity, turbulence, and magnetic fields. The processes by which gravitational energy is converted into turbulent and magnetic energies, however, remain poorly understood. Here, we show with high-resolution, adaptive-mesh simulations that MHD turbulence is efficiently driven by extracting energy from the gravitational potential during the collapse of a dense gas cloud. Compressible motions generated during the contraction are converted into solenoidal, turbulent motions, leading to a natural energy ratio of $E_{\rm sol}/E_{\rm tot} \approx 2/3$. We find that the energy injection scale of gravity-driven turbulence is close to the local Jeans scale. If small seeds of the magnetic field are present, they are amplified exponentially fast via the small-scale dynamo process. The magnetic field grows most efficiently on the smallest scales, for which the stretching, twisting, and folding of field lines, and the turbulent vortices are sufficiently resolved. We find that this scale corresponds to about 30 grid cells in the simulations. We thus suggest a new minimum resolution criterion of 30 cells per Jeans length in (magneto)hydrodynamical simulations of self-gravitating gas, in order to resolve turbulence on the Jeans scale, and to capture minimum dynamo amplification of the magnetic field. Due to numerical diffusion, however, any existing simulation today can at best provide lower limits on the physical growth rates. We conclude that a small, initial magnetic field can grow to dynamically important strength on time scales significantly shorter than the free-fall time of the cloud.

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http://www.ita.uni-heidelberg.de/∼chfeder/pubs/dynamo/dynamo.shtml

Millimeter and Submillimeter High Angular Resolution Interferometric Observations: Dust in the Heart of IRAS 18162–2048

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The GGD27 complex includes the HH 80-81-80N system, which is one of the most powerful molecular outflows associated with a high-mass star-forming region observed to date. This outflow is powered by the star associated with the source IRAS 18162–2048. Here, we report on the detection of continuum emission at subarcsec/arcsec resolution with the Submillimeter Array (SMA) at 1.36 mm and 456 μm, respectively. We detected dust emission arising from two compact cores, MM1 and MM2, separated by about $7''$ (∼12,000 AU in projected distance). MM1 spatially coincides with the powerful thermal radio continuum jet that powers the very extended molecular outflow, while MM2 is associated with the protostar that drives the compact molecular outflow recently found in this region. High angular resolution observations at 1.36 mm show that MM1 is unresolved and that MM2 splits into two subcomponents separated by $\sim 1''$. The mass of MM1 is about 4 $M_\odot$ and it has a size of < 300 AU. This is consistent with MM1 being associated with a massive and dense ($n(H_2) > 10^9$ cm^{-3}) circumstellar dusty disk surrounding a high-mass protostar, which has not yet developed a compact H II region. On the other hand, the masses of the two separate components of MM2 are about 2 $M_\odot$ each. One of these components is a compact core with an intermediate-mass young protostar

inside and the other component is probably a prestellar core. MM1 is the brightest source at 1.36 mm, while MM2 dominates the emission at 456 μm. These are the only (sub)millimeter sources detected in the SMA observations. Hence, it seems that both sources may contribute significantly to the bolometric luminosity of the region. Finally, we argue that the characteristics of these two sources indicate that MM2 is probably in an earlier evolutionary stage than MM1.

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Characterizing the IYJ Excess Continuum Emission in T Tauri Stars

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We present the first characterization of the excess continuum emission of accreting T Tauri stars between optical and near-infrared wavelengths. With nearly simultaneous spectra from 0.48 to 2.4 microns acquired with HIRES and NIRSPEC on Keck and SpeX on the IRTF, we find significant excess continuum emission throughout this region, including the I, Y, and J bands, which are usually thought to diagnose primarily photospheric emission. The IYJ excess correlates with the excess in the V band, attributed to accretion shocks in the photosphere, and the excess in the K band, attributed to dust in the inner disk near the dust sublimation radius, but it is too large to be an extension of the excess from these sources. The spectrum of the excess emission is broad and featureless, suggestive of blackbody radiation with a temperature between 2200 and 5000 K. The luminosity of the IYJ excess is comparable to the accretion luminosity inferred from modeling the blue and ultraviolet excess emission and may require reassessment of disk accretion rates. The source of the IYJ excess is unclear. In stars of low accretion rate, the size of the emitting region is consistent with cooler material surrounding small hot accretion spots in the photosphere. However, for stars with high accretion rates, the projected area is comparable to or exceeds that of the stellar surface. We suggest that at least some of the IYJ excess emission arises in the dust-free gas inside the dust sublimation radius in the disk.

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Carbon Isotope and Isotopomer Fractionation in Cold Dense Cloud Cores

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We construct the gas-grain chemical network model which includes carbon isotopes (^{12}C and ^{13}C) with an emphasis on isotopomer-exchange reactions. Temporal variations of molecular abundances, the carbon isotope ratios (^{12}CX/^{13}CX) and the isotopomer ratios (^{12}C^{13}CX/^{13}C^{12}CX) of CCH and CCS in cold dense cloud cores are investigated by numerical calculations. We confirm that the isotope ratios of molecules, both in the gas phase and grain surfaces, are significantly different depending on whether the molecule is formed from the carbon atom (ion) or the CO molecule. Molecules formed from carbon atoms have the CX/^{13}CX ratios greater than the elemental abundance ratio of [^{12}C/^{13}C]. On the other hand, molecules formed from CO molecules have the CX/^{13}CX ratios smaller than the [^{12}C/^{13}C] ratio. We reproduce the observed C^{13}CH/^{13}CCH ratio in TMC-1, if the isotopomer exchange reaction, ^{13}CCH + H $\rightleftharpoons$ C^{13}CH + H + 8.1 K, proceeds with the forward rate coefficient $k_f > 10^{-11}$ cm^3 s^{-1}. However, the C^{13}CS/^{13}CCS ratio is lower than that observed in TMC-1. We then assume the isotopomer exchange reaction catalyzed by the H atom, ^{13}CCS + H $\rightleftharpoons$ C^{13}CS + H + 17.4 K. In the model with this reaction, we reproduce the observed C^{13}CS/^{13}CCS, CCS/C^{13}CS and CCS/^{13}CCS ratio simultaneously.

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The Young Binary DQ Tau: A Hunt For X-ray Emission From Colliding Magnetospheres

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The young high-eccentricity binary DQ Tau exhibits powerful recurring millimeter-band (mm) flaring attributed to collisions between the two stellar magnetospheres near periastron, when the stars are separated by only 8Rstar. These magnetospheric interactions are expected to have scales and magnetic field strengths comparable to those of large X-ray flares from single pre-main-sequence (PMS) stars observed in the Chandra Orion Ultradeep Project (COUP). To search for X-rays arising from processes associated with colliding magnetospheres, we performed simultaneous X-ray and mm observations of DQ Tau near periastron phase. We report here several results. 1) As anticipated, DQ Tau was caught in a flare state in both mm and X-rays. A single long X-ray flare spanned the entire 16.5 hour Chandra exposure. 2) The inferred morphology, duration, and plasma temperature of the X-ray flare are typical of those of large flares from COUP stars. 3) However, our study provides three lines of evidence that this X-ray flare likely arises from colliding magnetospheres: the chance of capturing a large COUP-like flare within the span of our observation is small; the relative timing of the X-ray and mm flares indicates the Neupert effect and is consistent with a common coronal structure; the size of the emitting coronal structure (4-5Rstar) inferred from our analysis (which is admittedly model-dependent and should be considered with caution) is comparable to half the binary separation. 4) The peak flare X-ray luminosity is in agreement with an estimate of the power dissipated by magnetic reconnection within the framework of a simple model of interacting magnetospheres.

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Evolution of X-ray and FUV Disk-Dispersing Radiation Fields

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We present new X-ray and Far Ultraviolet (FUV) observations of T Tauri stars covering the age range 1 to 10 Myr. Our goals are to observationally constrain the intensity of radiation fields responsible for evaporating gas from the circumstellar disk and to assess the feasibility of current photoevaporation models, focusing on X-ray and UV radiation. We greatly increase the number of 7–10 Myr old T Tauri stars observed in the X-rays by including observations of the well populated 25 Ori aggregate in the Orion OB1a subassociation. With these new 7–10 Myr objects, we confirm that X-ray emission remains constant from 1–10 Myr. We also show, for the first time, observational evidence for the evolution of FUV radiation fields with a sample of 56 accreting and non-accreting young stars spanning 1 Myr to 1 Gyr. We find that the FUV emission decreases on timescales consistent with the decline of accretion in classical T Tauri stars until reaching the chromospheric level in weak T Tauri stars and debris disks. Overall, we find that the observed strength of high energy radiation is consistent with that required by photoevaporation models to dissipate the disks in timescales of approximately 10 Myr. Finally, we find that the high energy fields that affect gas evolution are not similarly affecting dust evolution; in particular, we find that disks with inner clearings, the transitional disks,

have similar levels of FUV emission as full disks.

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Evolution of the binary population in young dense star clusters

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Context: Field stars are not always single stars, but can often be found in bound double systems. Since binary frequencies in the birth places of stars, young embedded clusters, are sometimes even higher than on average the question arises of how binary stars form in young dense star clusters and how their properties evolve to those observed in the field population.
Aims: We assess, the influence of stellar dynamical interactions on the primordial binary population in young dense cluster environments.
Methods: We perform numerical N-body simulations of the Orion Nebula Cluster like star cluster models including primordial binary populations using the simulation code NBODY6++.
Results: We find two remarkable results that have yet not been reported: The first is that the evolution of the binary frequency in young dense star clusters is independent predictably of its initial value. The time evolution of the normalized number of binary systems has a fundamental shape. The second main result is that the mass of the primary star is of vital importance to the evolution of the binary. The more massive a primary star, the lower the probability that the binary is destroyed by gravitational interactions. This results in a higher binary frequency for stars more massive than $2M_{\odot}$ compared to the binary frequency of lower mass stars. The observed increase in the binary frequency with primary mass is therefore most likely not due to differences in the formation process but can be entirely explained as a dynamical effect.
Conclusions: Our results allow us to draw conclusions about the past and the future number of binary systems in young dense star clusters and demonstrate that the present field stellar population has been influenced significantly by its natal environments.

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The outburst and nature of two young eruptive stars in the North America/Pelican Nebula Complex

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Context. The sudden optical brightening of two young stellar objects, HBC 722 and VSX J205126.1+440523, located in the North America/Pelican Nebula Complex, was announced in August 2010. Early photometric and spectroscopic

observations of these objects indicated that they may belong to the FUor or EXor class of young eruptive stars. The eruptions of FUors and EXors are often explained by enhanced accretion of material from the circumstellar disk to the protostar.
Aims. In order to determine the true nature of these two objects, we started an optical and near-infrared monitoring program, and complemented our data with archival observations and data from the literature.
Methods. We plot and analyze pre-outburst and outburst spectral energy distributions (SEDs), multi-filter light curves, and color-color diagrams.
Results. The quiescent SED of HBC 722 is consistent with that of a slightly reddened normal T Tauri-type star. The source brightened monotonically in about two months, and the SED obtained during maximum brightness indicates the appearance of a hot, single-temperature blackbody. The current fading rate implies that the star will return to quiescence in about a year, which questions its classification as a bone fide FUor. The quiescent SED of VSX J205126.1+440523 looks like that of a highly embedded Class I source. The outburst of this source happened more gradually, but reached an unprecedentedly high amplitude. Its light curves showed a deep minimum two and a half months after the peak, when the object was close to its pre-outburst optical brightness. Further monitoring indicates that it is still far from being quiescent.
Conclusions. The shape of the light curves as well as the bolometric luminosities and accretion rates suggest that these objects do not fit into the classic FUor group. Although HBC 722 exhibits all spectral characteristics of a bona fide FUor, its luminosity and accretion rate is too low and its timescale is too fast compared with classical FUors. VSX J205126.1+440523 seems to be an example where quick extinction changes modulate the light curve.

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Mapping the Shores of the Brown Dwarf Desert II: Multiple Star Formation in Taurus-Auriga

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We have conducted a high-resolution imaging study of the Taurus-Auriga star-forming region in order to characterize the primordial outcome of multiple star formation and the extent of the brown dwarf desert. Our survey identified 16 new binary companions to primary stars with masses of 0.25-2.5 $M_\odot$, raising the total number of binary pairs (including components of high-order multiples) with separations of 3–5000 AU to 90. We find that ∼2/3–3/4 of all Taurus members are multiple systems of two or more stars, while the other ∼1/4–1/3 appear to have formed as single stars; the distribution of high-order multiplicity suggests that fragmentation into a wide binary has no impact on the subsequent probability that either component will fragment again. The separation distribution for solar-type stars (0.7–2.5 $M_\odot$) is nearly log-flat over separations of 3–5000 AU, but lower-mass stars (0.25–0.7 $M_\odot$) show a paucity of binary companions with separations of $\gtrsim$200 AU. Across this full mass range, companion masses are well described with a linear-flat function; all system mass ratios ($q = M_B/M_A$) are equally probable, apparently including substellar companions. Our results are broadly consistent with the two expected modes of binary formation (freefall fragmentation on large scales and disk fragmentation on small scales), but the distributions provide some clues as to the epochs at which the companions are likely to form.

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The initial period function of late-type binary stars and its variation

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The variation of the period distribution function of late-type binaries is studied. It is shown that the Taurus–Auriga pre-main sequence population and the main sequence G dwarf sample do not stem from the same parent period distribution with better than 95 per cent confidence probability. The Lupus, Upper Scorpius A and Taurus–Auriga populations are shown to be compatible with being drawn from the same initial period function (IPF), which is inconsistent with the main sequence data. Two possible IPF forms are used to find parent distributions to various permutations of the available data which include Upper Scorpius B (UScB), Chameleon and Orion Nebula Cluster pre-main sequence samples. All the pre-main sequence samples studied here are consistent with the hypothesis that there exists a universal IPF which is modified through binary-star disruption if it forms in an embedded star cluster leading to a general decline of the observed period function with increasing period. The pre-main sequence data admit a log-normal IPF similar to that arrived at by Duquennoy & Mayor (1991) for main sequence stars, provided the binary fraction among pre-main sequence stars is significantly higher. But, for consistency with proto-stellar data, the possibly universal IPF ought to be flat in log-P or log-semi-major axis and must be similar to the K1 IPF form derived through inverse dynamical population synthesis, which has been shown to lead to the main sequence period function if most stars form in typical embedded clusters.

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Radiation pressure feedback in the formation of massive stars

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We investigate the radiation pressure feedback in the formation of massive stars in 1, 2, and 3D radiation hydrodynamics simulations of the collapse of massive pre-stellar cores. In contrast to previous research, we consider frequency dependent stellar radiation feedback, resolve the dust sublimation front in the vicinity of the forming star down to 1.27 AU, compute the evolution for several 10^5 yrs covering the whole accretion phase of the forming star, and perform a comprehensive survey of the parameter space.
The most fundamental result is that the formation of a massive accretion disk in slowly rotating cores preserves a high anisotropy in the radiation field. The thermal radiation escapes through the optically thin atmosphere, effectively diminishing the radiation pressure feedback onto the accretion flow. Gravitational torques in the self-gravitating disk drive a sufficiently high accretion rate to overcome the residual radiation pressure. Simultaneously, the radiation pressure launches an outflow in the bipolar direction, which grows in angle with time and releases a substantial fraction of the initial core mass from the star-disk system.
Summarized, for an initial core mass of 60, 120, 240, and 480 Msol these mechanisms allow the star to grow up to 28.2, 56.5, 92.6, and at least 137.2 Msol respectively.

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An Implicit Scheme for Ohmic Dissipation with Adaptive Mesh Refinement

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An implicit method for the ohmic dissipation is proposed. The proposed method is based on the Crank-Nicolson method and exhibits second-order accuracy in time and space. The proposed method has been implemented in the SFUMATO adaptive mesh refinement (AMR) code. The multigrid method on the grids of the AMR hierarchy converges the solution. The convergence is fast but depends on the time step, resolution, and resistivity. Test problems demonstrated that decent solutions are obtained even at the interface between fine and coarse grids. Moreover, the solution obtained by the proposed method shows good agreement with that obtained by the explicit method, which required many time steps. The present method reduces the number of time steps, and hence the computational costs,

as compared with the explicit method.

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The North American and Pelican Nebulae II. MIPS Observations and Analysis

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We present observations of ∼7 square degrees of the North American and Pelican Nebulae region at 24, 70, and 160 μm with the *Spitzer Space Telescope* Multiband Imaging Photometer for Spitzer (MIPS). We incorporate the MIPS observations with earlier *Spitzer* Infrared Array Camera (IRAC) observations, as well as archival near-infrared (IR) and optical data. We use the MIPS data to identify 1286 young stellar object (YSO) candidates. IRAC data alone can identify 806 more YSO candidates, for a total of 2076 YSO candidates. Prior to the *Spitzer* observations, there were only ∼200 YSOs known in this region. Three subregions within the complex are highlighted as clusters: the Gulf of Mexico, the Pelican, and the Pelican's Hat. The Gulf of Mexico cluster is subject to the highest extinction (A_V at least ∼30) and has the widest range of infrared colors of the three clusters, including the largest excesses and by far the most point-source detections at 70 μm. Just 3% of the cluster members were previously identified; we have redefined this cluster as about 10-100 times larger (in projected area) than was previously realized.

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http://web.ipac.caltech.edu/staff/rebull/research.html

Spectral signatures of disk eccentricity in young binary systems: I. Circumprimary case

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Context. Star formation occurs via fragmentation of molecular clouds, which means that the majority of stars born are members of binary systems. There is growing evidence that planets might form in circumprimary disks of medium-separation ($\leq$ 50 AU) binaries. The tidal forces caused by the secondary generally act to distort the originally circular circumprimary disk to an eccentric one. Since the disk eccentricity might play a major role in planet formation, it is of great importance to understand how it evolves.
Aims. We investigate disk eccentricity evolution to reveal its dependence on the physical parameters of the binary system and the protoplanetary disk. To infer the disk eccentricity from high-resolution near-IR spectroscopy, we calculate the fundamental band (4.7 μm) emission lines of the CO molecule emerging from the atmosphere of the eccentric disk.
Methods. We model circumprimary disk evolution under the gravitational perturbation of the orbiting secondary using a 2D grid-based hydrodynamical code, assuming α-type viscosity. The hydrodynamical results are combined with our semianalytical spectral code to calculate the CO molecular line profiles. Our thermal disk model is based on the double-layer disk model approximation. We assume LTE and canonical dust and gas properties for the circumprimary disk.
Results. We find that the orbital velocity distribution of the gas parcels differs significantly from the circular Keplerian fashion. The line profiles are double-peaked and asymmetric in shape. The magnitude of asymmetry is insensitive to the binary mass ratio, the magnitude of viscosity (α), and the disk mass. In contrast, the disk eccentricity, thus the magnitude of the line profile asymmetry, is influenced significantly by the binary eccentricity and the disk geometrical

thickness.

Conclusions. We demonstrate that the disk eccentricity profile in the planet-forming region can be determined by fitting the high-resolution CO line profile asymmetry using a simple 2D spectral model that accounts for the velocity distortions caused by the disk eccentricity. Thus, with our novel approach the disk eccentricity can be inferred from high-resolution near-IR spectroscopy data acquired prior to the era of high angular resolution optical (ELT) or radio (ALMA, E-VLA) direct-imaging. By determining the disk eccentricity in medium-separation young binaries, we might be able to constrain the planet formation theories.

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Carbon Recombination Lines toward the Riegel-Crutcher Cloud and other Cold HI Regions in the inner Galaxy

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In the first paper in the series, Roshi, Kantharia & Anantharamaiah (2002) published the Galactic plane survey of carbon recombination lines (CRRL) at 327 MHz. CRRL were extensively detected from the inner Galaxy (longitudes$<$ 20°). We report here, for the first time, the association of low frequency CRRL with H I self-absorbing clouds in the inner Galaxy and that the CRRLs from the innermost $\sim 10^\circ$ of the Galaxy arise in the Riegel-Crutcher (R-C) cloud. The R-C cloud is amongst the most well known of H I self-absorbing (HISA) regions located at a distance of about 125 pc in the Galactic centre direction. Taking the R-C cloud as an example, we demonstrate that the physical properties of the HISA can be constrained by combining multi-frequency CRRL and H I observations. The derived physical properties of the HISA cloud are used to determine the cooling and heating rates. The dominant cooling process is emission of the C II 158 μm line whereas dominant heating process in the cloud interior is photoelectric emission. Constraints on the FUV flux (G0 $\sim$ 4 to 7) falling on the R-C cloud are obtained by assuming thermal balance between the dominant heating and cooling processes. The H_2 formation rate per unit volume in the cloud interior is $\sim 10^{-10} - 10^{-12}$ s^{-1} cm^{-3} , which far exceeds the H_2 dissociation rate per unit volume. We conclude that the self-absorbing cold H I gas in the R-C cloud may be in the process of converting to the molecular form. The cold H I gas observed as HISA features are ubiquitous in the inner Galaxy and form an important part of the ISM. Our analysis shows that combining CRRL and H I data can give important insight into the nature of these cold gas. We also estimate the integration times required to image the CRRL forming region with the upcoming SKA pathfinders. Imaging with the MWA telescope is feasible with reasonable observing times.

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Near-Infrared Spectroscopy of TW Hya: A Revised Spectral Type and Comparison with Magnetospheric Accretion Models

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We present high signal-to-noise, moderate spectral resolution ($R \sim 2000 - 2500$) near-infrared ($0.8 - 5.0$ μm) spectroscopy of the nearby T Tauri star TW Hya. By comparing the spectrum and the equivalent widths of several atomic and molecular features with those for stars in the IRTF near-infrared library, we revise the spectral type to M2.5V, which is later than usually adopted (K7V). This implies a substantially cooler stellar temperature than previously assumed. Comparison with various pre-main sequence models suggests that TW Hya is only $\sim$ 3 Myr old; much younger than the usually adopted $8 - 10$ Myr. Analysis of the relative strengths of the H lines seen in the spectrum yields estimates for the temperature and density of the emitting region of $T_e \geq 7500$ K and $n_e \sim 10^{12} - 10^{13}$ cm^{-3}. The thickness of the emitting region is $10^2 - 10^4$ km and the covering fraction is $f_* \sim 0.04$. Our derived physical parameter values agree with the predictions of the magnetospheric accretion scenario. The highest signal-to-noise H lines have profiles that indicate multiple emission components. We derive an excess spectrum (above that of the

M2.5V template) that peaks in the H band. Although our derived veiling values, ~ 0.1, agree with previous estimates, the excess spectrum does not match that of current models in which this flux is generated by an inner optically thin disk. We suggest that the excess flux spectrum instead reflects the differences in atmospheric opacity, gravity, and age between TW Hya and older, higher gravity field M2.5 dwarfs.

Accepted by Astrophysical Journal

http://arxiv.org/abs/1102.0535

On the methanol masers in G9.62+0.20E and G188.95+0.89

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A comparison between the observed light curves of periodic masers in G9.62+0.20E and G188.95+0.89 and the results of a simple colliding-wind binary model is made to establish whether the flaring and other time-dependent behaviour of the masers in these two star forming regions can be ascribed to changes in the environment of the masers or in the continuum emission from parts of the background HII region. It is found that the light curves of widely different shape and amplitude in these two objects can be explained within the framework of a periodic pulse of ionizing radiation that raises the electron density in a volume of partially ionized gas against which the masers are projected. It is also shown that the decay of the 11.405 km s^{-1} maser in G188.95+0.89 can be explained very well in terms of the recombination of the ionized gas against which the maser is projected while it would require very special conditions to explain it in terms of changes in environment of the maser. We conclude that for G9.62+0.20E and G188.95+0.89 the observed changes in the masers are most likely due to changes in the background free-free emission which is amplified by the masers.

Accepted by The Astronomical Journal

The JCMT Spectral Legacy Survey: physical structure of the molecular envelope of the high-mass protostar AFGL2591

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Context. The understanding of the formation process of massive stars ($>8\,M_{\odot}$) is limited, due to a combination of theoretical complications and observational challenges. The high UV luminosities of massive stars give rise to chemical complexity in their natal molecular clouds, and affect the dynamical properties of their circumstellar envelopes.
Aims. We investigate the physical structure of the large-scale ($\sim 10^4$–10^5 AU) molecular envelope of the high-mass protostar AFGL2591.
Methods. Observational constraints are provided by spectral imaging in the 330–373 GHz regime from the JCMT Spectral Legacy Survey and its high frequency extension. While the majority of the ~160 spectral features from the survey cube are spatially unresolved, this paper uses the 35 that are significantly extended in the spatial directions. For these features we present integrated intensity maps and velocity maps. The observed spatial distributions of a selection of six species are compared with radiative transfer models based on (i) a static spherically symmetric structure, (ii) a dynamic spherical structure, and (iii) a static flattened structure.
Results. The maps of CO and its isotopic variations exhibit elongated geometries on scales of ~100", and smaller scale substructure is found in maps of N_2H^+, o-H_2CO, CS, SO_2, C_2H, and various CH_3OH lines. In addition, a line of sight velocity gradient is apparent in maps of all molecular lines presented here, except SO, SO_2, and H_2CO. We find two emission peaks in warm ($E_{\rm up} \sim 200$ K) CH_3OH separated by 12" (12 000 AU), indicative of a secondary heating source in the envelope.

The spherical models are able to explain the distribution of emission for the optically thin $H^{13}CO^+$ and $C^{34}S$, but not for the optically thick HCN, HCO^+, and CS, nor for the optically thin $C^{17}O$. The introduction of velocity structure mitigates the optical depth effects, but does not fully explain the observations, especially in the spectral dimension. A static flattened envelope viewed at a small inclination angle does slightly better.
Conclusions. Based on radiative transfer modeling, we conclude that a geometry of the envelope other than an isotropic static sphere is needed to circumvent line optical depth effects. We propose that this could be achieved in circumstellar envelope models with an outflow cavity and/or inhomogeneous structure at scales smaller than $\sim 10^4$ AU. The picture of inhomogeneity is supported by observed substructure in at least six different species.

Accepted by A&A

http://arxiv.org/abs/1101.5529

Embedded protostellar disks around (sub-)solar stars. II. Disk masses, sizes, densities, temperatures and the planet formation perspective

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We present basic properties of protostellar disks in the embedded phase of star formation (EPSF), which is difficult to probe observationally using available observational facilities. We use numerical hydrodynamics simulations of cloud core collapse and focus on disks formed around stars in the $0.03-1.0\ M_\odot$ mass range. Our obtained disk masses scale near-linearly with the stellar mass. The mean and median disk masses in the Class 0 and I phases ($M^{\rm mean}_{\rm d,C0} = 0.12\ M_\odot$, $M^{\rm mdn}_{\rm d,C0} = 0.09\ M_\odot$ and $M^{\rm mean}_{\rm d,CI} = 0.18\ M_\odot$, $M^{\rm mdn}_{\rm d,CI} = 0.15\ M_\odot$, respectively) are greater than those inferred from observations by (at least) a factor of 2–3. We demonstrate that this disagreement may (in part) be caused by the optically thick inner regions of protostellar disks, which do not contribute to millimeter dust flux. We find that disk masses and surface densities start to systematically exceed those of the minimum mass solar nebular for objects with stellar mass as low as $M_* = 0.05-0.1\ M_\odot$. Concurrently, disk radii start to grow beyond 100 AU, making gravitational fragmentation in the disk outer regions possible. Large disk masses, surface densities, and sizes suggest that giant planets may start forming as early as in the EPSF, either by means of core accretion (inner disk regions) or direct gravitational instability (outer disk regions), thus breaking a longstanding stereotype that the planet formation process begins in the Class II phase.

Accepted by The Astrophysical Journal

Destruction of massive fragments in protostellar disks and crystalline silicate production

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We present a mechanism for the crystalline silicate production associated with the formation and subsequent destruction of massive fragments in young protostellar disks. The fragments form in the embedded phase of star formation via disk fragmentation at radial distances $\gtrsim 50-100$ AU and anneal small amorphous grains in their interior when the gas temperature exceeds the crystallization threshold of ~ 800 K. We demonstrate that fragments that form in the early embedded phase can be destroyed before they either form solid cores or vaporize dust grains, thus releasing the processed crystalline dust into various radial distances from sub-AU to hundred-AU scales. Two possible mechanisms for the destruction of fragments are the tidal disruption and photoevaporation as fragments migrate radially inward and approach the central star and also dispersal by tidal torques exerted by spiral arms. As a result, most of the crystalline dust concentrates to the disk inner regions and spiral arms, which are the likely sites of fragment destruction.

Accepted by The Astrophysical Journal Letters

Postdoctoral position for the Variable Young Stellar Objects Survey (VYSOS) at the University of Hawaii

The NASA Astrobiology Center at the University of Hawaii invites applications for a postdoctoral position in Astrophysics, to work at the VYSOS project led by Prof. Bo Reipurth. The position is initially for 2 years assuming a satisfactory performance review after the first year. Extensions are possible depending on the availability of funds.

The successful candidate will have a PhD in astronomy and experience in working with young stars and star formation, or time-variable stellar phenomenae, as documented by refereed publications. The VYSOS project is based on two robotic telescopes located at the Mauna Loa Observatory on the Big Island of Hawaii. One is a widefield 5.3-inch apochromatic refractor and the other is a 20-inch Ritchey-Chretien telescope. Every clear night the two telescopes monitor star forming regions along the Galactic plane. The goals are to find and analyse eclipsing pre-main sequence binaries and FUor and EXor events, to monitor and characterize the irregular variability of T Tauri stars, to determine rotation periods of weakline T Tauri stars in order to understand the angular momentum evolution during the pre-main sequence phase, to find and study pulsating young stars, and to develop statistics of flare events in young stars of different masses. Analysis of the photometric data will be supported by spectroscopic data obtained at the Mauna Kea Observatory. The successful candidate is expected to do research based on the VYSOS data base, and it is important that he/she must have practical experience in dealing with telescopes, detectors, and computers so as to be able to carry out regular maintenance of the telescopes. A facility with software and experience in handling very large data sets are advantageous.

The position is available immediately, and preference will be given to candidates who can start soon. The successful candidate will be paid a monthly stipend of US$5000, and will be offered the possibility to buy into certain health plans offered by the University of Hawaii. The Institute for Astronomy at the University of Hawaii at Manoa operates facilities on Oahu, on the Big Island of Hawaii, and on Maui. The present position is based in Hilo on the Big Island of Hawaii at the foot of the Mauna Loa and Mauna Kea volcanoes.

Candidates must send a complete curriculum vitae including a full list of publications, as well as a statement of previous experience and current professional interests, and arrange for two letters of recommendation to be sent to reipurth@ifa.hawaii.edu.

Review of applications will begin on April 1, but applications submitted thereafter will be fully considered until the post is filled.

Please send applications and inquiries by email to Prof. Bo Reipurth (reipurth@ifa.hawaii.edu).

The University of Hawaii is an EEO/AA employer and encourages applications from women and minorities.

Postdoctoral position on Turbulence and Star Formation

The Centro de Radioastronomia y Astrofisica (CRyA) of the Universidad Nacional Autonoma de Mexico (UNAM) calls for a second round of applications for a postdoctoral position in Astrophysics, to work with the Interstellar Turbulence group, led by Prof. Enrique Vazquez-Semadeni. Preference will be given to candidates with an expertise in the field of Computational Star Formation, although candidates in related fields, in particular observational star formation, are welcome to apply. The position is for one year, but can be extended for another year.

The successful candidate is expected to carry out original research in the theory of gravitational collapse in turbulent media and star formation, from the numerical and analytical viewpoints, and its connection to observations. The

CRyA is located in the beautiful city of Morelia, 300 km west of Mexico City, with direct flights from Mexico City, Houston, Los Angeles, and Chicago. CRyA members have access to the San Pedro Martir National Astronomical Observatory near Ensenada, Baja California. Astronomers at Mexican institutions have competitive access to the EVLA, the VLBA, and in the near future to ALMA, via a collaboration with the USA National Radio Astronomy Observatoty. The Interstellar Turbulence group has a 34-core cluster on site and is in the process of acquiring a new, 180-core + 1 GPU card machine, expected to be fully operational within the next two months. It also has access to UNAM's supercomputer, KanBalam (an HP CP 4000 with 1360 cores, rated at 7.1 TFlops with 3 Tbytes of memory and 160 Tbytes of storage). The CRyA provides funds for publishing, and limited support for traveling. Although work can be carried out in English, knowledge of, or willingness to learn Spanish is highly recommended.

Candidates must send a complete curriculum vitae including a full list of publications, as well as a statement of previous experience and current and future professional interests, and arrange for three recommendation letters to be sent to Prof. Vazquez-Semadeni by March 31st 2011, at the latest. The application can be sent by e-mail; recommendation letters can also be sent by e-mail, directly from the recommender. Please do not use regular mail.

Please send applications and inquiries to

Prof. Enrique Vazquez-Semadeni
Centro de Radioastronomia y Astrofisica
UNAM, Campus Morelia
P.O. Box 3-72
Morelia, Michoacan, 58089
MEXICO

Phone: 52 (443) 322 2753
Fax: 52 (443) 322 2726

e-mail: e.vazquez *at* crya.unam.mx

Postdoc position on Star Formation and Astrochemistry with Herschel

A 3-yr postdoctoral fellowship is available at Leiden Observatory within the Molecular Astrophysics group, as part of a long-term program to study the physical and chemical evolution of star- and planet-forming regions through a combination of theory and observations. In addition to carrying out a personal research program, the successful candidate is expected to take a significant role in the Herschel-HIFI key program on "Water in Star-Forming Regions" and related Herschel programs. The appointment is initially for two years, with the possibility of renewal for another year. It can start anytime up to Fall 2011. Candidates with an observational and/or modeling background in astrochemistry, low-mass star formation, circumstellar disks or submillimeter spectroscopy are encouraged to apply.

Leiden Observatory carries out observational, interpretative and theoretical research in the fields of the star and planet formation, laboratory astrophysics, galactic structure, the formation and dynamics of (high-redshift) galaxies and their nuclei, and cosmology. Leiden is a charming university town, within easy reach of the major European centers.

Applications should include a curriculum vitae, publication list, and a brief statement of research experience and interests, and arrange for three letters of reference to be uploaded at

http://jobs.strw.leidenuniv.nl/2011/dishoeckPD/

Review of applications will start on March 20 2011.

Exoplanets

Edited by Sara Seager

This new book in the well known Space Science Series from the University of Arizona Press deals with one of the most exciting topics of present-day astronomy. The twenty chapters are written by leading experts in the field and provide a systematic overview of the current techniques available to study exoplanets and an in-depth presentation of what is known today about the dynamics, formation, and evolution of exoplanets and their interiors and atmospheres. The book is very suitable for a graduate course, not least because the remarkably low price of US$ 35 (currently US$25 at amazon.com), made possible by a grant from NASA, has made it affordable for students.

The book contains the following chapters:

Planet Migration
by *S.H. Lubow and S. Ida*

Part V: Exoplanet Interiors and Atmospheres

Terrestrial Planet Interiors
by *C. Sotin, J.M. Jackson, and S. Seager*

Giant Planet Interior Structure and Thermal Evolution
by *J.J. Fortney, I. Baraffe, and B. Militzer*

Giant Planet Atmospheres
by *A. Burrows and G. Orton*

Terrestrial Planet Atmospheres and Biosignatures
by *V. Meadows and S. Seager*

Atmospheric Circulation of Exoplanets
by *A.P. Showman, J. Y.-K. Cho, and K. Menou*

The University of Arizona Press
Lunar and Planetary Institute
ISBN 978-0-8165-2945-2, hardback, 526 pages, 2010
US$35.00

Available from
http://www.uapress.arizona.edu/BOOKS/bid2263.htm

First Announcement of the workshop:

Formation and early evolution of very low mass stars and brown dwarfs

Garching, October 11-14, 2011

website: http://www.eso.org/sci/meetings/2011/vlms2011.html

email: vlms2011@eso.org

Wide area surveys in nearby molecular clouds are currently ongoing with Herschel in the far infrared and APEX in the submillimeter, these will soon be complemented and extended with SCUBA2 at the JCMT. They will add to the enormous amount of data that will be collected by ground-based wide-area surveys with telescopes like VISTA and VST, and those already available from other surveys, most notably those carried out with Spitzer. These surveys will offer complete samples of objects in nearby star forming regions from cores to protostars and young stars with unprecedented sensitivity, allowing to probe the physical conditions of the sites where the lowest mass isolated objects form. Together, these facilities will provide a multi-wavelength view of the origin of the full stellar and substellar mass function. In parallel detailed studies of individual objects and small samples are already ongoing with VLT/I existing and new (e.g. XShooter) instruments and with current millimeter interferometers, and shortly will begin with ALMA. At the same time, increasingly realistic computations of the collapse and fragmentation processes, the early evolution of the resulting objects, their inner structure, and the dynamics and chemistry of their atmospheres and of their surrounding medium are producing a sound framework for the interpretation of observations.

This workshop will review the current progress in our understanding of low mass star and brown dwarf formation in nearby molecular clouds, and will bring together observers and theoreticians to promote an energizing discussion.

Main topics include

- Properties of nearby molecular clouds and cores forming stars and BDs
- Collapse, protostars/protobinaries: theory and observations
- Early evolutionary stages of VLM stars and BDs: disk mediated accretion and ejection
- The IMF for stars and BDs and its possible relation with the Clumps MF
- The processes that regulate star formation in GMCs: theory and observational tests
- Surveys for young very low mass stars and brown dwarfs

Important dates:

Registration opening: March 2011
Registration/Abstracts Deadline: June 30, 2011
Selection of contributions: July 2011

Scientific Organizing Committee:

Isabelle Baraffe (Exeter), Matthew Bate (Exeter), Andreas Burkert (LMU/MPE), Fernando Comeron (ESO), Ewine van Dishoeck (Leiden/MPE), Greg Herczeg (MPE), Kevin Luhman (Princeton), Monika Petr-Gotzens (ESO, co-chair), Thomas Preibisch (LMU), Thomas Stanke (ESO), Paula Teixeira (ESO), Leonardo Testi (ESO, co-chair)

Workshop on

Star Formation through Spectroimaging at High Angular Resolution

and Star Formation Summer School

June 20-24, 2011 (Mon-Fri) and June 15-18, 2011 (Wed-Sat)

The Academia Sinica Institute of Astronomy and Astrophysics (ASIAA) and its Theoretical Institute for Advanced Research for Astrophysics (TIARA), is pleased to host a Star Formation Workshop jointly with the Astronomy Department of UC Berkeley entitled, "Star Formation through Spectroimaging at High Angular Resolution", on June 20th-24th, 2011, in ASIAA Taipei, Taiwan.

This is the second in a series of workshops alternating between Taipei and the San Francisco Bay Area, fostering a broader connection across the Pacific Rim with active researchers worldwide. The first workshop *Massive Star Formation: Observations, Theory and Diagnostic Tools* held in Berkeley, CA, in January 2010, was well-received and considered a great success by its participants. These workshops are modeled after the traditional annual workshops held by the Center for Star Formation Studies (CSFS) Consortium of the Bay Area, where timely topics were presented and discussed in an intimate setting. With this new series, the generation of astronomers that have been cultivated in the older series will branch out and form broader ties around the globe.

The theme of the workshop will be on

Theory and Computation - MHD simulations, dynamical simulations and chemical modeling, radiative transfer with complex treatments.

ISM and Chemistry - models, data of chemistry and molecular lines especially for ALMA.

Recent Observations - highlights from Herschel, observations from submm/mm interferometric arrays and other large telescopes.

On the road to ALMA - ALMA-related developments.

Each of the talks is scheduled for 30 minutes, followed by 15 minutes of questions and discussions. Ample time will be provided to facilitate close interactions and lively discussions among the speakers and the participants.

The invited speakers are to be announced.

Summer School:

A summer school on star formation will be held immediately prior to the workshop. The school intends to provide the background necessary for the students in an intensive presentation of the relevant material at the level of the book by Stahler and Palla (The Formation of Stars) for grad students in the mornings. Introductory overviews on chemistry, ISM, magnetic field, polarization, and line formation will be presented and discussed in the afternoons. Local support in the form of lodging based on double-occupancy with breakfast, and lunch and banquet will be provided for students traveling to Taiwan from other countries.

Pre-Registration is open!

Scientific Organizing Committee:

Leo Blitz (UCB, Co-Chair), Imke de Pater (UCB), Al Glassgold (UCB), James Graham (UCB), Paul Ho (ASIAA), David Hollenbach (SETI), Richard Klein (UCB), Sheng-Yuan Liu (ASIAA), Chris Mckee (UCB), Nagayoshi Ohashi (ASIAA), Hsien Shang (ASIAA, Co-Chair), Frank Shu (ASIAA), Ronald Taam (ASIAA)

Local Organizing Committee:

Miljenko Cemeljic (ASIAA), Cindy Chiu (ASIAA), Naomi Hirano (ASIAA), Hsu-Tai Lee (ASIAA), Suh-Lian Lin (ASIAA), Sheng-Yuan Liu (ASIAA),

Contact:
E-mail: sfw2011loc@asiaa.sinica.edu.tw
TEL: 886-2-2366-5320

http://events.asiaa.sinica.edu.tw/workshop/20110620/

Origins of Solar Systems
Composition of Forming Planets: A Tool to Understand Processes

July 17-22, 2011

Mount Holyoke College, South Hadley, MA, USA

The 2011 Gordon Research Conference on Origins of Solar Systems will take place at Mt. Holyoke College in South Hadley, MA 17-22 July. This unique interdisciplinary meeting includes astronomers and astrophysicists interested in star and planet formation, planetary scientists and cosmochemists interested in the early history, structure, and evolution of the Solar System, as well as scientists in related disciplines. By bringing together this mix of expertise the conference attempts to address fundamental questions that are not tractable within the confines of just one discipline. Our goal is to understand whether planetary systems like our own, and the potential for habitability that they represent are the exception or the rule in the Milky Way galaxy.

The focus of the 2011 meeting (the 11th since this series began twenty years ago) will be "Composition of Forming Planets: A Tool to Understand Processes". Topics covered will include: 1) the initial conditions for planet formation in circumstellar disks, including estimates of solar nebula composition from the Genesis mission; 2) the evolution of the physical structure of the gas and dust from which planets form; 3) progress in our theoretical understanding of the major physical processes that control planet formation; 4) the interplay between disk dynamics and disk chemistry in determining the composition of forming planets including new results from the Herschel Space Telescope; 5) meteoritic constraints on the physical and chemical conditions in the solar nebula; 6) the role of giant impacts in the structure and evolution of forming planets; 7) satellites and rings of giant planets as mini-laboratories to study the process of planet formation; 8) current census of extra-solar planets including new results from the Kepler and COROT missions as well as other facilities; 9) the essential chemical conditions for life and whether those are readily obtained through our current understanding of planet formation; and many other topics.

The conference will continue the usual format of invited lectures, extended discussion, and poster sessions. The meeting provides an excellent opportunity for young researchers to present their latest research results and to participate in the dynamic informal conversations that are typical of a Gordon Conference. We encourage young scientists, including graduate students and postdoctoral fellows, to attend. Special efforts will be made to promote interactions between invited speakers and junior participants and we expect to provide some financial support to facilitate the latter.

Chair: Michael R. Meyer

Vice Chair: Edward D. Young

http://www.grc.org/programs.aspx?year=2011&program=origins

Applications for this meeting must be submitted by June 19, 2011.

FIRST ANNOUNCEMENT

7th Potsdam Thinkshop on MAGNETIC FIELDS IN STARS AND EXOPLANETS: Future directions in observational and theoretical studies"

August 22-25, 2011, Potsdam, Germany

The conference is focused on stellar magnetic fields, stellar activity cycles and their interactions with exoplanets. The direct comparison of numerical simulations and observational results has special emphasis in this meeting. The program will be very open to discussions and vivid interactions between the scientists. It is planned to give fairly short talks to be able to hear as many news from the field as possible.

Registration is open on the web site

http://www.aip.de/thinkshop7

The list of invited speakers includes:

Axel Brandenburg (Stockholm), Matthew Browning (Toronto), Thorsten Carroll (Potsdam), Scott Gregory (Pasadena), Jean-Mathias Griessmeier (Dwingeloo), Huib Henrichs (Amsterdam), Swetlana Hubrig (Potsdam), Gaitee Hussain (Garching), Petri Kapyla (Helsinki), Leonid Kitchatinov (Irkutsk), Renada Konstantinova-Antova (Sofia), Norbert Langer (Bonn), Gautier Mathys (Garching), Ansgar Reiners (Goettingen), Markus Schoeller (Garching)

Scientific organizing committee:

Rainer Arlt, AIP, Potsdam (co-chair); Thomas R. Ayres, Univ. Colorado, Boulder; Alfio Bonanno, INAF, Catania; Thomas Hackman, Univ. Helsinki; Artie P. Hatzes, TLS, Tautenburg; Swetlana Hubrig, AIP, Potsdam (co-chair); Pascal Petit, Lab. Astrophys., Toulouse; Iosif I. Romanyuk, SAO, Nizhnij Arkhyz; Klaus G. Strassmeier, AIP, Potsdam.

The conference fee will be 220 EUR if paid before July 1, 2011. A special rate of 180 EUR will apply to students as well as PhD students if paid before July 1, 2011.

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.