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Abstracts of recently accepted papers

The Formation and Fragmentation of Primordial Molecular Clouds

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Many questions in physical cosmology regarding the thermal history of the intergalactic medium, chemical enrichment, reionization, etc. are thought to be intimately related to the nature and evolution of pregalactic structure. In particular the efficiency of primordial star formation and the primordial IMF are of special interest. We present results from high resolution three-dimensional adaptive mesh refinement simulations that follow the collapse of primordial molecular clouds and their subsequent fragmentation within a cosmologically representative volume. Comoving scales from 128 kpc down to 1 pc are followed accurately. Dark matter dynamics, hydrodynamics and all relevant chemical and radiative processes (cooling) are followed self-consistently for a cluster normalized CDM structure formation model. Primordial molecular clouds with $\sim 10^5$ solar masses are assembled by mergers of multiple objects that have formed hydrogen molecules in the gas phase with a fractional abundance of $\lesssim 10^{-4}$. As the subclumps merge cooling lowers the temperature to ~ 200 K in a “cold pocket” at the center of the halo. Within this cold pocket, a quasi-hydrostatically contracting core with mass $\sim 200M_{\odot}$ and number densities $\gtrsim 10^5 \text{ cm}^{-3}$ is found. We find that less than 1% of the primordial gas in such small scale structures cools and collapses to sufficiently high densities to be available for primordial star formation. Furthermore, it is worthwhile to note that this study achieved the highest dynamic range covered by structured adaptive mesh techniques in cosmological hydrodynamics to date.

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Accretion disc-stellar magnetosphere interaction: field line inflation and the effect on the spin-down torque.

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We calculate the structure of a force-free magnetosphere which is assumed to corotate with a central star and which interacts with an embedded differentially rotating accretion disc. The magnetic and rotation axes are aligned and the stellar field is assumed to be a dipole. We concentrate on the case when the amount of field line twisting through the disc-magnetosphere interaction is *large* and consider different outer boundary conditions. In general the field line twisting produces field line inflation (eg. Bardou & Heyvaerts 1996) and in some cases with large twisting many field lines can become open. We calculate the spin-down torque acting between the star and the disc and we find that it decreases significantly for cases with large field line twisting. This suggests that the oscillating torques observed for some accreting neutron stars could be due to the magnetosphere varying between states with low and high field line inflation. Calculations of the spin evolution of T Tauri stars may also have to be revised in light of the significant

effect that field line twisting has on the magnetic torque resulting from star-disc interactions.

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An ISOCAM absorption survey of the structure of pre-stellar cloud cores

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We present the results of a mid-infrared ($\lambda \simeq 7 \mu\text{m}$) imaging survey of a sample of 24 starless dense cores carried out at an angular resolution of $6''$ with the ISOCAM camera aboard the Infrared Space Observatory (ISO). The targeted cores are believed to be pre-stellar in nature and to represent the initial conditions of low-mass, isolated star formation. In previous submillimeter dust continuum studies of such pre-stellar cores, it was found that the derived column density profiles did not follow a single power-law such as $N_{H_2} \propto \bar{r}^{-1}$ throughout their full extent but flattened out near their center. These submillimeter observations however could not constrain the density profiles at radii greater than ~ 10000 AU. The present absorption study uses ISOCAM's sensitivity to map these pre-stellar cores in absorption against the diffuse mid-infrared background. The goal was to determine their structure at radii that extend beyond the limits of sensitivity of the submillimeter continuum maps and at twice as good an angular resolution. Among the 24 cores observed in our survey, a majority of them show deep absorption features. The starless cores studied here all show a column density profile that flattens in the center, which confirms the submillimeter emission results. Moreover, beyond a radius of $\sim 5000 - 10000$ AU, the typical column density profile steepens with distance from core center and gets steeper than $N_{H_2} \propto \bar{r}^{-1}$, until it eventually merges with the low-density ambient molecular cloud. At least three of the cores present sharp edges at $R \sim 15000 - 30000$ AU and appear to be decoupled from their parent clouds, providing finite reservoirs of mass for subsequent star formation.

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Preprints available at <http://www.astro.uni-jena.de/Users/bacmann/papers/>

Disks, Microjets, Windblown Bubbles, and Outflows in the Orion Nebula

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New, deep, narrow-band images of the Orion Nebula obtained with WFPC2 on the Hubble Space Telescope (HST) and spectra taken with the HIRES spectrometer at the Keck Observatory are presented. We report 8 new circumstellar disks seen in silhouette against the background nebular light and about 30 dark disks embedded within the bright proplyds rimmed by ionization fronts. Deep narrow band $\lambda 6300\text{\AA}$ images reveal skins of glowing [O I] emission associated with several disks embedded within bright proplyds. [O I] emission also surrounds one dark disk *not* surrounded by an ionization front; this object may be embedded within the photon-dominated mostly neutral region behind the ionization front of the Orion Nebula. The intensity and morphology of the [O I] emission provides support for the photon-dominated region (PDR) models of externally irradiated circumstellar disks in which soft UV powers photo-ablation of the disk surface.

Dozens of outflows powered by young stars have been discovered on the new images. More than 20 stellar jets emerge from the externally irradiated circumstellar disks or their associated young stars which are embedded within the Nebula. Most are one-sided (monopolar) sub-arcsecond scale *microjets* too small to be seen on ground-based images against the bright background nebular light. Additionally, wide-angle winds from ten young stars in the outskirts of

the Nebula power large scale bow shocks facing the Trapezium OB stars. These shocks may be produced by wind-wind interactions where the T-Tauri winds interact with the outflow of plasma from the core of M42. The largest such structure, associated with the star LL Ori, contains a number of compact high proper motion clumps moving almost tangentially to the bow shock.

The new data are combined with older HST images to determine proper motions for many nebular features. Neither the LL Ori type bow shocks in the outskirts of the nebula, nor the $H\alpha + [O III]$ arcs that surround many proplyds near the Trapezium show measurable proper motions and are therefore stationary structures. However, most other bow-shaped features not centered on young stars exhibit large proper motions with velocities ranging from 50 to 300 km s^{-1} . The sources of many of these moving features remain unknown.

The proper motion survey of the nebular core reveals the presence of about a dozen new large-scale (> 0.1 pc) outflow complexes. Many of these new outflows originate from the vicinity of the high luminosity OMC-1S infrared and sub-millimeter source complex located southwest of the Trapezium. These supersonic features provide evidence that stellar outflows inject large amounts of kinetic energy into the nebula. However, a quantitative analysis indicates that their total power is small compared to the power in the plasma flowing away from the main nebular ionization front.

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On the Interaction between Protoplanets and Protostellar Disks

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The recent discovery of a planetary system around Ups And raises questions concerning the formation process of several planets in the Jupiter mass range around a single host star. We consider numerically two scenarios involving the interaction of protoplanets with low-viscosity host disks. In the first case, a single protoplanet is assumed to have already been formed, and the development of a tidally induced gap in the disk is calculated. Beyond the outer boundary of the gap, a positive pressure gradient induces the disk gas to attain an azimuthal velocity which is larger than the Keplerian speed. The accumulation of small solid particles at the outer edge of this region provides a favorable location for the formation of an additional protoplanetary core with an orbital radius approximately twice that of the original protoplanet. In the second scenario, we assume that two protoplanets have formed simultaneously, one with twice the orbital radius of the other. Both clear gaps, and the ring of remaining disk material between the planets has a width only a few times the thickness of the disk. The density waves excited by planets on both sides of the ring propagate throughout the ring, and non-local dissipation of these waves leads to gas leakage from the ring edges into the gaps. After the ring is depleted, a torque calculation shows a tendency for the separation between the planets to decline as a result of angular momentum exchange between them and the surrounding inner and outer disk.

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The ortho:para- H_2 ratio in the primordial gas

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We have solved the time-dependent equations for the populations of the rovibrational levels of H_2 , from redshift $z = 5000$ to the present time. Population transfer, including ortho - para interconversion, is determined principally by collisions with H^+ . Simultaneously, we solved the chemical rate equations and for the temperatures of the radiation field and matter, distinguishing the electrons, the ions, and the neutrals. The ortho:para- H_2 ratio is found to decrease from the statistical value of 3 around $z = 100$ until it freezes at a value of 0.25 for $z \lesssim 20$. The significance of proton

collisions for the rates of heating and cooling of the gas by H_2 is investigated. Collisions with protons are found to be increasingly important with decreasing temperature. At $z = 20$, the net rate of heating of the gas, including proton collisions, exceeds the net heating rate neglecting proton collisions by approximately 3 orders of magnitude.

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The Propagation of Magneto-Centrifugally Launched Jets: I

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We present simulations of the propagation of magnetized jets. This work differs from previous studies in that the cross-sectional distributions of the jet state variables are derived from analytical models for magneto-centrifugal launching. The source is a magnetized rotator whose properties are specified as boundary conditions. The jets in these simulations are considerably more complex than the “top-hat” constant density etc. profiles used in previous work. We find that density and magnetic field stratification (with radius) in the jet leads to new behavior including the separation of an inner jet core from a low density collar. We find this *jet within a jet* structure, along with the magnetic stresses, leads to propagation behaviors not observed in previous simulation studies. Our methodology allows us to compare MHD jets from different types of sources whose properties could ultimately be derived from the behavior of the propagating jets.

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A multi-wavelength study of pre-main sequence stars in the Taurus-Auriga star-forming region

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Although many lowmass pre-main sequence stars are strong X-ray sources, the origin of the X-ray emission is not well known. Since these objects are variable at all frequencies, simultaneous observations in X-rays and in other wavelengths are able to constrain the properties of the X-ray emitting regions. In this paper, we report quasi-simultaneous observations in X-rays, the optical, and the radio regime for classical and weak-line T Tauri stars from the Taurus-Auriga star-forming region. We find that all detected T Tauri stars show significant night-to-night variations of the X-ray emission. For three of the stars, FM Tau and CW Tau, both classical T Tauri stars, and V773 Tau, a weak-line T Tauri star, the variations are especially large. From observations taken simultaneously, we also find that there is some correspondence between the strength of $H\alpha$ and the X-ray brightness in V773 Tau. The lack of a strong correlation leads us to conclude that the X-ray emission of V773 Tau is not a superposition of flares. However, we suggest that a weak correlation occurs because chromospherically active regions and regions of strong X-ray emission are generally related. V773 Tau was detected at 8.46 GHz as a weakly circularly polarised but highly variable source. We also find that the X-ray emission and the equivalent width of $H\alpha$ remained unchanged, while large variations of the flux

density in the radio regime were observed. This clearly indicates that the emitting regions are different. Using optical spectroscopy we detected a flare in H α and event which showed a flare-like light-curve of the continuum brightness in FM Tau. However, ROSAT did not observe the field at the times of these flares. Nevertheless, an interesting X-ray event was observed in V773 Tau, during which the flux increased for about 8 hours and then decreased back to the same level in 5 hours. We interpret this as a long-duration event similar to those seen on the sun and other active stars. In the course of the observations, we discovered a new weak-line T Tauri star, GSC-1839-5674. Results are also presented for several other stars in the ROSAT field.

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<http://www.tls-tautenburg.de/research/tls-research/pub00.html>

SCUBA imaging of high mass star formation regions

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We present 450 and 850 μ m images of five ultracompact HII regions (G10.47, G12.21, G13.87, G31.41 and G43.89) taken at 9''/15'' resolution with SCUBA on the JCMT, and photometric measurements of the central sources at 1350 and 2000 μ m. We confirm that the sources have high submillimetre fluxes as expected from their IRAS fluxes at 100 μ m and molecular line emission. Each submillimetre image peaks towards the UCHII regions. Three sources (G10.47, G12.21 and G31.41) have particularly strong central peaks. These peaked sources, which can be easily identified from radial profiles, were previously identified from spectral line surveys as containing hot molecular cores. The non-peaked sources G13.87 and G43.89 do not have hot molecular cores. Using the DUSTY radiative transfer code, we model both the spectral energy distributions and radial profiles of the sources using a combination of $r^{-3/2}$ density profile envelopes plus, for the peaked sources, compact high optical depth cores. Although previous modelling of the SED of UCHII regions has been achieved with constant density shells, we find that $r^{-3/2}$ density profiles are necessary to fit the submm radial emission profiles of these sources. In agreement with previous modelling, we find that the inner radius of the dust shells is larger than would be expected from dust sublimation; the physical mechanism for this is unknown. Two sources (G10.47 and G12.21) have additional peaks within the 2.5' SCUBA field of view which are not known to contain UCHII regions and may contain high mass protostars.

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<http://saturn.phy.umist.ac.uk:8000/~jjh/scuba.ps.gz>

A Variability Study of Pre-Main Sequence Stars in the Extremely Young Cluster IC 348

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The extremely young cluster IC 348 has been monitored in the Cousins I band with a 0.6 m telescope at Wesleyan's Van Vleck Observatory. Photometry of 150 stars was obtained on 76 images taken on 27 separate nights during the period December, 1998, through March, 1999. As expected, spectral characteristics largely determine the nature of a star's variability in this cluster. None of the stars with H α in absorption were found to be variables. On the other hand, all 16 stars identified as CTTS by their H α emission equivalent widths and the majority of the 49 WTTS in the part of the cluster we monitored showed evidence of variability. Nineteen stars were found to be periodic, with periods ranging from 2.24 to 16.2 days and masses ranging from 0.35 to 1.1 M $_{\odot}$. Seventeen of these are WTTS and the other 2 are of unknown spectral class. The period distribution is remarkably similar to what is found in the Orion Nebula Cluster for stars in the same mass range. Namely, it is bimodal with peaks at 2-3 days and 7-8 days, although there are not enough periods known to define these features significantly by the IC 348 data alone. The three fastest rotators are also the three most massive stars in the periodic sample. It is striking that none of the known CTTS were found

to be periodic even though they are more highly variable than the WTTS in the cluster. This supports the canonical view that WTTS variability is primarily caused by the rotation of a surface with large, cool spots whose pattern is often stable for many rotation periods, while CTTS variability has an additional component caused by accretion hot spots which typically come and go on shorter timescales. Stars with significant infrared excess emission in this sample do tend to be CTTS, while the WTTS (including periodic ones, with one possible exception) show no infrared excess and, therefore, no evidence of disks. Among the CTTS, neither H α emission equivalent width nor infrared excess emission shows any correlation with degree of variability.

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Constraints on the Stellar/Sub-stellar Mass Function in the Inner Orion Nebula Cluster

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We present the results of a 0.5-0.9" FWHM imaging survey at K (2.2 μ m) and H (1.6 μ m) covering $\sim 5.1' \times 5.1'$ centered on $\theta^1 C$ Ori, the most massive star in the Orion Nebula Cluster (ONC). At the age and distance of this cluster, and in the absence of extinction, the hydrogen burning limit (0.08 M_{\odot}) occurs at $K \approx 13.5$ mag while an object of mass 0.02 M_{\odot} has $K \approx 16.2$ mag. Our photometry is complete for source detection at the 7σ level to $K \approx 17.5$ mag and thus is sensitive to objects as low-mass as 0.02 M_{\odot} seen through visual extinction values as high as 10 magnitudes. We use the observed magnitudes, colors, and star counts to constrain the shape of the inner ONC stellar mass function across the hydrogen burning limit. After determining the stellar age and near-infrared excess properties of the optically visible stars in this same inner ONC region, we present a new technique that incorporates these distributions when extracting the mass function from the observed density of stars in the K-(H-K) diagram. We find that our data are inconsistent with a mass function that rises across the stellar/sub-stellar boundary. Instead, we find that the most likely form of the inner ONC mass function is one that rises to a peak around 0.15 M_{\odot} , and then declines across the hydrogen-burning limit with slope $N(\log M) \propto M^{0.57}$. We emphasize that our conclusions apply to the inner 0.71 pc \times 0.71 pc of the ONC only; they may not apply to the ONC as a whole where some evidence for general mass segregation has been found.

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<http://astro.caltech.edu/~lah/papers.html>

Probing the magnetic field with molecular ion spectra - II

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We present further observational evidence in support of our earlier proposal (Houde et al. 2000) for detecting the presence of the magnetic field in molecular clouds by comparing spectra of molecular ions with those of neutral molecules. The ion lines tend to be narrower and do not show the wings due to flows, when the magnetic field is sufficiently strong. We obtained spectra for the optically thin lines of the H¹³CN and H¹³CO⁺ species in a sample of ten molecular clouds and found the results to be in agreement with our previous observations of the main isotopic species, HCN and HCO⁺, made in OMC1, OMC2, OMC3 and DR21OH, thus eliminating the possibility of optical depth effects playing a role in the ion line narrowing. HCS⁺ was also detected in four of these star forming regions. We also discuss previously published results by Benson et al. (1998) of N₂H⁺ detections in a large sample of dark clouds. We show that the similarity in line widths between ion and neutral species in their sample is consistent with the relatively small amount of turbulence and other flows observed in these clouds.

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350 μm Images of Massive Star Formation Regions

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We present 350 μm continuum images of 24 massive star formation regions obtained with the Caltech Submillimeter Observatory (CSO) equipped with the SHARC focal plane array. At this wavelength the spatial resolution is $11''$. The 350 μm emission is compared with thermal radio continuum emission and OH, H₂O, and CH₃OH masers.

Emission at 350 μm is believed to be thermal emission from dust heated by embedded or nearby stars. Compact radio continuum sources are usually present in the mapped 350 μm fields and more than 60% of the 350 μm peaks coincide with radio continuum peaks. This association lends strong support to the notion that the dust is heated primarily by hot stars. Masers are also a common property of massive star formation regions. Usually OH, H₂O, and/or CH₃OH masers are found near, but generally not coincident with, the 350 μm peaks. Less than 25% of the 350 μm peaks have no reported masers located close-by. In most of the observed regions, the 350 μm dust maps show one or more components surrounded by fainter extended emission. In total, we identify 28 separate 350 μm components. Ten of the 28 350 μm components do not have radio continuum counterparts. These are luminous sources and should produce detectable HII regions. It is postulated that these sources may be undergoing such rapid accretion that the in-falling matter quenches the HII region very close to the protostar thereby making the HII region undetectable in free-free emission. Objects in this evolutionary state may well represent the long sought precursors to ultra compact (UC) HII regions and should have the properties of accreting massive protostars (i.e. accretion disks, bipolar molecular outflows, hot shocked gas, in-fall with spin-up toward the protostar, etc.). We suggest that the ten sources in this category in our sample merit further observational study for these properties.

Two-temperature greybody models constrained by the observed infrared spectral energy distributions were calculated to estimate the total mass, luminosity, average dust temperature, and hydrogen column and number densities for each source. The greybody models do not account for possible low-level emission from the coolest dust (<25 K) and therefore may under-estimate the total mass. There is, however, no evidence for emission in excess of the models at 1.3 mm, and we conclude that the mass contribution of dust colder than $\sim 25\text{K}$ cannot be large. Thus the greybody models showed provide useful average global properties required to understand massive star formation environments.

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Available via a ftp-server at ftp.astro.wisc.edu/watson/papers/ – Two postscript files must be downloaded:

ftp.astro.wisc.edu/watson/papers/cso.ps, ftp.astro.wisc.edu/watson/papers/sidetable.ps

Infrared Classification of Galactic Objects

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Unbiased analysis shows that IRAS data reliably differentiate between the early and late stages of stellar evolution because objects at these stages clearly segregate in infrared color-color diagrams. Structure in these diagrams is primarily controlled by the density distribution of circumstellar dust. The density profile around older objects is the steepest, declining as r^{-2} , while young objects have profiles that vary as $r^{-3/2}$ and flatter. The different density profiles reflect the different dynamics that govern the different environments. Our analysis also shows that high mass star formation is strongly concentrated within ~ 5 kpc around the Galactic center, in support of other studies.

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ftp://gradj.pa.uky.edu/moshe/IRAS_scaling.ps

One-Point Probability Distribution Functions of Supersonic Turbulent Flows in Self-Gravitating Media

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Turbulence is essential for understanding the structure and dynamics of molecular clouds and star-forming regions. There is a need for adequate tools to describe and characterize the properties of turbulent flows. One-point probability distribution functions (pdf's) of dynamical variables have been suggested as appropriate statistical measures and applied to several observed molecular clouds. However, the interpretation of these data requires comparison with numerical simulations. To address this issue, SPH simulations of driven and decaying, supersonic, turbulent flows with and without self-gravity are presented. In addition, random Gaussian velocity fields are analyzed to estimate the influence of variance effects. To characterize the flow properties, the pdf's of the density, of the line-of-sight velocity centroids, and of the line centroid increments are studied. This is supplemented by a discussion of the dispersion and the kurtosis of the increment pdf's, as well as the spatial distribution of velocity increments for small spatial lags. From the comparison between different models of interstellar turbulence, it follows that the inclusion of self-gravity leads to better agreement with the observed pdf's in molecular clouds. The increment pdf's for small spatial lags become exponential for all considered velocities. However, all the processes considered here lead to non-Gaussian signatures, differences are only gradual, and the analyzed pdf's are in addition projection dependent. It appears therefore very difficult to distinguish between different physical processes on the basis of pdf's only, which limits their applicability for adequately characterizing interstellar turbulence.

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(full resolution preprints are available at <http://www.strw.leidenuniv.nl/klessen/Preprints/p8.abstract.html>
see also astro-ph/0001379)

WFPC2 Images of a Face-On Disk Surrounding TW Hydrae

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Hubble Space Telescope observations of the isolated T Tauri star TW Hydrae reveal the presence of a compact circumstellar nebula. After subtraction of a reference point spread function (PSF), a smooth, symmetrical, circular halo can be seen in both WFPC2 R and I-band images. Its intensity declines with radius until reaching an outer sensitivity limit at 3.5" (≈ 200 AU). Numerical experiments show that PSF subtraction artifacts cannot account for the halo's brightness distribution. Instead, the most likely explanation is that the halo is a face-on circumstellar disk.

The radial brightness profile of the halo is complex, and can be described with multiple, contiguous zones with individual power law intensity relations. The halo appears slightly blue relative to the star, especially in the outer zones. We compare the TW Hya halo to single scattering models of face-on disks with multiple radial zones. While an optically thin disk model with a vertical optical depth $\tau_v \approx 10^{-2}$ can reproduce the relative brightness of the nebula and star, we find that such models have a large midplane optical depth and are therefore not self-consistent. We present an optically thick disk model which matches the radial brightness profile self-consistently, and which has a dust mass close to that implied by submillimeter continuum measurements. The zonal structure found in the disk could arise from radial variations in the dust properties that determine the local equilibrium temperature, or perhaps via dynamical effects of unseen companions.

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Preprint available via anonymous ftp to [wfp2.jpl.nasa.gov](ftp://wfp2.jpl.nasa.gov) in `pub/karl/twhya/twhya.tar.Z`.

DG Tau: A shocking jet

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We present spectro-imaging observations of DG Tau at 0.5'' resolution obtained with OASIS in [O I] λ 6300, H α , [N II] λ 6583, and [S II] λ 6716,6731. The fast jet core appears wiggling and surrounded by a slower moving flow or cavity. Line ratios are compared with available predictions for heating mechanisms in T Tauri jets (shocks, ambipolar diffusion, turbulent mixing-layers). Shocks with speeds 50-100 km s⁻¹ increasing with flow velocity, and preshock densities 10⁵-10³ cm⁻³ decreasing away from the star, are best able to reproduce the high level of excitation for velocities > 100 km s⁻¹.

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Preprint available by anonymous ftp to: ftp.obspm.fr in outgoing/cabrit/cb151.ps.gz

Far infrared spectroscopy of FU Ori objects: ISO-LWS observations

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We present the results of the first spectrophotometric observations of a sample of FU Ori objects obtained with the Long Wavelength Spectrometer (LWS) on board the Infrared Space Observatory (ISO). The [OI] (63 μ m) and the [CII] (158 μ m) lines are commonly observed in all spectra (both ON and OFF source). The observational novelty is the presence in most of the sources of the transition of ionised nitrogen [NII] (122 μ m), which is not detected in other objects in a similar evolutionary phase. This line probes low ionisation and low density material not easily traced by other lines. Line intensities and intensity ratios are used along with model predictions to infer the prevailing mechanisms for line excitation. To reconcile our far-infrared spectroscopy with previous knowledge of these objects, the simultaneous presence of two components is required: well localised J-shocks, responsible for the [OI] emission, and an extended low density ionised medium produced by UV photons from the disc boundary layer, responsible for the [NII] and [CII] emission. A few molecular lines (CO, OH, H₂O) associated with relatively cold and dense peaks are revealed and their intensities are in good agreement with the proposed scenario. Other ionic lines ([OIII] and [NIII]) are detected in two sources in the CygOB7 region and likely trace the presence of nearby HII regions.

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On the tilting of protostellar disks by resonant tidal effects

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We consider the dynamics of a protostellar disk surrounding a star in a circular-orbit binary system. Our aim is to determine whether, if the disk is initially tilted with respect to the plane of the binary orbit, the inclination of the system will increase or decrease with time. The problem is conveniently formulated in the binary frame in which the tidal potential of the companion star is static. We may then consider a steady, flat disk that is aligned with the binary plane and investigate its linear stability with respect to tilting or warping perturbations. The dynamics is controlled by the competing effects of the $m = 0$ and $m = 2$ azimuthal Fourier components of the tidal potential. In the presence of dissipation, the $m = 0$ component causes alignment of the system, while the $m = 2$ component has the opposite tendency. We find that disks that are sufficiently large, in particular those that extend to their tidal truncation radii, are generally stable and will therefore tend to alignment with the binary plane on a time-scale comparable to that found in previous studies. However, the effect of the $m = 2$ component is enhanced in the vicinity of resonances where the outer radius of the disk is such that the natural frequency of a global bending mode of the disk is equal to twice the binary orbital frequency. Under such circumstances, the disk can be unstable to tilting and acquire a warped shape, even in the absence of dissipation. The outer radius corresponding to the primary resonance is always smaller than the tidal truncation radius. For disks smaller than the primary resonance, the $m = 2$ component may be able to cause a very slow growth of inclination through the effect of a near resonance that occurs close to the disk center. We discuss these results in the light of recent observations of protostellar disks in binary systems.

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A Population of Very Young Brown Dwarfs and Free-floating Planets in Orion

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We describe the results of a very deep imaging survey of the Trapezium Cluster in the *IJH* bands, using the UKIRT high resolution camera UFTI. Approximately 32% of the 515 point sources detected are brown dwarf candidates, including several free floating objects with masses below the Deuterium burning (planetary) threshold at 0.013 solar masses, which are detectable because of their extreme youth. We have confidence that almost all the sources detected are cluster members, since foreground contamination is minimal in the 33 arcmin² area surveyed and the dense backdrop of OMC-1 obscures all background stars at these wavelengths. Extinction is calculated from the (*J-H*) colours, permitting accurate luminosity estimates and temperatures are derived from the dereddened (*I-J*) colours. There is some evidence for a cut-off in the luminosity function below the level corresponding to several Jupiter masses, which may represent the bottom end of the IMF. Since star formation is complete in the Trapezium this limit could have wide significance, if confirmed. However, it could well be an effect of the dispersal of the molecular cloud by the central O-type stars, a process whose timescale will vary between star formation regions.

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Preprint available by anon. ftp to star-ftp.herts.ac.uk in /pub/Lucas/Orion/bd1.ps

Star Formation in NGC 6334 I and I(N)

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The northern section of the molecular cloud complex NGC 6334 has been mapped in the CO and CS spectral line emission and in continuum emission at a wavelength of $1300\mu\text{m}$. Our observations highlight the two dominant sources, I and I(N), and a host of weaker sources. NGC 6334 I is associated with a cometary ultra-compact HII region and a hot, compact core $\leq 10''$, in size. Mid-IR and CH₃OH observations indicate that it is also associated with at least two protostellar sources, each of which may drive a molecular outflow. For region I we confirm the extreme high velocity outflow first discovered by Bachiller & Cernicharo (1990) and find that it is very energetic with a mechanical luminosity of $390 L_{\odot}$. A dynamical age for the outflow is ~ 3000 years. We also find a weaker outflow originating from the vicinity of NGC 6334 I. In CO and CS this outflow is quite prominent to the NW, but much less so on the eastern side of I, where there is very little molecular gas. Spectral survey data show a molecular environment at position I which is rich in methanol, methyl formate, and dimethyl ether, with lines ranging in energy up to 900 K above the ground state. NGC 6334 I(N) is more dense than I, but cooler, and has none of the high excitation lines observed toward I. I(N) also has an associated outflow, but it is less energetic than the outflow from I. The fully sampled continuum map shows a network of filaments, voids, and cores, many of which are likely to be sites of star formation. A striking feature is a narrow, linear ridge that defines the western boundary. It is unclear if there is a connection between this filament and the many potential sites of star formation, or if the filament existed prior to the star formation activity.

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ISO Spectroscopy of the HH 7-11 Flow and its red-shifted counterpart

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We have used the two spectrometers on the Infrared Space Observatory to observe the HH 7-11 flow, its red-shifted counterpart, and the candidate exciting source SVS 13, in the star formation region NGC 1333. We detect atomic ([O I] $63\mu\text{m}$, [O I] $145\mu\text{m}$, S II, [C II] $158\mu\text{m}$) and molecular (HII, CO, H₂O) lines at various positions along the bipolar flow.

Most of the observed lines can be explained in terms of shock-excited emission. In particular, our analysis shows that dissociative (J-type) and non-dissociative (C-type) shocks are simultaneously present everywhere along both lobes of the flow. We confirm the low-excitation nature of the Herbig-Haro nebulosities, with shock velocities $v_s \lesssim 40 - 50$ km s⁻¹. Toward both lobes of the outflow we find pre-shock densities of $n_0 \sim 10^4$ cm⁻³ for both the J and C

components, implying $B_0 \sim 100 \mu\text{G}$ for $B_0 \propto n_0^{0.5}$. In the central region of the flow, close to the exciting source, the pre-shock density deduced for the C-shock component is $n_0 \sim 10^5 \text{cm}^{-3}$, suggesting a magnetic field ~ 3 times stronger. We propose that the deficiency of gas-phase water in the post C-shock regions is due to freezing onto warm grains processed through the J-shock front and traveling along the magnetic field lines. The total observed cooling from the dissociative shock components is consistent with the power lost by a slow molecular outflow accelerated by a fast neutral HI wind.

Finally, the skin of the cloud seen in projection toward the flow appears to be weakly photo-ionised by BD +30° 549, the dominant illuminating source of the NGC 1333 reflection nebula.

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Disks in multiple systems: direct imaging of a nearly edge-on circumstellar disk in the young triple system HV Tau

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We present high resolution near infrared images of the young triple system HV Tau which clearly reveal a circumstellar disk around HV Tau C. The disk is seen nearly edge-on ($i \approx 84^\circ$), and has a radius of $\approx 50 \text{AU}$. HV Tau AB, a 74 mas binary (Simon et al. 1996), is resolved as well. If HV Tau C is bound to HV Tau AB, these are the first near-IR images of a circumtertiary disk in a young multiple system.

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<http://www-laog.obs.ujf-grenoble.fr/activites/starform/formation.html>

A New Star Forming Core in the Norma Filamentary Dark Cloud

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We report observations at millimeter and near-infrared wavelengths of the region near IRAS 16295–4452 seen toward the Sa 187 filamentary dark cloud in the southern constellation of Norma. Observations in the main rotational transitions of CO, ¹³CO, CS, and HCN reveal a new dense cloud core associated with IRAS 16295–4452. The core has a diameter of $\sim 0.3 \text{pc}$ and a total mass of $\sim 35 M_\odot$. Near-infrared imaging of the same region shows that the reddest ($H - K = 2.9$) source seen in our images, which is undetected in the J image, is located about $11''$ from IRAS 16295–4452, and is likely to be the near-infrared counterpart of the IRAS source. The millimeter observations reveal the presence of a molecular outflow with lobes extending in opposite directions from IRAS 16295–4452. The shape of the spectral energy distribution between $1.25 \mu\text{m}$ and $100 \mu\text{m}$ suggests that IRAS 16295–4452 is a Class I protostar with a total luminosity of about $35 L_\odot$.

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L1551NE - Discovery of a Binary Companion

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L1551NE is a very young (class 0 or I) low-mass protostar located close to the well-studied L1551 IRS5. We present here evidence, from 1.3mm continuum interferometric observations at $\sim 1''$ resolution, for a binary companion to L1551NE. The companion, whose 1.3mm flux density is $\sim 1/3$ that of the primary component, is located $1.43''$ (~ 230 A.U. at 160pc) to the southeast. The millimeterwave emission from the primary component may have been just barely resolved, with deconvolved size $\sim 0.82'' \times 0.70''$ ($\sim 131 \times 112$ A.U.). The companion emission was unresolved (< 100 A.U.). The pair is embedded within a flattened circum-binary envelope of size $\sim 5.4'' \times 2.3''$ ($\sim 860 \times 370$ A.U.). The masses of the three components (i.e. from the circumstellar material of the primary star and its companion, and the envelope) are approximately 0.044, 0.014 and 0.023 M_{\odot} respectively.

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High Angular Resolution Determination of Extinction in the Orion Nebula

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The optical appearance of the Orion Nebula is significantly altered by the presence of interstellar extinction. Since Orion is high above the Galactic plane and is nearby, most of this extinction is due to material immediately in front of the associated star cluster. This extinction fundamentally alters the optical appearance of the Orion Nebula. We have quantitatively determined the extinction correction by comparing the surface brightness of the nebula at a resolution of about $1.7''$ in the radio continuum and the $H\alpha$ emission line. The results compare well with new determinations made from $H\alpha$ and $H\beta$ line ratios. Extinction corrected optical images are generated and discussed. The most important extinction feature, the Dark Bay that obscures the east side of the nebula, has a mass of about $3 M_{\odot}$ and possesses numerous small knots of material in addition to a feature that appears to be a shock. We also find that the thin main emitting layer on the front of the parent Orion Molecular Cloud is marked by numerous walls and plateaus. Only one such structure had been previously known, which produces a Bright Bar across the southeast portion of the nebula. The sharpest structure is associated with the complex of molecular outflow and infrared sources near the region called Orion-S and is likely to be the result of uncollimated outflow from an imbedded young star.

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ISOCAM observations of the Chamaeleon I dark cloud

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We present the results of an ISOCAM survey of the Chamaeleon I dark cloud conducted in two broad-band filters at 6.7 and 14.3 μm . In an area of 0.59 sq.deg. we have detected a total of 282 mid-IR sources with 103 sources observed

in both filters. Combining the ISOCAM observations with the I, J, and K_s data obtained with DENIS, we have found 108 pre-main-sequence (PMS) stars in the region, of which 34 were previously unidentified. Several of these newly discovered young stellar objects are relatively faint suggesting a population in Cha I of very low mass objects that probably includes brown dwarfs in their early contraction phases. Finally, most of the PMS stars show the spectral index computed between 2.2 and 14.3 μm typical of Class II sources. The luminosity function (LF) derived for our detected PMS stars is discussed.

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preprints are available on the web page www.ias.rm.cnr.it/ias-home/preprints/prepri.htm

The NGC 6334 IV massive star formation site: A cluster in the making?

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Sub-arcsecond *JHK* images of the star formation region NGC 6334 IV covering 14.7 sq arcmin have been obtained. These were supplemented by H_2 and $\text{Br}\gamma$ images of the central 2 sq arcmin. A total of 1238 sources brighter than $K \simeq 17$ were detected. Due to the very high extinction in this region, only 685 of these are brighter at 1.2 μm than our limit, $J \simeq 20$. Only less than 5% of the sources exhibit excess emission at $\lambda > 2.0\mu\text{m}$ and they are scattered over the whole area covered. No evidence of a developed stellar cluster was found, but a small number of luminous (O–B2) young stellar objects were detected. These are embedded in the densest part of the molecular cloud that is at the centre of a giant bipolar structure seen in the radio and the infrared. This morphology is the result of the effect of massive stellar winds originating from the centre of a dense molecular toroid which collimates the outflow material giving rise to two lobes of thermal gas and dust emission. We confirm that the extinction is higher toward the southern lobe than toward the northern one but both are less reddened than their immediate surroundings. A new centre of active massive star formation is reported to the east of the central region. Close to a (sub)millimeter emission peak, a large infrared nebula with several point-like sources was found at 2.2 μm . The discovery of a small embedded low-luminosity bipolar object in the vicinity of one of the giant lobes is also reported.

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Circumstellar Disk Candidates Identified from UV Excesses in the Orion Nebula Cluster Flanking Fields

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We present an optical study of four $45' \times 45'$ fields centered $\sim 0.5^\circ$ east, west, north, and south of the Orion Nebula Cluster center. We have measured V and I_C photometry for ~ 5000 stars, and U photometry for ~ 1600 of these. We have obtained spectral classifications for ~ 300 of the stars with UVI_C photometry plus an additional ~ 200 stars located outside the area of our photometric survey. Dereddened photometry allows us to investigate the evidence for circumstellar accretion disks from excess emission at ultraviolet wavelengths, as well as the mass and age distributions of our sample. We find ~ 230 active accretion disk candidates and estimate the accretion disk fraction at $\gtrsim 40\%$. We use the magnitude of the ultraviolet excess to infer disk accretion rates. The mass accretion rate (\dot{M}) decreases slowly

with age over the limited age range spanned by our data, 1-3 Myr, and increases slowly with mass over the limited mass range 0.2-1.2 M_{\odot} . Although complicated selection effects are likely to affect the overall trends with mass and age, we are sensitive to, but do not see, high \dot{M} values associated with the older ages and lower masses in our sample. The mean value of \dot{M} is $\sim 10^{-8} M_{\odot}\text{yr}^{-1}$, with a range of more than an order of magnitude at all ages and masses. We find an age and age spread for our sample of $10^{6.0\pm 0.4}$ years with no variation within or between our fields. Meaningful constraint of the mass distribution is precluded due to the completeness limits of our survey.

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<http://astro.uchicago.edu/home/web/rebull/research/>

Photoevaporation of protostellar disks V. Circumstellar disks under the influence of both EUV and FUV radiation

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The evolution and appearance of protostellar disks can be significantly altered by their UV environment. We investigate numerically the photoevaporation of protostellar disks under the influence of an external radiation field with both EUV ($h\nu > 13.6$ eV) and FUV (6 eV $< h\nu < 13.6$ eV) components. Our 2D axisymmetric radiation hydrodynamics calculations begin with star-disk configurations resulting from previously published collapse simulations. We follow the evolution after the external UV radiation source has been turned on. We consider the transfer of both direct (from the UV point source) as well as diffuse radiation fields simultaneously with the ionization of hydrogen and carbon. A simplified cooling function is employed which assumes that the carbon ionization front separates the molecular region from the region in atomic or ionized form. For some simulations an isotropic stellar wind has been included at the position of the disk's central star. At selected evolutionary times a frequency-dependent ray-tracing diagnostic code is used to calculate emission line spectra and emission line maps over the volume of interest.

The interaction of the FUV-induced neutral flow at the disk surface with the direct and diffuse EUV radiation fields leads to the typical head-tail objects with bright emission line crescents and tails pointing away from the external radiation source. The properties of the head-tail objects are in agreement with the properties of the proplyds in the Orion Nebula, M8, NGC 2024, and — in a more extreme UV environment — of the newly discovered proplyds in NGC 3603. After losing material via photoevaporation over a time $> 10^5$ yr, our initially rather massive disks are reduced to typical observed disk masses. At this time the radius of the disk, the radius of the hydrogen ionization front, and the length of the tail are compatible to observed proplyds. Our model disks can be either silhouetted or non-silhouetted in the emission line maps, depending on orientation. The [OIII] 5007 Å emission appears diffuser than [OII] 3726 Å, because the abundance of OIII is low near the hydrogen ionization front and in the shadow regions along the tail. Monopolar and bipolar micro-jets emerging from the proplyds can be explained by spherically symmetric stellar winds hydrodynamically focused by the neutral evaporating flow from the disk surface.

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Detection of doubly deuterated ammonia in L134N

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ND₂H has been detected for the first time in the dense core of L134N, at the peak ammonia position. The abundance ratio [ND₂H]/[NH₂D] is 0.05, a slightly smaller value than the deuterium fractionation observed for ammonia [NH₂D]/[NH₃] ~ 0.1 (Tiné et al. 2000). This is the second doubly deuterated species detected so far in the interstellar

medium, and the first one in a cold dense core. The chemical processes leading to the formation of a significant amount of doubly deuterated ammonia ND_2H need to be thoroughly investigated.

Accepted by A & A

<http://much.a.obspm.fr/stine/tmr/papers.html>

(Sub)mm continuum mapping of NGC 6334 I & I(N) - A cobweb of filaments and protostars

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We present high resolution (sub)mm continuum maps obtained with the bolometer UKT14 on the JCMT of the high mass star formation complex NGC 6334I and I(N), the latter also known as Gezari's cold source (Gezari 1982, ApJ, 259, L29). The maps at 1.1 mm and 800 μm cover the whole northern part of the NGC 6334 complex ($\sim 5' \times 8'$), while the coverage is more limited at 450 μm and 350 μm and centered on NGC 6334I(N).

The strongest dust emission at all wavelengths originates from a compact source near or coincident with the Ultra-compact HII - region NGC 6334F and the FIR-source and hot core region NGC 6334I. The dust in NGC 6334I is hot, $T_d \geq 100$ K, and we derive a total mass (gas + dust) of $\sim 200 M_\odot$. We resolve Gezari's cold source into a compact (deconvolved FWHM $\sim 10''$) dust source, which appears optically thick even at 1.1 mm. I(N) is embedded in a dense cloud core, $\sim 2.5' \times 1.5'$, with a mass of $\sim 2200 M_\odot$. *I(N) is clearly a high-mass Class 0 object.* It emits a large fraction of its luminosity in the sub-mm ($L_{bol} \sim 1.7 \cdot 10^4 L_\odot$), it drives a molecular outflow and coincides with a CH_3OH maser, suggesting that I(N) has already formed a hot accretion disk. We derive a total mass of 250 – 400 M_\odot , corresponding to an average gas density $1.6 - 2.6 \cdot 10^7 \text{ cm}^{-3}$ and a line of sight visual extinction of $\geq 2000^m$, rendering it impossible to detect I(N) even in the thermal or mid-IR.

We also find eight additional compact sub-mm sources. Some of these are probable high-to-intermediate mass protostars, some may be massive cold starless cloud cores that eventually will collapse to form stars. Our sub-mm maps also show a remarkable narrow, lumpy, linear filament, which has no optical or near-IR counterpart. This filament bounds the dust emission to the west and is at least $7'$ (3.5 pc) in length with a width of $\sim 15'' - 20''$. It breaks up into dense condensations with a separation of 3 – 4 times the width of the filament.

Accepted by A & A

An internet server for pre-main sequence tracks of low- and intermediate-mass stars

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We present new grids of pre-main sequence (PMS) tracks for stars in the mass range 0.1 to 7.0 M_\odot . The computations were performed for four different metallicities ($Z=0.01, 0.02, 0.03$ and 0.04). A fifth table has been computed for the solar composition ($Z=0.02$), including a moderate overshooting. We describe the update in the physics of the Grenoble stellar evolution code which concerns mostly changes in the equation of state (EOS) adopting the formalism proposed by Pols et al. (1995) and in the treatment of the boundary condition. Comparisons of our models with other grids demonstrate the validity of this EOS in the domain of very low-mass stars. Finally, we present a new server dedicated to PMS stellar evolution which allows the determination of stellar parameters from observational data, the calculation of isochrones, the retrieval of evolutionary files and the possibility to generate graphic outputs.

Accepted by A & A

<http://www-laog.obs.ujf-grenoble.fr/activites/starevol/evol.html>

Deuterium Fractionation in Dense Ammonia Cores

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We report observations of several deuterated species in the dark clouds L134N and TMC1, and in particular of NH₂D (deuterated ammonia). NH₂D has been detected for the first time towards the dense core TMC1–N and very strong emission has been confirmed towards L134N. The deuterium fractionation is very different in these two clouds, with abundance ratio [NH₂D]/[NH₃] ~ 0.1 and ~ 0.02, [N₂D⁺]/[N₂H⁺] ~ 0.35 and ~ 0.08 and [DCO⁺]/[HCO⁺] ~ 0.18 and ~ 0.02, towards L134N and TMC1–N, respectively. For both clouds, but most clearly for L134N, the region of high deuterium fractionation is more localized and much more compact than the high column density region traced by C¹⁸O and C¹⁷O emission. We compare the observed deuterium fractionation with steady–state chemical models and we find that a better match is obtained when C and O are heavily depleted from the gas phase.

Accepted by A & A

<http://much.a.obspm.fr/stine/tmr/papers.html>

Detection of new sources of methanol emission at 95 GHz with the Mopra telescope

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A southern hemisphere survey of methanol emission sources has been carried out using the ATNF Mopra millimetre telescope. 85 sources, the majority of them masers, have been detected in the 8₀ – 7₁A⁺ transition of methanol at 95 GHz. Together with a similar northern hemisphere survey this completes the search for 95-GHz methanol emission from the Galactic Plane. The previously found correlation between intensity of methanol emission at 44 and 95 GHz is confirmed here with the larger sample of sources. The results of LVG statistical equilibrium calculations confirm the classification of these sources as class I methanol masers pumped through collisional excitation.

Accepted by MNRAS

Preprints available at <http://www-ra.phys.utas.edu.au/~sellings/preprints.html>

Kinematics, Kinetic Temperatures and Column Densities of NH₃ in the Orion Hot Core

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Using the VLA, we have mapped the Orion Hot Core region (full extent 10'') with an angular resolution of ~ 1'' in the (J,K)=(4,4) and (10,9) inversion transitions of ¹⁴NH₃ and an angular resolution of 4'' in the (J,K)=(2,2) and (3,3) inversion transitions of ¹⁵NH₃. All of the single-dish flux density for the (10,9) transition was recovered by the VLA, but a substantial fraction of the flux density in the (4,4) and ¹⁵NH₃ (3,3) lines was not detected. The missing flux density is from the spatially extended 'spike' component. Assuming that local thermodynamic equilibrium (LTE) holds, we have calculated the optical depths of the (4,4) inversion transition for all positions where the main and satellite lines were detected with sufficient signal-to-noise ratio. We combined our (10,9) data with these (4,4) line results to produce images of the rotational temperature, T_{rot}, and the column density of ammonia, N(NH₃). For the H₂ densities in the Hot Core, T_{rot} = T_{kin}, the kinetic temperature. An additional determination of T_{kin} and N(NH₃) was made by combining our (10,9) inversion line data with our ¹⁵NH₃ (3,3) inversion line results. The ¹⁵NH₃ inversion

transitions have no quadrupole hyperfine structure so that the line shapes are simpler. The moment distribution of the $^{15}\text{NH}_3$ (3,3) line shows that the largest intensity-weighted line width arises close to the center of the Hot Core region. Thus we may have discovered a low luminosity outflow source embedded in the Hot Core. Alternatively, this may be a result of gas motions related to source ‘I’, which is about half a beamwidth from this feature.

Accepted by Ap. J.

Radio Continuum Emission from the Central stars of M20 and the Detection of a New Supernova Remnant Near M20

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The Trifid nebula (M20) is a well-known prominent optical HII region trisected by obscuring dust lanes. Radio continuum VLA observations of this Nebula show free-free emission at λ 3.6 and 6cm from three stellar sources lying close to the O7V star at the center of the nebula. We argue that neutral material associated with these stars are photoionized externally by the UV radiation from the hot central star. We also report the discovery of a barrel-shaped SNR G7.06–0.12 at the northwest rim of the nebula and two shell-like features G6.67–0.42 and G6.83–0.21 adjacent to W28 and M20. We discuss the nature of these features and their possible relationship to the pulsar PSR 1801-2306 and W28 OH (1720 MHz) masers.

Accepted by ApJ

<http://arXiv.org/abs/astro-ph/0003295>

Identification of a nearby stellar association in the Hipparcos catalog: implications for recent, local star formation.

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The TW Hydrae Association (~ 55 pc from Earth) is the nearest known region of recent star formation. Based primarily on the Hipparcos catalog, we have now identified a group of 9 or 10 co-moving star systems at a common distance (~ 45 pc) from Earth that appear to comprise another, somewhat older, association (“the Tucanae Association”). Together with ages and motions recently determined for some nearby field stars, the existence of the Tucanae and TW Hydrae Associations suggests that the Sun is now close to a region that was the site of substantial star formation only 10-40 million years ago. The TW Hydrae Association represents a final chapter in the local star formation history.

Accepted by the Astrophysical Journal

Full text preprint available at: <http://arXiv.org/abs/astro-ph/0002461/>

Dissertation Abstracts

**Investigation of Herbig Ae/Be Stars in the Near-Infrared
with a Long Baseline Interferometer**

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Ph.D dissertation directed by: F. Peter Schloerb

Ph.D degree awarded: September 1999

In this thesis, we have conducted the first systematic study of young stellar objects of intermediate mass, the Herbig Ae/Be stars, using the technique of long baseline spatial interferometry in the near infrared (IR). The objective of our investigation is to characterize the circumstellar environment in which the continuum excess characteristic of these systems arises.

The observations for this work have been conducted at the Infrared Optical Telescope Array (IOTA). The observations were made in the H and K' bands, using two IOTA baselines of approximate lengths $B = 21 m$ and $38 m$. For reference, the resolutions corresponding to the longest baseline are $\lambda/2B = 4$ mas (2.5 AU) and 6 mas (3.7 AU) at H and K' respectively, where the linear separations are given for the mean distance of 617 pc to the stars in our sample.

Surprisingly, the IOTA resolves the source of the near-IR excess in 11 of the 15 systems surveyed. A new companion, to MWC 361-A, has been detected interferometrically for the first time, at a separation of 18.2 mas. A striking feature of our data set is that none of the other sources shows varying visibilities as the orientation of the interferometer baseline changes, indicative of circularly symmetric sources. The visibility amplitude data has been interpreted within the context of four models which represent the range of plausible representations for the source brightness. Each model has two components, with the stellar emission arising in a central point source, and the excess near-IR emission contributed by either: (1) a Gaussian brightness distribution, (2) a uniformly bright ring, (3) a "classical" accretion disk with a temperature law $T(r) \propto r^{-3/4}$ or (4) an infrared companion.

We find that the large sizes measured by the IOTA, 0.5 – 5.9 AU, essentially invalidate the accretion disk model, in conflict with the predictions of previous work based on modelling of the observed spectral energy distributions. Although our data are too limited in spatial frequency coverage to uniquely determine a model for each source, the observed symmetry favors, for the ensemble of observations, models in which the emitting dust is distributed around the star in spherical envelopes (the Gaussian model) or in thin shells (the ring model). This interpretation is supported by the result that the sizes given by the Gaussian model, combined with the excess near-IR fluxes, imply optically thin emission, as required by the fact that the central stars are optically visible.

We also find that the properties of the excess are not strongly correlated with those of the underlying star. Although there is a tendency for the excess sources with largest sizes and highest brightness to be associated with stars of highest luminosities and effective temperatures, the dependence is rather weak. It is also interesting to note that there are pairs of sources in which the stars and IR excess are essentially identical, but the sources of the IR excesses must differ in size by more than a factor of two. This might suggest that different physical mechanisms are responsible for the near-IR emission in these cases, and that there is no single phenomenon which scales with the properties of the central star or the magnitude of the excess in a simple way. Alternatively, if the same underlying mechanism is at work in all cases, then it must have the property that the same IR excess is produced by systems with very different physical scales.

For this work, a new fringe detection system for near-IR wavelengths based on a NICMOS3 array has been developed. The noise performance achieved is among the lowest known for this type of instrument (17 electrons per double read, or 8 electrons in an average of 32 consecutive double reads), and results in magnitude limits for fringe detection at the IOTA of about 8 in J and H bands (read-noise limited) and 6.5 in K' band (background limited).

<http://cfa-www.harvard.edu/~rmillan/>

Signatures of Planets in the Observable Structure of Circumstellar Debris Disks

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Ph.D dissertation directed by: Stanley F. Dermott

Ph.D degree awarded: December 1999

Recent advances in astronomical instrumentation have led to a vast increase in our knowledge of the environments of nearby stars. In particular, we are now able to image the thermal emission from the disks of dust around main sequence stars that may be the fossil remnants of planetary formation. These observations imply that the distribution of dust in the debris disks is neither smooth nor symmetrical; e.g., mid-infrared images of the disk of dust around the young A0V star HR 4796A show two lobes of emission, one of which may be $\sim 5\%$ brighter than the other. The observed structure of the debris disk in the solar system, i.e., the zodiacal cloud, also contains asymmetries: it has an offset center of symmetry, it is warped, and there is an asymmetric ring of dust co-orbiting with the Earth. Since the zodiacal cloud's asymmetries have been shown to be signatures of the gravitational perturbations of the solar system's planets, it is hoped that it may be possible to indirectly detect extrasolar planetary systems by their signatures in debris disk observations.

This dissertation uses the physical processes that affect the evolution of debris material in the solar system to create a generalized model for the evolution of circumstellar debris material. It then shows how planetary perturbations affect that evolution, thereby causing the signatures of planets seen in the structure of the zodiacal cloud. This model can be used to provide a quantitative interpretation of debris disk observations, and the necessary modeling techniques are demonstrated by their application to observations of the HR 4796 disk. As well as determining the large scale structure of the HR 4796 disk, the modeling shows how a small body ($> 10M_{\oplus}$) in the HR 4796 system that is on an orbit with an eccentricity larger than 0.02 could be the cause of the observed brightness asymmetry. The modeling also shows that the disk's mid-IR emitting particles are hotter than black body (and therefore small), and the dissertation discusses whether they are in the process of being blown out of the system by radiation pressure.

<http://xxx.lanl.gov/abs/astro-ph/0002410>

<http://www.roe.ac.uk/atc/research/>

New Jobs

The Astrophysical Institute and University Observatory of the Friedrich Schiller University Jena (Germany) will by the summer term 2001 fill a

Professorship in Astrophysics (C3)

The research fields of the institute are the physics and chemistry of the in-terstellar medium, star formation as well as protoplanetary accretion disks. The institute takes part in instrumentation projects for ESO, for the air-borne observatory SOFIA and the ESA Cornerstone Mission FIRST. The participation is pursued in a Sonderforschungsbereich (SFB) "Extrasolar Planets-Formation, Evolution and Structure".

The applicant should perform high-quality research in the field of infrared or millimetre astronomy *or* numerical astrophysics with reference to star and planet formation *or* the physics of interstellar media.

The future tasks of the applicant will include teaching of astronomy and as-trophysics for physics students and training for the teaching profession. It is expected that the applicant will actively participate in the preparation of the SFB.

Employment preconditions are the habilitation or scientific results of the same standard as well as educational abilities.

The Friedrich Schiller University aims at an increase of the share of women in teaching and research and therefore it encourages women to apply for this position. Handicapped with the same qualification are preferred.

Applications with CV, scientific and professional career, list of publications and lectures as well as a summary of research fields should be sent by 31 May 2000 to:

Friedrich-Schiller-Universität
Physikalisch-Astronomische Fakultät
Dekan
Max-Wien-Platz 1
07743 Jena
Germany

Star Formation Postdoc at Imperial College London

The Astrophysics Group, one of 10 research groups in the Physics Department of Imperial College London, invites applications for a postdoctoral position in observational studies of star formation. The successful applicant will work primarily with Prof. J. Drew, the holder of the PPARC grant funding the programme. The Postdoc's main responsibility will be the continuing development of an optical/IR observational programme of study of intermediate/high mass young stars and their environments. Latterly, this programme has contained a significant element of spectropolarimetry. A further feature of the group's work is close integration of the observing programme with theoretical spectral and hydrodynamic modelling.

Applicants should have a recent Ph.D. and should preferably have experience of and an interest in star formation research. The earliest start date is September 1 2000, and the post is funded for two years in the first instance. Pay will be set according to the national age-related academic scale. For further information about the post, please contact Janet Drew (email: j.drew@ic.ac.uk, postal address: Astrophysics Group, Blackett Laboratory, ICSTM, Prince Consort Road, London SW7 2BW, U.K.).

Applicants should submit a curriculum vita, publication list and a short statement of research interests either by email or conventional post. Applicants should also arrange for two letters of reference to be sent (again, email is acceptable) by April 15th. 2000

PDRA in Molecular Processes in Star-Forming Regions

A PPARC-supported position for a postdoctoral research assistantship will be available from 1st July 2000, or as soon as possible thereafter, to work on the identification and analysis of protostellar infall in molecular clouds. It is expected that the PDRA will be involved both with observational programmes to determine the physical and chemical characteristics of low mass star-forming regions and also in the analysis and interpretation of the data using astrochemical and radiative transfer models.

The PDRA will work jointly with Dr. Jonathan Rawlings, Prof. D.A. Williams (UCL) and Dr. D. Ward-Thompson (Cardiff). The PDRA will be primarily based in London, but is expected to be part of an active collaborative link between the two institutions.

Resources permit an appointment at the lower end of the Research Staff Scale 1A, so that the position is particularly appropriate for a recent PhD graduate. The appointment will initially be for one year, with renewal for a further two years subject to satisfactory performance. Candidates should have a background in IR/submm/mm observational astronomy and/or molecular astrophysics.

Prospective applicants are encouraged to make informal contact with Dr. J. Rawlings (jcr@star.ucl.ac.uk; +44-(0)20-7679-3471), Prof. D.A. Williams (daw@star.ucl.ac.uk; +44-(0)20-7679-1355) or Dr. D. Ward-Thompson (spxdw@astro.cf.ac.uk; +44-(0)2029-875314). Applications should be in the form of a full curriculum vitae including the names and addresses of two referees and should be sent to Dr. J. Rawlings, Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT. The closing date for applications is 31 May 2000.

The Star Formation Newsletter is a vehicle for fast distribution of information of interest for astronomers working on star formation and molecular clouds. You can submit material for the following sections: *Abstracts of recently accepted papers* (only for papers sent to refereed journals, not reviews nor conference notes), *Dissertation Abstracts* (presenting abstracts of new Ph.D dissertations), *Meetings* (announcing meetings broadly of interest to the star formation and interstellar medium community), *New Books* (giving details of books relevant for the same community), *New Jobs* (advertising jobs specifically aimed towards persons within our specialty), and *Short Announcements* (where you can inform or request information from the community).

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

The Star Formation Newsletter is available on the World Wide Web at <http://casa.colorado.edu/reipurth> or at <http://www.eso.org/gen-fac/pubs/starform/>.

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

Star Formation 1999

Edited by Taishi Nakamoto

These are the proceedings of the international conference "Star Formation 1999" held at Nagoya University, Japan, during June 21 - 25, 1999. These proceedings contain most of the oral presentations and poster papers of the conference relating to molecular clouds and cores, protostars and their associated disks, jets and other activities from YSOs, binary and cluster formation, and star formation in nearby and young galaxies. The proceedings summarize our present knowledge of star formation and point to future research directions in this field.

The book consists of the following eight chapters and 153 articles:

- Star Formation in External Galaxies and Early Universe
- Molecular Clouds in Our Galaxy
- From Cloud Cores to Protostars
- Circumstellar Disks
- Jets, Outflows, and Other Activities Related with YSOs
- Stellar Mass Function
- Cluster Formation and Sequential Star Formation
- Others

A limited number of free copies of these proceedings are available on request. Please contact the publisher when you wish your own copy. As long as supply permits, one copy per request will be mailed. It is also possible to access these proceedings electronically on the Internet by the courtesy of ADS, NASA (online conference proceedings page).

Nobeyama Radio Observatory 1999, 413 pages with CD-ROM

Published by:

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Nobeyama, Minamimaki, Minamisaku, Nagano 384-1305

Japan

Address for e-mail requests:

tatematsu@nro.nao.ac.jp

Announcements

The Two Micron All Sky Survey (2MASS) Second Incremental Data Release

is now available for public access. This Release includes data from the northern and southern 2MASS facilities, covering 47 Source Catalog containing positions and photometry for over 162 million objects, an Extended Source Catalog containing positions, photometry and basic shape information for over 585,000 resolved sources, approximately 1.9 million compressed 512x1024 pixel (1"/pixel) images in the three Survey bandpasses, and non-compressed "postage-stamp" images for all of the Extended Source Catalog objects.

The release data products can be accessed on-line from the IPAC/2MASS Web site at <http://www.ipac.caltech.edu/2mass/> or directly from the NASA/Infrared Science Archive site at <http://irsa.ipac.caltech.edu/>. In the near future, the release Catalogs will be available via ftp download, and on a limited distribution DVD-ROM. Access to the 2MASS Atlas Images is currently possible only via the on-line services.

The 2MASS/IPAC webpage contains general information about this data release, including an on-line Explanatory Supplement (<http://www.ipac.caltech.edu/2mass/releases/second/doc/explsup.html>), sky coverage maps, images of interesting objects in the release, catalog characteristics, etc. A tool for determining whether a specified position is included in the release area is available on the NASA/Infrared Science Archive webpage. Questions about the release can be directed to the 2MASS Help Desk at 2mass@ipac.caltech.edu.

We encourage you to notify us (at 2mass@ipac.caltech.edu) about any refereed publications or conference proceedings (even in preprint form) which make use of these or earlier 2MASS Release data products. We will gladly provide links to your papers from the 2MASS website. Thank you very much in advance.

The 2MASS Project

The Two Micron All Sky Survey is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology. Funding for the survey has been provided by the National Aeronautics and Space Administration and the National Science

Release of ROSAT All-Sky Survey Data

The ROSAT all-sky survey reprocessing (RASS3) has been completed and is now released to the scientific community.

There are 1378 RASS3 fields each 6.4 deg*6.4 deg covering the whole sky. Neighboring fields are overlapping by at least 0.23 degrees. Each field can be identified by an equatorial latitude zone number (running from 1 to 33) and an equatorial longitude segment number (running from 1 to 64, depending on the zone number). Accordingly there are 1378 directories in the ROSAT Data Archive each containing a README file and 10 standard FITS files. The names of the data directories have been adapted to match other ROSAT archival data. A 6-digit number (ROR number) is followed by 'p' for the detector used (PSPC). The ROR number consists of '93' as the first two digits ('9' for the ROR category 'other and survey data', '3' stands for RASS3), digits 3 and 4 correspond to the zone number, 5 and 6 to the segment number. RASS FITS data files start with the 2 characters "rs" to indicate survey data.

There are several ways to retrieve the ROSAT all-sky survey data; they are listed in the help file to be found on the web page: <http://www.xray.mpe.mpg.de/cgi-bin/rosat-survey>