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Abstracts of recently accepted papers

Far-infrared photometry and mapping of Herbig Ae/Be stars with ISO

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Seven Herbig Ae/Be stars were observed at mid- and far-infrared wavelengths with ISOPHOT, the photometer onboard the Infrared Space Observatory. At $\lambda \leq 25\mu$m, where the emission mainly arises from a compact circumstellar region, the observed spectral energy distributions can be described by power-law relationships between wavelength and flux density ($F_\nu \propto \nu^{-n}$). The exponent of the power-law changes considerably among the stars, from $n \approx 0$ for MWC 1080 to $n \approx 2.3$ in the case of LkHα 234, with a typical value of around 1. Interpreting the observed power-law relationships in terms of circumstellar disks, in 5 out of 6 cases relatively shallow radial temperature distributions have to be assumed ($T \propto r^{-q}$ where $0.37 \leq q \leq 0.53$). At longer wavelengths the observed emission is spatially extended, and in some cases significant discrepancy with IRAS was found due to beam size effects. The peak of the SEDs (in F_ν) is typically at 60–100μm, corresponding to temperatures of around 50 K. At $\lambda > 100\mu$m the emission observed by ISOPHOT is never dominated by the Herbig Ae/Be stars. The most likely sources of the far-infrared radiation are dust cores of about 1 arcminute in size. The dust cores are probably located in the vicinity of the stars, and may be related to the star forming process.

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A ROSAT pointed observation of the Chamaeleon II dark cloud

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A deep 13.5 ksec ROSAT PSPC pointed observation in the Chamaeleon II (Cha II) cloud is reported. 40 X-ray sources are detected of which 14 can be identified with previously known young stellar objects (YSOs), namely IRAS sources, classical T Tauri stars and weak T Tauri stars. From spectroscopic follow-up observations, four new weak T Tauri candidates have been found. The X-ray sources are mainly located on the north-east of the cloud and their spatial distribution follows the lanes of the 100μm dust emission. Their X-ray properties are similar to those of low-mass PMS stars. None of the protostar candidates in Cha II has been detected in the ROSAT pointed observation, in agreement with the ASCA observations results. The X-ray detection rates indicate that the weak T Tauri stars (WTTS) are less numerous than the classical T Tauri stars (CTTS), contrarily to the findings in Chamaeleon I (Cha I) and other star forming regions where the WTTS may outnumber the CTTS. The latter result could be a consequence of the fact that Cha II is in an earlier evolutionary stage as compared to Cha I, as conjectured by previous studies. The Cha II

young stellar objects (YSOs) are, on the average, slightly less X-ray luminous than those in Cha I, but the normalised X-ray luminosity distribution functions of the two regions are not significantly different.

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ftp://www.na.astro.it/pub/jmae/CHAPOII/chapoii.ps

Current-driven instabilities in astrophysical jets. Linear analysis

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Current-driven instabilities of force-free screw pinches are studied for a large variety of magnetic configurations by means of a global linear analysis in an ideal MHD framework. The magnetic pitch, $P = rB_z/B_\phi$, in particular its value on the axis, P_0, essentially determines the growth rate of the fastest growing kink instability and allows to identify two regimes. In the large pitch regime, representative for the majority of controlled fusion devices, the stability properties are highly sensitive to the radial pitch profile. Astrophysical jets of magnetic origin are likely to have dominantly azimuthal fields. For such configurations the properties of the fastest growing kink instability become nearly independent of the details of the pitch profile. The most unstable mode grows with an e-folding time $t_\mathrm{g} = 7.52\, P_0/v_\mathrm{A}$ and an axial wavelength $\lambda = 8.43\, P_0$ in the rest frame of the jet. The magnetic structure of jets with dominantly azimuthal fields will be modified by the fast growing kink instability. An analysis of the eigenfunction shows however that the kink is an internal mode which does not cause a significant sidewise displacement of the jet surface.

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Thermal Instability and the Formation of Clumpy Gas Clouds

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The radiative cooling of optically thin gaseous regions and the formation of a two-phase medium and of cold gas clouds with a clumpy substructure is investigated. We demonstrate how clumpiness can emerge as a result of thermal instability. In optically thin clouds, the growth rate of small density perturbations is independent of their length scale as long as the perturbations can adjust to an isobaric state. However, the growth of a perturbation is limited by its transition from isobaric to isochoric cooling when the cooling time scale is reduced below the sound crossing time scale across its length scale. The temperature at which this transition occurs decreases with the length scale of the perturbation. Consequently small scale perturbations have the potential to reach higher amplitudes than large scale perturbations. When the amplitude becomes nonlinear, advection overtakes the pressure gradient in promoting the compression resulting in an accelerated growth of the disturbance. The critical temperature for transition depends on the initial amplitude. The fluctuations which can first reach nonlinearity before their isobaric to isochoric transition will determine the characteristic size and mass of the cold dense clumps which would emerge from the cooling of an initially nearly homogeneous region of gas. Thermal conduction is in general very efficient in erasing isobaric, small-scale fluctuations, suppressing a cooling instability. A weak, tangled magnetic field can however reduce the conductive heat flux enough for low-amplitude fluctuations to grow isobarically and become non-linear if their length scales are of order 10^{-2} pc. If the amplitude of the initial perturbations is a decreasing function of the wavelength, the size of the emerging clumps will decrease with increasing magnetic field strength. Finally, we demonstrate how a 2-phase medium, with cold clumps being pressure confined in a diffuse hot residual background component, would be sustained if there is adequate heating to compensate the energy loss.

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The structure of the collapsing envelope around the low-mass protostar IRAS 16293-2422

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Using H_2O, OI and SiO data, we derive the structure of the collapsing envelope around the low-mass protostar IRAS16293-2422 down to $r \sim 30$ AU. With an accurate model which computes self-consistently the chemical composition, thermal balance and line emission from a collapsing envelope (Ceccarelli, Hollenbach & Tielens 1996), we find that IRAS16293-2422 is a 0.8 $M_\odot$ protostar accreting from the surrounding envelope at a rate of 3.5×10^{-5} $M_\odot$ yr^{-1}, in good agreement with previous studies. The model predicts that the water abundance in the outer (r $\geq$ 150 AU) part of the envelope is 5×10^{-7} with respect to H nuclei, while it is a few times larger at smaller radii (r $\leq$ 150 AU). This enhancement results from the evaporation of icy grain mantles when the temperature exceeds $\sim$ 100 K. The same model can reproduce the observations of the SiO J=2–3 to J=8–7 lines provided the abundance of SiO is 1.5×10^{-8} in the inner region, while it is only 4×10^{-12} in the rest of the envelope. The SiO abundance enhancement in the inner regions is likely due to the evaporation of the grain mantles also responsible for the abundance enhancement of H_2O. The cooling and heating mechanisms of the gas throughout the envelope as derived from the model are discussed, and used to derive the gas temperature profile.

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http://www-laog.obs.ujf-grenoble.fr/activites/starform/formation.html#new

The Composition and Distribution of Dust Along the Line of Sight Towards the Galactic Center

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We discuss the composition of dust and ice along the line of sight to the Galactic Center (GC) based on analysis of mid-infrared spectra (2.4–13 μm) from the Short Wavelength Spectrometer on the Infrared Space Observatory (ISO). We have analyzed dust absorption features arising in the molecular cloud material and the diffuse interstellar medium along the lines of sight toward Sagittarius A* and the Quintuplet sources, GCS3 and GCS4. It is evident from the depth of the 3.0 μm H_2O and the 4.27 μm CO_2 ice features that there is more molecular cloud material along the line of sight toward Sgr A* than GCS3 and 4. In fact, Sgr A* has a rich infrared ice spectrum with evidence for the presence of solid CH_4, NH_3, and possibly HCOOH.

Hydrocarbon dust in the diffuse interstellar medium along the line of sight to the GC is characterized by absorption features centered at 3.4 μm, 6.85 μm, and 7.25 μm. Ground-based studies have identified the 3.4 μm feature with

aliphatic hydrocarbons, and ISO has given us the first meaningful observations of the corresponding modes at longer wavelengths. The integrated strengths of these three features suggest that hydrogenated amorphous carbon is their carrier. We attribute an absorption feature centered at 3.28 μm in the GCS3 spectrum to the C-H stretch in aromatic hydrocarbons. This feature is not detected, and its C-C stretch counterpart appears to be weaker, in the Sgr A* spectrum. One of the key questions which now arises is whether aromatics are a widespread component of the diffuse interstellar medium, analogous to aliphatic hydrocarbons.

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High resolution near-infrared observations of Herbig-Haro flows – I. H_2 imaging and proper motions

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We present results of a H_2 proper motion study of 3 Herbig-Haro flows: HH 7-11, HH 25-26 and HH 33/40. These are the first proper motion measurements for these objects in the near-infrared, and are complimentary to a velocity resolved, echelle spectroscopy study of the H_2 line profile from these objects (Davis et al. 2000 – Paper II).

The results presented here cover a 4-5 year time span. The HH 7-11 outflow components have high proper motions, ranging between $\sim$ 200-450 km s^{-1}. The directions of their propagation are remarkably uniform, leading directly away from the outflow source. This proper motion pattern is in accordance with recent numerical simulations by Völker et al. (1999), and leads us to suggest that the HH 7-11 chain is produced by a (pulsed) heavy jet, of which HH 7 is the working surface, driving into a low density but clumpy medium. The HH 25-26 system is quite intriguing, with shock components furthest from the source having high proper motions ($\sim$ 200 km s^{-1}), while those closest to the source have negligibly small proper motions ($\leq$ 70 km s^{-1}). This system is interpreted in terms of working surface bow shocks internal to the jet, and a turbulent mixing layer between the flow and ambient medium. Indeed, HH 26A and HH 25C may represent the jet being deflected off nearby dense material. The HH 33/40 flow does not show any significant amount of proper motion, with an upper limit of $\sim$ 40-70 km s^{-1}. Situated at the terminus of the giant 'parsec-scale' HH 34 outflow, HH 33 is probably the working surface of the outflow while HH 40 must be material caught up in the general flow of the system.

Finally, it is shown that the limb brightened leading edges of the bow shocks in HH 7 and HH 33 are resolved. If the width of these leading edges represent cooling lengths, then the shocks are probably C-type, as opposed to J-type, bow shocks driving through pre-shock material with < 1 mG magnetic fields.

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Preprints available from: http://www.jach.hawaii.edu/~cdavis/papers.html

High resolution near-infrared observations of Herbig-Haro flows – II. Echelle spectroscopy

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Line profile data are used to probe the physical conditions associated with molecular hydrogen features in four Herbig-Haro flows; HH 7-11, HH 33/40, HH 26 and HH 212. These kinematic data are compared to new H_2 images and proper motion measurements presented in Chrysostomou et al. (2000 - Paper I).

We find in these combined data evidence for bow shocks and turbulent mixing layers. HH 7 and HH 33 represent

spectacular examples of resolved bow shocks; double-peaked H_2 emission profiles are observed in the flanks of both targets. HH 26C is also thought to be a bow shock, though one which has undergone considerable fragmentation during its life-time (based on its current proper motion [from Paper I], this bow has a dynamical age of roughly 600(±130) years). HH 40 and HH 26A instead seem to represent turbulent boundary layers between the HH flows and their ambient surroundings; both features have very low proper motions. However, although the H_2 profiles in HH 40 are narrow and symmetric, as one might expect from a turbulent spectrum of unresolved shocks, in HH 26A we see complex structure in position-velocity space. This suggests that shocks generated in the HH 26A turbulent boundary are resolved in these data. The associated curved shocks thus generate more asymmetric profiles and, in some cases, double-peaked profiles.

In HH 212 we see narrow, symmetric profiles in the knots along the flow axis, as well as clear evidence of acceleration along the jet. The spatial symmetry evident in images of this bipolar jet is also reflected in the velocities of the knots. The bow shocks NB1/2 and SB1 in HH 212 also possess bow-shock-like profiles in our position-velocity plots. Transverse velocity gradients in the knots provide some evidence for jet rotation. The rotation is consistent with the necessary extraction of angular momentum from the underlying rotating disk to enable the continued accretion of material onto the protostar.

Lastly, we return to the issue of whether H_2 shock features accelerate molecular gas to form the massive bipolar outflows usually traced in CO. Comparison of the mass fluxes measured in each HH object (from our H_2 data) with mass outflow rates typical of “CO” outflows suggests that this is indeed the case.

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The excitation and kinematical properties of H_2 and [Fe II] in the HH 46/47 bipolar outflow

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Long slit spectra of the molecular outflow Herbig-Haro (HH) 46/47 has been taken in the J and K near-infrared bands. The observed H_2 line emission confirms the existence of a bright and extended redshifted counter-jet outflow southwest of HH46. We show that this outflow seems to be composed of two different emission regions which have distinct heliocentric velocities, in contrast with the optical appearance, and which implies an acceleration of the counter-jet.

The observed [Fe II] emission suggests an average extinction of 7–9 visual magnitudes for the region associated with the counter-jet.

Through position-velocity diagrams, we show the existence of different morphologies for the H_2 and [Fe II] emission regions in the northern part of the HH 46/47 outflow. We have detected for the first time high velocity (-250 km s^{-1}) [Fe II] emission in the region bridging HH46 to HH47A. The two strong peaks detected can be identified with the optical positions B8 and HH47B.

The H_2 excitation diagrams for the counter-jet shock suggest an excitation temperature for the gas of $T_{\rm ex} \approx 2600$. The lack of emission from the higher energy H_2 lines such as the 4-3 S(3) transition, suggests a thermal excitation scenario for the origin of the observed emission. Comparison of the H_2 line ratios to various shock models yielded useful constraints about the geometry and type of these shocks. Planar shocks can be ruled out whereas curved or bow-shocks (both J and C-type) can be parametrised to adjust our data.

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HRI observations of PMS stars in NGC 2264

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We analyze six ROSAT HRI observations pointed toward the Star Forming Region (SFR) NGC 2264. Three are pointed to the southern star formation core, the other three about 20' to the north. We detect 169 X-ray sources, $\sim 95\%$ of which are likely to be Pre Main Sequence (PMS) stars, significantly enlarging the known population of the SFR in the area covered by the observations. Using published BVRI photometry we place the X-ray sources with well defined optical counterparts on the HRI diagram and estimate their masses and ages. Our comparison of the mass function and age distribution of the X-ray sources with results previously obtained for NGC 2264, demonstrates that deep X-ray observations provide, at least in this case, a very efficient method of selecting SFR members and does not introduce stronger biases than other methods.

Since the observation cover a time span of ~ 5 years, we are able to study in detail the X-ray variability of our sample of PMS stars. We find that: 1) a large fraction of our sources are variable on several time scales and 2) Classical T Tauri Systems (i.e. stars surrounded by disks) are significantly more variable than the rest of our sample, suggesting a role of accretion disks in the emission and/or in the absorption of the X-ray radiation.

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Sequential Star Formation Triggered by Expansion of an H II Region

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We show three-dimensional numerical simulations in which stars form sequentially in a filamentary molecular cloud. The star formation is triggered by expansion of an H II region. The H II region is distant from the filamentary cloud at the initial stage. As it expands, it interacts with the filamentary cloud. The cloud is pinched and separated into two. Subsequently, the gravitational instability is induced to form two cores of the first-generation along the filament axis in a typical model. The separation of the two cores is several times larger than the filament diameter. It is comparable to the wavelength of the fastest growing fragmentation mode. The first-generation cores become isolated, and filamentary clouds shorten to widen the separation. New cores of second-generation form at the edges of the shortened filamentary clouds. This core formation is recursive, and our model shows sequential star formation triggered by an expanding H II region. The age difference is several times of the dynamical time scale between the first- and second-generation cores. This sequential star formation is similar to that observed in the filamentary cloud associated with the H II region NGC 2024. Our first-generation cores correspond to FIR 4 and FIR 5 while the second-generation cores to FIR 3 and FIR 6.

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http://www.a.phys.nagoya-u.ac.jp/ fukuda/research/ms199909/ms_9909.html

Infrared emission from 6.7-GHz methanol maser sources

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Near-infrared photometry was done on 56 southern 6.7 GHz methanol maser sources. A simple spherically symmetric model of the radiative transfer through a dust shell was developed and used to study the conditions in the dust cloud in which the masers are produced. The parameters investigated were the size of the cloud, the spectral type of the embedded star, the optical depth of the dust cloud and the dust density distribution. It was found that the infrared colours of the models have a complex dependence on the parameters and that no unique combination of parameter values explains the spectral energy distribution of any particular source. The model effectively reproduces the far-infrared (*IRAS*) colours but cannot simultaneously explain the near-infrared colours for any of the observed sources.

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Probing the magnetic field with molecular ion spectra

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Observations of the effect of the magnetic field on its environment are usually achieved with techniques which rely on the interaction with the spin of the particles under study. Because of the relative weakness of this effect, extraction of the field characteristics proves to be a most challenging task. We take a totally different approach to the problem and show that the manifestation of the magnetic field can be directly observed by means of a comparison of the spectra of molecular ions with those of neutral molecules. This takes advantage of the strong cyclotron interaction between the ions and the field, but requires the presence of flows or turbulent motion in the gas. We compare our theory to data obtained on the OMC1, OMC2, OMC3 and DR21OH molecular clouds.

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Ionizing Radiation in Smoothed Particle Hydrodynamics

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A new method for the inclusion of ionizing radiation from uniform radiation fields into 3D Smoothed Particle Hydrodynamics (SPHI) simulations is presented. We calculate the optical depth for the Lyman continuum radiation from the source towards the SPHI particles by ray-tracing integration. The time-dependent ionization rate equation is then solved locally for the particles within the ionizing radiation field. Using test calculations, we explore the numerical behaviour of the code with respect to the implementation of the time-dependent ionization rate equation. We also test the coupling of the heating caused by the ionization to the hydrodynamical part of the SPHI code.

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Gravitational Collapse in Turbulent Molecular Clouds. I. Gasdynamical Turbulence.

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Observed molecular clouds often appear to have very low star formation efficiencies and lifetimes an order of magnitude longer than their free-fall times. Their support is attributed to the random supersonic motions observed in them. We study the support of molecular clouds against gravitational collapse by supersonic, gas dynamical turbulence using direct numerical simulation. Computations with two different algorithms are compared: a particle-based, Lagrangian method (SPH), and a grid-based, Eulerian, second-order method (ZEUS). The effects of both algorithm and resolution can be studied with this method. We find that, under typical molecular cloud conditions, global collapse can indeed be prevented, but density enhancements caused by strong shocks nevertheless become gravitationally unstable and collapse into dense cores and, presumably, stars. The occurance and efficiency of local collapse decreases as the driving wave length decreases and the driving strength increases. It appears that local collapse can only be prevented entirely with unrealistically short wave length driving, but observed core formation rates can be reproduced with more realistic driving. At high collapse rates, cores are formed on short time scales in coherent structures with high efficiency, while at low collapse rates they are scattered randomly throughout the region and exhibit considerable age spread. We suggest that this naturally explains the observed distinction between isolated and clustered star formation.

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full resolution preprints are available at http://www.strw.leidenuniv.nl/ klessen/Preprints/p7.abstract.html
see also astro-ph/9911068

A Third Star in the T Tauri System

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New speckle-holographic images of the T Tauri Infrared Companion (T Tauri IRC; T Tauri S) reveal it to be a double system with a sky-projected separation of 0.05 arcsec, corresponding to a linear distance of 7 AU. The presence of this third star may account for the relative paucity of dust surrounding the IRC.

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The Galactic Shock Pump: A Source of Supersonic Internal Motions in the Cool Interstellar Medium

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We propose that galactic shocks propagating through interstellar density fluctuations provide a mechanism for the intermittent replenishment, or "pumping," of the supersonic motions and internal density enhancements observed pervasively within cool atomic and molecular interstellar structures, without necessarily requiring the presence of self-gravity, magnetic fields, or young stars. The shocks are assumed to be due to a variety of galactic sources on a range of scales. An analytic result for the kinematic vorticity generated by a shock passing through a radially-stratified two-dimensional isobaric model cloud is derived, assuming that the Mach number is not so large that the cloud is disrupted, and neglecting the shock curvature and cloud distortion. Two-dimensional lattice gas hydrodynamic simulations at modest Mach numbers were used to verify the analytic result. The induced internal velocities are initially a significant fraction of the shock speed divided by the square root of the density contrast, accounting for both the observed linewidth amplitudes and the apparent cloud-to-cloud linewidth-density scaling. The linewidth-size relation could then be interpreted in terms of the well-known power spectrum of a system of shocks. The induced vortical energy should quickly be converted to compressible and MHD modes, and so would be difficult to observe directly, even though it would still be the power source for the other modes. The shockpump thus produces density structure without the necessity of any sort of instability. We argue that the shockpump should lead to nested shock-induced structures, providing a cascade mechanism for supersonic "turbulence" and a physical explanation for the fractal-like structure of the cool interstellar medium. The average time between shock exposures for an idealized cloud in our Galaxy is estimated and found to be small enough that the shockpump is capable of sustaining the supersonic motions against readjustment and dissipation, except for the smallest structures. This suggests an explanation of the roughly spatially uniform and nearly sonic linewidths in small "dense cores." We speculate that the avoidance of shock pumping may be necessary for a localized region to form stars, and that the inverse dependence of probability of avoidance on region size may be an important factor in determining the stellar initial mass function.

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Magnetised Protostellar Bipolar Outflows. I. Self-similar model with Poynting flux

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We study a self-similar circulation model for protostellar bipolar outflows. The model is axisymmetric and stationary, and now includes Poynting flux. Compared to an earlier version of the model, this addition produces faster and more collimated outflows. Moreover the luminosity needed for the radiative heating is smaller. The solutions are developed within the context of r-self-similarity, which is a separated type of solution wherein a power of r multiplies an unknown function of θ. For outflows surrounding a fixed point mass the velocity, density and magnetic field respectively scale with spherical radius r as $\vec{v} \propto r^{-1/2}$, $\rho \propto r^{2\alpha-1/2}$ and $\vec{B} \propto r^{\alpha-3/4}$. The parameter α must be larger than $-1/2$ and smaller than or equal to $1/4$. We obtain the θ-dependence of all flow quantities. Monte Carlo methods have been used to explore systematically the parameter space. An inflow/outflow pattern including collimation of high speed material and an infalling toroidal disc arises naturally. The disc shape depends on the imposed heating, but it is naturally Keplerian given the central point mass. Outflows can have large opening angles, that increase when the magnetic field weakens. Massive protostars produce faster but less collimated outflows than less massive protostars. The model is now at a stage where synthetic CO spectra reproduce very well the observational features. The results strengthen the idea that the Poynting flux and the radiative heating are ultimately the energy sources driving the outflow.

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Current-Driven Instabilities in Astrophysical Jets. Non Linear Development

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The non linear development of instabilities driven by the presence of an electric current is investigated for magnetized jets using 3-dimensional MHD simulations. General magnetic equilibria for cold supermagnetosonic jets with constant velocity are considered in order to study the influence of the initial configuration on the non linear evolution. It is

found that the current density is redistributed within the inner part of the jet radius with a characteristic time scale and an axial wavelength in agreement with the linear analysis. For equilibria having a pitch profile that increases with radius, an internal helical ribbon with a high current density is forming. It gives rise to considerable dissipation which is radially localized, and may result in heating and particle acceleration within the jet.

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New discovery of weak-line T Tauri stars in high-Galactic latitude molecular clouds

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Star formation efficiency in translucent molecular clouds has long been an unresolved and key issue in the field of low-mass star formation. In this paper, we report on the results of our survey for low-mass star formation in high-Galactic latitude molecular clouds, especially those of the translucent category, based on the ROSAT All-Sky Survey. Nine new weak-line T Tauri star candidates have been discovered at high-Galactic latitudes, among which, 6 are seen against — thus possibly associated with — the translucent molecular clouds, MBM 16, MBM 19 and MBM 55. Further study on the Li-rich X-ray active sources is necessary to shed more light on star formation in translucent molecular clouds.

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Water Masers Diagnosing Postshocked Conditions in W49 N

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We present spectroscopic results of 146 water maser outbursts in W49 N, obtained with the Metsähovi radio telescope at 22 GHz. We found the following characteristics: (1) Inside (outside) the velocity range of the dense ambient medium, the increase in flux density during an outburst is typically 10^4 Jy (10^3 Jy) and covers one order (2.5 orders) of magnitude. (2) The outburst durations closely trace space velocities of maser features. (3) Nonthermal velocity fluctuations produce variations in the line velocity of the maser features, which are comparable to the variations measured in the linewidth during outbursts. (4) There is no correlation between flux density and linewidth.

Combining this data with Gwinn's VLBI results, notably obtained during the same time period and with the same velocity resolution, we were able to fix the free parameters in the shock model of Hollenbach & McKee and the maser model of Elitzur, Hollenbach, & McKee. This enabled a straightforward determination of some 20 shock and maser parameters including, among others, the following typical values: kinetic temperature 350 K, postshock density 3.6 - 8.7 x 10^8 cm^{-3}, water abundance 1 - 5 x 10^{-4}, water density 0.9 - 1.9 x 10^5 cm^{-3}, water column density 2.2 - 7.9 x 10^{19} cm^{-2}, preshock field strength 0.8 - 1.6 mG, and total postshock field strength 80 - 160 mG. A step-by-step presentation of our diagnostic method is given and the relation between observations and model parameters is discussed.

One uniquely powerful outburst feature, hereafter referred to as the "big flare feature", showed also the narrowest linewidth (0.5 km s^{-1}). Observations indicate that the velocity of this feature lies in the plane of the sky, whereas preshock and postshock magnetic fields are directed nearly along the line of sight. Consequently, Alfvenic wave fluctuations along the line of sight, and linewidth, are minimal, and a very high aspect ratio is achieved. Furthermore, the big flare feature stands out through its low space velocity, higher temperature (480 K), and larger preshock field strength (8.2 mG). These are naturally explained, if the big flare feature was located closer to the shock front than the other masers.

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Pulsation in two Herbig Ae stars: HD 35929 and V351 Ori

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New photometric observations of seven intermediate mass pre-main sequence δ Scuti candidates are presented. The periods and pulsation modes are derived for two of these stars, namely HD 35929 and V351 Ori. The comparison between observations and nonlinear pulsational models allows us to provide some initial constraints on their mass and evolutionary state. As an illustration we discuss the use of periods to identify the mode of pulsation in these two stars and to have an independent estimate of their distances.

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ASCA Observations of NGC 2264 Molecular Cloud

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We have made ASCA observations of the molecular cloud associated with NGC 2264, and detected nine and five sources in the soft and hard X-ray band images, respectively. Most of them are identified with known pre-main sequence stars or protostellar objects. Two Class I sources with intermediate luminosities and one Class II source associated with molecular outflow, are promising candidates for X-ray emitters. An optically thin hot plasma model with two components can reproduce the GIS X-ray spectra including both of the Class I sources. The hard X-rays probably arise from these Class I sources and they are intrinsically very luminous, $> 10^{32}$ erg s^{-1} in the 0.7–10.0 keV energy band, and their luminosities lie between low-mass Class I sources and that of W3 massive core region. Since near infrared survey data reveal that Class I sources are surrounded by embedded young clusters, the soft X-ray components could be explained by aggregates of low mass pre-main sequence stars.

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On the possibility of ground-based direct imaging detection of extra-solar planets: The case of TWA-7

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We show that *ground-based* direct imaging detection of extra-solar planets is possible with current technology. As an example, we present evidence for a possible planetary companion to the young T Tauri star 1RXSJ104230.3−334014 (=TWA-7), discovered by ROSAT as a member of the nearby TW Hya association. In an HST NICMOS F160W image, an object is detected that is more than 9 mag fainter than TWA-7, located $2.445 \pm 0.035''$ south-east at a position angle of $142.24 \pm 1.34°$. One year later using the ESO-NTT with the SHARP speckle camera, we obtained H- and K-band detections of this faint object at a separation of $2.536 \pm 0.077''$ and a position angle of $139.3 \pm 2.1°$. Given the known proper motion of TWA-7, the pair may form a proper motion pair. If the faint object orbits TWA-7, then its apparent magnitudes of H=16.42 ± 0.11 and K=16.34 ± 0.15 mag yield absolute magnitudes consistent with

a $\sim 10^{6.5}$ yr old ~ 3 M_{jup} mass object according to the non-gray theory by Burrows et al. (1997). At ~ 55 pc, the angular separation of $\sim 2.5''$ corresponds to ~ 138 AU, clearly within typical disk sizes. However, position angles and separations are slightly more consistent with a background object than with a companion.

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Young Stellar Populations Around SN 1987A

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We present the first results of a study of the stellar population in a region of 30 pc radius around SN 1987A, based on an analysis of multi-band *HST-WFPC2* images.

The effective temperature, radius and, possibly, reddening of each star were determined by fitting the measured broad band magnitudes to the ones calculated with model atmospheres. In particular, we have determined effective temperatures and bolometric luminosities for 21,995 stars, and for a sub-sample of 2,510 stars we also determined individual reddening corrections. In addition, we have identified all stars with Hα equivalent widths in excess of 8 Å amounting to a total of 492 stars.

An inspection to the HR diagram reveals the presence of several generations of young stars, with ages between 1 and 150 $Myrs$, superposed on a much older field population ($0.6 - 6$ $Gyrs$). A substantial fraction of young stars have ages around 12 $Myrs$ which is the stellar generation coeval to SN 1987A progenitor. The youngest stars in the field appear to be strong-line *T Tauri* stars, identified on the basis of their conspicuous ($W_{eq} > 8$Å) Hα excesses. This constitute the first positive detection of low mass (about 1-2 $M_\odot$) Pre-Main-Sequence (PMS) stars outside the Milky Way. Their positions in the HR diagram appear to require that star formation in the LMC occurs with accretion rates about 10 times higher than in the Milky Way, *i.e.* $\sim 10^{-4} M_\odot \ yr^{-1}$.

SN 1987A appears to belong to a loose, young cluster 12±2 Myrs old, in which the slope of the present mass function is almost identical to Salpeter's, *i.e.* $\Gamma = dlogN/dlogM \simeq -1.25$ for masses above 3 $M_\odot$, but becomes much flatter for lower masses, *i.e.* $\Gamma \simeq -0.5$.

On a large scale, we find that the spatial distribution of massive stars and low-mass PMS stars are conclusively different, indicating that different star formation processes operate for high and low mass stars. This results casts doubts on the validity of an Initial Mass Function (IMF) concept on a small scale (say, less than 10pc). Moreover, it appears that a determination of the low-mass end IMF in the LMC requires an explicit identification of PMS stars. A preliminary analysis, done for the whole field as a single entity, shows that the IMF slope for the young population present over the entire region is steeper than $\Gamma \simeq -1.7$.

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On the orbital evolution and growth of protoplanets embedded in a gaseous disc

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We present a new computation of the linear tidal interaction of a protoplanetary core with a thin gaseous disc in which it is fully embedded. For the first time a discussion of the orbital evolution of cores on eccentric orbits with eccentricity (e) significantly larger than the gas-disc scale height to radius ratio (H/r) is given. We find that the direction of orbital migration reverses for $e > 1.1H/r$. This occurs as a result of the orbital crossing of resonances

in the disc that do not overlap the orbit when the eccentricity is very small. In that case resonances always give a net torque corresponding to inward migration. Simple expressions giving approximate fits to the eccentricity damping rate and the orbital migration rate are presented. We go on to calculate the rate of increase of the mean eccentricity for a system of protoplanetary cores due to dynamical relaxation. By equating the eccentricity damping time-scale with the dynamical relaxation time-scale we deduce that, for parameters thought to be applicable to protoplanetary discs, an equilibrium between eccentricity damping and excitation through scattering is attained on a 10^3–10^4 yr time-scale, at 1 au. This equilibrium is maintained during the further migrational and collisional evolution of the system, which occurs on much longer time-scales. The equilibrium thickness of the protoplanet distribution is related to the equilibrium eccentricity and is such that it is generally well confined within the gas disc. By use of a three dimensional direct summation N-body code we simulate the evolution of a system of protoplanetary cores, initialised with a uniform isolation mass of $0.1 M_\oplus$, incorporating our eccentricity damping and migration rates. Assuming that collisions lead to agglomeration, we find that the vertical confinement of the protoplanet distribution permits cores to build up in mass by a factor of ~ 10 in only $\sim 10^4$ yr, within 1 au. The time-scale required to achieve this is comparable to the migration time-scale. In the context of our model and its particular initial conditions we deduce that it is not possible to build up a massive enough core to form a gas giant planet, before orbital migration ultimately results in the preferential delivery of all such bodies to the neighbourhood of the central star. This problem could be overcome by allowing for the formation of massive cores at much larger radii than is usually considered. It remains to be investigated whether different disc models or initial planetesimal distributions might be more favourable for slowing or halting the migration, leading to possible giant planet formation at intermediate radii.

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http://www.maths.qmw.ac.uk/∼jdl/

Proper motion of water masers associated with IRAS 21391+5802: Bipolar Outflow and an AU-scale Dusty Circumstellar Shell

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We present VLBA observations of water maser emission associated with the star forming region IRAS 21391+5802, which is embedded in a bright rimmed cometary globule in IC1396. The angular resolution of the maps is ~ 0.8 mas, corresponding to a spatial resolution of ∼0.6 AU, at an estimated distance of 750 pc. Proper motions are derived for 10 maser features identified consistently over three epochs, which were separated by intervals of about one month. The masers appear in four groups, which are aligned linearly on the sky, roughly along a northeast–southwest direction, with a total separation of ∼520 AU (∼0.″7). The 3D velocities of the masers have a maximum value of ∼42 km s^{-1} (∼9 AU yr^{-1}). The average error on the derived proper motions is ∼4 km s^{-1}. The overall pattern of proper motions is indicative of a bipolar outflow. Proper motions of the masers in a central cluster, with a projected extent of ~ 20 AU, show systematic deviations from a radial outflow. However, we find no evidence of Keplerian rotation, as has been claimed elsewhere. A nearly circular loop of masers lies near the middle of the cluster. The radius of this loop is 1 AU and the line-of-sight velocities of the masers in the loop are within 2 km s^{-1} of the systemic velocity of the region. These masers presumably exist at the radial distance where significant dust condensation occurs in the outflow emanating from the star.
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An Intermittent Star Formation History in a ‘Normal’ Disk Galaxy: The Milky Way

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The star formation rate history of the Milky Way is derived using the chromospheric age distribution for 552 stars in the solar neighborhood. The stars' sample birthsites are distributed over a very large range of distances because of orbital diffusion, and so give an estimate of the global star formation rate history. The derivation incorporates the metallicity dependence of chromospheric emission at a given age, and corrections to account for incompleteness, scale height–age correlations, and stellar evolutionary effects. We find fluctuations in the global star formation rate with amplitudes greater than a factor of 2–3 on timescales less than 0.2–1 Gyr. The actual history is likely to be more bursty than found here because of the smearing effect of age uncertainties. There is some evidence for a slow secular increase in the star formation rate, perhaps a record of the accumulation history of our galaxy. A smooth nearly-constant star formation rate history is strongly ruled out, confirming the result first discovered by Barry (1988) using a smaller sample and a different age calibration. This result suggests that galaxies can fluctuate coherently on large scales.

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The shock waves in decaying supersonic turbulence

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We here analyse numerical simulations of supersonic, hypersonic and magnetohydrodynamic turbulence that is free to decay. Our goals are to understand the dynamics of the decay and the characteristic properties of the shock waves produced. This will be useful for interpretation of observations of both motions in molecular clouds and sources of non-thermal radiation.

We find that decaying hypersonic turbulence possesses an exponential tail of fast shocks and an exponential decay in time, i.e. the number of shocks is proportional to $t\ \exp(-ktv)$ for shock velocity jump v and mean initial wavenumber k. In contrast to the velocity gradients, the velocity Probability Distribution Function remains Gaussian with a more complex decay law.

The energy is dissipated not by fast shocks but by a large number of low Mach number shocks. The power loss peaks near a low-speed turn-over in an exponential distribution. An analytical extension of the mapping closure technique is able to predict the basic decay features. Our analytic description of the distribution of shock strengths should prove useful for direct modeling of observable emission. We note that an exponential distribution of shocks such as we find will, in general, generate very low excitation shock signatures.

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Preprints available at: http://star.arm.ac.uk/ mds/ or http://xxx.lanl.gov/abs/astro-ph/0002291

X-ray flares on zero-age and pre-main sequence stars in Taurus-Auriga-Perseus

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We present the results of a systematic search for X-ray flares on young stars observed during *ROSAT* PSPC observations of the Taurus-Auriga-Perseus sky region. All pointed PSPC observations currently available from the *ROSAT* Public Data Archive with known pre-main sequence T Tauri Stars or young Pleiads or Hyads in the field of view are analyzed. A study of the activity of late-type stars of different ages provides information on the evolution of their coronal activity,

which may be linked to their angular momentum.

We find a total of 52 flares in the PSPC observations. Among them 15 are detected on T Tauri Stars, 20 on Pleiads, and 17 on Hyads. Only the 38 events which can definitely be attributed to late-type stars (i.e. stars of spectral type G and later) are considered in the statistical analysis of the properties of flaring stars. We investigate the influence of stellar parameters such as age, rotation and multiplicity on individual flare parameters and flare frequency.

Our study contains the first presentation of flare rates obtained from a large sample of PMS stars. The flare rates of TTSs, Pleiads, and Hyads have been computed from the total exposure time and the duration of the individual flares. We take into account that the detection sensitivity for large X-ray flares depends on the S/N and hence on the stellar distance. A clear decline of the flare frequency with stellar age is observed. The flare rate of classical T Tauri Stars may be somewhat higher than that of weak-line T Tauri Stars.

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http://www.xray.mpe.mpg.de/~stelzer/publications.html

Structure and Evolution of the Envelopes of Deeply Embedded Massive Young Stars

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The physical structure of the envelopes around a sample of fourteen massive young stars is investigated using maps and spectra in submillimeter continuum and lines of $C^{17}O$, CS, $C^{34}S$ and H_2CO. Nine of the sources are highly embedded luminous ($10^3 - 10^5$ $L_\odot$) young stellar objects which are bright near-infrared sources, but weak in radio continuum; the other objects are similar but not bright in the near-infrared, and contain "hot core"-type objects and/or ultracompact H II regions. The data are used to constrain the temperature and density structure of the circumstellar envelopes on $10^2 - 10^5$ AU scales, to investigate the relation between the different objects and to search for evolutionary effects.

The total column densities and the temperature profiles are obtained by fitting self-consistent dust models to submillimeter photometry. The calculated temperatures range from 300 to 1000 K at $\sim 10^2$ AU and from 10 to 30 K at $\sim 10^5$ AU from the star. Visual extinctions are a few hundred to a few thousand magnitudes, assuming a grain opacity at $\lambda 1300 \mu$m of ≈ 1 cm^{-2} g^{-1} of dust, as derived earlier for one of our sources. The mid-infrared data are consistent with a 30% decrease of the opacity at higher temperatures, caused by the evaporation of the ice mantles.

The molecular line data as well as the submillimeter dust emission maps indicate density gradients $n \propto r^{-\alpha}$. Assuming a constant CS abundance throughout the envelope, values of $\alpha = 1.0 - 1.5$ are found, significantly flatter than the $\alpha = 2.0 \pm 0.3$ generally found for low-mass objects. This flattening may indicate that in massive young stellar objects, nonthermal pressure is more important for the support against gravitational collapse, while thermal pressure dominates for low-mass sources. We find $\alpha = 2$ for two hot core-type sources, but regard this as an upper limit since in these objects, the CS abundance may be enhanced in the warm gas close to the star.

The assumption of spherical symmetry is tested by modeling infrared absorption line data of ^{13}CO, CS emission line profiles and near-infrared continuum. There is a distinct, but small deviation from spherical symmetry: the data are consistent with a decrease of the optical depth by a factor of ≈ 3 in the central $\lesssim 10''$. The homogeneity of the envelopes is verified by the good agreement of the total masses in the power law models with the virial masses.

Modeling of $C^{17}O$ emission shows that $\approx 40 - 90\%$ of the CO is frozen out onto the dust. The CO abundances show a clear correlation with temperature, as expected if the abundance is controlled by freeze-out and thermal desorption. The CS abundance is 3×10^{-9} on average, ranging from $(4-8) \times 10^{-10}$ in the cold source GL 7009S to $(1-2) \times 10^{-8}$ in the two "hot core"-type sources.

Dense outflowing gas is seen in the CS and H_2CO line wings; the predominance of blueshifted emission suggests the presence of dense, optically thick material within $10''$ of the center. Interferometric continuum observations at $\lambda 1300 - 3500 \mu m$ show compact emission, probably from an $0''.3$ diameter, optically thick dust component, such as a dense shell or a disk. The emission is a factor of $10 - 100$ stronger than expected for the envelopes seen in the single-dish data, so that this component may be opaque enough to explain the asymmetric CS and H_2CO line profiles.

The evolution of the sources is traced by the overall temperature (measured by the far-infrared color), which increases systematically with decreasing ratio of envelope mass to stellar mass. The observed anticorrelation of near-infrared and radio continuum emission suggests that the erosion of the envelope proceeds from the inside out. Conventional tracers of the evolution of low-mass objects do not change much over this narrow age range.

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NH_3(1,1) Survey toward Southern Hemisphere HII Regions - I

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The (J,K) = (1,1) metastable ammonia line was searched for in the direction of more than one hundred southern HII regions located between 270^o and 15^o in galactic longitude, resulting in new detections toward 21 of them. Ammonia detection rate was about 30 % towards all directions except in the longitude interval 270^o to 290^o where no ammonia lines were found in the 15 selected HII regions. A high detection rate (≥ 0.6) was observed toward positions where IRAS point sources with color indices of ultra–compact HII regions were in the beam of the telescope. An anticorrelation between the number of detected NH_3 sources and the distance to the Galactic Center was found, compatible with the observed gradient in N abundance. From the value of this gradient and the detection rate of ammonia lines toward HII regions, it is inferred that the number of ammonia sources must be proportional to the inverse of the column density of the molecular cloud.

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The ortho:para-H_2 ratio in C- and J-type shocks

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We have computed extensive grids of models of both C- and J-type planar shock waves, propagating in dark, cold molecular clouds, in order to study systematically the behaviour of the ortho:para-H_2 ratio. Careful attention was paid to both macroscopic (dynamical) and microscopic (chemical reactions and collisional population transfer in H_2) aspects. We relate the predictions of the models to observational determinations of the ortho:para-H_2 ratio using both pure rotational lines and rovibrational lines. As an illustration, we consider ISO and ground-based H_2 observations of HH 54. Neither planar C-type nor planar J-type shocks appear able to account fully for these observations. Given the additional constraints provided by the observed ortho:para H_2 ratios, a C-type bowshock, or a C-type precursor followed by a J-type shock, remain as plausible models. Grid model results including line fluxes, temperatures, and ortho:para ratios are provided in Tables 2 and 4, available in electronic form only at `CDS` (via `http://cdsweb.u-strasbg.fr/Abstract.html` or via anonymous ftp to `cdsarc.u-strasbg.fr (130.79.128.5)`) and at `http://ccp7.dur.ac.uk/`.

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Evidence for Pressure Driven Flows and Turbulent Dissipation in the Serpens NW Cluster

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We have mapped the dense gas distribution and dynamics in the NW region of the Serpens molecular cloud in the CS(2–1) and N_2H^+(1–0) lines and 3 mm continuum using the FCRAO telescope and BIMA interferometer. 7 continuum sources are found. The N_2H^+ spectra are optically thin and fits to the 7 hyperfine components are used to determine the distribution of velocity dispersion. 8 cores, 2 with continuum sources, 6 without, lie at a local linewidth minimum and optical depth maximum. The CS spectra are optically thick and generally self-absorbed over the full 0.2 pc extent of the map. We use the line wings to trace outflows around at least 3, and possibly 4, of the continuum sources, and the asymmetry in the self-absorption as a diagnostic of relative motions between core centers and envelopes. The quiescent regions with low N_2H^+ linewidth tend to have more asymmetric CS spectra than the spectra around the continuum sources indicating higher infall speeds. These regions have typical sizes $\sim$ 5000 AU, linewidths $\sim$ 0.5 km s^{-1}, and infall speeds $\sim$ 0.05 km s^{-1}. The correlation of CS asymmetry with N_2H^+ velocity dispersion suggests that the inward flows of material that build up pre-protostellar cores are driven at least partly by a pressure gradient rather than by gravity alone. We discuss a scenario for core formation and eventual star forming collapse through the dissipation of turbulence.

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Preprint available at www.astro.ufl.edu/$\sim$williams/papers/serpens.ps

Multiline CO observations of MBM 32

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We present a detailed study of the high latitude cloud MBM 32. Observations were made in the J=(1–0), (2–1), and (3–2) transitions of ^{12}CO and in ^{13}CO(1–0) and (2–1). These data were complemented by 21 cm HI data and by IRAS 60 and 100μm data. Our data show that MBM 32 consists of a main cloud component at V_{lsr}>2 km s^{-1} (mass about 16.9 $M_\odot$), and a smaller component at V_{lsr}<0 km s^{-1} (4.1 $M_\odot$), in addition to some emission in between those two velocities (<0.5 $M_\odot$). We study the gas distribution and the CO line ratios within MBM 32, the latter also along a cut through both cloud components. We find that the ratios of different rotational transitions are constant within each cloud part. Only the ratio ^{12}CO(1–0)/^{13}CO(1–0) is lower in the cloud center. This suggests equal excitation conditions through MBM32 and line temperatures determined through clump filling factors. All CO components show associated HI emission, but small velocity differences of typically 1 km s^{-1} exist between the HI and CO gas. The mass of associated HI gas is similar to the molecular mass for all components. There is a good correlation between FIR, CO, and HI emission. The dust mass is about 0.073 $M_\odot$, and the ratio of gas and dust mass (280) is lower than found from similar (IRAS) data for denser clouds, suggesting that the amount of dust colder than 20 K is relatively small. We subdivide the CO data cubes in Gaussian shaped clumps; 40–50% of the CO emission can be assigned to the larger clumps. The remaining emission comes from either more extended clumps or from overlapping unresolved clumps.

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Correction

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The abstract in last month's Star Formation Newsletter titled "Planetesimal Formation in the Solar Nebula" was originally published in volume 83 of the Newsletter and titled "Dynamics of Circumstellar Disks II: Heating and Cooling". Due to insufficient communication between the authors it appeared again last month with a different and incorrect title. The paper itself is identical and is now in print in *The Astrophysical Journal* **529** 357, but has only very tangential connection to planetesimal formation. We regret the error.

Extinction and Star Formation Study in Molecular Clouds with DENIS infrared data and USNO optical data

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Ph.D dissertation directed by: Nicolas Epchtein

Ph.D degree awarded: November 1999

This thesis consists in a study of molecular clouds, essentially of the point of view of the interstellar environment, but also of the one of the star formation.

The original method to estimate extinction presented here is based on adaptive star counts as well as on a wavelet decomposition.

For the first time, an extinction map of the whole sky is proposed (USNO-PMM optical data). Access to very large field maps offers the opportunity to analyze the interstellar matter distribution in various environments. A first result is that the contained mass in regions for which $A_V > 1$ would not exceed half of the total cloud mass.

Using DENIS data, it becomes possible to probe dense regions of clouds. For instance, star counts in the Chamaeleon complex show cores which were not resolved before. Moreover, the selection of stars with a strong infrared excess yields about fifty T Tauri candidates. From their luminosity function, I derived the average lifetime of circumstellar disc of low–mass stars : $\sim 4 \cdot 10^6$ years.

It is difficult to understand the relation between extinction and molecular emission, but it appears clearly that molecular emission is a bad estimator of the column density for low extinction area. Actually, thresholds exist in the CO detection and I conclude that photodissociation, density and cloud geometry have important consequences on the CO emission when $A_V < 2$.

Investigation of the relation between extinction and far–infrared emission in Polaris leads to a four times larger emissivity in cold areas than in hot areas. This result explains the low temperatures in this cloud and implies severe restrictions concerning the use of far–infrared fluxes as an extinction estimator.

The Structure and Evolution of the Lagoon Nebula: Star Formation in the Sagittarius Arm

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The vast majority of star formation occurs in regions dominated by high-mass stars, such as the Orion complex. Through their HII regions, these massive stars profoundly affect the surrounding molecular gas, and quite probably trigger further star formation. This thesis presents the results of a submillimetre study of the interface between the Lagoon Nebula, M8, a large HII region in the southern hemisphere, and its associated molecular cloud.

Continuum maps of M8 were obtained at wavelengths of 450 μm and 850 μm with SCUBA on the JCMT, and at 1.3 mm with the MPIfR 37-channel array at IRAM. A new subroutine was added to the data reduction facility for SCUBA (SURF); when skydip data are analysed to calculate the atmospheric opacity, this subroutine estimates the error in the fitted opacity. The performance of the subroutine is discussed, based on the M8 map data. The continuum maps are analysed by fitting gaussian profiles to the clumpy structure (on the 0.1 pc scale). Discrepancies between the fitted profiles at different wavelengths suggest that there are very considerable errors in this fitting process. There are a number of possible sources of contamination of the continuum emission, both non-thermal (free-free emission and molecular line emission) and thermal (greybody emission from hotter dust associated with the HII region and PDRs on the surfaces of the clumps). The likely magnitude of contamination from these sources is assessed: Line contamination is likely to be the largest, comprising between 10% and 50% of the detected continuum flux. The greybody emission from PDRs is likely to be in the range 10–20%. The other sources of contamination are unlikely to be larger than the calibration error ($\sim$ 10%).

Partial maps of the Lagoon Nebula were obtained at the JCMT in the J=3-2 transitions of various isotopomers of CO. These data are used to estimate the temperatures of the clumps, and to estimate their densities independently of the continuum emission. Using the gas temperatures to estimate the dust temperatures in the clumps, the mean empirical emissivity index, m, is estimated to be 1.4 ± 0.3. Taking into account the likely effect of molecular line contamination, the underlying dust emissivity index, β, is estimated to be 1.7 ± 0.5.

The clump masses are estimated from continuum fluxes; above about 6 $M_{\odot}$, the clump mass spectrum can be fitted by a power-law: $dN/dM \propto M^{-\alpha}$, where $\alpha \approx 1.66 \pm 0.45$. The power-law index is found using Kolmogorov-Smirnov (KS) statistics, and the confidence interval of the index is estimated by Monte Carlo resampling and KS statistics. This determination is consistent with other studies on similar spatial scales using molecular line tracers, but is not consistent with recent studies at smaller scales using continuum emission as a tracer. This suggests firstly that molecular and continuum determinations of clump mass spectra are in agreement, and secondly that the clump mass spectrum is not spatially scale-free.

The likely evolution of the clumps, exposed to the UV field of massive stars, is discussed according to published analyses of similar structures. The external pressure on the clumps appears to be systematically higher than the internal pressure, suggesting that shock fronts have not yet penetrated the clumps. Despite large uncertainties in the mass estimates, the clumps seem to be gravitationally unstable, but it is not clear whether or not they can collapse before being photoevaporated by the UV field. The clumps are similar in nature to, but probably at an earlier stage of their evolution than, the 'fingers' in the Eagle Nebula; the effects of the UV field may be eventually be sufficient to produce a new stellar generation in these structures.

New Jobs

New Star Formation Postdoctoral Position at CfA

A postdoctoral position is available at the Smithsonian Astrophysical Observatory of the Harvard-Smithsonian Center for Astrophysics for a recent recipient of the Ph.D. degree to work with Dr. Charles J. Lada on an innovative observational program of dark cloud/star formation research. The successful applicant is expected to take a leading role in a major observational study designed to investigate the structure, chemistry and physical conditions in dark clouds using infrared extinction measurements in conjunction with submillimeter/millimeter-wave line and continuum observations. The successful applicant will work with astronomers at the CfA, ESO and the University of Florida to conduct the necessary observations and perform the reduction and analysis of the data.

Applicants should have experience with infrared or optical imaging and/or millimeter/submillimeter-line or continuum observations and analysis. Knowledge of IRAF is desirable. Applicants should also have a record of publication and achievements which have advanced our knowledge of molecular clouds, star formation or related fields. The position is for two years with an extension for a third year possible. The stipend is $42,000 starting in fall 2000. Applicants should submit a curriculum vitae, bibliography and a statement of research interests and should arrange for three letters of reference to be sent to Dr. Charles J. Lada, Smithsonian Astrophysical Observatory, MS 72, 60 Garden Street, Cambridge, MA 02138 USA. Review of applications will begin on 1 April 2000 and continue until the position is filled.

Postdoctoral Research Position

Applications are invited for a postdoctoral research position to work with Dr. Michael D. Smith on developing and undertaking supercomputer simulations of the events occuring during star formation. The aim is to trace the evolution of protostars through magnetohydrodynamic simulations of inflow and outflow, with emphasis on supersonic and hypersonic jets and turbulence. The preferred background is in theoretical astrophysics with experience of large-scale numerical simulations. Some experience in studies of star formation and/or fluid dynamics would be an advantage.

The post is a three year PPARC-funded research position, starting 1 May 2000 or as soon as possible thereafter. Starting salary, depending on age and experience, will be on the University RA1A Scale in the range £17238 to £18185. Further information is available from the address below, by e-mail to mds@star.arm.ac.uk, or at http://www.arm.ac.uk/.

Research interests of Observatory staff include Stellar Astrophysics, Solar System Astronomy, and Solar System – Terrestrial Relationships. The Observatory receives regular awards of telescope time and research grants from the PPARC and other organizations. Computing facilities are excellent and include a local Starlink node and an Origin 2000 supercomputer. Further information about the Armagh Observatory may be obtained by consulting the Observatory web-site at http://www.arm.ac.uk.

The closing date for applications is 15 April 2000. Prospective applicants should obtain an application pack from the Administrator and send this, together with a full curriculum vitae and bibliography, to: The Administrator, Armagh Observatory, College Hill, Armagh BT61 9DG, Northern Ireland, U.K. (Tel: +44-(0)28-3752-2928, FAX: +44-(0)28-3752-7174, e-mail: lfy@star.arm.ac.uk. References from three referees should also reach the Administrator by the same date.

Armagh Observatory is an equal opportunities employer and welcomes applications from candidates irrespective of ethnic origin, religion, gender, political opinion, marital status, sexual orientation, or disability.

Postdoctoral Position in Infrared Studies of Star Formation

Max-Planck-Institute for Radioastronomy
Auf dem Huegel 69
D-53121 Bonn
Germany

Tel: +49-228-525243
Fax: +49-228-525229
E-mail: weigelt@mpifr-bonn.mpg.de

URL: http://www.mpifr-bonn.mpg.de/div/speckle

The Infrared High-Resolution Imaging Group of the Max Planck Institute for Radioastronomy in Bonn invites applications for a postdoctoral position in the field of star formation. The successful applicant is expected to work primarily on the interpretation of high-resolution speckle observations of young stellar objects. Our main interests are the multiplicity of young stars and the disks and outflows of young stellar objects (for details see http://www.mpifr-bonn.mpg.de/div/speckle).

Applicants should have a Ph.D. and observational or theoretical experience in the field of star formation. The appointment is initially for one year, and is renewable for an additional year, possibly two. Interested scientists should send a letter of application with a summary of relevant experience and research interests, a curriculum vitae, a list of publications, and should arrange for two letters of reference to be sent to Prof. Gerd Weigelt at the above address.

Review of applications will begin on 31 March 2000 and continue until the position is filled. The Max Planck Society is an equal opportunity employer.

Postdoctoral Research Associateship in Star Formation or Instrumentation

A National Research Council Postdoctoral Research Associateship position is available in the Astrophysics Branch of NASA's Ames Research Center. Potential research opportunities include conducting IR spectroscopic studies of young stellar/pre-planetary systems and the development of airborne or space-flight IR astronomical instruments. Recent Ph.D. recipients with interests and experience in IR observational studies of young stars, their circumstellar environments, or developing astronomical instrumentation are encouraged to apply. The starting date is flexible but should be in the range 15 July 2000 – 15 July 2001.

Interested persons whose research activities are clearly in any of the above areas should contact Tom Greene at the address below as soon as possible to discuss potential projects and development of research proposals. These proposals are normally iterated with a potential advisor at Ames before submission with the candidate's application. Final applications and research proposals are due to the National Research Council by April 15, 2000. Information on the Ames Space Science Division and Astrophysics Branch is available at the URL http://www-space.arc.nasa.gov and the National Research Council Associateship program is described at http://national-academies.org/rap

For further information please contact:

Tom Greene
NASA / Ames Research Center
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Email: tgreene@mail.arc.nasa.gov

The Formation and Evolution of Young Stellar Clusters

Ten Postdoctoral and Predoctoral Positions Available

Our European Commission Research Training Network on "The Formation and Evolution of Young Stellar Clusters" will commence in June 2000 and run for three years. We now have positions open for seven postdoctoral researchers (one per team) and three predoctoral students (one each at Potsdam, Cambridge, and Cardiff), lasting roughly two and three years respectively. Each of the seven teams in the network will be leading one specific project:

- Astrophysikalisches Institut Potsdam, Germany
  "The spatial, luminosity, and mass distributions of young clusters"
  (Network coordinator: Mark McCaughrean, `mjm@aip.de`)
- Osservatorio Astrofisico di Arcetri, Firenze, Italy
  "Clusters as probes of early stellar evolution"
  (Contact: Daniele Galli, `galli@arcetri.astro.it`)
- Institute of Astronomy, Cambridge, England
  "Building the initial mass function through competitive accretion"
  (Contact: Cathie Clarke, `cclarke@ast.cam.ac.uk`)
- Department of Physics and Astronomy, University of Cardiff, Wales
  "The evolution of disks in dense stellar clusters"
  (Contact: Ant Whitworth, `Anthony.Whitworth@astro.cf.ac.uk`)
- Laboratoire d'Astrophysique de l'Observatoire de Grenoble, France
  "The statistical properties of young binary stars"
  (Contact: Jerôme Bouvier, `Jerome.Bouvier@obs.ujf-grenoble.fr`)
- Observatório Astronómico de Lisboa, Portugal
  "The formation of small stellar systems in isolated cores"
  (Contact: João Lin Yun, `yun@oal.ul.pt`)
- Commissariat à l'Energie Atomique, Direction des Sciences de la Matière, Saclay, France
  "The initial conditions for cluster-mode star formation in dense molecular clouds"
  (Contact: Philippe André, `pandre@discovery.saclay.cea.fr`)

Each project will involve a combination of observational and theoretical work in a web of overlapping collaborations between the teams: a key goal of the network is to broaden the skills of the young researchers through these collaborations and the series of joint workshops and conferences that will be held over the lifetime of the network. The young researchers employed by the network should: be 35 or under at the time of appointment; be a national of an EC member or associated state or have lived in the EC for at least five years before appointment; not be a national of the state in which they would be appointed; and not have lived in that country for more than 12 of the 24 months prior to appointment.

We are now accepting applications for these open positions. For the postdoctoral positions, please send a CV, a full bibliography, the names and contact information for two people familiar with your work, and a cover letter describing your present work and near-term goals. For the predoctoral positions, a CV, cover letter, and the name and contact information for one reference will suffice. In both cases, please make a preliminary choice of one or two teams where you think you would best fit in and most like to work.

Send your application to the network coordinator, Mark McCaughrean, at the address below, for distribution to and joint evaluation by all seven teams. Please also send an email to the coordinator(s) of your chosen team(s), to let them know you are applying. For more details on the network, the specific projects, and additional information, visit the network website and feel free to contact any of the team coordinators directly.

Astrophysikalisches Institut Potsdam, An der Sternwarte 16, D14482 Potsdam, Germany
Phone: +49 331 749 9525; Fax: +49 331 749 9267; Network website: `http://www.aip.de/~mjm/ecrtn_clusters/`

We will begin evaluating applications on April 19th 2000.

PhD position available at the AIP

A PhD position for 3 years is available at the Astrophysical Institute Potsdam, on the outskirts of Berlin in Germany, to work with Dr. Hans Zinnecker on HST NICMOS data of the dense, partially resolved 30 Doradus star cluster in the Large Magellanic Cloud. The project will involve reducing and analysing the infrared images, and making simulations of the images and the corresponding infrared luminosity function, in order understand issues of limiting mass sensitivity and completeness in this crowded region.

To apply, please send a brief summary of your experience and a letter of reference from your undergraduate supervisor to the address given below.

The successful applicant will enjoy a stimulating environment (scientific and otherwise), generous travel money, and a monthly salary equivalent to roughly 1000 Euros. Please do not hesitate to get in contact by phone or email should you have any further questions.

The position is available immediately and applications will be accepted until the deadline of May 1st 2000.

Dr. Hans Zinnecker
Astrophysikalisches Institut Potsdam
An der Sternwarte 16
D-14482 Potsdam, Germany

Email: `hzinnecker@aip.de`
Phone: (49) 331 7499 347
Fax: (49) 331 7499 267
Web: `http://www.aip.de`

Announcement

ALMA Scientific Advisory Committee

The Atacama Large Millimeter Array (ALMA) project has formed a new committee to provide scientific advice to the project and outreach to the wider community. We hold monthly telecons and hold other meetings at regular intervals. The minutes of the telecons and reports from the meetings are placed on the following web site.

http://www.alma.nrao.edu/committees/ASAC/index.html

A list of the committee members can also be found on this web site. Comments or questions can be addressed directly to the individual committee members or to the committee by email via the website. In addition, we are all willing to give colloquia or other presentations on the ALMA project.

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.

ITP Conference on Astrophysical Turbulence

May 8-12, 2000

Coordinators: E. Ostriker and E. Zweibel

It is difficult to exaggerate the importance of turbulence in astrophysics, or the challenges that it poses. Turbulence is responsible for dynamical pressure support, energy and angular momentum transport, chemical mixing, and magnetic field generation and evolution in a host of astrophysical settings, including stars, accretion disks, the interstellar medium, and the solar wind. Turbulent astrophysical flows differ from terrestrial forms of turbulence which have been studied traditionally by virtue of their inherent compressibility, strong radiative cooling, self-gravity, and the importance in many environments of magnetic fields. In this workshop we focus on turbulent processes in a variety of settings. The mornings will be in the usual conference format, with a program of invited talks, and the afternoons will be organized into discussion sections, including short contributions.

Confirmed speakers include: Jonathan Arons, Steven Balbus, Sarbani Basu, Nicolas Brummell, Benjamin Chandran, Stephen Childress, William Coles, James Cordes, Steven Cowley, Julian Elliott, George Field, Peter Gilman, Jeremy Goodman, John Hawley, Russell Kulsrud, Dana Longcope, Phillip Myers, Eve Ostriker, Alan Title, Steven Tobias, Juri Toomre, and Jean-Paul Zahn.

For further information about the scientific aspects of the conference, please contact:

E. Ostriker (ostriker@astro.umd.edu) or E. Zweibel (zweibel@lepton.colorado.edu).

For logistic details, please contact Dorene Sexton Iverson (dorene@itp.ucsb.edu).

Attendance at the conference is limited. Registration can be filled out on the ITP web site. See

http://www.itp.ucsb.edu/conference/Astro-Reg.html

Deadline for Registration is April 15, 2000

The Star Formation Newsletter is a vehicle for fast distribution of information of interest for astronomers working on galactic (incl. LMC/SMC) 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 *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/ .