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Abstracts of recently accepted papers

Formal Results Regarding Metric-Space Techniques for the Study of Astrophysical Maps

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We extend a newly developed formal system for the description of astrophysical maps. In this formalism, we consider the difference between maps to be the distance between elements of a pseudometric space (the space of all such maps). This ansatz allows us to measure quantitatively the difference between any two maps and to order the space of all maps. For each physical characteristic of interest, this technique assigns an “output” function to each map; the difference between the maps is then determined from the difference between their corresponding output functions. In this present study, we show that the results of this procedure are invariant under a class of transformations of the maps and the domains of the maps. In addition, we study the propagation of errors (observational uncertainties) through this formalism. We show that the uncertainties in the output functions can be controlled provided that the signal to noise ratios in the original astrophysical maps are sufficiently high. The results of this paper thus increase the effectiveness of this formal system for the description, classification, and analysis of astrophysical maps.

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Widespread water vapor emission in Orion

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We have discovered spatially extended emission in the 3(13)-2(20) line of water vapor in Orion. The mapped region is 160" x 240" wide. Many strong narrow features with flux density (1- 15) 10³ Jy have been detected around OriA-Irc2. These features appear over a weaker (10³ Jy) high velocity plateau whose half power size is 45", and its total extent is 80" x 80". Narrow lines with intensities 25- 200 Jy (i.e. much stronger than the expected contribution from the secondary and error beams) are detected at all observed positions outside the central region. These emission lines are not arising from point sources, and different emission regions are well resolved by our 15" beam. This is the first time that widespread water emission has been found in the interstellar medium. From statistical equilibrium calculations for the physical conditions of the Orion molecular cloud, we conclude that the observed emission is dominantly maser in nature. This is the first observation of spatially extended maser emission resolved by a single-dish telescope. The water abundance is estimated to be larger than 5 x 10⁻⁵, which confirms chemistry expectations that water vapor is a substantial component of the gas phase in warm molecular clouds, and one of the most important gas coolants.

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High Velocity Sulfur Monoxide Emission from Protostellar Outflows

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We have mapped the $J_N = 2_3 - 1_2$, $3_2 - 2_1$ and $6_5 - 5_4$ transitions of SO and the J=6-5 transition of SiO in nine regions containing protostellar molecular outflows. We find that, in general, the spatial pattern of the SO emission and shape of the line profiles are different for each transition. In the quiescent gas, the SO emission is widespread in the ambient clouds, but $2_3 - 1_2$ and $3_2 - 2_1$ emission is relatively weak in the warm, dense cores around the young stars, while the $6_5 - 5_4$ emission is found to be strongest in the cores. In the outflowing gas, the SO $6_5 - 5_4$ line is detected towards the outer parts of the CO lobes and shows high velocity (HV: $5\text{-}32 \text{ km s}^{-1}$) wings, while SO $3_2 - 2_1$ and $2_3 - 1_2$ emission is not detected. SiO J=6-5 shows similar HV emission to SO $6_5 - 5_4$, but little emission from the quiescent gas. In general, SO and SiO emission from the outflow does not resemble maps or line profiles of CO, CS, NH₃ or HCO⁺.

These results give further support that lines of SO and SiO can be very useful as specific tracers of shocked gas in outflows. The observations presented here are not easily explained with the current shock models.

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A postscript version of the paper can be obtained by anonymous ftp at cfa0.harvard.edu in */ftp/incoming/masson*.

Observation of [C I] toward the GL 2591 and W28 A2 Molecular Outflows

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Molecular outflows associated with GL 2591 and W28 A2 were observed in the 492 GHz [C I] line. Upper limits are set on the [C I] emission in the extremely high velocity line wings. These limits are discussed in terms of wind-driven and jet-driven models of molecular outflows.

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Do Star Forming Regions Have Different Binary Fractions?

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Two of the major contending theories for binary and multiple star formation are fragmentation driven by rotation during cloud collapse and gravitational instability of massive protostellar disks. Implicit in the literature on these two mechanisms is that the parameter space available for binary formation in a star forming region varies with the cloud temperature. The sense of the difference is that binary formation is more likely in low-temperature clouds. Observations of cloud conditions and of binary fractions among young stellar objects are approaching the necessary level of detail to test this prediction; and there are hints in recent observations that such differences exist.

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Optical nebulosities associated with IRAS sources in dense cloud cores

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I, H α and [SII] CCD images of the region around 4 young IRAS sources embedded in the dense molecular cloud cores CB 6, CB 39, AFGL 5142, and L 1251 are presented. Reflection nebulosities are found in all 4 regions. Herbig-Haro objects are detected in AFGL 5142 and L 1251. In both cases, the HH objects are new discoveries.

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S 269-IRS2: A massive young stellar object powering Herbig-Haro emission

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Near-IR images of S 269-IRS2 indicate that the young source is double with a projected separation of 4.1'' (2.45 10¹⁷ cm) at a position angle of 90°. The near-IR colours of both sources denote an infrared excess and, therefore, their very young nature. The western source, IRS2w, is the reddest one and is only detected at $\lambda \geq 2 \mu\text{m}$. We believe that IRS2w is associated with the young IRAS source 06117+1350 and with the H₂O and OH masers detected in the region. The total integrated infrared luminosity is 7.1 10⁴ L_⊙. Optical CCD images reveal a pure emission line condensation close to IRS2 and projected against the S 269 HII region. These images and spectroscopic data demonstrate that this condensation is shock excited. The condensation, designated HH 191, is to our knowledge the most distant HH object detected so far. It presents blueshifted radial velocities up to about 400 km/s with respect to the underlying HII region. PV diagrams and integrated line profiles from HH 191 suggest that the HH object is generated in a bow shock. Using published bow shock models we estimate a shock velocity of about 570 km/s. HH 191 is probably powered by the high luminosity object IRS2w. All the characteristics of the IRS2w/HH 191 system make it one of the extremest cases known among the HH objects and their exciting sources.

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Structure and Proper Motions in Herbig-Haro Objects 1 and 2

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We have carried out a detailed study on the structure and proper motions of the condensations in Herbig-Haro (HH) objects 1 and 2 and other HH objects in their immediate neighbourhood.

The presented proper motions are compatible with HH 1 being a bow shock, which is propagating into a moving medium ahead of it. They also reveal a very complex kinematical structure in HH 2. Proper motions for the nearby HH objects HH 144, HH 145 and the newly discovered HH 147 are presented and the probable outflow sources for HH 144 and HH 147 are identified. Tangential velocities in the range of 100 – 250 km s⁻¹ were measured for the condensations in HH 2, HH 144, and HH 147, while velocities of up to 380 km s⁻¹ were found in the HH 1 bow shock and in the jet pointing from the VLA1 source towards HH 1 (VLA1 jet). These outflows appear not to be well aligned with respect to each other, nor with the local cloud magnetic field.

Linear correlations between tangential velocities and excitation and radial velocity dispersion, respectively, were found for condensations in HH 1 and 2. Surprisingly an anti-correlation between tangential velocity and radial velocity dispersion was found in the VLA1 jet.

A deconvolved [SII] image of HH 1 (FWHM = 0."55) shows a wealth of structural details in the bow shock and (just) resolves the knots in the VLA1 jet, whose diameter could be measured. The deconvolved [SII] image, as well as an H α image and the low tangential velocity suggest, that knot G_J might consist of two closely spaced components, one of which is excited by the entrainment of ambient material into the VLA1 jet.

Photometric monitoring between 1987 and 1993 shows that many of the brighter condensation in HH 1 and 2 were variable in the [SII] $\lambda\lambda$ 6716, 6731 lines. Most notable are the brightening of HH 2H by about 25%, the fading of HH 2C and G by about 20% and the strong variability of 10 - 30% within only six years found for HH 1G, HH 2A', B, D and G.

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The Luminosity Functions of Embedded Stellar Clusters: I. Method of Solution and Analytic Results

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We describe a method for computing the history of the luminosity function in a young cluster still forming within a molecular cloud complex. Our method, which utilizes detailed results from stellar evolution theory, assumes that clusters arise from the continuous collapse of dense cloud cores over a protracted period of time. It is also assumed that stars reaching the main sequence are distributed in mass according to a prescribed Initial Mass Function (IMF). We keep track separately of the contributions to the luminosity function from the populations of protostars, pre-main-sequence, and main-sequence stars.

We derive expressions for the fractional contribution of these populations to both the total number of stars produced and to the total cluster luminosity. In our model, the number of protostars rises quickly at first, but then levels off to a nearly constant value, which it maintains until the dispersal of the cloud complex. The number fraction of protostars always decreases with time. Averaged over the life of the parent complex, this fraction is typically a few percent. The protostar mass distribution can be expressed as an integral over the IMF.

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The Luminosity Functions of Embedded Stellar Clusters: II. Numerical Results

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We use the theory developed previously to calculate the evolving luminosity functions of very young stellar clusters. The luminosity function of the protostars alone quickly attains a characteristic, sharply peaked shape, which it maintains throughout the time of cluster formation. For the pre-main-sequence stars, the function continually changes, but displays a pronounced "step" near a luminosity of $10 L_{\odot}$ for a prolonged period. At most times, the vast majority of cluster members are pre-main-sequence stars. However the total cluster luminosity is dominated first by the protostellar and later by the main-sequence component. At these late times, it is the brightest stars which reach the main sequence first. Finally, a preliminary application of our model to the ρ Ophiuchus embedded cluster indicates that star formation has proceeded in that region for 1×10^6 yr.

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Near-Infrared Spectroscopy and Imaging of Herbig-Haro Objects

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The results of a near-infrared study of the Herbig-Haro objects HH 43, HH 54, HH 56, HH 99A, HH 106, and HH 120 are presented. The H- and K-band spectra show molecular hydrogen emission that arises from vibrational levels $v' \leq 3$. The inferred population distribution is thermal in all objects, and can be well described by single excitation temperatures ranging from 2000–2700 K. Non-thermal excitation scenarios, such as fluorescence or H₂ formation in excited levels, or excitations in an UV or X-ray heated gas, are not observed. Emission from [FeII] is present towards all objects. Near-infrared images were obtained towards HH 43, HH 54, and HH 120. The morphology of the H₂ and [FeII] emission is similar on large scales but differs in the detail. The H₂ and [FeII] observations are difficult to reconcile with the predictions of C-type shock models. They indicate the presence of multiple, or curved J-shocks, where [FeII] arises in the faster, dissociative sections, and where H₂ arises in the slow, non-dissociative parts of the shocks.

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The Magnetic Field in the Dense Gas Bordering W3(OH)

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We report the detection of a 3.1 ± 0.4 mG magnetic field in the dense crescent of gas bordering the W3(OH) compact H II region. The Zeeman splitting in the highly excited ${}^2\Pi_{3/2}$ $J=7/2$ $F=3^+-3^-$ transition of OH was observed, in absorption against the radio continuum, with the MPIFR 100-m telescope. The derived field strength is, by far, the strongest ever reported from thermally excited, i.e., non-masing gas; it compares with the average field derived from the cluster of OH maser spots, thought to arise from within the same dense layer of gas. A quantitative analysis reveals that magnetic pressure dominates the clump energetics by nearly an order of magnitude over other processes. A possible scenario is discussed in terms of a bow-shock model, in which the magnetic field is compressed in the cooled post-shock layer preceding the compact H II region.

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The Stellar Population of the Lupus Clouds

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We present photometric and spectroscopic observations of the H α emission stars in the Lupus dark cloud complex. We estimate the effective temperatures of the stars from their spectral types and calculate the reddening towards each object from the (R–I) colors. From these data, we derive mass and age distributions for the Lupus stars using a new set of pre-main sequence evolutionary tracks. We compare the results for the Lupus stars with those for a similar population of young stellar objects in Taurus-Auriga and Chamaeleon and with the initial mass function for field stars in the solar neighborhood. From the H-R diagrams, Lupus appears to contain older stars than Taurus. The Lupus dark clouds form a greater proportion of low mass stars than the Taurus complex. Also, the proportion of low mass stars in Lupus is higher than that predicted by the Miller-Scalo initial mass function, and the lowest mass stars in Lupus are less active than similar T Tauri stars in other regions.

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Nonaxisymmetric Evolution in Protostellar Disks

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We present a two-dimensional, multi-gridded hydrodynamical simulation of the collapse of an axisymmetric rotating $1 M_{\odot}$ protostellar cloud, which forms a resolved hydrostatic disk. The code includes the effects of physical viscosity, radiative transfer, and radiative acceleration but not magnetic fields. We examine how the disk is affected by the inclusion of turbulent viscosity by comparing a viscous simulation with an inviscid model evolved from the same initial conditions, and we derive a disk evolutionary timescale on the order of 300,000 years if the viscosity parameter $\alpha = 0.01$. Effects arising from non-axisymmetric gravitational instabilities in the protostellar disk are followed with a 3-D SPH code, starting from the 2-D structure. We find that the disk is prone to a series of spiral instabilities with primary azimuthal mode numbers $m = 1$ and $m = 2$. The torques induced by these non-axisymmetric structures elicit material transport of angular momentum and mass through the disk, re-adjusting the surface density profile toward more stable configurations. We present a series of analyses which characterize both the development and the likely source of the instabilities. We speculate that an evolving disk which maintains a minimum Toomre Q value of approximately 1.4 will have a total evolutionary span of several times 10^5 years, comparable to but somewhat shorter than the evolutionary timescale arising from viscous turbulence alone. We compare the evolution resulting from nonaxisymmetric instabilities with solutions of a one-dimensional viscous diffusion equation applied to the initial surface density and temperature profile. We find that $\alpha = 0.03$ is a good fit to the results of the simulation. However, the effective α will depend on the minimum Q in the disk at the time the instability is activated. We argue that the major fraction of the transport characterized by the value of α is due to the action of gravitational torques, and does not arise from inherent viscosity within the SPH method.

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Fragmentation of a Magnetized Filamentary Molecular Cloud Rotating around its Axis

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The dynamical instability of a self-gravitating magnetized filamentary cloud was investigated while taking account of rotation around its axis. The filamentary cloud of our model is supported against self-gravity in part by both a magnetic field and rotation. The density distribution in equilibrium was assumed to be a function of the radial distance from the axis, $\rho_0(r) = \rho_c (1 + r^2/8H^2)^{-2}$, where ρ_c and H are model parameters specifying the density on the axis and the length scale, respectively; the magnetic field was assumed to have both longitudinal (z -) and azimuthal (φ -) components with a strength of $B_0(r) \propto \sqrt{\rho_0(r)}$. The rotation velocity was assumed to be $v_{0\varphi} = \Omega_c r (1 + r^2/8H^2)^{-1/2}$. We obtained the growth rate and eigenfunction numerically for (1) axisymmetric ($m = 0$) perturbations imposed on a rotating cloud with a longitudinal magnetic field, (2) non-axisymmetric ($m = 1$) perturbations imposed on a rotating cloud with a longitudinal magnetic field, and (3) axisymmetric perturbations imposed on a rotating cloud with a helical magnetic field. The fastest growing perturbation is an axisymmetric one for all of the model clouds studied. Its wavelength is $\lambda_{\max} \leq 11.14 H$ for a non-rotating cloud without a magnetic field, and is shorter when the magnetic field is stronger and/or the rotation is faster. For a rotating cloud without a magnetic field the most unstable axisymmetric mode is excited mainly by self-gravity (the Jeans instability), while the unstable non-axisymmetric mode is excited mainly by non-uniform rotation (the Kelvin-Helmholtz instability). The unstable non-axisymmetric perturbation corotates with a fluid at $r = 2 - 4 H$ and grows in time. When the equilibrium magnetic field is helical, the unstable perturbation grows in time and propagates along the axis. A rotating cloud with a helical magnetic field is less unstable than that with a longitudinal magnetic field.

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Molecular Hydrogen and Excitation in the HH 1 -2 System

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We present a series of molecular hydrogen images of the Herbig-Haro 1 - 2 system in the 1 - 0 S(1) transition at 2.121 μm , with a spatial resolution of $\sim 2''$. The distribution of H_2 is then compared with that of the excitation, given by the [S II] 6717+6731 to $\text{H}\alpha$ line ratio.

We find that most optical condensations in the HH 1 - 2 system, including the VLA 1 jet, have H_2 counterparts. H_2 emission is detected in most low excitation knots, as expected for low velocity shocks ($50 \text{ km s}^{-1} <$), but also in high excitation regions, like in HH 1F and HH 2A'. For these latter objects, the H_2 emission could be due to the interaction of the preionizing flux, produced by 150-200 km s^{-1} shocks, with the surrounding interstellar matter, i.e. fluorescence. The lack fluorescent lines in the UV, however, suggest a different mechanism. H_2 is detected at the tip of the VLA 1 jet, where the knot morphology suggests the presence of a second bow shock. H_2 is detected also SE of HH 2E and SW of HH 1F, in regions with known NH_3 emission.

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H_2O Masers from low and intermediate luminosity YSOs

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We have used the Medicina 32-m radiotelescope to search for H_2O 22.2 GHz maser emission from a sample of 68 red peculiar nebulosities associated with low luminosity ($L_{\text{IR}} < 10^3 L_{\odot}$) and intermediate luminosity ($L_{\text{IR}} \sim 10^4 L_{\odot}$) YSOs. H_2O maser emission was detected in 9 sources, with a new detection in IRAS 18265+0028. Comparison with other samples indicates that YSOs have a higher probability of hosting an H_2O maser, when they are associated with red peculiar nebulosities. Seven of the detected sources are associated with molecular outflows, which confirms that these two phenomena are strictly correlated. The maser sources associated with the Class I YSOs (IRAS 03225+3034, and IRAS 03245+3002, in the dark clouds L1448 and L1455 respectively) appear overluminous with respect to their IR luminosity. The maser emission shows a remarkable variability on time scales of months and years, which tends to be larger for lower luminosity sources. This is indicative of unsaturated emission in low luminosity sources.

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A Quantitative Analysis of IRAS Maps of Molecular Clouds

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We present an analysis of *IRAS* maps of five molecular clouds: Orion, Ophiuchus, Perseus, Taurus, and Lupus. For the classification and description of these astrophysical maps, we use a newly developed technique which considers all maps of a given type to be elements of a pseudometric space. For each physical characteristic of interest, this formal system assigns a distance function (a pseudometric) to the space of all maps; this procedure allows us to measure quantitatively the difference between any two maps and to order the space of all maps. We thus obtain a quantitative classification scheme for molecular clouds. In this present study we use the *IRAS* continuum maps at 100 μm and 60 μm to produce column density (or optical depth) maps for the five molecular cloud regions given above. For this sample of clouds, we compute the “output” functions which measure the distribution of density, the distribution of topological components, the self-gravity, and the filamentary nature of the clouds. The results of this work provide a quantitative description of the structure in these molecular cloud regions. We then order the clouds according to the overall environmental “complexity” of these star forming regions. Finally, we compare our results with the observed populations of young stellar objects in these clouds and discuss the possible environmental effects on the star formation process. Our results are consistent with the recently stated conjecture that more massive stars tend to form in more “complex” environments.

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Dissertation Abstracts

Anatomy of the Gem OB1 Molecular Cloud Complex

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I have conducted an extensive investigation of the global cloud structure of the Gem OB1 molecular cloud complex and the embedded star formation activity using (i) a large scale $^{12}\text{CO}(J=1-0)$ and $^{13}\text{CO}(J=1-0)$ survey covering $\sim 33 \text{ deg}^2$ at $50''$ (0.48 pc) sampling, (ii) a $\text{CS}(J=2-1)$ survey covering $\sim 15,500 \text{ arcmin}^2$ (3000 pc^2) also at $50''$ sampling, (iii) the IRAS catalog of far-infrared point sources, (iv) a $\text{CS}(J=2-1)$ survey of a $4.2' \times 5'$ region around 58 IRAS point sources with colors characteristic of young stellar objects, and (v) a J, H, and K band survey of a $30' \times 45'$ ($17 \text{ pc} \times 26 \text{ pc}$) region. These observations were designed to determine the large scale morphology of the Gem OB1 cloud complex and examine how the structure is related to the current distribution of star forming regions.

The large scale morphology of the molecular gas as determined from the ^{12}CO and ^{13}CO images is dominated by a series of arc and ring-like structures on spatial scales from 1 pc to 40 pc, and possibly as large as 100 pc. Several of these arc-shaped features are associated with optical HII regions, and are morphologically and quantitatively consistent with being swept up molecular gas by either expanding HII regions or stellar winds. Other ring and arc-like structures are not associated with obvious optical counterparts, but possess morphological and kinematic evidence suggesting that they also represent swept up molecular material, perhaps from older star formation events.

The distribution of dense molecular gas was determined by mapping regions with enhanced $^{13}\text{CO}(J=1-0)$ emission in $\text{CS}(J=2-1)$. Thirteen dense cores were found with masses between 40 and $2600 M_{\odot}$. These cores are generally found along the arc shape structures found in the ^{12}CO and ^{13}CO maps, suggesting that these massive cores have formed primarily through the external compression of the molecular gas. The star formation activity in the cores was determined from examination of the IRAS point source catalog. Only one dense core does not contain an IRAS point source within the boundaries of the CS emission or within a couple of arc minutes of the CS core, which indicates that star formation must proceed rapidly after the formation of dense cores, and that dense cores are likely continually formed throughout the lifetime of the cloud complex. The more luminous IRAS sources ($L_{\text{FIR}} \geq 1000 L_{\odot}$) contain an embedded clusters of stars as identified in the near-infrared images, while the more extended optical HII regions do not. It is suggested that these latter regions once had clusters that are no longer optically visible due to cluster dispersal and luminosity evolution as the cluster evolves with time.

These various observations of the molecular gas and star forming regions in the Gem OB1 cloud complex can be understood in a model in which the evolution of the cloud complex and the subsequent formation of massive stars and embedded clusters of stars is dominated by the interactions of massive stars with the ambient molecular gas. As massive stars form and evolve, the stellar winds and expanding HII regions sweep up shells or rings of molecular gas. If the swept up mass is large enough, gravitational instabilities develop in the gas and the molecular gas collapses to form massive dense cores, which quickly forms a cluster of stars. If a sufficiently massive star forms, eventually it too will drive an expanding shell, clear the surrounding molecular material, and become an optical member of the OB association. Thus the formation of high mass stars and the associated clusters in the Gem OB1 complex is "triggered" by the previous generation of massive stars.

Herbig-Haro Catalogue Available

A General Catalogue of Herbig-Haro Objects by Bo Reipurth is now available. The catalogue lists all known HH objects. For each object is given its HH number, previous designations if any, a position, the most probable energy source, and the region and distance. Additionally, extensive notes give a brief description of each object with detailed references to the literature. The catalogue will be updated on an approximately yearly basis. A hypertext version is planned.

The catalogue will not be published in any journal, but is rather published electronically. It is available through anonymous ftp to *ftp.hq.eso.org* under directory */pub/Catalogs/Herbig-Haro*, which contains, in addition to a *readme* file, the three files: *catalogue.tex*, *notes.tex*, *references.tex*. In total 89 pages.

Herbig-Bell Catalog Available in Hypertext

The Herbig-Bell catalog of emission line stars (HBC) is now available in a hypertext version on the University of Massachusetts Astronomy World Wide Web Server. The catalog can be used in the standard manner by scanning the pages using both the horizontal and vertical scrollbars. For ease of use, the catalog has been divided into four sections, as explained in my introduction there. The HBC number and the notes are linked, page 1 to page 2 (for each entry) via the HBC number, and the remarks are linked via the * in the notes column (and inversely back to the star). The references are not directly linked to the pages as there are many references per star and the same references may apply to many stars. The references are individually linked to the abstracts in the ADS abstract server when such abstracts are available. This may allow the reader to assess the value of the reference for his/her purposes. If you know the HBC number of the star, it is much easier to use the form-based access which allows you to specify the columns in which you are interested and returns a formatted page with this information.

We plan to update the references to papers that were in press at the time the catalog was published and add references to the private communications when the work referred to has been published.

We now have on line all of the standard star spectra from the Kleinmann-Hall atlas in the 2 - 2.4 μ region. These are available for examination and file transfer in fits format. In the near future we will make available all of our spectra of standards used for classifying the L1641 and L1495 stars in the 5700 - 9000 A region. We will also supply a set of MK standard in the 1.25 and 1.65 μ region taken with the KPNO FTS spectrometer.

The URL for the home page of our server is:

<http://donald.phast.umass.edu/>

For the HBC:

<http://donald.phast.umass.edu/latex/HBC/HBC.html>

For the spectra:

<http://donald.phast.umass.edu/spectra.html>

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Meetings

Chondrules and the Protoplanetary Disk

Dates: October 13 – 15, 1994

Location: Albuquerque, New Mexico, USA

Organizing Committee: A.P.Boss, P.Cassen, R.H.Hewins, R.H.Jones, A.E.Rubin, E.R.D.Scott, J.T.Wasson

This international topical conference will study the origin of chondrules and refractory inclusions in meteorites and the transient heating events in the protoplanetary disk that may have formed them. It is being held in association with the fiftieth anniversary of the Institute of Meteoritics.

Since the first conference on chondrules in 1982 in Houston, consensus has developed that chondrules and refractory inclusions in chondrites formed in the protoplanetary disk during transient heating events. The goal of this conference is to bring together meteorite researchers, astrophysicists, and astronomers to generate a mutual understanding of the constraints that can be imposed on the nature of these heating events and to develop plausible models for the formation of chondrules and refractory inclusions.

For further information, contact the convener, Dr. Roger Hewins,

before August 25:

at Laboratoire de Minéralogie, Paris, France: phone: 33-1-4079-3533, fax: 33-1-4079-3524, e-mail: meteor@mmhn.fr;

after August 25:

at Rutgers University, NJ, USA: phone: 1-908-932-3232, fax: 1-908-932-3374, e-mail: hewins@zodiac.rutgers.edu

This issue and all past issues of the Star Formation Newsletter are available, each as an individual file in LaTeX format, by anonymous ftp from ecf.hq.eso.org (134.171.11.4) in directory `/pub/star-formation`. The contents of all issues are additionally free-text searchable using WAIS, a publicly available information retrieval package. A file in the above anonymous ftp directory, called `WAIS-FAQ.txt`, provides further details on WAIS. The procedure to follow is also described in a 'readme' file.

The Star Formation Newsletter is also available on the World Wide Web. You can either access it via the ESO Portal (<http://http.hq.eso.org/eso-homepage.html>) or directly in two ways: by issue number (<http://http.hq.eso.org/star-form-newsletter/star-form-list.html>) or via a wais index (wais://http.hq.eso.org:2010/starform).