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Call for Dissertation Abstracts

During the month of January a special issue of the Newsletter will be issued that contains abstracts of Ph.D dissertations completed during 1992. If you have finished your Ph.D. thesis this year, or if you know of someone who has finished it this year within the subjects of galactic star formation processes, associated phenomena and molecular clouds, observationally or theoretically, please contact me to receive a macro specially designed for this purpose. The format will be the same as for the abstracts published in PASP, and each abstract will be given a full page of text. The goal of this effort is two-fold: to provide rapid dissemination of the basic results of the substantial research efforts which a Ph.D. thesis represents, and to help establish contacts between the new Ph.D.'s and institutes with specific interests in hiring post-doc's within certain fields of research. Abstracts which reach the editor before January 20 will be included in the dissertation issue. The normal mailing of newsletters during the first week of each month will not be affected by this extra issue.

Abstracts of recently accepted papers

Detection of Magnetohydrodynamic Shocks in the L1551 Outflow

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We report the results of CO J=1→0 mapping of portions of the blue outflow lobe of L1551 with $\sim 7''$ (N-S) $\times$ $4''$ (E-W) resolution, obtained with the 3-element OVRO millimeter array. Comparison of our interferometer mosaic with lower resolution single-dish data shows that we resolve the strongest single-dish emission regions into filamentary structures, such as are characteristic of shock fronts mapped via their near-infrared H_2 emission in other outflow sources.

We detect a continuous velocity gradient across the brightest filamentary structure in our maps. The projected, deconvolved, FWHM of this feature is 1–2 $\times$ 10^{16} cm, similar to that predicted in theoretical models of C-shocks. Combined with the velocity gradient, this suggests that the emission originates from within a magnetohydrodynamic shck front, possibly resulting from the interaction of a stellar wind with dense, ambient material. In contrast, the discontinuous J-shocks expected in regions with no magnetic field should have a thickness $\leq 10^{15}$ cm, which would be unresolved at our spatial resolution. Based on the shock models of Draine and coworkers, the magnetic field strengths required to account for the structure are in the range 10 to 30 μG. We suggest future high spatial resolution mapping of this feature in its near-infrared CO and H_2 emission, to characterize further the temperature and density structure of the neutral gas within the shock.

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Ammonia and Near-Infrared Observations of Southern Dark Clouds

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The Parkes radio telescope has been used to search a list of small, dense southern dark clouds and Bok globules for ammonia emission at 23.7 GHz. The ammonia observations, together with IRAS data and the cloud's visual appearance, have been used to determine a short list of dark clouds for observation with the infrared imaging system (IRIS) on the Anglo-Australian Telescope, in an attempt to determine the dust density distribution within the clouds. Near-infrared images of a number of the short listed clouds have been obtained with IRIS at *J, H* and K'. Preliminary results are reported for this ammonia survey, together with IRIS images of the strong ammonia source DC 297.7–2.8. Coincident with the dense ammonia core of this object is an IRAS 'core' source, IRAS 11590–6452, and an extremely interesting near-infrared source, which lies on the edge of the error ellipse of the IRAS source.

Accepted by Proc. Astron. Soc. Australia.

An Infrared Imaging Survey of the ρ Oph and R CrA Dark Cloud Cores

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We report on an initial survey of the cores of the Rho Ophiuchus and R Coronae Australis clouds, made with the AAT's new IR array camera, IRIS. No turnover is seen in the initial luminosity function for ρ Oph to the sensitivity limit of the survey. Some implications for the low mass end of the initial mass function are discussed.

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Mid–Infrared Rotational Line Emission from Interstellar Molecular Hydrogen

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We have modeled the line emission from the v=0–0 S(0), S(1), S(2) and S(3), and the v=1–0 and v=2–1 S(1) transitions of molecular hydrogen in clouds exposed to high far–ultraviolet fluxes (*i.e.* photodissociation regions or PDRs) and in shocks. In particular, we have studied the lowest pure rotational H_2 transitions (the 0–0 S(0) and 0–0 S(1) lines), at 28μm and 17μm respectively. We find that, in PDRs, the emission comes from the warm ($T \geq 100\,K$) molecular gas, situated at optical depths $A_v \geq 1$, beyond the hot atomic surface layer of the clouds. For FUV fields, $G_0 = 10^3$ to 10^5 times the average interstellar field, and densities, $n = 10^3$ to $10^7 cm^{-3}$, the typical line intensities are in the range 10^{-6} to 10^{-4} ergs s^{-1} cm^{-2} sr^{-1}. We compare the predictions for the line intensities from both C–type and J–type shock models. For both non-dissociative and dissociative molecular shocks, in the same density range, the line intensities range from 10^{-6} to 10^{-3} ergs s^{-1} cm^{-2} sr^{-1}. In the faster, dissociative shocks ($v_s \geq$ 25–30km/s), the H_2 line emission arises from reformed molecules, downstream of the shock front. Shocked line emission may be detectable from lower velocity shocks (*i.e.* $v_s \approx 5$km/s) than previously observed. Measurements of the relative line ratios may be used to help discriminate between competing models for the shock excitation of molecular gas. Observations of these lines will also provide a powerful probe of the extensive regions of warm molecular gas in the Galaxy. The results are applied to recent observations of the 0–0 S(1) transition in both the PDR and the shocked gas in Orion. The *Infrared Satellite Observatory* (ISO) should detect the v=0–0 low–J transitions in numerous active regions.

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Embedded Star Clusters Associated with Luminous IRAS Point Sources

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A 16 arcmin^2 region toward each of 20 bright IRAS sources in the second and third quadrants of the Galaxy have been imaged at J, H, and K bands and mapped in the CS(J=2–1) transition. The presence of one or two OB stars associated with each of these IRAS sources had been previously inferred from radio continuum observations, and the near–infrared images have revealed that a cluster of stars has formed in at least 19 of the 20 regions. These results strongly suggest that high mass stars almost always form in clusters and not in isolation. The number of observed cluster members brighter than m_H=15.5 mag vary between 15 and 91 stars. The clusters typically have diameters of $\sim$ 0.8 pc and stellar densities of $\sim$ 100 stars pc^{-3}.

Analysis of color–color and color–magnitude diagrams for 5 clusters show that many of the stars have red (J–H) and (H–K) colors. Many of the stars have colors not consistent with reddened main sequence stars and must produce excess emission at near–infrared wavelengths, presumably due to circumstellar disks. Many of the stars in these clusters have colors and absolute magnitudes similar to that of known solar mass T Tauri stars obscured by $\leq$ 10 magnitudes of visual extinction. The brightest stars in the clusters, however, are most consistent with a population of Ae/Be stars. The star formation efficiencies of the molecular clouds are typically $\sim$ 3%, while the star formation efficiencies of the cloud *cores* may be as high as 86%. The spatial relationship between the dense cores and the embedded clusters suggest that the molecular gas is beginning to be dispersed in some of regions, as optically visible sources tend to be associated with fragmented cores. Finally, the core morphology, the stellar colors, and the dynamical time scales for the outflows support the notion that an evolutionary sequence is observed among the clusters.

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The excitation and kinematics of DR21(OH) from observations of CS

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We have mapped the young star formation region DR21(OH) in the J=2–1 and 1–0 transitions of CS and C^{34}S, and we have obtained high signal–to–noise spectra towards the three main continuum sources within the core. We find that the CS emission corresponds closely with the thermal continuum, and that all three continuum sources are well separated in velocity as well as spatially. We suggest that wing emission in the CS lines is associated with an outflow originating from DR21(OH)Main, which also excites the observed CH_3OH masers. Our CS line profiles show clear self–absorption redshifted by about 0.5 kms^{-1} relative to the rest velocity of the cloud. In order to account for this feature, we also suggest that there is residual contraction of the outer, less dense, parts of the cloud. By approximating this cloud structure as two components – a warm background component plus cooler, foreground absorbing gas – we use an LTE model to examine the excitation of the cloud core. We find good agreement between our excitation temperatures and the temperatures derived from dust emission. The advantages and limitations of the model are also discussed.

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Near-infrared imaging of the BN-IRc2 region in Orion with sub-arcsecond resolution

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The BN source has been partially resolved by speckle imagery at 3.6 μm with an angular resolution of 0.2 arcsec. The images, fluxes and additional constraints are consistent with a spherical dust shell of inner diameter 0.1 arcsec, surrounding a hot star. The surrounding region, including the vicinity of IRc2, has been imaged with short expo-

sure/deconvolution methods at several wavelengths, at a resolution of 0.5 arcsec. IRc2 is resolved into four components, and the fluxes of the detected sources were determined at 3.8 and 4 μm. Accurate astrometry of the infrared sources with respect to the SiO maser emission has been obtained. The centroid of the SiO maser is definitely not located at the center of symmetry between lobes A and B, but may correspond with IRc2 component A. Component B may arise in scattering from one lobe of a bipolar flow from source A, but other explanations are still possible. The multiple structure of the IRc2 source, the new limits on the size of the components, and the positional correlations draw into question the previous hypothesis that a single, very luminous source dominates the energetics of the BN-KL nebula.

Accepted by Astrophysical Journal

On the Minimum Length for Magnetic Waves in Molecular Clouds

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The minimum wavelength for the propagation of magnetic waves in molecular clouds is derived, considering both ion-neutral and grain-neutral collisional viscosity. For the Mathis, Rumpl and Nordsieck grain size distribution and an Alfvén speed v_A =1 km s^{-1}, the rate of wave damping from collisions between neutral molecules and charged grains exceeds the damping rate for ion-neutral collisions when the gas density is in the range $\sim 5 \cdot 10^3$ - $4 \cdot 10^{10}$cm^{-3}; the upper limit is where the smallest grains stop gyrating around the field. For the Mathis and Whiffen distribution, which has fewer small grains, the ions always dominate the viscosity because at a high enough density for the total ion cross section to drop below the total grain cross section, the grains stop gyrating around the field. In either case, the molecular gas is strongly coupled to magnetic waves on all scales where the density is less than 10^6 cm^{-3} for $v_A = 1$ km s^{-1} and it is strongly coupled on all scales independent of density if B = constant, which seems likely for small, non-self-gravitating clumps. Such coupling allows the formation of even the smallest observed cloud structures by non-linear hydromagnetic processes.

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The illumination of the GGD30 nebulosity

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An optical polarization map of the GGD30 nebulosity shows that although it shares many of the morphological characteristics of the classical cometary nebulae such as NGC2261/R.Mon it differs in that the stellar-like knot at the head is not the illuminating and exciting source as previously assumed. The knot is reflection nebulosity and the true source, completely hidden from direct view at optical wavelengths, is located some 6″E of the knot.

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Further Studies on the Champagne Phase of GM 24 (IRAS 17136–3617)

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We observed with the VLA the HII region associated with the cometary nebula GM 24 at the 3.6 and 6 cm continuum, the H92α recombination line, and the water maser line. These observations suggest the presence of a "champagne"

flow of ionized gas. We detected two extended radio continuum sources emitting optically thin free-free radiation. The stronger one $\left(\mathrm{S}_\nu(\mathrm{total}) \simeq 4 \mathrm{\ Jy}\right)$ is associated with GM 24, while the weaker one $\left(S_\nu(\mathrm{total}) \simeq 0.1 \mathrm{\ Jy}\right)$, located $\sim 1.'5$ south of GM 24, is related to an optical nebula in the region. The maximum of radio continuum emission coincides with the source IRAS 17136–3617, which is the core of an infrared star cluster. The spectral line data show two velocity components toward GM 24 separated by ~ 10 km s^{-1}. The velocity of the stronger and more compact component is close to the molecular cloud velocity, while its peak of line intensity coincides with the core of the star cluster. The largest H92α line widths ($\Delta V \simeq 46$ km s^{-1}) are also observed toward this position. The second velocity component (the weaker and extended one) is redshifted by ~ 10 km s^{-1} with respect to the velocity of the ambient molecular cloud. We suggest as a possible scenario that this velocity component constitutes emission from the ionized gas which is breaking out of the cloud and expanding away from us. A water maser source, with four velocity components, is located $\sim 15''$ southwest of the peak of the radio continuum emission.

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The spectral variability of DR Tauri

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We present a series of CCD spectra of the very active T Tauri star DR Tau. The amount of veiling of the stellar absorption lines was unusually large and highly variable on timescales as short as a few hours. Inverse P Cygni profiles are visible over a wide range of line excitation: Na I D, Fe II, Hβ, and even He I λ5867. The equivalent widths of the emission and the inverse P Cygni absorption lines are 2 to 10 times larger in the high veiling state. However, the velocity structure of the inverse P Cygni lines is not affected by changes in the amount of veiling. We find a factor of 2-3 difference in the mean temperatures of the veiling continuum source between the most extreme veiling states. If the continuum source is an optically thick spot on the star itself, the projected area was 60% of the star in the "low" ($\mathrm{T} \approx 6000\,\mathrm{K}$) and less than about 30% in the "high" ($\mathrm{T} \geq 12\,000\,\mathrm{K}$) veiling states, respectively. These observations are most easily explained by magnetic accretion models, where an accretion shock is formed by matter falling freely along field lines from the circumstellar disk onto the star.

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Encounters with Protostellar Disks: I. Disk Tilt and the Non-zero Solar Obliquity

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A numerical study has been completed which examines the ability of a stellar encounter to tilt a circumstellar disk with respect to the rotation axis of the central star. A numerical code has been developed and tested which is capable of evolving a mixture of stars and gas in three dimensions. Disk tilt cross sections and rates are estimated from a large database of encounter simulations for a variety of environments.

It is shown that the non-zero obliquity of the Solar System could be the result of an encounter shortly after its formation. For the Orion B clusters as a whole, it is estimated that during a one million year period of time a few percent of the stars will experience an encounter that results in a disk tilt of 7° or greater. For the central regions of NGC 2024 and the Trapezium cluster values of 24% and 39% are obtained, respectively.

These estimates are lower limits and when factors such as subclustering, cluster expansion, and disk sizes are considered, substantially greater tilt rates are possible with the result that the generation of disk tilts by encounters may in fact be common.

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The Physical Structure of Orion-KL on 2500 AU Scales Using the K-Doublet Transitions of Formaldehyde

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The physical characteristics of a molecular cloud which relate most closely to star formation within it occur on the finest spatial scales. Generally, several transitions of a specific molecule must be mapped to securely determine molecular cloud physics. Toward this goal, interferometric observations of the $1_{10} \rightarrow 1_{11}$ and $5_{14} \rightarrow 5_{15}$ transitions of H_2CO have been made toward the Orion–KL molecular cloud. With synthesized beam widths of $5.''1$ (2400 AU) and $7.''6$ (3500 AU), respectively, we identify emission from the "hot core," "compact ridge," and "northern cloud" regions. We also detect $1_{10} \leftarrow 1_{11}$ H_2CO absorption toward the "Orion-S" region. These $1_{10} \rightarrow 1_{11}$ and $5_{14} \rightarrow 5_{15}$ emission measurements have been combined with $6''$ resolution measurements of the $2_{11} \rightarrow 2_{12}$ transition of H_2CO (Mangum *et al.* 1990) in a spherical large velocity gradient model of the H_2CO excitation to derive the H_2 density and H_2CO column density in the hot core, compact ridge, and northern cloud. Typical peak densities lie in the range (3-8) $\times$ 10^5 cm^{-3}, with H_2CO column densities in the range 10^{16}-10^{17} cm^{-2}. Highest spatial densities but lowest column densities occur in the northern cloud, while lowest spatial densities but highest column densities characterize the compact ridge. A critical discussion of H_2CO as a spatial density probe demonstrates that the K–doublet transitions provide an excellent spatial density probe, attaining substantial optical depths only at the highest column densities.

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Young Low Mass Stars in the Vicinity of σ Scorpii

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We examine the region near σ Scorpii, a member of the Sco–Cen OB association, for signs of recent star formation. Although there is some indication in the IRAS Point Source Catalog for a cluster of mid–infrared point sources near σ Sco, we find no evidence for such a cluster under the coadded survey data analysis presented here. A total of 13 candidate young stellar objects are identified over an 80 arcmin x 80 arcmin region centered on σ Sco using the Point Source Catalog and a recent survey for Hα emission–line stars. Near–infrared photometry, improved IRAS fluxes, and optical spectra are used to determine the nature of these candidate young stellar objects. Only four definite young stars are revealed, as well as 1 additional such object that fell just outside of our target region. These stars, all of spectral type K or M, probably formed in the vicinity of the B1 giant star σ Scorpii and represent a sub–sample of the low mass members of the association. Comparison of these results with the field star initial mass function suggests either that the mass function varies on size scales comparable to our survey region or our observations were not sensitive to a large segment of low mass association members.

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Carbon Monoxide and Far-Infrared Observations of the S155-Cepheus B Region

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We present maps of the CO J = 3→2 and ^{13}CO J = 2→1 molecular line and mid- to far-infrared continuum emission of the interface between the Cepheus B molecular cloud and the S155 HII region. Far-infrared dust colour temperature and optical depth maps show the molecular cloud to be externally heated and that the edge of the cloud is compressed by the expansion of S155. The data are compared with current models, and various dust grain parameters are derived. A *hotspot* is observed in the CO J = 3→2 emission line, at a position coincident with the radio continuum and infrared

emission peaks. The infrared, radio continuum and molecular line emission from the hotspot are all consistent with it being a compact HII region, ionized by an embedded B1-B0.5 star. The position of the compact HII region, adjacent to the northwestern edge of Cep B, suggests it is the product of a phase of sequential OB star formation, which has already been responsible for the youngest subgroup of the Cepheus OB3 association. The mass of the cloud is estimated to be $\sim$100-200$M_\odot$.

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Infrared Studies of Circumstellar Matter around Herbig Ae/Be and Related Stars

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High spatial-resolution data at 50 and 100 μm are presented for seven young, intermediate-mass stars with flat or rising spectral energy distributions. Five objects have been resolved in at least one direction at 100 μm and two were resolved at 50 μm. The far infrared emission from resolved sources comes from extended envelopes whose size varies between 5x10^3 AU and 8x10^4 AU. In most cases, the intensity profiles do not show large departures from spherical symmetry.

For the five resolved stars, we model the observations as emission from dust in an envelope, heated by a central source. The combination of the size information and the spectral energy distributions demonstrates that the central source spectra must be considerably redder than those of the stars. While several possible explanations exist, we adopt a model for the central source composed of a star and a circumstellar disk. By comparing the predictions of radiation transfer models to the observations (the far infrared scans and the spectral energy distribution from visual to millimeter wavelengths), it is possible to separate the contribution of the star, the disk, and the envelope, and to investigate their physical properties.

The derived density profiles of the envelopes show that in two cases the dust has a steep density profile ($n \sim r^{-\alpha}$, $\alpha \sim$2), while in three other objects the dust must be distributed with rather shallow gradients ($\alpha \sim$0.5). Thus, our sample of five Herbig AeBe stars, all surrounded by a significant amount of matter, includes objects that are probably still in an accretion phase, and objects that are not. It is at present unclear if this results from the action of the star/disk system on the environment, or if it reflects a difference in the pristine physical conditions before the star formed.

Circumstellar disks with temperatures given by $T \propto r^{-0.5}$ provide a good explanation for the spectral energy distributions in the mid-infrared. However, the excess luminosity at near infrared wavelengths, if interpreted as due to viscous dissipation, implies implausibly high mass accretion rates. A resolution to the problem of the origin of the excess luminosity and the role of accretion in PMS evolution awaits more accurate determinations of the *stellar* luminosities. Alternative explanations, such as several, independent dust structures near the star or of a component of small grains and PAHs, are in principle possible.

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Magnetic Nonthermal Activity in the T Tauri System

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The pre-main sequence binary T Tauri was observed in 1991 September using a simultaneous combination of the Very Large Array (VLA) and a four-antenna Very Long Baseline Interferometry (VLBI) array operating at λ18 cm. Strong circular polarization (25 to 30%) was detected in the VLA measurements, and there was evidence for variations in both circular polarization V and total intensity I on time scales of one hour. VLBI measurements of T Tauri taken in parallel failed to detect any compact flux density, despite having sufficient sensitivity to measure fringe visibilities as faint as 15% of the total flux density from the source. If the radiation from T Tau resembles that from other stellar radio sources in circular polarization fraction π, the VLBI measurements imply a lower limit on the size of unpolarized

radiation of $\sim$ 1 AU or 70 stellar radii.

The circular polarization and rapid flux variations indicate a significant nonthermal contribution in the radio emission from T Tau, previously thought to be solely thermal free-free radiation from stellar winds or inflows. Reanalysis of high-resolution 1983 VLA data implicates the protostar T Tau(S) as the probable source of the circular polarization. It thus appears to be the first protostar system to show nonthermal radio activity, previously documented to be present around 'weak' T Tauri stars (e.g. Phillips, Lonsdale and Feigelson 1991; hereafter PLF).

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Centrifugally Driven Winds from Protostellar Disks. I. Wind Model and Thermal Structure

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I discuss the thermal structure of a wind that is centrifugally driven from the surface of a protostellar disk. A generalized version of the Blandford & Payne self-similar wind model is introduced, and the temperature and ionization distributions in the outflow are investigated. Focusing on the evolution of atomic winds, the heat equation and the rate equations that describe the ionization and excitation state of hydrogen are solved self-consistently. I find that ambipolar diffusion is a robust mechanism for heating the gas. The heating rate is a sensitive function of the ionization fraction in the gas, and a strong feedback mechanism exists between the gas temperature and the gas ionization state. As a result of this, temperatures of the order of 10^4 K and ionization fractions $\sim 0.1 - 1$ are established at distances of $\sim 10^2$–10^3 a.u. from the central star. The Balmer-continuum photoionization of hydrogen atoms is of little importance in these outflows, but the UV radiation field generated in the accretion process is strong enough to ionize Na I and C I, providing good coupling between the neutral and the charged components at the base of the flow. In the more powerful outflows, molecular hydrogen is collisionally dissociated close to the disk surface and hydrogen is mainly atomic within a few a.u. from the central source. I also demonstrate that these outflows have enough momentum to lift dust grains from the disk surface. The implications of these findings to the line and continuum emission properties of T Tauri stars are discussed in the subsequent papers of this series.

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Centrifugally Driven Winds from Protostellar Disks. II. Forbidden Line Emission in T Tauri Stars

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I calculate the forbidden line emission from a radially self-similar wind that is driven centrifugally by a large-scale magnetic field from the surface of a weakly ionized, Keplerian disk. The wind is heated by ambipolar diffusion, and its thermal structure is computed self-consistently. I apply this model to the interpretation of the forbidden line emission in T Tauri stars, and make detailed comparisons with the observations. The model successfully accounts for the observed line luminosities and explains the observed correlation between the [S II]λ6731 and the [O I]λ6300 luminosities in terms of the mass outflow rate and the ratio of the mass accretion and the mass outflow rates. Observables that are more geometry-dependent, such as the line profiles and the [S II]λ6731/[S II]λ6717 line ratios, are reproduced less successfully (owing to the assumed self-similarity), but give useful constraints on the underlying wind geometry and density stratification. I also show that, in the context of this model, the line emission originates in a region with a smaller obscuration than that deduced for the central object, indicating that reddening corrections based on the extinction to the central star may lead to overestimates of the line luminosities.

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The nature of the optical nebulosity surrounding the star RNO 91 in the L43 dark cloud

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Polarization maps of the L43/RNO 91 nebulosity show that it is a large scale reflection nebula illuminated by the T Tauri star RNO 91. The highly structured nebulosity within 40arcsec of the central illuminator, which includes knots and a possible jet, is also seen solely by reflected light and we have no evidence for the presence of emission-line features such as Herbig-Haro objects and stellar jets. We find evidence for a small scale circumstellar disc of diameter no larger than 1200AU and possibly as small as 160AU, or even less, which we believe has collimated the outflow leading to the visible nebula. We conjecture on the cause of the lack of alignment between the optical and molecular features.

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Detection of a Gaseous Circumstellar Disk Associated with GG Tau

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We report detection of double-peaked ^{12}CO (1-0) emission (Δv_{FWHM} = 2.4 km s^{-1}) centered on the young (t $\approx$ 3 Myr) T Tauri star, GG Tau. The line profile can be modeled successfully by assuming that CO emission arises in an extended circumstellar disk, with half the emission arising inside a radius, r_0, where $400 < r_0 < 600$ AU (depending on the inclination of the GG Tau star/disk system to the line of sight). Our detection of ^{12}CO combined with our inability to measure C^{18}O bounds the observed gas mass between $2 \times 10^{-5} < M_{gas}/M_\odot < 1.1 \times 10^{-3}$. However, an arbitrarily large amount of mass could reside within a small (r $\gg$ 200 AU), optically thick region and would escape detection owing to beam dilution effects. Comparison of our estimated gas mass with the dust mass estimated from recent mm-continuum measurements over a region comparable to our 15" beam yields a gas/dust ratio on the order of 10 to 100 times smaller than the interstellar value. Either (1) the gas/dust ratio is abnormally low in the outer disk, or (2) CO may no longer accurately trace the gas mass, either because it is dissociated, frozen onto grains, or because carbon is locked up in more complex molecules. Observations of CS (2-1) obtained simultaneously with our ^{12}CO measurements show no evidence of emission in excess of T_A = 32 mK (1σ). Our derived upper limit to the CS emission implies a ratio N(CS)/N(CO) either comparable to its interstellar value in the event that ^{12}CO emission is optically thin, or smaller by a factor of $\approx$10, if we adopt the upper limit to ^{12}CO optical depth derived from our C^{18}O upper limit.

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Circumstellar Molecular Gas of the HH 34 and HH 111 Exciting Stars

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The HH 34 and HH 111 exciting stars, two pre-main sequence objects which are the sources of highly collimated optical jets, have been observed in the J= 1-0 transition of ^{13}CO and in the 2.7 millimeter continuum using the Owens Valley Radio Observatory Millimeter Interferometer. The high resolution aperture synthesis maps reveal dense molecular gas concentrations at the positions of both stars. The morphology and kinematics of the bright emission line cores suggest that the molecular gas is distributed in circumstellar disks, each about 2000 AU in diameter, elongated perpendicular to each system's outflow axis. A fainter component of ^{13}CO emission extends along each source's outflow

axis. Independent mass determinations based on the dust continuum and molecular line fluxes indicate for HH 34, a disk mass of 0.2 $M_\odot$; and for HH 111, a disk mass of 0.3 $M_\odot$. The inferred circumstellar disks of these two jet sources are significantly more massive than those found associated with T Tauri stars, and are therefore among the most massive disks known in association with low-mass pre-main sequence stars.

Accepted by Astrophysical Journal

Molecular Cloud Cores in the Orion A Cloud. I. Nobeyama CS (1–0) Survey

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A first high-resolution survey of molecular cloud cores in the Orion A giant molecular cloud is reported. We identified 125 molecular cloud cores from an analysis of the spatial and velocity distribution of the CS (1–0) emission. The cores are generally elongated along the filamentary molecular cloud, and the axial ratio is about 0.5. The mass spectrum index of the cores is –1.6 for $M \geq 50\ M_\odot$. The physical properties of the cores identified in Orion are compared with those of cores in dark clouds reported in the literature. The average radius of the cores in the Orion A cloud, 0.16 pc, is comparable to that of the cores in dark clouds. In contrast, the Orion A cloud contains molecular cloud cores with large line widths (1–2 km s^{-1} FWHM) and large masses ($M > 100\ M_\odot$), which are rarely observed in dark clouds. We suggest that the line width-radius relation differs between these two samples. Within the Orion A cloud the CS line width, core mass, average density, and core-to-core velocity dispersion all decrease toward the south. These trends can be seen, even when the cores with young stellar objects are excluded from the sample. We discuss the implications of the line width-radius relation, and suggest that cores in giant molecular clouds are bounded by higher external pressure, which eventually leads to massive star formation.

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Detection of the 2165 cm^{-1} (4.619 μm) XCN Band In the Spectrum of L1551 IRS 5

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We report the detection of a broad absorption band at 2165 cm^{-1} (4.619 μm) in the spectrum of L1551 IRS 5. New laboratory results over the 2200 - 2100 cm^{-1} wavenumber interval (4.55 - 4.76 μm), performed with realistic interstellar ice analogs, suggest that this feature is due to a CN-containing compound. We will refer to this compound as XCN. We also confirm the presence of frozen CO (both in non-polar and polar matricies) through absorption bands at 2140 cm^{-1} (4.67 μm) and 2135 cm^{-1} (4.68 μm). The relative abundance of solid state CO to frozen H_2O is $\sim$ 0.13 while the abundance of XCN seems comparable to that of frozen CO.

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Near-Infrared, Polarimetric Imaging of the Bipolar Lobes of GSS 30: Protostellar Infall and/or Outflow?

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We present 1.65 (H) and 2.2 (K) μm polarimetric images of the bipolar, reflection nebula GSS 30 (= El 21). The morphology of the polar lobes is consistent with that expected for protostellar infall and/or outflow. The absence of a confirmed molecular outflow suggests that either the dust to gas ratio in this outflow is unusually large or that GSS 30 is the collapsing envelope of GSS 30 - IRS 1, possibly surrounding a nascent outflow. The polarization maps suggest the scattering optical depth is larger along the limbs and the neck of the nebula than along the polar axis. Some polarization vectors along the presumed disk plane are perpendicular to the disk plane, indicating these maps have sufficient spatial resolution to resolve the disk. The pattern of polarization and the relative sizes of the lobes also suggest that the northern lobe is tilted toward the Earth. The detailed, arcsecond scale structure in the slopes of the $\log I(b)$ *vs.* $\log b$ profiles reveals significant spatial variability in the column densities of scattering material. We estimate the dust mass of the lobes is $\sim 2 \times 10^{-3}\ M_{\odot}$.

If the lobes are interpreted as cavities formed by polar outflows, the spatial variations in the $\log I(b)$ *vs.* $\log b$ profiles would suggest the outflow is characterized by temporal variability in either mass loss rate or outflow velocity on timescales of less than several hundred years. Alternatively, these variations may indicate the onset of turbulent mixing as the outflow encounters intracloud material. The high column densities and shallow radial density gradients in the more distant parts of the southern lobe may indicate that this material is also confined by an external barrier, perhaps the bipolar outflow from VLA 1623−243. The size of the polar lobes suggest that the age of the bipolar nebula, when interpreted as an outflow, is probably much less than $\sim$ 12,000 years.

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Evidence for Protostellar Collapse in B335

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We have observed five rotational transitions of H_2CO and CS toward the Bok globule, B335, with high spatial and spectral resolution. The characteristic shape of the observed profiles provides direct, kinematic evidence for collapse. In addition, we have modeled line profiles of collapsing dense cores with density and velocity structures taken from the theory of Shu and coworkers. Using the age of collapse as the only free parameter, we found that the strengths and profiles of the observed lines can be well fitted by the theoretical model. Our best-fit model gives an age of 1.5×10^5 yr, corresponding to an infall radius of 0.04 pc ($30''$) and a total mass of 0.4 $M_{\odot}$ for the central star and disk. Outside the infall radius, there is a static envelope with a r^{-2} density distribution, an average temperature of 13 K, and a turbulent velocity (1/e width) of 0.12 km s^{-1}. The CS abundance is 3.6×10^{-9} with about 30% uncertainty.

Accepted by Astrophys. J.

New Jobs

POST-DOCTORAL FELLOWSHIP IN ASTRONOMY

The Max-Planck-Institut f. Astronomie (MPIA) in Heidelberg, Germany is offering post-doctoral fellowships in astronomy starting in early 1993. Each fellowship is for one year with the likely extension to two years. The successful candidates will be expected to carry out programs of observational research in astronomy with emphasis on outflows from young stellar objects by making use of the exciting possibilities offered by the now much larger and better infrared imaging devices and infrared spectrographs. They are expected to carry out their research in collaboration with Dr. Reinhard Mundt and Prof. Steven Beckwith. The MPIA is currently building an infrared camera based on a 256x256 NICMOS3 array, which should be in use starting spring of 1993 on the 2.2 m or 3.5 m telescope of Calar Alto Observatory in Spain, where relatively large amounts of observing time per astronomer are available. The MPIA owns and runs this observatory, which has a total of four telescopes. Within the next year the MPIA hopes to have access to UKIRT with all it excellent infrared instrumentation and in addition the MPIA has 3 months per year observing time at the ESO/MPI 2.2 m telescope on La Silla (Chile) where the new ESO infrared camera IRAC2 can be used (based also on a 256x256 NICMOS3 array). All other ESO facilities on La Silla and the IRAM facilities (30 m telescope in Spain and the mm-interferometer on Plateau de Buerre, France) can also be used. Finally, there will be access to the ISO satellite, which will be launched in late 1994. The MPIA built the ISOPHOT instrument on the ISO satellite, and it plans to become a center for the ISOPHOT data.

The fellowship may commence as early as February 1st, 1993, but a later start date should be no problem. The monthly stipend depends on research experience and marital status; for example, a single person with two years experience could expect a tax-free stipend of about DM 3000 per month. Applicants should have a Ph.D. in astronomy or physics by the start of the fellowship. The applicant should send a letter of application including a description of research experience, curriculum vitae, bibliography, and arrange to have three letters of recommendation send by January 15, 1993 to:

Dr. Reinhard Mundt, Max-Planck-Institut fur Astronomie, Konigstuhl 17, W-6900 Heidelberg 1, Federal Republic of Germany. The MPG is an equal opportunity employer.

Short Announcements

I am in the process of writing a review of Pre-Main Sequence Binaries for the next volume of Annual Reviews of Astronomy and Astrophysics. I would greatly appreciate receiving any references, reprints, preprints, or information on work in progress pertinent to this subject. While the review will focus on observational results for pre-main sequence stars, studies of any related subjects (e.g., binary formation theory, binary protostars, disk/binary dynamics, etc.) will be gladly received.

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Meetings

The Physics of a Dynamic Interstellar medium

Dates: June 14 – July 4, 1993

Venue: Aspen Center for Physics, Colorado, USA

This is one of the annual three weeks Theoretical Astrophysics Workshops which are held at the Aspen Center for Physics. The workshop will emphasize recent and fundamental results from observations and theory and will explore the broad range of astrophysical problems that are relevant to a dynamically active ISM. The general approach will focus on the sources and sinks of mass and energy in the ISM, with less emphasis on star formation per se. Topics to be considered are the formation and stability of a multiphase ISM; the evolution and morphology of unstable regions; cloud collapse, cloud fragmentation and dissipation; radiative processes; formation of protostars; energy and mass input from young stellar objects, supernova remnants and OB associations; the formation of superbubbles, fountains, and galactic winds; the global circulation of mass and energy into and out of the halo; the role of infall and tidal stripping, and the nature of the ISM at large redshifts. The Scientific Organizing Committee includes D.DeYoung, R.Kennicutt, C.Norman, J.Scalo, and J.Truran.

The deadline for receipt of applications is February 1, 1993. More detailed information about the workshop and application forms can be obtained from:

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