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Abstracts of recently accepted papers

From T Tauri Stars to Protostars: Circumstellar Material and Young Stellar Objects in the ρ Ophiuchi Cloud

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We present the results of a 1.3-mm continuum survey for cold circumstellar dust, conducted with the IRAM 30-m telescope on a sample of over a hundred young stellar objects (YSOs) in or near the ρ Ophiuchi molecular cloud. To correlate the millimeter results with other source properties, we have used the IR classification of Wilking, Lada, & Young, but revising it critically to take into account factors such as heavy extinction. We find a sharp threshold in millimeter flux density at an infrared spectral index $\alpha_{IR}(2.2-10\mu\mathrm{m}) \simeq -1.5$, which is also visible in the IRAM 30-m survey of Taurus-Auriga T Tauri stars by Beckwith et al. We show that this threshold is well correlated with a disk opacity transition at $\lambda \simeq 10$ μm, and can be used to set a physical boundary between Class III and Class II IR sources. At a detection sensitivity of $\sim$ 20–30 mJy/beam (3σ) at 1.3 mm, less than 15 % of the Class III IR sources, but as much as 60 % of the Class II sources and 70–90 % of the Class I sources, are detected. Statistical studies show that the peak 1.3-mm fluxes of deeply embedded Class I sources, currently referred to as "protostars", and of "classical" T Tauri stars (Class II sources), are comparable within a factor of 2 at the angular resolution of the telescope (12" FWHM, or a linear diameter $\sim$ 2,000 AU). Maps of the millimeter emission are consistent with the presence of unresolved disks around Class II sources and of resolved, extended envelopes around Class I sources. Therefore, the difference between Class I and Class II YSOs lies mainly in the *spatial distribution* of their circumstellar dust. Converting the integrated millimeter fluxes derived from our maps into masses, we find that: (*i*) $\sim$ 30 % of the Class II sources have masses larger than the "minimum mass solar nebula" ($\sim 0.01\ M_\odot$); (*ii*) the envelopes of Class I sources contain more circumstellar material than Class II disks, consistent with Class I sources being younger than Class II sources, but (*iii*) their total circumstellar masses are not large ($\leq 0.1\ M_\odot$). This suggests that the central object has already accumulated most of its final stellar mass at the Class I stage. By contrast, a very strong 1.3 mm emission is found toward two deeply embedded outflow sources (IRAS 16293 and VLA 1623) which remain undetected shortward of 25 μm. These latter sources belong to a new class of YSOs ("Class 0") introduced by André, Ward-Thompson, & Barsony, which are surrounded by significantly larger amounts of circumstellar material ($\sim 0.5\ M_\odot$ or more), still to be accreted by the central protostellar core. Class 0 YSOs appear to be significantly younger, and therefore at an earlier protostar stage, than Class I sources.

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The HH83 Molecular Cloud: Gone With The Wind

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The HH83 optical outflow and its host cloud core has been mapped in the J=1-0 and J=2-1 transitions of CO and its isotopes. The ^{12}CO and ^{13}CO maps exhibit a hot spot, a column density enhancement, and increased velocity dispersion at the position of the young star driving the optical jet. The cloud exhibits an overall velocity gradient along its major axis, which if interpreted as rotation would be consistent with a rotation axis roughly aligned with the optical jet. The ^{13}CO linewidth and a region of enhanced velocity gradients surrounding HH83 IR are used to constrain the mass of this star and surrounding gas. In addition to the compact core, several other sub-condensations in the HH83 cloud have been identified in ^{13}CO map. The cloud may contain a pair of cavities symmetrically located on either side of HH83 IR that lie roughly along the axis defined by the optical jet. A very low velocity and poorly collimated molecular outflow with a large redshifted lobe and a small blueshifted one is associated with HH83. This molecular outflow has one of the lowest terminal velocities of any known source (about 5 km s^{-1}), a small total mass (0.1 to 0.2 M$_\odot$), and is one of the least energetic molecular flows (2×10^{43} ergs) known. In this system, the Herbig-Haro jet is the most energetic component and dominates the energy and momentum of the CO emitting lobes. The outflow from HH83 IR has "blown out" of the HH83 molecular cloud and may be interacting with predominantly atomic gas in the intercloud medium. The morphology and kinematics of the HH83 outflow suggests that it may be in a late stage of evolution.

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The Arcetri Catalogue of H_2O Maser Sources Update

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An update is presented of the Arcetri Atlas of water masers (Comoretto et al., 1990). It contains the results of observations of water masers with the Medicina 32-m antenna. The observed sources were all discovered in the period 1989-1993, and were found either directly in the course of our own programs or were taken from the literature in which case they were re-observed at Medicina. We give the observed parameters of 213 sources in tabular form, and present *all* the spectra of the 141 detections.

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First Results of the CIDA Schmidt Survey: Selected Zones in Taurus-Auriga

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We have begun an objective-prism Hα survey of star-forming regions using the CIDA 1 m Schmidt Camera, with a limiting magnitude $V \approx 18$. We report here first results for selected areas of the Taurus-Auriga molecular clouds. Of the list of candidates found in the objective-prism plates, 12 stars have been confirmed as pre-main sequence by the detection of the Li I 6707 $\AA$ absorption line. Five of these stars are in the dark cloud L1544, where only one T Tauri star was previously known. The new stars have very late spectral types and most have estimated masses between 0.2 M$_\odot$ and 0.3 M$_\odot$.

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Stellar Density Enhancements Associated with IRAS Sources in L1641

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We obtained H and K' images of 59 IRAS sources associated with dense molecular gas in L1641. Some of the sources were also imaged in narrow-band L and M. Using these near-IR images and photometry, we are able to identify the near-IR counterparts for most of the IRAS sources. The spectral energy distributions of the sources suggest that all of them are young stellar objects (Class I and II sources). Most importantly, we find in this study that 14 IRAS sources are associated with small (but statistically significant) groupings of bright near-IR sources defined as stellar density enhancements (SDEs). The spatial distribution of young stars in the Orion A molecular cloud can be characterized by a range of stellar densities, from the Trapezium Cluster, to the SDEs, to individual stars. We conjecture that the SDEs are regions of continuous star formation within or around dense molecular cores and that they may represent an important mode of star formation in L1641. If true, adjustments to the standard star formation model may be required.

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On the Theory of Astronomical Masers in Three Dimensions

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In the standard theory of three dimensional astronomical masers, the radiation field is described as if the source were comprised of a collection of linear masers, an approximation that has been justified by the highly beamed nature of the radiation. Recently, Neufeld has noted potential difficulties with this description and has supplied the general expressions for the maser problem without assuming beaming at the outset. The consequences of these general expressions, which have been formulated already in 1974 by Bettwieser and Kegel, are analyzed here. To leading order, the standard theory is shown to provide the correct description of three dimensional masers and its results remain intact, but only within a frequency core whose half-width is $x_s \Delta\nu_D$, where $\Delta\nu_D$ is the Doppler width and x_s is a dimensionless parameter. For any given geometry, x_s is $\sim 1/\theta_{sat}$, where θ_{sat} is the beaming angle of a maser with that geometry that has just saturated. For typical pumping schemes, x_s is ~ 2 in spherical masers, ~ 2.5–3 in disk masers and ~ 3–5 in cylindrical masers. For frequencies outside this core region, maser operation corresponds to a mode that will be called *suppressed* and the standard theory breaks down. In this frequency domain, interaction with core rays that are slightly slanted to the direction of propagation suppresses photon production. In contrast with the core region, in the suppressed regime the rate of maser photon generation never reaches the maximum allowed by the pump processes; this regime effectively corresponds to a maser whose inherent strength is weaker than that of a linear maser whose properties are otherwise identical. Observed maser radiation is effectively confined to the core region since frequencies in the suppressed domain are practically unobservable. In essence, x_s provides an effective cutoff, defining a width at zero intensity that depends on the geometry but is unaffected by growth at line center. In practice, suppression only affects extreme maser outbursts. Their profiles change in such a way that when fitted with a Gaussian, the linewidth decreases when the line center intensity increases, even for masers that are saturated at the line core — in marked contrast with the predictions of standard analysis of maser linewidths. This behavior could perhaps be related to the inverse relationship between intensity and linewidth displayed in some intense H_2O maser flares in star forming regions.

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The Multiplicity of T Tauri Stars in the Star Forming Regions Taurus-Auriga and Ophiuchus-Scorpius: A 2.2 μm Speckle Imaging Survey

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We present the results of a magnitude limited (K $\leq$ 8.5 mag) speckle imaging survey of 69 T Tauri stars in the star forming regions Taurus-Auriga and Ophiuchus-Scorpius. Thirty-three companion stars were found with separations ranging from $0.''07$ to $2.''5$; 9 are new detections.

This survey reveals a distinction between the classical T Tauri stars (CTTS) and the weak-lined T Tauri stars (WTTS) based on the binary star frequency as a function of separation: *the WTTS binary star distribution is enhanced at the closer separations (≤50 AU) relative to the CTTS binary star distribution.* We suggest that the nearby companion stars shorten the accretion time scale in multiple star systems, thereby accounting for the presence of WTTS that are coeval with many CTTS.

The binary star frequency in the projected linear separation range 16 to 252 AU for T Tauri stars (60[±17]%) is a factor of 4 greater than that of the solar-type main sequence stars (16[±3]%). Given the limited separation range of this survey, the rate at which binaries are detected suggests that *most, if not all, T Tauri stars have companions.* We propose that the observed overabundance of companions to T Tauri stars is an evolutionary effect, in which triple and higher order T Tauri stars are disrupted by close encounters with another star or system of stars.

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A 1.3 mm survey for circumstellar dust around young Chamaeleon objects

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We present the results of the first 1.3 mm continuum survey of young stellar objects in the Chamaeleon I and II dark clouds. 36 objects were observed, including five intermediate-mass stars. We detected emission from about 50% of the sources. At 1.3 mm, none of the sources with a spectral index a(2.2-25 μm) smaller than -1 could be found. There is no correlation between 1.3 mm flux and Hα equivalent width. The detected millimetre radiation is most probably thermal emission from cold circumstellar dust grains.
We combined the measured millimetre fluxes with infrared observations and modelled the broad-band energy distributions by both an exact spherically-symmetric radiative transfer model including scattering and properties of different dust populations and a model for geometrically thin disks with parametrized temperature and density distribution. In this way, we were able to constrain the parameters of the emission regions.

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'Cored Apple' Bipolarity : A Global Instability to Convection in Radial Accretion?

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We propose that the prevalence of bipolarity in Young Stellar Objects (YSO's) is due to the fine tuning that is required for spherical accretion of an ambient medium onto a central node. It is shown that there are two steady modes that are more likely than radial accretion, each of which is associated with a hyperbolic central point in the meridional stream lines, and consequently with either an equatorial inflow and an axial ejection or *vice versa.* In each case the stream lines pass through a thick accretion torus, which is better thought of as a standing pressure wave rather than as a relatively inert Keplerian structure. We base our arguments on a simple analytic example, which is topologically generic, wherein each bipolar mode is created by the 'rebound' of accreting matter under the action of

the thermal, magnetic, turbulent and centrifugal pressures created in the flow. In both bipolar modes the presence of non-zero angular momentum implies axial regions wherein the pressure is first reduced below the value at infinity and then becomes negative, where the solution fails because rotating material can not enter this region without 'suction'. The models thus have empty 'stems' where the activity of the central source must dominate. So the basic engine of the bipolar flow discussed here is simply the rebound of freely falling material from a thick pressure disc into an axial low pressure region. The low mass, high velocity outflow must be produced in this region by an additional mechanism. This is reminiscent of the 'cored apple' structure observed recently in the very young bipolar source VLA 1623.

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An Observational Estimate of the Probability of Encounters Between Mass-Losing Evolved Stars and Molecular Clouds

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One hypothesis for the elevated abundance of ^{26}Al present during the formation of the solar system is that an asymptotic giant branch (AGB) star expired within the molecular cloud (MC) containing the protosolar nebula. To test this hypothesis for star forming clouds at the present epoch, we compared nearly complete lists of rapidly mass-losing AGB stars and MCs in the solar neighborhood and identified those stars which are most likely to encounter a nearby cloud. Roughly ten stars satisfy our selection criteria. We estimated probabilities of encounter for these stars from the position of each star relative to cloud CO emission and the likely star-cloud distance along the line of sight. Typical encounter probabilities are $\sim 1\%$. The number of potential encounters and the probability for each star-cloud pair to result in an encounter suggest that within 1 kpc of the Sun, there is a $\sim$1% chance that a given cloud will be visited by a mass-losing AGB star over the next million years. This estimate is dominated by the possibility of encounters involving the stars IRC+60041 and S Cep. Over a MC lifetime, the probability for AGB encounter may be as high as $\sim$70%. We discuss the implications of these results for theories of ^{26}Al enrichment of processed and unprocessed meteoritic inclusions. If the ^{26}Al in either type of inclusion arose from AGB-MC interaction, the low probability estimated here seems to require that AGB-MC encounters trigger multiple star formation and/or that the production rate of AGB stars was higher during the epoch of solar system formation than at present. Various lines of evidence suggest only the more massive ($5-8M_\odot$) AGB stars can produce significant ^{26}Al enrichment of star-forming clouds.

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A Rotating Gaseous Disk Around the T Tauri Star GM Aurigae

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We report the detection of a gaseous circumstellar disk around a relatively old T Tauri star, GM Aurigae. Maps at $4''$ resolution in $\lambda = 1.4$ mm continuum emission and in the ^{13}CO (2–1) line reveal unresolved and compact dust and gas associated with the stellar position and at the core of a larger rotating gaseous disk, 950 $\times$ 530 AU in extent. The mean velocity gradient across the disk, which is oriented along PA $\sim 50°$, is consistent with rotation about an axis at PA=140°. The structure observed in ^{13}CO aperture synthesis maps agrees well with synthetic maps of the gas emission, generated from a model. For a disk that is inclined 30° from face on in Keplerian rotation, we derive a 0.80-$M_\odot$ central mass (star + disk), a systemic velocity, $v_{\rm hel}$, of 15.38 km s^{-1}, and a mass, 0.1 $M_\odot$. The spectral energy distribution of the dust continuum emission suggests a very similar mass, 0.09 $M_\odot$.

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A multi-transitional molecular and atomic line study of S140

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We present high-angular resolution maps of the S140 molecular cloud in various transitions of the ^{12}CO, ^{13}CO and C^{18}O molecules and single-channel observations of the $^3P_1 \rightarrow ^3P_0$ line of neutral atomic carbon (CI). Velocity channel maps of the ^{12}CO lines show a systematic shift of the emission peak away from the outflow source with increasing velocity offset from the line centre. The blue and redshifted outflow lobes are separated by ∼35 arcsec (0.15 pc) in projection and the outflow axis is believed to be directed close to the observers' line-of-sight. The masses of the blue and redshifted outflow lobes were found to be 19.5 and 8.1$M_\odot$ respectively, giving a total mass for the outflow of 27.6$M_\odot$. The higher J-level ^{12}CO lines are strongly self-absorbed, with the amount of self-absorption varying with position across the mapped region.

All the ^{12}CO, ^{13}CO and C^{18}O lines show enhanced main beam brightness temperatures at the molecular cloud/HII region interface. The ^{13}CO line intensities imply the excitation temperature increases from ∼65-70K at the position of the outflow source, to ∼250K at the interface region. The CI emission is mainly confined to a clumpy, elongated ridge-like feature adjacent to the edge of the molecular cloud and is coincident with a similar feature seen in ^{12}CO line emission. The coincidence of these features contradicts homogeneous cloud models and is interpreted as evidence that the molecular material is composed of dense clumps interspersed with a more tenuous interclump medium. A second region of intense CI emission is located inside a ring of CS emission, implying that ^{12}CO here is dissociated by the radiation field from the embedded infrared cluster and *not* the external radiation field. Observed positions on the PDR have significantly higher values of $T_{\rm mb}$(CI)/$T_{\rm mb}$(^{13}CO) than for the general cloud, implying N(CI)/N(^{13}CO) is likely to be significantly higher for positions on the PDR than in the general molecular cloud.

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Dust coagulation in dense molecular clouds - The formation of fluffy aggregates

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Dust extinction observations and the calculation of gas-dust dynamics indicate that in dense clumps of molecular clouds dust grains coagulate efficiently. We set up a detailed model for the dust coagulation process in dense cores of molecular clouds without beginning star formation. We took into account the effects of thermal, turbulent, gravitational motion, motion from incidential particle asymmetries, grain rotation, charges, and the accretion of molecules onto the particles. For most effects, we developed new formalisms. For the first time, we explicitly considered the irregularity and changing fluffiness of the clusters produced in the coagulation process. The basis for this treatment was an independent numerical simulation of the structure of such aggregates. Here, we considered especially the behaviour of aggregates smaller than the fractal limit and composed of subgrains with a spectrum of sizes. We fitted the structure parameters by analytic functions which were used in the final model for the coagulation of the interstellar particles.

With this model we carried out numerous simulations of the evolution of dust grain distributions in dense cores. The particles were characterized by two parameters, the particle mass and a quantity related to the internal density of the particles. Different gas densities, clump models, accretion rates, and initial grain size distributions were investigated. It was found that the main force driving the aggregation of dust particles in dense clumps is turbulence at gas densities below 10^8 H-atoms per cm^3 and Brownian motion at higher densities. The coagulation velocity is considerably influenced by electric charges on the grains. Both dust coagulation and ice accretion lead to a rapid growth of the smallest particles whereas the upper grain size limit is only slightly shifted. The resulting size and density distribution will be narrow on the grain mass scale but broad in the internal density parameters of the coagulates.

The total opacity of the resulting distributions of fluffy dust agglomerates was calculated using effective-medium theories combined with a core-mantle model for the aggregate particles. The far infrared absorptivity is enhanced by the factor 3 (at 200 mi) in the first steps of the coagulation process and hardly influenced by the further coagulation. For gas densities between 10^6 and 10^9 cm^{-3} and timescales below 10^5 yrs, the coagulation process is efficient in changing the optical properties of the dust particles but not in the production of large heavy particles.

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Infrared images, 1.3 mm continuum and ammonia line observations of IRAS 08076-3556

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We present J,H,K,and L' broad–band images, 1.3 mm continuum photometry and ammonia line observations of IRAS 08076-3556, the energy source of the Herbig Haro object HH120. Nebulosity is detected in the J,H and K bands; K and L' images show clearly the embedded young star coincident with the IRAS position. The energy distribution of the embedded object places it among the very young Class I sources. The ratio between the 1.3 mm luminosity and the bolometric luminosity is much higher than Class I sources, and similar to that of the extremely young "Class 0" sources. The strong 1.3 mm emission is probably due to a circumstellar dust disk with T_d= 20K and M_d= 7 10^{-2} $M_\odot$. The observed infrared nebulosity is most likely due to scattering of radiation from the HH120 exciting source by the dust associated with mass outflow escaping through the poles of this circumstellar disk. Finally, IRAS 08076-3556 appears embedded in a high density core, detected through our NH_3 observations, with a linear size $\leq$ 0.16 pc and a mass of 8 $M_\odot$.

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Numerical Simulations of Protostellar Jets with Nonequilibrium Cooling. III: Three Dimensional Results

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In the third of three papers, we present three dimensional time-dependent numerical simulations of the propagation of protostellar jets into uniform and plane stratified ambient media using a nonequilibrium treatment of optically thin radiative cooling. We find the evolution of the jet beam and cocoon is similar to the results of previous two dimensional simulations, including the formation of a thin dense shell at the head of the jet. However, in three dimensions this shell undergoes significant nonaxisymmetric fragmentation to form discrete knots and filaments. Knots shed from the head of the jet propagate nearly ballistically into the ambient gas, and can be characterized as "interstellar bullets". On the other hand, variations in the speed of advance of the Mach disk can cause knots formed in the cooling shell to become embedded in the jet beam, leading to "shocked cloudlets". When the jet propagates through an ambient medium with a lateral density gradient, the bow shock propagates more slowly in the direction of the highest densities as expected, leading to a distorted cocoon. However, we find the orientation of the bow shock at the tip of the jet is time variable as the dense shell fragments. Synthetic Hα emission maps and position-velocity diagrams are presented for direct comparison to observations.

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Anatomy of a Photodissociation Region: High Angular Resolution Images of Molecular Emission in the Orion Bar

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We present observations of the molecular component of the Orion Bar, a prototypical Photodissociation Region (PDR) illuminated by the Trapezium cluster. The high angular resolution (6″-10″) that we have achieved by combining single dish and interferometric observations has allowed us to examine in detail the spatial and kinematic morphology of this region, and to estimate the physical characteristics of the molecular gas it contains. Our observations indicate that this PDR can be essentially described as a homogeneously distributed slab of moderately dense material ($\sim 5\times10^4$ cm^{-3}), in which are embedded a small number of dense ($>10^6$ cm^{-3}) clumps. The latter play little or no role in determining the thickness and kinetic temperature structure of this PDR. This observational picture is largely supported by PDR model calculations for this region, which we describe in detail in this work. We also find our model predictions of the intensities of a variety of atomic and molecular lines to be in good general agreement with a number of previous observations.

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High Resolution Images of Shocked Molecular Clumps in the SNR IC443

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We present high angular resolution interferometric observations of HCO^+ J=1→0 line emission from two molecular clumps which are being shocked by the blast wave from the supernova which formed the remnant IC443. Our observations show that a range of gas densities exist within these clumps; this fact may explain the mixture of shock velocities inferred from other observations. Previous studies have shown evidence that molecular material is being accelerated by the blast wave in a systematic fashion around one of the clumps that we study. We show that this phenomenon also occurs at the small spatial scales that we observe. In addition, we present evidence that suggests that the velocity field may correspond to ablation from or a bow-shock around the denser cores present within the clumps.

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Structure of Dense Cores in M17 SW: I. A Multitransition CS and $C^{34}S$ Study

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We present results of a multitransition CS and $C^{34}S$ study of the M17 SW molecular cloud core. Fully sampled maps were obtained in the CS J=1→0, 2→1, and 7→6 lines and the $C^{34}S$ J=2→1 line with 18″ – 36″ resolution. Velocity channel maps reveal the clumpy emission from the dense gas on scales of about 0.2 pc (20″). The overall agreement in the cloud morphology among maps of different CS and $C^{34}S$ transitions suggests that all CS and $C^{34}S$ lines originate in the same dense gas. Excitation and opacity effects probably cause the modest differences between the maps.

We carried out a detailed excitation analysis of the multitransition data. The J=2→1 and J=7→6 transitions of CS, analyzed with an LVG radiative transfer model, produced 250-pixel maps of the volume density and the CS column density over an area of about 1.8 pc×2.4 pc. Peaks in the CS and $C^{34}S$ line temperature maps are maxima in column density, but not in density. The density map shows a fairly uniform, high density (n$\approx10^{5.7}$ cm^{-3}) throughout the cloud core. An independent estimate of the gas densities from analysis of the $C^{34}S$ observations confirms the CS results. Along with other evidence, these results imply a clumpy cloud model in which the CS emission arises from structures smaller than our beam.

We compared the observed CS maps with a specific clumpy cloud model with 179 clumps decomposed from the $C^{18}O$ J=2→1 maps (Stutzki & Güsten 1990). Model channel maps of CS were synthesized based on the clump parameters listed in Stutzki and Güsten (1990) and were compared with the observed maps. The gas densities used in the models were derived from the clump column densities (based on the $C^{18}O$ J=2→1 emission) and sizes. Most of the dominant

clumps had densities near 10^5 cm^{-3}. The resulting synthesized map does not reproduce the observed CS J=7→6 emission along the eastern ridge of the core. By assuming a constant gas density for all clumps, we were able to synthesize CS channel maps which reproduce the observed cloud morphology and the line intensities reasonably well. A mean clump density in the models of about 5×10^5 cm^{-3} (about five times higher than the density derived from $C^{18}O$) matches the observed CS line ratios and a CS/H_2 abundance ratio of about 4×10^{-9} fits the observed line intensities of the J=1→0, 2→1, and 7→6 transitions of CS. The discrepancy between densities derived from $C^{18}O$ and CS can be resolved if the clumps have internal density structure. Either smooth density gradients in clumps with sizes just below our angular resolution or a continuation of high-contrast clumping to still smaller scales could account for the difference. While we cannot rule out either of these pictures, it is noteworthy that the scale of the $C^{18}O$ observations (about 0.15 pc) is the largest for which the density discrepancy can be resolved with smooth density gradients in unresolved clumps.

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Previously unresolved IRAS sources in the ρ Oph A cloud

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A maximum entropy method (MEM) is used to construct an IRAS image of the central region of the ρ Oph A dark cloud at each of the IRAS wavebands (12, 25, 60 & 100 μm), in which no prior information of structure in the field is given to the maximum entropy routines. 6 sources are detected at two or more wavebands in the 10×12 arcmin area mapped. All 6 are coincident with near-IR sources known from ground-based observations, however 4 of the 6 have not been previously separated in the IRAS data using any other method. The other 2 sources, which are listed in the IRAS Point Source Catalogue, were recovered by MEM in their correct positions. No spurious, or unidentified sources were generated by MEM. Two other claimed faint IRAS sources within the field, which are not however in the IRAS Point Source Catalogue, were not detected by MEM. The typical gain in resolution of the images reconstructed by MEM over standard methods is 1.5 - 2 in the in-scan direction, and 3 - 10 in the cross-scan direction. The mean FWHM of the sources is 0.5 arcmin at 12 & 25 μm, 1 arcmin at 60 μm and 1.5 arcmin at 100 μm. The flux densities and luminosities of all 6 sources are derived, and the flux densities for the 2 known IRAS sources agree within errors with those listed in the Point Source Catalogue. The flux densities of 2 others are consistent with extrapolations of measurements made at other wavelengths, and typical errors are estimated to be $\sim$ 10 - 30%. 3-σ upper limits are placed on the IRAS flux densities of the sub-mm sources SM1 and VLA1623, which are lower than any previously obtained. The 6 sources are classified according to their infra-red SED's.

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