THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar evolution and molecular clouds

No. 42 — 10 Mar 1996 Editor: Bo Reipurth (reipurth@eso.org)

Abstracts of recently accepted papers

A Theory of the Initial Mass Function for Star Formation in Molecular Clouds

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We present a class of models for the initial mass function (IMF) for stars forming within molecular clouds. This class of models uses the idea that stars determine their own masses through the action of powerful stellar outflows. This concept allows us to calculate a semi-empirical mass formula (SEMF), which provides the transformation between initial conditions in molecular clouds and the final masses of forming stars. For a particular SEMF, a given distribution of initial conditions predicts a corresponding IMF. In this paper, we consider several different descriptions for the distribution of initial conditions in star forming molecular clouds. We first consider the limiting case in which only one physical variable – the effective sound speed – determines the initial conditions. In this limit, we use observed scaling laws to determine the distribution of sound speed and the SEMF to convert this distribution into an IMF. We next consider the opposite limit in which many different independent physical variables play a role in determining stellar masses. In this limit, the central limit theorem shows that the IMF approaches a log-normal form. Realistic star forming regions contain an intermediate number of relevant variables; we thus consider intermediate cases between the two limits. Our results show that this picture of star formation and the IMF naturally produces stellar mass distributions that are roughly consistent with observations. This paper thus provides a calculational framework to construct theoretical models of the IMF.

Accepted by the Astrophysical Journal

Adaptive Optics NIR Imaging of R136 in 30 Doradus: The Stellar Population of a Nearby Starburst

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We report $0.''15$ resolution near infrared imaging of R136, the central region of 30 Doradus in the LMC. Our $12.''8 \times 12.''8$ images were recorded with the MPE camera SHARP II at the 3.6m ESO telescope, using the adaptive optics system COME ON +. The high spatial resolution and sensitivity (20th magnitude in K) of our observations allow our H and K band images to be compared and combined with recent HST WFPC2 data of R136. We fit theoretical models with variable foreground extinction to the observed magnitudes of ca. 1000 stars (roughly half of which were detected in HST and NIR bands), and derive the stellar population in this starburst region. We find no red giants or supergiants, however we detect ca. 110 extremely red sources which are probably young, pre-main-sequence low or intermediate mass stars. We obtained narrow band images to identify known and new Wolf-Rayet stars by their He II (2.189μm) and Brγ (2.166μm) emission lines. The presence of WR stars and absence of red supergiants narrow the cluster age to $3-5$ Myr, while the derived ratio of WR to O stars of 0.05 in the central region favours an age of ~ 3.5 Myr, with

a relatively short starburst duration. For the O stars the core radius is found to be 0.1 pc, and appears to decrease with increasing stellar mass. The slope of the mass function is $\Gamma = -1.6$ on average, but steepens with increasing distance from the cluster center from $\Gamma = -1.3$ in the inner 0.4 pc to $\Gamma = -2.2$ outside 0.8 pc for stars more massive than $12\,M_{\odot}$. The radial variation of the mass function reveals strong mass segregation that is probably due to the cluster's dynamical evolution.

Accepted by Ap.J.

X-ray Emitting T Tauri Stars in the L1551 Cloud

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Low mass pre-main sequence stars in the nearby Lynds 1551 star forming cloud are studied with the *ROSAT* and *ASCA* X-ray satellites. An 8 ksec *ROSAT* image reveals 38 sources including 7 well-known T Tauri stars, 2 likely new weak-lined T Tauri stars, 5 potential new weak-lined T Tauri stars, one is a young B9 star, and the remaining sources are unrelated to the cloud or poorly identified. A 40 ksec *ASCA* image of the cloud detects seven of the *ROSAT* sources.

Spectral fitting of the brighter X-ray emitting stars suggests the emission is produced in either a multi-temperature plasma, with temperatures near 0.2 and 1 keV, or a single-temperature plasma with low metal abundances. XZ Tau, a young classical T Tauri star, is much stronger in *ASCA* than *ROSAT* observations showing a harder (1.5-2.0 kev) component. Timing analysis reveals all but one of the T Tauri stars are variable on timescales ranging from one hour to a year. A powerful flare, emitting 3×10^{34} ergs within a 40 minute rise and fall, was observed by *ASCA* on the weak-lined T Tauri star V826 Tau. The event was preceded and followed by constant quiescent X-ray emission. The extreme classical T Tauri star XZ Tau was also caught during both high and low states, varying by a factor of 15 between the *ASCA* and *ROSAT* observations. Neither of the luminous infrared embedded protostars L1551-IRS 5 or L1551NE were detected by *ROSAT* or *ASCA*.

Accepted by Astrophysical Journal

Text and tables available at: http://www.astro.psu.edu/users/carkner/ttauri/intro.html

Star formation in the NGC 2024 molecular ridge

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High-resolution images of the NGC 2024 molecular ridge in CS(2–1), CO(1–0), and 3 mm continuum emission have been obtained using the Owens Valley millimeter array. The data are used to determine the temperature and dynamics of the ridge, and to ascertain the evolutionary state of the embedded protostars FIR2–7. Dust continuum emission is detected from all six FIR sources, and masses of $\sim 1\ M_{\odot}$ are implied assuming a dust temperature of 30 K and a dust opacity index $\beta = 1$. The sources are resolved, the majority of the emission probably arising in extended envelopes around the embedded protostars rather than circumstellar disks.

The CS(2–1) follows the ridge closely, but does not always coincide with the FIR sources. The largest discrepancy is for FIR5, the brightest of the dust continuum sources, where column densities derived from the dust and the CS differ by an order of magnitude. Although either depletion of CS or anomalous grain properties in FIR5 can explain this result, we also show that if the dust and gas temperature is $\gtrsim 100$ K for this compact source the two column density estimates may be brought into agreement.

The CO(1–0) traces the structure of the compact outflow from FIR6, and reveals a new outflow from FIR4. The latter is unipolar, with only a redshifted lobe, but is oriented symmetrically opposite the infrared reflection nebula associated with this source. Assuming the dynamical ages of the outflows from FIR4–6 are proportional to the age of the underlying protostars, an evolutionary sequence is suggested in the ridge. The formation of so many young protostars at locations separated by ~ 0.3 pc may have been triggered by the interaction of the NGC 2024 HII region with the molecular gas.

Accepted by The Astrophysical Journal

High Resolution CO Observations of the Molecular Outflow in the Orion-IRc2 Region

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We present high spatial resolution (3-5″) interferometer data combined with single dish maps of the CO J=1-0 emission from the powerful molecular outflow originating near Orion-IRc2. The outflow lobes are spatially resolved, weakly bipolar, poorly collimated and we find no evidence for a jet-like molecular outflow. Instead, the CO outflow lobes fill a wide, $\geq 130°$ opening angle biconical flow, surrounding the Herbig-Haro objects and shocked H_2 knots.

The overall structure of the outflow is strongly affected by the clumpiness of the ambient gas. In particular, it seems that the lobe to the south-east is partly blocked by dense gas in the hot core. None of the current jet or wind outflow models are sufficient to explain the kinematics of the OMC 1 outflow. However, we suggest that a simple biconical flow model, in which the flow to the south-east is partly truncated by the hot core, is consistent with the data.

A postscript version of the paper can be found at http://ral.berkeley.edu:8000/home.html

Accepted by ApJ

Effect of Ambipolar Diffusion on Dust-to-Gas Ratio in Protostellar Cores

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Recent numerical simulations have shown that ambipolar diffusion can reduce the abundance of grains in magnetically and thermally supercritical protostellar cores during the core formation epoch. We derive analytical expressions that relate the predicted grain abundances in dense cores to physical quantities such as the grain radii and the initial central mass-to-flux ratios of the parent molecular clouds. We find that the abundance of grains with radii $\lesssim 10^{-5}$ cm can be reduced, compared to canonical values in the interstellar medium, by up to an order of magnitude. Observations previously interpreted as indicating growth of grains with increasing extinction find a new interpretation. Moreover, observations of grain abundances in the core and envelope of a molecular cloud can, at least in principle, be used to determine the initial mass-to-flux ratio of the cloud.

Accepted by The Astrophysical Journal

H I Zeeman Measurements of the Magnetic Field in Sagittarius B2

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We have measured the line-of-sight magnetic field toward the Sgr B2 North and Main regions with the VLA by Zeeman mapping of the H I line; $B_{los} \approx -0.5$ mG with spatial variations of about 50%. It is likely that the H I absorption line is produced mainly within the massive molecular envelope surrounding the dense Sgr B2 cores; if so, the B_{los} we measure is that of the Sgr B2 molecular cloud complex. Maps of the plane-of-sky magnetic field direction from polarized emission of dust have led others to suggest that the present north-south elongation of the Sgr B2 cloud was due to infall along the predominantly east-west oriented magnetic field lines. Our measured magnetic field strength is approximately equal to the critical magnetic field required to support the entire cloud complex against gravitational collapse, and thus provides support for this picture. Ambipolar diffusion heating may explain the high gas temperatures in the Sgr B2 cloud.

Accepted by Astrophys. J. Letters

Stationary Photodissociation Fronts

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The structure of stationary photodissociation fronts is revisited. H_2 self-shielding is discussed, including the effects of line overlap. We find that line overlap is important for $N(H_2) \gtrsim 10^{20}\,\mathrm{cm}^{-2}$, with a factor-of-two suppression of pumping rates at column densities $N(H_2) \approx 3 \times 10^{20}\,\mathrm{cm}^{-2}$. We compute multiline UV pumping models, and compare these with simple analytic approximations for the effects of self-shielding.

The overall fluorescent efficiency of the photodissociation front is obtained for different ratios of χ/n_H (where χ characterizes the intensity of the illuminating ultraviolet radiation) and different dust extinction laws. The dust optical depth τ_{pdr} to the point where 50% of the H is molecular is found to be a simple function of a dimensionless quantity ϕ_0 depending on χ/n_H, the rate coefficient $R(T)$ for H_2 formation on grains, and the UV dust opacity. The fluorescent efficiency of the PDR also depends primarily on ϕ_0 for $\chi \lesssim 3000$ and $n_\mathrm{H} \lesssim 10^4\,\mathrm{cm}^{-3}$; for stronger radiation fields and higher densities radiative and collisional depopulation of vibrationally-excited levels interferes with the radiative cascade. We show that the emission spectrum from the PDR is essentially independent of the color temperature T_{color} of the illuminating radiation for $10^4\,\mathrm{K} \lesssim T_{color}$, but shows some sensitivity to the rotation-vibration distribution of newly-formed H_2. The 1–0S(1)/2–1S(1) and 2–1S(1)/6–4Q(1) intensity ratios, the ortho/para ratio, and the rotational temperature in the v=1 and v=2 levels are computed as functions of the temperature and density, for different values of χ/n_H.

We apply our models to the reflection nebula NGC 2023. Apparent inconsistencies between published K-band and far-red spectroscopy of this object are discussed; we adjust the two sets of observations for consistency. We are able to approximately reproduce the (adjusted) observations with models having $\chi = 5000$, $n_\mathrm{H} = 10^5\,\mathrm{cm}^{-3}$, and a reasonable viewing angle. Further observations of NGC 2023 will be valuable to clarify the uncertain spatial structure of the emission.

Accepted by Astrophys. J.

preprints: http://www.astro.princeton.edu/∼draine/, or http://xxx.lanl.gov/archive/astro-ph (preprint 9603032)

Dispersed T Tauri Stars and Galactic Star Formation

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Existing samples of low-mass T Tauri stars from nearby star forming regions are very deficient in stars older than 2 Myr. We argue that this arises from the dispersal of stars outside well-surveyed regions, and is not due to a burst of star formation, erroneous theoretical isochrones or survey flux limits. Evidence is accumulating, most dramatically from the *ROSAT* All-Sky Survey, that a large population of weak-lined T Tauri stars (WTT) is widely dispersed within and around star forming complexes.

The spatial distribution, age distribution and kinematics of T Tauri stars, both close to and widely distributed around active clouds, are studied using simple models of T Tauri dispersal. Models are compared to observations of the Chamaeleon and Taurus-Auriga cloud complexes. The dispersal of T Tauri stars appears to have two major causes: slow isotropic drifting of stars away from long-lived star forming clouds, and star formation in short-lived rapidly moving cloudlets. The first mechanism is determined by the $\Delta v \simeq 1$ km s^{-1} thermal velocity dispersion of gas within molecular cloud cores. The second mechanism is determined by the large-scale turbulent motions of molecular cloud complexes. A third mechanism for dispersal, dynamical ejection of high velocity T Tauri stars, appears to be less important.

The results have a number of implications for star formation in the Galaxy including: star formation in at least one cloud (Chamaeleon I) has been continuous for $\simeq 20$ Myr; star formation efficiencies of clouds may often be 20% or higher; a large fraction of low-mass stars may form in small shoft-lived cloudlets each producing no more than a few stars; and T Tauri kinematics support molecular evidence for large-scale turbulence in molecular clouds.

Accepted by Astrophys. J.

Electronic version available from http://www.astro.psu.edu/users/edf/research/pms.html

A Survey of Water Maser Emission Toward Ultracompact HII Regions

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We present high resolution images and spectra of 21 H_2O maser sources in the vicinity of ultracompact (UC) HII regions. This survey provides the basis for future studies with milli–arcsecond resolution, utilizing very long baseline interferometry techniques. Emission from the $6_{16} - 5_{23}$ masing transition of interstellar H_2O is observed in the close vicinity of UC HII regions with a median angular distance of $2\farcs9$ and a median linear projected distance of 0.1 pc from the continuum peak. We find that for UC HII regions with cometary morphology the water maser emission is located in front of the cometary arc whereas for non-cometary UC HII regions the water masers are often observed projected onto the contours of the ionized gas. Due to the large median distance of the water masers from the I-front of the UC HII region, it is unlikely, that the water masers are formed in the shocked layer of warm molecular gas in the interface between the ionized gas of the UC HII region and surrounding molecular gas, which is predicted by the Bow Shock theory of UC HII regions. A comparison with maps in the NH_3 inversion transitions shows that in at least 7 cases, the water masers are associated with hot (T > 100 K), dense ($n(H_2) \approx 10^7$ cm^{-3}) molecular clumps. For the UC HII regions G5.89–0.38 and G45.07+0.13 we find good spatial and velocity correspondence between water masers and high velocity molecular gas. It is thus likely, that for these sources the H_2O masers are taking part in the bipolar outflow.

Accepted by Astronomy & Astrophysics Supplement Series

Infall Collapse Solutions in the Inner Limit: Radiation Pressure and its Effects on Star Formation

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In this paper, we study infall collapse solutions for star formation in the small radius limit where the particle orbits become nearly pressure-free. We generalize previous solutions to simultaneously include the effects of both radiation pressure and angular momentum. The effects of radiation pressure can be modeled using a modified potential; for representative cases of such potentials, we obtain analytical solutions for the density and velocity fields. In general, radiation pressure limits the maximum mass of a forming star by reversing the infall when the star becomes sufficiently large. Our results imply that this maximum mass scale is given by the condition that the turnaround radius R_R (the radius at which the radiation pressure force exceeds the gravitational force) exceeds the centrifugal radius R_C (the angular momentum barrier). The maximum mass scale for a star forming within a rotating collapse flow with radiation pressure depends on the initial conditions, but is generally much larger than for the case of spherical infall considered previously. In particular, stars with masses $M_* \sim 100\ M_\odot$ can form for a fairly wide range of initial conditions.

Accepted by the Astrophysical Journal

Near-Infrared Imaging of Embedded Clusters: NGC 1333

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We present the results of an extensive near-infrared (*JHK*) imaging survey of the NGC 1333 star forming region. Our survey covers an area more than 4 times larger than the previous imaging survey of this cloud reported by Aspin et al. (1994) and is sufficiently sensitive to render an accurate census of the embedded stellar population in the cloud. We detected 275 sources with $m_K < 14.5$ magnitudes within the 432 square arc minute region surveyed. The spatial distribution of these sources is found to be significantly clustered with approximately 45% of the sources contained within two adjacent stellar clusters which together occupy an area less than 16% of the entire region surveyed. From comparison with observations of nearby control fields we estimate that roughly 143 of the sources detected over the entire region are physically associated with or embedded in the NGC 1333 molecular cloud. The majority (94 or 66%) of these are also found within the boundaries of the double cluster. From analysis of the *JHK* colors of the stars in the NGC 1333 region we find that roughly 30% of all sources display detectable infrared excess. This corresponds to more than 50% of all the sources embedded in the cloud. The infrared-excess sources display a higher degree of clustering than the general K band source population with roughly 75% of all excess sources located within the boundaries of the double cluster. Moreover, infrared excess sources comprise roughly 60% of the sources within the cluster suggesting that it is extremely young ($\leq$ 1-2 $\times 10^6$ years). We also find that the stars in the cluster suffer from significant amounts of differential extinction indicating that the cluster is deeply embedded in molecular material.

We construct the K luminosity function (KLF) for the NGC 1333 cloud and compare it to that of the control fields off the cloud. We find that background field stars dominate the KLF at faint magnitudes and that the vast majority of stars associated with the cloud are brighter than our completeness limit. We use the infrared colors to de-redden the stars in the cluster and construct their (de-reddened) K luminosity function. The resulting KLF of the NGC 1333 cluster is compared to the KLFs of the Trapezium cluster in Orion and IC 348, a rich young cluster located within the same GMC complex as NGC 1333. The KLFs of NGC 1333 and the Trapezium cluster are found to be very similar in shape and extent while the KLFs of NGC 1333 and IC 348 are found to differ. We attribute this to the effects of luminosity evolution in these young clusters and suggest that the NGC 1333 cluster is similar in age to the Trapezium cluster (i.e., $\leq 10^6$ years) and significantly younger than IC 348 (i.e., $<$ 5-7 $\times 10^6$ years). This is consistent with both the large population of excess sources and outflow sources (Hodapp and Ladd 1995) contained in the NGC 1333 cluster. However, we derive a star formation rate of 4 x 10^{-5} $M_\odot$ yr^{-1} for NGC 1333 which is essentially the same as that characterizing IC 348 and nearly an order of magnitude lower than that found for the Trapezium cluster. The

two most active star forming regions in the Perseus cloud complex have now been throughly surveyed with comparable sensitivities at near-infrared wavelengths. Both regions have produced embedded stellar clusters, which are forming stars at a similar rate, but which appear to be in very different stages of evolution.

Accepted by Astron. J.

Preprint to be available on WWW at http://cfa-www.harvard.edu/cfa/rg/SF2.html

The High-latitude Cloud MBM7. I. HI and CO Observations

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The high-latitude cloud MBM7 has been observed in the 21cm HI line and the ^{12}CO(1-0) and ^{13}CO(1-0) lines with similar spatial resolutions. The data reveal a total mass ~30 $M_\odot$ for MBM7 and a complex morphology. The cloud consists of a cold dense core of 5 $M_\odot$ surrounded by atomic and molecular gas with about 25 $M_\odot$, which is embedded in hotter and more diffuse HI gas. We derive a total column density N(HI + 2H_2) of 1x10^{21} cm^{-2} toward the center and 1x10^{20} cm^{-3} toward the envelope of MBM7. The CO lines indicate the existence of dense cores (n(H_2) $\geq$ 2000 cm^{-3}) of size (FWHM) ~0.5 pc.

The morphology suggests shock compression from the SW direction, which can form molecular cores along the direction perpendicular to the HI distribution. The HI cloud extends to the NE, and the velocity gradient appears to be about 2.8 km s^{-1} pc^{-1} in this direction, which indicates a systematic outward motion which will disrupt the cloud in ~10^6 yr. The observed large linewidths of ~2 km s^{-1} for CO suggest that turbulent motions exist in the cloud, and hydrodynamical turbulence may dominate the line broadening. Considering the energy and pressure of MBM7, the dense cores appear not to be bound by gravity, and the whole cloud including the dense cores seems to be expanding.

The distance to HLCs suggests that they belong to the galactic plane, since the scale height of the cloud is ≤100 pc. Compared to the more familar dense dark clouds, HLCs may differ only in their small mass and low density, with their proximity reducing the filling factor and enhancing the contrast of the core and envelope structure.

Accepted by Ap. J.

Formation and Evolution of Filamentary Molecular Clouds with Oblique Magnetic Field

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Using two-dimensional numerical simulations we have constructed a model for formation of a filamentary molecular cloud permeated with almost perpendicular magnetic field. The model filamentary cloud is formed by fragmentation of a magnetized sheet-like cloud. It stays in a quasi-static equilibrium for a period much longer than its freefall time. In the quasi-static equilibrium the magnetic field runs parallel to the cloud axis in the central part of the cloud and almost perpendicularly to the axis in the less dense part of the cloud. The inner parallel magnetic field supports the cloud in part against the cloud gravity. The parallel magnetic field escapes from the cloud through the Alfvén wave and the quasi-static equilibrium state ends. During the quasi-static equilibrium the cloud is expected to fragment in the direction of the axis by gravitational instability. We discuss the application of our model to the filamentary clouds in Taurus.

Accepted by Ap. J.

Available at : http://www.a.phys.nagoya-u.ac.jp/ nakajima/work/paper.html

Possible Infall in The Gas Disk around L1551-IRS 5

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We report observations of ^{13}CO($J = 1-0$) emission from L1551-IRS5 carried out with the Nobeyama Millimeter Array. We detected a strong and compact condensation associated with L1551-IRS5, and weaker extended components with "U"-like features with a spatial resolution of $5.1'' \times 3.9''$ (PA=159°). The U-like features delineate the edges of the molecular outflow as well as the 2.2 μm infrared reflection nebula. This suggests that the extended component may be a dense shell swept up by the molecular outflow. The compact component was marginally resolved with the present angular resolution. The estimated deconvolved size is $\sim 1,200$ AU $\times$ 670 AU with a position angle perpendicular to the optical jet. This elongated structure is very similar to the compact gaseous disk observed in C^{18}O ($J = 1-0$). The ^{13}CO elongated structure may be more extended than the actually measured size, suggesting that the compact ^{13}CO gas is most probably the inner part of the gaseous disk around L1551-IRS5. The ^{13}CO disk has a velocity gradient along its minor axis, which can be explained in terms of infalling motion in the plane of the disk with a central mass of 0.5 $M_{\odot}$. We estimate the mass accretion rate at 600 AU in radius to be $1.3-2.6 \times 10^{-5}$ $M_{\odot} yr^{-1}$. The derived accretion rate might be larger than the accretion rate onto the star estimated from the bolometric luminosity of L1551-IRS5 on the assumption of steady accretion, which suggests that the accretion around L1551-IRS5 may also be non-steady as was the case for HL Tau.

Accepted by ApJ

A C^{18}O Survey of Dense Cloud Cores in Taurus: Core Properties

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This paper discusses observational results of physical properties of dense cores in the Taurus complex. The observations were carried out in the C^{18}O (J=1-0) line at a linear resolution of 0.1 pc with the 4 m millimeter radio telescope at Nagoya University. Based on the previous ^{13}CO observations of Mizuno et al. (1995) as a guide map, we obtained 7200 spectra (8 deg^2) at a 2' grid spacing, corresponding to more than 90 % of the area whose molecular column density is greater than 3.5×10^{21} cm^{-2}. The total molecular mass of the C^{18}O cloud is estimated to be 2900 M$_{\odot}$, which is 43 % of the mass of the ^{13}CO cloud. About 97 % of the C^{18}O spectra have an optical depth smaller than 0.5, and the C^{18}O emission is optically thin over almost all the region at a size scale down to $\sim$ 0.1 pc. The basic structure of the C^{18}O cloud is clumpy. We identified 40 dense cores of n(H_2) $\sim 10^4$ cm^{-3}, whose mass ranges from 1 to 80 M$_{\odot}$. The average physical parameters of the C^{18}O cores are as follows: radius 0.23 pc, linewidth 0.49 km s^{-1}, column density 6.9×10^{21} cm^{-2} and mass 23 M$_{\odot}$. The mass spectrum of the cores, dN/dM versus M is fitted by a power law with an index of -0.9 $\pm$ 0.2, which is significantly smaller than those of the previous surveys. Most of the cores are spatially elongated; the average aspect ratio is 1.8, and the direction of the major axis of the cores tends to be perpendicular to the typical direction of the optical polarization vectors. An analysis of correlations among the physical quantities of the cores indicates that the line width has a positive correlation with the mass and the column density but not with the size. Most of the cores are roughly gravitationally bound and at least approximately in virial equilibrium.

The paper is available on the WWW at: **http://www.a.phys.nagoya-u.ac.jp/~ohnishi/papers.html**

Accepted by Astrophysical Journal

HST WFPC2 Observations of the Binary Fraction Among Pre-Main Sequence Cluster Stars in Orion

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We present estimates of the binary frequency for optically-visible ($I_{HST} < 19$ mag) members of the dense (mean star separation ~ 0.05 pc) embedded stellar clusters associated with NGC 2024, NGC 2068, and NGC 2071 (distance = 460 pc) based on Hubble Space Telescope Wide Field Planetary Camera 2 observations. Of 99 targets, 15 are found to be double stars with projected linear separations of 138 AU - 1050 AU ($0.3 < \theta < 2.3$ arcsec). The resulting multiplicity fraction is 15/99 or 0.15 ± 0.04 in this separation range, while the comparable values observed for solar neighborhood G and K stars are 0.11 and 0.09, respectively. We also examined the archival F547M WFPC2 images of the Trapezium cluster obtained by O'Dell & Wen (1994), and found a binary frequency of 7/50 or 0.14 ± 0.05 in the separation range 138 AU - 828 AU for stars with $V_{HST} < 17$. There is thus no evidence that the fraction of binaries formed in relatively dense clusters differs from that characterizing the field. In fact, our results compare well with the value of 0.16 ± 0.03 determined recently by Reipurth & Zinnecker (1993) from observations of 238 PMS stars in nearby (d$\sim$ 150 pc) low density (mean star separation ~ 0.3 pc) star-forming regions over comparable separation ranges.

Accepted by Ap. J.

Atmospheric Parameters and Iron Abundances of Low Mass Pre-Main Sequence Stars in Nearby Star Formation Regions

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High-resolution echelle spectra have been obtained for low-mass, pre-main sequence stars in the Taurus-Auriga, Orion, Chamaeleon, Ophiuchus, and other star formation regions. Using temperature sensitive individual metallic line ratios, new effective temperatures are determined for a sample of 30 G and K pre-main sequence stars in nearby star-forming clouds to an accuracy of $\pm$ 200 K or better in most cases. Comparison of these values with previous spectral classifications using low-resolution spectra reveals occasional large discrepancies in spectral type. Microturbulences derived for 23 "weak-line" T Tauri stars range as high as 3.1 ± 0.4 km s^{-1}. The mean microturbulent velocity of the sample is 1.6 ± 0.6 km s^{-1}. Using these new effective temperatures and microturbulences, iron abundances have been determined for 30 pre-main sequence stars in several northern and southern hemisphere star-formation regions. By determining the mean [Fe/H] for at least five stars in each cloud, bulk metallicities have been derived for the Taurus-Auriga, Orion, Chamaeleon, and Ophiuchus molecular clouds. [Fe/H] is approximately solar in all the surveyed regions.

Accepted by Ap. J.

A Generalization of the Sobolev Method for Radiation Transport with Local and Non-local Line Overlap

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We have generalized the Sobolev or Large Velocity Gradient method for solving radiative transfer problems in moving media to treat spectral lines that overlap locally or non-locally. When the rest frequencies of two spectral lines differ by less than their thermal Doppler width, then the lines overlap locally and photons from one line can influence the populations of the levels of the other line. Similarly, in a medium with velocity gradients and velocity differences enough

to Doppler shift one line onto the other, the lines overlap non-locally and one line can affect the level populations of the other. We have derived expressions for both the intensity and the mean intensity when there is local or non-local line overlap. These expressions are general and can be used for any temperature as long as the large velocity gradient approximation is satisfied. The mean intensity is essential for the radiative rates that enter into the statistical equilibrium equations and the accurate inclusion of the effects of line overlap is crucial.

Accepted by Ap. J.

OH Masers as Diagnostics of Physical Conditions in Star-forming Regions. I. Thermal Effects.

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We have studied the pumping of OH masers in star-forming regions by introducing four pumping mechanisms one at a time. The four mechanisms are: collisions, local line overlap, non-local line overlap and external infrared radiation field. Here we restrict ourselves to collisions and local line overlap. This means that we consider relatively small velocity gradients and no significant external infrared radiation. We have used the most accurate collision rates of OH with ortho- and para-H_2 which became available recently and have taken the effects of line overlap into account as accurately as possible using a recently developed formalism. We have found that it makes a qualitative difference whether the OH molecules collide with para-H_2 or ortho-H_2. Thus, maser observations may reveal the fractional abundance of ortho-H_2 in star-forming regions. Our calculations have revealed a number of diagnostics of the physical conditions in star-forming regions. Under the assumption of $V < 1$ km s^{-1} and no FIR radiation field, the most important diagnostics are:
1) If the 1720 MHz is seen as the *only maser line* in a spatial region (the region could be as small as a maser spot), then we can safely infer that the density there (to within a factor of 3) is $n_{\rm H_2} \approx 3 \times 10^5 (10^{-5}/f_{\rm OH})^{1/2}$ cm^{-3} and the fractional abundance of ortho-H_2 is $f_{\rm ortho-H_2} \gtrsim 0.5$.
2) If we know that in some HII/OH region the density is of order $n_{\rm H_2} \approx 3 \times 10^5 (10^{-5}/f_{\rm OH})^{1/2}$ cm^{-3} *and no maser line is seen there*, then it means that $f_{\rm ortho-H_2} \lesssim 0.5$.
3) If the 1612 MHz and the 4766 MHz maser lines *coincide in space*, our prediction is that the brightness temperature of the first will be about an order of magnitude larger than that of the second. Furthermore, the local density there is expected to be $n_{\rm H_2} \approx 10^7 (10^{-5}/f_{\rm OH})^{1/2}$ cm^{-3} and the temperature $T_{\rm H_2} < 170$ K.
4) If instead the 4766 MHz and the 4751 MHz maser lines *coincide in space*, we predict that the brightness temperature of the first will be about two orders of magnitude larger than that of the second. Furthermore, the local density there is expected to be $n_{\rm H_2} \approx 3 \times 10^7 (10^{-5}/f_{\rm OH})^{1/2}$ cm^{-3}, the temperature $T_{\rm H_2} > 170$ K and $f_{\rm ortho-H_2} \lesssim 0.5$.
5) Finally, if the 1667 MHz and the 4766 MHz maser lines *coincide in space*, then two possibilities exist. If the first one is an order of magnitude brighter than the second, then the local density there is expected to be $n_{\rm H_2} \approx 10^7 (10^{-5}/f_{\rm OH})^{1/2}$ cm^{-3}, the temperature $T_{\rm H_2} > 170$ K and $f_{\rm ortho-H_2} \gtrsim 0.5$. However, if the brightness temperatures are comparable for the two lines, then we expect $n_{\rm H_2} \approx 10^7 (10^{-5}/f_{\rm OH})^{1/2}$ cm^{-3} and a strong infrared radiation field to be present.

Accepted by Ap. J.

OH Masers as Diagnostics of Physical Conditions in Star-forming Regions. II. Effects of Large Velocity Gradients and Far Infrared Radiation Field.

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We have studied the pumping of OH masers in star-forming regions by introducing four pumping mechanisms one at a time. The four mechanisms are: collisions, local line overlap, non-local line overlap and external infrared radiation field. The first two have been investigated in a previous paper (Paper I). Here we study the effects of non-local line overlap and of an external infrared radiation field. As in Paper I, we have used the most accurate collision rates of OH with ortho- and para-H_2, which became available recently, and have taken the effects of line overlap into account as accurately as possible using a recently developed formalism. We have found that, despite the significant change in

the collision rates, the effects of non-local line overlap and of an external infrared radiation field are necessary for the explanation of the main lines in the ground state of OH. The same is true for the explanation of the general qualitative behavior of HII/OH masers. Our calculations have revealed a number of diagnostics of the physical conditions in star-forming regions. These are:
1) If the 4660 MHz line is seen, it means that $n_{\mathrm{H_2}} \sim 10^8$ cm^{-3}. If the 4751 MHz line is seen in the same spatial region, it confirms that $n_{\mathrm{H_2}} \sim 10^8$ cm^{-3}.
2) In the presence of a FIR radiation field, it is more likely to see the 1612 MHz line in the same spatial region with the 1665 MHz line than with the 1667 MHz one. When the 1612 MHz line is seen in the same spatial region with the 1665 MHz one, it means that $n_{\mathrm{H_2}} \sim 10^6$ cm^{-3}.
3) If both the 1665 MHz and the 1667 MHz lines are seen in the same spatial region, a FIR radiation field must be present and $n_{\mathrm{H_2}} \lesssim 10^6$ cm^{-3} there. The 1665 MHz line is typically the stronger of the two.
4) When the 1612 MHz line is observed, it means that $n_{\mathrm{H_2}} \gtrsim 10^6$ cm^{-3}.
5) Inversion of the 4766 MHz line means relatively small velocity gradients. We have found that this line is seen only for $V \lesssim 1$ km s^{-1} under all conditions we investigated.
6) The existence of the lines 1667 and 4766 MHz in the same spatial region, with the 1667 MHz one typically an order of magnitude brighter than the other, means $T_{\mathrm{H_2}} > 150$ K, $f_{\mathrm{ortho-H_2}} \gtrsim 0.5$ and relatively small velocities (typically $V < 1$ km s^{-1}).
7) In the presence of moderate velocity gradients ($V \sim 1$ km s^{-1}), if the 4766 MHz line is seen together with the 4751 MHz one in the same spatial region, then $f_{\mathrm{ortho-H_2}} \lesssim 0.5$. The 4766 MHz line is much stronger than the 4751 MHz one.
8) In the presence of moderate velocity gradients ($V \sim 1$ km s^{-1}), if the 4766 MHz line is observed together with the 1612 MHz one in the same spatial region, then $f_{\mathrm{ortho-H_2}} \gtrsim 0.5$.
9) In the presence of significant velocity gradients ($V \geq 2$ km s^{-1}), it is more likely to have the 1720 MHz line strongly inverted at $n_{\mathrm{H_2}} \sim$ few $\times\, 10^8$ cm^{-3} than at $n_{\mathrm{H_2}} \lesssim$ few $\times\, 10^7$ cm^{-3}.
10) As the FIR radiation field increases, the 1665 MHz line increases in intensity and is inverted in a larger range of densities.
11) Contrary to common belief, the dust temperature need not be high in order to have the 1665 MHz line stronger than the 1667 MHz one.

Accepted by Ap. J.

^{13}CO ($J = 1$-0) Observations of the Lupus Molecular Clouds

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The large-scale ^{13}CO ($J = 1$-0) observations were carried out toward the Lupus region, using the new 4 m millimeter telescope at Nagoya University (HPBW = 2.7 arcmin). Four molecular clouds, Lupus 1, 2 and 3 and a newly found cloud, were mapped at an 8 arcmin grid spacing. The masses of the 4 clouds are estimated to be 1200, 100, 300 and 1000 $M_{\odot}$, respectively. Around an infrared point source IRAS 15398−3359 associated with Lupus 1, we discovered a CO molecular outflow with a relatively short dynamical time scale of $\sim$ 2000 yr, which indicates ongoing star formation in the Lupus region. Including the outflow source, about 50 candidates for young stellar objects are found in the literature, which are apparently associated with the ^{13}CO clouds. Comparing these objects with our ^{13}CO data, we find that star formation efficiency of the four clouds varies over a wide range from 0.4 to $\sim$ 3.8%, which might represent their different stages of star formation, or might be due to the difference in interaction with the nearby Scorpius HI shell.
Accepted by Publ. Astron. Soc. Japan

New weak-line–T Tauri stars in Taurus-Auriga

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On the basis of the ROSAT All-Sky-Survey, a study of the Taurus-Auriga star forming region has been performed in order to search for hitherto undiscovered T Tauri stars. Our study covers an area of about 280 square degrees, located between 4^h and 5^h in right ascension and between 15^o and 34^o in declination. Identification of ROSAT All-Sky Survey sources in this area by means of optical spectroscopy revealed 2 new classical T Tauri stars (CTTS) and 66 new weak-line–T Tauri stars (WTTS) with $W_\lambda(H\alpha) \leq 10$Å. Additional pointed ROSAT observations led to the identification of 6 more WTTS and 2 CTTS, giving a total of 76 new T Tauri stars.

The large area of our study, as compared with previous works, allows us to study the spatial distribution of WTTS in this star forming region. We find the WTTS of our survey to be distributed over the whole region investigated. There is a noticeable decline of the surface density from south to north within our study area, but the spatial distribution extends most probably beyond our study region. No clustering towards the population of T Tauri stars known prior to ROSAT in Taurus-Auriga could be observed. We suggest that the WTTS found in our study might in part be somewhat older than the previously known T Tauri stars in Taurus-Auriga, and that their broad spatial distribution is due to the typical velocity dispersion of a few km/s measured for Taurus T Tauri stars, in which case for some of our WTTS an age on the order of 10^7 years would be required for reaching the observed distances from the Taurus dark clouds.

We estimate a WTTS/CTTS ratio of about 6 within our study area, but conclude that because of the different spatial distribution of WTTS and CTTS this ratio will be most probably significantly larger for a more extended area.

Accepted by Astronomy & Astrophysics

A Large Photo-Dissociation Region around the Cold, Unusual Cloud, G216-2.5

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Observations are presented of an atomic cloud that we contend links a non-star forming giant molecular cloud discovered by Maddalena and Thaddeus to two separate regions of OB star formation each over 50 pc away. The maps suggest that the cloud is a part of a larger molecular complex that has been partially photo-dissociated by these stars. The association of the cloud with stars of known spectral type allows a more definitive estimate of its heliocentric distance, 2.3 kpc. The precise amount of HI that is associated with the molecular gas is highly uncertain because of the ubiquity of emission along the line of sight but it is argued that that it may possess a large envelope (as seen around other molecular clouds) of mass $\approx 1o^6$ $M_\odot$, and that the mass of photo-dissociated gas due to the nearby OB stars is only a small fraction of this, $\approx 10^5$ $M_\odot$. The molecular cloud itself is gravitationally bound, but the atomic cloud (whatever its mass) is unbound and probably evaporating into the general ISM. The two sites of star formation that are most likely to have caused the photo-dissociation are S287; an HII region dominated by an O9.5V star, and a second, unidentified HII region, with a infrared luminosity of 1.1 10^4 $L_\odot$. However, the incident flux on the molecular cloud due to these HII regions is extremely weak and appears to be no more than the average Habing value, i.e. $G_0 \approx 1$, implying that the current rate of dissociation is small. The implications of these observations for diverse arguments concerning the evolutionary state of this cloud is discussed.

Accepted by Astrophysical Journal

This paper is available from the NRAO WWW preprint site at http://annie.cv.nrao.edu/listings/current.html

Clumpy Ultracompact H II Regions III: Cometary morphologies around stationary stars

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Cometary ultracompact H II regions have been modelled as the interaction of the hypersonic wind from a moving star with the molecular cloud which surrounds the star. We here show that a similar morphology can ensue even if the star is stationary with respect to the cloud material. We assume that the H II region is within a stellar wind bubble which is strongly mass loaded: the cometary shape results from a gradient in the distribution of mass loading sources. This model circumvents problems associated with the necessarily high spatial velocities of stars in the moving star models.

Accepted by MNRAS, preprint available via http://axp2.ast.man.ac.uk:8000/preprints.html

A Search for Protoplanetary Disks around Naked T Tauri Stars

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We apply and extend a method of modeling circumstellar emission from circumstellar disks to an X–ray selected sample of stars in the Taurus–Auriga association. We model these stars from 0.36 to 60 μm using a three–zone model: a photosphere with starspots and an optically thick passive disk. Our objective is to make a conservative estimate of the number of these stars possessing disks. To accomplish this, we demonstrate that small near–infrared excesses do not necessarily imply the existence of an optically thin disk. Of the 39 X–ray selected stars in our sample, only 2 have an infrared excess attributable to an optically thick disk. Four have thin or cleared disks. We found near–IR flux excesses in 9 stars which can be explained by cool starspots. For all of the others, we can exclude any optically thick active or passive flat disk. We estimate the dissipation timescales of circumstellar disks to be less than about 100,000 years.

Accepted by Astron. J.

Preprints are available on the World Wide Web at http://sbast3.ess.sunysb.edu/~swolk/plan.html

Small Scale Structure of Candidates for Protostellar Collapse I: BIMA Observations of L1527 and CB 54

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Aperture synthesis observations of L1527 and CB 54 were made in the ^{13}CO and C^{18}O J = 1→0 lines using the BIMA interferometers, in order to probe the small-scale structure of the gas distribution and to test the collapse picture in these two sources. In L1527, a bipolar outflow is detected in ^{13}CO with an opening angle of 50° and its axis in the plane of the sky along the east-west direction. The profile difference between the ^{13}CO and C^{18}O J = 1→0 lines toward the center position is consistent with the signatures of infall, as suggested by previous single-dish observations of L1527. In CB54, a bipolar outflow is seen in ^{13}CO one of the red-shifted outflow peaks is less than 10″ from the center position, making it difficult to pick out possible signatures of infall. We have made radiative transfer models for L1527 based on the collapse solution of a rotating cloud by Terebey, Shu, & Cassen (1984). The best-fit parameters are as follows: the effective sound speed, $a = 0.25$ km s^{-1}; the infall radius, $r_{inf} = 0.026$ pc; the H$_2$CO abundance, $X(\mathrm{H_2CO}) = 4\times10^{-9}$; and the C^{18}O abundance, $X(\mathrm{C^{18}O}) = 1.4\times10^{-7}$. The model can reproduce the observed profiles of single-dish observations and also the qualitative feature of the interferometric observations. Comparisons are made with other models for L1527 in the literature.

Accepted by Ap. J.

Dissertation Abstracts

ROSAT Survey Observation of the Taurus–Auriga T Association

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Ph.D degree awarded: February 1996

This work presents results from the ROSAT All-Sky Survey (RASS) observations in the Taurus–Auriga T association. Prior to the ROSAT mission, about 150 low-mass late-type pre-main sequence stars were known in Taurus–Auriga, about as many classical T Tauri stars (cTTS) with $W_\lambda(H\alpha) > 10$ Å as weak-line T Tauri stars (wTTS) with $H\alpha$ either weak in emission or in absorption. Observations with the X-ray satellite EINSTEIN led to the conclusion that there might be as many as $\sim 10^3$ wTTS in Taurus–Auriga, many of which could be detectable with the flux-limited but spatially complete RASS. Two thirds of the well-known wTTS, but one sixth of the cTTS were detected with RASS. The energy resolution of the ROSAT PSPC allows some spectral analysis even for low S/N observations with RASS, where TTS are detected with typically 10^2 counts only or less. It was found that cTTS X-ray spectra appear to be harder than those of wTTS, because circumstellar material around cTTS absorbs X-rays, while wTTS are often clear of disks and envelopes. Correcting for both the X-ray emission energy and the (circumstellar, intercloud, and interstellar) absorption yield X-ray luminosities individually corrected for any detected star, so that one can study X-ray luminosity functions. Comparing cTTS and wTTS Kaplan-Meier estimators (including upper limits of undetected TTS), it was found that wTTS emit intrinsically significantly more X-rays than cTTS, consistent with significantly different RASS detection rates for wTTS and cTTS.

There is a significant correlation between X-ray emission and rotation period (and rotational velocity) in TTS suggesting that a dynamo mechanism is responsible for X-ray emission in TTS. The faster a TTS rotates, the larger the stellar magnetic field, so that field line emerge out of the stellar surface forming coronal loops that contain hot plasma. It is well known that cTTS rotate slower than wTTS, thus explaining the significantly different X-ray luminosity functions. Within the cTTS sample, there is no change in X-ray emission with age, because cTTS cannot spin up while contracting along the Hayashi track, as their stellar magnetic field ankers with the disk. As soon as a TTS looses its disk, it can spin up, thus emitting more X-rays as observed (see Neuhäuser et al. 1995, A&A **297**, 391).

In the 10^3 square degree wide area studied (including the Taurus–Auriga region and its surroundings), there are almost $2 \cdot 10^3$ X-ray sources which cannot be identified with known objects (see Neuhäuser et al. 1995, A&A **295**, L5). To find the most likely TTS candidates among them, a multi-parameter selection process can be applied. RASS X-ray colors, optical magnitudes, and the X-ray to optical flux ratios are known for all previously known TTS detected with RASS as well as for all unidentified sources with a near-by HST GSC counterpart. Well-known TTS can be used as training set in order to select those unidentified sources which resemble best typical TTS properties (see Sterzik et al. 1995, A&A **297**, 418). Ground-based optical follow-up observations of TTS candidates (performed not only in Taurus–Auriga but also in several other star forming regions) have resulted in the discovery of hundreds of hithertoo unknown TTS, most of which are wTTS with radial velocities consistent with other TTS in their region.

Additionally, 15 young stars have been found south of the Taurus–Auriga dark clouds, all of which display typical wTTS properties ($H\alpha$, Lithium, $v \cdot sin\ i$, and X-ray data). While some of them show radial velocities consistent with membership to the Taurus–Auriga T association (dispersed post-TTS?), others show radial velocities far off the Taurus mean. Their observed velocity dispersion is (a) much larger than typical of TTS in the dark clouds and (b) even when considering their young age (as concluded from high Lithium abundance), sufficient for the possible explanation that they have been formed in central Taurus and subsequently moved to their present location (see Neuhäuser et al. 1995, A&A **299**, L13). Quantitative age estimates based on photometry and evolutionary tracks together with measurements of their surface gravities (in order to eliminate possibly large errors in age estimates based on assumptions on the distance) as well as precise proper motions should be able to test this 'run–away TTS' hypothesis.

(Copies of the thesis (written in german language) and papers mentioned can be obtained from the address above.)

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Informal enquiries may be made to Dr Jim Emerson on: E-mail: j.p.emerson@qmw.ac.uk; Tel: (44) 171 975 5040; Fax: (44) 181 981 9465.

Deadline: Monday, April 15th, 1996.

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POSTDOCTORAL RESEARCH ASSOCIATE

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Attention: Office of the Director, NAIC

The National Astronomy and Ionosphere Center has an opening for a postdoctoral research associate in the Radio Astronomy group at the Arecibo Observatory, Puerto Rico. This would begin in the late summer or fall of 1996 and be a two-year appointment which may be renewable for an additional year. Applicants should have a doctoral degree and a proven ability to pursue independent astronomical research. The current research interests of observatory staff include observational cosmology, the properties and evolution of galaxies, studies of the interstellar medium, stellar evolution, and pulsars. The successful applicant will have full access to the facilities of NAIC and travel funds will be available to allow the use of other telescopes.

The Arecibo telescope is currently nearing completion of an extensive upgrade which will result in greatly increased sensitivity, plus frequency coverage extending up to 10 GHz. These aspects of the upgraded instrument make it very attractive for spectroscopic investigations of dark clouds, GMC's and circumstellar envelopes. Applicants with interests in astrochemistry and star formation are thus particularly encouraged to apply. First light post-upgrade is expected in late Spring 1996, with the telescope becoming fully operational by the end of the year. The successful applicant will be expected to participate in system calibration and other commissioning activities necessary to bring the upgraded telescope back into full operation.

The successful applicant would be an employee of Cornell University and eligible for all appropriate benefits including health insurance. NAIC will cover travel and some moving costs to and from Puerto Rico. Applicants should submit a resume, the names of three individuals for references together with the research plan they anticipate pursuing at Arecibo. The deadline for applications is April 1, 1996, although consideration may be given to applications received after this date. NAIC is operated by Cornell University under a cooperative agreement with the National Science Foundation. EOE/AAE.

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INAOE 1996 MILLIMETER SUMMER SCHOOL JULY 15TH TO AUGUST 2ND 1996

The Instituto Nacional de Astrofisica, Optica y Electronica (INAOE) is pleased to announce a summer school for Millimetric and Sub-millimetric Astronomy to be held in Tonantzintla, Puebla, Mexico from July 15th to August 2nd 1996.

INTRODUCTION AND LOCATION

INAOE and the University of Massachusetts are collaborating in the construction of a Large Millimeter Telescope: a 50 meter antenna which will operate at frequencies of 300 GHz. This unique telescope is expected to be finished in the year 2000 and will require expertise in the field of millimeter astronomy.

INAOE is a research and teaching institution situated in the small town of Tonantzintla, in the State of Puebla, 120 km east of Mexico City. From Tonantzintla there is a spectacular view of Popocatepetl and the Iztacihuatl volcanoes, both peaking above 5000 meters. Nearby is the colonial City of Puebla with over one million inhabitants. There are over 70 churches and 1000 other colonial buildings in the central area alone - many adorned with hand-painted tiles. Even closer is the town of Cholula with its impressive pyramid - the most voluminous pyramid in the world with a 425 metre-square base and a 60-metre height. Cholula was one of the largest cities and religious centres in pre-Hispanic Mexico. Legend has it that Cortes vowed to build a church on top of every pagan temple and, in accord with the legend, there is a large number of churches here and in the nearby towns; two of the most impressive churches are located in Tonantzintla and Acatepec. Also, recently opened to the public are two hilltop ruins located 35 km north-west of Puebla - Cacaxtla and Xochitecatl. Cacaxtla has some of the most vivid, best-preserved pre-Hispanic murals in the country.

PROPOSED TOPICS

i) Galactic Millimeter and Submillimeter Astrophysics. (Theory and Observations)
Theoretical:
o Physical Processes in Molecular Clouds
o Magnetic Fields in Molecular Clouds
o Dust Emission and What it Tells Us
o Chemical Models and Evolution of Molecular Clouds
Observational:
o Physical Conditions in Molecular Clouds
o Chemical Composition and Abundances in MC's
o GMC's and Galactic Structure
o Molecular Clouds and Star Formation
+ High mass star formation
+ Low mass star formation
+ Inhibited star formation (quiescent cores & other)

ii) Extragalactic Millimeter and Submillimeter Astrophysics. Current Problems and Perspectives.
o Molecular Observations as Mass Probes
o Large-Scale Structure in External Galaxies
o Molecular Clouds in External Galaxies

iii) Laboratory Astrophysics and Molecular Studies
Calculation of Collision Rates
Molecular Energy Levels and Spectroscopy

iv) Millimeter and Submillimeter Spectroscopic Systems; State of the Art and Current/Future Trends in Intrumentation.
o SIS and Schottky Mixers
o HEMT Amplifiers
o Optics at Millimeter and Submillimeter Wavelengths

v) Millimeter and Submillimeter Continuum Detectors.

o Bolometers and Heterodyne mm/submm radiation detection.
o Detector Arrays (JCMT; CSO; other)
o Polarimeters

PRELIMINARY LIST OF LECTURERS

Paul Goldsmith (Cornell Univ., USA); Andy Harris (Univ. Massachusetts, USA); Phil Solomon (State Univ. of New York, USA); Patricia Carral (Univ. of Guanajuato, Mxico); Eduardo Scalise (INPE, Sao Paolo, Brazil); Leo Bronfman (Univ. of Chile); Alejandro Palma (UAP, Mxico); Elizabeth Lada (Univ. of Maryland, USA)

More to come...

FORMAT OF THE SCHOOL

Lectures will be given 5 days a week: 4 days a week with 5 hours of lectures and one day with 2 or 3 hours. The three weeks of lectures will consist of theory, observations, and instrumentation, one week for each. Participants wishing to give a 30-minute talk should submit an abstract. Only a limited number of talks by participants is possible. A Certificate of Attendance will be given.

APPLICATION PROCEDURES

The school is open to graduate students and young post-docs in astronomy, showing a genuine interest in millimeter wave astronomy. Each MUST have a good knowledge of English, as the lectures will be in English only. Each application should be sent first in electronic form (e-mail preferred, FAX accepted) as soon as possible. A copy should be sent via airmail BEFORE APRIL 24. The application shall contain a short curriculum vitae, stating the academic accomplishments to date, the current stage of studies, and a short summary of the current research project, as well as a letter (200 words or less) by the applicant explaining his/her motivations in applying to this school. The applicant should also provide the names and addresses of two persons who are sending letters of recommendation on their behalf.

The participants will be responsible for travel expenses. INAOE will provide accommodation at the cost of $100.00(US)perweek.Afew$

SCIENTIFIC ORGANIZING COMMITTEE

Luis Carrasco (UNAM/INAOE, Mxico) Andy Harris (Univ. Massachusetts, USA) Paul Goldsmith (Cornell Univ., USA)

LOCAL ORGANIZING COMMITTEE

Alberto Carramiana Emmanuel Mendez Palma Mari Paz Miralles William Wall

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E-mail: verano@tonali.inaoep.mx

For more information on the summer school, refer to the WEB page http://www.inaoep.mx/ verano/millimetric/school.html
If you have any questions regarding this announcement please feel free to e-mail Mihae Lee at verano@tonali.inaoep.mx