THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar evolution and molecular clouds

No. 31 —11 Mar 1995 Editor: Bo Reipurth (reipurth@eso.org)

Abstracts of recently accepted papers

The Pre-Main-Sequence Triple TY CrA: Spectroscopic Detection of the Secondary and Tertiary Components

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We present new spectroscopic data for the eclipsing, pre-main-sequence binary TY CrA. Absorption lines from the secondary and from a previously unknown tertiary component are detected, including LiI 6708 Å in both stars which supports the pre-main-sequence status of the system. Radial velocities of the primary and secondary are given, from which we derive minimum masses of $M_1 \sin^3 i = 3.08 \pm 0.04$ $M_\odot$ and $M_2 \sin^3 i = 1.59 \pm 0.02$ $M_\odot$, and a mass ratio of $q = M_2/M_1 = 0.518 \pm 0.005$. Radial-velocity measurements for the tertiary, and variations in the binary center-of-mass velocity, suggest detection of of the orbital motion of the tertiary-binary system, but this requires confirmation. Analysis of these motions yields an estimated tertiary mass of 2.4 ± 0.5 $M_\odot$. We measure stellar luminosity ratios using observations of the FeI 6400 Å and LiI 6708 Å line strengths and application of appropriate bolometric corrections. We find the primary/secondary bolometric luminosity ratio to be between 10 and 33 and the tertiary/secondary bolometric luminosity ratio to be between 0.5 and 3.9, both depending on the secondary and tertiary effective temperatures. Adopting a ZAMS luminosity for the primary, the luminosity ratios indicate the secondary star is in the pre-main-sequence stage, likely near the base of the Hayashi track. The FWHM of primary lines is less than 10 km s^{-1}, which is consistent with earlier $v \sin i$ measurements of less than 10 km s^{-1} and indicates subsynchronous rotation. The projected rotational velocities of the secondary and tertiary are 32 ± 3 km s^{-1} and 50 ± 3 km s^{-1}, respectively. The secondary's rotation is consistent with synchronism for radii calculated from evolutionary models. For radii derived from the observed luminosity, the secondary is slightly subsychronous, though the uncertainties in this empirical radius determination permit synchronism. We identify a candidate solution for the secondary which is reasonably consistent with the dynamical mass, the spectroscopically determined luminosities, synchronous rotation, and the 1.6 $M_\odot$ evolutionary track of Swenson *et al.* (1994) at an age of 3 million years.

Accepted by Astron. J.

Interstellar Alcohols

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We have investigated the gas phase chemistry in dense cores heated by nearby stars where ice mantles containing ethanol and other alcohols have been evaporated. Model calculations show that methanol, ethanol, propanol and

butanol drive a chemistry leading to the formation of several large ethers and esters. Of these molecules, methyl ethyl ether ($CH_3OC_2H_5$) and diethyl ether ($C_2H_5OC_2H_5$) attain the highest abundances and should be present in detectable quantities within cores rich in ethanol and methanol. Gas phase reactions act to destroy evaporated ethanol and a low observed abundance of gas phase C_2H_5OH does not rule out a high solid phase abundance. Grain surface formation mechanisms and other possible gas phase reactions driven by alcohols are discussed, as are observing strategies for the detection of these large interstellar molecules.

Accepted by The Astrophysical Journal, to appear July 20, 1995

Modeling Line Profiles of Protostellar Collapse in B335 with the Monte Carlo Method

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A collapsing dark cloud core, B335, is modeled as an inside-out collapse. The radiative transfer code uses the Monte Carlo method and new collision rates for CS. Line profiles for several observed transitions of CS and H_2CO are computed. We confirm that a double peaked spectrum with a stronger blue peak is a good qualitative signature of infall. Compared to the models using the LVG method by Zhou et al., our best-fit model using the Monte Carlo method has 20% smaller infall radius, 70% larger CS abundance, and 30% larger H_2CO abundance. Also, infall radii found from CS and H_2CO agree better than they did in the modeling by Zhou et al. Our model also produces off-center spectra close to the observations.

To appear in The Astrophysical Journal, 1995 August 1

SAO 206462 - A solar-type star with a dusty organically rich environment

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We report photometric, polarimetric and spectroscopic observations of SAO 206462 in the optical, near infrared and sub-millimetre. The system has near- and far-infrared excesses and emissions from atomic hydrogen and PAH molecules. We interpret these data and the IRAS far-IR photometry in terms of a dusty environment around the star. SAO 206462 is unique in being a solar-type Vega-excess star with an organic component to its surrounding dust.

Accepted by MNRAS

The Sagittarius B2 Star-forming Region: I. Sensitive 1.3 cm Continuum Observations

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The radio continuum toward the Sgr B2 region of star formation has been imaged at a wavelength of 1.3 cm with a spatial resolution of 2000 AU (0.25 arcsec) and a sensitivity of 0.4 mJy beam^{-1}. These high quality images show many newly detected continuum components and reveal remarkable features associated with several previously known H II regions. Current models of ultracompact H II regions are discussed within the context of these new data. The images detail 49 individual continuum components within the Sgr B2 complex. Half of these have diameters < 5000 AU, including several unresolved components (diameters < 2100 AU). These H II regions may be explained by a disk photoevaporation model. There are many asymmetrically bright shell-like and arc-like H II regions in Sgr B2. The asymmetries observed in the 1.3 cm continuum from these shell-like and arc-like H II regions correspond to gradients in the 20 cm $\rightarrow$ 1.3 cm spectral indices, reflecting gradients in the electron densities within many of these H II regions. These shell- and arc-like sources may be best described by an "improved" champagne flow model, incorporating stellar winds and significant gradients in the density of ambient neutral material. Numerous filamentary structures are seen in images of the long-tail cometary H II region Sgr B2 I. At least three components are identified in the tail region

exhibiting two different position angles on the plane of the sky. The morphology may result from an interaction between the ionized gas of Sgr B2 I and external winds which originate within the nearby Sgr B2 F cluster of H II regions.

Accepted by Ap.J.

Does near-infrared polarimetry reveal the magnetic field in cold dark clouds?

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We present near infrared (*J,H,K*) observations of the polarization of background starlight seen through the filamentary dark cloud L1755. The mean position angle and dispersion of the polarization vectors measured in the near-infrared, for stars along lines of sight passing through the densest portions ($1 < A_V < 10$ mag) of L1755, are virtually identical to those in an optical polarization map of stars around the *periphery* ($A_V \approx 1$ mag) of L1755. Furthermore, the percentage of polarization is not seen to increase, at all, with extinction in the near-infrared observations. We surmise that much of the dust in the dark cloud is *extinguishing* background starlight significantly, but not polarizing it efficiently; and thus that the *polarization map of background starlight cannot reliably trace the magnetic field associated with the dense interior of the dark cloud.* Our results in L1755 are remarkably similar to what we found in the dark cloud B216-217 (Goodman et al. 1992), which also shows no change in the polarization map associated with the cloud, and no rise in percentage polarization with extinction.

Using our multi-wavelength polarimetric observations of L1755, we have estimated the wavelength of maximum polarization, $lamdba_{\rm max}$, for most of the 53 stars in our sample. We find an unusually broad distribution of $lamdba_{\rm max}$, with a mean at mm. The large range of $lamdba_{\rm max}$ leads us to the hypothesis that there is a wide range of grain sizes and/or shapes along the lines of sight through L1755. We conclude that only a small subset of grains is responsible for producing the polarization of background starlight, and that these grains may be critically underrepresented in the dense interiors of cold dark clouds.

Accepted by Astrophys. J.

An Infrared Spectroscopic Survey of the ρ Ophiuchi Young Stellar Cluster: Masses and Ages from the H-R Diagram

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We have conducted near-IR spectroscopic observations of young stellar objects (YSOs) in the ρ Ophiuchi dark cloud (L1688), many of which are optically invisible. We present equivalent widths of K band spectral features for 34 YSOs, and we determine their spectral types, stellar luminosities, and extinctions. A subset of 19 YSOs with small near-IR excesses are placed in the H-R diagram, and we estimate their masses and ages via comparisons to pre-main-sequence (PMS) stellar models. These objects are apparently very young, low-mass, PMS stars. The median stellar age is about 3×10^5 yr according to modern PMS models. Most stars in the cloud core are certainly less than 3×10^6 yr old and probably less than 10^6 yr old. The sample spans a mass range 0.1 – 2.5 $M_\odot$, with a median mass of 0.4 – 0.5 $M_\odot$. Combining these results with previous photometric studies, we find the distribution of masses in the ρ Oph cloud core to be consistent with the initial mass function of field stars in the solar neighborhood. In addition, we find that this IR population is significantly younger and more coeval than the optically visible weak line T Tauri stars found in a much larger region encompassing the core. This study quantitatively confirms previous results which suggested that a very young, low-mass cluster is forming in the ρ Oph cloud core. The technique of IR spectroscopy has proven

valuable in compiling a detailed picture of star formation in this deeply embedded cluster of young stars.

Accepted by The Astrophysical Journal

Observational Constraints on FU Ori Winds

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We have searched for velocity shifts in the photospheric lines of four FU Orionis objects which could show that their winds originate from the surfaces of pre-main sequence accretion disks. We confirm the pattern of photospheric line shifts in FU Ori first observed by Petrov and Herbig, in which increasingly strong photospheric lines are increasingly blueshifted as the two absorption components move closer together in wavelength. We show that this pattern is precisely that predicted by a disk wind model: the profiles of the weaker lines exhibit mostly Keplerian rotation, and thus should show nearly-symmetric double-peaked absorption, while the stronger lines, formed further out in the expanding wind, are more blueshifted and less double-peaked. These observations provide at present the only direct evidence for a continuously accelerating wind originating from the surface of a pre-main sequence disk. Similar velocity shifts are not observed in the photospheric lines of V1057 Cyg, V1515 Cyg, and Z CMa, even though all exhibit strong blueshifted absorption in the Na I and Hβ line profiles. We suggest that the Na I and Hβ lines are generally saturated and thus not sensitive measures of mass loss rates, and that V1057 Cyg and V1515 Cyg have smaller mass loss rates than FU Ori. Z CMa may have a mass loss rate similar to that of FU Ori, but photospheric velocity shifts may be less apparent because Z CMa has a higher projected rotational velocity. Our estimates of mass loss rates do not support the "extreme" wind model, in which all of the angular momentum needed for accretion is removed by the wind.

Accepted by Astron. J.

Hamilton Echelle Spectra of Young Stars II: Time Series Analysis of Hα Variations

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We present the results of time series analysis on the Hα profile variations in 7 T Tauri stars (TTS). All stars show strong line profile variability. Included in the data are 37 almost fully contiguous nights of profile data on 5 TTS. For these stars (T Tau, RY Tau, DF Tau, DR Tau, and RW Aur) our temporal sampling is adequate to look for periodicities. We detect periodic variations on the red side of the profile near the peak of the line in two of our stars (7.3 days in DF Tau and 5.1 days in DR Tau). The periods recovered and the location in the line profiles displaying the periodicity do not provide the convincing support for magnetocentrifugally controlled accretion and wind generation which SU Aur exhibited. The other stars show no evidence for periodic profile behavior.

Correlation analysis shows that the blue-shifted absorption component of the line profile visible in most of these stars varies on a longer timescale and is basically uncorrelated with the rest of the line profiles. We interpret this as evidence for this feature forming far from the star and that the velocity of this feature indicates the terminal velocity of the flow from TTS seen in Hα, which is substantially below escape velocity. We find that TTS Hα profile variations are not due to global changes in the physical parameters of the wind and accretion flows surrounding these stars but instead represent smaller-scale stochastic variability. Changes in the profiles tend to occur in discrete velocity patches rather than across the whole line. Over most of the profile the timescale for this tends to be less than two days. While of the general nature of a "stochastic wind", the variations differ substantially in detail from a model which has been proposed for this. A new result is the common appearance of variance peaks on the red side of Hα as well. These peaks are likely indirect evidence of variable accretion seen in this line, which rarely shows overt red-shifted absorption.

Accepted by The Astronomical Journal

The extended structure of the HH 30 jet and other Herbig-Haro objects in the HL Tauri region

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We present a deep, wide-field ($\sim 10' \times 10'$) [SII] $\lambda\lambda$ 6717, 6731 image of the HL Tauri region. This image reveals a spatially extended emission region, previously undetected, which is aligned with the HH 30 jet and counterjet, ending in a bow-shaped structure to the NE. We also detect HH 266, a second bow-shaped structure which might correspond to the NE head of the jet emanating from HL Tauri. Our image also includes HH 262, which is shown to have a previously undetected extended emission region.

Accepted by Monthly Notices of the Royal Astronomical Society (Pink Pages)

Large Proper Motions and Ejection of New Condensations in the HH 80-81 Thermal Radio Jet

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The HH 80-81 complex is the largest and most powerful stellar jet system of high collimation known. We have obtained second-epoch (1994.3) VLA observations of the HH 80-81 thermal radio jet and compared them with previous observations made 4.1 years before (1990.2). Both sets of observations were made at 3.5 and 6-cm with an angular resolution of $\sim 0\farcs3$. Large proper motions have been detected in the condensations along the jet. These proper motions are in the range of 70-160 mas yr^{-1}, equivalent to 600 to 1400 km s^{-1} at the distance of 1.7 kpc of the source. Such large velocities have not been previously measured in the context of jets from young stellar objects, and give support to the identification of the powering source of this Herbig-Haro complex as a very massive star. Between the two epochs of observation an ejection event created two new knots in the jet flow, that in 1994.3 appear symmetrically projected at only 500 AU from the central source. The existence of significant clumpiness and symmetry in the jet so close to the star gives support to the notion that disturbances in stellar jets are produced by the driving source, and not as a result of instabilities produced later in the flow.

Accepted by Astrophysical Journal

The L1551NE Molecular Outflow

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L1551NE is a very young protostar (Class I or perhaps Class 0), located very close to L1551-IRS5. It is the second brightest far-infrared source in the Taurus molecular cloud complex, but its proximity to the brightest source IRS5 has prevented effective observations of any molecular outflow. We here present evidence that it does indeed possess an outflow, that the optical/infrared reflection nebula is associated with the blue-shifted outflow lobe, and that the L1551W outflow does not originate from L1551NE as has been suggested.

Accepted by ApJ Letters

Object 17: Another Cluster of Emission Line Stars Near the Galactic Center

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Infrared imaging and spectroscopic studies suggest that regions of recent massive star formation exist in the central region of the Galaxy. Here, we present $J(1.29\ \mu\mathrm{m})$, $H(1.67\ \mu\mathrm{m})$, $K(2.23\ \mu\mathrm{m})$, and $L'(3.82\ \mu\mathrm{m})$ broadband images as well as Brγ and Brα hydrogen recombination line images of the Object #17 detected in a near-infrared survey at a projected distance of 30 pc from the Galactic center. Our data show that this source is a cluster of luminous stars with emission lines. The line flux and width of these stars are similar to those of Of-type stars, Wolf-Rayet stars, and He I emission-line stars recently discovered in the central parsec of the Galaxy. However, although the He II line at 3.09 μm has been detected in Object #17, the He I line at 2.06 μm seems weak. The weakness contrasts with stars in the central parsec of the Galaxy. The broadband colors are consistent with the idea that the #17 cluster is near the Galactic center, and this consistency is further evidence for the recent occurrence of massive star formation near the Galactic center. It is possible that this cluster is responsible for the ionization of the thermal arched filaments observed in the radio.

Accepted by Astron. J., to appear in April 1995

IRAS 08159-3543 - Optical Detection of the Dusty, Neutral Bipolar Wind of a Luminous YSO

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We have detected by optical means the neutral bipolar wind from IRAS 08159-3543, a deeply embedded, luminous Class I YSO ($L \approx 2.410^4 L_\odot, A_V \geq 43$mag). The wind is observable because it carries huge amounts of dust flowing outwards in the bright lobes at $v_f \approx 570$km/s.The velocity field of the neutral flow was determined by longslit spectroscopy of the broad Hα line emitted by the ionized envelope near the unseen YSO and scattered by the moving dust. The velocity of the neutral flow far out in the lobes is nearly the same as the outflow velocity reached in the ionized envelope. Therefore, most of the outflowing material in the lobes must have been accelerated by the primary mechanism at work near the YSO. The ionized envelope is bisected in its equatorial plane by an optically thick layer; also, in the scattered spectrum of the YSO several chromospheric FeII emission lines are observed. These findings can be taken as evidence for an active accretion disk surrounding the YSO and driving the wind seen in the ionized envelope. The outflowing dust observed in the lobes may be carried along by a neutral wind leaving the outer (cooler) parts of the disk. We estimate the spectral type of the YSO (F...K) from the brightness and colour of the scattered continuum: in the H-R diagram the YSO is located far above the ZAMS and the theoretical stellar birth-line. The total mass loss in the neutral wind is $\dot{M} \approx 610^{-5}...210^{-4} M_\odot/yr$. The corresponding ratio $\dot{M/L}$ lies within the range derived from CO outflows (Levreault 1988). Thus, relative to the luminosity of the source, the neutral wind carries as much momentum as is observed in molecular outflows driven by YSOs of low and intermediate luminosity. Within a volume, whose total extent is about 0.5 pc, the neutral outflow in the lobes is interspersed with shock-ionized material (filling factor$\approx$ 0.04), wich moves outwards at about 1/4 of the speed of the neutral flow.

To appear in the Astrophysical Journal, August 1, 1995

Mass loss rates from HI infrared lines in Herbig Ae/Be stars

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We present results of the observations of infrared HI recombination lines (namely Paβ, Brγ, Brα, Pfγ and Pfβ) from 14 Herbig Ae/Be stars. From line luminosities, and using an ionized wind model, we have determined the wind mass loss rates of these stars. The values obtained are in the range 10^{-8} to 10^{-6} $M_\odot$ yr^{-1}. For those stars for which $\dot{M}_w$ has also been independently determined from CO observations, we find a reasonable agreement between the two estimates. We find a correlation between $\dot{M}_w$ and the star's bolometric luminosity, which is in agreement with previous results for Young Stellar Objects (YSOs): a similar relation holds also for classical Be stars, although at a significantly lower level, suggesting a continuity of the mass loss mechanism during the evolution of intermediate mass stars. ¿From the analysis of the correlation between mass loss rates and different indicators of the source stellar and circumstellar environment, we conclude that a proportionality between the mass loss rate and the stellar mass can account for the observed results.

Accepted by Astron. Astrophys.

Near-Infrared Imaging of the Herbig-Haro Object HH124.

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We report our findings from near-infrared imaging of the Herbig-Haro object HH124. The outflow driving source is found to be deeply embedded near the symmetry center of the outflow. This near-infrared source, which we identify with IRAS 06382+1017, is associated with an infrared reflection nebula. The reflection nebula morphology and the spatial distribution of H_2 emission in the vicinity of HH124D leads us to propose, as one possibility, the existence of two outflows. An alternate interpretation of the reflection nebula morphology is reflection off a dusty torus situated in the equatorial plane of IRAS 06382+1017. We also report a tentative detection of Brγ emission associated with IRAS 06382+1017. This emission may originate from the circumstellar accretion disk's boundary layer or from a stellar wind, and indicates that IRAS 06382+1017 is a young, active T Tauri star. The H_2 1-0 S(1) emission in HH124 is clumpy, especially in HH124C. The overall spatial distribution of the H_2 emission in the different shock fronts is consistent with emission on the wings of bow shocks with a higher shock velocity for HH124C than for HH124E.

Accepted by MNRAS

WFPC2 Imaging of the Circumstellar Nebulosity of HL Tauri

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Planetary camera images of HL Tauri have been obtained through V, R, and I band filters using the Wide Field and Planetary Camera 2 aboard the refurbished Hubble Space Telescope. These images show that HL Tauri is entirely reflection nebulosity at optical wavelengths, with no optical star visible to a limiting magnitude of V= 25.5. The

optical nebula extends NE of the stellar position along the direction of HL Tau's optical jet and has an unusual "letter C" morphology. The bright core of the nebula is only $1''$ in size, and is centered only $1.2''$ from the actual stellar position. We estimate that visual extinction toward the unseen point source is at least 22 mag, and that the stellar photospheric luminosity must be at least 3 $L_\odot$. These findings corroborate other evidence that this star is significantly younger and more embedded than typical T Tauri stars.

Accepted by Astrophysical Journal

The Star Formation Newsletter is a vehicle for fast distribution of information of interest for astronomers working on star formation and molecular clouds. You can submit material for the following sections: *Abstracts of recently accepted papers* (only for papers sent to refereed journals, not reviews nor conference notes), *Dissertation Abstracts* (presenting abstracts of new Ph.D dissertations), *Meetings* (announcing meetings broadly of interest to the star formation and interstellar medium community), *New Books* (giving details of books relevant for the same community), *New Jobs* (advertising jobs specifically aimed towards persons within our specialty), and *Short Announcements* (where you can inform or request information from the community).

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Dissertation Abstracts

X-ray emission of young solar type stars

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Ph.D degree awarded: December 1994

T Tauri Stars (TTS) are young ($\leq 10^7$ yrs) low mass ($\leq 2M_\odot$) stars. They have been originally characterized by strong emission lines (CTTS), and by IR excesses interpreted in terms of circumstellar disks. Ten years ago, the "Einstein" satellite discovered the extraordinary X-ray activity of young low-mass stars. This activity, presumably magnetic in origin, is interpreted in terms of solar type flares, but up to 10^5 times more powerful than on the Sun. It also allowed to discover a new class of T Tauri stars called "Weak line T Tauri Stars", without emission lines or IR excess and presumably without disk, which are 3 to 10 times more numerous than the CTTS. The ROSAT satellite, launched in 1990, has a much better resolution and sensitivity than "Einstein". This work is based on the first ROSAT observations of molecular clouds, which are the stellar nurseries.

1) ROSAT X-ray study of the Chamaeleon cloud (see also Feigelson et al. 1993, ApJ, 416, 623). Using an important sample of young stars (60) in the Chamaeleon I star forming region, we have studied the influence of various stellar parameters on the X-ray emission. We find unexpected correlations of the X-ray luminosity with the stellar mass, radius and luminosity, but we could not detect any effect of rotation or age. These results are still unexplained by the standard dynamo theory of generation of a magnetic field. We show that the X-ray luminosity fonctions are the same for CTTS and WTTS which indicates that the X-ray emission mecanism is independent of the circumstellar disk, and that the X-rays can be used as a homogeneous tracer of all TTS.

2) ROSAT X-ray study of the ρ Oph Cloud (see also Casanova et al., 1995, ApJ, 439, 752). We show that the X-rays do also detect sources deeeply embedded in molecular clouds which are certainly very young. In fact it seems that even protostars (age $\sim 10^5$ yrs) are detected. For the embedded sources we estimate the bolometric luminosity from the dereddened J (1.25 μm) magnitude, and we find the same correlation with the X-ray luminosity than for the visible stars of the Chamaeleon Cloud. Thanks to the near equality of the absorption in the keV X-ray and J bands we derive a relation between the X-ray counts and J magnitude which may be used as a selection criterion for the young stars. We also discuss the influence of the X-rays on the interstellar gas and dust.

3) Young stars far from dense cores. We then present the preliminary results of an on-going program of optical spectroscopy carried out at La Palma and ESO to caracterize the counterparts of new ROSAT sources far from the ρ Oph dense core. Thanks to the detection of the lithium absorption line and of the H_α emission line we classiify most of them as CTTS or WTTS. We show that great differences in the density of sources, in the WTTS/CTTS ratio and in the equivalent width of the lithium line exist between regions relatively close to one another in the sky. One possibility could be that these stars outside the dense core may be older, possibly "Post T Tauri" Stars, on their way to the main sequence.

4) Variability of the Xray emission of T Tauri stars. The last part of the thesis deals with the study of time variability of the X-ray emission of TTS. These sources show evidence of variabilility both in the form of rare strong events (eruptions) and of more subtle variations of the presumed "quiescent" emission. In some cases, we have access to the heating and cooling timescales which constrain some parameters of the plasma confined in flare loops. It is important to note that the X-ray emission of all strong sources is variable, which indicates that probably only the lack of statistics may prevent the detection of flares for the faint sources. Besides, a circumstellar disk has no influence on the variability of the star.

In conclusion, X-ray are necessary to have access to the total population of young solar-type stars. They should allow to understand better the process of stellar formation and the evolution from the protostar down to the main sequence.

The Occurrence of H_2O Maser in H II regions

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It is well known that 22.2 GHz water maser sources are associated with young star forming regions and that the conditions for the onset of the maser phase are already set in the evolutionary stages in which high density ionized gas can be detected. The main question approached with the present work was to see whether water maser emission continues up to the stage in which a diffuse H II region becomes observable. In order to study the occurrence of water maser in these evolutionary stages, a sample of 462 classic H II regions (defined as those which have already entered the diffuse stage) has been chosen to be investigated through a search for maser emission performed with the 32-m radiotelescope of Medicina (Italy). It has been found 68 water maser sources, 17 of which are new detections. The overall maser percentage is low (19%), much less than what found in samples of ultracompact (UC) H II regions. The percentage changes if the sample is divided into two sub-classes: H II regions known to have ultracompact components (i.e. where a younger generation of star formation is also present) and the rest. In the first sub-class the maser percentage is 28%, in the second 15%. Moreover, in apparent contrast with the common belief that galactic H_2O masers are always found associated with H II regions, if one considers all the H_2O masers of star forming type, the majority (80%) are without any known diffuse H II region. In order to see if these sources represent a homogeneous sub-class in an earlier evolutionary phase in which a diffuse H II region has not yet formed a search for H89α (3 cm) hydrogen recombination line towards a sub-sample of 60 of these masers has been performed with the NRAO 43-m radiotelescope of Green Bank (USA). The detection rate is very low: only 2 sources (3%) show recombination line emission. In order to explain this low detection rate, possible selection effects have been examined, such as sensitivity of the recombination line observations, or lack of ionized gas because of the low luminosity of the associated star. Although both effects can play some role, by no means can they account for the large number of masers without associated diffuse H II regions. The most probable answer is that masers form very early, much before the formation of a diffuse H II region, and spend most of their life in this evolutionary stage. In conclusion, the 20% positional agreement between H II regions and water masers found in low resolution (arcmin) surveys may simply reflect that more than one star-formation event (i.e. the formation of a new maser) occurs in a stellar cluster and that these are spread over an extended period, longer than that required by the first massive stars of the cluster to develop their own H II regions. In this thesis, the investigation of the association between H II regions and IRAS point sources has been also reported. To distinguish the true IRAS counterpart of the H II region from chance coincidences the distribution of offset and the position in colour-colour plots as a function of the F(60 μm) have been studied. It has been found that sources with 60 μm flux density less than 100 Jy have a high probability of being chance coincidences. The majority of the IRAS counterparts satisfy the Wood and Churchwell colour criteria which identify ultracompact H II regions; therefore, these criteria select ultracompact as well as more diffuse H II regions

Morover, another related research effort has been reported in the thesis: a search for water maser emission at 22.2 GHz has been performed with the Medicina antenna towards 160 IRAS sources selected using the Wood & Churchwell colour criteria to identify high-mass star forming regions. The aim of the survey was to verify the existence of a substantial variation of the maser detection rate within the Wood & Churchwell sample, and to estimate its possible contamination due to spurious sources. Out of the whole sample, water maser emission was found in only 11 sources (7%), 2 of which for the first time. There is a strong dependence of the maser occurrence on the IRAS flux density at 60 μm: the rate drops from $\sim$24% for sources brighter than 100 Jy to $\sim$1% for weaker sources. These results, combined with those found in previous surveys, indicate that it is very unlikely that the population of weak IRAS sources with shallow far-infrared continuum spectra is associated with high-mass star forming regions. Since these sources account for about 50% of the total number of the IRAS PS located inside the Wood & Churchwell colour box, the predicted population of OB-type stars may have been overestimated by a factor up to 50%.

Stellar X-Ray Emission in the Orion Nebula Region

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Ph.D degree awarded: December 1994

Results from two extensive X-ray imaging surveys of the Orion Nebula are presented. In 6 *Einstein* High Resolution Imager (HRI) and 17 Imaging Proportional Counter (IPC) images of a roughly 4.5 square degree region, 245 distinct X-ray sources have been detected. In three *ROSAT* HRI images of a 0.8 square degree region, 389 distinct X-ray sources have been detected, $\gtrsim \frac{2}{3}$ of which are associated with a single proper-motion cluster member. The hot main-sequence O6-B5 stars detected in Orion have X-ray activity levels comparable to field O and B stars. X-ray emission has also been detected in the direction of a handful of main sequence late-B and early-A stars. Since the mechanisms producing X-rays in late-type coronae and early-type winds cannot operate in the late-B and early-A type atmospheres, it is argued that the observed X-rays are probably produced in the coronae of unseen late-type binary companions. When plotted in an X-ray luminosity versus bolometric luminosity diagram, late-type PMS stars lie below a "saturation" line corresponding to $L_{\rm X}/L_{\rm bol} \sim 10^{-3}$. The late-G, K, and M-type stars exhibit a nearly two orders-of-magnitude spread in X-ray luminosity and in $L_{\rm X}/L_{\rm bol}$ at a given effective temperature. Plots of X-ray activity versus $v \sin i$ rotational velocity and rotational period appear to show no clear dependance of activity on rotation. However, because of biases and uncertainties in the X-ray and optical samples, the data are not conclusive on this point. *ROSAT* light curves of the detected X-ray sources have revealed at least 10 strong X-ray flares with energies in excess of 3×10^{35} ergs.

New Books

Clouds, Cores and Low Mass Stars

Edited by Dan P. Clemens and Richard Barvainis

These are the proceedings of the Fourth Haystack Observatory Conference held at Haystack Observatory, Westford, Massachusetts on 18-20 May 1994.

The book is divided in five sections:
I. Cloud Core Properties
II. Models of Cloud Core Formation, Evolution, and Collapse
III. Observations of Core Collapse and Protostars
IV. The Protostellar Environment
V. Winds, Jets, Disks, and Outflows

Among the papers presented are:
Dense Cores: Locations and Densities (G.A.Fuller)
Properties of Dark Cloud and Warm Cloud Cores (L.G.Mundy)
Velocity Structure in Dense Cores (A.A.Goodman & J.A.Barranco)
Observations of Magnetic Fields in Molecular Cloud Cores (R.M.Crutcher)
A Guide to Isothermal Gravitational Collapse (P.Foster)
Fragmentation and the Formation of Binary and Multiple Systems (I.A.Bonnell)
Hierarchical Star Formation (R.B.Larson)
Self-Initiated Formation and Evolution of Protostellar Cores in Magnetically Supported Molecular Clouds (T.Ch.Mouschovias)
Kinematic Signatures of Protostellar Collapse (S.Zhou & N.J.Evans II)
Class 0 Protostars (M.Barsony)
The Protostellar Environment: Millimeter and Submillimeter Continuum Emission (C.J.Chandler, J.E.Carlstrom & S.Terebey)
Bolometric Temperature and Young Stars in the Taurus and Ophiuchus Complexes (H.Chen, P.C.Myers, E.F.Ladd, D.O.S.Wood)
The Power of Polarized Imaging at Infrared Wavelengths (D.A.Weintraub, J.H.Kastner, P.Lowrance)
Disk Winds (L.Hartmann & N.Calvet)
Entrainment by Stellar Jets (S.W.Stahler)
Wind Driven Outflows: Disks and Stellar Spins (R.E.Pudritz & A.Dudorov)
Observational Constraints on Outflow Models (C.R.Masson & L.M.Chernin)
Near Infrared Luminosity Functions of Embedded Clusters (E.A.Lada)

Astronomical Society of the Pacific Conference Series, Vol. 65
1994, 436pp. ISBN 0-937707-84-8.
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Stellar and Circumstellar Astrophysics

Edited by G.Wallerstein and A.Noriega-Crespo

These are the proceedings of a conference held at the University of Washington, on 9-11 September 1993, in honor of the 70th birthdays of Karl-Heinz Böhm and Erika Böhm-Vitense

The book is divided into eight sections:
I. Setting the Scene
II. T Tauri Stars
III. Herbig-Haro Objects
IV. Jets
V. Winds and Chromospheres
VI. Cepheid Variables
VII. Planetary Nebulae
VIII. White Dwarfs

The papers related to star formation are:
Sub-Arcsecond Spectroscopic Imaging of Mass Outflows in the Vicinity of Their Stellar Sources (J.Solf)
Forbidden Emission Lines of T Tauri Stars as Tracers of Their Jets and Disk Winds (G.A.Hirth)
The Herbig-Haro 1-2 System Revisited (R.D.Schwartz)
Entrainment of Molecular Gas in Herbig-Haro 47 (J.Raymond et al.)
Proper Motions in Herbig-Haro Objects (J.Eislöffel)
Variability in the Ultraviolet of Herbig-Haro 1 and 2 (A.Noriega-Crespo & J.Solf)
Beyond Herbig-Haro 7-11: Another Look at the Interstellar Environment of Molecular Outflows (J.Schmid-Burgk & D.Muders)
Models of Jets from Young Stars (A.C.Raga)
Low-Excitation Herbig-Haro Objects (P.Hartigan)
Blue Spectroscopy of the Herbig-Haro 111 Jet (A.Noriega-Crespo et al)

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Infrared Cirrus and Diffuse Interstellar Clouds

Edited by R.M.Cutri and W.B.Latter

These are the proceedings of a conference held 7-9 April 1993 in Tucson, Arizona.

The book is divided into seven sections:
I. Absorption and Scattering in Diffuse Interstellar Clouds
II. Infrared Spatial and Spectral Studies
III. Molecular Line and HI Studies of Interstellar Clouds
IV. Cirrus in External Galaxies
V. Dust and Organic Matter in Diffuse Interstellar Clouds
VI. Cloud Chemistry
VII. Cloud Energetics and Dynamics

Among the papers presented:
Very High Resolution, High Signal-to-Noise Spectroscopy of Diffuse Interstellar Bands (J.Krelowski & C.Sneden)
Variability of Interstellar Extinction and Its Relationship to Environment (J.A.Cardelli)
Optical Studies of High Latitude Dust (P.Guhathakurta & R.M.Cutri)
X-ray Shadows of Cirrus Clouds (U.Mebold et al.)
A Comparison of the Diffuse Clouds in Front of ζ Oph and σ Sco (T.P.Snow & J.Krelowski)
Dust and Gas in the Infrared Cirrus (F.Boulanger)
Molecular Line Surveys at High Galactic Latitudes (L.Magnani)
Dust in Diffuse Interstellar Clouds (B.T.Draine)
Tiny Grains, Large Molecules, and the Infrared Cirrus (K.Sellgren)
Infrared Spectroscopy of Organic Material in Diffuse Clouds (Y.J.Pendleton)
The Physics and Chemistry of Cirrus Cloud Cores and Other Translucent Clouds (B.E.Turner)
Photochemistry and the Interstellar Radiation Field (E.F.van Dishoeck)
Energy Budgets of Diffuse Clouds (J.H.Black)
Dynamics of Interstellar Clouds: Turbulence, Shocks (E.Falgarone)
Magnetic Effects in Diffuse Clouds (B.G.Elmegreen)

Astronomical Society of the Pacific Conference Series, Vol. 58
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Cool Stars, Stellar Systems, and the Sun
Eight Cambridge Workshop

Edited by J.-P. Caillault

These are the proceedings of the eight Cambridge Workshop on Cool Stars, Stellar Systems and the Sun, held in Athens, Georgia, USA during October 11-14, 1993.

The book is divided into eight sections:
I. Results of Recent Space Missions
II. Angular Momentum Evolution
III. Lithium Abundances
IV. Evolution of Magnetic Activity in the Sun and Stars
V. The Ages, Masses and Positions of Cool stars in the HR Diagram
VI. Infrared Spectroscopy
VII. High-Resolution Imaging
VIII. Additional Contributions

The following invited reviews are presented:
Doing Hot Cool Star Science with EUVE (B.Haisch et al.)
EUVE Photometry Observations of Cool Stars (P.W.Vedder et al.)
Coronal and Transition Region Spectroscopy of Cool Stars using EUVE (A.Brown)
The Rotational Evolution of Low-Mass Pre-Main Sequence Stars (J.Bouvier)
The Angular Momentum Evolution of Young Main Sequence Stars (J.R.Stauffer)
Angular Momentum Evolution of Late-Type Stars: A Theoretical Perspective (K.B.MacGregor & P.Charbonneau)
Li Abundances and Surface Rotation: Evolution from Pre-Main Sequence Phases to the ZAMS (S.E.Strom)
Lithium on the Main Sequence (S.Balachandran)
Lithium, Activity and Post-Main-Sequence Evolution (R.Pallavicini)
Stellar Evolution and Lithium (M.H.Pinsonneault)
Characteristic Signatures of Solar Activity from the Small Scale Magnetic Field (S.R.Habbal)
The Time Evolution of Magnetic Flux, Dynamos, and Surface Structures on Cool Dwarfs (S.H.Saar)
Activity and Braking of Evolving Cool Stars (C.J.Schrijver)
Perspectives on the Relationship between Activity and Fundamental Stellar Parameters (M.S.Giampapa)
The Parameters of M Dwarfs (J.Liebert)
Astronomy on the Edge: The Physical Theory of Brown Dwarfs and Late M Dwarfs (A.Burrows et al.)
Infrared Spectroscopy of Young Stellar Objects (J.S.Carr)
Some Recent Advances in Iterative Blind Deconvolution (S.M.Jefferies)
Stellar Surface Mapping by Matrix Lightcurve Inversion (W.J.Wild et al.)
Interferometric Imaging of Cool Stars: Progress & Potential (H.A.McAlister)

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Meetings

First Franco-British Meeting on the Physics and Chemistry of the Interstellar Medium

July 10-12, 1995

Université des Sciences et Technologies de LILLE (France)

The meeting aims to bringing together physicists, chemists and astronomers involved in both modelling and observations, who share a common interest in the following:

- o Observations and their means
- o Spectroscopy of molecules, radicals and ions
- o Gas phase rate constants
- o Photon-induced reactions
- o Chemical modelling of astrophysical objects
- o Chemistry on grains, surface reactions
- o Dust properties and laboratory analogues

The oral programme will consist of 9 reviews and 18 contributions. These will be supplemented by poster sessions. The oral contributions will be selected, in part, on the basis of abstracts of poster papers received by the deadline, 1 May 1995.

Review Speakers:

M. Baguhl (Max-Planck-Institut für Kernphysik, Heidelberg)
In-situ measurements of interstellar dust grains with the Ulysses and Galileo dust detectors.
J.H. Black (University of Arizona, Tucson)
Molecular environments in astrophysics.
M. Bogey (Université des Sciences et Technologies de Lille)
Recent observations of transient species in the laboratory: carbon and silicon compounds.
Y. Ellinger (Ecole Normale Superieure, Paris)
Quantum-chemical calculations aimed at the detection of astrophysical molecules.
D. Gauyacq (Université de Paris-Sud) [to be confirmed]
Laboratory studies of photodissociation and photoionization processes.
E. Herbst (Ohio State University)
Recent interstellar models: how secure are the predictions?
G. Pineau des Foréts (Observatoire de Paris)
Chemistry in Shocks; the gas-grain interface.
I. Smith (University of Birmingham)
Laboratory measurements of important astrophysical reactions between neutral species.
M. Walmsley (Universität zu Köln)
Observations of outflows from young stars.

Scientific Organizing Committee:
P.Brechignac, D.R.Flower, E.Roueff, D.Field, J.-L.Destombes, C.S.Jeffery - on behalf of the scientific committees of the French Groupement de Recherche sur la Physico-Chimie del Mol'ecules et des Grains Interstellaires (PCMGI, CNRS) and the British Collaborative Computational Project on the Analysis of Astronomical Spectra (CCP7, PPARC).

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