THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar evolution and molecular clouds

No. 59 — 26 Aug 1997 Editor: Bo Reipurth (reipurth@casa.colorado.edu)

Abstracts of recently accepted papers

Bending Instabilities in Magnetized Accretion Discs

Vasso Agapitou[1], John C.B. Papaloizou[1] and Caroline Terquem[2,1,3]

[1] Astronomy Unit, School of Mathematical Sciences, Queen Mary & Westfield College, London E1 4NS, UK
[2] Lick Observatory, University of California, Santa Cruz, CA 95064, USA
[3] Laboratoire d'Astrophysique, Université Joseph Fourier/CNRS, BP 53, 38041 Grenoble Cedex 9, France

E-mail contact: V.Agapitou@qmw.ac.uk

We study the global bending modes of a thin annular disc subject to both an internally generated magnetic field and a magnetic field due to a dipole embedded in the central star with axis aligned with the disc rotation axis. When there is a significant inner region of the disc corotating with the star, we find spectra of unstable bending modes. These may lead to elevation of the disc above the original symmetry plane facilitating accretion along the magnetospheric field lines. The resulting non-axisymmetric disc configuration may result in the creation of hot spots on the stellar surface and the periodic photometric variations observed in many classical T Tauri stars (CTTS). Time–dependent behaviour may occur including the shadowing of the central source in magnetic accretors even when the dipole and rotation axes are aligned.

Accepted by Monthly Notices of the Royal Astronomical Society

HTML and PostScript files available: http://www-star.qmw.ac.uk/∼va/

Molecular clouds are not fractal: a characteristic size scale in Taurus

Leo Blitz[1] and Jonathan Williams[2]

[1] Department of Astronomy, University of California at Berkeley, CA 94720, USA
[2] Harvard–Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA

E-mail contact: blitz@gmc.berkeley.edu; jpw@cfa.harvard.edu

A simple, robust method of determining whether molecular clouds are fractal is described. The method is applied to the Taurus Molecular Cloud which is shown to exhibit a change in the character of the structure on a scale of 0.25 – 0.5 pc, close to the thermal Jeans length at the gas densities probed by ^{13}CO. The method is applicable to any data cube of optically thin emission.

Accepted by the Ap. J. Letters

Preprint available at: http://cfa–www.harvard.edu/∼jpw/papers.html

Radio Emission from ROSAT Discovered Young Stars in and Around Taurus-Auriga

Lee Carkner[1], Eric Mamajek[1], Eric Feigelson[1], Ralph Neuhäuser[2], Rainer Wichmann[3] and Joachim Krautter[3]

[1] Department of Astronomy & Astrophysics, Pennsylvania State University, University Park PA 16802, USA
[2] Max-Planck-Institut für extraterrestrische Physik, D-85740 Garching, Germany
[3] Landessternwarte Königstuhl, D-69117 Heidelberg, Germany

E-mail contact: acarkner@astro.psu.edu

An 8.4 GHz VLA survey of 91 recently discovered lithium-rich late-type stars from the *ROSAT* All-Sky Survey and pointed observations is presented. These objects lie in the vicinity of the Taurus-Auriga star-forming region (d $\simeq$ 140 pc), however some are dispersed nearly 30° from known active star-forming cloud cores. This sample represents a spatially-complete, flux-limited population of X-ray bright young stars both within and away from the primary Tau-Aur stellar nurseries. Of the 91 sources, 29 are detected in this radio survey with a sensitivity limit of ~0.15 mJy. If they are at the distance of the star forming clouds, we find 32% of widely distributed young stars with $L_X \geq 5{\times}10^{28}$ ergs s^{-1} have radio luminosity densities in excess of $3.5{\times}10^{15}$ erg $s^{-1}Hz^{-1}$. This detection rate, the ranges of radio and X-ray luminosities and L_R/L_X ratios are consistent with known young weak-lined T Tauri stars (ages $\sim 10^6$ yr) which reside *within* the Taurus molecular clouds, but is considerably higher than a zero-age main sequence population such as the Pleiades (age $\simeq 7{\times}10^7$ yr). The radio properties thus support the pre-main sequence classification of the stars. They fit well among other active young stars on the empirical L_R vs. L_X diagram, implying that solar type gyro-synchrotron activity is the radio emission mechanism.

Accepted by ApJ

Available on the WWW at: http://www.astro.psu.edu/users/carkner/ttauri/intro.html

Detection of 7 mm Sources near Cometary HII Regions

Patricia Carral[1], Stan E. Kurtz[2], Luis F. Rodríguez[2], Chris De Pree[3] and Peter Hofner[4]

[1] Departamento de Astronomía, Universidad de Guanajuato, Apdo. Postal 144, 36000, Guanajuato, Gto., MEXICO
[2] Instituto de Astronomía, UNAM, Apdo. Postal 70-264, 04510 México, D.F., MEXICO
[3] Agnes Scott College, Decatur, GA 30030
[4] Arecibo Observatory, P. O. Box 995, Arecibo, PR 00613

E-mail contact: patricia@astro.ugto.mx

We present 7 mm VLA observations of five ultracompact HII regions of cometary morphology that have H_2O masers near their cometary arcs. We detect 7 mm sources near two of these, NGC 6334F and G75.78+0.34. In the latter case, the emission coincides with the cluster of H_2O masers. We discuss the possibility that the observed 7 mm emission could be produced by warm dust condensations or optically thick ultracompact HII regions. Additional studies are required to firmly establish the nature of the emitting sources which may be tracing the very early stages of massive star formation. The presence of such young objects near the head of cometary ultracompact HII regions may favor, in these cases, either the champagne model or a mass-loading model as explanations for the radio continuum morphology.

Accepted by Ap J Letters

Chemical models of interstellar gas-grain processes-III. Molecular depletion in NGC 2024

S. B. Charnley[1,2]

[1] Astronomy Department, University of California, Berkeley, CA 94720, U.S.A.
[2] Space Science Division, MS 245–3, NASA Ames Research Center, Moffett Field, CA 94035, U.S.A.

E-mail contact: charnley@dusty.arc.nasa.gov

The chemistry arising from the exchange of molecules between dust and gas in ultradense ($n_{\rm H} \geq 10^7{\rm cm}^{-3}$) cool cores is described. Under certain assumptions concerning molecule-grain binding energies and dust temperature, slight warming of cold dust grains can induce selective desorption of mantle volatiles. It is theoretically possible for ultradense cores to become depleted in CO but to remain abundant in N_2 and so be relatively rich in nitrogen-bearing molecules. This effect may explain the apparent depletion of CO and the presence of ammonia in several cores within the NGC 2024 cloud. The theory implies that heavy metal atoms should be almost entirely absent from the gas phase of high density cores, and that a mantle of CO, O_2, N_2 and other weakly-bound molecules should cover water ice mantles, forming a 'volatile crust'. Molecular observations are suggested which will allow a test of this model.

Accepted by M.N.R.A.S.

Kinematics and Evolution of the Giant HH 34 Complex

D. Devine[1], J. Bally[1], B. Reipurth[2] and S. Heathcote[3]

[1] CASA, Univ. of Colorado, CO 80309, USA
[2] European Southern Observatory, Casilla 19001, Santiago 19, Chile
[3] Cerro Tololo Inter-American Observatory, Casilla 603, La Serena, Chile

E-mail contact: devine@casa.colorado.edu

We present morphological and kinematic evidence that the HH34 protostellar outflow extends symmetrically about the HH34 source for roughly 1.5 parsecs, and has a total length of at least 3 parsecs. The northern components of the flow (HH34N, HH126, HH85, HH33 and HH40) are all red shifted, while the southern components (HH34, HH34X, HH173, HH86, HH87 and HH88) are all blue shifted. The northern and southern components are symmetrically placed relative to the driving source HH34 IRS, and their radial velocities are symmetric relative to the radial velocity of the cloud core containing HH34 IRS. The magnitude of the radial velocity tends to decrease with increasing distance from HH34 IRS. Proper motions of some of the components (HH33, HH40, HH85A, HH86A, HH86B, HH87 and HH88) were also determined and are consistent with the single flow hypothesis; the proper motions of knots north of the HH34 source are directed to the northwest, while those to the south are directed to the southeast. The proper motions also tend to decrease with increasing distance from the HH34 source. The dynamic age of the flow is at least 10^4 years. We propose that the parsec-scale chain of Herbig-Haro objects in the HH34 system is powered by a time variable, quasi-episodic jet and discuss the the expected behavior of the resulting shock structures over the lifetime of the flow.

Accepted by Astron. J.

The Initial Stellar Mass Function from Random Sampling in a Turbulent Fractal Cloud

B.G. Elmegreen

IBM Research Division, T.J. Watson Research Center P.O. Box 218, Yorktown Heights, NY 10598, USA

The initial mass function (IMF) for stars is proposed to result from two distinct physical processes that determine its shape separately in two intervals of mass: random sampling of mass in a fractal cloud gives the power law portion at intermediate to high mass, and insufficient self-gravity at the local temperature and pressure gives the cutoff at low mass. The entire function is modelled numerically, with the assumption that a star's mass is proportional to the mass of the piece of cloud in which it forms. The results typically give an IMF with the Salpeter value for the slope and a flattening at a low mass. There is little sensitivity to parameters at masses greater than the cutoff, although slightly shallower IMFs might be expected in regions with high levels of ionization and turbulence. The low mass cutoff is essentially the thermal Jeans mass in the star-forming cloud; models with a high value of this mass produce a truncated IMF similar to that proposed for starburst galaxies. The mass of the largest star increases with total stellar mass because of the stochastic nature of the model. The star IMF is steeper than the cloud mass spectrum because of competition for mass and the density dependence of star formation.

Accepted by Ap. J.

Is it possible to observe radiation of FUORs boundary layer?

L.Errico[1], S.A.Lamzin[2], M.Teodorani[1], A.A.Vittone[1], F.Giovannelli[3], C.Rossi[4]

[1] Osservatorio Astronomico di Capodimonte, Via Moiariello 16, I-80131 Napoli,Italy
[2] Sternberg Astronomical Institute, Moscow V-234, 119899 Russia
[3] Istituto di Astrofisica Spaziale, CNR, Via E.Fermi 21, C.P. 67, I-00044 Frascati (Roma), Italy
[4] Istituto Astronomico, Universita' "La Sapienza" di Roma, Via Lancisi 29, I-00161 Roma, Italy

E-mail contact: lamzin@sai.msu.su

We have estimated the optical depth of stellar wind of 3 FUORs (V1015 Cyg, FU Ori, Z CMa) in Balmer and Paschen continuum and conclude that it seems plausible that it exceeds unity. If so it is not possible in principle to observe optical and UV radiation from the innermost and the hottest regions of these objects – boundary layer of the accretion disk.

Accepted by Astronomy Letters

Carbon Monoxide and Dust Column Densities: The Dust to Gas Ratio and Structure of Three Giant Molecular Cloud Cores

Paul F. Goldsmith[1], Edwin A. Bergin[2], and Darek C. Lis[3]

[1] National Astronomy and Ionosphere Center, Department of Astronomy, Cornell University, Ithaca NY 14853, USA
[2] Harvard-Smithsonian Center for Astrophysics MS-66, 60 Garden Street, Cambridge, MA 02138-1596, USA
[3] California Institute of Technology, Downs Laboratory of Physics 320-47, Pasadena CA 91125, USA

Email contact goldsmit@astrosun.tn.cornell.edu

We have observed emission in the three lowest rotational transitions of the optically thin species $C^{18}O$ and the dust continuum emission at three millimeter/submillimeter wavelengths. By employing the proper combination of the intensities of the three lowest rotational transitions of $C^{18}O$, we can obtain the total molecular column density relatively independent of the density and temperature variations along the line of sight. We use the line and continuum data to determine column densities of the dust and gas across three Giant Molecular Cloud cores. We find that two of the three sources, M17 and Cepheus A, have the same gas column density to dust optical depth ratio, given by log[N($C^{18}O$)/τ(790 μm)] = 18.8. In the third source, Orion A, the gas to dust ratio is typically a factor of three lower than in the other two sources. The gas to dust ratio shows little variation across the region of M17 that we have mapped, and only a small (factor $\leq$ 3) drop at the center of Cepheus A relative to the cloud edge. We attribute an apparent drop in the gas to dust ratio around the IR sources KL and 1.5$'$ S in Orion to our not properly accounting for the much increased dust and gas temperature in the immediate vicinity of these embedded heating sources. We have good evidence for the correlation of the continuum emission in different bands for the Orion molecular cloud, and find the frequency dependence of the optical depth in the densest regions near the embedded sources to be given by $\tau \propto \nu^{1.9}$. For positions away from the embedded sources there is a larger scatter in the data points, with a suggestion that the frequency-dependence is steeper, such that $\tau \propto \nu^{2.4}$. This may be an indication of a change in the grain properties between less dense and very dense regions, and is consistent with the results of grain growth. Using standard values for the fractional abundance of $C^{18}O$ relative to H_2, the mean densities of the cloud cores are 3 - 5 $\times$ 10^4 cm^{-3} . These regions appear to be close to virial equilibrium. The dense gas (revealed by multiple transition studies of tracers such as CS and HC_3N to have $n(H_2) \simeq 10^6$ cm^{-3}) has a volume filling factor of $\simeq$ a few percent. Assuming a fractional abundance of $C^{18}O$ equal to 1.7 $\times 10^{-7}$, we find that the 790 μm dust optical depth to mass column density ratio for M17 and Cepheus A is 0.0062 cm^2 g^{-1}, while the average value for the Orion molecular cloud is a factor of 3 larger.

Accepted by the Astrophysical Journal

Preprints available on the WWW at http://aosun.naic.edu/vscience/publtion/public.htm and also at http://cfa-www.harvard.edu/~ebergin/, or via anonymous ftp from aosun.naic.edu/pub/publications as pfg3.ps.

3 Micron Ice Band Absorption in Young Stellar Objects

John A. Graham

Carnegie Institution of Washington, Dept. of Terrestrial Magnetism, 5241 Broad Branch Road NW, Washington DC, U.S.A

E-mail contact: graham@jag.ciw.edu

Profiles of the 3 μm ice band with moderate spectral resolution ($\lambda/\Delta\lambda = 1300$) are presented for 4 young stellar objects. Of special interest is a comparison between those for the embedded HH 100−IR source and the FU Orionis star V 346 Normae near HH 57 whose most recent outburst was in 1983. In the new spectra, there is no sign of the absorption feature at 2.97 μm attributed by Graham & Chen (1991) to ammonia ice. We now believe that this identification was spurious. The ice band in V 346 Nor has a weaker long wavelength wing than that in HH 100−IR. It matches well a profile observed in the star Elias 13 which lies behind the Taurus dark cloud and leads to the conclusion that the line-of-sight to V 346 Nor passes through quiescent intra-cloud material rather than through the dense dust observed in emission at longer wavelengths. Fine structure in the ice band wing, probably due to C−H stretch absorption, is detected at 3.47 μm in the embedded objects HH 100−IR and [TS84] 13.1 in the Corona Australis cloud but not in V 346 Nor. A second dip at 3.55 μm, which is plausibly linked to CH_3OH, is observed in HH 100−IR.

Accepted by Astrophysical J.

Near-Infrared Spectra of Flat-Spectrum Protostars: Extremely Young Photospheres Revealed

Thomas P. Greene[1] and Charles J. Lada[2]

[1] Institute for Astronomy, University of Hawaii, 2680 Woodlawn Drive, Honolulu, HI 96822, USA
[2] Smithsonian Astrophysical Observatory, 60 Garden Street, Cambridge, MA 02138, USA

E-mail contact: clada@cfa.harvard.edu

We present new high resolution ($R \simeq 21,000$) near-infrared ($\lambda = 2\mu$m) spectroscopic observations of a sample of flat-spectrum and Class II young stellar objects in the ρ Ophiuchi dark cloud. Our observations of the flat-spectrum sources are the first to reveal details about the atmospheres of objects so young that they are still in the protostellar stages of early stellar evolution. The flat-spectrum objects exhibit molecular (CO) and atomic (Na, Sc, Si) line shapes which are consistent with those expected for rotating stellar photospheres. No clear spectroscopic signatures of line formation in Keplerian circumstellar disks are found. The 2.294 μm $\nu = 0-2$ CO spectra show that the flat-spectrum objects are rotating more rapidly ($\langle v\sin i\rangle \simeq 26$ km s^{-1}) than the Class II pre-main-sequence stars in our sample ($\langle v\sin i\rangle \simeq 12$ km s^{-1}). Analysis of the relative strengths of the atomic lines of the two flat-spectrum sources GY21 and VSSG17 indicates that these objects have late spectral types, M0 and M2 (or later), respectively. Their surface gravities are more similar to those of late-type dwarfs or pre-main-sequence subgiant stars than to those of late-type stellar giants or FU Ori stars. These characteristics can be understood if the absorption lines of flat-spectrum sources arise in stellar (rather than disk) atmospheres that are similar to those of pre-main-sequence subgiant T Tauri stars but are accreting mass from their circumstellar disks at higher rates.

Accepted by The Astronomical Journal, to be published November 1997

A Preliminary Study of the Orion Nebula Cluster Structure and Dynamics

Lynne A. Hillenbrand [1], Lee W. Hartmann[2]

[1] Department of Astronomy; 601 Campbell Hall; University of California; Berkeley, CA 94720, USA
[2] Harvard-Smithsonian Center for Astrophysics; 60 Garden St.; Cambridge, MA 02138, USA

E-mail contact: lynne@astron.berkeley.edu

We use optical and near-infrared star counts to explore the structure and dynamics of the Orion Nebula Cluster. This very young (< 1 Myr) cluster is not circularly symmetric in projection, but is elongated north-south in a manner similar to the molecular gas distribution in the region, suggesting that the stellar system may still reflect the geometry of the proto-cluster cloud. Azimuthally-averaged stellar source counts compare well to simple spherically-symmetric, single-mass King cluster models. The model fits suggest that the inner Trapezium region should be regarded as the core of the Orion Nebula Cluster, not as a distinct entity as sometimes advocated. We estimate that the core radius of the cluster is 0.16-0.21 pc and that the central stellar density approaches 2×10^4 stars pc^{-3}. Adopting the stellar velocity dispersion from published proper motion studies, virial equilibrium would require a total mass within about 2 pc of the Trapezium of $\sim 4500 M_\odot$, slightly more than twice the mass of the known stellar population, and comparable to the estimated mass in molecular gas projected onto the same region of the sky. If ∼20% of the remaining molecular gas is converted into stars, thus adding to the binding mass, given that the present stellar population alone has a total energy close to zero, the ONC is likely to produce a gravitationally bound cluster. The ONC also exhibits mass segregation, with the most massive (Trapezium) stars clearly concentrated towards the center of the cluster, and some evidence for the degree of central concentration to decrease with decreasing mass down to $1 - 2M_\odot$, as would be expected for general mass segregation. Given the extreme youth of the stars compared to the estimated range of collisional relaxation times, the mass segregation is unlikely the result of cluster relaxation. Instead, we suggest that the mass segregation reflects a preference for higher-mass stars to form in dense, central cluster regions.

Accepted by ApJ

preprints available at http://astron.berkeley.edu/lynne/home.html

Clump mass spectra of molecular clouds

Carsten Kramer, Jürgen Stutzki, Ralf Röhrig, and Uwe Corneliussen

Universität zu Köln, I. Physikalisches Institut, Zülpicher Strasse 77, D-50937 Köln, Germany

E-mail contact: kramer@ph1.uni-koeln.de

We present clump mass spectra of the seven molecular clouds L1457, MCLD 126.6 + 24.5, NGC 1499 SW, Orion B South, S140, M17 SW, and NGC 7538, which were derived by a Gaussian clump decomposition algorithm from large scale isotopomeric CO maps.

We discuss in detail the reliability of the mass spectra derived by studying their dependence on the control parameters of the decomposition algorithm.

All clump mass spectra found are consistent with a power law, $dN/dM \propto M^{-\alpha}$, with α between 1.6 and 1.8. Due to the different resolution of the observations and the different distances of the clouds, the clump masses range from several 10^4 $M_\odot$ in NGC 7538 down to 10^{-4} $M_\odot$, less than the mass of Jupiter, in the nearby cloud L1457. The large dynamic range covered by the observations is reflected by the high number of clumps found in each cloud, which lie between 100 and 1300. The spectral index of the clump mass distributions thus is independent of the wide range of physical properties of the clouds studied. In particular, there are no indications of a turnover of the clump mass power law index at a characteristic clump mass such as the Jeans mass, below which the clumps become gravitationally unbound. This is particularly emphasized by the clump properties in L1457 most of which are clearly substellar and which are far from being gravitationally bound objects.

Accepted by Astronomy & Astrophysics

Preprint available at http://www.ph1.uni-koeln.de/∼kramer/publications.html

Constraints on the HL Tau Protostellar Disk from Millimeter– and Submillimeter–wave Interferometry

O. P. Lay[1], J. E. Carlstrom[2] and R. E. Hills[3]

[1] NASA Ames Research Center M-S 245-3, Moffett Field, CA 94035, USA
[2] Dept. of Astronomy and Astrophysics, University of Chicago, 5640 S. Ellis Avenue, Chicago, IL 60637, USA
[3] Mullard Radio Astronomy Observatory, Cavendish Laboratory, Madingley Road, Cambridge CB3 0HE, UK

E-mail contact: lay@barsoom.arc.nasa.gov

Millimeter and submillimeter interferometry are used to probe the dusty accretion disks around young protostars. New 460 GHz ($\lambda = 650$ μm) data from the CSO–JCMT Interferometer are combined with previous CSO–JCMT data at 345 GHz ($\lambda = 870$ μm), 220 GHz ($\lambda = 1.4$ mm) data from the Owens Valley Millimeter Array, 110 GHz ($\lambda = 2.7$ mm) data from the Berkeley–Illinois–Maryland Association Array and 43 GHz ($\lambda = 7$ mm) data from the VLA, to constrain the nature of the protostellar disk around HL Tau on size scales of 50 AU and above. A power-law disk model is fitted directly to the measured visibility data and probability distributions are derived for the parameters. The effects of instrumental uncertainties are included in a consistent way.

The position angle of the major axis of the emission is determined to be $127^\circ \pm 5^\circ$ and the inclination $42^\circ \pm 5^\circ$ (where 0° is face-on), assuming the disk is thin, flat and circular. A strongly flared disk that is close to edge-on cannot be ruled out, however. The CSO–JCMT and OVRO data favor centrally concentrated distributions of the surface density Σ, with $p > 1$ (where $\Sigma \propto r^{-p}$). This is not compatible with the relatively large sizes measured at lower frequency by BIMA and the VLA. No simple power law disk model can be found that reproduces all of the millimeter and submillimeter data well. Such a model, with radial power laws in the surface density and temperature and a single dust component, is therefore unlikely to be a good representation of the actual disk structure. One possibility that would help to reconcile the model with the data is that there is more than one dust component, i.e. there is a range of grain sizes or structures in the disk and there is no unique value of the emissivity index β. Future models should allow for this, as well as disk geometries that are not thin and flat.

Accepted by Ap. J.

Nonlinear Development and Observational Consequences of Wardle C-Shock Instabilities

Mordecai-Mark Mac Low[1] and Michael D. Smith[2]

[1] Max-Planck-Institut für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany; mordecai@mpia-hd.mpg.de
[2] Astronomisches Institut der Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany; smith@astro.uni-wuerzburg.de

E-mail contact: mordecai@mpia-hd.mpg.de

We compute the nonlinear development of the instabilities in C-shocks first described by Wardle, using a version of the ZEUS code modified to include a semi-implicit treatment of ambipolar diffusion. We find that, in three dimensions, thin sheets parallel to the shock velocity and perpendicular to the magnetic field lines form. High resolution, two-dimensional models show that the sheets are confined by the Brandenburg & Zweibel ambipolar diffusion singularity, forcing them to numerically unresolvable thinness. Hot and cold regions form around these filaments, disrupting the uniform temperature structure characteristic of a steady-state C-shock. This filamentary region steadily grows as the shock progresses. We compare steady-state to unstable C-shocks, showing excitation diagrams, images, line ratios, and line profiles for molecular hydrogen lines visible in the K-band, with the *Infrared Space Observatory*, and with NICMOS on the *Hubble Space Telescope*.

Accepted by Astroph. J., 10 Dec 1997

Preprints available from http://www.mpia-hd.mpg.de/MPIA/Projects/THEORY/maclow/papers/cshk/p2.html

Nonlinear Development and Observational Consequences of Wardle C-Shock Instabilities

Mordecai-Mark Mac Low[1] and Michael D. Smith[2]

[1] Max-Planck-Institut für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany; mordecai@mpia-hd.mpg.de
[2] Astronomisches Institut der Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany; smith@astro.uni-wuerzburg.de

E-mail contact: mordecai@mpia-hd.mpg.de

We compute the nonlinear development of the instabilities in C-shocks first described by Wardle, using a version of the ZEUS code modified to include a semi-implicit treatment of ambipolar diffusion. We find that, in three dimensions, thin sheets parallel to the shock velocity and perpendicular to the magnetic field lines form. High resolution, two-dimensional models show that the sheets are confined by the Brandenburg & Zweibel ambipolar diffusion singularity, forcing them to numerically unresolvable thinness. Hot and cold regions form around these filaments, disrupting the uniform temperature structure characteristic of a steady-state C-shock. This filamentary region steadily grows as the shock progresses. We compare steady-state to unstable C-shocks, showing excitation diagrams, images, line ratios, and line profiles for molecular hydrogen lines visible in the K-band, with the *Infrared Space Observatory*, and with NICMOS on the *Hubble Space Telescope*.

Accepted by Astroph. J., 10 Dec 1997

Preprints available from http://www.mpia-hd.mpg.de/MPIA/Projects/THEORY/maclow/papers/n11/n11.html

Near Infrared Spectra of the Orion Bar

A. Marconi[1,3], L. Testi[1,4], A. Natta[2], C.M. Walmsley[2]

[1] Dipartimento di Astronomia, Università degli Studi di Firenze, Largo E. Fermi 5, I-50125 Firenze, Italy
[2] Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, I-50125 Firenze, Italy
[3] Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA
[4] Division of Physics Mathematics and Astronomy, Caltech, MS 105-24, Pasadena, CA 91125, USA

E-mail contact: walmsley@arcetri.astro.it

We have used the LONGSP spectrometer on the 1.5-m TIRGO telescope to obtain long slit spectra in the J, H, and K wavelength bands towards two positions along the Orion bar. These data have been supplemented with images

made using the ARNICA camera mounted on TIRGO as well as with an ESO NTT observation carried out by Dr A. Moorwood. We detect a variety of transitions of hydrogen, helium, OI, FeII, FeIII, and H_2. From our molecular hydrogen data, we conclude that densities are moderate ($3-6\times10^4$ cm^{-3}) in the layer responsible for the molecular hydrogen emission and give no evidence for the presence of dense neutral clumps. We also find that the molecular hydrogen bar is likely to be tilted by ~10 degrees relative to the line of sight. We discuss the relative merits of several models of the structure of the bar and conclude that it may be split into two structures separated by 0.2-0.3 parsec along the line of sight. It also seems likely to us that in both structures, density increases along a line perpendicular to the ionization front which penetrates into the neutral gas.

We have used the 1.317μm OI line to estimate the FUV radiation field incident at the ionization front and find values of $1-3\times10^4$ greater than the average interstellar field. From [FeII] line measurements, we conclude that the electron density in the ionized layer associated with the ionization front is of order 10^4 cm^{-3}. Finally, our analysis of the helium and hydrogen recombination lines implies essential coincidence of the helium and hydrogen Strömgren spheres.

Accepted by Astronomy & Astrophysics

http://www.arcetri.astro.it/science/SF/ (ITALY)
http://astro.caltech.edu/~lt/preprints/preprints.html (USA)

VLA Observations of the Sagittarius D Star-Forming Region

David M. Mehringer[1], W. M. Goss [2], D. C. Lis[1], Patrick Palmer[3], and Karl M. Menten[4]

[1]California Institute of Technology, Downs Laboratory of Physics
[2]National Radio Astronomy Observatory
[3]University of Chicago, Department of Astronomy and Astrophysics
[4]Max-Planck-Institut für Radioastronomie

E-mail contact: dmehring@socrates.caltech.edu

We have carried out a program of VLA observations of the Sgr D (G1.13–0.10) star-forming region in order to gain a better understanding of this source. Continuum observations at 6 and 18 cm show a region which is dominated by a single compact source. This source is embedded in a halo of ionized gas and there are several compact continuum sources scattered about the field. The supernova remnant G1.05–0.15 is located 5′ south of the main H II region. From the continuum observations we determined the physical conditions of the thermal sources in Sgr D. Observations of the 6 cm transition of H_2CO which appears in absorption were also carried out to study the distribution and kinematics of molecular material in this region. These data indicate that the distribution of molecular material is clumpy, with apparent optical depths varying by about one order of magnitude within single clouds. In addition, the line widths of the molecular clouds associated with the Sgr D H II region (G1.13–0.10) are ~3 km s^{-1}, which is more typical of Galactic disk than Galactic center sources. The narrow molecular lines and the presence of higher velocity, broader H_2CO absorption lines in the Sgr D spectrum indicate that this region is probably located on the far side of the Galactic center region. OH and H_2O maser observations indicate that there may be at least three sites of very recent star formation in this region.

Accepted by ApJ

Preprints available at http://www.patnet.caltech.edu/~dmehring/preprint_links.shtml

CS observations of star-forming regions

O. Morata[1], R. Estalella[1], R. López[1] and P. Planesas[2]

[1] Departament d'Astronomia i Meteorologia, Universitat de Barcelona, Av. Diagonal 647, E-08028 Barcelona, Spain
[2] Observatorio Astronómico Nacional, Instituto Geográfico Nacional, Apdo. 1143, E-28800 Alcalá de Henares, Spain

E-mail contact: robert@mizar.am.ub.es

We mapped the CS (J=1→0) emission in five star-forming regions, HH 43, AFGL 6366S, L673, and L1251, using the 14-m Yebes telescope, and W75S using the 37-m Haystack telescope. Additionally, we observed C^{34}S (J=1→0) emission at selected positions of these regions. These sources had all been previously mapped with similar angular resolution in the $(J,K)=(1,1)$ inversion transition of the n_{H_2} . The comparison of both emissions showed a separation

between the CS and $n_{\rm H_2}$ peaks of ~ 0.2 pc. The regions traced by the CS molecule were, in general, larger than those traced by the $n_{\rm H_2}$. However, our data suggest that the size ratio depends on the size of the source. The line width of the CS lines was, on average, ~ 0.5km s^{-1} larger than that of $n_{\rm H_2}$ lines. This difference in line width can be attributed to the different size of the region traced by each molecule. The difference in the spatial distribution of the CS and $n_{\rm H_2}$ emission is interpreted in terms of the different evolutionary stage of the emitting clumps.

Accepted by Mon. Not. R. Astron. Soc.

Preprint available at http://www.am.ub.es/~robert/articles/Preprints.html

The Evolutionary Status of UX Ori-Type Stars

A. Natta[1], V. P. Grinin[2,3], V. Mannings[4], and H. Ungerechts[5]

[1] Osservatorio Astrofisico di Arcetri, Largo Enrico Fermi 5, I-50125 Firenze, Italy
[2] Astronomical Institute of St. Petersburg University, St. Petersburg, Russia
[3] Crimean Astrophysical Observatory, 334413, Crimea, Ukraine
[4] Division of Physics, Mathematics and Astronomy, California Institute of Technology, Pasadena, CA 91125, USA
[5] Instituto de Radioastronomia Milimetrica, Avenida Divina Pastora 7-NC, E-18012, Granada, Spain

E-mail contact: natta@arcetri.astro.it

We present measurements of 1.3-mm continuum emission from a sample of UX Ori stars. The "UXors" are pre-main-sequence stars, typically of intermediate mass, and they are distinguished from other pre-main-sequence stars by their large photometric and polarimetric variations that are thought to be due to variable extinction by circumstellar dust. Transient optical and UV absorption lines are a second defining characteristic, and have been interpreted in terms of the disruption of infalling cometary bodies. Our new mm fluxes are used to derive masses of circumstellar dust, $M_{\rm CSD}$. We combine these measurements with data from the literature to examine a sample of 30 pre-main-sequence systems with spectral types F0−B9, i.e. Herbig Ae stars, about half of which display UXor characteristics. We find no systematic differences in $M_{\rm CSD}$ between the two groups of stars. Moreover, no statistically significant correlation between $M_{\rm CSD}$ and stellar age is found, and the amplitude of photometric variability appears to be independent of age. We propose that UXor phenomena do not characterize a more evolved environment. They are probably common to the majority of stars in our sample, but are observed only when the line-of-sight is close to the equatorial plane of an aspherical circumstellar nebula.

Accepted by ApJ

Diffuse interstellar bands in the spectra of massive YSOs

René D. Oudmaijer, Graeme Busfield & Janet E. Drew

Imperial College of Science, Technology and Medicine, Blackett Laboratory, Prince Consort Road,
London, SW7 2BZ, U.K.

E-mail contact: r.oudmaijer@ic.ac.uk

We have compared the $B-V$ colour excess, *E(B–V)*, obtained for a sample of five optically visible massive YSOs both from diffuse interstellar bands (DIBs) in their spectra and from their optical continuum slopes. Our targets are HD 200775, BD+40°4124, MWC 1080, MWC 297 and MWC 349A. First, *E(B–V)* towards each of the targets is derived by dereddening the observed continua to match those of B-type standard stars. A survey of DIBs in the spectra of the massive YSOs, and a control field star, then reveals that the DIBs are significantly weaker in the former than would be expected based on the total *E(B–V)* values. This result is strengthened by the finding that the DIBs in the control field star, HD 154445, have on average the strength expected from its continuum *E(B–V).*

A rough estimate of the foreground reddening of intervening diffuse interstellar medium shows it to be smaller than the DIB- *E(B–V)*, implying that at least part of the DIB carriers are formed within the parental molecular clouds in which the YSOs are embedded. The formation efficiency of the DIBs varies strongly however from cloud to cloud. The DIB- *E(B–V)* compares favourably with the total *E(B–V)* towards BD+40°4124, but is almost negligible in the line of sight towards MWC 297. Despite this general, but not unexpected, deficit we provide evidence that the DIB at 5849Å is a good tracer of total extinction in these lines of sight.

Accepted by MNRAS

Helium absorption and emission towards Θ^1 Ori C

René D. Oudmaijer[1], Janet E. Drew[1], M. J. Barlow[2], I. A. Crawford[2], & D. Proga[1]

[1] Imperial College of Science, Technology and Medicine, Blackett Laboratory, Prince Consort Road, London, SW7 2BZ, U.K.
[2] Department of Physics & Astronomy, University College London, Gower Street, London WC1E 6BT,U.K.

E-mail contact: r.oudmaijer@ic.ac.uk

The He I absorption and emission systems towards Θ^1Ori C, the exciting star of the Orion Nebula, are investigated. To this end, high resolution near-infrared long-slit spectra centred on the He I 1.083μm and Brγ lines and an ultra-high resolution (R $\sim 10^6$) spectrum of the optical He I 3889Å line have been obtained. These data are supplemented by blue high spectral resolution echelle observations of Θ^1Ori C and the other members of the Trapezium. Even at R $\sim 10^6$, the He I absorption profile, associated with foreground gas at a heliocentric velocity of +3 km s^{-1}, is very smooth suggesting a simple broadening mechanism and homogeneity. The combination of the He I 2^3S column density deduced from the 3889Å line with the non-detection of Brγ emission at the same velocities sets an upper limit on the electron density in this medium of 10^{10} m^{-3}. The He I 1.083 μm long-slit spectrum shows the familiar background nebular emission, while a second blueshifted component is visible off-star at the same velocities as the absorption. Several mechanisms to explain this emission are explored. We conclude that it is most probably emission formed behind and leaking through the absorbing gas layer. A clue to the origin of this emission is found in its spatial distribution: unlike the bright background nebular emission, the blueshifted component peaks symmetrically around the position of Θ^1Ori C, suggesting a physical association with the star. A possible model for the blueshifted emission is that it arises in a large scale, dense shock front, provoked in some way by the wind of Θ^1Ori C.

Accepted by MNRAS

The Sobolev approximation in molecular clouds

V. Ossenkopf

Astrophysikalisches Institut und Universitäts-Sternwarte, Schillergäßchen 2, 07745 Jena, Federal Republic of Germany
Physikalisches Institut der Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Federal Republic of Germany

E-mail contact: ossk@zeus.ph1.uni-koeln.de

To derive the physical properties of a molecular cloud from line observations, one has to know or assume the molecular excitation conditions. The Sobolev approximation neglecting nonlocal radiative interactions is often used for a simple estimate. It is based on the existence of large velocity gradients throughout the cloud.

We have investigated the justification of the Sobolev approximation in situations where this condition is not strictly fulfilled. A semi-analytical extension of the Sobolev approximation for the line radiative transfer problem in molecular clouds and outflows is developed. It is applied to test the range of the validity of the ordinary Sobolev approximation and to solve problems beyond its limits.

This linear approximation is able to treat configurations with moderate velocity gradients where the basic assumption of the Sobolev approximation, taking constant physical parameters within the radiative interaction region, is no longer justified.

It turns out that the Sobolev approximation is quite accurate even far beyond the limits of its strict applicability. The computed energy densities deviate by less than a factor 2.5 in systems with a smooth, monotonic density and velocity structure. This maximum error is further reduced in regions with constant density gradients falling down to 20 % for spherical homogeneous flows.

For situations requiring high accuracies of the line intensity computations, a simple way for the improvement of results obtained by the ordinary Sobolev approximation is demonstrated.

Accepted by New Astronomy

A Long-slit, High Resolution Spectrum of the HH 30 Jet

A. C. Raga[1], R. López[2], A. Riera[3], R. Estalella[2] and G. Anglada[4]

[1]Instituto de Astronomía, UNAM, Ap. 70-264, 04510 México, D. F., México
[2]Departament d'Astronomia i Meteorologia, Universitat de Barcelona, Av. Diagonal 647, E-08028 Barcelona, Spain
[3]Departament de Física i Enginyeria Nuclear, Universitat Politécnica de Catalunya, Av. Víctor Balaguer s/n, E-0800 Barcelona, Spain
[4]Instituto de Astrofísica de Andalucía, CSIC, Ap. 3004, C/ Sancho Panza S/N, E-18080 Granada, Spain

E-mail contact: raga @ astroscu.unam.mx

The HH 30 jet has been observed quite extensively in the past. This paper is an addition to the HH 30 data set, presenting a new long-slit, high resolution spectrum (including the Hα and red [N II] and [S II] lines), with a spatial coverage of $\sim 10'$. From this spectrum, we carry out radial velocity determinations for the jet and its working surface, as well as for the counterjet. We find that the measured velocities appear to be consistent with an interpretation of HH 30 as a curved jet.

Accepted by Rev. Mex. Astron. Astrof.

Young Cool Stars in the Solar Neighbourhood

Michael F. Sterzik and Jürgen H.M.M. Schmitt

Max-Planck Institut f. extraterrestrische Physik, 85740 Garching, Germany

E-mail contact: sterzik@mpe-garching.mpg.de

We present evidence for a bimodal distribution of the coronal activity for a sample of 802 cool ($B-V > 0.5$) stars within 25 *pc* of the sun. The X-ray data obtained during the ROSAT all-sky survey resemble a characteristic activiy gap found in former surveys of Ca II H+K chromospheric emission. Coronal activity as expressed with $\log L_X/L_{bol}$ is shown to correlate with the chromospheric activity indicator R'_{HK}. The coronal most active objects also exhibit the largest Li I equivalent widths and are probably young. Our observations suggest that we can efficiently single out the youngest objects in the vicinity of the sun on the basis of their characteristic levels of coronal activity. Young, late-type stars are abundant in the solar neighbourhood.

Accepted by Astron. J.

preprints: ftp://hpth03.mpe-garching.mpg.de/pub/gliese

Velocity Shifts in L1228: the Disruption of a Core by an Outflow

Mario Tafalla[1,2] and Philip C. Myers[1]

[1] Harvard-Smithsonian Center for Astrophysics, MS 42, 60 Garden St., Cambridge, MA 02138, USA
[2] Observatorio Astronómico Nacional, Apartado 1143, E-28800 Alcalá de Henares, Spain E-mail contact: tafalla@oan.es

We present ^{12}CO(1–0), ^{13}CO(1–0), CS(2–1), and C_3H_2 (2_{12}–1_{01}) observations of the L1228 outflow and dense core with resolutions between 50 and 25″. The bipolar molecular outflow originates from IRAS 20582+7724 and extends over almost 15 arc minutes ($\approx$ 1.2 pc). It has a well collimated blue lobe and a less collimated red lobe, which is split into two branches that diverge from the IRAS position. The two CO outflow lobes are well aligned with previously observed high excitation emission from H_2 and Hα, although these emissions present bendings from a straight line, suggesting that the outflow driving wind changes direction by interacting with the ambient cloud. The dense gas in the core also shows evidence for acceleration in the outflow direction, although its velocity is significantly lower than that of the CO emission. The dense gas acceleration appears in the CS and C_3H_2 spectra as velocity shifts in the line centroid of the order of one C_3H_2 full line width (≈ 0.4 km s^{-1}). These shifted line profiles are not accompanied by any significant emission at ambient core velocities. Furthermore, there is very little or no quiescent C_3H_2 emission towards the outflow lobes, as if the outflow acceleration had been so efficient that all the dense gas has been set into motion. This acceleration, in addition, has occurred without appreciable line width enhancement, suggesting that it has not increased substantially the turbulence of the gas. From the large size of the velocity shifts (comparable to the gas escape velocity) and from our energetics estimates, we infer that the L1228 outflow could significantly disperse the dense gas in the core by the time the outflow phase ends.

Accepted by The Astrophysical Journal

HII and hot dust emission around young massive stars in G9.62+0.19

L. Testi[1,2], M. Felli[3], P. Persi[4], M. Roth[5]

[1] Dipartimento di Astronomia, Università degli Studi di Firenze, Largo E. Fermi 5, I-50125 Firenze, Italy
[2] Division of Physics Mathematics and Astronomy, Caltech, MS 105-24, Pasadena, CA 91125, USA
[3] Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, I-50125 Firenze, Italy
[4] Istituto di Astrofisica Spaziale, C.N.R., C.P. 67, I-00044 Frascati, Italy
[5] Las Campanas Observatory, Casilla 601, La Serena, Chile

E-mail contact: lt@astro.caltech.edu

In this paper we present new near infrared (NIR) observations (J, H, and K broadbands), of the G9.62 + 0.19 star forming complex.

Comparison of our observations with similar resolution centimetric continuum, millimeter continuum and molecular emission show that the mm continuum source F, not detected in the cm wavelength free-free radio continuum and associated with a high density molecular peak, is detected at $2.2\,\mu$m, while the ultracompact HII region D, one of the youngest of the HII regions in the complex, is not detected in the near infrared.

We propose a simple model that explains why, in the first stages of evolution of a young massive star, the source may be observable at K but not in the cm radio continuum. When the size of the UC HII region is $\ll 10^{-3}$ pc the hot dust present around the YSO strongly emits at K band, but the radio emission will be strongly self-absorbed. At later stages, when the size of the UC HII becomes greater than $\geq 10^{-3}$ pc, the dust temperature goes down and the K band dust emission strongly decreases; at the same time the cm radio continuum becomes detectable. As the UCHII expands the extinction drops and the K band emission rises again due to the stellar and ionized gas free-free and free-bound emission.

We propose an evolutionary sequence of the different sites of star formation in the complex, based on the radio continuum–infrared morphology and on the association with H_2O masers.

Accepted by Astronomy & Astrophysics

http://www.arcetri.astro.it/science/SF/ (ITALY)
http://astro.caltech.edu/~lt/preprints/preprints.html (USA)

Does Turbulent Pressure Behave as a Logatrope?

Enrique Vázquez-Semadeni, Jorge Cantó and Susana Lizano

Instituto de Astronomía, UNAM, Apdo. Postal 70-264, México, D. F. 04510, México

E-mail contact: enro@astroscu.unam.mx

We present numerical simulations of an isothermal turbulent gas undergoing gravitational collapse, aimed at testing for "logatropic" behavior of the form $P_t \sim \log\rho$, where P_t is the "turbulent pressure" and ρ is the density. To this end, we monitor the evolution of the turbulent velocity dispersion σ as the density increases during the collapse. A logatropic behavior would require that $\sigma \propto \rho^{-1/2}$, a result which, however, is not verified in the simulations. Instead, the velocity dispersion *increases* with density, implying a polytropic behavior of P_t. This behavior is found both in purely hydrodynamic as well as hydromagnetic runs. For purely hydrodynamic and rapidly-collapsing magnetic cases, the velocity dispersion increases roughly as $\sigma \propto \rho^{1/2}$, implying $P_t \sim \rho^2$, where P_t is the turbulent pressure. For slowly-collapsing magnetic cases the behavior is close to $\sigma \propto \rho^{1/4}$, which implies $P_t \sim \rho^{3/2}$. We thus suggest that the logatropic "equation of state" may represent only the statistically most probable state of an ensemble of clouds in equilibrium between self-gravity and kinetic support, but does not adequately represent the behavior of the "turbulent pressure" within a cloud undergoing a dynamic compression due to gravitational collapse. Finally, we discuss the importance of the underlying physical model for the clouds (in equilibrium vs. dynamic) on the results obtained.

Accepted by The AStrophysical Journal.

Postscript file available by anonymous ftp at

ftp://kepler.astroscu.unam.mx/incoming/enro/papers/logatrope.ps.gz

Deep Infrared Imaging of the R Coronae Australis Cloud Core

Bruce A. Wilking[1], Mark J. McCaughrean[2], Michael G. Burton[3], Timothy Giblin[1], John T. Rayner[4], and Hans Zinnecker[5]

[1] Dept. of Physics & Astronomy, Univ. of Missouri-St. Louis, 8001 Natural Bridge Road, St. Louis, MO 63121, USA
[2] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121, Bonn, Germany
[3] School of Physics, University of New South Wales, PO Box 1, Kensington, NSW 2033, Australia
[4] Institute for Astronomy, 2680 Woodlawn Drive, Honolulu, HI 96822, USA
[5] Astrophysikalisches Institut Potsdam, An der Sternwarte 16, D-14482 Potsdam, Germany

E-mail contact: brucew@newton.umsl.edu

Infrared images of the R Coronae Australis molecular core in broad-band J, H, and K′ filters and in narrow-band [Fe II] and H_2 filters are used to investigate star formation in this nearby cloud. Broad-band images with completeness limits of J=17.5, H=17.0, and K′ =16.5 mag have revealed a total of 253, 482, and 692 sources, respectively. Color-color and color-magnitude diagrams are used to identify sources associated with the cloud and their evolutionary states. Assuming an age of 3×10^6 years, our H and K observations have completely sampled young stellar objects with M>0.1 $M_\odot$ through about 80% of the depth of the molecular core. As few as 22, and as many as 40, sources are associated with the cloud. In addition, there are five brown dwarf candidates. The large number of background stars in our sample is the key to the proper interpretation of our color-color diagram. As a result, only 8 sources are observed to have infrared excesses at K′, implying a disk frequency for the association members between 16% and 35%. A focus of our study is the Coronet cluster, a compact group of ∼10 young stellar objects associated with the star R Cr A. We find that these objects are associated with extensive reflection nebulae, dust-free cavities, and Herbig-Haro (HH) objects. Detailed study of the HH complexes 99A & B and 104C & D suggests they are associated with winds from cluster members IRS 9 and IRS 5 and/or IRS 6, respectively. The true position of the most deeply embedded cluster member, IRS 7, is established through 10 μm imaging. It appears that young stellar objects in this cluster have formed nearly simultaneously and undoubtedly influenced the formation and evolution of their nearest neighbors.

Accepted by the Astronomical Journal

Preprint available on the WWW at http://newton.umsl.edu/˜ brucew

Carbon radio recombination lines in the Orion Bar

F. Wyrowski[1], P. Schilke[1,2], P. Hofner[3], C.M. Walmsley[4]

[1] I. Physikalisches Institut, Univ. zu Köln, Zülpicherstr. 77, D-50937 Köln. Germany
[2] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany
[3] Cornell University, NAIC, Arecibo Observatory, P.O. Box 995, Arecibo, P.R. 00613, USA
[4] Osservatorio Astrofisico di Arcetri, Largo E.Fermi 5, I-50125 Firenze, Italy

E-mail contact: wyrowski@ph1.uni-koeln.de

We have carried out VLA D-array observations of the C91α carbon recombination line as well as Effelsberg 100-m observations of the C65α line in a 5′ square region centered between the Bar and the Trapezium stars in the Orion Nebula with spatial resolutions of 10″ and 40″, respectively. The results show the ionized carbon in the PDR associated with the Orion Bar to be in a thin, clumpy layer sandwiched between the ionization front and the molecular gas. From the observed line widths we get an upper limit on the temperature in the C^+ layer of 1500 K and from the line intensity a hydrogen density between 5×10^4 and 2.5×10^5 cm^{-3} for a homogeneous medium. The observed carbon level population is not consistent with predictions of hydrogenic recombination theory but could be explained by dielectronic recombination. The layer of ionized carbon seen in C91α is found to be essentially coincident with emission in the v=1-0 S(1) line of vibrationally excited molecular hydrogen. This is surprising in the light of current PDR models and some possible explanations of the discrepancy are discussed.

Accepted by ApJ Letters

Preprints are available at http://www.ph1.uni-koeln.de/∼wyrowski

Dissertation Abstracts

A Submillimeter Imaging Survey of Ultracompact HII Regions

Todd R. Hunter

Thesis work conducted at: California Institute of Technology, Pasadena, USA

Current address: Smithsonian Astrophysical Observatory, 60 Garden St. MS-78, Cambridge, MA 02178, USA

Electronic mail: thunter@cfa.harvard.edu

Ph.D dissertation directed by: T.G. Phillips

Ph.D degree awarded: June 1997

This research explores the process of massive star formation in the Galaxy through submillimeter continuum and spectral line observations of ultracompact HII (UCHII) regions. First, I describe the design and operation of the Submillimeter High Angular Resolution Camera (SHARC)–a 24-pixel bolometer array camera for broadband continuum imaging at 350 and 450μm at the Caltech Submillimeter Observatory (CSO). Detailed information is included on the reflective off-axis optical design (see PASP 108, 1042) and the instrument control software interface.

Second, I present $10''$ to $12''$ resolution SHARC images of 350 and 450μm continuum emission from a sample of 17 UCHII regions with different radio morphologies. The sample includes: G19.61−0.23, G29.96−0.02, G34.26+0.14, G45.12+0.13, G45.07+0.13, K3-50A, K3-50C, G75.84+0.34, G75.78+0.34, W3(OH), GGD12−15, G138.295+1.555, G139.909+0.197, Monoceros R2, S255FIR2, G192.584−0.041 and G240.31+0.07. Although the dust emission typically peaks at or near the UCHII region, additional sources are often present, sometimes coincident with the position of H_2O masers. The combination of submillimeter, millimeter and IRAS far-infrared flux densities forms the basis of modified greybody models of the spectral energy distributions. The average dust temperature is 40 ± 10 K and the average grain emissivity index (β) is 2.00 ± 0.25. Using a radiative transfer program that solves for the dust temperature versus radius, the distribution of dust around UCHII regions is modeled with a power-law spherical density profile to match the observed radial flux density profiles. By fixing the source boundary at the outer limit of the submillimeter emission, the resulting density profiles $n(r) \propto r^{-p}$ can be classified into four categories: 3 regions exhibit $p = 2$ (isothermal sphere), 4 exhibit $p = 1.5$ (dynamical collapse), 2 exhibit $p = 2$ in the outer regions and $p = 1.5$ in the inner regions, and 6 exhibit $p = 1$ (logatropic). Although these simplified models may not be unique, a strong correlation between the dust luminosity-to-mass ratio and the dust temperature indicates that the more centrally-condensed sources exhibit higher star formation rates.

Third, I present $20''$ to $30''$ resolution CO maps which reveal bipolar outflows from 15 out of 17 UCHII regions. The outflow mechanical luminosities and mass ejection rates follow the scaling relations with bolometric luminosity established for less luminous pre-main sequence stars. However, in contrast to lower luminosity sources, the momentum from stellar radiation pressure is comparable to that required to drive the outflows. Many regions show evidence of separate, overlapping outflows.

In a final detailed study, $2''$ resolution images obtained with the Owens Valley Millimeter Array reveal multiple CO outflows emanating from the molecular core containing the UCHII region G45.12+0.13, while simultaneous outflow and infall motion is seen in CS toward the neighboring, less-evolved core containing G45.07+0.13 (see ApJ 478, 283).

Announcement

Dear Colleague,

I am preparing a second edition of the monograph "Dust in the Galactic Environment", for publication by the Institute of Physics in approximately two years from now. The first edition was completed in 1991, and there have been many advances in the field since then, both in terms of databases (e.g. ISO, HST, WUPPE; laboratory results) and theoretical models (e.g. grain alignment; surface chemistry). I will attempt to include these new results, and some discussion of their implications, without greatly changing the structure of the book, and with only a modest increase in length.

I would be pleased to receive comments from anyone familiar with the first edition on what should be included (or excluded) in the new one. Any comments, large or small, would be most welcome. As a guideline, I would especially appreciate input on any or all of the following, as appropriate:

1) What new results are most important to include in the new edition?

2) What material in the first edition is inessential and could be deleted to make way for new results?

3) What errors, omissions or inconsistencies appear in the first edition that should be rectified?

4) How might the book be made more useful as a learning aid for students?

5) How might the book be made more useful to researchers?

6) Any other comments?

I should also appreciate receiving preprints or reprints of recent work on interstellar/circumstellar dust and related topics.

Thank you!

Doug Whittet

Department of Physics, Applied Physics & Astronomy
Rensselaer Polytechnic Institute
Troy, NY 12180
USA

Phone: (518) 276-8413
Fax: (518) 276-6680
Email: doug@whittet.phys.rpi.edu

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).

Latex macros for submitting abstracts and dissertation abstracts are appended to each issue of the newsletter.

The Star Formation Newsletter is available on the World Wide Web, where you can access it via the ESO Portal (http://http.hq.eso.org/eso-homepage.html). You can also access it through the University of Massachusetts Astronomy World Wide Web server, the URL for its home page is http://www-astro.phast.umass.edu/

Moving ... ??

If you move or your e-mail address changes, please send the editor your new address. If the Newsletter bounces back from an address for three consecutive months, the address is deleted from the mailing list.