THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar evolution and molecular clouds

No. 81 — 16 June 1999 Editor: Bo Reipurth (reipurth@casa.colorado.edu)

Abstracts of recently accepted papers

Clustering around Herbig AeBe stars

Ian A. Bonnell & Cathie J. Clarke

Institute of Astronomy, Madingley Road, Cambridge CB3 0HA, UK

E-mail contact: bonnell@ast.cam.ac.uk

We show that the observed correlation between the luminosity of young stars and the richness of associated clusters does *not* necessarily imply that there is a physical mechanism that favours the formation of massive stars in clusters. Instead, the data is compatible with a scenario in which stars are assembled at random into clusters with a spectrum of membership number, N. We also show that the required spectrum is of the form $g(N) \propto N^{-\alpha}$ where α is in the range 1.5 to 2 and note that this is also the mass spectrum of clumps in molecular gas.

Accepted by MNRAS

A Large Scale Objective Prism and X-ray Survey in Taurus-Auriga

César Briceño[1,2,3], Nuria Calvet[1], Scott Kenyon[1] and Lee Hartmann[1]

[1] Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA 02138, USA
[2] Present address: Yale University, Physics Department, P.O. Box 208121, New Haven, CT 06520-8121, USA
[3] Also at Centro de Investigaciones de Astronomía (CIDA), Mérida, Venezuela.

E-mail contact: briceno@hepmail.physics.yale.edu

We present the results of a moderately deep, wide-field optical/X-ray survey extending over $\sim 60\Box^o$ in the Taurus-Auriga molecular cloud complex. Our observations are sensitive enough to allow us to detect lower mass and older pre-main sequence stars that could have been missed in previous surveys.

We identify 4 new T Tauri stars, 2 in the area of L1500 and L1503, 1 in L1538 and 1 in L1544. X-rays were detected from 3 near-IR sources, one of them a very reddened Class II T Tauri star. Four X-ray sources have no known optical/IR known counterpart; they could be very reddened pre-main sequence stars. Our findings are consistent with the idea that little (if any) star formation has taken place in L1537 and L1538.

Though we found 1 slightly older T Tauri star ($\sim 3-4$ Myr old), our survey yields no evidence for any significant number of T Tauri stars, regardless of mass and age, outside the main groups of young stars in Taurus. We conclude that the M stars which comprise the low-mass end of the *ROSAT* All-Sky Survey (RASS) source population must be older than ~ 10 Myr, and most probably unrelated to the ongoing process of star formation in Taurus, in agreement with the predictions of Briceño et al. (1997). Instead, the bulk of the RASS sources seen towards regions like Taurus seem to trace the history of star formation over a longer period in the solar vicinity.

Accepted by Astron. J.

Understanding the atmospheric structure of T Tauri stars - I. Improved atomic physics applied to IUE data of BP Tauri

D. H. Brooks[1], V. M. Costa[1,2], M. T. V. T. Lago[1,3] and A. C. Lanzafame[4]

[1] Centro de Astrofisica da Universidade do Porto, Rua das Estrelas, Porto 4150, Portugal
[2] Departamento de Matemática, Instituto Superior de Engenharia do Porto
[3] Departamento de Matemática Aplicada, Faculdade de Ciências da Universidade do Porto
[4] Istituto di Astronomia, Universita di Catania, Viale Andrea Doria 6, I-95125 Catania, Italy

E-mail contact: brooks@astro.up.pt

Recent advances in modelling the radiating character of dynamic laboratory and astrophysical plasmas are applied here in a new examination of the properties of the atmosphere of the classical T Tauri star BP Tau. We analyse archived International Ultraviolet Explorer (IUE) UV spectra of BP Tau. We adopt a collisional-radiative model and utilise emission measure (EM) and differential emission measure (DEM) techniques to try to constrain the distribution of emitting material in temperature in the atmosphere of this star. We use spectroscopic diagnostic techniques to probe atmospheric parameters such as electron density and to set constraints on the volume of emission regions. This work is important for understanding the fundamental properties of BP Tau and other T Tauri stars and to provide a more complete basis for models of their atmospheres.

Accepted by MNRAS

http://www.astro.up.pt/investigacao/index.html

The Bow Shock and Jet in L483

J. V. Buckle[1], J. Hatchell[1] and G. A. Fuller[1]

[1] Department of Physics, UMIST, P O Box 88, Manchester M60 1QD, United Kingdom

E-mail contact: jvb@bootes.phy.umist.ac.uk

The physical parameters of jets are still poorly understood. Here we present long slit spectra of the molecular hydrogen emission from the jet powered by the young stellar object in L483, from which we obtain details of the jet structure and shock velocities. The jet has a knotty structure, and, in addition, weaker emission is seen between the knots, so that emission is observed along the full length of the jet. The H_2 emission from the bright bow shock at the end of the jet has an excitation temperature of 2200 K, and is consistent with a bow C–shock of speed 40–45 kms^{-1}. Lower speed J–shocks, which could also match the H_2 emission, are ruled out by a lower limit on the shock speed provided by an analysis of the CO emission from the outflow. Assuming a jet velocity of $\sim$ 200 kms^{-1}, this shock velocity indicates that the jet from L483 has a density of about 10 times less that the medium into which it is propagating. The H_2 knots are possibly due to jet instabilities, or could be indicative of episodic activity. Emission from between the knots could be indicative of a partially molecular jet, entrainment in a mixing layer, or unresolved sub-knots. These possibilities, and how they impact on outflow models, are discussed.

Accepted by A&A

http:/saturn.phy.umist.ac.uk:8000/∼jvb/l483h2.ps.gz

Large atomic oxygen abundance towards the molecular cloud L1689N

E. Caux[1], C. Ceccarelli[2], A. Castets[2], C. Vastel[1], R. Liseau[3], S. Molinari[4], B. Nisini[5], P. Saraceno[6], G.J. White[7,3]

[1]CESR CNRS-UPS, BP 4346, F-31028 - Toulouse cedex 04, France
[2]Laboratoire d'Astrophysique, Observatoire de Grenoble - BP 53, F-38041 Grenoble cedex 09, France
[3]Stockholm Observatory, S-133 36 Saltsjöbaden, Sweden
[4]IPAC/Caltech, MS 100-22, Pasadena, California, USA
[5]Osservatorio Astronomico di Roma, via Frascati 33, I-00044 Monte Porzio, Italy
[6]Instituto di Fisica dello Spazio Interplanetario - CNR, area di ricerca Tor Vergata, via Fosso del Cavaliere 00133 Roma, Italy
[7]Queen Mary & Westfield College, Mile End Road, London E1 4NS, UK

E-mail contact: Emmanuel.Caux@cesr.fr

We present spectroscopic ISO-LWS observations of the [OI] (63μm and 145μm), the [CII] (158μm) and the H_2O (179μm) lines towards the molecular cloud L1689N. From the observed ratio of the two [OI] lines, we deduce a mean gas temperature of (26 $\pm$0.5) K, an H_2 density $\geq$ 3 $\times$ 10^4 cm^{-3} and an [OI] column density $\geq$ 5 $\times$ 10^{19} cm^{-2}. Combining these observations with previous CO observations, we obtain [OI]/[CO] $\sim$ 50. This ratio implies that up to 98% of oxygen abundance is in atomic form in the gas phase. Furthermore, assuming all the gaseous carbon is locked into the CO, carbon has to be depleted by more than a factor 24. Finally, the upper limit derived for the H_2O (179μm) line (3×10^{-13} erg s^{-1} cm^{-2}) implies that the water abundance in this region is less than 6×10^{-7} with respect to H nuclei.

Accepted by Astronomy & Astrophysics Letters

http://www-laog.obs.ujf-grenoble.fr/

Physical conditions in shocked regions of Orion from ground-based observations of H_2O

José Cernicharo[1], J.R. Pardo[2], E. González-Alfonso[1,3], Eugene Serabyn[2], Thomas G. Phillips[2], Dominic J. Benford[2], and David Mehringer[2]

[1] Instituto de Estructura de la Materia, Dpto. de Física Molecular, CSIC, Serrano 121, E-28006 Madrid, Spain.
e-mail: cerni@astro.iem.csic.es
[2] California Institute of Technology, MS 320-47, Pasadena, CA 91125, USA
[3] Universidad de Alcalá de Henares, Dpto. de Física, Campus Universitario, E-28871 Alcalá de Henares, Spain

E-mail contact: cerni@astro.iem.csic.es

We present observations of the $5_{1,5} \rightarrow 4_{2,2}$ transition of water vapor *at 325.15 GHz* taken with the CSO telescope towards Orion IRc2. The emission is more extended than that of other molecular species such as CH_3OH. However, it is much less extended than the emission of water vapor at 183.31 GHz reported by Cernicharo et al (1994). A comparison of the line intensities at 325.15 GHz and 183.31 GHz puts useful constraints on the density and temperature of the emitting regions and allows an estimate of H_2O abundance, x(H_2O), of $\simeq 10^{-4}$ in the Plateau and $\simeq 10^{-6}$-10^{-5} in the Ridge.

Accepted by The Astrophysical Journal Letters

Is LkHα 264 like a young, extremely active Sun?

V. M. Costa[1,2], J.F. Gameiro[1,3], and M. T. V. T. Lago[1,3]

[1] Centro de Astrofisica da Universidade do Porto, Rua das Estrelas, Porto 4150, Portugal
[2] Departamento de Matemática, Instituto Superior de Engenharia do Porto
[3] Departamento de Matemática Aplicada, Faculdade de Ciências da Universidade do Porto

E-mail contact: vcosta@astro.up.pt

We combine calibrated IUE data archive and new low resolution optical data for the T Tauri star LkHα 264 covering the region from 1200 to 7000 Å. The UV continuum is well fitted by the combination of a black body at 4300 K plus hydrogenic free-free and free-bound emission from a dense plasma at 3.5×10^4 K plus the emission by a second black body. This last component is at T$\approx$ 8700 K and covers about 4% of the stellar surface. We interpret this last component to be the result of emission from one or various hot spots. The interesting result is that this combined emission also fits well the observed optical continuum. We conclude that this star is an analogue of the Sun however displaying a much higher level of activity.

Accepted by MNRAS

Excitation and kinematics in H_2 bow shocks: near-IR observations of HH 99 and VLA 1623A (HH 313)

Christopher J. Davis[1], Michael D. Smith[2], Jochen Eislöffel[3] and John K. Davies[1]

[1]Joint Astronomy Centre, 660 North A'ohōkū Place, University Park, Hilo, Hawaii 96720, USA.
[2]Armagh Observatory, College Hill, Armagh BT61 9DG, Northern Ireland.

[3]Thüringer Landessternwarte Tautenburg, Sternwarte 5, D-07778 Tautenburg, Germany.

E-mail contact: cdavis@jach.hawaii.edu

We present a comprehensive near-IR study of two molecular bow shocks in two protostellar outflows, HH 99 in R Coronae Australis and VLA 1623A (HH 313) in Rho Ophiuci. New, high-resolution, narrow-band images reveal the well-defined bow shock morphologies of both sources. These are compared to 2-D MHD modelling of molecular bows from which we infer flow inclination angles, shock speeds and the magnetic field in the pre-shock gas in each system. With combined echelle spectroscopy and low-resolution K-band spectra we further examine the kinematics and excitation of each source. Bow shock models are used to interpret excitation (CDR) diagrams and estimate the extinction and, in the case of VLA 1623, the ortho-para ratio associated with the observed H_2 population. For the first time, morphology, excitation *and* kinematics are fit with a single bow-shock model.

Specifically, we find that HH 99 is best fit by a C-type bow shock model (although a J-type cap is probably responsible for the [FeII] emission). The bow is flowing away from the observer (at an angle to the line of sight of $\sim 45°$) at a speed of roughly 100 km s^{-1}. VLA 1623A is interpreted in terms of a C-type bow moving towards the observer (at an angle to the line of sight of $\sim 75°$) at a speed of ~ 80 km s^{-1}. The magnetic field associated with HH 99 is thought to be orientated parallel to the flow axis; in VLA 1623A the field is probably oblique to the flow axis, since this source is clearly asymmetric in our H_2 images.

Accepted by MNRAS

Preprints available from http://www.jach.hawaii.edu/~cdavis/papers.html

A spectroscopic study of flares on T Tauri and zero-age main-sequence stars

Eike W. Guenther and Mathias Ball

Thüringer Landessternwarte Tautenburg, Karl-Schwarzschild-Observatorium, D-07778 Tautenburg, Germany

E-mail contact: guenther@tls-tautenburg.de

Using a multi-object spectrograph on the Schmidt telescope in Tautenburg, we study the flare-activity of T Tauri stars and of zero-age main sequence stars. The sample comprises both classical, and weak-line T Tauri stars (cTTSs, wTTSs) in the Taurus-Auriga star forming region, as well as zero-age main-sequence stars (ZAMSSs) in the open cluster α Persei. The properties of the flares detected on V486 Per in the α Persei region, and on the Weak-Line T Tauri stars V819 Tau and V410 Tau are rather similar: All events show a rapid increase and a slow decay of the strength of the Balmer lines, and all events have similar flux-ratios of Hγ to Hβ. An event which shares these properties has also been detected in the cTTS FN Tau, and we correspondingly interpret it as a magnetic flare. Using the properties of observed flares as criteria for the detection of such events, we study the frequency of flares in the three classes of objects. Using these criteria, we detected flares on 80% of the wTTSs, on 56% of the cTTSs, and on 16% of the ZAMSSs. We find that the intrinsic flare rate is only about a factor of two smaller for cTTSs than for wTTSs for our sample of stars, and for flares with energies $\geq 2\,10^{32}$ erg in Hβ. We thus conclude that a strong flare activity is a common property of both types of T Tauri stars. In contrast to the T Tauri stars, we find a drastically lower flare rate for the zero-age main sequence stars.

Accepted by Astronomy and Astrophysics

Preprint available at: http://www.tls-tautenburg.de/research/tls-research/pub99.html

The Complex Protostellar Source IRAS 04325+2402

Lee Hartmann[1], Nuria Calvet[1,2], Lori Allen[1], Hua Chen[3], and Ray Jayawardhana[1]

[1] Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge MA 02138, USA
[2] also Centro de Investigaciones de Astronomía, Mérida, Venezuela
[3] Currently at N.E.T., 6500 Paseo Padre Parkway, Fremont, CA 94555, USA

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

We report *Hubble Space Telescope* near-infrared NICMOS observations of a remarkable low-luminosity Class I (protostellar) source in the Taurus Molecular Cloud. IRAS 04325+2402 exhibits a complex bipolar scattered light nebula. The central continuum source is resolved and may be multiple, or may be crossed by a small dust lane. Complex arcs seen in scattered light surround the central source; the physical nature of these structures is not clear, but they

may reflect perturbations from multiple stellar sources or from time-dependent mass ejection. A second, resolved continuum source is found at a projected distance of approximately 1150 AU fromthe central region, near the edge of a nebular lobe probably produced by outflow. The images indicate that this second source is another low-luminosity young stellar object, seen nearly edge-on through a dusty disk and envelope system with disk diameter ~ 60 AU. We suggest that the scattered light "streaks" associated with this second source are limb-brightened outflow cavities in the dusty envelope, possibly perturbed by interaction with the outflow lobes of the main source. The nature of the companion is uncertain, since it is observed mostly in scattered light, but is most probably a very low mass star or brown dwarf, with a minimum luminosity of $\sim 10^{-2} L_{\odot}$. Our results show that protostellar sources may have multiple centers of infall and non-aligned disks and outflows, even on relatively small scales.

Accepted by Astron. J.

Mid-infrared imaging of the young binary star Hen 3-600: Evidence for a dust disk around the primary

Ray Jayawardhana[1], Lee Hartmann[1], Giovanni Fazio[1], Scott Fisher[2], Charles Telesco[2] and Robert Piña[2]

[1] Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA 02138, USA
[2] Department of Astronomy, University of Florida, Gainesville, FL 32611, USA

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

We present high-resolution mid-infrared observations of the nearby late-type young binary system Hen 3-600. The binary, at a distance of ~ 50 pc, could be a member of the TW Hydrae Association, the nearest known group of young stars, with an age of a few million years. Our images make it possible for the first time to determine which star in the pair, separated by 1.4", harbors the mid-infrared excess detected by IRAS. In the near-infrared, where the radiation is primarily photospheric, Hen 3-600A (M3) and Hen 3-600B (M3.5) have a flux ratio of 1.6. At 4.8μm, 10.8μm, and 18.2μm, the primary becomes increasingly dominant over the secondary, suggesting that most of the circumstellar dust in the system resides around Hen 3-600A. Comparison of the spectral energy distribution (SED) of Hen 3-600A to the median SED of classical T Tauri stars suggests that its disk may be truncated by the secondary and provides tentative evidence for a central disk hole. The distribution of dust in the Hen 3-600 system may provide important clues to the formation and evolution of protoplanetary disks in close binaries.

Accepted by Astrophysical Journal Letters

Available on the WWW at http://xxx.lanl.gov/abs/astro-ph/9905173

X-ray Spectroscopy of the Nearby, Classical T Tauri Star TW Hya

Joel H. Kastner[1,2], David P. Huenemoerder[1], Norbert S. Schulz[1] and David A. Weintraub[3]

[1] Center for Space Research, Massachusetts Institute of Technology, NE80–6007, Cambridge, MA 02139, USA
[2] Address as of 7/15/99: Rochester Institute of Technology, Chester F. Carlson Center for Imaging Science, 84 Lomb Memorial Drive, Rochester, NY 14623, USA
[3] Department of Physics & Astronomy, Vanderbilt University, P.O. Box 1807 Station B, Nashville, TN 37235, USA

E-mail contact: jhk@juggler.mit.ed

We present ASCA and ROSAT X-ray observations of the classical T Tauri star TW Hya, the namesake of a small association that, at a distance of ~ 50 pc, represents the nearest known region of recent star formation. Analysis of ASCA and ROSAT spectra indicates characteristic temperatures of ~ 1.7 MK and ~ 9.7 MK for the X-ray emitting region(s) of TW Hya, with emission lines of highly ionized Fe dominating the spectrum at energies ~ 1 keV. The X-ray data show variations in X-ray flux on ~ 1 hr timescales as well as indications of changes in X-ray absorbing column on timescales of several years, suggesting that flares and variable obscuration are responsible for the large amplitude optical variability of TW Hya on short and long timescales, respectively. Comparison with model calculations suggests that TW Hya produces sufficient hard X-ray flux to produce significant ionization of molecular gas within its circumstellar disk; such X-ray ionization may regulate both protoplanetary accretion and protoplanetary chemistry.

Accepted by Astrophys. J.

Preprints are available at `http://xxx.lanl.gov/ps/astro-ph/9905126`

First Image with the CfA Superconductive HEB Receiver: The Protostellar Outflow from IRAS 20126+4104 in CO (J=7–6)

J.H. Kawamura[1], T.R. Hunter[2], C.-Y.E. Tong[2], R. Blundell[2], Q. Zhang[2], C.A. Katz[2], D.C. Papa[2], T.K. Sridharan[2,3]

[1] California Institute of Technology, MS 320-47, Pasadena, CA 91125, USA
[2] Harvard-Smithsonian Center for Astrophysics, MS-78, 60 Garden St., Cambridge, MA 02138, USA
[3] On leave from Raman Research Institute, Bangalore, India

E-mail contact: kawamura@submm.caltech.edu

We present a spectral line image in CO (J=7–6) of the spatially compact molecular outflow from the massive protostar IRAS 20126+4014, observed using a novel superconductive hot-electron bolometer (HEB) heterodyne receiver we recently installed at the 10 m Heinrich Hertz Telescope. The bipolar outflow is clearly detected and resolved with a center of symmetry situated at the position of the massive protostar, previously identified as an *IRAS* source and a millimeter continuum source. The peaks of the emission from the red- and blue-shifted CO lobes are separated by $\approx 14''$ (0.1 pc), and the velocity of the CO emission extends ± 30 km s^{-1} from the ambient cloud velocity. The total outflowing gas mass is approximately $4\,M_\odot$, while the outflow rate is at least $6 \times 10^{-4}\,M_\odot\,\mathrm{yr}^{-1}$. Both high-velocity CO emission maxima trail the NH_3 (3,3) and SiO clumps located $3''$ to $4''$ downstream (further from the IR source) in the flow. The high-excitation CO line and the NH_3 are likely tracing the heated gas entrained in different parts of the bow shocks. By interpreting our observations in terms of a jet-driven model, we estimate the density in the underlying jet to be at least $10^5\,\mathrm{cm}^{-3}$. The outflow appears much more compact and in a different orientation than the arcminute-scale north/south flow seen in low-J transitions of CO. These observations represent the first successful operation of a superconductive HEB receiver on a telescope and demonstrate the importance of high frequency submillimeter lines to the understanding of the protostellar environment.

Accepted by Publications of the Astronomical Society of the Pacific

http://cfa-www.harvard.edu/∼thunter/i20126heb.ps

Accretion in the Early Outer Solar System

Scott J. Kenyon[1] and Jane X. Luu[2]

[1] Harvard-Smithsonian Center for Astrophysics, 60 Garden St, Cambridge, MA 02138 USA
[2] Leiden Observatory, PO Box 9513, 2300 RA Leiden, The Netherlands

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

We describe calculations of the evolution of an ensemble of small planetesimals in the outer solar system. In a solar nebula with a mass of several times the Minimum Mass Solar Nebula, objects with radii of 100-1000 km can form on timescales of 10-100 Myr. Model luminosity functions derived from these calculations agree with current observations of bodies beyond the orbit of Neptune (Kuiper Belt objects). New surveys with current and planned instruments can place better constraints on the mass and dynamics of the solar nebula by measuring the luminosity function at red magnitudes $m_R \geq 28$.

to appear in the Astrophysical Journal

Preprints: http://xxx.lanl.gov/abs/astro-ph/9906143

Molecular line observations of southern main-sequence stars with dust disks: α Ps A, β Pic, ϵ Eri and HR 4796 A Does the low gas content of the β Pic and ε Eri disks hint at the presence of planets?

René Liseau

Stockholm Observatory, S-133 36, Saltsjöbaden, Sweden

E-mail contact: rene@astro.su.se

The results of molecular line observations with the 15 m SEST of southern Vega-excess stars are presented. The stars α Ps A, ε Eri and HR 4796 A were observed in the CO (1–0) and (2–1) lines and β Pic was observed in the vibrational

ground state of SiO, in the (2–1) and (5–4) transitions. In spite of considerably more sensitive observations than in previous attempts, none of these systems was detected with the SEST.

We use theoretical models of stellar atmospheres, of the structure and chemistry of interface regions (PDRs) and of molecular excitation in Keplerian disks of gas and dust to analyze these observational results. Among the observed objects, the K2 V star ε Eri appears particularly suitable and the analysis focusses on this system. A disk model with simple geometry is capable of explaining recent dust continuum observations. Applying this model to the associable molecular gas leads to the conclusion that it is most likely that the disk/ring around ε Eri is largely devoid of *any* gas ($m_{\rm gas}/m_{\rm dust}$ less than 10^{-3} of the interstellar value), presumably due to consumption during planetary system formation. We propose that ε Eri should be a prime candidate for searches for extrasolar planets.

In the β Pic disk, the gas content may be as low, or even lower, as for ε Eri which could be taken as indirect support of the suggested existence of a planetary system associated with this star.

Accepted by Astron. Astrophys.

The Energy Dissipation Rate of Supersonic, Magnetohydrodynamic Turbulence in Molecular Clouds

Mordecai-Mark Mac Low[1]

[1] Dept. of Astrophysics, American Museum of Natural History, 79th St. at Central Park W., NY, NY, 10024-5192, USA

E-mail contact: mordecai@amnh.org

Molecular clouds have broad linewidths suggesting turbulent supersonic motions in the clouds. These motions are usually invoked to explain why molecular clouds take much longer than a free-fall time to form stars. It has classically been thought that supersonic hydrodynamical turbulence would dissipate its energy quickly, but that the introduction of strong magnetic fields could maintain these motions. In a previous paper it has been shown, however, that isothermal, compressible, MHD and hydrodynamical turbulence decay at virtually the same rate, requiring that constant driving occur to maintain the observed turbulence. In this paper direct numerical computations of uniform randomly driven turbulence with the ZEUS astrophysical MHD code are used to derive the value of the energy dissipation coefficient, which is found to be

$$\dot{E}_{\rm kin} \simeq -\eta_v m \tilde{k} v_{\rm rms}^3,$$

with $\eta_v = 0.21/\pi$, where $v_{\rm rms}$ is the root-mean-square velocity in the region, $E_{\rm kin}$ is the total kinetic energy in the region, m is the mass of the region, and $\tilde{k}$ is the driving wavenumber. The ratio τ of the formal decay time $E_{\rm kin}/\dot{E}_{\rm kin}$ of turbulence to the free-fall time of the gas can then be shown to be

$$\tau(\kappa) = \frac{\kappa}{M_{\rm rms}} \frac{1}{4\pi\eta_v},$$

where $M_{\rm rms}$ is the rms Mach number, and κ is the ratio of the driving wavelength to the Jeans wavelength. It is likely that $\kappa < 1$ is required for turbulence to support gas against gravitational collapse, so the decay time will probably always be far less than the free-fall time in molecular clouds, again showing that turbulence there must be constantly and strongly driven. Finally, the typical decay time constant of the turbulence can be shown to be

$$t_0 \simeq 1.0 \ \mathcal{L}/v_{\rm rms},$$

where $\mathcal{L}$ is the driving wavelength.

Accepted by Astrophys. J., Vol. 524, October 10, 1999

Available at http://www.mpia-hd.mpg.de/theory/preprints.html#maclow

The Lithium Test in Young Brown Dwarf Candidates

E.L. Martín[1], G. Basri[1] and M.R. Zapatero Osorio[2]

[1] Astronomy Department, University of California, Berkeley, CA 94720, USA
[2] Instituto de Astrofísica de Canarias, 38200 La Laguna, Spain

E-mail contact: ege@popsicle.berkeley.edu

We present high, mid and low-resolution spectroscopy of the field brown dwarf candidate PC 0025+0447 (M9.5) spanning a 4-year baseline (1994-1998). The strength of the emission lines and the amount of optical veiling are very variable. Our spectra taken at an epoch of low veiling allow us to detect the lithium resonance line, which was not detected when the veiling was high. The presence of lithium proves that PC 0025+0447 is a substellar object less massive than $\sim$0.06 $M_\odot$ and younger than $\sim$1 Gyr. We also present mid-resolution spectra of three brown dwarf candidates in star forming regions, namely ρOph 162349.8-242601 (M8.5), V410 Tau X3 (M6.5) and V410 Tau X6 (M6). Lithium is detected in all of them, supporting their very young age. Of these three objects, only the one in ρOph is sufficiently cool to warrant an unambiguous substellar status. The spectroscopic characteristics that PC 0025+0447 and ρOph 162349.8-242601 have in common are moderately strong Li I lines (PEW$\sim$1 Å), persistent H_α emission with equivalent width >50 Å and weaker K I and Na I lines than field dwarfs of the same spectral type.

Accepted by Astron. J. (August 1999 issue)

Preprints available at http://astro.berkeley.edu/∼ege/

Multi–Pressure Polytropes as Models for the Structure and Stability of Molecular Clouds. I. Theory

Christopher F. McKee[1], John H. Holliman, II[2]

[1] Departments of Physics and Astronomy, University of California, Berkeley CA 94720, USA
[2] Department of Astronomy, University of California, Berkeley CA 94720, USA

E-mail contact: cmckee@astro.berkeley.edu

We present a theoretical formalism for determining the structure of molecular clouds and the precollapse conditions in star–forming regions. The model consists of a pressure-bounded, self-gravitating sphere of an ideal gas that is supported by several distinct pressures. Since each pressure component is assumed to obey a polytropic law $P_i(r) \propto \rho_{\rm p}^{\gamma}{}_i$, we refer to these models as *multi–pressure polytropes*. We treat the case without rotation. The time evolution of one of these polytropes depends additionally on the adiabatic index γ_i of each component, which is modified to account for the effects of any thermal coupling to the environment of the cloud. We derive structure equations, as well as perturbation equations for performing a linear stability analysis. Special attention is given to properly representing the significant pressure components in molecular clouds: thermal motions, static magnetic fields, and turbulence. The fundamental approximation in our treatment is that the effects of turbulent motions in supporting a cloud against gravity can be approximated by a polytropic pressure component. In particular, we approximate the turbulent motions as a superposition of Alfvén waves. We generalize the standard treatment of the stability of polytropes to allow for the flow of entropy in response to a perturbation, as expected for the entropy associated with wave pressure. In contrast to the pressure components within stars, the pressure components within interstellar clouds are "soft", with polytropic indexes $\gamma_{{\rm p}i} \leq 4/3$ and (except for Alfvén waves) adiabatic indexes $\gamma_i \leq 4/3$. This paper focuses on the characteristics of adiabatic polytropes with a single pressure component that are near the brink of gravitational instability as a function of $\gamma_{{\rm p}i}$ and γ_i for $\gamma_{{\rm p}i} \leq 4/3$. The properties of such polytropes are generally governed by the conditions at the surface. We obtain upper limits for the mass and size of polytropes in terms of the density and sound speed at the surface. The mean–to–surface density and pressure drops are limited to less than a factor 4 for $\gamma_{\rm p} \leq 1$, regardless of the value of γ. The central–to–surface density and pressure drops in isentropic clouds ($\gamma_i = \gamma_{{\rm p}i}$) are also limited, but they can become quite large (as observed) in non–isentropic clouds, which have $\gamma_i > \gamma_{{\rm p}i}$. We find that the motions associated with Alfvén waves are somewhat less effective in supporting clouds than are the kinetic motions in an isothermal gas.

Accepted by Ap. J.

Preprints available at astro-ph 9903213

Dust emission from Herbig Ae/Be stars — Evidence for disks and envelopes

Anatoly Miroshnichenko[1], Željko Ivezić[2], Dejan Vinković[3] and Moshe Elitzur[3,4]

[1] Pulkovo Observatory, St. Petersburg 196140, Russia
[2] Princeton University, Department of Astrophysical Sciences
[3] Department of Physics and Astronomy, University of Kentucky, Lexington, KY 40506-0055, USA
[4] Service d'Astrophysique, CEA Saclay, 91190 Gif-sur-Yvette, France

E-mail contact: moshe@pa.uky.edu

IR and mm-wave emission from Herbig Ae/Be stars has produced conflicting conclusions regarding the dust geometry in these objects. We show that the compact dimensions of the mm-wave emitting regions are a decisive indication for disks. But a disk cannot explain the spectral energy distribution (SED) unless it is embedded in an extended envelope that (1) dominates the IR emission and (2) provides additional disk heating on top of the direct stellar radiation. Detailed radiative transfer calculations based on the simplest model for envelope-embedded disks successfully fit the data from UV to mm wavelengths and show that the disks have central holes. This model also resolves naturally some puzzling results of IR imaging.

Accepted by Astrophys. J. Letters

ftp://gradj.pa.uky.edu/moshe/Herbig_Ae_Be/Disks/

Detection of the 62 μm crystalline H_2O ice feature in emission toward HH 7 with ISO-LWS

Sergio Molinari[1], Cecilia Ceccarelli[2], Glenn J. White[3,4], Paolo Saraceno[5], Brunella Nisini[6], Teresa Giannini[6] and Emmanuel Caux[7]

[1] California Institue of Technology, MS 100-22, Pasadena CA 91125, USA
[2] Laboratoire d'Astrophysique, Observatoire de Grenoble - BP 53, F-38041 Grenoble cedex 09, France
[3] Dept. of Physics, Queen Mary and Westfield College, University of London, Mile End Road, London E1 4NS, UK
[4] Stockholm Observatory, S-133 36 - Saltsjösbaden, Sweden
[5] CNR-Istituto di Fisica dello Spazio Interplanetario, Area di Ricerca Tor Vergata, via Fosso del Cavaliere I-00133 Roma, Italy
[6] Osservatorio Astronomico di Roma, via Frascati 33, I-00044 Monte Porzio, Italy
[7] CESR CNRS-UPS, BP 4346, F-31028 Toulouse Cedex 04, France

E-mail contact: molinari@ipac.caltech.edu

We report the detection of the 62 μm feature of *crystalline* water ice in emission towards the bow-shaped Herbig-Haro object HH 7. Significant amounts of far infrared continuum emission are also detected between 10 and 200 μm, so that Herbig-Haro objects cease to be pure emission-line objects at FIR wavelengths. The formation of crystalline water ice mantles requires grain temperatures $T_{gr} \gtrsim$ 100 K at the time of mantle formation, suggesting that we are seeing material processed by the HH 7 shock front. The deduced ice mass is $\sim 2\times10^{-5}$ $M_\odot$ corresponding to a water column density $N(H_2O)\sim 10^{18}$ cm^2; an estimate of the $[H_2O]/[H]$ abundance yields values close to the interstellar gas-phase oxygen abundance. The relatively high dust temperature and the copious amounts of gas-phase water needed to produce the observed quantity of crystalline water ice, suggest a scenario where both dissociative and non-dissociative shocks co-exist. The timescale for ice mantle formation is of the order of $\sim$ 400 years, so that the importance of gas-phase water cooling as a shock diagnostic may be greatly diminished.

Accepted by Astrophysical Journal Letters

VLA Observations of Bok Globules: New Protostellar Candidates

Miguel C. Moreira[1], João L. Yun[1], José M. Torrelles[2,3], José M. Afonso[1,4], & Carlos A. Santos[1]

[1]Observatório Astronómico de Lisboa, Tapada da Ajuda, 1300 Lisboa, Portugal
[2]Institut d'Estudis Espacials de Catalunya (IEEC/CSIC), C/ Gran Capitá 2-4, E-08034 Barcelona, Spain
[3]Instituto de Astrofísica de Andalucía (CSIC), Spain
[4]Imperial College of Science, Technology and Medicine, Prince Consort Road, London SW7 2BZ, UK

As part of a comprehensive centimeter radio continuum survey of deeply embedded young stellar objects in Bok globules, we present deep VLA 3.6 cm continuum observations toward a sample of seven Bok globules. A total of twenty-one radio sources were detected above a 5σ sensitivity threshold of 0.1 mJy. Five of these sources are located within the optical extent of the globules and may correspond to very deeply embedded protostars. We have also identified one bona fide starless globule.

Accepted by The Astronomical Journal

The Kinematics of Stars Emerging from Expanding Shells: An Analysis of Gould's Belt

Edmundo Moreno[1], Emilio J. Alfaro[2] and José Franco[1]

[1]Instituto de Astronomía-UNAM, Apdo Postal 70-264, 04510 México D. F., Mexico
[2]Instituto de Astrofísica de Andalucía (CSIC), Apdo. Correos 3004,Granada, 18080 Spain

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

Using the available data for nearby stars from the *Hipparcos* Catalog, we derive the velocity ellipsoid of dwarf O-B5.5 stars belonging to the Gould Belt (GB). The resulting vertex deviation for the whole sample of 252 stars is $l_v \sim -64^\circ \pm 20^\circ$, and this value is modified to $l_v = 22^\circ \pm 8^\circ$ when the members of the Pleiades moving group are removed from the sample. This implies the existence of, at least, two different kinematic groups defining the GB system. We also model the evolution of a supershell in the solar neighborhood, and obtain a fit to the shape and kinematics of the gas in the GB. Assuming that the expanding shell is also forming stars, we obtain the corresponding velocity fields for the shell and its newly formed stars. The average vertex deviation value resulting from these models for the new stars (assuming different velocity dispersion values and cut-off distances) is $l_v \simeq 20^\circ$, and is consistent with the observed value when the Pleiades moving group members are excluded from the GB.

Accepted by Ap. J.

A Molecular Counterpart to the Herbig-Haro 1-2 Flow

A. Moro-Martín[1], J. Cernicharo[1], A. Noriega-Crespo[2], and J. Martín-Pintado[3]

[1] Instituto de Estructura dela Materia, Dpto. de Fisica Molecular, CSIC, Serrano 121, E-28006 Madrid, Spain
[2] Infrared Processing and Analysis Center, CalTech-JPL, Pasadena, CA 91125, USA
[3] Observatorio Astronómico Nacional. Apartado 1143, E-28800 Alcalá de Henares. Spain

E-mail contact: amaya@as.arizona.edu, cerni@astro.iem.csic.es, alberto@ipac.caltech.edu

We present high angular resolution (12″-24″) and high sensitivity ^{12}CO and ^{13}CO J = 2-1 and J = 1-0 observations of the HH 1-2 outflow. The observations show the molecular counterpart, moving with a velocity of $\simeq$ 30 km s^{-1}, of the optical bipolar system driven by the VLA 1 embedded source. Along the optical jet there are certain regions where the molecular gas reaches deprojected velocities of 100 - 200 km s^{-1}, and that we interpret as the molecular jet. The bipolar CO outflow has a length of $\sim 260''$ with a curved morphology towards the North where it extends beyond the HH 1 object ($\simeq 120$ ″) .

Two new molecular outflows have been detected, one arising from IRAS 05339-0647 which excites the HH 147 optical flow and another powered by VLA 2 which drives the HH 144 optical outflow. The molecular outflow driven by the VLA 3 source is also clearly detected and spatially resolved from the VLA 1 main outflow.

Accepted by ApJ Letters

Upper limit on C_{60} and C_{60}^+ features in the ISO-SWS spectrum of the reflection nebula NGC 7023

C. Moutou [1], K. Sellgren [2], L. Verstraete [3], A. Léger [3]

[1] European Southern Observatory, Casilla 19001, Santiago 19, Chile
[2] Astronomy Department, Ohio State University, 174 West 18th Avenue, Columbus OH 43210, USA
[3] Institut d'Astrophysique Spatiale, CNRS, Université Paris Sud, bâtiment 121, F-91405 Orsay, France

E-mail contact: cmoutou@eso.org

We present here the 7.0 – 8.7 μm spectrum of the bright reflection nebula NGC 7023. Our observations are made with the Short Wavelength Spectrometer (SWS) on the European satellite Infrared Space Observatory (ISO). The vibrational bands of the ionized fullerene C_{60}^+ are expected at 7.11 and 7.51 μm, while those of the neutral fullerene C_{60} are expected at 7.0 and 8.45 μm. We estimate an upper limit in NGC 7023 for the C_{60}^+ abundance of <0.26% of the interstellar abundance of carbon, while C_{60} contains <0.27% of interstellar carbon.

Accepted by Astronomy and Astrophysics

astro-ph/9905374

The Abundance of C_7^- in Diffuse Clouds

Deborah P. Ruffle[1], R.P.A. Bettens [2], Radoslava Terzieva[3] and Eric Herbst[4]

[1] Department of Physics, The Ohio State University, Columbus, OH 43210, USA// [2] Research School of Chemistry, Australian National University, Canberra, ACT 0200, Australia// [3] Department of Chemistry and Chemical Physics Program, The Ohio State University, Columbus, OH 43210, USA // [4] Departments of Physics and Astronomy, The Ohio State University, Columbus, OH 43210, USA

E-mail contact: ruffle@pacific.mps.ohio-state.edu

It has recently been proposed that C_7^- is a carrier of five of the numerous diffuse interstellar bands. In this paper, we report an attempt to reproduce the required abundance of C_7^- relative to hydrogen of $n(C_7^-) \sim 1 \times 10^{-9}$ n_H through the use of various models for the chemistry in diffuse clouds. Our model network contains large neutral and charged linear hydrocarbons, and incorporates the time-dependent desorption of seed molecules from grain surfaces. We find a limited set of physical and chemical conditions that result in the required fractional abundance of C_7^- but only for rather short periods of time.

Accepted by ApJ.

Non–equilibrium excitation of methanol in Galactic molecular clouds: multi–transitional observations at 2 mm.

V.I. Slysh[1], S.V. Kalenskii[1], I.E. Val'tts[1], V.V. Golubev[1], and K. Mead[2]

[1] Astro Space Center, P.N. Lebedev Physical Institute, Profsoyuznaya 84/32, Moscow 117810, Russia
[2] National Radio Astronomy Observatory, Arizona Operations, Campus Building 65, 949 N. Cherry Avenue, Tucson, AZ 85721–0665, USA

E-mail contact: vslysh@dpc.asc.rssi.ru, kalensky@dpc.asc.rssi.ru

We observed 14 methanol transitions near $\lambda = 2$ mm in Galactic star-forming regions. Broad, quasi-thermal $J_0 - J_{-1}E$ methanol lines near 157 GHz were detected toward 73 sources. Together with the $6_{-1} - 5_0E$ and $5_{-2} - 6_{-1}E$ lines at 133 GHz and the $7_1 - 7_0E$ line at 165 GHz, they were used to study the methanol excitation. In the majority of the observed objects, the Class I $6_{-1} - 5_0E$ transition is inverted, and the Class II $5_{-2} - 6_{-1}E$ and $6_0 - 6_{-1}E$ transitions are overcooled. This is exactly as predicted by models of low gain Class I masers. The absence of the inversion of Class II transitions $5_{-2} - 6_{-1}E$ and $6_0 - 6_{-1}E$ means that quasi-thermal methanol emission in all objects arises in areas without a strong radiation field, which is required for the inversion.

Accepted by Astrophysical Journal Supplement Series.

Detection of interstellar H_2D^+ emission

Ronald Stark[1], Floris F.S. van der Tak[2], and Ewine F. van Dishoeck[2]

[1] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany
[2] Sterrewacht Leiden, Postbus 9513, NL-2300 RA Leiden, The Netherlands

E-mail contact: stark@mpifr-bonn.mpg.de

We report the detection of the $1_{10} - 1_{11}$ ground state transition of ortho-H_2D^+ at 372.421 GHz in emission from the young stellar object NGC 1333 IRAS 4A. Detailed excitation models with a power-law temperature and density structure yield a beam-averaged H_2D^+ abundance of 3×10^{-12} with an uncertainty of a factor of two. The line was

not detected toward W 33A, GL 2591, and NGC 2264 IRS, in the latter source at a level which is $3-8$ times lower than previous observations. The H_2D^+ data provide direct evidence in support of low-temperature chemical models in which H_2D^+ is enhanced by the reaction of H_3^+ and HD. The H_2D^+ enhancement toward NGC 1333 IRAS 4A is also reflected in the high DCO^+/HCO^+ abundance ratio. Simultaneous observations of the N_2H^+ $4-3$ line show that its abundance is about $50-100$ times lower in NGC 1333 IRAS 4A than in the other sources, suggesting significant depletion of N_2. The N_2H^+ data provide independent lower limits on the H_3^+ abundance which are consistent with the abundances derived from H_2D^+. The corresponding limits on the H_3^+ column density agree with recent near-infrared absorption measurements of H_3^+ toward W 33A and GL 2591.

Accepted by ApJ Letters
WWW-preprint: <xxx.lanl.gov/abs/astro-ph/9906215>

New T Tauri stars in the vicinity of TW Hydrae

Michael F. Sterzik[1], Juan M. Alcalá[2,3], Elvira Covino[2] and Monika G. Petr[1]

[1] European Southern Observatory, Casilla 19001, Santiago 19, Chile
[2] Osservatorio Astronomico de Capodimonte, Via Moiariello 16, I-80131 Napoli, Italy
[3] Instituto Nacional de Astrofísica, Optica y Electrónica, A.P. 51 y 216 C.P. 72000, Puebla, México

E-mail contact: msterzik@eso.org

We report the discovery of four weak-line T Tauri star candidates in the vicinity of the TW Hydrae association, the closest known region of recent star formation. Three stars are probably association members. They exhibit high Lithium abundances, M spectral types, and a high level of chromospheric and coronal activity. Two of them form a binary system. They also share a consistent radial velocity with previously known members of the association. A fourth candidate T Tauri star is of earlier spectral type, has a weaker Lithium absorption feature, and a different radial velocity, and is probably located in the background of the association. Our findings support the idea that the isolated T Tauri stars in that region belong to a physical association around TW Hydrae.

Accepted by A&A Letters

Discovery of solid HDO in grain mantles

T.C. Teixeira[1], J.P. Devlin[2], V. Buch[3] and J.P. Emerson[4]

[1] Institute of Physics and Astronomy, University of Århus, Ny Munkegade, 8000 Århus C, Denmark
[2] Dept. of Chemistry, Oklahoma State University, USA
[3] Dept. of Physical Chemistry, Hebrew University of Jerusalem, Israel
[4] Dept. of Physics, Queen Mary and Westfield College, Mile End Road, London E1 4NS, England

E-mail contact: tct@obs.aau.dk

The observation of deuterium fractionation in the molecular gas in hot cores is currently interpreted as evaporation of deuterium-rich molecules from the icy grain mantles where they accumulated during the cold, dense cloud core stage. The predicted enrichment in deuterium of the ices has never been observed. This work provides the first detections of solid HDO in grain mantles. We find column densities in the solid state of $N_s(\mathrm{HDO}) = (3.23 \pm 0.03) \times 10^{16}\,\mathrm{cm}^{-2}$ for W33A, and $N_s(\mathrm{HDO}) = (7.78 \pm 0.03) \times 10^{16}\,\mathrm{cm}^{-2}$ for NGC7538 IRS9. The estimated $[\mathrm{HDO}]/[\mathrm{H_2O}]$ ratios range from 8×10^{-4} in W33A to 10^{-2} in NGC7538 IRS9. These values are comparable to the predictions by chemical models, and provide support for the assumption that the origin of the deuterium enhancement in "hot cores" is evaporation from grain mantles.

Accepted by Astron. & Astrophys. (Letters)

http://www.obs.aau.dk/∼tct/

Young massive stars in the ISOGAL survey. I. VLA observations of the ISOGAL l=+45 field

Leonardo Testi[1,2], Marcello Felli[1] and Gregory B. Taylor[3]

[1] Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, I-50125 Firenze, Italy

[2] Division of Physics, Mathematics and Astronomy, California Institute of Technology, MS 105-24, Pasadena, CA 91125, USA
[3] National Radio Astronomy Observatory, P.O. Box O, Socorro, NM 87801, USA

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

We present VLA radio continuum observations at 3.6 and 6 cm of a ∼0.65 sq. deg. field in the galactic plane at $l = +45°$. These observations are meant to be used in a comparison with ISO observations at 7 and 15 μm of the same region. In this paper we compare the radio results with other radio surveys and with the IRAS-PSC.

At 3.6 and/or 6 cm we detect a total of 34 discrete sources, 13 of which are found in five separate extended complexes. These are all multiple or single extended thermal ultra-compact HII (UCHII) regions. While for each of these complexes an IRAS counterpart could be reliably found, no IRAS counterpart could be reliably identified for any of the remaining 21 sources. Of these 21 compact sources, six are candidate UCHII regions, and the other 15 are most probably background extragalactic non-thermal sources.

The five IRAS sources associated with the radio continuum complexes all satisfy the Wood & Churchwell (1989; WC89) color criteria for UCHII. None of the other 38 IRAS point sources present in our surveyed field show the same colors. This fraction of WC89 type to total IRAS sources is consistent with what is found over the entire galactic plane. The fact that, when observed with a compact VLA configuration, the IRAS sources with "UCHII colors" are found to be associated with arcminute-scale extended sources, rather than with compact or unresolved radio sources, may have important implications on the estimated lifetime of UCHII regions.

Accepted by Astronomy & Astrophysics Supplement Series

http://www.arcetri.astro.it/∼lt/preprints/preprints.html

Detection of H_2 pure rotational line emission from the GG Tau binary system

Wing-Fai Thi[1], Ewine F. van Dishoeck[1], Geoffrey A. Blake[2], Gerd-Jan van Zadelhoff[1] and Michiel R. Hogerheijde[3]

[1] Leiden Observatory, P.O. Box 9513, 2300 Leiden, The Netherlands
[2] Division of Geological & Planetary Sciences, California Institute of Technology 150–21, Pasadena, CA 91125, USA
[3] Department of Astronomy, 601 Campbell Hall, University of California, Berkeley, CA 94720-3411, USA

E-mail contact: thi@strw.leidenuniv.nl

We present the first detection of the low-lying pure rotational emission lines of H_2 from circumstellar disks around T Tauri stars, using the Short Wavelength Spectrometer on the *Infrared Space Observatory*. These lines provide a direct measure of the total amount of warm molecular gas in disks. The J=2→0 S(0) line at 28.218 μm and the J=3→1 S(1) line at 17.035 μm have been observed toward the double binary system GG Tau. Together with limits on the J=5 → 3 S(3) and $J = 7 \rightarrow 5$ S(5) lines, the data suggest the presence of gas at $T_{\rm kin} \approx 110 \pm 10$ K with a mass of $(3.6 \pm 2.0) \times 10^{-3}$ $M_\odot$ ($\pm 3\sigma$). This amounts to ∼ 3 % of the total gas + dust mass of the circumbinary disk as imaged by millimeter interferometry, but is larger than the estimated mass of the circumstellar disk(s). Possible origins for the warm gas seen in H_2 are discussed in terms of photon and wind-shock heating mechanisms of the circumbinary material, and comparisons with model calculations are made.

Accepted by Astrophys. J. Letters

astro-ph/9906231

Driving Outflows From Young Stars Through the Effects of Internal Disk Fields

N. J. Turner[1], P. Bodenheimer[1], and M. Różyczka[2]

[1] UCO/Lick Observatory, University of California, Santa Cruz, CA 95064, U. S. A.
[2] N. Copernicus Astronomical Center, Bartycka 18, 00-716 Warszawa, Poland

E-mail contact: neal@astro.umd.edu

We examine the evolution of magnetized, differentially rotating buoyant elements ejected through the surface of an accretion disk into an unmagnetized ambient medium, using axisymmetric magnetohydrodynamic calculations. The evolution occurs in three distinct stages. First, angular momentum transfer along radial magnetic field lines allows

part of each element to plunge towards the rotation axis. Next, the vertical gradient in total pressure accelerates some of the material at the axis upwards to escape speed, forming a jet collimated by azimuthal field. Finally, material near the base of the jet is brought close to solid-body rotation by Lorentz forces, the jet ceases, and material subsequently ejected through the disk surface angles away from the axis and enters a magneto-centrifugal flow. Jets are produced over a large range in injection and Alfvén speeds, while the magneto-centrifugal flows reach escape speed only when mass flux per field line is low. This mechanism may be useful in explaining the speeds, variability and mass flow rates of jets and winds from protostars and T Tauri stars.

Accepted by Ap. J.

Bispectrum speckle interferometry of the Orion Trapezium stars: detection of a close (33 mas) companion of Θ^1Ori C

Gerd Weigelt[1], Yuri Balega[2], Thomas Preibisch[1], Dieter Schertl[1], Markus Schöller[3], Hans Zinnecker[4]
[1] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D–95121 Bonn, Germany
[2] Special Astrophysical Observatory, Nizhnij Arkhyz, Zelenchuk region, Karachai-Cherkesia, 357147, Russia
[3] European Southern Observatory, Karl-Schwarzschild-Str. 2, D–85748 Garching, Germany
[4] Astrophysikalisches Institut Potsdam, An der Sternwarte 16, D–14482 Potsdam, Germany
E-mail contact: weigelt@mpifr-bonn.mpg.de

We present bispectrum speckle interferometry observations with the SAO 6 m telescope of the four brightest stars in the Orion Trapezium. Diffraction-limited images with an unprecedented resolution λ/D of 57 mas and 76 mas were obtained in the H- and K-band, respectively. The H and K images of Θ^1Ori C (the star responsible for the proplyds) show for the first time that Θ^1Ori C is a close binary with a separation of only $\sim$33 mas (H-band observation). The sub-arcsecond companions of Θ^1Ori A and Θ^1Ori B reported by Petr et al. (1998) are confirmed. We use the magnitudes and colors of the companions to derive information about their stellar properties from the HR-diagram. In addition we briefly discuss the multiplicity of the Trapezium stars. Considering both, the visual and the spectroscopic companions of the 4 Trapezium stars, there are at least 7 companions, i.e. at least 1.75 companions per primary on average. This number is clearly higher than that found for the low-mass stars in the Orion Nebula cluster as well as in the field population. This suggests that a different mechanism is at work in the formation of high-mass multiple systems in the dense Trapezium cluster than for low-mass stars.

Accepted by Astron. & Astrophys.

http://www.mpifr-bonn.mpg.de/div/speckle/papers/Weigelt_etal_AuA_thetaoric_1999.html
or
http://www.mpifr-bonn.mpg.de/staff/tpreibis/trapezium.html

HCN in cloud cores: a good tracer of Class 0 young stellar objects

João L. Yun[1], Miguel C. Moreira[1], José M. Afonso[1,2], & Dan Clemens[3]

[1]Observatório Astronómico de Lisboa, Tapada da Ajuda, 1300 Lisboa, Portugal
[2]Astrophysics Group, Imperial College of Science, Technology and Medicine, Prince Consort Road, London SW7 2BZ
[3]Institute for Astrophysical Research, Boston University, 725 Commonwealth Avenue, Boston, MA 02215, USA

We have conducted a HCN (J=1-0) survey of 37 star-forming and quiescent dense cloud cores. HCN emission was detected towards 31 of the 33 cores containing embedded point sources with only weak or no HCN detection among 4 starless sources.

We find that the J=1-0 transition of the HCN molecule is particularly well-suited for revealing the early stages of star formation in molecular clouds. In the sample of star-forming cores, there is excellent spatial coincidence between the position of the peak integrated HCN emission and the location of the associated YSO. Furthermore, emission strength in this HCN transition is well correlated with the YSO class: Class 0 and Class I YSOs are preferentially detected. Detecting strong (> 1 K km s^{-1}) HCN emission from a molecular cloud core indicates the presence of an embedded YSO and thus, indirectly, that of a collapsing core. In addition, detection of very strong (> 3 K km s^{-1}) HCN emission implies an 80 % likelihood of the presence of an embedded Class 0 YSO.

Accepted by The Astronomical Journal

A copy of this paper is available via the World Wide Web. Connect to http://astro.oal.ul.pt/papers/Class0-HCN/

Dissertation Abstracts

The properties and evolution of the dusty disks surrounding Herbig Ae/Be stars

Koen Malfait

Thesis work conducted at: Instituut voor Sterrenkunde, K.U.Leuven, Belgium

Current address: Inst. voor Sterrenkunde, K.U.Leuven, Celestijnenlaan 200B, B-3001 Heverlee, BELGIUM

Electronic mail: Koen.Malfait@ster.kuleuven.ac.be

Ph.D dissertation directed by: Prof. dr. Christoffel Waelkens

Ph.D degree awarded: May 1999

This study helps us to understand and describe the processes that occur in the dusty environment of Herbig Ae/Be stars, which are young stars of a few solar masses. A circumstellar dust disk in addition to the star is formed during the gravitational collapse of a molecular cloud. This dust disk is believed to disappear subsequently, influenced by diverse physical processes.

In 1983, the infrared satellite IRAS discovered the presence of dust disks surrounding main sequence stars. This is in contradiction with the calculated time scale on which the dust disks should be removed. A high interest in the physical properties of these dust disks emerged. We studied so called 'isolated' Herbig Ae/Be stars, that are believed to be situated in an evolutionary stage in between that of the classical Herbig Ae/Be stars, which still are associated with a star forming region, and that of the main sequence stars with an infrared excess caused by dust, such as β Pictoris and Vega. The objects that are subject of this study, are not associated with a nebulous environment, so no confusion between the star-disk system and filamentary nebulosity is present.

First of all, we determined the spectral energy distribution for a sample of 62 candidate Herbig Ae/Be stars. Part of the used measurements have been acquired during several observational campaigns, the rest has been gathered from the literature. The infrared part of the spectrum is dominated by re-emission of absorbed starlight by the dust particles in the disk. A significant fraction of the objects exhibit a double-peaked infrared excess, indicating the presence of both warm and cold dust, emitting respectively in the near- and the far-infrared. The broad infrared excess that has been observed in most classical Herbig Ae/Be stars breaks up, and subsequently the near-infrared excess disappears. This trend indicates the evolution from young to main sequence stars, and might be caused by planet formation.

With the Infrared Space Observatory ISO, an ESA-satellite that opened the spectral window from 2 to 200 μm, we could obtain detailed infrared spectroscopy (resolution $\sim$ 300-1500) of some of the objects. The features that can be distinguished from the spectrum enable us to determine the chemical composition and mineralogical structure of the dust that is present in these disks. Astonishing similarities with Solar System dust have been found, e.g. with interplanetary dust particles and with comet Hale-Bopp. The evolutionary trend seen in the energy distributions is confirmed as well. We can therefore conclude that we have been witnessing the formation of planetary systems around other stars.

In the near future, it is my purpose to make my Ph.D.-dissertation available on http://www.ster.kuleuven.ac.be/$\sim$koenm However, this has not been done yet!

New Jobs

Astrophysical and Theoretical-Physics Institute of the University of Jena

PhD Position Vacancy Notice

Applications are invited for a research position as a graduate student at the Astrophysikalisches Institut Jena, Germany. Completion of a PhD thesis related to this work (funded by the German Science foundation, DFG) is expected during three years.

The topic of research will be in Computational Astrophysics. The successful applicant will be working on the formation of planets going on in a protostellar environment. This includes the usage and development of numerical models to simulate the interaction of an accretion disk with an embedded protoplanet. Questions concerning the evolution of the planet and the disk will be adressed.

The applicant is expected to participate actively in the research group in Jena which is specialized in astrophysical processes related to the formation of stars and planets. At the same time a close collaboration with the Max-Planck Institute for Astronomy in Heidelberg is envisaged.

The salary will be according to the German Public Service Tarifs (BAT-O IIa/2). Women and minorities are encouraged to apply.

Applications should be sent until June 30th to:

Prof. Dr. Thomas Henning
Astrophysikalisches Institut
Schillerg"a"schen 2-3
D-07745 Jena
Germany

Informal inquiries are welcome and should be directed to:
Dr. W. Kley, wak@tpi.uni-jena.de, Tel. (03641) 947117 or
Prof. Th. Henning, henning@astro.uni-jena.de, Tel. (3641) 947530

Further information about the research in Jena under:
http://www.astro.uni-jena.de/ and
http://www.tpi.uni-jena.de/~wak

Research Assistantship in Computational Astrophysics

A research assistantship in computational astrophysics is available at the School of Mathematics, Trinity College, Dublin. The successful candidate will work with Dr Turlough Downes (Trinity College, Dublin) and Professor Tom Ray (Dublin Institute for Advanced Studies) on numerical modeling of jets from young stars. The research to be carried out combines the areas of computational fluid dynamics and star formation. It is expected that the research carried out will lead to a PhD and the project is due to start in October 1999.

Applicants should have, or expect to obtain, either an MSc or a first class honours degree in computational physics, mathematical physics or a related area.

Further information can be obtained from:

Dr. Turlough Downes,
School of Mathematics,
Trinity College,
Dublin 2,
Ireland.

Email: tppd@maths.tcd.ie
Phone: +353-1-6083542

New Books

ON-LINE PREPRINTS: PROTOSTARS AND PLANETS IV

The University of Arizona Press has approved our request to be allowed to post preprint versions of all PPIV review chapters on the web. Preprints can be downloaded from:

`http://astro.caltech.edu/~vgm/ppiv/`

The PPIV book comprises 49 reviews by 166 collaborating authors. It is divided into eight sections:

- Molecular Clouds and Star Formation
- Circumstellar Envelopes and Disks
- Young Binaries
- Jets and Outflows
- Early Solar System and Planet Formation
- Comets and the Kuiper Belt
- Extrasolar Planets and Brown Dwarfs
- Initial Conditions for Astrobiology

Editors: V. Mannings, A. P. Boss, & S. S. Russell

Announcement

The Two Micron All Sky Survey (2MASS) announces the public availability of its first large Incremental Data Release. The release data products can be accessed from the IPAC/2MASS Web site at http://www.ipac.caltech.edu/2mass/ or directly from the NASA/Infrared Science Archive site at http://irsa.ipac.caltech.edu/.

The 2MASS 1999 Spring Incremental Data Release consists of a Point Source Catalog containing 20.2 million objects, an Extended Source Catalog containing 73,980 resolved sources, and 233,979 compressed 512x1024 pixel (1"/pixel) images, covering about 2,483 square degrees of the northern sky. Also provided are tools for a) obtaining full resolution (non-compressed) "postage-stamp" images for the Extended Source Catalog objects, and b) for determining whether a specified position is included in the release area.

The 2MASS webpage contains general information, including sky coverage, and documentation about this data release. A gallery of interesting example objects, including several star formation regions and young stellar objects, in the release can be found at the 2MASS website. Assistance with the release is available via the 2MASS Help Desk at 2mass@ipac.caltech.edu.

The Two Micron All Sky Survey is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center, funded by the National Aeronautics and Space Administration and the National Science Foundation.

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://www.eso.org/gen-fac/pubs/starform/). 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.

Meetings

ASTROPHYSICAL PLASMAS: Codes, Models and Observations

hosted by the **Instituto de Astronomía, Universidad Nacional Autónoma de México**

Mexico City, October 25–29, 1999

You are invited to preregister for this event by filling in the forms on our website (see below)

Further announcements will be sent to all those who preregister. The second announcement, detailing registration fee, hotel reservations, etc, will be sent by June 15th.

Ionized gas constitutes a large fraction of the volume of the Universe. This gas is observed at almost all wavelengths, with visible, ultraviolet and X-ray observations being particularly informative. These observations provide us with information about the temperatures, densities, velocity fields and chemical composition of the astrophysical plasmas, which, in turn, allow us to investigate their dynamics and energetics. The light we observe is due to radiative processes at the atomic level for which we can construct theoretical models. By comparing theoretical and observational results we can improve our understanding about the physical characteristics of the cosmic gas.

We currently find ourselves at the threshold of a new era in the study of ionized gas. New X-ray satellites (Chandra, XMM and ASTRO-E) will be launched in the near future, improving the spectral and spatial resolution of X-ray observations. A new generation of terrestrial optical telescopes is being completed (VLT, Geminis, Keck, GTC), with larger diameters and the best optics and instrumentation seen to date. These technological advances will provide us with a wealth of new observational data. The challenge is then for the theoretical models to explain the new observations and to predict new phenomena.

The aim of this conference is to bring together observational and theoretical astrophysicists to discuss recent advances and future work in the field of ionized astrophysical plasmas.

SCIENTIFIC ORGANIZING COMMITTEE

Jane Arthur, Luc Binette, Nancy Brickhouse, Giussepina Fabbiano, Jose Franco (chair), Guillermo Garcia-Segura, Chris F. McKee, Marco Martos, Eugene Parker, Manuel Peimbert, John Raymond, Ronald J. Reynolds, Paul Shapiro, Grazyna Stasinska, Elena Terlevich

LOCAL ORGANIZING COMMITTEE

S.J. Arthur (chair), L. Binette, J. Espresate, J. Franco, S. Kurtz, M. Martos, A. Watson

Possible list of topics

I.- Cooling and ionization of low-density plasmas

a) Photoionized plasma; b) Collisionally excited plasma; c) Dusty plasma; d) Plasmas in the lab

II.- Evolution of astrophysical plasmas

a) The intergalactic medium: x-ray haloes, cooling flows, high-redshift absorbers, re-ionization of the Universe; b) Active galactic nuclei; c) The ISM in the Milky Way and external galaxies; d) HII regions, PNs, SNRs and ring nebulae; e) Solar and stellar activity

III.- Space observatories

a) Existing missions; b) Forthcoming satellites

Contact Address

Dr. Jane Arthur
ASTROPHYSICAL PLASMAS: CODES, MODELS & OBSERVATIONS
Instituto de Astronomia, UNAM
Apartado Postal 70-264
04510 Mexico, D.F.
MEXICO

Fax: (52-43) 236165 (attn: Jane Arthur) E-mail: plasma99@astroscu.unam.mx
http://www.astroscu.unam.mx/plasma99/

Darwin and Astronomy: the Infrared Space Interferometer (IRSI)
November 17 - 19, 1999, Stockholm, Sweden

Organisers: Swedish National Space Board (SNSB), European Space Agency (ESA) and Stockholm Observatory

Stockholm, Sweden, November 17 - 19, 1999

E-mail contact: darwin@astro.su.se

This is the first announcement for the conference 'Darwin and Astronomy - the Infrared Space Interferometer' to be held in Stockholm, Sweden, from November 17 to 19, 1999. The conference is organised by the Swedish National Space Board (SNSB) and the European Space Agency (ESA), with support by Stockholm Observatory.

All relevant documentation regarding the conference, including electronic forms for registration and hotel reservations, can be found on the web at

http://www.astro.su.se/~index.html

Purpose of this conference:
- to identify the most profound questions in the fields of modern astrophysics that can be adressed with a space-based interferometer working from 5 to 25 μm with baselines of up to 500 m and much more sensitive than ground-based instruments.

- to provide insights into the optimisation of the design of the instrument in the light of those questions.

It is envisaged that 30% of the time of the ESA candidate space mission for the Darwin infrared space interferometer will be devoted to general astrophysics. While much of the design will driven by its primary aim of extrasolar planetary systems studies, the astrophysical aims will also be important factors in the design.

This conference will start from a description of the present Darwin concept and its performance in different astrophysical observations. The inputs from participants in this conference will then constitute an important driving mechanism for the development of design characteristics of the instrument.

If you want to understand the prospects for space infrared interferometer astronomy or if you want to affect the design of Darwin so it can address your needs, you should attend this conference.

Topics and invited speakers include:
Galaxies and their Evolution Andrew Wilson (confirmed),
Active Galactic Nuclei/GC Reinhard Genzel (confirmed),
Observational Cosmology Malcolm Longair (tbc),
Supernovae (and Cosmology) Jason Spyromilio (tbc),
AGB and Related Phases of Stellar Evolution Hans Olofsson (confirmed),
Star Formation and Early Stellar Evolution Stephen Strom (confirmed),
Planet Formation and Disk Evolution Pawel Artymowicz (confirmed),
Physics of Planets Tristan Guillot (confirmed),
Planetology and Zodiacal Light Jane Luu (confirmed),
Astrobiology Baruch Blumberg (tbc),
Planets and Life Tobias Owen (tbc),
Origin of Life André Brack (confirmed),
Nulling Interferometry Neville Woolf and Bertrand Mennesson (confirmed),
Darwin - the Infrared Space Interferometer Malcolm Fridlund (confirmed),
TPF - the Terrestial Planet Finder Chas Beichman (confirmed),
GAIA - the Global Astrometric Interferometer for Astrophysics Lennart Lindegren (confirmed),
NGST - the Next Generation Space Telescope Peter Jakobsen (confirmed),
VLTI - the Very Large Telescope Interferometer Francesco Paresce (confirmed),
ALMA - the Atacama Large Millimeter Array Roy Booth (tbc)

Scientific Organising Committee: R. Genzel (chair), R. Liseau (co-chair), G. Arrhenius, C. Beichman, A. Brack, F. Capaccioni, C. Eiroa, M. Fridlund, T. Herbst, A. Léger, L. Nordh, A. Penny, D. Queloz, H. Roettgering, S. Volonte

Local Organising Committee: R. Liseau (chair), A. Brandeker, G. Gahm, E. Gullbring, K. Justtanont, M. Lannerö, B. Larsson, P. Lundqvist, L. Nordh, G. Olofsson, L. Sjöstrand, N. van der Bliek, U. Wänn