THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar evolution and molecular clouds

No. 117 — 17 July 2002 Editor: Bo Reipurth (reipurth@ifa.hawaii.edu)

Abstracts of recently accepted papers

Probing Dust around Brown Dwarfs: The naked LP 944-20 and the Disk of Cha Hα2

Dániel Apai[1,2], Ilaria Pascucci[1,2], Thomas Henning[1,2], Michael F. Sterzik[3], Randolf Klein[2], Dimitri Semenov[2], Eike Günther[4] and Bringfried Stecklum[4]

[1] Astrophys. Inst. and Univ. Observatory, Schillergässchen 2-3, D-07745 Jena, Germany
[2] Max Planck Institute for Astronomy, Königstuhl 17, D-69117, Heidelberg, Germany
[3] European Southern Observatory, Casilla 19001, Santiago 19, Chile
[4] TLS Tautenburg, Sternwarte 5, D-07778 Tautenburg, Germany

E-mail contact: apai@mpia.de

We present the first mid-infrared (MIR) detection of a field brown dwarf (BD) and the first ground-based MIR measurements of a disk around a young BD candidate. We prove the absence of warm dust surrounding the field BD LP 944-20. In the case of the young BD candidate Cha Hα2, we find clear evidence for thermal dust emission from a disk. Surprisingly, the object does not exhibit any silicate feature as previously predicted. We show that the flat spectrum can be explained by an optically thick flat dust disk but not by a flared one.

Accepted by Astrophysical Journal Letters

The Fountains of Youth: Irradiated Breakout of Outflows in S140

John Bally[1], Bo Reipurth[2], Josh Walawender[1] and Tina Armond[2,3]

[1] Department of Astrophysical and Planetary Sciences and Center for Astrophysics and Space Astronomy, University of Colorado, Campus Box 389, Boulder, CO 80309-0389, USA
[2] Institute for Astronomy, University of Hawaii, 2680 Woodlawn Drive, Honolulu, HI 96822, USA
[3] Departamento de Física, ICEx-UFMG, CP. 702, 30123-970 Belo Horizonte - MG, Brazil

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

We present a wide-field CCD survey of Herbig-Haro objects in the S140 HII region and the adjacent molecular cloud. Two outflows originating in the S140 molecular cloud core are breaking into the surrounding HII region. The PA = $65^o/245^o$ molecular outflow that originates from IRS3 in the S140 infrared cluster has driven an optically visible bow shock into the S140 HII region. This externally irradiated shock, HH 617, appears to be the counterflow associated with an H_2–bright bow shock located 90 arcsec northeast of S140 IRS3. A second, even larger bow shock, HH 616, located about 1 arcmin south of this shock indicates another major outflow whose as yet unidentified driving source must lie south of the S140 infrared cluster. These observations indicate that additional molecular outflows and embedded young stars remain to be identified in the S140 molecular cloud core. Furthermore, we report the detection of a dozen new Herbig-Haro objects in other cloud cores near S140.

Accepted by Astron. J.

Spectroscopic Survey of the Galactic Open Cluster NGC 6871
I. New Emission Line Stars

Zoltan Balog[1,2], **Scott J. Kenyon**[1]

[1] Smithsonian Astrophysical Observatory, 60 Garden St. MS 15 Cambridge, MA 02138 USA
[2] Dept of Optics and Quantum Electronics, Univ. of Szeged, Dom tér 9. Szeged, Hungary H-6720

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

We analyze spectra of 44 emission line stars detected in a low resolution optical spectroscopic survey of the galactic open cluster NGC 6871. The survey of 1217 stars is complete to $V = 14.9$ and includes stars with $V < 16.5$ between the zero age main sequence (ZAMS) and the 10^7 yr pre-main sequence (PMS) isochrone. Of the 44 emission line stars in this survey, 28 show obvious emission in $H\alpha$ and 16 have weak $H\alpha$ absorption (compared to $H\gamma$). We use the reddening to separate foreground and background stars from the cluster members; the position in the HR diagram (HRD) or the presence of forbidden emission lines ([NII], [SII]) then yields the evolutionary status of the emission line stars. A comparison of the $H\alpha$ spectral index distribution in NGC 6871 with the distribution of young stars in the Taurus-Auriga molecular cloud indicates that the late type PMS stars in our sample may be weak line T Tauri stars (wTTs). Many of these stars show [SII] (36%) and [NII] (45%) emission.

Accepted by Astron. J.

The Formation of Close Binary Systems by Dynamical Interactions and Orbital Decay

M. R. Bate[1,2], **I. A. Bonnell**[3], **and V. Bromm**[2,4]

[1] School of Physics, University of Exeter, Stocker Road, Exeter EX4 4QL, United Kingdom
[2] Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, United Kingdom
[3] School of Physics and Astronomy, University of St Andrews, North Haugh, St Andrews, Fife, KY16 9SS, United Kingdom
[4] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, U.S.A.

E-mail contact: mbate@astro.ex.ac.uk

We present results from the first hydrodynamical star formation calculation to demonstrate that close binary stellar systems (separations $\lesssim$ 10 AU) need not be formed directly by fragmentation. Instead, a high frequency of close binaries can be produced through a combination of dynamical interactions in unstable multiple systems and the orbital decay of initially wider binaries. Orbital decay may occur due to gas accretion and/or the interaction of a binary with its circumbinary disc. These three mechanisms avoid the problems associated with the fragmentation of optically-thick gas to form close systems directly. They also result in a preference for close binaries to have roughly equal-mass components because dynamical exchange interactions and the accretion of gas with high specific angular momentum drive mass ratios towards unity. Furthermore, due to the importance of dynamical interactions, we find that stars with greater masses ought to have a higher frequency of close companions, and that many close binaries ought to have wide companions. These properties are in good agreement with the results of observational surveys.

Accepted by MNRAS

http://www.astro.ex.ac.uk/people/mbate

Molecular line study of the very young protostar IRAM 04191 in Taurus:
Infall, rotation, and outflow

A. Belloche[1], **P. André**[1], **D. Despois**[2] **and S. Blinder**[2,3]

[1] Service d'Astrophysique, CEA/DSM/DAPNIA, C.E. Saclay, F-91191, Gif-sur-Yvette Cedex, France
[2] Observatoire de Bordeaux (INSU/CNRS), B.P. 89, F-33270 Floirac, France
[3] Division of Nuclear Medicine, Vancouver Hospital and Health Sciences Center, Vancouver, B.C., Canada

E-mail contact: belloche@discovery.saclay.cea.fr or pandre@cea.fr

We present a detailed millimeter line study of the circumstellar environment of the low-luminosity Class 0 protostar IRAM 04191 + 1522 in the Taurus molecular cloud. New line observations demonstrate that the $\sim$ 14000 AU radius protostellar envelope is undergoing both extended infall and fast, differential rotation. Radiative transfer modeling of multitransition CS and $C^{34}S$ maps indicate an infall velocity $v_{\rm inf} \sim 0.15$ km s^{-1} at $r \sim 1500$ AU and $v_{\rm inf} \sim 0.1$ km s^{-1} up to $r \sim 11000$ AU, as well as a rotational angular velocity $\Omega \sim 3.9 \times 10^{-13}$ rad s^{-1}, strongly decreasing with radius beyond 3500 AU down to a value $\Omega \sim 1.5$–3×10^{-14} rad s^{-1} at ~ 11000 AU. Two distinct regions, which differ in both their infall and their rotation properties, therefore seem to stand out: the inner part of the envelope ($r \lesssim 2000 - 4000$ AU) is rapidly collapsing and rotating, while the outer part undergoes only moderate infall/contraction and slower rotation. These contrasted features suggest that angular momentum is conserved in the collapsing inner region but efficiently dissipated due to magnetic braking in the slowly contracting outer region. We propose that the inner envelope is in the process of decoupling from the ambient cloud and corresponds to the effective mass reservoir ($\sim 0.5\,M_\odot$) from which the central star is being built. Comparison with the rotational properties of other objects in Taurus suggests that IRAM 04191 is at a pivotal stage between a prestellar regime of constant angular velocity enforced by magnetic braking and a dynamical, protostellar regime of nearly conserved angular momentum. The rotation velocity profile we derive for the inner IRAM 04191 envelope should thus set some constraints on the distribution of angular momentum on the scale of the outer Solar system at the onset of protostar/disk formation.

Accepted by Astronomy & Astrophysics

Preprint available at : http://xxx.lanl.gov/abs/astro-ph/0207287

Formation of Gas and Ice Giant Planets

Alan P. Boss

DTM, Carnegie Institution of Washington, 5241 Broad Branch Road, NW, Washington, DC 20015-1305, USA

E-mail contact: boss@dtm.ciw.edu

Agreement about planetary formation processes deteriorates sharply with distance from the Sun. While the terrestrial planets are widely believed to have formed from the collisional accumulation of solid bodies, there are two competing mechanisms for the formation of the gas giant planets, basically “bottom-up” or “top-down”. The former is the traditional core accretion mechanism, where a roughly 10 Earth-mass solid core forms by collisional accumulation, followed by hydrodynamic accretion of a gaseous envelope. The latter is the recently-revived disk instability mechanism, where a protoplanetary disk forms self-gravitating protoplanets through a gravitational instability of the gaseous disk, followed by settling and coagulation of dust grains to form central solid cores. These same two mechanisms have been modified to explain the formation of the ice giant planets. Their solid cores are thought to form too slowly to accrete substantial gaseous envelopes prior to disk removal in the core accretion mechanism, while in the disk instability mechanism, radiation from nearby massive stars is hypothesized to remove most of the protoplanets’ gaseous envelopes following core formation. Both of these mechanisms for gas and ice giant planet formation have a number of advantages and disadvantages, making a purely theoretical choice between them challenging. However, the ongoing discovery of extrasolar planetary systems promises to provide considerable insight into which of these mechanisms is responsible for forming most gas and ice giant planets in the galaxy, and by inference, those in our own Solar System.

Accepted by Earth Planet. Sci. Letters

Preprint available at http://www.ciw.edu/boss/ftp/planets/epsl.ps

Star Formation in Bright Rimmed Clouds. I. Millimeter and Submillimeter Molecular Line Surveys

Christopher H. De Vries[1], Gopal Narayanan[1] and Ronald L. Snell[1]

[1] Five College Radio Astronomy Observatory, 619 LGRC, University of Massachusetts, Amherst, MA 01003, USA

E-mail contact: devries@astro.umass.edu

We present the results of the first detailed millimeter and submillimeter molecular line survey of bright rimmed clouds, observed at FCRAO in the CO ($J = 1 \to 0$), $C^{18}O$ ($J = 1 \to 0$), HCO^+ ($J = 1 \to 0$), $H^{13}CO^+$ ($J = 1 \to 0$), and N_2H^+ ($J = 1 \to 0$) transitions, and at the HHT in the CO ($J = 2 \to 1$), HCO^+ ($J = 3 \to 2$), HCO^+ ($J = 4 \to 3$), $H^{13}CO^+$ ($J = 3 \to 2$), and $H^{13}CO^+$ ($J = 4 \to 3$) molecular line transitions. The source list is composed of a selection of bright rimmed clouds from the catalog of such objects compiled by Sugitani et al. (1991). We also present observations of three Bok globules done for comparison with the bright rimmed clouds. We find that the appearance of the millimeter CO and HCO^+ emission is dominated by the morphology of the shock front in the bright rimmed clouds. The HCO^+ ($J = 1 \rightarrow 0$) emission tends to trace the swept up gas ridge and overdense regions which may be triggered to collapse as a result of sequential star formation. Five of the seven bright rimmed clouds we observe seem to have an outflow, however only one shows the spectral line blue-asymmetric signature that is indicative of infall, in the optically thick HCO^+ emission. We also present evidence that in bright rimmed clouds the nearby shock front may heat the core from outside-in thereby washing out the normally observed line infall signatures seen in isolated star forming regions. We find that the derived core masses of these bright rimmed clouds are similar to other low and intermediate mass star forming regions.

Accepted by The Astrophysical Journal

Preprint available at `http://www.astro.umass.edu/~devries/brc1/`

Young massive stars in the ISOGAL survey II. The catalogue of bright YSO candidates

M. Felli[1], L. Testi[1], F. Schuller[2], A. Omont[2]

[1] Osservatorio Astrofisico di Arcetri, INAF, Largo E. Fermi 5, I-50125 Firenze, Italy
[2] Institut d'Astrophysique de Paris, CNRS, 98 bis Bd Arago, F-75014 Paris, France

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

The 7 and 15 μm observations of selected fields in the Galactic Plane obtained with ISOCAM during the ISOGAL program offer an unique possibility to search for previously unknown YSOs, undetected by IRAS because of lower sensitivity or confusion problems. In a previous paper (Felli et al. 2000) we established criteria of general validity to select YSOs from the much larger population of Post Main Sequence (Post-MS) stars present in the ISOGAL fields by comparing radio and IR observations of five fields located at l$\sim$+45°. The selection was based primarily on the position of the point sources in the [15] - [7]–[15] diagram, which involves only ISOGAL data and allows to find possible YSOs using the survey data alone. In the present work we revise the adopted criteria by comparing radio-identified UC HII regions and ISOGAL observations over a much larger region. The main indications of the previous analysis are confirmed, but the criteria for selecting YSO candidates had to be revised to select only bright objects, in order to limit the contamination of the sample by Post-MS stars. The revised criteria ([15]$\leq$4.5, [7]–[15]$\geq$1.8) are then used to extract YSO candidates from the ISOGAL Point Source Catalogue in preparation. We select a total of 715 YSO candidates, corresponding to $\sim$2% of the sources with good detections at 7 and 15 μm. The results are presented in a table form that provides an unique input list of small diameter, $\leq 6''$, Galactic YSO candidates. The global properties of the sample of YSO candidates are briefly discussed.

Accepted by A&A

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

Water Maser Survey towards Low-Mass Young Stellar Objects in the Northern Sky with the Nobeyama 45-m Telescope and the Very Large Array

Ray S. Furuya[1], Yoshimi Kitamura[2] Alwyn Wootten[3], Mark J. Claussen[4] and Ryohei Kawabe[5]

[1] INAF, Osservatorio Astrofisico di Arcetri, Largo Enrico Fermi 5, I-50125, Firenze, Italy
[2] Institute of Space and Astronautical Science, Yoshinodai 3-1-1, Sagamihara, Kanagawa 229-8510, Japan
[3] National Radio Astronomy Observatory, 520 Edgemont Road, Charlottesville, VA 22903, USA
[4] National Radio Astronomy Observatory, 1003 Lopezville Road, Socorro, NM 87801, USA
[5] National Astronomical Observatory, Osawa 2-21-1, Mitaka, Tokyo 181-8588, Japan

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

We give a detailed presentation of all the data from a multi-epoch 22 GHz H_2O maser survey mainly towards low-mass young stellar objects (YSOs) using the Nobeyama 45-m telescope and the Very Large Array (VLA). Our major results are already published (Furuya et al. 2001; hereafter paper I). The Nobeyama survey is the first complete H_2O maser survey towards known class 0 sources in the northern sky ($\delta > -35°$), and is one of the most sensitive surveys ever performed. The survey was conducted from 1996 May through 1999 March over 32 periods. A total of 603 observations was carried out toward 173 YSOs including 36 unknown luminosity sources, and toward 31 preprotostellar cores (PPSCs) in the Ophiuchus star forming region. We detected 149 spectra toward 39 YSOs, and zero spectra toward

the 31 PPSCs. Subsequent to the Nobeyama survey, we performed a follow-up interferometric survey with the VLA in order to associate 19 maser sources detected by the 45-m telescope with individual YSOs. In this paper, we compile properties of 142 YSOs together with their H_2O maser activity. On the basis of this data set, we use properties of water maser emission as a probe of jet phenomena in low-mass stars.

Accepted by ApJ Supplement Series

http://www.arcetri.astro.it/~starform/publ2002.htm

Radio Continuum Observations towards Optical and Molecular Outflows

J.M. Girart[1], S. Curiel[2], L.F. Rodríguez[3], and J. Cantó[2]

[1] Departament d'Astronomia i Meteorologia, Universitat de Barcelona, Av. Diagonal 647, 08028 Barcelona, Catalunya, Spain
[2] Instituto de Astronomía, UNAM. Apdo. Postal 70-264, 04510 México D.F., México
[3] Instituto de Astronomía, UNAM. Apdo. Postal 3-72 (Xangari), 58089 Morelia, Michoacán, México

E-mail contact: jgirart@am.ub.es

We present multi-frequency VLA continuum observations towards 8 star forming regions with molecular and optical outflows: L1489, HH 68-69, HH 94-95, NGC 2264D, L1681B, L778, MWC 1080 and V645 Cyg. We detect three thermal radio jets, L1489, YLW 16A in L1681B and NGC 2264D VLA 7, associated with molecular and/or HH outflows. The L1489 and NGC 2264D VLA 7 thermal radio jets appear elongated in the direction of the larger scale outflow. We report the first tentative detection of a non-thermal radio jet, L778 VLA 5, associated with a low mass Class I protostar and powering a molecular outflow. For HH 68-69, HH 94-95 and the molecular outflow in NGC 2264D we could not identify a candidate of the exciting source of these outflows. The radio emission associated with V645 Cyg is quite extended, ~ 0.1 pc, and time variable. We detect three radio sources in the MWC 1080 that could be associated with YSOs.

Accepted by RevMexAA

astro−ph/0207018

Photoelectric Heating and [C II] Cooling of High Galactic Latitude Translucent Clouds

James G. Ingalls[1], William T. Reach[1] and T. M. Bania[2]

[1] SIRTF Science Center, California Institute of Technology, Pasadena, CA 91125
[2] Institute for Astrophysical Research, Boston University, Boston, MA 02215

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

The $({}^2P_{3/2} \rightarrow {}^2P_{1/2})$ transition of singly–ionized carbon, [C II], is the primary coolant of diffuse interstellar gas. We describe observations of [C II] emission towards nine high Galactic latitude translucent molecular clouds, made with the long wavelength spectrometer on board the Infrared Space Observatory. To understand the role of dust grains in processing the interstellar radiation field (ISRF) and heating the gas, we compare the [C II] integrated intensity with the far-infrared (FIR) integrated surface brightness for the 101 sampled lines of sight. We find that [C II] is linearly correlated with FIR, and the average ratio is equal to that measured with the *COBE* satellite for all high-latitude Milky Way gas. There is a significant decrease that was not detected with *COBE* in [C II] emissivity at high values of FIR. Our sample splits naturally into two populations depending on the $60\,\mu$m/$100\,\mu$m surface brightness ratio, or color: "warm" positions with $60/100 > 0.16$, and "cold" positions with $60/100 < 0.16$. A transition from sources with warm to those with cold 60/100 colors coincides approximately with the transition from constant to decreasing [C II] emissivity. We model the [C II] and far–infrared emission under conditions of thermal equilibrium, using the simplifying assumptions that, in all regions heated by the ISRF, the most important source of gas heating is the photoelectric effect on grains and the most important source of gas cooling is [C II] emission. The model matches the data well, provided the ISRF incident flux is $\chi_0 \approx 1.6$ (in units of the nominal value near the Sun), and the photoelectric heating efficiency is $\epsilon \approx 4.3\%$. There are no statistically significant differences in the derived values of χ_0 and ϵ for warm and cold sources. The observed variations in the [C II] emissivity and the 60/100 colors can be understood entirely in terms of the attenuation and softening of the ISRF by translucent clouds, not changes in dust properties.

Accepted by the Astrophysical Journal

Preprints are available at http://xxx.lanl.gov/abs/astro-ph/0207264

Physical structure and CO abundance of low-mass protostellar envelopes

J. K. Jørgensen[1], F.L. Schöier[1] and E.F. van Dishoeck[1]

[1] Leiden Observatory, P.O. Box 9513, NL-2300 RA Leiden, Netherlands

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

We present 1D radiative transfer modelling of the envelopes of a sample of 18 low-mass protostars and pre-stellar cores with the aim of setting up realistic physical models, for use in a chemical description of the sources. The density and temperature profiles of the envelopes are constrained from their radial profiles obtained from SCUBA maps at 450 and 850 μm and from measurements of the source fluxes ranging from 60 μm to 1.3 mm. The densities of the envelopes within $\sim$10000 AU can be described by single power-laws $\rho \propto r^{-\alpha}$ for the class 0 and I sources with α ranging from 1.3 to 1.9, with typical uncertainties of $\pm$0.2. Four sources have flatter profiles, either due to asymmetries or to the presence of an outer constant density region. No significant difference is found between class 0 and I sources. The power-law fits fail for the pre-stellar cores, supporting recent results that such cores do not have a central source of heating. The derived physical models are used as input for Monte Carlo modelling of submillimeter $C^{18}O$ and $C^{17}O$ emission. It is found that class I objects typically show CO abundances close to those found in local molecular clouds, but that class 0 sources and pre-stellar cores show lower abundances by almost an order of magnitude implying that significant depletion occurs for the early phases of star formation. While the 2–1 and 3–2 isotopic lines can be fitted using a constant fractional CO abundance throughout the envelope, the 1–0 lines are significantly underestimated, possibly due to contribution of ambient molecular cloud material to the observed emission. The difference between the class 0 and I objects may be related to the properties of the CO ices.

Accepted by A&A

Preprints in astro-ph/0205068 ; see also Schöier et al. paper in this newsletter

Distances of absorbing features in the LDN 1622 direction

J. Knude[1], C. Fabricius[1], E. Høg[1] and V. Makarov[2]

[1] Niels Bohr Institute for Astronomy, Geophysics and Physics, Juliane Maries Vej 30, DK-2100 København Ø, Danmark
[2] Universities Space Research Association, 300 D St. SW, Washington, DC 20024, USA

E-mail contact: indus@astro.ku.dk

With Tycho-2 B_T and V_T photometry of Hipparcos stars with $\pi > 8.0$ mas, $\sigma_\pi/\pi < 15\%$ and with spectral type and luminosity classification from the Michigan Catalogues we have a presumably unreddened sample for establishing a $(B_T - V_T)_0 - M_{V_T}$ main sequence relation in the range from A0 to G5. We discuss the location of the median main sequence relation relative to published ZAMS relations for the A0 $-$ G5 range in some detail since the applications of this relation will have to assume that the evolutionary status of the calibration sample is representative of the local disk. If the ZAMS is defined as the lower envelope of the class V stars the published versions we discuss seem to be too bright by about half a magnitude in the F0 $-$ G5 range. The resulting intrinsic color and absolute magnitude estimates have errors of the mean of 0.03° and 0.3 – 0.4 mag respectively. From this relation any given star with Tycho-2 photometry, spectral classification and luminosity class V can have its color excess E(B_T - V_T) and distance modulus estimated. This means that the local interstellar extinction may be estimated for the $\sim$50% of the sky where Michigan classification presently is available. The individual color excesses and distance moduli may not be particularly accurate but we propose that they may be used to indicate extinction discontinuities caused by interstellar material at well defined distances. We have applied this new technique on stars from the Michigan Catalogue in the direction of LDN 1622 (l, b) = (204.7, -11.8) supposed to be associated to the Orion B region 400 – 500 pc away but color excesses E(B_T -V_T) exceeding 0.15 mag start appearing already in the distance slot 160 – 200 pc. Presently we can not decide whether this nearby dust is related to LDN 1622 or that this cloud is associated to Orion B. In a final comparison we study the color excess – distance variation in a 4° region centered on LDN 1622 from Hipparcos – Tycho$-$1 – Michigan data and the dust at $\sim$160 pc is confirmed.

Accepted by Astronomy and Astrophysics

The vertical structure of T Tauri accretion discs
III. Consistent interpretation of spectra and visibilities with a two-layer model

Régis Lachaume[1], Fabien Malbet[1] and Jean-Louis Monin[1,2]

[1] Laboratoire d'Astrophysique de Grenoble, Grenoble, France
[2] Institut Universitaire de France

E-mail contact: Regis.Lachaume@obs.ujf-grenoble.fr

We present a two-layer accretion disc model developed to simultaneously fit optical long baseline visibilities and spectral energy distributions of T Tauri accretion discs.

Our model includes several heating processes like viscous heating and absorption of stellar irradiation. The disc is modelled with concentric cylinders for which the vertical radiation transfer is computed using two layers with vertically averaged temperatures: the outer layer is heated by the stellar irradiation and the inner layer by viscous dissipation and by the outer layer. We then derive the disc structure in the case of the α and β viscosity prescriptions as well as for various optical thickness regime of the disc.

This analytical model allows us to disentangle regions where the mid-plane temperature and the effective temperature are dominated by accretion, from regions dominated by reprocessing of stellar light. We predict the flaring index of the disc surface for these various regions. In the case of α-prescription, we find that the structure of our model is consistent with those predicted by numerical simulations from previous authors.

From the disc structure, we derive the spectral energy distributions, images and interferometric visibilities. We analyse the influence of the disc parameters on the resulting structure and on the observable outputs. We apply our model to interpret consistently the spectral energy distributions and visibilities of SU Aur and FU Ori for which interferometric data are available, and that are not known to be part of a multiple system. We were not able to derive a consistent fit for T Tau North, which might come from caveats in the flux correction from its South component, but were able to separately derive fits for its spectrum and its visibility.

We find that even a single interferometric measurement at one infrared wavelength can bring a very strong constraint on disc models. We predict that future massive interferometric observations of accretion discs will provide a breakthrough in the understanding of accretion disc physics.

Accepted by Astronomy & Astrophysics

Fragmentation of Magnetically Subcritical Clouds into Multiple Supercritical Cores and the Formation of Small Stellar Groups

Zhi-Yun Li[1] and Fumitaka Nakamura[2]

[1] Department of Astronomy, University of Virginia, P.O. Box 3818, Charlottesville, VA 22903, USA
[2] Faculty of Education and Human Sciences, Niigata University, 8050 Ikarashi-2, Niigata 950-2181, Japan, and Astronomy Department, University of California at Berkeley, Berkeley, CA 94720, USA

E-mail contact: zl4h@virginia.edu, fnakamur@ed.niigata-u.ac.jp

Isolated low-mass stars are formed in dense cores of molecular clouds. In the standard picture, the cores are envisioned to condense out of strongly magnetized clouds through ambipolar diffusion. Most previous calculations based on this scenario are limited to axisymmetric cloud evolution leading to a single core, which collapses to form an isolated star or stellar system at the center. These calculations are here extended to the nonaxisymmetric case under thin-disk approximation, which allows for a detailed investigation into the process of fragmentation, fundamental to binary, multiple system, and cluster formation. We have shown previously that initially axisymmetric, magnetically subcritical clouds with an $m = 2$ density perturbation of modest fractional amplitude ($\sim 5\%$) can develop highly elongated bars, which facilitate binary and multiple system formation. In this paper, we show that in the presence of higher order ($m \geq 3$) perturbations of similar amplitude such clouds are capable of breaking up into a set of discrete dense cores. These multiple cores are magnetically supercritical. They are expected to collapse into single stars or stellar systems individually and, collectively, to form a small stellar group. Our calculations demonstrate that the standard scenario for single star formation involving magnetically subcritical clouds and ambipolar diffusion can readily produce more than one star, provided that the cloud mass is well above the Jeans limit and relatively uniformly distributed. The fragments develop in the central part of the cloud, after the region has become magnetically supercritical but before

rapid collapse sets in. It is enhanced by the flattening of mass distribution along the field lines and by the magnetic tension force, which is strong enough during the subcritical-to-supercritical transition to balance out the gravity to a large extent and thus lengthen the time for perturbations to grow and fragments to separate out from the background.

Accepted by ApJ

preprint available at http://xxx.lanl.gov/abs/astro-ph/0206352

Self-Gravitating Magnetically-Supported Protostellar Disks and the Formation of Substellar Companions

Zhi-Yun Li[1]

[1] Department of Astronomy, University of Virginia, P.O. Box 3818, Charlottesville, VA 22903, USA

E-mail contact: zl4h@virginia.edu

Isolated low-mass stars are formed, in the standard picture, from the collapse of dense cores condensed out of strongly magnetized molecular clouds. The dynamically collapsing inflow traps nearly half of the critical magnetic flux needed for the core support and deposits it in a small region surrounding the protostar. It has been argued previously that the deposited flux can slow down the inflow, allowing matter to pile up and settle along field lines into a magnetically supported, circumstellar disk. Here we show that the disk typically contains $\sim 10\%$ of the stellar mass, and that it could become self-gravitating under plausible conditions during the rapidly accreting, "Class 0" phase of star formation. Subsequent fragmentation of the self-gravitating, magnetically subcritical disk, driven by magnetic diffusion, could produce fragments of substellar masses, which collapse to form brown dwarfs and possibly massive planets. This scenario predicts substellar object formation at distances of order 100 AU from the central star, although orbital evolution is possible after formation. It may provide an explanation for the small, but growing, number of brown dwarf companions found around nearby stars by direct imaging. The relatively large formation distances make the substellar companions vulnerable to dynamic ejection, particularly in binary (multiple) systems and dense clusters. Those ejected may account for, at least in part, the isolated brown dwarfs and perhaps free-floating planetary mass objects.

Accepted by ApJ Letters

preprint available at http://xxx.lanl.gov/abs/astro-ph/0207014

The complete far infrared spectroscopic survey of Herbig AeBe stars obtained by ISO-LWS

Dario Lorenzetti[1]**, Teresa Giannini**[1]**, Brunella Nisini**[1]**, Milena Benedettini**[2]**, Davide Elia**[3]**, Loretta Campeggio**[3]**, and Francesco Strafella**[3]

[1] INAF - Osservatorio Astronomico di Roma, via Frascati 33, I-00040 Monte Porzio, Italy

[2] Istituto di Fisica Spazio Interplanetario - CNR Area Ricerca Tor Vergata, via Fosso del Cavaliere, I-00133 Roma, Italy

[3] Università degli Studi di Lecce - Dipartimento di Fisica, via Arnesano, I-73100 Lecce, Italy

E-mail contact: dloren@mporzio.astro.it

The ISO-LWS archive has been systematically searched in order to obtain a complete far IR spectrophotometric survey of Herbig AeBe (HAEBE) stars. The investigated sample is constituted by 15 objects which, together with the 11 HAEBE we have published in two previous papers, represents about 25% of all the known HAEBE. This catalogue constitues an essential data-base in view of far IR forthcoming space missions (e.g. Herschel Space Observatory), whose scientific programs are now in the planning phase. The new sources are analysed following the same approach as in our previous papers and both differences and similarities are discussed in a coherent framework. The [OI] 63 μm and the [CII] 158 μm lines are observed in many of the investigated sources, while the [OI] 145 μm remains often undetected, due to its relative faintness. Molecular lines, in form of CO high-J rotational transitions are detected in only three cases and appear associated to local density peaks. A new class of ISO-LWS spectra of HAEBE emerges, constituted by objects without any detected gas feature either in emission or in absorption. Not unexpectedly, these HAEBE are isolated from molecular clouds and, as such, lack of the cold circumstellar material probed by far IR ionic and molecular transitions. By comparing line intensity ratios with model predictions we find that photodissociation

caused by the stellar photons and active in a clumpy medium is likely the prevalent excitation mechanism for the far IR lines. Finally, an evolutionary trend is found according to which the contribution of the far IR line emission to the total emitted energy is less and less important with time.

Accepted by Astronomy & Astrophysics

Preprints available at http://www.mporzio.astro.it/∼bruni

Post-T Tauri Stars in the Nearest OB Association

Eric E. Mamajek[1], Michael R. Meyer[1] and James Liebert[1]

[1] Steward Observatory, The University of Arizona, Tucson, AZ 85721-0065 USA

E-mail contact: eem@as.arizona.edu

We present results of a spectroscopic survey of X-ray- and proper motion-selected samples of late-type stars in the Lower Centaurus-Crux (LCC) and Upper Centaurus-Lupus (UCL) subgroups of the nearest OB association: Scorpius-Centaurus. The primary goals of the survey are to determine the star-formation history of the OB subgroups, and to assess the frequency of accreting stars in a sample dominated by "post-T Tauri" pre-main sequence (pre-MS) stars. We investigate two samples: (1) proper motion candidates from the ACT and TRC astrometric catalogs (Hoogerwerf 2000) with X-ray counterparts in the *ROSAT* All-Sky Survey (RASS) Bright Source Catalog, and (2) G and K-type stars in the *Hipparcos* catalog found to be candidate members by de Zeeuw et al. (1999). We obtained optical spectra of 130 candidates with the Siding Springs 2.3-m dual-beam spectrograph. Pre-MS stars were identified by (1) strong Li λ6707 absorption, (2) subgiant surface gravities, (3) proper motions consistent with Sco-Cen membership, and (4) HR diagram positions consistent with being pre-MS. We find 93% of the RASS-ACT/TRC stars to be probable pre-MS members, compared to 73% of the *Hipparcos* candidates. We demonstrate that measuring the gravity-sensitive band-ratio of Sr I λ4077 to Fe I λ4071 is a valuable means of discriminating pre-MS and zero-age main sequence (ZAMS) stars. Using secular parallaxes, and *Hipparcos*, Tycho-2, and 2MASS photometry, we construct an HR diagram. Depending on the choice of published evolutionary tracks, we find the mean ages of the pre-MS populations to range between 17-23 Myr for LCC, and 15-22 Myr for UCL. Taking into account observational errors, it appears that 95% of the low-mass star-formation in each subgroup must have occurred in less than 8 Myr (LCC) and 12 Myr (UCL). Using the Bertelli et al. 1994 tracks, we find main sequence turn-off ages for *Hipparcos* B-type members to be 16 ± 1 Myr for LCC and 17 ± 1 Myr for UCL. Contrary to previous findings, it appears that LCC is coeval with, or slightly older than, UCL. The secular parallaxes of the Sco-Cen pre-MS stars yield distances of 85-215 pc, with 12 of the LCC members lying within 100 pc of the Sun. Only 1 out of 110 ($0.9^{+2.1}_{-0.8}$%; 1σ) pre-MS solar-type stars in the sample with ages of 13 ± 1 (s.e.) ± 6 (1σ) Myr and masses of 1.3 ± 0.2 (1σ) M$_\odot$, shows both enhanced Hα emission and a K-band excess indicative of accretion from a truncated circumstellar disk: the nearby ($d \simeq 86$ pc) classical T Tauri star PDS 66.

Accepted by Astron. J.

http://etacha.as.arizona.edu/ eem/scocen/index.html

The Physical Conditions for Massive Star Formation: Dust Continuum Maps and Modeling

Kaisa E. Mueller[1], Yancy L. Shirley[1], Neal J. Evans II[1] and Heather R. Jacobson[1]

[1] Department of Astronomy, The University of Texas at Austin, Austin, Texas 78712-1083, USA

E-mail contact: mueller@astro.as.utexas.edu

Fifty-one dense cores associated with water masers were mapped at 350 μm. These cores are very luminous, $10^3 < L_{bol}/L_\odot < 10^6$, indicative of the formation of massive stars. Dust continuum contour maps, radial intensity profiles, and photometry are presented for these sources. The submillimeter dust emission peak is, on average, nearly coincident with the water maser position. The spectral energy distributions and normalized radial profiles of dust continuum emission were modeled for 31 sources using a one-dimensional dust radiative transfer code, assuming a power law density distribution in the envelope, $n = n_f(r/r_f)^{-p}$. The best fit density power law exponent, p, ranged from 0.75 to 2.5 with $\langle p \rangle = 1.8 \pm 0.4$, similar to the mean value found by Beuther et al. (2002) in a large sample of massive star forming regions. The mean value of p is also comparable to that found in regions forming only low mass stars, but $\langle n_f \rangle$ is over two orders of magnitude greater for the massive cores. The mean p is incompatible with a logatropic sphere (p

= 1), but other star formation models cannot be ruled out. Different mass estimates are compared and mean masses of gas and dust are reported within a half-power radius determined from the dust emission, $\langle\log(M(< r_{dec}))\rangle = 2.0 \pm 0.6$, and within a radius where the total density exceeds 10^4 cm^{-3}, $\langle\log(M(< r_n))\rangle = 2.5 \pm 0.6$. Evolutionary indicators commonly used for low mass star formation, such as T_{bol} and L_{bol}/L_{smm}, may have some utility for regions forming massive stars. Additionally, for comparison with extragalactic star formation studies, the luminosity to dust mass ratio is calculated for these sources, $\langle L_{bol}/M_D\rangle = 1.4 \times 10^4$ L$_\odot$/M$_\odot$, with a method most parallel to that used in studies of distant galaxies. This ratio is similar to that seen in high redshift starburst galaxies.

Accepted by Astrophysical Journal Supplement

The molecular environment of NGC 3603 I. Spatial distribution and kinematic structure

Dieter E. A. Nürnberger[1,2], Leonardo Bronfman[3], Harold W. Yorke[4] and Hans Zinnecker[5]

[1] Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany
[2] Institut de Radio-Astronomie Millimétrique, 300 Rue de la Piscine DU, 38406 St. Martin-d'Hères, France
[3] Departamento de Astronomía, Universidad de Chile, Casilla 36 - D, Santiago, Chile
[4] Jet Propulsion Laboratory, California Inst. of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, U.S.A.
[5] Astrophysikalisches Institut Potsdam, An der Sternwarte 16, 14482 Potsdam, Germany

E-mail contact: nurnberg@astro.uni-wuerzburg.de

We present CS (2–1) and CS (3–2) observations of the molecular gas associated with the Galactic starburst template NGC 3603, over an area of $5'.8 \times 16'.7$, with the OB cluster at the center. Total velocity integrated maps and channel maps give insight into the spatial distribution and the kinematic structure of the dense gas in the giant molecular cloud from which the starburst cluster originated.
We identify 13 molecular clumps with radii less than 0.8 pc and derive upper limits for their virial masses as well as lower limits for their H_2 column densities: $\langle\mathcal{M}_{\rm vir}\rangle \lesssim (1.0 \pm 0.6) \cdot 10^3\,\mathcal{M}_\odot$ and $\langle\mathcal{N}(H_2)\rangle \gtrsim (0.4 \pm 0.2) \cdot 10^{23}\,{\rm cm}^{-2}$. One of the clumps, MM 11, clearly stands out with a mass and column density 4 times higher than average. The CS (3–2) / CS (2–1) map shows higher intensity ratios to the south of the OB cluster than to the north (0.80 ± 0.08 versus 0.32 ± 0.11), which indicates a substantial difference in the physical conditions (either opacities or excitation temperatures) of the molecular gas. From the average of the line peak velocities, $14.2 \pm 1.6\,{\rm km\,s^{-1}}$, we deduce a kinematic distance of 7.7 ± 0.2 kpc for NGC 3603 .
We estimate the star formation efficiency ($\gtrsim 30\,\%$) of the central part of the NGC 3603 H II region. If we assume the age of the OB cluster to be less than 3 Myr and the star formation rate to be larger than $1.3 \cdot 10^{-3}\,\mathcal{M}_\odot\,{\rm yr}^{-1}$, the derived timescale for gas removal ($\tau \sim 6$ Myr) can explain why the starburst cluster itself is nearly void of interstellar material. The remnant clump MM 1 appears to constitute the head of a prominent pillar which still becomes dispersed by ionizing radiation and stellar winds originating from the massive stars of the cluster. Because some of the molecular clumps are associated with near and mid infrared sources as well as OH, H_2O and CH_3OH maser sources we conclude that star formation is still going on within NGC 3603 .

Accepted by A&A

Constraints on star formation theories from the Serpens molecular cloud and protocluster

L. Olmi[1,2,3] and L. Testi[4]

[1] LMT/GTM Project, Dept. of Astronomy, 815J Lederle GRT Tower B, University of Massachusetts, 710 N. Pleasant st. Amherst, MA 01003–9305, USA
[2] University of Puerto Rico, Dept. of Physics, PO Box 23343 University Station, S. Juan PR 00931-3343, USA
[3] CNR - Istituto di Radioastronomia, Largo E. Fermi 5, I-50125 Firenze, Italy
[4] Osservatorio Astrofisico di Arcetri, INAF, Largo E. Fermi 5, I-50125 Firenze, Italy

E-mail contact: olmi@naic.edu, lt@arcetri.astro.it

We have mapped the large-scale structure of the Serpens cloud core using moderately optically thick (^{13}CO(1–0) and CS(2–1)) and optically thin tracers (C^{18}O(1–0), C^{34}S(2–1), and N_2H^+(1–0)), using the 16-element focal plane

array operating at a wavelength of 3mm at the Five College Radio Astronomy Observatory. Our main goal was to study the large-scale distribution of the molecular gas in the Serpens region and to understand its relation with the denser gas in the cloud cores, previously studied at high angular resolution. All our molecular tracers show two main gas condensations, or sub-clumps, roughly corresponding to the North-West and South-East clusters of submillimeter continuum sources. We also carried out a kinematical study of the Serpens cloud. The ^{13}CO and C^{18}O(1–0) maps of the centroid velocity show an increasing, smooth gradient in velocity from East to West, which we think may be caused by a global rotation of the Serpens molecular cloud whose rotation axis is roughly aligned in the SN direction. Although it appears that the cloud angular momentum is not sufficient for being dynamically important in the global evolution of the cluster, the fact that the observed molecular outflows are roughly aligned with it may suggest a link between the large-scale angular momentum and the circumstellar disks around individual protostars in the cluster. We also used the normalized centroid velocity difference as an infall indicator. We find two large regions of the map, approximately coincident with the SE and NW sub-clumps, which are undergoing an infalling motion. Although our evidence is not conclusive, our data appear to be in qualitative agreement with the expectation of a slow contraction followed by a rapid and highly efficient star formation phase in localized high density regions.

Accepted by A&A

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

The Origin of the β Pictoris Moving Group

V. G. Ortega[1], R. de la Reza[1], E. Jilinski[2,3] & B. Bazzanella[1]

[1] Observatório Nacional, Rua General José Cristino 77, Rio de Janeiro 20921-4000 - Brazil
[2] Laboratório Nacional de Computação Científica, Petrópolis (RJ) 25651-070 - Brazil
[3] Pulkovo Observatory, 196140 St. Petersburg - Russia

E-mail contact: delareza@on.br

The β Pictoris Moving Group (BPMG) as proposed by Zuckerman et al. (2001) is a group of 19 low mass star systems containing β Pictoris and its protoplanetary disk. This nearest moving group is at a mean distance of 36 pc from the Earth and these authors have proposed, by means of an HR diagram, an evolutionary age of 12^{+8}_{-4} Myr for this group. Here, by retracing the 3-D orbits of all the members of BPMG, and using a realistic Galactic potential, we find that a first maximum concentration of orbits occurs at 11.5 Myr and in a space region having a maximum size of 24 pc, three times smaller than its present size. We consider this region to be the birthplace of BPMG. This interesting similarity of independently obtained evolutionary and kinematical ages, indicates that this group could have already been formed as an unbound system, as observed today. The birthplace of BPMG is located in a 3-D space, at $\sim$ 45 pc from the region where the LCC and UCL subgroups of the Sco-Cen OB association were when they were between 4 to 6 Myr old. At that age, both subgroups were able to produce SNe capable of triggering the formation of BPMG. This interaction distance could even be smaller, up to $\sim$ 26 pc, if SNe exploded in the outer regions of LCC or UCL near the proposed birthplace of BPMG. This scenario confirms, at least for BPMG, the suggestion made by Mamajek & Feigelson (2001) and other authors that young unbound nearby stellar associations with ages around $\sim$ 10 Myr originated in this OB complex. In contrast to the BPMG, for which we propose a coeval formation, the LCC and UCL subgroups appear not to be truly coeval.

Accepted by Astrophysical Journal Letters.

Molecular line emission from turbulent clouds

V. Ossenkopf[1]

[1] I. Physikalisches Institut der Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Germany

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

In the last years substantial progress has been made in modelling turbulent clouds and describing their structure by characteristic parameters. The missing link for a systematic comparison between models and observations is the lack of efficient radiative transfer algorithms to generate molecular line maps from the models comparable to the observed maps. A fully self-consistent solution of the radiative transfer problem is computationally very demanding and hardly suited to evaluate a large set of cloud models with regard to their agreement with observed molecular cloud

structures. We introduce a new, computationally efficient code to calculate the line profiles based on two reasonable approximations. It is able to compute the molecular line maps in turbulent cloud models with an accuracy of about 20 % fast enough to be run on large sets of model clouds.
Applying the code to hydrodynamic, and magnetohydrodynamic cloud models we study how their structure would appear in molecular line observations. We show that no single molecular line provides a good measure for the density structure in the models. The X factor, translating the integrated line intensities into column densities, can be approximately constant within a density range covering up to a factor 100 in few transitions but for each line this behaviour breaks down outside of a limited range of densities. Optical depth effects and subthermal excitation result in a significant modification of the distribution of line intensities relative to the column density distribution.
All lower transitions of CO isotopes only trace gas at low and intermediate densities which is distributed over all scales in molecular clouds. Turbulence models driven on the largest scales reproduce the observed scaling behaviour. Higher CO transitions are only excited in dense cores resulting from shocks or gravitational collapse. The existence of massive dense cores resulting from collapse can only be inferred when comparing observations in different transitions taken with an excellent signal-to-noise ratio or from dedicated high-density tracers.
The line profiles obtained from turbulence models driven on large scales break up into several fragments in contrast to observations of molecular clouds without heavy star-formation which show typically smooth profiles with close-to-Gaussian shape. None of the turbulence simulations provides a good match of all observed properties for this type of clouds. The velocity scaling behaviour of all observations and turbulence models is consistent with the interpretation of a molecular cloud as shock-dominated medium. More observational data are needed to provide a reliable conclusion on the degree of intermittency.
As molecular lines fail to reflect the density structure of an interstellar cloud line observations should be combined with dust continuum observations to deduce column densities. On the other hand we need the velocity information contained in line observations to discriminate between different turbulence models.

Accepted by Astron. Astrophys.

High-resolution study of the young stellar objects in Mon R2 IRS 3

Thomas Preibisch[1], Yuri Y. Balega[2], Dieter Schertl[1], Gerd Weigelt[1]

[1] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D–53121 Bonn, Germany
[2] Special Astrophysical Observatory, Nizhnij Arkhyz, Zelenchuk region, Karachai-Cherkesia, 357147, Russia

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

We present a bispectrum speckle interferometry study of the embedded young stellar objects in Mon R2 IRS 3 in the near-infrared H and K bands. Our images with a resolution of 75 mas ($\widehat{=}$ 62 AU) show a close triple system surrounded by strong diffuse nebulosity and three additional infrared sources (K magnitudes $\sim 11.8 - 13.7$) within $3''$ of the brightest object IRS 3 A ($K \sim 7.9$). We use HST/NICMOS archive images to derive near-infrared photometry for the sources and estimate the stellar masses of the three brightest objects IRS 3 A, B, and C to be in the range $\sim 5-15\,M_\odot$.

IRS 3 A is surrounded by a bipolar nebula (position angle $\sim 30°$), suggesting it to be embedded in a thick circumstellar disk or a torus with polar cavities. IRS 3 B shows a remarkable jet-like emission feature pointing towards the north-east (position angle 50°). This feature consists of at least three individual knots with projected separations of 130, 230, and 290 mas (110, 190, and 240 AU) from IRS 3 B, which are much brighter in the K band than in the H band. This strongly indicates outflow activity from IRS 3 B, which is therefore probably the source of the compact high velocity molecular outflow reported from Mon R2 IRS 3.

We also analyze *Chandra* X-ray archive data for the Mon R2 region and find IRS 3 A and IRS 3 C to be sources of hard ($3-10$ keV) and variable X-ray emission, suggesting plasma temperatures of at least 50×10^6 K. The similarity of the X-ray properties to those of Class I protostars suggests magnetic interaction between the protostars and their circumstellar disks to be the origin of the X-ray emission; this provides indirect evidence for the presence of circumstellar disks in the intermediate- to high-mass young stellar objects IRS 3 A and IRS 3 C.

Accepted by Astron. & Astrophys.

Preprints are available at http://www.mpifr-bonn.mpg.de/staff/tpreibis/publications.html (paper # 31)
or http://www.mpifr-bonn.mpg.de/div/ir-interferometry/papers/monr2.html

A Near-Infrared Imaging Survey of Coalsack Globule 2

Germán Racca[1], Mercedes Gómez[1] and Scott J. Kenyon[2]

[1] Observatorio Astronómico de Córdoba, Laprida 854, 5000 Córdoba, Argentina
[2] Smithsonian Astrophysical Observatory, 60 Garden Street, Cambridge MA 02138, USA

E-mail contact: mercedes@oac.uncor.edu

We describe a near-infrared imaging survey of Globule 2 in the Coalsack. This Bok globule is the highest density region of this southern hemisphere molecular cloud and is the most likely location for young stars in this complex. The survey is complete for $K < 14.0$, $H < 14.5$, and $J < 15.5$, several magnitudes more sensitive than previous observations of this globule. From the large number of background stars, we derive an accurate near-infrared extinction law for the cloud. Our result, $E_{J-H}/E_{H-K} = 2.08 \pm 0.03$, is significantly steeper than results for other southern clouds. We use the $J - H/H - K$ color-color diagram to identify two potential young stars with $K < 14.0$ in the region. We apply H-band star counts to derive the density profile of the Coalsack Globule 2 and use a polytropic model to describe the internal structure of this small cloud. For a gas temperature T $\sim$ 15 K, this globule is moderately unstable.

Accepted by The Astronomical Journal

preprints: http://arXiv.org/abs/astro-ph/0207099

Evolution of the FU Orionis Object BBW 76

Bo Reipurth[1], Lee Hartmann[2], Scott J. Kenyon[2], Alain Smette[3] & Patrice Bouchet[4]

[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
[3] Institut d'Astrophysique et de Géophysique, Université de Liège, Avenue de Cointe, 5, B-4000 Liège, Belgium
[4] Cerro Tololo Interamerican Observatory, Casilla 603, La Serena, Chile

E-mail contact: reipurth@ifa.hawaii.edu

We have carried out a long-term photometric and spectroscopic monitoring program of the southern FU Orionis type object BBW 76 spanning the period from 1982 to 1997. BBW 76 has the same radial velocity as the small cloud towards which it is projected, and for which a kinematic distance of about 1.8 kpc has been derived. We have determined a large reddening of E(B–V) $\sim$0.7 for BBW 76. Optical and infrared spectra show the change towards later spectral type with increasing wavelength characteristic of FUors, and indicative of a hot luminous disk. High resolution echelle spectra of BBW 76 show P Cygni profiles with extended blueshifted absorption troughs at the Hα and Sodium lines from a neutral, supersonic wind. Comparison of such spectra obtained at six different epochs between 1985 and 1997 reveal major changes in these Hα and Sodium line profiles. For a period of 10 years from 1985, the massive absorption troughs diminished in extent and depth, until by 1994 they had all but disappeared, while at the same time the blueshifted emission peak in the Hα line increased markedly in strength. However, when observed in 1997, the absorption had increased again and the emission had diminished. We interpret this in terms of an extended period during which accretion through a circumstellar disk decreased with a resulting decrease in wind production. But the increased activity by 1997 shows that this is not a constant decay, and that the star was not about to revert to its presumably original T Tauri stage. We monitored the star with optical photometry from 1983 to 1994, during which period it decreased almost monotonically in brightness by 0.2 magnitudes in V. Infrared J, H, and K photometry from 1983 to 1991 shows a period of monotonic fading between 1984 and 1988, followed by more irregular behavior. In a search of the Harvard plate archives we have found a plate from year 1900, on which BBW 76 is seen at approximately its present brightness, and certainly not 2 magnitudes brighter as expected if the optical decline between 1983 and 1994 had persisted during the whole century. Also, a plate taken for the Franklin-Adams charts in 1927 again shows BBW 76 at approximately the same brightness. This historical light curve makes BBW 76 the FUor with the longest documented period in a high state. Overall, the observations suggest that BBW 76 is virtually identical to the prototype of its class, FU Orionis itself, in all respects except that BBW 76 has not shown the regular fading that FU Orionis has displayed after its eruption in 1936. This may be due to continued replenishment of the circumstellar accretion disk.

Accepted by Astron. J.

The Infrared Emission of Circumstellar Envelopes, Dark Silhouettes and Photoionized Disks in HII Regions

M. Robberto[1,2], S. V. W. Beckwith[1] and N. Panagia[1,2]

[1] Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA
[2] Space Telescope Operations Division of the European Space Agency (ESA)

E-mail contact: robberto@stsci.edu

We have modeled the infrared (IR) Spectral Energy Distribution (SED) of circumstellar disks embedded in a HII region and photoevaporated by the external ultraviolet radiation. The model applies to the photoevaporated disks (proplyds) in the Orion Nebula, most of them illuminated by the O6.5 star θ^1Ori C. First we calculate the IR emission of a Pre-Main-Sequence star surrounded by a dusty globule that is immersed within an HII region. The globule is assumed to be spherical, homogeneous, optically thin at IR wavelengths and photoevaporated according to the Dyson (1968) model. Second, we consider the IR emission of a disk directly exposed to the nebular environment. The reprocessing disk is passive and treated according to the Chiang and Goldreich (1997, CG97) model. We improve over the CG97 treatment by tracing the propagation of the various radiative fluxes (from the star exciting the HII region, nebular, and grazing from the disk central star) through the disk superheated atmosphere. Since the opposite disk sides receive different amounts of radiation, the flaring angle and the surface temperature distributions are different, resulting in well distinguished SEDs for the two disk faces. Finally, we combine the globule and disk models to estimate the IR emission of proplyds. The energy input from the central star and the nebular environment increase the disk flaring angle, and therefore also the amount of stellar radiation intercepted by the disk. The relative intensity of the disk vs. envelope emission varies with the tilt angle relative to the directions of θ^1Ori C, and of the Earth. We explore the dependence of the SEDs upon the tilt angle with respect to the Earth, the distance from θ^1Ori C, the size on the envelope, the inner disk radius and the temperature of the central star. The resulting SEDs are characterized by a broad peak of emission at 30-60 μm, and are in general significantly different from those of isolated disks in low-mass star forming regions like Taurus-Auriga. Our model indicates that in the presence of an external radiation field, relatively evolved "Class 2" objects may display a SED peaking at mid-IR and far-IR wavelengths. Also, the model can account for the strong mid-IR excess we have recently detected at 10 μm, from embedded disks in the Orion Nebula.

Accepted by Astroph. J., (v578, n2, October 20, 2002)

Preprint available at www.stsci.edu/~robberto/web/

VLA Detection of the Exciting Sources of the HH 288 and HHL59 Outflows

Mónica Rodríguez[1], Luis F. Rodríguez[1], Armen L. Gyulbudaghian[2], and Jorge May[3]

[1] Instituto de Astronomía, UNAM, Campus Morelia, Apdo. Postal 3-72, Morelia, Michoacán 58089, México
[2] Byurakan Astrophysical Observatory,, Byurakan, Armenia
[3] Departamento de Astronomía, Universidad de Chile, Casilla 36-D, Santiago, Chile

E-mail contact: m.rodriguez@astrosmo.unam.mx

We present VLA observations at 3.6-cm of three fields containing molecular outflows, including the HHL59 region, whose CO molecular flow is reported here. We detected candidates for the exciting sources of the molecular outflows in the three fields observed: L1287, HH 288, and HHL59. The exciting source of L1287 has been reported previously, but those toward HH 288 and HHL59 are first presented here. We discuss the parameters of these sources, as well as their relation with sources detected at other wavelengths.

Accepted by Revista Mexicana de Astronomía y Astrofísica

http://www.astrosmo.unam.mx/~luisfr/publ.html

Does IRAS 16293–2422 have a hot core? Chemical inventory and abundance changes in its protostellar environment

F. L. Schöier[1], J. K. Jørgensen[1], E. F. van Dishoeck[1], G. A. Blake[2]

[1] Leiden Observatory, P.O. Box 9513, NL-2300 RA Leiden, The Netherlands

[2] Division of Geological and Planetary Sciences, California Institute of Technology, MS 150-21, Pasadena, CA 91125, USA

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

A detailed radiative transfer analysis of the observed continuum and molecular line emission toward the deeply embedded young stellar object IRAS 16293–2422 is performed. Accurate molecular abundances and abundance changes with radius are presented. The continuum modelling is used to constrain the temperature and density distributions in the envelope, enabling quantitative estimates of various molecular abundances. The density structure is well described by a single power-law falling off as $r^{-1.7}$, i.e., in the range of values predicted by infall models. A detailed analysis of the molecular line emission strengthens the adopted physical model and lends further support that parts of the circumstellar surroundings of IRAS 16293–2422 are in a state of collapse. The molecular excitation analysis reveals that the emission from some molecular species is well reproduced assuming a constant fractional abundance throughout the envelope. The abundances and isotope ratios are generally close to typical values found in cold molecular clouds in these cases, and there is a high degree of deuterium fractionation. There are, however, a number of notable exceptions. Lines covering a wide range of excitation conditions indicate for some molecules, e.g., H_2CO, CH_3OH, SO, SO_2 and OCS, a drastic increase in their abundances in the warm and dense inner region of the circumstellar envelope. The location at which this increase occurs is consistent with the radius at which ices are expected to thermally evaporate off the grains. In all, there is strong evidence for the presence of a 'hot core' close to the protostar, whose physical properties are similar to those detected towards most high mass protostars except for a scaling factor. However, the small scale of the hot gas and the infalling nature of the envelope lead to very different chemical time scales between low mass and high mass hot cores, such that only very rapidly produced second-generation complex molecules can be formed in IRAS 16293–2422. Alternatively, the ices may be liberated due to grain-grain collisions in turbulent shear zones where the outflow interacts with the envelope. Higher angular resolution observations are needed to pinpoint the origin of the abundance enhancements and distinguish these two scenarios. The accurate molecular abundances presented for this low-mass protostar serve as a reference for comparison with other objects, in particular circumstellar disks and comets.

Accepted by A&A

www.strw.leidenuniv.nl/~fredrik/papers.html; astro-ph/0205457

Triggered star formation in Orion cometary clouds? I. The case of L1616

T. Stanke[1], M.D. Smith[2], R. Gredel[3] and G. Szokoly[4]

[1] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany
[2] Armagh Observatory, College Hill, Armagh BT61 9DG, Northern Ireland, UK
[3] Max-Planck Institut für Astronomie, Königsstuhl 17, D-69117 Heidelberg, Germany
[4] Astrophysikalisches Institut Potsdam, An der Sternwarte 16, D-14482 Potsdam, Germany

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

We present new 1.2 mm continuum maps and near- and mid-infrared images of the cometary cloud L1616 located to the west of the Orion OB associations and apparently shaped by the winds and radiation coming from the massive, hot stars in the OB association. The new data reveal evidence for ongoing star formation in the cloud in addition to the known cluster of somewhat more evolved stars illuminating the NGC1788 reflection nebula in the head of the cometary cloud. The 1.2 mm survey reveals a tight group of dust continuum sources, the brightest of which is seen to drive a powerful near-infrared H_2 jet, apparently a very young protostar of Class 0 type. The location of the newly discovered protostar with respect to the older cluster and the direction towards the OB association suggests an age sequence due to a wave of star formation driven through the cloud and triggered by the impact of the nearby OB association: the older generation of stars is located on the side of the cloud directly facing the OB association, whereas a new generation of star formation takes place deeper within the cloud.

Accepted by A&A

Preprints available at http://www.mpifr-bonn.mpg.de/staff/tstanke/preprints.html

Enhanced molecular abundances in low-mass star-forming cores

Serena Viti, Sukina Natarajan, David A Williams

Department of Physics and Astronomy, University College London, London WC1E 6BT, UK

E-mail contact: sv@star.ucl.ac.uk

The outflow from a YSO interacts with the dense core in which it is embedded to create anomalously high abundances of HCO^+ which show under high resolution a ‘butterfly’ morphology (Hogerheijde et al. 1998). Rawlings et al. (2000) suggested that the high HCO^+ abundance and its morphology arose in a photochemistry induced in the highly turbulent interface induced between the outflow and the core. In this paper we use a very large chemical network to explore the molecular nature of this interface, and demonstrate that, beside HCO^+, many other molecular tracers should be anomalously enhanced in this interface and should under high resolution show the same morphology as HCO^+. We predict that particularly abundant species should include H_2S, CS, H_2CS, SO, SO_2, CH_3OH and recommend that a study for these species and their morphologies be made in star-forming cores. Such observations should help to define the fluid interaction in the interface. The range of molecules predicted here should more generally represent a chemical signature of energetic turbulent mixing of hot and cold interstellar fluids, and our models developed may be able to interpret observations to determine the nature of the fluids and their interaction.

Accepted by Monthly Notices of the Royal Astronomical Society

Diffraction-limited bispectrum speckle interferometry of the Herbig Be star R Mon

Gerd Weigelt[1], Yuri Y. Balega[2], Karl-Heinz Hofmann[1], Thomas Preibisch[1]

[1] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D–53121 Bonn, Germany
[2] Special Astrophysical Observatory, Nizhnij Arkhyz, Zelenchuk region, Karachai-Cherkesia, 357147, Russia

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

We explore the structures immediately surrounding the intermediate-mass young stellar object R Mon with bispectrum speckle interferometry, conventional near-infrared imaging and by analyzing optical HST archive data. Our near-infrared speckle images with unprecedented diffraction-limited resolution of 55 mas ($\sim$ 44 AU; H-band) and 76 mas ($\sim$ 61 AU; K-band) represent the highest resolution R Mon images obtained so far and exhibit previously unseen complex structures. While the binary companion R Mon B appears as an unresolved point source in our speckle images, the image of the primary R Mon A is marginally extended in the K-band and significantly extended in the H-band. The most prominent new feature is a bright arc-shaped structure, pointing away from R Mon in north-western direction. We interpret this feature as the surface of a dense structure near the thick circumstellar disk or torus around R Mon. Our images also reveal several twisted filaments of helical shape which are similar to the twisted filaments in the outer parts of the nebula. We identify structures which probably are responsible for casting pronounced shadows in the outer regions of the NGC 2261 reflection nebula. Finally, we discuss the relation of the observed features, in particular the arc-shaped speckle feature, to the wind and outflow activity (Herbig-Haro objects and jets) of R Mon.

Accepted by Astron. & Astrophys.

Preprints are available at http://www.mpifr-bonn.mpg.de/div/ir-interferometry/papers/rmon.html
or http://www.mpifr-bonn.mpg.de/staff/tpreibis/publications.html (paper # 30)

HST/STIS Observations of the Bipolar Jet from RW Aurigae: Tracing Outflow Asymmetries Close to the Source

Jens Woitas[1], Thomas P. Ray[2], Francesca Bacciotti[3], Christopher J. Davis[4] and Jochen Eislöffel[1]

[1] Thüringer Landessternwarte Tautenburg, Sternwarte 5, D-07778 Tautenburg, Germany
[2] School of Cosmic Physics, Dublin Institute for Advanced Studies, 5 Merrion Square, Dublin 2, Ireland
[3] I.N.A.F. - Osservatorio Astrofisico di Arcetri, Largo E. Fermi, I-50125 Firenze, Italy
[4] Joint Astronomy Centre, 660 North A’ohōkū Place, University Park, Hilo, HI 96720, USA

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

We have observed the bipolar jet from RW Aur A with STIS on board the HST. After continuum subtraction, morphological and kinematic properties of this outflow can be traced to within $0.''1$ from the source in forbidden emission

lines. The jet appears well collimated, with typical FWHMs of 20 to 30 AU in the first 2″ and surprisingly does not show a separate low-velocity component in contrast to earlier observations. The systemic radial outflow velocity of the blueshifted lobe is typically 50% larger than that of the redshifted one with a velocity difference of about 65 km s^{-1}. Although such asymmetries have been seen before on larger scales, our high spatial resolution observations suggest that they are intrinsic to the "central engine" rather than effects of the star's immediate environment. Temporal variations of the bipolar jet's outflow velocities appear to occur on timescales of a few years. They have combined to produce a 55% increase in the velocity asymmetry between the two lobes over the past decade. In the red lobe estimated mass flux $\dot{M}_j$ and momentum flux $\dot{P}_j$ values are around one half and one third of those for the blue lobe, respectively. The mass outflow to mass accretion rate is 0.05, the former being measured at a distance of 0.″35 from the source.

Accepted by ApJ

http://www.tls-tautenburg.de/research/tls-research/pub2002.html

A Methane Isolated Planetary Mass Object in Orion

M. R. Zapatero Osorio[1], V. J. S. Béjar[2], E. L. Martín[3], R. Rebolo[2], D. Barrado y Navascués[1], R. Mundt[4], J. Eislöffel[5], and J. A. Caballero[2]

[1] LAEFF-INTA, P. O. Box 50727, E-28080 Madrid, Spain
[2] Instituto de Astrofísica de Canarias, E-38205 La Laguna, Tenerife, Spain
[3] Institute of Astronomy, Univ. of Hawaii at Manoa, 2680 Woodlawn Drive, Honolulu, HI 96822 USA
[4] Max-Planck-Institut für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany
[5] Thüringer Landessternwarte Tautenburg, Sternwarte 5, D-07778 Tautenburg, Germany

E-mail contact: mosorio@laeff.esa.es

We report on the discovery of a free-floating methane dwarf toward the direction of the young star cluster σ Orionis. Based on the object's far-red optical and near-infrared photometry and spectroscopy, we conclude that it is a possible member of this association. We have named it as S Ori J053810.1–023626 (S Ori 70 is the abridged name). If it is a true member of σ Orionis, the comparison of the photometric and spectroscopic properties of S Ori 70 with state-of-the-art evolutionary models yields a mass of 3^{+5}_{-1} Jupiter mass for ages between 1 Myr and 8 Myr. The presence of such a low-mass object in our small search area (55.4 arcmin^2) would indicate a rising substellar initial mass function in the σ Orionis cluster even for planetary masses.

Accepted by Astrophys. J.

Preprint available at http://xxx.lanl.gov/abs/astro-ph/0206353

Dissertation Abstracts

Polycyclic Aromatic Hydrocarbons and Diamonds around Young Stellar Objects

Caroline Van Kerckhoven

Thesis work conducted at: Institute of Astronomy, KULeuven, Celestijnenlaan 200B, 3001 Heverlee, Belgium

Electronic mail: caroline@ster.kuleuven.ac.be

Ph.D dissertation directed by: A.G.G.M Tielens and C. Waelkens

Ph.D degree awarded: june 2002

The research performed in this thesis concentrates on the analysis and interpretation of the Infra-Red (IR) emission lines in the near and mid IR of spectra of Young Stellar Objects (YSOs). The IR-spectra of a sample of YSOs is observed with the Short-Wavelength Spectrometer (SWS) on board the Infra-red Space Observatory (ISO). This research is mainly based on the analysis of these spectra.

The IR lines are characteristic for Polycylcic Aromatic Hydrocarbons (PAHs). PAHs are the most complex molecules observed in space, and play an important role in the physics and chemistry of the InterStellar Medium . One of the aims of this thesis was the characterisation of PAHs in the environment of YSOs. Our analysis shows that PAHs are modified in the immediate circumstellar environment of YSOs; the '7.7' μm band is the most obviously varying band. We discuss the possible mechanisms modifying the '7.7' μm band in the environment of YSOs. We conclude that processes in the protostellar or protoplanetary environment during the formation and/or early evolution of the YSO are the main drivers. Special attention is given to the possible role of clustering. We conclude that PAH clustering is not important in these environments.

We report the detection of a new emission plateau extending from 15 to 20 μm. We attribute this plateau to a blend of emission features arising from C–C–C bending modes, causing in– and out–of–plane distortion of the carbon skeleton of PAHs. We conclude that the observed increased strength of the 15–20 μm plateau relative to the shorter wavelength IR emission features in the harsh environment of HII regions, is caused by the higher relative abundance of larger PAHs and PAH clusters.

In the circumstellar environment of two YSOs, HD 97048 and Elias 1, emission bands from hydrogenated diamonds are identified. Analysis of the emission bands and the radiative energy budget indicates that the diamond carriers in HD 97048 have very small sizes, typically 1–10 nm. The abscence of other common dust grains in the cirumstellar environment of HD 97048 together with the specific conditions required for diamond formation and the characteristics of meteoritic diamond make us conclude that in situ formation of the diamonds in these objects is more likely than a stardust origin.

New Books

Star Formation and the Physics of Young Stars

Edited by Jérôme Bouvier and Jean-Paul Zahn

The book contains the proceedings of the tenth school in the *Summer School on Stellar Physics* series, held in Aussois, France from September 18 to 22, 2000. These schools are primarily directed towards Ph.D. students in astrophysics and researchers from neighbouring astrophysical fields, and give an overview of a selected topic in stellar physics. The lecturers have written up their presentations in a highly readable volume, which provides an excellent overview of star formation processes, early stellar evolution, and the properties of young stars. As such, the book will be particularly useful as a supporting text for a graduate course in star formation.

The book contains the following chapters:

The Initial Conditions for Protostellar Collapse [Ph. André]
Introduction – Density Structure of Individual Cloud Cores – Velocity Structure – Comparison with Collapse Models – Global Aspects: Origin of the IMF – Conclusions and Future Prospects

Massive Pre-Main Sequence Stars in the Magellanic Clouds [J.Ph. Beaulieu & W.J. de Wit] *Low Mass Star Formation in External Galaxies – The Discovery of PMS HAeBe Stars in the Magellanic Clouds – The Low Mass Stellar Populations near HAeBe Stars in the LMC and SMC – The Young Stellar Population around SN1987A – Conclusions*

Massive Star Forming Regions: From the Local Universe to High Redshift [D. Schaerer] *Introduction – Formation and Evolution of Massive Stars – Massive Star Forming Regions in the Galaxy and the Magellanic Clouds – Analysis of Stelar populations – Starburst Galaxies*

Cosmological Star Formation History [F. Hammer] *Introduction – Instrumental Progresses and their Limitations – Star Formation Rate Estimates – Cosmological Star/Metal Formation History – Discussion and Conclusion*

The Physics of Young Stellar Objects: X-Rays, Magnetism, and High-Energy Phenomena [T. Montmerle] *Introduction – X-Ray Observations of Star-Forming Regions – Irradiation Phenomena and Consequences – Concluding Remarks*

The Physics of Pre-Main Sequence Evolution [F. Palla] *Introduction – The Classical Theory of Pre-Main Sequence Evolution – The Impact of Star Formation – Evolutionary Models – the H-R Diagram – Testing the Evolutionary Tracks – Stelar populations in Clusters and Associations*

Constraints on Accretion-Ejection Structures in Young Stars [S. Cabrit] *Introduction – Jet Morphology and Collimation Scale – Kinematics and Time Variability – Jet density and Excitation Conditions – Estimating Mass-Loss Rates from Direct Jet Observations – Estimating Wind Dynamics from its Interaction with Ambient Gas – Accretion-Ejection Correlations – Evidence for a Wide-angle Component – Conclusions and Open Questions*

Accretion Disks around Young Stars: An Observational Perspective [F. Ménard & C. Bertout] *Historical Background – Unresolved Observations & Global Disk Observables – the Evolution and Dissipation of Accretion Disks*

Theory of Turbulent Accretion Disks [C. Terquem] *Introduction – Fundamental of Hydrodynamics – Angular Momentum Transport by Turbulence – Magnetohydrodynamic Instabilities – α Disk Models – Conclusion*

Theory of Magnetized Accretion Discs Driving Jets [J. Ferreira] *Introduction – Theoretical Framework of MAES – Magnetized Jets – Magnetized Accretion Discs Driving Jets – Self-Similar Solution of MAES – Some Perspectives*

ISBN 2-86883-601-1 hardback - published 2002 - 277 pages
Price 40 Euros, plus postage (European Astronomical Society members get 20% discount)

EDP Sciences, 17 avenue du Hoggar, PA de Courtabaeuf, B.P. 112, F-91944 Les Ulis cedex A, France

http://www.edpsciences.org/docinfos/EAS/ (e-mail to subscribers@edpsciences.org)

Planetary Sciences

Imke de Pater and Jack J. Lissauer

Researchers and students working on star formation are increasingly faced with a need to understand planetary sciences. Planet formation is a rapidly developing discipline, and studies of extrasolar planets offer insights into planetary system architectures different from our own. Studies of meteorites, comets and asteroids provide information on the conditions in the early solar nebula. The evolution of disks around newborn stars is shaped by dynamical interactions with protoplanets. Star formation thus interfaces with planetary sciences in multiple ways. The present book provides a detailed and up-to-date overview of the concepts, processes, and observational facts of planetary sciences, and as such is an invaluable tool for star formation researchers who wish to develop their understanding of this rapidly developing field. The book is organized so it can be used as a textbook for a graduate course.

1. Introduction *1.1 Inventory of the Solar System; 1.2 Planetary Properties; 1.3 Formation of the Solar System.*

2. Dynamics *2.1 The Two-Body Problem; The Three-Body Problem; 2.3 Planetary Pertubations and Resonances; 2.4 Long-term Stability of Planetary Orbits; 2.5 Orbits about an Oblate Planet; 2.6 Tides; 2.7 Dissipative Forces and the Orbits of Small Bodies.*

3. Solar Heating and Energy Transport *3.1 Energy Balance and Temperature; 3.2 Energy Transport; 3.3 Radiative Equilibrium in an Atmosphere.*

4. Planetary Atmospheres *4.1 Density and Scale Height; 4.2 Thermal Structure; 4.3 Atmospheric Composition; 4.4 Clouds; 4.5 Meteorology; 4.6 Photochemistry; 4.7 Molecular and Eddy Diffusion; 4.8 Atmospheric Escape; 4.9 Evolution of Terrestrial Planet Atmospheres and Climate.*

5. Planetary Surfaces *5.1 Mineralogy and Petrology; 5.2 Crystallization of a Magma; 5.3 Surface Morphology; 5.4 Impact Cratering; 5.5 Surface Geology of Individual Bodies.*

6. Planetary Interiors *6.1 Modeling the Interior Structure of a Planet; 6.2 Seismic Tomography and the Earth's Interior; 6.3 Interior Structure of other Terrestrial Bodies and Moons; 6.4 Interior Structure of the Giant Planets.*

7. Planetary Magnetospheres and the Interplanetary Medium *7.1 The Interplanetary medium; 7.2 Magnetic Filed Configuration: Mathematical Description; 7.3 Magnetospheric Plasma and Particle Motions; 7.4 Magnetospheres of Individual Bodies; 7.5 Radio Emissions; 7.6 Waves in Magnetospheres; 7.7 Generation of Magnetic Fields.*

8. Meteorites *8.1 Basic Classification and Fall Statistics; 8.2 Source Regions; 8.3 Fall Phenomena; 8.4 Chemical and Isotopic Fractionation; 8.5 Radiometric Dating; 8.6 Physical Characteristics of Chondrites; 8.7 Meteorite Clues to the Formation of the Solar System.*

9. Asteroids *9.1 orbits; 9.2 Size Distribution and Collisional Evolution; 9.3 Observing Techniques; 9.4 Surface Composition; 9.5 Structure; 9.6 origin and Evolution of the Asteroid Belt.*

10. Comets *10.1 Nomenclature; 10.2 Cometary orbits and Comet Reservoirs; 10.3 Gaseous Coma; 10.4 Dust; 10.5 Magnetosphere; 10.6 Nucleus; 10.7 Comet Formation and Constraints on Theories of Solar System Formation; 10.8 Future.*

11. Planetary Rings *11.1 Tidal Forces and Roche's limit; 11.2 Flattening and Spreading of Rings; 11.3 Observations of Planetary Rings; 11.4 Ringt-Moon Interactions; 11.5 Physics of Dust Rings; 11.6 Meteoroid Bombardment of Planetary Rings; 11.7 origins of Planetary Rings; 11.8 Summary.*

12. Planet Formation *12.1 Observational Constraints; 12.2 Nucleosynthesis; 12.3 Star Formation: A Brief Overview; 12.4 Evolution of the Solar nebula: The protoplanetary disk; 12.5 Condensation and Growth of Solid Bodies; 12.6 Formation of Terrestrial Planets; 12.7 Formation of the Giant Planets; 12.8 Planetary Migration; 12.9 Small Bodies in orbit about the Sun; 12.10 Planetary Rotation; 12.11 Origin of Planetary Satellites; 12.12 Confronting Theory with Observations.*

13. Extrasolar Planets *13.1 Physics and Sizes of Giant Planets, Brown Dwarfs and Low-Mass Stars; 13.2 Detecting Extrasolar Planets; 13.3 Observations of Extrasolar Planets; 13.4 Models of the Formation of Planets observed to orbit Main Sequence Stars other than the Sun; 13.5 Planets and Life; 13.6 SETI; 13.7 Conclusions.*

ISBN 0 521 48219 4 hardback - published 2001 - 528 pages Price US$ 75.00 plus postage

Cambridge University Press, 110 Midland Avenue, Port Chester, NY 10573-4930, USA Fax: 914-937-4712

Meetings

First Announcement:

The Dense Interstellar Medium in Galaxies

4th Cologne-Bonn-Zermatt-Symposium
Zermatt, Switzerland
22-26 September 2003

Symposium Objectives:

The conference will focus on the structure and processes in molecular clouds and on the general interstellar medium ranging from star formation in the early universe to the composition of the ISM in our neighborhood. It will provide an international platform for reviewing the fast developing field of interstellar medium research.

Zermatt Conferences on the interstellar medium are held since 1988 in a regular 5 years interval. The conference is organized by the KOSMA group of the University of Cologne in collaboration with the Max Planck Institute for Radioastronomy and the Radioastronomical Institute of the University Bonn. Just as the previous ones, the 4th conference will bring together scientists and experts in the field and give them the opportunity to report and discuss on the latest astrophysical research and the rapidly processing technology developments.

Major topics are:

- Physical condition and structure of the dense ISM
- Star formation
- Galactic structure and dynamics
- Astrochemistry and laboratory astrophysics
- Instrumentation from the mm to the NIR domain

Scientific Organising Committee (preliminary):

J. Cernicharo, F. Combes, D. Downes, O. Gerhard, M. Gerin, Y. Fukui, T. Henning, E. Herbst, M. Morris, P. Saraceno, P. Shaver, P. Strittmatter, E. van Diskoeck, G. White, C. Wilson, H. Yorke, as well as A. Eckart, K. Menten, J. Stutzki

Local Organizing Committee:

A. Eckart, A. Heithausen, C. Kramer, S. Pfalzner, R. Schieder, J. Stutzki, C. Straubmeier, F. Wyrowski

Additional details will be available in the near future. A call for contributions will be released in fall. See also our Conference web page: http://www.ph1.uni-koeln.de/zermatt2003

For further information send an email to zermatt2003@ph1.uni-koeln.de or contact the Local Organizing Committee. Feel free to distribute this announcement to other interested scientists and students.

I. Physikalisches Institut	Radioastronomisches Institut	Max-Planck-Institut für Radioastronomie
Univerität zu Köln	Universität Bonn	
Zülpicher Str 77	Auf dem Hügel 71	Auf dem Hügel 69
50937 Köln	53121 Bonn	53121 Bonn
Germany	Germany	Germany

SIRTF Observation Planning Workshops

November 22-23 and December 6-7, 2002

http://sirtf.caltech.edu/SSC/OST/WORKSHOP/

The SIRTF Science Center (SSC) announces two identical "SIRTF Observation Planning Workshops", to be held at the SSC in Pasadena, CA on November 22-23 and December 6-7, 2002. The purpose of these workshops is to provide detailed information on the SIRTF observatory, the various modes of observation and how to prepare technically sound proposals that will take advantage of the extraordinary capabilities of SIRTF instruments. The workshops will be used to train a cadre of SIRTF GO science liaisons within a range of astronomical departments. The goal is to reach a broad audience, thus we expect to have only 1-2 people from a single institution. Graduate students will be required to have a letter of recommendation to attend from the head of their department. Registration details can be found on the workshop webpage (http://sirtf.caltech.edu/SSC/OST/WORKSHOP/).

Deadline for travel assistance requests: 30 August 2002, 5pm PDT

Final deadline for registration: 15 October 2002.

Contact: obsplan@ipac.caltech.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 at http://www.ifa.hawaii.edu/ reipurth or at http://www.eso.org/gen-fac/pubs/starform/ .

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.