THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar evolution and molecular clouds

No. 139 — 11 May 2004 Editor: Bo Reipurth (reipurth@ifa.hawaii.edu)

Abstracts of recently accepted papers

The infrared properties of the new outburst star IRAS 05436−0007 in quiescent phase

Péter Ábrahám[1], Ágnes Kóspál[2], Szilárd Csizmadia[1], Attila Moór[1], Mária Kun[1] and Guy Stringfellow[3]

[1] Konkoly Observatory of the Hungarian Academy of Sciences, P.O. Box 67, H-1525 Budapest, Hungary
[2] Department of Astronomy, Eötvös Loránd University, P.O. Box 32, H-1518 Budapest, Hungary
[3] Center for Astrophysics & Space Astronomy, Univ. Colorado at Boulder, 389 UCB, Boulder, CO 80309-0389, USA

E-mail contact: abraham@konkoly.hu

We compiled and investigated the infrared/sub-mm/mm SED of the new outburst star IRAS 05436−0007 in quiescent phase. The star is a flat-spectrum source, with an estimated total luminosity of $L_{\rm bol} \approx 5.6\,L_{\odot}$, typical of low-mass T Tauri stars. The derived circumstellar mass of $0.5\,M_{\odot}$ is rather high among low-mass YSOs. The observed SED differs from the SEDs of typical T Tauri stars and of 4 well-known EXors, and resembles more the SEDs of FU Orionis objects indicating the presence of a circumstellar envelope. IRAS 05436−0007 seems to be a Class II source with an age of approximately $4{\times}10^5$ yr. In this evolutionary stage an accretion disk is already fully developed, though a circumstellar envelope may also be present. Observations of the present outburst will provide additional knowledge on the source.

Accepted by Astronomy & Astrophysics Letters

astro-ph/0404249

Correlation between grain growth and disk geometry in Herbig Ae/Be systems

B. Acke,[1] M.E. van den Ancker,[2] C.P. Dullemond,[3] R. van Boekel,[4] L.B.F.M. Waters[1,4]

[1] Instituut voor Sterrenkunde, Katholieke Universiteit Leuven, Celestijnenlaan 200B, 3001 Leuven, Belgium
[2] European Southern Observatory, Karl-Schwarzschild Strasse 2, D-85748 Garching bei München, Germany
[3] Max-Planck-Institut für Astrophysik, Karl-Schwarzschildstrasse 1, Postfach 1317, D-85748 Garching bei München, Germany [4] Astronomical Institute "Anton Pannekoek", University of Amsterdam, Kruislaan 403, NL-1098 SJ Amsterdam, The Netherlands

E-mail contact: bram@ster.kuleuven.ac.be

We have calculated the (sub-)mm spectral indices of 26 Herbig Ae/Be stars, for which we can determine the infrared spectral energy distribution (SED). We find a clear correlation between the strength of the ratio of the near- to mid-infrared excess of these sources, and the slope of the (sub-)mm energy distribution. Based on earlier multi-dimensional modeling of disks around Herbig Ae stars, we interpret this as a correlation between the geometry of the disk (flared or self-shadowed) and the size of the grains: self-shadowed disks have, on average, larger grains than their flared counterparts. These data suggest that the geometry of a young stellar disk evolves from flared to self-shadowed.

Accepted by A&A

http://arxiv.org/abs/astro-ph/0404553

Photoevaporation of Circumstellar Disks Due to External FUV Radiation in Stellar Aggregates

Fred C. Adams[1,2], David Hollenbach[3], Gregory Laughlin[4], and Uma Gorti[3]

[1]Michigan Center for Theoretical Physics, Physics Department, University of Michigan, Ann Arbor, MI 48109, USA
[2]Astronomy Department, University of Michigan, Ann Arbor, MI 48109, USA
[3]NASA Ames Research Center, Moffett Field, CA 94035, USA
[4]Lick Observatory, University of California, Santa Cruz, CA 95064, USA

E-mail contact: fca@umich.edu

When stars form within small groups (with $N_\star \approx 100-500$ members), their circumstellar disks are exposed to relatively little EUV ($h\nu > 13.6$ eV) radiation but a great deal of FUV (6 eV $< h\nu <$ 13.6 eV) radiation ($\sim 10^3$ times the local interstellar FUV field) from the most massive stars in the group. This paper calculates the mass loss rates and evaporation time scales for circumstellar disks exposed to external FUV radiation. Previous work treated large disks and/or intense radiation fields in which the disk radius r_d exceeds the critical radius r_g where the sound speed in the FUV heated surface layer exceeds the escape speed; it has often been assumed that photoevaporation occurs for $r_d > r_g$ and is negligible for $r_d < r_g$. Since $r_g \gtrsim 100$ AU for FUV heating, this would imply little mass loss from the planet-forming regions of a disk. In this paper, we focus on systems in which photoevaporation is suppressed because $r_d < r_g$ and show that significant mass loss still takes place as long as $r_d/r_g \gtrsim 0.1 - 0.2$. Some of the gas extends beyond the disk edge (or above the disk surface) to larger distances where the temperature is higher, the escape speed is lower, and an outflow develops. The resulting evaporation rate is a sensitive function of the central stellar mass and disk radius, which determine the escape speed, and the external FUV flux, which determines the temperature structure of the surfaces layers and outflowing gas. Disks around red dwarfs, low mass stars with $M_* \lesssim 0.5\ M_\odot$, are evaporated and shrink to disk radii $r_d \lesssim 15$ AU on short time scales $t \lesssim 10$ Myr when exposed to moderate FUV fields with $G_0 = 3000$ (where $G_0 = 1.7$ for the local interstellar FUV field). The disks around solar type stars are more durable. For intense FUV radiation fields with $G_0 = 30{,}000$, however, even these disks shrink to $r_d \lesssim 15$ AU on time scales $t \sim 10$ Myr. Such fields exist within about 0.7 pc of the center of a cluster with $N_\star \approx 4000$ stars. If our solar system formed in the presence of such strong FUV radiation fields, this mechanism could explain why Neptune and Uranus in our solar system are gas poor, whereas Jupiter and Saturn are relatively gas rich. This mechanism for photoevaporation can also limit the production of Kuiper belt objects and can suppress giant planet formation in sufficiently large clusters, such as the Hyades, especially for disks associated with low mass stars.

Accepted by ApJ

web address: astro-ph/0404383

Disappearance of N_2H^+ from the Gas Phase in the Class 0 Protostar IRAM 04191

Arnaud Belloche[1,2] and Philippe André[3]

[1] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany
[2] LERMA/LRA, Ecole Normale Supérieure, 24 rue Lhomond, F-75231 Paris Cedex 05, France
[3] Service d'Astrophysique, CEA/DSM/DAPNIA, C.E. Saclay, F-91191, Gif-sur-Yvette Cedex, France

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

We present a high-resolution millimeter study of the very young Class 0 protostar IRAM 04191+1522 in the Taurus molecular cloud. N_2H^+(1-0) observations with the IRAM Plateau de Bure Interferometer and 30m telescope demonstrate that the molecular ion N_2H^+ disappears from the gas phase in the inner part of the protostellar envelope ($r < 1600$ AU, $n_{\rm H_2} > 5 \times 10^5$ cm^{-3}). This result departs from the predictions of current chemical models. It suggests either that N_2 is more depleted than the models predict, owing to a higher binding energy on polar ice or an enhanced grain chemistry transforming N_2 to less volatile species, or that strong deuterium fractionation enhances N_2D^+ to the detriment of N_2H^+.

Accepted by Astronomy & Astrophysics Letters

A young binary Brown Dwarf in the R-CrA star formation region

H. Bouy[1,2,5], W. Brandner[3], E. L. Martín[4], X. Delfosse[5], F. Allard[6], I. Baraffe[6], T. Forveille[5,7], R. Demarco[8]

[1] Max-Planck Institut für extraterrestrische Physik, Giessenachstraße 1, D-85748 Garching bei München, Germany
[2] European Southern Observatory, Karl Schwarzschildstraße 2, D-85748 Garching bei München, Germany
[3] Max-Planck Institut für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany
[4] Instituto de Astrofisica de Canarias, 38200 La Laguna, Spain
[5] Laboratoire d'Astrophysique de l'Observatoire de Grenoble, 414 rue de la piscine, F-38400 Saint Martin d'Hère, France
[6] Centre de Recherche Astronomique de Lyon (UML 5574), Ecole Normale Supérieure, 69364 Lyon Cedex 07, France
[7] Canada-France-Hawaii Telescope Corporation, PO Box 1597, Kamuela Hi-96743, USA
[8] Institut d'Astrophysique de Paris, 98bis, Bd Arago, F-75014 Paris, France

E-mail contact: hbouy@mpe.mpg.de

We present imaging and spectroscopic observations with HST (WFPC2, ACS/HRC and STIS), VLT (FORS2) and Keck (HIRES) of the dM8 ultra-cool dwarf DENIS-P J185950.9-370632, located in the R-CrA region. The presence of lithium absorption at 670.8 nm and the strong Hα emission indicate a young age and a sub-stellar mass. Our diffraction-limited images resolve a companion at the separation limit of HST/ACS ($\sim$ 0.06"). The 2.1 mJy flux in the LW2 filter (5.0-8.5μm) of the Infrared Space Observatory (Olofsson et al., 1999, A&A 350,383) likely corresponds to an infrared excess, suggesting the presence of circumstellar material. Proper motion and photometric measurements, as well as the Hα activity, confirm membership in the R-CrA star forming region. If confirmed by further observations, DENIS-P J185950.9-370632 would be the first accreting sub-stellar multiple system observed to date.

Accepted by Astronomy & Astrophysics

Preprints available on
http://arxiv.org/abs/astro-ph/0404576 or ftp://ftp.mpe.mpg.de/people/hbouy/publications/DENIS1859.ps.gz

Physical and kinematical properties of a newly discovered star cluster and its associated jet in the Vela Molecular Clouds

A. Caratti o Garatti[1,2], T. Giannini[1], D. Lorenzetti[1], F. Massi[3], B. Nisini[1] and F. Vitali[1]

[1] INAF - Osservatorio Astronomico di Roma, via Frascati 33, I-00040 Monte Porzio, Italy
[2] Università degli Studi di Roma "Tor Vergata" - Dipartimento di Fisica, via della Ricerca Scientifica 1, I-00133 Roma, Italy
[3] INAF - Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, I-50125 Firenze, Italy

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

The star forming region associated with IRAS 08211-4158 and located in the Vela Molecular Ridge (VMR) has been investigated through low ($\mathcal{R} \approx 600$) and high resolution ($\mathcal{R} \approx 9000$) near infrared spectroscopy (1-2.5 μm) together with narrow band ([Fe II] and H_2) and broad band (H, K, L, M) imaging. The photometric results allow us to identify for the first time a young cluster with the less evolved star lying toward its center. Our results confirm that the most massive stars found in the clusters of the VMR do not form before the low mass ones. In particular, the only bipolar jet detected across the investigated field is driven by the most massive object which lacks an optical counterpart. Such a jet is composed by individual knots showing several H_2 and [Fe II] emission lines indicative of a coexistence of different shocks responsible for their excitation. Physical parameters of the emitting gas such as electron density, extinction and temperature have been derived from the low resolution spectroscopy. Some knots are already thermalized, while other present a stratification of temperature up to values of 5000 K. Through high resolution spectroscopy the [Fe II] lines profile for the majority of the knots can be resolved in a double peaked structure which is consistent with bow shock model predictions. Moreover, the radial velocity component is determined for different knots. Finally, by comparing [Fe II] images taken in different epochs, we have been able to derive the proper motion for some knots, hence to evaluate their total velocity ($\sim$ 300 km s^{-1}), the dynamical age and the jet inclination with respect to the plane of the sky.

Accepted by A&A

Available at http://www.mporzio.astro.it/∼bruni/publ/0053.ps

The Evolution and Simulation of the Outburst from XZ Tauri - A Possible EXor?

D Coffey[1], T. P. Downes[2] and T. P. Ray[1]

[1] The Dublin Institute for Advanced Studies, 5 Merrion Square, Dublin 2, Ireland.
[2] Dublin City University, Dublin 9, Ireland.

E-mail contact: dac@cp.dias.ie

We report on multi-epoch HST/WFPC2 images of the XZ Tauri binary, and its outflow, covering the period from 1995 to 2001. Data from 1995 to 1998 have already been published in the literature. Additional images, from 1999, 2000 and 2001 are presented here. These reveal not only further dynamical and morphological evolution of the XZ Tauri outflow but also that the suspected outflow source, XZ Tauri North, has flared in EXor-type fashion. In particular our proper motion studies suggests that the recently discovered bubble-like shock, driven by the the XZ Tauri outflow, is slowing down (its tangential velocity decreasing from $146\,\mathrm{km\,s^{-1}}$ to $117\,\mathrm{km\,s^{-1}}$). We also present simulations of the outflow itself, with plausible ambient and outflow parameters, that appear to reproduce not only the dynamical evolution of the flow, but also its shape and emission line luminosity.

Accepted by A&A

Preprints at: http://arXiv.org/abs/astro-ph/0402635

First polarimetry results of two candidate high-mass protostellar objects

R.L. Curran[1], A. Chrysostomou[1], J.L. Collett[1], T. Jenness[2] and D.K. Aitken[1]

[1] Centre for Astrophysics Research, Science and Technology Research Centre, University of Hertfordshire, College Lane, Hatfield, HERTS, AL10 9AB, UK
[2] Joint Astronomy Centre, 660 N. A'ohōkū Place, Hilo, HI 96720, USA

E-mail contact: rcurran@star.herts.ac.uk

We present 850μm imaging polarimetry of two high-mass star forming regions – W48 and S152. Within these regions we have identified two candidate high-mass protostellar objects – W48W and S152SE. The submillimetre continuum emission from the candidate HMPOs is bright in comparison to the nearby HII regions. W48W is a cold dense source, with no radio or mid-infrared emission. S152SE has an IRAS source IRAS 22566 +5828 in the Southwestern part of the region, which appears in the mid-infrared 8.28μm emission, but there is no radio emission. The 850μm data shows another core within the region, in the Northeast. The polarimetry is ordered and the degree of polarisation is high over the candidate HMPOs – $\sim 6\%$ for W48W and $\sim 8\%$ for S152SE. Polarimetry results of this nature indicate a strong, ordered magnetic field threading the candidate HMPOs. The magnetic field direction in both S152SE and W48W is perpendicular to the direction of elongation of the cloud which would imply collapse along the field lines. Estimates of the magnetic field strength are derived using the Chandrasekhar & Fermi method. We calculate plane of the sky field strengths of $\sim$0.7 mG for W48W and $\sim$0.2 mG for S152SE. We discuss the drawbacks of using the Chandrasekhar & Fermi method with a large beam size. Mass-to-flux ratios have been calculated and both clouds are found to be roughly critical.

Accepted by A&A

Photometric and Spectroscopic Study of Stars in the Field of the Young Open Cluster Roslund 4

A.J. Delgado[1], L.F. Miranda[1], M. Fernández[1] and E.J. Alfaro[1]

[1] Instituto de Astrofísica de Andalucía. CSIC. Apdo. 3004. 18080-Granada. Spain

E-mail contact: delgado@iaa.es, lfm@iaa.es, matilde@iaa.es, emilio@iaa.es

We present photometric and spectroscopic observations performed in the field of the galactic open cluster Roslund 4, which contains the two catalogued nebulae IC 4954 and IC 4955. $UBVRI$ photometry was carried out in a field of $11' \times 6'$ around the cluster center. Medium resolution optical spectroscopy has been obtained for 41 stars, including previously selected main-sequence and pre-main sequence candidate cluster members. Narrow band Hα, [SII], and continuum images have been secured.

The observations allow us the measurement of different physical parameters for the cluster. Assuming an absorption coefficient $A_V/E(B-V) = 3.1$ and a reddening slope $E(U-B)/E(B-V) = 0.72$, we obtain a color excess $E(B-V) = 1.1 \pm 0.2$ and a distance modulus $DM_0 = 11.7 \pm 0.5$. Fitting of isochrones to the color-magnitude diagrams gives $LogAge(years) = 7.2 \pm 0.2$, and the spectroscopic measurements provide the value $V_R = -15.7 \pm 5.2$ ks for the heliocentric radial velocity. Among the 41 star with spectroscopic data, 11 stars are probable cluster members on the basis of their radial velocity, and another 10 are considered as possible members.

Two probable member stars of spectral types A5 and G1 show hints of absorption in the Lithium line, with respective equivalent widths of 0.10 and 0.28 Å, and 22 stars of spectral types from B2 to G0 show different degrees of emission in Hα, [NII] and [SII] lines. With the exception of three stars of spectral type earlier than A0, the emission of which is mainly photospheric, all other emissions seen in Hα and forbidden lines have a nebular origin. They arise in an ionized cloud that sorrounds the cluster, and is causing diffuse emission and, possibly, local variations in the extinction law from star to star. In addition to the stars, spectra of several nebular condensations with relatively higher excitation have been analyzed. Two of them have been suggested to be Herbig-Haro (HH) objects. Our spectra indicate that only one of these condensations could be considered as an HH object.

Accepted by Astron. J.

ISOCAM observations of the L1551 star formation region

M. Gålfalk[1], G. Olofsson[1], A.A. Kaas[2], S. Olofsson[1], S. Bontemps[3], L. Nordh[4], A. Abergel[5], P. André[6], F. Boulanger[5], M. Burgdorf[13], M.M. Casali[8], C.J. Cesarsky[6], J. Davies[9], E. Falgarone[10], T. Montmerle[6], M. Perault[10], P. Persi[11], T. Prusti[7], J.L. Puget[5], F. Sibille[12]

[1] Stockholm Observatory, Sweden
[2] Nordic Optical Telescope, Canary Islands, Spain
[3] Observatoire de Bordeaux, Floirac, France
[4] SNSB, Box 4006, 171 04 Solna, Sweden
[5] IAS, Université Paris XI, Orsay, France
[6] Service d'Astrophysique, CEA Saclay, Gif-sur-Yvette, France
[7] ISO Data Centre, ESA Astrophysics Division, Villafranca del Castillo, Spain
[8] Royal Observatory, Blackford Hill, Edinburgh, UK
[9] Joint Astronomy Center, Hawaii, USA
[10] ENS Radioastronomie, Paris, France
[11] IAS, CNR, Rome, Italy
[12] Observatoire de Lyon, France
[13] SIRTF Science Center, California Institute of Technology, 220-6, Pasadena, CA 91125, USA

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

The results of a deep mid-IR ISOCAM survey of the L1551 dark molecular cloud are presented. The aim of this survey is a search for new YSO (Young Stellar Object) candidates, using two broad-band filters centred at 6.7 and 14.3 μm. Although two regions close to the centre of L1551 had to be avoided due to saturation problems, 96 sources were detected in total (76 sources at 6.7 μm and 44 sources at 14.3 μm). Using the 24 sources detected in both filters, 14 were found to have intrinsic mid-IR excess at 14.3 μm and were therefore classified as YSO candidates. Using additional observations in B, V, I, J, H and K obtained from the ground, most candidates detected at these wavelengths were confirmed to have mid-IR excess at 6.7 μm as well, and three additional YSO candidates were found. Prior to this survey only three YSOs were known in the observed region (avoiding L1551 IRS 5/NE and HL/XZ Tau). This survey reveals 15 new YSO candidates, although several of these are uncertain due to their extended nature either in the mid-IR or in the optical/near-IR observations. Two of the sources with mid-IR excess are previously known YSOs, one is a brown dwarf (MHO 5) and the other is the well known T Tauri star HH 30, consisting of an outflow and an optically thick disk seen edge on.

Accepted by Astronomy & Astrophysics

Preprints available at http://arxiv.org/abs/astro-ph/0405075

A 4 - 6 GHz Spectral Scan and 8 - 10 GHz Observations of the Dark Cloud TMC-1

S. V. Kalenskii[1], V. I. Slysh[1, 2], P. F. Goldsmith[3], and L. E. B. Johansson[4]

[1] Astro Space Center, Profsoyuznaya 84/32 117997 Moscow, Russia
[2] Arecibo Observatory, Arecibo, PR, USA
[3] Department of Astronomy, Cornell University, and National Astronomy and Ionosphere Center, Ithaca, NY 14853, USA [4] Onsala Space Observatory. SE-439 92 Onsala, Sweden

The results of the lowest frequency spectral survey carried out toward a molecular cloud and sensitive observations at selected frequencies are presented. The entire Arecibo C-band (4–6 GHz) was observed towards the cyanopolyyne peak of TMC-1 with an rms sensitivity of about 17–18 mK (about 2–2.5 mJy). In addition, a number of selected frequency ranges within the C-band and X-band (8–10 GHz) were observed with longer integration times and rms sensitivities 7–8 mK (about 2 mJy) or higher. In the spectral scan itself, already–known H2CO and HC5N lines were detected. However, in more sensitive observations at selected frequencies, lines of C2S, C3S, C4H, C4H2, HC3N and its 13C substituted isotopic species, HC5N, HC7N, and HC9N were found, about half of them detected for the first time. The rotational temperatures of the detected molecules fall in the range 4–9 K. Cyanopolyyne column densities vary from 5.6x10$^{13}cm^{-2}$ for HC5N to 2.7x10$^{12}cm^{-2}$ for HC9N. Our results show that for molecular observations at low frequencies (4–10 GHz) to be useful for studying dark clouds, the sensitivity must be of the order of 5–10 mK or better. To date, observations at around 10 GHz have been more productive than those at lower frequencies.

Accepted by the Astrophys. J.

http://www.arXiv.org/abs/astro-ph/0404051

Embedding Lagrangian Sink Particles in Eulerian Grids

Mark R. Krumholz[1], Christopher F. McKee[1,2] and Richard I. Klein[2,3]

[1] Physics Department, University of California, Berkeley, Berkeley, CA 94720, USA
[2] Astronomy Department, University of California, Berkeley, Berkeley, CA 94720, USA
[3] Lawrence Livermore National Laboratory, P.O. Box 808, L-23, Livermore, CA 94550, USA

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

We introduce a new computational method for embedding Lagrangian sink particles into an Eulerian calculation. Simulations of gravitational collapse or accretion generally produce regions whose density greatly exceeds the mean density in the simulation. These dense regions require extremely small time steps to maintain numerical stability. Smoothed particle hydrodynamics (SPH) codes approach this problem by introducing non-gaseous, accreting sink particles, and Eulerian codes may introduce fixed sink cells. However, until now there has been no approach that allows Eulerian codes to follow accretion onto multiple, moving objects. We have removed that limitation by extending the sink particle capability to Eulerian hydrodynamics codes. We have tested this new method and found that it produces excellent agreement with analytic solutions. In analyzing our sink particle method, we present a method for evaluating the disk viscosity parameter α due to the numerical viscosity of a hydrodynamics code, and use it to compute α for our Cartesian AMR code. We also present a simple application of this new method: studying the transition from Bondi to Bondi-Hoyle accretion that occurs when a shock hits a particle undergoing Bondi accretion.

Accepted by ApJ

Kinematics and parameters of gas in the vicinity of TW Hya

S.A. Lamzin[1], A.S. Kravtsova[1], M.M. Romanova[2] and C. Batalha[3]

[1] Sternberg Astronomical Institute, Moscow, 119992 Russia
[2] Astronomy Department, Cornell University. Ithaca, NY 14853, USA
[3] Brasil National Observatory, Rua General Jose Cristino 77, Rio de Janeiro, Brasil

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

The following conclusions about the kinematics and parameters of the gas in the vicinity of TW Hya have been drawn from an analysis of optical and ultraviolet line profiles and intensities. The accretion matter rises in the magnetosphere to a distance $z > R_*$ above the disk midplane and falls to the star near its equator almost perpendecular to its plane. The matter outflows from a disk region with an outer radius of ≤ 0.5 a.u. The [OI], [SII] and H_2 lines originate in the

disk atmosphere outside the outflow region, where the turbulent gas velocity is close to the local speed of sound. In the formation region of the forbidden lines $T \simeq 8500$ K and $N_e \simeq 5 \cdot 10^6$ cm^{-3}, and the hydrogen is almost neutral: $x_e < 0.03$. The absorption features observed in the blue wings of some of the UV lines originate in the part of the wind that moves almost perpendecular to the disk plane, i.e. in the jet of TW Hya. The V_z gas velocity component in the jet decreases with increasing distance from the jet axis from 200 to 30 km/s. The matter outflowing from the inner disk boundary, in the forming region of absorption line components moves perpendecular to the disk plane at a distance of ~ 0.5 a.u. from the axis of symmetry of the disk. This region of the wind is collimated into the jet at a distance of < 3 a.u. from the disk midplane. The gas temperature in the formation region of absorption components is $\simeq 2 \cdot 10^4$ K, and the gas density is $< 3 \cdot 10^6$ cm^{-3}. This region of the jet is on the order of sevral a.u. away from the disk plane, while free recombination in the jet begins even father from the disk. The mass-loss rate for TW Hya is $\dot{M}_w < 7 \cdot 10^{-10}$ M$_\odot$/yr, which is a factor of 3 lower than the mean accretion rate. The relative abundance of silicon and aluminium in the jet gas is at least an order of magnitude lower than its standard value.

Accepted by Astron. Letters

A Survey for Infall Motions toward Starless Cores. III. CS $(3-2)$ and DCO^+ $(2-1)$ Observations

Chang Won Lee[1,2], Philip C. Myers[2], and René Plume[2,3]

[1] Korea Astronomy Observatory, 61-1 Hwaam-dong, Yusung-gu, Daejon 305-348, Korea
[2] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, MS 42, Cambridge, MA 02138, USA
[3] University of Calgary, Department of Physics & Astronomy 2500 University Drive NW, Calgary, Alberta, Canada T2N 1N4

E-mail contact: cwl@trao.re.kr

We present CS(3-2) and DCO^+(2-1) observations of 94 starless cores and compare the results with previous CS(2-1) and N_2H^+(1-0) observations to study inward motions in starless cores. Eighty-four cores were detected in both CS and DCO^+ lines. A significant number of CS(3-2) profiles and a small number of DCO^+(2-1) lines show the classical "infall asymmetry" similar to that seen in CS(2-1) observations. The DCO^+(2-1) lines, however, usually show a single Gaussian peak. The integrated intensity of N_2H^+ correlates well with that of DCO^+(2-1), but poorly with that of CS(2-1) and CS(3-2), suggesting that CS suffers significantly more depletion onto grains than do either DCO^+ or N_2H^+. Despite these depletion effects, there is evidently enough optical depth for the CS(3-2) and CS(2-1) spectral lines to exhibit infall asymmetries.

The velocity shifts of the CS(3-2) and (2-1) lines with respect to N_2H^+ correlate well with each other and have similar distributions. This implies that, in many cores, systematic inward motions of gaseous material may occur over a range of density of at least a factor ~ 4.

We identify 18 infall candidates based on observations of CS(3-2), CS(2-1), DCO^+ (2-1) and N_2H^+ (1-0). The eight best candidates, L1355, L1498, L1521F, L1544, L158, L492, L694-2, and L1155C-1, each show at least four indications of infall asymmetry and no counter-indications. Fits of the spectra to a 2-layer radiative transfer model in ten infall candidates suggest that the median effective line-of-sight speed of the inward-moving gas is ~ 0.07 km s^{-1} for CS (3-2) and ~ 0.04 km s^{-1} for CS(2-1). Considering that the optical depth obtained from the fits is usually smaller in CS(3-2) than in (2-1) line, this may imply that CS(3-2) usually traces inner denser gas in higher inward motions than CS(2-1). However, it is also possible that this conclusion is not representative of all starless core infall candidates, due to the statistically small number analyzed here. Further line observations will be useful to test this conclusion.

Accepted by ApJS

Preprint is available at http://arxiv.org/abs/astro-ph/0404517

Search for HH objects and emission-line stars in star forming regions. III. PMS-stars in NGC 7129

T.Yu. Magakian[1], T.A. Movsessian[1] and E.H. Nikogossian[1]

[1] Byurakan Astrophysical Observatory, Aragatsotn prov. 378433, Armenia

E-mail contact: tigmag@sci.am

By the method of slitless field spectroscopy 22 emission-line stars are discovered in the central and northeast parts of

the star cluster, located inside the NGC 7129 nebula. The 16 of them were found for the first time. This sample is complete up to V $\leq$ 20.0. The emission-line stars are non-uniformly distributed in a field, mainly concentrating in the central part of the cluster. V, R and I photometry was performed for the more than one hundred stars of the cluster. The average extinction $A_V = 1.7 \pm 0.27$ was determined for the studied area. On the basis of their position in optical and near-IR color diagrams the majority of emission-line stars with a high probability belong to the T Tau objects.

Accepted by Astrophysics

XMM-Newton study of the very young stellar cluster IC 348

Thomas Preibisch[1] **& Hans Zinnecker**[2]

[1] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D–53121 Bonn, Germany
[2] Astrophysikalisches Institut Potsdam, An der Sternwarte 16, D–14482 Potsdam, Germany

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

We analyze a *XMM-Newton* X-ray imaging observation of the very young stellar cluster IC 348 with an observing time of 12 hours and a corresponding total (all detector) MOS-equivalent exposure time of 207 ksec. Our observation is strongly affected by a very intense solar particle flare, due to which only the first half of the exposure time can be used for scientific analysis. We compare the X-ray sources seen by *XMM-Newton* with those found in our previous *Chandra* study of IC 348 and find that *XMM-Newton* reveals 71 new X-ray sources, most of which are located outside the field-of-view of the *Chandra* observation. 20 of these new X-ray sources can be identified with known cluster members, and 19 sources are likely to be new low-mass members of the cluster. The lightcurves of the *XMM-Newton* sources show at most moderate levels of variability, but no large flares. We compare the spectral fitting results for 10 stars for which we have good spectra from both *Chandra* and *XMM-Newton*, and find good agreement in the fitted plasma temperatures, but a systematic difference in the fitted values of the hydrogen column density (extinction). We finally discuss the X-ray properties of the optically bright B1 star *o* Per and the X-ray detections among the deeply embedded young stellar objects to the south of the optical cluster center (including HH 211-mm), and find that none of the 23 spectroscopically identified brown dwarfs in IC 348 is detected in our *XMM-Newton* data.

Accepted by Astronomy & Astrophysics

Preprints are available at `http://www.mpifr-bonn.mpg.de/staff/tpreibis/ic348_xmm.html`

Chandra X-ray observations of Young Clusters II. Orion Flanking Fields Data

Solange V. Ramírez [1], **Luisa Rebull** [1], **John Stauffer** [1], **Steven Strom** [2], **Lynne Hillenbrand** [3], **Thomas Hearty** [4], **Eugene L. Kopan** [5], **Steven Pravdo** [4], **Russell Makidon** [6], **and Burton Jones** [7]

[1] Spitzer Science Center, Mail Stop 220-06, California Institute of Technology, USA
[2] NOAO, Kitt Peak National Observatory, AZ, USA
[3] Astronomy Department, California Institute of Technology, USA
[4] Jet Propulsion Laboratory, USA
[5] IPAC, California Institute of Technology, USA
[6] Space Telescope Science Institute, Baltimore, USA
[7] University of California, Santa Cruz, CA, USA

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

We present results of Chandra observations of two flanking fields (FF) in Orion, outside the Orion Nebula Cluster (ONC). The observations were taken with the ACIS-I camera with an exposure time of about 48 ks each field. We present a catalog of 417 sources, which includes X-ray luminosity, optical and infrared photometry and X-ray variability information. We have found 91 variable sources, 33 of which have a flare-like light curve, and 11 of which have a pattern of a steady increase or decrease over a 10 hour period. The optical and infrared photometry for the stars identified as X-ray sources are consistent with most of these objects being pre-main sequence stars with ages younger than 10 Myr. We present evidence for an age difference among the X-ray selected samples of NGC 2264, Orion FF, and ONC, with NGC 2264 being the oldest, and ONC being the youngest.

Accepted by Astron. J.

http://spider.ipac.caltech.edu/staff/solange/paper.html and http://xxx.lanl.gov/astro-ph/0405003

The Sensitivity of Infall Molecular Line Profiles to the Ambient Radiation Field

M. P. Redman[1,2], J.M.C Rawlings[1], J.A. Yates[1], and D.A. Williams[1]

[1] Department of Physics and Astronomy, University College London, Gower Street,London WC1E 6BT, UK
[2] School of Cosmic Physics, Dublin Institute for Advanced Studies, 5 Merrion Square, Dublin 2, Ireland

E-mail contact: mpr@cp.dias.ie

In cold molecular clouds submillimetre emission lines are excited by the ambient radiation field. The pumping is dominated by the cosmic microwave background (CMB). It is usual in molecular line radiative transfer modelling to simply assume that this is the only incident radiation field. In this paper, a molecular line transport code and a dust radiative transfer code are used to explore the effects of the inclusion of a full interstellar radiation field (ISRF) on a simple test molecular cloud. It is found that in many galactic situations, the shape and strength of the line profiles that result are robust to variations in the ISRF and thus that in most cases, it is safe to adopt the CMB radiation field for the molecular line transport calculations. However, we show that in two examples, the inclusion of a plausible radiation field can have a significant effect on the the line profiles. Firstly, in the vicinity of an embedded massive star, there will be an enhanced far infared component to the radiation field. Secondly, for molecular clouds at large redshift, the CMB temperature increases and this of course also alters the radiation field. In both of these cases, the line profiles are weakened significantly compared to a cloud exposed to a standard radiation field. Therefore this effect should be accounted for when investigating prestellar cores in massive star forming regions and when searching for molecular clouds at high redshift.

Accepted by MNRAS

http://arxiv.org/abs/astro-ph/0404198

The FU Orionis Binary System and the Formation of Close Binaries

Bo Reipurth[1] and Colin Aspin[2]

[1] Institute for Astronomy, University of Hawaii, 2680 Woodlawn Drive, Honolulu, HI 96822, USA
[2] Gemini Observatory, 670 North A'ohoku Place, University Park, Hilo, HI 96720, USA

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

The faint star next to FU Orionis recently discovered by Wang et al. has been observed with adaptive optics at the Subaru telescope. Infrared JHK′L′ photometry shows clear infrared excess, indicating that the object is a pre-main sequence star. Its infrared K-band spectrum is very different from that of FU Orionis, and suggests a star of spectral type K. We discuss these observations in light of the hypothesis that FUors may be newborn binaries that have become bound when a small non-hierarchical multiple system breaks up. This scenario predicts that FU Orionis must be a close binary (<10 AU), and if so the newly discovered companion is the outlying member in a triple system. We discuss various implications of this scenario, in particular we note that FUor eruptions should commonly occur during a relatively brief evolutionary phase partly overlapping with and immediately following the formation of Herbig-Haro jets. If this is the dominant mechanism to trigger FUor outbursts, then FUor eruptions should preferentially occur in close binaries, i.e. in about 20% of all stars.

Accepted by ApJ Letters

Rotation periods for very low mass stars in the Pleiades

Alexander Scholz[1] and Jochen Eislöffel[1]

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

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

We present the results of a photometric monitoring campaign for very low mass (VLM) members of the Pleiades. Periodic photometric variability was detected for nine VLM stars with masses between 0.08 and 0.25 $M_{\odot}$. These variations are most likely caused by co-rotating, magnetically induced spots. In comparison with solar-mass stars, the photometric amplitudes are very low (< 0.04 mag), implying that either the fraction of the spot-covered area, the asymmetry of the spot distribution, or the contrast between spots and photospheric environment decreases with mass. From our lightcurves, there is evidence for temporal evolution of the spot patterns on timescales of about two

weeks. The rotation periods range from 2.9 h to 40 h and tend to increase linearly with mass. Compared with more massive stars, we clearly see a lack of slow rotators among VLM objects. The rotational evolution of VLM stars is investigated by evolving the previously published periods for very young objects (Scholz & Eislöffel 2004) forward in time, and comparing them with those observed here in the Pleiades. We find that the combination of spin-up by pre-main sequence contraction and exponential angular momentum loss through stellar winds is able to reproduce the observed period distribution in the Pleiades. This result may be explained as a consequence of convective, small-scale magnetic fields.

Accepted by Astronomy & Astrophysics

http://www.tls-tautenburg.de/research/tls-research/pub2004.html

X-ray and Infrared Observations of Embedded Young Stars in L1630

Theodore Simon[1], Sean M. Andrews[1], John T. Rayner[1], and Stephen A. Drake[2]

[1] Institute for Astronomy, University of Hawaii, Honolulu, HI 96822, USA
[2] HEASARC, NASA/GSFC

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

The HH 24-26 star forming region within the Lynds 1630 (L1630) dark cloud in Orion contains a remarkable collection of rare Class 0 and Class I protostars, collimated molecular and ionized jets, and a luminous but spatially unresolved ASCA X-ray source. To study the X-ray properties of the embedded protostar population of that region, we have obtained a deep X-ray image with the ACIS-S camera on board the *Chandra X-Ray Observatory*. A number of Hα emission-line objects were detected in the areas surrounding HH 24-26, of which the weak-line T Tauri star SSV 61 was the brightest source, at a steady luminosity of L_x(0.3-10 keV)=$10^{31.9}$ ergs s^{-1}. Two Class I protostars aligned with optical jets in HH 24, SSV 63E and SSV 63W, were also detected, as was the continuum radio source SSV 63NE, which is very likely an extreme Class I or Class 0 object. We observed no X rays from the Class 0 protostars HH 24-MMS and HH 25-MMS, nor any from regions of the cloud bounded by HH 25 and HH 26, at a 2σ upper limit of $L_x \sim 10^{30.0}$ ergs s^{-1}. HH 26-IR, the Class I object thought to be the origin of the HH 26 flow, was not detected. Near-infrared spectroscopy obtained at the NASA IRTF reveals 3 μm ice bands in the spectra of SSV 59, 63E, 63W, and HH 26-IR, and 2.3 μm CO overtone absorption bands for SSV 61. SSV 60, which lies astride one end of the great arc of nebulosity forming HH 25, exhibits a deep infrared ice band and CO absorption, but is not an X-ray source, and is most likely a distant background giant of late spectral type.

Accepted by Astrophysical Journal

preprints available at http://www.ifa.hawaii.edu/publications/preprints/04preprints/Simon_04-044.pdf

The Spectroscopically Determined Substellar Mass Function of the Orion Nebula Cluster

Catherine L. Slesnick[1], Lynne A. Hillenbrand[1] and John M. Carpenter[1]

[1] Dept. of Astronomy, MS105-24, California Institute of Technology,Pasadena, CA 91125, USA

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

We present a spectroscopic study of candidate brown dwarf members of the Orion Nebula Cluster (ONC). We obtained new J– and/or K–band spectra of ∼100 objects within the ONC which are expected to be substellar based on their $K, (H-K)$ magnitudes and colors. Spectral classification in the near-infrared of young low mass objects is described, including the effects of surface gravity, veiling due to circumstellar material, and reddening. From our derived spectral types and existing near-infrared photometry we construct an HR diagram for the cluster. Masses are inferred for each object and used to derive the brown dwarf fraction and assess the mass function for the inner 5.'1 × 5.'1 of the ONC, down to ∼0.02 $M_\odot$. The logarithmic mass function rises to a peak at ∼0.2 $M_\odot$, similar to previous IMF determinations derived from purely photometric methods, but falls off more sharply at the hydrogen-burning limit before leveling through the substellar regime. We compare the mass function derived here for the inner ONC to those presented in recent literature for the sparsely populated Taurus cloud members and the rich cluster IC 348. We find good agreement between the shapes and peak values of the ONC and IC 348 mass distributions, but little similarity between the ONC and Taurus results.

Accepted by ApJ

astro-ph/0404292

Carina's Defiant Finger: HST Observations of a Photoevaporating Globule in NGC3372

Nathan Smith[1], **Rodolfo Barbá**[2] **and Nolan R. Walborn**[3]

[1] Center for Astrophysics and Space Astronomy, University of Colorado, 389 UCB, Boulder, CO 80309, USA
[2] Departmento de Física, Universidad de La Serena, Benavente 980, La Serena, Chile
[3] Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA

E-mail contact: nathans@colorado.edu

We present *Hubble Space Telescope* Wide Field Planetary Camera 2 images of a prominent externally-ionized molecular globule in the Carina Nebula (NGC 3372), supplemented with ground-based infrared images and visual-wavelength spectra. This molecular globule has a shape resembling a human hand, with an extended finger that points toward its likely source of ionizing radiation. Following an analysis of the spatially-resolved ionization structure and spectrum of the photoevaporative flow from the Finger, we conclude that the dominant ionizing source is either the WNL star WR25 (HD 93162), the adjacent O4 If-type star Tr16-244, or perhaps both. We estimate a mass-loss rate of $\sim 2\times10^{-5}$ $M_\odot$ yr^{-1} from the main evaporating surface of the globule, suggesting a remaining lifetime of $10^{5.3}$ to 10^6 years. We find a total mass for the entire globule of more than 6 $M_\odot$, in agreement with previous estimates. The hydrogen column density through the globule derived from extinction measurements is a few times 10^{22} cm^{-2}, so the photodissociation region behind the ionization front should be limited to a thin layer compared to the size of the globule, in agreement with the morphology seen in H_2 images. Although a few reddened stars are seen within the boundary of the globule in near-infrared continuum images, these may be background stars. We do not detect a reddened star at the apex of the finger, for example, down to a limiting magnitude of $m_K \simeq 17$. However, considering the physical properties of the globule and the advancing ionization front, it appears that future star formation is likely in the Finger globule, induced by radiation-driven implosion.

Accepted by MNRAS

http://xxx.lanl.gov/abs/astro-ph/0404495

XMM-Newton probes the stellar population in Cha I South

B. Stelzer[1], **G. Micela**[1] **and R. Neuhäuser**[2]

[1] INAF - Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, I-90134 Palermo, Italy
[2] Astrophysikalisches Institut und Universitäts-Sternwarte, Schillergässchen 2-3, D-07745 Jena, Germany

E-mail contact: stelzer@astropa.unipa.it

We report on a 30 ksec *XMM-Newton* observation of the central region of the Cha I star forming cloud. We detect the majority of the very-low mass Hα emitters including two bona-fide brown dwarfs (spectral types M7.5 and M8). Spectral analysis of the X-ray bright stars shows that previous X-ray studies in Cha I have underestimated the X-ray luminosities, as a result of simplified assumptions on the spectral shape. In particular, the extinction is variable over the field, such that the choice of a uniform value for the column density is inappropriate. We establish that the X-ray saturation level for the late-type stars in Cha I is located near $L_{\rm x}/L_{\rm bol} \sim 10^{-2.5}$, with a possible decline to $L_{\rm x}/L_{\rm bol} \sim 10^{-3}$ for the lowest mass stars. No dramatic changes in the correlations between X-ray luminosity with age, effective temperature and mass are seen at the substellar boundary, suggesting that the same dynamo mechanism operates in both low-mass stars and brown dwarfs, at least at young ages. The variability of the lowest-mass objects is also similar to that of higher-mass T Tauri stars. A group of strongly absorbed stars with unusual hard X-ray emission is clustered around HD 97048, a HAeBe star and the only confirmed intermediate-mass star in the field. While the X-ray properties of HD 97048 are indistinguishable from its lower-mass neighbors, another presumably A-type star (identified as such based on NIR photometry) stands out as the softest X-ray emitter in the whole sample. This suggests that various X-ray emission mechanisms may be at work in intermediate-mass pre-main sequence stars.

Accepted by A&A

For preprints via ftp or WWW: `http://www.astropa.unipa.it/~stelzer/publications.html`

The close T Tauri binary V 4046 Sagittarii

H.C. Stempels[1] **and G.F. Gahm**[2]

[1] Department of Astronomy and Space Physics, Box 515, SE-751 20 Uppsala, Sweden
[2] Stockholm Observatory, AlbaNova University Center, SE-106 91 Stockholm, Sweden

E-mail contact: Eric.Stempels@not.iac.es

We have collected high-resolution ($R \approx 60\,000$) VLT-UVES spectrograms of the close T Tauri binary V 4046 Sgr from 3500 – 6750 Å at different phases of its 2.4 day orbital period. The high quality of these spectra allows us to present an improved ephemeris of the system. To model the photospheric absorption line spectrum we calculate synthetic spectra for the observed phases of the system. These synthetic spectra are used to determine veiling levels, and to extract emission line profiles that are undistorted by photospheric absorption lines. We find that the shapes of the strong emission lines of H and Ca II H & K all vary periodically with phase. A weak veiling continuum is superimposed on the stellar absorption line spectra. The Ca II H & K emission lines are composed of two narrow emission components that closely follow the stellar orbital motion, and we speculate that these lines are formed in global chromospheric networks on the stars. Also the Balmer lines have similar narrow "stellar" components, possibly also chromospheric. However, in addition there are extended wings on each side of the line centers of all H lines, which change dramatically in shape with the orbital period. We find that the shape, form and velocity changes of the wing components are consistent with two concentrations of gas moving at high velocity but co-rotating with the stars. These concentrations move with a projected velocity of 80 km s^{-1} around the center of mass. They are located well inside the edge of the circumbinary disk, and also inside the co-linear Lagrangian points of this binary. With this concept we obtain a very good agreement between calculated and observed line profiles of H8, H9 and H10 as a function of time. In some recent calculations of mass transfer from circumbinary disks to close binaries in circular motion, accumulations of gas in co-rotation with the stars develop, resulting in structures which are similar to what we have found from our observations. We also investigate the cause of periodic photometric variations observed by others.

Accepted by Astronomy & Astrophysics

ftp://ftp.astro.su.se/pub/gahm/preprints/v4046.ps.gz

Submillimeter Array Observations of L1551 IRS 5 in CS (J=7–6)

Shigehisa Takakuwa[1], **Nagayoshi Ohashi**[2], **Paul T. P. Ho**[3], **Chunhua Qi**[3], **David Wilner**[3], **Qizhou Zhang**[3], **Tyler L. Bourke**[1], **Naomi Hirano**[4], **Minho Choi**[4,5], **and Ji Yang**[6]

[1] Harvard-Smithsonian Center for Astrophysics, Submillimeter Array Project, 645 North A'ohoku, Hilo, HI 96720, U.S.A.
[2] Academia Sinica Institute of Astronomy and Astrophysics, 645 North A'ohoku, Hilo, HI 96720, U.S.A.
[3] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, U.S.A.
[4] Academia Sinica Institute of Astronomy and Astrophysics, P.O. Box 23-141, Taipei 106, Taiwan
[5] Taeduk Radio Astronomy Observatory, Korea Astronomy Observatory, Hwaam 61-1, Yuseong, Daejeon, 305-348, Korea
[6] Purple Mountain Observatory, Chinese Academy of Sciences, Nanjing 21008, China

E-mail contact: stakakuwa@sma.hawaii.edu

We have imaged the circumstellar envelope around the binary protostar L1551 IRS 5 in CS (J=7–6) and 343 GHz continuum emission at $\sim 3''$ resolution using the Submillimeter Array. The continuum emission shows an elongated structure ($\sim 220 \times 100$ AU) around the binary perpendicular to the axis of the associated radio jet. The CS emission extends over $\sim$ 400 AU, appears approximately circularly symmetric, and shows a velocity gradient from southeast (blueshifted) to northwest (redshifted). The direction of the velocity gradient is different from that observed in $C^{18}O$ (J=1–0). This may be because rotation is more dominant in the CS envelope than the $C^{18}O$ envelope, in which both infall and rotation exist. The CS emission may be divided into two velocity components: (1) a "high" velocity disk-like structure surrounding the protostar, $\pm 1.0 - 1.5$ km s^{-1} from the systemic velocity, and (2) a "low" velocity structure, located southwest of the protostar, < 1.0 km s^{-1} from the systemic velocity. The high-velocity component traces warm and dense gas with kinematics consistent with rotation around the protostar. The low-velocity component may arise from dense gas entrained in the outflow. Alternatively, this component may trace infalling and rotating gas in an envelope with a vertical structure.

Accepted by ApJ Letters
astro-ph/0404346

The profiles of the 3 to 12 μm PAH features

B. van Diedenhoven[1], E. Peeters[2,1,3], C. Van Kerckhoven[4], S. Hony[5], D.M. Hudgins[3],L.J. Allamandola[3], A.G.G.M. Tielens[2,1]

[1] Kapteyn Institute, P.O. Box 800, 9700 AV Groningen, The Netherlands
[2] SRON National Institute for Space Research, P.O. Box 800, 9700 AV Groningen, The Netherlands
[3] NASA-Ames Research Center, Mail Stop 245-6, Moffett Field, CA 94035, USA
[4] Instituut voor Sterrenkunde, K.U.Leuven, Celestijnlaan 200B, 3100 Heverlee, Belgium
[5] RSSD-ESA/ESTEC, PO Box 299, 2200 AG Noordwijk, The Netherlands

E-mail contact: epeeters@mail.arc.nasa.gov

We present spectra of the 3.3 μm and 11.2 μm PAH features of a large number of stellar sources, planetary nebulae, reflection nebulae, HII regions and galaxies, obtained with ISO-SWS. Clear variations are present in the profiles of these features. Most of the sources show a symmetric 3.3 μm feature peaking at $\sim$3.290 μm, while only very few show an asymmetric 3.3 μm feature peaking at a slightly longer wavelength. The profiles of the 11.2 μm feature are distinctly asymmetric. The majority of the sources has a 11.2 μm feature peaking between 11.20 and 11.24 μm, with a very steep blue rise and a low tail-to-top ratio. A few sources show a 11.2 μm feature with a peak position of $\sim$11.25 μm, a less steep blue rise and a high tail-to-top ratio. The sources are classified independently based on the 3.3 and 11.2 μm feature profiles and peak positions. Correlations between these classes and those based on the 6–9 μm features (Peeters et al., 2002) are found. In particular, sources with the most common profiles in the 6–9 μm region also show the most common 3.3 and 11.2 μm feature profiles. However, the uncommon profiles do not correlate with each other. Also, these classifications depend on the type of object. In general, HII regions, non-isolated Herbig AeBe stars and YSO's show the same profiles for all 3-12 μm features. Many planetary nebulae and Post-AGB stars show uncommon feature profiles. The 3 galaxies in our sample show the same profiles as the HII regions for all but the 11.2 μm feature, being similar to that of evolved stars. The observed pronounced contrast in the spectral variations for the CH modes (3.3 and 11.2 μm bands) versus the CC modes (6.2, 7.7 and 8.6 μm bands) is striking : the peak wavelengths of the features attributed to CC modes vary by $\sim$15–80 cm^{-1}, while for the CH modes the variations are $\sim$4–6.5 cm^{-1}. We summarize existing laboratory data and theoretical calculations of the modes emitting in the 3–12 μm region of PAH molecules and complexes. In contrast to the 6.2 and 7.7 μm components which are attributed to PAH cations, the 3.3 μm feature appears to originate in neutral and/or negatively charged PAHs. We attribute the variations in peak position and profile of these IR emission features to the composition of the PAH family. The variations in FWHM of the 3.3 μm feature remains an enigma while those of the 11.2 μm can be explained by anharmonicity and molecular structure. The possible origin of the observed contrast in profile variations between the CH modes and the CC modes is highlighted.

Accepted by ApJ

Resetting chemical clocks of hot cores based on S–bearing molecules

V. Wakelam[1], P. Caselli[2], C. Ceccarelli[3], E. Herbst[4] and A. Castets[1]

[1] Observatoire de Bordeaux, BP 89, 33270 Floirac, France
[2] INAF–Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, 50125 Firenze, Italy
[3] Laboratoire d'Astrophysique, Observatoire de Grenoble - BP 53, F-38041 Grenoble cedex 09, France
[4] Departments of Physics, Chemistry, and Astronomy, The Ohio State University, Columbus, OH 43210, USA

E-mail contact: wakelam@obs.u-bordeaux1.fr

We report a theoretical study of sulphur chemistry, as applied to hot cores, where S-bearing molecular ratios have been previously proposed and used as chemical clocks. As in previous models, we follow the S-bearing molecular composition after the injection of grain mantle components into the gas phase. For this study, we developed a time-dependent chemical model with up-to-date reaction rate coefficients. We ran several cases, using different realistic chemical compositions for the grain mantles and for the gas prior to mantle evaporation. The modeling shows that S-bearing

molecular ratios depend very critically on the gas temperature and density, the abundance of atomic oxygen, and, most importantly, on the form of sulphur injected in the gas phase, which is very poorly known. Consequently, ratios of S-bearing molecules cannot be easily used as chemical clocks. However, detailed observations and careful modeling of both physical and chemical structure can give hints on the source age and constrain the mantle composition (i.e. the form of sulphur in cold molecular clouds) and, thus, help to solve the mystery of the sulphur depletion. We analyse in detail the cases of Orion and IRAS16293-2422. The comparison of the available observations with our model suggests that the majority of sulphur released from the mantles is mainly in, or soon converted into, atomic form.

Accepted by Astronomy and Astrophysics

http://xxx.lanl.gov/pdf/astro-ph/0404246

W49A North - Global or Local or No Collapse?

John A. Williams[1], Hélène R. Dickel[2] and Lawrence H. Auer[3]

[1] Physics Department, Albion College, Albion, MI 49224, USA
[2] Department of Astronomy, University of Illinois, 103 Astronomy Building, 1002 West Green Street, Urbana, IL 61801, USA
[3] Earth and Environmental Sciences 5, Los Alamos National Laboratory, MS-F665, Los Alamos, NM 87545, USA

E-mail contact: lanie@astro.uiuc.edu

We attempt to fit observations with $5''$ resolution of the J=2−1 transition of CS in the directions of H II regions A, B, and G of W49A North as well as observations with $20''$ resolution of the J=2−1, 3−2, 5−4, and 7−6 transitions in the directions of H II regions A and G by using radiative transfer calculations. These calculations predict the intensity profiles resulting from several spherical clouds along the line of sight. We consider three models: global collapse of a very large (5 pc radius) cloud, localized collapse from smaller (1 pc) clouds around individual H II regions, and multiple, static clouds. For all three models we can find combinations of parameters that reproduce the CS profiles reasonably well provided that the component clouds have a core-envelope structure with a temperature gradient. Cores with high temperature and high molecular hydrogen density are needed to match the higher transitions (e.g. J=7−6) observed towards A and G. The lower temperature, low density gas needed to create the inverse P-Cygni profile seen in the CS J=2−1 line (with $5''$ beam) towards H II region G arises from different components in the 3 models. The infalling envelope of cloud G plus cloud B creates the absorption in global collapse, cloud B is responsible in local collapse, and a separate cloud, G', is needed in the case of many static clouds. The exact nature of the velocity field in the envelopes for the case of local collapse is not important as long as it is in the range of 1 to 5 km s^{-1} for a turbulent velocity of about 6 km s^{-1}. High resolution observations of the J=1−0 and 5−4 transitions of CS and $C^{34}S$ may distinguish between these three models. Modeling existing observations of HCO^+ and $C^{18}O$ does not allow one to distinguish between the three models but does indicate the existence of a bipolar outflow.

Accepted by Astrophysical J. Suppl. (August 2004, v153)

Preprint at http://arXiv.org/abs/astro-ph/0405085

Dissertation Abstracts

Shock Processing of Icy Grain Mantles In Protoplanetary Disks

George E. Hassel

Thesis work conducted at: Rensselaer Polytechnic Institute, Troy, NY, USA

Current address: RPI Physics Dept., 110 8th Street, Troy, NY 12180, USA

Electronic mail: hasseg@rpi.edu

Ph.D dissertation directed by: Wayne G. Roberge

Ph.D degree awarded: May 2004

The water ice mantles on interstellar grains trap volatile molecules, such as CO and CH_3OH, with an efficiency that depends on the amorphous or crystalline structure of the ice. The ice structure therefore affects the composition of comets formed from the icy grains. We present a detailed study of the processing of mantled grains by shock waves in protoplanetary disks. The grains suffer a sudden increase in temperature that can evaporate the mantles. This is followed by an extended cooling time during which the mantles recondense on timescales comparable to the crystallization timescale for hydrodynamic parameters consistent with the Jupiter-Saturn region of the solar nebula. We evaluate different scenarios for re-deposition of the mantles, and the possibility of re-trapping the co-adsorbing volatiles. The crystallization of ice and the exclusion of volatiles from the matrix may explain the volatile-depleted composition observed recently in Comet C/1999 S4 (LINEAR), an Oort-Cloud comet originating from the Jupiter-Saturn region (Mumma *et al.* 2001).

We demonstrate that the bulk ice desorbs for shock speeds greater than a critical value for a given preshock gas density. Crystallization of water ice is most efficient for models that completely remove and re-accrete the mantle. Weakly polar or apolar molecules such as CO will be retained, at least partially, for mantles that do not sublimate, but will be completely lost if the bulk H_2O ice is removed in the shock. Strongly polar molecules such as CH_3OH will participate in the hydrogen bonding network for the water ice, and will be retained for all shock models considered.

We associate hydrodynamic parameters with radial positions in protoplanetary disks by means of a viscous accretion disk model (Aikawa *et al.* 1998). Pickett *et al.* (2003) showed that shocks due to gravitational instabilities propagate at oblique incidence to the rotation of the disk, thereby causing the shock speeds to be much lower than the Keplerian speed. For a speed of 2 km s^{-1}, crystallization and volatile removal is efficient within the Jupiter-Saturn region of the nebula, but the mantles will remain unprocessed for the conditions near Uranus and beyond.

New Jobs

Postdoctoral Research Position – Star and Planet Formation

UNIVERSITY OF TORONTO

Applications are invited for a postdoctoral research position at the University of Toronto to start anytime after September 1, 2004. The successful candidate will work with Prof. Ray Jayawardhana and his collaborators on observational and analytical studies of the formation of planets, brown dwarfs and stars, and will be encouraged to pursue independent research on related topics. On-going projects include mid-infrared and sub-millimeter studies of circumstellar disk evolution, adaptive optics imaging searches for young planets, and optical/infrared imaging and spectroscopy of young brown dwarfs and very-low-mass objects using data from Keck, Gemini, VLT, JCMT, Magellan and other major observatories. The position is for two years, with extension to a third year possible, and comes with funds for research expenses.

Applicants should send a curriculum vitae, a description of research interests and plans, a list of publications, and should arrange for three letters of recommendation to be sent directly to the above address. Applications received before July 10 will receive full consideration.

Prof. Ray Jayawardhana
Department of Astronomy & Astrophysics
University of Toronto
60 St. George Street, Rm 1403
Toronto, ON M5S 3H8
CANADA

E-mail inquiries and submission: rayjay@astro.utoronto.ca

Department web page: http://www.astro.utoronto.ca

Postdoctoral appointment in Millimetre/Submillimetre Studies of Star Forming Regions, University of Cambridge, UK

RESEARCH ASSOCIATE - Cambridge University, Department of Physics

Ref No: KA 981 Grade: NRAS Salary: 18,893 - 28,279 pa
Limit of tenure: 3 years
Proposed start date: 1 October 2004.

We seek a postdoctoral researcher to join the Astrophysics Group to work on observations of star-forming regions using the HARP receiver array. HARP will be installed at the James Clerk Maxwell Telescope in 2005, and will present exciting and unique possibilities for investigating the large-scale physical and chemical structure of star-forming regions, turbulence, and the properties of protostellar outflows.

The successful candidate will work with John Richer and other group members, to carry out and analyse some of the first data from HARP and play a role in the scientific commissioning of the array. This is an exciting opportunity to get involved with the first science from HARP, and we expect during the course of this project to do follow-up observations using SCUBA-2 and interferometers.

A PhD in astrophysics is required, although candidates who are about to submit or have recently submitted their thesis will be considered. Good data analysis, programming, organisational and communication skills are essential. Applicants should have the ability to work in a team and be able to carry out observations at high altitude. Strong observational skills, and an understanding of relevant theoretical developments in the field, would be advantageous. Informal enquiries about the work may be addressed to John Richer (jsr@mrao.cam.ac.uk).

Further information may be obtained from: Kate Gilbert, Cavendish Laboratory, Madingley Road, Cambridge CB3 0HE, tel: (01223) 337294 (kjg26@mrao.cam.ac.uk). Applications should contain a full CV, the names and contact details of two referees and a completed application PD18 form. The closing date is 1 June 2004.

Postdoctoral Positions in Theoretical/Computational Astrophysics

Theoretical Institute for Advanced Research in Astrophysics Academia Sinica, Taiwan

The newly established Theoretical Institute for Advanced Research in Astrophysics (TIARA) is seeking applications to fill several postdoctoral positions in theoretical/computational astrophysics in Fall 2004. TIARA is a joint collaboration between the National Tsing Hua University based in Hsinchu and Academia Sinica based in Taipei and has a mission to carry out research at the highest level and to establish a vigorous visitors program in theoretical astrophysics. Present research at TIARA include investigations in the areas of Galactic Dynamics, Star and Planet Formation, High Energy/Relativistic Astrophysics and Computational Fluid Dynamics and Magnetohydrodynamics. The successful candidates will also have the opportunity for collaborations with scientists in the ongoing observational programs (SMA, AMiBA, TAOS projects) within the Academia Sinica Institute of Astronomy and Astrophysics (http://www.asiaa.sinica.edu.tw).

We are particularly interested in applicants in the field of star formation, but will consider applications in all areas of theoretical astrophysics

Applicants should submit a curriculum vita, a brief summary of research and future research plans, and arrange for three letters of recommendation to be sent to Ms. Winny Hsieh, Institute of Astronomy and Astrophysics, TIARA Postdoctoral Positions, Academia Sinica, P.O. Box 23-141, Taipei 106, Taiwan; Email: asiaa@asiaa.sinica.edu.tw.

The closing date for applications is June 30, 2004.

The Thüringer Landessternwarte Tautenburg (TLS) is looking for a young

ASTRONOMER/ASTROPHYSICIST

to be employed as soon as possible. The staff position is initially for 3 years.

Preference will be given to applicants working in fields closely related to the research areas of TLS, which include **extrasolar planets (radial velocity and transit searches) and star formation**. Scientists working in other areas (both observations or theory) will be considered as well.

The Thüringer Landessternwarte operates a 2-m-telescope in Tautenburg, which can be used in Schmidt-, Cassegrain-, or Coudé-mode. The telescope is equipped with state of the art post-focus instruments for wide-field imaging, low- and high-resolution spectroscopy.

Duties: Successful observational applicants are expected to conduct independent research programs using the 2-m-telescope in Tautenburg, as well as international observatories. We expect such an applicant to partly support the operation of the telescope and its instruments. The successful theory applicant should be able to collaborate with observational astronomers at the institute.

Requirements: Applicants should have a PhD in astronomy, astrophysics, or physics. A demonstrated ability to conduct independent research is highly desirable.

Applications should include a CV, a publication list, a short summary of research interests, a statement of research plans while at TLS, and three letters of reference. Applications will be reviewed starting 1 July and will continue until a suitable candidate is found. Applications can be sent via post to:

Prof. Dr. Artie Hatzes
Thüringer Landessternwarte
Sternwarte 5
D-07778 Tautenburg
Germany

or via email to artie@tls-tautenburg.de

The contract can start as early as 1 September 2004. Payment is according to the BAT-O IIa payment scheme of civil servants in Germany. We especially encourage female applicants to apply for the job. Handicapped persons of equal qualification will be preferred. More information about the Thüringer Landessternwarte can be found under http://www.tls-tautenburg.de.

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

XVI Canary Islands Winter School of Astrophysics
Extrasolar Planets
November 22nd - December 3rd, 2004

The XVI Canary Islands Winter School of Astrophysics (WS), organized by the Instituto de Astrofisica de Canarias (IAC), will be dedicated to extrasolar planets, with the focus on bridging theoretical developments and observational advances. The WS welcomes a maximum of 70 PhD students and young Post-Docs, and provides each year a unique opportunity for the participants to broaden their knowledge in a key field of Astronomy.

The school is intended to give a thorough introduction into this topic, with solid foundations in both theoretical and observational aspects. The received training should enable young researchers to participate actively in current or future research projects and to develop projects on their own. Training on exoplanets may be considered very valuable for young researchers as, due to the novelty of the subject, new research groups are frequently being formed, giving excellent opportunities for participation by qualified personnel. Another consequence of the recent emergence of exoplanets is the little impact this subject has had in the standard astronomy curriculum lectured at Universities, and an absence of monographs on this topic. The XVI Canary Island Winter School is intended to fill this gap, with the coverage of the following four sections:

i) Planet detection and characterization - the observational foundations, ii) a review on observational results, describing the current state of knowledge, which gives the basis for the section on iii) theories on planet formation and evolution. Finally, a section on iv) habitability and bio-markers, in which the conditions for the development of biological activity are reviewed, with an emphasis on bio-markers that may be observable by future astronomical experiments.

While current exoplanets science is certainly being driven by observations, their theoretical interpretations have undergone a great refinement since the first planet discoveries. These theories are fundamental to our understanding of these objects. They are also needed to formulate the questions that may be resolved by the next generation of observing projects, and they may provide ideas for their design. Hence, observers need to have a theoretical understanding in order to be able to define observing projects that are able to advance theory. To achieve these goals the WS will bring together eight eminent scientists that are actively working on a variety of forefront research projects, of both theoretical and observational nature, and that have played key roles in major advances of the recent years.

The school is primarily intended for doctoral students and recent postdocs who consider to focus their research towards extrasolar planets. Participants of the WS will have the opportunity to display their current work by presenting a poster contribution (1m square panels). Dedicated sessions to discuss some of the posters might be organized within the WS.

The WS will take place in Puerto de la Cruz (Tenerife, Canary Islands, Spain). The lectures will be delivered in English and will be published subsequently in a dedicated monograph. Speakers will present their topics in a series of five lectures. Strong emphasis will be given to interaction between speakers and students through discussion sessions, coffee breaks, and some excursions. Visits to the IAC's Headquarter in La Laguna and the Teide Observatory in Tenerife (and possibly, the Roque de los Muchachos Observatory in La Palma) will be scheduled as part of the activities, with a focus on instruments involved in exoplanet research.

The registration fee is Euro 1200, which covers the Conference Fee (Euro 400.-) and full-board accommodation in a four-star hotel. All WS activities and a copy of the monograph are included at no additional charge.

Those interested in attending the WS should send a Curriculum Vitae, a short summary of their current research project and a letter of reference from their thesis advisor, or Head of Department, by filling out the web forms in http://www.iac.es/winschool2004 or by mailing to the address below. These should reach the IAC before June 30th. Selected candidates will be informed by July 30th.

The Instituto de Astrofisica de Canarias has applied for financial support to the European Commission (EC) under the Marie Curie Conference and Training Courses Action of the Sixth Framework Programme (FP6) to support early stage researchers and young postdocs to attend this WS. You are invited to apply for these EC grants to attend the event. The availability of these funds will not be confirmed (or otherwise) until September. Applicants from any country and nationality are invited to complete the application form provided in the web-site.

LECTURERS and TOPICS:

Stephane Udry: *Properties of extrasolar planets*
Tim Brown: *Characterizing extrasolar planets*
Laurance Doyle: *Planet detection projects and methods*
Günther Wuchterl: *From clouds to planet systems (formation and evolution)*
Rafael Rebolo: *From planets to brown dwarfs to stars*
Agustin Sanchez-Lavega: *The solar system in perspective*
Jim F. Kasting: *The potential for life (habitability)*
Franck Selsis: *Can life be detected?*

Organizing Committee:
H.J. Deeg, J.A. Belmonte, A. Aparicio & F. Sanchez

Contact:
Ms. Nieves Villoslada - Ms. Lourdes Gonzalez
Instituto de Astrofisica de Canarias
C. Via Lactea S/N
E-38205 La Laguna, Tenerife
Spain

Fax: + 34 922 605210
E-mail: xviwinter@ll.iac.es

Web: **http://www.iac.es/winschool2004/info.html**

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/ .