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Abstracts of recently accepted papers

Spitzer's view on aromatic and aliphatic hydrocarbon emission in Herbig Ae stars

B. Acke[1], J. Bouwman[2], A. Juhasz[2], Th. Henning[2], M. E. van den Ancker[3], G. Meeus[4], A. G. G. M. Tielens[5] and L. B. F. M. Waters[1,6]

[1] K.U.Leuven, Leuven, Belgium
[2] MPIA, Heidelberg, Germany
[3] ESO, Garching bei Munchen, Germany
[4] UAM, Madrid, Spain
[5] Leiden Observatory, Leiden, the Netherlands
[6] UvA, Amsterdam, the Netherlands

E-mail contact: bram *at* ster.kuleuven.be

The chemistry of astronomical hydrocarbons, responsible for the well-known infrared emission features detected in a wide variety of targets, remains enigmatic. Here we focus on the group of young intermediate-mass Herbig Ae stars. We have analyzed the aliphatic and polycyclic aromatic hydrocarbon (PAH) emission features in the infrared spectra of a sample of 53 Herbig Ae stars, obtained with the Infrared Spectrograph aboard the Spitzer Space Telescope. We confirm that the PAH-to-stellar luminosity ratio is higher in targets with a flared dust disk. However, a few sources with a flattened dust disk still show relatively strong PAH emission. Since PAH molecules trace the gas disk, this indicates that gas disks may still be flared, while the dust disk has settled due to grain growth. There are indications that the strength of the 11.3 um feature also depends on dust disk structure, with flattened disks being less bright in this feature. We confirm that the CC bond features at 6.2 and 7.8 um shift to redder wavelengths with decreasing stellar effective temperature. Moreover, we show that this redshift is accompanied by a relative increase of aliphatic CH emission and a decrease of the aromatic 8.6 um CH feature strength. Cool stars in our sample are surrounded by hydrocarbons with a high aliphatic/aromatic CH ratio and a low aromatic CH/CC ratio, and vice versa for the hot stars. We conclude that, while the overall hydrocarbon emission strength depends on the dust disk's geometry, the relative differences seen in the IR emission features in disks around Herbig Ae stars are mainly due to chemical differences of the hydrocarbon molecules induced by the stellar UV field. Strong UV flux reduces the aliphatic component and emphasizes the spectral signature of the aromatic molecules in the IR spectra.

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Accretion dynamics and disk evolution in NGC 2264: a study based on the Corot photometric observations

S.H.P. Alencar[1], P.S. Teixeira[2], M.M. Guimarães[1,3], P.T. McGinnis[1], J.F. Gameiro[4], J. Bouvier[5], S. Aigrain[6,7], E. Flaccomio[8] and F. Favata[9]

[1] Departamento de Física – ICEx – UFMG, Av. Antônio Carlos, 6627, 30270-901, Belo Horizonte, MG, Brazil
[2] ESO, Karl-Schwarzschild-Strasse 2, D-85748 Garching bei München, Germany
[3] UFSJ – Campus Alto Paraopeba – Rodovia MG 443, KM 7, 36420-000, Ouro Branco, MG, Brazil
[4] Centro de Astrofisica da Universidade do Porto, Rua das Estrelas, 4150 Porto, Portugal

[5] Laboratoire d'Astrophysique, Observatoire de Grenoble, BP 53, F-38041 Grenoble Cédex 9, France
[6] School of Physics, University of Exeter, Exeter, EX4 4QL, UK
[7] Astrophysics, University of Oxford, Denys Wilkinson Building, Oxford, OX4 1DQ, UK
[8] INAF - Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, 90134 Palermo, Italy
[9] European Space Agency, 8-10 rue Mario Nikis, 75015 Paris, France

E-mail contact: silvia@fisica.ufmg.br

The young cluster NGC 2264 was observed with the Corot satellite for 23 days uninterruptedly in March 2008 with unprecedent photometric accuracy. We present here the first results of the analysis of the accreting population that belongs to the cluster and was observed by Corot. We intended to look for possible light curve variability of the same nature as that observed in the classical T Tauri star AA Tau, which was attributed to a magnetically controlled inner disk warp. The inner warp dynamics is directly associated with the interaction between the stellar magnetic field and the inner disk region.
We analysed the Corot light curves of 83 previously known classical T Tauri stars that belong to NGC 2264 and classified them according to their morphology. We also studied the Corot light curve morphology as a function of a *Spitzer*-based classification of the star-disk systems. The classification derived on the basis of the Corot light curve morphology agrees very well with the *Spitzer* IRAC-based classification of the systems. The percentage of AA Tau-like light curves decreases as the inner disk dissipates, from 40% ± 10% in systems with thick inner disks to 36% ± 16% in systems with anemic disks and none in naked photosphere systems. Indeed, 91% ± 29% of the CTTS with naked photospheres exhibit pure spot-like variability, while only 18% ± 7% of the thick disk systems do so, presumably those seen at low inclination and thus free of variable obscuration. AA Tau-like light curves are found to be fairly common, with a frequency of at least ∼ 30 to 40% in young stars with inner dusty disks. The temporal evolution of the light curves indicates that the structure of the inner disk warp, located close to the corotation radius and responsible for the obscuration episodes, varies over a timescale of a few (∼1-3) rotational periods. This probably reflects the highly dynamical nature of the star-disk magnetospheric interaction.

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Gas- and dust evolution in protoplanetary disks

T. Birnstiel[1], C.P. Dullemond[1] and F. Brauer[1]

[1] Max-Planck Research Group at the Max-Planck-Institut für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany

E-mail contact: birnstiel *at* mpia.de

Context. Current models of the size- and radial evolution of dust in protoplanetary disks generally oversimplify either the radial evolution of the disk (by focusing at one single radius or by using steady state disk models) or they assume particle growth to proceed monodispersely or without fragmentation. Further studies of protoplanetary disks – such as observations, disk chemistry and structure calculations or planet population synthesis models – depend on the distribution of dust as a function of grain size and radial position in the disk.
Aims. We attempt to improve upon current models to be able to investigate how the initial conditions, the build-up phase, and the evolution of the protoplanetary disk influence growth and transport of dust.
Methods. We introduce a new model similar to Brauer et al. (2008, A&A, 480, 859) in which we now include the time-dependent viscous evolution of the gas disk, and in which more advanced input physics and numerical integration methods are implemented.
Results. We show that grain properties, the gas pressure gradient, and the amount of turbulence are much more influencing the evolution of dust than the initial conditions or the build-up phase of the protoplanetary disk. We quantify which conditions or environments are favorable for growth beyond the meter size barrier. High gas surface densities or zonal flows may help to overcome the problem of radial drift, however already a small amount of turbulence poses a much stronger obstacle for grain growth.

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The CHESS chemical Herschel surveys of star forming regions: Peering into the protostellar shock L1157-B1 – I. Shock chemical complexity

C. Codella[1], B. Lefloch[2], C. Ceccarelli[2], the CHESS team, and the HIFI team

[1] INAF, Osservatorio Astrofisico di Arcetri, Firenze, Italy

[2] Laboratoire d'Astrophysique de Grenoble, UMR 5571-CNRS, Université Joseph Fourier, Grenoble, France

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

We present the first results of the unbiased survey of the L1157-B1 bow shock, obtained with HIFI in the framework of the key program Chemical *Herschel* surveys of star forming regions (CHESS). The L1157 outflow is driven by a low-mass Class 0 protostar and is considered the prototype of the so-called chemically active outflows. The bright blue-shifted bow shock B1 is the ideal laboratory for studying the link between the hot ($\sim$ 1000-2000 K) component traced by H_2 IR-emission and the cold ($\sim$ 10–20 K) swept-up material. The main aim is to trace the warm gas chemically enriched by the passage of a shock and to infer the excitation conditions in L1157-B1. A total of 27 lines are identified in the 555–636 GHz region, down to an average 3σ level of 30 mK. The emission is dominated by CO(5–4) and $H_2O(1_{10}–1_{01})$ transitions, as discussed by Lefloch et al. in this volume. Here we report on the identification of lines from NH_3, H_2CO, CH_3OH, CS, HCN, and HCO^+. The comparison between the profiles produced by molecules released from dust mantles (NH_3, H_2CO, CH_3OH) and that of H_2O is consistent with a scenario in which water is also formed in the gas-phase in high-temperature regions where sputtering or grain-grain collisions are not efficient. The high excitation range of the observed tracers allows us to infer, for the first time for these species, the existence of a warm ($\geq$ 200 K) gas component coexisting in the B1 bow structure with the cold and hot gas detected from ground.

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www.arcetri.astro.it/∼codella/papers/codella-chess.ps.gz

A submillimetre survey of the kinematics of the Perseus molecular cloud – II. Molecular outflows

Emily I. Curtis[1,2], John S. Richer[1,2], Jonathan J. Swift[3] and Jonathan P. Williams[3]

[1] Astrophysics Group, Cavendish Laboratory, 19 J.J. Thomson Avenue, Cambridge, CB3 0HE

[2] Kavli Institute for Cosmology, c/o Inst. of Astronomy, Univ. of Cambridge, Madingley Road, Cambridge, CB3 0HA

[3] Institute for Astronomy, 2680 Woodlawn Drive, Honolulu, HI, 96822-1897, USA

E-mail contact: e.curtis *at* mrao.cam.ac.uk

We present a census of molecular outflows across four active regions of star formation in the Perseus molecular cloud (NGC 1333, IC348/HH211, L1448 and L1455), totalling an area of over 1000 arcmin^2. This is one of the largest surveys of outflow evolution in a single molecular cloud published to date. We analyse large-scale, sensitive CO $J = 3 \rightarrow 2$ datasets from the James Clerk Maxwell Telescope, including new data towards NGC 1333. Where possible we make use of our complementary ^{13}CO and $C^{18}O$ data to correct for the ^{12}CO optical depth and measure ambient cloud properties. Of the 65 submillimetre cores in our fields, we detect outflows towards 45. 24 of these are marginal detections where the outflow's shape is unclear or could be confused with the other outflows. We compare various parameters between the outflows from Class 0 and I protostars, including their mass, momentum, energy and momentum flux. Class 0 outflows are longer, faster, more massive and have more energy than Class I outflows. The dynamical time-scales we derive from these outflows are uncorrelated to the age of the outflow driving source, computed from the protostar's bolometric temperature. We confirm the results of Bontemps et al., that outflows decrease in force as they age. There is a decrease in momentum flux from the Class 0 to I stage: $\langle F_{\rm CO}\rangle = (8 \pm 3) \times 10^{-5}$ compared to $(1.1 \pm 0.3) \times 10^{-5}\,\mathrm{M_\odot\,km\,s^{-1}\,yr^{-1}}$, suggesting a decline in the mass accretion rate assuming the same entrainment fraction for both classes of outflow. If $F_{\rm rad} = L_{\rm bol}/c$ is the flux expected in radiation from the central source, then $F_{\rm CO}(\mathrm{Class\,I}) \sim 100F_{\rm rad}$ and $F_{\rm CO}(\mathrm{Class\,0}) \sim 1000F_{\rm rad}$. Furthermore, we confirm there are additional sources of mass loss from protostars. If a core's mass is only lost from outflows at the current rate, cores would endure a few million years, much longer than current estimates for the duration of the protostellar stage. Finally, we note that the total energy contained in outflows in NGC 1333, L1448 and L1455 is greater than the estimated turbulent energy in the respective regions, which may have implications for the regions' evolution.

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Supernova Remnants and Star Formation in the Large Magellanic Cloud

K. M. Desai[1], Y.-H. Chu[1], R. A. Gruendl[1], W. Dluger[1], M. Katz[1], T. Wong[1], C.-H. R. Chen[2], L. W. Looney[1], A. Hughes[3,4], E. Muller[5], J. Ott[6] and J. L. Pineda[7]

[1] Department of Astronomy, University of Illinois at Urbana-Champaign, USA
[2] Department of Astronomy, University of Virginia, Charlottesville, USA
[3] Centre for Supercomputing and Astrophysics, Swinburne University of Technology, Australia
[4] CSIRO Australia Telescope National Facility, Australia
[5] Department of Physics and Astrophysics, Nagoya University, Japan
[6] National Radio Astronomy Observatory, USA
[7] NASA/JPL, USA

E-mail contact: kdesai7 *at* illinois.edu

It has often been suggested that supernova remnants (SNRs) can trigger star formation. To investigate the relationship between SNRs and star formation, we have examined the known sample of 45 SNRs in the Large Magellanic Cloud to search for associated young stellar objects (YSOs) and molecular clouds. We find seven SNRs associated with both YSOs and molecular clouds, three SNRs associated with YSOs but not molecular clouds, and eight SNRs near molecular clouds but not associated with YSOs. Among the 10 SNRs associated with YSOs, the association between the YSOs and SNRs can be either rejected or cannot be convincingly established for eight cases. Only two SNRs have YSOs closely aligned along their rims; however, the time elapsed since the SNR began to interact with the YSOs' natal clouds is much shorter than the contraction timescales of the YSOs, and thus we do not see any evidence of SNR-triggered star formation in the LMC. The 15 SNRs that are near molecular clouds may trigger star formation in the future when the SNR shocks have slowed down to < 45 km s^{-1}. We discuss how SNRs can alter the physical properties and abundances of YSOs.

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Nothing to hide: An X-ray survey for young stellar objects in the Pipe Nebula

Jan Forbrich[1], Bettina Posselt[1], Kevin R. Covey[2] and Charles J. Lada[1]

[1] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA
[2] Department of Astronomy, Cornell University, Ithaca, NY 14853, USA

E-mail contact: jforbrich at cfa.harvard.edu

We have previously analyzed sensitive mid-infrared observations to establish that the Pipe Nebula has a very low star-formation efficiency. That study focused on YSOs with excess infrared emission (i.e, protostars and pre-main sequence stars with disks), however, and could have missed a population of more evolved pre-main sequence stars or Class III objects (i.e., young stars with dissipated disks that no longer show excess infrared emission). Evolved pre-main sequence stars are X-ray bright, so we have used ROSAT All-Sky Survey data to search for diskless pre-main sequence stars throughout the Pipe Nebula. We have also analyzed archival XMM-*Newton* observations of three prominent areas within the Pipe: Barnard 59, containing a known cluster of young stellar objects; Barnard 68, a dense core that has yet to form stars; and the Pipe molecular ring, a high-extinction region in the bowl of the Pipe. We additionally characterize the X-ray properties of YSOs in Barnard 59. The ROSAT and XMM-*Newton* data provide no indication of a significant population of more evolved pre-main sequence stars within the Pipe, reinforcing our previous measurement of the Pipe's very low star formation efficiency.

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On the origin of [NeII] 12.81 μm emission from pre-main sequence stars: Disks, jets, and accretion

Manuel Güdel[1,2,3,4], Fred Lahuis[5,4], Kevin R. Briggs[2], John Carr[6], Alfred E. Glassgold[7], Thomas Henning[3], Joan R. Najita[8], Roy van Boekel[3] and Ewine F. van Dishoeck[4,9]

[1] University of Vienna, Department of Astronomy, Türkenschanzstrasse 17, 1180 Vienna, Austria

[2] ETH Zurich, Institute of Astronomy, 8093 Zurich, Switzerland
[3] Max-Planck-Institute for Astronomy, Königstuhl 17, 69117 Heidelberg, Germany
[4] Leiden Observatory, Leiden University, PO Box 9513, 2300 RA Leiden, The Netherlands
[5] SRON Netherlands Institute for Space Research, P.O. Box 800, 9700 AV Groningen, The Netherlands
[6] Naval Research Laboratory, Code 7213, Washington, DC 20375, USA
[7] University of California at Berkeley, Berkeley, CA, 94720, USA
[8] National Optical Astronomy Observatory, 950 N. Cherry Ave., Tucson, AZ 85719, USA
[9] Max-Planck Institut für Extraterrestrische Physik (MPE), Giessenbachstr. 1, 85748 Garching, Germany

E-mail contact: manuel.guedel *at* univie.ac.at

Extreme-ultraviolet (EUV) and X-ray photons are powerful ionization and heating agents that drive disk chemistry, disk instabilities, and photoevaporative flows. The mid-infrared fine-structure line of [Ne II] at 12.81 μm has been proposed to trace gas in disk surface layers heated and ionized by stellar X-ray and EUV radiation.
We aim at locating the origin of [Ne II] line emission in circumstellar environments by studying distributions of [Ne II] emission and correlating the inferred [Ne II] luminosities, $L_{[\mathrm{Ne\,II}]}$, with stellar and circumstellar disk parameters.
We have conducted a study of [Ne II] line emission based on a sample of 92 pre-main sequence stars mostly belonging to the infrared Class II, but including 13 accreting transition disk objects, and also 14 objects that drive known jets and outflows.
We find several significant correlations between $L_{[\mathrm{Ne\,II}]}$ and stellar parameters, in particular L_{X} and the wind mass loss rate, $\dot{M}_{\mathrm{loss}}$. Most correlations are, however, strongly dominated by systematic scatter of unknown origin. While there is a positive correlation between $L_{[\mathrm{Ne\,II}]}$ and L_{X}, the stellar mass accretion rate, $\dot{M}_{\mathrm{acc}}$, induces a correlation only if we combine the largely different subsets of jet sources and stars without jets. Our results indeed suggest that $L_{[\mathrm{Ne\,II}]}$ is bi-modally distributed, with separate distributions for the two subsamples. The jet sources show systematically higher $L_{[\mathrm{Ne\,II}]}$, by 1-2 orders of magnitude with respect to objects without jets. Jet-driving stars also tend to show higher mass accretion rates. We therefore hypothesize that the trend with $\dot{M}_{\mathrm{acc}}$ only reflects a trend with $\dot{M}_{\mathrm{loss}}$ that is more physically relevant for [Ne II] emission.
The [Ne II] luminosities measured for objects without known outflows and jets are found to agree with simplified calculations of [Ne II] emission from disk surface layers if the measured stellar X-rays are responsible for heating and ionizing of the gas. The large scatter in $L_{[\mathrm{Ne\,II}]}$ may be introduced by variations of disk properties and the irradiation spectrum, as previously suggested. If these additional factors can be sufficiently well constrained, then the [Ne II] 12.81μm line should be an important diagnostic for disk surface ionization and heating, at least in the inner disk region. This applies in particular to transition disks also included in our sample. The systematically enhanced [Ne II] flux from jet sources clearly suggests a role for the jets themselves, as previously demonstrated by a spatially resolved observation of the outflow system in the T Tau triple.

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A Four-Stokes-Parameter Spectral Line Polarimeter at the Caltech Submillimeter Observatory

Talayeh Hezareh[1] and Martin Houde[1]

[1] The Department of Physics and Astronomy, The University of Western Ontario, London, Ontario, Canada N6A 3K7

E-mail contact: thezareh *at* uwo.ca

We designed and built a new Four-Stokes-Parameter spectral line Polarimeter (FSPPol) for the Caltech Submillimeter Observatory (CSO). The simple design of FSPPol does not include any mirrors or optical components to redirect or re-image the radiation beam and simply transmits the beam to the receiver through its retarder plates. FSPPol is currently optimized for observation in the 200-260 GHz range and measures all four Stokes parameters, I, Q, U, and V. The very low level of instrument polarization makes it possible to obtain reliable measurements of the Goldreich-Kylafis effect in molecular spectral lines. Accordingly, we measured a polarization fraction of a few percent in the spectral line wings of ^{12}CO($J = 2 \rightarrow 1$) in Orion KL/IRc2, which is consistent with previous observations. We also used FSPPol to study the Zeeman effect in the $N = 2 \rightarrow 1$ transition of CN in DR21(OH) for the first time. At this point we cannot report a Zeeman detection, but more observations are ongoing.

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Improved radial velocity orbit of the young binary brown dwarf candidate ChaHa8

Viki Joergens[1,2], Andre Mueller[1,3] and Sabine Reffert[4]

[1] Max-Planck Institute for Astronomy Heidelberg
[2] ITA Heidelberg
[3] ESO Garching
[4] LSW Heidelberg

E-mail contact: viki *at* mpia.de

The very young brown dwarf candidate Cha Hα 8 was recently discovered to have a close ($\sim$1 AU) companion through radial velocity monitoring. We present here new radial velocity data obtained with UVES/VLT between 2007 and 2010, which significantly improve the orbit of the system. The combined data set spans ten years of radial velocity monitoring for Cha Hα 8. A Kepler fit to the data yields an orbital period of 5.2 years, an eccentricity of e=0.59, and a radial velocity semi-amplitude of 2.4 km s^{-1}. A companion mass $M_2 \sin i$ (which is a lower limit due to the unknown orbital inclination i) of 25$\pm$7 $M_{\rm Jup}$ and of 31$\pm$8 $M_{\rm Jup}$ is derived when using model-dependent mass estimates for the primary of 0.07 M$_\odot$ and 0.10 M$_\odot$, respectively. The companion of Cha Hα 8 is with very high probability ($\geq$87%) of substellar nature when assuming random orientation of orbits in space: With more than 50% probability ($i \geq 60°$) the companion mass is between 30 and 35 $M_{\rm Jup}$ and the mass ratio M_2/M_1 smaller than 0.4; with more than 87% probability ($i \geq 30°$) the companion mass is between 30 and 69 $M_{\rm Jup}$ and the mass ratio smaller than 0.7. The absence of any evidence of the companion in the cross-correlation function together with the size of the radial velocity amplitude also indicates a mass ratio of at most 0.7, and likely smaller. Furthermore, the new data rule out the possibility that the companion has a mass in the planetary regime ($\leq$13 $M_{\rm Jup}$). We show that the companion contributes a significant fraction to the total luminosity of the system, model-dependent estimates give a minimum for the luminosity ratio L_2/L_1 of 0.2. Cha Hα 8 is the fourth known spectroscopic brown dwarf or very low-mass stellar binary with determined orbital parameters, and the second known very young one. With an age of only about 3 Myr it is of particular interest for very low-mass formation and evolution theories. In contrast to most other spectroscopic binaries, it has a relatively long orbital period and it might be possible to determine the astrometric orbit of the primary and, thus, the orbital inclination.

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http://www.mpia.de/homes/joergens/

Disk Formation Enabled by Enhanced Resistivity

Ruben Krasnopolsky[1,3], Zhi-Yun Li[2,3] and Hsien Shang[1,3]

[1] Academia Sinica, Institute of Astronomy and Astrophysics, Taipei, Taiwan
[2] University of Virginia, Astronomy Department, Charlottesville, VA, USA
[3] Academia Sinica, Theoretical Institute for Advanced Research in Astrophysics, Taipei, Taiwan

E-mail contact: ruben *at* asiaa.sinica.edu.tw

Disk formation in magnetized cloud cores is hindered by magnetic braking. Previous work has shown that for realistic levels of core magnetization, the magnetic field suppresses the formation of rotationally supported disks during the protostellar mass accretion phase of low-mass star formation both in the ideal MHD limit and in the presence of ambipolar diffusion for typical rates of cosmic ray ionization. Additional effects, such as ohmic dissipation, the Hall effect, and protostellar outflow, are needed to weaken the magnetic braking and enable the formation of persistent, rotationally supported, protostellar disks. In this paper, we first demonstrate that the classic microscopic resistivity is not large enough to enable disk formation by itself. We then experiment with a set of enhanced values for the resistivity in the range $\eta = 10^{17}$–10^{22} cm^2 s^{-1}. We find that a value of order 10^{19} cm^2 s^{-1} is needed to enable the formation of a 10^2 AU-scale Keplerian disk; the value depends somewhat on the degree of core magnetization. The required resistivity is a few orders of magnitude larger than the classic microscopic values. Whether it can be achieved naturally during protostellar collapse remains to be determined.

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CHESS: Chemical Herschel surveys of star forming regions: Peering into the protostellar shock L1157-B1

B. Lefloch[1], S. Cabrit[2], C. Codella[3], G. Melnick[4], J. Cernicharo[5] and E. Caux and the CHESS Team[6]

[1] Laboratoire d'Astrophysique de Grenoble, UMR 5571-CNRS, Universite Joseph Fourier, Grenoble, France
[2] Observatoire de Paris-Meudon, LERMA UMR CNRS 8112. Meudon, France
[3] INAF, Osservatorio Astrofisico di Arcetri, Firenze, Italy
[4] Center for Astrophysics, Cambridge MA, USA
[5] Centro de Astrobiologa, CSIC-INTA, Madrid, Spain
[6] CESR, Universite Toulouse 3 and CNRS, Toulouse, France

E-mail contact: lefloch *at* obs.ujf-grenoble.fr

The outflow driven by the low-mass class 0 protostar L1157 is the prototype of the so-called chemically active outflows. The bright bowshock B1 in the southern outflow lobe is a privileged testbed of magneto-hydrodynamical (MHD) shock models, for which dynamical and chemical processes are strongly interdependent. We present the first results of the unbiased spectral survey of the L1157-B1 bowshock, obtained in the framework of the key program "Chemical Herschel Surveys of Star Forming Regions" (CHESS). The main aim is to trace the warm and chemically enriched gas and to infer the excitation conditions in the shock region. The CO 5-4 and o-H_2O $1_{10}-1_{01}$ lines have been detected at high-spectral resolution in the unbiased spectral survey of the HIFI-Band 1b spectral window (555-636 GHz), presented by Codella et al. in this volume. Complementary ground-based observations in the submm window help establish the origin of the emission detected in the main-beam of HIFI, and the physical conditions in the shock. Both lines exhibit broad wings, which extend to velocities much higher than reported up to now. We find that the molecular emission arises from two regions with distinct physical conditions : an extended, warm (100 K), dense ($3\times10^5\,cm^{-3}$) component at low-velocity, which dominates the water line flux in Band 1; a secondary component in a small region of B1 (a few arcsec) associated with high-velocity, hot (>400 K) gas of moderate density ($(1.0-3.0)\times10^4\,cm^{-3}$), which appears to dominate the flux of the water line at 179 μm observed with PACS. The water abundance is enhanced by two orders of magnitude between the low- and the high-velocity component, from 8×10^{-7} up to 8×10^{-5}. The properties of the high-velocity component agree well with the predictions of steady-state C-shock models.

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A method to determine distances to molecular clouds using near-IR photometry

G. Maheswar[1,2], C.-W. Lee[1], H.C. Bhatt[3], S. V. Mallik[3] and Dib Sami[4,5]

[1] Korea Astronomy and Space Science Institute, 61-1, Hwaam-dong, Yuseong-gu, Daejeon 305-348, Republic of Korea
[2] Aryabhatta Research Institute of Observational Sciences, Manora Peak, Nainital 263 129, India
[3] Indian Institute of Astrophysics, Koramangala, Bangalore 560 034, India
[4] Service d'Astrophysique, DSM/Irfu, CEA/Saclay, 91191 Gif-sur-Yvette Cedex, France
[5] Lebanese University, Faculty of Sciences, Department of Physics, El-Hadath, Beirut, Lebanon

E-mail contact: maheswar *at* aries.res.in

Aims: We aim to develop a method to determine distances to molecular clouds using JHK near-infrared photometry.
Methods: The method is based on a technique that aids spectral classification of stars lying towards the fields containing the clouds into main sequence and giants. In this technique, the observed (J-H) and (H-K_s) colours are dereddened simultaneously using trial values of A V and a normal interstellar extinction law. The best fit of the dereddened colours to the intrinsic colours giving a minimum value of χ^2 then yields the corresponding spectral type and A V for the star. The main sequence stars, thus classified, are then utilized in an A V versus distance plot to bracket the cloud distances.
Results: We applied the method to four clouds, L1517, Chamaeleon I, Lupus 3 and NGC 7023 and estimated their distances as 167 ± 30, 151 ± 28, 157 ± 29 and 408 ± 76 pc respectively, which are in good agreement with the previous distance estimations available in the literature.

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Tracing early evolutionary stages of high-mass star formation with molecular lines

M.G. Marseille[1], F.F.S van der Tak[1,2], F. Herpin[3,4] and T. Jacq[3,4]

[1] SRON Netherlands Institute for Space Research, Landleven 12, 9747AD Groningen, The Netherlands
[2] Kapteyn Astronomical Institute, PO Box 800, 9700 AV, Groningen, The Netherlands
[3] Université Bordeaux 1, Laboratoire d'Astrophysique de Bordeaux, 2 rue de l'Observatoire, BP 89, 33271 Floirac CEDEX, France
[4] CNRS/INSU, UMR 5804, BP 89 33271 Floirac CEDEX, France

E-mail contact: m.marseille *at* sron.nl

Despite its major role in the evolution of the interstellar medium, the formation of high-mass stars ($M \geq 10$ M$_\odot$) is still poorly understood. Two types of massive star cluster precursors, the so-called Massive Dense Cores (MDCs), have been observed, which differ in their mid-infrared brightness. The origin of this difference is not established and could be the result of evolution, density, geometry differences, or a combination of these.
We compare several molecular tracers of physical conditions (hot cores, shocks) observed in a sample of mid-IR weak emitting MDCs with previous results obtained in a sample of exclusively mid-IR bright MDCs. The aim is to understand the differences between these two types of object.
We present single-dish observations of HDO, $H_2^{18}O$, SO_2 and CH_3OH lines at $\lambda = 1.3 - 3.5$ mm. We study line profiles and estimate abundances of these molecules, and use a partial correlation method to search for trends in the results.
The detection rates of thermal emission lines are found to be very similar between mid-IR quiet and bright objects. The abundances of H_2O, HDO (10^{-13} to 10^{-9} in the cold outer envelopes), SO_2 and CH_3OH differ from source to source but independently of their mid-IR flux. In contrast, the methanol class I maser emission, a tracer of outflow shocks, is found to be strongly anti-correlated with the 12 μm source brightnesses.
The enhancement of the methanol maser emission in mid-IR quiet MDCs may indicate a more embedded nature. Since total masses are similar between the two samples, we suggest that the matter distribution is spherical around mid-IR quiet sources but flattened around mid-IR bright ones. In contrast, water emission is associated with objects containing a hot molecular core, irrespective of their mid-IR brightness. These results indicate that the mid-IR brightness of MDCs is an indicator of their evolutionary stage.

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Ammonia Observations of Bright-Rimmed Clouds: Establishing a Sample of Triggered Protostars

L.K. Morgan[1], C.C. Figura[2], J.S. Urquhart[3] and M.A. Thompson[4]

[1] Astrophysics Research Institute, Liverpool John Moores University, Twelve Quays House, Egerton Wharf, Birkenhead, Wirral. CH41 1LD. United Kingdom
[2] Wartburg College, 100 Wartburg Blvd. Waverley, IA 50677, USA
[3] Australia Telescope National Facility, CSIRO, Sydney, NSW 2052, Australia
[4] Centre for Astrophysics Research, Science and Technology Research Institute, University of Hertfordshire, College Lane, Hatfield AL10 9AB, U.K.

E-mail contact: lkm *at* astro.livjm.ac.uk

We observed 42 molecular condensations within previously identified bright-rimmed clouds in the ammonia rotational inversion lines NH3(1,1), (2,2), (3,3) and (4,4) using the Green Bank Telescope in Green Bank, West Virginia. Using the relative peaks of the ammonia lines and their hyperfine satellites we have determined important parameters of these clouds, including rotational temperatures and column densities. These observations confirm the presence of dense gas towards IRAS point sources detected at submillimetre wavelengths. Derived physical properties allow us to refine the sample of bright-rimmed clouds into those likely to be sites of star formation, triggered via the process of radiatively-driven implosion. An investigation of the physical properties of our sources show that triggered sources are host to greater turbulent velocity dispersions, likely indicative of shock motions within the cloud material. These may be attributed to the passage of triggered shocks or simply the association of outflow activity with the sources. In all, we have refined the Sugitani et al. (1991) catalogue to 15 clouds which are clearly star-forming and influenced by external photoionisation-induced shocks. These sources may be said, with high confidence, to represent the best examples of triggering within bright-rimmed clouds.

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Water cooling of shocks in protostellar outflows: Herschel-PACS map of L1157

B. Nisini[1], M. Benedettini[2], C. Codella[3], T. Giannini[1], R. Liseau[4], D. Neufeld[5], M. Tafalla[6], E. F. van Dishoeck[7,8], R. Bachiller[6], A. Baudry[9], A. O. Benz[10], E. Bergin[11], P. Bjerkeli[4], G. Blake[12], S. Bontemps[9], J. Braine[9], S. Bruderer[10], P. Caselli[13,3], J. Cernicharo[14], F. Daniel[14], P. Encrenaz[15], A.M. di Giorgio[2], C. Dominik[16,17], S. Doty[18], M. Fich[19], A. Fuente[6], J.R. Goicoechea[14], Th. de Graauw[20], F. Helmich[20], G. Herczeg[8], F. Herpin[9], M. Hogerheijde [7], T. Jacq[9], D. Johnstone[21,22], J. Jørgensen[23], M. Kaufman[24], L. Kristensen[7], B. Larsson[25], D. Lis[12], M. Marseille[20], C. McCoey[19], G. Melnick[26], M. Olberg[4], B. Parise[25], J. Pearson[28], R. Plume[29], C. Risacher[20], J. Santiago[6], P. Saraceno[2], R. Shipman[20], T.A. van Kempen[26], R. Visser[7], S. Viti[30,2], S. Wampfler[10], F. Wyrowski[27], F. van der Tak[20,31], U.A. Yıldız[7], B. Delforge[32,17], J. Desbat[9,33], W.A. Hatch[29], I. Péron[34,32,17], R. Schieder[35], J.A. Stern[29], D. Teyssier[36], N. Whyborn[37]

[1]INAF - Osservatorio Astronomico di Roma, Via di Frascati 33, 00040 Monte Porzio Catone, Italy
[2] Istituto di Fisica dello Spazio Interplanetario, INAF, Via del Fosso del Cavaliere 100, I-00133 Roma, Italy
[3] INAF Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, 50125 Firenze, Italy
[4] Chalmers University of Technology, Onsala Space Observatory, 439 92 Onsala, Sweden
[5] Johns Hopkins University, 3400 North Charles Street, Baltimore, MD 21218, USA
[6] IGN Observatorio Astronómico Nacional, Apartado 1143, 28800 Alcalá de Henares, Spain
[7] Leiden Observatory, Leiden University, PO Box 9513, 2300 RA Leiden, The Netherlands
[8] Max Planck Institut for Extraterestrische Physik, Garching, Germany
[9] Université de Bordeaux, Laboratoire dAstrophysique de Bordeaux, France; CNRS/INSU, UMR 5804, Floirac, France
[10] Institute of Astronomy, ETH Zurich, 8093 Zurich, Switzerland
[11] Department of Astronomy, The University of Michigan, 500 Church Street, Ann Arbor, MI 48109-1042, USA
[12] California Institute of Technology, MS 150-21, Pasadena, CA 91125, USA
[13] School of Physics and Astronomy, University of Leeds, Leeds LS2 9JT
[14] CSIC-INTA. Carretera de Ajalvir, Km 4, Torrejón de Ardoz. 28850, Madrid, Spain.
[15] LERMA and UMR 8112 du CNRS, Observatoire de Paris, 61 Av. de l'Observatoire, 75014 Paris, France
[16] University of Amsterdam, Kruislaan 403, 1098 SJ Amsterdam, The Netherlands
[17] Radboud University Nijmegen, P.O. Box 9010, 6500 GL Nijmegen, The Netherlands
[18] Department of Physics and Astronomy, Denison University, Granville, OH, 43023, USA
[19] University of Waterloo, Department of Physics and Astronomy, Waterloo, Ontario, Canada
[20] SRON Netherlands Institute for Space Research, PO Box 800, 9700 AV, Groningen, The Netherlands
[21] NRC Canada, Herzberg Institute of Astrophysics, 5071 West Saanich Road, Victoria, BC V9E 2E7, Canada
[22] Department of Physics and Astronomy, University of Victoria, Victoria, BC V8P 1A1, Canada
[23] Natural History Museum of Denmark, University of Copenhagen, Øster Voldgade 5-7, DK-1350, Denmark
[24] Department of Physics and Astronomy, San Jose State University, One Washington Square, CA 95192, USA
[25] Department of Astronomy, Stockholm University, AlbaNova, 106 91 Stockholm, Sweden
[26] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, MS 42, Cambridge, MA 02138, USA
[27] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany
[28] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA
[29] Department of Physics and Astronomy, University of Calgary, Calgary, T2N 1N4, AB, Canada
[30] Department of Physics and Astronomy, University College London, Gower Street, London WC1E6BT
[31] Kapteyn Astronomical Institute, University of Groningen, PO Box 800, 9700 AV, Groningen, The Netherlands
[32] CNRS/INSU, UMR 8112, OP, ENS, UPMC, UCP, Paris, France
[33] CNRS/INSU, UMR 5804, B.P. 89, 33271 Floirac cedex, France
[34] Institute Institut de Radioastronomie Millimetrique, IRAM, 300 rue de la Piscine, F-38406 St Martin d'Heres
[35] KOSMA, I. Physik. Institut, Universität zu Köln, Zülpicher Str. 77, D 50937 Köln
[36] European Space Astronomy Centre, ESA, P.O. Box 78, E-28691 Villanueva de la Caada, Madrid
[36] ALMA

E-mail contact: brunella.nisini *at* oa-roma.inaf.it

In the framework of the Water in Star-forming regions with Herschel (WISH) key program, maps in water lines of several outflows from young stars are being obtained, to study the water production in shocks and its role in the outflow cooling. This paper reports the first results of this program, presenting a PACS map of the o-H_2O 179μm transition obtained toward the young outflow L1157. The 179μm map is compared with those of other important shock tracers, and with previous single-pointing ISO, SWAS, and Odin water observations of the same source that allow us to constrain the water abundance and total cooling. Strong H_2O peaks are localized on both shocked emission knots and the central source position. The H_2O 179μm emission is spatially correlated with emission from H_2 rotational lines, excited in shocks leading to a significant enhancement of the water abundance. Water emission peaks along the outflow also correlate with peaks of other shock-produced molecular species, such as SiO and NH_3. A strong H_2O peak is also observed at the location of the proto-star, where none of the other molecules have significant emission. The absolute 179μm intensity and its intensity ratio to the H_2O 557 GHz line previously observed with Odin/SWAS indicate that the water emission originates in warm compact clumps, spatially unresolved by PACS, having a H_2O abundance of the order of 10^{-4}. This testifies that the clumps have been heated for a time long enough to allow the conversion of almost all the available gas-phase oxygen into water. The total water cooling is $\sim 10^{-1}$ $L_\odot$, about 40% of the cooling due to H_2 and 23% of the total energy released in shocks along the L1157 outflow.

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The Hα line forming region of AB Aur spatially resolved at sub-AU with the VEGA/CHARA spectro-interferometer

K. Perraut[1], M. Benisty[2], D. Mourard[3], S. Rajabi[2,4], F. Bacciotti[2], Ph. Bério[3], D. Bonneau[3], O. Chesneau[3], J.M. Clausse[3], O. Delaa[3], A. Marcotto[3], A. Roussel[3], A. Spang[3], Ph. Stee[3], I. Tallon-Bosc[5], H. McAlister[6,7], T. ten Brummelaar[6], J. Sturmann[6], L. Sturmann[6], N. Turner[6], C. Farrington[6] and P.J. Goldfinger[6]

[1] Laboratoire d'Astrophysique de Grenoble (LAOG), Université Joseph-Fourier, UMR 5571 CNRS, BP 53, 38041 Grenoble Cedex 09, France

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

[3] Laboratoire Fizeau, OCA/UNS/CNRS UMR6525, Parc Valrose, 06108 Nice cedex 2, France

[4] Centro de Astrofisica, Universidade do Porto, 4150-752 Porto, Portugal

[5] Université de Lyon, Lyon, F-69003, France; Université Lyon 1, Observatoire de Lyon, 9 avenue Charles André, Saint Genis Laval, F-69230; CNRS, UMR 5574, Centre de Recherche Astrophysique de Lyon; Ecole Normale Supérieure, Lyon, F-69007, France

[6] Georgia State University, P.O. Box 3969, Atlanta GA 30302-3969, USA

[7] CHARA Array, Mount Wilson Observatory, 91023 Mount Wilson CA, USA

E-mail contact: karine.perraut@obs.ujf-grenoble.fr

A crucial issue in star formation is to understand the physical mechanism by which mass is accreted onto and ejected by a young star. To derive key constraints on the launching point of the jets and on the geometry of the winds, the visible spectro-polarimeter VEGA installed on the CHARA optical array can be an efficient means of probing the structure and the kinematics of the hot circumstellar gas at sub-AU. For the first time, we observed the Herbig Ae star AB Aur in the Hα emission line, using the VEGA low spectral resolution (R=1700) on two baselines of the array. We computed and calibrated the spectral visibilities of AB Aur between 610 nm and 700 nm in spectral bands of 20.4 nm. To simultaneously reproduce the line profile and the inferred visibility around Hα, we used a 1-D radiative transfer code (RAMIDUS/PROFILER) that calculates level populations for hydrogen atoms in a spherical geometry and that produces synthetic spectro-interferometric observables. We clearly resolved AB Aur in the Hα line and in a part of the continuum, even at the smallest baseline of 34 m. The small P-Cygni absorption feature is indicative of an outflow but could not be explained by a spherical stellar wind model. Instead, it favors a magneto- centrifugal X-disk or disk-wind geometry. The fit of the spectral visibilities from 610 to 700 nm could not be accounted for by a wind alone, so another component inducing a visibility modulation around Hα needed to be considered. We thus considered a brightness asymmetry possibly caused by large-scale nebulosity or by the known spiral structures. Thanks to the unique capabilities of VEGA, we managed to simultaneously record for the first time a spectrum at a resolution of 1700 and spectral visibilities in the visible range on a target as faint as $m_V = 7.1$. It was possible to rule out a spherical

geometry for the wind of AB Aur and provide realistic solutions to account for the Hα emission compatible with magneto-centrifugal acceleration. It was difficult, however, to determine the exact morphology of the wind because of the surrounding asymmetric nebulosity. The study illustrates the advantages of optical interferometry and motivates observations of other bright young stars in the same way to shed light on the accretion/ejection processes.

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Understanding Spatial and Spectral Morphologies of Ultracompact H II Regions

Thomas Peters[1], Mordecai-Mark Mac Low[2], Robi Banerjee[1], Ralf S. Klessen[1] and Cornelis P. Dullemond[3]

[1] Zentrum für Astronomie der Universität Heidelberg, Institut für Theoretische Astrophysik, Albert-Ueberle-Str. 2, D-69120 Heidelberg, Germany
[2] Department of Astrophysics, American Museum of Natural History, 79th Street at Central Park West, New York, New York 10024-5192, USA
[3] Max-Planck-Institut für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany

E-mail contact: thomas.peters *at* ita.uni-heidelberg.de

The spatial morphology, spectral characteristics, and time variability of ultracompact H II regions provide strong constraints on the process of massive star formation. We have performed simulations of the gravitational collapse of rotating molecular cloud cores, including treatments of the propagation of ionizing and non-ionizing radiation. We here present synthetic radio continuum observations of H II regions from our collapse simulations, to investigate how well they agree with observation, and what we can learn about how massive star formation proceeds. We find that intermittent shielding by dense filaments in the gravitationally unstable accretion flow around the massive star leads to highly variable H II regions that do not grow monotonically, but rather flicker, growing and shrinking repeatedly. This behavior appears able to resolve the well-known lifetime problem. We find that multiple ionizing sources generally form, resulting in groups of ultracompact H II regions, consistent with observations. We confirm that our model reproduces the qualitative H II region morphologies found in surveys, with generally consistent relative frequencies. We also find that simulated spectral energy distributions (SEDs) from our model are consistent with the range of observed H II region SEDs, including both regions showing a normal transition from optically thick to optically thin emission, and those with intermediate spectral slopes. In our models, anomalous slopes are solely produced by inhomogeneities in the H II region, with no contribution from dust emission at millimeter or submillimeter wavelengths. We conclude that many observed characteristics of ultracompact H II regions appear consistent with massive star formation in fast, gravitationally unstable, accretion flows.

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A large, massive, rotating disk around an isolated young stellar object

Sascha P. Quanz[1,2], Henrik Beuther[2], Juergen Steinacker[2,3], Hendrik Linz[2], Stephan M. Birkmann[4], Oliver Krause[2], Thomas Henning[2] and Qizhou Zhang[5]

[1] Institute for Astronomy, ETH Zurich, Wolfgang-Pauli-Strasse 27, 8093 Zurich, Switzerland
[2] Max Planck Institute for Astronomy, Koenigstuhl 17, 69117 Heidelberg
[3] LERMA, Observatoire de Paris, 61 Av. de l'Observatoire, 75014 Paris, France
[4] ESA/ESTEC, Keplerlaan 1, Postbus 299, 2200 AG Noordwijk, The Netherlands
[5] Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, USA

E-mail contact: quanz *at* astro.phys.ethz.ch

We present multi-wavelengths observations and a radiative transfer model of a newly discovered massive circumstellar disk of gas and dust which is one of the largest disks known today. Seen almost edge-on, the disk is resolved in high-resolution near-infrared (NIR) images and appears as a dark lane of high opacity intersecting a bipolar reflection nebula. Based on molecular line observations we estimate the distance to the object to be 3.5 kpc. This leads to a size for the dark lane of ∼10500 AU but due to shadowing effects the true disk size could be smaller. In *Spitzer/IRAC* 3.6 μm images the elongated shape of the bipolar reflection nebula is still preserved and the bulk of the flux seems to come

from disk regions that can be detected due to the slight inclination of the disk. At longer *IRAC* wavelengths, the flux is mainly coming from the central regions penetrating directly through the dust lane. Interferometric observations of the dust continuum emission at millimeter wavelengths with the SMA confirm this finding as the peak of the unresolved mm-emission coincides perfectly with the peak of the *Spitzer/IRAC* 5.8 μm flux and the center of the dark lane seen in the NIR images. Simultaneously acquired CO data reveal a molecular outflow along the northern part of the reflection nebula which seems to be the outflow cavity. An elongated gaseous disk component is also detected and shows signs of rotation. The emission is perpendicular to the molecular outflow and thus parallel to but even more extended than the dark lane in the NIR images. Based on the dust continuum and the CO observations we estimate a disk mass of up to a few solar masses depending on the underlying assumptions. Whether the disk-like structure is an actual accretion disk or rather a larger-scale flattened envelope or pseudodisk is difficult to discriminate with the current dataset. The existence of $HCO^+/H^{13}CO^+$ emission proofs the presence of dense gas in the disk and the molecules' abundances are similar to those found in other circumstellar disks. We furthermore detected C_2H towards the objects and discuss this finding in the context of star formation. Finally, we have performed radiative transfer modeling of the K band scattered light image varying a disk plus outflow 2D density profile and the stellar properties. The model approximately reproduces extent and location of the dark lane, and the basic appearance of the outflow. We do not find any hints for other young stars in the immediate vicinity of the new disk and speculate to have detected a rather rare case of relatively isolated star formation. We discuss our findings in the context of circumstellar disks across all mass regimes and conclude that our discovery is an ideal laboratory to study the early phases in the evolution of massive circumstellar disks surrounding young stellar objects.

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"Starless" Super-Jeans Cores in Four Gould Belt Clouds

Sarah I Sadavoy[1,2], James Di Francesco[2,1] and Doug Johnstone[2,1]

[1] Department of Physics and Astronomy, University of Victoria, P.O. Box 355, STN CSC, Victoria BC, V8W 3P6, Canada

[2] National Research Council Canada, Herzberg Institute of Astrophysics, 5071 West Saanich Road, Victoria BC, V9E 2E7, Canada

E-mail contact: ssadavoy *at* uvic.ca

From a survey of 729 cores based on JCMT/SCUBA data, we present an analysis of 17 candidate starless cores with masses that exceed their stable Jeans masses. We re-examine the classification of these super-Jeans cores using Spitzer maps and find that 3 are re-classified as protostellar, 11 have ambiguous emission near the core positions, and 3 appear to be genuinely starless. We suggest the 3 starless and 11 undetermined super-Jeans cores represent excellent targets for future observational and computational study to understand the evolution of dense cores and the process of star formation.

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The molecular environment of the Galactic star forming region G19.61-0.23

G. Santangelo[1,2,3,4], L. Testi[1,4], S. Leurini [1,6], C.M. Walmsley[4], R. Cesaroni[4], L. Bronfman[7], S. Carey[9], L. Gregorini[2,3], K.M. Menten[6], S. Molinari[8], A. Noriega-Crespo[9], L. Olmi[4,5] and F. Schuller[6]

[1] European Southern Observatory, Karl Schwarzschild str.2, D-85748 Garching bei Muenchen, Germany

[2] INAF - Istituto di Radioastronomia, via Gobetti 101, 40129 Bologna, Italy

[3] Dipartimento di Astronomia, Università di Bologna, via Ranzani 1, 40127 Bologna, Italy

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

[5] University of Puerto Rico, Rio Piedras Campus, Physics Department, Box 23343, UPR Station, San Juan, Puerto Rico

[6] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany

[7] Departamento de Astronomía, Universidad de Chile, Casilla 36-D, Santiago, Chile

[8] Istituto Nazionale di Astrofisica - Istituto Fisica spazio interplanetario, Via Fosso del Cavaliere 100, I-00133 Rome, Italy
[9] Spitzer Science Center, California Institute of Technology, Pasadena, CA 91125, USA

E-mail contact: santangelo *at* ira.inaf.it

Although current facilities allow the study of Galactic star formation at high angular resolution, our current understanding of the high-mass star-formation process is still very poor. In particular, we still need to characterize the properties of clouds giving birth to high-mass stars in our own Galaxy and use them as templates for our understanding of extragalactic star formation.
We present single-dish (sub)millimeter observations of gas and dust in the Galactic high-mass star-forming region G19.61-0.23, with the aim of studying the large-scale properties and physical conditions of the molecular gas across the region. The final aim is to compare the large-scale (about 100 pc) properties with the small-scale (about 3 pc) properties and to consider possible implications for extragalactic studies.
We have mapped CO isotopologues in the $J = 1-0$ transition using the FCRAO-14m telescope and the $J = 2-1$ transition using the IRAM-30m telescope. We have also used APEX 870 μm continuum data from the ATLASGAL survey and FCRAO supplementary observations of the ^{13}CO $J = 1-0$ line from the BU-FCRAO Galactic Ring Survey, as well as the Spitzer infrared Galactic plane surveys GLIMPSE and MIPSGAL to characterize the star-formation activity within the molecular clouds.
We reveal a population of molecular clumps in the ^{13}CO(1-0) emission, for which we derived the physical parameters, including sizes and masses. Our analysis of the ^{13}CO suggests that the virial parameter (ratio of kinetic to gravitational energy) varies over an order of magnitude between clumps that are unbound and some that are apparently "unstable". This conclusion is independent of whether they show evidence of ongoing star formation. We find that the majority of ATLASGAL sources have MIPSGAL counterparts with luminosities in the range 10^4-$5\,10^4$ $L_\odot$ and are presumably forming relatively massive stars. We compare our results with previous extragalactic studies of the nearby spiral galaxies M31 and M33; and the blue compact dwarf galaxy Henize 2-10. We find that the main giant molecular cloud surrounding G19.61-0.23 has physical properties typical for Galactic GMCs and which are comparable to the GMCs in M31 and M33. However, the GMC studied here shows smaller surface densities and masses than the clouds identified in Henize 2-10 and associated with super star cluster formation.

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An Observed Lack of Substructure in Starless Cores

Scott Schnee[1], Melissa Enoch[2], Doug Johnstone[1,3], Thomas Culverhouse[4,5], Erik Leitch[4,5], Daniel P Marrone[4,5] and Anneila Sargent[6]

[1] National Research Council Canada, Herzberg Institute of Astrophysics, 5071 West Saanich Road Victoria, BC V9E 2E7, Canada
[2] Department of Astronomy, University of California, Berkeley, CA 94720, USA
[3] Department of Physics & Astronomy, University of Victoria, Victoria, BC, V8P 1A1, Canada
[4] Kavli Institute for Cosmological Physics, Department of Astronomy and Astrophysics, University of Chicago, Chicago, IL 60637, USA
[5] Department of Astronomy and Astrophysics, University of Chicago, Chicago, IL 60637, USA
[6] Department of Astronomy, California Institute of Technology, MC 105-24 Pasadena, CA 91125, USA

E-mail contact: scott.schnee *at* nrc-cnrc.gc.ca

In this paper we present the results of a high resolution (5″) CARMA and SZA survey of the 3 mm continuum emission from 11 of the brightest (at 1.1 mm) starless cores in the Perseus molecular cloud. We detect 2 of the 11 cores, both of which are composed of single structures, and the median 3σ upper limit for the non-detections is 0.2 M_{sun} in a ~5″ beam. These results are consisent with, and as stringent as, the low detection rate of compact 3 mm continuum emission in dense cores in Perseus reported by Olmi et al. (2005). From the non-detection of multiple components in any of the eleven cores we conclude that starless core mass functions derived from bolometer maps at resolutions from 10″–30″ (e.g. with MAMBO, SCUBA or Bolocam) are unlikely to be significantly biased by the blending of lower mass cores with small separations. These observations provide additional evidence that the majority of starless cores in Perseus have inner density profiles shallower than r^{-2}.

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Ne II Fine-Structure Line Emission from the Outflows of Young Stellar Objects

Hsien Shang[1], Alfred E. Glassgold[2], Wei-Chieh Lin[1,3] and Chun-Fan J. Liu[1,3]

[1] Institute of Astronomy and Astrophysics (ASIAA), and Theoretical Institute for Advanced Research in Astrophysics (TIARA), Academia Sinica, P. O. Box 23-131, Taipei 10641, Taiwan
[2] Astronomy Department, University of California, Berkeley, CA 94720-3411, USA
[3] Graduate Institute of Astronomy and Astrophysics, National Taiwan University, No. 1, Sec. 4, Roosevelt Road, Taipei 10617, Taiwan

E-mail contact: shang *at* asiaa.sinica.edu.tw

The flux and line shape of the fine-structure transitions of Ne II and Ne III at 12.8 and 15.55 μm and of the forbidden transitions of O I λ6300 are calculated for young stellar objects with a range of mass-loss rates and X-ray luminosities using the X-wind model of jets and the associated wide-angle winds. For moderate and high accretion rates, the calculated Ne II line luminosity is comparable to or much larger than produced in X-ray irradiated disk models. All of the line luminosities correlate well with the main parameter in the X-wind model, the mass-loss rate, and also with the assumed X-ray luminosity — and with one another. The line shapes of an approaching jet are broad and have strong blue-shifted peaks near the effective terminal velocity of the jet. They serve as a characteristic and testable aspect of jet production of the neon fine-structure lines and the O I forbidden transitions.

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Molecular Line Profiles from Contracting Dense Cores

Steven W. Stahler[1] and Jeffrey J. Yen[2]

[1] Astronomy Department, U. of California, Berkeley, CA 94720, USA
[2] Physics Department, Stanford University, Stanford, CA 94305, USA

E-mail contact: Sstahler *at* astro.berkeley.edu

We recently proposed that molecular cloud dense cores undergo a prolonged period of quasi-static contraction prior to true collapse. This theory could explain the observation that many starless cores exhibit, through their spectral line profiles, signs of inward motion. We now use our model, together with a publicly available radiative transfer code, to determine the emission from three commonly used species - N2H+, CS, and HCN. A representative dense core of 3 Msun that has been contracting for 1 Myr has line profiles that qualitatively match the observed ones. In particular, optically thick lines have about the right degree of blue-red asymmetry, the empirical hallmark of contraction. The J=2-1 rotational transition of CS only attains the correct type of profile if the species is centrally depleted, as has been suggested by previous studies. These results support the idea that a slow, but accelerating, contraction leads to protostellar collapse. In the future, the kind of analysis presented here can be used to assign ages to individual starless cores.

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Modelling Herschel observations of infrared-dark clouds in the Hi-GAL survey

D. Stamatellos[1], M. Griffin[1], J. Kirk[1], S. Molinari[2], B. Sibthorpe[3], D. Ward-Thompson[1], A. Whitworth[1] and L. Wilcock[1]

[1] Cardiff University
[2] INAF-IFSI, Roma, Italy
[3] UK Astronomy Technology Centre, Royal Observatory, Edinburgh

E-mail contact: D.Stamatellos *at* astro.cf.ac.uk

We demonstrate the use of the 3D Monte Carlo radiative transfer code PHAETHON to model infrared-dark clouds (IRDCs) that are externally illuminated by the interstellar radiation field (ISRF). These clouds are believed to be the earliest observed phase of high-mass star formation, and may be the high-mass equivalent of lower-mass prestellar cores. We model three different cases as examples of the use of the code, in which we vary the mass, density, radius, morphology and internal velocity field of the IRDC. We show the predicted output of the models at different wavelengths chosen to match the observing wavebands of Herschel and Spitzer. For the wavebands of the long-wavelength SPIRE photometer on Herschel, we also pass the model output through the SPIRE simulator to generate output images that are as close as possible to the ones that would be seen using SPIRE. We then analyse the images as if they were real observations, and compare the results of this analysis with the results of the radiative transfer models. We find that detailed radiative transfer modelling is necessary to accurately determine the physical parameters of IRDCs (e.g. dust temperature, density profile). This method is applied to study G29.55+00.18, an IRDC observed by the Herschel Infrared Galactic Plane survey (Hi-GAL), and in the future it will be used to model a larger sample of IRDCs from the same survey.

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The enigmatic young brown dwarf binary FU Tau: accretion and activity

Beate Stelzer[1], Aleks Scholz[2], Costanza Argiroffi[1,3] and Giuseppina Micela[1]

[1] INAF - Osservatorio Astronomico di Palermo, Italy
[2] School of Cosmic Physics, Dublin Institute for Advanced Studies, Ireland
[3] Dipartimento di Scienze Fisiche ed Astronomiche, Sezione di Astronomia, Università di Palermo, Italy

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

FU Tau belongs to a rare class of young, wide brown dwarf binaries. We have resolved the system in a *Chandra* X-ray observation and detected only the primary, FU Tau A. Hard X-ray emission, presumably from a corona, is present but, unexpectedly, we detect also a strong and unusually soft component from FU Tau A. Its X-ray properties, so far unique among brown dwarfs, are very similar to those of the T Tauri star TW Hya. The analogy with TW Hya suggests that the dominating soft X-ray component can be explained by emission from accretion shocks. However, the typical free-fall velocities of a brown dwarf are too low for an interpretation of the observed X-ray temperature as post-shock region. On the other hand, velocities in excess of the free-fall speed are derived from archival optical spectroscopy, and independent pieces of evidence for strong accretion in FU Tau A are found in optical photometry. The high X-ray luminosity of FU Tau A coincides with a high bolometric luminosity confirming an unexplained trend among young brown dwarfs. In fact, FU Tau A is overluminous with respect to evolutionary models while FU Tau B is on the 1 Myr isochrone suggesting non-contemporaneous formation of the two components in the binary. The extreme youth of FU Tau A could be responsible for its peculiar X-ray properties, in terms of atypical magnetic activity or accretion. Alternatively, rotation and magnetic field effects may reduce the efficiency of convection which in turn affects the effective temperature and radius of FU Tau A shifting its position in the HR diagram. Although there is no direct proof of this latter scenario so far we present arguments for its plausibility.

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http://www.astropa.unipa.it/Library/preprint.html

Disks in the Arches cluster – survival in a starburst environment

Andrea Stolte[1], Mark Morris[2], Andrea M. Ghez[2,3], Tuan Do[2], Jessica R. Lu[4], Shelley A. Wright[5], Elizabeth Mills[2], Christopher Ballard[6] and Keith Matthews[4]

[1] I. Physikalisches Institut, University of Cologne, Germany
[2] Division of Astronomy and Astrophysics, UCLA, Los Angeles, CA 90095-1547, USA
[3] Institute of Geophysics and Planetary Physics, UCLA, Los Angeles, CA 90095, USA
[4] Caltech Optical Observatories, California Institute of Technology, MS 320-47, Pasadena, CA 91225, USA
[5] UC Berkeley, Astronomy Department, 601 Campbell Hall, Berkeley, CA 94720-3411, USA

[6] 14090 Robler Road, Sherman Oaks, CA 91423, USA

E-mail contact: astolte *at* ph1.uni-koeln.de

Deep Keck/NIRC2 $HK'L'$ observations of the Arches cluster near the Galactic center reveal a significant population of near-infrared excess sources. We combine the L'-band excess observations with K'-band proper motions, which allow us to confirm cluster membership of excess sources in a starburst cluster for the first time. The robust removal of field contamination provides a reliable disk fraction down to our completeness limit of $H = 19$ mag, or $\sim 5\,M_\odot$ at the distance of the Arches. Of the 24 identified sources with $K' - L' > 2.0$ mag, 21 have reliable proper motion measurements, all of which are proper motion members of the Arches cluster. VLT/SINFONI K'-band spectroscopy of three excess sources reveals strong CO bandhead emission, which we interpret as the signature of dense circumstellar disks. The detection of strong disk emission from the Arches stars is surprising in view of the high mass of the B-type main sequence host stars of the disks and the intense starburst environment. We find a disk fraction of $6 \pm 2\%$ among B-type stars in the Arches cluster. A radial increase in the disk fraction from 3 to 10% suggests rapid disk destruction in the immediate vicinity of numerous O-type stars in the cluster core. A comparison between the Arches and other high- and low-mass star-forming regions provides strong indication that disk depletion is significantly more rapid in compact starburst clusters than in moderate star-forming environments.

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Do Lognormal Column-Density Distributions in Molecular Clouds Imply Supersonic Turbulence?

K. Tassis[1], D. A. Christie[2], A. Urban[1], J. L. Pineda[1], T. Ch. Mouschovias[2], H. W. Yorke[1] and H. Martel[3,4]

[1] JPL/Caltech
[2] University of Illinois at Urbana-Champaign
[3] U. Laval, Quebec
[4] CRAQ

E-mail contact: ktassis *at* jpl.nasa.gov

Recent observations of column densities in molecular clouds find lognormal distributions with power-law high-density tails. These results are often interpreted as indications that supersonic turbulence dominates the dynamics of the observed clouds. We calculate and present the column-density distributions of three clouds, modeled with very different techniques, none of which is dominated by supersonic turbulence. The first star-forming cloud is simulated using smoothed particle hydrodynamics (SPH); in this case gravity, opposed only by thermal-pressure forces, drives the evolution. The second cloud is magnetically subcritical with subsonic turbulence, simulated using nonideal MHD; in this case the evolution is due to gravitationally-driven ambipolar diffusion. The third cloud is isothermal, self gravitating, and has a smooth density distribution analytically approximated with a uniform inner region and an r^{-2} profile at larger radii. We show that in all three cases the column-density distributions are lognormal. Power-law tails develop only at late times (or, in the case of the smooth analytic profile, for strongly centrally concentrated configurations), when gravity dominates all opposing forces. It therefore follows that lognormal column-density distributions are generic features of diverse model clouds, and should not be interpreted as being a consequence of supersonic turbulence.

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The near-infrared reflected spectrum of source I in Orion-KL

Leonardo Testi[1,2], Jonathan Tan[3] and Francesco Palla[2]

[1] European Southern Observatory, Garching, Germany
[2] INAF-Osservatorio Astrofisico di Arcetri, Florence, Italy [3] University of Florida, Gainesville, USA

E-mail contact: ltesti *at* eso.org

Source I in the Orion-KL nebula is believed to be the nearest example of a massive star still in the main accretion phase. It is thus one of the best cases to study the properties of massive protostars to constrain high-mass star formation theories. Near-infrared radiation from source I escapes through the cavity opened by the OMC1 outflow and is scattered by dust towards our line of sight. The reflected spectrum offers a unique possibility to observe the emission from the innermost regions of the system and to probe the nature of source I and its immediate surroundings. We have obtained moderately high spectral resolution ($\lambda/\Delta\lambda \sim 9000$) observations of the near infrared diffuse emission in several locations around source I/Orion-KL. We observe a widespread rich absorption line spectrum that we compare with cool stellar photospheres and protostellar accretion disk models. The spectrum is broadly similar to strongly veiled, cool, low-gravity stellar photospheres in the range $T_{\rm eff} \sim 3500 - 4500$ K, luminosity class I-III. An exact match explaining all features has not been found and a plausible explanation is that a range of different temperatures contribute to the observed absorption spectrum. The 1D velocity dispersions implied by the absorption spectra, $\sigma \sim 30\,{\rm km\,s^{-1}}$, can be explained by the emission from a disk around a massive, $m_* \sim 10 M_\odot$, protostar that is accreting at a high rate, $\dot{m}_* \sim 3\times10^{-3}$ $M_\odot{\rm yr}^{-1}$. Our observations suggest that the near-infrared reflection spectrum observed in the Orion-KL region is produced close to source I and scattered to our line of sight in the OMC1 outflow cavity. The spectrum allows us to exclude that source I is a very large, massive protostar rotating at breakup speed. We suggest that the absorption spectrum is produced in a disk surrounding a $\sim$10 $M_\odot$ protostar, accreting from its disk at a high rate of $\sim$ few $\times10^{-3}$ $M_\odot$/yr).

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Accretion of Jupiter's Atmosphere from a Supernova-Contaminated Molecular Cloud

Henry Throop[1] and John Bally[2]

[1] Southwest Research Institute, 1050 Walnut St, Boulder, CO 80302, USA
[2] CASA, University of Colorado, Boulder, CO 80309-0391, USA

E-mail contact: throop *at* boulder.swri.edu

If Jupiter and the Sun both formed directly from the same well-mixed proto-solar nebula, then their atmospheric compositions should be similar. However, direct sampling of Jupiter's troposphere indicates that it is enriched in elements such as C, N, S, Ar, Kr, and Xe by 2–6× relative to the Sun. Most existing models to explain this enrichment require an extremely cold proto-solar nebula which allows these heavy elements to condense, and cannot easily explain the observed variations between these species. We find that Jupiter's atmospheric composition may be explained if the Solar System's disk heterogeneously accretes small amounts of enriched material such as supernova ejecta from the interstellar medium during Jupiter's formation. Our results are similar to, but substantially larger than, isotopic anomalies in terrestrial material that indicate the Solar System formed from multiple distinct reservoirs of material simultaneously with one or more nearby supernovas. Such temporal and spatial heterogeneities could have been common at the time of the Solar System's formation, rather than the cloud having a purely well-mixed 'solar nebula' composition.

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http://www.boulder.swri.edu/ throop/files/tb10.pdf

The Edgeworth-Kuiper debris disk

Christian Vitense[1], Alexander V. Krivov[1] and Torsten Lhne[1]

[1] Astrophysikalisches Institut, Friedrich-Schiller-Universitaet Jena, Schillergaesschen 2-3, 07745 Jena, Germany

E-mail contact: vitense *at* astro.uni-jena.de

The Edgeworth-Kuiper belt (EKB) and its presumed dusty debris is a natural reference for extrsolar debris disks. We re-analyze the current database of known transneptunian objects (TNOs) and employ a new algorithm to eliminate the inclination and the distance selection effects in the known TNO populations to derive expected parameters of the "true" EKB. Its estimated mass is $M_{EKB} = 0.12 M_{Earth}$, which is by a factor of $\sim$ 15 larger than the mass of the EKB objects detected so far. About a half of the total EKB mass is in classical and resonant objects and another half is in scattered ones. Treating the debiased populations of EKB objects as dust parent bodies, we then "generate"

their dust disk with our collisional code. Apart from accurate handling of destructive and cratering collisions and direct radiation pressure, we include the Poynting-Robertson (P-R) drag. The latter is known to be unimportant for debris disks around other stars detected so far, but cannot be ignored for the EKB dust disk because of its much lower optical depth. We find the radial profile of the normal optical depth to peak at the inner edge of the classical belt, ≈ 40 AU. Outside the classical EKB, it approximately follows $\tau \propto r^{-2}$ which is roughly intermediate between the slope predicted analytically for collision-dominated ($r^{-1.5}$) and transport-dominated ($r^{-2.5}$) disks. The size distribution of dust is less affected by the P-R effect. The cross section-dominating grain size still lies just above the blowout size ($\sim 1 \ldots 2\mu m$), as it would if the P-R effect was ignored. However, if the EKB were by one order of magnitude less massive, its dust disk would have distinctly different properties. The optical depth profile would fall off as $\tau \propto r^{-3}$, and the cross section-dominating grain size would shift from $\sim 1 \ldots 2\mu m$ to $\sim 100\mu m$. These properties are seen if dust is assumed to be generated only by known TNOs without applying the debiasing algorithm. An upper limit of the in-plane optical depth of the EKB dust set by our model is $\tau = 2 \times 10^{-5}$ outside 30 AU. If the solar system were observed from outside, the thermal emission flux from the EKB dust would be about two orders of magnitude lower than for solar-type stars with the brightest known infrared excesses observed from the same distance. Herschel and other new-generation facilities should reveal extrasolar debris disks nearly as tenuous as the EKB disk. We estimate that the Herschel/PACS instrument should be able to detect disks at a $\sim 1 \ldots 2M_{EKB}$ level.

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High-velocity feature of the class I methanol maser in G309.38-0.13

M.A. Voronkov[1,2], J. L. Caswell[1], T. R. Britton[3,1], J. A. Green[1], A. M. Sobolev[4] and S. P. Ellingsen[5]

[1] Australia Telescope National Facility, CSIRO Astronomy and Space Science, PO Box 76, Epping, NSW, 1710, Australia
[2] Astro Space Centre, Profsouznaya st. 84/32, 117997 Moscow, Russia
[3] Macquarie University, Department of Physics and Engineering, NSW 2109, Australia
[4] Ural State University, Lenin ave. 51, 620083 Ekaterinburg, Russia
[5] School of Mathematics and Physics, University of Tasmania, GPO Box 252-37, Hobart, Tasmania 7000, Australia

E-mail contact: Maxim.Voronkov *at* csiro.au

The Australia Telescope Compact Array (ATCA) has been used to map class I methanol masers at 36 and 44 GHz in G309.38−0.13. Maser spots are found at nine locations in an area of 50 arcsec×30 arcsec, with both transitions reliably detected at only two locations. The brightest spot is associated with shocked gas traced by 4.5-μm emission. The data allowed us to make a serendipitous discovery of a high-velocity 36-GHz spectral feature, which is blue-shifted by about 30 km s^{-1} from the peak velocity at this frequency, but spatially located close to (within a few arcseconds of) the brightest maser spot. We interpret this as indicating an outflow parallel to the line of sight. Such a high velocity spread of maser features, which has not been previously reported in the class I methanol masers associated with a single molecular cloud, suggests that the outflow most likely interacts with a moving parcel of gas.

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Probing the evolving massive star population in Orion with kinematic and radioactive tracers

Rasmus Voss[1], Roland Diehl[1], Jorick S. Vink[2] and Dieter H. Hartmann[3]

[1] Max Planck Institute for extraterrestrial physics
[2] Armagh Observatory
[3] Clemson University

E-mail contact: rvoss *at* mpe.mpg.de

Orion is the nearest star-forming region to host a significant number of young and massive stars. The energy injected by these OB stars is thought to have created the Eridanus superbubble. Because of its proximity, Orion is a prime target for a detailed investigation of the interaction between massive stars and their environment. We study the massive star population of Orion and its feedback in terms of energy and mass, in order to compare the current knowledge of massive stars with kinematic and radioactive tracers in the surrounding interstellar medium (ISM). We assembled a census of the most massive stars in Orion, then used stellar isochrones to estimate their masses and ages, and used these results to establish the stellar content of Orion's individual OB associations. From this, our new population synthesis code was utilized to derive the history of the emission of UV radiation and kinetic energy of the material ejected by the massive stars and also to follow the ejection of the long-lived radioactive isotopes ^{26}Al and ^{60}Fe. To estimate the precision of our method, we compare and contrast three distinct representations of the massive stars. We compared the expected outputs with observations of ^{26}Al gamma-ray signal and the extent of the Eridanus cavity. We find an integrated kinetic energy emitted by the massive stars of $1.8^{+1.5}_{-0.4} \times 10^{52}$ erg. This number is consistent with the energy thought to be required to create the Eridanus superbubble. We also find good agreement between our model and the observed ^{26}Al signal, estimating a mass of $5.8^{+2.7}_{-2.5} \times 10^{-4}$ $M_{\odot}$ of ^{26}Al in the Orion region. Our population synthesis approach is demonstrated for the Orion region to reproduce three different kinds of observable outputs from massive stars in a consistent manner: Kinetic energy as manifested in ISM excavation, and ionization as manifested in free-free emission, and nucleosynthesis ejecta as manifested in radioactivity gammarays. The good match between our model and the observables does not argue for considerable modifications of mass loss. If clumping effects turn out to be strong, other processes would need to be identified to compensate for their impact on massive-star outputs. Our population synthesis analysis jointly treats kinematic output and the return of radioactive isotopes, which proves a powerful extension of the methodology that constrains feedback from massive stars.

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Triggered Star Formation and Dust around Mid-Infrared-Identified Bubbles

C. Watson[1], U. Hanspal[2] and A. Mengistu[1]

[1] Manchester College, 604 E College Ave, North Manchester, IN 46962, USA
[2] Ross University School of Medicine, 630 US Highway 1, North Brunswick, NJ 08902, USA

E-mail contact: cwatson *at* manchester.edu

We use Two Micron All Sky Survey, GLIMPSE, and MIPSGAL survey data to analyze the young stellar object (YSO) and warm dust distribution around several mid-infrared-identified bubbles. We identify YSOs using J-band to 8 um photometry and correlate their distribution relative to the PDR (as traced by diffuse 8 um emission) which we assume to be associated with and surround a HII region. We find that only 20% of the sample HII regions appear to have a significant number of YSOs associated with their PDRs, implying that triggered star formation mechanisms acting on the boundary of the expanding HII region do not dominate in this sample. We also measure the temperature of dust inside 20 HII regions using 24 um and 70 um MIPSGAL images. In eight circularly symmetric sources we analyze the temperature distribution and find shallower temperature gradients than is predicted by an analytic model. Possible explanations of this shallow temperature gradient are a radially dependent grain-size distribution and/or non-equilibrium radiative processes.

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The Properties of X-ray Luminous Young Stellar Objects in the NGC 1333 and Serpens Embedded Clusters

E. Winston[1], S.T. Megeath[2], S. Wolk[3], B. Spitzbart[3], R. Gutermuth[4,5], L.E. Allen[6], J. Hernandez[7], K. Covey[3], J. Muzerolle[8], J.L. Hora[3], P.C. Myers[3] and G.G. Fazio[3]

[1] University of Exeter, Stocker Road, Exeter, EX4 4QL, UK
[2] Dept. Physics & Astronomy, Univeristy of Toledo, OH 43606, USA
[3] Harvard Smithsonian Center for Astrophysics, MA 02138, USA
[4] Five Colleges Astronomy Dept., MA 01027, USA
[5] Dept. Astronomy, UNiversity of Massachusetts, MA 01003, USA
[6] NOAO, Tucson, USA
[7] Dept. of Astronomy, Univeristy of Michigan, MI 48109, USA
[8] STScI, Baltimore, MD, USA

E-mail contact: ewinston *at* astro.ex.ac.uk

We present new *Chandra* X-ray data of the NGC 1333 embedded cluster and combine these data with existing *Chandra* data, *Sptizer* photometry and ground based spectroscopy of both the NGC 1333 and Serpens Cloud Core clusters to perform a detailed study of the X-ray properties of two of the nearest embedded clusters to the Sun.

We first present new, deeper observations of NGC 1333 with *Chandra ACIS-I* and combine these with existing *Spitzer* observations of the region. In NGC 1333, a total of 95 cluster members are detected in X-rays, of which 54 were previously identified in the *Spitzer* data. Of the *Spitzer* identified sources, we detected 23% of the Class I protostars, 53% of the Flat Spectrum sources, 52% of the Class II, and 50% of the Transition Disk young stellar objects (YSO). Forty-one Class III members of the cluster are identified, bringing the total identified YSO population to 178.
The X-ray Luminosity Functions (XLFs) of the NGC 1333 and Serpens clusters are compared to each other and the Orion Nebula Cluster. Based on a comparison of the XLFs of the Serpens and NGC 1333 clusters to the previously published ONC, we obtain a new distance for the Serpens cluster of 360^{+22}_{-13} pc.
Using our previously published spectral types, effective temperatures and bolometric luminosities, we analyze the dependence of the X-ray emission on the measured stellar properties. The X-ray luminosity was found to depend on the calculated bolometric luminosity as in previous studies of other clusters. We examine the dependence of L_X on stellar surface area and effective temperature, and find that L_X depends primarily on the stellar surface area. In the NGC 1333 cluster, the Class III sources have a somewhat higher X-ray luminosity for a given surface area. We also find evidence in NGC 1333 for a jump in the X-ray luminosity between spectral types of M0 and K7, we speculate that this may result from the presence of radiative zones in the K-stars.
The gas column density vs. extinction in the NGC 1333 parental molecular cloud was examined using the Hydrogen column density determined from the X-ray absorption to the embedded stars and the K-band extinction measured to those stars. In NGC 1333, we find $N_H = 0.89 \pm 0.13 \times 10^{22}\ A_K$, this is lower than expected of the standard ISM but similar to that found previously in the Serpens Cloud Core.

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The fragmentation of expanding shells II: Thickness matters

Richard Wunsch[1], James E. Dale[1], Jan Palous[1] and Anthony P. Whitworth[2]

[1] Astronomical Institute, Academy of Sciences of the Czech Republic, Bocni II 1401, 141 31 Prague, Czech Republic
[2] School of Physics and Astronomy, Cardiff University, Queens Buildings, The Parade, Cardiff, CF24 3AA

E-mail contact: richard *at* wunsch.cz

We study analytically the development of gravitational instability in an expanding shell having finite thickness. We consider three models for the radial density profile of the shell: (i) an analytic uniform-density model, (ii) a semi-analytic model obtained by numerical solution of the hydrostatic equilibrium equation, and (iii) a 3D hydrodynamic simulation. We show that all three profiles are in close agreement, and this allows us to use the first model to describe fragments in the radial direction of the shell. We then use non-linear equations describing the time-evolution of a uniform oblate spheroid to derive the growth rates of shell fragments having different sizes. This yields a dispersion relation which depends on the shell thickness, and hence on the pressure confining the shell. We compare this dispersion relation with the dispersion relation obtained using the standard thin-shell analysis, and show that, if the confining pressure is low, only large fragments are unstable. On the other hand, if the confining pressure is high, fragments smaller than predicted by the thin-shell analysis become unstable. Finally, we compare the new dispersion relation with the results of 3D hydrodynamic simulations, and show that the two are in good agreement.

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Probing Star Formation with High Resolution Spectroscopy: Multiplicity, Disk Braking, and Accretion in Chamaeleon I and Taurus-Auriga

Duy Cuong Nguyen

Department of Astronomy and Astrophysics, University of Toronto, Canada

50 St George Street, Toronto, Ontario, M5S 3H4, Canada

Address as of 08 Oct 2009: University of Florida, Department of Astronomy, 211 Bryant Space Science Center, Gainesville, Florida, USA

Electronic mail: nguyen *at* astro.utoronto.ca

Ph.D dissertation directed by: Ray Jayawardhana and Marten van Kerkwijk

Ph.D degree awarded: March 2010

In this thesis, we focus on obtaining and interpreting observational information on (i) the role of multiplicity on the properties of young stars; (ii) the early evolutionary influence of circumstellar disks; and (iii) the nature of accretion in young systems. To facilitate this research, we conducted an extensive multi-epoch high-resolution spectroscopic survey at optical wavelengths (3 200–10 000 Å) of $\sim$200 T Tauri stars in the $\sim$2 Myr old Chamaeleon I, and Taurus-Auriga star-forming regions with the Magellan Inamori Kyocera Echelle (MIKE) spectrograph on the Magellan Clay 6.5 m telescope.

From the spectroscopic data, we identify eight close binaries and four close triples, of which three and two, respectively, are new discoveries. We find that the multiplicity fraction for Cha I and Tau-Aur are similar to each other, and to the results of field star surveys. The frequency of systems with close companions in our sample is not seen to depend on primary mass or accretion.

We probed for evidence of disk braking. We did not see a statistically significant difference between the distribution of rotational velocities with the presence of an inner disk. Also, our findings show that F–K stars in our sample have larger rotational velocities and specific angular momentum than M stars.

We also analyzed accretion variability in our sample using the Hα 10% width and the CaII-λ8662 line flux as accretion diagnostics. We find that the maximum extent of accretion variability in our sample was reached on timescale of a few days, indicating that rotation could significantly contribute to the variability.

Millimeter characteristics of Galactic and extragalactic starbursts

Gina Santangelo

University of Bologna, Italy; ESO Garching, Germany; INAF–IRA Bologna, Italy; and INAF–Arcetri Florence, Italy

Istituto di Radioastronomia, via P. Gobetti 101, 40129 Bologna, Italy

Electronic mail: santangelo@ira.inaf.it

Ph.D dissertation directed by: Loretta Gregorini, Leonardo Testi and C. Malcolm Walmsley

Ph.D degree awarded: April 2010

The goal of the thesis was to compare Galactic and extragalactic star-forming environments, to understand whether we can derive scaling relations for the extragalactic star formation from our understanding of the Galactic star formation; and to analyze the effect of the angular resolution of the observations and the molecular tracer used in extragalactic studies. With this in mind we have started a program aimed at comparing properties of mini-starburst regions in our Galaxy and starbursts in nearby galaxies at similar linear resolutions.

For the Galactic observations we chose luminous high-mass star-forming regions to analyze the properties of the molecular gas in star-forming complexes of 20-50 pc size and in the single clumps of 1-3 pc size within them; and to compare with the properties of extragalactic star formation. In order to select our extragalactic targets, we obtained time with single-dish telescopes to detect molecular gas in nearby dwarf starburst galaxies for further interferometric follow-up at higher angular resolution and we combined with data from molecular surveys in the literature. In this way, we selected two starburst regions in our Galaxy (G19.61-0.23 and W51A) for single-dish observations and two nearby starbursts (Henize 2-10 and NGC 253) for millimeter interferometric observations.

We revealed a population of molecular clumps in the high-mass star-forming region G19.61-0.23 through single-dish observations of the molecular gas and the sub-mm continuum. The identified clumps range from gravitationally unstable to unbound and these results seem to be independent of the presence or otherwise of star-formation indicators in the clump. We find evidence that the gas traced by the ^{13}CO is more virialized than the gas traced by the C^{17}O, which in turn seems to indicate that the clumps are globally in equilibrium but locally unstable. The analysis of the APEX continuum emission towards G19.61-0.23 shows that most continuum sources have counterparts in the mid-IR emission at the peaks of the sub-millimeter continuum emission. We find that the majority of the continuum sources are associated with star-forming regions of luminosity 1–5 $10^4\,L_\odot$ and gas masses 400–6000 $M_\odot$.

We have presented new single-dish and interferometric observations of the molecular gas and millimeter continuum of the starburst region in the dwarf galaxy Henize 2-10. The relatively strong detections of high density molecular tracers associated with the young SSCs confirm that this galaxy is undergoing vigorous star formation and is an ideal laboratory to study extragalactic starbursts. In this context, our CO(2-1) and 1.3mm continuum SMA observations in Henize 2-10 reveal a rich population of molecular clouds with estimated masses and densities in the upper range of those measured in our Galaxy. The molecular gas accounts for approximately half of the total mass in the inner region of the galaxy, while the young stellar clusters account for the remaining mass.

We compared our results for the Galactic luminous high-mass star-forming region G19.61-0.23 with those for Henize 2-10. We find that the main cloud in G19.61-0.23 has physical properties comparable with the typical Galactic GMCs and with the GMCs in M31 and M33. However this cloud shows less extreme properties than the clouds identified in Henize 2-10, in particular smaller surface densities and masses. Our observations are consistent with the hypothesis that the clusters in Henize 2-10 form from small clumps at much higher surface densities and pressure than the rest of the GMCs and than the typical Galactic clumps.

In conclusion, our study highlights the crucial role of the pressure in the star-formation process. We demonstrated how the analysis and comparison between Galactic and extragalactic star formation can bring important improvements in our understanding of the extragalactic star formation. We also confirmed that the linear resolution of the observations is a major constrain in such studies.

ftp://www.ira.inaf.it/pub/outgoing/santangelo/tesi.pdf

Postdoctoral research position in star formation - Department of Astronomy, University of Vienna, Austria

The Department of Astronomy at the University of Vienna invites applications for a postdoctoral position in the field of star formation, specifically in topics related to protoplanetary disks. The successful candidate will be free to develop his/her own observational, numerical or theoretical research programs but is also invited to collaborate within existing projects in the new research group on star formation and young stellar environments led by Professor Manuel Güdel. Expertise in radiative transport, disk modeling, disk chemistry, or observational infrared/millimeter disk diagnostics (e.g. using major observatories such as Herschel, Spitzer, the VLT and, in the future, ALMA or JWST) is especially welcome. Initial appointment is for 4 years, with a possibility of extension. Participation in teaching activities at a modest level is expected.

The Department is undergoing a major new development with the establishment of three new chairs in astrophysics. It offers a stimulating research environment with a large staff working in various areas of astrophysics, and provides access to an in-house PC cluster and to a new supercomputer. Collaborations in stellar and planetary research are being established with other institutes in Austria and abroad. As a member state of ESA and ESO, Austria has access to their first-class facilities. The department is involved in, or in planning participation in major observatories of ESA/JAXA/NASA (Spica, Plato, Euclid, JWST) and ESO (VLT instrumentation, E-ELT).

Review of applications starts July 20, 2010 and will continue until the position is filled. Applications should be sent electronically (to manuel.guedel *at* univie.ac.at) and should include CV, publication list and a brief description of past research and future plans. Three letters of reference should be sent (directly by the referees).

Postdoctoral Fellow(s) - Exo-Planets, Brown Dwarfs and Young Stars University of Toronto

Applications are invited for one or more postdoctoral research position(s) at the University of Toronto to start in fall 2010 or later. The successful candidate(s) will work with Prof. Ray Jayawardhana and his collaborators on observational and analytical studies of extra-solar planets, brown dwarfs and young stars, and will be encouraged to pursue independent research on related topics. On-going projects include photometric and spectroscopic studies of exo-planets (e.g., approved CFHT Large Program for ground-based secondary eclipse detection), high-contrast imaging searches for companions around young stars, the SONYC (Substellar Objects in Nearby Young Clusters) ultra-deep survey, and investigations of brown dwarf variability, using data from VLT, Subaru, Gemini, Keck, CFHT and other major observatories. The position is for two years, with extension to a third year possible, and comes with a competitive salary and funds for research expenses. Applicants should send a curriculum vitae, a description of research interests and plans and a list of publications, and should arrange for three letters of recommendation to be sent directly to rayjay *at* astro.utoronto.ca Applications received before 2010 August 15 will receive full consideration. Early expressions of interest and inquiries are welcome.

Post-doc in High-Mass Star Formation in Bordeaux

In the context of PROBES, a research program funded by the french National Research Agency (ANR), we open a third post-doctoral position in the Laboratoire d'Astrophysique de Bordeaux , after two positions appointed in AIM/Saclay and LAM/Marseille in 2009 (see http://www.obs.u-bordeaux1.fr/radio/SBontemps/probes/).

The Laboratoire d'Astrophysique de Bordeaux (LAB) carries out observational and theoretical research in various fields of Astrophysics including the interstellar medium, planet and star formation, and stellar populations in the Galaxy. The LAB has also been involved in the technical development and commissioning of several major subsystems for the Herschel satellite and ground-based millimeter interferometer ALMA, along with preparation of the astrometric space mission Gaia.

The position is offered in the star formation group whose activities cover observational studies of complex molecules in dense interstellar medium, surveys for the early phases of star formation, detailed investigations of high-mass protostars, and large-scale studies of star and molecular cloud formation in Galaxies of the local group. The proposed research project will focus on observations of high-mass proto-stellar objects as part of the large programs with Herschel (spectroscopy with HIFI and PACS, and photometric survey with SPIRE and PACS), with APEX (participation to ATLASGAL), and in the goal to prepare participation to ALMA project on that scientific topic. A special emphasis can also be given to the Cygnus X project which aims at connecting low-mass to high-mass star formation in the richest intermediate distance giant molecular cloud, Cygnus X. This program is dedicated to protostars of all masses based on Herschel (key program HOBYS), Spitzer, and IRAM 30m and PdBI extensive studies.

The position is granted for a period of two years starting not later than end of 2010. Applicants must have a PhD and a good background in star formation or molecular cloud/interstellar medium observational studies or in comparison between simulations and observations in these fields. Experience in millimeter single-dish and interferometer observations, or with Herschel, or in the use of state-of-the-art (M)HD simulations will be an asset.

Applications should include a CV, a list of publications, and a statement of research interests. The applicant should also arrange for two letters of reference to be sent independently. Applications and inquiries should be directed to Sylvain Bontemps by August 15, 2010.

Dr. Sylvain Bontemps
Laboratoire d'Astrophysique de Bordeaux/OASU
2, rue de l'Observatoire, BP89, F-33271 Floirac Cedex
Tel: +33 (0)-557776168 / +33 (0)169085847
bontemps *at* obs.u-bordeaux1.fr

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), *Abstracts of recently accepted major reviews* (not standard conference contributions), *Dissertation Abstracts* (presenting abstracts of new Ph.D dissertations), *Meetings* (announcing meetings broadly of interest to the star and planet formation and early solar system community), *New Jobs* (advertising jobs specifically aimed towards persons within the areas of the Newsletter), and *Short Announcements* (where you can inform or request information from the community).

Latex macros for submitting abstracts and dissertation abstracts (by e-mail to reipurth@ifa.hawaii.edu) are appended to each issue of the newsletter. You can also submit via the Newsletter web interface at http://www2.ifa.hawaii.edu/star-formation/index.cfm
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The Star Formation Newsletter is available on the World Wide Web at http://www.ifa.hawaii.edu/users/reipurth/newsletter.htm.

IAU Symposium 280

The Molecular Universe

May 30 - June 3, 2011 Toledo, Spain

http://cab.inta-csic.es/molecular_universe

This meeting is the 6'th in a series of IAU Symposia on Astrochemistry, following the 1985 Goa, 1991 Brazil, 1996 Leiden, 1999 Korea and 2005 Asilomar symposia. The main goal of the meeting is to bring together observers, theoreticians, and experimentalists from different communities to discuss the many different aspects of our rapidly developing field.

The Scientific Organizing Committee is formed by the IAU Working Group on Astrochemistry of IAU Commission 34/Division VI (Interstellar Medium), whereas the Local Organizing Committee is led by the Department of Astrophysics of the CAB (CSIC-INTA) and the Observatorio Astronomico Nacional (OAN) in Madrid.

Topics include:

- star-forming regions from cold pre-stellar clouds to hot cores
- protoplanetary disks
- exoplanets and their atmospheres
- solar system objects from comets to Kuiper Belt
- envelopes around evolved stars
- extragalactic astrochemistry out to high redshift
- diffuse and dense interstellar clouds
- laboratory astrochemistry: gas and solid state
- theoretical studies of basic molecular data
- new tools for the analysis of spectral data
- role of heterogeneity and dynamics in chemical modeling
- "hot" results from Herschel and promise of ALMA

The meeting will be held on the beautifully renovated campus of the Universidad de Castilla-La Mancha in Toledo, close to the old city walls (http://www.toledo-turismo.com/turismo/contenido/vive-toledo.aspx). Toledo is about 1 hr travel from Madrid and easily can be reached by train or car.

We look forward to see many of you in Toledo in 2011. Don't forget to bookmark the Website and note the dates in your agenda. The next announcement containing the list of invited speakers will be sent in September 2010.

On behalf of the SOC:

Ewine van Dishoeck (chair)
Eric Herbst (vice-chair)

On behalf of the LOC:

José Cernicharo (chair)
Rafael Bachiller (vice-chair)

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.