THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar evolution and molecular clouds

No. 211 — 18 Jul 2010 Editor: Bo Reipurth (reipurth@ifa.hawaii.edu)

Abstracts of recently accepted papers

The Green Bank Telescope Galactic H II Region Discovery Survey

T. M. Bania[1], L. D. Anderson[1], 2, Dana S. Balser[3] and R. T. Rood[4]

[1] Astronomy Department, 725 Commonwealth Ave., Boston University, Boston MA 02215, USA
[2] Current Address: Laboratoire d'Astrophysique de Marseille (UMR 6110 CNRS & Université de Provence), 38 rue F. Joliot-Curie, 13388 Marseille Cedex 13, France
[3] National Radio Astronomy Observatory, 520 Edgemont Road, Charlottesville VA, 22903-2475, USA
[4] Astronomy Department, University of Virginia, P.O. Box 3818, Charlottesville VA 22903-0818, USA

E-mail contact: bania *at* bu.edu

We discovered a large population of previously unknown Galactic H II regions by using the Green Bank Telescope to detect their hydrogen radio recombination line emission. Since the interstellar medium is optically thin at $3\,cm$ wavelength, we can detect H II regions across the entire Galactic disk. Our targets were selected based on spatially coincident $24\,\mu$m and $21\,cm$ continuum emission. For the Galactic zone $-16\,^\circ \leq \ell \leq 67\,^\circ$ and $|b| \leq 1\,^\circ$ we detected 602 discrete recombination line components from 448 lines of sight, 95% of the sample targets, which more than doubles the number of known H IIregions in this part of the Milky Way. We found 25 new first quadrant nebulae with negative LSR velocities, placing them beyond the Solar orbit. Because we can detect all nebulae inside the Solar orbit that are ionized by O-stars, the Discovery Survey targets, when combined with existing H II region catalogs, give a more accurate census of Galactic H IIregions and their properties. The distribution of H II regions across the Galactic disk shows strong, narrow ($\sim$1 kpc wide) peaks at Galactic radii of 4.3 and 6.0 kpc. The longitude-velocity distribution of H II regions now gives unambiguous evidence for Galactic structure, including the kinematic signatures of the radial peaks in the spatial distribution, a concentration of nebulae at the end of the Galactic Bar, and nebulae located on the kinematic locus of the $3\,kpc$ Arm.

Accepted by ApJLett. (718, L106-L111)

IRS Scan-Mapping of the Wasp-Waist Nebula (IRAS 16253−2429): I. Derivation of Shock Conditions from H_2 Emission and Discovery of 11.3 μm PAH Absorption

M. Barsony[1,2], G.A. Wolf-Chase[3,4], D. Ciardi[5], & J. O'Linger[6]

[1] Department of Physics & Astronomy, San Francisco State University, 1600 Holloway Drive, San Francisco, CA 94132, USA
[2] Space Science Institute, 4750 Walnut Street, Suite 205, Boulder, CO 80301, USA
[3] Astronomy Department, Adler Planetarium, 1300 South Lake Shore Drive, Chicago, IL 60605, USA
[4] Dep't. of Astronomy & Astrophysics, University of Chicago, 5640 S. Ellis Ave., Chicago, IL 60637, USA
[5] NASA Exoplanet Science Institute/Caltech, 770 S. Wilson Ave., MS 100-22, Pasadena, CA 91125, USA
[6] Spitzer Science Center, California Institute of Technology MS314-6, Pasadena, CA 91125, USA

E-mail contact: mbarsony *at* stars.sfsu.edu

The outflow driven by the Class 0 protostar, IRAS 16253−2429, is associated with bipolar cavities visible in scattered mid-infrared light, which we refer to as the Wasp-Waist Nebula. InfraRed Spectometer (IRS) scan mapping with the *Spitzer Space Telescope* of a $\sim 1' \times 2'$ area centered on the protostar was carried out. The outflow is imaged in six pure rotational (0-0 S(2) through 0-0 S(7)) H_2 lines, revealing a distinct, S-shaped morphology in all maps. A source map in the 11.3 μm PAH (polycyclic aromatic hydrocarbon) feature is presented in which the protostellar envelope appears in absorption. This is the first detection of absorption in the 11.3 μm PAH feature. Spatially resolved excitation analysis of positions in the blue- and red-shifted outflow lobes, with extinction-corrections determined from archival *Spitzer* 8 μm imaging, shows remarkably constant temperatures of $\sim$1000 K in the shocked gas. The radiated luminosity in the observed H_2 transitions is found to be $1.94 \pm 0.05 \times 10^{-5}$ $L_\odot$ in the red-shifted lobe and $1.86 \pm 0.04 \times 10^{-5}$ $L_\odot$ in the blue-shifted lobe. These values are comparable to the mechanical luminosity of the flow. By contrast, the mass of hot (T$\sim$1000K) H_2 gas is $7.95 \pm 0.19 \times 10^{-7}$ $M_\odot$ in the red-shifted lobe and $5.78 \pm 0.17 \times 10^{-7}$ $M_\odot$ in the blue-shifted lobe. This is just a tiny fraction, of order 10^{-3}, of the gas in the the cold (30K), swept-up gas mass derived from millimeter CO observations. The H_2 *ortho/para* ratio of 3:1 found at all mapped points in this flow suggests previous passages of shocks through the gas. Comparison of the H_2 data with detailed shock models of Wilgenbus et al. (2000) shows the emitting gas is passing through Jump (J-type) shocks. Pre-shock densities of 10^4 cm^{-3} $\leq n_H \leq$ 10^5 cm^{-3} are inferred for the red-shifted lobe and $n_H \leq 10^3$ cm^{-3} for the blue-shifted lobe. Shock velocities are 5 km s^{-1} $\leq v_s \leq$ 10 km s^{-1} for the red-shifted gas and v_s = 10 km s^{-1} for the blue-shifted gas. Initial transverse (to the shock) magnetic field strengths for the red-shifted lobe are in the range 10μG$-$32μG, and just 3μG for the blue-shifted lobe. A cookbook for using the CUBISM contributed software for IRS spectral mapping data is presented in the Appendix.

Accepted by Ap. J.

http://physics.sfsu.edu/~mbarsony/html/pubs.html

The 2008 outburst in the young stellar system Z CMa: I. Evidence of an enhanced bipolar wind on the AU-scale

M. Benisty[1], F. Malbet[2], C. Dougados[2], A. Natta[1], J-B. Le Bouquin[2], F. Massi[1], M. Bonnefoy[2], J. Bouvier[2], G. Chauvin[2], O. Chesneau[3], P.J.V. Garcia[2,4], K. Grankin[5], A. Isella[6], T. Ratzka[7], E. Tatulli[2], L. Testi[8], G. Weigelt[9], E.T. Whelan[2]

[1] INAF-Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, 50125 Firenze, Italy
[2] Laboratoire d'Astrophysique de Grenoble, 414 rue de la piscine, 38400 St Martin d'Hères, France
[3] Laboratoire A. H. Fizeau, UMR 6525, Parc Valrose, 06108 Nice Cedex 02, France
[4] Universidade do Porto, SIM Unidade FCT 4006, Rua Dr. Roberto Frias, s/n P-4200-465 Porto, Portugal
[5] Crimean Astrophysical Observatory, 98409 Nauchny, Crimea, Ukraine
[6] Caltech, MC 249-17, 1200 East California Blvd, Pasadena, CA 91125, USA
[7] Universitäts-Sternwarte München Scheinerstr. 1. 81679 München, Germany
[8] European Southern Observatory, Karl-Schwarzschild-Strasse 2, 85748 Garching, Germany
[9] Max Planck Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany

E-mail contact: benisty *at* arcetri.astro.it

Accretion is a fundamental process in star formation. Although the time evolution of accretion remains a matter of debate, observations and modelling studies suggest that episodic outbursts of strong accretion may dominate the formation of the central protostar. Observing young stellar objects during these elevated accretion states is crucial to understanding the origin of unsteady accretion.
Z CMa is a pre-main-sequence binary system composed of an embedded Herbig Be star, undergoing photometric outbursts, and a FU Orionis star. This system therefore provides a unique opportunity to study unsteady accretion processes. The Herbig Be component recently underwent its largest optical photometric outburst detected so far. We aim to constrain the origin of this outburst by studying the emission region of the HI Br_γ line, a powerful tracer of accretion/ejection processes on the AU-scale in young stars.
Using the AMBER/VLTI instrument at spectral resolutions of 1500 and 12 000, we performed spatially and spectrally resolved interferometric observations of the hot gas emitting across the Br_γ emission line, during and after the outburst. From the visibilities and differential phases, we derive characteristic sizes for the Br_γ emission and spectro-astrometric measurements across the line, with respect to the continuum.
We find that the line profile, the astrometric signal, and the visibilities are inconsistent with the signature of either a Keplerian disk or infall of matter. They are, instead, evidence of a bipolar wind, maybe partly seen through a disk hole inside the dust sublimation radius. The disappearance of the Br_γ emission line after the outburst suggests that

the outburst is related to a period of strong mass loss rather than a change of the extinction along the line of sight. Apart from the photometric increase of the system, the main consequence of the outburst is to trigger a massive bipolar outflow from the Herbig Be component. Based on these conclusions, we speculate that the origin of the outburst is an event of enhanced mass accretion, similar to those occuring in EX Ors and FU Ors.

Accepted by Astronomy & Astrophysics Letters

arXiv:1007.0682

Hydrides in Young Stellar Objects: Radiation tracers in a protostar-disk-outflow system

Arnold O. Benz[1], Simon Bruderer[1], Ewine F. van Dishoeck[2,3], WISH team[2] and HIFI team[1]

[1] Institute of Astronomy, ETH Zurich, Switzerland
[2] Leiden Observatory, Leiden University, Leiden, The Netherlands
[3] Max Planck Institut für Extraterrestrische Physik, Giessenbachstrasse 1, 85748 Garching, Germany

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

Hydrides of the most abundant heavier elements are fundamental molecules in cosmic chemistry. Some of them trace gas irradiated by UV or X-rays.
We aim at exploring the abundances of major hydrides in W3 IRS5, a prototypical region of high-mass star formation. W3 IRS5 was observed by HIFI on the Herschel Space Observatory with deep integration ($\simeq$ 2500 s) in 8 spectral regions.
The target lines including CH, NH, H_3O^+ and the new molecules SH^+, H_2O^+, and OH^+ are detected. The H_2O^+ and OH^+ $J = 1 - 0$ lines are found mostly in absorption, but appear to have also weak emissions (P-Cyg-like). Emissions need high density and thus originate likely near the protostar. This is corroborated by the absence of line shifts relative to the young stellar object (YSO). In addition, H_2O^+ and OH^+ also show strong absorption components shifted relative to W3 IRS5, which are attributed to foreground clouds.
The molecular column densities derived from observations correlate well with predictions of a model assuming the main emission region in outflow walls, heated and irradiated by protostellar UV radiation.

Accepted by Astronomy and Astrophysics Letters

http://www.exp-astro.phys.ethz.ch/astro1/Users/benz/papers/Hydrides1.pdf

Testing the theory of grain growth and fragmentation by millimeter observations of protoplanetary disks

T. Birnstiel[1], L. Ricci[2], F. Trotta[2,3], C.P. Dullemond[1], A. Natta[3], L. Testi[2,3], C. Dominik[4,5], T. Henning[1], C.W. Ormel[1] and A. Zsom[1]

[1] Max-Planck-Institut für Astronomie, Königstuhl 17, 69117 Heidelberg, Germany
[2] European Southern Observatory, Karl-Schwarzschild-Strasse 2, 85748 Garching, Germany
[3] Osservatorio Astrofisico di Arcetri, INAF, Largo E. Fermi 5, 50125 Firenze, Italy
[4] Astronomical Institute "Anton Pannekoek", University of Amsterdam, PO Box 94249, 1090 GE Amsterdam, The Netherlands
[5] Afdeling Sterrenkunde, Radboud Universiteit Nijmegen, Postbus 9010, 6500 GL Nijmegen, The Netherlands

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

Context. Observations at sub-millimeter and mm wavelengths will in the near future be able to resolve the radial dependence of the mm spectral slope in circumstellar disks with a resolution of around a few AU at the distance of the closest star-forming regions.
Aim. We aim to constrain physical models of grain growth and fragmentation by a large sample of (sub-)mm observations of disks around pre-main sequence stars in the Taurus-Auriga and Ophiuchus star-forming regions.
Methods. State-of-the-art coagulation/fragmentation and disk-structure codes are coupled to produce steady-state grain size distributions and to predict the spectral slopes at (sub-)mm wavelengths.
Results. This work presents the first calculations predicting the mm spectral slope based on a physical model of grain growth. Our models can quite naturally reproduce the observed mm-slopes, but a simultaneous match to the observed range of flux levels can only be reached by a reduction of the dust mass by a factor of a few up to about 30 while

keeping the gas mass of the disk the same. This dust reduction can either be caused by radial drift at a reduced rate or during an earlier evolutionary time (otherwise the predicted fluxes would become too low) or due to efficient conversion of dust into larger, unseen bodies.

Accepted by A&A Letters

http://adsabs.harvard.edu/abs/2010arXiv1006.0940B

The NH_2D/NH_3 ratio toward pre-protostellar cores around the UCH II region in IRAS 20293+3952

G. Busquet[1], A. Palau[2], R. Estalella[1], J. M. Girart[2], Á. Sánchez-Monge[1], S. Viti[3], P. T. P. Ho[4,5] and Q. Zhang[5]

[1] Departament d'Astronomia i Meteorologia (IEEC-UB), Institut de Ciències del Cosmos, Universitat de Barcelona, Martí i Franquès 1, E-08028 Barcelona, Catalunya, Spain
[2] Institut de Ciències de l'Espai (CSIC-IEEC), Campus UAB, Facultat de Ciències, Torre C-5 parell, E-08193 Bellaterra, Catalunya, Spain
[3] Department of Physics and Astronomy, University College London, Grower Street, London WC1E 6BT, UK
[4] Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, 02138, USA
[5] Academia Sinica Institute of Astronomy and Astrophysics, Taipei, Taiwan

E-mail contact: gbusquet *at* am.ub.es

Context. The deuterium fractionation, $D_{\rm frac}$, has been proposed as an evolutionary indicator in pre-protostellar and protostellar cores of low-mass star-forming regions.
Aims. We investigate $D_{\rm frac}$, with high angular resolution, in the cluster environment surrounding the UCH II region IRAS 20293+3952.
Methods. We performed high angular resolution observations with the IRAM Plateau de Bure Interferometer (PdBI) of the ortho-NH_2D 1_{11}–1_{01} line at 85.926 GHz and compared them with previously reported VLA NH_3 data.
Results. We detected strong NH_2D emission toward the pre-protostellar cores identified in NH_3 and dust emission, all located in the vicinity of the UCH II region IRAS 20293+3952. We found high values of $D_{\rm frac} \simeq$0.1–0.8 in all the pre-protostellar cores and low values, $D_{\rm frac} < 0.1$, associated with young stellar objects.
Conclusions. The high values of $D_{\rm frac}$ in pre-protostellar cores could be indicative of evolution, although outflow interactions and UV radiation could also play a role.

Accepted by Astronomy & Astrophysics Letters

http://arxiv.org/abs/1006.4280

New Herbig Ae/Be stars confirmed via high-resolution optical spectroscopy.

A. Carmona[1], M.E. van den Ancker[2], M. Audard[1], Th. Henning [3], J. Setiawan[3], and J. Rodmann[4]

[1] ISDC Data Centre for Astrophysics & Geneva Observatory, University of Geneva, chemin d'Ecogia 16, 1290 Versoix, Switzerland
[2] European Southern Observatory, Karl Schwarzschild Str 2 , 85748 Garching bei München, Germany
[3] Max-Planck Institute for Astronomy, Königstuhl 17, 69117 Heidelberg, Germany
[4] ESA/ESTEC, Space Environments & Effects (TEC-EES), 2200 AG Noordwijk, The Netherlands

E-mail contact: andres.carmona *at* unige.ch

We present FEROS high-resolution (R$\sim$ 45000) optical spectroscopy of 34 Herbig Ae/Be star candidates with previously unknown or poorly constrained spectral types. Within the sample, 16 sources are positionally coincident with nearby (d<250 pc) star-forming regions (SFRs). All the candidates have reported infrared excess. We determine the spectral type and luminosity class of the sources, derive their radial and projected rotational velocities, and constrain their distances employing spectroscopic parallaxes and photometry from the literature. We confirm 13 sources as Herbig Ae/Be stars and find one classical T Tauri star. Three sources are emission line early-type giants (B, A, and F stars with luminosity class III) and may be Herbig Ae/Be stars. One source is a main-sequence A-type star. Fourteen sources are post-main-sequence giant and supergiant stars (7 with Hα emission and 7 without). Two sources are extreme emission-line stars and no accurate spectral classification was possible because of strong veiling. Most of the

sources appear to be background stars at distances over 700 pc. We show that high-resolution optical spectroscopy is a crucial tool for distinguishing young stars (in particular Herbig Be stars) from post-main sequence stars in samples taken from emission-line star catalogs based on low-resolution spectroscopy. Within the sample, three young stars (CD-38 4380, Hen 3-1145, and HD 145718) and one early-type luminosity class III giant with emission lines (Hen 3-416) are at distances closer than 300 pc and are positionally coincident with a nearby SFR. These 4 sources are likely to be nearby young stars and are interesting for follow-up observations at high-angular resolution. Furthermore, seven confirmed Herbig Ae/Be stars at $d > 700$ pc (Hen 2-80, Hen 3–1121 N&S, HD 313571, MWC 953, WRAY 15-1435, and Th 17-35) are inside or close ($< 5'$) to regions with extended 8 μm continuum emission and in their 20' vicinity have astronomical sources characteristic of SFRs (e.g., HII regions, molecular clouds, dark nebulae, masers, young stellar-objects). These 7 sources are likely to be members of SFRs.

Accepted by A&A

http://arxiv.org/abs/1004.3386

CI observations in the CQ Tau proto-planetary disk: evidence of a very low gas-to-dust ratio ?

Edwige Chapillon[1], Bérengère Parise[1], Stéphane Guilloteau[2,3], Anne Dutrey[2,3] and Valentine Wakelam[2,3]

[1] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany
[2] Université de Bordeaux, Observatoire Aquitain des Sciences de l'Univers, BP 89, F-33271 Floirac Cedex, France
[3] CNRS, UMR 5804, Laboratoire d'Astrophysique de Bordeaux, BP 89, F-33271 Floirac Cedex, France

E-mail contact: echapill *at* mpifr-bonn.mpg.de

Context. The gas and dust dissipation processes of proto-planetary disks are hardly known. Transition disks between Class II (proto-planetary disks) and Class III (debris disks) remain difficult to detect.
Aims. We investigate the carbon chemistry of the peculiar CQ Tau gas disk. It is likely to be a transition disk because it exhibits weak CO emission with a relatively strong millimeter continuum, indicating that the disk may currently be dissipating its gas content.
Methods. We used APEX to observe the two CI transitions $^3P_1 \rightarrow {}^3P_0$ at 492 GHz and $^3P_2 \rightarrow {}^3P_1$ at 809 GHz in the disk orbiting CQ Tau. We compare the observations to several chemical model predictions. We focus our study on the influence of the stellar UV radiation shape and gas-to-dust ratio.
Results. We did not detect the CI lines. However, our upper limits are deep enough to exclude high-CI models. The only available models compatible with our limits imply very low gas-to-dust ratios, of the order of only a few.
Conclusions. These observations strengthen the hypothesis that CQ Tau is likely to be a transition disk and suggest that gas disappears before dust.

Accepted by A&A

Hydrogen permitted lines in the first near-IR spectra of Th 28 microjet: accretion or ejection tracers?

Deirdre Coffey[1], Francesca Bacciotti[2], Linda Podio[1] and Brunella Nisini[3]

[1] The Dublin Institute for Advanced Studies, 31 Fitzwilliam place, Dublin 2, Ireland
[2] Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, 50125 Firenze, Italy
[3] Osservatorio di Roma, Frascati, Roma, Italy

E-mail contact: dac *at* cp.dias.ie

We report the first near-infrared detection of the bipolar microjet from T Tauri star ThA 15-28 (hereafter Th 28). Spectra were obtained with VLT/ISAAC for the slit both perpendicular and parallel to the flow to examine jet kinematics and gas physics within the first arcsecond from the star. The jet was successfully detected in both molecular and atomic lines. The H_2 component was found to be entirely blueshifted around the base of the bipolar jet. It shows that only the blue lobe is emitting in H_2 while light is scattered in the direction of the red lobe, highlighting an asymmetric extinction and/or excitation between the two lobes. Consistent with this view, the red lobe is brighter in all atomic lines. Interestingly, the jet was detected not only in [Fe II], but also in Brγ and Paβ lines. Though considered tracers mainly of accretion, we find that these high excitation hydrogen permitted lines trace the jet as

far as 150 AU from the star. This is confirmed in a number of ways: the presence of the [Fe II] 2.13 micron line which is of similarly high excitation; H I velocities which match the jet [Fe II] velocities in both the blue and red lobe; and high electron density close to the source of $>6\times10^4$ cm^{-3} derived from the [Fe II] 1.64,1.60 micron ratio. These near-infrared data complement HST/STIS optical and near-ultraviolet data for the same target which were used in a jet rotation study, although no rotation signature could be identified here due to insufficient angular resolution. The unpublished HST/STIS Hα emission is included here along side the other H I lines. Identifying Brγ and Paβ as tracers of ejection is significant because of the importance of finding strong near-infrared probes close to the star, where forbidden lines are quenched, which will help understand accretion-ejection when observed with high spatial resolution instruments such as VLTI/AMBER.

Accepted by The Astrophysical Journal

http://arxiv.org/abs/1006.5400

Dead zones in protostellar discs: the case of Jet Emitting Discs

Celine Combet[1], Jonathan Ferreira[2] and Fabien Casse[3]

[1] Dept. of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH, United Kingdom
[2] Laboratoire d'Astrophysique de Grenoble, UJF/CNRS, BP 53, 38041 Grenoble Cedex 9, France
[3] Laboratoire APC, Universite Paris Diderot, 10, rue A. Domon et L. Duquet 75205, Paris Cedex 13, France

E-mail contact: celine.combet *at* astro.le.ac.uk

Planet formation and migration in accretion discs is a very active topic. Among the many aspects related to that question, dead zones are of particular importance as they can influence both the formation and the migration of planetary embryos. The ionisation level in the disc is the key element in determining the existence and the location of the dead zone. This has been studied either within the Standard Accretion Disc (SAD) framework or using parametric discs. In this paper, we extend this study to the case of Jet Emitting Discs (JED), the structure of which strongly differ from SADs because of the new energy balance and angular momentum extraction imposed by the jets. We make use of the (r, z) density distributions provided by self-similar accretion-ejection models, along with the JED thermal structure derived in a previous paper, to create maps of the ionisation structure of JEDs. We compare the ionisation rates we obtain to the critical value required to trigger the magneto-rotational instability.It is found that JEDs have a much higher ionisation degree than SADs which renders very unlikely the presence of a dead zone in these discs. As JEDs are believed to occupy the inner regions of accretion discs, the extension of the dead zones published in the literature should be re-considered for systems in which a jet is present. Moreover, since JEDs require large scale magnetic fields close to equipartition, our findings raise again the question of magnetic field advection in circumstellar accretion discs.

Accepted by A&A

http://arxiv.org/abs/1006.4715

Strong accretion on a deuterium-burning brown dwarf

F. Comerón[1], L. Testi[1] and A. Natta[2]

[1] ESO, Karl-Schwarzschild-Strasse 2, D-85748 Garching bei München, Germany
[2] Osservatorio Astrofisico di Arcetri, INAF, Largo E. Fermi 5, I-50125 Firenze, Italy

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

Context: The accretion processes that accompany the earliest stages of star formation have been shown in recent years to extend to masses well below the substellar limit, and even to masses close to the deuterium-burning limit, suggesting that the features characteristic of the T Tauri phase are also common to brown dwarfs.
Aims: We discuss new observations of GY 11, a young brown dwarf in the ρ Ophiuchi embedded cluster.
Methods: We have obtained for the first time low resolution long-slit spectroscopy of GY 11 in the red visible region, using the FORS1 instrument at the VLT. The spectral region includes accretion diagnostic lines such as Hα and the CaII infrared triplet.
Results: The visible spectrum allows us to confirm that GY 11 lies well below the hydrogen-burning limit, in agreement with earlier findings based on the near-infrared spectral energy distribution. We obtain an improved derivation of its

physical parameters, which suggest that GY 11 is on or near the deuterium-burning phase. We estimate a mass of 30 M_{Jup}, a luminosity of 6×10^{-3} $L_\odot$, and a temperature of 2700 K. We detect strong Hα and CaII triplet emission, and we estimate from the latter an accretion rate $\dot{M}_{acc} = 9.5 \times 10^{-10}$ $M_\odot$ yr^{-1}, which places GY 11 among the objects with the largest $\dot{M}_{acc}/M_*$ ratios measured thus far in their mass range. This might be an indication that accretion in GY 11 is driven by gravitational instability of its circum(sub-)stellar disk. The intense Hα emission is in contrast with the non-detection of Paβ and Brγ emission reported by Natta et al. (2004), and we discuss possible implications of this on the physical characteristics of the region where hydrogen emission is produced. Using archive near-infrared imaging obtained at different epochs we prove that the H_2 emission previously reported in infrared spectra of GY 11 is due to a chance coincidence with Herbig-Haro knots from the nearby source VLA1623, and not to a molecular outflow driven by GY 11. As a byproduct of our observations we also have obtained a spectrum of the neighboring embedded low mass star GY 10, which we classify as M5.5.

Accepted by Astronomy and Astrophysics

http://www.eso.org/∼fcomeron/GY11.pdf

The Angular Momentum of Magnetized Molecular Cloud Cores: a 2D-3D comparison

Sami Dib[1,2], Patrick Hennebelle[3], Jaime E. Pineda[4], Timea Csengeri[1], Sylvain Bontemps[5], Edouard Audit[1] and Alyssa A. Goodman[4,6]

[1] Service d'Astrophysique, DSM/Irfu, CEA/Saclay, F-91191, Gif-sur-Yvette Cedex, France
[2] Astronomical Institute, University of Utrecht, Princetonplein 5, 3584 CC, Utrecht, The Netherlands
[3] Laboratoire de Radioastronomie, UMR CNRS 8112, Ecole Normale Superieure, Observatoire de Paris, 24 rue Lhomond, 75231 Paris Cedex 05, France
[4] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA
[5] CNRS/INU, Laboratoire d'Astrophysique de Bordeaux, UMR 5804, BP 89, 33271, Floirac, Cedex, France
[6] Initiative for Innovative Computing, Harvard University, 60 Oxford Street, Cambridge, MA 02138, USA

E-mail contact: sami.dib *at* cea.fr

In this work, we present a detailed study of the rotational properties of magnetized and self-gravitating dense molecular cloud cores formed in a set of two very high resolution three-dimensional molecular cloud simulations with decaying turbulence. The simulations have been performed using the adaptative mesh refinement code RAMSES with an effective resolution of 4096^3 grid cells. One simulation represents a mildly magnetically-supercritical cloud and the other a strongly magnetically-supercritical cloud. We identify dense cores at a number of selected epochs in the simulations at two density thresholds which roughly mimick the excitation densities of the NH_3 $(J-K)$=(1,1) transition and the N_2H^+ (1-0) emission line. A noticeable global difference between the two simulations is the core formation efficiency (CFE) of the high density cores. In the strongly supercritical simulations the CFE is 33 percent per unit free-fall time of the cloud ($t_{ff,cl}$), whereas in the mildly supercritical simulations this value goes down to $\sim$ 6 percent per unit $t_{ff,cl}$. A comparison of the intrinsic specific angular momentum (j_{3D}) distributions of the cores with the specific angular momentum derived using synthetic two-dimensional velocity maps of the cores (j_{2D}), shows that the synthetic observations tend to overestimate the true value of the specific angular momentum by a factor of $\sim 8-10$. We find that the distribution of the ratio j_{3D}/j_{2D} of the cores peaks at around ~ 0.1. The origin of this discrepancy lies in the fact that contrary to the intrinsic determination of j which sums up the individual gas parcels contributions to the angular momentum, the determination of the specific angular momentum using the standard observational procedure which is based on a measurement on the global velocity gradient under the hypothesis of uniform rotation smoothes out the complex fluctuations present in the three-dimensional velocity field. Our results may well provide a natural explanation for the discrepancy by a factor ~ 10 observed between the intrinsic three-dimensional distributions of the specific angular momentum and the corresponding distributions derived in real observations. We suggest that previous and future measurements of the specific angular momentum of dense cores which are based on the measurement of the observed global velocity gradients may need to be reduced by a factor of ~ 10 in order to derive a more accurate estimate of the true specific angular momentum in the cores. We also show that the exponent of the size-specific angular momentum relation are smaller (~ 1.4) in the synthetic observations than their values derived in the three-dimensional space (~ 1.8).

Accepted by Astrophysical Journal

http://arxiv.org/abs/1003.5118

The physical and dynamical structure of Serpens: Two very different sub-(proto)clusters

A. Duarte-Cabral[1], G. A. Fuller[1], N. Peretto[1], J. Hatchell[2], E. F. Ladd[3], J. Buckle[4,5], J. Richer[4,5] and S. F. Graves[4,5]

[1] Jodrell Bank Centre for Astrophysics, School of Physics and Astronomy, The University of Manchester, Manchester, M13 9PL, U.K.
[2] School of Physics, University of Exeter, Exeter EX4 4QL, U.K.
[3] Department of Physics, Bucknell University, Lewisburg, PA 17837, U.S.A.
[4] Astrophysics Group, Cavendish Laboratory, J J Thomson Avenue, Cambridge, CB3 0HE, U.K.
[5] Kavli Institute for Cosmology, c/o Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge, CB3 0HA, U.K.

E-mail contact: Ana.Cabral *at* postgrad.manchester.ac.uk

The Serpens North Cluster is a nearby low mass star forming region which is part of the Gould Belt. It contains a range of young stars thought to correspond to two different bursts of star formation and provides the opportunity to study different stages of cluster formation. This work aims to study the molecular gas in the Serpens North Cluster to probe the origin of the most recent burst of star formation in Serpens. Transitions of the $C^{17}O$ and $C^{18}O$ observed with the IRAM 30m telescope and JCMT are used to study the mass and velocity structure of the region while the physical properties of the gas are derived using LTE and non-LTE analyses of the three lowest transitions of $C^{18}O$. The molecular emission traces the two centres of star formation which are seen in submillimetre dust continuum emission. In the $\sim$40 $M_\odot$ NW sub-cluster the gas and dust emission trace the same structures although there is evidence of some depletion of the gas phase $C^{18}O$. The gas has a very uniform temperature ($\sim$10 K) and velocity ($\sim$8.5 km/s) throughout the region. This is in marked contrast to the SE sub-cluster. In this region the dust and the gas trace different features, with the temperature peaking between the submillimetre continuum sources, reaching up to $\sim$14 K. The gas in this region has double peaked line profiles which reveal the presence of a second cloud in the line of sight. The submillimetre dust continuum sources predominantly appear located in the interface region between the two clouds. Even though they are at a similar stage of evolution, the two Serpens sub-clusters have very different characteristics. We propose that these differences are linked to the initial trigger of the collapse in the regions and suggest that a cloud-cloud collision could explain the observed properties.

Accepted by A&A

http://arxiv.org/abs/1006.0879

Modeling Mid-Infrared Variability of Circumstellar Disks with Non-Axisymmetric Structure

Kevin Flaherty[1] and James Muzerolle[1,2]

[1] Steward Observatory, University of Arizona
[2] Space Telescope Science Institute

E-mail contact: kflaherty *at* as.arizona.edu

Recent mid-infrared observations of young stellar objects have found significant variations possibly indicative of changes in the structure of the circumstellar disk. Previous models of this variability have been restricted to axisymmetric perturbations in the disk. We consider simple models of a non-axisymmetric variation in the inner disk, such as a warp or a spiral wave. We find that the precession of these non-axisymmetric structures produce negligible flux variations but a change in the height of these structures can lead to significant changes in the mid-infrared flux. Applying these models to observations of the young stellar object LRLL 31 suggests that the observed variability could be explained by a warped inner disk with variable scale height. This suggests that some of the variability observed in young stellar objects could be explained by non-axisymmetric disturbances in the inner disk and this variability would be easily observable in future studies.

Accepted by ApJ

http://arxiv.org/abs/1007.1249

Infall, outflow, and rotation in the G19.61-0.23 hot molecular core

R. S. Furuya[1], R. Cesaroni[2], and H. Shinnaga[3]

[1] Subaru Telescope, National Astronomical Observatory of Japan, 650 North A'ohoku Place, Hilo, HI 96720, U.S.A.
[2] INAF-Osservatorio Astrofisico di Arcetri, Largo Enrico Fermi 5, I-50125 Firenze, Italy
[3] Caltech Submillimeter Observatory, California Institute of Technology, 111 Nowelo Street, Hilo, HI 96720, U.S.A.

E-mail contact: rsf *at* subaru.naoj.org

Aims. The main goal of this study is to perform a sub-arcsecond resolution analysis of the high-mass star formation region G 19.61-0.23, both in the continuum and molecular line emission. While the centimeter continuum images will be discussed in detail in a forthcoming paper, here we focus on the (sub)mm emission, devoting special attention to the hot molecular core.
Methods. A set of multi-wavelength continuum and molecular line emission data between 6 cm and 890 μm were taken with the Very Large Array (VLA), Nobeyama Millimeter Array (NMA), Owens Valley Radio Observatory (OVRO), and Submillimeter Array (SMA). These data were analyzed in conjuction with previously published data.
Results. Our observations resolve the HMC into three cores whose masses are on the order of $10^1 - 10^3$ $M_\odot$. No submm core presents detectable free-free emission in the centimeter regime, but they appear to be associated with masers and thermal line emission from complex organic molecules. Towards the most massive core, SMA1, the CH_3CN ($18_K - 17_K$) lines reveal hints of rotation about the axis of a jet/outflow traced by H_2O maser and $H^{13}CO^+$ (1–0) line emission. Inverse P-Cygni profiles of the ^{13}CO (3–2) and $C^{18}O$ (3–2) lines seen towards SMA1 indicate that the central high-mass (proto)star(s) is (are) still gaining mass with an accretion rate $\geq 3\ 10^{-3}$ $M_\odot$ yr^{-1}. Due to the linear scales and the large values of the accretion rate, we hypothesize that we are observing an accretion flow towards a cluster in the making, rather than towards a single massive star.

Accepted by A&A

Preprint with full-resolution figures is available at `http://subarutelescope.org/staff/rsf/publication.html`

Pre-main sequence stars with disks in the Eagle Nebula observed in scattered light

M. G. Guarcello[1,2,3], F. Damiani[2], G. Micela[2], G. Peres[1], L. Prisinzano[2] and S. Sciortino[2]

[1] Dipart. di Scienze Fisiche ed Astronomiche, Universit di Palermo, Piazza del Parlamento 1, I-90134 Palermo Italy
[2] INAF - Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, 90134 Palermo Italy
[3] Currently at Smithsonian Astrophysical Observatory, MS-3, 60 Garden Street, Cambridge, MA 02138, USA

E-mail contact: mguarcel *at* head.cfa.harvard.edu

NGC 6611 and its parental cloud, the Eagle Nebula (M16), are well-studied star-forming regions, thanks to their large content of both OB stars and stars with disks and the observed ongoing star formation. In our previous studies of the Eagle Nebula, we identified 834 disk-bearing stars associated with the cloud, after detecting their excesses in NIR bands from J band to $8.0\mu m$. In this paper, we study in detail the nature of a subsample of disk-bearing stars that show peculiar characteristics. They appear older than the other members in the V vs. $V - I$ diagram, and/or they have one or more IRAC colors at pure photospheric values, despite showing NIR excesses, when optical and infrared colors are compared. We confirm the membership of these stars to M16 by a spectroscopic analysis. The physical properties of these stars with disks are studied by comparing their spectral energy distributions (SEDs) with the SEDs predicted by models of T-Tauri stars with disks and envelopes. We show that the age of these stars estimated from the V vs. $V - I$ diagram is unreliable since their $V - I$ colors are altered by the light scattered by the disk into the line of sight. Only in a few cases their SEDs are compatible with models with excesses in V band caused by optical veiling. Candidate members with disks and photospheric IRAC colors are selected by the used NIR disk diagnostic, which is sensitive to moderate excesses, such as those produced by disks with low masses. In 1/3 of these cases, scattering of stellar flux by the disks can also be invoked. The photospheric light scattered by the disk grains into the line of sight can affect the derivation of physical parameters of Class II stars from photometric optical and NIR data. Besides, the disks diagnostic we defined are useful for selecting stars with disks, even those with moderate excesses or whose optical colors are altered by veiling or photospheric scattered light.

Accepted by Astronomy and Astrophysics

http://www.astropa.unipa.it/ mguarce/6611_scatter.ps

Spitzer Observations of IC 2118

S. Guieu[1], L. M. Rebull[1], J. R. Stauffer[1], F. J. Vrba[2], A. Noriega-Crespo[1], T. Spuck[3], T. Rolofsen Moody[4], B. Sepulveda[5], C. Weehler[6], A. Maranto[7], D. M. Cole[1], N. Flagey[1], R. Laher[1], B. Penprase[8], S. Ramirez[9] and S. Stolovy[1]

[1] SSC
[2] USNO/Flagstaff
[3] OCHS
[4] NJAC
[5] LHS
[6] LBHS
[7] McDonogh
[8] Pomona
[9] IPAC

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

IC 2118, also known as the Witch Head Nebula, is a wispy, roughly cometary, ∼5 degree long reflection nebula, and is thought to be a site of triggered star formation. In order to search for new young stellar objects (YSOs), we have observed this region in 7 mid- and far-infrared bands using the Spitzer Space Telescope and in 4 bands in the optical using the U. S. Naval Observatory 40-inch telescope. We find infrared excesses in 4 of the 6 previously-known T Tauri stars in our combined infrared maps, and we find 6 entirely new candidate YSOs, one of which may be an edge-on disk. Most of the YSOs seen in the infrared are Class II objects, and they are all in the "head" of the nebula, within the most massive molecular cloud of the region.

Accepted by ApJ

http://arxiv.org/abs/1007.0241

Star formation in Cometary globule 1: the second generation

L. K. Haikala[1,2], M. M. Mäkelä[1,2] and P. Väisänen[3,4]

[1] Observatory, University of Helsinki, Finland
[2] Department of Physics, University of Helsinki, Finland
[3] South African Astronomical Observatory, Cape Town, South Africa
[4] Southern African Large Telescope Foundation, Cape Town, South Africa

E-mail contact: lauri.haikala *at* helsinki.fi

Context. Cometary Globule 1 (CG 1) is the archetype cometary globule in the Gum nebula.
Aims. To discover the stars possibly embedded in the globule head and to map the distribution of ISM in it.
Methods. $C^{18}O$ spectral line observations, NIR spectrosopy, narrow and broad band NIR imaging and stellar photometry are used to analyse the structure of CG 1 head and the extinction of stars in its direction.
Results. A young stellar object (YSO) associated with a bright NIR nebulosity and a molecular hydrogen object (MHO 1411, a probable obscured HH-object), were discovered in the globule. Molecular hydrogen and Brγ line emission is seen in the direction of the YSO. The YSO is a Class II candidate. The observed maximum optical extinction in the globule head is 9.2 magnitudes. The peak N(H_2) column density and the total mass derived from the extinction are 9.0 10^{21}cm^{-2} and 16.7 M$_\odot$ (d/300pc)^2. $C^{18}O$ emission in the globule head is detected in a 4' by 1'5 area with a sharp maximum SW of the YSO. Three regions ($C^{18}O$_SE, $C^{18}O$_max and $C^{18}O$_NW) can be discerned in $C^{18}O$ line velocity and excitation temperature. $C^{18}O$_SE coincides with a strong NIR surface brightness below the bright HAeBe star NX Pup and $C^{18}O$_NW with the optical extinction maximum. Because of variations in the $C^{18}O$ excitation temperature the integrated $C^{18}O$ line emission does not follow the optical extinction. It is argued that the $C^{18}O$ excitation temperatures in $C^{18}O$_SE and $C^{18}O$_max is higher than in $C^{18}O$_NW because of radiative heating by NX Pup ($C^{18}O$_SE) and interaction of the YSO with the parent cloud ($C^{18}O$_max). No indication other than the molecular hydrogen emission and the molecular hydrogen object of a strong molecular outflow from the YSO is evident. The IRAS point source 07178–4429 located in the CG 1 head resolves into two sources in the HIRES enhanced IRAS images. The 12 and 25 micron emission originates mainly in the star NX Puppis and the 60 and 100 micron emission in the YSO. The IRAS FIR luminosity of the YSO is 3.1 $L_\odot$.

Accepted by Astronomy and Astrophysics

http://arxiv.org/abs/1007.2087

A Methane Imaging Survey for T Dwarf Candidates in Rho Ophiuchi

Karl E. Haisch Jr.[1], Mary Barsony[2] and Chris Tinney[3]

[1] Utah Valley University
[2] Space Science Institute
[3] University of New South Wales

E-mail contact: Karl.Haisch *at* uvu.edu

We report the results of the first deep, wide-field, near-infrared methane imaging survey of the ρ Ophiuchi cloud core to search for T dwarfs. Among the 6587 objects detected, 22 were identified as T dwarf candidates. Brown dwarf models indicate that at the age and distance of the ρ Ophiuchi cloud, these T dwarf candidates have masses between 1 and 2 Jupiter masses. If confirmed as genuine T dwarfs, these objects would be the youngest, lowest mass, and lowest gravity free-floating objects ever directly observed. The existence of these candidates suggests that the initial mass function of the ρ Ophiuchi cloud extends well into the regime of planetary mass objects. A large fraction (59% $\pm$ 16%) of our T dwarf candidates appear to be surrounded by circumstellar disks, and thus represent the lowest mass objects yet found to harbor circumstellar disks.

Accepted by ApJ Letters

http://arxiv.org/abs/1007.2406

Vortices as Nurseries for Planetesimal Formation in Protoplanetary Discs

Kevin Heng[1] and Scott J. Kenyon[2]

[1] Institute for Advanced Study (Princeton) and ETH Zurich
[2] Harvard-Smithsonian Center for Astrophysics

E-mail contact: heng *at* ias.edu

Turbulent, two-dimensional, hydrodynamic flows are characterized by the emergence of coherent, long-lived vortices without a need to invoke special initial conditions. Vortices have the ability to sequester particles, with typical radii from about 1 mm to 10 cm, that are slightly decoupled from the gas. A generic feature of discs with surface density and effective temperature profiles that are decreasing, power-law functions of radial distance is that four vortex zones exist for a fixed particle size. In particular, two of the zones form an annulus at intermediate radial distances within which small particles reside. Particle capture by vortices occurs on a dynamical time scale near and at the boundaries of this annulus. As the disc ages and the particles grow via coagulation, the size of the annulus shrinks. Older discs prefer to capture smaller particles because the gas surface density decreases with time, a phenomenon we term ?vortex aging?. More viscous, more dust-opaque and/or less massive discs can have vortices that age faster and trap a broader range of particle sizes throughout the lifetime of the disc. Thus, how efficiently a disc retains its mass in solids depends on the relative time scales between coagulation and vortex aging. If vortices form in protoplanetary discs, they are important in discs with typical masses and for particles that are likely to condense out of the protostellar nebula. Particle capture also occurs at distances relevant to planet formation. Future infrared, submillimetre and centimetre observations of grain opacity as a function of radial distance will test the hypothesis that vortices serve as nurseries for particle growth in protoplanetary discs.

Accepted by MNRAS

http://arxiv.org/abs/1005.1660

Long-Lived Planetesimal Discs

Kevin Heng[1] and Scott Tremaine[1]

[1] Institute for Advanced Study (Princeton)

E-mail contact: heng *at* ias.edu

We investigate the survival of planetesimal discs over Gyr time-scales, using a unified approach that is applicable to all

Keplerian discs of solid bodies: dust grains, asteroids, planets, etc. Planetesimal discs can be characterized locally by four parameters: surface density, semimajor axis, planetesimal size and planetesimal radial velocity dispersion. Any planetesimal disc must have survived all dynamical processes, including gravitational instability, dynamical chaos, gravitational scattering, physical collisions, and radiation forces, that would lead to significant evolution over its lifetime. These processes lead to a rich set of constraints that strongly restrict the possible properties of long-lived discs. Within this framework, we also discuss the detection of planetesimal discs using radial velocity measurements, transits, microlensing and the infrared emission from the planetesimals themselves or from dust generated by planetesimal collisions.

Accepted by MNRAS

http://adsabs.harvard.edu/abs/2010MNRAS.401..867H

Observational Determination of the Turbulent Ambipolar Diffusion Scale and Magnetic Field Strength in Molecular Clouds

Talayeh Hezareh[1], Martin Houde[1], Carolyn McCoey[2] and Hua-bai Li[3]

[1] The University of Western Ontario
[2] University of Waterloo
[3] Max-Planck-Institut fuer Astronomie

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

We study the correlation of the velocity dispersion of the coexisting molecules $H^{13}CN$ and $H^{13}CO^+$ and the turbulent energy dissipation scale in the DR21(OH) star-forming region. The down-shift of the $H^{13}CO^+$ spectrum relative to $H^{13}CN$ is consistent with the presence of ambipolar diffusion at dissipation length scales that helps the process of turbulent energy dissipation, but at a different cut-off for ions compared to the neutrals. We use our observational data to calculate a turbulent ambipolar diffusion length scale $L^{'} \simeq 17$ mpc and a strength of $B_{pos} \simeq 1.7$ mG for the plane of the sky component of the magnetic field in DR21(OH).

Accepted by Astrophysical Journal

Depletion of CCS in a Candidate Warm-Carbon-Chain-Chemistry Source L483

Tomoya Hirota[1], Nami Sakai[2] and Satoshi Yamamoto[2]

[1] National Astronomical Observatory of Japan, Mitaka, Tokyo 181-8588, Japan
[2] Department of Physics, The University of Tokyo, Bunkyo-ku, Tokyo 113-0033, Japan

E-mail contact: tomoya.hirota *at* nao.ac.jp

We have carried out an observation of the CCS (J_N=2_1-1_0) line with the VLA in its D-configuration toward a protostellar core L483 (IRAS 18140-0440). This is a candidate source of the newly found carbon-chain rich environment called "Warm-Carbon-Chain-Chemistry (WCCC)", according to the previous observations of carbon-chain molecules. The CCS distribution in L483 is found to consist of two clumps aligned in the northwest-southeast direction, well tracing the CCS ridge observed with the single-dish radio telescope. The most remarkable feature is that CCS is depleted at the core center. Such a CCS distribution with the central hole is consistent with those of previously observed prestellar and protostellar cores, but it is rather unexpected for L483. This is because the distribution of CS, which is usually similar to that of CCS, is centrally peaked. Our results imply that the CCS (J_N=2_1-1_0) line would selectively trace the outer cold envelope in the chemically less evolved phase that is seriously resolved out with the interferometric observation. Thus, it is most likely that the high abundance of CCS in L483 relative to the other WCCC sources is not due to the activity of the protostar, although it would be related to its younger chemical evolutionary stage, or a short timescale of the prestellar phase.

Accepted by ApJ

http://arxiv.org/abs/1007.1066

Emergence of Protoplanetary Disks and Successive Formation of Gaseous Planets by Gravitational Instability

Shu-ichiro Inutsuka[1], Masahiro N. Machida[2] and Tomoaki Matsumoto[3]

[1] Department of Physics, Nagoya University
[2] National Astronomical Observatory
[3] Faculty of Humanity and Environment, Hosei University

E-mail contact: inutsuka *at* nagoya-u.jp

We use resistive magnetohydrodynamical (MHD) simulations with the nested grid technique to study the formation of protoplanetary disks around protostars from molecular cloud cores that provide the realistic environments for planet formation. We find that gaseous planetary-mass objects are formed in the early evolutionary phase by gravitational instability in regions that are decoupled from the magnetic field and surrounded by the injection points of the MHD outflows during the formation phase of protoplanetary disks. Magnetic decoupling enables massive disks to form and these are subject to gravitational instability, even at 10 AU. The frequent formation of planetary-mass objects in the disk suggests the possibility of constructing a hybrid planet formation scenario, where the rocky planets form later under the influence of the giant planets in the protoplanetary disk.

Accepted by The Astrophysical Journal Letters (Vol.718, L58-L62)

http://arxiv.org/abs/0912.5439

The Directly Imaged Planet around the Young Solar Analog 1RXS J160929.1-210524: Confirmation of Common Proper Motion, Temperature and Mass

David Lafrenière[1,2], Ray Jayawardhana[2] and Marten H. van Kerkwijk[2]

[1] Département de physique, Université de Montréal, C.P. 6128 Succ. Centre-Ville, Montréal, QC, H3C 3J7, Canada
[2] Department of Astronomy and Astrophysics, University of Toronto, 50 St. George Street, Toronto, ON, M5S 3H4, Canada

E-mail contact: david *at* astro.umontreal.ca

Giant planets are usually thought to form within a few tens of AU of their host stars, and hence it came as a surprise when we found what appeared to be a planetary mass ($\sim 0.008\ M_\odot$) companion around the 5 Myr-old solar mass star 1RXS J160929.1-210524 in the Upper Scorpius association. At the time, we took the object's membership in Upper Scorpius —established from near-infrared, H- and K-band spectroscopy— and its proximity (2.2 arcsec, or 330 AU) to the primary as strong evidence for companionship, but could not verify their common proper motion. Here, we present follow-up astrometric measurements that confirm that the companion is indeed co-moving with the primary star, which we interpret as evidence that it is a truly bound planetary mass companion. We also present new J-band spectroscopy and 3.0-3.8 μm photometry of the companion. Based on a comparison with model spectra, these new measurements are consistent with the previous estimate of the companion effective temperature of 1800 ± 200 K. We present a new estimate of the companion mass based on evolution models and the calculated bolometric luminosity of the companion; we obtain a value of $0.008^{+0.003}_{-0.002}\ \mathrm{M}_\odot$, again consistent with our previous result. Finally, we present angular differential imaging observations of the system allowing us to rule out additional planets in the system more massive than 1 $M_{\rm Jup}$, 2 $M_{\rm Jup}$ and 8 $M_{\rm Jup}$ at projected separations larger than 3 arcsec ($\sim$440 AU), 0.7 arcsec ($\sim$100 AU) and 0.35 arcsec ($\sim$50 AU), respectively. This companion is the least massive known to date at such a large orbital distance; it shows that objects in the planetary mass range exist at orbital separations of several hundred AU, posing a serious challenge for current formation models.

Accepted by The Astrophysical Journal

http://arxiv.org/abs/1006.3070

c2d Spitzer IRS spectra of embedded low-mass young stars: gas-phase emission lines

Fred Lahuis[1,2], Ewine F. van Dishoeck[2,3], Jes K. Jørgensen[4], Geoffrey A. Blake[5] and Neal J. Evans II[6]

[1] SRON Netherlands Institute for Space Research,P.O. Box 800, 9700 AV Groningen, The Netherlands
[2] Leiden Observatory, Leiden University, P.O. Box 9513, 2300 RA Leiden, The Netherlands

[3] Max-Planck-Institut für extraterrestrische Physik (MPE), Giessenbachstraat 1, 85748 Garching, Germany
[4] Centre for Star and Planet Formation, Natural History Museum of Denmark, University of Copenhagen, Øster Voldgade 5-7, DK-1350 Copenhagen K, Denmark
[5] Division of Geological and Planetary Sciences 150-21, California Institute of Technology, Pasadena, CA 91125, USA
[6] The University of Texas at Austin, Dept. of Astronomy, 1 University Station C1400, Austin, Texas 78712–0259, USA

E-mail contact: F.Lahuis *at* sron.nl

A survey of mid-infrared gas-phase emission lines of H_2, H_2O and various atoms toward a sample of 43 embedded low-mass young stars in nearby star-forming regions is presented. The sources are selected from the *Spitzer* "Cores to Disks" (c2d) legacy program.
Aims: The environment of embedded protostars is complex both in its physical structure (envelopes, outflows, jets, protostellar disks) and the physical processes (accretion, irradiation by UV and/or X-rays, excitation through slow and fast shocks) which take place. The mid-IR spectral range hosts a suite of diagnostic lines which can distinguish them. A key point is to spatially resolve the emission in the *Spitzer*-IRS spectra to separate extended PDR and shock emission from compact source emission associated with the circumstellar disk and jets.
Methods: An optimal extraction method is used to separate both spatially unresolved (compact, up to a few hundred AU) and spatially resolved (extended, thousand AU or more) emission from the IRS spectra. The results are compared with the c2d disk sample and literature PDR and shock models to address the physical nature of the sources.
Results: Both compact and extended emission features are observed. Warm ($T_{\rm ex}$ few hundred K) H_2, observed through the pure rotational H_2 S(0), S(1) and S(2) lines, and [S I] 25 μm emission is observed primarily in the extended component. [S I] is observed uniquely toward truly embedded sources and not toward disks. On the other hand hot ($T_{\rm ex} \gtrsim 700$ K) H_2, observed primarily through the S(4) line, and [Ne II] emission is seen mostly in the spatially unresolved component. [Fe II] and [Si II] lines are observed in both spatial components. Hot H_2O emission is found in the spatially unresolved component of some sources.
Conclusions: The observed emission on $\geq$1000 AU scales is characteristic of PDR emission and likely originates in the outflow cavities in the remnant envelope created by the stellar wind and jets from the embedded young stars. Weak shocks along the outflow wall can also contribute. The compact emission is likely of mixed origin, comprised of optically thick circumstellar disk and/or jet/out flow emission from the protostellar object.

Accepted by A&A

Sub-Alfvénic Non-Ideal MHD Turbulence Simulations with Ambipolar Diffusion: II. Comparison with Observation, Clump Properties, and Scaling to Physical Units

Christopher F. McKee[1], Pak Shing Li[2] and Richard I. Klein[3]

[1] Physics Department and Astronomy Department, University of California, Berkeley, CA 94720, USA; and Laboratoire d'Etudes du Rayonnement et de la Matièreen Astrophysique, LERMA-LRA, Ecole Normale Superieure, 24 rue Lhomond, 75005 Paris, France
[2] Astronomy Department, University of California, Berkeley, CA 94720, USA
[3] Astronomy Department, University of California, Berkeley, CA 94720, USA; and Lawrence Livermore National Laboratory, P.O.Box 808, L-23, Livermore, CA 94550, USA

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

Ambipolar diffusion is important in redistributing magnetic flux and in damping Alfvén waves in molecular clouds. The importance of ambipolar diffusion on a length scale ℓ is governed by the ambipolar diffusion Reynolds number, $R_{\rm AD} = \ell/\ell_{\rm AD}$, where $\ell_{\rm AD}$ is the characteristic length scale for ambipolar diffusion. The logarithmic mean of the AD Reynolds number in a sample of 15 molecular clumps with measured magnetic fields (Crutcher 1999) is 17, comparable to the theoretically expected value. We identify several regimes of ambipolar diffusion in a turbulent medium, depending on the ratio of the flow time to collision times between ions and neutrals; the clumps observed by Crutcher (1999) are all in the standard regime of ambipolar diffusion, in which the neutrals and ions are coupled over a flow time. We have carried out two-fluid simulations of ambipolar diffusion in isothermal, turbulent boxes for a range of values of $R_{\rm AD}$. The mean Mach numbers were fixed at $\mathcal{M} = 3$ and $\mathcal{M}_A = 0.67$; self-gravity was not included. We study the properties of overdensities–i.e., clumps–in the simulation and show that the slope of the higher-mass portion of the clump mass spectrum increases as $R_{\rm AD}$ decreases, which is qualitatively consistent with Padoan et al. (2007)'s

finding that the mass spectrum in hydrodynamic turbulence is significantly steeper than in ideal MHD turbulence. For a value of $R_{\rm AD}$ similar to the observed value, we find a slope that is consistent with that of the high-mass end of the Initial Mass Function for stars. However, the value we find for the spectral index in our ideal MHD simulation differs from theirs, presumably because our simulations have different initial conditions. This suggests that the mass spectrum of the clumps in the Padoan et al. (2007) turbulent fragmentation model for the IMF depends on the environment, which would conflict with evidence for a universal IMF. In addition, we give a general discussion of how the results of simulations of magnetized, turbulent, isothermal boxes can be scaled to physical systems. Each physical process that is introduced into the simulation, such as ambipolar diffusion, introduces a dimensionless parameter, such as $R_{\rm AD}$, which must be fixed for the simulation, thereby reducing the number of scaling parameters by one. We show that the importance of self-gravity is fixed in any simulation of ambipolar diffusion; it is not possible to carry out a simulation in which self-gravity and ambipolar diffusion are varied independently unless the ionization is a free parameter. We show that our simulations apply to small regions in molecular clouds, generally with $\ell_0 \leq 0.4$ pc and $M \leq 25\ M_\odot$. A general discussion of the scaling relations for magnetized, isothermal, turbulent boxes, including self-gravitating systems, is given in the Appendix.

Accepted by ApJ

http://arxiv.org/abs/1007.2032

Wall emission in circumbinary disks: the case of CoKu Tau/4

Erick Nagel[1], Paola D'Alessio[2], Nuria Calvet[3], Catherine Espaillat[4], Ben Sargent[5], Jesús Hernández[6], and William J. Forrest[7]

[1] Departamento de Astronomía, Universidad de Guanajuato, Guanajuato,cGto, México 36240
[2] Centro de Radioastronomía y Astrofísica, UNAM, Morelia, Michoacán, México 58089
[3] Department of Astronomy, University of Michigan, Ann Arbor, MI 48109, USA
[4] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, MS-78, Cambridge, MA, 02138, USA
[5] Space Telescope Science Institute, Baltimore, MD 21218, USA
[6] Centro de Investigaciones de Astronomía, Mérida 5101-A, Venezuela
[7] Department of Physics and Astronomy, University of Rochester, Rochester, NY 14627, USA

E-mail contact: erick *at* astro.ugto.mx

A few years ago, the mid-IR spectrum of a Weak Line T Tauri Star, CoKu Tau/4, was explained as emission from the inner wall of a *circumstellar* disk, with the inner disk truncated at ~ 10 AU. Based on the SED shape and the assumption that it was produced by a single star and its disk, CoKu Tau/4 was classified as a prototypical transitional disk, with a clean inner hole possibly carved out by a planet, some other orbiting body, or by photodissociation. However, recently it has been discovered that CoKu Tau/4 is a close binary system. This implies that the observed mid-IR SED is probably produced by the *circumbinary* disk. The aim of the present paper is to model the SED of CoKu Tau/4 as arising from the inner wall of a circumbinary disk, with parameters constrained by what is known about the central stars and by a dynamical model for the interaction between these stars and their surrounding disk. We lack a physical prescription for the shape of the wall, thus, here we use a simplified and unrealistic assumption: the wall is vertical. In order to fit the Spitzer IRS SED, the binary orbit should be almost circular, implying a small mid-IR variability (10 %) related to the variable distances of the stars to the inner wall of the circumbinary disk. In the context of the present model, higher eccentricities would imply that the stars are farther from the wall, the latter being too cold to explain the observed SED. Our models suggest that the inner wall of CoKu Tau/4 is located at $1.7a$, where a is the semi-major axis of the binary system ($a \sim 8AU$). A small amount of optically thin dust in the hole ($\lesssim$0.01 lunar masses) helps to improve the fit to the 10 μm silicate band. The dust properties are not well constrained, since depend on the extinction law, but standard abundances of silicates (olivine or pyroxene) and graphite explains the observed SED. Also, we find that water ice should be absent or have a very small abundance (a dust to gas mass ratio $\lesssim 5.6 \times 10^{-5}$). In general, for a binary system with eccentricity $e > 0$, the model predicts mid-IR variability with periods similar to orbital timescales, assuming that thermal equilibrium is reached instantaneously.

Accepted by Astrophysical Journal

Disk Imaging Survey of Chemistry with SMA (DISCS): I. Taurus Protoplanetary Disk Data

Karin I. Öberg[1], Chunhua Qi[1], Jeffrey K.J. Fogel[2], Edwin A. Bergin[2], Sean M. Andrews[1], Catherine Espaillat[1], Tim A. van Kempen[1], David J. Wilner[1] and Ilaria Pascucci[3]

[1] Harvard-Smithsonian Center for Astrophysics, Cambridge, USA
[2] University of Michigan, Ann Arbor, USA
[3] Johns Hopkins University, Baltimore, USA

E-mail contact: koberg *at* cfa.harvard.edu

Chemistry plays an important role in the structure and evolution of protoplanetary disks, with implications for the composition of comets and planets. This is the first of a series of papers based on data from DISCS, a Submillimeter Array survey of the chemical composition of protoplanetary disks. The six Taurus sources in the program (DM Tau, AA Tau, LkCa 15, GM Aur, CQ Tau and MWC 480) range in stellar spectral type from M1 to A4 and offer an opportunity to test the effects of stellar luminosity on the disk chemistry. The disks were observed in 10 different lines at ∼3 arcsec resolution and an rms of $\sim$ 100 mJy beam^{-1} at $\sim$ 0.5 km s^{-1}. The four brightest lines are CO 2–1, HCO^+ 3–2, CN $2_{3\,3/4/2} - 1_{2\,2/3/1}$ and HCN 3–2 and these are detected toward all sources (except for HCN toward CQ Tau). The weaker lines of CN $2_{2\,2} - 1_{1\,1}$, DCO^+ 3–2, N_2H^+ 3–2, H_2CO $3_{0\,3} - 2_{0\,2}$ and $4_{1\,4} - 3_{1\,3}$ are detected toward two to three disks each, and DCN 3–2 only toward LkCa 15. CH_3OH $4_{2\,1} - 3_{1\,2}$ and *c*-C_3H_2 are not detected. There is no obvious difference between the T Tauri and Herbig Ae sources with regard to CN and HCN intensities. In contrast, DCO^+, DCN, N_2H^+ and H_2CO are detected only toward the T Tauri stars, suggesting that the disks around Herbig Ae stars lack cold regions for long enough timescales to allow for efficient deuterium chemistry, CO freeze-out, and grain chemistry.

Accepted by Astrophysical Journal

http://arxiv.org/abs/1007.1476

The effect of H_2O on ice photochemistry

Karin I. Öberg[1,2], Ewine F. van Dishoeck[3,4], Harold Linnartz[2] and Stefan Andersson[5]

[1] Harvard-Smithsonian Center for Astrophysics, Cambridge, USA
[2] Sackler Laboratory for Astrophysics, Leiden Observatory, Leiden University, Netherlands
[3] Leiden Observatory, Leiden University, Netherlands
[4] Max-Planck Institute für Extraterrestrische Physik, Garching, Germany
[5] INTEF Materials and Chemistry, Trondheim, Norway

E-mail contact: koberg *at* cfa.harvard.edu

UV irradiation of simple ices is proposed to efficiently produce complex organic species during star- and planet-formation. Through a series of laboratory experiments, we investigate the effects of the H_2O concentration, the dominant ice constituent in space, on the photochemistry of more volatile species, especially CH_4, in ice mixtures. In the experiments, thin (∼40 ML) ice mixtures, kept at 20–60 K, are irradiated under ultra-high vacuum conditions with a broad-band UV hydrogen discharge lamp. Photodestruction cross sections of volatile species (CH_4 and NH_3) and production efficiencies of new species (C_2H_6, C_2H_4, CO, H_2CO, CH_3OH, CH_3CHO and CH_3CH_2OH) in water-containing ice mixtures are determined using reflection-absorption infrared spectroscopy during irradiation and during a subsequent slow warm-up. The four major effects of increasing the H_2O concentration are 1) an increase of the destruction efficiency of the volatile mixture constituent by up to an order of magnitude due to a reduction of back reactions following photodissociation, 2) a shift to products rich in oxygen e.g. CH_3OH and H_2CO, 3) trapping of up to a factor of five more of the formed radicals in the ice and 4) a disproportional increase in the diffusion barrier for the OH radical compared to the CH_3 and HCO radicals. The radical diffusion temperature dependencies are consistent with calculated H_2O-radical bond strengths. All the listed effects are potentially important for the production of complex organics in H_2O-rich icy grain mantles around protostars and should thus be taken into account when modeling ice chemistry.

Accepted by Astrophysical Journal

http://arxiv.org/abs/1006.2190

Mapping the column density and dust temperature structure of IRDCs with Herschel

N. Peretto[1,2], G.A. Fuller[1], R. Plume[3] and the Hi-GAL consortium[4]

[1] Jodrell Bank Centre for Astrophysics, University of Manchester, UK
[2] Laboratoire AIM, CEA/DSM-CNRS-Universite Paris Diderot, IRFU/Service d'Astrophysique, C.E. Saclay, France
[3] Department of Physics and Astronomy, University of Calgary, Canada
[4] INAF-IFSI, Roma, Italy

E-mail contact: nicolas.peretto *at* cea.fr

Infrared dark clouds (IRDCs) are cold and dense reservoirs of gas potentially available to form stars. Many of these clouds are likely to be pristine structures representing the initial conditions for star formation. The study presented here aims to construct and analyze accurate column density and dust temperature maps of IRDCs by using the first Herschel data from the Hi-GAL galactic plane survey. These fundamental quantities, are essential for understanding processes such as fragmentation in the early stages of the formation of stars in molecular clouds. We have developed a simple pixel-by-pixel SED fitting method, which accounts for the background emission. By fitting a grey-body function at each position, we recover the spatial variations in both the dust column density and temperature within the IRDCs. This method is applied to a sample of 22 IRDCs exhibiting a range of angular sizes and peak column densities. Our analysis shows that the dust temperature decreases significantly within IRDCs, from background temperatures of 20-30 K to minimum temperatures of 8-15 K within the clouds, showing that dense molecular clouds are not isothermal. Temperature gradients have most likely an important impact on the fragmentation of IRDCs. Local temperature minima are strongly correlated with column density peaks, which in a few cases reach $N_{H_2} = 1 \times 10^{23}$ cm^{-2} , identifying these clouds as candidate massive prestellar cores. Applying this technique to the full Hi-GAL data set will provide important constraints on the fragmentation and thermal properties of IRDCs, and help identify hundreds of massive prestellar core candidates.

Accepted by A&A

http://arxiv.org/pdf/1005.1506v1

Faint Collimated Herbig-Haro Jets from Visible Stars in L1641

Bo Reipurth[1], Colin Aspin[1], John Bally[2], John J. Tobin[3], and Josh Walawender[1]

[1] Institute for Astronomy, University of Hawaii at Manoa, 640 N. Aohoku Place, HI 96720, USA
[2] Center for Astrophysics and Space Astronomy, University of Colorado, Boulder, CO 80309, USA
[3] Department of Astronomy, University of Michigan, Ann Arbor, MI 48109, USA

E-mail contact: reipurth *at* ifa.hawaii.edu

A population of 11 faint, collimated jets has been discovered in the northern part of the L1641 cloud in the region of HH 1/2, HH 34, and the L1641-N cluster. These jets were missed in previous imaging surveys on account of their weak emission, and they were discovered only on deep exposures with the Subaru 8m telescope. With these new faint jets, the number of HH flows within the area surveyed has doubled. This suggests that collimated jets from young stars may be more common than assumed so far. It is noteworthy that all of the jets are associated with optically visible stars with r-magnitudes ranging from 13.8 to 22.0. The driving sources of jets in regions flooded by ultraviolet radiation from nearby OB stars are known to be excavated by photo-ionization, and in three cases remnant Hα emission envelopes are found associated with the sources, although the more benign environment in the region observed here, about 10 pc distant from the Orion Nebula Cluster, makes the optical visibility of all these sources rather surprising. Such faint jets from visible stars represent either the final vestiges of the outflow phenomenon, or they are triggered by disturbances of the remnant disks, possibly initiated by the orbital evolution of binaries that spiral in to form close binaries. Among the known H emission stars within the region surveyed, 8% are found to be associated with jets.

Accepted by Astron. J.

Http://www.ifa.hawaii.edu/publications/preprints/10preprints/Reipurth_10-104.pdf

On the observability of T Tauri accretion shocks in the X-ray band

G. G. Sacco[1,2], S. Orlando[2], C. Argiroffi[3,2], A. Maggio[2], G. Peres[3,2], F. Reale[3,2] and R. L. Curran[2,4]

[1] Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology, 54 Lomb Memorial Drive, Rochester, 14623 NY, USA

[2] INAF-Osservatorio Astronomico di Palermo, Piazza del Parlamento, 1, 90134, Palermo, Italy

[3] DSFA-Universita' degli Studi di Palermo, Piazza del Parlamento, 1, 90134, Palermo, Italy

[4] Department of Physics, Rochester Institute of Technology, 54 Lomb Memorial Dr., Rochester, NY 14623, USA

E-mail contact: sacco *at* cis.rit.edu

Context. High resolution X-ray observations of classical T Tauri stars (CTTSs) show a soft X-ray excess due to high density plasma ($n_e = 10^{11} - 10^{13}$ cm^{-3}). This emission has been attributed to shock-heated accreting material impacting onto the stellar surface.
Aims. We investigate the observability of the shock-heated accreting material in the X-ray band as a function of the accretion stream properties (velocity, density, and metal abundance) in the case of plasma-$\beta \ll 1$ (thermal pressure $\ll$ magnetic pressure) in the post-shock zone.
Methods. We use a 1-D hydrodynamic model describing the impact of an accretion stream onto the chromosphere of a CTTS, including the effects of radiative cooling, gravity stratification and thermal conduction. We explore the space of relevant parameters and synthesize from the model results the X-ray emission in the $[0.5 - 8.0]$ keV band and in the resonance lines of O VII (21.60 Å) and Ne IX (13.45 Å), taking into account the absorption from the chromosphere.
Results. The accretion stream properties largely influence the temperature and the stand-off height of the shocked slab and its sinking in the chromosphere, determining the observability of the shocked plasma affected by chromospheric absorption. Our model predicts that X-ray observations preferentially detect emission from low density and high velocity shocked accretion streams due to the large absorption of dense post-shock plasma. In all the cases examined, the post-shock zone exhibits quasi-periodic oscillations due to thermal instabilities with periods ranging from 3×10^{-2} to 4×10^3 s. In the case of inhomogeneous streams and $\beta \ll 1$, the shock oscillations are hardly detectable.
Conclusions. We suggest that, if accretion streams are inhomogeneous, the selection effect introduced by the absorption on observable plasma components may easily explain the discrepancy between the accretion rate measured by optical and X-ray data as well as the different densities measured using different He-like triplets in the X-ray band.

Accepted by Astronomy & Astrophysics

http://arxiv.org/abs/1007.2423

Dynamic star formation in the massive DR21 filament

N. Schneider[1], T. Csengeri[1], S. Bontemps[2], F. Motte[1], R. Simon[3], P. Hennebelle[4], C. Federrath[5] and R. Klessen[5,6]

[1] IRFU/SAp CEA-Saclay, Laboratoire AIM, CEA/DSM - INSU/CNRS, France

[2] OASU/LAB-UMR5804 Bordeaux, France

[3] I. Physikalisches Institut Koeln, Univ. Koeln, Germany

[4] Laboratoire de radioastronomie, UMR CNRS 8112, Observatoire de Paris, France

[5] Zentrum fuer Astronomie Univ. Heidelberg, Inst. fuer Theor. Astrophysik, Heidelberg, Germany

[6] Kavli Institute for Particle Astrophysics and Cosmology, Stanford, USA

E-mail contact: nschneid *at* cea.fr

The formation of massive stars is a highly complex process in which it is unclear whether the star-forming gas is in global gravitational collapse or an equilibrium state supported by turbulence and/or magnetic fields. In addition, magnetic fields may play a decisive role in the star-formation process since they influence the efficiency of gas infall onto the protostar. By studying one of the most massive and dense star-forming regions in the Galaxy at a distance of less than 3 kpc, i.e. the filament containing the well-known sources DR21 and DR21(OH), we attempt to obtain observational evidence to help us to discriminate between these two views. We use molecular line data from our ^{13}CO 1→0, CS 2→1, and N_2H^+ 1→0 survey of the Cygnus X region obtained with the FCRAO and high-angular resolution observations in isotopomeric lines of CO, CS, HCO^+, N_2H^+, and H_2CO, obtained with the IRAM 30m telescope, to investigate the distribution of the different phases of molecular gas. Gravitational infall is identified by the presence of inverse P Cygni profiles that are detected in optically thick lines, while the optically thinner isotopomers are found to reach a peak in the self-absorption gap. We observe a complex velocity field and velocity dispersion in the DR21 filament in which regions of the highest column-density, i.e., dense cores, have a lower velocity dispersion than the surrounding gas and velocity gradients that are not (only) due to rotation. Infall signatures in optically thick line profiles of HCO^+ and ^{12}CO are observed along and across the whole DR21 filament. By modelling the observed spectra, we obtain a typical infall speed of $\sim$0.6 km s^{-1} and mass accretion rates of the order of a few 10^{-3} M$_\odot$ yr^{-1} for the two main clumps constituting the filament. These massive clumps (4900 and 3300 M$_\odot$ at densities of around 10^5 cm^{-3} within 1 pc diameter) are both gravitationally contracting (with free-fall times much shorter than sound crossing times and low virial parameter α). The more massive of the clumps, DR21(OH), is connected to a sub-filament, apparently 'falling' onto the clump. This filament runs parallel to the magnetic field. All observed kinematic features in the DR21 filament (velocity field, velocity dispersion, and infall), its filamentary morphology, and the existence of (a) sub-filament(s) can be explained if the DR21 filament was formed by the convergence of flows on large scales and is now in a state of global gravitational collapse. Whether this convergence of flows originated from self-gravity on larger scales or from other processes cannot be determined by the present study. The observed velocity field and velocity dispersion are consistent with results from (magneto)-hydrodynamic simulations where the cores lie at the stagnation points of convergent turbulent flows.

Accepted by Astronomy and Astrophysics

http://lanl.arxiv.org/abs/1003.4198

A bipolar outflow from the massive protostellar core W51e2-E

Hui Shi[1], Jun-Hui Zhao[2] and Jinlin Han[1]

[1] Nat. Astron. Obs., Chinese Academy of Sciences, 20A Datun Road, Chaoyang District, Beijing 100012, China
[2] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA

E-mail contact: shihui *at* nao.cas.cn

We present high resolution images of the bipolar outflow in W51e2, which are produced from the Submillimeter Array archival data observed for CO(3-2) and HCN(4-3) lines with angular resolutions of $0.8'' \times 0.6''$ and $0.3'' \times 0.2''$, respectively. The images show that the powerful outflow originates from the protostellar core W51e2-E rather than from the ultracompact HII region W51e2-W. The kinematic timescale of the outflow from W51e2-E is about 1000 yr, younger than the age ($\sim$5000 yr) of the ultracompact HII region W51e2-W. A large mass loss rate of $\sim 1 \times 10^{-3}$M$_\odot$ yr^{-1} and a high mechanical power of 120 L$_\odot$ are inferred, suggesting that an O star or a cluster of B stars are forming in W51e2-E. The observed outflow activity along with the inferred large accretion rate indicates that at present W51e2-E is in a rapid phase of star formation.

Accepted by ApJL

http://arxiv.org/abs/1006.4058

Debris Disks of Members of the Blanco 1 Open Cluster

J. R. Stauffer[1], L. M. Rebull[1], D. James[2], A. Noriega-Crespo[1], S. E. Strom[3], S. Wolk[4], M. Meyer[5], J. Carpenter[6], D. Barrado y Navascues[7], G. Micela[8], D. Backman[9] and P. Cargile[10]

[1] SSC
[2] UH
[3] NOAO
[4] CXC
[5] UA/Zurich
[6] Caltech
[7] LAEFF
[8] INAF
[9] SETI
[10] Vanderbilt

E-mail contact: stauffer *at* ipac.caltech.edu

We have used the Spitzer Space Telescope to obtain Multiband Imaging Photometer for Spitzer (MIPS) 24 um

photometry for 37 members of the 100 Myr old open cluster Blanco 1. For the brightest 25 of these stars (where we have 3sigma uncertainties less than 15%), we find significant mid-IR excesses for eight stars, corresponding to a debris disk detection frequency of about 32%. The stars with excesses include two A stars, four F dwarfs and two G dwarfs. The most significant linkage between 24 um excess and any other stellar property for our Blanco 1 sample of stars is with binarity. Blanco 1 members that are photometric binaries show few or no detected 24 um excesses whereas a quarter of the apparently single Blanco 1 members do have excesses. We have examined the MIPS data for two other clusters of similar age to Blanco 1 – NGC 2547 and the Pleiades. The AFGK photometric binary star members of both of these clusters also show a much lower frequency of 24 um excesses compared to stars that lie near the single-star main sequence. We provide a new determination of the relation between V-Ks color and Ks-[24] color for main sequence photospheres based on Hyades members observed with MIPS. As a result of our analysis of the Hyades data, we identify three low mass Hyades members as candidates for having debris disks near the MIPS detection limit.

Accepted by ApJ

http://arxiv.org/abs/1007.0239

Herschel/HIFI observations of spectrally resolved methylidyne signatures toward the high-mass star-forming core NGC 6334I

M.H.D. van der Wiel[1,2], F.F.S. van der Tak[2,1], D.C. Lis[3] and the CHESS and HIFI teams[4]

[1] Kapteyn Astronomical Institute, Groningen, NL
[2] SRON Netherlands Institute for Space Research, Groningen, NL
[3] California Institute of Technology, Pasadena, USA
[4] various

E-mail contact: wiel *at* astro.rug.nl

Context. In contrast to the more extensively studied dense star-forming cores, little is known about diffuse gas surrounding star-forming regions.
Aims. We study the molecular gas in the Galactic high-mass star-forming region NGC 6334I, which contains diffuse, quiescent components that are inconspicuous in widely used molecular tracers such as CO.
Methods. We present Herschel/HIFI observations of methylidyne (CH) toward NGC 6334I observed as part of the 'Chemical Herschel Surveys of Star Forming Regions' (CHESS) key program. HIFI resolves each of the six hyperfine components of the lowest rotational transition ($J{=}\frac{3}{2}{-}\frac{1}{2}$) of CH, observed in both emission and absorption.
Results. The CH emission features appear close to the systemic velocity of NGC 6334I, while its measured FWHM linewidth of $3\,\mathrm{km\,s^{-1}}$ is smaller than previously observed in dense gas tracers such as NH_3 and SiO. The CH abundance in the hot core is $\sim7\times10^{-11}$, two to three orders of magnitude lower than in diffuse clouds. While other studies find distinct outflows in, e.g., CO and H_2O toward NGC 6334I, we do not detect any outflow signatures in CH. At least two redshifted components of cold absorbing material must be present at -3.0 and $+6.5\,\mathrm{km\,s^{-1}}$ to explain the absorption signatures. We derive a CH column density (N_{CH}) of 7×10^{13} and 3×10^{13} $\mathrm{cm^{-2}}$ for these two absorbing clouds. We find evidence of two additional absorbing clouds at $+8.0$ and $0.0\,\mathrm{km\,s^{-1}}$, both with $N_{\mathrm{CH}} \approx 2\times10^{13}$ $\mathrm{cm^{-2}}$. Turbulent linewidths for the four absorption components vary between 1.5 and $5.0\,\mathrm{km\,s^{-1}}$ in FWHM. We constrain the physical properties and locations of the clouds by matching our CH absorbers with the absorption signatures seen in other molecular tracers.
Conclusions. In the hot core, molecules such as H_2O and CO trace gas that is heated and dynamically influenced by outflow activity, whereas the CH molecule traces more quiescent material. The four CH absorbing clouds have column densities and turbulent properties that are consistent with those of diffuse clouds: two are located in the direct surroundings of NGC 6334, and two are unrelated foreground clouds. Local density and dynamical effects influence the chemical composition of the physical components of NGC 6334, which causes some components to be seen in CH but not in other tracers, and vice versa.

Accepted by Astronomy & Astrophysics Letters, HIFI special issue

http://arxiv.org/abs/1007.1539

The burst mode of accretion and disk fragmentation in the early embedded stages of star formation

Eduard Vorobyov[1] **and Shantanu Basu**[2]

[1] The Institute for Computational Astrophysics, Saint Mary's University, Halifax, Canada
[2] The University of Western Ontario, London, Canada

E-mail contact: vorobyov *at* ap.smu.ca

We revisit our original papers on the burst mode of accretion by incorporating a detailed energy balance equation into a thin-disk model for the formation and evolution of circumstellar disks around low-mass protostars. Our model includes the effect of radiative cooling, viscous and shock heating, and heating due to stellar and background irradiation. Following the collapse from the prestellar phase allows us to model the early embedded phase of disk formation and evolution. During this time, the disk is susceptible to fragmentation, depending upon the properties of the initial prestellar core. Globally, we find that higher initial core angular momentum and mass content favors more fragmentation, but higher levels of background radiation can moderate the tendency to fragment. A higher rate of mass infall onto the disk than that onto the star is a necessary but not sufficient condition for disk fragmentation. More locally, both the Toomre Q-parameter needs to be below a critical value *and* the local cooling time needs to be shorter than a few times the local dynamical time. Fragments that form during the early embedded phase tend to be driven into the inner disk regions, and likely trigger mass accretion and luminosity bursts that are similar in magnitude to FU-Orionis-type or EX-Lupi-like events. Disk accretion is shown to be an intrinsically variable process, thanks to disk fragmentation, nonaxisymmetric structure, and the effect of gravitational torques. The additional effect of a generic α-type viscosity acts to reduce burst frequency and accretion variability, and is likely to not be viable for values of α significantly greater than 0.01.

Accepted by The Astrophysical Journal

Herschel observations of the hydroxyl radical (OH) in young stellar objects

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

[1] Institute for Astronomy, ETH Zurich, 8093 Zurich, Switzerland
[2] Max Planck Institut für Extraterrestrische Physik, Giessenbachstrasse 1, 85748 Garching, Germany
[3] Leiden Observatory, Leiden University, PO Box 9513, 2300 RA Leiden, The Netherlands
[4] Department of Physics and Astronomy, Denison University, Granville, OH, 43023, USA
[5] Institute of 4D Technologies, University of Applied Sciences NW, CH-5210 Windisch, Switzerland
[6] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, MS 42, Cambridge, MA 02138, USA
[7] Centro de Astrobiología. Departamento de Astrofísica. CSIC-INTA. Carretera de Ajalvir, Km 4, Torrejón de Ardoz. 28850, Madrid, Spain.
[8] Université de Bordeaux, Laboratoire d'Astrophysique de Bordeaux, France; CNRS/INSU, UMR 5804, Floirac, France
[9] Observatorio Astronómico Nacional (IGN), Calle Alfonso XII,3. 28014, Madrid, Spain
[10] INAF - Istituto di Fisica dello Spazio Interplanetario, Area di Ricerca di Tor Vergata, via Fosso del Cavaliere 100, 00133 Roma, Italy
[11] Department of Astronomy, The University of Michigan, 500 Church Street, Ann Arbor, MI 48109-1042, USA
[12] Department of Radio and Space Science, Chalmers University of Technology, Onsala Space Observatory, 439 92 Onsala, Sweden
[13] California Institute of Technology, Division of Geological and Planetary Sciences, MS 150-21, Pasadena, CA 91125, USA
[14] School of Physics and Astronomy, University of Leeds, Leeds LS2 9JT, UK

[15] INAF - Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, 50125 Firenze, Italy
[16] Astronomical Institute Anton Pannekoek, University of Amsterdam, Kruislaan 403, 1098 SJ Amsterdam, The Netherlands
[17] Department of Astrophysics/IMAPP, Radboud University Nijmegen, P.O. Box 9010, 6500 GL Nijmegen, The Netherlands
[18] LERMA and UMR 8112 du CNRS, Observatoire de Paris, 61 Av. de l'Observatoire, 75014 Paris, France
[19] University of Waterloo, Department of Physics and Astronomy, Waterloo, Ontario, Canada
[20] Observatorio Astronómico Nacional, Apartado 112, 28803 Alcalá de Henares, Spain
[21] INAF - Osservatorio Astronomico di Roma, 00040 Monte Porzio catone, Italy
[22] SRON Netherlands Institute for Space Research, PO Box 800, 9700 AV, Groningen, The Netherlands
[23] National Research Council Canada, Herzberg Institute of Astrophysics, 5071 West Saanich Road, Victoria, BC V9E 2E7, Canada
[24] Department of Physics and Astronomy, University of Victoria, Victoria, BC V8P 1A1, Canada
[25] Centre for Star and Planet Formation, Natural History Museum of Denmark, University of Copenhagen, Øster Voldgade 5-7, DK-1350 Copenhagen K., Denmark
[26] Department of Astronomy, Stockholm University, AlbaNova, 106 91 Stockholm, Sweden
[27] California Institute of Technology, Cahill Center for Astronomy and Astrophysics, MS 301-17, Pasadena, CA 91125, USA
[28] the University of Western Ontario, Department of Physics and Astronomy, London, Ontario, N6A 3K7, Canada
[29] Department of Physics and Astronomy, Johns Hopkins University, 3400 North Charles Street, Baltimore, MD 21218, USA
[30] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany
[31] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA
[32] Department of Physics and Astronomy, University of Calgary, Calgary, T2N 1N4, AB, Canada
[33] Instituto de Radioastronomía Milimétrica (IRAM), Avenida Divina Pastora 7, Núcleo Central, E-18012 Granada, Spain
[34] Kapteyn Astronomical Institute, University of Groningen, PO Box 800, 9700 AV, Groningen, The Netherlands
[35] Centre d'Etude Spatiale des Rayonnements, Université de Toulouse [UPS], 31062 Toulouse Cedex 9, France
[36] CNRS/INSU, UMR 5187, 9 avenue du Colonel Roche, 31028 Toulouse Cedex 4, France
[37] KOSMA, I. Physik. Institut, Universität zu Köln, Zülpicher Str. 77, D 50937 Köln, Germany

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

'Water in Star-forming regions with Herschel' (WISH) is a Herschel Key Program investigating the water chemistry in young stellar objects (YSOs) during protostellar evolution. Hydroxyl (OH) is one of the reactants in the chemical network most closely linked to the formation and destruction of H_2O. High-temperature ($T > 250$ K) chemistry connects OH and H_2O through the OH + $H_2 \Leftrightarrow H_2O$ + H reactions. Formation of H_2O from OH is efficient in the high temperature regime found in shocks and the innermost part of protostellar envelopes. Moreover, in the presence of UV photons, OH can be produced from the photo-dissociation of H_2O through $H_2O + \gamma_{\rm UV} \Rightarrow$ OH + H.
High-resolution spectroscopy of the 163.12 μm triplet of OH towards HH 46 and NGC 1333 IRAS 2A was carried out with the Heterodyne Instrument for the Far Infrared (HIFI) on board the Herschel Space Observatory. The low- and intermediate-mass protostars HH 46, TMR 1, IRAS 15398-3359, DK Cha, NGC 7129 FIRS 2 and NGC 1333 IRAS 2A were observed with the Photodetector Array Camera and Spectrometer (PACS) on Herschel in four transitions of OH and two [OI] lines.
The OH transitions at 79, 84, 119, and 163 μm and [OI] emission at 63 and 145 μm were detected with PACS towards the class I low-mass YSOs as well as the intermediate-mass and class I Herbig Ae sources. No OH emission was detected from the class 0 YSO NGC 1333 IRAS 2A, though the 119 μm was detected in absorption. With HIFI, the 163.12 μm was not detected from HH 46 and only tentatively detected from NGC 1333 IRAS 2A. The combination of the PACS and HIFI results for HH 46 constrains the line width (FWHM > 11 km s^{-1}) and indicates that the OH emission likely originates from shocked gas. This scenario is supported by trends of the OH flux increasing with the [OI] flux and the bolometric luminosity, as found in our sample.
Similar OH line ratios for most sources suggest that OH has comparable excitation temperatures despite the different physical properties of the sources.

Accepted by Astronomy & Astrophysics (Herschel HIFI special issue)

http://arxiv.org/abs/1007.2198

Dependence of the Turbulent Velocity Field on Gas Density in L1551

Atsushi Yoshida[1], Yoshimi Kitamura[2], Yoshito Shimajiri[3,4] and Ryohei Kawabe[4,5]

[1] Department of Earth and Planetary Sciences, Tokyo Institute of Technology, 2-12-1, Ookayama, Meguro-ku, Tokyo 152-8551, Japan

[2] Institute of Space and Astronautical Science/Japan Aerospace Exploration Agency, 3-1-1, Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan

[3] Department of Astronomy, School of Science, University of Tokyo, Bunkyo, Tokyo 113-0033, Japan

[4] Nobeyama Radio Observatory, Minamimaki, Minamisaku, Nagano 384-1805, Japan

[5] National Astronomical Observatory of Japan, Osawa 2-21-1, Mitaka, Tokyo 181-8588, Japan

E-mail contact: ayoshida *at* geo.titech.ac.jp

qWe have carried out mapping observations of the entire L1551 molecular cloud with about 2 pc × 2 pc size in the ^{12}CO(1-0) line with the Nobeyama 45 m radio telescope at the high effective resolution of 22″ (corresponding to 0.017 pc at the distance of 160 pc), and analyzed the ^{12}CO data together with the ^{13}CO(1-0) and C^{18}O(1-0) data from the Nobeyama Radio Observatory database. We derived the new non-thermal line width−size relations, $\sigma_{\rm NT} proptoL^{\gamma}$, for the three molecular lines, corrected for the effect of optical depth and the line-of-sight integration. To investigate the characteristic of the intrinsic turbulence, the effects of the outflows were removed. The derived relations are ($\sigma_{\rm NT}$/km s^{-1}) = $(0.18 \pm 0.010)(L/{\rm pc})^{0.45\pm0.095}$, $(0.20 \pm 0.020)(L/{\rm pc})^{0.48\pm0.091}$, and $(0.22 \pm 0.050)(L/{\rm pc})^{0.54\pm0.21}$ for the ^{12}CO, ^{13}CO, and C^{18}O lines, respectively, suggesting that the line width−size relation of the turbulence very weakly depends on our observed molecular lines, i.e., the relation does not change between the density ranges of $10^2 - 10^3$ and $10^3 - 10^4$ cm^{-3}. In addition, the relations indicate that incompressible turbulence is dominant at the scales smaller than 0.6 pc in L1551. The power spectrum indices converted from the relations, however, seem to be larger than that of the Kolmogorov spectrum for incompressible flow. The disagreement could be explained by the anisotropy in the turbulent velocity field in L1551, as expected in MHD turbulence. Actually, the autocorrelation functions of the centroid velocity fluctuations show larger correlation along the direction of the magnetic field measured for the whole Taurus cloud, which is consistent with the results of numerical simulations for incompressible MHD flow.

Accepted by ApJ

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
.

The Star Formation Newsletter is available on the World Wide Web at http://www.ifa.hawaii.edu/users/reipurth/newsletter.htm.

Circumstellar Disk Structure and Evolution through Resolved Submillimeter Observations

A. Meredith Hughes

Harvard University

60 Garden St. MS-10, Cambridge, MA 02138

Address as of 30 Aug 2010: UC Berkeley Dept. of Astronomy, 601 Campbell Hall, Berkeley, CA 94720

Electronic mail: mhughes *at* cfa.harvard.edu

Ph.D dissertation directed by: David J. Wilner

Ph.D degree awarded: May 2010

Circumstellar disks provide the reservoirs of raw material and determine conditions for the formation of nascent planetary systems. This thesis presents observations from millimeter-wavelength interferometers, particularly the Submillimeter Array, that address the following outstanding problems in the study of protoplanetary disks: (1) constraining the physical mechanisms driving the viscous transport of material through the disk, and (2) carrying out detailed studies of 'transitional' objects between the gas-rich protoplanetary and tenuous, dusty debris disk phases to better understand how gas and dust are cleared from the system. We study accretion processes in three complementary ways: using spatially resolved observations of molecular gas lines at high spectral resolution to determine the magnitude and spatial distribution of turbulence in the disk; using polarimetry to constrain the magnetic properties of the outer disk in order to evaluate whether the MRI is a plausible origin for this turbulence; and investigating the gas and dust distribution at the outer disk edge in the context of self-similar models of accretion disk structure and evolution. The studies of transition disks use spatially resolved observations to study the detailed structure of the gas and dust in systems that are currently in the process of clearing material. We obtain snapshots of the inside-out clearing of gas and dust in several systems, and compare our observations with the theoretical predictions generated for different disk clearing mechanisms. Our observations are generally consistent with the characteristics predicted for viscous transport driven by the magnetorotational instability and disk clearing accomplished through the dual action of giant planet formation and photoevaporation by energetic radiation from the star.

https://www.cfa.harvard.edu/~mhughes/download/amh_thesis.pdf

First Announcement

CPS 7th International School of Planetary Sciences

https://www.cps-jp.org/~pschool/pub/2011-01-10/index.html

Date: 10 – 15 January 2011

Venue: Seapal Suma, a casual seaside resort located in the west part of Kobe, Japan

Address: 1-1-1 Sumaura-dori, Suma, Kobe 654-0055 Japan
Phone: +81 78 731 6815 / Fax: +81 78 734 1896
Japanese site: http://www.seapalsuma.com/?
English site: http://web.travel.rakuten.co.jp/portal/my/info_page_e.Eng?f_no=13907&f_ptn1=&f_teikei=

Objective and Scope:
The objective of CPS International School of Planetary Sciences is to promote education and research in planetary sciences for highly motivated graduate students and young researchers worldwide. It will offer them an opportunity to interact with leading scientists in a specific field of the year. Note that 'Planetary Sciences' includes astronomy (astrophysics, astrochemistry, astrobiology, etc.), geosciences, space science, and other related fields.

Topic of the coming school:
Theory of Stellar Evolution and Its Applications – from the First Stars to Planet-Hosting Stars and Gas Giant Planets

The main part of the school will be a series of lectures on the structure and evolution of stars with various masses including gas giant planets and on the effects of mass loss and stellar rotation upon them. Then a series of lectures follow on their contributions to the nucleosynthesis and chemical evolution of the Milky Way and dwarf galaxies in the local group and to the evolutionary characteristics of planet-hosting stars from theoretical and observational viewpoints. The development of our understandings in these fields has been achieved by recent observations with large ground-based telescopes and space telescopes and owing to large-scaled surveys of metal-poor stars, supernova searches and searches for exo-planetary systems.

CPS 7th International School has a special session dedicated to the memory of Prof. Chushiro Hayashi who was one of the founders of the theory of stellar evolution and passed away in 2010.

Internationally well-established experts in various fields will review recent progress in our understandings of those fields. The lecturers and their topics are listed below:

Daiichiro Sugimoto (The University of Tokyo, Japan)
—Why the Stars and the Universe evolve? — Fundamentals of Stellar Structure and Evolution and Their Gravothermal Natures

Peter R. Wood (Australian National University, Australia)
—Evolution and Mass Loss of Low- and Intermediate-Mass Stars

Georges Meynet (University of Geneva, Switzerland)
—Evolution of Massive Stars and the Effects of Rotation

Stanley P. Owocki (University of Delaware, USA)
—Mass Loss from Massive Stars

Alexander Heger (University of Minnesota, USA)
—Explosive Nucleosynthesis

Martin Asplund (Max-Planck-Institut für Astrophysik, Germany)
—Solar Abundances, Solar Twins, and Planet Harboring Stars

Arlette Noels (Université de Liège, Belgium)
—Seismology and Oscillations of Stars

Jonathan J. Fortney (University of California, Santa Cruz, USA)
—Structure and Evolution of Gas Giant Planets

Andrea Ferrara (Scuola Normale Superiore, Italy)
—Star Formation in the Early Universe and the Transition from Population III to Populations II and I

Eline Tolstoy (University of Groningen, The Netherlands)
—Chemical Evolution of the Milky Way and Local Group Galaxies

Memorial Lecture for Prof. Chushiro Hayashi
Daiichiro Sugimoto (The University of Tokyo, Japan) —The Discovery of Hayashi Phase and His Way of Thinking

Who are the target participants?
- The lectures are targeted on PhD students and post-docs
- Please note that this school is not for bachelor and diploma students
- All the lectures are in English and we welcome eligible applicants worldwide

How to apply?
- Please go to the following webpage
https://www.cps-jp.org/guestEntryPrivacypolicySimple.php?ml_lang=en
First, create your CPS account at this page.
Then, go to CPS website https://www.cps-jp.org/ and login with your CPS User ID you have registered.
You will see 'CPS 7th International School of Planetary Sciences' at the right column. Click there and start registration application.

Important Dates:
All deadline times are 23:59 Japanese Standard Time, UTC+9

22 August 2010	Travel Grant Application deadline
29 August 2010	Registration Application deadline
9 September 2010	Result Notification
27 November 2010	Poster presentation abstract deadline
10-15 January 2011	CPS 7th International School of Planetary Sciences

Advisory Committee
Ken-ichi Nomoto (IPMU, The University of Tokyo)
Hiroyasu Ando (National Astronomical Observatory of Japan)
Takashi Kozasa (Hokkaido University)
Hiromoto Shibahashi (The University of Tokyo)
Nobuo Arimoto (National Astronomical Observatory of Japan)
Toshitaka Kajino (National Astronomical Observatory of Japan)
Toshikazu Shigeyama (RESCEU, The University of Tokyo)
Issei Yamamura (ISAS/JAXA)
Wako Aoki (National Astronomical Observatory of Japan)
Masahiro Ikoma (Tokyo Institute of Technology)

Local Organizing Committee (* Chair, ** Scientific secretary, *** Secretary)
Masayuki Y. Fujimoto* (CPS, Hokkaido University)
Takuma Suda** (Hokkaido University)
Yutaka Katsuta** (Hokkaido University)
Nozomu Tominaga** (Konan University)
Hiroshi Kimura (CPS)
Ko-ichiro Sugiyama (CPS)
Yoshiyuki O. Takahashi (CPS)
Seiya Nishizawa (CPS)
Jun Kimura (CPS)
Ayako Suzuki (CPS)
Takayuki Tanigawa (CPS)
Ko Yamada (CPS)

Asako Sato*** (CPS)
Yoshiko Honjo*** (CPS)
Mire Murakami*** (CPS)
Mariko Hirano*** (CPS)
Yasuko Uematsu*** (CPS)

Program Committee
Masayuki Y. Fujimoto (CPS, Hokkaido University)
Toshikazu Shigeyama (RESCEU, The University of Tokyo)
Yoichi Itoh (CPS, Kobe University)
Yuri Aikawa (CPS, Kobe University)
Masahiro Ikoma (Tokyo Institute of Technology)
Takuma Suda (Hokkaido University)
Nozomu Tominaga (Konan University)

Contact us
E-mail: pschool-7info *at* cps-jp.org
Fax:+81 78 803 5731
Center for Planetary Science
1-1 Rokkodai, Nada, Kobe 657-8501, Japan

Short Announcements

The refereeing process for the HIFI First Result special issue of A & A will conclude on July 31, 2010. As of this writing, a large number of papers have already been accepted and are available through Astroph. Together, these papers give a good impression of the versatility of HIFI and the expected breadth of HIFI's impact on astrophysics and astrochemistry. We want to alert you to the website, **http://hifi.strw.leidenuniv.nl/**, where we collect these papers and provide relevant links to the teams webpages. As a service to the community, we will add HIFI papers, as they are accepted for publication, to this page throughout the mission. So, you might want to bookmark this page as an easy entry point for HIFI results.

Xander Tielens
HIFI project scientist

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.