THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar evolution and molecular clouds

No. 233 — 23 May 2012 Editor: Bo Reipurth (reipurth@ifa.hawaii.edu)

Abstracts of recently accepted papers

On turbulent fragmentation and the origin of the stellar IMF

S. Anathpindika[1]

[1] Indian Institute of Astrophysics, Bangalore, India

E-mail contact: sumedh_a *at* iiap.res.in

Two varieties of the universal stellar initial mass function (IMF) viz., the Kroupa and the Chabrier IMF, have emerged over the last decade to explain the observed distribution of stellar masses. The possibility of the universal nature of the stellar IMF leads us to the interesting prospect of a universal mode of star-formation. It is well-known that turbulent fragmentation of gas in the interstellar medium produces a lognormal distribution of density which is further reflected by the mass-function for clumps at low and intermediate masses. Stars condense out of unstable clumps through a complex interplay between a number of dynamic processes which must be accounted for when tracing the origin of the stellar IMF. In the present work, applying the theory of gravitational fragmentation we first derive the mass function (MF) for clumps. Then a core mass function (CMF) is derived by allowing the clumps to fragment, having subjected each one to a random choice of gas temperature. Finally, the stellar IMF is derived by applying a random core-to-star conversion efficiency, ϵ, in the range of 5%-15% to each CMF. We obtain a power-law IMF that has exponents within the error-bars on the Kropua IMF. This derived IMF is preceded by a similar core mass function which suggests, gravoturbulent fragmentation plays a key role in assembling necessary conditions that relate the two mass-functions. In this sense the star-formation process, at least at low redshifts where gas cooling is efficient, is likely to be universal. We argue that the observed knee in the CMF and the stellar IMF may alternatively be interpreted in terms of the characteristic temperature at which gas in potential star-forming clouds is likely to be found. Our results also show that turbulence in star-forming clouds is probably driven on large spatial scales with a power-spectrum steeper than Kolmogorov-type.

Accepted by New Astronomy

http://arxiv.org/abs/1205.4498

The Green Bank Telescope HII Region Discovery Survey: III. Kinematic Distances

Loren D. Anderson[1], **T. M. Bania**[2], **Dana S. Balser**[3] **and Robert T. Rood**[4]

[1] Department of Physics, West Virginia University, Morgantown, WV 26506, USA
[2] 2 Institute for Astrophysical Research, Department of Astronomy, Boston University, 725 Commonwealth Ave., Boston MA 02215, USA
[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: Loren.Anderson *at* mail.wvu.edu

Using the H I Emission/Absorption method, we resolve the kinematic distance ambiguity and derive distances for 149 of 182 (82%) H II regions discovered by the Green Bank Telescope H II Region Discovery Survey (GBT HRDS). The HRDS is an X-band (9 GHz, 3 cm) GBT survey of 448 previously unknown H II regions in radio recombination line and radio continuum emission. Here we focus on HRDS sources from $67^\circ \geq \ell \geq 18^\circ$, where kinematic distances are more reliable. The 25 HRDS sources in this zone that have negative recombination line velocities are unambiguously

beyond the orbit of the Sun, up to 20 kpc distant. They are the most distant H II regions yet discovered. We find that 61% of HRDS sources are located at the far distance, 31% at the tangent point distance, and only 7% at the near distance. "Bubble" H II regions are not preferentially at the near distance (as was assumed previously) but average 10 kpc from the Sun. The HRDS nebulae, when combined with a large sample of H II regions with previously known distances, show evidence of spiral structure in two circular arc segments of mean Galactocentric radii of 4.25 and 6.0 kpc. We perform a thorough uncertainty analysis to analyze the effect of using different rotation curves, streaming motions, and a change to the Solar circular rotation speed. The median distance uncertainty for our sample of H II regions is only 0.5 kpc, or 5%. This is significantly less than the median difference between the near and far kinematic distances, 6 kpc. The basic Galactic structure results are unchanged after considering these sources of uncertainty.

Accepted by ApJ

http://arxiv.org/abs/1205.4228 Data can be found here: http://www.cv.nrao.edu/hrds/

Circumbinary Gas Accretion onto a Central Binary: Infrared Molecular Hydrogen Emission from GG Tau A

Tracy L. Beck[1], Jeffrey. S. Bary[2], Anne Dutrey[3], Vincent Pietu[4], Stephane Guilloteau[3], S. H. Lubow[1] and M. Simon[5]

[1] STScI
[2] Colgate University
[3] Universit de Bordeaux
[4] IRAM
[5] Stony Brook University

E-mail contact: tbeck *at* stsci.edu

We present high spatial resolution maps of ro-vibrational molecular hydrogen emission from the environment of the GG Tau A binary component in the GG Tau quadruple system. The H_2 v = 1-0 S(1) emission is spatially resolved and encompasses the inner binary, with emission detected at locations that should be dynamically cleared on several hundred-year timescales. Extensions of H_2 gas emission are seen to ∼100 AU distances from the central stars. The v = 2-1 S(1) emission at 2.24 μm is also detected at ∼30 AU from the central stars, with a line ratio of 0.05±0.01 with respect to the v = 1-0 S(1) emission. Assuming gas in LTE, this ratio corresponds to an emission environment at ∼1700 K . We estimate that this temperature is too high for quiescent gas heated by X-ray or UV emission from the central stars. Surprisingly, we find that the brightest region of H_2 emission arises from a spatial location that is exactly coincident with a recently revealed dust "streamer" which seems to be transferring material from the outer circumbinary ring around GG Tau A into the inner region. As a result, we identify a new excitation mechanism for ro-vibrational H_2 stimulation in the environment of young stars. The H_2 in the GG Tau A system appears to be stimulated by mass accretion *infall* as material in the circumbinary ring accretes onto the system to replenish the inner circumstellar disks. We postulate that H_2 stimulated by accretion infall could be present in other systems, particularly binaries and "transition disk" systems which have dust cleared gaps in their circumstellar environments.

Accepted by The Astrophysical Journal

http://arxiv.org/abs/1205.1526

Close encounters of protostellar kind in IC 1396N

M. T. Beltrán[1], F. Massi[1], F. Fontani[1], C. Codella[1,2], and R. López[3]

[1] INAF-Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, 50125 Firenze, Italy
[2] UJF-Grenoble 1/CNRS-INSU, Institut de Planétologie et d'Astrophysique de Grenoble (IPAG) UMR 5274, Grenoble, France
[3] Departament d'Astronomia i Meteorologia, Universitat de Barcelona, Martí i Franquès 1, 08028 Barcelona, Catalunya, Spain

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

We have mapped in the 2.7 mm continuum and ^{12}CO with the PdBI the IR-dark "tail" that crosses the IC 1396N globule from south to north, and is the most extincted part of this cloud. These observations have allowed us to

distinguish all possible associations of molecular hydrogen emission features by revealing two well-collimated low-mass protostellar outflows at the northern part of the globule. The outflows are located almost in the plane of the sky and are colliding with each other towards the position of a strong 2.12 μm H_2 line emission feature.

Accepted by A&A Letters

http://arxiv.org/abs/1205.2267

Crossing the Gould Belt in the Orion vicinity

K. Biazzo[1], J. M. Alcal[1], E. Covino[1], M. F. Sterzik[2], P. Guillout[3], C. Chavarria-K.[4], A. Frasca[5] and R. Raddi[6]

[1] INAF - Osservatorio Astronomico di Capodimonte
[1] INAF - Osservatorio Astronomico di Capodimonte
[1] INAF - Osservatorio Astronomico di Capodimonte
[2] ESO - European Southern Observatory
[3] Observatoire Astronomique de Strasbourg
[4] Universidad Nacional Autonoma de Mexico
[5] INAF - Osservatorio Astrofisico di Catania
[6] University of Hertfordshire

E-mail contact: katia.biazzo *at* oacn.inaf.it

Context: The recent star formation history in the solar vicinity is not yet well constrained, and the real nature of the so-called Gould Belt is still unclear.
Aims: We present a study of the large-scale spatial distribution of 6482 ROSAT All-Sky Survey (RASS) X-ray sources in approximately 5000 deg^2 in the general direction of Orion. We examine the astrophysical properties of a sub-sample of about 100 optical counterparts, using optical spectroscopy. This sub-sample is then used to investigate the space density of the RASS young star candidates by comparing X-ray number counts with Galactic model predictions.
Methods: The young star candidates were selected from the RASS using X-ray criteria. We characterize the observed sub-sample in terms of spectral type, lithium content, radial and rotational velocities, and iron abundance. A population synthesis model is then applied to analyze the stellar content of the RASS in the studied area.
Results: We find that stars associated with the Orion star-forming region, as expected, do show a high lithium content. As in previous RASS studies, a population of late-type stars with lithium equivalent widths larger than that of the Pleiades stars of the same spectral type (hence younger than about 70-100 Myr) is found widely spread over the studied area. Two new young stellar aggregates, namely "X-ray Clump 0534+22" (age: 2-10 Myr) and "X-ray Clump 0430-08" (age: 2-20 Myr), are also identified.
Conclusions: The spectroscopic follow-up and comparison with Galactic model predictions reveal that the X-ray selected stellar population in the general direction of Orion is characterized by three distinct components, namely the clustered, the young dispersed, and the widespread field populations. The clustered population is mainly associated with regions of recent or ongoing star formation and correlates spatially with molecular clouds. The dispersed young population follows a broad lane that apparently coincides spatially with the Gould Belt, while the widespread population consists primarily of active field stars older than 100 Myr. We expect the still "bi-dimensional" picture emerging from this study to grow in depth as soon as the distance and the kinematics of the studied sources will become available from the future Gaia mission.

Accepted by Astronomy and Astrophysics

http://cdsads.u-strasbg.fr/abs/2012arXiv1204.3509B

Mid-Infrared Extinction Mapping of Infrared Dark Clouds II. The Structure of Massive Starless Cores and Clumps

Michael J. Butler[1] and Jonathan C. Tan[1,2]

[1] Dept. of Astronomy, University of Florida
[2] Dept. of Physics, University of Florida

E-mail contact: butler85 *at* astro.ufl.edu

We develop the mid-infrared extinction (MIREX) mapping technique of Butler & Tan (2009, Paper I), presenting a new method to correct for the Galactic foreground emission based on observed saturation in independent cores. Using *Spitzer* GLIMPSE 8 μm images, this allows us to accurately probe mass surface densities, Σ, up to $\simeq 0.5\,\mathrm{g\,cm^{-2}}$ with 2 arcsec resolution and mitigate one of the main sources of uncertainty associated with Galactic MIREX mapping. We then characterize the structure of 42 massive starless and early-stage cores and their surrounding clumps, selected from 10 infrared dark clouds (IRDCs), measuring $\Sigma_{\rm cl}(r)$ from the core/clump centers. We first assess the properties of the core/clump at a scale where the total enclosed mass as projected on the sky is $M_{\rm cl} = 60\,M_\odot$. We find these objects have a mean radius of $R_{\rm cl} \simeq 0.1$ pc, mean $\bar{\Sigma}_{\rm cl} = 0.3\ g\ cm^{-2}$ and, if fit by a power law density profile $\rho_{\rm cl} \propto r^{-k_{\rho,{\rm cl}}}$, a mean value of $k_{\rho,{\rm cl}} = 1.1$. If we assume a core is embedded in each clump and subtract the surrounding clump envelope to derive the core properties, we find a mean core density power law index of $k_{\rho,c} = 1.6$. We repeat this analysis as a function of radius and derive the best-fitting power law plus uniform clump envelope model for each of the 42 core/clumps. The cores have typical masses of $M_c \sim 100\,M_\odot$ and $\bar{\Sigma}_c \sim 0.1\ g\ cm^{-2}$, and are embedded in clumps with comparable mass surface densities. We also consider Bonnor-Ebert density models, but these do not fit the observed Σ profiles as well as power laws. We conclude massive starless cores exist and are well-described by singular polytropic spheres. Their relatively low values of Σ and the fact that they are IR dark may imply that their fragmentation is inhibited by magnetic fields rather than radiative heating. Comparing to massive star-forming cores and clumps, there is tentative evidence for an evolution towards higher densities and steeper density profiles as star formation proceeds.

Accepted by The Astrophysical Journal

http://arxiv.org/abs/1205.2391

Resolving the Circumstellar Disk Around the Massive Protostar Driving the HH 80-81 Jet

Carlos Carrasco-Gonzalez[1], Roberto Galvan-Madrid[2], Guillem Anglada[3], Mayra Osorio[3], Paola D'Alessio[4], Peter Hofner[5,6], Luis F. Rodriguez[4], Hendrik Linz[7] and Esteban D. Araya[8]

[1] Max-Planck-Institut fuer Radioastronomie
[2] European Southern Observatory (Garching)
[3] Instituto de Astrofisica de Andalucia
[4] Centro de Radioastronomia y Astrofisica, UNAM
[5] Physics Department, New Mexico Tech
[6] National Radio Astronomy Observatory (Socorro)
[7] Max-Planck-Institut fuer Astronomie
[8] Physics Department, Western Illinois University

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

We present new high-angular resolution observations toward the driving source of the HH 80–81 jet (IRAS 18162–2048). Continuum emission was observed with the Very Large Array at 7 mm and 1.3 cm, and with the Submillimeter Array at 860 μm, with angular resolutions of $\sim 0.1''$ and $\sim 0.8''$ respectively. Submillimeter observations of the sulfur oxide (SO) molecule are reported as well. At 1.3 cm the emission traces the well-known radio jet, while at 7 mm the continuum morphology is quadrupolar and seems to be produced by a combination of free-free and dust emission. An elongated structure perpendicular to the jet remains in the 7 mm image after subtraction of the free-free contribution. This structure is interpreted as a compact accretion disk of ~ 200 AU radius. Our interpretation is favored by the presence of rotation in our SO observations observed at larger scales. The observations presented here add to the small list of cases where the hundred-AU scale emission from a circumstellar disk around a massive protostar has been resolved.

Accepted by ApJ Letters

http://arxiv.org/abs/1205.3302

HII Regions, Embedded Protostars, and Starless Cores in Sharpless 2-157

Chian-Chou Chen[1], Jonathan P. Williams[1] and Jagadheep D. Pandian[1]

[1] Institute for Astronomy, University of Hawaii, Honolulu

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

We present arcsecond resolution 1.4mm observations of the high mass star forming region, Sharpless 2-157, that reveal the cool dust associated with the first stages of star formation. These data are compared with archival images at optical, infrared, and radio wavelengths, and complemented with new arcsecond resolution mid-infrared data. We identify a dusty young HII region, numerous infrared sources within the cluster envelope, and four starless condensations. Three of the cores lie in a line to the south of the cluster peak, but the most massive one is right at the center and associated with a jumble of bright radio and infrared sources. This presents an interesting juxtaposition of high and low mass star formation within the same cluster which we compare with similar observations of other high mass star forming regions and discuss in the context of cluster formation theory.

Accepted by Astrophysical Journal

http://arxiv.org/abs/1204.4486

A spectroscopic survey on the multiplicity of high-mass stars

R. Chini[1,2], V.H. Hoffmeister[1], A. Nasseri[1], O. Stahl[3] and H. Zinnecker[4]

[1] Astronomisches Institut, Ruhr-Universität Bochum, Universitätsstraße 150, D-44780 Bochum, Germany
[2] Instituto de Astronomía, Universidad Católica del Norte, Antofagasta, Chile
[3] ZAH, Landessternwarte Heidelberg-Königstuhl, D-69117 Heidelberg, Germany
[4] SOFIA Science Center, Mailstop 211-3, Moffett Field, CA94035, USA

E-mail contact: chini *at* astro.rub.de

The formation of stars above about twenty solar masses and their apparently high multiplicity remain heavily debated subjects in astrophysics. We have performed a vast high-resolution radial velocity spectroscopic survey of about 250 O- and 540 B-type stars in the southern Milky Way which indicates that the majority of stars ($> 82\%$) with masses above 16 solar masses form close binary systems while this fraction rapidly drops to 20% for stars of 3 solar masses. The binary fractions of O-type stars among different environment classes are: clusters ($72 \pm 13\%$), associations ($73 \pm 8\%$), field ($43 \pm 13\%$), and runaways ($69 \pm 11\%$). The high frequency of close pairs with components of similar mass argues in favour of a multiplicity originating from the formation process rather than from a tidal capture in a dense cluster. The high binary frequency of runaway O stars that we found in our survey (69% compared to $19 - 26\%$ in previous surveys) points to the importance of ejection from young star clusters and thus supports the competitive accretion scenario.

Accepted by MNRAS

New members of the massive stellar population in Cygnus

F. Comerón[1] and A. Pasquali[2]

[1] European Southern Observatory, Karl-Schwarzschild-Str. 2, D-85748 Garching bei München, Germany
[2] Astronomisches Rechen-Institut, Zentrum für Astronomie der Universität Heidelberg, Mönchhofstr. 12-14, D-69120 Heidelberg, Germany

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

Context: The Cygnus OB2 association and its surroundings display the richest collection of massive stars in our nearby Galactic environment and a wealth of signposts of the interaction between these stars and the interstellar gas.
Aims: We perform a magnitude-limited, homogeneous census of O and early B-type stars with accurate spectral classifications in the blue, in a $6^\circ \times 4^\circ$ region centered on Cygnus OB2 that includes most of the Cygnus X complex, a sizeable fraction of the adjacent Cygnus OB9 association, and a large area of the field surrounding these complexes.
Methods: By using reddening-free indices based on $BJHK$ magnitudes from the USNO-B and 2MASS catalogs, we are able to produce a highly complete, highly uncontaminated sample of O and early B stars, which nearly duplicates any previous census of the region for the same range of spectral types. We provide the spectral types of 60 new O and B stars, as well as a list of an additional 60 candidates pending spectroscopic confirmation. In addition, the UBV imaging of the surroundings of three apparently isolated O stars is used to investigate the possible presence of small

clusters of young stars around them.
Results: Early-type stars are consistent with similar distances for Cygnus OB2, OB9, and the field stars surrounding them. We confirm previous findings of an older population in Cygnus OB2 spatially offset from where the stellar density of the association peaks. Some new remarkable objects are identified, including BD+40 4210, a B0 supergiant member of Cygnus OB2 that is among the brightest members of the association sharing some characteristics with luminous blue variable (LBV) candidates, located at a projected distance of 5 pc from another LBV candidate. A new O5If member of Cygnus OB9 is found, as well as several other O stars and B supergiants. On the other hand, while no obvious clustering is found around the apparently isolated O stars, the fields around two of them seem to contain objects with strong ultraviolet excessethey are accreting, although their nature and possible relationship to the O stars in the field are unclear.
Conclusions: Star formation in Cygnus has been taking place in a sustained manner for well over 10 Myr, with a large-scale trend of proceeding from lower to higher Galactic longitudes. Star formation inside Cygnus OB2 follows this trend, with indications of intense star formation activity having started in the southern (lower galactic latitude) part of the association about 10 Myr ago and probably continuing at present in the north.

Accepted by Astronomy and Astrophysics

http://www.eso.org/∼fcomeron/cyg_large.pdf

The molecular gas content of the Pipe Nebula I. Direct evidence of outflow-generated turbulence in B59?

A. Duarte-Cabral[1,2,3], A. Chrysostomou[4], N. Peretto[5], G. A. Fuller[3], B. Matthews[6,7], G. Schieven[6,7] and G. R. Davis[4]

[1] Univ. Bordeaux, LAB, UMR 5804, F-33270, Floirac, France.
[2] CNRS, LAB, UMR 5804, F-33270, Floirac, France
[3] Jodrell Bank Centre for Astrophysics, School of Physics and Astronomy, University of Manchester, Oxford Road, Manchester, M13 9PL, U.K.
[4] Joint Astronomy Centre, 660 North Aohoku Place, Hilo, HI 96720, USA
[5] Laboratoire AIM, CEA/DSM-CNRS-Universite Paris Diderot, IRFU/Service d'Astrophysique, C.E.Saclay, Orme de merisiers, 91191 Gif-sur-Yvette, France
[6] Herzberg Institute of Astrophysics, National Research Council Canada, 5071 West Saanich Road., Victoria, BC, Canada, V9E 2E7, Canada
[7] University of Victoria, Finnerty Road, Victoria, BC, V8W 3P6 Canada

E-mail contact: cabral *at* obs.u-bordeaux1.fr

Star forming regions may share many characteristics, but the specific interplay between gravity, magnetic fields, large-scale dynamics, and protostellar feedback will have an impact on the specific star formation history of each region. The particular importance of outflows is subject of debate, where we are yet to understand whether they can input and sustain turbulence in the cloud, and if this turbulence is enough to support the cloud and prevent further fragmentation. The Pipe Nebula is a molecular cloud hosting the B59 region as its only active star-forming clump. The quiet nature of the gas in this cloud makes B59 a good site to directly see the impact of protostellar feedback on the quiescent dense gas. This paper focuses on a study of the global dynamics of B59, its temperature structure, and its outflowing gas, with the goal of revealing the local and global impact of the protostellar outflows. Using HARP at the JCMT, we mapped the B59 region with the J = 3 - 2 transition of ^{12}CO to study the kinematics and energetics of the outflows, and ^{13}CO and C^{18}O to study the overall dynamics of the ambient cloud, the physical properties of the gas, and the hierarchical structure of the region.
The B59 region has a total of ~ 30 M$_\odot$ of cold and quiescent material, mostly gravitationally bound, with narrow line widths throughout. Such low levels of turbulence in non-star-forming sites of B59 are indicative of the intrinsic initial conditions of the cloud. On the other hand, close to the forming protostars the impact of the outflows is observed as a localised increase of both line widths from ~ 0.3 km/s to ~ 1 km/s, and ^{13}CO excitation temperatures by 2 - 3 K. The impact of the outflows is also evident in the low column density material which shows signs of being pushed, shaped and carved by the outflow bow shocks as they pierce their way out of the cloud. Much of this structure is readily apparent in a dendrogram analysis of the cloud. B59's low mass, intrinsically quiescent gas and small number of protostars, allows the identification of specific regions of the outflows' interaction with the dense gas. Our study

suggests that outflows are an important mechanism in injecting and sustaining supersonic turbulence at sub-parsec scales. We find that only a fraction, i.e. less than half, of the outflow energy is deposited as turbulent energy of the gas. This turbulent energy is sufficient to slow down the collapse of the region.

Accepted by A&A

http://arxiv.org/abs/1205.4100

Distances to Dark Clouds: Comparing Extinction Distances to Maser Parallax Distances

Jonathan B. Foster[1], Joseph J. Stead[2], Robert A. Benjamin[3], Melvin G. Hoare[2] and James M. Jackson[1]

[1] Institute for Astrophysical Research, Boston University, Boston, MA 02215, USA
[2] School of Physics and Astronomy, University of Leeds, Leeds LS2 9JT, UK
[3] Physics Department, University of Wisconsin Whitewater, Whitewater, WI 53190, USA

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

We test two different methods of using near-infrared extinction to estimate distances to dark clouds in the first quadrant of the Galaxy using large near-infrared (Two Micron All Sky Survey and UKIRT Infrared Deep Sky Survey) surveys. Very long baseline interferometry parallax measurements of masers around massive young stars provide the most direct and bias-free measurement of the distance to these dark clouds. We compare the extinction distance estimates to these maser parallax distances. We also compare these distances to kinematic distances, including recent re-calibrations of the Galactic rotation curve. The extinction distance methods agree with the maser parallax distances (within the errors) between 66% and 100% of the time (depending on method and input survey) and between 85% and 100% of the time outside of the crowded Galactic center. Although the sample size is small, extinction distance methods reproduce maser parallax distances better than kinematic distances; furthermore, extinction distance methods do not suffer from the kinematic distance ambiguity. This validation gives us confidence that these extinction methods may be extended to additional dark clouds where maser parallaxes are not available.

Accepted by ApJ

http://arxiv.org/abs/1204.5484

Chandra/ACIS-I study of the X-ray properties of the NGC 6611 and M16 stellar population

Guarcello, M. G.[1], Caramazza, M.[2], Micela, G.[2], Sciortino, S.[2], Drake, J. J.[1] and Prisinzano, L.[2]

[1] Smithsonian Astrophysical Observatory, MS-67, 60 Garden Street, Cambridge, MA 02138, USA
[2] INAF - Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, 90134 Palermo, Italy

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

Mechanisms regulating the origin of X-rays in YSOs and the correlation with their evolutionary stage are under debate. Studies of the X-ray properties in young clusters allow to understand these mechanisms. One ideal target for this analysis is the Eagle Nebula (M16), with its central cluster NGC6611. At 1750 pc from the Sun, it harbors 93 OB stars, together with a population of low-mass stars from embedded protostars to disk-less Class III objects, with age ≤ 3 Myrs. We study an archival 78 ksec Chandra/ACIS-I observation of NGC6611, and two new 80 ksec observations of the outer region of M16, one centered on the Column V, and one on a region of the molecular cloud with ongoing star-formation. We detect 1755 point sources, with 1183 candidate cluster members (219 disk-bearing and 964 disk-less). We study the global X-ray properties of M16 and compare them with those of the Orion Nebula Cluster. We also compare the level of X-ray emission of Class II and Class III stars, and analyze the X-ray spectral properties of OB stars. Our study supports the lower level of X-ray activity for the disk-bearing stars with respect to the disk-less members. The X-ray Luminosity Function (XLF) of M16 is similar to that of Orion, supporting the universality of the XLF in young clusters. 85% of the O stars of NGC6611 have been detected in X-rays. With only one possible exception, they show soft spectra with no hard component, indicating that mechanisms for the production of hard X-ray emission in O stars are not operating in NGC 6611.

Accepted by ApJ

http://arxiv.org/pdf/1205.2111v1.pdf

On the nature of dust clouds in the region towards M 81 and NGC 3077

Andreas Heithausen[1]

[1] Institut für Physik und ihre Didaktik, Universität zu Köln, Gronewaldstr. 2, 50931 Köln, Germany

E-mail contact: aheithau *at* uni-koeln.de

There is some controversy on the nature of dust clouds found in direction of the interacting galaxy triplett M 81, M 82, and NGC 3077. Are they associated with the tidal arms seen in HI around those galaxies or are they simply Galactic foreground clouds? Data from the SPIRE instrument onboard HERSCHEL and MIPS onboard of SPITZER are used to derive physical parameters for the dust clouds. These observions are compared to CO clouds previously mapped with the IRAM and the FCRAO radio telescopes. SPIRE and MIPS maps show several dust clouds north of M 81 and south of NGC 3077. Modelling of the dust emission provides total hydrogen column densities between 1.5 and $5.0 \cdot 10^{20}\,\mathrm{cm}^{-2}$. Dust temperatures are between 13 to 17 K. No significant difference in the dust emission can be found between individual clouds. It is shown that CO line emission provides the best clues on the origin of those clouds. Most of the clouds seen towards M 81 are associated with small-area molecular structures (SAMS), i.e. tiny CO clouds of Galactic origin. The clouds seen towards NGC 3077 are partly associated with the tidal arms and are partly in the Galactic foreground associated with SAMS.

Accepted by Astronomy & Astrophysics

http://arxiv.org/abs/1205.4531

The M16 molecular complex under the influence of NGC6611. Herschel's perspective of the heating effect on the Eagle Nebula

T. Hill[1], **F. Motte**[1], **P. Didelon**[1], **G. J. White**[2,3], **A. P. Marston**[4], **Q. Nguyen Luong**[1], **S. Bontemps**[5], **Ph. André**[1], **N. Schneider**[1], **M. Hennemann**[1], **M. Sauvage**[1], **J. Di Francesco**[6], **V. Minier**[1], **L. D. Anderson**[7], **J. P. Bernard**[8], **D. Elia**[9], **M. J. Griffin**[10], **J. Z. Li**[11], **N. Peretto**[1], **S. Pezzuto**[9], **D. Polychroni**[9], **H. Roussel**[12], **K. L. J. Rygl**[9], **E. Schisano**[9], **T. Sousbie**[12], **L. Testi**[13], **D. Ward Thompson**[10,14], **and A. Zavagno**[15]

[1] Laboratoire AIM, CEA/IRFU CNRS/INSU Université Paris Diderot, CEA-Saclay, 91191 Gif-sur-Yvette Cedex, France
[2] The Rutherford Appleton Laboratory, Chilton, Didcot, OX11 0NL, UK
[3] Department of Physics and Astronomy, The Open University, Milton Keynes, UK
[4] Herschel Science Centre, ESAC, Spain
[5] Université de Bordeaux, OASU, Bordeaux, France
[6] National Research Council of Canada, 5071 West Saanich Road, Victoria, BC, Canada V9E 2E7.
[7] Department of Physics, West Virginia University, Morgantown, WV 26506, USA
[8] Université de Toulouse, UPS, CESR, 9 avenue du colonel Roche, 31028 Toulouse Cedex 4, France; CNRS, UMR5187, 31028 Toulouse
[9] IAPS- Instituto di Astrofisica e Planetologia Spaziali, via Fosso del Cavaliere 100, 00133 Roma, Italy
[10] School of Physics and Astronomy, Cardiff University, Queens Buildings, The Parade, Cardiff, CF243AA, UK
[11] National Astronomical Observatories, Chinese Academy of Sciences, A20 Datun Road, Chaoyang District, Beijing 100012, China
[12] Institut dAstrophysique de Paris, Université Pierre et Marie Curie (UPMC), CNRS (UMR 7095), 75014 Paris, France
[13] ESO, Karl Schwarzschild str. 2, 85748 Garching bei Munchen, Germany.
[14] Jeremiah Horrocks Institute, University of Central Lancashire, PR1 2HE, UK
[15] Laboratoire d'Astrophysique de Marseille UMR6110, CNRS, Université de Provence, 38 rue F. Joliot-Curie, 13388 Marseille, France

E-mail contact: tracey.hill *at* cea.fr

We present *Herschel* images from the HOBYS key program of the Eagle Nebula (M16) in the far-infrared and sub-millimetre, using the PACS and SPIRE cameras at 70 μm, 160 μm, 250 μm, 350 μm, 500 μm. M16, home to the Pillars of Creation, is largely under the influence of the nearby NGC 6611 high-mass star cluster. The *Herschel* images reveal a clear dust temperature gradient running away from the centre of the cavity carved by the OB cluster. We investigate the heating effect of NGC 6611 on the entire M16 star-forming complex seen by *Herschel* including the

diffuse cloud environment *and* the dense filamentary structures identified in this region. In addition, we interpret the three-dimensional geometry of M16 with respect to the nebula, its surrounding environment, and the NGC 6611 cavity. The dust temperature and column density maps reveal a prominent eastern filament running north-south and away from the high-mass star-forming central region and the NGC 6611 cluster, as well as a northern filament which extends around and away from the cluster. The dust temperature in each of these filaments decreases with increasing distance from the NGC 6611 cluster, indicating a heating penetration depth of ~ 10 pc in each direction in $3-6\times10^{22}$ cm^{-2} column density filaments. We show that in high-mass star-forming regions OB clusters impact the temperature of future star-forming sites, modifying the initial conditions for collapse and effecting the evolutionary criteria of protostars developed from spectral energy distributions. Possible scenarios for the origin of the morphology seen in this region are discussed, including a western equivalent to the eastern filament, which was destroyed by the creation of the OB cluster and its subsequent winds and radiation.

Accepted by A&A

ArXiv e-prints: 1204.6317

Short Gas Dissipation Timescales: Diskless Stars in Taurus and Chamaeleon I

L. Ingleby[1], N. Calvet[1], G. Herczeg[2] and C. Briceno[3]

[1] University of Michigan
[2] The Kavli Institute for Astronomy and Astrophysics
[3] Visiting Scientist, University of Michigan

E-mail contact: lingleby *at* umich.edu

We present an Advanced Camera for Surveys/ Solar Blind Channel far-ultraviolet (FUV) study of H2 gas in 12 weak T Tauri stars in nearby star-forming regions. The sample consists of sources which have no evidence of inner disk dust. Our new FUV spectra show that in addition to the dust, the gas is depleted from the inner disk. This sample is combined with a larger FUV sample of accretors and non-accretors with ages between 1 and 100 Myr, showing that as early as 1–3 Myr, systems both with and without gas are found. Possible mechanisms for depleting gas quickly include viscous evolution, planet formation and photoevaporation by stellar radiation fields. Since these mechanisms alone cannot account for the lack of gas at 1–3 Myr, it is likely that the initial conditions (e.g. initial disk mass or core angular momentum) contribute to the variety of disks observed at any age. We estimate the angular momentum of a cloud needed for most of the mass to fall very close to the central object and compare this to models of the expected distribution of angular momenta. Up to 20% of cloud cores have low enough angular momenta to form disks with the mass close to the star, which would then accrete quickly; this percentage is similar to the fraction of diskless stars in the youngest star forming regions. With our sample, we characterize the chromospheric contribution to the FUV luminosity and find that L_{FUV}/L_{bol} saturates at $\sim 10^{-4.1}$.

Accepted by ApJL

http://arxiv.org/abs/1205.2049

Chemical segregation toward massive hot cores: The AFGL2591 star forming region

Izaskun Jimenez-Serra[1], Qizhou Zhang[1], Serena Viti[2], Jesus Martin-Pintado[3] and Willem-Jan de Wit[4]

[1] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, 02138 Cambridge MA, USA
[2] Department of Physics & Astronomy, University College London, Gower Place, London WC1E 6BT, UK
[3] Centro de Astrobiologia (CSIC/INTA), Ctra. de Torrejon a Ajalvir km 4, E-28850 Torrejon de Ardoz, Madrid, Spain
[4] European Southern Observatory, Alonso de Cordova 3107, Vitacura, Santiago, Chile

E-mail contact: ijimenez-serra *at* cfa.harvard.edu

We present high angular resolution observations (0.5"$\times$0.3") carried out with the Submillimeter Array (SMA) toward the AFGL2591 high-mass star forming region. Our SMA images reveal a clear chemical segregation within the AFGL2591 VLA 3 hot core, where different molecular species (Type I, II and III) appear distributed in three concentric shells. This is the first time that such a chemical segregation is ever reported at linear scales $\leq$3000 AU within a hot core. While Type I species (H_2S and ^{13}CS) peak at the AFGL2591 VLA 3 protostar, Type II molecules (HC_3N, OCS, SO and SO_2) show a double-peaked structure circumventing the continuum peak. Type III species, represented by

CH_3OH, form a ring-like structure surrounding the continuum emission. The excitation temperatures of SO_2, HC_3N and CH_3OH (185±11 K, 150±20 K and 124±12 K, respectively) show a temperature gradient within the AFGL2591 VLA 3 envelope, consistent with previous observations and modeling of the source. By combining the H_2S, SO_2 and CH_3OH images, representative of the three concentric shells, we find that the global kinematics of the molecular gas follow Keplerian-like rotation around a 40 $M_\odot$-star. The chemical segregation observed toward AFGL2591 VLA 3 is explained by the combination of molecular UV photo-dissociation and a high-temperature (∼1000 K) gas-phase chemistry within the low extinction innermost region in the AFGL2591 VLA 3 hot core.

Accepted by Astrophysical Journal

http://arxiv.org/abs/1204.6335

The bipolar outflow and the disk of ISO217

V. Joergens[1,2], A. Pohl[2], A. Sicilia-Aguilar[3] and Th. Henning[2]

[1] Zentrum für Astronomie Heidelberg, Institut für Theoretische Astrophysik, Heidelberg, Germany
[2] Max-Planck Institut für Astronomie, Heidelberg, Germany
[3] Departamento de Física Teórica, Universidad Autónoma de Madrid, Spain

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

We show that the very young brown dwarf candidate ISO 217 (M6.25) is driving an intrinsically asymmetric bipolar outflow with a stronger and slightly faster red-shifted component based on spectro-astrometry of forbidden [S II] emission lines at 6716 Å and 6731 Å observed in UVES/VLT spectra taken in 2009. ISO 217 is only one out of a handful of brown dwarfs and very low-mass stars (M5-M8) for which the existence of an outflow has been detected and which show that the T Tauri phase continues at the substellar limit. We measure a spatial extension of the outflow in [S II] of up to ±190 mas (about ±30 AU) and velocities of up to ±40-50 km s^{-1}. We find that the basic outflow properties (spatial extension, velocities, outflow PA) are of similar order as those determined in the discovery spectra from May 2007 by Whelan and coworkers. We show that the strong velocity asymmetry between both lobes of a factor of two found in 2007 might be smaller than originally anticipated (when using a more realistic stellar rest velocity) and likely evolves over a period of a few years. We detect also forbidden line emission of [Fe II]λ7155 Å, which could potentially originate at the hot inner region of the outflow. To comprehensively understand the ISO 217 system, we have determined the properties of its accretion disk based on radiative transfer modeling of the SED from 0.66 to 24 μm. This disk model is also in very good agreement with Herschel/PACS data at 70 μm. We find that the disk is flared and intermediately inclined (i ∼45°). The total disk mass of the best-fit model is $4\times10^{-6} M_\odot$. This is small compared to the accretion and outflow rate of ISO 217 from the literature (∼ $10^{-10}\, M_\odot\, \mathrm{yr}^{-1}$). We suggest to explain this discrepancy by either a larger disk mass than inferred from the model because of strong undetected grain growth and/or by an on average lower accretion rate and outflow rate than the determined values. We show that a disk inclination significantly exceeding 45°, as suggested from Hα modeling and from the fact that both lobes of the outflow are visible, is not consistent with the SED data. Thus, despite its intermediate inclination angle, the disk of this brown dwarf appears to not obscure the red outflow component in [S II], which is very rarely seen for T Tauri objects in general (only one other case).

Accepted by A&A

http://www.mpia.de/homes/joergens/publications/iso217.pdf

Interactions between brown-dwarf binaries and Sun-like stars

Murat Kaplan[1], Dimitris Stamatellos[2] and Anthony Whitworth[2]

[1] Akdeniz University, Department of Space Sciences and Technologies, 07058 Antalya,Turkey
[2] School of Physics and Astronomy, Cardiff University, Queens Buildings, The Parade, Cardiff, CF24 3AA, Wales, UK

E-mail contact: muratkaplan *at* akdeniz.edu.tr

Several mechanisms have been proposed for the formation of brown dwarfs, but there is as yet no consensus as to which – if any – are operative in nature. Any theory of brown dwarf formation must explain the observed statistics of brown dwarfs. These statistics are limited by selection effects, but they are becoming increasingly discriminating. In particular, it appears (a) that brown dwarfs that are secondaries to Sun-like stars tend to be on wide orbits,

$a \gtrsim 100$ AU (the Brown Dwarf Desert), and (b) that these brown dwarfs have a significantly higher chance of being in a close ($a \lesssim 10$ AU) binary system with another brown dwarf than do brown dwarfs in the field. This then raises the issue of whether these brown dwarfs have formed *in situ*, i.e. by fragmentation of a circumstellar disc; or have formed elsewhere and subsequently been captured. We present numerical simulations of the purely gravitational interaction between a close brown-dwarf binary and a Sun-like star. These simulations demonstrate that such interactions have a negligible chance (< 0.001) of leading to the close brown-dwarf binary being captured by the Sun-like star. Making the interactions dissipative by invoking the hydrodynamic effects of attendant discs might alter this conclusion. However, in order to explain the above statistics, this dissipation would have to favour the capture of brown-dwarf binaries over single brown-dwarfs, and we present arguments why this is unlikely. The simplest inference is that most brown-dwarf binaries – and therefore possibly also most single brown dwarfs – form by fragmentation of circumstellar discs around Sun-like protostars, with some of them subsequently being ejected into the field.

Accepted by Astrophysics and Space Science

A Wide-Field Near-Ir H_2 2.122μm line survey of the Braid Nebula Star Formation Region in Cygnus OB7

T. Khanzadyan[1], C.J. Davis[2,3], C. Aspin[4], D. Froebrich[5], M.D. Smith[5], T.Yu. Magakian[6], T. Movsessian[6], G.H. Moriarty-Schieven[7], E.H. Nikogossian[6], T.S. Pyo[8] and T.L. Beck[9]

[1] Max-Plank-Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany
[2] Joint Astronomy Centre, 660 N. A'ohōkū Place, University Park, Hilo, HI 96720, USA
[3] Astrophysics Division, NASA HQ, 300 E Street SW, Mail Stop 3Y28 Washington DC 20546, USA
[4] Institute for Astronomy, University of Hawaii, 640 N. A'ohōkū Place, Hilo, HI 96720, USA
[5] Centre for Astrophysics & Planetary Science, School of Physical Sciences, The University of Kent, Canterbury CT2 7NH, UK
[6] V. A. Ambartsumyan Byurakan Astrophysical Observatory, 0213 Aragatsotn reg., Armenia
[7] NRC Herzberg Institute of Astrophysics 5071 West Saanich Road Victoria, British Columbia, V9E 2E7, Canada
[8] Subaru Telescope, National Astronomical Observatory of Japan, 650 N. A'ohōkū Place, Hilo, HI 96720, USA
[9] Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA

E-mail contact: tkhanzadyan *at* mpifr.de

Context: Outflows and jets are the first signposts of ongoing star formation processes in any molecular cloud, yet their study in optical bands provides limited results due to the large extinction present. Near-infrared unbiased wide-field observations in the H2 1-0 S(1) line at 2.122 μm alleviates the problem, enabling us to detect more outflows and trace them closer to their driving sources.
Aims: As part of a large-scale multi-waveband study of ongoing star formation in the Braid Nebula Star Formation region, we focus on a one square degree region that includes Lynds Dark Nebula 1003 and 1004. Our goal is to find all of the near-infrared outflows, uncover their driving sources and estimate their evolutionary phase.
Methods: We use near-infrared wide-field observations obtained with WFCAM on UKIRT, in conjunction with previously-published optical and archival MM data, to search for outflows and identify their driving sources; we subsequently use colour-colour analysis to determine the evolutionary phase of each source.
Results: Within a one square degree field we have identified 37 complex MHOs, most of which are new. After combining our findings with other wide-field, multi-waveband observations of the same region we were able to discern 28 outflows and at least 18 protostars. Our analysis suggests that these protostars are younger and/or more energetic than those of the Taurus-Auriga region. The outflow data enable us to suggest connection between outflow ejection and repetitive FU Ori outburst events. We also find that star formation progresses from W to E across the investigated region.

Accepted by A&A

http://dx.doi.org/10.1051/0004-6361/201219124

Integral Field Spectroscopy of the Brightest Knots of HH 223 in L723

R. López[1], B. García-Lorenzo[2,3], R. Estalella[1], A. Riera[4], C. Carrasco-González[5] and G. Gómez[6,2]

[1] Departament d'Astronomia i Meteorologia (IEEC-UB), Institut de Ciències del Cosmos, Universitat de Barcelona,

Martí i Franquès 1, E-08028 Barcelona, Spain.
[2] Instituto de Astrofísica de Canarias, E-38200 La Laguna, Spain.
[3] Departamento de Astrofísica, Universidad de La Laguna, E-38205, Tenerife, Spain.
[4] Dept. Física i Enginyeria Nuclear. EUETI de Barcelona. Universitat Politècnica de Catalunya. Comte d'Urgell 187, E-08036 Barcelona, Spain.
[5] Max-Planck-Institut für Radioastronomie (MPIfR). Auf dem Hügel 69, 53121 Bonn, Germany.
[6] GTC Project Office, GRANTECAN S.A. (CALP), E-38712 Breña Baja, La Palma, Spain.

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

HH 223 is the optical counterpart of a larger scale H_2 outflow, driven by the protostellar source VLA 2A, in L723. Its poorly collimated and rather chaotic morphology suggested the Integral Field Spectroscopy (IFS) as an appropriate option to map the emission for deriving the physical conditions and the kinematics. Here we present new results based on the IFS observations made with the INTEGRAL system at the WHT. The brightest knots of HH 223 ($\sim$ 16 arcsec, $\simeq$ 0.02 pc at a distance of 300 pc) were mapped with a single pointing in the spectral range 6200–7700 Å. We obtained the emission-line intensity maps for Hα, [N II] 6584 Å and [S II] 6716, 6731 Å, and explored the distribution of the excitation and electron density from [N II]/Hα, [S II]/Hα, and [S II] 6716/6731 line-ratio maps. Maps of the radial velocity field were obtained. We analysed the 3D-kinematics by combining the knot radial velocities, derived from IFS data, with the knot proper motions derived from multi-epoch, narrow-band images. The intensity maps built from IFS data reproduced well the morphology found in the narrow-band images. We checked the results obtained from previous long-slit observations with those derived from IFS spectra extracted with a similar spatial sampling. At the positions intersected by the slit, the physical conditions and kinematics derived from IFS are compatible with those derived from long-slit data. In contrast, significant discrepancies were found when the results from long-slit data were compared with the ones derived from IFS spectra extracted at positions shifted a few arcsec from those intersected by the slit. This clearly revealed IFS observations as the best choice to get a reliable picture of the HH emission properties.

Accepted by MNRAS

http://www.am.ub.edu/ robert/ISMpub.html

Inverse dynamical population synthesis: Constraining the initial conditions of young stellar clusters by studying their binary populations

Michael Marks[1,2,3] **and Pavel Kroupa**[1]

[1] Argelander Institut für Astronomie, University of Bonn, Auf dem Hügel 71, 53121 Bonn, Germany
[2] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany
[3] Member of the International Max Planck Research School (IMPRS) for Astronomy and Astrophysics at the Universities of Bonn and Cologne

E-mail contact: mmarks *at* astro.uni-bonn.de

Binary populations in young star clusters show multiplicity fractions both lower and up to twice as high as those observed in the Galactic field. We follow the evolution of a population of binary stars in dense and loose star clusters starting with an invariant initial binary population and a formal multiplicity fraction of unity, and demonstrate that these models can explain the observed binary properties in Taurus, Rho-Ophiuchus, Chamaeleon, Orion, IC 348, Upper Scorpius A, Praesepe, and the Pleiades. The model needs to consider solely different birth densities for these regions. The evolved theoretical orbital-parameter distributions are highly probable parent distributions for the observed ones. We constrain the birth conditions (stellar mass, $M_{\rm ecl}$, and half-mass radius, r_h) for the derived progenitors of the star clusters and the overall present-day binary fractions allowed by the present model. The results compare very well with properties of molecular cloud clumps on the verge of star formation. Combining these with previously and independently obtained constraints on the birth densities of globular clusters, we identify a weak stellar mass – half-mass radius correlation for cluster-forming cloud clumps, r_h / pc $(M_{\rm ecl}/M_{\rm sun})^{0.13\pm0.04}$. The ability of the model to reproduce the binary properties in all the investigated young objects, covering present-day densities from 1-10 stars pc$^{-}3$ (Taurus) to 2×10^4 stars pc$^{-}3$ (Orion), suggests that environment-dependent dynamical evolution plays an important role in shaping the present-day properties of binary populations in star clusters, and that the initial binary properties may not vary dramatically between different environments.

Accepted by Astronomy & Astrophysics

http://arxiv.org/abs/1205.1508

880 μm Imaging of a Transitional Disk in Upper Scorpius: Holdover from the Era of Giant Planet Formation?

Geoffrey S. Mathews[1], Jonathan P. Williams[1] and Francois Menard[2]

[1] Institute for Astronomy, University of Hawaii, Honolulu
[2] Université Joseph-Fourier and LAOG, Grenoble, France

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

We present 880 μm images of the transition disk around the star [PZ99] J160421.7-213028, a solar-mass star in the nearby Upper Scorpius association. With a resolution down to $0\overset{''}{.}34$, we resolve the inner hole in this disk, and via model fitting to the visibilities and spectral energy distribution we determine both the structure of the outer region and the presence of sparse dust within the cavity. The disk contains about 0.1 Jupiter masses of mm-emitting grains, with an inner disk edge of about 70 AU. The inner cavity contains a small amount of dust with a depleted surface density in a region extending from about 20-70 AU. Taking into account prior observations indicating little to no stellar accretion, the lack of a binary companion, and the presence of dust near 0.1 AU, we determine that the most likely mechanism for the formation of this inner hole is the presence of one or more giant planets.

Accepted by Astrophysical Journal

http://arxiv.org/abs/1205.3545

The Density Variance–Mach Number Relation in Supersonic Turbulence: I. Isothermal, magnetised gas.

F. Z. Molina[1], S. C. O. Glover[1], C. Federrath[3,2,1] and R. S. Klessen[1]

[1] Zentrum für Astronomie der Universität Heidelberg, Institut für Theoretische Astrophysik, Albert-Ueberle-Str. 2, 69120. Heidelberg, Germany
[2] Ecole Normale Superieure de Lyon, Centre de Recherche Astrophysique, 46 Allée d'Italie, F-69364 Lyon, France
[3] Monash Centre for Astrophysics (MoCA) and School of Mathematical Sciences, University of Monash, VIC 3800, Australia

E-mail contact: molina *at* stud.uni-heidelberg.de

It is widely accepted that supersonic, magnetized turbulence plays a fundamental role for star formation in molecular clouds. It produces the initial dense gas seeds out of which new stars can form. However, the exact relation between gas compression, turbulent Mach number, and magnetic field strength is still poorly understood. Here, we introduce and test an analytical prediction for the relation between the density variance and the root-mean-square Mach number M in supersonic, isothermal, magnetized turbulent flows. We approximate the density and velocity structure of the interstellar medium as a superposition of shock waves. We obtain the density contrast considering the momentum equation for a single magnetized shock and extrapolate this result to the entire cloud. Depending on the field geometry, we then make three different assumptions based on observational and theoretical constraints: B independent of ρ, $B \propto \rho^{1/2}$ and $B \propto \rho$. We test the analytically derived density variance–Mach number relation with numerical simulations, and find that for $B \propto \rho^{1/2}$, the variance in the logarithmic density contrast, $\sigma^2_{\ln \rho/\rho_0} = \ln[1 + b^2 M^2 \beta_0/(\beta_0 + 1)]$, fits very well to simulated data with turbulent forcing parameter $b = 0.4$, when the gas is super-Alfvénic. However, this result breaks down when the turbulence becomes trans-Alfvénic or sub-Alfvénic, because in this regime the turbulence becomes highly anisotropic. Our density variance–Mach number relations simplify to the purely hydrodynamic relation as the ratio of thermal to magnetic pressure $\beta_0 \to \infty$.

Accepted by MNRAS

http://adsabs.harvard.edu/doi/10.1111/j.1365-2966.2012.21075.x

Adaptable Radiative Transfer Innovations for Submillimetre Telescopes (ARTIST) - Dust polarisation module (DustPol)

Marco Padovani[1], Christian Brinch[2], Josep Miquel Girart[1], Jes K. Jørgensen[2], Pau Frau[1], Patrick Hennebelle[3], Rolf Kuiper[4], Wouter H. T. Vlemmings[5], Frank Bertoldi[6], Michiel Hogerheijde[7], Attila Juhasz[7] and Reinhold Schaaf[6]

[1] Institut de Ciències de l'Espai (CSIC-IEEC), Campus UAB, Facultat de Ciències, Torre C5p, 08193 Bellaterra, Spain
[2] Centre for Star and Planet Formation and Niels Bohr Institute, University of Copenhagen, Juliane Maries Vej 30, 2100 Copenhagen Ø, Denmark
[3] Laboratoire de radioastronomie, UMR 8112 du CNRS, École normale supérieure et Observatoire de Paris, 24 rue Lhomond, 75231 Paris Cedex 05, France
[4] Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109, USA
[5] Department of Earth and Space Sciences, Chalmers University of Technology, Onsala Space Observatory, 439 92 Onsala, Sweden
[6] Argenlander Institute for Astronomy, University of Bonn, Auf dem Hügel 71, 53121 Bonn, Germany
[7] Leiden Observatory, Leiden University, PO Box 9513, 2300 RA Leiden, The Netherlands

E-mail contact: padovani *at* ieec.uab.es

We present a new publicly available tool (`DustPol`) aimed to model the polarised thermal dust emission. The module `DustPol`, which is publicly available, is part of the ARTIST (Adaptable Radiative Transfer Innovations for Submillimetre Telescopes) package, which also offers tools for modelling the polarisation of line emission together with a model library and a Python-based user interface. `DustPol` can easily manage analytical as well as pre-gridded models to generate synthetic maps of the Stokes I, Q, and U parameters. These maps are stored in FITS format which is straightforwardly read by the data reduction software used, e.g., by the Atacama Large Millimeter Array (ALMA). This turns `DustPol` into a powerful engine for the prediction of the expected polarisation features of a source observed with ALMA or the Planck satellite as well as for the interpretation of existing submillimetre observations obtained with other telescopes. `DustPol` allows the parameterisation of the maximum degree of polarisation and we find that, in a prestellar core, if there is depolarisation, this effect should happen at densities of 10^6 cm^{-3} or larger. We compare a model generated by `DustPol` with the observational polarisation data of the low-mass Class 0 object NGC 1333 IRAS 4A, finding that the total and the polarised emission are consistent.

Accepted by Astronomy & Astrophysics

http://arxiv.org/abs/1204.6668

Absence of coreshine in the Gum/Vela region

Laurent Pagani[1], Charlène Lefèvre[1], Aurore Bacmann[2] and Jürgen Steinacker[2,3]

[1] LERMA, UMR8112 du CNRS, Observatoire de Paris, 61, Av. de l'Observatoire, 75014 Paris
[2] UJF-Grenoble 1 / CNRS-INSU, Institut de Planétologie et d'Astrophysique de Grenoble (IPAG) UMR 5274, Grenoble, F-38041, France
[3] Max-Planck-Institut für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany

E-mail contact: laurent.pagani *at* obspm.fr

Context: We recently discovered mid-infrared light scattering by micron-size grains deeply buried in dark clouds. We have named this coreshine. We also showed that this effect is widespread across the Galaxy except in the Gum/Vela region, the only region among those we explored without any trace of coreshine.
Aims: We aim to check whether the Gum/Vela situation is a chance effect or if coreshine is really absent from the region.
Methods: We explored the entire available Spitzer/Infrared Red Array Camera (IRAC) archive centered on the Gum/Vela region in search of the coreshine effect.
Results. Out of 24 validated objects (of a total of 32), we found three cases of coreshine and three possible other cases, while we detect nine cases of non-coreshine emission (bright rimmed clouds – BRC – or polycyclic aromatic hydrocarbon – PAH – emission). This is markedly different from our previous galactic-wide survey with a ratio of 7–8 coreshine cases per PAH case. In Gum/Vela, a majority of the clouds with protostars or young stellar objects do not show a coreshine effect, while in the galactic-wide survey, 75% of the protostellar clouds do.

Conclusions. The rare occurence of coreshine, outnumbered by PAH and BRC cases, together with a large number of protostars, let us conclude that the Gum Nebula is a supernova remnant (SNR), and that the blast wave has both reset the grain size distribution and induced the formation of several protostars. The absence of coreshine in the vicinity of several of the Class I objects also implies that the growth time for grains to efficiently scatter mid-infrared radiation exceeds the Class I life duration, which is typically 2×10^5 years, and it also implies that the blast wave has reached these clouds only recently despite the age of the Gum region (over 1.5 My). This is consistent with their large distance from the center of the SNR.

Accepted by A&A

http://aramis.obspm.fr/∼pagani/Gum.pdf

Detection of the hydroperoxyl radical HO_2 toward ρ Ophiuchi A: Additional constraints on the water chemical network

B. Parise[1], P. Bergman[2] and F. Du[1]

[1] MPIfR, Auf dem Hügel 69, 53121 Bonn, Germany
[2] Onsala Space Observatory, Chalmers University of Technology, 43992 Onsala, Sweden

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

Context: Hydrogen peroxide (HOOH) was recently detected toward ρ Oph A. Subsequent astrochemical modeling that included reactions in the gas phase and on the surface of dust grains was able to explain the observed abundance, and highlighted the importance of grain chemistry in the formation of HOOH as an intermediate product in water formation. This study also predicted that the hydroperoxyl radical HO_2, the precursor of HOOH, should be detectable.
Aims: We aim at detecting the hydroperoxyl radical HO_2 in ρ Oph A.
Methods: We used the IRAM 30m and the APEX telescopes to target the brightest HO_2 lines at about 130 and 260 GHz.
Results: We detect five lines of HO_2 (comprising seven individual molecular transitions). The fractional abundance of HO_2 is found to be about 10^{-10}, a value similar to the abundance of HOOH. This observational result is consistent with the prediction of the above mentioned astrochemical model, and thereby validates our current understanding of the water formation on dust grains.
Conclusions: This detection, anticipated by a sophisticated gas-grain chemical model, demonstrates that models of grain chemistry have improved tremendously and that grain surface reactions now form a crucial part of the overall astrochemical network.

Accepted by Astronomy and Astrophysics

http://de.arxiv.org/abs/1205.0361

The same, but different: Stochasticity in binary destruction

Richard J. Parker[1] and Simon P. Goodwin[2]

[1] Institute for Astronomy, ETH Zürich, Wolfgang-Pauli-Strasse 27, 8093, Zürich, Switzerland
[2] Department of Physics and Astronomy, University of Sheffield, Sheffield, S3 7RH, UK

E-mail contact: rparker *at* phys.ethz.ch

Observations of binaries in clusters tend to be of visual binaries with separations of 10s – 100s au. Such binaries are 'intermediates' and their destruction or survival depends on the exact details of their individual dynamical history. We investigate the stochasticity of the destruction of such binaries and the differences between the initial and processed populations using N-body simulations. We concentrate on Orion Nebula Cluster-like clusters, where the observed binary separation distribution ranges from 62 – 620 au.
We find that, starting from the same initial binary population in statistically identical clusters, the number of intermediate binaries that are destroyed after 1 Myr can vary by a factor of > 2, and that the resulting separation distributions can be statistically completely different in initially substructured clusters. We also find that the mass ratio distributions are altered (destroying more low mass ratio systems), but not as significantly as the binary fractions or separation distributions. We conclude that finding very different intermediate (visual) binary populations in different clusters does not provide conclusive evidence that the initial populations were different.

Accepted by MNRAS

http://arxiv.org/abs/1204.6037

Free-free Emission and Radio Recombination Lines from Photoevaporating Disks

I. Pascucci[1], U. Gorti[2,3] and D. Hollenbach[2]

[1] LPL/University of Arizona
[2] SETI Institute
[3] NASA Ames Research Center

E-mail contact: pascucci *at* lpl.arizona.edu

Recent infrared observations have demonstrated that photoevaporation driven by high-energy photons from the central star contributes to the dispersal of protoplanetary disks. Here, we show that photoevaporative winds should produce a detectable free-free continuum emission given the range of stellar ionizing photons and X-ray luminosities inferred for young sun-like stars. We point out that VLA observations of the nearby disk around TWHya might have already detected this emission at centimeter wavelengths and calculate the wind electron density and mass flow rate. We also estimate the intensities of H radio recombination lines tracing the wind and discuss which ones could be detected with current instrumentation. The detection and profiles of these recombination lines would unambiguously prove our inference of free-free emission from photoevaporating disks like TWHya. In addition, radio/millimeter data can help constraining wind parameters such as temperature and electron density that are fundamental in measuring mass flow rates.

Accepted by The Astrophysical Journal Letters

http://arxiv.org/abs/1205.1079

A rotating molecular jet from a Perseus protostar

Gerardo Pech[1], Luis A. Zapata[1], Laurent Loinard[1,2], and Luis F. Rodríguez[1]

[1]Centro de Radioastronomía y Astrofísica, Universidad Nacional Autónoma de México, Morelia 58090, Mexico
[2]Max-Planck Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany

E-mail contact: g.pech@crya.unam.mx

We present ^{12}CO(2-1) line and 1.4 mm continuum archival observations, made with the Submillimeter Array, of the outflow HH 797 located in the IC 348 cluster in Perseus. The continuum emission is associated with a circumstellar disk surrounding the class 0 object IC 348-MMS/SMM2, a very young solar analog. The line emission, on the other hand, delineates a collimated outflow, and reveals velocity asymmetries about the flow axis over the entire length of the flow. The amplitude of velocity differences is of order 2 km s^{-1} over distances of about 1000 AU, and we interpret them as evidence for jet rotation –although we also discuss alternative possibilities. A comparison with theoretical models suggests that the magnetic field lines threading the protostellar jet might be anchored to the disk of a radius of about 20 AU.

Accepted by ApJ (751:78)

Measuring the mass accretion rates of Herbig Ae/Be stars with X-shooter

M. A. Pogodin[1,2], S. Hubrig[3], R. V. Yudin[1,2], M. Schöller[4], J. F. González[5] and B. Stelzer[6]

[1] Central Astronomical Observatory at Pulkovo, St. Petersburg 196140, Russia
[2] Isaac Newton Institute of Chile, Saint-Petersburg Branch, Russia
[3] Leibniz-Institut für Astrophysik Potsdam, An der Sternwarte 16, 14482 Potsdam, Germany
[4] European Southern Observatory, Karl-Schwarzschild-Str. 2, 85748 Garching, Germany
[5] Instituto de Ciencias Astronomicas, de la Tierra, y del Espacio (ICATE), 5400, San Juan, Argentina
[6] INAF-Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, 90134 Palermo, Italy

E-mail contact: pogodin *at* gao.spb.ru

We present the results of our observations of eight magnetic Herbig Ae/Be stars obtained with the X-shooter spectrograph mounted on UT2 at the VLT. X-shooter provides a simultaneous, medium-resolution and high-sensitivity spectrum over the entire wavelength range from 300 to 2500 nm. We estimate the mass accretion rates ($\dot{M}_{\rm acc}$) of the targets from 13 different spectral diagnostics using empiric calibrations derived previously for T Tauri-type stars and brown dwarfs. We have estimated the mass accretion rates of our targets, which range from 2×10^{-9} to $2\times10^{-7}\,M_{\odot}$/yr. Furthermore, we have found accretion rate variability with amplitudes of 0.10–0.40 dex taking place on time scales from one day to tens of days. Additional future night-to-night observations need to be carried out to investigate the character of $\dot{M}_{\rm acc}$ variability in details. Our study shows that the majority of the calibrational relations can be applied to Herbig Ae/Be stars, but several of them need to be re-calibrated on the basis of new spectral data for a larger number of Herbig Ae/Be stars.

Accepted by Astronomische Nachrichten

http://arxiv.org/abs/1205.3732

The Small-Scale Dynamo and Non-Ideal MHD in Primordial Star Formation

Jennifer Schober[1], Dominik Schleicher[2], Christoph Federrath[3], Simon Glover[1], Ralf S. Klessen[1] and Robi Banerjee[4]

[1] Zentrum für Astronomie der Universität Heidelberg, Institut für Theoretische Astrophysik, Albert-Überle-Str. 2, 69120 Heidelberg, Germany
[2] Georg-August-Universität Göttingen, Institut für Astrophysik, Friedrich-Hund-Platz, 37077 Göttingen, Germany
[3] Monash Centre for Astrophysics (MoCA), School of Mathematical Sciences, Monash University, Vic 3800, Australia
[4] Hamburger Sternwarte, Gojenbergsweg 112, 21029 Hamburg, Germany

E-mail contact: Schober *at* stud.uni-heidelberg.de

We study the amplification of magnetic fields during the formation of primordial halos. The turbulence generated by gravitational infall motions during the formation of the first stars and galaxies can amplify magnetic fields very efficiently and on short timescales up to dynamically significant values. Using the Kazantsev theory, which describes the so-called small-scale dynamo - a magnetohydrodynamical process converting kinetic energy from turbulence into magnetic energy - we can then calculate the growth rate of the small-scale magnetic field. Our calculations are based on a detailed chemical network and we include non-ideal magnetohydrodynamical effects such as ambipolar diffusion and Ohmic dissipation. We follow the evolution of the magnetic field up to larger scales until saturation occurs on the Jeans scale. Assuming a weak magnetic seed field generated by the Biermann battery process, both Burgers and Kolmogorov turbulence lead to saturation within a rather small density range. Such fields are likely to become relevant after the formation of a protostellar disk and, thus, could influence the formation of the first stars and galaxies in the Universe.

Accepted by ApJ

http://de.arxiv.org/abs/1204.0658

Optical photometric and spectral study of the new FU Orionis object V2493 Cyg (HBC 722)

E. H. Semkov[1], S. P. Peneva[1], U. Munari[2], M. K. Tsvetkov[1], R. Jurdana-Sepic[3], E. de Miguel[4], R. D. Schwartz[5], D. P. Dimitrov[1], D. P. Kjurkchieva[6] and V. S. Radeva[6,7]

[1] Institute of Astronomy and National Astronomical Observatory, Bulgarian Academy of Sciences, 72 Tsarigradsko Shose blvd., BG-1784 Sofia, Bulgaria
[2] INAF Osservatorio Astronomico di Padova, Sede di Asiago, I-36032 Asiago (VI), Italy
[3] Physics Department, University of Rijeka, Omladinska 14, HR-51000 Rijeka, Croatia
[4] Departamento de Fisica Aplicada, Facultad de Ciencias Experimentales, Universidad de Huelva, 21071 Huelva, Spain
[5] Galaxy View Observatory, 102 Galaxy View Ct., Sequim, WA 98382, USA
[6] Department of Physics, Shumen University, 9700 Shumen, Bulgaria
[7] Public Astronomical Observatory and Planetarium, Varna, Bulgaria

E-mail contact: evgeni *at* skyarchive.org

We present new results from optical photometric and spectroscopic observations of the eruptive pre-main sequence star V2493 Cyg (HBC 722). The object has continued to undergo significant brightness variations over the past few months and is an ideal target for follow-up observations. We carried out CCD BVRI photometric observations in the field of V2493 Cyg ("Gulf of Mexico") from August 1994 to April 2012, i.e. at the pre-outburst states and during the phases of the outburst. We acquired high, medium, and low resolution spectroscopy of V2493 Cyg during the outburst. To study the pre-outburst variability of the target and construct its historical light curve, we searched for archival observations in photographic plate collections. Both CCD and photographic observations were analyzed using 15 comparison stars in the field of V2493 Cyg. The pre-outburst photographic and CCD photometric observations of V2493 Cyg show low-amplitude light variations typical of T Tauri stars. The recent photometric data show a slow light decrease from October 2010 to June 2011 followed by an increase in brightness that continued until early 2012. The spectral observations of V2493 Cyg are typical of FU Orionis stars absorption spectra with strong P Cyg profiles of H alpha and Na I D lines. On the basis of photometric monitoring performed over the past two years, the spectral properties at the maximal light, as well as the shape of long-term light curves, we confirm that the observed outburst of V2493 Cyg is of FU Orionis type.

Accepted by Astronomy & Astrophysics

http://arxiv.org/abs/1205.2532

A Keplerian Circumbinary Disk around the Protostellar System L1551 NE

Shigehisa Takakuwa[1], Masao Saito[2], Jeremy Lim[3], Kazuya Saigo[2], T. K. Sridharan[4] and Nimesh A. Patel[4]

[1] Academia Sinica Institute of Astronomy and Astrophysics, P.O. Box 23-141, Taipei 10617, Taiwan
[2] ALMA Project Office, National Astronomical Observatory of Japan, Osawa 2-21-1, Mitaka, Tokyo 181-8588, Japan
[3] Department of Physics, University of Hong Kong, Pokfulam Road, Hong Kong
[4] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, MS78, Cambridge, Massachusetts 02138, U.S.A.

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

We present SubMillimeter-Array observations of a Keplerian disk around the Class I protobinary system L1551 NE in 335 GHz continuum emission and submillimeter line emission in ^{13}CO (J=3–2) and C^{18}O (J=3–2) at a resolution of $\sim$120 $\times$ 80 AU. The 335-GHz dust-continuum image shows a strong central peak closely coincident with the binary protostars and likely corresponding to circumstellar disks, surrounded by a $\sim$600 $\times$ 300 AU feature elongated approximately perpendicular to the [Fe II] jet from the southern protostellar component suggestive of a circumbinary disk. The ^{13}CO and C^{18}O images confirm that the circumbinary continuum feature is indeed a rotating disk; furthermore, the C^{18}O channel maps can be well modeled by a geometrically-thin disk exhibiting Keplerian rotation. We estimate a mass for the circumbinary disk of $\sim$0.03-0.12 $M_{\odot}$, compared with an enclosed mass of $\sim$0.8 $M_{\odot}$ that is dominated by the protobinary system. Compared with several other Class I protostars known to exhibit Keplerian disks, L1551 NE has the lowest bolometric temperature ($\sim$91 K), highest envelope mass ($\sim$0.39 $M_{\odot}$), and the lowest ratio in stellar mass to envelope + disk + stellar mass ($\sim$0.65). L1551 NE may therefore be the youngest protostellar object so far found to exhibit a Keplerian disk. Our observations present firm evidence that Keplerian disks around binary protostellar systems, "Keplerian circumbinary disks", can exist. We speculate that tidal effects from binary companions could transport angular momenta toward the inner edge of the circumbinary disk and create the Keplerian circumbinary disk.

Accepted by ApJ

http://arxiv.org/abs/1205.3854

Non-Equilibrium Chemistry of Dynamically Evolving Prestellar Cores: I. Basic Magnetic and Non-Magnetic Models and Parameter Studies

K. Tassis[1], K. Willacy[1], H. W. Yorke[1] and N. J. Turner[1]

[1] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA

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

We combine dynamical and non-equilibrium chemical modeling of evolving prestellar molecular cloud cores, and

explore the evolution of molecular abundances in the contracting core. We model both magnetic cores, with varying degrees of initial magnetic support, and non-magnetic cores, with varying collapse delay times. We explore, through a parameter study, the competing effects of various model parameters in the evolving molecular abundances, including the elemental C/O ratio, the temperature, and the cosmic-ray ionization rate. We find that different models show their largest quantitative differences at the center of the core, whereas the outer layers, which evolve slower, have abundances which are severely degenerate among different dynamical models. There is a large range of possible abundance values for different models at a fixed evolutionary stage (central density), which demonstrates the large potential of chemical differentiation in prestellar cores. However, degeneracies among different models, compounded with uncertainties induced by other model parameters, make it difficult to discriminate among dynamical models. To address these difficulties, we identify abundance ratios between particular molecules, the measurement of which would have maximal potential for discrimination among the different models examined here. In particular, we find that the ratios between NH3 and CO; NH2 and CO; NH3 and HCO+ are sensitive to the evolutionary timescale, and that the ratio between HCN and OH is sensitive to the C/O ratio. Finally, we demonstrate that measurements of the central deviation (central depletion or enhancement) of abundances of certain molecules are good indicators of the dynamics of the core.

Accepted by ApJ

http://arxiv.org/abs/1111.3948

Non-Equilibrium Chemistry of Dynamically Evolving Prestellar Cores: II. Ionization and Magnetic Field

K. Tassis[1], K. Willacy[1], H. W. Yorke[1] and N. J. Turner[1]

[1] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA

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

We study the effect that non-equilibrium chemistry in dynamical models of collapsing molecular cloud cores has on measurements of the magnetic field in these cores, the degree of ionization, and the mean molecular weight of ions. We find that OH and CN, usually used in Zeeman observations of the line-of-sight magnetic field, have an abundance that decreases toward the center of the core much faster than the density increases. As a result, Zeeman observations tend to sample the outer layers of the core and consistently underestimate the core magnetic field. The degree of ionization follows a complicated dependence on the number density at central densities up to $10^5\,\mathrm{cm}^{-3}$ for magnetic models and $10^6\,\mathrm{cm}^{-3}$ in non-magnetic models. At higher central densities the scaling approaches a power-law with a slope of -0.6 and a normalization which depends on the cosmic-ray ionization rate ζ and the temperature T as $(\zeta T)^{1/2}$. The mean molecular weight of ions is systematically lower than the usually assumed value of 20 - 30, and, at high densities, approaches a value of 3 due to the asymptotic dominance of the H3+ ion. This significantly lower value implies that ambipolar diffusion operates faster.

Accepted by ApJ

http://arxiv.org/abs/1111.4218

Molecular hydrogen jets and outflows in the Serpens south filamentary cloud

G. D. C. Teixeira[1], M. S. N. Kumar[1], R. Bachiller[2] and J. M. C. Grave[1]

[1] Centro de Astrofísica da Universidade do Porto, Rua das Estrelas, 4150-762 Porto, Portugal
[2] Observatorio Astronómico Nacional (IGN), Calle Alfonso XII, 3. 28014 Madrid, Spain

E-mail contact: guilhermedcteixeira *at* gmail.com

We aimed to map the jets and outflows from the Serpens South star forming region and find an empirical relationship between the magnetic field and outflow orientation. Near-infrared H_2 v=1-0 S(1) 2.122μm-line imaging of the $\sim$30'-long filamentary shaped Serpens South star forming region was carried out. K_s broadband imaging of the same region was used for continuum subraction. Candidate driving sources of the mapped jets/outflows are identified from the list of known protostars and young stars in this region, which was derived from studies using recent *Spitzer* and *Herschel* telescope observations. 14 Molecular Hydrogen emission-line objects(MHOs) are identified using our continuum-subtracted images. They are found to constitute ten individual flows. Out of these, nine flows are located in the

lower-half(southern) part of the Serpens South filament, and one flow is located at the northern tip of the filament. Four flows are driven by well-identified Class 0 protostars, while the remaining six flows are driven by candidate protostars mostly in the Class I stage, based on the *Spitzer* and *Herschel* observations. The orientation of the outflows is systematically perpendicular to the direction of the near-infrared polarization vector, recently published in the literature. No significant correlation was observed between the orientation of the flows and the axis of the filamentary cloud.

Accepted by Astronomy & Astrophysics

http://arxiv.org/abs/1204.4946

Discovery of Crystallized Water Ice in a Silhouette Disk in the M43 Region

Hiroshi Terada[1] and Alan T. Tokunaga[2]

[1] Subaru Telescope, National Astronomical Observatory of Japan
[2] Institute for Astronomy, University of Hawaii

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

We present the 1.9–4.2 μm spectra of the five bright (L $\leq$ 11.2) young stars associated with silhouette disks with moderate to high inclination angle of 39–80° in the M42 and M43 regions. The water ice absorption is seen toward d121-1925 and d216-0939, while the spectra of d182-316, d183-405, and d218-354 show no water ice feature around 3.1 μm within the detection limits. By comparing the water ice features toward nearby stars, we find that the water ice absorption toward d121-1925 and d216-0939 most likely originates from the foreground material and the surrounding disk, respectively. The angle of the disk inclination is found to be mainly responsible for the difference of the optical depth of the water ice among the five young stars. Our results suggest that there is a critical inclination angle between 65° and 75° for the circumstellar disk where the water ice absorption becomes strong. The average density at the disk surface of d216-0939 was found to be 6.38×10^{-18} g cm^{-3}. The water ice absorption band in the d216-0939 disk is remarkable in that the maximum optical depth of the water ice band is at a longer wavelength than detected before. It indicates that the primary carrier of the feature is purely crystallized water ice at the surface of the d216-0939 disk with characteristic size of $\sim$ 0.8 μm, which suggests grain growth. This is the first direct detection of purely crystallized water ice in a silhouette disk.

Accepted by Astrophysical Journal

http://arxiv.org/abs/1204.5503

A near-infrared study of the star forming region RCW 34

D.J. van der Walt[1], H.M. de Villiers[1] and R.J. Czanik[1]

[1] Centre for Space Research, North-West University, Hoffman Street, Potchefstroom, South Africa

E-mail contact: johan.vanderwalt *at* nwu.ac.za

We report the results of a near-infrared imaging study of a 7.8×7.8 arcmin^2 region centered on the 6.7 GHz methanol maser associated with the RCW 34 star forming region using the 1.4m IRSF telescope at Sutherland. A total of 1283 objects were detected simultaneously in J, H, and K for an exposure time of 10800 seconds. The J-H, H-K two-colour diagram revealed a strong concentration of more than 700 objects with colours similar to what is expected of reddened classical T Tauri stars. The distribution of the objects on the K *vs* J-K colour-magnitude diagram is also suggestive that a significant fraction of the 1283 objects is lower mass pre-main sequence stars. We also present the luminosity function for the subset of about 700 pre-main sequence stars and show that it suggests ongoing star formation activity for about 10^7 years. An examination of the spatial distribution of the pre-main sequence stars shows that the fainter (older) part of the population is more dispersed over the observed region and the brighter (younger) subset is more concentrated around the position of the O8.5V star. This suggests that the physical effects of the O8.5V star and the two early B-type stars on the remainder of the cloud out of which they formed, could have played a role in the onset of the more recent episode of star formation in RCW 34.

Accepted by The Astronomical Journal

Isolated starless cores in IRDCs in the Hi-GAL survey

L. A. Wilcock[1], D. Ward-Thompson[1], J. M. Kirk[1], D. Stamatellos[1], A. Whitworth[1], C. Battersby[2], D. Elia[3], G. A. Fuller[4], A. DiGiorgio[3], M. J. Griffin[1], S. Molinari[3], P. Martin[5], J. C. Mottram[6,7], N. Peretto[8], M. Pestalozzi[3], E. Schisano[3], H. A. Smith[9] and M. A. Thompson[10]

[1] School of Physics and Astronomy, Cardiff University, Queen's Buildings, Cardiff, CF24 3AA, UK
[2] Center for Astrophysics & Space Astronomy, University of Colorado, Boulder, Colorado, 80309, USA
[3] Instituto di Fisica dello Spazio Interplanetario, CNR, via Fosso del Cavaliere, I-00133 Roma, Italy
[4] Jodrell Bank Centre for Astrophysics, School of Physics and Astronomy, University of Manchester, Manchester, M13 9PL, UK
[5] Canadian Institute for Theoretical Astrophysics, University of Toronto, Toronto, Canada, M5S 3H8
[6] School of Physics, University of Exeter, Stocker Road, Exeter, EX4 4QL, UK
[7] Leiden Observatory, Leiden University, PO Box 9513, 2300 RA Leiden, The Netherlands
[8] Laboratoire AIM, CEA/DSM-CNRS-Université Paris Diderot, IFRU/Service d'Astrophysique, C.E. Saclay, Orme des merisiers, 91191 Gif-sur-Yvette, France
[9] Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA, 02138, USA
[10] Centre for Astrophysics Research, Science and Technology Research Institute, University of Hertfordshire, AL10 9AB, UK

E-mail contact: lucy.wilcock *at* astro.cf.ac.uk

In a previous paper we identified cores within infrared dark clouds (IRDCs). We regarded those without embedded sources as the least evolved, and labelled them starless. Here we identify the most isolated starless cores and model them using a three-dimensional, multi-wavelength, Monte Carlo, radiative transfer code. We derive the cores' physical parameters and discuss the relation between the mass, temperature, density, size and the surrounding interstellar radiation field (ISRF) for the cores. The masses of the cores were found not to correlate with their radial size or central density. The temperature at the surface of a core was seen to depend almost entirely on the level of the ISRF surrounding the core. No correlation was found between the temperature at the centre of a core and its local ISRF. This was seen to depend, instead, on the density and mass of the core.

Accepted by MNRAS

http://arxiv.org/abs/1205.1647

A Proper Motion Study of the Haro 6-10 Outflow: Evidence for a Subarcsecond Binary

Bruce A. Wilking[1], Kevin B. Marvel[2], Mark J. Claussen[3], Bradley M. Gerling[1], Alwyn Wootten[4] and Erika Gibb[1]

[1] Univ. of Missouri-St. Louis, 1 University Blvd., St. Louis, MO 63121
[2] American Astronomical Society, 2000 Florida Avenue, NW, Suite 400,Washington, DC 20009
[3] NRAO Array Operations Center, 1003 Lopezville Road, Socorro, NM 87801
[4] NRAO, 520 Edgemont Road, Charlottesville, VA 22903-2475

E-mail contact: bwilking *at* umsl.edu

We present single-dish and VLBI observations of an outburst of water maser emission from the young binary system Haro 6-10. Haro 6-10 lies in the Taurus molecular cloud and contains a visible T Tauri star with an infrared companion 1.3″ north. Using the Very Long Baseline Array, we obtained five observations spanning 3 months and derived absolute positions for 20 distinct maser spots. Three of the masers can be traced over 3 or more epochs, enabling us to extract absolute proper motions and tangential velocities. We deduce that the masers represent one side of a bipolar outflow that lies nearly in the plane of the sky with an opening angle of ∼45°. They are located within 50 mas of the southern component of the binary, the visible T Tauri star Haro 6-10S. The mean position angle on the sky of the maser proper motions (∼220°) suggests they are related to the previously observed giant Herbig-Haro (HH) flow which includes HH 410, HH 411, HH 412, and HH 184A-E. A previously observed HH jet and extended radio continuum emission (mean position angle of ∼190°) must also originate in the vicinity of Haro 6-10S and represent a second, distinct outflow in this region. We propose that a yet unobserved companion within 150 mas of Haro 6-10S is responsible for the giant HH/maser outflow while the visible star is associated with the HH jet. Despite the presence of H_2 emission in the spectrum of the northern component of the binary, Haro 6-10N, none of outflows/jets can be tied directly to

this young stellar object.

Accepted by The Astrophysical Journal

http://www.umsl.edu/∼wilkingb/Haro6_10/vlba.html

Astronomical Evidence for the Rapid Growth of Millimeter Sized Particles in Protoplanetary Disks

Jonathan P. Williams[1]

[1] Institute for Astronomy, University of Hawaii, Honolulu

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

I summarize recent surveys of protoplanetary disks at millimeter wavelengths and show that the distribution of luminosity, equivalent to the mass in small dust grains, declines rapidly. This contrasts with statistics on the lifetime of disks from infrared observations and the high occurrence of planets from radial velocity and transit surveys. I suggest that these disparate results can be reconciled if most of the dust in a disk is locked up in millimeter and larger sized particles within about 2 Myr. This general statistical result on disk evolution agrees with detailed modeling of a small number of individual disks and with cosmochemical measurements of chondrule ages.

Accepted by Meteoritics and Planetary Science

http://arxiv.org/abs/1205.2461

A Far-ultraviolet Atlas of Low-resolution Hubble Space Telescope Spectra of T Tauri Stars

Hao Yang[1], **Gregory J. Herczeg**[2], **Jeffrey L. Linsky**[1], **Alexander Brown**[3], **Christopher M. Johns-Krull**[4], **Laura Ingleby**[5], **Nuria Calvet**[5], **Edwin Bergin**[5] **and Jeff A. Valenti**[6]

[1] JILA, University of Colorado and NIST, Boulder, CO 80309-0440, USA
[2] Max-Planck-Institut für extraterrestriche Physik, 85741 Garching, Germany
[3] CASA, University of Colorado, Boulder, CO 80309-0389, USA
[4] Department of Physics and Astronomy, Rice University, Houston, TX 77005, USA
[5] Department of Astronomy, University of Michigan, 830 Dennison Building, Ann Arbor, MI 48109, USA
[6] Space Telescope Science Institute, Baltimore, MD 21218, USA

E-mail contact: haoyang *at* phy.ccnu.edu.cn

We present a far-ultraviolet (FUV) spectral atlas consisting of spectra of 91 pre-main sequence stars. Most stars in this sample were observed with the Space Telescope Imaging Spectrograph (STIS) and Advanced Camera for Surveys (ACS) on the *Hubble Space Telescope* (*HST*). A few archival spectra from *International Ultraviolet Explorer* (*IUE*) and the Goddard High Resolution Spectrograph (GHRS) on the *HST* are included for completeness. We find strong correlations among the O I λ1304 triplet, C II λ1335, the Si IV $\lambda\lambda$1394/1403 doublet, the C IV λ1549 doublet, and the He II λ1640 line luminosities. For classical T Tauri stars (CTTSs), we also find strong correlations between these lines and the accretion luminosity, suggesting that these lines form in processes related to accretion. These FUV line fluxes and X-ray luminosity correlate loosely with large scatters. The FUV emission also correlates well with Hα, Hβ, and Ca II K line luminosities. These correlations between FUV and optical diagostics can be used to obtain rough estimates of FUV line fluxes from optical observations. Molecular hydrogen (H_2) emission is generally present in the spectra of actively accreting CTTSs but not the weak-lined T Tauri stars (WTTSs) that are not accreting. The presence of H_2 emission in the spectrum of HD 98800 N suggests that the disk should be classified as actively accreting rather than a debris disk. We discuss the importance of FUV radiation, including the hydrogen Lyα line, on the photoevaporation of exoplanet atmospheres. We find that the Ca II/C IV flux ratios for more evolved stars are lower than those for less evolved accretors, indicating preferential depletion of refactory metals into dust grains. The spectra in the atlas are available at http://archive.stsci.edu/prepds/ttauriatlas.

Accepted by ApJ

http://arxiv.org/abs/1205.4789

Post-doctoral position in "modeling the physics and chemistry of interstellar medium in galaxies". - Laboratory Universe and Theories (LUTH) - Paris Observatory.

In the context of the ANR project SYMPATICO (SYnthetic MultiPhase Analysis of The Ism of Cosmic Objects, P.I. S. Madden, CEA/IRFU), LUTH invites applications for a postdoctoral position to investigate the physics and chemistry of the interstellar medium in low metallicity galaxies. We intend to extend the capabilities of our 'Meudon PDR code' (pdr.obspm.fr) to take into account high energy processes at the edges of neutral clouds of gas in a variety of galactic environments.

Higher sensitivity and spectral resolution of, e.g. the Herschel Space Telescope or ALMA provide a wealth of informations on the interstellar medium in distant galaxies, through the interpretation of various emission and absorption lines. We aim to better understand the impact of cosmic rays and high energy photons on neutral gas in low metallicity galaxies as well as the interaction of H II regions and PDRs.

The successful applicant will implement in the Meudon PDR code a detailed treatment of the effects of cosmic rays and X rays on atomic and molecular species excitation, on chemical reactions and on heating processes. Then, coupling with models of HII regions will provide integrated predictions on observable quantities in unresolved galaxies or regions of galaxies. Specific applications to dwarf galaxies observed by Herschel will be done in collaboration with Suzanne Madden's team at IRFU - CEA within their various Herschel key programs and Spitzer results.

The candidate will work in collaboration with Jacques Le Bourlot, Franck Le Petit and Evelyne Roueff at the LUTH - Paris Observatory, located in Meudon, close to Paris.

Applicants should have a strong expertise in numerical modeling. Prospective applicants are encouraged to contact us by E-mail for further informations. The position can start as early as the fall of 2012. It can be funded for 2 years with year by year contracts. A CV, including a publication list and a brief motivation letter and research statement should be sent electronically. A minimum of three letters of reference should be sent independently of the application.

Contact: Jacques.LeBourlot@obspm.fr and Franck.LePetit@obspm.fr
LUTH - Observatoire de Paris
Place Jules Janssen
92190 Meudon, France.

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.

The Origins of Stars and their Planetary Systems

This is the second announcement for an interdisciplinary conference to be hosted by the Origins Institute at McMaster University in Hamilton, Ontario, Canada, titled

The Origins of Stars and Planetary Systems

http://origins.physics.mcmaster.ca/oi_planets/

It is not too late to register!

The conference will take place 10-15 June 2012 at McMaster University in Hamilton, Ontario, Canada.

This interdisciplinary conference will explore the deep links between the processes of star and planet formation, highlighting recent advances in observations (Kepler, Herschell), theory, and computation.

The conference features 9 interdisciplinary and interleaved sessions, each with an invited Review Speaker, who will set up the session with a true review of the current state of that field, as well a Keynote Speaker who will focus more on their own contributions to the subject. The 9 sessions are

1. Star Formation in Clusters
2. Planets-Statistical Properties
3. Planets in Cluster Context
4. Young, Gas-Rich Disks
5. Atmospheres and Evolutionary Models
6. Cores and Small Scale Collapse
7. Planet Formation-Early Stages in Disks
8. Planet Formation-Late Stages
9. Brown Dwarfs and Lower Mass End of IMF

Three days will also feature Discussion sessions at day's end, meant to provide a stimulating forum for the key results and issues raised in the presentations.

Ralph Pudritz, James Wadsley, and Chris Wilson (SOC)

Fizeau exchange visitors program - call for applications

Dear colleagues!

The Fizeau exchange visitors program in optical interferometry funds (travel and accommodation) visits of researchers to an institute of his/her choice (within the European Community) to perform collaborative work and training on one of the active topics of the European Interferometry Initiative. The visits will typically last for one month, and strengthen the network of astronomers engaged in technical, scientific and training work on optical/infrared interferometry. The program is open for all levels of astronomers (Ph.D. students to tenured staff). Applicants are strongly encouraged to seek also partial support from their home or host institutions.

The deadline for applications is June 15 for visits between July 15 and December 31.

Further informations and application forms can be found at www.european-interferometry.eu

The program is funded by OPTICON/FP7.

Please distribute this message also to potentially interested colleagues outside of your community!

Looking forward to your applications, Josef Hron & Laszlo Mosoni (for the European Interferometry Initiative)

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.