

# THE STAR FORMATION NEWSLETTER

*An electronic publication dedicated to early stellar evolution and molecular clouds*

No. 239 — 10 Nov 2012

Editor: Bo Reipurth (reipurth@ifa.hawaii.edu)

## *Abstracts of recently accepted papers*

### **Phosphorous chemistry in the shocked region L1157 B1**

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We study the evolution of phosphorous-bearing species in one-dimensional C-shock models. We find that the abundances of P-bearing species depend sensitively on the elemental abundance of P in the gas phase and on the abundance of N atoms in the pre-shock gas. The observed abundance of PN and the non-detection of PO towards L1157 B1 are reproduced in C-shock models with shock velocity  $v = 20 \text{ km s}^{-1}$  and pre-shock density  $n(\text{H}_2) = 10^4 - 10^5 \text{ cm}^{-3}$ , if the elemental abundance of P in the gas phase is  $\sim 10^{-9}$  and the N-atom abundance is  $n(\text{N})/n_{\text{H}} \sim 10^{-5}$  in the pre-shock gas. We also find that P-chemistry is sensitive to O- and N-chemistry, because N atoms are destroyed mainly by OH and NO. We identify the reactions of O-bearing and N-bearing species that significantly affect P chemistry.

Accepted by The Astrophysical Journal

<http://arxiv.org/abs/1210.7900>

### **The Migrating Embryo Model for Disk Evolution**

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A new view of disk evolution is emerging from self-consistent numerical simulation modeling of the formation of circumstellar disks from the direct collapse of prestellar cloud cores. This has implications for many aspects of star and planet formation, including the growth of dust and high-temperature processing of materials. A defining result is that the early evolution of a disk is crucially affected by the continuing mass loading from the core envelope, and is driven into recurrent phases of gravitational instability. Nonlinear spiral arms formed during these episodes fragment to form gaseous clumps in the disk. These clumps generally migrate inward due to gravitational torques arising from their interaction with a trailing spiral arm. Occasionally, a clump can open up a gap in the disk and settle into a stable orbit, revealing a direct pathway to the formation of companion stars, brown dwarfs, or giant planets. At other times, when multiple clumps are present, a low mass clump may even be ejected from the system, providing a pathway to the formation of free-floating brown dwarfs and giant planets in addition to low mass stars. Finally, it has been suggested that the inward migration of gaseous clumps can provide the proper conditions for the transport of high-temperature processed solids from the outer disk to the inner disk, and even possibly accelerate the formation of terrestrial planets in the inner disk. All of these features arising from clump formation and migration can be tied together conceptually in a Migrating Embryo model for disk evolution that can complement the well-known Core Accretion model for planet formation.

Accepted by Meteoritics and Planetary Science

<http://arxiv.org/abs/1211.0625>

# The Chamaeleon II low-mass star-forming region: radial velocities, elemental abundances, and accretion properties

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*Context.* Knowledge of radial velocities, elemental abundances, and accretion properties of members of star-forming regions is important for our understanding of stellar and planetary formation. While infrared observations reveal the evolutionary status of the disk, optical spectroscopy is fundamental to acquire information on the properties of the central star and on the accretion characteristics.

*Aims.* Existing *2MASS* archive data and the *Spitzer c2d* survey of the Chamaeleon II dark cloud have provided disk properties of a large number of young stars. We complement these data with optical spectroscopy with the aim of providing physical stellar parameters and accretion properties.

*Methods.* We use FLAMES/UVES and FLAMES/GIRAFFE spectroscopic observations of 40 members of the Chamaeleon II star-forming region to measure radial velocities through cross-correlation technique, lithium abundances by means of curves of growth, and for a suitable star elemental abundances of Fe, Al, Si, Ca, Ti, and Ni using the code MOOG. From the equivalent widths of the H $\alpha$ , H $\beta$ , and the HeI  $\lambda$ 5876,  $\lambda$ 6678,  $\lambda$ 7065 Å emission lines, we estimate the mass accretion rates,  $\dot{M}_{\text{acc}}$ , for all the objects.

*Results.* We derive a radial velocity distribution for the Chamaeleon II stars, which is peaked at  $\langle V_{\text{rad}} \rangle = 11.4 \pm 2.0 \text{ km s}^{-1}$ . We find dependencies of  $\dot{M}_{\text{acc}} \propto M_{\star}^{1.3}$  and of  $\dot{M}_{\text{acc}} \propto \text{Age}^{-0.82}$  in the  $\sim 0.1 - 1.0 M_{\odot}$  mass regime, as well as a mean mass accretion rate for Chamaeleon II of  $\dot{M}_{\text{acc}} \sim 7_{-5}^{+26} \times 10^{-10} M_{\odot} \text{ yr}^{-1}$ . We also establish a relationship between the HeI  $\lambda$ 7065 Å line emission and the accretion luminosity.

*Conclusions.* The radial velocity distributions of stars and gas in Chamaeleon II are consistent. The spread in  $\dot{M}_{\text{acc}}$  at a given stellar mass is about one order of magnitude and can not be ascribed entirely to short timescale variability. Analyzing the relation between  $\dot{M}_{\text{acc}}$  and the colors in *Spitzer c2d* and *2MASS* bands, we find indications that the inner disk changes from optically thick to optically thin at  $\dot{M}_{\text{acc}} \sim 10^{-10} M_{\odot} \text{ yr}^{-1}$ . Finally, the disk fraction is consistent with the age of Chamaeleon II.

Accepted by Astronomy and Astrophysics

## Scattering of small bodies by planets: a potential origin for exozodiacal dust ?

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High levels of exozodiacal dust are observed around a growing number of main sequence stars. The origin of such dust is not clear, given that it has a short lifetime against both collisions and radiative forces. Even a collisional cascade with km-sized parent bodies, as suggested to explain outer debris discs, cannot survive sufficiently long. In this work we investigate whether the observed exozodiacal dust could originate from an outer planetesimal belt. We investigate the scattering processes in stable planetary systems in order to determine whether sufficient material could be scattered inwards in order to retain the exozodiacal dust at its currently observed levels. We use N-body simulations to investigate the efficiency of this scattering and its dependence on the architecture of the planetary system. The results of these simulations can be used to assess the ability of hypothetical chains of planets to produce exozodi in observed systems. We find that for older ( $> 100 \text{ Myr}$ ) stars with exozodiacal dust, a massive, large radii ( $> 20 \text{ AU}$ ) outer belt and a chain of tightly packed, low-mass planets would be required in order to retain the dust at its currently observed levels. This brings into question how many, if any, real systems possess such a contrived architecture and are therefore capable of scattering at sufficiently high rates to retain exozodi dust on long timescales.

Accepted by Astronomy & Astrophysics

# High SiO abundance in the HH212 protostellar jet

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Previous SiO maps of the innermost regions of HH212 set strong constraints on the structure and origin of this jet. They rule out a fast wide-angle wind, and tentatively favor a magneto-centrifugal disk wind launched out to 0.6 AU. Here, we aim to assess the SiO content at the base of the HH212 jet to set an independent constraint on the location of the jet launch zone with respect to the dust sublimation radius. We present the first sub-arcsecond ( $0.44'' \times 0.96''$ ) CO map of the HH212 jet base, obtained with the IRAM Plateau de Bure Interferometer. Combining this with previous SiO(5-4) data, we infer the CO(2-1) opacity and mass-flux in the high-velocity jet and arrive at a much tighter lower limit to the SiO abundance than possible from the (optically thick) SiO emission alone. We find that gas-phase SiO at high velocity contains at least 10% of the elemental silicon if the jet is dusty, and at least 40% if the jet is dust-free, if CO and SiO have similar excitation temperatures. Such a high SiO content is challenging for current chemical models of both dust-free winds and dusty interstellar shocks. We conclude that updated chemical models (equatorial dust-free winds, highly magnetized dusty shocks) and observations of higher J CO lines are required to elucidate the dust content and launch radius of the HH212 high-velocity jet.

Accepted by A&A, Letters to the Editor

<http://arxiv.org/abs/1211.1258>

## ATLASGAL — Compact source catalogue: $330 < l < 21$ degrees

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*Context.* The APEX Telescope Large Area Survey of the Galaxy (ATLASGAL) is the first systematic survey of the inner Galactic plane in the sub-millimetre. The observations were carried out with the Large APEX Bolometer Camera (LABOCA), an array of 295 bolometers observing at 870 microns (345 GHz).

*Aims.* Here we present a first version of the compact source catalogue extracted from this survey. This catalogue provides an unbiased database of dusty clumps in the inner Galaxy.

*Methods.* The construction of this catalogue was made using the source extraction routine SExtractor. We have cross-associated the obtained sources with the IRAS and MSX catalogues, in order to constrain their nature.

*Results.* We have detected 6639 compact sources in the range from  $330 < l < 21$  degrees and  $|b| < 1.5$  degrees. The catalogue has a 99% completeness for sources with a peak flux above  $6\sigma$ , which corresponds to a flux density of  $\sim 0.4$  Jy/beam. The parameters extracted for sources with peak fluxes below the  $6\sigma$  completeness threshold should be used with caution. Tests on simulated data find the uncertainty in the flux measurement to be  $\sim 12\%$ , however, in more complex regions the flux values can be overestimated by a factor of 2 due to the additional background emission. Using a search radius of  $30''$  we found that 40% of ATLASGAL compact sources are associated with an IRAS or MSX point

source, but,  $\sim 50\%$  are found to be associated with MSX 21 microns fluxes above the local background level, which is probably a lower limit to the actual number of sources associated with star formation.

*Conclusions.* Although infrared emission is found towards the majority of the clumps detected, this catalogue is still likely to include a significant number of clumps that are devoid of star formation activity and therefore excellent candidates for objects in the coldest, earliest stages of (high-mass) star formation.

Accepted by A&A

<http://arxiv.org/abs/1211.0741>

## A limit on eccentricity growth from global 3-D simulations of disc-planet interactions

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We present high resolution 3-D simulations of the planet-disc interaction using smoothed particle hydrodynamics, to investigate the possibility of driving eccentricity growth by this mechanism. For models with a given disc viscosity ( $\alpha = 0.01$ ), we find that for small planet masses (a few Jupiter masses) and canonical surface densities, no significant eccentricity growth is seen over the duration of our simulations. This contrasts with the limiting case of large planet mass (over twenty Jupiter masses) and extremely high surface densities, where we find eccentricity growth in agreement with previously published results. We identify the cause of this as being a threshold surface density for a given planet mass below which eccentricity growth cannot be excited by this method. Further, the radial profile of the disc surface density is found to have a stronger effect on eccentricity growth than previously acknowledged, implying that care must be taken when contrasting results from different disc models. We discuss the implication of this result for real planets embedded in gaseous discs, and suggest that the disc-planet interaction does not contribute significantly to observed exoplanet eccentricities.

Accepted by MNRAS

<http://arxiv.org/abs/1210.6035>

## Young stars in $\epsilon$ Cha and their disks: disk evolution in sparse associations

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*Context.* The nearby young stellar association  $\epsilon$  Cha has an estimated age of 3–5 Myr, making it an ideal laboratory to study the disk dissipation process and provide empirical constraints on the timescale of planet formation.

*Aims.* We wish to complement existing optical and near-infrared data of the  $\epsilon$  Cha association, which provide the stellar properties of its members, with mid-infrared data that probe the presence, geometry, and mineralogical composition of protoplanetary disks around individual stars.

*Methods.* We combine the available literature data with our Spitzer IRS spectroscopy and VLT/VISIR imaging data. We use proper motions to refine the membership of  $\epsilon$  Cha. Masses and ages of individual stars are estimated by fitting model atmospheres to the optical and near-infrared photometry, followed by placement in the HR-diagram. The Spitzer IRS spectra are analyzed using the two-layer temperature distribution spectral decomposition method.

*Results.* Two stars previously identified as members, CXOU J120152.8 and 2MASS J12074597, have proper motions that are very different from those of the other stars. But other observations suggest that the two stars are still young and thus might still be related to  $\epsilon$  Cha. HD 104237C is the lowest mass member of  $\epsilon$  Cha with an estimated mass

of  $\sim 13$ – $15$  Jupiter masses. The very low mass stars USNO-B120144.7 and 2MASS J12005517 show globally depleted spectral energy distributions, pointing at strong dust settling. 2MASS J12014343 may have a disk with a very specific inclination, where the central star is effectively screened by the cold outer parts of a flared disk, but the  $10\ \mu\text{m}$  radiation of the warm inner disk can still reach us. We find that the disks in sparse stellar associations are dissipated more slowly than those in denser (cluster) environments. We detect  $\text{C}_2\text{H}_2$  rovibrational band around  $13.7\ \mu\text{m}$  on the IRS spectrum of USNO-B120144.7. We find strong signatures of grain growth and crystallization in all  $\epsilon$  Cha members with  $10\ \mu\text{m}$  features detected in their IRS spectra. We combine the dust properties derived in the  $\epsilon$  Cha sample with those found using identical or similar methods in the MBM12, Coronet,  $\eta$  Cha associations, and in the cores-to-disks legacy program. We find that disks around low-mass young stars show a negative radial gradient in the mass-averaged grain size and mass fraction of crystalline silicates. A positive correlation exists between the mass-averaged grain sizes of amorphous silicates and the accretion rates if the latter is above  $\sim 10^{-9} M_\odot \text{yr}^{-1}$ , possibly indicating that those disks are sufficiently turbulent to prevent grains of several microns in size to sink into the disk interior.

Accepted by A&A

<http://arxiv.org/abs/1209.5832>

## Complex, Quiescent Kinematics in a Highly Filamentary Infrared Dark Cloud

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Infrared Dark Clouds (IRDCs) host the initial conditions under which massive stars and stellar clusters form. It is therefore important to study the kinematics, as well as the physical and chemical properties of these regions. Their complex structure however posits challenges in the data interpretation. We have obtained high sensitivity and high spectral resolution observations with the IRAM 30 m antenna, which allowed us to perform detailed analysis of the kinematics within one IRDC, G035.39-00.33. This cloud has been selected for its highly filamentary morphology and the presence of extended quiescent regions, characteristics of dynamical youth. We focus on the  $J = 1 \rightarrow 0$  and  $J = 3 \rightarrow 2$  transitions of  $\text{N}_2\text{H}^+$ ,  $\text{C}^{18}\text{O}$  ( $1 - 0$ ), and make comparison with  $\text{SiO}$  ( $2 - 1$ ) observations and extinction mapping. Three interacting filaments of gas are found. We report large-scale velocity coherence throughout the cloud, evidenced through small velocity gradients and relatively narrow line widths. This suggests that the merging of these filaments is somewhat “gentle”, possibly regulated by magnetic fields. This merging of filaments may be responsible for the weak parsec-scale  $\text{SiO}$  emission detected by Jiménez-Serra et al. 2010, via grain mantle vaporization. A systematic velocity shift between the  $\text{N}_2\text{H}^+$  ( $1 - 0$ ) and  $\text{C}^{18}\text{O}$  ( $1 - 0$ ) gas throughout the cloud of  $0.18 \pm 0.04 \text{ km s}^{-1}$  is also found, consistent with a scenario of collisions between filaments which is still ongoing. The  $\text{N}_2\text{H}^+$  ( $1 - 0$ ) is extended throughout the IRDC and it does not only trace dense cores, as found in nearby low-mass star-forming regions. The average  $\text{H}_2$  number density across the IRDC is  $\simeq 5 \times 10^4 \text{ cm}^{-3}$ , at least one order of magnitude larger than in nearby molecular clouds where low-mass stars are forming. A temperature gradient perpendicular to the filament is found. From our study, we conclude that G035.39-00.33 (clearly seen in the extinction map and in  $\text{N}_2\text{H}^+$ ) has been formed via the collision between two relatively quiescent filaments with average densities of  $\simeq 5 \times 10^3 \text{ cm}^{-3}$ , moving with relative velocities of  $\simeq 5 \text{ km s}^{-1}$ . The accumulation of material at the merging points started  $> 1 \text{ Myr}$  ago and it is still ongoing.

Accepted by MNRAS

<http://arxiv.org/abs/1210.6835>

## Resolving the Vela C ridge with P-ArTeMiS and Herschel

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We present APEX/P–ArTeMiS 450  $\mu\text{m}$  continuum observations of RCW 36 and the adjacent ridge, a high-mass high-column density filamentary structure at the centre of the Vela C molecular cloud. These observations, at higher resolution than Herschel's SPIRE camera, reveal clear fragmentation of the central star-forming ridge. Combined with PACS far-infrared and SPIRE sub-millimetre observations from the Herschel HOBYS project we build a high resolution column density map of the region mapped with P–ArTeMiS. We extract the radial density profile of the Vela C ridge which with a  $\sim 0.1$  pc central width is consistent with that measured for low-mass star-forming filaments in the Herschel Gould Belt survey. Direct comparison with Serpens South, of the Gould Belt Aquila complex, reveals many similarities between the two regions. Despite likely different formation mechanisms and histories, the Vela C ridge and Serpens South filament share common characteristics, including their filament central widths.

Accepted by A&A Letters

ArXiv:1211.0275

## **Pilot Observations for MALT-45: A Galactic Plane Survey at 7mm**

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We introduce the MALT-45 (Millimetre Astronomer's Legacy Team - 45 GHz) Galactic plane survey and describe pilot survey results with the Australia Telescope Compact Array (ATCA). The pilot survey was conducted to test the instrumentation and observational technique of MALT-45, before commencing the full survey. We mapped two half-square degree regions within the southern Galactic plane around the G333 giant molecular cloud, using fast mosaic mapping. Using the new Compact Array Broadband Backend (CABB) on the ATCA, we were able to observe two 2048 MHz spectral windows, centred on frequencies 43.2 and 48.2 GHz. Although only a coarse spectral resolution of around  $7 \text{ km s}^{-1}$  was available to us, we detect widespread, extended emission in the  $^{13}\text{CS}(1-0)$  ground state transition. We also detect eight Class I  $\text{CH}_3\text{OH}$  masers at 44 GHz and three SiO masers in vibrationally excited (1–0) transitions. We also detect the  $\text{H}53\alpha$  radio recombination line, non-vibrationally excited SiO (1–0) and emission in the  $\text{CH}_3\text{OH } 1_1-0_0 \text{ A}^+$  line.

Accepted by Monthly Notices of the Royal Astronomical Society

<http://arxiv.org/abs/1211.0753>

## Interactions between brown-dwarf binaries and Sun-like stars

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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 Ap&SS

<http://arxiv.org/abs/1205.2279>

## Exploring Magnetic Field Structure in Star-Forming Cores with Polarization of Thermal Dust Emission

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The configuration and evolution of the magnetic field in star-forming cores are investigated in order to directly compare simulations and observations. We prepare four different initial clouds having different magnetic field strengths and rotation rates, in which magnetic field lines are aligned/misaligned with the rotation axis. First, we calculate the evolution of such clouds from the prestellar stage until long after protostar formation. Then, we calculate the polarization of thermal dust emission expected from the simulation data. We create polarization maps with arbitrary viewing angles and compare them with observations. Using this procedure, we confirmed that the polarization distribution projected on the celestial plane strongly depends on the viewing angle of the cloud. Thus, by comparing the observations with the polarization map predicted by the simulations, we can roughly determine the angle between the direction of the global magnetic field and the line of sight. The configuration of the polarization vectors also depends on the viewing angle. We find that an hourglass configuration of magnetic field lines is not always realized in a collapsing cloud when the global magnetic field is misaligned with the cloud rotation axis. Depending on the viewing angle, an *S*-shaped configuration of the magnetic field (or the polarization vectors) appears early in the protostellar accretion phase. This indicates that not only the magnetic field but also the cloud rotation affects the dynamical evolution of such a cloud. In addition, by comparing the simulated polarization with actual observations, we can estimate properties of the host cloud such as the evolutionary stage, magnetic field strength, and rotation rate.

Accepted by The Astrophysical Journal

<http://arxiv.org/abs/1210.7637>

## Star formation, structure, and formation mechanism of cometary globules: NIR observations of CG 1 and CG 2

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*Context.* Cometary globule (CG) 1 and CG 2 are “classic” cometary globules in the Gum Nebula. They have compact heads and long dusty tails that point away from the centre of the Gum Nebula.

*Aims.* We study the structure of CG 1 and CG 2 and the star formation in them to find clues to the CG formation mechanism. The two possible CG formation mechanisms, radiation-driven implosion (RDI) and a supernova blast wave, produce a characteristic mass distribution where the major part of the mass is situated in either the head (RDI) or the tail (supernova blast).

*Methods.* CG 1 and CG 2 were imaged in the near infrared (NIR) *JshKs* bands. NIR photometry was used to locate NIR excess objects and to create visual extinction maps of the CGs. The  $A_V$  maps allow us to analyse the large-scale structure of CG 1 and CG 2. Archival images from the WISE and Spitzer satellites and HIRES-processed IRAS images were used to study the globule’s small-scale structure. Fits were made to the spectral energy distribution plots of the NIR-excess stars to estimate their age and mass.

*Results.* In addition to the previously known CG 1 IRS 1 we discovered three new NIR-excess objects in IR imaging, two in CG 1 and one in CG 2. CG 2 IRS 1 is the first detection of star formation in CG 2. The objects are young low-mass stars. CG 1 IRS 1 is probably a class I protostar in the head of CG 1. CG 1 IRS 1 drives a bipolar outflow, which is very weak in CO, but the cavity walls are seen in reflected light in our NIR and in the Spitzer 3.6 and 4.5  $\mu\text{m}$  images. Strong emission from excited polycyclic aromatic hydrocarbon particles and very small grains were detected in the CG 1 tail. The total mass of CG 1 in the observed area is  $41.9 M_\odot$  of which  $16.8 M_\odot$  lies in the head. For CG 2 these values are  $31.0 M_\odot$  total and  $19.1 M_\odot$  in the head. The observed mass distribution does not offer a firm conclusion for the formation mechanism of the two CGs: CG 1 is in too evolved a state, and in CG 2 part of the globule tail was outside the observed area.

*Conclusions.* Even though the masses of the two CGs are similar, star formation has been more efficient in CG 1. By now, altogether six young low-mass stars have been detected in CG 1 and only one in CG 2. A possible new outflow was discovered to be emanating from CG 1 IRS 1.

Accepted by Astronomy & Astrophysics

<http://arxiv.org/abs/1211.1263>

## Mapping water in protostellar outflows with Herschel: PACS and HIFI observations of L1448-C

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Water is a key probe of shocks and outflows from young stars, being extremely sensitive to both the physical conditions

associated with the interaction of supersonic outflows with the ambient medium and the chemical processes at play. Our aim is to investigate the spatial and velocity distribution of H<sub>2</sub>O along outflows, its relationship with other tracers, and its abundance variations. In particular, this study focuses on the outflow driven by the low-mass protostar L1448-C, which previous observations have shown to be one of the brightest H<sub>2</sub>O emitters among the class 0 outflows. To this end, maps of the o-H<sub>2</sub>O 1<sub>10</sub>-1<sub>01</sub> and 2<sub>12</sub>-1<sub>01</sub> transitions taken with the *Herschel*-HIFI and PACS instruments, respectively, are presented. For comparison, complementary maps of the CO(3-2) and SiO(8-7) transitions, obtained at the JCMT, and the H<sub>2</sub> S(0) and S(1) transitions, taken from the literature, were used as well. Physical conditions and H<sub>2</sub>O column densities were inferred using LVG radiative transfer calculations. The water distribution appears to be clumpy, with individual peaks corresponding to shock spots along the outflow. The bulk of the 557 GHz line is confined to radial velocities in the range  $\pm 10$ -50 km s<sup>-1</sup>, but extended emission at extreme velocities (up to  $v_r \sim 80$  km s<sup>-1</sup>) is detected and is associated with the L1448-C extreme high-velocity (EHV) jet. The H<sub>2</sub>O 1<sub>10</sub>-1<sub>01</sub>/CO(3-2) ratio shows strong variations as a function of velocity that likely reflect different and changing physical conditions in the gas that is responsible for the emissions from the two species. In the EHV jet, a low H<sub>2</sub>O/SiO abundance ratio is inferred, which could indicate molecular formation from dust-free gas directly ejected from the proto-stellar wind. The ratio between the two observed H<sub>2</sub>O lines and the comparison with H<sub>2</sub>, indicate *averaged*  $T_{\text{kin}}$  and  $n(\text{H}_2)$  values of  $\sim 300$ -500 K and  $5 \times 10^6$  cm<sup>-3</sup>, respectively, while a water abundance with respect to H<sub>2</sub> of about  $0.5$ - $1 \times 10^{-6}$  along the outflow is estimated, in agreement with results found by previous studies. The fairly constant conditions found all along the outflow imply that evolutionary effects on the timescales of outflow propagation do not play a major role in the H<sub>2</sub>O chemistry. The results of our analysis show that the bulk of the observed H<sub>2</sub>O lines comes from post-shocked regions where the gas, after being heated to high temperatures, has already been cooled down to a few hundred K. The relatively low derived abundances, however, call for some mechanism that diminishes the H<sub>2</sub>O gas in the post-shock region. Among the possible scenarios, we favor H<sub>2</sub>O photodissociation, which requires the superposition of a low-velocity non dissociative shock with a fast dissociative shock able to produce a FUV field of sufficient strength.

Accepted by Astronomy & Astrophysics

<http://arxiv.org/abs/1210.7178>

## The thermal reactivity of HCN and NH<sub>3</sub> in interstellar ice analogues.

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HCN is a molecule central to interstellar chemistry, since it is the simplest molecule containing a carbon-nitrogen bond and its solid state chemistry is rich. The aim of this work was to study the  $\text{NH}_3 + \text{HCN} \rightarrow \text{NH}_4^+ \text{CN}^-$  thermal reaction in interstellar ice analogues. Laboratory experiments based on Fourier transform infrared spectroscopy and mass spectrometry were performed to characterise the  $\text{NH}_4^+ \text{CN}^-$  reaction product and its formation kinetics. This reaction is purely thermal and can occur at low temperatures in interstellar ices without requiring non-thermal processing by photons, electrons or cosmic rays. The reaction rate constant has a temperature dependence of  $k(T) = 0.016_{-0.006}^{+0.010} \text{ s}^{-1} \exp\left(\frac{-2.7 \pm 0.4 \text{ kJ mol}^{-1}}{RT}\right)$  when NH<sub>3</sub> is much more abundant than HCN. When both reactants are diluted in water ice, the reaction is slowed down. We have estimated the CN<sup>-</sup> ion band strength to be  $A_{\text{CN}^-} = 1.8 \pm 1.5 \times 10^{-17} \text{ cm molec}^{-1}$  at both 20 K and 140 K.  $\text{NH}_4^+ \text{CN}^-$  exhibits zeroth-order multilayer desorption kinetics with a rate of  $k_{\text{des}}(T) = 10^{28} \text{ molecules cm}^{-2} \text{ s}^{-1} \exp\left(\frac{-38.0 \pm 1.4 \text{ kJ mol}^{-1}}{RT}\right)$ . The  $\text{NH}_3 + \text{HCN} \rightarrow \text{NH}_4^+ \text{CN}^-$  thermal reaction is of primary importance because (i) it decreases the amount of HCN available to be hydrogenated into CH<sub>2</sub>NH, (ii) the NH<sub>4</sub><sup>+</sup> and CN<sup>-</sup> ions react with species such as H<sub>2</sub>CO, or CH<sub>2</sub>NH to form complex molecules, and (iii) NH<sub>4</sub><sup>+</sup> CN<sup>-</sup> is a reservoir of NH<sub>3</sub> and HCN, which can be made available to a high temperature chemistry.

Accepted by MNRAS

<http://arxiv.org/abs/1210.7066>

## Early-stage young stellar objects in the Small Magellanic Cloud

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We present new observations of 34 Young Stellar Object (YSO) candidates in the Small Magellanic Cloud (SMC). The photometric selection required sources to be bright at 24 and 70  $\mu\text{m}$  (to exclude evolved stars and galaxies). The anchor of the analysis is a set of *Spitzer*-IRS spectra, supplemented by groundbased 3–5  $\mu\text{m}$  spectra, *Spitzer* IRAC and MIPS photometry, near-IR imaging and photometry, optical spectroscopy and radio data. The sources' spectral energy distributions (SEDs) and spectral indices are consistent with embedded YSOs; prominent silicate absorption is observed in the spectra of at least ten sources, silicate emission is observed towards four sources. Polycyclic Aromatic Hydrocarbon (PAH) emission is detected towards all but two sources. Based on band ratios (in particular the strength of the 11.3- $\mu\text{m}$  and the weakness of the 8.6- $\mu\text{m}$  bands) PAH emission towards SMC YSOs is dominated by predominantly small neutral grains. Ice absorption is observed towards fourteen sources in the SMC. The comparison of H<sub>2</sub>O and CO<sub>2</sub> ice column densities for SMC, Large Magellanic Cloud (LMC) and Galactic samples suggests that there is a significant H<sub>2</sub>O column density threshold for the detection of CO<sub>2</sub> ice. This supports the scenario proposed by Oliveira et al. (2011) where the reduced shielding in metal-poor environments depletes the H<sub>2</sub>O column density in the outer regions of the YSO envelopes. No CO ice is detected towards the SMC sources. Emission due to pure-rotational 0 – 0 transitions of molecular hydrogen is detected towards the majority of SMC sources, allowing us to estimate rotational temperatures and H<sub>2</sub> column densities. All but one source are spectroscopically confirmed as SMC YSOs. Based on the presence of ice absorption, silicate emission or absorption, and PAH emission, the sources are classified and placed in an evolutionary sequence. Of the 33 YSOs identified in the SMC, 30 sources populate different stages of massive stellar evolution. The presence of ice- and/or silicate-absorption features indicates sources in the early embedded stages; as a source evolves, a compact H II region starts to emerge, and at the later stages the source's IR spectrum is completely dominated by PAH and fine-structure emission. The remaining three sources are classified as intermediate-mass YSOs with a thick dusty disc and a tenuous envelope still present. We propose one of the SMC sources is a D-type symbiotic system, based on the presence of Raman, H and He emission lines in the optical spectrum, and silicate emission in the IRS-spectrum. This would be the first dust-rich symbiotic system identified in the SMC.

Accepted by MNRAS

arXiv:1210.5193

## A method to measure CO and N<sub>2</sub> depletion profiles inside prestellar cores

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*Context.* In the dense and cold prestellar cores, many species freeze out onto grains to form ices. The most conspicuous case is that of CO itself. Only upper limits of this depletion amplitude can be estimated because the CO emission from the external undepleted layers mask the emission of CO left inside the depleted region. The finite signal-to-noise ratio of the observations is another limitation. However, depletion and even more desorption mechanisms are not well-known and need observational constraints, i.e., depletion profiles.

*Aims.* We describe a method for retrieving the CO and N<sub>2</sub> abundance profiles inside prestellar cores, which is mostly free from initial conditions.

*Method.* DCO<sup>+</sup> is a daughter molecule of CO, which appears inside depleted prestellar cores. The main deuteration partners are the H<sub>3</sub><sup>+</sup> isotopologues. By determining the abundance of these isotopologues via N<sub>2</sub>D<sup>+</sup>, N<sub>2</sub>H<sup>+</sup>, and ortho-H<sub>2</sub>D<sup>+</sup> observations and a chemical model, we can uniquely constrain the CO abundance, the only free parameter left, to fit the observed DCO<sup>+</sup> abundance. The N<sub>2</sub> abundance is also determined in the same manner once CO is known. DCO<sup>+</sup>-H<sub>2</sub> collisional rates including the hyperfine structure were computed in order to determine the DCO<sup>+</sup> abundance.

*Results.* To illustrate the method, we apply it to the main L183 prestellar core and find that the CO abundance profile varies from  $\geq 2.4 \times 10^{-5}$  at the core edge to  $\leq 6.6 \times 10^{-8}$  at the center. This represents a relative decrease in abundance by  $\geq 360$ , and by  $\geq 2000$  compared to the standard undepleted CO abundance ( $1-2 \times 10^{-4}$ ). Comparatively, N<sub>2</sub> abundance decreases much less, from  $\leq 3.7 \times 10^{-7}$  down to  $\sim 2.9 \times 10^{-8}$ , in contrast to the similar binding properties of the two species. Because the N<sub>2</sub> abundance is lower than its steady state value at the edge, while CO is close to its own, a possible explanation is that N<sub>2</sub> is still in its production phase in competition with depletion.

*Conclusions.* The method allows the CO and N<sub>2</sub> abundance profiles to be retrieved in the depleted zone both without needing extremely high signal-to-noise observations and free of masking effects by extended emission from the cloud envelope. The main uncertainties are linked to the N<sub>2</sub>H<sup>+</sup> collisional rates and somewhat to the H<sub>3</sub><sup>+</sup> isotopologue rates, both collisional and chemical, but hardly to the initial conditions of the model. This method opens up possibilities testing depletion and desorption mechanisms in prestellar cores and time evolution models, and of addressing the debated CO/N<sub>2</sub> depletion controversy.

Accepted by A&A Letters

[http://aramis.obspm.fr/~pagani/depletion\\_dcop.pdf](http://aramis.obspm.fr/~pagani/depletion_dcop.pdf)

## Constraints on the Radial Variation of Grain Growth in the AS 209 Circumstellar Disk

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We present dust continuum observations of the protoplanetary disk surrounding the pre-main sequence star AS 209, spanning more than an order of magnitude in wavelength from 0.88 to 9.8 mm. The disk was observed with sub-arcsecond angular resolution ( $0.2'' - 0.5''$ ) to investigate radial variations in its dust properties. At longer wavelengths,

the disk emission structure is notably more compact, providing model-independent evidence for changes in the grain properties across the disk. We find that physical models which reproduce the disk emission require a radial dependence of the dust opacity  $\kappa_\nu$ . Assuming that the observed wavelength-dependent structure can be attributed to radial variations in the dust opacity spectral index ( $\beta$ ), we find that  $\beta(R)$  increases from  $\beta < 0.5$  at  $\sim 20$  AU to  $\beta > 1.5$  for  $R \geq 80$  AU, inconsistent with a constant value of  $\beta$  across the disk (at the  $10\sigma$  level). Furthermore, if radial variations of  $\kappa_\nu$  are caused by particle growth, we find that the maximum size of the particle-size distribution ( $a_{max}$ ) increases from sub-millimeter-sized grains in the outer disk ( $R \geq 70$  AU) to millimeter and centimeter-sized grains in the inner disk regions ( $R \leq 70$  AU). We compare our observational constraint on  $a_{max}(R)$  with predictions from physical models of dust evolution in proto-planetary disks. For the dust composition and particle-size distribution investigated here, our observational constraints on  $a_{max}(R)$  are consistent with models where the maximum grain size is limited by radial drift.

Accepted by ApJ Letters

<http://arxiv.org/abs/1210.5252>

## The IRAM-30m line survey of the Horsehead PDR: II. First detection of the l-C<sub>3</sub>H<sup>+</sup> hydrocarbon cation

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We present the first detection of the l-C<sub>3</sub>H<sup>+</sup> hydrocarbon in the interstellar medium. The Horsehead WHISPER project, a millimeter unbiased line survey at two positions, namely the photo-dissociation region (PDR) and the nearby shielded core, revealed a consistent set of eight unidentified lines toward the PDR position. Six of them are detected with a signal-to-noise ratio from 6 to 19, while the two last ones are tentatively detected. Mostly noise appears at the same frequency toward the dense core, located less than 40'' away. We simultaneously fit 1) the rotational and centrifugal distortion constants of a linear rotor, and 2) the Gaussian line shapes located at the eight predicted frequencies. The observed lines can be accurately fitted with a linear rotor model, implying a <sup>1</sup>Σ ground electronic state. The deduced rotational constant value is  $B = 11244.9512 \pm 0.0015$  MHz, close to that of l-C<sub>3</sub>H. We thus associate the lines to the l-C<sub>3</sub>H<sup>+</sup> hydrocarbon cation, which enables us to constrain the chemistry of small hydrocarbons. A rotational diagram is used to infer the excitation temperature and the column density. We finally compare the abundance to the results of the Meudon PDR photochemical model.

Accepted by Astronomy & Astrophysics

arXiv:1210.8178

## Early evolution of the birth cluster of the solar system

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The solar system was most likely born in a star cluster containing at least 1000 stars. It is highly probable that this cluster environment influenced various properties of the solar system like its chemical composition, size and the orbital parameters of some of its constituting bodies. In the Milky Way, clusters with more than 2000 stars only form in two types - starburst clusters and leaky clusters - each following a unique temporal development in the mass-radius plane. The aim is here to determine the encounter probability in the range relevant to solar system formation for starburst or

leaky cluster environments as a function of cluster age. N-body methods are used to investigate the cluster dynamics and the effect of gravitational interactions between cluster members on young solar-type stars surrounded by discs. Using the now available knowledge of the cluster density at a given cluster age it is demonstrated that in starburst clusters the central densities over the first 5Myr are so high (initially  $> 10^5 M_{\odot}\text{pc}^{-3}$ ) that hardly any discs with solar system building potential would survive this phase. This makes a starburst clusters an unlikely environment for the formation of our solar system. Instead it is highly probable that the solar system formed in a leaky cluster (often classified as OB association). It is demonstrated that an encounter determining the characteristic properties existing in our solar systems most likely happened very early on ( $< 2\text{Myr}$ ) in its formation history and that after 5Myr the likelihood of a solar-type star experiencing such an encounter in a leaky cluster is negligible even if it was still part of the bound remnant. This explains why the solar system could develop and maintain its high circularity later in its development.

Accepted by A&A

<http://arxiv.org/abs/1210.8255>

## Are Large, Cometary-Shaped Proplyds really (free-floating) EGGs?

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We report the detection of strong and compact molecular line emission (in the CO J=3–2, 4–3, 6–5, 7–6, <sup>13</sup>CO J=3–2, HCN and HCO<sup>+</sup> J=4–3 transitions) from a cometary-shaped object (Carina-frEGG1) in the Carina star-forming region (SFR) previously classified as a photoevaporating protoplanetary disk (proplyd). We derive a molecular mass of  $0.35m_{\text{s}}^{-1}$  for Carina-frEGG1, which shows that it is not a proplyd, but belongs to a class of free-floating evaporating gas globules (frEGGs) recently found in the Cygnus SFR by Sahai, Morris & Claussen (2012). Archival Adaptive Optics near-IR (Ks) images show a central hourglass-shaped nebula. The derived source luminosity (about 8 – 18 L<sub>⊙</sub>), the hourglass morphology, and the presence of collimated jets seen in HST images, imply the presence of a jet-driving, young, low-mass star deeply embedded in the dust inside Carina-frEGG1. Our results suggest that the true nature of many or most such cometary-shaped objects seen in massive SFRs and previously labelled as proplyds has been misunderstood, and that these are really frEGGs.

Accepted by Astrophysical Journal (Letters)

<http://arxiv.org/abs/1211.0345>

## Different evolutionary stages in massive star formation. Centimeter continuum and H<sub>2</sub>O maser emission with ATCA

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We present ATCA observations of the H<sub>2</sub>O maser line and radio continuum at 18.0 GHz and 22.8 GHz, toward a sample of 192 massive star forming regions containing several clumps already imaged at 1.2 mm. The main aim of this study is to investigate the water maser and centimeter continuum emission (likely tracing thermal free-free emission) in sources at different evolutionary stages, using the evolutionary classifications proposed by Palla et al. (1991) and Molinari et al. (2008). We used the recently commissioned CABB backend at ATCA obtaining images with

$\sim 20''$  resolution in the 1.3 cm continuum and H<sub>2</sub>O maser emission, in all targets. For the evolutionary analysis of the sources we used the millimeter continuum emission from Beltrán et al. (2006) and the infrared emission from the MSX Point Source Catalogue. We detect centimeter continuum emission in 88% of the observed fields with a typical rms noise level of 0.45 mJy beam<sup>-1</sup>. Most of the fields show a single radio continuum source, while in 20% of them we identify multiple components. A total of 214 centimeter continuum sources have been identified, likely tracing optically thin HII regions, with physical parameters typical of both extended and compact HII regions. Water maser emission was detected in 41% of the regions, resulting in a total of 85 distinct components. The low angular ( $\sim 20''$ ) and spectral ( $\sim 14$  km s<sup>-1</sup>) resolutions do not allow a proper analysis of the water maser emission, but suffice to investigate its association with the continuum sources. We have also studied the detection rate of HII regions in the two types of IRAS sources defined by Palla et al. (1991) on the basis of the IRAS colours: High and Low. No significant differences are found, with large detection rates (>90%) for both High and Low sources. We classify the millimeter and infrared sources in our fields in three evolutionary stages following the scheme presented by Molinari et al. (2008): (type 1) millimeter-only sources, (type 2) millimeter plus infrared sources, (type 3) infrared-only sources. We find that HII regions are mainly associated with type 2 and 3 objects, confirming that these are more evolved than type 1 sources. The HII regions associated with type 3 sources are slightly less dense and larger in size than those associated with type 2 sources, as expected if the HII region expands as it evolves, and type 3 objects are older than type 2 ones. Regarding the maser emission, it is mostly found associated with type 1 and 2 sources, with a higher detection rate toward type 2, consistent with the results of Breen et al. (2010). Finally, our results on HII region and H<sub>2</sub>O maser association with different evolutionary types confirm the evolutionary classification proposed by Molinari et al. (2008).

Accepted by Astronomy and Astrophysics

<http://arxiv.org/abs/1211.0847>

## Water ice deuteration: a tracer of the chemical history of protostars

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*Context.* Millimetric observations have measured large degrees of molecular deuteration in several species seen around low-mass protostars. The Herschel Space Telescope, launched in 2009, is now providing new measures of the deuterium fractionation of water, the main constituent of interstellar ices.

*Aims.* We aim at theoretically studying the formation and the deuteration of water which is believed to be formed on interstellar grain surfaces in molecular clouds.

*Methods.* We used our gas-grain astrochemical model GRAINOBLE which considers the multilayer formation of interstellar ices. We varied several input parameters to study their impact on water deuteration. We included the treatment of ortho and para states of key species, including H<sub>2</sub>, that affects the deuterium fractionation of all molecules. The model also includes relevant laboratory and theoretical works on water formation and deuteration on grain surfaces. In particular, we computed the transmission probabilities of surface reactions using the Eckart model and we considered ice photodissociation following molecular dynamics simulations.

*Results.* The use of a multilayer approach allowed us to study the influence of various parameters on the abundance and the deuteration of water. Deuteration of water is found to be very sensitive to the ortho-to-para ratio of H<sub>2</sub> and the total density, but it also depends on the gas/grain temperatures and the visual extinction of the cloud. Since the deuteration is very sensitive to the physical conditions, the comparison with sub-millimetric observation towards the low-mass protostar IRAS 16293 allowed us to suggest that water ice is formed together with CO<sub>2</sub> in molecular clouds with limited density while formaldehyde and methanol are mainly formed in a later phase, where the condensation becomes denser and colder.

Accepted by Astronomy & Astrophysics

<http://arxiv.org/abs/1211.0514>

## Adaptive Optics Observations of 3 $\mu\text{m}$ Water Ice in Silhouette Disks in the Orion Nebula Cluster and M43

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We present the near-infrared images and spectra of four silhouette disks in the Orion Nebula Cluster (M42) and M43 using the Subaru Adaptive Optics system. While d053-717 and d141-1952 show no water ice feature at 3.1  $\mu\text{m}$ , a moderately deep ( $\tau_{ice} \sim 0.7$ ) water ice absorption is detected toward d132-1832 and d216-0939. Taking into account the water ice so far detected in the silhouette disks, the critical inclination angle to produce a water ice absorption feature is confirmed to be 65°–75°. As for d216-0939, the crystallized water ice profile is exactly the same as in the previous observations taken 3.63 years ago. If the water ice material is located at 30 AU, then the observations suggest it is uniform at a scale of about 3.5 AU.

Accepted by Astronomical Journal

<http://arxiv.org/abs/1210.5772>

## Orbital evolution of a planet on an inclined orbit interacting with a disc

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We study the dynamics of a planet on an orbit inclined with respect to a disc. If the initial inclination of the orbit is larger than some critical value, the gravitational force exerted by the disc on the planet leads to a Kozai cycle in which the eccentricity of the orbit is pumped up to large values and oscillates with time in antiphase with the inclination. On the other hand, both the inclination and the eccentricity are damped by the frictional force that the planet is subject to when it crosses the disc. We show that, by maintaining either the inclination or the eccentricity at large values, the Kozai effect provides a way of delaying alignment with the disc and circularization of the orbit. We find the critical value to be characteristically as small as about 20 degrees. Typically, Neptune or lower mass planets would remain on inclined and eccentric orbits over the disc lifetime, whereas orbits of Jupiter or higher mass planets would align and circularize. This could play a significant role in planet formation scenarios.

Accepted by MNRAS

<http://arxiv.org/abs/1209.4843>

## Planet Signatures in Collisionally Active Debris Discs: scattered light images

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Planet perturbations have been often invoked as a potential explanation for many spatial structures that have been imaged in debris discs. So far this issue has been mostly investigated with pure N-body numerical models, which

neglect the crucial effect collisions within the disc can have on the disc's response to dynamical perturbations. We numerically investigate how the coupled effect of collisions and radiation pressure can affect the formation and survival of radial and azimuthal structures in a disc perturbed by a planet. We consider two different set-ups: a planet embedded within an extended disc and a planet exterior to an inner debris ring. One important issue we want to address is under which conditions a planet's signature can be observable in a collisionally active disc.

We use the DyCoSS code of Thebault(2012), which is designed to investigate the structure of perturbed debris discs at dynamical and collisional steady-state, and derive synthetic images of the system in scattered light. The planet's mass and orbit, as well as the disc's collisional activity (parameterized by its average vertical optical depth  $\tau_0$ ) are explored as free parameters.

We find that collisions always significantly damp planet-induced spatial structures. For the case of an embedded planet, the planet's signature, mostly a density gap around its radial position, should remain detectable in head-on images if  $M_{planet} \geq M_{Saturn}$ . If the system is seen edge-on, however, inferring the presence of the planet is much more difficult, as only weak asymmetries remain in a collisionally active disc, although some planet-induced signatures might be observable under very favourable conditions.

For the case of an inner ring and an external planet, planetary perturbations cannot prevent collision-produced small fragments from populating the regions beyond the ring. The radial luminosity profile exterior to the ring is in most cases close to the one it should have in the absence of the external planet. The most significant signature left by a Jovian planet on a circular orbit are precessing azimuthal structures that can be used to indirectly infer its presence. For a planet on an eccentric orbit, we show that the ring becomes elliptic and that the well known pericentre glow effect is visible despite of collisions and radiation pressure, but that detecting such features in observed discs is not an unambiguous indicator of the presence of an outer planet.

Accepted by Astronomy and Astrophysics

<http://lesia.obspm.fr/perso/philippe-thebault/planpapph.pdf>

## MHD Modeling of a Disk-Wind from a High-Mass Protobinary: the case of Orion Source I

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Very long baseline interferometry (VLBI) observations of SiO masers in Orion Source I has enabled for the first time to resolve the outflow from a high-mass protostar in the launch and collimation region. Therefore, Source I provides a unique laboratory to study mass-loss and mass-accretion in a high-mass protostar. We numerically simulate the dynamics of the disk-wind inside 100 AU from Source I. This enables us to investigate the balance of different forces (gravitational, magnetic, thermal) regulating gas dynamics in massive star formation. In this work, we adopt magnetohydrodynamic (MHD) disk-wind models to explain the observed properties of the disk-wind from Orion Source I. The central source is assumed to be a binary composed of two  $10 M_{\odot}$  stars in a circular orbit with an orbital separation of 7 AU. High resolution ideal MHD wind launching simulations (which prescribe disk as a boundary) are performed using the PLUTO code. The simulations are allowed to run until a steady state is obtained. MHD driven disk-wind provides a consistent model for the wide-angle flow from Source I probed by SiO masers, reproducing the bipolar morphology, the velocity amplitude and rotational profile, the physical conditions, and the magnetic field strength.

Accepted by MNRAS Letters

<http://arxiv.org/abs/1210.7775>

## Tearing the Veil: interaction of the Orion Nebula with its neutral environment

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We present HI 21cm observations of the Orion Nebula, obtained with the Karl G. Jansky Very Large Array, at an angular resolution of  $7.2'' \times 5.7''$  and a velocity resolution of 0.77 km/s. Our data reveal HI absorption towards the radio continuum of the HII region, and HI emission arising from the Orion Bar photon-dominated region (PDR) and from the Orion-KL outflow. In the Orion Bar PDR, the HI signal peaks in the same layer as the H<sub>2</sub> near-infrared vibrational line emission, in agreement with models of the photodissociation of H<sub>2</sub>. The gas temperature in this region is approximately 540K, and the HI abundance in the interclump gas in the PDR is 5-10% of the available hydrogen nuclei. Most of the gas in this region therefore remains molecular. Mechanical feedback on the Veil manifests itself through the interaction of ionized flow systems in the Orion Nebula, in particular the Herbig-Haro object HH 202, with the Veil. These interactions give rise to prominent blueward velocity shifts of the gas in the Veil. The unambiguous evidence for interaction of this flow system with the Veil shows that the distance between the Veil and the Trapezium stars needs to be revised downwards to about 0.4 pc. The depth of the ionized cavity is about 0.7 pc, which is much smaller than the depth and the lateral extent of the Veil. Our results reaffirm the blister model for the M42 HII region, while also revealing its relation to the neutral environment on a larger scale.

Accepted by The Astrophysical Journal

<http://arxiv.org/abs/1211.0470>

## **A mapping study of L1174 with $^{13}\text{CO } J = 2 - 1$ and $^{12}\text{CO } J = 3 - 2$ : star formation triggered by a Herbig Ae/Be star**

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We have carried out a comprehensive study of the molecular conditions and star-forming activities in dark cloud L1174 with multi-wavelength data. Mapping observations of L1174 in  $^{13}\text{CO } J = 2 - 1$  and  $^{12}\text{CO } J = 3 - 2$  were performed using the KOSMA 3-meter telescope. Six molecular cores with masses ranging from 5 to 31  $M_{\odot}$  and sizes ranging from 0.17 to 0.39 pc are resolved. Large area ahead of a Herbig Be star, HD 200775, is in expanding and core 1 is with collapse signature. Large line widths of  $^{13}\text{CO } J = 2 - 1$  indicate the ubiquity of turbulent motions in this region. Spectra of  $^{12}\text{CO } J = 3 - 2$  prevalently show conspicuously asymmetric double-peaked profiles. In a large area, red-skewed profiles are detected and suggestive of a scenario of global expansion. There is a large cavity around the Herbig Be star HD 200775, the brightest star in L1174. The gas around the cavity has been severely compressed by the stellar winds from HD 200775. Feedbacks from HD 200775 may have helped form the molecular cores around the cavity. Seventeen 2MASS potential young stellar objects were identified according to their 2MASS colour indices. The spatial distribution of the these 2MASS sources indicates that some of them have a triggered origin. All these suggest that feedbacks from a Herbig Ae/Be star may also have the potential to trigger star forming activities.

Accepted by MNRAS

## *Abstracts of recently accepted major reviews*

### **Our astrochemical heritage**

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Our Sun and planetary system were born about 4.5 billion years ago. How did this happen and what is our heritage from these early times? This review tries to address these questions from an astrochemical point of view. On the one hand, we have some crucial information from meteorites, comets and other small bodies of the Solar System. On the other hand, we have the results of studies on the formation process of Sun-like stars in our Galaxy. These results tell us that Sun-like stars form in dense regions of molecular clouds and that three major steps are involved before the planet formation period. They are represented by the pre-stellar core, protostellar envelope and protoplanetary disk phases. Simultaneously with the evolution from one phase to the other, the chemical composition gains increasing complexity.

In this review, we first present the information on the chemical composition of meteorites, comets and other small bodies of the Solar System, which is potentially linked to the first phases of the Solar System's formation. Then we describe the observed chemical composition in the pre-stellar core, protostellar envelope and protoplanetary disk phases, including the processes that lead to them. Finally, we draw together pieces from the different objects and phases to understand whether and how much we inherited chemically from the time of the Sun's birth.

Accepted by The Astronomy and Astrophysics Review

<http://arxiv.org/abs/1210.6368>

### **Turbulent molecular clouds**

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Stars form within molecular clouds but our understanding of this fundamental process remains hampered by the complexity of the physics that drives their evolution. We review our observational and theoretical knowledge of molecular clouds trying to confront the two approaches wherever possible. After a broad presentation of the cold interstellar medium and molecular clouds, we emphasize the dynamical processes with special focus to turbulence and its impact on cloud evolution. We then review our knowledge of the velocity, density and magnetic fields. We end by openings towards new chemistry models and the links between molecular cloud structure and star-formation rates.

Accepted by The Astronomy and Astrophysics Review

*Dissertation Abstracts*

**Magnetic Fields in the Milky Way:  
Near-Infrared Polarimetry**

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Ph.D dissertation directed by: Dan P. Clemens

Ph.D degree awarded: July 2012

Astronomers have a limited understanding of the large-scale structure of the Galactic magnetic field and its role in the evolution of the interstellar medium (ISM). This understanding derives primarily from Faraday rotation and synchrotron observations which do not probe the cool, dusty ISM. To advance our knowledge of the Galactic magnetic field, this dissertation reports on the application of a different method, near-infrared (NIR) polarization of background starlight, to place new observational constraints on the nature of the Galactic magnetic field and to study the field's role in the evolution of interstellar material.

A radiative transfer computer code was developed to predict all-sky starlight polarization observations. Starlight polarimetry predictions were made for several different dynamo-driven magnetic field geometries, assuming that magnetically-aligned interstellar dust grains polarize background starlight. New NIR starlight polarimetry measurements in the outer Galaxy were tested against these predictions. These observations favor disk-symmetric magnetic fields while rejecting disk-antisymmetric magnetic fields. This result contradicts some previous interpretations of all-sky, radio Faraday rotation measurements. The Galactic magnetic pitch angle is constrained to  $p = -6 \pm 2^\circ$ .

The physical orientations of Galactic HII regions, traced by mid-infrared emission, are compared to the large-scale, disk-symmetric Galactic magnetic field geometry derived above. Hydrogen recombination line spectra towards these same objects revealed that many possessed turbulent linewidths. If fluid turbulence decays with time, then it may be used as a relative age indicator. A trend is seen between magnetic alignment and the degree of turbulence in the HII region. This result leads to the development of an observationally-driven HII region magnetic evolutionary sequence.

Resolved polarimetry across the face of the galaxy M51 was measured for comparison with the internal, edge-on view of the Milky Way seen from Earth. Strong upper limits ( $< 0.05\%$  at a resolution of 0.6 arcseconds) were placed on the degree of NIR polarization across the face of M51. These results were combined with resolved optical polarimetry measurements from the literature. Normal polarization mechanisms cannot explain the observed polarization dependence on wavelength.

<http://people.bu.edu/pavelmi/thesis.pdf>

## *New Jobs*

### **Postdoctoral position in the ISM / star formation at the University of Exeter**

Applications are invited for a postdoctoral position in the Astrophysics group at the University of Exeter. The successful candidate will be expected to work with Dr Clare Dobbs on an ERC funded project studying molecular cloud formation and evolution, and star formation on galactic scales. This position will involve working on molecular clouds and the interstellar medium, with an emphasis on bridging the gap between numerical simulations and observations. The work carried out by the candidate will include producing synthetic maps of observed tracers from numerical simulations, and comparing these to observations.

Applicants will possess a relevant PhD by commencement of the position. Applicants should have experience in the fields of the interstellar medium and / or star formation, but this can be from a theoretical, numerical, or observational background.

The University of Exeter Astrophysics group has a strong emphasis on star formation, with both theorists and observers working on star formation and molecular clouds. The University has a supercomputer which is available for members of the astrophysics group, and Exeter is part of the DiRAC high performance computing consortium in the UK.

The position will be for 3 years, starting in the fall of 2013. The salary will be in the range 24,520 to 31,020 depending on qualifications and experience. There are also funds for travel and computing.

Applicants should send a CV, list of publications, and a statement of research including future research plans, to [dobbs@astro.ex.ac.uk](mailto:dobbs@astro.ex.ac.uk) by 15th December 2012. Applicants should also arrange for 3 letters of reference to be sent by email to the same address by the same date.

### **Postdoctoral Position in Star Formation and Astrochemistry**

The Institut de Planétologie et d'Astrophysique de Grenoble (IPAG) is seeking applications for a Postdoctoral position in star formation and astrochemistry. The successful applicant will work with Sébastien Maret (IPAG) and Benoît Commerçon (LERMA, Paris) on the modeling of an extensive set of observations of young solar type protostars obtained with the Plateau de Bure interferometer (PdBI) as part of an IRAM large program (PI Philippe André). The postdoctoral researcher will lead the development of a numerical model that couples the result of state-of-the-art MHD simulations of pre- and proto-stellar core dynamical evolution with a complete chemistry network. He/she will also contribute to analyze and interpret the PdBI observations, as well as follow-up observations that we plan on obtaining with ALMA and NOEMA.

Applicants should have a PhD in astronomy and a strong background in numerical modeling of the dynamics, chemistry and/or radiative transfer of star forming regions. Knowledge of millimeter or sub-millimeter interferometry is an asset. Good English communication skills and ability to work in a team are essential (note that knowledge of the French language is not required). Regular travels between Grenoble and Paris are expected.

The postdoctoral researcher will be appointed for an initial period of two years with the possibility of renewal for one year, with an attractive salary that commensurate with experience. The appointment is expected to start in early 2013. A full working environment, including a laptop, a workstation, and an access to a 352-cores grid computer, will be provided. Travel funds are also available upon prior agreement with the postdoc supervisor.

Applicants should send a curriculum vitae, a publication list, and a statement of research experience and interests by email to Sébastien Maret ([sebastien.maret@obs.ujf-grenoble.fr](mailto:sebastien.maret@obs.ujf-grenoble.fr)). They should also arrange for three reference letters (to be sent directly by the referees by email). Deadline for applications is December, 14th 2012.

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).

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