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Abstracts of recently accepted papers

A multi-wavelength study of the young star V1118 Orionis in outburst

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The accretion history of low-mass young stars is not smooth but shows spikes of accretion that can last from months and years to decades and centuries. Observations of young stars in outbursts can help us understand the temporal evolution of accreting stars and the interplay between the accretion disk and the stellar magnetosphere. The young late-type star V1118 Orionis was in outburst from 2005 to 2006. We followed the outburst with optical and near-infrared photometry; the X-ray emission was further probed with observations taken with *XMM-Newton* and *Chandra* during and after the outburst. In addition, we obtained mid-infrared photometry and spectroscopy with *Spitzer* at the peak of the outburst and in the post-outburst phase. The spectral energy distribution of V1118 Ori varied significantly over the course of the outburst. The optical flux showed the largest variations, most likely due to enhanced emission by a hot spot. The latter dominated the optical and near-infrared emission at the peak of the outburst, while the disk emission dominated in the mid-infrared. The emission silicate feature in V1118 Ori is flat and does not vary in shape, but was slightly brighter at the peak of the outburst compared to the post-outburst spectrum. The X-ray flux correlated with the optical and infrared fluxes, indicating that accretion affected the magnetically active corona and the stellar magnetosphere. The thermal structure of the corona was variable with some indication of a cooling of the coronal temperature in the early phase of the outburst with a gradual return to normal values. Color-color diagrams in the optical and infrared showed variations during the outburst, with no obvious signature of reddening due to circumstellar matter. Using Monte-Carlo realizations of star+disk+hotspot models to fit the spectral energy distributions in “quiescence” and at the peak of the outburst, we determined that the mass accretion rate varied from about $2.5 \times 10^{-7} M_{\odot} \text{ yr}^{-1}$ to $1.0 \times 10^{-6} M_{\odot} \text{ yr}^{-1}$; in addition the fractional area of the hotspot increased significantly as well. The multi-wavelength study of the V1118 Ori outburst helped us to understand the variations in spectral energy distributions and demonstrated the interplay between the disk and the stellar magnetosphere in a young, strongly accreting star.

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Molecular Rings around Interstellar Bubbles and the Thickness of Star-Forming Clouds

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The winds and radiation from massive stars clear out large cavities in the interstellar medium. These bubbles, as they have been called, impact their surrounding molecular clouds and may influence the formation of stars therein. Here we

present JCMT observations of the J=3-2 line of CO in 43 bubbles identified with Spitzer Space Telescope observations. These spectroscopic data reveal the three-dimensional structure of the bubbles. In particular, we show that the cold gas lies in a ring, not a sphere, around the bubbles indicating that the parent molecular clouds are flattened with a typical thickness of a few parsecs. We also mapped 7 bubbles in the J=4-3 line of HCO+ and find that the column densities inferred from the CO and HCO+ line intensities are below that necessary for "collect and collapse" models of induced star formation. We hypothesize that the flattened molecular clouds are not greatly compressed by expanding shock fronts, which may hinder the formation of new stars.

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<http://lanl.arxiv.org/abs/0912.1852>

Looking for high-mass young stellar objects: H₂O and OH masers in ammonia cores

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Context: The earliest stages of high-mass star formation have yet to be characterised well, because high-angular resolution observations are required to infer the properties of the molecular gas hosting the newly formed stars.

Aims: We search for high-mass molecular cores in a large sample of 15 high-mass star-forming regions that are observed at high-angular resolution, extending a pilot survey based on a smaller number of objects.

Methods: The sample was chosen from surveys of H₂O and OH masers to favour the earliest phases of high-mass star formation. Each source was first observed with the 32-m single-dish Medicina antenna in the (1,1) and (2,2) inversion transitions at 1.3 cm of ammonia, which is an excellent tracer of dense gas. High-resolution maps in the NH₃(2,2) and (3,3) lines and the 1.3 cm continuum were obtained successively with the VLA interferometer.

Results: We detect continuum emission in almost all the observed star-forming regions, which corresponds to extended and UCHII regions created by young stellar objects with typical luminosities of $\sim 10^4 L_{\odot}$. However, only in three cases do we find a projected overlap between HII regions and H₂O and OH maser spots. On the other hand, the VLA images detect eight ammonia cores closely associated with the maser sources. The ammonia cores have sizes of $\sim 10^4$ AU, and high masses (up to $10^4 M_{\odot}$), and are very dense (from $\sim 10^6$ to a few $\times 10^9$ cm⁻³). The typical relative NH₃ abundance is $\leq 10^{-7}$, in agreement with previous measurements in high-mass star-forming regions.

Conclusions: The statistical analysis of the distribution between H₂O and OH masers, NH₃ cores, and HII regions confirms that the earliest stages of high-mass star formation are characterised by high-density molecular cores with temperatures of on average ≥ 30 K, either without a detectable ionised region or associated with a hypercompact HII region.

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<http://www.arcetri.astro.it/~codella/papers/nh3.ps.gz>

Protostellar collapse: radiative and magnetic feedbacks on small scale fragmentation.

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It is established that both radiative transfer and magnetic field have a strong impact on the collapse and the fragmentation of prestellar dense cores, but no consistent calculation exists yet at such scales. We perform the first Radiation-Magneto-HydroDynamics numerical calculations at a prestellar core scale. We present original AMR calculations

including magnetic field (in the ideal MHD limit) and radiative transfer, within the Flux Limited Diffusion approximation, of the collapse of a 1 solar mass dense core. We compare the results with calculations performed with a barotropic EOS. We show that radiative transfer has an important impact on the collapse and the fragmentation, through the cooling or heating of the gas, and its importance depends upon the magnetic field. A larger field yields a stronger magnetic braking, increasing the accretion rate and thus the effect of the radiative feedback. Even for a strongly magnetized core, where the dynamics of the collapse is dominated by the magnetic field, radiative transfer is crucial to determine the temperature and optical depth distributions, two potentially accessible observational diagnostics. A barotropic EOS cannot account for realistic fragmentation. The diffusivity of the numerical scheme, however, is found to strongly affect the output of the collapse, leading eventually to spurious fragmentation. Both radiative transfer and magnetic field must be included in numerical calculations of star formation to obtain realistic collapse configurations and observable signatures. Nevertheless, the numerical resolution and the robustness of the solver are of prime importance to obtain reliable results. When using an accurate solver, the fragmentation is found to always remain inhibited by the magnetic field, at least in the ideal MHD limit, even when radiative transfer is included.

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<http://arxiv.org/abs/0912.3138>

Self-Consistent Analysis of OH Zeeman Observations

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Crutcher, Hakobian, and Troland (2009) used OH Zeeman observations of four nearby molecular dark clouds to show that the ratio of mass to magnetic flux was smaller in the 0.1 pc cores than in the 1 pc envelopes, in contradiction to the prediction of ambipolar diffusion driven core formation. A crucial assumption was that the magnetic field direction is nearly the same in the envelope and core regions of each cloud. Mouschovias and Tassis (2009) have argued that the data are not consistent with this assumption, and presented a new analysis that changes the conclusions of the study. Here we show that the data are in fact consistent with the nearly uniform field direction assumption; hence, the original study is internally self-consistent and the conclusions are valid under the assumptions that were made. We also show that the Mouschovias and Tassis model of magnetic fields in cloud envelopes is inconsistent with their own analysis of the data. However, the data do not rule out a more complex field configuration that future observations may discern.

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The Stellar Population of η and χ Persei: Cluster Properties, Membership, and the Intrinsic Colors and Temperatures of Stars

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(Abridged) From photometric observations of $\sim 47,000$ stars and spectroscopy of $\sim 11,000$ stars, we describe the first extensive study of the stellar population of the famous Double Cluster, η and χ Persei, down to subsolar masses. Both clusters have $E(B-V) \sim 0.52-0.55$ and $dM = 11.8-11.85$; the halo population, while more poorly constrained, likely has identical properties. As determined from the main sequence turnoff, the luminosity of M supergiants, and pre-main

sequence isochrones, ages for η Persei, χ Persei and the halo population all converge on ≈ 14 Myr. From these data, we establish the first spectroscopic and photometric membership lists of cluster stars down to early/mid M dwarfs. At minimum, there are $\sim 5,000$ members within $10'$ of the cluster centers, while the entire η and χ Persei region has at least $\sim 13,000$ and as many as 20,000 members. The Double Cluster contains $\approx 8,400 M_{\odot}$ of stars within $10'$ of the cluster centers. We estimate a total mass of at least $20,000 M_{\odot}$. We conclude our study by outlining outstanding questions regarding the properties of η and χ Persei. From comparing recent work, we compile a list of intrinsic colors and derive a new effective temperature scale for O–M dwarfs, giants, and supergiants.

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Millimeter Dust Emission in the GQ Lup System

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We present Submillimeter Array observations of the GQ Lup system at 1.3 millimeters wavelength with $0.4''$ (~ 60 AU) resolution. Emission is detected from the position of the primary star, GQ Lup A, and is marginally resolved. No emission is detected from the substellar companion, GQ Lup B, $0.7''$ away. These data, together with models of the spectral energy distribution, suggest a compact disk around GQ Lup A with mass $\sim 3 M_{Jup}$, perhaps truncated by tidal forces. There is no evidence for a gap or hole in the disk that might be the signature of an additional inner companion body capable of scattering GQ Lup B out to ~ 100 AU separation from GQ Lup A. For GQ Lup B to have formed *in situ*, the disk would have to have been much more massive and extended.

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A General Catalogue of Molecular Hydrogen Emission-Line Objects (MHOs) in Outflows from Young Stars

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We present a catalogue of Molecular Hydrogen emission-line Objects (MHOs) in outflows from young stars, most of which are deeply embedded. All objects are identified in the near-infrared lines of molecular hydrogen, all reside in the Milky Way, and all are associated with jets or molecular outflows. Objects in both low and high-mass star forming regions are included. This catalogue complements the existing database of Herbig-Haro objects; indeed, for completeness, HH objects that are detected in H_2 emission are included in the MHO catalogue.

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Catalogue website: <http://www.jach.hawaii.edu/UKIRT/MHCat>

The origin of mid-infrared emission in massive young stellar objects: multi-baseline VLTI observations of W33A

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In this paper we aim to determine the structure on 100 AU scales of the massive young stellar object W33A, using interferometric observations in the mid-infrared. This emission could be due to a variety of elements, for example the inner protostellar envelope, outflow cavity walls, dusty or gaseous accretion disk. We use the Unit Telescopes of the VLT Interferometer in conjunction with the MIDI instrument to obtain spectrally dispersed visibilities in the N -band on 4 baselines with an angular resolution between 25 and 60 milli-arcseconds (equivalent to 95 and 228 AU at 3.8 kpc). The visibility spectra and spectral energy distribution are compared to 2D-axi-symmetric dust radiative transfer models with a geometry including a rotationally flattened envelope and outflow cavities. We assume an O 7.5 ZAMS star as the central source, consistent with the observed bolometric luminosity. The observations are compared to models with and without (dusty and gaseous) accretion disks. The visibilities are between 5% and 15%, and the non-spherically symmetric emitting structure has a typical size of 100 AU. A satisfactory model is constructed which reproduces the visibility spectra for each (u,v) point. It fits the N -band flux spectrum, the mid-infrared slope, the far-infrared peak, and the (sub)mm regime of the SED. It produces a 350 μm morphology consistent with the observations. The mid-infrared emission of W33A on 100 AU scales is dominated by the irradiated walls of the cavity sculpted by the outflow. The protostellar envelope has an equivalent mass infall rate of $7.5 \cdot 10^{-4} M_{\odot}/\text{yr}$, and an outflow opening angle of $2\theta = 20^{\circ}$. The visibilities rule out the presence of dust disks with total (gas and dust) masses more than $0.01 M_{\odot}$. Within the model, this implies a disk \dot{M}_{acc} of less than $1.1 \cdot 10^{-7} (\alpha/0.01) M_{\odot}/\text{yr}$, where α is the viscosity of the Shakura-Sunyaev prescription. However, optically thick accretion disks, interior to the dust sublimation radius, are allowed to accrete at rates equalling the envelope's mass infall rate (up to $10^{-3} M_{\odot}/\text{yr}$) without substantially affecting the visibilities due to the extinction by the extremely massive envelope of W33A.

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Planet formation in binary systems: A separation-dependent mechanism?

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In this article, I examine several observational trends regarding protoplanetary disks, debris disks and exoplanets in binary systems in an attempt to constrain the physical mechanisms of planet formation in such a context. Binaries wider than about 100 AU are indistinguishable from single stars in all aspects. Binaries in the 5-100 AU range, on the other hand, are associated with shorter-lived but (at least in some cases) equally massive disks. Furthermore, they form planetesimals and mature planetary systems at a similar rate as wider binaries and single stars, albeit with the peculiarity that they predominantly produce high-mass planets. I posit that the location of a stellar companion influences the relative importance of the core accretion and disk fragmentation planet formation processes, with the latter mechanism being predominant in binaries tighter than 100 AU.

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Panchromatic observations and modeling of the HV Tau C edge-on disk

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We present new high spatial resolution ($\lesssim 0.1''$) $1\text{--}5\mu\text{m}$ adaptive optics images, interferometric 1.3mm continuum and ^{12}CO 2–1 maps, and $350\mu\text{m}$, 2.8 and 3.3mm fluxes measurements of the HV Tau system. Our adaptive optics images unambiguously demonstrate that HV Tau AB–C is a common proper motion pair. They further reveal an unusually slow orbital motion within the tight HV Tau AB pair that suggests a highly eccentric orbit and/or a large deprojected physical separation. Scattered light images of the HV Tau C edge-on protoplanetary disk suggest that the anisotropy of the dust scattering phase function is almost independent of wavelength from 0.8 to $5\mu\text{m}$, whereas the dust opacity decreases significantly over the same range. The images further reveal a marked lateral asymmetry in the disk that does not vary over a timescale of 2 years. We further detect a radial velocity gradient in the disk in our ^{12}CO map that lies along the same position angle as the elongation of the continuum emission, which is consistent with Keplerian rotation around an $0.5\text{--}1M_{\odot}$ central star, suggesting that it could be the most massive component in the triple system. To obtain a global representation of the HV Tau C disk, we search for a model that self-consistently reproduces observations of the disk from the visible regime up to millimeter wavelengths. We use a powerful radiative transfer model to compute synthetic disk observations and use a Bayesian inference method to extract constraints on the disk properties. Each individual image, as well as the spectral energy distribution, of HV Tau C can be well reproduced by our models with fully mixed dust provided grain growth has already produced larger-than-interstellar dust grains. However, no single model can satisfactorily simultaneously account for all observations. We suggest that future attempts to model this source include more complex dust properties and possibly vertical stratification. While both grain growth and stratification have already been suggested in many disks, only a panchromatic analysis, such as presented here, can provide a complete picture of the structure of a disk, a necessary step towards quantitatively testing the predictions of numerical models of disk evolution.

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Timescale of Mass Accretion in Pre-Main-Sequence Stars

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We present initial result of a large spectroscopic survey aimed at measuring the timescale of mass accretion in young, pre-main-sequence stars in the spectral type range K0 – M5. Using multi-object spectroscopy with VIMOS at the VLT we identified the fraction of accreting stars in a number of young stellar clusters and associations of ages between $1\text{--}50$ Myr. The fraction of accreting stars decreases from $\sim 60\%$ at $1.5\text{--}2$ Myr to $\sim 2\%$ at 10 Myr. No accreting stars are found after 10 Myr at a sensitivity limit of $10^{-11} M_{\odot}\text{yr}^{-1}$. We compared the fraction of stars showing ongoing accretion (f_{acc}) to the fraction of stars with near-to-mid infrared excess (f_{IRAC}). In most cases we find $f_{acc} < f_{IRAC}$, *i.e.*, mass accretion appears to cease (or drop below detectable level) earlier than the dust is dissipated in the inner disk. At 5 Myr, 95% of the stellar population has stopped accreting material at a rate of $\gtrsim 10^{-11} M_{\odot}\text{yr}^{-1}$, while $\sim 20\%$ of the stars show near-infrared excess emission. Assuming an exponential decay, we measure a mass accretion timescale (τ_{acc}) of 2.3 Myr, compared to a near-to-mid infrared excess timescale (τ_{IRAC}) of 2.9 Myr. Planet

formation, and/or migration, in the inner disk might be a viable mechanism to halt further accretion onto the central star on such a short timescale.

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Four highly luminous massive star forming regions in the Norma Spiral Arm: I. Molecular gas and dust observations

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We report molecular line and dust continuum observations, made with the SEST telescope, towards four young high-mass star forming regions associated with highly luminous ($\mathcal{L} > 6 \times 10^5 \mathcal{L}_\odot$) IRAS sources (15290-5546, 15502-5302, 15567-5236 and 16060-5146). Molecular emission was mapped in three lines of CS ($J=2 \rightarrow 1$, $3 \rightarrow 2$ and $5 \rightarrow 4$), two lines of SiO ($J=2 \rightarrow 1$ and $3 \rightarrow 2$), two rotational transitions of CH₃OH ($J_k=3_k \rightarrow 2_k$ and $2_k \rightarrow 1_k$), and in the C³⁴S ($J=3 \rightarrow 2$) line. In addition, single spectra at the peak position were taken in the CO ($J=1 \rightarrow 0$), ¹³CO ($J=1 \rightarrow 0$) and C¹⁸O ($J=1 \rightarrow 0$) lines. We find that the luminous star forming regions are associated with molecular gas and dust structures with radii of typically 0.5 pc, masses of $\sim 5 \times 10^3 M_\odot$, column densities of $\sim 5 \times 10^{23} \text{ cm}^{-2}$, molecular hydrogen densities of typically $\sim 2 \times 10^5 \text{ cm}^{-3}$ and dust temperatures of ~ 40 K. The 1.2 mm dust continuum observations further indicate that the cores are centrally condensed, having radial density profiles with power-law indices in the range 1.6 – 1.9. We find that under these conditions dynamical friction by the gas plays an important role in the migration of high-mass stars towards the central core region, providing an explanation for the observed stellar mass segregation within the cores.

The CS profiles show two distinct emission components: a bright component, with line widths of typically 5 km s⁻¹ (FWHM), and a weaker and wider velocity component, which extends up to typically ± 13 km s⁻¹ from the ambient cloud velocity. The SiO profiles also show emission from both components, but the intensity of the pedestal feature relative to that of the bright component is stronger than for CS. The narrow SiO component is likely to trace warm ambient gas close to the recently formed massive stars, whereas the high velocity emission indicates mass outflows produced by either the expansion of the HII regions, stellar winds, and/or collimated outflows. We find that the abundances of CS, CH₃OH and SiO, relative to H₂, in the warm ambient gas of the massive cores are typically 4×10^{-8} , 6×10^{-9} , and 5×10^{-11} , respectively.

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Metallicity of the Massive Protoplanets Around HR 8799 if Formed by Gravitational Instability

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The final composition of giant planets formed as a result of gravitational instability in the disk gas depends on their ability to capture solid material (planetesimals) during their 'pre-collapse' stage, when they are extended and cold, and contracting quasi-statically. The duration of the pre-collapse stage is inversely proportional roughly to the square of the planetary mass, so massive protoplanets have shorter pre-collapse timescales and therefore limited opportunity for planetesimal capture. The available accretion time for protoplanets with masses of 3, 5, 7, and 10 Jupiter masses

is found to be 7.82×10^4 , 2.62×10^4 , 1.17×10^4 and 5.67×10^3 years, respectively. The total mass that can be captured by the protoplanets depends on the planetary mass, planetesimal size, the radial distance of the protoplanet from the parent star, and the local solid surface density. We consider three radial distances, 24, 38, and 68 AU, similar to the radial distances of the planets in the system HR 8799, and estimate the mass of heavy elements that can be accreted. We find that for the planetary masses usually adopted for the HR 8799 system, the amount of heavy elements accreted by the planets is small, leaving them with nearly stellar compositions.

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Physical characterisation of southern massive star-forming regions using Parkes NH_3 observations

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We have undertaken a Parkes ammonia spectral line study, in the lowest two inversion transitions, of southern massive star formation regions, including young massive candidate protostars, with the aim of characterising the earliest stages of massive star formation. 138 sources from the submillimetre continuum emission studies of Hill et al. were found to have robust (1,1) detections, including two sources with two velocity components, and 102 in the (2,2) transition.

We determine the ammonia line properties of the sources: linewidth, flux density, kinetic temperature, NH_3 , column density and opacity, and revisit our SED modelling procedure to derive the mass for 52 of the sources. By combining the continuum emission information with ammonia observations we substantially constrain the physical properties of the high-mass clumps. There is clear complementarity between ammonia and continuum observations for derivations of physical parameters.

The MM-only class, identified in the continuum studies of Hill et al., display smaller sizes, mass and velocity dispersion and/or turbulence than star-forming clumps, suggesting a quiescent prestellar stage and/or the formation of less massive stars.

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The Thermodynamics of Molecular Cloud Fragmentation: Star Formation Under Non-Milky Way Conditions

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Properties of candidate stars, forming out of molecular clouds, depend on the ambient conditions of the parent cloud. We present a series of 2D and 3D simulations of fragmentation of molecular clouds in starburst regions as well as clouds under conditions in dwarf galaxies, leading to the formation of protostellar cores. We explore in particular the metallicity dependence of molecular cloud fragmentation and the possible variations in the dense core mass function, as the expression of a multi-phase ISM, due to dynamic and thermodynamic effects in starburst and metal-poor environments. To study the level of fragmentation during the collapse, the adaptive mesh refinement code FLASH is used. With this code, including self-gravity, thermal balance, turbulence and shocks, collapse is simulated with four different metallicity dependent cooling functions. Turbulent and rotational energies are considered as well. During the simulations, number densities of 10^8 - 10^9 cm^{-3} are reached. The influences of dust and cosmic ray heating are investigated and a comparison to isothermal cases is made. The presented results indicate that fragmentation increases

with metallicity, while cosmic ray and gas-grain collisional heating counteract this. We also find that modest rotation and turbulence can impact the cloud evolution as far as fragmentation is concerned. In this light, we conclude that radiative feedback, in starburst regions, will inhibit fragmentation, while low-metallicity dwarfs also should enjoy a star formation mode in which fragmentation is suppressed.

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Interaction of a giant planet in an inclined orbit with a circum-stellar disk

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We investigate the dynamical evolution of a Jovian-mass planet injected into an orbit highly inclined with respect to its nesting gaseous disk. Planet-planet scattering induced by convergent planetary migration and mean motion resonances may push a planet into such an out of plane configuration with inclinations as large as $20^\circ - 30^\circ$. In this scenario the tidal interaction of the planet with the disk is more complex and, in addition to the usual Lindblad and corotation resonances, it involves also inclination resonances responsible of bending waves.

We have performed three-dimensional hydrodynamic simulations of the disk and of its interactions with the planet with a Smoothed Particle Hydrodynamics (SPH) code. A main result is that the initial large eccentricity and inclination of the planetary orbit are rapidly damped on a timescale of the order of 10^3 yrs, almost independently of the initial semimajor axis and eccentricity of the planet. The disk is warped in response to the planet perturbations and it precesses. Inward migration occurs also when the planet is inclined and it has a drift rate which is intermediate between type I and type II migration. The planet is not able to open a gap until its inclination becomes lower than $\sim 10^\circ$ when it also begins to accrete a significant amount of mass from the disk.

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The Atomic-to-Molecular Transition in Galaxies. III. A New Method for Determining the Molecular Content of Primordial and Dusty Clouds

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Understanding the molecular content of galaxies is a critical problem in star formation and galactic evolution. Here we present a new method, based on a Strömgen-type analysis, to calculate the amount of HI that surrounds a molecular cloud irradiated by an isotropic radiation field. We consider both planar and spherical clouds, and H₂ formation either in the gas phase or catalyzed by dust grains. Under the assumption that the transition from atomic to molecular gas is sharp, our method gives the solution without any reference to the photodissociation cross section. We test our results for the planar case against those of a PDR code, and find typical accuracies of about 10%. Our results are also consistent with the scaling relations found in Paper I of this series, but they apply to a wider range of physical conditions. We present simple, accurate analytic fits to our results that are suitable for comparison to observations and to implementation in numerical and semi-analytic models.

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The RMS Survey: Far-Infrared Photometry of Young Massive Stars

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Context: The Red MSX Source (RMS) survey is a multi-wavelength campaign of follow-up observations of a colour-selected sample of candidate massive young stellar objects (MYSOs) in the galactic plane. This survey is returning the largest well-selected sample of MYSOs to date, while identifying other dust contaminant sources with similar mid-infrared colours including a large number of new ultra-compact (UC) H II regions.

Aims: To measure the far-infrared (IR) flux, which lies near the peak of the spectral energy distribution (SED) of MYSOs and UCH II regions, so that, together with distance information, the luminosity of these sources can be obtained.

Methods: Less than 50 % of RMS sources are associated with IRAS point sources with detections at 60 μm and 100 μm , though the vast majority are visible in Spitzer MIPS GAL or IRAS Galaxy Atlas (IGA) images. However, standard aperture photometry is not appropriate for these data due to crowding of sources and strong spatially variable far-IR background emission in the galactic plane. A new technique using a 2-dimensional fit to the background in an annulus around each source is therefore used to obtain far-IR photometry for young RMS sources.

Results: Far-IR fluxes are obtained for a total of 1113 RMS candidates identified as young sources. Of these 734 have flux measurements using IGA 60 μm and 100 μm images and 724 using MIPS GAL 70 μm images, with 345 having measurements in both data sets.

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Bipolar jets produced by a spectroscopic binary

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We present evidence that the spectroscopically identified bipolar jets of the pre-main sequence binary KH 15D ($P = 48.4$ d, $\epsilon \sim 0.6$, periastron separation $\sim 18 R_A$, $M_A = 0.6 M_\odot$, $M_B = 0.7 M_\odot$) are a common product of the whole binary system, rather than being launched from either star individually. They may be launched from the innermost part of the circumbinary disk (CBD) or may result from the merging of two outflows driven by the individual stars. This evidence is based on high-resolution H-alpha and [OI] 6300Å line profiles obtained during eclipse phases of this nearly edge-on system. The occultation of star A (the only currently visible star) by the disk strongly suppresses the stellar H-alpha and continuum emission and allows one to study the faint redshifted and blueshifted emission components of the bipolar jets. The strongest evidence for jet production by the whole binary system comes from the observed radial velocity symmetry of the two jet components relative to the systemic velocity of the binary, in combination with current accretion models from the CBD onto a binary system.

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The Debris Disk of Vega: A Steady-State Collisional Cascade, Naturally

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It has been argued that the photometric data and images of the archetypical debris disk round Vega may be in contradiction with the standard, steady-state collisional scenario of the disk evolution. Here we perform physical modeling of the Vega disk “from the sources”. We assume that dust is maintained by a “Kuiper belt” of parent planetesimals at ~ 100 AU and employ our collisional and radiative transfer codes to consistently model the size and radial distribution of the disk material and then thermal emission of dust. In doing so, we vary a broad set of parameters, including the stellar properties, the exact location, extension, and dynamical excitation of the planetesimal belt, chemical composition of solids, and the collisional prescription. We are able to reproduce the spectral energy distribution in the entire wavelength range from the near-infrared to millimeter, as well as the mid-IR and sub-millimeter radial brightness profiles of the Vega disk. Thus our results suggest that the Vega disk observations are compatible with a steady-state collisional dust production, and we put important constraints on the disk parameters and physical processes that sustain it. The total disk mass in $\lesssim 100$ km-sized bodies is estimated to be ~ 10 Earth masses. Provided that collisional cascade has been operating over much of the Vega age of ~ 350 Myr, the disk must have lost a few Earth masses of solids during that time. We also demonstrate that using an intermediate luminosity of the star between the pole and the equator, as derived from its fast rotation, is required to reproduce the debris disk observations. Finally, we show that including cratering collisions into the model is mandatory.

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The Power Spectrum of Turbulence in NGC 1333: Outflows or Large-Scale Driving?

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Is the turbulence in cluster-forming regions internally driven by stellar outflows or the consequence of a large-scale turbulent cascade? We address this question by studying the turbulent energy spectrum in NGC 1333. Using synthetic ¹³CO maps computed with a snapshot of a supersonic turbulence simulation, we show that the VCS method of Lazarian and Pogosyan provides an accurate estimate of the turbulent energy spectrum. We then apply this method to the ¹³CO map of NGC 1333 from the COMPLETE database. We find the turbulent energy spectrum is a power law, $E(k) \propto k^{-\beta}$, in the range of scales $0.06 \text{ pc} \leq \ell \leq 1.5 \text{ pc}$, with slope $\beta = 1.85 \pm 0.04$. The estimated energy injection scale of stellar outflows in NGC 1333 is $\ell_{\text{inj}} \approx 0.3 \text{ pc}$, well resolved by the observations. There is no evidence of the flattening of the energy spectrum above the scale ℓ_{inj} predicted by outflow-driven simulations and analytical models. The power spectrum of integrated intensity is also a nearly perfect power law in the range of scales $0.16 \text{ pc} < \ell < 7.9 \text{ pc}$, with no feature above ℓ_{inj} . We conclude that the observed turbulence in NGC 1333 does not appear to be driven primarily by stellar outflows.

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L1506: a prestellar core in the making

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Context : Exploring the structure and dynamics of cold starless clouds is necessary to understand the different steps leading to the formation of protostars. Because clouds evolve slowly, many of them must be studied in detail to pick up different moments of a cloud’s lifetime.

Aims : We study here a fragment of the long filament L1506 in the Taurus region which we name L1506C, a core with interesting dust properties which have been evidenced with the PRONAOS balloon-borne telescope.

Methods : To trace the mass content of L1506C and its kinematics, we mapped the dust emission, and the line emission of two key species, $C^{18}O$ and N_2H^+ . ^{13}CO and $C^{17}O$ were also observed. We model the species emission using 1D Monte Carlo models.

Results : This cloud is reminiscent of L1498 but also shows peculiar features: i) a large envelope traced solely by ^{13}CO holding a much smaller core with a strong $C^{18}O$ depletion in its center despite a low maximum opacity ($A_V \sim 20$ mag), ii) extremely narrow $C^{18}O$ lines indicating a low, non-measurable turbulence, iii) contraction traced by $C^{18}O$ itself (plus rotation), iv) unexpectedly, the kinematical signature from the external envelope is opposite to the core one: the ^{13}CO and $C^{18}O$ velocity gradients have opposite directions and the $C^{18}O$ line profile is blue peaked on the contrary to the ^{13}CO one which is red peaked. The core is large ($r = 3 \times 10^4$ A.U.) and not very dense ($n(H_2) \leq 5 \times 10^4$ cm^{-3} , possibly less). This core is therefore not prestellar yet.

Conclusions : All these facts suggest that the core is kinematically detached from its envelope and in the process of forming a prestellar core. This is the first time that the dynamical formation of a prestellar core is witnessed. The extremely low turbulence could be the reason for the strong depletion of this core despite its relatively low density and opacity in contrast with undepleted cores such as L1521E which shows a turbulence at least 4 times as high.

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Young stars and reflection nebulae near the lower “edge” of the Galactic molecular disc

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Aims: We investigate the star formation occurring in a region well below the Galactic plane towards the optical reflection nebula ESO 368-8 (IRAS 07383–3325). We confirm the presence of a small young stellar cluster (or aggregate of tens of YSOs) identified earlier, embedded in a molecular cloud located near the lower “edge” of the Galactic disc, and characterise the young stellar population. We report the discovery of a near-infrared nebula, and present a CO map revealing a new dense, dynamic cloud core.

Methods: We used near-infrared JHK_S images obtained with VLT/ISAAC, millimetre CO spectra obtained with the SEST telescope, and optical V -band images from the YALO telescope.

Results: This star formation region displays an optical reflection nebula (ESO 368-8) and a near-infrared nebula located about $46''$ (1.1 pc) from each other. The two nebulae are likely to be coeval and to represent two manifestations of the same single star formation episode with about 1 Myr age. The near-IR nebula reveals an embedded, optically and near-IR invisible source whose light scatters off a cavity carved by previous stellar jets or molecular outflows and into our line-of-sight. The molecular cloud is fully covered by our $CO(J=1-0)$ maps and, traced by this line, extends over a region of $\sim 7.8 \times 7.8$ pc², exhibiting an angular size $\sim 5.4' \times 5.4'$ and shape (close to circular) similar to spherical (or slightly cometary) globules. Towards the direction of the near-IR nebula, the molecular cloud contains a dense core where the molecular gas exhibits large line widths indicative of a very dynamical state, with stirred gas and supersonic motions. Our estimates of the mass of the molecular gas in this region range from 600 to 1600 M_\odot . The extinction A_V towards the positions of the optical reflection nebula and of the near-IR nebula was found to be $A_V \simeq 3 - 4$ mag and $A_V \simeq 12 - 15$ mag, respectively.

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Ruling out Stellar Companions and Resolving the Innermost Regions of Transitional Disks with the Keck Interferometer

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With the Keck Interferometer, we have studied at 2 μm the innermost regions of several nearby, young, dust depleted "transitional" disks. Our observations target five of the six clearest cases of transitional disks in the Taurus/Auriga star-forming region (DM Tau, GM Aur, LkCa 15, UX Tau A, and RY Tau) to explore the possibility that the depletion of optically thick dust from the inner disks is caused by stellar companions rather than the more typical planet-formation hypothesis. At the 99.7% confidence level, the observed visibilities exclude binaries with flux ratios of at least 0.05 and separations ranging from 2.5 to 30 mas (0.35 - 4 AU) over $\gtrsim 94\%$ of the area covered by our measurements. All targets but DM Tau show near-infrared excess in their SED higher than our companion flux ratio detection limits. While a companion has previously been detected in the candidate transitional disk system CoKu Tau/4, we can exclude similar mass companions as the typical origin for the clearing of inner dust in transitional disks and of the near-infrared excess emission. Unlike CoKu Tau/4, all our targets show some evidence of accretion. We find that all but one of the targets are clearly spatially resolved, and UX Tau A is marginally resolved. Our data is consistent with hot material on small scales (0.1 AU) inside of and separated from the cooler outer disk, consistent with the recent SED modeling. These observations support the notion that some transitional disks have radial gaps in their optically thick material, which could be an indication for planet formation in the habitable zone (\sim a few AU) of a protoplanetary disk.

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Dust Properties of Protoplanetary Disks in the Taurus-Auriga Star Forming Region from Millimeter Wavelengths

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We present the most sensitive 3 mm-survey to date of protoplanetary disks carried in the Taurus-Auriga star forming region (average rms of about 0.3 mJy), using the IRAM PdBI. With our high detection rate of 17/19, we provide the first detections at wavelengths longer than about 1 mm for 12 sources. This enables us to study statistically the mm SED slopes and dust properties of faint disks and compare them to brighter disks using a uniform analysis method. With these new data and literature measurements at sub-millimeter and millimeter wavelengths, we analyze the dust properties of a sample of 21 isolated disks around T Tauri stars in the Taurus-Auriga star forming region. Together with the information about the disks spatial extension from sub/mm-mm interferometric studies, we derive from the observed sub-mm/mm spectral energy distribution constraints on the dust opacity law at these wavelengths, using two-layer flared disk models and a self-consistent dust model that takes properly into account the variation of the dust opacity with grain growth. We find evidence for the presence in the disk midplane of dust particles that have grown to sizes as large as at least 1 millimeter in all the disks of our sample, confirming what was previously observed on smaller brighter objects. This indicates that the dust coagulation from ISM dust to mm-sized grains is a very fast process in protoplanetary disks, that appears to occur before a young stellar object enters the Class II evolutionary stage. Also, the amount of these large grains in the disk outer regions is stationary throughout all the Class II evolutionary stage, indicating that mechanisms slowing down the dust inward migration are playing an important role in the Taurus-Auriga protoplanetary disks. Another result is that the spectral index between 1 and 3 mm for the 6 faintest disks in our sample is on average smaller than for the brighter disks, indicating either that these fainter, yet unmapped, disks are spatially much less extended than the brighter spatially resolved disks, or that fainter disks have typically larger dust grains in their outer regions. Considering that these fainter disks are more

representative of the bulk of the disk population than the brighter ones, this may have important consequences for the theories of planetesimal formation and disk formation and evolution. Finally, we investigate the relations between the derived dust properties, namely dust mass and grain growth, and the properties of the central star, like its mass, age and mass accretion rate.

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The massive star binary fraction in young open clusters - II. NGC 6611 (Eagle Nebula)

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Based on a set of over 100 medium- to high-resolution optical spectra collected from 2003 to 2009, we investigate the properties of the O-type star population in NGC 6611 in the core of the Eagle Nebula (M16). Using a much more extended data set than previously available, we revise the spectral classification and multiplicity status of the nine O-type stars in our sample. We confirm two suspected binaries and derive the first SB2 orbital solutions for two systems. We further report that two other objects are displaying a composite spectrum, suggesting possible long-period binaries. Our analysis is supported by a set of Monte-Carlo simulations, allowing us to estimate the detection biases of our campaign and showing that the latter do not affect our conclusions. The absolute minimal binary fraction in our sample is $f_{\min}=0.44$ but could be as high as 0.67 if all the binary candidates are confirmed. As in NGC 6231 (see Paper I), up to 75% of the O star population in NGC 6611 are found in an O+OB system, thus implicitly excluding random pairing from a classical IMF as a process to describe the companion association in massive binaries. No statistical difference could be further identified in the binary fraction, mass-ratio and period distributions between NGC 6231 and NGC 6611, despite the difference in age and environment of the two clusters.

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The Dust Emissivity Spectral Index in the Starless Core TMC-1C

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In this paper, we present a dust emission map of the starless core TMC-1C taken at 2100 microns. Along with maps at 160, 450, 850, and 1200 microns, we study the dust emissivity spectral index from the (sub)millimeter spectral energy distribution, and find that it is close to the typically assumed value of $\beta = 2$. We also map the dust temperature and column density in TMC-1C, and find that at the position of the dust peak ($A_V \sim 50$) the line-of-sight-averaged temperature is ~ 7 K. Employing simple Monte Carlo modeling, we show that the data are consistent with a constant value for the emissivity spectral index over the whole map of TMC-1C.

Modelling line emission of deuterated H_3^+ from prestellar cores**O. Sipilä¹, E. Hugo², J. Harju¹, O. Asvany², M. Juvela¹ and S. Schlemmer²**¹ Observatory, PO Box 14, 00014, University of Helsinki, Finland² I. Physikalisches Institut, Universität zu Köln, Germany

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Context. The depletion of heavy elements in cold cores of interstellar molecular clouds can lead to a situation where deuterated forms of H_3^+ are the most useful spectroscopic probes of the physical conditions.

Aims. The aim is to predict the observability of the rotational lines of H_2D^+ and D_2H^+ from prestellar cores.

Methods. Recently derived rate coefficients for the $\text{H}_3^+ + \text{H}_2$ isotopic system were applied to the "complete depletion" reaction scheme to calculate abundance profiles in hydrostatic core models. The ground-state lines of $\text{H}_2\text{D}^+(\text{o})$ (372 GHz) and $\text{D}_2\text{H}^+(\text{p})$ (692 GHz) arising from these cores were simulated. The excitation of the rotational levels of these molecules was approximated by using the state-to-state coefficients for collisions with H_2 . We also predicted line profiles from cores with a power-law density distribution advocated in some previous studies.

Results. The new rate coefficients introduce some changes to the complete depletion model, but do not alter the general tendencies. One of the modifications with respect to the previous results is the increase of the D_3^+ abundance at the cost of other isotopologues. Furthermore, the present model predicts a lower $\text{H}_2\text{D}^+(\text{o}/\text{p})$ ratio, and a slightly higher $\text{D}_2\text{H}^+(\text{p}/\text{o})$ ratio in very cold, dense cores, as compared with previous modelling results. These nuclear spin ratios affect the detectability of the submm lines of $\text{H}_2\text{D}^+(\text{o})$ and $\text{D}_2\text{H}^+(\text{p})$. The previously detected H_2D^+ and D_2H^+ lines towards the core I16293E, and the H_2D^+ line observed towards Oph D can be reproduced using the present excitation model and the physical models suggested in the original papers.

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<http://arxiv.org/abs/0911.1236>**Direct evidence for dust growth in L183 from MIR light scattering****J. Steinacker^{1,2}, L. Pagani¹, A. Bacmann³ and S. Guieu⁴**¹ LERMA & UMR 8112 du CNRS, Observatoire de Paris, 61 Av. de l'Observatoire, 75014 Paris, France² Max-Planck-Institut fuer Astronomie, Koenigstuhl 17, D-69117 Heidelberg, Germany³ Laboratoire d'Astrophysique, Observatoire de Grenoble, BP 53, F-38041 Grenoble, Cedex 9, France⁴ Spitzer Science Center, 1200 E California Blvd, Mail Stop 220-6, Pasadena CA 91125, USA

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Theoretical arguments suggest that dust grains should grow in the dense cold parts of molecular clouds. Evidence for larger grains has so far been gathered in Near/Mid Infrared extinction and millimeter observations. Interpreting the data is, however, aggravated due to the complex interplay of density and dust properties (as well as temperature for thermal emission). We present new Spitzer data of L183 in bands sensitive and non-sensitive to PAHs. The visual extinction A_V map derived in a former paper is fitted by a series of 3D Gaussian distribution. For different dust models, we calculate the scattered MIR radiation images of structures being in agreement with the A_V map and compare them to the Spitzer data. The Spitzer data of L183 show emission in the 3.6 and 4.5 micron bands while the 5.8 micron band shows slight absorption. The emission layer of stochastically heated particles should coincide with the layer of strongest scattering of optical interstellar radiation which is seen as an outer surface on I band images different from the emission region seen in the Spitzer images. Moreover, PAH emission is expected to strongly increase from 4.5 to 5.8 micron which is not seen. Hence, we interpret this emission to be MIR cloudshine. Scattered light modeling assuming interstellar medium dust grains without growth does not reproduce flux measurable by Spitzer. On the contrary, models with grains growing with density yield images with a flux and pattern comparable to the Spitzer images in the bands 3.6, 4.5, and 8.0 micron. We conclude that there is direct evidence for dust grain growth in the inner part of L183 from the scattered light MIR images seen by Spitzer.

Discerning the Form of the Dense Core Mass Function

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We investigate the ability to discern between lognormal and powerlaw forms for the observed mass function of dense cores in star forming regions. After testing our fitting, goodness-of-fit, and model selection procedures on simulated data, we apply our analysis to 14 datasets from the literature. Whether the core mass function has a powerlaw tail or whether it follows a pure lognormal form cannot be distinguished from current data. From our simulations it is estimated that datasets from uniform surveys containing more than ≈ 500 cores with a completeness limit below the peak of the mass distribution are needed to definitively discern between these two functional forms. We also conclude that the width of the core mass function may be more reliably estimated than the powerlaw index of the high mass tail and that the width may also be a more useful parameter in comparing with the stellar initial mass function to deduce the statistical evolution of dense cores into stars.

Accepted by PASP

<http://arxiv.org/abs/0912.0933>

Fragmentation and Evolution of Molecular Clouds. II: The Effect of Dust Heating

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We investigate the effect of heating by luminosity sources in a simulation of clustered star formation. Our heating method involves a simplified continuum radiative transfer method that calculates the dust temperature. The gas temperature is set by the dust temperature. We present the results of four simulations, two simulations assume an isothermal equation of state and the two other simulations include dust heating. We investigate two mass regimes, i.e., 84 Msun and 671 Msun, using these two different energetics algorithms. The mass functions for the isothermal simulations and simulations which include dust heating are drastically different. In the isothermal simulation, we do not form any objects with masses above 1 Msun. However, the simulation with dust heating, while missing some of the low-mass objects, forms high-mass objects (≈ 20 Msun) which have a distribution similar to the Salpeter IMF. The envelope density profiles around the stars formed in our simulation match observed values around isolated, low-mass star-forming cores. We find the accretion rates to be highly variable and, on average, increasing with final stellar mass. By including radiative feedback from stars in a cluster-scale simulation, we have determined that it is a very important effect which drastically affects the mass function and yields important insights into the formation of massive stars.

Accepted by Astrophysical Journal

Low res. version: [astro-ph 0912.3819](http://astro-ph/0912.3819)

High res. version: http://www.astro.phy.ulaval.ca/staff/hugo/dust/ms_dust.big.pdf

Rayleigh Adjustment of Narrow Barriers in Protoplanetary Discs

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Sharp density features in protoplanetary discs, for instance at the edge of a magnetically dead zone, have recently been proposed as effective barriers to slow down or even stop the problematically fast migration of planetary cores into their central star. Density features on a radial scale approaching the disc vertical scale height might not exist, however, since they could be Rayleigh (or more generally Solberg–Høiland) unstable. Stability must be checked explicitly in one-dimensional viscous accretion disc models because these instabilities are artificially eliminated in the process of reducing the full set of axisymmetric equations. The disc thermodynamics, via the entropy stratification, and its vertical structure also influence stability when sharp density features are present. We propose the concept of Rayleigh adjustment for viscous disc models: any density feature that violates Rayleigh stability (or its generalization) should be diffused radially by hydrodynamical turbulence on a dynamical time-scale, approaching marginal stability in a quasi-continuous manner.

Accepted by Monthly Notices of the Royal Astronomical Society

<http://arxiv.org/abs/0904.4266>

Parallactic Motion for Companion Discovery: An M-Dwarf Orbiting Alcor

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The A5V star Alcor has an M3-M4 dwarf companion, as evidenced by a novel astrometric technique. Imaging spectroscopy combined with adaptive optics coronagraphy allowed for the detection and spectrophotometric characterization of the point source at a contrast of ~ 6 J - and H -band magnitudes and separation of $1''$ from the primary star. The use of an astrometric pupil plane grid allowed us to determine the projected separations between the companion and the coronagraphically occulted primary star to ≤ 3 milliarcsecond precision at two observation epochs. Our measurements demonstrate common parallactic and proper motion over the course of 103 days, significantly shorter than the period of time needed for most companion confirmations through proper motion measurements alone. This common parallax method is potentially more rigorous than common proper motion, ensuring that the neighboring bodies lie at the same distance, rather than relying on the statistical improbability that two objects in close proximity to each other on the sky move in the same direction. The discovery of a low-mass ($\sim 0.25 M_{\odot}$) companion around a bright ($V = 4.0^m$), nearby ($d = 25$ pc) star highlights a region of binary star parameter space that to date has not been fully probed.

Accepted by The Astrophysical Journal

<http://lanl.arxiv.org/abs/0912.1597>

Star formation: study of the collapse of prestellar dense cores

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Ph.D dissertation directed by: Gilles Chabrier and Edouard Audit

Ph.D degree awarded: September 2009

One of the priorities of contemporary astrophysics remains to understand the mechanisms which lead to star formation. In the dense cores where star formation occurs, temperature, pressure, etc... are such that it is impossible to reproduce them in the laboratory. Numerical calculations remain the only mean to study physical phenomena that are involved in the star formation process. The focus of this thesis has been on the numerical methods that are used in the star formation context to describe highly non-linear and multi-scale phenomena. In particular, I have concentrated my work on the first stages of the prestellar dense cores collapse. This work is divided in 4 linked part. In a first study, I use a 1D Lagrangean code in spherical symmetry (Audit et al. 2002) to compare three models that incorporate radiative transfer and matter-radiation interactions. This comparison was based on simple gravitational collapse calculations which lead to the first Larson core formation. It was found that the Flux Limited Diffusion model is appropriate for star formation calculations. I also took benefit from this first work to study the properties of the accretion shock on the first Larson core. We developed a semi-analytic model based on well-known assumptions, which reproduces the jump properties at the shock. The second study consisted in implementing the Flux Limited Diffusion model with the radiation-hydrodynamics equations in the RAMSES code (Teyssier 2002). After a first step of numerical tests that validate the scheme, we used RAMSES to perform the first multidimensional collapse calculations that combine magnetic field and radiative transfer effects at small scales with a high numerical resolution. Our results show that the radiative transfer has a significant impact on the fragmentation in the collapse of prestellar dense cores. I also present a comparison we made between the RAMSES code (Eulerian approach) and the SPH code DRAGON (Goodwin 2004, Langrangean approach). We studied the effect of the numerical resolution on the angular momentum conservation and on the fragmentation. We show that the two methods converge, provided that we use high numerical resolution criteria, which are much greater than the usual criteria found in the literature. The two methods then seem to be adapted to the study of tar formation.

<http://tel.archives-ouvertes.fr> (search for "commercon")

Chemistry in the ISM and disks on the verge of planet formation

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Ph.D dissertation directed by: Prof. Dr. Thomas Henning

Ph.D degree awarded: December 2009

The general purpose of the thesis work is to improve astrochemical models in the era of ALMA. This era is characterized by the active study of protoplanetary disks and the search for extraterrestrial life.

First, we study how uncertainties in the rate coefficients of chemical reactions affect the abundances and column densities of key molecules in protoplanetary disks. We isolate a group of key species which have column densities that are not very sensitive to the rate uncertainties, making them good potential tracers of physical conditions in disks. We identify about a hundred reactions with the most problematic rate coefficients, which need to be determined more accurately in order to improve the reliability of modern astrochemical models.

Second, we build a realistic astrochemical model using a Monte Carlo approach to all chemical processes, which is the first time this has been done. This allows us to properly take into account the stochastic nature of grain surface chemical reactions, which are of essential importance for the formation of organic molecules – i.e., the precursors of life as we know it. The recent modified rate approach (MRE) of Garrod et al. (2008) is shown to be the most accurate fast approach of accounting for stochastic effects in astrochemical modeling.

Finally, we apply our model to the study of the chemical composition of an evolving protoplanetary disk with grain growth, in order to reveal chemical tracers of this process. For the first time, a state-of-the-art astrochemical model is coupled with a detailed model of grain growth and sedimentation.

http://archiv.ub.uni-heidelberg.de/volltextserver/frontdoor.php?source_opus=10161

PhD position in high-mass star formation research at the Kapteyn Astronomical Institute, University of Groningen (The Netherlands)

Dr. Floris van der Tak has a PhD studentship available in his group studying the physics of the interstellar medium and the formation of stars. The project is to analyze images and spectra of Galactic star-forming regions at submillimeter wavelengths. The bulk of the observational material will come from the Herschel Space Observatory, launched May 2009, in particular from the Guaranteed Time Key Programs on water line emission and unbiased spectral surveys from star-forming regions. Supplementary data will come from ground-based telescopes such as JCMT, APEX and interferometers such as IRAM and SMA. The data will be used to measure physical parameters such as temperatures and densities of the regions, and also to infer their chemical composition. By comparing these quantities to model calculations, we hope to achieve a better understanding of how stars form.

The study is expected to lead to a PhD degree within a period of four years, and will be carried out at SRON, the Netherlands Institute for Space Research. Being the PI institute of HIFI, one of the instruments onboard Herschel, SRON offers a direct link to the instrument team, so that the student can make the most of the data.

The project is being carried out in collaboration with researchers at other institutes in Europe and North America and the selected student will have opportunities to spend periods working with other members of the team. In particular, active collaboration with the group of Prof. Ewine van Dishoeck at Leiden Observatory is foreseen.

The studentship is funded by NOVA, the Netherlands Research School for Astronomy. In the first year of the program, the student will participate in the NOVA Summer School. Attendance of 1-2 more such schools on the topics of star formation and/or submillimeter observations is also foreseen. Participation in University courses and/or teaching activities is allowed but not required.

The Kapteyn Institute is a medium-sized research facility with about 20 staff members and about 50 students from all over the world. Groningen is a lively student town with about 180000 inhabitants and plenty of social and cultural opportunities.

The student's application should include a curriculum vitae, an academic transcript including indication of the (expected) date of the award of a MSc (doctoraal) degree or equivalent, two reference letters, and a summary of undergraduate research projects carried out and how they fit into the student's aims for PhD research. If English or Dutch is not the student's native language, the reference letters should include an assessment of the English level (written and oral) of the student. All materials should arrive via email, FAX, or regular post no later than 1 February 2010 addressed to

Dr. F.F.S. van der Tak
SRON
Landleven 12
9747 AD Groningen
The Netherlands

Fax: +31-50-3634033
Email: vdtak *at* sron.nl

More information can be obtained by emailing Dr. van der Tak.

Postdoc and research associate positions (2 to 5 years) in the Theoretical Astrophysics group of Ecole Normale Superieure de Lyon (ENS-Lyon, France)

Several postdoc and research associate positions (2 to 5 years) will be open in the Theoretical Astrophysics group of Ecole Normale Superieure de Lyon (ENS-Lyon; head: G. Chabrier), in the domain of star and planet formation (see URL links below). The positions can start as early as June 1st, 2010.

Contact for information: [chabrier at ens-lyon.fr](mailto:chabrier@ens-lyon.fr)

<http://members.aas.org/JobReg/JobDetailPage.cfm?JobID=26192>

<http://members.aas.org/JobReg/JobDetailPage.cfm?JobID=26193>

Postdoctoral Position for studies of the "star-disk connection" in young stellar objects (University of Michigan, Astronomy Department)

We seek a postdoctoral researcher interested in studying the star-disk connection in young stellar objects. The goal of the research is apply state-of-the-art radiative transfer modeling to improve our understanding of the structure of the gas flow from the circumstellar disk onto the central star as well as the nature of associated outflows. Previous experience modeling circumstellar disks and their winds is highly desired and familiarity with high-resolution spectroscopy and high angular resolution interferometry data will be helpful.

The successful applicant will work closely with Drs. John Monnier and Nuria Calvet in the active and diverse star and planet formation group at UM, which also includes Professors Fred Adams, Ted Bergin, and Lee Hartmann. As a Postdoctoral Fellow, the successful applicant will also have access to available UM research facilities including the twin Magellan 6.5 meter telescopes in Chile, the MDM 1.3 meter and 2.4 meter telescopes on Kitt Peak, the 26 meter UM radio telescope and the departmental computing network.

This position is initially for one year and may be extended up to three years (subject to continued NASA funding and to annual performance review), and can begin as early as March 2010. Applicants should provide a vita, bibliography and a statement of research interests, and secure at least three letters of recommendation. Applications received prior to February 15, 2010, will receive first consideration. Please address all applications and recommendations to Prof. John Monnier at the above address (email submissions are preferred). The University of Michigan is an Equal Opportunity/Affirmative Action Employer. Women and minorities are encouraged to apply.

Postdoctoral Positions in Galactic Radio and (Sub)millimeter Astronomy

For the major project "A Global View of Star Formation in the Milky Way (GLOSTAR)" financed by an Advanced Investigator Grant of the European Research Council (ERC), the Max Planck Institute fuer Radioastronomie (MPIfR) in Bonn, Germany, at this point is seeking up to three highly qualified postdoctoral researchers with solid experience in interferometry, in particular very long baseline interferometry (VLBI) and/or cm-to-submm interferometry of star forming regions.

The successful applicants will work with Prof. Karl M. Menten's group and international collaborators on GLOSTAR using a powerful multi-pronged approach:

1) Using VLBI observations of maser sources GLOSTAR will measure distances by trigonometric parallax to most of the dominant star forming regions in the Galaxy, which will reveal its spiral structure as well as faithfully represent the luminosity and masses of its constituents.

2) Very sensitive observations of the Galactic plane with the newly Expanded Very Large Array are planned to find masers and hyper- and ultracompact HII regions, pinpointing the very centers of the earliest star-forming activity. Furthermore, follow-up observations of pre-star cluster clumps found in the APEX ATLASGAL submillimeter dust continuum survey are foreseen in ALMA early science.

3) Observations of infrared emission from more developed massive star clusters coupled with classic spectro-photometric methods applied at IR wavelengths will yield distances that can be properly calibrated with the trigonometric parallaxes.

All together, GLOSTAR aims at building a unique dataset with true legacy value for a global perspective on star formation in our Galaxy.

The MPIfR offers a vibrant research environment with a strong expertise in star formation and interferometry. It is the leading radioastronomical institute in Germany, operates the 100-m radio telescope at Effelsberg, which is a key element of the European VLBI Network, holds a 50% share of the observing time with the APEX telescope in Chile and offers access to the IRAM instruments.

Salaries are paid at German civil service rates according to TvD 14 (gross annual pre-tax income including health insurance contributions and social security currently in the range 40.000 EUR to 50.000 EUR, depending on experience).

Applicants must have a PhD in astronomy, astrophysics, or a closely related field. Interested candidates should send application materials including curriculum vitae, list of publications, a two-page summary of relevant experience and plans, and the names of three professional referees who have been asked by the applicant to be willing to submit letters of recommendation by email to kmenten *at* mpifr-bonn.mpg.de. Initial review of applicants will begin on February 5, 2010; however, applications will be accepted until the position is filled. The earliest starting date is May 1, 2010.

Max-Planck-Institut fuer Radioastronomie

Prof. Karl M. Menten

Auf dem Hgel 69

D-53121 Bonn

Germany

E-Mail submission: kmenten *at* mpifr-bonn.mpg.de

The Max Planck Society is an equal opportunity employer. Applications from women, disabled people and minority groups are particularly welcome. The MPIfR supports its employees in their search for suitable child care.

Included Benefits: Health insurance contributions and social security payments are included in the salary.

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.

Great Barriers in High Mass Star Formation

to be held in Townsville, North Queensland, Australia

13th - 17th September 2010

Objectives

High mass stars are one of the major players in galaxies, shaping the interstellar medium during all stages of their lives. They end their lives in catastrophic supernova explosions that may outshine their host galaxy. They can pump as much energy into the interstellar medium during their short time on the main sequence as is delivered in those catastrophic supernova explosions. In the earliest stages of their lives, they are responsible for shaping the molecular clouds that gave rise to their birth, and probably regulate further star formation.

However, these early stages have only recently received detailed attention from astronomers, compared to their low mass stellar cousins. This is usually attributed to the difficulty in studying objects that evolve extremely quickly, are intrinsically rare and probably only form within busy clusters of star formation.

Over the past decade, the field of high mass star formation (HMSF) has matured into a popular discipline of research. Furthermore, many of the new generation of astrophysical facilities will be coming online in the next few years, including Herschel, ALMA and SOFIA. There are also significant upgrades to telescopes around the world that will impact on this research field (eg. eVLA, ATCA, IRAM 30m, CARMA, PdBI, APEX and Mopra). It is our intention to highlight early results from these new and upgraded facilities, pertaining to HMSF.

Recent years have seen an explosion of activity in Galactic Plane surveys (eg. ATLASGAL, RMS, GLIMPSE, MIPS-GAL, NANTEN, MMB, CORNISH and HOPS). The results of which are of utmost importance to HMSF, as these young, high mass stars tend to dominate the emission seen from the Galaxy across a large fraction of the electromagnetic spectrum. Thus, we intend to devote time to discuss the results of these surveys in light of HMSF.

Previous meetings in the field have occurred at regular intervals. A summary of the major international conferences devoted solely to this research area is given below:

"The Earliest Phases of Massive Star Birth", Boulder, Co, USA, 2001

"Massive Star Birth: A Crossroads of Astrophysics", IAUS227, Acireale, Italy, 2005

"Massive Star Formation: Observations confront Theory", Heidelberg, Germany, 2007

Thus, it is timely that a new conference in 2010 be held.

Topics

Extragalactic HMSF and the First Stars

HMSF throughout the Galaxy, mm and submm Surveys

HMSF throughout the Galaxy, IR and Radio Surveys

Clustered HMSF

Early Stages of HMSF

Astrochemistry of HMSF

Masers

HMSF Interaction with the ISM

High Mass Disks

Magnetic Fields and HMSF

X-ray and Gamma-ray observations of HMSF

HMSF Simulations

HMSF Theory

Early results from new facilities (including Herschel, ALMA and SOFIA)

Scientific Organizing Committee

Andrew Walsh (Chair, James Cook University), Kate Brooks (ATNF), Lori Allen (NOAO), Maite Beltran (Arcetri), Henrik Beuther (MPIA), Michael Burton (UNSW), Neal Evans (University of Texas at Austin), Melvin Hoare (Leeds), Akiko Kawamura (Nagoya), Susana Lizano (UNAM), Diego Mardones (University of Chile), Frederique Motte (CEA Saclay), Malcolm Walmsley (Arcetri)

Invited Speakers

Ian Bonnell (St. Andrews), Crystal Brogan (ALMA Science Center, NRAO), Daniela Calzetti (UMass, Amherst), Ricardo Cesaroni (Arcetri), Claudia Comito (MPIfR), Jim De Buizer (SOFIA), Simon Ellingsen (UTas), Guido Garay (UCHile), Josep Miquel Girart (IEEC), Fabian Heitsch (Michigan), Mark Krumholtz (UCSC), Stuart Lumsden (Leeds), Tom Megeath (Toledo), Karl Menten (MPIfR), Hideko Nomura (Kyoto), Thushara Pillai (CfA), Gavin Rowell (Ade-laide), Fredric Schuller (MPIfR), Annie Zavagno (OAMP)

Location

The conference will be held at Rydges Southbank, in Townsville, Tropical North Queensland, Australia. Townsville is located on the north-east coast of Australia with a climate termed Dry Tropics. Townsville averages over 300 days of sunshine a year and average temperatures in September are around 28C (87F).

Website

More information on the conference can be found on the website: <http://www.jcu.edu.au/hmsf10>

Pre-registration

To show interest in registering for the conference, to receive further updates and for general enquiries, please send an email to:

hmsf10@jcu.edu.au

We intend to open up full registration for the conference early in 2010.

Andrew Walsh,
on behalf of the SOC and LOC

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>.