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Abstracts of recently accepted papers

The CMF as provenance of the stellar IMF ?

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In the present work we examined the hypothesis that, a core mass function (CMF), such as the one deduced for cores in the Orion molecular cloud (OMC), could possibly be the primogenitor of the stellar initial mass function (IMF). Using the rate of accretion of a protostar from its natal core as a free parameter, we demonstrate its quintessential role in determining the shape of the IMF. By varying the rate of accretion, we show that a stellar mass distribution similar to the universal IMF could possibly be generated starting from either a typical CMF such as the one for the OMC, or a uniform distribution of prestellar core masses which leads us to suggest, the apparent similarity in shapes of the CMF and the IMF is perhaps, only incidental. The apodosis of the argument being, complex physical processes leading to stellar birth are crucial in determining the final stellar masses, and consequently, the shape of stellar mass distribution. This work entails partial Monte-Carlo treatment of the problem, and starting with a randomly picked sample of cores, and on the basis of classical arguments which include protostellar feedback and cooling due to emission from warm dust, a theoretical distribution of stellar masses is derived for five realisations of the problem; the magnetic field, though, has been left out of this exercise.

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On the propensity of the formation of massive clumps via fragmentation of driven shells

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Early type massive stars drive thin, dense shells whose edges often show evidence of star-formation. The possibility of fragmentation of these shells, leading to the formation of putative star-forming clumps is examined with the aid of semi-analytic arguments. We also derive a mass-spectrum for clumps condensing out of these shells by performing Monte-Carlo simulations of the problem. By extending on results from our previous work on the stability of thin, dense shells, we argue that clump-mass estimated by other authors in the past, under a set of simplifying assumptions, are several orders of magnitude smaller than those calculated here. Using the expression for the fastest growing unstable mode in a shock-confined shell, we show that fragmentation of a typical shell can produce clumps with a typical mass $\gtrsim 10^3$ $M_\odot$. It is likely that such clumps could spawn a second generation of massive and/or intermediate-mass stars which could in turn, trigger the next cycle of star-formation. We suggest that the ratio of shell thickness-to-radius evolves only weakly with time. Calculations have been performed for stars of seven spectral types, ranging from B1 to O5. We separately consider the stability of supernova remnants.

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Characterizing interstellar filaments with Herschel in IC 5146

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We provide a first look at the results of the *Herschel* Gould Belt survey toward the IC5146 molecular cloud and present a preliminary analysis of the filamentary structure in this region. The column density map, derived from our 70-500 μm *Herschel* data, reveals a complex network of filaments and confirms that these filaments are the main birth sites of prestellar cores. We analyze the column density profiles of 27 filaments and show that the underlying radial density profiles fall off as $r^{-1.5}$ to $r^{-2.5}$ at large radii. Our main result is that the filaments seem to be characterized by a narrow distribution of widths with a median value of 0.10 ± 0.03 pc, which is in stark contrast to a much broader distribution of central Jeans lengths. This characteristic width of ~ 0.1 pc corresponds to within a factor of ~ 2 to the sonic scale below which interstellar turbulence becomes subsonic in diffuse gas, which supports the argument that the filaments may form as a result of the dissipation of large-scale turbulence.

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T Tauri candidates and accretion rates using IPHAS: method and application to IC1396

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The INT Photometric H-Alpha Survey (IPHAS) is a 1800 deg^2 survey of the Northern Galactic Plane, reaching down to r' ∼21. We demonstrate how the survey can be used to (1) reliably select classical T Tauri star candidates and (2) constrain the mass accretion rates with an estimated relative uncertainty of 0.6 dex. IPHAS is a necessary addition to spectroscopic surveys because it allows large and uniform samples of accretion rates to be obtained with a precise handle on the selection effects.
We apply the method on a region of 7 deg^2 towards the HII region IC 1396 in Cepheus OB2 and identify 158 pre-main sequence candidates with masses between 0.2 and 2.0 $M_{\odot}$ and accretion rates between $10^{-9.2}$ and $10^{-7.0}$ $M_{\odot} yr^{-1}$.

We find a power-law dependency between the stellar mass and the accretion rates with a slope of $\alpha = 1.1 \pm 0.2$, which is less steep than indicated by previous studies. We discuss the influence of method-dependent systematic effects on the determination of this relationship.
The majority of our sample consists of faint, previously unknown, low-mass T Tauri candidates (56 per cent between 0.2 and 0.5 $M_{\odot}$). Many candidates are clustered in front of three bright-rimmed molecular clouds, which are being ionized by the massive star HD 206267 (O6.5V). We discover a spatio-temporal gradient of increasing accretion rates, increasing Spitzer infrared excess, and younger ages away from the ionizing star, providing a strong indication that the formation of these clusters has been sequentially triggered by HD 206267 during the last ~1 Myr.

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First astronomical unit scale image of the GW Ori triple system. Direct detection of a new stellar companion.

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Young and close multiple systems are unique laboratories to probe the initial dynamical interactions between forming stellar systems and their dust and gas environment. Their study is a key building block to understanding the high frequency of main-sequence multiple systems. However, the number of detected spectroscopic young multiple systems that allow dynamical studies is limited. GW Orionis is one such system. It is one of the brightest young T Tauri stars and is surrounded by a massive disk. Our goal is to probe the GW Orionis multiplicity at angular scales at which we can spatially resolve the orbit. We used the IOTA/IONIC3 interferometer to probe the environment of GW Orionis with an astronomical unit resolution in 2003, 2004, and 2005. By measuring squared visibilities and closure phases with a good UV coverage we carry out the first image reconstruction of GW Ori from infrared long-baseline interferometry. *We obtained the first infrared image of a T Tauri multiple system with astronomical unit resolution.* We show that GW Orionis is a triple system, resolve for the first time the previously known inner pair (separation ρ ~1.4 AU) and reveal a new more distant component (GW Ori C) with a projected separation of ~8 AU with direct evidence of motion. Furthermore, the nearly equal (2:1) H-band flux ratio of the inner components suggests that either GW Ori B is undergoing a preferential accretion event that increases its disk luminosity or that the estimate of the masses has to be revisited in favour of a more equal mass-ratio system that is seen at lower inclination. Accretion disk models of GW Ori will need to be completely reconsidered because of this outer companion C and the unexpected brightness of companion B.

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Formation of Giant Planets by Disk Instability on Wide Orbits Around Protostars with Varied Masses

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Doppler surveys have shown that more massive stars have significantly higher frequencies of giant planets inside $\sim$ 3 AU than lower mass stars, consistent with giant planet formation by core accretion. Direct imaging searches have begun to discover significant numbers of giant planet candidates around stars with masses of $\sim 1\ M_\odot$ to $\sim 2\ M_\odot$ at orbital distances of $\sim$ 20 AU to $\sim$ 120 AU. Given the inability of core accretion to form giant planets at such large distances, gravitational instabilities of the gas disk leading to clump formation have been suggested as the more likely formation mechanism. Here we present five new models of the evolution of disks with inner radii of 20 AU and outer radii of 60 AU, for central protostars with masses of 0.1, 0.5, 1.0, 1.5, and 2.0 $M_\odot$, in order to assess the likelihood of planet formation on wide orbits around stars with varied masses. The disk masses range from 0.028 $M_\odot$ to 0.21 $M_\odot$, with initial Toomre Q stability values ranging from 1.1 in the inner disks to $\sim$ 1.6 in the outer disks. These five models show that disk instability is capable of forming clumps on time scales of $\sim 10^3$ yr that, if they survive for longer times, could form giant planets initially on orbits with semimajor axes of $\sim$ 30 AU to $\sim$ 70 AU and eccenticities of $\sim$ 0 to $\sim$ 0.35, with initial masses of $\sim 1M_{Jup}$ to $\sim 5M_{Jup}$, around solar-type stars, with more protoplanets forming as the mass of the protostar (and protoplanetary disk) are increased. In particular, disk instability appears to be a likely formation mechanism for the HR 8799 gas giant planetary system.

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http://www.dtm.ciw.edu/downloads/cat_view/113-dtm/132-alan-boss/133-documents

VLA Observations of the Infrared Dark Cloud G19.30+0.07

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We present Very Large Array observations of ammonia (NH_3) (1,1), (2,2), and CCS ($2_1 - 1_0$) emission toward the Infrared Dark Cloud (IRDC) G19.30+0.07 at $\sim$ 22 GHz. The NH_3 emission closely follows the 8 μm extinction. The NH_3 (1,1) and (2,2) lines provide diagnostics of the temperature and density structure within the IRDC, with typical rotation temperatures of $\sim$ 10 to 20 K and NH_3 column densities of $\sim 10^{15}$ cm^{-2}. The estimated total mass of G19.30+0.07 is $\sim$1130 M$_\odot$. The cloud comprises four compact NH_3 clumps of mass $\sim$ 30 to 160 M$_\odot$. Two coincide with 24 μm emission, indicating heating by protostars, and show evidence of outflow in the NH_3 emission. We report a water maser associated with a third clump; the fourth clump is apparently starless. A non-detection of 8.4 GHz emission suggests that the IRDC contains no bright H II regions, and places a limit on the spectral type of an embedded ZAMS star to early-B or later. From the NH_3 emission we find G19.30+0.07 is composed of three distinct velocity components, or "subclouds". One velocity component contains the two 24 μm sources and the starless clump, another contains the clump with the water maser, while the third velocity component is diffuse, with no significant high-density peaks. The spatial distribution of NH_3 and CCS emission from G19.30+0.07 is highly anti-correlated, with the NH_3 predominantly in the high-density clumps, and the CCS tracing lower-density envelopes around those clumps. This spatial distribution is consistent with theories of evolution for chemically young low-mass cores, in which CCS has not yet been processed to other species and/or depleted in high-density regions.

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High-angular resolution observations of methanol in the infrared dark cloud core G11.11-0.12P1

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Recent studies suggest that infrared dark clouds (IRDCs) have the potential of harboring the earliest stages of massive star formation and indeed evidence for this is found toward distinct regions within them. We present a study with the Plateau de Bure Interferometer of a core in the archetypal filamentary IRDC G11.11-0.12 at few arcsecond resolution to determine its physical and chemical structure. The data consist of continuum and line observations covering the $C^{34}S$ $2 \rightarrow 1$ line and the methanol $2_k \rightarrow 1_k$ $v_t = 0$ lines at 3mm and the methanol $5_k \rightarrow 4_k$ $v_t = 0$ lines at 1mm. Our observations show extended emission in the continuum at 1 and 3 mm. The methanol $2_k \rightarrow 1_k$ $v_t = 0$ emission presents three maxima extending over 1 pc scale (when merged with single-dish short-spacing observations); one of the maxima is spatially coincident with the continuum emission. The fitting results show enhanced methanol fractional abundance ($\sim 3 \times 10^{-8}$) at the central peak with respect to the other two peaks, where it decreases by about an order of magnitude ($\sim$4-6 $\times 10^{-9}$). Evidence of extended 4.5 μm emission, "wings" in the CH_3OH $2_k \rightarrow 1_k$ spectra, and CH_3OH abundance enhancement point to the presence of an outflow in the East-West direction. In addition, we find a gradient of $\sim$4 km s^{-1} in the same direction, which we interpret as being produced by an outflow(s)-cloud interaction.

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Structure and Composition of Molecular Clouds with CN Zeeman Detections I: W3OH

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We have carried out a multi-species study of a region which has had previous measurements of strong magnetic fields through the CN Zeeman effect in order to to explore the relationship between CN and N_2H^+, both of which have evidence that they remain in the gas phase at densities of 10^5 - 10^6 cm^{-3}. To achieve this we map the 1 $arcmin^2$ region around the UCHII region of W3(OH) using the Combined Array for Millimeter-wave Astronomy (CARMA). Approximately 105 hours of data were collected in multiple array configurations to produce maps with an effective resolution of $\sim$ 2.5 arcsec at high signal-to-noise in CN, $C^{18}O$, HCN, HCO^+, N_2H^+, and two continuum bands (91.2 GHz and 112 GHz). These data allow us to compare tracer molecules associated with both low and high density regions to infer gas properties. We determine that CARMA resolves out approximately 35% of the CN emission around W3(OH) when compared with spectra obtained from the IRAM-30 meter telescope. The presence of strong absorption lines towards the continuum source in three of the molecular transitions infers the presence of a cold, dark, optically thick region in front of the continuum source. In addition, the presence of high-velocity emission lines near the continuum source shows the presence of hot clumpy emission behind the continuum source. These data determine that future high-resolution interferometric CN Zeeman measurements which cannot currently be performed (due to technical limitations of current telescopes) are feasible. We confirm that CN is indeed a good tracer for high density regions; with certain objects such as W3(OH) it appears to be a more accurate tracer than N_2H^+.

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SEREN - A new SPH code for star and planet formation simulations

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We present SEREN, a new hybrid Smoothed Particle Hydrodynamics and N-body code designed to simulate astrophysical processes such as star and planet formation. It is written in Fortran 95/2003 and has been parallelised using OpenMP. SEREN is designed in a flexible, modular style, thereby allowing a large number of options to be selected or disabled easily and without compromising performance. SEREN uses the conservative ?grad-h? formulation of SPH, but can easily be configured to use traditional SPH or Godunov SPH. Thermal physics is treated either with a barotropic equation of state, or by solving the energy equation and modelling the transport of cooling radiation. A Barnes-Hut tree is used to obtain neighbour lists and compute gravitational accelerations efficiently, and an hierarchical time-stepping scheme is used to reduce the number of computations per timestep. Dense gravitationally bound objects are replaced by sink particles, to allow the simulation to be evolved longer, and to facilitate the identification of protostars and the compilation of stellar and binary properties. At the termination of a hydrodynamical simulation, SEREN has the option of switching to a pure N-body simulation, using a 4th-order Hermite integrator, and following the ballistic evolution of the sink particles (e.g. to determine the final binary statistics once a star cluster has relaxed). We describe in detail all the algorithms implemented in SEREN and we present the results of a suite of tests designed to demonstrate the fidelity of SEREN and its performance and scalability. Further information and additional tests of SEREN can be found at the web-page http://www.astro.group.shef.ac.uk/seren

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Similarity between the $C^{18}O$ (J=1–0) core mass function and the IMF in the S 140 region

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We present the results of $C^{18}O$(J=1–0) mapping observations of a $20' \times 18'$ area in the Lynds 1204 molecular cloud associated with the Sharpless 2-140 (S140) H II region. The $C^{18}O$ cube (α-δ-$v_{\rm LSR}$) data shows that there are three clumps with sizes of ~ 1 pc in the region. Two of them have peculiar red shifted velocity components at their edges, which can be interpreted as the results of the interaction between the cloud and the Cepheus Bubble. From the $C^{18}O$ cube data, the `clumpfind` identified 123 $C^{18}O$ cores, which have mean radius, velocity width in FWHM, and LTE mass of 0.36±0.07 pc, 0.37±0.09 km s^{-1}, and 41±29 $M_\odot$, respectively. All the cores in S140 are most likely to be gravitationally bound by considering the uncertainty in the $C^{18}O$ abundance. We derived a $C^{18}O$ core mass function (CMF), which shows a power-law-like behavior above a turnover at 30 $M_\odot$. The best-fit power-law index of -2.1 ± 0.2 is quite consistent with those of the IMF and the $C^{18}O$ CMF in the OMC-1 region by Ikeda & Kitamura (2009). Kramer et al. (1998) estimated the power-law index of -1.65 in S140 from the $C^{18}O$(J=2–1) data, which is inconsistent with this study. However, the $C^{18}O$(J=2–1) data are spatially limited to the central part of the cloud and are likely to be biased toward high-mass cores, leading to the flatter CMF. Consequently, this study and our previous one strongly support that the power-law form of the IMF has been already determined at the density of $\lesssim 10^{3-4}$ cm^{-3}, traced by the $C^{18}O$(J=1–0) line.

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High-resolution simulations of planetesimal formation in turbulent protoplanetary discs

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We present high-resolution computer simulations of dust dynamics and planetesimal formation in turbulence generated by the magnetorotational instability. We show that the turbulent viscosity associated with magnetorotational turbulence in a non-stratified shearing box increases when going from 256^3 to 512^3 grid points in the presence of a weak imposed magnetic field, yielding a turbulent viscosity of $\alpha \approx 0.003$ at high resolution. Particles representing approximately meter-sized boulders concentrate in large-scale high-pressure regions in the simulation box. The appearance of zonal flows and particle concentration in pressure bumps is relatively similar at moderate (256^3) and high (512^3) resolution. In the moderate-resolution simulation we activate particle self-gravity at a time when there is little particle concentration, in contrast with previous simulations where particle self-gravity was activated during a concentration event. We observe that bound clumps form over the next ten orbits, with initial birth masses of a few times the dwarf planet Ceres. At high resolution we activate self-gravity during a particle concentration event, leading to a burst of planetesimal formation, with clump masses ranging from a significant fraction of to several times the mass of Ceres. We present a new domain decomposition algorithm for particle-mesh schemes. Particles are spread evenly among the processors and the local gas velocity field and assigned drag forces are exchanged between a domain-decomposed mesh and discrete blocks of particles. We obtain good load balancing on up to 4096 cores even in simulations where particles sediment to the mid-plane and concentrate in pressure bumps.

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Three-dimensional simulation of massive star formation in the disk accretion scenario

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The most massive stars can form via standard disk accretion - despite of the radiation pressure generated - due to the fact that the massive accretion disk yields a strong anisotropy in the radiation field, releasing most of the radiation pressure perpendicular to the disk accretion flow. Here, we analyze the self-gravity of the forming circumstellar disk as the potential major driver of the angular momentum transport in such massive disks responsible for the high accretion rates needed for the formation of massive stars.
For this purpose, we perform self-gravity radiation hydrodynamics simulations of the collapse of massive pre-stellar cores. The formation and evolution of the resulting circumstellar disk is investigated in

1. axially symmetric simulations using an α-shear-viscosity prescription and

2. a three-dimensional simulation, in which the angular momentum transport is provided self-consistently by developing gravitational torques in the self-gravitating accretion disk.

The simulation series of different strength of the α-viscosity shows that the accretion history of the forming star is mostly independent of the α-viscosity-parameter. The accretion history of the three-dimensional run driven by self-gravity is more time-dependent than the viscous disk evolution in axial symmetry. The mean accretion rate, i.e. the stellar mass growth, is nearly identical to the α-viscosity models.
We conclude that the development of gravitational torques in self-gravitating disks around forming massive stars provides a self-consistent mechanism to efficiently transport the angular momentum to outer disk radii. Also the formation of the most massive stars can therefore be understood in the standard accretion disk scenario.

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Statistical comparison of clouds and star clusters

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The extent to which the projected distribution of stars in a cluster is due to a large-scale radial gradient, and the extent to which it is due to fractal sub-structure, can be quantified – statistically – using the measure $\mathcal{Q} = \bar{m}/\bar{s}$. Here $\bar{m}$ is the normalized mean edge length of its minimum spanning tree (i.e. the shortest network of edges connecting all stars in the cluster) and $\bar{s}$ is the correlation length (i.e. the normalized mean separation between all pairs of stars). We show how $\mathcal{Q}$ can be indirectly applied to grey-scale images by decomposing the image into a distribution of points from which $\bar{m}$ and $\bar{s}$ can be calculated. This provides a powerful technique for comparing the distribution of dense gas in a molecular cloud with the distribution of the stars that condense out of it. We illustrate the application of this technique by comparing $\mathcal{Q}$ values from simulated clouds and star clusters.

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A proper motion study of the Lupus clouds using VO tools

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Context. The Lupus dark cloud complex is a well-known, nearby low-mass star-forming region, probably associated with the Gould Belt. In recent years, the number of stellar and substellar Lupus candidate members has been remarkably increased thanks to the *Cores to Disks (c2d) Spitzer* Legacy Program and other studies. However, most of these newly discovered objects still lack confirmation that they belong to the dark clouds.

Aims. By using available kinematical information, we test the membership of the new Lupus candidate members proposed by the *c2d* program and by a complementary optical survey. We also investigate the relationship between the proper motions and other properties of the objects, in order to get some clues about their formation and early evolution.

Methods. We compiled a list of members and possible members of Lupus 1, 3, and 4, together with all available information on their spectral types, disks, and physical parameters. Using Virtual Observatory tools, we cross-matched this list with the available astrometric catalogues to get proper motions for our objects. Our final sample contains sources with magnitudes $I < 16$ mag and estimated masses $\geq 0.1 M_{\odot}$.

Results. According to the kinematic information, our sources can be divided into two main groups. The first one contains sources with higher proper motions in agreement with other Gould Belt populations and with spatial distribution, optical and near-infrared colours, and disk composition consistent with these objects belonging to the Lupus clouds. In the second group, sources have lower proper motions with random orientations, and they are mostly located outside the cloud cores, making their association with the Lupus complex more doubtful. We investigate the properties of the higher proper motion group, but cannot find any correlations with spatial location, binarity, the presence of a circumstellar disk, or with physical properties such as effective temperature, luminosity, mass, or age.

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http://es.arxiv.org/abs/1103.2667

Simultaneous monitoring of the photometric and polarimetric activity of the young star PV Cep in the optical/near-infrared bands

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We present the results of a simultaneous monitoring, lasting more than 2 years, of the optical and near-infrared photometric and polarimetric activity of the variable protostar PV Cep. During the monitoring period, an outburst has occurred in all the photometric bands, whose declining phase (ΔJ $\approx$ 3 mag) lasted about 120 days. A time lag of $\sim$ 30 days between optical and infrared light curves has been measured and interpreted in the framework of an accretion event. This latter is directly recognizable in the significant variations of the near-infrared colors, that appear bluer in the outburst phase, when the star dominates the emission, and redder in declining phase, when the disk emission prevails.
All the observational data have been combined to derive a coherent picture of the complex morphology of the whole PV Cep system, that, in addition to the star and the accretion disk, is composed also by a variable biconical nebula. In particular, the mutual interaction between all these components is the cause of the high value of the polarization ($\approx$ 20%) and of its fluctuations.
The observational data concur to indicate that PV Cep is not a genuine EXor star, but rather a more complex object; moreover the case of PV Cep leads to argue about the classification of other recently discovered young sources in outburst, that have been considered, maybe over-simplifying, as EXor.

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The formation of permanent soft binaries in dispersing clusters

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Wide, fragile binary stellar systems are found in the galactic field, and have recently been noted in the outskirts of expanding star clusters in numerical simulations. Energetically soft, with semi-major axes exceeding the initial size of their birth cluster, it is puzzling how these binaries are created and preserved. We provide an interpretation of the formation of these binaries that explains the total number formed and their distribution of energies. A population of weakly bound binaries can always be found in the cluster, in accordance with statistical detailed balance, limited at the soft end only by the current size of the cluster and whatever observational criteria are imposed. At any given time, the observed soft binary distribution is predominantly a snapshot of a transient population. However, there is a constantly growing population of long-lived soft binaries that are removed from the detailed balance cycle due to the changing density and velocity dispersion of an expanding cluster. The total number of wide binaries that form, and their energy distribution, are insensitive to the cluster population; the number is approximately one per cluster. This suggests that a population composed of many dissolved small-N clusters will more efficiently populate the field with wide binaries than that composed of dissolved large-N clusters. Locally such binaries are present at approximately the 2% level; thus the production rate is consistent with the field being populated by clusters with a median of a few hundred stars rather than a few thousand.

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The Luminosity Functions and Timescales of MYSOs and Compact HII regions

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We present a determination of the luminosity functions of massive young stellar objects (MYSOs) and compact (C) H II regions within the Milky Way Galaxy using the large, well-selected sample of these sources identified by the Red MSX Source (RMS) survey. The MYSO luminosity function decreases monotonically such that there are few with $L \gtrsim 10^5 L_\odot$, whilst the CH II regions are detected up to $\sim 10^6 L_\odot$. The lifetimes of these phases are also calculated as a function of luminosity by comparison with the luminosity function for local main-sequence OB stars. These indicate that the MYSO phase has a duration ranging from 4×10^5 yrs for $10^4 L_\odot$ to $\sim 7\times10^4$ yrs at $10^5 L_\odot$, whilst the CH II region phase lasts of order 3×10^5 yrs or ∼3-10% of the exciting star's main-sequence lifetime. MYSOs between $10^4 L_\odot$ and $\sim 10^5 L_\odot$ are massive but do not display the radio continuum or near-IR H I recombination line emission indicative of an H II region, consistent with being swollen due to high ongoing or recent accretion rates. Above $\sim 10^5 L_\odot$ the MYSO phase lifetime becomes comparable to the main-sequence Kelvin-Helmholtz timescale, at which point the central star can rapidly contract onto the main-sequence even if still accreting, and ionise a CH II region, thus explaining why few highly luminous MYSOs are observed.

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Substellar Objects in Nearby Young Clusters (SONYC) III: Chamaeleon-I

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SONYC – *Substellar Objects in Nearby Young Clusters* – is a survey program to investigate the frequency and properties of substellar objects with masses down to a few times that of Jupiter in nearby star-forming regions. In this third paper, we present our recent results in the Chamaeleon-I star forming region. We have carried out deep optical and near-infrared imaging in four bands (I, z, J, K_S) using VIMOS on the ESO Very Large Telescope and SOFI on the New Technology Telescope, and combined our data with mid-infrared data from the Spitzer Space Telescope. The survey covers $\sim 0.25\,\mathrm{deg}^2$ on the sky, and reaches completeness limits of 23.0 in the I-band, 18.3 in the J-band, and 16.7 in K_S-band. Follow-up spectroscopy of the candidates selected from the optical photometry ($I \leq 21$) was carried out using the multi-object spectrograph VIMOS on the VLT. We identify 13 objects consistent with M spectral types, 11 of which are previously known M-dwarfs with confirmed membership in the cluster. The 2 newly reported objects have effective temperatures above the substellar limit. We also present two new candidate members of Chamaeleon-I, selected from our JK photometry combined with the Spitzer data. Based on the results of our survey, we estimate that the number of missing very-low-mass members down to $\sim 0.008 M_\odot$ and $A_V \leq 5$ is ≤ 7, i.e. $\leq 3\%$ of the total cluster population according to the current census.

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http://arxiv.org/abs/1103.0978

W43: the closest molecular complex of the Galactic bar?

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In the framework of the multi-wavelength Galactic surveys of star-formation presently underway, complexes of molecular clouds that stretch over up to hundreds of parsecs are of particular interest. This is because a large population of stars are forming within them, thus all at the same distance from the Sun and under similar physical conditions. We study the Galactic plane between ≈ 29.5 and 31.5 degrees of longitude, which is especially rich in terms of molecular clouds and star-formation activity. It is located within what is sometimes called the molecular ring and contains the Galactic mini-starburst region W43, as well as the prominent hot core G29.96-0.02 with its associated compact H II region. We used a large database extracted from Galaxy-wide surveys of H I, ^{13}CO 1-0, 8 μm, and 870 μm continuum to trace diffuse atomic gas, low- to medium-density molecular gas, high-density molecular gas, and star-formation activity, which we complemented by dedicated ^{12}CO 2–1, 3–2 observations of the region. From the detailed 3D (space-space-velocity) analysis of the molecular and atomic cloud tracers through the region and despite its wide velocity range ($FWHM \sim 22.3\ km/s$ around $v_{lsr} \sim 95.9\ km/s$), we identified W43 as a large (equivalent diameter ∼ 140 pc) and coherent complex of molecular clouds that is surrounded by an atomic gas envelope (equivalent diameter ∼ 290 pc). We measured both the total mass of this newly identified molecular complex ($M_{\rm total} \sim 7.1 \times 10^6\ M_\odot$) and the mass contained in dense 870 μm clumps (< 5 pc dense cloud structures, $M_{\rm clumps} \sim 8.4 \times 10^5\ M_\odot$), and conclude that W43 is particularly massive and concentrated. The distance that we assume for the W43 complex is 6 kpc from the Sun, which may place it at the meeting point of the Scutum-Centaurus (or Scutum-Crux) Galactic arm and the bar, a dynamically complex region where high-velocity streams could easily collide. We propose that the star-formation rate of W43 is not steady but increases from $\sim 0.01\ M_\odot, {\rm yr}^{-1}$ (measured from its 8 μm luminosity) to $\sim 0.1\ M_\odot, {\rm yr}^{-1}$ (measured from its molecular content). From the global properties of W43, we claim that it is an extreme molecular complex in the Milky Way and it might even form starburst clusters in the near future. W43 is the perfect testbed to investigate (1) the star-formation process occuring through bursts as well as (2) the formation of such an extreme complex in the framework of converging flows scenarios.

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http://arxiv.org/pdf/1102.3460
http://www.aanda.org/articles/aa/pdf/forth/aa16271-10.pdf

Evidence Against an Edge-On Disk Around the Extrasolar Planet, 2MASS 1207 b and a New Thick Cloud Explanation for its Under-Luminosity

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Since the discovery of the first directly-imaged, planetary-mass object, 2MASS 1207 b, several works have sought to explain a disparity between its observed temperature and luminosity. Given its known age, distance, and spectral type, 2MASS 1207 b is under-luminous by a factor of ∼10 (∼2.5 mags) when compared to standard models of brown-dwarf/giant-planet evolution. In this paper, we study three possible sources of 2MASS 1207 b's under-luminosity. First, we investigate Mohanty et al (2007)'s hypothesis that a near edge-on disk, comprising large, gray-extincting

grains, might be responsible for 2MASS 1207 b's under-luminosity. After radiative transfer modeling we conclude that the hypothesis is unlikely due to the lack of variability seen in multi-epoch photometry and unnecessary due to the increasing sample of under-luminous brown-dwarfs/giant-exoplanets that cannot be explained by an edge-on disk. Next, we test the analogous possibility that a spherical shell of dust, could explain 2MASS 1207 b's under-luminosity. Models containing enough dust to create ∼2.5 mags of extinction, placed at reasonable radii, are ruled out by our new Gemini/T-ReCS 8.7 micron photometric upper-limit for 2MASS 1207 b. Finally, we investigate the possibility that 2MASS 1207 b is intrinsically cooler than the commonly used AMES-DUSTY fits to its spectrum, and thus it is not, in fact, under-luminous. New, thick cloud model grids by Madusudhan et al. (2011) fit 2MASS 1207 b's 1-10 micron SED well, but they do not quite fit its near-infrared spectrum. However, we suggest that with some "tuning", they might be capable of simultaneously reproducing 2MASS 1207 b's spectral shape and luminosity. In this case, the whole class of young, under-luminous brown-dwarfs/giant-exoplanets might be explained by atmospheres that are able to suspend thick, dusty clouds in their photospheres at lower temperatures than field brown-dwarfs.

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The importance of episodic accretion for low-mass star formation

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A star acquires much of its mass by accreting material from a disc. Accretion is probably not continuous but episodic. We have developed a method to include the effects of episodic accretion in simulations of star formation. Episodic accretion results in bursts of radiative feedback, during which a protostar is very luminous, and its surrounding disc is heated and stabilised. These bursts typically last only a few hundred years. In contrast, the lulls between bursts may last a few thousand years; during these lulls the luminosity of the protostar is very low, and its disc cools and fragments. Thus, episodic accretion enables the formation of low-mass stars, brown dwarfs and planetary-mass objects by disc fragmentation. If episodic accretion is a common phenomenon among young protostars, then the frequency and duration of accretion bursts may be critical in determining the low-mass end of the stellar initial mass function.

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http://www.astro.cf.ac.uk/pub/Dimitrios.Stamatellos/Publications.html

3D numerical simulations of photodissociated and photoionized disks

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Aims. In this work we study the influence of the UV radiation field of a massive star on the evolution of a disklike mass of gas and dust around a nearby star. This system has similarities with the proplyds seen in Orion.
Methods. We study disks with different inclinations and distances from the source, performing fully 3D numerical simulations. We use the YGUAZÚ-A adaptative grid code modified to account for EUV/FUV fluxes and non-spherical mass distributions. We treat H and C photoionization in order to reproduce the ionization fronts and photodissociation regions observed in proplyds. We also incorporate a wind from the ionizing source, in order to investigate the formation of the bow shock observed in several proplyds. We examine density and Hα maps, as well as the mass loss rates in the photoevaporated winds.
Results. Our results show that a photoevaporated wind propagates from the disk surface and becomes ionized after an ionization front (IF) seen as a bright peak in the Hα maps. We follow the development of an HI region inside the photoevaporated wind which corresponds to a photodissociated region (PDR) for most of our models, except those without a FUV flux. For disks that are at a distance from the source d $\geq$ 0.1 pc, the PDR is thick and the IF is

detached from the disk surface. In contrast, for disks that are closer to the source, the PDR is thin and not resolved in our simulations. The IF then coincides with the first grid points of the disk that are facing the ionizing photon source. In both cases, the photoevaporated wind shocks (after the IF) with the wind that comes from the ionizing source, and this interaction region is bright in Hα.

Conclusions. Our 3D models produce two emission features: a hemispherically shaped structure (associated with the IF) and a detached bow shock where both winds collide. A photodissociated region develops in all of the models exposed to the FUV flux. More importantly, disks with different inclinations with respect to the ionizating source have relatively similar photodissociation regions. If the disk axis is not aligned with the direction of the ionizing photon flux, the IF displays moderate side-to-side asymmetries, in qualitative agreement with images of proplyds, which also show such asymmetries. The mass loss rates are $\sim 10^{-7}$ $M_\odot$ yr^{-1} for face-on disks, and 5×10^{-8} $M_\odot$ yr^{-1} for inclined disks at distances from 0.1 to 0.2 pc from the ionizing photon sources.

Accepted by Astronomy & Astrophysics

http://arxiv.org/abs/1102.3066

Magnetic-Field Measurement of T Tauri Stars in the Orion Nebula Cluster

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We present an analysis of high-resolution ($R \sim 50,000$) infrared K-band echelle spectra of 14 T Tauri stars in the Orion Nebula Cluster. We model Zeeman broadening in three magnetically sensitive Ti I lines near 2.2 μm and consistently detect kilogauss-level magnetic fields in the stellar photospheres. The data are consistent in each case with the entire stellar surface being covered with magnetic fields, suggesting that magnetic pressure likely dominates over gas pressure in the photospheres of these stars. These very strong magnetic fields might themselves be responsible for the underproduction of X-ray emission of T Tauri stars relative to what is expected based on main-sequence star calibrations. We combine these results with previous measurements of 14 stars in Taurus and 5 stars in the TW Hydrae association to study the potential variation of magnetic-field properties during the first 10 million years of stellar evolution, finding a steady decline in total magnetic flux with age.

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http://arxiv.org/abs/1102.3662

HST/COS Spectra OF DF Tau AND V4046 Sgr: First Detection of Molecular Hydrogen Absorption Against the Lyα Emission Line

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We report the first detection of molecular hydrogen (H_2) absorption in the Lyman-α emission line profiles of two classical T Tauri stars (CTTSs), DF Tau and V4046 Sgr, observed by *HST*/COS. This absorption is the energy source for many of the Lyman-band H_2 fluorescent lines commonly seen in the far-ultraviolet spectra of CTTSs. We find that the absorbed energy in the H_2 pumping transitions from a portion of the Lyman-α line significantly differ from the amount of energy in the resulting fluorescent emission. By assuming additional absorption in the H I Lyman-α profile along our light of sight, we can correct the H_2 absorption/emission ratios so that they are close to unity. The required H I absorption for DF Tau is at a velocity close to the radial velocity of the star, consistent with H I absorption in the edge-on disk and interstellar medium. For V4046 Sgr, a nearly face-on system, the required absorption is between +100 km s^{-1} and +290 km s^{-1}, most likely resulting from H I gas in the accretion columns falling onto the star.

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Early phase of massive star formation: A case study of Infrared dark cloud G084.81−01.09

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We mapped the Mid-course Space Experiment dark cloud G084.81−01.09 in the NH_3 (1,1) - (4,4) lines and in the J = 1-0 transitions of ^{12}CO, ^{13}CO, $C^{18}O$ and HCO^+ in order to study the physical properties of infrared dark clouds, and to better understand the initial conditions for massive star formation. Six ammonia cores are identified with masses ranging from 60 to 250 $M_\odot$, a kinetic temperature of 12 K, and a molecular hydrogen number density $n(H_2) \sim 10^5$ cm^{-3}. In our high mass cores, the ammonia line width of 1 km s^{-1} is larger than those found in lower mass cores but narrower than the more evolved massive ones. We detected self-reversed profiles in HCO^+ across the northern part of our cloud and velocity gradients in different molecules. These indicate an expanding motion in the outer layer and more complex motions of the clumps more inside our cloud. We also discuss the millimeter wave continuum from the dust. These properties indicate that our cloud is a potential site of massive star formation but is still in a very early evolutionary stage.

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http://iopscience.iop.org/0067-0049/193/1/10/

Radiation Transfer of Models of Massive Star Formation. I. Dependence on Basic Core Properties

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Radiative transfer calculations of massive star formation are presented. These are based on the Turbulent Core Model of McKee & Tan and self-consistently included a hydrostatic core, an inside-out expansion wave, a zone of free-falling rotating collapse, wide-angle dust-free outflow cavities, an active accretion disk, and a massive protostar. For the first time for such models, an optically thick inner gas disk extends inside the dust destruction front. This is important to conserve the accretion energy naturally and for its shielding effect on the outer region of the disk and envelope. The simulation of radiation transfer is performed with the Monte Carlo code of Whitney, yielding spectral energy distributions (SEDs) for the model series, from the simplest spherical model to the fiducial one, with the above components each added step-by-step. Images are also presented in different wavebands of various telescope cameras, including Spitzer IRAC and MIPS, SOFIA FORCAST and Herschel PACS and SPIRE. The existence of the optically thick inner disk produces higher optical wavelength fluxes but reduces near- and mid-IR emission. The presence of outflow cavities, the inclination angle to the line of sight, and the thickness of the disk all affect the SEDs and images significantly. For the high mass surface density cores considered here, the mid-IR emission can be dominated by the outflow cavity walls, as has been suggested by De Buizer. The effect of varying the pressure of the environment bounding the surface of the massive core is also studied. With lower surface pressures, the core is larger, has lower extinction and accretion rates, and the observed mid-IR flux from the disk can then be relatively high even though the accretion luminosity is lower. In this case the silicate absorption feature becomes prominent, in contrast to higher density cores forming under higher pressures.

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http://arxiv.org/abs/1103.3068

Abstracts of recently accepted major reviews

Protoplanetary Disks and Their Evolution

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Flattened, rotating disks of cool dust and gas extending for tens to hundreds of AU are found around almost all low mass stars shortly after their birth. These disks generally persist for several Myr, during which time some material accretes onto the star, some is lost through outflows and photoevaporation, and some condenses into centimeter- and larger-sized bodies or planetesimals. Through observations mainly at infrared through millimeter wavelengths, we can determine how common disks are at different ages, measure basic properties including mass, size, structure, and composition, and follow their varied evolutionary pathways. In this way, we see the first steps toward exoplanet formation and learn about the origins of the Solar System. This review addresses observations of the outer parts, beyond 1 AU, of protoplanetary disks with a focus on recent infrared and (sub-)millimeter results and an eye to the promise of new facilities in the immediate future.

Accepted by Annual Review of Astronomy and Astrophysics

http://arxiv.org/abs/1103.0556

Postdoc position on protoplanetary disks at IPAG, Grenoble

Applications are invited for a postdoctoral position at the Institute of Planetology and Astrophysics of Grenoble (IPAG, formerly LAOG) in the framework of DiskEvol, a research project funded by the French National Research Agency (ANR).

The proposed research project will focus on the analysis and interpretation of observations of the dust and gas phases of protoplanetary disks, with the aim of constraining the processes of disk evolution. In particular, the successful applicant will play a central role in the analysis of data from the GASPS/Herschel Key Project along with continuum data and resolved molecular maps in the millimetre domain, as well as in the preparation for ALMA and JWST.

The successful candidate will work with the star formation team at IPAG, with close interactions with the molecular astronomy team. Members of the project team can provide expertise in observations of circumstellar disks at all wavelengths, as well as in numerical and theoretical modeling of radiative transfer and chemistry in disks. A full working environment will be provided to the selected candidate, including access to the local 464-core dedicated supercomputer.

Applicants must have a PhD. Preferably, she/he will have experience in the techniques of radiative transfer or chemistry modelling and will be able to modify/improve the existing numerical and analysis tools as required. Knowledge in the treatment and analysis of radio interferometric data would be particularly appreciated. However, candidates with all relevant backgrounds will be considered with full attention. The position is initially for two years.

Applications should include a CV, a list of publications and a statement of research interests and experience. The applicants should also arrange for two letters of recommendation to be sent independently. All material should be directed to Christophe Pinte by April,15, 2011.

Christophe Pinte
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Workshop on

Formation of the First Solids in the Solar System

November 7-9, 2011 – Kauai, Hawaii

Objectives:

This interdisciplinary meeting (cosmochemistry, astrophysics, and astronomy) is dedicated to Klaus Keil to honor his distinguished career in meteoritics and cosmochemistry. It is focused on four major but related issues that are crucial in deciphering the meteorite record of the early solar system:

• Origin of refractory inclusions [Ca,Al-rich inclusions (CAIs) and amoeboid olivine aggregates (AOAs)]: astrophysical environment; mechanism and timing of formation; chemical, isotopic, and experimental constraints on their origin and radial transport in the protoplanetary disk; as well as the relationship between refractory inclusions and chondrules.

• Short-lived isotopes in meteorites: initial abundances, sources (stellar, irradiation), chronology, consistency among short-lived and long-lived isotopic chronometers.

• Stable isotopic anomalies in meteorites: carriers of anomalies in Cr, Ni, Ti, etc., primary vs.secondary heterogeneity.

• Oxygen isotopes: galactic chemical evolution, initial composition of dust and gas in the solar system, CO self-shielding, correlations with stable isotope anomalies.

Workshop Format:

The three-day meeting will consist of invited talks, contributed talks, and a poster session. The workshop proceedings will be published as review papers or regular articles in Meteoritics & Planetary Science. All papers will be subject to the normal MAPS review process.

Scientific Organizing Committee:

Francis Albarede (France), Yuri Amelin (Australia), Martin Bizzarro (Denmark), Marc Chaussidon (France), Harold Connolly (USA), Andrew Davis (USA), Gary Huss (USA), Ian Hutcheon (USA), Thorsten Kleine (Germany), Alexander Krot (USA), Glenn MacPherson (USA), Herbert Palme (Germany), Bo Reipurth (USA), Sara Russell (UK), Edward Scott (USA), Mario Trieloff (Germany), Meenakshi Wadhwa (USA), Jonathan Williams (USA), Hisayoshi Yurimoto (Japan).

http://www.lpi.usra.edu/meetings/solids2011

The Central Kiloparsec in Galactic Nuclei Astronomy at High Angular Resolution

29.8.-2.9.2011 - DPG Physikzentrum Bad Honnef (Cologne/Bonn) Germany

http://www.astro.uni-koeln.de/afs/teaching_seminars/conferences/AHAR2011/

The conference will cover high mass star formation in nuclei of galaxies, the interplay with BH accretion phenomena, and will have a section on the Galactic Center.

Further information is given on the homepage.

EWASS2011 - Special Session SPS2: Massive Stars Formation

JENAM-2011, Saint-Petersburg, July 4, 2011

Conveners:
Igor Zinchenko, Institute of Applied Physics RAS, (Russia), zin@appl.sci-nnov.ru
Malcolm Walmsley, Arcetri Astrophysical Observatory (Italy), walmsley@arcetri.astro.it

Studies of high mass star formation are currently a "hot topic" of astrophysical research. Despite of their great importance in almost all areas of astronomy, the formation of stars larger than 8–10 $M_{\odot}$ is still poorly understood. In part this is because high mass star forming regions are more distant, more active, and shorter lived than their low-mass counterparts. An enhanced attention is paid to the earliest phases of high mass star formation which are most probably represented by Infrared Dark Clouds. The research in this area greatly benefits from the new European ground-based and space millimeter and submillimeter wave observatories (APEX, Herschel). The coming era of ALMA opens new prospects for these studies.

This special session is arranged in the framework of the European Week of Astronomy and Space Science (JENAM-2011) which will take place July 4 to 8, 2011 in Saint-Petersburg. The venue of the conference is Park Inn Hotel 'Pulkovskaya'. The session will last 4.5 hours on July 4. It is intended to discuss the main achievements and future directions of the research in this field. The program will include several invited talks and a limited number of original contributions in the form of short talks and posters.

SOC:
Thomas Henning (MPIA, Germany), Karl Menten (MPIfR, Germany), Andrej Sobolev (Ural Univ., Russia), Malcolm Walmsley (Arcetri Astrophys. Obs., Italy), Igor Zinchenko (Inst. Applied Phys. RAS, Russia)

Invited speakers:
Henrik Beuther (MPIA, Germany), Ian Bonnell (Univ. of St Andrews, UK), Riccardo Cesaroni (Arcetri Astrophys. Obs, Italy), Thomas Henning (MPIA, Germany), Jan Palous (Astronomical Inst. of the Academy of Sciences of the Czech Republic), Andrej Sobolev (Ural Univ., Russia)

Contact:
zin@appl.sci-nnov.ru

URL:
http://www.jenam2011.org/conf/submission/special/s2.php

Recent Advances in Star Formation: Observations and Theory

Part of the Silver Jubilee celebration of the Vainu Bappu Telescope

Star forming regions are replete with dense pockets of molecular hydrogen. Protostellar systems form in some of the densest regions of these pockets, with a number of star-forming clouds having a filamentary appearance. Extensive multi-wavelength studies of star-forming regions have led to better understanding of the physics of star formation and proto-stellar evolution. Theoretical understanding of star-formation too, has improved enormously to encompass different modes of triggering the star-forming cycle. This workshop will cover some of the crucial topics in star-formation : (1)Structure and dynamics of molecular clouds (2)Triggered star-formation (3)Low and high-mass star forming regions, and HII regions (4)Protostellar evolution, jets and outflows (5)Star-clusters, binaries, system initial mass function (IMF)

Dates : 28^{th} June to 01^{st} July 2011
Venue : Indian Institute of Astrophysics, Bangalore

Scientific organising committee:
H.C.Bhatt, Annapurni Subramaniam, Sumedh Anathpindika, Padmakar Parihar, Mousumi Das

Contact:
purni@iiap.res.in or sumedh_a@iiap.res.in

An Introduction to Star Formation

Derek Ward-Thompson and Anthony P. Whitworth

This is a textbook aimed at advanced undergraduate students and first year graduate students and providing a broad overview of star formation. The book examines the underlying physical processes that govern the evolution from a molecular cloud core to a main-sequence star, and focuses on the formation of solar-mass stars. Each chapter combines theory and observation, helping readers to connect with and understand the theory behind star formation. Beginning with an explanation of the interstellar medium and molecular clouds as sites of star formation, subsequent chapters address the building of typical stars and the formation of high-mass stars, concluding with a discussion of the by-products and consequences of star formation.

The book contains the following chapters:

1: Introduction

1.1 About this book – 1.2 The stellar life-cycle – 1.3 The space between the stars – 1.4 The distribution of the stars – 1.5 The magnetic field – 1.6 Star formation in a galactic context – 1.7 Known sites of contemporary star formation – 1.8 The initial mass function – 1.9 Objectives of star-formation theory

2: Probing star formation

2.1 Introduction – 2.2 Properties of photons – 2.3 Intensity – 2.4 Flux – 2.5 Radiant energy density – 2.6 Continuum radiation - studying the dust – 2.7 Radiative transfer – 2.8 Calculating the dust mass – 2.9 Line radiation - studying the gas

3: The ISM – the beginnings of star formation

3.1 Introduction – 3.2 The 21-cm line of atomic hydrogen – 3.3 Molecular gas – 3.4 Line shapes and the motion of the gas – 3.5 Absorption lines - searchlights through the ISM – 3.6 The curve of growth – 3.7 The use of absorption lines

4: Molecular clouds – the sites of star formation

4.1 The equation of state – 4.2 Fluid mechanics of molecular clouds – 4.3 Gravitational instability – 4.4 The virial theorem – 4.5 Observations of molecular clouds – 4.6 Turbulence in molecular clouds – 4.7 Magnetic fields in molecular clouds – 4.8 Chemistry on molecular clouds

5: Fragmentation and collapse – the road to star formation

5.1 The road to star formation – 5.2 Theoretical collapse solutions – 5.3 The minimum mass of a star – 5.4 Effects of the magnetic field – 5.5 Observations of the initial conditions of collapse – 5.6 Binary and multiple star formation

6: Young stars, protostars and accretion – building a typical star

6.1 Pre-main sequence evolution – 6.2 Hayashi tracks – 6.3 Henyey tracks – 6.4 Accretion onto protostars – 6.5 Observations of protostars - the birth line – 6.6 Millimetre-wave continuum observations – 6.7 Millimetre-wave spectroscopy – 6.8 Infrared and optical observations

7: The formation of high-mass stars, and their surroundings

7.1 Introduction – 7.2 The main stages of high-mass star formation – 7.3 Building a high-mass star – 7.4 Line radiation from HII regions – 7.5 Recombinatin rate and emission meassure – 7.6 Free-free radio continuum – 7.7 Size of an HII region - Strömgren radius – 7.8 Ionization fronts – 7.9 Expansion of an HII region

8: By-products and consequences of star formation

8.1 Introduction – 8.2 Circumstellar disks – 8.3 Bipolar outflows – 8.4 Disc fragmentation – 8.5 Planet formation – 8.6 Brown dwarf stars – 8.7 Galaxy formation – 8.8 The epoch of star formation

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