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Abstracts of recently accepted papers

The low-mass population of the ρ Ophiuchi molecular cloud

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Context. Star formation theories are currently divergent regarding the fundamental physical processes that dominate the substellar regime. Observations of nearby young open clusters allow the brown dwarf (BD) population to be characterised down to the planetary mass regime, which ultimately must be accommodated by a successful theory.
Aims. We hope to uncover the low-mass population of the ρ Ophiuchi molecular cloud and investigate the properties of the newly found brown dwarfs.
Methods. We use near-IR deep images (reaching completeness limits of approximately 20.5 mag in J, and 18.9 mag in H and K_s) taken with the Wide Field IR Camera (WIRCam) at the Canada France Hawaii Telescope (CFHT) to identify candidate members of ρ Oph in the substellar regime. A spectroscopic follow-up of a small sample of the candidates allows us to assess their spectral type, and subsequently their temperature and membership.
Results. We select 110 candidate members of the ρ Ophiuchi molecular cloud, from which 80 have not previously been associated with the cloud. We observed a small sample of these and spectroscopically confirm six new brown dwarfs with spectral types ranging from M6.5 to M8.25.

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http://arxiv.org/abs/1003.2205

Collapse of a molecular cloud core to stellar densities: the radiative impact of stellar core formation on the circumstellar disc

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We present results from the first three-dimensional radiation hydrodynamical calculations to follow the collapse of a molecular cloud core beyond the formation of the stellar core. We find the energy released by the formation of the stellar core, within the optically-thick first hydrostatic core, is comparable to the binding energy of the disc-like first core. This heats the inner regions of the disc, drives a shock wave through the disc, dramatically decreases the accretion rate on to the stellar core, and launches a temporary bipolar outflow perpendicular to the rotation axis that travels in excess of 50 AU into the infalling envelope. This outburst may assist the young protostar in launching a conventional magnetic jet. Furthermore, if these events are cyclic, they may provide a mechanism for intense bursts of accretion separated by long periods of relatively quiescent accretion which can potentially solve both the protostellar luminosity problem and the apparent age spread of stars in young clusters. Such outbursts may also

provide a formation mechanism for the chondrules found in meteorites, with the outflow transporting them to large distances in the circumstellar disc.

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http://arxiv.org/abs/1003.3034
Animations can be found at http://www.astro.ex.ac.uk/people/mbate/Animations/Stellar/

Interpretation of historical lightcurve of young binary (?) system UY Aur

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We constructed historical ($\Delta t > 100$ yr) lightcurve of young binary system UY Aur using visual, photographic and photoelectric measurements. More than a quarter of all measurements we derived for the first time from photographic plates of Harvard and Moscow glass libraries. The following conclusions were obtained from the analysis of the lightcurve and dependence of degree of polarization and $B - V$ color index on magnitude.

Cyclic variations of UY Aur A brightness with period $\simeq 16.3$ yr occured from the middle of 20-th to the middle of 40-th years of the last century as well as after 1986 yr. We argue that the variability occured due to modulation of disk accretion rate onto UY Aur A induced by orbital motion of its hypothetic companion UY Aur C. The major semiaxis of UY Aur C orbit is near 6 a.u.

The periodicity of UY Aur A's brightness variations disappeared from the begining of 50-th up to the middle of 80-th years of the last century due to non-periodic eclipses of the star by dusty clouds. Another dusty cloud has eclipsed UY Aur B companion somewhen between 1945 yr and 1974 yr and still eclipses it. The average brightness of UY Aur B in visual band decreased over some magnitudes due to this reason.

We suppose that dusty clouds, that produced nearly simultaneous eclipses of stars with projection separation > 100 a.u., are more dense and puffed regions of UY Aur A and UY Aur B circumstellar disks. These regions has arisen due to dinamical interaction of the companions with circumbinary disk. Variations of extinction in the course of time occur due to orbital motion of UY Aur A and UY Aur B as well as due to inhomogenity of disk's puffed regions in the azimuthal direction.

A number of observational tests are proposed to check our conclusions.

Accepted by Astronomy Letters

A method for reconstructing the PDF of a 3D turbulent density field from 2D observations

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We introduce a method for calculating the probability density function (PDF) of a turbulent density field in three dimensions using only information contained in the projected two-dimensional column density field. We test the method by applying it to numerical simulations of hydrodynamic and magnetohydrodynamic turbulence in molecular clouds. To a good approximation, the PDF of log(normalised column density) is a compressed, shifted version of the PDF of log(normalised density). The degree of compression can be determined observationally from the column density power spectrum, under the assumption of statistical isotropy of the turbulence.

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Relative velocities of solids in a turbulent protoplanetary disc

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We use magnetohydrodynamic simulations to measure relative speeds of solids in a protoplanetary disc with turbulence generated by the magnetorotational instability. Relative velocities are calculated as functions of particle Stokes number St, which measures the aerodynamic coupling to the gas. When relative velocities $V_{\rm rel}$ are cal- culated between two particles i and j such that $Sti \gg Stj$ and $Stj \ll 1$, the data matches the analytical model of Ormel & Cuzzi (2007). However, if $V_{\rm rel}$ corresponds to two particles with the same St, only the data for the more loosely-coupled solids (i.e., those with large St) follow the model. The discrepancy at the low-St end can be attributed to: 1) the numerical disc model?s coarse resolution, which is unable to probe smaller turbulent eddies and, therefore, the dominant contribution to the par- ticle relative velocities is given by the interpolation of the gas velocity inside the grid cells; 2) the sparse particle sampling, which prevents the measurement of relative ve- locities between two particles in the same place at the same time. The distribution of turbulence-induced relative speeds can have a wide spread of values, which may lead to particle shattering, subject to the turbulent gas velocity. Codes such as the one used in this work, in general, underestimate relative velocities in turbulence for particles with $St \approx 1$ because they lack energy on short time scales (relative to a Kolmogorov spectrum). In making comparisons with theory, it is important to use the exact numerical energy spectrum instead of assuming a Kolmogorov inertial range.

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Photometric determination of the mass accretion rates of pre-main sequence stars. I. Method and application to the SN 1987A field

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We have developed and successfully tested a new self-consistent method to reliably identify pre-main sequence (PMS) objects actively undergoing mass accretion in a resolved stellar population, regardless of their age. The method does not require spectroscopy and combines broad-band V and I photometry with narrow-band $H\alpha$ imaging to: (1) identify all stars with excess Hα emission; (2) convert the excess Hα magnitude into Hα luminosity $L(H\alpha)$; (3) estimate the Hα emission equivalent width; (4) derive the accretion luminosity $L_{\rm acc}$ from $L(H\alpha)$; and finally (5) obtain the mass accretion rate $\dot{M}_{\rm acc}$ from $L_{\rm acc}$ and the stellar parameters (mass and radius). By selecting stars with an accuracy of 15 % or better in the Hα photometry, the statistical uncertainty on the derived $\dot{M}_{\rm acc}$ is typically $\lesssim$17 % and is dictated by the precision of the Hα photometry. Systematic uncertainties, of up to a factor of 3 on the value of $\dot{M}_{\rm acc}$, are caused by our incomplete understanding of the physics of the accretion process and affect all determinations of the mass accretion rate, including those based on a spectroscopic Hα line analysis.

As an application of our method, we study the accretion process in a field of 9.16 arcmin^2 around SN 1987A, using existing Hubble Space Telescope photometry. We identify as bona-fide PMS stars a total of 133 objects with a Hα excess above the $4\,\sigma$ level and a median age of 13.5 Myr. Their median mass accretion rate of $2.6 \times 10^{-8}\,{\rm M}_\odot\,{\rm yr}^{-1}$ is in excellent agreement with previous determinations based on the U-band excess of the stars in the same field, as well as with the value measured for G-type PMS stars in the Milky Way. The accretion luminosity of these PMS objects shows a strong dependence on their distance from a group of hot massive stars in the field and suggests that the ultraviolet radiation of the latter is rapidly eroding the circumstellar discs around PMS stars.

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Testing circumstellar disk lifetimes in young embedded clusters associated with the Vela Molecular Ridge

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Context. The Vela Molecular Ridge hosts a number of young embedded star clusters in the same evolutionary stage.
Aims. The main aim of the present work is testing whether the fraction of members with a circumstellar disk in a sample of clusters in the cloud D of the Vela Molecular Ridge, is consistent with relations derived for larger samples of star clusters with an age spread. Besides, we want to constrain the age of the young embedded star clusters associated with cloud D.
Methods. We carried out L (3.78 μm) photometry on images of six young embedded star clusters associated with cloud D of the Vela Molecular Ridge, taken with ISAAC at the VLT. These data are complemented with the available HK_s photometry. The 6 clusters are roughly of the same size and appear to be in the same evolutionary stage. The fraction of stars with a circumstellar disk was measured in each cluster by counting the fraction of sources displaying a NIR excess in colour-colour (HK_sL) diagrams.
Results. The L photometry allowed us to identify the NIR counterparts of the IRAS sources associated with the clusters. The fraction of stars with a circumstellar disk appears to be constant within errors for the 6 clusters. There is a hint that this is lower for the most massive stars. The age of the clusters is constrained to ∼1–2 Myr.
Conclusions. The fraction of stars with a circumstellar disk in the observed sample is consistent with the relations derived from larger samples of star clusters and with other age estimates for cloud D. The fraction may be lower for the most massive stars. Our results agree with a scenario where all intermediate and low-mass stars form with a disk, whose lifetime is shorter for higher mass stars.

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Modeling Collapse and Accretion in Turbulent Gas Clouds: Implementation and Comparison of Sink Particles in AMR and SPH

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Star formation is such a complex process that accurate numerical tools are needed to quantitatively examine the mass distribution and accretion of fragments in collapsing, turbulent, magnetized gas clouds. To enable a numerical treatment of this regime, we implemented sink particles in the adaptive mesh refinement (AMR) hydrodynamics code FLASH. Sink particles are created in regions of local gravitational collapse, and their trajectories and accretion can be followed over many dynamical times. We perform a series of tests including the time integration of circular and elliptical orbits, the collapse of a Bonnor-Ebert sphere and a rotating, fragmenting cloud core. We compare the collapse of a highly unstable singular isothermal sphere to the theory by Shu, and show that the sink particle accretion rate is in excellent agreement with the theoretical prediction. To model eccentric orbits and close encounters of sink particles accurately, we show that a very small timestep is often required, for which we implemented subcycling of the N-body system. We emphasize that a sole density threshold for sink particle creation is insufficient in supersonic flows, if the density threshold is below the opacity limit. In that case, the density can exceed the threshold in strong shocks

that do not necessarily lead to local collapse. Additional checks for bound state, gravitational potential minimum, Jeans instability and converging flows are absolutely necessary for a meaningful creation of sink particles. We apply our new sink particle module for FLASH to the formation of a stellar cluster, and compare to a smoothed particle hydrodynamics (SPH) code with sink particles. Our comparison shows encouraging agreement of gas properties, indicated by column density distributions and radial profiles, and of sink particle formation times and positions. We find excellent agreement in the number of sink particles formed, and in their accretion and mass distributions.

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Beyond the pseudo-time-dependent approach: chemical models of dense core precursors

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Chemical models of dense cloud cores often utilize the so-called pseudo-time-dependent approximation, in which the physical conditions are held fixed and uniform as the chemistry occurs. In this approximation, the initial abundances chosen, which are totally atomic in nature except for molecular hydrogen, are artificial. A more detailed approach to the chemistry of dense cloud cores should include the physical evolution during their early stages of formation. Our major goal is to investigate the initial synthesis of molecular ices and gas-phase molecules as cold molecular gas begins to form behind a shock in the diffuse interstellar medium. The abundances calculated as the conditions evolve can then be utilized as reasonable initial conditions for a theory of the chemistry of dense cores. Hydrodynamic shock-wave simulations of the early stages of cold core formation are used to determine the time-dependent physical conditions for a gas-grain chemical network. We follow the cold post-shock molecular evolution of ices and gas-phase molecules for a range of visual extinction up to $A_V \approx 3$, which increases with time. At higher extinction, self-gravity becomes important. As the newly condensed gas enters its cool post-shock phase, a large amount of CO is produced in the gas. As the CO forms, water ice is produced on grains, whille accretion of CO produces CO ice. The production of CO_2 ice from CO occurs via several surface mechanisms, while the production of CH_4 ice is slowed by gas-phase conversion of C into CO.

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Investigating planet formation in circumstellar disks: CARMA observations of RY Tau and DG Tau

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We present CARMA observations of the thermal dust emission from the circumstellar disks around the young stars RY Tau and DG Tau at wavelengths of 1.3 mm and 2.8 mm. The angular resolution of the maps is as high as 0.15 arcsec, or 20 AU at the distance of the Taurus cloud, which is a factor of 2 higher than has been achieved to date at these wavelengths. The unprecedented detail of the resulting disk images enables us to address three important questions related to the formation of planets. (1) What is the radial distribution of the circumstellar dust? (2) Does the dust emission show any indication of gaps that might signify the presence of (proto-)planets? (3) Do the dust properties depend on the orbital radius?

We find that modeling the disk surface density in terms of either a classical power law or the similarity solution for viscous disk evolution, reproduces the observations well. Both models constrain the surface density between 15 and 50 AU to within 30% for a given dust opacity. Outside this range, the densities inferred from the two models differ by almost an order of magnitude. The 1.3 mm image from RY Tau shows two peaks separated by 0.2 arcsec with a decline in the dust emission toward the stellar position, which is significant at about 2-4σ. For both RY Tau and DG Tau, the dust emission at radii larger than 15 AU displays no significant deviation from an unperturbed viscous disk model. In particular, no radial gaps in the dust distribution are detected. Under reasonable assumptions, we exclude the presence of planets more massive than 5 Jupiter masses orbiting either star at distances between about 10 and 60 AU, unless such a planet is so young that there has been insufficient time to open a gap in the disk surface density. The radial variation of the dust opacity slope, β, was investigated by comparing the 1.3 mm and 2.8 mm observations. We find mean values of β of 0.5 and 0.7 for DG Tau and RY Tau respectively. Variations in β are smaller than $\Delta\beta = 0.7$ between 20 and 70 AU. These results confirm that the circumstellar dust throughout these disks differs significantly from dust in the interstellar medium.

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Parsec-scale SiO Emission in an Infrared Dark Cloud

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We present high-sensitivity $2'\times4'$ maps of the J=2$\rightarrow$1 rotational lines of SiO, CO, ^{13}CO and C^{18}O, observed toward the filamentary Infrared Dark Cloud (IRDC) G035.39-00.33. Single-pointing spectra of the SiO J=2$\rightarrow$1 and J=3$\rightarrow$2 lines toward several regions in the filament, are also reported. The SiO images reveal that SiO is widespread along the IRDC (size $\geq$2 pc), showing two different components: one bright and compact arising from three condensations (N, E and S), and the other weak and extended along the filament. While the first component shows broad lines (linewidths of $\sim$4-7 km s^{-1}) in both SiO J=2$\rightarrow$1 and SiO J=3$\rightarrow$2, the second one is only detected in SiO J=2$\rightarrow$1 and has narrow lines ($\sim$0.8 km s^{-1}). The maps of CO and its isotopologues show that low-density filaments are intersecting the IRDC and appear to merge toward the densest portion of the cloud. This resembles the molecular structures predicted by flow-driven, shock-induced and magnetically-regulated cloud formation models. As in outflows associated with low-mass star formation, the excitation temperatures and fractional abundances of SiO toward N, E and S, increase with velocity from $\sim$6 to 40 K, and from $\sim$10^{-10} to $\geq$10^{-8} respectively, over a velocity range of $\sim$7 km s^{-1}. Since 8 μm sources, 24 μm sources and/or extended 4.5 μm emission are detected in N, E and S, broad SiO is likely produced in outflows associated with high-mass protostars. The excitation temperatures and fractional abundances of the narrow SiO lines, however, are very low ($\sim$9 K and $\sim$10^{-11}, respectively), and consistent with the processing of interstellar grains by the passage of a shock with $v_s$$\sim$12 km s^{-1}. This emission could be generated i) by a large-scale shock, perhaps remnant of the IRDC formation process; ii) by decelerated or recently processed gas in large-scale outflows driven by 8 μm and 24 μm sources; or iii) by an undetected and widespread population of lower mass protostars. High-angular resolution observations are needed to disentangle between these three scenarios.

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The formation of very wide binaries during the star cluster dissolution phase

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Over the past few decades, numerous wide (>1000 au) binaries in the Galactic field and halo have been discovered. Their existence cannot be explained by the process of star formation or by dynamical interactions in the field, and their origin has long been a mystery. We explain the origin of these wide binaries by formation during the dissolution phase of young star clusters: an initially unbound pair of stars may form a binary when their distance in phase-space is small. Using N-body simulations, we find that the resulting wide binary fraction in the semi-major axis range 1000 au−0.1 pc for individual clusters is $1 - 30\%$, depending on the initial conditions. The existence of numerous wide binaries in the field is consistent with observational evidence that most clusters start out with a large degree of substructure. The wide binary fraction decreases strongly with increasing cluster mass, and the semi-major axis of the newly formed binaries is determined by the initial cluster size. The resulting eccentricity distribution is thermal, and the mass ratio distribution is consistent with gravitationally-focused random pairing. As a large fraction of the stars form in primordial binaries, we predict that a large number of the observed 'wide binaries' are in fact triple or quadruple systems. By integrating over the initial cluster mass distribution, we predict a binary fraction of a few per cent in the semi-major axis range 1000 au - 0.1 pc in the Galactic field, which is smaller than the observed wide binary fraction. However, this discrepancy may be solved when we consider a broad range of cluster morphologies.

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The reflection-symmetric wiggle of the young protostellar jet HH 211

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HH 211 is a highly collimated jet originating from a nearby young Class 0 protostar. Here is a follow-up study of the jet with our previous observations at unprecedented resolution up to $\sim 0''.3$ in SiO ($J = 8-7$), CO ($J = 3-2$), and SO ($N_J = 8_9 - 7_8$). SiO, CO, and SO can all be a good tracer of the HH 211 jet, tracing the internal shocks in the jet. Although the emissions of these molecules show roughly the same morphology of the jet, there are detailed differences. In particular, the CO emission traces the jet closer to the source than the SiO and SO emissions. In addition, in the better resolved internal shocks, both the CO and SO emission are seen slightly ahead of the SiO emission. The jet is clearly seen on both sides of the source with more than one cycle of wiggle. The wiggle is reflection-symmetric about the source and can be reasonably fitted by an orbiting source jet model. The best-fit parameters suggest that the source itself could be a very low-mass protobinary with a total mass of $\sim 60\ M_{\rm Jup}$ and a binary separation of $\sim$ 4.6 AU. The abundances of SiO and SO in the gas phase are found to be highly enhanced in the jet as compared to the quiescent molecular clouds, even close to within 300 AU from the source where the dynamical time scale is < 10 yrs. The abundance enhancements of these molecules are closely related to the internal shocks. The detected SiO is either the consequence of the release of Si-bearing material from dust grains or of its formation via gas chemistry in the shocks. The SO, on the other hand, seems to form via gas chemistry in the shocks.

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On the low-mass diskless population of Corona Australis

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We combine published optical and near-infrared photometry to identify new low-mass candidate members in an area of about 0.64 deg^2 in Corona Australis, using the S-parameter method developed by Comerón et al. (2009). Five new candidate members of the region are selected, with estimated ages between 3 and 15 Myr, and masses between 0.05 and 0.15 $M_\odot$. Using *Spitzer* photometry, we confirm that these objects are not surrounded by optically thick disks. However, one of them is found to display excess at 24 μm, thus suggesting it harbours a disk with an inner hole. With an estimated mass of $0.07 M_\odot$ according to the SED fitting, this is one of the lowest-mass objects reported to possess a transitional disk.

Including these new members, the fraction of disks is about 50% among the total Corona Australis population selected by the same criteria, lower than the 70% fraction reported by Sicilia-Aguilar et al. (2008) for this region. Even so, we find a ratio of transitional to primordial disks (45%) very similar to the value derived by these authors. This ratio is higher than for solar-type stars (5-10%), suggesting that disk evolution is faster in the latter, and/or that the "transitional disk" stage is not such a short-lived step in the case of very low-mass objects. However, this impression needs to be confirmed with better statistics.

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Stellar Motion Induced by Gravitational Instabilities in Protoplanetary Disks

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We test the effect of assumptions about stellar motion on the behavior of gravitational instabilities in protoplanetary disks around solar-type stars by performing two simulations that are identical in all respects except the treatment of the star. In one simulation, the star is assumed to remain fixed at the center of the inertial reference frame. In the other, stellar motion is handled properly by including an indirect potential in the hydrodynamic equations to model the star's reference frame as one which is accelerated by star/disk interactions. The disks in both simulations orbit a solar mass star, initially extend from 2.3 to 40 AU with a $\varpi^{-1/2}$ surface density profile, and have a total mass of 0.14 $M_\odot$. The $\gamma = 5/3$ ideal gas is assumed to cool everywhere with a constant cooling time of two outer rotation periods.

The overall behavior of the disk evolution is similar, except for weakening in various measures of GI activity by about at most tens of percent for the indirect potential case. Overall conclusions about disk evolution in earlier papers by our group, where the star was always assumed to be fixed in an inertial frame, remain valid. There is no evidence for independent one-armed instabilities, like SLING, in either simulation. On the other hand, the stellar motion about the system center of mass (COM) in the simulation with the indirect potential is substantial, up to 0.25 AU during the burst phase, as GIs initiate, and averaging about 0.9 AU during the asymptotic phase, when the GIs reach an overall balance of heating and cooling. These motions appear to be a stellar response to nonlinear interactions between discrete global spiral modes in both the burst and asymptotic phases of the evolution, and the star's orbital motion about the COM reflects the orbit periods of disk material near the corotation radii of the dominant spiral waves. This motion is, in principle, large enough to be observable and could be confused with stellar wobble due to the presence of one or more super-Jupiter mass protoplanets orbiting at 10's AU. We discuss why the excursions in our simulation are so much larger than those seen in simulations by Rice et al. 2003a.

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LABOCA mapping of the infrared dark cloud MSXDC G304.74+01.32

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Context. Infrared dark clouds (IRDCs) likely represent very early stages of high-mass star/star cluster formation.

Aims. The aim is to determine the physical properties and spatial distribution of dense clumps in the IRDC MSXDC G304.74+01.32 (G304.74), and bring these characteristics into relation to theories concerning the origin of IRDCs and their fragmentation into clumps and star-forming cores.

Methods. G304.74 was mapped in the 870 μm dust continuum with the LABOCA bolometer on APEX. The 870 μm map was compared with the 1.2 mm continuum map of the cloud by Béltran et al. (2006). Archival MSX and IRAS infrared data were used to study the nature and properties of the submillimetre clumps within the cloud. The H_2 column densities were estimated using both the 870 μm dust emission and the MSX 8 μm extinction data. The obtained values were compared with near-infrared extinction which could be estimated along a few lines of sight. We compared the clump masses and their spatial distribution in G304.74 with those in several other recently studied IRDCs.

Results. Twelve clumps were identified from the 870 μm dust continuum map. Three of them are associated with the MSX and IRAS point sources. Moreover, one of the clumps (SMM 6) is associated with two MSX 8 μm point-like sources. Thus, there are 8 clumps within G304.74 which are not associated with mid-infrared (MIR) emission. The H_2 column densities derived from the dust continuum and extinction data are similar. The comparison suggests that the dust temperature may be elevated (20-30 K) near the southern end of the cloud, whereas the starless clumps in the centre and in the north are cool ($T_{\rm d} \sim 15$ K). There is a high likelihood that the clump mass distributions in G304.74 and in several other IRDCs represent the samples of the same parent distribution. In most cases the spatial distributions of clumps in IRDCs do not deviate significantly from random distributions.

Conclusions. G304.74 contains several massive clumps that are not associated with MIR emission. On statistical grounds it is likely that some of them are or harbour high-mass starless cores (HMSCs). The fact that the clump mass distributions (resembling the high-mass stellar IMF), and in some cases also the random-like spatial distributions, seem to be comparable between different IRDCs, is consistent with the idea that the origin of IRDCs, and their further sub-fragmentation down to scales of clumps is caused by supersonic turbulence in accordance with results from giant molecular clouds.

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The large scale disk fraction of brown dwarfs in the Taurus cloud as measured with Spitzer

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The brown dwarf (BD) formation process is not yet completely understood. In order to shed more light on the differences and resemblances between star and BD formation process, we study and compare the disk fraction among both kind of objects over a large angular surface in the Taurus cloud and we study their spatial distribution relative to the underlying molecular gas, rather than to the surrounding stellar population. More than 40 young BDs are known in the Taurus cloud, spread across a wide surface area of more than 200 square degrees. Such a large population has been the subject of many investigations. Guieu et al. (2007) have published a study of the circumstellar environment of 23 brown dwarfs in the Taurus cloud and found that ≈ 48% have disks, a result consistent with previous work by Luhman et al. (2006). Guieu et al. (2007) also found that the objects with and without disks may possibly be distributed differently across the Taurus cloud. In this paper, we present new and updated photometry data from the Infrared Array Camera (IRAC) aboard the *Spitzer Space Telescope* on 43 brown dwarfs in the Taurus cloud, and provide a recalculation of the brown dwarf disk fraction in this region. We also use recently available CO mm data from Goldsmith et al. (2008) to study the spatial distribution of stars and brown dwarfs relative to the cloud molecular gas. We find that the disk fraction among BD in the Taurus cloud is $41 \pm 12\%$, a value statistically consistent with the one among TTS ($58 \pm 9\%$). We find that BDs in transition from a state where they have a disk to a diskless state are rare, and we study one isolated example of a transitional disk with an inner radius of $\approx 0.1\,AU$ (CFHT BD Tau 12, found via its relatively small mid-IR excess compared to most members of Taurus that have disks. We find that BD are statistically found in regions of similar molecular surface density as stars. Furthermore, comparing the distribution of objects with and without disks (stars & BD) with respect to the underlying gas density distribution, we find that the gas column density distribution is almost identical for stars and BDs on one hand, and for objects with and without disks on the other hand.

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http://www-laog.obs.ujf-grenoble.fr̃monin/publis/disk-nb-spitzer.pdf

Spitzer Spectroscopy of the Transition Object TW Hya

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We report sensitive Spitzer IRS spectroscopy in the 10-20 micron region of TW Hya, a nearby T Tauri star. The unusual spectral energy distribution of the source, that of a transition object, indicates that the circumstellar disk in the system has experienced significant evolution, possibly as a result of planet formation. The spectrum we measure is strikingly different from that of other classical T Tauri stars reported in the literature, displaying no strong emission features of water, acetylene, or HCN. The difference indicates that the inner planet formation region (within 5 AU) of the gaseous disk has evolved physically and/or chemically away from the classical T Tauri norm. Nevertheless, TW Hya does show a rich spectrum of emission features of atoms (HI, [NeII], and [NeIII]) and molecules (H2, OH, CO2, HCO+, and possibly CH3), some of which are also detected in classical T Tauri spectra. The properties of the neon emission are consistent with an origin for the emission in a disk irradiated by X-rays (with a possible role for additional irradiation by stellar EUV). The OH emission we detect, which also likely originates in the disk, is hot, arising from energy levels up to 23,000 K above ground, and may be produced by the UV photodissociation of water. The HI emission is surprisingly strong, with relative strengths that are consistent with case B recombination. While the absence of strong molecular emission in the 10-20 micron region may indicate that the inner region of the gaseous disk has been partly cleared by an orbiting giant planet, chemical and/or excitation effects may be responsible instead. We discuss these issues and how our results bear on our understanding of the evolutionary state of the TW Hya disk.

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The early stages of star formation in Infrared Dark Clouds: characterizing the core dust properties

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Identified as extinction features against the bright Galactic mid-infrared background, infrared dark clouds (IRDCs) are thought to harbor the very earliest stages of star and cluster formation. In order to better characterize the properties of their embedded cores, we have obtained new 24 μm, 60–100 μm, and sub-millimeter continuum data toward a sample of 38 IRDCs. The 24 μm *Spitzer* images reveal that while the IRDCs remain dark, many of the cores are associated with bright 24 μm emission sources, which suggests that they contain one or more embedded protostars. Combining the 24 μm, 60–100 μm, and sub-millimeter continuum data, we have constructed broadband spectral energy distributions (SEDs) for 157 of the cores within these IRDCs and, using simple gray-body fits to the SEDs, have estimated their dust temperatures, emissivities, opacities, bolometric luminosities, masses and densities. Based on their *Spitzer*/IRAC 3–8 μm colors and the presence of 24 μm point source emission, we have separated cores that harbor active, high-mass star formation from cores that are quiescent. The active 'protostellar' cores typically have warmer dust temperatures and higher bolometric luminosities than the more quiescent, perhaps 'pre-protostellar', cores. Because the mass distributions of the populations are similar, however, we speculate that the active and quiescent cores may represent different evolutionary stages of the same underlying population of cores. Although we cannot rule out low-mass star-formation in the quiescent cores, the most massive of them are excellent candidates for the 'high-mass starless core' phase, the very earliest in the formation of a high-mass star.

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HNCO enhancement by shocks in the L1157 molecular outflow

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The isocyanic acid (HNCO) presents an extended distribution in the centers of the Milky Way and the spiral galaxy IC342. Based on the morphology of the emission and the HNCO abundance with respect to H_2, several authors made the hypothesis that HNCO could be a good tracer of interstellar shocks. Here we test this hypothesis by observing a well-known Galactic source where the chemistry is dominated by shocks. We have observed several transitions of HNCO towards L1157-mm and two positions (B1 and B2) in the blue lobe of the molecular outflow. The HNCO line profiles exhibit the same characteristics of other well-known shock tracers like CH_3OH, H_2CO, SO or SO_2. HNCO, together with SO_2 and OCS, are the only three molecules detected so far whose emission is much more intense in B2 than in B1, making these species valuable probes of chemical differences along the outflow. The HNCO abundance with respect to H_2 is 0.4-1.8 10^{-8} in B1 and 0.3-1 10^{-7} in B2. These abundances are the highest ever measured, and imply an increment with respect to L1157-mm of a factor up to 83, demonstrating that this molecule is actually a good shock tracer. Our results probe that shocks can actually produce the HNCO abundance measured in galactic nuclei and even higher ones. We propose that the gas phase abundance of HNCO is due both to grain mantles erosion by the shock waves and by neutral-neutral reactions in gas phase involving CN and O_2. The observed anticorrelation of CN and HNCO fluxes supports this scenario. The observed similarities of the HNCO emission and the sulfured molecules may arise due to formation pathways involving also O_2.

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A multiwavelength study of star formation in the vicinity of Galactic HII region Sh 2-100

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We present multiwavelength investigation of morphology, physical-environment, stellar contents and star formation activity in the vicinity of star-forming region Sh 2-100. It is found that the Sh 2-100 region contains seven HII regions of ultracompact and compact nature. The present estimation of distance for three HII regions, along with the kinematic distance for others, suggests that all of them belong to the same molecular cloud complex. Using near-infrared photometry, we identified the most probable ionizing sources of six HII regions. Their approximate photometric spectral type estimates suggest that they are massive early-B to mid-O zero-age-main-sequence stars and agree well with radio continuum observations at 1280 MHz, for sources whose emissions are optically thin at this frequency. The morphology of the complex shows a non-uniform distribution of warm and hot dust, well mixed with the ionized gas, which correlates well with the variation of average visual extinction ($\sim$ 4.2 - 97 mag) across the region. We estimated the physical parameters of ionized gas with the help of radio continuum observations. We detected an optically visible compact nebula located to the south of the 850 μm emission associated with one of the HII regions and the diagnostic of the optical emission line ratios gives electron density and electron temperature of $\sim 0.67 \times 10^3$ cm^{-3} and $\sim 10^4$ K, respectively. The physical parameters suggest that all the HII regions are in different stages of evolution, which correlate well with the probable ages in the range $\sim$ 0.01 - 2 Myr of the ionizing sources. The spatial distribution of infrared excess stars, selected from near-infrared and IRAC color-color diagrams, correlates well with the association of gas and dust. The positions of infrared excess stars, ultracompact and compact HII regions at the periphery of an HI shell, possibly created by a WR star, indicate that star formation in Sh 2-100 region might have been induced by an expanding HI shell.

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A MAD view of Trumpler 14

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We present adaptive optics (AO) near-infrared observations of the core of the Tr 14 cluster in the Carina region obtained with the ESO multi-conjugate AO demonstrator, MAD. Our campaign yields AO-corrected observations with an image quality of about 0.2 arcsec across the 2 arcmin field of view, which is the widest AO mosaic ever obtained. We detected almost 2000 sources spanning a dynamic range of 10 mag. The pre-main sequence (PMS) locus in the colour-magnitude diagram is well reproduced by Palla & Stahler isochrones with an age of 3 to 5×10^5 yr, confirming the very young age of the cluster. We derive a very high (deprojected) central density $n_0 \sim 4.5(\pm 0.5) \times 10^4$ pc^{-3} and estimate the total mass of the cluster to be about $\sim 4.3^{+3.3}_{-1.5} \times 10^3$ M$_\odot$, although contamination of the field of view might have a significant impact on the derived mass. We show that the pairing process is largely dominated by chance alignment so that physical pairs are difficult to disentangle from spurious ones based on our single epoch observation.

Yet, we identify 150 likely bound pairs, 30% of these with a separation smaller than 0.5 arcsec (∼1300AU). We further show that at the 2σ level massive stars have more companions than lower-mass stars and that those companions are respectively brighter on average, thus more massive. Finally, we find some hints of mass segregation for stars heavier than about 10 $M_\odot$. If confirmed, the observed degree of mass segregation could be explained by dynamical evolution, despite the young age of the cluster.

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Lifetime of the embedded phase of low-mass star formation and the envelope depletion rates

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Motivated by a considerable scatter in the observationally inferred lifetimes of the embedded phase of star formation, we study the duration of the Class 0 and Class I phases in upper-mass brown dwarfs and low-mass stars using numerical hydrodynamics simulations of the gravitational collapse of a large sample of cloud cores. We resolve the formation of a star/disk/envelope system and extend our numerical simulations to the late accretion phase when the envelope is nearly totally depleted of matter. We adopted a classification scheme of André et al. and calculate the lifetimes of the Class 0 and Class I phases ($\tau_{\rm C0}$ and $\tau_{\rm CI}$, respectively) based on the mass remaining in the envelope. When cloud cores with various rotation rates, masses, and sizes (but identical otherwise) are considered, our modeling reveals a sub-linear correlation between the Class 0 lifetimes and stellar masses in the Class 0 phase with the least-squares fit exponent $m = 0.8 \pm 0.05$. The corresponding correlation between the Class I lifetimes and stellar masses in the Class I is super-linear with $m = 1.2 \pm 0.05$. If a wider sample of cloud cores is considered, which includes possible variations in the initial gas temperature, cloud core truncation radii, density enhancement amplitudes, initial gas density and angular velocity profiles, and magnetic fields, then the corresponding exponents may decrease by as much as 0.3. The duration of the Class I phase is found to be longer than that of the Class 0 phase in most models, with a mean ratio $\tau_{\rm CI}/\tau_{\rm C0} \approx 1.5$–2. A notable exception are YSOs that form from cloud cores with large initial density enhancements, in which case $\tau_{\rm C0}$ may be greater than $\tau_{\rm CI}$. Moreover, the upper-mass ($\geq 1.0\ M_\odot$) cloud cores with frozen-in magnetic fields and high cloud core rotation rates may have the $\tau_{\rm CI}/\tau_{\rm C0}$ ratios as large as 3.0–4.0. We calculate the rate of mass accretion from the envelope onto the star/disk system and provide an approximation formula that can be used in semi-analytic models of cloud core collapse.

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Formation and survivability of giant planets on wide orbits

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Motivated by the recent discovery of massive planets on wide orbits, we present a mechanism for the formation of such planets via disk fragmentation in the embedded phase of star formation. In this phase, the forming disk intensively accretes matter from the natal cloud core and undergoes several fragmentation episodes. However, most fragments are either destroyed or driven into the innermost regions (and probably onto the star) due to angular momentum exchange with spiral arms, leading to multiple FU-Ori-like bursts and disk expansion. Fragments that are sufficiently massive and form in the late embedded phase (when the disk conditions are less extreme) may open a gap and evolve into giant planets on typical orbits of several tens to several hundreds of AU. For this mechanism to work, the natal cloud core must have sufficient mass and angular momentum to trigger the burst mode and also form extended disks of the order of several hundreds of AU. When mass loading from the natal cloud core diminishes and the main fragmentation

phase ends, such extended disks undergo a transient episode of contraction and density increase, during which they may give birth to a last and survivable set of giant planets on wide and relatively stable orbits.

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New 9.9-GHz methanol masers

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The Australia Telescope Compact Array (ATCA) has been used to make the first extensive search for the class I methanol masers at 9.9 GHz. In total, 48 regions of high-mass star formation were observed. In addition to masers in W33-Met (G12.80−0.19) and G343.12−0.06 (IRAS 16547−4247) which have already been reported in the literature, two new 9.9-GHz masers have been found towards G331.13−0.24 and G19.61−0.23. We have determined absolute positions (accurate to roughly a second of arc) for all the detected masers and suggest that some class I masers may be associated with shocks driven into molecular clouds by expanding Hii regions. Our observations also imply that the evolutionary stage of a high-mass star forming region when the class I masers are present can outlast the stage when the class II masers at 6.7-GHz are detectable, and overlaps significantly with the stage when OH masers are active.

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X-Ray and Infrared Emission from Young Stellar Objects near LkHα 101

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We report on a multiwavelength study of a partially embedded region of star formation centered on the Herbig Be star LkHα 101. Using two 40 ks *Chandra* observations, we detect 213 X-ray sources in the ≈17 arcmin × 17 arcmin ACIS-I field. We combine the X-ray data with 2MASS near–IR observations and *Spitzer* IRAC and MIPS 24μm observations to obtain a complete picture of the cluster. A total of 158 of the X-ray sources have infrared counterparts. Of these, we find 9 protostars, 48 Class II objects, 5 transition objects and 72 Class III objects. From the *Spitzer* data we identify an additional 10 protostars, 53 Class II objects and 4 transition disk candidates which are not detected by *Chandra*. We obtained optical spectra of a sample of both X-ray detected and non-Xray detected objects. Combining the X-ray, *Spitzer* and spectral data, we obtain independent estimates of cluster distance and the total cluster size – excluding protostars. We obtain consistent distance estimates of 510^{+100}_{-40} pc and a total cluster size of 255^{+50}_{-25} stars. We find the Class II:III ratio is about 5:7 with some evidence that the Class III sources are spatially more dispersed. The cluster appears very young with three sites of active star formation and a median age of about 1 Myr

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The Massive Star Forming Region Cygnus OB2. II. Integrated Stellar Properties and the Star Formation History

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Cygnus OB2 is the nearest example of a massive star forming region, containing over 50 O-type stars and hundreds of B-type stars. We have analysed the properties of young stars in two fields in Cyg OB2 using the recently published deep catalogue of *Chandra* X-ray point sources with complementary optical and near-IR photometry. Our sample is complete to $\sim$1 $M_\odot$ (excluding A and B-type stars that do not emit X-rays), making this the deepest study of the stellar properties and star formation history in Cyg OB2 to date. From Siess et al. (2000) isochrone fits to the near-IR color-magnitude diagram, we derive ages of $3.5^{+0.75}_{-1.0}$ and $5.25^{+1.5}_{-1.0}$ Myrs for sources in the two fields, both with considerable spreads around the pre-MS isochrones. The presence of a stellar population somewhat older than the present-day O-type stars, also fits in with the low fraction of sources with inner circumstellar disks (as traced by the K-band excess) that we find to be very low, but appropriate for a population of age $\sim$5 Myrs. We also find that the region lacks a population of highly embedded sources that is often observed in young star forming regions, suggesting star formation in the vicinity has declined. We measure the stellar mass functions in this limit and find a power-law slope of $\Gamma = -1.09 \pm 0.13$, in good agreement with the global mean value estimated by Kroupa 2002. A steepening of the slope at higher masses is observed and suggested as due to the presence of the previous generation of stars that have lost their most massive members. Finally, combining our mass function and an estimate of the radial density profile of the association suggests a total mass of Cyg OB2 of $\sim 3 \times 10^4$ $M_\odot$, similar to that of many of our Galaxy's most massive star forming regions.

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Spitzer and near-infrared observations of a new bi-polar protostellar outflow in the Rosette Molecular Cloud

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We present and discuss *Spitzer* and near-infrared H_2 observations of a new bi-polar protostellar outflow in the Rosette Molecular Cloud. The outflow is seen in all four IRAC bands and partially as diffuse emission in the MIPS 24 μm band. An embedded MIPS 24 μm source bisects the outflow and appears to be the driving source. This source is coincident with a dark patch seen in absorption in the 8 μm IRAC image. *Spitzer* IRAC color analysis of the shocked emission was performed from which thermal and column density maps of the outflow were constructed. Narrow-band near-infrared (NIR) images of the flow reveal H_2 emission features coincident with the high temperature regions of the outflow. This outflow has now been given the designation MHO 1321 due to the detection of NIR H_2 features. We use these data and maps to probe the physical conditions and structure of the flow.

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Long-term Evolution of Protostellar and Protoplanetary Disks. I. Outbursts

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As an initial investigation into the long-term evolution of protostellar disks, we explore the conditions required to explain the large outbursts of disk accretion seen in some young stellar objects. We use one-dimensional time-dependent disk models with a phenomenological treatment of the magnetorotational instability (MRI) and gravitational torques to follow disk evolution over long timescales. Comparison with our previous two-dimensional disk model calculations (Zhu et al. 2009b, Z2009b) indicates that the neglect of radial effects and two-dimensional disk structure in the one-dimensional case makes only modest differences in the results; this allows us to use the simpler models to explore parameter space efficiently. We find that the mass infall rates typically estimated for low-mass protostars generally result in AU-scale disk accretion outbursts, as predicted by our previous analysis (Zhu et al. 2009a,Z2009a). We also confirm quasi-steady accretion behavior for high mass infall rates if the values of α-parameter for the magnetorotational instability is small, while at this high accretion rate convection from the thermal instability may lead to some variations. We further constrain the combinations of the α-parameter and the MRI critical temperature, which can reproduce observed outburst behavior. Our results suggest that dust sublimation may be connected with full activation of the MRI. This is consistent with the idea that small dust captures ions and electrons to suppress the MRI. In a later paper we will explore both long-term outburst and disk evolution with this model, allowing for infall from protostellar envelopes with differing angular momenta.

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http://arxiv.org/abs/1003.1759

Long-term Evolution of Protostellar and Protoplanetary Disks. II. Layered Accretion with Infall

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We use one-dimensional two-zone time-dependent accretion disk models to study the long-term evolution of protostellar disks subject to mass addition from the collapse of a rotating cloud core. Our model consists of a constant surface density magnetically coupled active layer, with transport and dissipation in inactive regions only via gravitational instability. We start our simulations after a central protostar has formed, containing $\sim$ 10% of the mass of the protostellar cloud. Subsequent evolution depends on the angular momentum of the accreting envelope. We find that disk accretion matches the infall rate early in the disk evolution because much of the inner disk is hot enough to couple to the magnetic field. Later infall reaches the disk beyond $\sim$10 AU, and the disk undergoes outbursts of accretion in FU Ori-like events as described in Zhu et al. 2009c. If the initial cloud core is moderately rotating most of the central star's mass is built up by these outburst events. Our results suggest that the protostellar "luminosity problem" is eased by accretion during these FU Ori-like outbursts. After infall stops the disk enters the T Tauri phase. An outer, viscously evolving disk has structure that is in reasonable agreement with recent submillimeter studies and its surface density evolves from $\Sigma \propto R^{-1}$ to $R^{-1.5}$. An inner, massive belt of material– the "dead zone" – would not have been observed yet but should be seen in future high angular resolution observations by EVLA and ALMA. This high surface density belt is a generic consequence of low angular momentum transport efficiency at radii where the disk is magnetically decoupled, and would strongly affect planet formation and migration.

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http://arxiv.org/abs/1003.1756

The Birth Environment of the Solar System

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This paper reviews our current understanding of the possible birth environments of our Solar System. Since most stars form within groups and clusters, the question becomes one of determining the nature of the birth aggregate of the Sun. This discussion starts by reviewing Solar System properties that provide constraints on our environmental history. We then outline the range of star-forming environments that are available in the Galaxy, and discuss how they affect star and planet formation. The nature of the solar birth cluster is constrained by many physical considerations, including radiation fields provided by the background environment, dynamical scattering interactions, and by the necessity of producing the short-lived radioactive nuclear species inferred from meteoritic measurements. Working scenarios for the solar birth aggregate can be constructed, as discussed herein, although significant uncertainties remain.

Accepted by Annual Reviews of Astronomy and Astrophysics

http://arxiv.org/abs/1001.5444

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.

Postdoctoral Position in Exoplanet Research

The School of Physics wishes to recruit a Postdoctoral Researcher to work with Dr Jennifer Patience. This STFC funded post is available from April 2010, or as soon as the position is filled. The successful applicant will conduct observations and analysis to search for and characterize substellar companions to nearby young stars, using high contrast techniques. The work must be completed within three years, by which time the project data acquisition and analysis will be finalized. The successful applicant will be able to present information on research progress and outcomes, communicate complex information, orally, in writing and electronically and prepare proposals and applications to external bodies.

Applicants will possess a relevant PhD and be able to demonstrate sufficient knowledge in the discipline and of research methods and techniques to work within established research programmes. Applicants will be experienced in the data reduction and analysis of high contrast adaptive optics imaging and, ideally, also have experience in spectroscopy of low-mass objects and sub-millimetre astronomical observations. Salary will be circa 24,273 pa on the Associate Research Fellow scale, depending on knowledge, skills and experience.

For further information please contact Dr Jennifer Patience e-mail patience *at* astro.ex.ac.uk or telephone 44 1392 264125. To apply, applicants should submit an application form, CV and publications list with the contact details of three referees, quoting the job reference #N2656. The closing date for full consideration of applications is April 30, 2010.

PhD positions in the field of extra-solar planets

The Centro de Astrofisica da Universidade do Porto (CAUP) opens a call for 3 PhD student positions. The positions are offered in the context of the Starting Grant "EXtra-solar planets and stellar astrophysics: towards the detection of Other Earths" funded by the European Community/European Research Council under the FP7 Ideas programme.

The positions, with a maximum duration of 4 years, are open in the field of extra-solar planets, and are to be started from the 1st of October 2010.

The PhD fellowship (according to the rules of the National Science Foundation FCT) have an yearly income of nearly 12 000 euros, tax free. Funds for traveling (conferences, collaborations, observing missions) are also available.

The above mentioned research is to be seen in the context of the participation in the project of the ESPRESSO@VLT instrument (http://espresso.astro.up.pt), a new high resolution ultra stable spectrograph for the VLT/ESO.

Details on the application can be found in:

http://www.astro.up.pt/caup/index.php?WID=141&Lang=uk&CID=1&ID=56

The deadline for application is the 31th of May 2010.

Research Associate in Brown Dwarfs and Star Formation

Applications are invited for a 2.5 year Research Associate position within the Astrophysics Group, to start on 1st September 2010 or as soon as possible thereafter. The successful applicant will work with Dr. Subhanjoy Mohanty on low-mass stars and brown dwarfs: in particular, on their formation mechanisms and accretion disk properties; their evolution; and their interior and atmospheric characteristics. The work will encompass both observational and theoretical perspectives. The precise subset of topics, and focus on observational or theoretical aspects, may be tailored to the inclinations and expertise of the successful applicant. The postholder will be expected to contribute to the Department s teaching activities up to approximately half a day per week during the academic year, as appropriate. A PhD or an equivalent level of professional qualifications and experience in astrophysics is essential. A strong background in either low-mass stars and brown dwarfs or in stellar accretion disk physics is also essential. Applicants may have either theoretical or observational backgrounds; both are equally welcome. A good understanding of radiative transfer and/or magneto-hydrodynamics is desirable. Experience with coding (e.g., either astronomical data processing or astrophysical simulations) is also desirable. Informal inquiries may be directed to Dr. Subhanjoy Mohanty at: s.mohanty *at* imperial.ac.uk. Our preferred method of application is online via our website: http://www.imperial.ac.uk/employment (Please select "Job Search", then enter the job title or vacancy reference number NS2010062NT into "Keywords"). Please complete and upload an application form as directed, also providing a CV and a list of publications, and the names of three referees. Should you have any queries about the application process please contact the Astrophysics Group Administration office via astro@imperial.ac.uk

Salary 30,520 to 33,080 British pounds per annum
Fixed term: 2.5 years commencing 1 September 2010

Jets from Young Stars IV
From Models to Observations and Experiments
Edited by Paulo J.V. Garcia and João M. Ferreira

This book is the fourth in a series devoted to the study of Herbig-Haro jets and is printed as a Springer Lecture Notes in Physics volume. It focuses on the need for building connections between laboratory experiments, numerical models, radiation processes, and observations with high spatial and spectral resolution in order to understand the jet launching and collimation region.

The book contains the following chapters:

Laboratory Astrophysics and Scaling *Rob Coker*

1. Introduction
2. The Concept of Scaling
3. Experimental Facilities
4. Detailed Example and a Challenge
5. Summary

Laboratory Studies of Astrophysical Jets *Andrea Ciardi*

1. Introduction
2. Plasma Conditions in z-Pinch and Laser Experiments
3. Relating Laboratory and Astrophysical Phenomena
4. Young Stellar Jets from z-Pinch Machines
5. Summary

Output from MHD Models *Nektarios Vlahakis*

1. Steady, Axisymmetric, Nonrelativistic, Magnetized Outflows
2. Relativistic MHD
3. Conclusion

Coronal Heating *Alan William Hood*

1. The Sun
2. The Energy Budget
3. Observed Coronal Phenomena
4. Alternative Heating Observations
5. MHD Equations
6. Wave Heating Mechanisms
7. Magnetic Reconnection Theory: Two Dimensions
8. Magnetic Reconnection Theory: Three Dimensions
9. Applications to the Solar Corona
10. Plasma Response to Nanoflare Heating
11. Summary

Flows in Molecular Media *David Flower*

1. Introduction
2. The MHD Conservation Equations
3. The Structure of Interstellar Shock Waves
4. Shock Waves in Dark Clouds

5. Shock Waves in the Presence of an Ultraviolet radiation Field
6. Diagnostics of Shock Waves: The H_2 Excitation Diagram

The Ionisation and Excitation State of Stellar Outflows *A.C. Raga*

1. Introduction
2. The Gas Dynamic Equations
3. The Ionisation State of the Gas
4. The Cooling Function
5. Recipes for Calculating the Cooling Function
6. Calculation of the Emitted Spectrum
7. Summary

Deriving Physical Diagnostics from Observations C. Dougados, F. Bacciotti, S. Cabrit, and B. Nisini

1. Introduction
2. Model-Independent Diagnostics of Plasma Excitation Conditions
3. Deriving Excitation Conditions from Shock Diagnostics
4. Derivation of Mass-Loss Rates
5. Projection and Convolution Effects

Springer Verlag, ISBN 978-3-642-02288-3, hardback, 252 pages, 2010, US$79.95

Available from: http://www.springer.com/astronomy/book/978-3-642-02288-3

The Frontier on Interstellar Medium
40th Anniversary on the Discovery of CO in ISM

June 6 - June 10, 2010 at Kavli Institute for Astronomy and Astrophysics, Peking University

Scientific Rationale:

The discovery of interstellar carbon monoxide CO in 1970 by Wilson, Jefferts and Penzias led to the detection of many other interstellar diatomic molecules. Millimeter and sub-millimeter Astronomy then came into existence, which covers the areas including star formation, planet formation, and physics of highly evolved stars as well as interstellar medium in galaxies. During the past four decades, many unexpected astrophysical objects or phenomena were discovered in these areas. A new layer of astrophysics was revealed.
Currently there are still many challenges in these frontiers. In order to review our knowledge of ISM and to discuss which directions might be the best for our future efforts, we will hold this workshop. The topics include:
1. Molecular cloud and star formation.
- cloud structure and fragmentation; initial conditions;
- dynamical mechanisms that induce infall and outflow; circumstellar disks, and the growth of high-mass stars;
- chemistry from early core to UC HII region.
2. Formation and activities of the proto-planetary systems: composition of the disk system, the dynamics and chemical evolution.
3. The AGB stars: circumstellar envelopes, dust and gas properties, outflows.
4. The interactions between the stellar systems and their surrounding medium.

Registration time: from February 8 to March 31. Late registration time: from April 1 to April 30.

For further details see the workshop website at

http://kiaa.pku.edu.cn/Activities/ism2010/main.html

FRONTIERS IN COMPUTATIONAL ASTROPHYSICS
Particle and Flames in Radiative and Magnetic Flows

Organizers: Rolf Walder (ENS-Lyon), Isabelle Baraffe(ENS-Lyon/Univ. Exeter), Gilles Chabrier (ENS-Lyon)

Dates: October 11-15 2010

Venue: Ecole Normale Superieure de Lyon, Lyon, France

Conference website: http://fca2010.univ-lyon1.fr

Computational astrophysics has rapidly evolved in recent years. Multi-scale, multi-physics simulations of entire stars, planets, galaxies come within reach today. While promising new and decisive insights, this progress also challenges the computational astrophysics community. The workshop wants to support this development by bringing together researchers from different fields within and outside astrophysics. The goal of the workshop is to discuss computational approaches and strategies to efficiently tackle the above challenges in the age of massive parallelism.

Topics covered

- Astrophysics: interstellar medium turbulence and star formation, multi-dimensional stellar structure models, atmospheres of stars and planets, accretion flows.
- Physical processes: turbulence, combustion and explosive physics, particle acceleration and propagation, interplay between hydrodynamical and kinetic models in high energy objects, dynamos and magnetism, radiative transfer.
- Computational methods: multi-scale algorithms, efficient solvers of large linear systems, stiff equations, adaptive meshes, interface tracking, subgrid-scale modeling, massive parallelism and GPUs, visualization and data-analysis.