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Abstracts of recently accepted papers

The extreme T Tauri star RW Aur: accretion and outflow variability

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We present an analysis of the classical T Tauri star RW Aur A, based on 77 echelle spectra obtained at Lick Observatory over a decade of observations. RW Aur, which has a higher than average mass accretion rate among T Tauri stars, exhibits permitted (Hα, Hβ, Ca II, He I, NaD) and forbidden ([OI]6300Å) emission lines with strong variability. The permitted lines display multiple periodicities over the years, often with variable accretion (redshifted) and outflow (blueshifted) absorption components, implying that both processes are active and changing in this system. The broad components of the different emission lines exhibit correlated behavior, indicating a common origin for all of them. We compute simple magnetospheric accretion and disk-wind Hα, Hβ and NaD line profiles for RW Aur. The observed Balmer emission lines do not have magnetospheric accretion line profiles. Our modeling indicates that the wind contribution to these line profiles is very important and must be taken into account. Our results indicate that the Hα, Hβ and NaD observed line profiles of RW Aur are better reproduced by collimated disk-winds starting from a small region near the disk inner radius. Calculations were performed in a region extending out to 100 $R_\star$. Within this volume, extended winds originating over many stellar radii along the disk are not able to reproduce the three lines simultaneously. Strongly open-angled winds also generate profiles that do not look like the observed ones. We also see evidence that the outflow process is highly dynamic – the low- and high-velocity components of the [OI](6300Å) line vary independently on timescales of days. The apparent disappearance from December 1999 to December 2000 of the [OI](6300Å) low velocity component, which is thought to come from the disk-wind, shows that the the slow wind can exhibit dramatic variability on timescales of months (placing limits on how extended it can be). There is no comprehensive explanation yet for the behavior of RW Aur, which may in part be due to complications that would be introduced if it is actually a close binary.

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http://www.fisica.ufmg.br/∼silvia/papers.html

What are the temperatures of T Tauri stars?-Constraints from coeval formation of young eclipsing binaries

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We show how the assumption of coeval formation can be used to constrain the effective temperatures of the components of young eclipsing double-lined spectroscopic binaries. Our method extends the approach of White et al. (1999) to a two-step analysis. The first step compares evolutionary models to the observed masses and radii and selects those

models that predict ages that are consistent with coeval formation. The second step then uses these models to constrain the effective temperatures. We applied the method to literature values of the stellar parameters of the eclipsing binaries RX J0529.4+0041 A and V1174 Ori and confirm that V1174 Ori A has dwarf-like temperatures at an age of 9 Myrs, while we cannot draw any conclusions for RX J0529.4+0041 A and V1174 Ori B. Considering these binaries, we find that none of the evolutionary models gives coeval solutions simultaneously in mass, radius and effective temperature.

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Submm line imaging of Orion-KL with the Submillimeter Array

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We present the first submm (865 μm) imaging spectral line survey at one arcsecond resolution conducted with the Submillimeter Array toward Orion-KL. Within the two $\times$ two GHz bandpasses (lower and upper sidebands, 337.2–339.2 GHz and 347.2–349.2 GHz), we find about 145 spectral lines from 13 species, 6 isotopologues, and 5 vibrational excited states. Most nitrogen-bearing molecules are strong toward the hot core, whereas the oxygen-bearing molecules peak toward the south-west in the so-called compact ridge. Imaging of spectral lines is shown to be an additional tool to improve the identifications of molecular lines. Arcsecond spatial resolution allows us to distinguish the molecular line emission of the sources *I* and *n* from that of the hot core. The only molecular species detected strongly toward source *I* is SiO, delineating mainly the collimated north-east south-west low-velocity outflow. The two positions close to source *I*, which have previously been reported to show maser emission in the v=0 ^{28}SiO(1–0) and (2–1) lines, show no detectable maser emission in the v=0 ^{28}SiO(8–7) line at our spatial resolution. SiO is weak toward source *n*, and thus source *n* may not currently be driving a molecular outflow. CH_3OH is the molecule with the highest number of identified lines (46) in this spectral window. This "line forest" allows us to estimate temperatures in the region, and we find temperatures between 50 and 350 K, with the peak temperatures occurring toward the hot core. The detection of strong vibrational excited line emission from the submm continuum peak SMA1 supports the interpretation that the source SMA1 is likely of protostellar nature.

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Binary systems and stellar mergers in massive star formation

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We present a model for the formation of high-mass close binary systems in the context of forming massive stars through gas accretion in the centres of stellar clusters. A low-mass wide binary evolves under mass accretion towards a high-mass close binary, attaining system masses of order 30-50 $M_\odot$at separations of order 1 AU. The resulting high frequency of binary systems with two massive components is in agreement with observations. These systems are typically highly eccentric and may evolve to have periastron separations less than their stellar radii. Mergers of these binary systems are therefore likely and can lead to the formation of the most massive stars, circumventing the problem of radiation pressure stopping the accretion. The stellar density required to induce binary mergers is $\approx 10^6$ stars pc^{-3}, or ≈ 0.01 that required for direct stellar collisions.

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The photometric evolution of FU Orionis objects: disc instability and wind-envelope interaction

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We present the results of a photometric monitoring campaign of three well studied FU Orionis systems (FU Orionis, V1057 Cygni and V1515 Cygni) undertaken at Maidanak Observatory between 1981 and 2003. When combined with photometric data in the literature, this database provides a valuable resource for searching for short timescale variability - both periodic and aperiodic - as well as for studying the secular evolution of these systems. In the case of V1057 Cyg (which is the system exhibiting the largest changes in brightness since it went into outburst) we compare the photometric data with time dependent models. We show that prior to the end of the 'plateau' stage in 1996, the evolution of V1057 Cyg in the $V-(B-V)$ colour-magnitude diagram is well represented by disc instability models in which the outburst is triggered by some agent - such as an orbiting planet - in the inner disc. Following the end of the plateau phase in 1996, the dimming and irregular variations are consistent with occultation of the source by a variable dust screen, which has previously been interpreted in terms of dust condensation events in the observed disc wind. Here we instead suggest that this effect results from the interaction between the wind and an infalling dusty envelope, the existence of this envelope having been previously invoked in order to explain the mid infrared emission of FU Orionis systems. We discuss how this model may explain some of the photometric and spectroscopic characteristics of FU Orionis systems in general.

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http://xxx.lanl.gov/abs/astro-ph/0505515,
http://www.ast.cam.ac.uk/ giuseppe/Publications/FUORs/

Investigating the Nature of the Dust Emission around Massive Protostar NGC 7538 IRS 1: Circumstellar Disk and Outflow?

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We have obtained high resolution mid-infrared images of the high mass protostar NGC 7538 IRS 1 using Michelle on Gemini North and find that the circumstellar dust associated with this source is extended on both large and small scales. The large-scale mid-infrared emission is asymmetric about the peak of IRS 1, being more extended to the northwest than the southeast. The position angle of the mid-infrared emission is similar to the position angle of the linearly distributed methanol masers at this location which are thought to trace a circumstellar disk. However, this position angle is also very similar to that of the CO outflow in this region which appears to be centered on IRS 1. We suggest that the large-scale extended mid-infrared emission is coming from dust heated on the walls of the outflow cavities near the source. IRS 1 is also elongated in the mid-infrared on a smaller scale, and this elongation is near *perpendicular* to the axis of the CO outflow (and the linearly distributed methanol masers). Because of its orientation with respect to the outflow and its estimated size ($R_{disk} \simeq 450$ AU at 11.7 μm), we propose that the small-scale elongation seen in the mid-infrared is a circumstellar disk that may be collimating the outflow from IRS 1.

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Effects of clumping on temperature I: externally heated clouds

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We present a study of radiative transfer in dusty, clumpy star-forming regions. A series of self-consistent, 3-D, continuum radiative transfer models are constructed for a grid of models parameterized by central luminosity, filling factor, clump radius, and face-averaged optical depth. The temperature distribution within the clouds is studied as a function of this parameterization. Among our results, we find that: (a) the effective optical depth is smaller in clumpy regions than in equivalent homogeneous regions; (b) penetration of radiation is drive by the fraction of open sky (FOS) – which measures the fraction of solid angle which is devoid of clumps; (c) FOS increases as clump radius increases and filling factor decreases; (d) for FOS ¿ 0.6-0.8 the sky is sufficiently open that the temperature is relatively insensitive to FOS; (e) the physical process by which radiation penetrates is streaming between clumps; (f) filling factor dominates the temperature distribution for large optical depths, and at small clump radii for small optical depths; (g) at lower optical depths, the temperature distribution is most sensitive to filling factors of 1-10 per cent, in accordance with many observations; (h) direct shadowing can be important approximately one clump radius behind a clump.

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Global X-ray properties of the Orion Nebula region

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Based on the *Chandra* Orion Ultradeep Project (COUP) observation, we establish the global X-ray properties of the stellar population associated with the Orion Nebula. Three components contribute roughly equally to the integrated COUP luminosity in the hard ($2-8$ keV) X-ray band: several OB stars, 822 lightly obscured cool stars in the Orion Nebula Cluster (ONC), and 559 heavily obscured stars. ONC stars $0.5-2$ pc from the center show a spatial asymmetry consistent with violent relaxation in the stellar dynamics. The obscured COUP sources concentrate around both OMC-1 molecular cores; these small-scale structures indicate ages $t < 0.1$ Myr. The X-ray luminosity function (XLF) of the lightly obscured sample is roughly lognormal in shape. The obscured population is deficient in lower-luminosity stars, perhaps due to localized circumstellar material. Mass-stratified XLFs show that one-third of the Orion Nebula region hard-band emission is produced by the bright O6 star θ^1 Ori C and half is produced by lower mass pre-main sequence stars with masses $0.3 < M < 3$ $M_\odot$. Very low mass stars contribute little to the cluster X-ray emission.

Using the hard band emission, we show that young stellar clusters like the ONC can be readily detected and resolved with *Chandra* across the Galactic disk, even in the presence of heavy obscuration. The Orion Nebula sample is a valuable template for studies of distant clusters. For example, the peak of the XLF shape can serve as a standard candle for a new distance measure to distant young stellar clusters, and the presence of a neon emission line complex around 1 keV can serve as a diagnostic for young stars.

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The effect of MHD turbulence on massive protoplanetary disk fragmentation

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Massive disk fragmentation has been suggested to be one of the mechanisms leading to the formation of giant planets. While it has been heavily studied in quiescent hydrodynamic disks, the effect of MHD turbulence arising from the magnetorotational instability (MRI) has never been investigated. This paper fills this gap and presents 3D numerical simulations of the evolution of locally isothermal, massive and magnetized disks. In the absence of magnetic fields, a laminar disk fragments and clumps are formed due to the effect of self–gravity. Although they disapear in less than a dynamical timescale in the simulations because of the limited numerical resolution, various diagnostics suggest that they should survive and form giant planets in real disks. When the disk is magnetized, it becomes turbulent at the same time as gravitational instabilities develop. At intermediate resolution, no fragmentation is observed in these turbulent models, while a large number of fragments appear in the equivalent hydrodynamical runs. This is because MHD turbulence reduces the strength of the gravitational instability. As the resolution is increased, the most unstable wavelengths of the MRI are better resolved and small scale angular momentum transport starts to play a role: fragments are found to form in massive and turbulent disks in that case. All of these results indicate that there is a complicated interaction between gravitational instabilities and MHD turbulence that influences disk fragmentation processes.

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Detection of a hot core in the intermediate-mass Class 0 protostar NGC 7129–FIRS 2

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We report high angular resolution (HPBW$\sim$ $0.6'' \times 0.5''$ at 1.3mm) observations of the Class 0 intermediate-mass (IM) protostar NGC 7129–FIRS 2 using the Plateau de Bure Interferometer. Our observations show the existence of an intense unresolved source in the continuum at 1.3mm and 3mm at the position of the Class 0 object. In addition, compact CH_3CN emission is detected at this position. The high rotational temperature derived from the CH_3CN lines ($T_{rot}\approx$50 K) as well as the enhanced CH_3CN fractional abundance (X(CH_3CN)$\sim$7.0 10^{-9}) show the existence of a hot core in this IM young stellar object. This is, up to our knowledge, the first IM hot core detected so far. Interferometric maps of the region in the CH_3OH $5_{kk'}\rightarrow4_{kk'}$, and D_2CO $4_{04}\rightarrow3_{03}$ lines are also presented in this paper. The methanol emission presents two condensations, one associated with the hot core which is very intense in the high upper state energy lines (E_u>100 K) and other associated with the bipolar outflow which dominates the emission in the low excitation lines. Enhanced CH_3OH abundances (X(CH_3OH) $\sim$ 3 10^{-8}– a few 10^{-7}) are measured in both components. While intense D_2CO $4_{04}\rightarrow3_{03}$ emission is detected towards the hot core, the N_2D^+ 3→2 line has not been detected in our interferometric observations. The different behaviors of D_2CO and N_2D^+ emissions suggest different formation mechanisms for the two species and different deuteration processes for H_2CO and N_2H^+ (surface and gas-phase chemistry, respectively). Finally, the spectrum of the large bandwidth correlator show a forest of lines at the hot core position reavealing that this object is extraordinarily rich in complex molecules. To have a deeper insight into the chemistry of complex molecules, we have compared the fractional abundances of the complex O- and N- bearing species in FIRS 2 with those in hot corinos and massive hot cores. Within the large uncertainty involved in fractional abundance estimates towards hot cores, we do not detect any variation of the relative abundances of O- and N-bearing molecules ([CH_3CN]/[CH_3OH]) with the hot core luminosity. However, the O-bearing species H_2CO and HCOOH seem to be more abundant in low and intermediate mass stars than in massive star forming regions. We propose that this could be the consequence of a different grain mantle composition in low and massive star forming regions.

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Membership of the Orion Nebula population from the Chandra Orion Ultradeep Project

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The *Chandra* Orion Ultradeep project (COUP) observation described in a companion paper by Getman et al. provides an exceptionally deep X-ray survey of the Orion Nebula Cluster and associated embedded young stellar objects. Membership of the region is important for studies of the stellar IMF, cluster dynamics, and star formation. The COUP study detected 1616 X-ray sources.

In this study we confirm cloud membership for 1315 stars, identify 16 probable foreground field stars having optical counterparts with discrepant proper motions, and classify the remaining 285 X-ray sources, of which 51 are lightly and 234 heavily obscured.

The 51 lightly obscured sources without known counterparts fall into three groups. (i) Sixteen are likely new members of the Orion Nebula Cluster. (ii) Two with unusually soft and non-flaring X-ray emission appear to be associated with nebular shocks, and may be new examples of X-rays produced at the bow shocks of Herbig-Haro outflows. (iii) The remaining thirty three are very weak uncertain sources, possibly spurious.

Out of 234 heavily absorbed sources without optical or near-infrared counterparts 75 COUP sources are likely new embedded cloud members (with membership for 42 confirmed by powerful X-ray flares), and the remaining 159 are likely extragalactic AGN seen through the molecular cloud, as argued by a careful simulation of the extragalactic background population.

Finally, a few new binary companions to Orion stars may have been found, but most cases of proximate COUP sources can be attributed to chance superpositions in this crowded field.

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The Initial Configuration of Young Stellar Clusters: A K–band Number Counts Analysis of the Surface Density of Stars

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We present an analysis of stellar distributions for the young stellar clusters GGD 12-15, IRAS 20050+2720, and NGC 7129, which range in far-IR luminosity from 227 to 5.68 $\times 10^3$ $L_\odot$ and are all still associated with their natal molecular clouds. The data used for this analysis includes near-IR data obtained with FLAMINGOS on the MMT Telescope and newly obtained wide-field 850 μm emission maps from SCUBA on the JCMT. Cluster size and azimuthal asymmetry are measured via azimuthal and radial averaging methods respectively. To quantify the deviation of the distribution of stars from circular symmetry, we define an azimuthal asymmetry parameter and we investigate the statistical properties of this parameter through Monte Carlo simulations. The distribution of young stars is compared to the morphology of the molecular gas using stellar surface density maps and the 850 μm maps. We find that two of the clusters are not azimuthally symmetric and show a high degree of structure. The GGD 12-15 cluster is elongated, and is aligned with newly detected filamentary structure at 850 μm. IRAS 20050+2720 is composed of a chain of three

subclusters, in agreement with Chen et al. (1997), although our results show that two of the subclusters appear to overlap. Significant 850 μm emission is detected toward two of the subclusters, but is not detected toward the central subcluster, suggesting that the dense gas may already be cleared there. In contrast to these two highly embedded subclusters, we find an anti-correlation of the stars and dust in NGC 7129, indicating that much of the parental gas and dust has been dispersed. The NGC 7129 cluster exhibits a higher degree of azimuthal symmetry, a lower stellar surface density, and a larger size than the other two clusters, suggesting that the cluster may be dynamically expanding following the recent dispersal of natal molecular gas. These analyses are further evidence that embedded, forming clusters are often not spherically symmetric structures, but can be elongated and clumpy, and that these morphologies may reflect the initial structure of the dense molecular gas. Furthermore, this work suggests that gas expulsion by stellar feedback results in significant dynamical evolution within the first 3 Myr of cluster evolution. We estimate peak stellar volume densities and discuss the impact of these densities on the evolution of circumstellar disks and protostellar envelopes.

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http://astro.pas.rochester.edu/∼rguter/preprints/gutermuth_sd.tar.gz

Star formation in Perseus: Clusters, filaments and the conditions for star formation

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We present a complete survey of current star formation in the Perseus molecular cloud, made at 850 and 450 μm with SCUBA at the JCMT. Covering 3 deg^2, this submillimetre continuum survey for protostellar activity is second in size only to that of ρ Ophiuchus (Johnstone et al. 2004). Complete above 0.4 $M_\odot$ (5σ detection in a $14''$ beam), we detect a total of 91 protostars and prestellar cores. Of these, 80% lie in clusters, representative of star formation across the Galaxy. Two of the groups of cores are associated with the young stellar clusters IC348 and NGC1333, and are consistent with a steady or reduced star formation rate in the last 0.5 Myr, but not an increasing one. In Perseus, 40–60% of cores are in small clusters ($< 50\ M_\odot$) and isolated objects, much more than the 10% suggested from infrared studies. Complementing the dust continuum, we present a $C^{18}O$ map of the whole cloud at $1'$ resolution. The gas and dust show filamentary structure of the dense gas on large and small scales, with the high column density filaments breaking up into clusters of cores. The filament mass per unit length is 5–11 $M_\odot$ per 0.1 pc. Given these filament masses, there is no requirement for substantial large scale flows along or onto the filaments in order to gather sufficient material for star formation. We find that the probability of finding a submillimetre core is a strongly increasing function of column density, as measured by $C^{18}O$ integrated intensity, P(core) $\propto I^{3.0}$. This power law relation holds down to low column density, suggesting that there is no A_v threshold for star formation in Perseus, unless all the low-A_v submm cores can be demonstrated to be older protostars which have begun to lose their natal molecular cloud.

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http://www.astro.ex.ac.uk/people/hatchell/publications.html

Millimetre continuum observations of southern massive star formation regions. I. SIMBA observations of cold cores.

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We report the results of a 1.2 mm continuum emission survey toward 131 star forming complexes suspected of undergoing massive star formation. These regions have previously been identified as harbouring a methanol maser and/or a radio continuum source (UC HII region), whose presence is in most instances indicative of massive star formation. The 1.2 mm emission was mapped using the SIMBA instrument on the 15 m Swedish ESO Submillimetre Telescope (SEST). Emission is detected toward all of the methanol maser and UC HII regions targeted, as well as towards 20 others lying within the fields mapped, implying that these objects are associated with cold, deeply embedded objects. Interestingly, there are also 20 methanol maser sites and 9 UC HII regions within the fields mapped which are devoid of millimetre continuum emission.

In addition to the maser and UC HII regions detected, we have also identified 253 other sources within the SIMBA maps. All of these (253) are new sources, detected solely from their millimetre continuum emission. These 'mm-only' cores are devoid of the traditional indicators of massive star formation, (i.e. methanol/OH maser, UC HII regions, *IRAS* point sources). At least 45% of these mm-only cores are also without mid-infrared *MSX* emission. The 'mm-only' core may be an entirely new class of source that represents an earlier stage in the evolution of massive stars, prior to the onset of methanol maser emission. Or, they may harbour protoclusters which do not contain any high mass stars (i.e. below the HII region limit).

In total, 404 sources are detected representing four classes of sources which are distinguished by the presence of the different combination of associated tracer/s. Their masses, estimated assuming a dust temperature of 20 K and adopting kinematic distances, range from 0.5 $\times 10^1 M_\odot$ to 3.7 $\times 10^4 M_\odot$, with an average mass for the sample of 1.5 $\times 10^3 M_\odot$. The H_2 number density (n_{H_2}) of the source sample ranges from 1.4 $\times$ 10^3 cm^{-3} to 1.9 $\times$ 10^6 cm^{-3}, with an average of 8.7 $\times$ 10^4 cm^{-3}. The average radius of the sample is 0.5 pc. The visual extinction ranges from 10 to 500 mag with an average of 80 mag, which implies a high degree of embedding. The surface density (Σ) varies from 0.2 to 18.0 kg m^{-2} with an average of 2.8 kg m^{-2}.

Analysis of the mm-only sources shows that they are less massive ($\bar{\mathrm{M}} = 0.9 \times 10^3 M_\odot$), and smaller ($\bar{\mathrm{R}} = 0.4$ pc) than sources with methanol maser and/or radio continuum emission, which collectively have a mean mass of 2.5 $\times 10^3 M_\odot$ and a mean radius of 0.7 pc.

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Probing the inner 200 AU of low-mass protostars with the Submillimeter Array: Dust and organic molecules in NGC 1333-IRAS2A

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The Submillimeter Array has opened a new window to study the innermost warm and dense regions of the envelopes and disks around deeply embedded protostars. This paper presents high-angular resolution ($< 2''$) submillimeter observations of the class 0 young stellar object NGC 1333-IRAS2A. Dust continuum emission and lines of complex organic molecules such as CH_3OCH_3 and CH_3OCHO, high excitation CH_3OH transitions, deuterated methanol CH_3OD as well as lines of CO, HCN, $H^{13}CN$, SO and SO_2 are detected on $\sim$ 200 AU scales. The observations are interpreted using detailed radiative transfer models of the physical and chemical structure, consistent with both single-dish and interferometer data. The continuum emission is explained by an extended envelope and a compact but resolved component, presumably a circumstellar disk with a diameter of 200–300 AU and a mass of $\sim$ a few$\times 0.01 - 0.1$ $M_\odot$. If related to the rotation of the envelope, then the size of this disk suggests a centrifugal barrier of 200–300 AU, which implies that the temperature in the envelope does not increase above 100 K. Its large size also suggests that the build-up of disks proceeds rapidly throughout the early protostellar stages. The smaller (< 100 AU) disks found around other deeply embedded protostars may be a result of tidal truncation. The high-resolution observations of SO can be explained with a simple constant abundance, $\sim 10^{-9}$, constrained through single-dish observations, whereas

those of $H^{13}CN$ and the organic species require high abundances, increased by one to two orders of magnitude, or an additional compact source of emission at small scales. The compact molecular emission could originate in a hot core region of the inner envelope, but a more likely reservoir is the circumstellar disk.

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Laboratory synthesized calcium oxide and calcium hydroxide grains: A candidate to explain the 6.8 μm band

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We will demonstrate that CaO and $Ca(OH)_2$ are excellent candidates to explain the 6.8 μm feature, which is one of the most obscure features in young stellar objects. We discuss the condensation of CaO grains and the potential formation of a $Ca(OH)_2$ surface layer. The infrared spectra of these grains are compared with the spectra of fifteen young stellar objects. We note that CaO-rich grains are seen in all meteoritic CAIs (calcium-aluminum-rich inclusions) and the 6.8 μm feature has only been observed in young stellar objects. Therefore, we consider CaO grains to be a plausible candidate to explain the 6.8 μm feature and hypothesize that they are produced in the hot interiors of young stellar environments.

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Water Masers Toward Ultracompact HII Regions

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We present a survey in the 22 GHz rotational water transition toward 33 galactic ultracompact HII regions. Maser emission is detected toward 18 of these sources; two are new detections. High quality spectra are provided for all 18 sources. We discuss the detection rate of this survey and the correlation of various maser properties with other physical parameters. In addition, we report wide-bandwidth (316 km/s), moderate-resolution (3") water maser observations of the HH80-81 region. We report the first detection of water maser emission at the approximate velocity of the molecular core. This emission is coincident with the extreme tip of the thermal jet, and well-removed from the much stronger and well-known maser emission at the position of VLA-3.

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Outflow and Infall in a Star-Forming Region L1221

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We have mapped the 3.3 mm continuum, CO, HCO^+, N_2H^+, and CS emission around a nearby Class I source, IRAS 22266+6845, in the L1221 cometary dark cloud. L1221 is a complicated star-forming region. It hosts three infrared sources: a close binary consisting of an east source and a west source around the IRAS source position and a southeast source $\sim 45''$ to the southeast (T. Bourke, private communication). The east source is identified as the IRAS source. Continuum emission is seen around the east source and the southeast source, probably tracing the dust around them.

No continuum emission is seen toward the west source, probably indicating that there is not much dust there. An east-west molecular outflow is seen in CO, HCO^+, and CS originated from around the binary. It is bipolar with an east lobe and a west lobe, both appearing as a wide-opening outflow shell originated from around the binary. It is likely powered by the east source, which shows a southeast extension along the outflow axis in the K' image. A ringlike envelope is seen in N_2H^+ around the binary surrounding the outflow waist. It is tilted with the major axis perpendicular to the outflow axis. The kinematics is well reproduced by a thin disk model with both infall and rotation, and a column density peak in a ring. The ringlike envelope is not rotationally supported as the rotation velocity is smaller than the infall velocity.

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High Resolution Observations of the Near-Infrared Emission from NGC 6822 Hubble V

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We observed Hubble V, the brightest HII region complex in the dwarf irregular galaxy NGC 6822, at near-infrared (1.8–2.4 μm) wavelengths using the Cooled Grating Spectrometer 4 (CGS4) at the United Kingdom Infra-Red Telescope (UKIRT). The line emission maps of Hubble V show the typical structure of a photo-dissociation region (PDR) where an ionized core, traced by compact He I emission (2.0587 μm) and Brγ emission (2.1661 μm), is surrounded by an outer layer traced by molecular hydrogen (H_2) emission. The measured line ratios of H_2 $2-1$ S(1) (2.2477 μm) / $1-0$ S(1) (2.1218 μm) from 0.2 to 0.6 and the un-shifted and un-resolved line profiles suggest that the H_2 emission originates purely from a PDR. By comparing the H_2 results with a PDR model, we conclude that Hubble V includes dense ($10^{4.5}$cm^{-3}) and warm PDRs. In this environment, most of the H_2 molecules are excited by far-UV photons (with a field strength of 10^{2-4} times that of the average interstellar field), although collisional processes de-excite H_2 and contribute significantly to the excitation of the first vibrational level. We expect that Hubble V is in the early stage of molecular cloud dissolution.

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CH_3OH emission from low mass protostars

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We present observations of methanol lines in a sample of Class 0 low mass protostars. Using a 1-D radiative transfer model, we derive the abundances in the envelopes. In two sources of the sample, the observations can only be reproduced by the model if the methanol abundance is enhanced by about two order of magnitude in the inner hot region of the envelope. Two other sources show similar jumps, although at a lower confidence level. The observations

for the other three sources are well reproduced with a constant abundance, but the presence of a jump cannot be ruled out. The observed methanol abundances in the warm gas around low mass protostars are orders of magnitude higher than gas phase chemistry models predict. Hence, in agreement with other evidences, this suggest that the high methanol abundance reflects recent evaporation of ices due to the heating by the newly formed star. The observed abundance ratios of CH_3OH, H_2CO, and CO are in good agreement with grain surface chemistry models. However, the absolute abundances are more difficult to reproduce and may point towards the presence of multiple ice components in these regions.

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A new intermediate mass protostar in the Cepheus A HW2 region

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We present the discovery of the first molecular hot core associated with an intermediate mass protostar in the Cep A HW2 region. The hot condensation was detected from single dish and interferometric observations of several high excitation rotational lines (from 100 to 880 K above the ground state) of SO_2 in the ground vibrational state and of HC_3N in the vibrationally excited states v_7=1 and v_7=2. The kinetic temperature derived from both molecules is $\sim$160 K. The high–angular resolution observations ($1.25''\times0.99''$) of the SO_2 $J = 28_{7,21} \rightarrow 29_{6,24}$ line (488 K above the ground state) show that the hot gas is concentrated in a compact condensation with a size of $\sim0.6''$ ($\sim$430 AU), located $0.4''$ (300 AU) east from the radio–jet HW2. The total SO_2 column density in the hot condensation is $\sim10^{18}$cm^{-2}, with a H_2 column density ranging from $\sim10^{23}$ to 6×10^{24} cm^{-2}. The H_2 density and the SO_2 fractional abundance must be larger than 10^7 cm^{-3} and 2×10^{-7} respectively. The most likely alternatives for the nature of the hot and very dense condensation are discussed. From the large column densities of hot gas, the detection of the HC_3N vibrationally excited lines and the large SO_2 abundance, we favor the interpretation of a hot core heated by an intermediate mass protostar of 10^3 $L_\odot$. This indicates that the Cep A HW2 region contains a cluster of very young stars.

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Photometric Accretion Signatures Near the Substellar Boundary

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Multi-epoch imaging of the Orion equatorial region by the Sloan Digital Sky Survey has revealed that significant variability in the blue continuum persists into the late-M spectral types, indicating that magnetospheric accretion processes occur below the substellar boundary in the Orion OB1 association. We investigate the strength of the accretion-related continuum veiling by comparing the reddening-invariant colors of the most highly variable stars against those of main sequence M dwarfs and evolutionary models. A gradual decrease in the g band veiling is seen

for the cooler and less massive members, as expected for a declining accretion rate with decreasing mass. We also see evidence that the temperature of the accretion shock decreases in the very low mass regime, reflecting a reduction in the energy flux carried by the accretion columns. We find that the near-IR excess attributed to circumstellar disk thermal emission drops rapidly for spectral types later than M4. This is likely due to the decrease in color contrast between the disk and the cooler stellar photosphere. Since accretion, which requires a substantial stellar magnetic field and the presence of a circumstellar disk, is inferred for masses down to 0.05 $M_\odot$ we surmise that brown dwarfs and low mass stars share a common mode of formation.

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Dust outflows and inner gaps generated by massive planets in debris disks

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Main sequence stars are commonly surrounded by debris disks, formed by cold far-IR-emitting dust that is thought to be continuously replenished by a reservoir of undetected dust-producing planetesimals. We have investigated the orbital evolution of dust particles in debris disks harboring massive planets. Small dust grains are blown out by radiation pressure, as is well known; in addition, gravitational scattering by the giant planets also creates an outflow of large grains. We describe the characteristics of this large-particle outflow in different planetary architectures and for different particle sizes. In addition, the ejection of particles is responsible for the clearing of dust inside the orbit of the planet. We study the efficiency of particle ejection and the resulting dust density contrast inside and outside the orbit of the planet, as a function of the planet's mass and orbital elements and the particle size. We discuss its implications for exo-planetary debris disks and for the interpretation of in-situ dust detection experiments on space probes traveling in the outer solar system.

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Signatures of Planets in Spatially Unresolved Debris Disks

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Main sequence stars are commonly surrounded by debris disks, composed of cold dust continuously replenished by a reservoir of undetected dust-producing planetesimals. In a planetary system with a belt of planetesimals (like the Solar System's Kuiper Belt) and one or more interior giant planets, the trapping of dust particles in the mean motion resonances with the planets can create structure in the dust disk, as the particles accumulate at certain semimajor axes. Sufficiently massive planets may also scatter and eject dust particles out of a planetary system, creating a dust depleted region inside the orbit of the planet. In anticipation of future observations of spatially unresolved debris disks with the *Spitzer Space Telescope*, we are interested in studying how the structure carved by planets affects the shape of the disk's spectral energy distribution (SED), and consequently if the SED can be used to infer the presence of planets. We numerically calculate the equilibrium spatial density distributions and SEDs of dust disks originated by a belt of planetesimals in the presence of interior giant planets in different planetary configurations, and for a representative sample of chemical compositions. The dynamical models are necessary to estimate the enhancement of particles near the mean motion resonances with the planets, and to determine how many particles drift inside the planet's orbit. Based on the SEDs and predicted *Spitzer* colors we discuss what types of planetary systems can be distinguishable from one another and the main parameter degeneracies in the model SEDs.

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A combined optical/infrared spectral diagnostic analysis of the HH1 jet

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Complete flux-calibrated spectra covering the spectral range from 6000Å to 2.5μm have been obtained along the HH1 jet and analysed in order to explore the potential of a combined optical/near-IR diagnostic applied to jets from young stellar objects. The main physical parameters (visual extinction, electron temperature and density, ionization fraction and total density) have been derived along the jet using various diagnostic line ratios. This multi-line analysis shows, in each spatially unresolved knot, the presence of zones at different excitation conditions, as expected from the cooling layers behind a shock front. In particular, a density stratification in the jet is evident from ratios of various lines of different critical density. We measure electron densities in the range $6\,10^2$-$3\,10^3$ cm^{-3} with the [S II] optical doublet lines, $4\,10^3$-10^4 cm^{-3} with the near-IR [Fe II] lines, and 10^5-10^6 cm^{-3} with optical [Fe II] and CaII lines. The electron temperature also shows variations, with values between 8000-11000 K derived from optical/near-IR [Fe II] lines and 11000-20000 K from a combined diagnostic employing optical [O I] and [N II] lines. Thus [Fe II] lines originate in a cooling layer located at larger distances from the shock front than that generating the optical lines, where the compression is higher and the temperature is declining.

The derived parameters were used to measure the mass flux along the jet, adopting different procedures, the advantages and limitations of which are discussed. The [Fe II] 1.64 μm line luminosity turns out to be more suitable to measure $\dot{M}_{jet}$ than the optical lines, since it samples a fraction of the total mass flowing through a knot larger than the [O I] or [S II] lines. $\dot{M}_{jet}$ is high in the initial part of the flow ($\sim 2.2\,10^{-7}$ M$_\odot$ yr^{-1}) but decreases by about an order of magnitude further out. Conversely, the mass flux associated with the warm molecular material is low, $\dot{M}_{H2}\sim 10^{-9}$ M$_\odot$ yr^{-1}, and does not show appreciable variations along the jet. We suggest that part of the mass flux in the external regions is not revealed in optical and IR lines because it is associated with a colder atomic component, which may be traced by the far-IR [O I] 63 μm line.

Finally, we find that the gas-phase abundance of refractory species, such as Fe, C, Ca, and Ni, is lower than the solar value, with the lowest values (between 10 and 30% of solar) derived in the inner and densest regions. This suggests a significant fraction of dust grains may *still be present* in the jet beam, imposing constraints on the efficiency of grain destruction by multiple low-velocity shock events.

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The Origin of T Tauri X-ray Emission: New Insights from the *Chandra* Orion Ultradeep Project

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The *Chandra* Orion Ultradeep Project (COUP) provides the most comprehensive dataset ever acquired on the X-ray emission of pre-main sequence stars. In this paper, we study the nearly 600 X-ray sources that can be reliably identified with optically well characterized T Tauri stars (TTS) in the Orion Nebula Cluster. With a detection limit of $L_{\rm X,min} \sim 10^{27.3}$ erg/sec for lightly absorbed sources, we detect X-ray emission from more than 97% of the optically visible late-type (spectral types F to M) cluster stars. This proofs that there is no "X-ray quiet" population of late-type stars with suppressed magnetic activity. We use this exceptional optical, infrared, and X-ray data set to study the dependencies of the X-ray properties on other stellar parameters. All TTS with known rotation periods lie in the saturated or super-saturated regime of the relation between activity and Rossby numbers seen for main-sequence (MS) stars, but the TTS show a much larger scatter in X-ray activity than seen for the MS stars. Strong near-linear relations between X-ray luminosities, bolometric luminosities and mass are present. We also find that the fractional X-ray luminosity $L_{\rm X}/L_{\rm bol}$ rises slowly with mass over the $0.1 - 2\,M_{\odot}$ range. The plasma temperatures determined from the X-ray spectra of the TTS are much hotter than in MS stars, but seem to follow a general solar-stellar correlation between plasma temperature and activity level. The scatter about the relations between X-ray activity and stellar parameters is larger than the expected effects of X-ray variability, uncertainties in the variables, and unresolved binaries. This large scatter seems to be related to the influence of accretion on the X-ray emission. While the X-ray activity of the non-accreting TTS is consistent with that of rapidly rotating MS stars, the accreting stars are less X-ray active (by a factor of $\sim 2-3$ on average) and produce much less well defined correlations than the non-accretors. We discuss possible reasons for the suppression of X-ray emission by accretion and the implications of our findings on long-standing questions related to the origin of the X-ray emission from young stars, considering in particular the location of the X-ray emitting structures and inferences for pre-main-sequence magnetic dynamos.

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Terrestrial Planet Formation in Disks with Varying Surface Density Profiles

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The "minimum-mass solar nebula" (MMSN) model estimates the surface density distribution of the protoplanetary disk by assuming the planets to have formed *in situ*. However, significant radial migration of the giant planets likely occurred in the Solar system, implying a distortion in the values derived by the MMSN method. The true density profiles of protoplanetary disks is therefore uncertain. Here we present results of simulations of late-stage terrestrial accretion, each starting from a disk of planetary embryos. We assume a power-law surface density profile that varies with heliocentric distance r as $r^{-\alpha}$, and vary α between 1/2 and 5/2 ($\alpha = 3/2$ for the MMSN model). We find that for steeper profiles (higher values of α), the terrestrial planets (i) are more numerous, (ii) form more quickly, (iii) form closer to the star, (iv) are more massive, (v) have higher iron contents, and (vi) have lower water contents. However, the possibility of forming potentially habitable planets does not appear to vary strongly with α.

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http://www.astro.washington.edu/raymond/alpha.pdf

The N2K Consortium. II.
A Transiting Hot Saturn Around HD 149026 With a Large Dense Core

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Doppler measurements from Subaru and Keck have revealed radial velocity variations in the $V = 8.15$, G0IV star HD 149026 consistent with a Saturn-mass planet in a 2.8766 day orbit. Photometric observations at Fairborn Observatory have detected three complete transit events with depths of 0.003 mag at the predicted times of conjunction. HD 149026 is now the second brightest star with a transiting extrasolar planet. The mass of the star, based on interpolation of stellar evolutionary models, is $1.3 \pm 0.1\ M_{\odot}$; together with the Doppler amplitude, $K_1 = 43.3$ m s^{-1}, we derive a planet mass, $M \sin i = 0.36\ M_{\rm Jup}$, and orbital radius of 0.042 AU. HD 149026 is chromospherically inactive and metal-rich with spectroscopically derived [Fe/H] = +0.36, $T_{\rm eff}$= 6147 K, $\log g$= 4.26 and $v \sin i = 6.0$ km s^{-1}. Based on $T_{\rm eff}$ and the stellar luminosity of 2.72 $L_{\odot}$, we derive a stellar radius of 1.45 $R_{\odot}$. Modeling of the three photometric transits provides an orbital inclination of 85.3 ± 1.0 degrees and (including the uncertainty in the stellar radius) a planet radius of $0.725 \pm 0.05\ R_{\rm Jup}$. Models for this planet mass and radius suggest the presence of a $\sim 67\ M_{\oplus}$ core composed of elements heavier than hydrogen and helium. This substantial planet core would be difficult to construct by gravitational instability.

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Whims of an Accreting Young Brown Dwarf:
Exploring Emission Line Variability of 2MASSW J1207334-393254

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We report the first comprehensive study of emission line variability in an accreting young brown dwarf. We have collected 14 high-resolution optical spectra of 2MASSW J1207334-393254 (M8), a likely member of the nearby 8-million-year-old TW Hydrae association with a recently identified planetary mass companion, in three observing runs between 2005 January-March on Magellan Clay telescope. These spectra show a variety of emission lines that are commonly seen in classical T Tauri stars. Hα line in particular shows dramatic changes in shape and intensity in our dataset, both on timescales of several weeks and several hours. In spectra from late-January, the line is relatively weak and only slightly asymmetric. Spectra from mid- and late-March show intense, broad (10% width $\sim$280 km s^{-1}) and

asymmetric Hα emission, indicative of on-going disk accretion. Based on empirical diagnostics, we estimate that the accretion rate could have changed by a factor of 5-10 over $\sim$6 weeks in this brown dwarf, which may be in the final stages of accreting from its disk. March spectra also reveal significant 'quasi-periodic' changes in the Hα line profile over the course of a night, from clearly double-peaked to nearly symmetric. These nightly profile changes, roughly consistent with the brown dwarf's rotation period, could be the result of a redshifted absorption feature coming into and out of our line of sight; when the profile is double-peaked we may be looking into an accretion column, flowing from the inner disk edge on to the central object, indicating that the accretion is probably channelled along the magnetic field lines. Our findings provide strong support for the magnetospheric accretion scenario, and thus for the existence of large-scale magnetic fields, in the sub-stellar regime. We also present the first high-resolution optical spectrum of SSSPM J1102-3431 (M8.5), which has recently been identified as another likely sub-stellar member of the TW Hydrae association. Its emission lines are relatively narrow and fairly symmetric, suggesting that it is accreting only very weakly, if at all.

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http://www.astro.utoronto.ca/$\sim$aleks/pub.html

Thermal Dust Emission from Proplyds, Unresolved, Disks, and Shocks in the Orion Nebula

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We present a new 11.7 μm mosaic image of the inner Orion nebula obtained with T-ReCS on Gemini South. The map covers $2.7' \times 1.6'$ with diffraction-limited spatial resolution of $0.35''$; it includes the BN/KL region, the Trapezium, and OMC-1 South. Excluding BN/KL, we detect 91 thermal-infrared point sources, with 27 known proplyds and over 30 "naked" stars showing no extended structure in *Hubble Space Telescope* (*HST*) images. Within the region we surveyed, $\sim$80% of known proplyds show detectable thermal-infrared emission, almost 40% of naked stars are detected at 11.7 μm, and the fraction of all visible sources with 11.7 μm excess emission (including both proplyds and stars with unresolved disks) is roughly 50%. These fractions exclude embedded sources. Thermal dust emission from stars exhibiting no extended structure in *HST* images is surprising, and means that they have retained circumstellar dust disks comparable to the size of our solar system. Proplyds and stars with infrared excess are not distributed randomly in the nebula; instead, they show a clear anti-correlation in their spatial distribution, with proplyds clustered close to θ^1C, and other infrared sources found preferentially farther away. We suspect that the clustered proplyds trace the youngest $\sim$0.5 Myr age group associated with the Trapezium, while the more uniformly-distributed sources trace the older 1–2 Myr population of the Orion Nebula Cluster. This suggests that small protoplanetary disks persist for a few Myr in irradiated environments, and hints that hierarchical sub-clustering has been important on $\sim$30 arcsec scales around the Trapezium. We detect 11.7 μm emission from the five brightest members of the Trapezium (θ^1ABCDE), caused by free-free stellar wind emission and possibly emission from dusty disks around companion stars. Within 30 arcsec of θ^1C Ori, 100% of known proplyds are detected at 11.7 μm, and they exhibit remarkable limb-brightened dust arcs at the collision of the proplyd mass loss and the wind from θ^1C. The star θ^1D is associated with the most prominent mid-IR dust arc of the Ney-Allen nebula. We propose that this arc is the consequence of θ^1D being the closest member of the Trapezium to the background cloud. Finally, we detect dust emission from Herbig-Haro jets in Orion, including HH 202, HH 529, HH 513, and HH 514. This is the first detection of mid-infrared continuum emission from dust in the body of a collimated HH jet or bow shock. The presence of dust implies that some jet material must be lifted from large radii in the accretion disk (outside the dust sublimation radius) or entrained from the circumstellar environment.

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http://xxx.lanl.gov/abs/astro-ph/0506445

The Arches Cluster - Evidence for a Truncated Mass Function?

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We have analyzed high-resolution, adaptive optics (AO) HK observations of the Arches cluster obtained with NAOS-CONICA. With a spatial resolution of 84 mas, the cluster center is uniquely resolved. From these data the present-day mass function (MF) of Arches is derived down to $\sim 4\,M_\odot$. The integrated MF as well as the core and 2^{nd} annulus MFs are consistent with a turn-over at $6-7\,M_\odot$. This turn-over indicates severe depletion of intermediate and low-mass stars in the Arches cluster, possibly caused by its evolution in the Galactic Center environment. The Arches MF represents the first resolved observation of a starburst cluster exhibiting a low-mass truncated MF. This finding has severe implications for stellar population synthesis modelling of extragalactic starbursts, the derivation of integrated properties such as the total mass of star clusters in dense environments, the survival of low-mass remnants from starburst populations, and chemical enrichment during starburst phases.

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http://xxx.lanl.gov/abs/astro-ph/0506575

X-ray chemistry in the envelopes around young stellar objects

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We present chemical models of the envelope of a young stellar object (YSO) exposed to a central X-ray source. The models are applied to the massive star-forming region AFGL 2591 for different X-ray fluxes. Model results for this region show that the X-ray ionization rate with and without the effects of Compton scattering differs by only a few percent and the influence of Compton scattering on the chemistry is negligible. The total X-ray ionization rate is dominated by the 'secondary' ionization rate of H_2 resulting from fast electrons. The abundance profiles of several molecular and atomic species are shown to depend on the X-ray luminosity and on the distance from the source. The carbon, sulphur and nitrogen chemistries are discussed. It is found that He^+ and H_3^+ are enhanced and trigger a peculiar chemistry. Several molecular X-ray tracers are found and compared to tracers of the far ultraviolet (FUV) field. Like ultraviolet radiation fields, X-rays enhance simple hydrides, ions and radicals. In contrast to ultraviolet photons, X-rays can penetrate deep into the envelope and affect the chemistry even at large distances from the source. Whereas the FUV enhanced species cover a region of $\approx$ 200–300 AU, the region enhanced by X-rays is ≥ 1000 AU. We find that N_2O, HNO, SO, SO^+, HCO^+, CO^+, OH^+, N_2H^+, SH^+ and HSO^+ (among others) are more enhanced by X-rays than by FUV photons even for X-ray luminosities as low as $L_X \approx 10^{30}\,\mathrm{ergs\,s^{-1}}$. CO_2 abundances are reduced in the gas-phase through X-ray induced FUV photons. For temperatures $T \leq 230$ K, H_2O is destroyed by X-rays with luminosities $L_X \geq 10^{30}\,\mathrm{ergs\,s^{-1}}$. Best-fit models for AFGL 2591 predict an X-ray luminosity $L_X \geq 10^{31}\,\mathrm{ergs\,s^{-1}}$ with a hard X-ray spectrum $T_X \geq 3\times10^7$ K. This is the first time that the X-ray flux of a highly obscured source has been estimated by its envelope chemistry. Furthermore, we find $L_X/L_{bol} \approx 10^{-6}$. The chemistry of the bulk of the envelope mass is dominated by cosmic-ray induced reactions rather than by X-ray induced ionization for X-ray luminosities $L_X \leq 10^{33}\,\mathrm{ergs\,s^{-1}}$. The calculated line intensities of HCO^+ and HCS^+ show that high-J lines are more affected than lower J lines by the presence of X-rays due to their higher critical densities, and that such differences are detectable even with large aperture single-dish telescopes. Future instruments such as Herschel-HIFI or SOFIA will be able to observe X-ray enhanced hydrides whereas the sensitivity and spatial resolution of ALMA is well-suited to measure the size and geometry of the region affected by X-rays.

Accepted by Astronomy & Astrophysics

http://arxiv.org/ftp/astro-ph/papers/0506/0506306.pdf

Spitzer Observations of G Dwarfs in the Pleiades: Circumstellar Debris Disks at 100 Myr Age

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Fluxes and upper limits in the wavelength range from 3.6 to 70 μm from the Spitzer Space Telescope are provided for twenty solar-mass Pleiades members. One of these stars shows a probable mid-IR excess and two others have possible excesses, presumably due to circumstellar debris disks. For the star with the largest, most secure excess flux at MIPS wavelengths, HII1101, we derive Log(L_{dust}/L_*) $\sim$ -3.8 and an estimated debris disk mass of 4.2×10^{-5} M(Earth) for an assumed uniform dust grain size of 10μm. If the stars with detected excesses are interpreted as stars with relatively recent, large collision events producing a transient excess of small dust particles, the frequency of such disk transients is about $\sim$10% for our $\sim$100 Myr, Pleiades G dwarf sample. For the stars without detected 24-70μm excesses, the upper limits to their fluxes correspond to approximate 3σ upper limits to their disk masses of 6×10^{-6} M(Earth) using the MIPS 24μm upper limit, or 2×10^{-4} M(Earth) using the MIPS 70μm limit. These upper limit disk masses (for "warm" and "cold" dust, respectively) are roughly consistent, but somewhat lower than, predictions of a heuristic model for the evolution of an "average" solar-mass star's debris disk based on extrapolation backwards in time from current properties of the Sun's Kuiper belt.

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http://arxiv.org/abs/astro-ph/0506743

X-ray and Near-infrared Studies of a Star-forming Cloud; L1448

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We present the results of X-ray and near-infrared (NIR) observations of L1448, a star-forming region in the Perseus cloud complex using the *Chandra* X-ray Observatory and the 4 m telescope at the Kitt Peak National Observatory. We detect 72 X-ray sources in a $\sim17''\times17''$ region with a $\sim$68 ks ACIS exposure, for which we conduct follow-up NIR imaging observations in a concentric $\sim11''\times11''$ region with FLAMINGOS down to $m_{K_S} \sim 17$ mag. Twelve X-ray sources have NIR or optical counterparts. By plotting X-ray mean energy versus NIR to X-ray flux ratio, the X-ray sources are clearly separated into two groups. The X-ray spectral and temporal features as well as NIR magnitudes and colors indicate that one group mainly consists of young stellar objects (YSOs) in the cloud and the other of background extragalactic sources. Ten X-ray-emitting YSO candidates are thus newly identified, which are low-mass or brown dwarf mass sources from their NIR magnitudes. In addition, a possible X-ray signal is found from a mid-infrared protostar L1448 IRS 3(A). The lack of detection of this source in our deep NIR images indicates that this source has a very steep spectral slope of >3.2 in 2–10 μm.

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Size distribution of circumstellar disks in the Trapezium cluster

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In this paper we present results on the size distribution of circumstellar disks in the Trapezium cluster as measured from HST/WFPC2 data. Direct diameter measurements of a sample of 135 bright proplyds and 14 silhouettes disks suggest that there is a single population of disks well characterized by a power-law distribution with an exponent of -1.9 ± 0.3 between disk diameters 100–400 AU. For the stellar mass sampled (from late G to late M stars) we find no obvious correlation between disk diameter and stellar mass. We also find that there is no obvious correlation between disk diameter and the projected distance to the ionizing Trapezium OB stars. We estimate that about 40% of the disks in the Trapezium have radius larger than 50 AU. We suggest that the origin of the Solar system's (Kuiper belt) outer edge is likely to be due to the star formation environment and disk destruction processes (photoevaporation, collisions) present in the stellar cluster on which the Sun was probably formed. Finally, we identified a previously unknown proplyd and named it 266-557, following convention.

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Preprints available at http://arXiv.org/abs/astro-ph/050685

The 6.7-GHz and 25-GHz methanol masers in OMC-1

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The Australia Telescope Compact Array (ATCA) has been used to search for methanol maser emission at 6.7 GHz towards OMC-1. Two features peaking at 7.2 km s^{-1} and -1.1 km s^{-1} have been detected. The former has at least two components close in both velocity and position. It is located south-east of the Orion Kleinmann-Low (Orion-KL) nebula in the region of outflow traced by the 25-GHz methanol masers and the 95-GHz methanol emission. It is shown by modelling that in contrast to the widespread opinion that simultaneous masing of methanol transitions of different classes is impossible there are conditions for which simultaneous masing of the class II transition at 6.7-GHz and some class I transitions (e.g. the series at 25 GHz) is possible. A relevant example is provided, in which the pumping occurs via the first torsionally excited state and is driven by radiation of the dust intermixed with the gas in the cloud. In this regime the dust temperature is significantly lower (T$\approx$60 K) than in the case of bright 6.7-GHz masers (T$>$150 K). The narrow spectral feature at -1.1 km s^{-1} has a brightness temperature greater than about 1400 K, which suggests that it is probably a maser. It emanates from the Orion South region and is probably associated with the approaching part of outflow seen in CO. The 25-GHz maser associated with OMC-1 was observed quasi-simultaneously with the 6.7-GHz observations. No 25-GHz emission associated with the -1.1 km s^{-1} 6.7 GHz feature towards Orion South was detected.

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http://arxiv.org/abs/astro-ph/0507048

Multiple Outflows and Protostars in Barnard 1

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Using optical (Hα & [SII]), Near-IR (H_2 & K_S), and submillimeter (850 μm & 450 μm) data, we have examined the region surrounding the Barnard1 (B1) core and found a multitude of new shocks from protostellar outflows. We trace several flows, some of which are large, parsec scale outflows with dynamic ages of order 10^4 yr, indicating that star formation has been taking place in Barnard 1 for at least that long. We can confidently identify eight protostars which are driving outflows. Of those eight protostars, one source, SMM 2 (SMMJ 033330+31095) is a new class-0 source, giving B1 a total of 3 class-0 protostars. Based on the number of shocks and protostars in this region, B1 appears to be a much more active region of star formation than previously thought. The number of shocks is comparable to or greater than those of other active star forming regions in Perseus (e.g. IC 348, L1455, & L1448).

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http://solo.colorado.edu/ walawend/research.shtml

The Masses of the Orion Proplyds from Submillimeter Dust Emission

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We have imaged the 880 μm continuum emission from the "proplyds" in the center of the Trapezium Cluster in Orion using the Submillimeter Array with a beam size 1.5″ FWHM and an rms of 2.7 mJy. Five sources are detected with fluxes in the range 18 to 38 mJy, which includes dust emission from four proplyds and ionized gas from θ^1 Ori G. The total masses of the detected proplyds derived from their dust emission range from 1.3 to 2.4×10^{-2} $M_\odot$ assuming a dust temperature of 20 K and mass opacity of 0.03 cm^2 g^{-1}. The eighteen other proplyds within the field-of-view were not formally detected individually, but by combining the fluxes measured at their locations, an average flux of 1.1mJy was determined for them on a statistical basis, corresponding to a mass of $8 \times 10^{-4} M_\odot$. The four detected proplyds have sufficient disk mass bound to their central stars to form planetary systems on the scale of our Solar System.

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astro-ph/0506225

Towards Planetesimals in the Disk around TW Hya: $\lambda = 3.5$ centimeter Dust Emission

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We present Very Large Array observations at $\lambda = 3.5$ cm of the nearby young star TW Hya that show the emission is constant in time over weeks, months and years, and spatially resolved with peak brightness temperature ~ 10 K at 0.″25 (15 AU) resolution. These features are naturally explained if the emission mechanism at this wavelength is thermal emission from dust particles in the disk surrounding the star. To account quantitatively for the observations, we construct a self-consistent accretion disk model that incorporates a population of centimeter size particles that matches the long wavelength spectrum and spatial distribution. A substantial mass fraction of orbiting particles in the TW Hya disk must have agglomerated to centimeter size. These data provide the first clear indication that dust emission from protoplanetary disks may be observed at centimeter wavelengths, and that changes in the spectral slope of the dust emission may be detected, providing constraints on dust evolution and the planet formation process.

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http://arxiv.org/abs/astro-ph/0506644

Stellar Activity on the Young Suns of Orion: COUP Observations of K5-7 Pre-Main Sequence Stars

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In January 2003, the *Chandra* Orion Ultradeep Project (COUP) detected about 1400 young stars during a 13.2 day observation of the Orion Nebula Cluster (ONC). This paper is a study of the X-ray properties of a well-defined sample of 28 solar-mass ONC stars based on COUP data. Our goals are to characterize the magnetic activity of analogs of the young Sun and thereby to improve understanding of the effects of solar X-rays on the solar nebula during the era of planet formation. Given the length of the COUP observation we are able to clearly distinguish characteristic and flare periods for all stars. We find that active young Suns spend 70% of their time in a characteristic state with relatively constant flux and magnetically confined plasma with temperatures $kT_2 \simeq 2.1 \times kT_1$. During characteristic periods, the $0.5 - 8$ keV X-ray luminosity is about 0.03% of the bolometric luminosity. One or two powerful flares per week with peak luminosities $\log L_x \sim 30 - 32$ ergs s^{-1} are typically superposed on this characteristic emission accompanied by heating of the hot plasma component from $\simeq 2.4$ keV to $\simeq 7$ keV at the flare peak. The energy distribution of flares superposed on the characteristic emission level follows the relationship $dN/dE \propto E^{-1.7}$. The flare rates are consistent with the production of sufficiently energetic protons to spawn a spallogenic origin of some important short-lived radionuclides found in ancient meteorites. The X-rays can ionize gas in the circumstellar disk at a rate of 6×10^{-9} ionizations per second at 1 AU from the central star, orders of magnitude above cosmic ray ionization rates. The estimated energetic particle fluences are sufficient to account for many isotopic anomalies observed in meteoritic inclusions.

Accepted by ApJS

Dissertation Abstracts

Late-stage Accretion and Habitability of Terrestrial Planets

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Ph.D dissertation directed by: Thomas Quinn

Ph.D degree awarded: June 2005

The final stage in the formation of terrestrial planets consists of the accumulation of ~ 1000 km "planetary embryos" and ~ 1 km planetesimals via collisional accretion, under the mutual gravity of other solid bodies and the gas giant planets (if any). Water is delivered to planets via collisions with volatile-rich bodies that condensed past the snow line, beyond about 2.5 AU.

We present results of a large number of relatively low-resolution simulations, designed to assess the predictability of systems of terrestrial planets as a function of "observables" such as the orbit of gas giant planets. These show that a variety of terrestrial planets can form, from small, dry, Mars-like worlds to planets with similar properties to Earth, to > 3 Earth mass "water worlds" with ≥ 30 times as much water as the Earth. The terrestrial planets are largely shaped by the influence of the giant planets and the surface density of material. We have uncovered trends between the terrestrial planets and i) the mass, ii) the orbital distance and iii) the orbital eccentricity of a giant planet, iv) the surface density of the disk, and v) the disk's density profile.

Five simulations with 1000-2000 particles reveal new aspects of the accretion process. Water is delivered to the terrestrial planets as a few large planetary embryos in a "hit or miss" process, and as billions of planetesimals in a statistically robust way. The water delivery process is therefore more robust than previously thought, implying that the range of water contents of extra-solar Earths is less stochastic than indicated in previous studies; most planets accrete water-rich bodies.

We simulate terrestrial accretion in the presence of close-in giant planets (e.g., "hot jupiters"), assuming these form and migrate quickly. Potentially habitable planets can form in these systems, but are likely to be iron-poor. Asteroid belts may exist between the terrestrial planets and hot jupiters in these systems. We have also tested the accretion process in four known extra-solar planetary systems. In 55 Cancri, terrestrial planets form relatively easily, and may have orbits in the habitable zone and significant water contents.

New Jobs

J. MAYO GREENBERG SCHOLARSHIP PRIZE

Leiden Observatory and the Leids Universiteitfonds have pleasure in inviting applications for the second J. Mayo Greenberg Scholarship Prize

Mrs. Naomi Greenberg and family members of the late Professor J. Mayo Greenberg, the distinguished Leiden astrophysicist who died on 29 November 2001, have generously provided funds for this scholarship in memory of Professor Greenberg.

The purpose of the funds is to provide an opportunity for a talented needy graduate student to come to Leiden for a period of about 3 months carrying out research and/or receiving education at Leiden in one or more of the following fields that were of interest to Professor Greenberg: Laboratory astrophysics, Comet formation, Interstellar dust and the Origin of life. Although applications will be considered from the whole world, preference will be given to applicants resident in Asia, Africa or South America.

For students from developing countries, the ICSC - World Laboratory will provide additional funding to extend the stay of the student for up to 6 months, making a total maximum period for the visit of 9 months.

Applications for the second prize (2006-07 time-frame) should be received before 30 September 2005. They should include a curriculum vitae and a statement containing the purpose for which the grant is requested (including duration) and a motivation for the request. Applicants should arrange for 2 - 3 references to be sent under separate cover.

Applications should be addressed to:
Professor G.K. Miley,
Chairman, Selection Committee,
J. Mayo Greenberg Scholarship Prize,
Leiden Observatory,
Postbus 9513, 2300 RA Leiden,
THE NETHERLANDS

Applications can also be sent via email to drost@strw.leidenuniv.nl, with the relevant documentation as attachments in MSWord, latex, pdf or postcript format.

The results of the selection will be announced on or before 15 December 2005.

PPARC Postdoctoral Fellowships in the United Kingdom

PPARC offers a number of Postdoctoral (3-year) and Advanced (5-year) Fellowships, the details of which can be found at http://www.pparc.ac.uk/Rs/Fs/Fw/Fellindex.asp.

The closing date for applications is 15 October 2005. However, applicants will need to contact sponsoring institutions well before this date. Those interesting in working on star or planet formation are encouraged to approach the following, or another contact they may have at a UK institution.

Armagh Observatory	Michael Smith
Cavendish Astrophysics, Cambridge	John Richer
DAMTP, Cambridge	John Papaloizou
Institute of Astronomy, Cambridge	Cathie Clarke
Queen Mary, London	Richard Nelson
Open University	Barry Jones
University College, London	Jonathan Rawlings
University of Cardiff	Ant Whitworth
University of Exeter	Matthew Bate
University of Hertfordshire	Phil Lucas
University of Leeds	Tom Hartquist
University of Manchester	Gary Fuller
University of Oxford	Pat Roche
University of St. Andrews	Ian Bonnell

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New Books

Star Formation in the Interstellar Medium

In Honor of David Hollenbach, Chris McKee and Frank Shu

Edited by D. Johnstone, F.C. Adams, D.N.C. Lin, D.A. Neufeld, & E.C. Ostriker

These are the proceedings of a conference held at Lake Tahoe in California on 30 June to 3 July, 2003. The following is a selection of the larger of the papers in the book.

The Disruption of Planet-Forming Disks *D. Hollenbach & F.C. Adams*
Massive Star Formation: Now and Then *C.F. McKee*
The Stellar Initial Mass Function *F.H. Shu, Z.-Y. Li, & A. Allen*
The Neutral ISM in Luminous Compact Blue Galaxies *J.P. Williams & C.A. Garland*
Star Formation in the Central regions of Disk Galaxies *C. Yuan & D.C.C. Yen*
Observed Properties of the Diffuse HI *C. Heiles*
Ambipolar Diffusion in a Turbulent Medium E.G. Zweibel
HI SNRs, FV Wings, and the Structure of the ISM *B.-C. Koo*
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The Formation and Evolution of Massive Young Star Clusters

Edited by H.J.G.L.M. Lamers, L.J. Smith, & A. Nota

These are the proceedings of a conference held in Cancun, Mexico on 17-21 November 2003. The following is a selection of the larger of the papers in the book.

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Short Announcements

Colleagues –

On behalf of the Chandra Orion Ultradeep Project (COUP) Team, I announce the release of 13 papers and associated data products. These studies are based on a nearly-continuous two-week observation of the Orion Nebula with the Chandra X-ray Observatory. It provides a comprehensive view of magnetic activity and flares in pre-main sequence stars. The papers will appear in a special issue of the Astrophysical Journal Supplements in October. The source tables, images and 1616-page Source Atlas can be downloaded from ftp://ftp.astro.psu.edu/pub/gkosta/COUP_PUBLIC.

Following are very brief descriptions of the papers with links to the full texts. A better guide to COUP studies can be found at http://www.astro.psu.edu/coup.

Eric Feigelson

1. **Observations & source lists**
Getman et al. (2005a) http://arxiv.org/abs/astro-ph/0410136
Describes ACIS Extract methodology. Gives comprehensive maps of the COUP field and tables of the 1616 sources with X-ray properties and stellar counterparts. Source Atlas shows images, spectra, lightcurves & properties of each source.

2. **Orion population membership**
Getman et al. (2005b) http://arxiv.org/abs/astro-ph/0504370
Identifies several dozen new YSOs in the Orion Nebula region, 2 Herbig-Haro outflow X-ray sources, a few foreground stars, and 159 probable background extragalactic sources.

3. **Global X-ray properties of the Orion Nebula**
Feigelson et al. (2005) http://arxiv.org/abs/astro-ph/0506503
Examines stellar X-ray luminosity functions (XLFs), spatial distribution (which suggests unvirialized dynamics), and the X-ray spectrum (which shows neon excess). Results are useful for comparison with distant young stellar clusters.

4. **Evolution of X-ray emission in young stars**
Preibisch & Feigelson (2005) http://arxiv.org/abs/astro-ph/0506052
Mass-stratified XLFs are compared to older populations to demonstrate monotonic decay of magnetic activity from 10^5 to 10^{10} yrs. M star evolution differs from solar mass evolution. The possible role of convective dynamos is discussed.

5. **Origins of young stellar X-rays**
Preibisch et al. (2005a) http://arxiv.org/abs/astro-ph/0506526
Correlation plots of X-ray emission vs. stellar mass, size, rotation, disks and accretion are examined. Strong dependencies on mass and bolometric luminosity are found, but not on rotation. Accreting stars produce somewhat lower X-ray emission. Extensive discussion follows.

6. **X-rays properties of young solar analogs**
Wolk et al. (2005) http://arxiv.org/abs/astro-ph/0507151
X-ray flare properties in a complete sample of 28 1-solar mass are presented. Every few days, each star exhibits a flare with peak logLx 30-32 erg/s. Flare statistics are similar to solar flares enhanced several orders of magnitudes in power.

7. **Rotational modulation of X-ray emission**
Flaccomio et al. (2005) http://arxiv.org/abs/astro-ph/0506164
10% of bright COUP sources show sinusoidal X-ray variations which can be attributed to rotational modulation of coronal structures. X-ray periods are 1 or 1/2 times the optical photometric periods.

8. **Modelling the brightest COUP flares**
Favata et al. (2005) http://arxiv.org/abs/astro-ph/0506134
The decay phases of bright flares are modeled as the cooling plasma in a magnetic loop. The evolution in some cases requires extremely long loops with L 10^{12} cm or 5-20 stellar radii. These may be star-disk magnetic fields.

9. **X-ray irradiation of protoplanetary disks**
Tsujimoto et al. (2005) http://arxiv.org/abs/astro-ph/0412608
Seven embedded YSOs with IR-excess disks show a 6.4 keV emission line from fluorescence by cold iron. Fluorescence

from the photosphere or foreground ISM is excluded, so we infer it arises from X-rays reflecting off the disk.

10. **X-rays, proplyds & protostellar jets**
Kastner et al. (2005) http://arxiv.org/abs/astro-ph/0506650
2/3 of 140 disks imaged with HST harbor COUP X-ray sources. The soft X-ray absorption increase with disk inclination, demonstrating X-ray ionization of disk gases. The Beehive system shows strong X-ray jet emission.

11. **Embedded clusters and protostars**
Grosso et al. (2005) http://arxiv.org/abs/astro-ph/0504204
Several dozen faint COUP sources are found in the BN/KL and OMC-1 South star forming regions including 4 high-mass mid-IR stars are detected and a spectacularly flaring protostar. BN is dominated by a low-mass companion. The total population of each cluster is 50 stars.

12. **Early-type Orion stars**
Stelzer et al. (2005) http://arxiv.org/abs/astro-ph/0505503
X-rays from 20 OBA Trapezium stars are studied. Stars later than B4 generally show emission from a low-mass companion. B3-O7 stars show combinations of soft-spectrum wind emission, hard-spectrum flares and magnetically confined wind shocks.

13. **Orion brown dwarfs**
Preibisch et al. (2005b) http://arxiv.org/abs/astro-ph/0506049
9 of 34 spectroscopically sub-stellar Orion members are detected as weak COUP sources. The X-ray luminosities, spectra and flare rates are similar to low-mass Orion stars.

The Star Formation Newsletter is a vehicle for fast distribution of information of interest for astronomers working on star formation and molecular clouds. You can submit material for the following sections: *Abstracts of recently accepted papers* (only for papers sent to refereed journals, not reviews nor conference notes), *Dissertation Abstracts* (presenting abstracts of new Ph.D dissertations), *Meetings* (announcing meetings broadly of interest to the star formation and interstellar medium community), *New Books* (giving details of books relevant for the same community), *New Jobs* (advertising jobs specifically aimed towards persons within our specialty), and *Short Announcements* (where you can inform or request information from the community).

Latex macros for submitting abstracts and dissertation abstracts are appended to each issue of the newsletter.

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