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Abstracts of recently accepted papers

Chemical analysis of 24 dusty (pre-)main-sequence stars

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We have analysed the chemical photospheric composition of 24 Herbig Ae/Be and Vega-type stars in search for the λ Bootis phenomenon. We present the results of the elemental abundances of the sample stars. Some of the stars were never before studied spectroscopically at optical wavelengths. We have determined the projected rotational velocities of our sample stars. Furthermore, we discuss stars that depict a (selective) depletion pattern in detail. HD 4881 and HD 139614 seem to display an overall deficiency. AB Aur and possibly HD 126367 have subsolar values for the iron abundance, but are almost solar in silicon. HD 100546 is the only clear λ Bootis star in our sample.

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<http://arxiv.org/pdf/astro-ph/0408221>

A Near-Infrared (JHK) Survey of the Vicinity of the HII region NGC 7538: Evidence for a Young Embedded Cluster

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We describe the results of two near infrared (K -band) imaging surveys and a three color (JHK) survey of the vicinity of NGC 7538. The limiting magnitudes are $K \simeq 16.5$ and $K \simeq 17.5$ mag for the K -band surveys and $K \simeq 15$ mag for the JHK survey. We identify more than 2000 and 9000 near-infrared (NIR) sources on the images of the two K -band surveys and 786 NIR sources in the JHK survey. From color-color diagrams, we derive a reddening law for background stars and identify 238 stars with NIR excesses. Contour maps indicate a high density peak coincident with a concentration of stars with NIR excesses. We identify this peak as a young, embedded cluster and confirm this result with the K -band luminosity function, color histograms, and color-magnitude diagrams. The center of the cluster is at $RA = 23:13:39.34$, $DEC = 61:29:18.9$. The cluster radius is $\sim 3' \sim 2.5$ pc for an adopted distance, $d \simeq 2.8$ kpc. For $d = 2.8$ kpc, and reddening, $E_{J-K} = 0.55$ mag, the slope of the logarithmic K -band luminosity function (KLF) of the cluster, $s \sim 0.32 \pm 0.03$, agrees well with previous results for L1630 ($s = 0.34$) and M17 ($s = 0.26$)

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The Unique Eclipsing System KH 15D: New Photometric Data

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We present results of the photometric observations of the young eclipsing binary KH 15D obtained during the two observational seasons of 2002-2004 years. A comparison of our data with those by Hamilton et al. (2001) and Herbst et al. (2002) reveals an existence of the long-term photometrical brightness trend: during 5 years a system brightness in the I band decreased by about one stellar magnitude. It is also shown that a systematic change of the eclipse parameters found by Herbst et al. (2002) is continuing up to now. The shape of the light curve did not change essentially and is characterized with a small brightening in the central part of the eclipses. The results obtained are discussed in the context of the current models of KH 15D.

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The preprint is available at astro-ph/0409060

Accretion Signatures from Massive Young Stellar Objects

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High resolution ($\lambda/\Delta\lambda = 50,000$) K -band spectra of massive, embedded, young stellar objects are presented. The present sample consists of four massive young stars located in nascent clusters powering Galactic giant H II regions. Emission in the $2.3\ \mu\text{m}$ 2-0 vibrational-rotational bandhead of CO is observed. A range of velocity broadened profiles seen in three of the objects is consistent with the emission arising from a circumstellar disk seen at various inclination angles. Br γ spectra of the same spectral and spatial resolution are also presented which support an accretion disk or torus model for massive stars. In the fourth object, Br emission suggesting a rotating torus is observed, but the CO profile is narrow, indicating that there may be different CO emission mechanisms in massive stars and this is consistent with earlier observations of the BN object and MWC 349. To-date, only young massive stars of late O or early B types have been identified with clear accretion disk signatures in such embedded clusters. Often such stars are found in the presence of other more massive stars which are revealed by their photospheric spectra but which exhibit no disk signatures. This suggests the timescale for dissipating their disks is much faster than the less massive OB stars or that the most massive stars do not form with accretion disks.

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preprints: <http://xxx.lanl.gov/abs/astro-ph/0409190>

Evolution of the Solar Nebula. VI. Mixing and Transport of Isotopic Heterogeneity

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Meteoritical studies have shown that the solar nebula was basically well-mixed, as shown by the homogeneity of many isotopes of refractory elements. However, isotopic anomalies in certain elements, such as the short-lived isotope ^{26}Al , imply the presence of either spatial or temporal heterogeneity. Spatial heterogeneity could result from the injection of short-lived isotopes into the solar nebula following their production in a supernova, or from spraying these isotopes

across the nebula's surface following their production by solar flares and transport outward by an X-wind. If the nebula was thoroughly mixed soon after the introduction of spatially heterogeneous ^{26}Al , producing a homogeneous spatial distribution of ^{26}Al , then the measured abundances of ^{26}Al provide a chronometer for early Solar System processes. For these reasons and others it is important to understand the efficiency of mixing and transport processes in the solar nebula. Here we study mixing and transport in fully three dimensional models of gravitationally-unstable disks that are likely to occur during the phase when planetesimal growth is beginning. The 3D models show that isotopes which are sprayed onto an annular region of the surface of a disk around 9 AU remain remarkably concentrated after $\sim 10^3$ yrs, in spite of mixing by convection, which transports material between the surface and midplane on time scales of ~ 30 yrs, and radially inward and outward as well. Mixing caused by a generic turbulent viscosity dominates only when $\alpha \geq 0.01$, implying that the effective α of the convective motions and gravitational torques is $\alpha \sim 10^{-3}$. The 3D models show that spatial heterogeneity can persist in a disk evolving by gravitational torques for significant periods, even in the most dynamically active region. This time period, $\sim 10^3$ yrs, is similar to the time scale for presolar dust grains to coagulate while settling to the midplane and growing to cm-size. If such solids can be preserved and incorporated into chondrites, then it is conceivable that some observed isotopic anomalies could have been derived from a spatially heterogeneous nebula.

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Preprint available at <http://www.ciw.edu/boss/ftp/nebulavi/>

3-D numerical simulations of rotating jets: The case of the DG Tau microjet

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We here present results of three-dimensional Smoothed Particle hydro and magnetohydrodynamics simulations of rotating jets, also including the effects of radiative cooling, precession and velocity variability. Using initial conditions and parameters which are particularly suitable for the DG Tau microjet, we have been able to approximately reproduce its complex knotty morphology and kinematics. We have also obtained radial velocity maps which are in good qualitative and quantitative agreement with the data obtained by Bacciotti et al., thus indicating that their interpretation that the DG Tau microjet is rotating is correct. Finally, we have found that a magnetic field of the order of ≈ 0.5 mG is sufficient to collimate the jet against the lateral expansion that is caused by the centrifugal forces.

Accepted by *Astronomy and Astrophysics Letters*

A molecular line survey of Orion-KL in the 350- μm band

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With the Caltech Submillimeter Observatory, we have carried out an unbiased spectral line survey of Orion-KL throughout the 350- μm band (from 795 to 903 GHz). This is the *first* systematic study of molecular radiation in this frequency range. 541 features, resulting from 929 transitions from a total of 26 species, have been detected. High-excitation transitions from CH_3OH , CH_3CN , H_2CO , HNCO and $\text{C}_2\text{H}_5\text{CN}$ indicate the presence of a very hot (~ 250 K) component at the systemic velocity characteristic of the Hot Core. Physical parameters (column density and rotational temperature) relative to a number of species have been estimated by fitting, in the LTE approximation, the whole 100-GHz spectrum at once, thus taking line blending and optical depth effects properly into account. We also report the tentative detection, for the first time outside the Galactic Center region, of the radical NH_2 , one of the building blocks of the chemistry of ammonia.

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<ftp://ftp.mpifr-bonn.mpg.de/outgoing/ccomito/survey/paper/accepted/orion-850ghz-ApJS.ps.gz>

Improved fundamental parameters for the low-mass Pre-Main Sequence eclipsing system RX J0529.4+0041

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We report new photometric observations and a new determination of the fundamental stellar parameters for the low-mass pre-main sequence eclipsing system RX J0529.4+0041A based on high-precision, near-IR (*JHK*) differential photometry obtained using adaptive optics at the ESO-La Silla 3.6m telescope, and *UBV(RI)_C* CCD photometry performed with the OIG camera at TNG. The new photometric data, in combination with already published photoelectric photometry and solution of the radial velocity curve, yield a more precise determination of the absolute dimensions and masses as well as of other basic physical properties of the components.

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On the Rotation of Post-T Tauri Stars in Associations

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Nearby associations or moving groups of post-T Tauri stars with ages between ~ 10 and 30 Myr are excellent objects for the study of the initial spin up phase during the pre-main sequence evolution. An empirical approach is adopted here for the first time with these stars to infer their rotations properties and relations to X-ray emission. Three nearby associations with distances less than 100 pc are considered. The TW Hya association (TWA) with an age of 8 Myr, the Beta Pictoris moving group (BPMG) with an age of 12 Myr and a combination of Tucana and Horologium associations Tuc/HorA (30 Myr). Two low and high rotation modes are considered for each association with stellar masses of $0.1 \leq M < 1.5 M_{\odot}$ and $1.5 \leq M \leq 2.6 M_{\odot}$ respectively. Because no observed rotational periods are known for these stars, we use a mathematical tool to infer representative equatorial rotation velocities $v_0(eq)$ from the observed distribution of projected rotational velocities ($v \sin i$). This is done for each mode and for each association. A spin up is found for the high rotation mode, whereas in the low rotation mode the $v_0(eq)$ do not increase significantly. This insufficient increase of $v_0(eq)$ is probably the cause of a decrease of the total mean specific angular momentum for the low mass stars between 8 and 30 Myr. However, for the high mass stars, where a sufficient spin up is present, the specific angular momentum is practically conserved in this same time interval. A two dimensional (mass and $v \sin i$) K-S statistical test yields results compatible with an spin up scenario. By supposing that the distribution of masses of these three associations follows a universal mass function, we estimate the number of members of these associations that remain to be detected. The analysis of rotation and stellar masses using the luminosity X-rays indicators L_x and L_x/L_b present similar properties, as the dependence on stellar mass and rotation, at least for the younger associations TWA and BPMG, to those obtained for T Tauri stars in the Orion Nebula Cluster (1 Myr). A strong desaturation effect appears at ~ 30 Myr, the age of Tuc/HorA, measured essentially by the early G and late type F stars. This effect seems to be provoked by the minimum configuration of the stellar convection layers, attained for the first time for the higher mass stars at ~ 30 Myr. The desaturation appears to be independent of rotation at this stage.

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Quiescent Dense Gas in Protostellar Clusters: the Ophiuchus A Core

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We present combined BIMA interferometer and IRAM 30 m Telescope data of N_2H^+ 1–0 line emission across the nearby dense, star forming core Ophiuchus A (Oph A) at high linear resolution (e.g., ~ 1000 AU). Six maxima of integrated line intensity are detected which we designate Oph A-N1 through N6. The N4 and N5 maxima are coincident with the starless continuum objects SM1 and SM2 respectively but the other maxima are not coincident with previously-identified objects. In contrast, relatively little N_2H^+ 1–0 emission is coincident with the starless object SM2 and the Class 0 protostar VLA 1623. The FWHM of the N_2H^+ 1–0 line, ΔV , varies by a factor of ~ 5 across Oph A. Values of $\Delta V < 0.3 \text{ km s}^{-1}$ are found in 14 locations in Oph A, but only that associated with N6 is both well-defined spatially and larger than the beam size. Centroid velocities of the line, V_{LSR} , vary relatively little, having an rms of only $\sim 0.17 \text{ km s}^{-1}$. Small-scale V_{LSR} gradients of $< 0.5 \text{ km s}^{-1}$ over $\sim 0.01 \text{ pc}$ are found near SM1, SM1N, and SM2, but not N6. The low N_2H^+ abundances of SM2 or VLA 1623 relative to SM1, SM1N, or N6 may reflect relatively greater amounts of N_2 adsorption onto dust grains in their colder and probably denser interiors. The low ΔV of N6, i.e., 0.193 km s^{-1} FWHM, is only marginally larger than the FWHM expected from thermal motions alone, suggesting turbulent motions in the Oph A core have been reduced dramatically at this location. The non-detection of N6 in previous thermal continuum maps suggests that interesting sites possibly related to star formation may be overlooked in such data.

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Variability in the stellar initial mass function at low and high mass: 3-component IMF models

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Three component models of the IMF are made to consider possible origins for the observed relative variations in the numbers of brown dwarfs, solar-to-intermediate mass stars, and high mass stars. The differences between the IMFs observed for clusters, field, and remote field are also discussed. Three distinct physical processes that should dominate the three stellar mass regimes are noted. The characteristic mass for most star formation is identified with the thermal Jeans mass in the molecular cloud core, and this presumably leads to the middle mass range by the usual collapse and accretion processes. Pre-stellar condensations (PSCs) observed in mm-wave continuum studies presumably form at this mass. Significantly smaller self-gravitating masses require much larger pressures and may arise following dynamical processes inside these PSCs, including disk formation, tight-cluster ejection, and photoevaporation as studied elsewhere, but also gravitational collapse of shocked gas in colliding PSCs. Significantly larger stellar masses form in relatively low abundance by normal cloud processes, possibly leading to steep IMFs in low-pressure field regions, but this mass range can be significantly extended in high pressure cloud cores by gravitationally-focussed gas accretion onto PSCs and by the coalescence of PSCs. These models suggest that the observed variations in brown dwarf, solar-to-intermediate mass, and high mass populations are the result of dynamical effects that depend on environmental density and velocity dispersion. They accommodate observations ranging from shallow IMFs in cluster cores to Salpeter IMFs in average clusters and whole galaxies to steep and even steeper IMFs in field and remote field regions. They also suggest how the top-heavy IMFs in some starburst clusters may originate and they explain bottom-heavy IMFs in low surface brightness galaxies.

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High-velocity gas toward hot molecular cores: evidence for collimated outflows from embedded sources

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We present observations made with the Berkeley-Illinois-Maryland Association millimeter array of the H₂S 2(2,0)→2(1,1) and C¹⁸O 2→1 transitions toward a sample of four hot molecular cores associated with ultracompact H II regions: G9.62+0.19, G10.47+0.03, G29.96−0.02 and G31.41+0.31. The angular resolution varies from 1.5 to 2.4 arcsec, corresponding to scales of ∼0.06 pc at the distance of these sources. High-velocity wings characteristic of molecular outflows are detected toward all four sources in the H₂S line. In two cases (G29.96 and G31.41) red- and blueshifted lobes are clearly defined and spatially separate, indicating that the flows are collimated. We also confirm the previous detection of the outflow in G9.62F. Although the gas-phase H₂S abundance is not well constrained, assuming a value of 10^{−7} yields lower limits to total outflow masses of ∼8 M_⊙, values which are consistent with the driving sources being massive protostars. Linear velocity gradients are detected in both C¹⁸O and H₂S across G9.62, G29.96 and, to a lesser extent, G31.41. These gradients are observed to be at a different position angle to the outflow in G9.62F and G29.96, suggestive of a rotation signature in these two hot cores. Our observations show that these hot cores contain embedded massive protostellar objects which are driving bipolar outflows. Furthermore, the lack of strong centimeter-wave emission toward the outflow centers in G29.96 and G31.41 indicates that the outflow phase begins prior to the formation of a detectable ultracompact H II region.

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Long-term monitoring of 6.7-GHz methanol masers

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A sample of 54 6.7-GHz methanol masers was monitored using the Hartebeesthoek 26-m telescope during the period 1999 January – 2003 March. The observations were taken at 1–2 week intervals, with daily observations when possible if a source was seen to be varying rapidly. It was found that the majority of the sources display a significant level of variability. The time range of variations range from a few days up to several years. The types of behaviour observed included non-varying, monotonic increases or decreases, as well as aperiodic, quasi-periodic and periodic variations. Seven sources show clear evidence of periodicity, with periods ranging from 132 days up to 520 days.

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Infrared Emission Lines of [Fe II] as Diagnostics of Shocked Gas in Stellar Jets

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We predict fluxes for the brightest lines of [Fe II] at wavelengths longer than 8000 Å for several radiative shocks whose parameters resemble those typically present in stellar jets. The models show that the brightest lines are those at 1.257 μm, 1.643 μm, 5.340 μm, 17.94 μm, and 25.99 μm. Depending on the model, these lines typically have comparable fluxes and are usually brighter than the [O I] 63.3 μm and [Si II] 34.8 μm lines. We call attention to the 5.34 μm line of Fe II, which cannot be seen from the ground but should be easily observable with the Spitzer satellite and SOFIA for many sources. This line should be an excellent probe of outflows from the youngest stars; at mid-IR wavelengths,

it penetrates through most dusty regions of star formation, yet has a short enough wavelength to retain good spatial resolution in diffraction-limited images obtainable from space.

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<http://sparky.rice.edu/~hartigan/pub.html>

Molecular Hydrogen Kinematics in Cepheus A

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We present the radial velocity structure of the molecular hydrogen outflows associated to the star forming region Cepheus A. This structure is derived from the doppler shift of the H₂ $v=1-0$ $S(1)$ emission line obtained by Fabry–Pérot spectroscopy. The East and West regions of emission, called Cep A (E) and Cep A (W), show radial velocities in the range of -20 to 0 km s⁻¹ with respect to the molecular cloud. Cep A (W) shows an increasing velocity with position offset from the core indicating the existence of a possible accelerating mechanism. Cep A (E) has an almost constant mean radial velocity of -18 km s⁻¹ along the region although with a large dispersion in velocity, indicating the possibility of a turbulent outflow. A detailed analysis of the Cep A (E) region shows evidence for the presence of a Mach disk on that outflow. Also, we argue that the presence of a velocity gradient in Cep A (W) is indicative of a C-shock in this region. Following Riera et al. (2003), we analyzed the data using wavelet analysis to study the line width and central radial velocity distributions. We found that both outflows have complex spatial and velocity structure characteristic of a turbulent flow.

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Molecular Line Observations of Carbon-Chain-Producing Regions L1495B and L1521B

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We present the first comprehensive study on physical and chemical properties of quiescent starless cores L1495B and L1521B, which are known to be rich in carbon-chain molecules like the cyanopolyne peak of TMC-1 and L1521E. We have detected radio spectral lines of various carbon-chain molecules such as CCS, C₃S, C₄H, HC₃N, and HC₅N. On the other hand, the NH₃ lines are weak and the N₂H⁺ lines are not detected. According to our mapping observations of the HC₃N, CCS, and C₃S lines, the dense cores in L1495B and L1521B are compact with the radius of 0.063 and 0.044 pc, respectively, and have a simple elliptical structure. The distributions of CCS seem to be different from those of well-studied starless cores, L1498 and L1544, where the distribution of CCS shows a shell-like structure. Since the H¹³CO⁺, HN¹³C, and C³⁴S lines are detected in L1495B and L1521B, the densities of these cores are high enough to excite the NH₃ and N₂H⁺ lines. Therefore, the abundances of NH₃ and N₂H⁺ relative to carbon-chain molecules are apparently deficient, as observed in L1521E. We found that longer carbon-chain molecules such as HC₅N and C₄H are more abundant in TMC-1 than L1495B and L1521B, while those of sulfur-bearing molecules such as C³⁴S, CCS, and C₃S are comparable. Both distributions and abundances of the observed molecules of L1495B and L1521B are quite similar to those of L1521E, strongly suggesting that L1495B and L1521B is in a very early stage of physical and chemical evolution.

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<http://www.nro.nao.ac.jp/library/report/>

Looking for outflows from brown dwarfs

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First evidences of IR excess and disk mass accretion (strong H α emission) around brown dwarfs seem to indicate the existence of circumstellar disks around these sub-stellar objects. Nothing is known at the present time about outflows which potentially might be launched from brown dwarfs, although jets are typically associated with the accretion in standard T Tauri star disks. In this paper we calculate the H α emission of internal working surfaces produced by a radiative jet in a neutral and in a photoionized environment as a function of the jet parameters (the ejection velocity v_j , shock velocity v_s , mass loss rate \dot{M} and radius r_j of the jet) and we provide estimates of the H α luminosity for the parameters of “standard” Herbig-Haro (HH) jets from T Tauri stars and for the parameters expected for jets from BDs. Interestingly, we find that while the mass loss rates associated with jets from BDs are found to be two orders of magnitude lower than the mass loss rates associated with “standard” HH jets (from T Tauri stars), their velocities are likely to be similar. Based on our calculations, we discuss the conditions in which jets from BDs can be detected and we conclude that the H α luminosities of internal working surfaces of jets from BDs in a photoionized environment should have only one order of magnitude lower than the H α luminosities of T Tauri jets in a neutral environment.

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The V1647 Ori (IRAS 05436-0007) Protostar and Its Environment

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We present Sloan Digital Sky Survey and United States Naval Observatory observations of the V1647 Ori protostar and surrounding field near NGC 2068. V1647 Ori, the likely driving source for HH 23, brightened significantly in November 2003. Analysis of SDSS imaging acquired in November 1998 and February 2002 during the quiescent state, recent USNO photometry, and published 2MASS and Gemini data shows that the color changes associated with brightening suggest an EXor outburst rather than a simple dust clearing event.

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<http://astro.nmsu.edu/~peregrin/research/mcneil/v1647ori.ps>

Initial Results from the Palomar Adaptive Optics Survey of Young Solar-Type Stars: a Brown Dwarf and Three Stellar Companions

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We present first results from the Palomar Adaptive Optics Survey of Young Stars conducted at the Hale 5 m telescope. Through direct imaging we have discovered a brown dwarf and two low-mass stellar companions to the young solar-type stars HD 49197, HD 129333 (EK Dra), and V522 Per, and confirmed a previously suspected companion to

RX J0329.1+0118 (Sterzik et al. 1997), at respective separations of 0.95'' (43 AU), 0.74'' (25 AU), 2.09'' (400 AU), and 3.78'' (380 AU). Physical association of each binary system is established through common proper motion and/or low-resolution infrared spectroscopy. Based on the companion spectral types, we estimate their masses at 0.06, 0.20, 0.13, and 0.20 M_{\odot} , respectively. From analysis of our imaging data combined with archival radial velocity data, we find that the spatially resolved companion to HD 129333 is potentially identical to the previously identified spectroscopic companion to this star (Duquennoy & Mayor 1991). However, a discrepancy with the absolute magnitude suggests that the two companions could also be distinct, with the resolved one being the outermost component of a triple system. The brown dwarf HD 49197B is a new member of a growing list of directly imaged sub-stellar companions at 10–1000 AU separations from main sequence stars, indicating that such brown dwarfs may be more common than initially speculated.

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Magnetospheres and Disk Accretion in Herbig Ae/Be Stars

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We present evidence of magnetically-mediated disk accretion in Herbig Ae/Be stars. Magnetospheric accretion models of Balmer and sodium profiles calculated with appropriate stellar and rotational parameters are in qualitative agreement with the observed profiles of the Herbig Ae star UX Ori, and yield a mass accretion rate of $\sim 10^{-8} M_{\odot} \text{ yr}^{-1}$. If more recent indications of an extremely large rotation rate for this object are correct, the magnetic field geometry must deviate from that of a standard dipole in order to produce line emission consistent with observed flux levels. Models of the associated accretion shock qualitatively explain the observed distribution of excess fluxes in the Balmer discontinuity for a large ensemble of Herbig Ae/Be stars, and imply typically small mass accretion rates, $< 10^{-7} M_{\odot} \text{ yr}^{-1}$. In order for accretion to proceed onto the star, significant amounts of gas must exist inside the dust destruction radius, which is potentially problematic for recently advocated scenarios of “puffed” inner dust wall geometries. However, our models of the inner gas disk show that for the typical accretion rates we have derived, the gas should be generally optically thin, thus allowing direct stellar irradiation of the inner dust edge of the disk.

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Probing the embedded YSOs of the R CrA region through VLT-ISAAC spectroscopy

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Near IR spectra at low ($R \sim 800$) and medium ($R \sim 9000$) resolution, obtained with ISAAC at VLT, have been used to pose constraints on the evolutionary state and accretion properties of a sample of five embedded YSOs located in the R CrA core. This sample includes three Class I sources (HH100 IR, IRS2 and IRS5), and two sources with NIR excesses (IRS6 and IRS3). IRS5 and IRS6 have been discovered to be binaries with a separation between the two components of 97 and 78 AU, respectively. Absorption lines, typical of late-type photospheres, have been detected in the medium resolution spectra of all the observed targets, including HH100 IR and IRS2 which have high values of infrared continuum veiling ($r_k = 6$ and 3, respectively). These two sources also present low resolution spectra rich of emission lines (HI, CO and plenty of other permitted lines from neutral atoms) likely originating in the disk-star-wind connected regions. Among the features observed in HH100 IR and IRS2, Na I at 2.205 μm and CO at 2.3 μm which are more commonly used for stellar classification, are detected in emission instead of absorption. Several strong photospheric lines, which lie around 2.12 and 2.23 μm and whose ratio is sensitive to both effective temperature and

gravity, are proposed as independent diagnostic tools for this type of sources. We derived spectral types, veiling and stellar luminosity of the five observed sources, which in turn have been used to infer their mass (ranging between 0.3-1.2 M_{\odot}) and age (between 10^5 and 10^6 yr) adopting pre-main sequence evolutionary tracks. We find that in HH100 IR and IRS2 most of the bolometric luminosity is due to accretion ($L_{acc}/L_{bol} \sim 0.8$ and 0.6 respectively), while the other three investigated sources, including the Class I object IRS5a, present a low accretion activity ($L_{acc}/L_{bol} < 0.2$). Mass accretion rates of the order of $2 \cdot 10^{-6}$ and $3 \cdot 10^{-7} M_{\odot} \text{ yr}^{-1}$ are derived for HH100 IR and IRS2, respectively, i.e. higher by an order of magnitude with respect to the average values derived in T Tauri stars. We observe a general correlation between the accretion luminosity, the IR veiling and the emission line activity of the sources. In particular, we find that the correlation between L_{acc} and $L_{Br\gamma}$, previously reported for optical T Tauri stars, can be extended also to the embedded sources, up to at least one order of magnitude larger line luminosity. A correlation between the accretion activity and the spectral energy distribution slope is recognizable but with the notable exception of IRS5a. Our analysis therefore shows how the definition of the evolutionary stage of deeply embedded YSOs by means of IR colors needs to be more carefully refined.

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Preprint available at <http://www.mporzio.astro.it/~bruni/publ.html>
or <http://xxx.lanl.gov/abs/astro-ph/0408574>

A near-infrared study of the NGC 7538 star forming region

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We present sub-arcsecond (FWHM $\sim 0''.7$), near-infrared (NIR) JHK_s-band images and a high sensitivity radio continuum image at 1280 MHz, using SIRIUS on UH 88-inch telescope and GMRT. The NIR survey covers an area of ~ 24 arcmin² with 10σ limiting magnitudes of ~ 19.5 , 18.4 , and 17.3 in J, H, and K_s-band, respectively. Our NIR images are deeper than any JHK surveys to date for the larger area of NGC 7538 star forming region. We construct JHK color-color and J-H/J and H-K/K color-magnitude diagrams to identify young stellar objects (YSOs) and to estimate their masses. Based on these color-color and color-magnitude diagrams, we identified a rich population of YSOs (Class I and Class II), associated with the NGC 7538 region. A large number of red sources (H-K > 2) have also been detected around NGC 7538. We argue that these red stars are most probably pre-main sequence stars with intrinsic color excesses. Most of YSOs in NGC 7538 are arranged from the north-west toward south-east regions, forming a sequence in age: the diffuse H II region (north-west, oldest: where most of the Class II and Class I sources are detected); the compact IR core (center); and the regions with the extensive IR reflection nebula and a cluster of red young stars (south-east and south). We find that the slope of the K_s-band luminosity function of NGC 7538 is lower than the typical values reported for the young embedded clusters, although equally low values have also been reported in the W3 Main star forming region. From the slope of the K_s-band luminosity function and the analysis by Megeath et al. (1996), we infer that the embedded stellar population is comprised of YSOs with an age of ~ 1 Myr. Based on the comparison between models of pre-main sequence stars with the observed color-magnitude diagram we find that the stellar population in NGC 7538 is primarily composed of low mass pre-main sequence stars similar to those observed in the W3 Main star forming region. The radio continuum image from the GMRT observations at 1280 MHz shows an arc-shaped structure due to the interaction between the H II region and the adjacent molecular cloud. The ionization front at the interface between the H II region and the molecular cloud is clearly delineated by comparing the radio continuum, molecular line, and near-infrared images.

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A new Constraint on the Formation of Jupiter

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Data from the mass spectrometer on the Galileo Probe indicate an approximately uniform enrichment (relative to hydrogen) of 3 ± 1 times the solar value for Ar, Kr, Xe, C, S and N on Jupiter. These data also reveal that $^{15}\text{N}/^{14}\text{N} = 2.3\pm 0.3 \times 10^{-3}$ in Jupiter's nitrogen, indicating that this element reached the planet primarily in the form of N_2 . These two findings strongly suggest that a disk instability in the solar nebula could not have produced this giant planet.

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Planets opening dust gaps in gas disks

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We investigate the interaction of gas and dust in a protoplanetary disk in the presence of a massive planet using a new two-fluid hydrodynamics code. In view of future observations of planet-forming disks we focus on the condition for gap formation in the dust fluid. While only planets more massive than 1 Jupiter mass open up a gap in the gas disk, we find that a planet of 0.1 Jupiter mass already creates a gap in the dust disk. This makes it easier to find lower-mass planets orbiting in their protoplanetary disk if there is a significant population of mm-sized particles.

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<ftp://ftp.strw.leidenuniv.nl/pub/mellema/preprints/dustletter.ps.gz>

L183 (L134N) Revisited III. The gas depletion

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We present a detailed study of the gas depletion in L183 (= L134N) for a set of important species, namely, CO, CS, SO, N_2H^+ and NH_3 . We show that all these species are depleted at some level. This level seems to depend mostly on a density threshold rather than on dust opacity. Therefore UV shielding would not be a main factor in the triggering of depletion. Our data suggest that CO, CS and SO depletion happen at densities of $\sim 3 \times 10^4$ cc, while N_2H^+ and NH_3 seem to deplete at densities close to 10^6 cc. The latter result is consistent with the Bergin & Langer (1997) polar (H_2O) ice case but not with the more recent models of Aikawa et al. (2003). CS depletion occurs much below its (J:2-1) critical density, (7×10^5 cc) and therefore makes this species unsuitable to study the density structure of many dark cloud cores.

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http://aramis.obspm.fr/~pagani/l183_aa_a2.pdf

Accelerated planetesimal growth in self-gravitating protoplanetary discs

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In this paper we consider the evolution of small planetesimals (radii $\sim 1 - 10$ metres) in marginally stable, self-gravitating protoplanetary discs. The drag force between the disc gas and the embedded planetesimals generally causes the planetesimals to drift inwards through the disc at a rate that depends on the particle size. In a marginally stable, self-gravitating disc, however, the planetesimals are significantly influenced by the non-axisymmetric spiral structures resulting from the growth of the gravitational instability. The drag force now causes the planetesimals to drift towards the peaks of the spiral arms where the density and pressure are highest. For small particles, that are strongly coupled to the disc gas, and for large particles, that have essentially decoupled from the disc gas, the effect is not particularly significant. Intermediate sized particles, which would generally have the largest radial drift rates, do, however, become significantly concentrated at the peaks of the spiral arms. These high density regions may persist for, of order, an orbital period and may attain densities comparable to that of the disc gas. Although at the end of the simulation only $\sim 25\%$ of the planetesimal particles lie in regions of enhanced density, during the course of the simulation at least 75% of the planetesimal particles have at some stage been in a such a region. We find that the concentration of particles in the spiral arms results in an increased collision rate, an effect that could significantly accelerate planetesimal growth. The density enhancements may also be sufficient for the growth of planetesimals through direct gravitational collapse. The interaction between small planetesimals and self-gravitating spiral structures may therefore play an important role in the formation of large planetesimals that will ultimately coagulate to form terrestrial planets or the cores of gas/ice giant planets.

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ISO observations of the Galactic center Interstellar Medium: neutral gas and dust

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The 500 central pc of the Galaxy (hereafter GC) exhibit a widespread gas component with a kinetic temperature of 100-200 K. The bulk of this gas is not associated to the well-known thermal radio continuum or far infrared sources like Sgr A or Sgr B. How this gas is heated has been a longstanding problem. With the aim of studying the thermal balance of the neutral gas and dust in the GC, we have observed 18 molecular clouds located at projected distances far from thermal continuum sources with the Infrared Space Observatory (ISO). In this paper we present observations of several fine structure lines ([OI] 63 and 146 μm , [CII] 158 μm , [Si II] 35 μm , [S I] 25 μm and [Fe II] 26 μm), which are the main coolants of the gas with kinetic temperatures of several hundred K. We also present the full continuum spectra of the dust between 40 and 190 μm . All the clouds exhibit a cold dust component with a temperature of ~ 15 K. A warmer dust component is also required to fit the spectra. The temperature of this dust component changes between 27 and 42 K from source to source. We have compared the gas and the dust emission with the predictions from J-type and C-type shocks and photodissociation region (PDRs) models. We conclude that the dust and the fine structure lines observations are best explained by a PDR with a density of 10^3 cm^{-3} and an incident far-ultraviolet field 10^3 times higher than the local interstellar radiation field. The fine structure line emission arises in PDRs in the interface between a diffuse ionized gas component and the dense molecular clouds. The [CII] 158 μm and [Si II] 35 μm lines also have an important contribution from the ionized gas component. PDRs can naturally explain the discrepancy between the gas and the dust temperatures. However, these PDRs can only account for 10-30% of the total H_2 column density with a temperature of ~ 150 K. We discuss other possible heating mechanisms for the rest the warm molecular gas, such as non-stationary PDRs, X-ray Dominated Regions (XDRs) or the dissipation of supersonic turbulence.

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<http://arxiv.org/abs/astro-ph/0407479> or <http://aramis.obspm.fr/~nemesio/out/1370.ps.gz>

The Double-Lined Spectroscopic Binary Haro 1-14c

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We report detection of the low-mass secondary in the spectroscopic binary Haro 1-14c in the Ophiuchus star forming region. The secondary/primary mass ratio is 0.310 ± 0.014 . With an estimated photometric primary mass of $1.2 M_{\odot}$, the secondary mass is $\sim 0.4 M_{\odot}$ and the projected semi-major axis is ~ 1.5 AU. The system is well-suited for astrometric mapping of its orbit with the current generation of ground-based IR interferometers. This could yield precision values of the system's component masses and distance.

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Model of W3(OH) environment based on data for both maser and ‘quasi-thermal’ methanol lines

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In studies of the environment of massive young stellar objects, recent progress in both observations and theory allows a unified treatment of data for maser and ‘quasi-thermal’ lines. Interferometric maser images provide information on the distribution and kinematics of masing gas on small spatial scales. Observations of multiple masing transitions provide constraints on the physical parameters.

Interferometric data on ‘quasi-thermal’ molecular lines permits an investigation of the overall distribution and kinematics of the molecular gas in the vicinity of young stellar objects, including those which are deeply embedded. Using multiple transitions of different molecules, one can obtain good constraints on the physical and chemical parameters. Combining these data enables the construction of unified models, which take into account spatial scales differing by orders of magnitude.

The paper is devoted to the implications of such combined analysis to the studies of environment of the W3(OH) ultracompact HII region. This includes structure of the methanol masing region, physical structure of the near vicinity of W3(OH), detection of a new masers in the large-scale shock front and embedded sources in the vicinity of the TW young stellar object.

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High-resolution NIR Observations of the Circumstellar Disk System in the Bok Globule CB 26¹

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We report on results of near-infrared and optical observations of the mm disk embedded in the Bok globule CB 26 (Launhardt & Sargent 2001). The near-infrared images show a bipolar reflection nebula with a central extinction

lane which coincides with the mm disk. Imaging polarimetry of this object yielded a polarization pattern which is typical for a young stellar object surrounded by a large circumstellar disk and an envelope, seen almost edge-on. The strong linear polarization in the bipolar lobes is caused by single scattering at dust grains and allowed to locate the illuminating source which coincides with the center of the mm disk. The spectral energy distribution of the YSO embedded in CB 26 resembles that of a Class I source with a luminosity of $0.5 L_{\odot}$. Using the pre-main-sequence evolutionary tracks and the stellar mass inferred from the rotation curve of the disk, we derive an age of the system of $\leq 10^6$ yr. $H\alpha$ and [SII] narrow-band imaging as well as optical spectroscopy revealed an Herbig-Haro object 6.15 arcmin northwest of CB 26 YSO 1, perfectly aligned with the symmetry axis of the bipolar nebula. This Herbig-Haro object (HH 494) indicates ongoing accretion and outflow activity in CB 26 YSO 1. Its excitation characteristics indicate that the Herbig-Haro flow is propagating into a low-density environment. We suggest that CB 26 YSO 1 represents the transition stage between embedded protostellar accretion disks and more evolved protoplanetary disks around T Tauri stars in an undisturbed environment.

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Evolution of Young Brown Dwarf Disks in the Mid-Infrared

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We have imaged two bona-fide brown dwarfs with TReCS/GEMINI-S and find mid-infrared excess emission that can be explained by optically thick dust disk models. In the case of the young (≈ 2 Myr) Cha H α 1 we measure fluxes at $10.4\mu\text{m}$ and $12.3\mu\text{m}$ that are fully consistent with a standard flared disk model and prominent silicate emission. For the ≈ 10 Myr old brown dwarf 2MASS1207-3932 located in the TW Hydrae association we find excess emission at $8.7\mu\text{m}$ and $10.4\mu\text{m}$ with respect to the photosphere, and confirm disk accretion as likely cause of its strong activity. Disks around brown dwarfs likely last at least as long as their low-mass stellar counterparts in the T-Tauri phase. Grain growth, dust settling, and evolution of the geometry of brown dwarfs disks may appear on a timescale of 10 Myr and can be witnessed by observations in the mid-infrared.

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Organic molecules in protoplanetary disks around T Tauri and Herbig Ae stars

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The results of single-dish observations of low- and high- J transitions of selected molecules from protoplanetary disks around two T Tauri stars (LkCa 15 and TW Hya) and two Herbig Ae stars (HD 163296 and MWC 480) are reported. Simple molecules such as CO, ^{13}CO , HCO^+ , CN and HCN are detected. Several lines of H_2CO are found toward the T Tauri star LkCa 15 but not in other objects. No CH_3OH has been detected down to abundances of $10^{-9} - 10^{-8}$ with respect to H_2 . SO and CS lines have been searched for without success. Line ratios indicate that the molecular emission arises from dense ($10^6 - 10^8 \text{ cm}^{-3}$) and moderately warm ($T \sim 20 - 40 \text{ K}$) intermediate height regions of the disk atmosphere between the midplane and the upper layer, in accordance with predictions from models of the chemistry in disks. The sizes of the disks were estimated from model fits to the ^{12}CO 3-2 line profiles. The abundances of most species are lower than in the envelope around the solar-mass protostar IRAS 16293-2422. Freeze-out in the cold midplane and photodissociation by stellar and interstellar ultraviolet photons in the upper layers are likely causes of

the depletion. CN is strongly detected in all disks, and the CN/HCN abundance ratio toward the Herbig Ae stars is even higher than that found in galactic photon-dominated regions, testifying to the importance of photodissociation by radiation from the central object in the upper layers. DCO⁺ is detected toward TW Hya, but not in other objects. The high inferred DCO⁺/HCO⁺ ratio of ~ 0.035 is consistent with models of the deuterium fractionation in disks which include strong depletion of CO. The inferred ionization fraction in the intermediate height regions as deduced from HCO⁺ is at least $10^{-11} - 10^{-10}$, comparable to that derived for the midplane from recent H₂D⁺ observations. Comparison with the abundances found in cometary comae is made.

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High-mass star formation within the bright-rimmed cloud SFO 79

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We report Radio Recombination Line (RRL) and continuum observations toward the IRAS point source 16362–4845, embedded within the Bright-Rimmed Cloud (BRC) SFO 79, a small molecular cloud lying at the edge of the HII region RCW 108. High resolution observations of the H92_α hydrogen recombination line and of the continuum emission (3.6 and 6 cm) confirm the presence of a resolved Ultra Compact (UC) HII region embedded within the molecular cloud. The integrated radio fluxes suggest the source of the ionisation to be an O9 Zero Age Main Sequence (ZAMS) star. Millimetre observations of ¹²CO, ¹³CO and C¹⁸O ($J=1-0$) molecular lines reveal the presence of a molecular condensation offset $\sim 30''$ to the north of the IRAS position on the boundary of the UC HII region. Analysis of 2MASS data has led to the identification of a small IR cluster of Young Stellar Objects (YSOs) that are positionally coincident with the UC HII region, lying to the south east of the peak of the radio emission. Moreover, the UC HII region appears to be extended in the direction of the IR cluster, which suggests that the radio emission and the IR cluster are in some way related to each other. MSX 8.3 μm and 21.3 μm images have been used to trace the large scale structure of the BRC, revealing the presence of a Photo Dominated Region (PDR) and three embedded thermal sources within the molecular cloud. The PDR has a plane parallel morphology which correlates extremely well with the morphology of the ionised gas traced by the optical emission. The three thermal sources (labelled A, B, C) all lie at a similar projected distance from the interface between the HII region and the molecular gas of the cloud. Thermal sources A and C are positionally coincident with the IRAS point sources 16362–4845 and 16362–4841 respectively, both of which have IRAS colours consistent with the presence of UC HII regions. Given that UC HII regions are relatively short lived ($\sim 10^5$ yrs) it is reasonable to suggest that these two UC HII regions are of a similar age. The alignment of the three thermal sources along a line parallel to the bright rim suggests that they could have been triggered by the propagation of a plane parallel shock through the cloud.

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Lifetimes and Evolution of Molecular Cloud Cores

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We discuss the lifetimes and evolution of clumps and cores formed as turbulent density fluctuations in nearly isothermal molecular clouds. In order to maintain a broad perspective, we consider both the magnetic and non-magnetic cases. In the latter, we argue that clumps are unlikely to reach a hydrostatic state if molecular clouds can in general be

described as single-phase media with an effective polytropic exponent $\gamma_e < 4/3$. In this case, clumps are expected to be short-lived, either proceeding directly to collapse, or else “rebounding” towards the mean pressure and density as the parent cloud. Rebounding clumps are delayed in their re-expansion by their self-gravity. From a simple Virial Theorem calculation, we find re-expansion times ~ 1 Myr, i.e., of the order of a few local free-fall times $t_{fc} \equiv L_{J,c}/c$, where $L_{J,c} = \sqrt{\pi c^2/G\rho_c}$ is the Jeans length at the clump’s mean density ρ_c and c is the isothermal sound speed.

In the magnetic case, we present a series of driven-turbulence, ideal-MHD numerical simulations in which we follow the evolution of clumps and cores in relation to the magnetic criticality of their “parent clouds” (the numerical boxes). In subcritical boxes, magnetostatic clumps do not form. A minority of moderately-gravitationally bound clumps form which however are dispersed by the turbulence in $\lesssim 1.3$ Myr. An estimate of the ambipolar diffusion (AD) time scale at the physical conditions of these cores gives characteristic times $\gtrsim 1.3$ Myr, suggesting that these few longer-lived cores can marginally be “captured” by AD to increase their mass-to-flux ratio and eventually collapse, although on time scales not significantly longer than the dynamical ones. In supercritical boxes, some cores manage to become locally supercritical and collapse in typical time scales of $2 t_{fc}$ (~ 1 Myr). In the most supercritical simulation, a few longer-lived cores are observed, which last for up to ~ 3 Myr, but these end up re-expanding rather than collapsing, because they are sub-Jeans in spite of being super-critical. Fewer clumps and cores form in these simulations than in their non-magnetic counterpart.

Our results suggest that *a)* Not all cores observed in molecular clouds will necessarily form stars, and that a class of “failed cores” should exist, which will eventually re-disperse, and which may be related to the observed starless cores. *b)* Cores may be out-of-equilibrium, transient structures, rather than quasi-magnetostatic configurations. *c)* The magnetic field may help reduce the star formation efficiency by reducing the probability of core formation, rather than by significantly delaying the collapse of individual cores.

Accepted by ApJ

Preprints can be retrieved from

<http://www.astrosmo.unam.mx/~e.vazquez/turbulence/prepr.html>

and soon also on astro-ph. Animations can be retrieved from

<http://www.astrosmo.unam.mx/~e.vazquez/turbulence/movies/VKSB04.html>

Maser action in methanol transitions

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We report the detection of 6.7 GHz methanol emission towards OMC-1 with ATCA. The source with size from $40''$ to $90''$ is located to the south-east from Ori-KL and can coincide in position with the 25 GHz masers. The source may be an interesting case recently predicted in theory when these transitions of different traditional methanol maser classes show maser activity simultaneously. In addition, recent results of the methanol maser search at 25 GHz and 104.3 GHz are reported.

Accepted by Astrophysics and Space Science

Optical Outflows in the R CrA Molecular Cloud

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A deep [SII] $\lambda\lambda$ 6717/6731 wide-field survey of Herbig-Haro (HH) objects has been carried out in two fields towards

the R CrA molecular cloud, using the ESO/MPG 2.2m Wide Field Imager (WFI). Twelve new HH objects, many of which consisting of several condensations or knots, have been discovered and new details of the known HH objects are revealed. Combining the results of previous optical, infrared, and millimeter-wavelength observations, the possible exciting sources of HH objects in the region are discussed. On the basis of the previously known and newly discovered HH objects, at least 5 HH flows in the region around R CrA and at least 2 outflows in the region around VV CrA can be identified. In combination with the previously detected molecular outflows, the HH flows in the R CrA region indicate rather active star formation in the R CrA core in the past $10^5 - 10^6$ yr.

Accepted by The Astrophysical Journal

Preprints: <http://www.journals.uchicago.edu/ApJ/future.html>

A Deep Objective Prism Survey for Classical T Tauri Stars in the Sigma Orionis Region

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A very deep 1976 CTIO Curtis Schmidt objective prism plate of the Sigma Orionis Association taken under excellent conditions has permitted us to search for fainter classical T Tauri stars associated with this cluster. We have discovered 63 H-alpha emission stars in the area to a limiting magnitude of about 18. Most of these stars are new additions to the growing list of Pre-Main-Sequence objects identified in this very dense, very young cluster. Since T Tauri stars vary in light and emission-line strength on all time scales, these data also provide an historical record of the association. By comparison with later observations, we are able to estimate the average space density of the H α emission-line stars in the surveyed area as 0.67 pc^{-3} down to a spectral class of dM2. This is about 1/3 the number of dwarf or subgiants stars in the region that could have been detected as emission-line stars in these surveys.

Accepted by PASP

On the Evolutionary Status of Class I Stars and Herbig-Haro Energy Sources in Taurus-Auriga

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We present high resolution ($R \sim 34,000$) optical (6330 - 8750 Å) spectra obtained with the HIRES spectrograph on the W. M. Keck I telescope of stars in Taurus-Auriga whose circumstellar environment suggests that they are less evolved than optically revealed T Tauri stars. Many of the stars are seen only via scattered light. The sample includes 15 Class I stars and all Class II stars that power Herbig-Haro flows in this region. For 28 of the 36 stars observed, our measurements are the first high dispersion optical spectra ever obtained. Photospheric features are observed in all stars with detected continuum, 11/15 Class I stars (42% of known Taurus Class I stars) and 21/21 Class II stars; strong emission lines (e.g. H α) are detected in the spectra of all stars. These spectra, in combination with previous measurements, are used to search for differences between stars which power Herbig-Haro flows and stars which do not, and to reassess the evolutionary state of so-called protostars (Class I stars) relative to optically revealed T Tauri stars (Class II stars).

The stellar mass distribution of Class I stars is similar to that of Class II stars and includes 3 spectroscopically confirmed Class I brown dwarfs. Class I stars (and brown dwarfs) in Taurus are slowly rotating ($v \sin i < 35 \text{ km/s}$); the angular momentum of a young star appears to dissipate prior to the optically revealed T Tauri phase. The amount of optical veiling and the inferred mass accretion rates of Class I stars are surprisingly indistinguishable from Class II stars. Class I stars do not have accretion dominated luminosities; the accretion luminosity accounts for $\sim 25\%$ of the bolometric luminosity. The median mass accretion rate of Class I and Class II stars of K7-M1 spectral type is $4 \times 10^{-8} M_{\odot}/\text{yr}$ and the median mass outflow rate is 5% of the mass accretion rate. The large ranges in mass accretion rate (~ 2 orders of magnitude), mass outflow rate (~ 3 orders of magnitude) and ratio of these quantities (~ 2 orders of magnitude) represent real dispersions in young accreting stars of similar mass. We confirm previous results that find larger forbidden-line emission associated with Class I stars than Class II stars. We suggest that this is caused

by an orientation bias that allows a more direct view of the somewhat extended forbidden emission line regions than of the obscured stellar photospheres, rather than because of larger mass outflow rates. Overall, the similar masses, luminosities, rotation rates, mass accretion rates, mass outflow rates, and millimeter flux densities of Class I stars and Class II stars are best explained by a scenario in which most Class I stars are no longer in the main accretion phase and are much older than traditionally assumed. Similarly, although stars which power Herbig-Haro flows appear to have larger mass outflow rates, their stellar and circumstellar properties are generally indistinguishable from those of similar mass stars that do not power these flows.

Accepted by The Astrophysical Journal

<http://xxx.lanl.gov/abs/astro-ph/0408244>

The Formation of Free-Floating Brown Dwarves and Planetary-Mass Objects by Photo-Erosion of Prestellar Cores

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We explore the possibility that, in the vicinity of an OB star, a prestellar core which would otherwise have formed an intermediate or low-mass star may form a free-floating brown dwarf or planetary-mass object, because the outer layers of the core are eroded by the ionizing radiation from the OB star before they can accrete onto the protostar at the centre of the core. The masses of objects formed in this way are given approximately by

$$\sim 0.010M_{\odot} \left(\frac{a_{\text{I}}}{0.3 \text{ km s}^{-1}} \right)^6 \left(\frac{\dot{N}_{\text{Lyc}}}{10^{50} \text{ s}^{-1}} \right)^{-1/3} \left(\frac{n_0}{10^3 \text{ cm}^{-3}} \right)^{-1/3},$$

where a_{I} is the isothermal sound speed in the neutral gas of the core, \dot{N}_{Lyc} is the rate of emission of Lyman continuum photons from the OB star (or stars), and n_0 is the number-density of protons in the HII region surrounding the core. We conclude that the formation of low-mass objects by this mechanism should be quite routine, because the mechanism operates over a wide range of conditions ($10^{50} \text{ s}^{-1} \lesssim \dot{N}_{\text{Lyc}} \lesssim 10^{52} \text{ s}^{-1}$, $10 \text{ cm}^{-3} \lesssim n_0 \lesssim 10^5 \text{ cm}^{-3}$, $0.2 \text{ km s}^{-1} \lesssim a_{\text{I}} \lesssim 0.6 \text{ km s}^{-1}$) and is very effective. However, it is also a rather wasteful way of forming low-mass objects, in the sense that it requires a relatively massive initial core to form a single low-mass object. The effectiveness of photo-erosion also implies that any intermediate-mass protostars which have formed in the vicinity of a group of OB stars must already have been well on the way to formation before the OB stars switched on their ionizing radiation; otherwise these protostars would have been stripped down to extremely low mass.

Accepted by Astron. & Astrophys.

[astro-ph/0408522](http://xxx.lanl.gov/abs/astro-ph/0408522)

The polarization of mm methanol masers

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We present a survey of the polarization properties of mm-wavelength methanol masers, comprising both classes, and transitions from 84.5 to 157.0 GHz. Linear polarization is found in more than half of the observed objects, and circular polarization is tentatively detected in two sources. Class I and Class II CH₃OH masers show similar polarization properties. The largest linear polarization is found in the 133 GHz Class I maser towards L 379 (39.5%), and in the 157 GHz Class II maser towards G 9.62+0.19 (36.7%). The spectral profiles of the polarization angle of Class I masers are mostly flat, except for two sources showing a linear slope. Since the mm-line methanol masers are expected to be weakly (or not) saturated, we suggest that the stronger fractional polarizations found by us are enhanced by

anisotropic pumping and radiative losses. In NGC 7538, we find, for both maser classes, a good agreement between our polarization angles, and those measured for the submillimeter dust continuum. This can be taken as evidence for magnetic alignment of dust grains. It is also possible that an unsaturated maser with equally populated magnetic substates simply amplifies polarized continuum seed radiation. For Class II masers, the polarization properties of the various velocity components towards a given source with detectable polarization are quite homogeneous. A possible explanation is discussed. Since methanol is non-paramagnetic, the circular polarization of the unsaturated maser emission can only be due to variations of the angle between the magnetic field and the line of sight along the maser propagation path.

Accepted by Astronomy & Astrophysics

astro-ph/0408446

A “Starless” Core that Isn’t: Detection of a Source in the L1014 Dense Core with the Spitzer Space Telescope

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We present observations of L1014, a dense core in the Cygnus region previously thought to be starless, but data from the Spitzer Space Telescope shows the presence of an embedded source. We propose a model for this source that includes a cold core, heated by the interstellar radiation field, and a low-luminosity internal source. The low luminosity of the internal source suggests a substellar object. If L1014 is representative, other “starless” cores may turn out to harbor central sources.

Accepted by ApJS – Spitzer Special Edition

astro-ph/0406371

A $\lambda 20\text{cm}$ Survey of the Galactic Center Region I: Detection of Numerous Linear Filaments

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This is a first in a series of papers presenting a sensitive $\lambda 20\text{cm}$ VLA continuum survey of the Galactic center region

using new and archival data based on multi-configuration observations taken with relatively uniform uv coverage. The high dynamic range images cover the regions within $-2^\circ < l < 5^\circ$ and $-40' < b < 40'$ with a spatial resolution of $\approx 30''$ and $10''$. The wide field imaging technique is used to construct a low-resolution mosaic of 40 overlapping pointings. The mosaic image includes the Effelsburg observations filling the low spatial frequency uv data. We also present high resolution images of twenty three overlapping fields using DnC and CnB array configurations. These high-resolution images are sensitive to both compact and extended continuum features with a wide range of angular scales with rms noise of $0.2 \text{ mJy beam}^{-1}$ in the outer parts of the Galactic center region. The survey has resulted in a catalog of 345 discrete sources as well as 140 images revealing structural details of HII regions, SNRs, pulsar wind nebulae and more than 80 linear filaments distributed toward the complex region of the Galactic center.

These observations show the evidence for an order of magnitude increase in the number of faint linear filaments with typical lengths of few arcminutes. Many of the filaments show morphological characteristics similar to the Galactic center nonthermal radio filaments (NRFs). The linear filaments are not isolated but are generally clustered in star forming regions where prominent NRFs had been detected previously. The extensions of many of these linear filaments appear to terminate at either a compact source or a resolved shell-like thermal source. A relationship between the filaments, the compact and extended thermal sources as well as a lack of preferred orientation for many RFs should constrain models that are proposed to explain the origin of nonthermal radio filaments in the Galactic center.

Accepted by ApJS

<http://www.journals.uchicago.edu/ApJ/future.html>

Abstracts of papers in Nature and Science

Because of embargoes on preprints for Nature and Science, abstracts for these two journals will be accepted for papers that have already been published

An X-ray outburst from the rapidly accreting young star that illuminates McNeil's nebula

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Young, low-mass stars are luminous X-ray sources whose powerful X-ray flares may exert a profound influence over the process of planet formation. The origin of the X-ray emission is uncertain. Although many (or perhaps most) recently formed, low-mass stars emit X-rays as a consequence of solar-like coronal activity it has also been suggested that X-ray emission may be a direct result of mass accretion onto the forming star. Here we report X-ray imaging spectroscopy observations which reveal a factor ~ 50 increase in the X-ray flux from a young star that is at present undergoing a spectacular optical/infrared outburst (this star illuminates McNeil's nebula). The outburst seems to be due to the sudden onset of a phase of rapid accretion. The coincidence of a surge in X-ray brightness with the optical/infrared eruption demonstrates that strongly enhanced high energy emission from young stars can occur as a consequence of high accretion rates. We suggest that such accretion-enhanced X-ray emission from erupting young stars may be short-lived, because intense star-disk magnetospheric interactions are quenched rapidly by the subsequent flood of new material onto the star.

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http://www.nature.com/cgi-taf/DynaPage.taf?file=/nature/journal/v430/n6998/abs/nature02747_fs.html

Dissertation Abstracts

Star Formation in the Magellanic Clouds based on 1.2 mm Continuum Observations

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Ph.D degree awarded: July 2004

This thesis reports on results of a large 1.2 mm survey of the Magellanic Clouds. Prominent star forming regions have been investigated for the first time at 1.2 mm with the 37 channel bolometer array SIMBA by using the fastscanning observing technique. The obtained data were reduced with the MOPSI software package. The present thesis concentrates on the detection of cool dust, which may best be found inside the molecular clouds. For this purpose, the investigations were concentrated towards the positions of a sample of CO clouds. The here performed study shows in which way the cool dust exists under the different physical conditions of these dwarf irregular galaxies. Apart from positions and flux densities, spectral energy distributions (SEDs) have been determined allowing, through the fitting of modified Planck functions, the derivation of dust temperatures and dust masses. The gas-to-dust ratios and the star formation efficiencies have been obtained for the detections in this study.

The study comprises 40 dust clouds of which 33 are located in the LMC, while 21 of them being associated with the 30 Dor complex. The eight mosaics in the LMC cover selected areas in the 30 Dor central field and its southern HII regions associated with molecular clouds; these regions have been previously investigated by the ESO-SEST Key Programme: *CO in the Magellanic Clouds*. In addition, a few other HII regions have also been studied. In the SMC, the SIMBA survey was also based on the same ESO-SEST Key Programme towards selected regions in the SW Bar (where a large CO complex is located), in the northern Bar and in the Shapley Wing. All 40 sources investigated in the LMC and SMC have been detected for the first time at 1.2 mm.

The molecular gas-to-dust ratios of the different sources show a high dispersion through the individual regions of both Magellanic Clouds. The variations in the molecular gas-to-dust mass ratio in the LMC show east-west and north-south asymmetries, bimodal behavior and correlation with the cloud size depending on the analyzed region. In the SMC, similarities in two regions of the SW Bar are found. A substantial variation in the star formation efficiency within a galaxy reflects the temporal evolution of star forming regions in molecular cloud complexes or localized bursts of star formation and is very well seen in the LMC. The highest activity stage in the LMC is found in 30 Dor A, while regions outside the 30 Dor complex such as N 44 present on average much lower SFE values. In contrast, all studied regions in the SMC show a fairly low SFE.

<http://hydra.ub.ruhr-uni-bochum.de/netahtml/HSS/Diss/MerkelFerreiraElisa>

Unveiling the hidden life of Stellar Embryos

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The earliest evolutionary phase of star formation, in which a deeply embedded protostar is known to exist, is the so-called Class 0 stage (André et al. 1993, ApJ 406, 122). Because protostars in this phase, called Class 0 sources, are difficult to detect, constraining their physical properties is a challenging task. In this dissertation I study the thermal emission from the dust of the circumstellar envelopes of Class 0 sources in order to investigate the physical structure (geometry, radial intensity profile, spatial temperature and spectral energy distributions (SEDs)), and the properties of these objects (mass, size, bolometric luminosity (L_{bol}) and temperature (T_{bol}), and age). Submillimetre Common-User Bolometer Array (SCUBA) imaging at 450 and 850 μm of the thermal dust emission of envelopes of Class 0 sources in the Perseus and Orion molecular cloud complexes, a model of the envelope, the implementation of techniques like the blackbody fitting and the 1D radiative transfer code (by Wolf, Henning & Stecklum 1999, A&A 349, 839), and an evolutionary model for protostars (by Smith 2002, in “The Origins of Stars and Planets: the VLT view”, ESO Astrophysics Symposia, eds. J. Alves & M. McCaughrean) provide a way to model and to interpret the structure of Class 0 sources, and to estimate their physical properties in an evolutionary context.

The main results of this study are: 1) From the continuum SCUBA maps, 36 submillimetre sources ($> 3\sigma$) are detected. Some of them are extended, and many contain multiple condensations, as well as extended diffuse features. Twelve of these objects are reported here for the first time, 15 sources are analyzed, and nine Class 0 sources are studied in detail. 2) An average value of the aspect ratio of the sample of 1.3 ± 0.1 is found, suggesting that the envelopes of Class 0 sources can be described approximately as spherically symmetric. Nevertheless, a departure of this symmetry in some cases is found. This mismatch could be produced by several factors like magnetic fields of energy densities sufficiently large to influence the object structure, the bipolar outflow, rapidly rotating structures, or high levels of angular momentum. 3) The sample consists of cool objects (T_{bol} ranges of $\sim 27\text{-}50\text{ K}$) which have L_{bol} of $\sim 4\text{-}85 L_{\odot}$. 4) The physical structure of a Class 0 envelope is characterized by the gas and dust temperature distribution $T(r) \propto r^{-q}$, and the density distribution $\rho(r) \propto r^{-p}$, with $q=0.4$ and p in the range of 1.5-2 ($p=2$ at younger ages and $p=1.5$ at later times). In the inner part of the envelope (10 AU), $T(r)$ departs from the single-power law index of 0.4, a phenomenon caused probably by thermal convection in the inner envelope. 5) From the thermal emission of the dust and following an emissivity model (Hildebrand 1983, QJRAS 24, 264), the average value of the gas and dust mass of a sample based on 15 sub-mm selected objects is $2.5 \pm 0.6 M_{\odot}$. Examination of the radial profiles of the sample shows that the objects are surrounded by extended envelopes. Typically, the sizes are $\sim 1500\text{-}6000\text{ AU}$ (at 450 μm) and $\sim 4000\text{-}9000\text{ AU}$ (at 850 μm). 6) A sublimation radius of 3-5 AU at 450 μm , $\tau=1$ and $p=2$ ($\sim 10\text{ AU}$ for $p=1.5$) is estimated, which is roughly the same as the radius of the photosphere (because the gas that is accreted close to the central object is optically thick, the central source should radiate from this specific radius, where the layer changes between the optically thick and the thin regime). 7) The blackbody curve and the data-points show significant deviations at the Infrared Astronomy Satellite (IRAS) 12 and the 25 μm points for the Class 0 sample. If these data-points had correct flux measurements, the sources would exhibit an excess of mid-IR emission which could be caused by ongoing outflow/dust interactions. Because it is likely that these IRAS points are incorrect in some cases, further mid-IR observations of these objects are necessary to investigate the nature of this possible excess. 8) The assumption of spherical symmetry in the envelope model is reasonable. Nevertheless, deviations from this geometry between observed and modeled SEDs at short wavelengths, and between observed and simulated radial profiles of relatively spherical Class 0 sources become extremely prominent. This discrepancy could be due to the exclusion of a non-spherical geometry, of cavities produced by molecular outflows, or of a flattened disk in the model; it could also be due to specific assumptions considered here, e.g. a single point-like nature of the sources, and a constant dust opacity with radius in the model. 9) For the sample of Class 0 sources, the model-dependent ages are in a range of 1-3 10^4 yr.

New Jobs

Dublin Institute for Advanced Studies, School of Cosmic Physics Research Assistant in Star Formation

Applications are invited for a Science Foundation Ireland funded postdoctoral position to work on a project entitled "Understanding the Central Engines of Young Stars" the emphasis being on YSO jets and outflows. The successful applicant should have, or expect to have, a PhD in Astrophysics and a background in observational techniques is essential. He or she will join a growing research group working on star formation and will have access to in-house grid computing facilities.

The post is available for a period of 3 years starting from 1st November 2004, or as soon as possible thereafter, and the salary will be on the DIAS Research Assistant Scale (current starting point is 39,394 Euro per annum). Applications, including a CV and the names of 3 referees, should be sent by Friday 29th October to The Secretary, Astrophysics Section, School of Cosmic Physics, Dublin Institute for Advanced Studies, 5 Merrion Square, Dublin 2, Ireland (e-mail: ec@cp.dias.ie [jmailto:ec@cp.dias.ie](mailto:ec@cp.dias.ie);

Further details are available from Professor Tom Ray, e-mail: tr@cp.dias.ie

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.

The Star Formation Newsletter is available on the World Wide Web at <http://www.ifa.hawaii.edu/~reipurth> or at <http://www.eso.org/gen-fac/pubs/starform/> .

Moving ... ??

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New Books

Jets in Young Stellar Objects: Theory and Observations

Edited by A.J.L. Fernandes, P.V. Garcia, and J.J.G. Lima

These are the proceedings of a workshop held in Porto, Portugal on 3-5 September 2002. The book contains 43 articles based on the oral presentations at the workshop. The poster papers are available on a CD-Rom that is enclosed with the book. Both oral and poster papers are reprinted from *Astrophysics and Space Science* vol. 287, Nos. 1-4, 2003. The book is divided into six sections. The following are the major articles in the book:

1. Steady-state Winds

Observations of Jet Diameter, Density, and Dynamics *F. Bacciotti et al.*

Self-Collimated Jets, Accretion Disks and Young Stars *J. Ferreira*

Star-Driven Wind and Jet Models *C. Sauty et al.*

2. Time-dependent Winds/Jets

Continuum Excess Emission in Young Low Mass Stars *D.F.M. Folha*

Observations of the Star-Disk Interface: Search for Wind Origins *S. Edwards*

MHD Simulations of the Long-Term Evolution of a Dipolar Magnetosphere surrounded by an Accretion Disk *C. Fendt*

MHD Models and Laboratory Experiments of Jets *T.A. Gardiner et al.*

Three-Dimensional Simulations of Jets from Keplerian Disks: Stability Issues *R. Ouyed*

3. Jet Energetics

Shock Waves in Outflows from Young Stars *P. Hartigan*

Developing Diagnostic Tools for X-Wind Jets *H. Shang*

Mechanical Heating in Disk-Driven Winds - Thermal Structure and Observational predictions *D. O'Brien et al.*

4. Jet/Wind Propagation

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5. Jets in Other Objects

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Jets in AGN as seen with an Ultimate Angular Resolution *L.I. Gurvits*

6. The Future

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Meetings

Hawaii Astrobiology Winter School 2005

Water on Earth and in Space

10 – 21 January 2005

The University of Hawaii NASA Astrobiology Institute (NAI) invites graduate students from all over the world to attend a winter school to be held in Hawaii in January 2005. Life as we know it is dependent on water, and in this winter school we will explore the multiple aspects of water in a very broad context, from water on Earth and the origin of Earth's oceans, life on Earth near deep-sea vents, ice in the Solar System on planets, moons, and in cometary bodies, to ice in circumstellar disks and the interstellar medium.

The lectures and lecturers are:

- **Water Ice and Chemistry in Circumstellar Disks and the Interstellar Medium**
Cecilia Ceccarelli (*Laboratoire d'Astrophysique, Grenoble, France*)
- **Geochemical Processes and Microbiospheres in Hydrothermal Systems**
Jim Cowen (*Department of Oceanography, Honolulu, USA*)
- **Icy Bodies in the Solar System and the Origin of the Earth's Oceans**
Karen Meech (*Institute for Astronomy, Honolulu, USA*)
- **Ice on Earth, Mars, and Europa**
Thorsteinn Thorsteinsson (*National Energy Authority, Reykjavik, Iceland*)

In addition to the main lectures, several guest lectures will be given that cover specialized topics within the four lecture series.

Two 90 min lectures will be given each morning. Students will spend the afternoons working in small groups, each group writing up specific subsections of the lectures in consultation with the lecturers. At the end of the winter school, the resulting lecture write-ups will be put on the web.

The 2005 UH astrobiology winter school will during the first week be held in Honolulu (Jan 10 - 14, 2005), and will during the second week (Jan 17 - 21, 2005) be held in Hilo on the Big Island of Hawaii.

While on Oahu, the students will be housed in the Ocean Resorts hotel in Waikiki, and on the Big Island they will be housed in the Hilo Hawaiian hotel. On Oahu, we will utilize the Institute for Astronomy auditorium, as well as some of our small classrooms for discussion sessions. In Hilo we will use the facilities at the Institute for Astronomy Hilo building in the Astronomy research park, which has a large lecture hall and wireless internet access.

We are arranging a field trip to the Mauna Kea Observatories on Saturday Jan 15. Furthermore, the winter school has been scheduled such that students can take advantage of an observing run Karen Meech has at the University of Hawaii 2.2m telescope on Mauna Kea to study comets. On January 16 and 17 students will therefore have the opportunity to participate in real-time remote observing from a control room at the Institute for Astronomy in Hilo.

Students will get travel grants up to US\$ 1000, and will have all expenses for food, housing, inter island travel, and field trips covered. The winter school is limited to 40 students. Foreign students should be aware of the strict new visa regulations for visits to the United States, and will need to inquire at their American consulate about the time required for obtaining a visa.

To apply, check details at <http://www.ifa.hawaii.edu/UHNAI/ws.html> and submit applications to haws05@ifa.hawaii.edu.

Application deadline: **October 20, 2004.** Applicants will be notified by Nov 1, 2004.

Organizing Committee: David Karl, Klaus Keil, Karen Meech (co-chair), Michael Meyer, Bo Reipurth (co-chair).

Astrobiology: The Search for our Origins and Life Elsewhere

THE TENTH VATICAN OBSERVATORY SUMMER SCHOOL IN OBSERVATIONAL ASTRONOMY AND ASTROPHYSICS – CASTEL GANDOLFO, ROME, ITALY – **12 JUNE TO 8 JULY, 2005**

FACULTY: Jonathan I. Lunine (Chair), University of Arizona, Tucson, Arizona; Christopher J. Corbally, S.J. (Dean), Vatican Observatory; George V. Coyne, S.J. (Director) Vatican Observatory; John Baross, University of Washington, Seattle, Washington; Chris D. Impey, University of Arizona, Tucson, Arizona; Woodruff T. Sullivan, University of Washington, Seattle, Washington; Neville J. Woolf, University of Arizona, Tucson, Arizona.

DESCRIPTION: Two lectures will be given each morning, with evening seminars by the Vatican staff and visiting astronomers. During the course of the school, students will also present a short paper on their research or the research of their home institution. Other activities will include laboratory exercises, use of the Observatory computers for data reduction and image processing, and use of astronomical databases.

There will also be opportunities for observations with on-site 40 cm refractor and 60 cm reflector telescopes. Field trips to visit sites of historical interest to astronomy will be included. Students will have the opportunity to discuss their own research with members of the faculty and with the observatory staff. No formal course credits will be given, but certification of satisfactory completion of the course will be supplied.

TOPICS: Basic tour of the solar system and known extrasolar planets; scale of the cosmos; introduction to chemistry and chemical bonding; introduction to spectroscopy from the UV through the radio; the discovery of past salty seas on Mars; the discovery of an ocean under Jupiter's moon Europa; the search for pre-biotic molecules on Titan; search for life on Mars and Europa; bioethics and planetary protection; the microwave background and models for the Big Bang; origin of the elements; search for extrasolar habitable planets with optical telescopes; search for extraterrestrial civilizations with radio telescopes; introduction to biology for astronomers; models of the origin of life; origin of metabolisms; extremophiles; the tree of life; evolution of life and Earth's climate through time; the future of life on and off the Earth.

PARTICIPATION: Students in upper level university classes or in their beginning years of graduate studies who have mastered the fundamentals of astrophysics and are considering the possibility of future careers in astronomy or astrophysics are invited to apply. Students must have a working knowledge of English, which will be the official language of the school; faculty and staff members can assist students, as required, in other languages. Proven skill in mathematics or physics at the university level plus demonstrable signs of genuine interest in research are the prime qualities sought for in candidates. Twenty-five students will be selected; it is planned that at least one-third would come from non-industrialized countries, with a limit of no more than three students from any given country. Otherwise, selection will be made without reference to race, religion, national origin, gender, or physical handicap.

FINANCES: Students from non-industrialized countries will receive scholarships to cover at least 75% of all costs including travel. Other students will be expected to pay their travel and living costs but economical living and meal arrangements will be made. Lunch each day will be offered gratis to all. There are no other costs associated with the school.

APPLY WITH: 1. Your name, address and nationality. 2. Your year and stage of academic studies. 3. Your reasons for wishing to attend this school (200 words or less) and your self evaluation of your competence (indicate 'fair, good, very good, or excellent') in mathematics, physics, biology and chemistry. The selection process gives great importance to this item. 4. The names and addresses, including e-mail address, of two persons whom you have asked to send a recommendation on your behalf. Please tell these two persons to send their recommendations by e-mail (see address below) as soon as possible. 5. Mail separately a college or university transcript (or equivalent documents) listing grades achieved in all college level courses to date. Please communicate by e-mail except for item 5. It would be helpful if, in addition to mailing your transcript, you scanned it and sent it by e-mail. Be sure to write 'Vatican Summer School' on all correspondence.

DEADLINE: Apply by 15 December 2004 to:

Dr. George V. Coyne, S.J., Vatican Summer School, Specola Vaticana, V-00120 Vatican City, Rome, Italy

TEL: 39 06 69885266; FAX: 39 06 69884671; e-mail: gcoyne@specola.va

with a copy to:

Dr. Christopher J. Corbally, S.J., Steward Observatory, University of Arizona, Tucson, Arizona 85721, USA

TEL: USA (520) 621 3225; e-mail: corbally@as.arizona.edu