THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar evolution and molecular clouds

No. 120 — 8 October 2002 Editor: Bo Reipurth (reipurth@ifa.hawaii.edu)

The Star Formation Newsletter celebrates its 10th Anniversary

On this day 10 years ago the Star Formation Newsletter appeared with its first issue. It has since then been circulated every month to a steadily increasing number of subscribers. The current issue is being sent to 974 scientists and students in 37 countries. It is interesting to browse through these 120 issues and see how star formation studies have developed and expanded, encompassing new areas and employing new techniques. And it is exciting to think about what the field will look like in another 10 years, when we will have results coming in from the VLT and Keck Interferometers, from NGST, from ALMA, and from Herschel. With superb observational and computational facilities at our disposal, there has never been a better time for our field.

Abstracts of recently accepted papers

Near Infrared Adaptive Optics Imaging of the Embedded Cluster NGC 2024

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We present the results of a high resolution near infrared adaptive optics survey of the young obscured star forming region NGC 2024. Out of the total 73 stars detected in the adaptive optics survey of the cluster, we find 3 binaries and one triple. The resulting companion star fraction, 7±3% in the separation range of 0.″35-2.″3 (145-950 AU), is consistent with that expected from the multiplicity of mature solar-type stars in the local neighborhood. Our survey was sensitive to faint secondaries but no companions with $\Delta K' > 1.2$ magnitudes are detected within 2″ of any star. The cluster has a K′ luminosity function that peaks at ∼12, and although our completeness limit was 17.7 magnitude at K′, the faintest star we detect had a K′ magnitude of 16.62.

Accepted by the Astrophysical Journal

Preprint: available at astro-ph/0210053

Adaptive optics imaging of the MBM 12 association

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We report adaptive optics (AO) observations of the young and nearby association MBM 12 obtained with the Canada-France-Hawaii Telescope. Our main observational result is the discovery of six new binary systems, LkHα264,

E 0255+2018, RX J0255.4+2005, S18, MBM 12-10, RX J0255.3+1915, and the confirmation of HD 17332, already known as a binary. We also detected a possible quadruple system. It is composed of the close binary LkHα 263 AB (separation of $\sim 0.41''$), of LkHα 262 located $\sim 15.25''$ from LkHα 263 A, and of LkHα 263 C, located $\sim 4.1''$ from LkHα 263 A. A preliminary study of the binary fraction suggests a binary excess in the MBM 12 association as compared to the field and IC 348. Because of the high binarity rate, previous estimations of spectral types and measurements of IR excesses for several candidate members of MBM 12 have to be revised. LkHα 263 C is a nebulous object that we interpret as a disk oriented almost perfectly edge-on and seen in scattered light. This object has already been reported by Jayawardhana et al. (2002). Scattered light models allow us to estimate some of the structural parameters (i.e. inclination, diameter and to a lesser extent dust mass) of the circumstellar disk. We find an inclination of 89^o and a outer radius for the disk, ~ 165 AU if the distance to MBM 12 is 275 pc. With the present data set, we do not attempt to re-assess the distance to MBM 12. We estimate however that the distance to the candidate member RX J0255.3+1915 is d > 175 pc.

Accepted by A&A

Preprints available at http://xxx.lpthe.jussieu.fr/abs/astro-ph/0209290

No disk needed around HD 199143 B

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We present new, high angular resolution images of HD 199143 in the Capricornus association, obtained with the adaptive optics system ADONIS+SHARPII at the ESO 3.6m Telescope of La Silla Observatory. HD 199143 and its neighbour star HD 358623 (separation $\sim 5'$ away) have previously been imaged with adaptive optics. For each star, a companion has been detected in the J and K bands at respective separations of $1.1''$ and $2.2''$ (Jayawardhana & Brandeker 2001). Our new photometry of HD 199143 B suggests that it is a M2 star and that the presence of circumstellar dust proposed by Van den Ancker et al. (2000) is no longer necessary. We show that the 12 μm flux detected by IRAS previously interpreted as an IR excess, can be explained by the presence of the late-type companion.

Accepted by A&A

Preprints available at http://xxx.lpthe.jussieu.fr/abs/astro-ph/0209211

An Infrared Multiplicity Survey of Class I/Flat-Spectrum Systems in the ρ Ophiuchi and Serpens Molecular Clouds

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We present new near- and mid-IR observations of 19 Class I/flat-spectrum young stellar objects in the nearby ρ Ophiuchi ($d = 125$ pc) and Serpens ($d = 310$ pc) dark clouds. These observations are part of a larger systematic infrared multiplicity survey of Class I/flat-spectrum objects in the nearest dark clouds. We find 7/19 ($37\% \pm 14\%$) of the sources surveyed to be multiple systems over a separation range of $\sim 150 - 1800$ AU. This is consistent with the fraction of multiple systems found among older pre-main-sequence stars in each of the Taurus, ρ Ophiuchi, Chamaeleon, Lupus, and Corona Australis star-forming regions over a similar separation range. However, solar-type main-sequence

stars in the solar neighborhood have a fraction approximately one-third that of our Class I/flat-spectrum sample (11% ± 3%). This may be attributed to evolutionary effects or environmental differences. An examination of the spectral energy distributions (SEDs) of th! e SVS 20 and WL 1 binaries reveals that the individual components of each source exhibit the same SED classifications, similar to what one typically finds for binary TTS systems, where the companion of a classical TTS also tends to be of the same SED type.

Accepted by Astron. J.

Preprints available from astro-ph/0209224

A Spectroscopic Survey of Subarcsecond Binaries in the Taurus-Auriga Dark Cloud with the Hubble Space Telescope

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We report the results of a spectroscopic survey of 20 close T Tauri binaries in the Taurus-Auriga dark cloud where the separations between primaries and their secondaries are less than the typical size of a circumstellar disk around a young star. Analysis of low-resolution and medium-resolution STIS spectra yields the stellar luminosities, reddenings, ages, masses, mass accretion rates, IR excesses, and emission line luminosities for each star in each pair. We examine the ability of IR color excesses, Hα equivalent widths, [O I] emission, and veiling to distinguish between weak emission and classical T Tauri stars. Four pairs have one cTTs and one wTTs; the cTTs is the primary in three of these systems. This frequency of mixed pairs among the close T Tauri binaries is similar to the frequency of mixed pairs in wider young binaries. Extinctions within pairs are usually similar; however, the secondary is more heavily reddened than the primary in some systems, where it may be viewed through the primary's disk. Mass accretion rates of primaries and secondaries are strongly correlated, and Hα luminosities, IR excesses, and ages also correlate within pairs. Primaries tend to have somewhat larger accretion rates than their secondaries do, and are typically slightly older than their secondaries according to three different sets of modern pre-main-sequence evolutionary tracks. Age differences for XZ Tau and FS Tau, systems embedded in reflection nebulae, are striking; the secondary in each pair is less massive but more luminous than the primary. The stellar masses of the UY Aur and GG Tau binaries measured from their rotating molecular disks are about 30% larger than the masses inferred from the spectra and evolutionary tracks. This discrepancy can be resolved in several ways, among them a 10% closer distance for the Taurus-Auriga dark cloud.

Accepted by Ap. J. (Jan, 2003)

http://sparky.rice.edu/∼hartigan/pub.html

Inner Structure of Protostellar Collapse Candidate B335 Derived from Millimeter-Wave Interferometry

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We present a study of the density structure of the protostellar collapse candidate B335 using continuum observations from the IRAM Plateau de Bure Interferometer made at wavelengths of 1.2 mm and 3.0 mm. We analyze these data, which probe spatial scales from 5000 AU to 500 AU, directly in the visibility domain by comparison to synthetic observations constructed from models that assume different physical conditions. This approach allows for much more stringent constraints to be derived from the data than from analysis of images. A single radial power law in density provides a good description of the data, with best fit power law density index $p = 1.65 \pm 0.05$. Through simulations, we quantify the sensitivity of this result to various model uncertainties, including assumptions of temperature distribution, outer boundary, dust opacity spectral index, and an unresolved central component. The largest uncertainty comes from the unknown presence of a centralized point source. The maximal point source with 1.2 mm flux of $F = 12 \pm 7$ mJy

reduces the power law density index to $p = 1.47 \pm 0.07$. The remaining sources of systematic uncertainty, of which the most important is the radial dependence of the temperature distribution, likely contribute a total uncertainty at the level of $\delta p \leq 0.2$. Taking account the uncertainties, we find strong evidence that the power law index of the density distribution within 5000 AU is significantly less than the value at larger radii, close to 2.0 from previous studies of dust emission and extinction. Images made from the data show clear departures from spherical symmetry, with the globule being slightly extended perpendicular to the outflow axis. The inclusion of a crude model of the outflow as a hollowed bipolar cone of constant opening angle improves the fit and leaves the resulting density power law index unchanged. These results conform well to the generic paradigm of isolated, low-mass star formation which predicts a power law density index close to $p = 1.5$ for an inner region of gravitational free fall onto the protostar. However, the standard inside-out collapse model does not fit the data as successfully as a simple $p = 1.5$ power law because of the relative shallowness of the predicted density profile just within the infall radius.

Accepted by Astrophys. J.

http://xxx.lanl.gov/abs/astro-ph/0210081

Fast Reconnection in a Two-Stage Process

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Magnetic reconnection plays an essential role in the generation and evolution of astrophysical magnetic fields. The best tested and most robust reconnection theory is that of Parker and Sweet. According to this theory, the reconnection rate scales with magnetic diffusivity λ_Ω as $\lambda_\Omega^{1/2}$. In the interstellar medium, the Parker-Sweet reconnection rate is far too slow to be of interest. Thus, a mechanism for fast reconnection seems to be required.

We have studied the magnetic merging of two oppositely directed flux systems in weakly ionized, but highly conducting, compressible gas. In such systems, ambipolar diffusion steepens the magnetic profile, leading to a thin current sheet. If the ion pressure is small enough, and the recombination of ions is fast enough, the resulting rate of magnetic merging is fast, and independent of λ_Ω. Slow recombination or sufficiently large ion pressure leads to slower merging which scales with λ_Ω as $\lambda_\Omega^{1/2}$. We derive a criterion for distinguishing these two regimes, and discuss applications to the weakly ionized ISM and to protoplanetary accretion disks.

Accepted by ApJ (Jan 2003)

http://lcd-www.colorado.edu/heitsch/preprints/HEZ2003/

Stellar Rotation and Variability in the Orion Nebula Cluster

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A wide field imager attached to the MPG/ESO 2.2 m telescope on La Silla has been used to monitor the Orion Nebula Cluster on 45 nights between 25 Dec 1998 and 28 Feb 1999. Ninety-two images were obtained during this period through an intermediate band filter centered at 815.9 nm. More than 1500 sources with I magnitudes between 12.5 and 20 were monitored. We find that essentially every star brighter than 16th mag (where the precision is <0.01 mag) is a variable, with about half having a peak-to-peak variation of ∼0.2 mag or more. A clear correlation is found between the level of variability and infrared excess emission, in the sense that stars with evidence for circumstellar disks have larger amplitudes of variation. A search for periodic variables was carried out and 369 such stars were discovered, most or all of which are rotating, spotted T Tauri stars. Periodic variables are most commonly found among the low amplitude variables. 46% of the stars with magnitudes between 12.5 and 16 and standard deviation, $\sigma < 0.1$ mag, were found to be periodic, whereas only 24% of the stars in the same magnitude range with $\sigma > 0.1$ yielded periods.

Our work confirms the existence of a bimodal period distribution, with peaks near 2 and 8 days, for stars with M >

0.25 $M_\odot$ and a unimodal distribution peaked near 2 days, for lower mass stars. We show that a statistically significant correlation exists between infrared excess emission and rotation in the sense that slower rotators are more likely to show evidence of circumstellar disks. Slowly rotating stars, with angular velocities, $\omega < 1$ radian/d, corresponding to rotation periods longer than 6.28 d, have a mean infrared excess emission, Δ(I-K) = 0.55 $\pm$ 0.05, indicative of the presence of inner disks, while rapid rotators, with $\omega > 2$ radians/d, corresponding to rotation periods shorter than 3.14 d, have a much smaller mean of 0.17 $\pm$ 0.05. This supports the hypothesis that disks are involved in regulating stellar rotation during the pre-main sequence phase.

We explore a simple and commonly adopted model of rotational evolution in which stars conserve angular velocity while locked to a disk and conserve angular momentum once released. If these assumptions are valid, and if the locking period is 8 days, we find that more than half of the stars in the ONC are no longer locked to disks and that an exponential decay model with a disk-locking half-life of about 0.5-1 My fits the observations well. Assuming that the mean ages of the higher and lower mass stars are the same, the faster rotation of the lower mass stars can be understood as either a consequence of a shorter disk-locking time or a shorter initial disk-locking period, or both.

Accepted by A & A

Preprint available at URL: http://www.astro.wesleyan.edu/∼bill/

X-Ray Detection of the Ionizing Stars in Ultracompact HII Regions

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We present observations of the W3 complex of massive star formation regions with the *Chandra X-Ray Observatory*. In the W3 core region our observations resolve the emission previously observed with *ASCA* into 101 compact sources. The integrated spectrum is consistent with that observed earlier by *ASCA* and shows significant emission at energies larger than 2.5 keV. Comparing our *Chandra* data with existing NIR images we find X-ray counterparts for W3 IRS2, W3 IRS2a, and W3 IRS3a which are believed to be the ionizing stars for the HII regions W3 A and B. We also detect X-ray emission coincident with the massive proto-star candidate W3 IRS5. Comparing our *Chandra* data with existing radio continuum data, we find that for radio continuum components A, B, C, D, G, and H one or several X-ray sources are located at the peak radio position, and/or geometric center of the HII region. We postulate that the X-ray sources are the young massive stars which are also responsible for the ionization of the compact and ultracompact HII regions in the W3 core. Our observations show that very young massive stars are emitters of relatively hard X-rays, and that they can be detected with *Chandra* even in a high density environment.

Accepted by Ap. J. Letters

The kinetic temperature of Barnard 68

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We have observed the nearby isolated globule Barnard 68 (B68) in the $(J,K) = (1,1)$ and $(2,2)$ inversion lines of ammonia. The gas kinetic temperature derived from these is $T = 10 \pm 1.2$ K. The observed line-widths are almost thermal: $\Delta V = 0.181 \pm 0.003$ km s^{-1} ($\Delta V_{\rm therm} = 0.164 \pm 0.010$ km s^{-1}), supporting the earlier hypothesis that B68 is in hydrostatic equilibrium. The kinetic temperature is an input parameter to the physical cloud model put forward recently, and we discuss the impact of the new value in this context.

Accepted by A&A (Letters)

http://www.astro.helsinki.fi/~hotzel/paper2.ps.gz

Probing Disk Accretion in Young Brown Dwarfs

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We present high-resolution optical spectra of 15 objects near or below the sub-stellar limit in the Upper Scorpius and ρ Ophiuchus star-forming regions. These spectra, obtained with the HIRES instrument on the Keck I telescope, are used to investigate disk accretion, rotation and activity in young very low mass objects. We report the detection of a broad, asymmetric Hα emission line in the ρ Oph source GY 5 which is also known to harbor mid-infrared excess, consistent with the presence of an accreting disk. The Hα profiles of the Upper Sco objects suggest little or no on-going accretion. Our results imply that if most brown dwarfs are born with disks, their accretion rates decrease rapidly, at timescales comparable to or smaller than those for T Tauri disks. The Upper Sco brown dwarfs appear to be rotating faster than their somewhat younger counterparts in Taurus, consistent with spin-up due to contraction following disk unlocking. The Hα activity is comparable to saturated activity levels in field M dwarfs with similar spectral type and rotation rates. Comparison of our data with published (albeit lower-resolution) spectra of a few of the same objects from other epochs suggests possible variability in accretion/activity indicators.

Accepted by The Astrophysical Journal Letters

Available at http://arxiv.org/abs/astro-ph/0209275

A Multi-Epoch Near-Infrared Study of the HH 7-11 Protostellar Outflow

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We present near-infrared observations of the protostellar outflow HH 7-11 in the molecular hydrogen 1-0 S(1) and [FeII] 1.644 μm emission lines. Images at four epochs spread over 11 years constrain the proper motions of the H_2 emission knots to be less than 0.045 arcseconds per year, corresponding to tangential speeds of under 47 km s^{-1} at 220 pc distance, consistent with the proper motions derived in the optical for the atomic component. Reanalysis of previous observations shows that variability and distortion of the SVS 13 reference star led to erroneous high H_2 proper motions. The SVS 13 K-band flux is a factor of 3 higher in 1994–2000 than in 1989. Numerous H_2 sub-knots are identified on images taken in 1998 and 2000. No significant relative variability is found in these sub-knots, consistent with slow outflow evolution. Compact [FeII] emission peaks are found at the locations of atomic emission line features observed in the optical. We also identify in this line an elongated feature corresponding to the proposed jet Mach Disk.

Accepted by MNRAS

Preprints available at http://star.arm.ac.uk/∼tig/research.html

Investigation of the physical properties of protoplanetary disks around T Tauri stars by a one-arcsecond imaging survey: Evolution and diversity of the disks in their accretion stage

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We present the results of an imaging survey of protoplanetary disks around single T Tauri stars in Taurus. Thermal emission at 2 mm from dust in the disks has been imaged with a maximum spatial resolution of one arcsecond by using the Nobeyama Millimeter Array (NMA). Disk images have been successfully obtained under almost uniform conditions for 13 T Tauri stars, two of which are thought to be embedded. We have derived the disk properties of outer radius, surface density distribution, mass, temperature distribution, and dust opacity coefficient, by analyzing both our images and the spectral energy distributions (SEDs) on the basis of two disk models: the usual power-law model and the standard model for viscous accretion disks. By examining correlations between the disk properties and disk clocks, we have found radial expansion of the disks with decreasing Hα line luminosity, a measure of disk evolution. This expansion can be interpreted as radial expansion of accretion disks due to outward transport of angular momentum with evolution. The increasing rate of the disk radius suggests that the viscosity has weak dependence on radius r and $\alpha \sim 0.01$ for the α parameterization of the viscosity. The power-law index p of the surface density distribution ($\Sigma(r) = \Sigma_0(r/r_0)^{-p}$) is 0 - 1 in most cases, which is smaller than 1.5 adopted in the Hayashi model for the origin of our solar system, while the surface density at 100 AU is 0.1 - 10 g cm^{-2}, which is consistent with the extrapolated value in the Hayashi model. These facts may imply that in the disks of our sample it is very difficult to make planets like ours without redistribution of solids, if such low values for p hold even in the innermost regions.

Accepted by ApJ

Preprint available at ftp://ftp.nro.nao.ac.jp/nroreport/ykitamura.pdf (1.1 MB)

Models of the formation of the planets in the 47 UMa system

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Formation of planets in the 47 UMa system is followed in an evolving protoplanetary disk composed of gas and solids. The evolution of the disk is calculated from an early stage, when all solids, assumed to be high-temperature silicates, are in the dust form, to the stage when most solids are locked in planetesimals. The simulation of planetary evolution starts with a solid embryo of $\sim$1 Earth mass, and proceeds according to the core accretion – gas capture model. Orbital parameters are kept constant, and it is assumed that the environment of each planet is not perturbed by the second planet. It is found that conditions suitable for both planets to form within several Myr are easily created, and maintained throughout the formation time, in disks with $\alpha \approx 0.01$. In such disks, a planet of 2.6 Jupiter masses (the minimum for the inner planet of the 47 UMa system) may be formed at 2.1 AU from the star in $\sim$3 Myr, while a planet of 0.89 Jupiter masses (the minimum for the outer planet) may be formed at 3.95 AU from the star in about the same time. The formation of planets is possible as a result of a significant enhancement of the surface density of solids between 1.0 and 4.0 AU, which results from the evolution of a disk with an initially uniform gas-to-dust ratio of 167 and an initial radius of 40 AU.

Accepted by Astronomy & Astrophysics

Available at http://xxx.lanl.gov/abs/astro-ph/0209613

A very young star forming region detected by the ISOPHOT Serendipity Survey

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We present a multi-wavelength study of the star forming region ISOSS J 20298+3559, which was identified by a cross-

correlation of cold compact sources from the 170 μm ISOPHOT Serendipity Survey (ISOSS) database coinciding with objects detected by the MSX, 2MASS and IRAS infrared surveys. ISOSS J 20298+3559 is associated with a massive dark cloud complex (M $\sim$ 760 $M_\odot$) and located in the Cygnus X giant molecular cloud. We derive a distance of 1800 pc on the basis of optical extinction data. The low average dust temperature (T $\sim$ 16 K) and large mass (M $\sim$ 120 $M_\odot$) of the dense inner part of the cloud, which has not been dispersed, indicates a recent begin of star formation. The youth of the region is supported by the early evolutionary stage of several pre- and protostellar objects discovered across the region: I) Two candidate Class 0 objects with masses of 8 and 3.5 $M_\odot$, II) a gravitationally bound, cold (T $\sim$ 12 K) and dense (n(H_2) $\sim 2 \cdot 10^5$ cm^{-3}) cloud core with a mass of 50 $M_\odot$ and III) a Herbig B2 star with a mass of 6.5 $M_\odot$ and a bolometric luminosity of 2200 $L_\odot$, showing evidence for ongoing accretion and a stellar age of less than 40000 years. The dereddened SED of the Herbig star is well reproduced by an accretion disc + star model. The externally heated cold cloud core is a good candidate for a massive pre-protostellar object. The star formation efficiency in the central cloud region is about 14 %.

Accepted by Astronomy & Astrophysics

Computation of Light Scattering in Young Stellar Objects

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A Monte Carlo light scattering code incorporating aligned non-spherical particles is described. The major effects on the flux distribution, linear polarisation and circular polarisation are presented, with emphasis on the application to Young Stellar Objects (YSOs). The need for models with non-spherical particles in order to successfully model polarisation data is reviewed. The potential of this type of model to map magnetic field structure in embedded YSOs is described. The possible application to the question of the origin of biomolecular homochirality via UV circular polarisation in star forming regions is also briefly discussed.

Accepted by the Journal of Quantitative Spectroscopy and Radiative Transfer

This paper is available at http://uk.arxiv.org/abs/astro-ph/0208342

Search for HH objects and emission-line stars in star forming regions. I. Lynds 1340 dark cloud.

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The results of spectral and photometric observations of objects embedded in the L 1340 dark cloud are presented. Quite a few HH objects, among them new ones, were found in the field of RNO 7. They form two or three flows. Several other cases of HH-like emission are suspected. Besides, 14 emission-line stars (11 new ones) were found in this area. They mostly are located inside the RNO 7 nebula, which thus embeds a compact cluster of very young stars.

Other nebulous objects in L 1340 cloud are described. Many of them are associated with IR sources. As a whole this cloud represents a rather active star forming region.

Accepted by Astrophysics

Water emission in NGC1333-IRAS4: The physical structure of the envelope

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We report ISO-LWS far infrared observations of CO, water and oxygen lines towards the protobinary system IRAS4 in the NGC1333 cloud. We detected several water, OH, CO rotational lines, and two [OI] and [CII] fine structure lines. Given the relatively poor spectral and spatial resolution of these observations, assessing the origin of the observed emission is not straightforward. In this paper, we focus on the water line emission and explore the hypothesis that it originates in the envelopes that surround the two protostars, IRAS4 A and B, thanks to an accurate model. The model reproduces quite well the observed water line fluxes, predicting a density profile, mass accretion rate, central mass, and water abundance profile in agreement with previous works. We hence conclude that the emission from the envelopes is a viable explanation for the observed water emission, although we cannot totally rule out the alternative that the observed water emission originates in the outflow. The envelopes are formed by a static envelope where the density follows the r^{-2} law, at $r \geq 1500$ AU, and a collapsing envelope where the density follows the $r^{-3/2}$ law. The density of the envelopes at 1500 AU from the center is $\sim 4 \times 10^6$ cm^{-3} and the dust temperature is ~ 30 K, i.e. about the evaporation temperature of CO-rich ices. This may explain previous observations that claimed a factor of 10 depletion of CO in IRAS4, as those observations probe the outer ≤ 30 K region of the envelope. The water is $\sim 5 \times 10^{-7}$ less abundant than H_2 in the outer and cold envelope, whereas its abundance jumps to $\sim 5 \times 10^{-6}$ in the innermost warm region, at $r \leq 80$ AU where the dust temperature exceeds 100 K, the evaporation temperature of H_2O-rich ices. We derive a mass of 0.5 $M_\odot$ for each protostar, and an accretion rate of 5×10^{-5} $M_\odot$ yr^{-1} , implying an age of about 10000 years, if the accretion rate remains constant. We finally discuss the difference between IRAS4 and IRAS16293-2422, where a similar analysis has been carried out. We found that IRAS4 is probably a younger system than IRAS16293-2422. This fact, coupled with the larger distance of IRAS4 from the Sun, fully explains the apparent difference in the molecular emission of these two sources, which is much richer in IRAS16293-2422.

Accepted by Astronomy & Astrophysics

Preprint available at: http://www.cesr.fr/∼maret/publications/aea-iras4-h2o.ps or astro-ph/0209366

A Keplerian disk around the Herbig Ae star HD 34282

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We report new millimeter observations of the circumstellar material surrounding the Herbig Ae A0.5 star HD 34282 performed with the IRAM array in ^{12}CO $J = 2 \rightarrow 1$ and in continuum at 1.3 mm. These observations have revealed the existence of a large Keplerian disk around the star. We have analysed simultaneously the line and continuum emissions to derive the physical properties of both the gas and the dust. The analysis of our observations also shows that the Hipparcos distance to the star is somewhat underestimated ; the actual distance is probably about 400 pc. With this distance the disk around HD 34282 appears more massive and somewhat hotter than the observed disks around less massive T Tauri stars, but shares the general behaviour of passive disks.

Accepted by Astronomy & Astrophysics

http://arXiv.org/abs/astro-ph/0210097

Component Masses of the Young Spectroscopic Binary UZ Tau E

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We report estimates of the masses of the component stars in the pre−main-sequence spectroscopic binary UZ Tau E. These results come from the combination of our measurements of the mass ratio, $M_2/M_1 = 0.28 \pm 0.01$, obtained using high resolution H-band spectroscopy, with the total mass of the system, (1.31 ± 0.08)(D/140pc) $M_\odot$, derived from millimeter observations of the circumbinary disk (Simon et al. 2000). The masses of the primary and secondary are

(1.016±0.065)(D/140pc) $M_\odot$ and (0.294±0.027)(D/140pc) $M_\odot$, respectively. Using the orbital parameters determined from our six epochs of observation, we find that the inclination of the binary orbit, 59.8±4.4 degrees, is consistent with that determined for the circumbinary disk from the millimeter observations, indicating that the disk and binary orbits are probably coplanar.

Accepted by ApJ Letters

Astrometric signatures of self-gravitating protoplanetary discs

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We use high resolution numerical simulations to study whether gravitational instabilities within circumstellar discs can produce astrometrically detectable motion of the central star. For discs with masses of $M_{\rm disc} = 0.1\ M_*$, which are permanantly stable against fragmentation, we find that the magnitude of the astrometric signal depends upon the efficiency of disc cooling. Short cooling times produce prominent filamentary spiral structures in the disc, and lead to stellar motions that are potentially observable with future high precision astrometric experiments. For a disc that is marginally unstable within radii of ~ 10 au, we estimate astrometric displacements of $10 - 10^2$ μarcsec on decade timescales for a star at a distance of 100 pc. The predicted displacement is suppressed by a factor of several in more stable discs in which the cooling time exceeds the local dynamical time by an order of magnitude. We find that the largest contribution comes from material in the outer regions of the disc and hence, in the most pessimistic scenario, the stellar motions caused by the disc could confuse astrometric searches for low mass planets orbiting at large radii. They are, however, unlikely to present any complications in searches for embedded planets orbiting at small radii, relative to the disc size, or Jupiter mass planets or greater orbiting at large radii.

Accepted by MNRAS

http://star-www.st-and.ac.uk/astronomy/Welcome

VLA Observations of Proper Motions in L1551 IRS5

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Using high angular resolution ($\sim 0\farcs1$) Very Large Array observations made at 2 cm during the period 1983 to 1998, we report the detection of proper motions in the components of the binary radio source in L1551 IRS5. The absolute proper motions observed in these two protostars, of order 25 mas year^{-1} or $\sim$17 km s^{-1} at a distance of 140 pc, are very similar in magnitude and direction to those of T Tauri stars in the same region and are attributed to the large-scale motion of the parent molecular complex. The relative astrometry between the two components reveals orbital proper motions that suggest that the total mass and period of the binary system are $\sim 1.2\ M_\odot$ and $\sim 260\ yr$, respectively.

Accepted by The Astrophysical Journal

http://www.astrosmo.unam.mx/~luisfr/publ.html

The kinematic relationship between disk and jet in the DG Tauri system

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We present high angular resolution millimeter wavelength continuum and ^{13}CO(2–1) observations of the circumstellar disk surrounding the T Tauri star DG Tauri. We show that the velocity pattern in the inner regions of the disk is consistent with Keplerian rotation about a central 0.67 $M_\odot$ star. The disk rotation is also consistent with the toroidal velocity pattern in the initial channel of the optical jet, as inferred from HST spectra of the first de-projected 100 AU from the source. Our observations support the tight relationship between disk and jet kinematics postulated by the popular magneto-centrifugal models for jet formation and collimation.

Accepted by A&A Letters

http://www.arcetri.astro.it/∼lt/preprints/preprints.html
http://arXiv.org/abs/astro-ph/0209464

Detection of abundant solid CO in the disk around CRBR 2422.8-3423

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We present direct evidence for CO freeze-out in a circumstellar disk around the edge-on class I object CRBR 2422.8-3423, observed in the M band with VLT-ISAAC at a resolving power $R \simeq 10\,000$. The spectrum shows strong solid CO absorption, with a lower limit on the column density of 2.2×10^{18} cm^{-2}. The solid CO column is the highest observed so far, including high-mass protostars and background field stars. Absorption by foreground cloud material likely accounts for only a small fraction of the total solid CO, based on the weakness of solid CO absorption toward nearby sources and the absence of gaseous C^{18}O $J = 2 \rightarrow 1$ emission 30″ south. Gas-phase ro-vibrational CO absorption lines are also detected with a mean temperature of 50 ±10 K. The average gas/solid CO ratio is ∼ 1 along the line of sight. For an estimated inclination of 20° ± 5°, the solid CO absorption originates mostly in the cold, shielded outer part of the flaring disk, consistent with the predominance of apolar solid CO in the spectrum and the non-detection of solid OCN$^-$, an indicator of thermal/ultraviolet processing of the ice mantle. By contrast, the warm gaseous CO likely originates closer to the star.

Accepted by Astronomy and Astrophysics Letters

http://xxx.lanl.gov/abs/astro-ph/0209428

Probing the circumstellar structure of Herbig Ae/Be stars

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We present Hα spectropolarimetry observations of a sample of 23 Herbig Ae/Be stars. A change in the linear polarisation across Hα is detected in a large fraction of the objects, which indicates that the regions around Herbig stars are flattened (disc-like) on small scales. A second outcome of our study is that the spectropolarimetric signatures for the Ae stars differ from those of the Herbig Be stars, with characteristics changing from depolarisation across Hα in

the Herbig Be stars, to line polarisations in the Ae group. The frequency of depolarisations detected in the Herbig Be stars (7/12) is particularly interesting as, by analogy to classical Be stars, it may be the best evidence to date that the higher mass Herbig stars are surrounded by flattened structures. For the Herbig Ae stars, 9 out of 11 show a line polarisation effect that can be understood in terms of a compact Hα emission that is itself polarised by a rotating disc-like circumstellar medium. The spectropolarimetric difference between the Herbig Be and Ae stars may be the first indication that there is a transition in the Hertzsprung-Russell Diagram from magnetic accretion at spectral type A to disc accretion at spectral type B. Alternatively, the interior polarised line emission apparent in the Ae stars may be masked in the Herbig Be stars due to their higher levels of Hα emission.

Accepted by MNRAS

http://astro.ic.ac.uk/∼jvink/

Very Low Mass Stars and Brown Dwarfs in Taurus-Auriga

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We present high resolution optical spectra obtained with the HIRES spectrograph on the W. M. Keck I telescope of seven low mass T Tauri stars and brown dwarfs (LMTTs) in Taurus-Auriga. The observed Li I 6708 Å absorption, low surface gravity signatures, and radial velocities confirm that all are members of the Taurus star forming region; no new spectroscopic binaries are identified. Four of the seven targets observed appear to be T Tauri brown dwarfs. Of particular interest is the previously classified "continuum T Tauri star" GM Tau, which has a spectral type of M6.5 and a mass just below the stellar/substellar boundary.

These spectra, in combination with previous high resolution spectra of LMTTs, are used to understand the formation and early evolution of objects in Taurus-Auriga with masses near and below the stellar/substellar boundary. None of the LMTTs in Taurus are rapidly rotating (vsin$i$ $<$ 30 km/s), unlike low mass objects in Orion. Many of the slowly rotating, non-accreting stars and brown dwarfs exhibit prominent Hα emission (equivalent widths of 3 - 36 Å), indicative of active chromospheres. We demonstrate empirically that the full-width at 10% of the Hα emission profile peak is a more practical and possibly more accurate indicator of accretion than either the equivalent width of Hα or optical veiling: 10%-widths $>$ 270 km/s are classical T Tauri stars (i.e. accreting), independent of stellar spectral type. Although LMTTs can have accretion rates comparable to that of more typical, higher-mass T Tauri stars (e.g. K7-M0 spectral types), the average mass accretion rate appears to decrease with decreasing mass. A functional form of $\dot{M} \propto M$ is consistent with the available data, but the dependence is difficult to establish because of both selection biases in observed samples, and the decreasing frequency of active accretion disks at low masses (M $<$ 0.2 M$_\odot$). The diminished frequency of accretion disks for LMTTs, in conjunction with their lower, on average, mass accretion rates, implies that they are formed with less massive disks than higher-mass T Tauri stars. The radial velocities, circumstellar properties and known binaries do not support the suggestion that many of the lowest mass members of Taurus have been ejected from higher stellar density regions within the cloud. Instead, LMTTs appear to have formed and are evolving in the same way as higher-mass T Tauri stars, but with smaller disks and shorter disk lifetimes.

Accepted by The Astrophysical Journal.

Preprint available at http://xxx.lanl.gov/abs/astro-ph/0209164

Thermal OH (1667/65 MHz) Absorption and Nonthermal OH (1720 MHz) Emission Towards the W28 Supernova Remnant

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The W28 supernova remnant is an excellent prototype for observing shocked gas resulting from the interaction of supernova remnants (SNRs) and adjacent molecular clouds (MCs). We present two new signatures of shocked molecular gas in this remnant. One is the detection of main-line extended OH (1667 MHz) absorption with broad linewidths. The column density of OH estimated from the optical depth profiles is consistent with a theoretical model in which OH is formed behind a C-type shock front. The second is the detection of extended, weak OH (1720 MHz) line emission with narrow linewidth distributed throughout the shocked region of W28. These give observational support to the idea that compact maser sources delineate the brightest component of a much larger region of main line OH absorption and nonthermal OH (1720 MHz) emission tracing the global structure of shocked molecular gas. Main line OH (1665/67) absorption and extended OH (1720 MHz) emission line studies can serve as powerful tools to detect SNR-MC interaction even when bright OH (1720 MHz) masers are absent.

Accepted by ApJ (Jan. 20, 2003)

http://xxx.lanl.gov/abs/astro-ph/0209485

Near-infrared imaging of RAFGL7009S

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RAFGL7009S is a deeply embedded massive young stellar objet (YSO) showing strong ice and saturated silicate absorption features in the mid infrared. It is associated with the ultracompact H II region G25.65+1.05, which may be excited by a B1V star. We have obtained JHK images of a $1'$ field centred on this YSO. In K we detect a non-resolved object coinciding with the radio continuum emission peak. Considering the high extinction towards this source ($A_V \geq$ 100 mag), the observed K emission is more than 7 mag in excess of that expected for a B1V star. We suggest that this emission is mainly due to scattering of the central zone emission, as recently found for a sample of embedded massive YSOs associated with 3.1 μm H_2O ice absorption (Ishii et al. 2002). We estimate the YSO's age to be 2×10^4 years. The outflow, the methanol maser emission and the strong ice absorption features suggest the presence of a dense medium very close to the star, possibly a disk.

Accepted by A&A

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Dissertation Abstracts

Outflows from Massive Young Stellar Objects

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The interaction of the outflows from a sample of massive Young Stellar Objects (YSOs) has been studied at very small and at very large scales. Near-IR speckle imaging is used to image the sub-arcsecond reflection nebulae associated with the base of the outflow cavities. Sub-arcsecond nebulae were detected in 30% of the sources. The massive YSOs that do not show sub-arcsecond nebulosities are probably not embedded enough. None of the sources appear to show evidence of jets.

To investigate the morphology of the circumstellar density distribution, the speckle observations are compared with synthetic nebulae that result from an axi-symmetric radiative transfer Monte Carlo code. The morphology of the synthetic nebulae are found to be governed mainly by the optical depth, system inclination angle and cavity opening angle.

The radiative transfer model was used to constrain the density distribution in Mon R2 IRS3 S. A reasonable match to the observed K band morphology was found using a model with a cavity opening angle of 20°, an inclination angle of 45°, and an overall K band optical depth of 8. This value of the optical depth is consistent with the total extinction to the source inferred from the strength of the 9.7 μm silicate absorption feature. All attempts to model the H-band nebula were too extended, with an opacity law shallower than the standard yielding a better match. Conical cavities were found to yield slightly better fits than parabolic cavities.

Narrow-band imaging with the Taurus Tunable Filter was used to search for optical shock-excited emission in the outer parts of the outflow cavity from four massive YSOs. In most cases, no emission was found that could be clearly related with the outflow at parsec scales. Emission features that were detected need further investigation using long slit spectroscopy to analyse their kinematics. The observed fluxes and upper limits were compared with the predictions from radiative shock models available in the literature. The upper limits are difficult to reconcile with fast shocks ($V_s \geq 400$ kms^{-1}) that would arise from jet interactions. Any shock interaction from fast winds would need to be oblique, implying poorly collimated winds. This indicates that different outflow driving and collimation mechanisms are likely to take place in low mass and in high mass star formation.

The Collapse of Rotating Clouds

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In order to investigate fragmentation, as a possible mechanism for binary formation, we have performed numerical simulations of the collapse of a differentially rotating cloud. A ring forms in the collapse of a rotating cloud. This ring is unstable, and is easily broken to form fragments in one rotational period. In the case of solid-body rotation, a ring forms due to rotational bounce just after the isothermal stage. However a ring forms without rotational bounce in the case of differential rotation. The ring forms because the rapidly collapsing outer part catches up with the rotationally supported inner part in the differentially rotating cloud. We have found the criterion for formation of a ring in the isothermal collapse of a slowly rotating uniform density cloud ($\beta_o \left(\equiv \frac{1}{3}\frac{R_c^3\Omega_c^2}{GM_c}\right) \leq 0.035$). An isothermal ring is formed when the power index of differential rotation, $P\,(\equiv -d\ln[\omega]/d\ln[r])$, is larger than $\frac{1}{2}$.

With a barotropic equation of state, rotational bounce always occurs in the early adiabatic stage, whether $P < \frac{1}{2}$ or $P > \frac{1}{2}$. However, if $P > \frac{1}{2}$, there is a ring already, so the rotational bounce only enhances the density of the ring.

We have performed the same simulations with an $m = 2$ density perturbation. The initial perturbation does not change the criterion for isothermal ring formation, but it enhances the density contrast in the ring and accelerates the formation of spiral structure.

We have developed Godunov-type Particle Hydrodynamics (GPH) for the simulations of the differentially rotating cloud, because Smoothed Particle Hydrodynamics (SPH) has a side-effect in a system with velocity shear. GPH is a hybrid scheme of SPH and the Godunov-type upwind scheme, so it inherits all the advantages of SPH and the upwind scheme. We have performed von Neumann stability analysis for isothermal SPH and GPH, and have shown that GPH is stable for all wavelengths.

Ten tests have been performed to estimate the performance of GPH. Although GPH is a first-ordered scheme in time, its performance in the tests is better than, or equal to, that of SPH. GPH can describe shock waves without an explicit artificial viscosity in the equations of momentum and energy. Furthermore GPH prevents particle penetration effectively, and is affected by velocity shear less seriously than SPH.

The Influence of Poloidal Magnetic Fields on Astrophysical Outflows

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We have studied the effects of poloidal magnetic fields on two classes of outflows via time-dependent, numerical magnetohydrodynamic simulations. Correspondingly, this thesis is divided into two parts: a study of winds from isolated stars with dipole magnetic fields; and a study on outflows from pre-main sequence stars, surrounded by and interacting with accretion disks.

We begin with a study of the effects of stellar dipole magnetic field on winds from isolated stars. Our simulations indicate that a wind from the surface of a non-rotating AGB star, if sufficiently ionized, may be channeled into an outflowing disk by a dipolar field of only a few Gauss. This type of wind may be partly responsible for shaping planetary nebulae. If the star rotates, the additional magnetic pressure, associated with the azimuthal component of the field (generated by rotation), has the effect of enhancing the outflowing disk and simultaneously produces a jet. We show that the resulting quadrupolar density pattern (disk plus jet) in the wind may explain observations of reflected starlight in proto-planetary nebulae.

Next, we carry out a parameter study of an episodic magnetospheric inflation (EMI) model for launching outflows from young stellar objects (YSO's), first proposed by Hayashi et al. (1996) and Goodson et al. (1997). The basic mechanism produces an intermittent, collimated jet and an uncollimated, wide-angle wind and partially explains the mass loss and intermittent accretion of YSO's. We find that the EMI mechanism is robust, and the system is self-regulating (i.e., the outflow properties depend relatively weakly on the parameters we varied). Also, the addition of a weak vertical field initially threading the accretion disk has no effect on the EMI mechanism. However, we demonstrate that the weak vertical field can collimate the entire flow (including the component that is initially launched with a wide opening angle) into a physically broader and more powerful jet than produced by the central launching mechanism alone.

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Two Postdoctoral Positions in Star Formation
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Two post-doctoral positions will shortly become available to work on a joint Dublin City University and Dublin Institute for Advanced Studies project in star formation.

Ideally one person should have a background in astrophysical numerical simulations while the other should be an observer with extensive experience of modelling and an interest in simulations. Candidates must have a PhD, or have recently submitted their thesis. For further details please contact either Prof. Tom Ray (tr@cp.dias.ie), Dublin Institute for Advanced Studies, 5 Merrion Square, Dublin 2, Ireland or Dr. Turlough Downes (turlough.downes@dcu.ie), School of Mathematical Sciences, Dublin City University, Glasnevin, Dublin 9, Ireland.

The postdoctoral researchers will be paid in the range 24,000-33,000 Euro per annum depending upon experience. Both of these positions are for two years initially. Application is by letter and CV naming 3 academic referees. The closing date for applications is Friday 29th November. Letters of application, statements of research interest and CVs should be sent to: Ms. A. Shaw, CosmoGrid Administrator, Dublin Institute for Advanced Studies, 5 Merrion Square, Dublin 2, Ireland.

Funded by the Program for Research in Third Level Institutions under the Irish National Development Plan and with assistance from the European Regional Development Fund.

Postdoctoral Research Position
Department of Astrophysics
American Museum of Natural History

The Department of Astrophysics at the American Museum of Natural History invites applications to compete for a postdoctoral research position funded by the Museum. The position would have a term of two years (extension dependent on additional funding), and carries a small research fund with it. At least 50% of time would be available for independently directed research, with remaining time devoted to collaborative projects of mutual interest with department members. Research interests in the department include *theoretical and computational modeling of star formation and the interstellar medium in both the local and high-redshift universe* (Mac Low), and observations and simulations of novae and globular clusters, as well as large-scale surveys (Shara). Roughly ten postdoctoral fellows and graduate students reside in the department each year. The department has a workstation network, a cluster of nine Alpha processors with three GRAPE 6 boards attached, access to the 12 and 28-processor SGI Onyx 2000 machines of the Hayden Planetarium, and access to a 560-processor Beowulf cluster elsewhere in the Museum. We maintain close ties with Columbia University and other research institutes in the NYC area.

Applicants should send a vita, list of publications, and statement of research interests to the address below, and arrange for three letters of recommendation to be sent directly to the same address. The department will request that the top two applicants prepare Scientific American level research statements by November 15 for consideration by the Museum-wide Grants & Fellowships committee. Funding for this position is dependent on approval by that committee. Initial consideration of applications will begin 20 October 2002.

Department of Astrophysics
American Museum of Natural History
79th St. and Central Park West
New York, NY, 10024-5192
Tel: +1-212-313-7441
Fax: +1-212-769-5007
email: mordecai@amnh.org
URL: http://research.amnh.org/astrophysics

Attention: Beth Lebwohl, Admin. Asst.

Postdoctoral Research Position – Young Sub-Stellar Objects

UNIVERSITY OF MICHIGAN

Applications are invited for a postdoctoral research position at the University of Michigan, to start anytime in the next year. The successful candidate will work with Prof. Ray Jayawardhana and his collaborators on observational and analytical studies of the formation of very low mass stars, brown dwarfs and planets, and will be encouraged to pursue independent research on related topics. On-going projects include identification and characterization of young sub-stellar objects with a view to understanding their origin and early evolution, using data from Keck, VLT, Magellan and other major observatories. Prior experience with infrared/optical photometry and/or spectroscopy is desirable. The successful applicant will have independent access to the two Magellan 6.5-meter telescopes in Chile, the MDM 2.4-meter and 1.3-meter telescopes on Kitt Peak, the 26-meter radio telescope near Dexter, Michigan, and the department image processing and computing network for research activities. The position is for two years, with extension to a third year possible, and includes substantial research support.

Applicants should send a curriculum vitae, a description of research interests, and a list of publications, and should arrange for three letters of recommendation to be sent directly to the address below. Please indicate the preferred starting date. Applications received prior to 15 December 2002 wil receive first consideration.

Prof. Ray Jayawardhana
Department of Astronomy
University of Michigan
830 Dennison Building
501 E. University
Ann Arbor, MI 48109-1090
U.S.A.

Email Inquiries: rayjay@umich.edu

Department Web page: http://www.astro.lsa.umich.edu

Moving ... ??

If you move or your e-mail address changes, please send the editor your new address. If the Newsletter bounces back from an address for three consecutive months, the address is deleted from the mailing list.

New Books

The Origins of Stars and Planets: The VLT View

Edited by J.F. Alves and M.J. McCaughrean

This book presents the proceedings of an ESO workshop held in Garching, Germany 24 - 27 April 2001. The meeting was well attended by almost 200 scientists from all over the world. The motivation for the meeting was to review the status of star formation studies at a time when ESO's Very Large Telescope is coming online, and to consider in which directions the VLT may most profitably contribute to our field. First Light for the four 8.2 telescopes occurred between 1998 and 2000, and since then a wealth of sophisticated instrumentation has become available at an impressive rate. Moreover, only a few months after the meeting, two of the four VLT units were for the first time combined as a stellar interferometer and achieved fringes. With this milestone, the VLT is becoming positioned to make enormous and entirely new contributions to star formation studies in the coming years. The book contains 63 chapters, covering most aspects of star and planet formation, from cores to disks, from single stars to clusters, from planet-mass objects to massive stars. Additionally, a number of chapters discuss first results from several VLT instruments, as well as plans for other future facilities, like SIRTF, Herschel, and the NGST. The book comes with a CD where all text and figures is available electronically, as well as all the poster papers of the meeting.

ISBN 3-540-43541-7 hardback - published 2002 - 515 pages
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Meetings

Astrophysics of Dust

A Comprehensive International Symposium on Cosmic Dust

May 26-30, 2003

Estes Park, Colorado, USA

This is the first announcement of plans to convene a comprehensive international symposium on "ASTROPHYSICS OF DUST", to take place in Estes Park, Colorado, during 26 - 30 May, 2003. The conference site is the YMCA of the Rockies Conference Center, located near the entrance to the Rocky Mountains National Park.

This conference should be of interest to anyone, who is professionally involved with observational, experimental, or theoretical aspects of cosmic dust in astrophysical environments ranging from the solar system to high-redshift galaxies and quasars. The major themes of the symposium are dust in galaxies, dust in circumstellar environments, origin and evolution of dust, dust physics, composition of dust, and models of dust and radiative transfer through dusty systems.

If you would like more information about the list of subjects to be covered at this conference, the preliminary list of topics and associated speakers, the meeting venue, and the makeup of the Scientific Organizing Committee, you are invited to visit our web site http://www.physics.utoledo.edu/ aod03/

If you would like to receive further details about this upcoming symposium through subsequent mailings, please take a minute and submit your contact information through our online interactive pre-registration form, accessible through the web site listed above.

The meeting is planned for the participation of not more than 250 attendees, and we will have provisions for an equivalent number of poster papers to be presented. Please, sign up now, if there is even a small chance that you may want to participate and present a poster paper at this symposium.

Further details will be given in subsequent messages to pre-registered individuals at later dates.

Scientific Organizing Committee:

Lou Allamandola, Geoff Clayton, Luigi Colangeli, Bruce Draine, Hans-Peter Gail, Eberhard Gruen, Thomas Henning, Takashi Onaka, Ted Snow, Kris Sellgren, Xander Tielens, Doug Whittet, Adolf Witt (Chair),

Sessions:

I: DUST IN GALAXIES

II: DUST IN CIRCUMSTELLAR ENVIRONMENTS

III: ORIGIN AND EVOLUTION OF DUST

IV. DUST PHYSICS

V. COMPOSITION OF DUST

VI. MODELS

VII. SUMMARY

Contact: Adolf N. Witt awitt@dusty.astro.utoledo.edu

http://www.physics.utoledo.edu/∼aod03/

Extrasolar Planets: Today and Tomorrow

30 June – 4 July 2003

Institut d'Astrophysique de Paris, France

The XIXth IAP international astrophysical colloquium will be held on 30 June–4 July 2003, at the Institut d'Astrophysique de Paris, France. The conference is on Extrasolar Planets. Major topics are:

- Detections of extrasolar planets: methods, results and programs
- Extrasolar planets images and spectroscopy
- Planetary systems properties
- Atmospheres and exospheres of extrasolar planets
- Extrasolar comets
- Planetary systems evolution
- Protoplanetary and planetary disks: structure, properties and evolution
- Planetary formation
- Interaction between disks and planets
- Dynamics of multiple planetary systems

Anyone interesting in participating is encouraged to pre-register at the conference web site

http://www.iap.fr/col2003/

Pre-registration will start on 14 October 2002. Specific enquiries about the conference can be made to col2003@iap.fr from 14 Oct. 2002.

Scientific Organizing Committee:

S. Balbus (USA), P.–O. Lagage (France), A.–M. Lagrange (France), A. Leger (France), G. Marcy (USA), M. Mayor (Switzerland), J. Papaloizou (UK), P. Sackett (Australia), D. Sasselov (USA), W. Ward (USA), G. Wetherill (USA).

Local Organizing Committee:

Jean–Philippe Beaulieu, Alain Lecavelier des Etangs, Caroline Terquem

IAU Symposium 217:

Recycling Intergalactic and Interstellar Matter

July 14-17, 2003 Sydney, Australia

http://www.mso.anu.edu.au/∼iauxxv/scientific_programme.shtml#S217

Scientific rationale:

Over the recent years, great progress has been made in the area of galaxy evolution. This was facilitated by the wealth of new high spatial and spectral resolution observations from space (HST, XMM-Newton, Chandra); by large increases in sensitivity from ground-based 10m-class telescopes (VLT, Keck, Subaru, Gemini, etc.); by the availability of deep or/and large radio surveys (VLA, HIPASS) and by similar increases in the computing power available for running numerical simulations. However, one critical aspect of galaxy evolution that has never been explored per se is the transformation and recycling of the gaseous and stellar material both within and outside of galaxies: gas consumed by star formation and subsequently ejected by supernovae or superwinds into the inter-galactic medium (IGM); injection in the IGM of metal-enriched material via AGN-driven jets; material ejected from galaxies through interactions and mergers; and gas stripped from galaxies by the ram-pressure of the intracluster medium (ICM). Numerical simulations can now follow in detail the evolution of the gaseous medium in galaxies through these violent events.

At the same time, our knowledge of the IGM has improved dramatically. In clusters of galaxies, the nature of the ICM can now be constrained more tightly through X-ray observations by Chandra and XMM. These observations have revolutionized our understanding of the cooling/heating processes in the intracluster medium, and allow us to measure its elemental abundances with unprecedented precision. The intergalactic medium at high redshift is investigated using absorption lines detected in high resolution spectra of background QSOs. In the local Universe, molecules in low-density gas clouds are observed well outside galactic disks through absorption against background UV sources. The first metallicity measurements of the high-velocity clouds in the Local Group were obtained by this method. Strangely enough, no pristine hydrogen clouds, devoid of any heavy elements, have yet been found, either locally or at high redshift. All these observations suggest a general "pollution" of the intergalactic medium by galaxy ejecta, even at high redshift. Even more surprisingly, surveys of planetary nebulae and RGB/AGB stars in 'empty' fields of nearby clusters confirmed that a large (10 to 50total stellar population lie between galaxies. Various models of galaxy mass-loss via dynamical processes or superwinds have attempted to account for these observations, but they still disagree on the efficiency of the IGM enrichment mechanisms and on the nature of the progenitors.

What is the fate of the material liberated by galaxies during their evolution and currently observed in the IGM? It is very likely that the fraction of it that is not dispersed or evaporated, and hence lost for future recycling, may fall back onto galaxies. This is in agreement with numerical experiments which predict the re-accretion of tidal debris as well as gas stripped by ram-pressure. This reservoir of expelled material can be recycled in their progenitors, fueling star-formation episodes with a time delay depending on how far into the IGM the gas clouds had been injected. On the other hand, there is now observational evidence that galactic material may be recycled in the space between galaxies, forming a new generation of objects. Tidal Dwarf Galaxies (TDGs) are young galaxies assembled from the gas and stars ejected from interacting galaxies. Unfortunately, while numerical models support the formation of such objects, the conditions for their formation have not been fully investigated, and it is difficult to assess their cosmological importance. However, it has been claimed that TDGs could be good laboratories to study, in the local universe, the process of galaxy formation more commonly investigated through observations at high redshift. Also their dark matter content or absence of it may be used to constraint the dark matter distribution in the parent galaxies.

The IAU symposium will address in a concise manner all of these issues, following the fate of galaxy material, from its liberation by galaxies, its journey into the intra-cluster medium, to its final recycling in and outside galaxies. Experts of all the various wavelength domains will meet there and confront their observations and models, to compare and complement the constraints in this very active, yet still growing, field of research.

Scientific Organizing Committee:

Hans Böhringer, Jonathan Braine, Elias Brinks, Pierre-Alain Duc (Chair), Ken Freeman, Uta Fritze-v.Alvensleben, Jay Gallagher, Brbel Koribalski, Felix Mirabel, Max Pettini, Yoshiaki Taniguchi, Silvia Torres-Peimbert

Contact person: Pierre-Alain Duc paduc@cea.fr

IAU Colloquium No. 191

The Environments and Evolution of Double and Multiple Stars

February 3 - 7, 2003, Merida, Yucatan, Mexico

Scientific Goals:

The subject matter of IAU Colloquium 191 follows naturally from that of IAU Symposium 200, held in Potsdam in April 2000 on binary star formation. Another of its forebears is Colloquium 33, on the observational parameters and dynamical evolution of multiple stars. That colloquium was held in Mexico, and owed its existence in large measure to Arcadio Poveda. We now wish to honour Dr. Poveda's contributions to multiple star astronomy by holding Colloquium 191 in Merida, his birthplace.

Binary formation is so active a field that sufficient advances have been made since Symposium 200 to warrant spending some time on new developments in that area. But the main thrust of Colloquium 191 will be on the later evolution of binary and multiple stars, and in particular on the role played by their environment in that evolution. We wish to consider the interaction between the evolution of binary stars and their surroundings, be they interstellar material, cluster stars, or simply other components of a hierarchical multiple. In turn we wish to see what effect evolving binary stars have on their environment.

We are concerned with the physical processes that characterize the episodes of evolution that occur after binary stars have formed, and the observations required to elucidate them. Many of those observations, such as binary frequencies in different environments, are statistical in nature. The distributions of orbital parameters, and correlations between them, seem to be dependent upon environment, both interstellar and cluster, as well as upon age and population type. Furthermore, the evidence for dynamical interactions within multiple systems has increased greatly since they were considered at Colloquium 33. We need to be able to interpret statistical distributions in terms of physical processes, such as the accretion, exchange and loss of mass, angular momentum and energy.

Finally, Commission 26 is devising a new system of nomenclature for components of stellar systems, which is becoming increasingly necessary as a result of recent discoveries of stellar and substellar components in increasing numbers, and of the large number of new discoveries anticipated from future space missions. Growing numbers of planetary companions must also fit into any new scheme. Colleagues at the U.S. Naval Observatory are developing the Washington system into one that will accommodate those discoveries. The intention is that this should be in time to be able to present a formal resolution in Sydney in 2003. It is thus most appropriate to have at least some informal discussion of the matter at Colloquium 191.

It is our intention to keep the number of invited talks to a minimum, and to provide as much time as possible to contributed talks and posters. A preliminary program follows. Both the topics and the allotted time are subject to adjustment depending on the numbers of papers submitted. Both oral and poster papers are welcome on all relevant topics.

Scientific Organizing Committee:

Sverre Aarseth, Christine Allen (Co-Chair), Francis Fekel, William Hartkopf, Gloria Koenigsberger, Patricia Lampens, Hugo Levato, Eugene Milone, Bo Reipurth, Luis Felipe Rodriguez, Colin Scarfe (Co-Chair), Andrei Tokovinin, Mauri Valtonen

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