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Abstracts of recently accepted papers

Arecibo Observations of Formaldehyde and Radio Recombination Lines toward Ultracompact HII Regions

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We report observations of the H110α radio recombination line and H_2CO $1_{1,0}$ - $1_{1,1}$ toward 21 ultracompact HII regions with the Arecibo 305 m Telescope. We detect the H110α line in 20 sources, and for each of these we detect a H_2CO absorption feature at nearly the same velocity demonstrating the association between molecular and ionized gas. We determine kinematic distances, and resolve the distance ambiguity for all observed HII regions, as well as for 19 intervening molecular clouds. A galactic plane plot of these objects traces part of the spiral structure in the first galactic quadrant. We compare flux densities and velocities measured with the Arecibo Telescope with interferometric measurements of our sample of ultracompact HII regions. Our results agree with the hypothesis that UC HII regions have an extended component of radio continuum emission.

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Multiwavelength study of the powering sources of the double H_2 bipolar jet in L1634

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We present observations of the centimeter, millimeter, and submillimeter continuum emission toward the core of L1634, a region with two embedded young stellar objects, IRAS 05173−0555 and IRS 7, which are powering two outflows. The submillimeter dust emission around IRAS 05173−0555 is resolved and shows two components, a centrally peaked source plus a considerably extended envelope, while the emission around IRS 7 appears unresolved with an angular resolution of $\sim 8''$. The dust emissivity index, derived from the submillimeter spectral index, is $\beta \sim 1.8$ for both embedded sources, implying that the properties of the dust are similar around both objects. The submillimeter spectral index varies throughout the region, with lower values found toward the compact embedded sources, likely indicating grain growth on small scales. The high quality of the 850 and 450 μm continuum maps allows us to fit the radial intensity profiles of the extended emission around IRAS 05173−0555 with a power-law model that constrains the density distribution. The best fit to the data is a model with a multiple power-law density distribution, with slopes consistent with the predictions of the inside-out protostellar collapse model. We derive an infall rate of 2.6–8.0 $\times 10^{-5}$ $M_\odot$ yr^{-1} for the free-falling inner region of the envelope. The submillimeter luminosity, the total

circumstellar mass derived, and the infall rate estimate, are consistent with IRAS 05173−0555 being a Class 0 object.

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Preprints available at: `http://cfa-www.harvard.edu/sfgroup/` (CfA Star Formation/ISM www page)

An ISO investigation of the MWC297 circumstellar region

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The ISO-SWS full grating spectrum (2.3–45 μm) of the Herbig Be star MWC297 is presented. The spectrum is dominated by a strong continuum with superimposed emission lines and features both in absorption and in emission. In particular, we detect in emission 23 HI recombination lines of the Brackett, Pfund and Humphreys series and four PAH features, while in absorption two broad silicate bands at 9.7 and 16.4 μm, solid CO_2 at 4.27 μm and solid H_2O at 2.96 μm have been observed. The ISO-SWS spectrum has been combined with ISO-LWS data and ground based photometry to derive the spectral energy distribution (SED) from optical to radio wavelengths. The observed SED has been fitted with a model that assumes a spherical dusty envelope parametrized by density and temperature power laws, deriving suitable values for the spectral type (B2), the visual extinction (7.5 mag) and the distance (280 pc). Consistent determination of the extinction and estimates of both the source mass loss rate ($9{\cdot}10^{-7}$ $M_\odot yr^{-1}$) and the size of the emitting ionized region (30 stellar radii) have been derived by the analysis of the HI recombination lines of the Brackett, Pfund and Humphreys series observed by ISO-SWS together with Paschen and Brackett lines observed from the ground. Some peculiarities have been observed in the ISO-SWS spectrum of this source: *i)* the ratio between the column density of the solid CO_2 and H_2O (2.0±1.5) higher than the values usually observed and *ii)* the presence of a silicate broad absorption band at 16.4 μm stronger than the 9.7 μm absorption. The observed silicate absorption features are probably due to the extended dusty cloud in which the star is embedded and their relative strengths could be an evidence that they are composed by processed grains.

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Discovery of a New Companion and Evidence of a Circumprimary Disk: Adaptive Optics Imaging of the Young Multiple System VW Cha

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Since a majority of young low-mass stars are members of multiple systems, the study of their stellar and disk configurations is crucial to our understanding of both star and planet formation processes. Here we present near-infrared adaptive optics observations of the young multiple star system VW Cha. The previously known $0\farcs7$ binary is clearly resolved already in our raw J and K band images. We report the discovery of a new, faint companion to the secondary, at an apparent separation of only $0\farcs1$ or 16 AU. Our high-resolution photometric observations also make it possible to measure the $J-K$ colors of each of the three components individually. We detect an infrared excess in the primary, consistent with theoretical models of a circumprimary disk. Analytical and numerical calculations of orbital stability show that VW Cha may be a stable triple system. Using models for the age and total mass of the secondary pair, we estimate the orbital period to be 74 years. Thus, follow-up astrometric observations might yield direct dynamical masses within a few years, and constrain evolutionary models of low-mass stars. Our results demonstrate that adaptive optics imaging in conjunction with deconvolution techniques is a powerful tool for probing close multiple systems.

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The Interaction Between Protostars and Their Environment : Carbon-bearing Species Towards Low Mass Protostars

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It is clear that outflow activity can have a significant impact on the structure and evolution of material in protostellar environments, but the detailed nature of the interaction between the outflow and surrounding material is not clearly understood. To probe the impact of outflow activity on protostellar core material, in this paper we present observations of CH_3OH (J_k=3_k→2_k), c-C_3H_2 (J_{k_-,k_+}=$3_{1,2}$→$2_{2,1}$) and DCN (J=2→1 multiplet) at 145 GHz towards a sample of Class 0 and Class I sources, to place constraints on the physical and chemical changes which have taken place through the onset of star formation. CH_3OH was detected towards all of the sources and positions observed. In many sources, the CH_3OH lines have two velocity components : one broad ($\langle \Delta v \rangle \sim 1.5$ kms^{-1}), and one narrow ($\langle \Delta v \rangle \sim 0.7$ kms^{-1}). Both velocity components of CH_3OH show significantly (>10) enhanced abundances relative to quiescent dark clouds. These two components are predominantly a feature of the Class 0 sources. These sources also have the broadest lines in both components. c-C_3H_2 was detected towards 87% of the sources observed and DCN was detected towards 66% of the sources observed. The narrowest detected component of c-C_3H_2 has similar linewidths to NH_3, and is detected towards only a small fraction of positions, implying that only a small number of sources contain undisturbed material. The degree of activity implied by the enhanced abundances in CH_3OH is larger in the Class 0 sources than the Class I sources. Since the narrower linewidth components also show enhanced abundances in this molecule, we conclude that energetic activity during the star formation process, which may include both outflow and infall processes, affects the apparently quiescent core material very early in the star formation process.

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http://saturn.phy.umist.ac.uk:8000/˜ jvb/pub.html

Gas-grain chemical models of star-forming molecular clouds as constrained by ISO and SWAS observations

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We have investigated the gaseous and solid state molecular composition of dense interstellar material that periodically experiences processing in the shock waves associated with ongoing star formation. Our motivation is to confront these models with the stringent abundance constraints on CO_2, H_2O and O_2, in both gas and solid phases, that have been set by ISO and SWAS. We also compare our results with the chemical composition of dark molecular clouds as determined by ground-based telescopes. Beginning with the simplest possible model needed to study molecular cloud gas-grain chemistry, we only include additional processes where they are clearly required to satisfy one or more of the ISO-SWAS constraints. When CO, N_2 and atoms of N, C and S are efficiently desorbed from grains, a chemical quasi-steady-state develops after about one million years. We find that accretion of CO_2 and H_2O cannot explain the $[CO_2/H_2O]_{ice}$ ISO observations; as with previous models, accretion and reaction of oxygen atoms are necessary although a high O atom abundance can still be derived from the CO that remains in the gas. The observational constraints on solid and gaseous molecular oxygen are both met in this model. However, we find that we cannot explain the lowest H_2O abundances seen by SWAS or the highest atomic carbon abundances found in molecular clouds; additional chemical processes are required and possible candidates are given. One prediction of models of this type is that there should be some regions of molecular clouds which contain high gas phase abundances of H_2O , O_2 and NO. A further consequence, we find, is that interstellar grain mantles could be rich in NH_2OH and NO_2. The search for these regions, as well as NH_2OH and NO_2 in ices and in hot cores, is an important further test of this scenario. The model can give good agreement with observations of simple molecules in dark molecular clouds such as TMC-1 and L134N. Despite the fact that S atoms are assumed to be continously desorbed from grain surfaces, we find that the sulphur chemistry independently experiences an 'accretion catastrophe'. The S-bearing molecular abundances cease to lie within the observed range after about 3×10^6 years and this indicates that there may be at least two efficient surface desorption mechanisms

operating in dark clouds - one quasi-continous and the other operating more sporadically on this time-scale. We suggest that mantle removal on short time-scales is mediated by clump dynamics, and by the effects of star formation on longer time-scales. The applicability of this type of dynamical-chemical model for molecular cloud evolution is discussed and comparison is made with other models of dark cloud chemistry.

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http://www.strw.leidenuniv.nl/∼ pascale/publications.html#reviews

Stochastic Theory of Molecule Formation on Dust

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The formation of interstellar molecules on the surfaces of dust grains is calculated in the framework of stochastic reaction kinetics. The master equation and the state transition probabilities are defined and the growth of grain mantles following accretion and reaction of gas phase species is computed. The results are compared to the observed composition and structure of interstellar ices. The differences between this approach to gas-grain kinetics and previous work is discussed and possible extensions of the theory are outlined.

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Near Infrared Observations of the Giant HII Region W49A: A Starbirth Cluster

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W49A is one of the most luminous giant H II (GH II) regions in our Galaxy. This star forming complex contains numerous compact and ultra-compact (UC) H II regions, extending over an area of ≈ 15 pc. It emits about 10^{51} Lyman continuum photons per second, equivalent to the presence of about 100 O stars, but it is completely obscured in optical wavelengths by intervening interstellar dust. The center holds a "cluster" of about 30 O stars, each within an individual UCHII region emitting free–free emission at cm wavelengths. Our deep $K-$band (2.2 μm) image toward the W49A cluster reveals just two of the individual exciting stars, each associated with a point–like radio source, but the rest are invisible. These O stars are so recently born as to not yet have emerged from their natal dust cocoons, in contrast to other Galactic clusters embedded in GH II regions in which many of the individual massive stars are already revealed. Plausibility arguments are made which suggest that a stellar disc might be common during the entire UCH II phase of massive star birth, as it persists after accretion ceases in some stars. Nebular emission (e.g., from Brγ) is visible around the periphery of the central region of W49A, along with candidate exciting stars. Star formation there may have preceeded that in the center, or its lower density environment may have speeded up the dispersal of the natal dust cocoons. The W49A cluster can serve as a template for the more luminous buried star clusters now being found in normal galaxies and starbursts.

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High-Resolution Mid-Infrared Imaging of G339.88-1.26

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G339.88-1.26 is considered to be a good candidate for a massive star with a circumstellar disk. This has been supported by the observations of linearly distributed methanol maser spots believed to delineate this disk, and mid-infrared observations that have discovered a source at this location that is elongated at the same position angle as the methanol maser distribution. We used the mid-infrared imager/spectrometer OSCIR at Keck to make high-resolution images of G339.88-1.26. We resolve the mid-infrared emission into 3 sources within 1.5 arcsec of the location of the masers. We determine that the methanol masers are most likely not located in a circumstellar disk. Furthermore we find that the observed radio continuum emission most likely comes from two sources in close proximity to each other. One source is an unobscured massive star with an extended HII region that is responsible for the peak in the radio continuum emission. A second source is embedded and centered on the elongation in the radio continuum emission that is believed to be tracing an outflow in this region.

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http://www.ctio.noao.edu/ debuizer

A Photometric Study of the Young Stellar Population Throughout the λ Ori Star-Forming Region

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We present VRI photometry of 320,917 stars with $11 \leq R \leq 18$ throughout the λ Ori star-forming region. Using the more spatially limited spectroscopic surveys of Dolan & Mathieu to define the color - magnitude domain of young low-mass members of the association, and removing statistically the field stars in this domain, we use our photometry to identify a representative PMS population throughout the interior of the molecular ring. The spatial distribution of this population shows a concentration of PMS stars around λ Ori and in front of the B35 dark cloud. However, few PMS stars are found outside these pockets of high stellar density, suggesting that star formation was concentrated in an elongated cloud extending from B35 through λ Ori to the B30 cloud.

We find a lower limit for the global stellar mass of about 500 $M_{\odot}$. We find that the global ratio of low- to high-mass stars is similar to that predicted by the field initial mass function, but this ratio varies strongly as a function of position in the star-forming region. Locally, the star-formation process does not produce a universal initial mass function.

Using our derived stellar ages across the region, we construct a history of the star-forming complex. This history incorporates a recent supernova to explain the distribution of stars and gas today. We infer that most of the present molecular ring was formed by ejecta from the center driven by the supernova blast about 1 Myr ago. However, we suggest that the B30 and B35 clouds were primordial, and massive enough to be mostly little disturbed by the shock. The stars which we see today trace the former extent of the cloud complex. Given the kinematics of the stellar population, we predict that the association will disperse into the field within a few tens of Myr. The gas will be dispersed on a similar time scale, or faster if λ Ori becomes a supernova before it escapes the region.

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Visual binaries among high-mass stars – An adaptive optics survey of OB stars in the NGC 6611 cluster

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We have searched for visual binaries with projected separations in the range 200–3000 AU (0.1"–1.5") among a sample

of 96 stars in the massive young NGC 6611 cluster, 60 of them being subsequently identified as high probability cluster members of mainly OB spectral type. This is the first visual binary survey among such a large and homogeneous sample of high-mass stars. We find an uncorrected binary frequency of 18±6 % over the surveyed separation range. Considering only binaries with mass ratios $q > 0.1$, we find that OB stars in NGC 6611 host more companions than solar-type field stars. We derive mass ratios for the detected binaries from their near-infrared flux ratios and conclude that about half of the detected binaries have $q < 0.2$, which does not contradict the assumption that companion masses are randomly drawn from the initial mass function. There is no evidence in our sample that wide-binary properties depend upon the mass of the primary star. The high frequency of massive binaries in a cluster as rich as NGC 6611 and the lack of a strong mass dependence of their properties are difficult to reconcile with the scenario whereby massive stars form as the result of mergers of smaller stars. The canonical protostellar accretion scenario together with cloud fragmentation, on the other hand, can naturally explain most of the observed binary properties, although the very high stellar density in the protocluster is likely to require significant modification to that picture as well.

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http://arXiv.org/abs/astro-ph/0109327

VLT-ISAAC 3-5 μm spectroscopy as a new tool for investigating H_2 emission in protostellar jets

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We report 3-5 μm IR spectroscopy obtained with VLT-ISAAC on the IRS17 molecular hydrogen jet in the Vela-D Molecular Cloud. Together with H_2 emission lines from the v=1 rovibrational state, the spectra show several pure rotational lines of the fundamental state with excitation temperature up to $\sim$ 22 000 K. We show how theoretical rotation diagrams indicate these lines as unique both to probe the presence of collisionally excited gas in NLTE conditions and to infer the gas density.

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preprint available on : www.mporzio.astro.it/~bruni/

Star Formation Signatures in the Condensation Downstream of HH 80N

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HH80N is one of the Herbig-Haro objects that have associated quiescent dense clumps. We report CO and CS BIMA observations that reveal star formation within the HH80N dense clump. The CO emission reveals clearly a bipolar molecular outflow centered on the dense clump. The CS emission traces a ring-like structure of radius $\simeq$ 0.24 pc. The CS kinematics shows that the ring is collapsing with an infall speed of $\sim$ 0.6 km s^{-1}. The required mass to produce the collapse is in agreement with previous ammonia observations of the 20 $M_\odot$ core, which is embedded within the CS structure. However, we cannot discard that the ring structure is expanding driven by protostellar winds, if the CS abundance if unusually high and the CO momentum rate is much higher than that measured, due to inclination and optical depth effects. The properties of the molecular outflow and of the dense core suggest that it harbors a Class 0 object. There are also signatures of interaction of the HH 80/81/80N outflow with the dense gas. In particular it is possible that the HH 80/81/80N outflow has triggered or at least speed up the star formation in this region.

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http://www.am.ub.es/~jgirart/curro.html

New embedded Herbig-Haro objects in the ρ Ophiuchi dark cloud

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We report here the discovery of a 30″-chain of embedded Herbig-Haro (HH) objects in the ρ Ophiuchi dark cloud. These HH objects were first detected during a deep K_S-band observation (completeness magnitude for point source$\sim$19) made with NTT/SOFI. We confirm their nature with follow-up observations made with H_2 v=1–0 S(1) narrow-band filter. We argue that they belong to two different jets emanating from two Class I protostars: the main component of the recently resolved subarcsecond radio binary YLW15 (also called IRS43), and IRS54. We propose also to identify the [S II] knot HH224NW1 (Gómez et al. 1998) as emanating from a counterjet of YLW15. The alignment between these HH objects and the thermal jet candidate found in YLW15 by Girart et al. (2000) implies that this jet is not precessing at least on timescale $\sim(2\text{–}4)\times10^4$ yr.

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The Young Cluster IC 5146

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The B0 V star BD +46° 3474 lies near the front surface of a dense molecular cloud and illuminates the emission/reflection nebula IC 5146. The HAeBe variable BD +46° 3471 is embedded in the same cloud, about 10′ (3.5 pc) away. CCD photometry in BVRI (to V = 22) and in JHK (to about K = 16.5) has been obtained for the young clusters surrounding each of these two bright stars. Some 100 emission-Hα stars brighter than R = 20.5 have been found in the area, most of them in IC 5146. (Among these are two that have spectra resembling a high-excitation H-H Object plus a stellar continuum.) A distance of 1.2 kpc follows from the photometry of several late B-type IC 5146 cluster members; the average extinction from 38 stars classified spectroscopically is $A_V = 3.0 \pm 0.2$ mag. Although optical photometry is available for 700 stars in the IC 5146 field, only about half (including all the Hα emitters) lie above the main sequence, while a substantial fraction of these are estimated to be foreground. A number of such interlopers have been identified on the basis of proper motion or abnormally low A_V. The age distribution of the Hα emitters has been estimated by reference to several sets of theoretical isochrones. There is substantial disagreement but the median age does appear to be near 1 Myr. The spectrum of +46° 3474 is unexceptional except for an unusually low v sin i (10 km s^{-1}), but +46° 3471 has a complex emission + absorption spectrum. Our interpretation of the structure of IC 5146 on the basis of optical and radio radial velocities follows a proposal by Roger & Irwin (1982), namely that +46° 3474 formed near the near surface of the present cloud and evacuated a blister cavity out of which gas and dust are now flowing through a funnel-shaped volume in the approximate direction of the Sun. It is suggested that the IC 5146 cluster stars formed in a dense foreground section of the molecular cloud that was dissipated following the appearance of +46° 3474.

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Discovery of close companions to the nearby young stars HD 199143 and HD 358623

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Young stellar systems in the solar neighborhood provide valuable laboratories for detailed studies of star and planet formation. The bright F8V star HD 199143 and the Li-rich late-type emission line star HD 358623 are among the

nearest young stars identified to date, and may be members of a young association in Capricornus. We present high-resolution near-infrared images of these two sources, obtained using the adaptive optics system on the 3.6-meter telescope at the European Southern Observatory in La Silla, Chile. Our observations reveal that both are in fact close binary systems. The newly discovered companion at a separation of ∼1" may account for the unusual characteristics of HD 199143 –rapid rotation, emission lines, ultraviolet variability, and excess infrared emission– recently discussed by van den Ancker and co-workers. HD 199143 may be a rare example of a close binary with only a circum*secondary* disk. With the detection of a ∼2" companion, HD 358623 is now possibly one of the closest known T Tauri binaries. Both binary systems are prime targets for follow-up spectroscopic and astrometric observations.

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UVES spectra of young brown dwarfs in Cha I: radial and rotational velocities

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Based on high-resolution UVES spectra we found that the radial velocity (RV) dispersion of nine of twelve known young bona fide and candidate brown dwarfs in the Cha I dark cloud is $2.0\,\mathrm{km\,s^{-1}}$, i.e. significantly smaller than the RV dispersion of T Tauri stars in Cha I (3.6 km/s) and only slightly larger than the dispersion of the surrounding molecular gas (1.2 km/s) (Mizuno et al. 1999). This result indicates that the majority of these brown dwarfs are not ejected with high velocity out of a dense region as proposed by some formation scenarios for brown dwarfs. The mean RV values are consistent with the objects being kinematic members of Cha I. The RV dispersion of the T Tauri stars confined to the Cha I region is based on a compilation of T Tauri stars with known RVs from the literature plus three T Tauri stars observed with UVES and unpublished RVs for nine T Tauri stars. Time–resolved spectroscopy revealed RV variations for five out of nine of the bona fide and candidate brown dwarfs in Cha I, which could be due to orbiting planets or surface features. Furthermore we derived rotational velocities $v \sin i$ and the Lithium 6708 Å equivalent width.

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Preprints available at www.xray.mpe.mpg.de/∼viki/publications.html

Millimeter-wave Aperture Synthesis Imaging of Vega: Evidence for a Ring Arc at 95 AU

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We present the first millimeter-wave aperture synthesis map of dust around a main sequence star. A 3″ resolution image of 1.3 mm continuum emission from Vega reveals a clump of emission 12″ from the star at PA 45°, consistent with the location of maximum 850 μm emission in a lower resolution JCMT/SCUBA map. The flux density is 4.0±0.9 mJy. Adjacent 1.3 mm peaks with flux densities 3.4±1.0 mJy and 2.8±0.9 mJy are located 14″ and 13″ from the star at PA 67° and 18°, respectively. An arc-like bridge connects the two strongest peaks. There is an additional 2.4 ±0.8 mJy peak to the SW 11″ from the star at PA 215° and a marginal detection, 1.4±0.5 mJy, at the stellar position, consistent with photospheric emission. An extrapolation from the 850 μm flux, assuming $F_{1.3mm-0.85mm} \propto \lambda^{-2.8}$, agrees well with the total detected flux for Vega at 1.3 mm, and implies a dust emissivity index, β, of 0.8 We conclude that we have detected all but a very small fraction of the dust imaged by SCUBA in our aperture synthesis map and that these grains are largely confined to segments of a ring of radius 95 AU.

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Formation and pre–MS evolution of massive stars with growing accretion

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We briefly describe the three existing scenarios for forming massive stars and emphasize that the arguments often used to reject the accretion scenario for massive stars are misleading. It is usually not accounted for the fact that the turbulent pressure associated to large turbulent velocities in clouds necessarily imply relatively high accretion rates for massive stars.

We show the basic difference between the formation of low and high mass stars based on the values of the free fall time and of the Kelvin-Helmoltz timescale, and define the concept of birthline for massive stars.

Due to D-burning, the radius and location of the birthline in the HR diagram, as well as the lifetimes are very sensitive to the accretion rate $\dot{M}_{\rm accr}$. If a form $\dot{M}_{\rm accr} \propto A\,(M/M_{\rm O})^{\varphi}$ is adopted, the observations in the HR diagram and the lifetimes support a value of $A \approx 10^{-5}\,M_{\rm O}\cdot{\rm yr}^{-1}$ and a value of $\varphi \geq 1$. Remarkably, such a law is consistent with the relation found by Churchwell (1998) and Henning et al. (2000) between the outflow rates and the luminosities of ultra–compact HII regions, if we assume that a fraction 0.15 to 0.3 of the global inflow is accreted. The above relation implies high $\dot{M}_{\rm accr} \approx 10^{-3}\,M_{\rm O}\cdot{\rm yr}^{-1}$ for the most massive stars. The physical possibility of such high $\dot{M}_{\rm accr}$ is supported by current numerical models.

Finally, we give simple analytical arguments in favour of the growth of $\dot{M}_{\rm accr}$ with the already accreted mass. We also suggest that due to Bondi-Hoyle accretion, the formation of binary stars is largely favoured among massive stars in the accretion scenario.

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The vertical structure of T Tauri accretion disks – II. Physical conditions in the disk

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We present a self-consistent analytical model for the computation of the physical conditions in a steady quasi-Keplerian accretion disk. The method, based on the thin disk approximation, considers the disk as concentric cylinders in which we treat the vertical transfer as in a plane-parallel medium. The formalism generalizes a work by Hubeny (1990), linking the disk temperature distribution to the local energy dissipation and leads to analytical formulae for the temperature distribution which help to understand the behaviour of the radiation propagated inside the disks. One of the main features of our new model is that it can take into account many heating sources. We apply the method first to two sources: viscous dissipation and stellar irradiation. We show that other heating sources like horizontal transfer or irradiation from the ambiant medium can also be taken into account. Using the analytical formulation in the case of a modified Shakura & Sunyaev radial distribution that allow the accretion rate to be partly self-similar in the inner region, and, for an α and β prescription of the viscosity, we obtain two-dimensional maps of the temperature, pressure and density in the close environment of low mass young stars. We use these maps to derive the observational properties of the disks such as spectral energy distributions, high resolution spatial images or visibilities in order to underline their different behaviours under different input models.

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CH_2DCCH along the TMC-1 ridge

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In this paper we present measurements of the CH_2DCCH/CH_3CCH ratio along the TMC-1 ridge. The level of deuterium fractionation in this molecule is found to be larger than previously thought, but more significantly, the fractionation increases as one moves from the cyanopolyyne peak to the ammonia peak, as is the case with measurements of other molecules in TMC-1. This confirms the prediction of our recent chemical/dynamical model of TMC-1 and supports the hypothesis that the chemical evolution of TMC-1 has been affected by Alfvén waves.

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http://saturn.phy.umist.ac.uk:8000/

Four Brown Dwarfs in the Taurus Star-Forming Region

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We have identified four brown dwarfs in the Taurus star-forming region. They were first selected from R and I CCD photometry of 2.29 square degrees obtained at the Canada-France-Hawaii Telescope. Subsequently, they were recovered in the 2MASS second incremental data release point source catalog. Low-resolution optical spectra obtained at the William Herschel Telescope allow us to derive spectral types in the range M7–M9. One of the brown dwarfs has very strong Hα emission (EW=-340 Å). It also displays Brγ emission in an infrared spectrum obtained with IRCS on the Subaru telescope, suggesting that it is accreting matter from a disk. The K I resonance doublet and the Na I subordinate doublet at 818.3 and 819.5 nm in these Taurus objects are weaker than in field dwarfs of similar spectral type, consistent with low surface gravities as expected for young brown dwarfs. Two of the objects are cooler and fainter than GG Tau Bb, the lowest mass known member of the Taurus association. We estimate masses of only 0.03 $M_\odot$ for them. The spatial distribution of brown dwarfs in Taurus hints to a possible anticorrelation between the density of stars and the density of brown dwarfs.

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The Dependence of Characteristics of the Brightness Variability of Herbig Ae/Be Stars on the Orientation of their Star-Disk Systems

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We analyze the brightness variability of six Herbig Ae/Be stars: V1331 Cyg, LkHα 198 = V633 Cas, AS 442, XY Per, V517 Cyg, and WW Vul. The last two objects are UX Ori stars showing Algol-like brightness dips with amplitudes of $2^m.0-2^m.5$. AS 442 and XY Per also exhibit brightness dips, but with considerably lower amplitudes, $0^m.3-0^m.6$. On the contrary, such dips are not present in the light curves of V1331 Cyg and LkHα 198, where stochastic variability with amplitudes of $0^m.1-0^m.2$ on timescales of about a day can be seen. AS 442 and XY Per also show stochastic variability, but with lower amplitudes ($\approx 0^m.05$). These different types of variability could be related to the orientations of the star-disk systems. We suggest that the brightness variations in young stars whose disks are viewed edge-on are mainly

due to non-uniform absorption, whereas the character of the variability in stars with pole-on disks is determined by non-stationary accretion.

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Preprint available via request

On the Pre-main sequence circularization period

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In this paper we present an updated compilation of the currently known pre-main sequence (PMS) spectroscopic binaries (SB) for which orbital elements have been determined. In particular we report our results for and discuss the case of the *bona-fide* PMS system RXJ1603.9-3938, which has a circular orbit and a period of 7.56 days. This is the longest orbital period for a circular orbit found among the bona-fide PMS spectroscopic binaries so far, and we suggest that this system may be thus considered to now set the PMS circularization period. The longer period is compatible with the circularization periods already known for older binary populations such as the Hyades and Praesepe. When considered in the context of the circularization periods for other binary populations of different ages, the new PMS circularization period strongly supports the suggestion of Mathieu et al. (1992) that a hybrid scenario (tidal circularization occurring on both PMS phase and on MS phase) could explain the observed circularization periods as a function of age. The apparently circular orbit observed in another PMS system, RXJ1301.0-7654a, with an orbital period of nearly 13 days, may perhaps change this picture when the orbit is improved and the system is better understood.

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Kinematics of the 12 GHz methanol masers towards W3(OH)

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In this paper, two epochs (February 1994 and December 1998) of VLBA observations of the 12 GHz CH_3OH masers towards the UC HII region W3(OH) are compared. The 12 GHz maser emission is observed in three separated clumps (< 500 AU in size), located north,south and at the centre of the UC HII region. The general structure of the 12 GHz maser emission has remained remarkably constant, with the maser spots identified in the 1994 epoch maps having similar relative positions (within few mas), shapes and line-of-sight velocities (within few tenths of km s^{-1}) as in the 1998 epoch maps.

Cross-correlating the intensity distribution of the corresponding spots between the two epochs, we measure relative proper motions of amplitude in the range 1–7 km s^{-1}. The spots of the southern clump move relative to the reference feature (located in the northern clump) with high velocities (≈ 4 km s^{-1}), and have similar directions of motion. This suggests that the whole southern clump moves relative to the northern clump. The amplitude of the proper motions of the 12 GHz masers agrees well with the values measured for the 1.665 GHz OH masers in W3(OH). The different spatial distribution of the 1.665 GHz and 12 GHz maser spots prevents one to perform a detailed comparison of the gas motion traced by the two maser transitions. The 12 GHz CH_3OH masers of the northern clump are clearly associated with both the 6.035 GHz OH and 6.7 GHz CH_3OH masers. In particular, the same "linear structure" (≈ 200 mas in size, at P.A. $= 141^o$) is traced by the most intense spots of the three maser species, and they all show a common regular variation of the line-of-sight velocities along it.

We fit the measured 3-dimensional velocities and the sky-projected positions of the 12 GHz maser spots of the northern clump with an "expanding conical model", where the spots lie on the surface of a bipolar cone and are accelerated radially outward spiraling with a constant angular velocity around the cone axis. The model suggests that geometrical conditions may play an important selective role in the observation of the strong 12 GHz masers, as the strongest spots are predicted at positions on the conical surface where the cone generators are approximately parallel (within few degrees) to the line-of-sight.

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Detection of Infall Signatures Towards Serpens SMM4

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We present the detection of kinematic infall signatures towards the Class 0 protostellar system SMM4 in the Serpens cloud core. We have observed the dense molecular gas towards the embedded source using millimeter and submillimeter line transitions of density sensitive molecular tracers. High signal-to-noise ratio maps obtained in HCO^+ J=1→0, J=3→2 and J=4→3, and CS J=2→1 show the blue-bulge infall signature. The blue-bulge infall signature can be observed in the centroid velocity maps of protostellar objects when infall dominates over rotation. The line profiles of HCO^+ and CS exhibit the characteristic blue asymmetric line profile signature consistent with infall. In addition, HCO^+ and CS optical depth profiles obtained using isotopic observations show a red asymmetry also consistent with an infall interpretation. Using three-dimensional radiative transfer models based on the rotating, collapse model of Terebey, Shu and Cassen, we derive infall parameters of the source. To determine the direction and orientation of molecular outflows in the larger Serpens cluster, wide-field mapping of CO J=1→0 emission was also performed.

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The Optical Proper Motions of HH 7-11 and Cep E (HH 377)

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A key ingredient in understanding the dynamics of stellar outflows is their proper motion. We have used optical images in the [SII] emission at 6717/31 Å and the red Digitized Palomar Observatory Sky Survey (DSS) plates to determine the proper motion of HH 7-11 system and the optical knot of Cep E (HH 377). The DSS plate measurements span nearly 37 years for both HH 7-11 and HH 377 and have wide field of view, which allows an accurate determination of the proper motions despite their relatively low angular resolution. The optical images, with higher angular resolution, cover a shorter period of 7 and 4 years, respectively, and have been used to complement the DSS measurements. ¿From the DSS plates we have found that HH 377 has a proper motion of 0.031 ± 0.003 arcsec/yr with a PA = 206°, i. e. moving away from IRAS 230111+63, that at a distance of 730 pc corresponds to a tangential velocity of 107 ± 14 km s^{-1}. The values obtained from the optical images are consistent with these measurements. Similarly, the proper motions of HH 7 - 11 range from 0.015 ± 0.009 (HH 9) to 0.044 ± 0.007 (HH 11) arcsec/yr, and the flow is moving away from SVS 13 with a mean PA$\sim$ 136°. At a distance of 330 pc, these motions correspond to tangential velocities of $\sim 25 - 70$ km s^{-1}, i. e. comparable to the original values obtained by Herbig & Jones (1983). The measurements from the optical CCD [S II] images are again consistent with these motions, although in detail there are some difference, particularly for HH 7 and HH 10.

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On the Formation of Massive Primordial Stars

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We investigate the formation by accretion of massive primordial protostars in the range 10 to 300 $M_\odot$. The high accretion rate used in the models ($\dot{M} = 4.4 \times 10^{-3}\, M_\odot\, \mathrm{yr}^{-1}$) causes the structure and evolution to differ significantly from those of both present-day protostars and primordial zero-age main sequence stars. After an initial expansion of the radius (for $M_* < 12 M_\odot$), the protostar undergoes an extended phase of contraction (up to $M_* \simeq 60 M_\odot$). The stellar surface is not visible throughout most of the main accretion phase, since a photosphere is formed in the infalling envelope. Also, significant nuclear burning does not take place until a protostellar mass of about $80\, M_\odot$. As the interior luminosity approaches the Eddington luminosity, the protostellar radius rapidly expands, reaching a maximum around $100\, M_\odot$. Changes in the ionization of the surface layers induce a secondary phase of contraction, followed by a final swelling due to radiation pressure when the stellar mass reaches about $300\, M_\odot$. This expansion is likely to signal the end of the main accretion phase, thus setting an upper limit to the protostellar mass formed in these conditions.

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EXPORT: Optical photometry and polarimetry of Vega-type and pre-main sequence stars

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This paper presents optical *UBVRI* broadband photo-polarimetry of the EXPORT sample obtained at the 2.5m Nordic Optical Telescope. The database consists of multi-epoch photo-polarimetry of 68 pre-main-sequence and main-sequence stars. An investigation of the polarization variability indicates that 22 objects are variable at the 3σ level in our data. All these objects are pre-main sequence stars, consisting of both T Tauri and Herbig Ae/Be objects while the main sequence, Vega type and post-T Tauri type objects are not variable. The polarization properties of the variable sources are mostly indicative of the UXOR-type behaviour; the objects show highest polarization when the brightness is at minimum. We add nine new objects to the class of UXOR variables (BH Cep, VX Cas, DK Tau, HK Ori, LkHα 234, KK Oph and RY Ori). The main reason for their discovery is the fact that our data-set is the largest in its kind, indicating that many more young UXOR-type pre-main sequence stars remain to be discovered. The set of Vega-like systems has been investigated for the presence of intrinsic polarization. As they lack variability, this was done using indirect methods, and apart from the known case of BD $+31^o643$, the following stars were found to be strong candidates to exhibit polarization due to the presence of circumstellar disks: 51 Oph, BD $+31^o643$C, HD 58647 and HD 233517.

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http://export.ft.uam.es/export-public/papers/

Hubble Space Telescope Images of the HH 34 Jet and Bow Shock: Structure and Proper Motions

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We present new, deep Hα and [S II] images of the HH 34 jet and bow shock obtained with WFPC2 onboard *HST*, which reveal the structure of this fine HH flow with unprecedented detail. Many of the knots in the jet appear to form small working surfaces with bright [S II] cores and thin Hα filaments where the mini-bow shocks extend into the surrounding medium. In combination with earlier, short-exposure *HST* images we have determined very precise proper motion vectors for the various shock structures in the outflow. The jet becomes visible within about an arcsecond of the source, where a new knot has emerged between our two epoch images; it has a space velocity of at least 300 km s^{-1} as derived from the proper motions and correcting for the 30^o angle of the flow to the line-of-sight. The jet rapidly slows down to a mean space velocity of about 220 km s^{-1}, with a standard deviation of 20 km s^{-1} among the jet knots. Such low internal velocities lead to weak shocks, consistent with the high [S II]/Hα ratio along the jet body and in accordance with the internal working surface model for jets. The jet motion appears to be ballistic, with no evidence for a turbulent boundary layer. The jet is well resolved, and steadily expands with a half-opening angle of 0.4^o. The large HH 34 working surface shows a multitude of knots, all of which are enveloped by a series of very thin, limb brightened Hα emitting filaments immediately behind the shock front where the flow faces into the pre-shock medium. One of these filaments developed four regularly spaced tiny knots between the two epochs, possibly due to a Rayleigh-Taylor instability along the filament, or caused by the presence of small, dense clumps in the ambient medium. Proper motions of the HH 34 working surface show an obvious expansion due to material being squirted side-ways. In addition to the large scale *S*-shaped symmetry of the giant HH 34 flow, the jet shows a marked and surprisingly abrupt change in flow direction during a 65 yr interval which ended 10 yr ago, suggesting that the jet/disk system may have been influenced by powerful tidal effects by a companion star during a recent periastron passage. A second, smaller bow-like flow, called HH 534, possibly emanates from the HH 34 source region, and if so supports the contention that the source is a binary. This data set is a testament to the unique abilities of the *HST* to follow morphological, photometric and excitation changes on cooling time scales in the shocks of flows from young stars.

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Rotational Velocities and Radii of Pre-Main-Sequence Stars in the Orion Nebula Cluster

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We have obtained high-dispersion spectra for a sample of 256 pre-main-sequence stars in the Orion Nebula Cluster in order to measure their projected rotational velocities and investigate the rotational evolution and physical properties of young, low-mass stars. Half the stars were chosen because they had known photometric periods and the other half were selected as a control sample of objects without known periods from the same portion of the H-R diagram. More than 90% of the spectra yielded $v\,sin(i)$ measurements, although about one-third are upper limits. We find strong evidence confirming the long-held assumption that the periodic light variations of T Tauri stars are caused by rotation of spots on their surfaces. We find no statistically significant difference between the $v\,sin(i)$ distributions of the periodic and control samples, indicating that there is no strong bias in studying the rotational properties of young stars using periodic variables. Likewise, the classical and weak T Tauri stars exhibit $v\,sin(i)$ distributions that are statistically the same. For stars with known period and $v\,sin(i)$, the mean value of $sin(i)$ is significantly lower than expected for a random distribution of stellar rotation axes. This could be caused by errors in one or more of the quantities that contribute to the $sin(i)$ calculation or to a real physical effect. We investigate the possible causes and find that $\langle sin(i) \rangle$ has the expected value if we increase the effective temperatures of our stars by 400−600 K. Finally, we have calculated minimum radii ($R\ sin(i)$) for stars with both $v\,sin(i)$ and period, as well as average radii for objects grouped by their location in the H-R diagram. We find evidence at the three-sigma level that the radii of the stars on similar mass tracks are decreasing as the stars move closer to the ZAMS.

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Infall variability in the classical T Tauri system VZ Cha

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We present time series spectroscopy of the Classical T Tauri star VZ Cha. We follow spectral variations at intermediate resolution over five successive nights, or approximately two rotation periods. We see profile features which persist on timescales longer than the expected infall time from the inner disc, and we see expected evidence of rotational variations in the lines, but we also note that rotation alone cannot produce all the observed variability and some other mechanism must be invoked. The behaviour of Hα is observed to be markedly different from that of the other lines. In particular, the evidence of rotational effects is lacking at Hα, and the activity in the red and blue wings of the line is not significantly correlated, in contrast to the other Balmer lines.

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http://www.astro.phys.ethz.ch/papers/smith/smith_p_m.html

The ionization fraction in α–models of protoplanetary disks

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We calculate the ionization fraction of protostellar α disks, taking into account vertical temperature structure, and the possible presence of trace metal atoms. Both thermal and X–ray ionization are considered. Previous investigations of layered disks used radial power–law models with isothermal vertical structure. But α models are used to model accretion, and the present work is a step towards a self-consistent treatment. The extent of the magnetically uncoupled ("dead") zone depends sensitively on α, on the assumed accretion rate, and on the critical magnetic Reynolds number, below which MHD turbulence cannot be self–sustained. Its extent is extremely model-dependent. It is also shown that a tiny fraction of the cosmic abundance of metal atoms can dramatically affect the ionization balance. Gravitational instabilities are an unpromising source of transport, except in the early stages of disk formation.

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Long-term study of water maser emission associated with Young Stellar Objects. I: The database

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We present the results of more than 10 years of monitoring of the water vapor maser emission in 14 star forming regions obtained with the Medicina 32-m radiotelescope. The sample of objects covers a large range of luminosities of the associated FIR sources. In order to present in a compact and representative way the large amount of data available, we give for each source: a time-velocity-flux density plot, the time dependent integrated flux, the lower and upper envelopes of the maser emission, the frequency of the maser occurrence as a function of velocity, and the mean

velocity averaged over the observing period. A brief morphological description of the environment of the maser source is also given. The present data form the basis for a discussion of the main properties of the water vapor maser emission to be presented in a forthcoming paper.

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VLA Observations of Z CMa: The Orientation and Origin of the Thermal Jet

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We present sensitive, high angular resolution (∼0.″45) Very Large Array observations made at 6 and 3.5 cm toward the thermal jet associated with the young star Z CMa. We found that the position angle of the axis of the thermal jet is coincident within error with the orientation of the optical jet and the orientation of the CO bipolar outflow. The faint radio features detected around this young star (mostly to its east) are probably the result of periodic material ejection from the central source. It is known that Z CMa has an infrared companion about 0.″1 to its northwest. We have used our high angular resolution (∼0.″2) A configuration data and the astrometric position from Hipparcos to establish that the jet originates from the optical component of this binary.

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

Low mass T Tauri and young brown dwarf candidates in the Chamaeleon II dark cloud found by DENIS

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We define a sample designed to select low-mass T Tauri stars and young brown dwarfs using DENIS data in the Chamaeleon II molecular cloud. We use a star count method to construct an extinction map of the Chamaeleon II cloud. We select our low-mass T Tauri star and young brown dwarf candidates by their strong infrared color excess in the $I-J/J-K_s$ color-color dereddened diagram. We retain only objects with colors $I-J \geq 2$, and spatially distributed in groups around the cloud cores . This provides a sample of 70 stars of which 4 are previously known T Tauri stars. We have carefully checked the reliability of all these objects by visual inspection on the DENIS images. Thanks to the association of the optical I band to the infra-red J and K_s bands in DENIS, we can apply this selection method to all star formation regions observed in the southern hemisphere. We also identify six DENIS sources with X-ray sources detected by *ROSAT*. Assuming that they are reliable low-mass candidates and using the evolutionary models for low-mass stars, we estimate the age of these sources between 1 Myr and < 10 Myr.

Accepted by Astronomy & Astrophysics

http://arXiv.org/abs/astro-ph/0109427

The Massive Star Forming Region G323.74-0.26

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We report near-infrared molecular hydrogen and Brackettγ observations towards the massive star formation site G323.74-0.26. The region contains an HII region, about 30" across, and two Class II methanol maser sites, which are separate from the HII region. We show the spectral type of the star powering the HII region is B0. We also show that at least one of the maser sites is powered by an infrared source that appears to be at least as luminous as the star responsible for the HII region. However, neither of the two stars associated with the methanol maser sites show any signs of radio continuum emission above 0.2mJy. For at least one of these maser sites, this shows a real deficiency in the radio continuum flux, which we suggest is an indication that the star is in an early stage of development, before its HII region becomes visible, or it is a multiple intermediate mass star system. A shocked molecular hydrogen outflow seen extending from one of the maser sites towards the west and possibly in a fan shape, suggesting that the stars associated with the maser sites are indeed at a very early stage of evolution.

Accepted by MNRAS

preprint available at: ftp://ftp.mpifr-bonn.mpg.de/outgoing/awalsh/preprint.ps.gz

The initial conditions of isolated star formation. V: ISOPHOT imaging and the temperature and energy balance of pre-stellar cores

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ISO data taken with the long-wavelength imaging photo-polarimeter ISOPHOT are presented of 18 pre-stellar cores at three far-infrared wavelengths – 90, 170 & 200 μm. Most of the cores are detected clearly at 170 and 200 μm, but only one is detected strongly at 90 μm, indicating that mostly they are very cold, with typical temperatures of only $\sim$10–20 K. Colour temperature images are constructed for each of the cores. Most of the cores are seen to be either isothermal, or to have associated temperature gradients from the core centres to their edges, with all except one being cooler at the centre. We compare the data with previous ISOCAM absorption data and calculate the energy balance for those cores in common between the two samples. We find that the energy radiated by each core in the far-IR is similar to that absorbed at shorter wavelengths. Hence there is no evidence for a central heating source in any of the cores – even those for which previous evidence for core contraction exists. This is all consistent with external heating of the cores by the local interstellar radiation field, confirming their pre-stellar nature.

Accepted by MNRAS

http://www.astro.cf.ac.uk/pub/Derek.Ward-Thompson/publications.html

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://casa.colorado.edu/reipurth or at http://www.eso.org/gen-fac/pubs/starform/ .

Dissertation Abstracts

A multi-wavelength study of the circumstellar environment of isolated Herbig Ae/Be stars

Gwendolyn Meeus

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Ph.D dissertation directed by: Prof. dr. Christoffel Waelkens
Prof. dr. Rens Waters

Ph.D degree awarded: June 2001

Our solar system was born from a disc of dust and gas surrounding the sun. It is very likely that the same kind of discs exists around a lot of young stars. Studies of the formation and evolution of solar-system-like discs are hampered by the relatively low spatial resolution currently reachable. However, detailed studies of the chemical composition and the size, density and temperature distribution of the dust in the dics surrounding young stars can help constraining disc evolution processes.In this thesis, we study the properties of the circumstellar (CS) environment of the young intermediate-mass Herbig Ae/Be stars (HAEBEs). This is mostly done through observations in the infrared (ISO-SWS spectra), but also other wavelength regions are used to obtain a better insight in the CS structures.

The effect of the CS environment on optical spectra and variability of HAEBEs is studied by comparing spectra and photometry of HD 139614, HD 142666 and HD 144432. It is shown that, under the assumption of a disc-like morphology, the *inclination of the disc* has an important effect on how a star appears to the observer; from this study the viewing angle for these objects could be constrained.

An important part of our work consists in classifying a sample of 14 HAEBEs based on their infrared appearance. We analyze and compare their spectral energy distributions (SEDs) and IR spectra. We show that the SEDs can be decomposed into at maximum three components: a power-law, solid state bands and a black-body. Based on this decomposition and the presence of the different components, two main groups are defined; these groups are furtheron subdivided based upon the presence/absence of the 10 μm silicate feature. The different SED components are furtheron associated with different locations in a disc, and a geometrical model is presented, in which a flaring disc plays a key role. The presence of polycyclic aromatic hydrocarbons (PAHs) appears to be coupled to the presence of a flared region around the mid-plane disc. From the slope of the SED in the millimetre we derive that the dust around HAEBEs is coagulated.

One star jumped out of our sample of 14 HAEBEs: 51 Ophiuchi. It differs from the other HAEBEs in the behaviour of its SED at longer wavelengths: the excess in the IR is much smaller and is nearly unexistent in the millimetre region. Even more important, it is the only object in our sample that shows IR emission bands due to *molecular gas*. Also the 10 μm silicate feature is particular for a HAEBE star. These observations lead us to the suggestion that the dust around 51 Oph is formed recently, and we speculate about the nature of this puzzling object.

In a last part we discuss the absence of the 10 μm silicate feature around severval isolated HAEBEs. We study the star HD 100453 by modelling its dust with an optically thin radiative transfer code. We explain the absence of the feature by a *size effect*: if the silicate grains are large enough, they will not produce a feature at the required wavelength. Alternatively, the absence can also be caused by a *temperature effect*, such as shielding by an inner wall of a region in a disc which otherwise would be responsible for producing the silicate feature. In this scenario, small silicate particles can still be present. This geometry is supported by theoretical models by Dullemond (2001).

New Jobs

UNIVERSITY OF CAMBRIDGE
Institute of Astronomy

RESEARCH APPOINTMENT IN STAR FORMATION

We aim to fill a two year post-doctoral position in Star Formation at the IOA. Current research in this area is mainly theoretical, including the study of accretion discs, cluster formation, the modeling of feedback processes and star formation at high redshifts. Applicants with experience of numerical hydrodynamics are particularly sought, although those with wider interests (including observational ones) are also encouraged to apply. The IOA is a participating node of the European Commission's Research Training Network on 'The Formation and Evolution of Young Stellar Clusters' and the appointee is expected to benefit from the opportunities for European collaboration afforded by this Network. (For details see http://www.aip.de./People/ mjm/ecrtn_clusters/; note, however, that eligibility for the post advertised here is NOT restricted to those that would be eligible for direct appointment by the Network).

The preferred starting dates for these positions are not later than 1 October 2002. The salary scale is pounds 17,626 (age 25) to pounds 26,491 (age 34 and over) plus USS benefits. Applications including CV, publications list and a statement of research interests should be sent to: Dr C.J. Clarke, Institute of Astronomy, Madingley Road, Cambridge, CB3 0HA, United Kingdom, to arrive by 15 January 2002. Applicants should ask three referees to write to Dr Clarke by the same date. For further information about these positions and theoretical star formation studies at the Institute of Astronomy email cclarke@ast.cam.ac.uk

Postdoctoral Research Position – Star and Planet Formation

UNIVERSITY OF MICHIGAN

Applications are invited for a postdoctoral research position at the University of Michigan, starting Fall 2002. The successful candidate will work with Prof. Ray Jayawardhana and his collaborators on observational and analytical studies of star and planet formation, and will be encouraged to pursue independent research on related topics. On-going projects include mid-infrared and sub-millimeter studies of circumstellar disk evolution, adaptive optics imaging searches for young planets, and optical/infrared imaging and spectroscopy of young brown dwarfs and very-low-mass objects using data from Keck, Gemini, VLT, JCMT, OVRO and other major observatories. The successful applicant will also 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 UM 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. The stipend is $40,000/year, and funds for research expenses will be provided.

Applicants should send a curriculum vitae, a description of research interests and plans, a list of publications, and should arrange for three letters of recommendation to be sent directly to the address below. The deadline for receipt of all application materials is 15 December 2001.

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Meetings

IAU Symposium No. 211

BROWN DWARFS

First Announcement and Call for Papers

2002 May 20–24
Outrigger Waikoloa Beach Hotel, Big Island of Hawaii

International Scientific Commitee: T. Forveille, T. P. Greene, H. R. A. Jones, A. Magazzu, E. L. Martin (chair), T. Mazeh, R. Neuhauser, Ya. V. Pavlenko, D. Queloz, T. Tsuji
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Brown dwarfs have emerged as new objects in observational astronomy in the last few years. Our knowledge of the solar neighborhood, star and planet formation processes, galactic evolution and dynamics, is incomplete until we find many Brown Dwarfs and learn about their statistics. Deep surveys for Brown Dwarfs in star-forming regions and young open clusters are finding extremely low-mass objects. The luminosities of these faint free-floaters overlap with those expected for recently formed giant planets. These discoveries are opening challenging new questions about the origin and evolution of Brown Dwarfs and their relation to star and planet formation. High-resolution imaging and spectroscopy are being applied to the search for Brow Dwarf companions to stars, and for Brow Dwarf binaries. The statistics of binary systems as a function of age and mass will constrain formation scenarios. The timing of a Symposium in May, 2002, will be perfect to take advantage of the interest that will be strong among the community in gathering together existing survey data on Brown Dwarfs as well as in planning for coordinated observations during the lifetime of Chandra, XMM, and SIRTF. Currently SIRTF is planned to launch in July 2002, and the 2MASS and DENIS surveys should be released in 2002 also. FAME, an astrometric mission, will launch in 2004 and this workshop will help select objects for its input catalog. The scientific mining of the huge databases provided by DENIS, 2MASS and SDSS is just starting, and we are sure that many new Brown Dwarfs will be reported at the Symposium.

Topics to be covered:

- Imaging Surveys for Brown Dwarfs
- Companion Detection Techniques
- Measurements of Fundamental Properties of Brown Dwarfs
- Classification Schemes for Ultracool Dwarfs
- Origins and Evolution of Brown Dwarfs
- Atmospheres and Interiors of Brown Dwarfs
- Time Variable Phenomena in Brown Dwarfs
- Comparisons between Brown Dwarfs and Planets
- Substellar Mass Functions
- Future Prospects

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PRE-REGISTRATION BEFORE OCTOBER 30, 2001 IS WELCOME !

F I R S T A N N O U N C E M E N T

The International Astronomical Observatories in Chile

Workshop On

GALACTIC STAR FORMATION ACROSS THE STELLAR MASS SPECTRUM

March 10-15, 2001 La Serena, Chile

Pre-Register at: http://www.ctio.noao.edu/workshop2002/

The purpose of this First Announcement is to bring the meeting to the attention of astronomers, and to solicit expressions of interest in attending. If you are interested, please pre-register for this event by using our online registration program on our website at http://www.ctio.noao.edu/workshop2002/ . Pre-registration does not sign you up for the workshop, but simply guarantees that you will receive all further announcements and information regarding the workshop. If you know someone who may be interested in this meeting, please forward them this email announcement.

Registration for the estimated 150 participants will be opened in a following announcement of the meeting. Following announcements will also include details about hotel information, the final program, and list of invited speakers. These details will also be added to the website as they become official and will be emailed to those who are pre-registered.

SCIENTIFIC RATIONALE

Until recently, observation and theory of star formation was focused on low-mass stars. However, there has been increased interest and work in the areas of intermediate and high mass star formation in the recent decade. This work has progressed to the point where we can now begin to create a coherent understanding of star formation across the entire mass spectrum.

It is hoped that the workshop will bring together a mix of observational and theoretical studies in the field. Though some review talks will be given, the purpose of this workshop is for the participants to focus the information within their talks or posters so that they address their work in the context star formation as a whole.

PRELIMINARY TOPIC LIST

We will explore the similarities and differences between low, intermediate, and high mass star formation IN THE CONTEXT OF:

Structure and Initial Conditions of the ISM and Molecular Clouds
Initial Mass Function, Star Formation Rate, and Star Formation Efficiency
Star Formation Theory and Supporting Observations
- General Star Formation
- Low Mass Star Formation (Turbulence vs. Gravity)
- Intermediate Mass Star Formation
- High Mass Star Formation (Mergers vs. Accretion)

Disks and Planet Formation around Stars of Increasing Mass
Energetics (Jets, Winds, Outflows, Infall, Ionizing Radiation)
Multiplicity of Formation
- Binaries, Multiple Systems, Clusters, and Dynamical Interactions
- Effect of High Mass Stars on Low Mass Star Formation (Proplyds, Eggs, Ionized Radiation)

Future Instrumentation and Its Application to Star Formation Studies in Chile

SCIENTIFIC ORGANIZING COMMITTEE

Ewine van Dishoeck (Leiden U., Netherlands); Edith Falgarone (ENS Radioastronomie, France); Yasuo Fukui (Nagoya U., Japan); Guido Garay (U. Chile, Chile); Lee Hartmann (SAO, USA); George Herbig (IfA/Hawaii, USA); Elizabeth Lada (U. Florida, USA); Antonella Natta (Arcetri Obs., Italy); Bo Reipurth (U. Colorado, USA); Luis F. Rodriguez (UNAM, Mexico); Hans Zinnecker (Potsdam U., Germany).

LOCAL ORGANIZING COMMITTEE

Danielle Alloin (ESO); James De Buizer (Chair) (CTIO); Eduardo Hardy (NRAO); Tom Hayward (Gemini); Diego Mardones (U. Chile); Miguel Roth (LCO); Michael Sterzik (ESO); Nicole van der Bliek (CTIO); Stefanie Wachter

(CTIO).

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New Books

Meteorites

Their Impact on Science and History

Edited by Brigitte Zanda & Monica Rotaru

This well illustrated little book provides an easily accessible and yet detailed and well researched presentation of where meteorite research is at the moment. Increasingly, a connection is being established between our understanding of how stars are forming and the birth of our own solar system. Yet, differences in scientific backgrounds and even in terminology have traditionally set up barriers between the disciplines of star formation and cosmogony. This book, which was written by a team of mostly french meteorite experts in connection with the recent acclaimed exhibition of meteorites at the Muséum National d'Histoire Naturelle in Paris, will help not only the more general public but also astronomers to appreciate the importance of meteorites.

The following lists the chapters of the book:

The harder they fall (*C. Perron*)
Stones which fell from the sky (*U. Marvin*)
Impact Craters (*P.Thomas*)
Cretaceous Park (*R. Rocchia & E. Robin*)
Like no stone on Earth (*B. Zanda et al.*)
Little Planets (*D. Benest*)
The sound and the fury (*J.-P. Bibring*)
Signed Carbon (*F. Robert*)
A stormy nebula (*R. Hewins*)
The age of the solar system (*G. Manhes*)
Galactic Fossils (*E. Zinner*)
Leafing through the past two centuries (*P. Pellas*)

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