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*Abstracts of recently accepted papers*

## A Single Circumstellar Disk in the SVS 13 Close Binary System

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We present Very Large Array observations at 7 mm of the sources IRAS 2A, IRAS 2B, MMS2, MMS3 and SVS 13, in the NGC1333 region. SVS 13 is a young close binary system whose components are separated by 65 AU in projection. Our high angular resolution observations reveal that only one of the components of the SVS 13 system (VLA 4B) is associated with detectable circumstellar dust emission. This result is in contrast with the well known case of L1551 IRS5, a binary system of two protostars separated by 45 AU, where each component is associated with a disk of dust. Both in SVS 13 and in L1551 IRS5 the emission apparently arises from compact accretion disks, smaller than those observed around single stars, but still massive enough to form planetary systems like the solar one. These observational results confirm that the formation of planets can occur in close binary systems, either in one or in both components of the system, depending on the specific angular momentum of the infalling material.

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<http://arxiv.org/abs/astro-ph/0403151>

## Fragmentation in Massive Star Formation

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Studies of evolved massive stars indicate that they form in a clustered mode. During the earliest evolutionary stages, these regions are embedded within their natal cores. Here, we show high-spatial-resolution interferometric dust continuum observations disentangling the cluster-like structure of a young massive star-forming region. The derived protocluster mass distribution is consistent with the stellar initial mass function. Thus, fragmentation of the initial massive cores may determine the initial mass function and the masses of the final stars. This implies that stars of all masses can form via accretion processes, and coalescence of intermediate-mass protostars appears not to be necessary.

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<http://cfa-www.harvard.edu/~hbeuther>

## Massive molecular outflows at high spatial resolution

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We present high-spatial resolution Plateau de Bure Interferometer CO(2–1) and SiO(2–1) observations of one intermediate-mass and one high-mass star-forming region. The intermediate-mass region IRAS 20293+3952 exhibits four molecular outflows, one being as collimated as the highly collimated jet-like outflows observed in low-mass star formation sources. Furthermore, comparing the data with additional infrared H<sub>2</sub> and cm observations we see indications that the nearby ultracompact HII region triggers a shock wave interacting with the outflow. The high-mass region IRAS 19217+1651 exhibits a bipolar outflow as well and the region is dominated by the central driving source. Adding two more sources from the literature, we compare position-velocity diagrams of the intermediate- to high-mass sources with previous studies in the low-mass regime. We find similar kinematic signatures, some sources can be explained by jet-driven outflows whereas other are better constrained by wind-driven models. The data also allow to estimate accretion rates varying from a few times  $10^{-5} M_{\odot}\text{yr}^{-1}$  for the intermediate-mass sources to a few times  $10^{-4} M_{\odot}\text{yr}^{-1}$  for the high-mass source, consistent with models explaining star formation of all masses via accretion processes.

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<http://cfa-www.harvard.edu/~hbeuther>

## SMA outflow/disk studies in the massive star-forming region IRAS 18089-1732

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SMA observations of the massive star-forming region IRAS 18089-1732 in the 1 mm and 850  $\mu\text{m}$  band reveal outflow and disk signatures in different molecular lines. The SiO(5–4) data show a collimated outflow in the northern direction. In contrast, the HCOOCH<sub>3</sub>(20–19) line, which traces high-density gas, is confined to the very center of the region and shows a velocity gradient across the core. The HCOOCH<sub>3</sub> velocity gradient is not exactly perpendicular to the outflow axis but between an assumed disk plane and the outflow axis. We interpret these HCOOCH<sub>3</sub> features as originating from a rotating disk that is influenced by the outflow and infall. Based on the (sub-)mm continuum emission, the mass of the central core is estimated to be around  $38 M_{\odot}$ . The dynamical mass derived from the HCOOCH<sub>3</sub> data is  $22 M_{\odot}$ , of about the same order as the core mass. Thus, the mass of the protostar/disk/envelope system is dominated by its disk and envelope. The two frequency continuum data of the core indicate a low dust opacity index  $\beta \sim 1.2$  in the outer part, decreasing to  $\beta \sim 0.5$  on shorter spatial scales.

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<http://cfa-ww.harvard.edu/~hbeuther>

## Optical imaging and spectroscopy of the H II region G353.2+0.9 in NGC 6357 and its relation to Pismis 24

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G353.2+0.9 is the brightest H II region in NGC 6357. The present observations imply that it is optically thin and

contains  $\sim 300 M_{\odot}$  of ionized gas. It is probably expanding into the surrounding medium due to its higher thermal pressure. Its chemical composition is similar to that found in other H II regions located at comparable galactocentric distances. The inner regions are probably made of thin shells and filaments, whereas extended slabs of material, probably shells seen edge-on, are found in the periphery. Extinction, though abnormal, is quite uniform but somewhat larger in the brightest optical regions. The radio continuum and H $\alpha$  emission maps are very similar, indicating that most of the optical nebula is not embedded in the denser regions traced by molecular gas and by the presence of IR sources. About  $10^{50}$  UV photons per second are required to produce the H $\beta$  flux from the  $11.3 \times 10$  square arcmin region surrounding Pis 24 and the more highly excited regions in G353.2+0.9 are facing this cluster. Thus, most of the energy powering G353.2+0.9 and the surrounding environment is produced by the O3-7 stars in Pis 24. Practically all *2MASS* sources with large near-infrared excesses are within G353.2+0.9, indicating that the most recent star forming process occurred in this region. Some amount of heating and ionization is due to these stars. The formation of the Pis 24 cluster preceded and caused the formation of this new generation of stars and may be responsible for the present-day morphology of the entire NGC 6357 region.

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## The formation of a massive protostar through disk accretion of gas

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The formation of low-mass stars like our Sun can be explained by the gravitational collapse of a molecular cloud fragment and the subsequent accretion from the surrounding interstellar medium onto a protostellar core. Theoretical considerations, however, show that the radiation pressure onto the in-falling dust and gas may prevent the formation of stars above ten solar masses. Given this theoretical limit and the fact that most massive stars are born in dense clusters, it was suggested that high-mass stars are the result of the runaway merging of intermediate-mass stars. Here we report on observations which clearly indicate that a massive star is currently being born from a large rotating accretion disk. The protostar has already assembled about 20 solar masses but the accretion process is still going on. The gas reservoir of the circumstellar disk contains at least 100 solar masses providing sufficient fuel for substantial growth of the forming star. Our observations corroborate recent theoretical calculations which have claimed that stars up to 40 solar masses can in principle be formed via accretion through a disk.

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## The circumstellar environment of IRAS 16293–2422: ISO–LWS and SCUBA observations

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We present far-infrared (FIR) continuum observations of the deeply embedded source IRAS 16293–2422 performed with the Long Wavelength Spectrometer (LWS) on-board the Infrared Space Observatory (ISO). We also report 450 and 850  $\mu\text{m}$  mapping observations done with the Submillimetre Common–User Bolometer Array (SCUBA) at the James Clerk Maxwell Telescope (JCMT). We combined these observations with IRAS and other JCMT data available in the literature to construct a complete spectral energy distribution (SED) of the source. A spherically symmetric dusty envelope model was used to reproduce the SED and to characterize the circumstellar matter around the object. We call attention to the fact that when using models such as the one presented here, one needs spatial

information about the object to distinguish between different possible fits to the SED. A comparison between the intensity profiles at 450 and 850  $\mu\text{m}$  obtained from the SCUBA observations and the profiles predicted by the model allowed us to constrain the size of the envelope and its density distribution. The SED and the 850  $\mu\text{m}$  intensity profile of the source are consistent with a centrally peaked power law dust density distribution of the form  $\rho(r) \propto r^{-p}$  with  $p = 1.5 - 2$ , with a radius  $R_{env} = 3000 - 3250$  AU, defining a very compact circumstellar envelope. We estimate a bolometric luminosity  $L_{bol} = 36 L_{\odot}$ , an envelope mass  $M_{env} = 3.4 M_{\odot}$ , and a submillimetre to bolometric luminosity ratio  $L_{submm}/L_{bol} = 1.9\%$ , confirming that the source shows a submillimetre excess characteristic of Class 0 sources.

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Preprints available from <http://fisica.fc.ul.pt/~jcc/>

## On the Properties of Young Multiple Stars

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We present numerical results on the properties of young binary and multiple stellar systems. Our analysis is based on a series of SPH +  $N$ -body simulations of the fragmentation of small molecular clouds, that fully resolve the opacity limit for fragmentation. These simulations demonstrate that multiple star formation is a major channel for star formation in turbulent flows. We have produced a statistically significant number of stable multiple systems, with components separations in the range  $\sim 1 - 10^3$  AU. At the end of the hydrodynamic stage (0.5 Myr) we find that  $\approx 60\%$  of stars and brown dwarfs are members of multiples systems, with about a third of these being low mass, weakly bound outliers in wide eccentric orbits. Our results imply that in the stellar regime most stars are in multiples ( $\approx 80\%$ ) and that this fraction is an increasing function of primary mass. After  $N$ -body integration to 10.5 Myr, the percentage of bound objects has dropped to about 40%, this decrease arising mostly from very low mass stars and brown dwarfs that have been released into the field. Brown dwarfs are never found to be very close companions to stars (the *brown dwarf desert at very small separations*), but one case exists of a brown dwarf companion at intermediate separations (10 AU). Our simulations can accommodate the existence of brown dwarf companions at large separations, but only if the primaries of these systems are themselves multiples.

We have compared the outcome of our simulations with the properties of real stellar systems as deduced from the IR colour-magnitude diagram of the Praesepe cluster and from spectroscopic and high-resolution imaging surveys of young clusters and the field. We find that the spread of the observed main sequence of Praesepe in the  $0.4 - 1M_{\odot}$  range appears to require that stars are indeed commonly assembled into high-order multiple systems. Similarly, observational results from Taurus and  $\rho$  Ophiuchus, or moving groups such as TW Hydrae and MBM 12, suggest that companion frequencies in young systems can be indeed as high as we predict. The comparison with observational data also illustrates two problems with the simulation results. Firstly, low mass ratio ( $q < 0.2$ ) binaries are not produced by our models, in conflict with both the Praesepe colour magnitude diagram and independent evidence from field binary surveys. Secondly, very low mass stars and brown dwarf binaries appear to be considerably under-produced by our simulations.

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## Linear Analysis of the Magnetorotational Instability, Including Ambipolar Diffusion, with Application to Protoplanetary Disks

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We present a linear analysis of the magnetorotational instability (MRI) in differentially rotating disks, and derive the

most general instability criterion to date. Our analysis improves on earlier work on this topic in that it simultaneously accounts for arbitrary geometry and the full effects of magnetic diffusion. We allow the magnetic field to have arbitrary orientation and for linear modes to propagate at an angle to the rotation axis. We also include in our analysis all three forms of magnetic diffusion: Ohmic dissipation, ambipolar diffusion and Hall currents. Previous analyses either have included arbitrary geometry *or* ambipolar diffusion, but never both. The simultaneous inclusion of these effects allows us to identify a new unstable mode in which ambipolar diffusion and differential rotation can couple and amplify the magnetic field. We provide a physical explanation of this mode.

Our linear analysis is aimed at determining which parts of protoplanetary disks may be unstable to the MRI. Accordingly, we outline the conditions that are likely to obtain in protoplanetary disks and make estimates of the coupling between the gas and the magnetic field. We derive a linear stability criterion that can be applied to protoplanetary disks.

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## Internal Velocities in the Orion Nebula: Large Radial Velocity Features

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A map of high velocity features in the 3'x 5' central region of the Orion Nebula was created from slit spectra with a velocity resolution of 8 km s<sup>-1</sup>. We identified two new bipolar flows, Herbig Haro (HH) 725 and HH 726, as well as a highly redshifted flow, HH 512. We also found multiple new high velocity co-moving features, all lying in the velocity range of -30 km s<sup>-1</sup> to -100 km s<sup>-1</sup>. The newly discovered Big Arc appears as a low blueshifted feature. Unlike the other objects found, the Big Arc is not a shock, rather, it is a result of a structural alteration in the nebula extended nearly across the region sampled.

Spatial velocities of 19 features belonging to 11 HH objects were obtained by combining these radial velocity data with existing proper motion data. Most HH objects in the H II region exhibit spatial velocities ranging from 50 km s<sup>-1</sup> to 150 km s<sup>-1</sup>. By analyzing their three-dimensional paths, HH 202 and HH 203 + 204 were found to be formed on the curved main ionization front, not on the Veil, as previously proposed.

We have been able to locate the source of the HH 201 outflow (possibly the IRc 2 feature within the BN-KL region) at 0.21 pc behind the ionization front of the nebula. This is in contrast to the Optical Outflow Source, which gives rise to most of the HH objects in the Orion Nebula and lies only a few hundredths of a parsec behind the ionization front of the nebula.

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## Physical-chemical modeling of the low-mass protostar IRAS 16293-2422

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We present detailed gas-phase chemical models for the envelope of the low-mass star-forming region IRAS 16293-2422. By considering both time- and space-dependent chemistry, these models are used to study both the physical structure proposed by Schöier et al. ([?]), as well as the chemical evolution of this region. A new feature of our study is the use of a detailed, self-consistent radiative transfer model to translate the model abundances into line strengths and compare them directly with observations of a total of 76 transitions for 18 chemical species, and their isotopes. The model can reproduce many of the line strengths observed within 50%. The best fit is for times in the range of  $3 \times 10^3 - 3 \times 10^4$  yrs

and requires only minor modifications to our model for the high-mass star-forming region AFGL 2591. The ionization rate for the source may be higher than previously expected – either due to an enhanced cosmic-ray ionization rate, or, more probably, to the presence of X-ray induced ionization from the center. A significant fraction of the CO is found to desorb in the temperature range of 15–40 K; below this temperature  $\sim 90\%$  or more of the CO is frozen out. The inability of the model to explain the HCS<sup>+</sup>, C<sub>2</sub>H, and OCS abundances suggests the importance of further laboratory studies of basic reaction rates. Finally, predictions of the abundances and spatial distributions of other species which could be observed by future facilities (e.g. Herschel-HIFI, SOFIA, millimeter arrays) are provided.

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## Photoevaporation of Circumstellar Disks around Young Stars

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We examine the ability of photoevaporative disk winds to explain the low-velocity components observed in the forbidden line spectra of low-mass T Tauri stars. Using the analytic model of Shu, Johnstone, & Hollenbach (1993) and Hollenbach et al. (1994) as a basis, we examine the characteristics of photoevaporative outflows with hydrodynamic simulations. General results from the simulations agree well with the analytic predictions, although some small differences are present. Most importantly, the flow of material from the disk surface develops at smaller radii than in the analytic approximations and the flow-velocity from the disk surface is only one-third the sound speed. A detailed presentation of observational consequences of the model is given, including predicted line widths, blue-shifts, and integrated luminosities of observable sulfur and nitrogen emission lines. We demonstrate that these predictions are in agreement with current observational data on the low-velocity forbidden line emission of ionized species from T Tauri stars. This is in contrast with magnetic wind models, which systematically under-predict these forbidden line luminosities. However, the present model cannot easily account for the luminosities of neutral oxygen lines in T Tauri stars.

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## Time Variation in the Radio Flux Density from the Bipolar Ultracompact H II Region NGC 7538 IRS1

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We present high angular resolution ( $\sim 0''.1-0''.4$ ) VLA observations at 2 and 6 cm made in 1983, 1986, and 1995 toward the ultracompact bipolar H II region NGC 7538 IRS1. We find, at both wavelengths, clear evidence of a decrease in the emission from the lobes. This decrease, of order 20-30%, has not been observed previously in any ultracompact H II region. Most likely, it is due to recombination of the ionized gas in the lobes as a result of a decrease in the available ionizing photon flux. It is unclear if this decrease in the ionizing photon flux is due to an intrinsic change in the exciting star or to increased absorption of ionizing photons in the optically-thick core of the nebula.

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## On the excitation of the infrared knots along protostellar jets

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The complete near infrared (0.9-2.5  $\mu\text{m}$ ) spectra in three different star forming regions (HH24-26, HH72 and BHR71) are presented and analyzed in the framework of shock excitation models. The spectra are dominated by H<sub>2</sub> rovibrational emission (vibrational state  $\nu \leq 5$ , excitation energy  $T_{ex} \leq 35\,000$  K), while emission from ionized material, recognizable from [Fe II] and [S II] lines, is significantly fainter. The analysis of the H<sub>2</sub> excitation diagrams points to the existence of two different excitation regimes: whilst condensations observed only in the infrared appear to have temperatures rarely exceeding 3000 K and can be modelled in the framework of steady-state C-shock models, the infrared counterparts of Herbig Haro (HH) objects exhibit a temperature stratification with components up to more than 5000 K. The H<sub>2</sub> emission from representative HH objects (HH26A, HH72A and HH320A) has been successfully modelled by planar J-shocks with magnetic precursors, for which the main parameters (pre-shock density, speed) are derived. However, these same models are unable to reproduce the observed atomic and ionic emission, which probably arises from a distinct and perhaps more embedded region with respect to that traced by the H<sub>2</sub>. Some of the physical parameters of such regions (fractional ionization, density) have been estimated in HH72, on the basis of the observed ionic lines.

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Available at [www.mporzio.astro.it/~bruni/publ/h4678.ps.gz](http://www.mporzio.astro.it/~bruni/publ/h4678.ps.gz)  
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## On the Evolutionary State of the Components of the YLW 15 Binary System

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We report centimeter continuum observations with the VLA and the VLBA as well as mid-infrared observations with COMICS/SUBARU toward the components of the YLW 15 very young binary system, VLA 1 and VLA 2. The centimeter emission of the two components traces partially thick free-free emission, likely due to collimated, ionized winds. VLA 1 is an embedded protostar, undetected in the near-IR, and possibly in the Class 0 to Class I transition and powering a Herbig-Haro outflow. Its mid-IR emission appears slightly resolved with a diameter of  $\sim 16$  AU, possibly tracing circumstellar material from both the envelope and the disk. VLA 2 is a typical Class I object, unresolved in the mid-IR, and is the responsible of the strong X-ray emission associated with YLW 15. The expected centimeter “peri-stellar” emission associated with the X-ray emission is not detected with the VLBA at 6 cm likely due to the high optical depth of the free-free emission. Strikingly, the near to mid-IR properties of YLW 15 suggest that VLA 1 is a more embedded YSO, or alternatively, less luminous than VLA 2, whereas orbital proper motions of this binary system indicate that VLA 1 is more massive than VLA 2. This result is apparently against the expected evolutionary scenario, where one expects that the more massive YSO in a binary system is the more evolved and luminous YSO. Finally, the nearby source YLW 16A is detected with the VLA, its position coincides with reported near-IR and X-ray sources.

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## Supermassive Stars in Quasar Disks

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We propose that supermassive stars may form in quasar accretion disks, and we discuss possible observational consequences. The structure and stability of very massive stars are reviewed. Because of high accretion rates, quasar disks are massive and the fringes of their optically luminous parts are prone to fragmentation. Starting from a few hundred solar masses, a dominant fragment will grow to the isolation mass, which is a significant fraction of the disk mass, more quickly than the fragment contracts onto the stellar main sequence. A gap will form in the disk and the star will migrate inward on the accretion timescale, which is comparable to the star's main sequence lifetime. By interrupting the gas supply to the inner disk, the gap may temporarily dim and redden the quasar. The final stages of stellar migration will be a strong source of low-frequency gravitational waves.

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## An explanation for the unusual IMF in Taurus

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In comparison with other well studied star formation regions, Taurus is unusual in several respects. (i) Its stellar initial mass function (IMF) peaks at relatively high mass ( $\sim 0.8M_{\odot}$ ), but contains very few stars much more massive than  $1M_{\odot}$ , and is relatively deficient in brown dwarfs. (ii) It has a higher binary fraction, particularly at large separations. (iii) Its core mass function is strongly peaked at a few  $M_{\odot}$ , and the cores have extended envelopes and relatively low levels of turbulence.

We present here the results of an ensemble of hydrodynamic simulations which suggest that the unusual stellar IMF in Taurus is a direct consequence of the unusual properties of the cores there. By following the collapse and fragmentation of cores having properties typical of Taurus, we find that roughly 50% of the objects formed in a core, predominantly the low-mass ones, are ejected from the core to form a population of low-mass stars and brown dwarfs with a flat mass function. The remaining objects form multiple systems within the core, accreting until their masses approach  $1M_{\odot}$ ; this produces a population of intermediate-mass stars whose mass function peaks at  $\sim 0.8M_{\odot}$ . Together these two populations reproduce the IMF in Taurus very well. This demonstrates, for the first time, a direct causal link between the core mass function and the stellar IMF in a star formation region.

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## The Environment of the Optically Brightest Herbig Ae Star HD 104237

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We investigate the environment of the nearest Herbig Ae star, HD 104237, with a multiwavelength combination of optical coronagraphic, near-IR and mid-IR imaging supported by optical, UV, and FUV spectroscopy. We confirm the presence of T Tauri stars associated with the Herbig Ae star HD 104237, noted by Feigelson et al. (2003). We find that 2 of the stars within 15 arcsec of HD 104237 have IR excesses, potentially indicating the presence of circumstellar disks, in addition to the Herbig Ae star itself. We derive a new spectral type of A7.5Ve-A8Ve for HD 104237, and find  $\log(L/L_{\odot})=1.39$ . With these data, HD 104237 has an age of  $t \approx 5$  Myr, in agreement with the estimates for the other members of the association. HD 104237 is still actively accreting, with a conspicuous UV/FUV excess seen down to 1040 Å, and is driving a bipolar microjet termed HH 669. This makes it the second, older Herbig Ae star known to have a microjet. The presence of the microjet enables us to constrain the circumstellar disk to  $r \leq 0.6$  arcsec (70 AU) with an inclination angle of  $i = 18^{\circ}_{-11}^{+14}$  from pole-on. The absence of a spatially extended continuum and fluorescent H<sub>2</sub> emission near Ly $\alpha$  is in agreement with the prediction of shadowed disk models for the IR spectral energy distribution. With the high spatial density of disks in this group of stars, proximity, and minimal reddening, HD 104237 and its companions should serve as ideal laboratories for probing the comparative evolution of planetary systems.

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## The Far-Ultraviolet Spectra of TW Hya. II. Models of H<sub>2</sub> Fluorescence in a Disk

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We measure the temperature of warm gas at planet-forming radii in the disk around the classical T Tauri star (CTTS) TW Hya by modelling the H<sub>2</sub> fluorescence observed in *HST*/STIS and *FUSE* spectra. Strong Lyman- $\alpha$  emission irradiates a warm disk surface within 2 AU of the central star and pumps certain excited levels of H<sub>2</sub>. We simulate a 1D plane-parallel atmosphere to estimate fluxes for the 140 observed H<sub>2</sub> emission lines and to reconstruct the Lyman- $\alpha$  emission profile incident upon the warm H<sub>2</sub>. The excitation of H<sub>2</sub> can be determined from relative line strengths by measuring self-absorption in lines with low-energy lower levels, or by reconstructing the Lyman- $\alpha$  profile incident upon the warm H<sub>2</sub> using the total flux from a single upper level and the opacity in the pumping transition. Based on those diagnostics, we estimate that the warm disk surface has a column density of  $\log N(\text{H}_2) = 18.5^{+1.2}_{-0.8}$ , a temperature  $T = 2500^{+700}_{-500}$  K, and a filling factor of H<sub>2</sub>, as seen by the source of Lyman- $\alpha$  emission, of  $0.25 \pm 0.08$  (all  $2\sigma$  error bars). TW Hya produces approximately  $10^{-3} L_{\odot}$  in the FUV, about 85% of which is in the Lyman- $\alpha$  emission line. From the ionH1 absorption observed in the Lyman- $\alpha$  emission, we infer that dust extinction in our line of sight to TW Hya is negligible.

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## Discovery of a large dust disk around the nearby star AU Microscopium

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We present the discovery of a circumstellar dust disk surrounding AU Microscopium (AU Mic, GJ 803, HD 197481). This young M star at 10 parsec has the same age and origin as  $\beta$  Pictoris, another nearby star surrounded by a dust disk. The AU Mic disk is detected between 50 AU and 210 AU radius, a region where dust lifetimes exceed the

present stellar age. Thus, AU Mic is the nearest star where we directly observe the solid material required for planet formation. Since 85% of stars are M-type, the AU Mic disk provides new clues on how the majority of planetary systems might form and evolve.

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## A Sub-Millimeter Search of Nearby Young Stars for Cold Dust: Discovery of Debris Disks around Two Low-Mass Stars

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We present results from a JCMT/SCUBA 850  $\mu\text{m}$  search for cold dust around eight nearby young stars belonging to the  $\beta$  Pic ( $t \approx 12$  Myr) and the Local Association ( $t \approx 50$  Myr) moving groups. Unlike most past sub-mm studies, our sample was chosen solely on the basis of stellar age. Our observations achieve about an order of magnitude greater sensitivity in dust mass compared to previous work in this age range. We detected two of the three M dwarfs in our sample at 850  $\mu\text{m}$ , GJ 182 and GJ 803 ( $M_* \approx 0.5 M_\odot$ ), with inferred dust masses of only  $\approx 0.01$ – $0.03 M_\oplus$ . GJ 182 may also possess a 25  $\mu\text{m}$  excess, indicative of warm dust in the inner few AU of its disk. For GJ 803 (AU Mic; HD 197481), sub-mm mapping finds that the 850  $\mu\text{m}$  emission is unresolved. A non-detection of the CO 3–2 line indicates the system is gas-poor, and the spectral energy distribution suggests the presence of a large inner disk hole ( $\approx 17$  AU =  $1.7''$  in radius for blackbody grains). These are possible indications that planets at large separations can form around M dwarfs within  $\sim 10$  Myr. In a companion paper (Kalas, Liu & Matthews 2004), we confirm the existence of a dust disk around GJ 803 using optical coronagraphic imaging. Given its youthfulness, proximity, and detectability, the GJ 803 disk will be a valuable system for studying disk, and perhaps planet, formation in great detail. Overall, sub-mm measurements of debris disks point to a drop in dust mass by a factor of  $\sim 10^3$  within the first  $\sim 10$  Myr, with the subsequent decline in the masses of sub-mm detected disks consistent with  $t^{-0.5}$  to  $t^{-1}$ .

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## Study of the properties and spectral energy distributions of the Herbig AeBe stars HD 34282 and HD 141569

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We present a study of the stellar parameters, distances and spectral energy distributions (SEDs) of HD 34282 and HD 141569, two pre-main sequence Herbig AeBe stars. Both objects have been reported to show ‘anomalous positions’ in the HR diagram in the sense that they appear below the main sequence. A significant result of this work is that both stars are metal-deficient. The *Hipparcos* distance of HD 34282 is very uncertain and the current study places the star at the expected evolutionary position in the HR diagram, i.e. as a PMS star. The distance for HD 141569 found in this work matches the *Hipparcos* distance, and the problem of its anomalous position is solved as a result of the low metallicity of the object: using the right metallicity tracks, the star is in the PMS region. The SEDs are constructed using data covering ultraviolet to millimetre wavelengths. Physical, non-parametric models, have been applied in order to extract some properties of the disks surrounding the stars. The disk around HD 34282 is accreting

actively, it is massive and presents large grains in the mid-plane and small grains in the surface. HD 141569 has a very low mass disk, which is in an intermediate stage towards a debris-type disk.

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## I. Measuring Surface Gravities of Substellar Objects

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We present an analysis of high resolution optical spectra for a sample of very young, mid- to late M, low-mass stellar and substellar objects: 11 in the Upper Scorpius association, and 2 (GG Tau Ba and Bb) in the Taurus star-forming region. Effective temperatures and surface gravities are derived from a multi-feature spectral analysis using TiO, NaI and KI, through comparison with the latest synthetic spectra. We show that these spectral diagnostics complement each other, removing degeneracies with temperature and gravity in the behavior of each. In combination, they allow us to determine temperature to within 50K and gravity to within 0.25 dex, in very cool young objects. Our high-resolution spectral analysis does not require extinction estimates. Moreover, it yields temperatures and gravities *independent* of theoretical evolutionary models (though our estimates do depend on the synthetic spectral modeling). We find that our gravities for most of the sample agree remarkably well with the isochrone predictions for the likely cluster ages. However, discrepancies appear in our coolest targets: these appear to have significantly lower gravity (by upto 0.75 dex) than our hotter objects, even though our entire sample covers a relatively narrow range in effective temperature ( $\sim 300\text{K}$ ). This drop in gravity is also implied by inter-comparisons of the data alone, without recourse to synthetic spectra. We consider, and argue against, dust opacity, cool stellar spots or metallicity differences leading to the observed spectral effects; a real decline in gravity is strongly indicated. Such gravity variations are contrary to the predictions of the evolutionary tracks, causing improbably low ages to be inferred from the tracks for our coolest targets. Through a simple consideration of contraction timescales, we quantify the age errors introduced into the tracks through the particular choice of initial conditions, and demonstrate that they can be significant for low-mass objects that are only a few Myr old. However, we also find that these errors appear insufficient to explain the magnitude of the age offsets in our lowest gravity targets. We venture that our results may arise from evolutionary model uncertainties related to accretion, deuterium-burning and/or convection effects. Finally, when combined with photometry and distance information, our technique for deriving surface gravities and effective temperatures provides a way of obtaining masses and radii for substellar objects independent of evolutionary models; radius and mass determinations are presented in Paper II.

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<http://www.astro.lsa.umich.edu/~rayjay/parselink.php?link=research>

## II. Measuring Masses and Radii of Substellar Objects

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We present mass and radius derivations for a sample of very young, mid- to late M, low-mass stellar and substellar objects in Upper Scorpius and Taurus. In a previous paper, we determined effective temperatures and surface gravities

for these targets, from an analysis of their high-resolution optical spectra and comparisons to the latest synthetic spectra. We now derive extinctions, radii, masses and luminosities by combining our previous results with observed photometry, surface fluxes from the synthetic spectra and the known cluster distances. These are the first mass and radius estimates for young, very low mass bodies that are *independent* of theoretical evolutionary models (though our estimates do depend on spectral modeling). We find that for most of our sample, our derived mass-radius and mass-luminosity relationships are in very good agreement with the theoretical predictions. However, our results diverge from the evolutionary model values for the coolest, lowest-mass targets: our inferred radii and luminosities are significantly larger than predicted for these objects at the likely cluster ages, causing them to appear much younger than expected. We suggest that uncertainties in the evolutionary models - e.g., in the choice of initial conditions and/or treatment of interior convection - may be responsible for this discrepancy. Finally, two of our late-M objects (USco 128 and 130) appear to have masses close to the deuterium-fusion boundary ( $\sim 9$ – $14$  Jupiters, within a factor of 2). This conclusion is primarily a consequence of their considerable faintness compared to other targets with similar extinction, spectral type, and temperature (difference of  $\sim 1$  mag). Our result suggests that the faintest young late-M or cooler objects may be significantly lower in mass than current theoretical tracks indicate.

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## Dynamics of the circumstellar gas in the Herbig Ae stars BF Orionis, SV Cephei, WW Vulpeculae and XY Persei

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We present high resolution ( $\lambda/\Delta\lambda = 49\,000$ ) échelle spectra of the intermediate mass, pre-main sequence stars BF Ori, SV Cep, WW Wul and XY Per. The spectra cover the range 3800 – 5900 Å and monitor the stars on time scales of months and days. All spectra show a large number of Balmer and metallic lines with variable blueshifted and redshifted absorption features superimposed to the photospheric stellar spectra. Synthetic Kurucz models are used to estimate rotational velocities, effective temperatures and gravities of the stars. The best photospheric models are subtracted from each observed spectrum to determine the variable absorption features due to the circumstellar gas; those features are characterized in terms of their velocity,  $v$ , dispersion velocity,  $\Delta v$ , and residual absorption,  $R_{\max}$ . The absorption components detected in each spectrum can be grouped by their similar radial velocities and are interpreted as the signature of the dynamical evolution of gaseous clumps with, in most cases, solar-like chemical composition. This

infalling and outflowing gas has similar properties to the circumstellar gas observed in UX Ori, emphasizing the need for detailed theoretical models, probably in the framework of the magnetospheric accretion scenario, to understand the complex environment in Herbig Ae (HAe) stars. WW Vul is unusual because, in addition to infalling and outflowing gas with properties similar to those observed in the other stars, it shows also transient absorption features in metallic lines with no obvious counterparts in the hydrogen lines. This could, in principle, suggest the presence of CS gas clouds with enhanced metallicity around WW Vul. The existence of such a metal-rich gas component, however, needs to be confirmed by further observations and a more quantitative analysis.

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Preprints available at:

[http://laeff.inta.es/EXPORT/Export\\_results.html](http://laeff.inta.es/EXPORT/Export_results.html)

<http://www.arxiv.org/abs/astro-ph/0402614>

## **Infrared spectroscopy of a brown dwarf companion candidate near the young star GSC 08047-00232 in Horologium**

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We present infrared H- and K-band spectra of a companion candidate 3'' north of the young star GSC 08047-00232, a probable member of the nearby young Horologium association. From previously obtained JHK-band colors and the magnitude difference between primary and companion candidate, the latter could well be substellar (Neuhäuser et al. 2003) with the spectral type being roughly M7-L9 from the JHK colors (Chauvin et al. 2003). With the H- and K-band spectra now obtained with ISAAC at the VLT, the spectral type of the companion candidate is found to be M6-9.5. Assuming the same age and distance as for the primary star ( $\sim 35$  Myrs, 50 to 85 pc), this yields a mass of  $\sim 25$  Jupiter masses for the companion, hence indeed substellar. After TWA-5 B and HR 7329 B, this is the third brown dwarf companion around a nearby ( $\leq 100$  pc) young ( $\leq 100$  Myrs) star. A total of three confirmed brown dwarf companions (any mass, separation  $\geq 50$  AU) around 79 stars surveyed in three young nearby associations corresponds to a frequency of  $6 \pm 4$  % (with a correction for missing companions which are almost on the same line-of-sight as the primary star instead of being separated well), consistent with the expectation, if binaries have the same mass function as field stars. Hence, it seems that there is no brown dwarf desert at wide separations.

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## **Deep near-infrared observations of W3 Main star forming region**

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We present a deep JHK<sub>s</sub>-band imaging survey of the W3 Main star forming region, using the near-infrared camera, SIRIUS (Simultaneous three-color InfraRed Imager for Unbiased Surveys), mounted on the University of Hawaii 2.2 m telescope. The near-infrared survey covers an area of  $\sim 24$  arcmin<sup>2</sup> with  $10 \sigma$  limiting magnitudes of  $\sim 19.0$ , 18.1, and 17.3 in J, H, and K<sub>s</sub>-band, respectively. We construct JHK color-color and J/J-H and K/H-K color-magnitude diagrams to identify young stellar objects and estimate their masses. Based on these color-color and color-magnitude diagrams, a rich population of YSOs is identified which is associated with the W3 Main region. A large number of

previously unreported red sources ( $H-K > 2$ ) have also been detected around W3 Main. We argue that these red stars are most probably pre-main sequence stars with intrinsic color excesses. We find that the slope of the  $K_s$ -band luminosity function of W3 Main is lower than the typical values reported for the young embedded clusters. The derived slope of the KLF is the same as that found by Megeath et al. (1996), from which analysis by Megeath et al. indicates that the W3 Main region has an age in the range of 0.3–1 Myr. Based on the comparison between models of pre-main sequence stars with the observed color-magnitude diagram we find that the stellar population in W3 Main is primarily composed of low mass pre-main sequence stars. We also report the detection of isolated young stars with large infrared excesses which are most probably in their earliest evolutionary phases.

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Preprint available to download at <http://www.tifr.res.in/~ojha/W3Main.html>

## HST/WFPC2 Study of the Trapezium Cluster: the Influence of Circumstellar Disks on the Initial Mass Function

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We have performed the first measures of mass accretion rates in the core of the Orion Nebula Cluster. Four adjacent fields centered on the Trapezium stars have been imaged in the U- and B-bands using the Wide Field Planetary Camera 2 on board the *Hubble Space Telescope*. We obtained photometry for 91 stars in the U-band (F336W) and 71 stars in the B-band (F439W). The WFPC2 archive was also searched to obtain complementary V-band (F547M) and I-band (F791W) photometry. In this paper we focus our attention on a group of 40 stars with known spectral types and complete UBV<sub>I</sub> WFPC2 photometry. We locate each star on the HR diagram considering both the standard ISM reddening law with  $R_V = 3.1$  and the “anomalous” reddening law with  $R_V = 5.5$  more appropriate for the Orion Nebula. Then we derive the stellar masses and ages by comparing with the evolutionary tracks and isochrones calculated by D’Antona & Mazzitelli and Palla & Stahler. Approximately three quarters of the sources show excess luminosity in the U-band, that we attribute to mass accretion. The known correlation between the U-band excess and the total accretion luminosity, recalibrated for our photometric system, allows us to estimate the accretion rates, which are all found to be in the range  $10^{-8} - 10^{-12} M_{\odot} \text{yr}^{-1}$ . For stars older than 1 Myr there is some evidence of a relation between mass accretion rates and stellar age. Overall, mass accretion rates appear lower than those measured by other authors in the Orion flanking fields or in Taurus-Auriga. Mass accretion rates remain low even in the vicinity of the  $10^{-5} M_{\odot} \text{yr}^{-1}$  birth line of Palla & Stahler, suggesting that in the core of the Trapezium cluster disk accretion has been recently depressed by an external mechanism. We suggest that the UV radiation generated by the Trapezium OB stars, responsible for the disk evaporation, may also cause the drop of the mass accretion rate. In this scenario, low-mass stars may terminate their pre-main sequence evolution with masses lower than those they would have reached if disk accretion could have proceeded undisturbed until the final disk consumption. In OB associations the low-mass end of the Initial Mass Function may therefore be affected by the rapid evolution of the most massive cluster’s stars, causing a surplus of “accretion aborted” very low-mass stars and brown dwarfs, and a deficit of intermediate mass stars. This trend is in agreement with recent observations of the IMF in the Trapezium cluster.

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preprint available at [http://arxiv.org/PS\\_cache/astro-ph/pdf/0402/0402195.pdf](http://arxiv.org/PS_cache/astro-ph/pdf/0402/0402195.pdf)

## Low-Mass Pre-Main Sequence Stars in the Large Magellanic Cloud - III: Accretion Rates from HST-WFPC2 Observations

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We have measured the present accretion rate of roughly 800 low-mass ( $\sim 1 - 1.4 M_{\odot}$ ) pre-Main Sequence stars in the field of Supernova 1987A in the Large Magellanic Cloud (LMC,  $Z \simeq 0.3 Z_{\odot}$ ). It is the first time that this fundamental parameter for star formation is determined for low-mass stars outside our Galaxy. The Balmer continuum emission used to derive the accretion rate positively correlates with the H $\alpha$  excess. Both these phenomena are believed to originate from accretion from a circumstellar disk so that their simultaneous detection provides an important confirmation of the pre-Main Sequence nature of the H $\alpha$  and UV excess objects, which are likely to be the LMC equivalent of Galactic Classical T Tauri stars. The stars with statistically significant excesses are measured to have accretion rates larger than  $\sim 1.5 \times 10^{-8} M_{\odot} \text{ yr}^{-1}$  at an age of 12-16 Myrs. For comparison, the time scale for disk dissipation observed in the Galaxy is of the order of 6 Myrs. Moreover, the oldest Classical T Tauri star known in the Milky Way (TW Hydræ, with 10 Myrs of age) has a measured accretion rate of only  $5 \times 10^{-10} M_{\odot} / \text{yr}$ , *i.e.* 30 times less than what we measure for stars at a comparable age in the LMC. Our findings indicate that metallicity plays a major role in regulating the formation of low-mass stars.

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## Protostellar mass accretion rates from gravoturbulent fragmentation

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We analyse protostellar mass accretion rates  $\dot{M}$  from numerical models of star formation based on gravoturbulent fragmentation, considering a large number of different environments. To within one order of magnitude,  $\dot{M} \approx M_{\text{J}} / \tau_{\text{ff}}$  with  $M_{\text{J}}$  being the mean thermal Jeans mass and  $\tau_{\text{ff}}$  the corresponding free-fall time. However, mass accretion rates are highly time-variant, with a sharp peak shortly after the formation of the protostellar core. We present an empirical exponential fit formula to describe the time evolution of the mass accretion and discuss the resulting fit parameters. There is a positive correlation between the peak accretion rate and the final mass of the protostar. We also investigate the relation of  $\dot{M}$  with the turbulent flow velocity as well as with the driving wavenumbers in different environments. We then compare our results with other theoretical models of star formation and with observational data.

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## Probing the Early Stages of Low-Mass Star Formation in LDN 1689N: Dust and Water in IRAS 16293–2422A, B, and E

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We present deep images of dust continuum emission at 450, 800, and 850  $\mu\text{m}$  of the dark cloud LDN 1689N which harbors the low-mass young stellar objects (YSOs) IRAS 16293–2422A and B (I16293A and I16293B) and the cold

prestellar object I16293E. Toward the positions of I16293A and E we also obtained spectra of CO-isotopomers and deep submillimeter observations of chemically related molecules with high critical densities ( $\text{HCO}^+$ ,  $\text{H}^{13}\text{CO}^+$ ,  $\text{DCO}^+$ ,  $\text{H}_2\text{O}$ ,  $\text{HDO}$ ,  $\text{H}_2\text{D}^+$ ). To I16293A we report the detection of the  $\text{HDO } 1_{01}-0_{00}$  and  $\text{H}_2\text{O } 1_{10}-1_{01}$  ground-state transitions as broad self-reversed emission profiles with narrow absorption, and a tentative detection of  $\text{H}_2\text{D}^+ 1_{10}-1_{11}$ . To I16293E we detect weak emission of subthermally excited  $\text{HDO } 1_{01}-0_{00}$ . Based on this set of submillimeter continuum and line data we model the envelopes around I16293A and E. The density and velocity structure of I16293A is fit by an inside-out collapse model, yielding a sound speed of  $a=0.7 \text{ km s}^{-1}$ , an age of  $t=(0.6-2.5)\times 10^4 \text{ yr}$ , and a mass of  $6.1 M_\odot$ . The density in the envelope of I16293E is fit by a radial power law with index  $-1.0 \pm 0.2$ , a mass of  $4.4 M_\odot$ , and a constant temperature of 16 K. These respective models are used to study the chemistry of the envelopes of these pre- and protostellar objects.

We made a large, fully sampled CO  $J=2-1$  map of LDN 1689N which clearly shows the two outflows from I16293A and B, and the interaction of one of the flows with I16293E. An outflow from I16293E as reported elsewhere is not confirmed. Instead, we find that the motions around I16293E identified from small maps are part of a larger scale fossil flow from I16293B. Modeling of the I16293A outflow shows that the broad HDO, water ground-state, and CO  $J=6-5$  and  $7-6$  emission lines originate in this flow, while the HDO and  $\text{H}_2\text{O}$  line cores originate in the envelope. The narrow absorption feature in the ground-state water line is due to cold gas in the outer envelope. The derived  $\text{H}_2\text{O}$  abundance is  $3 \times 10^{-9}$  in the cold regions of the envelope of I16293A ( $T_{\text{kin}} < 14 \text{ K}$ ),  $2 \times 10^{-7}$  in warmer regions of the envelope ( $> 14 \text{ K}$ ), and  $10^{-8}$  in the outflow. The HDO abundance is constant at a few  $\times 10^{-10}$  throughout the envelopes of I16293A and E. Because the derived  $\text{H}_2\text{O}$  and HDO abundances in the two objects can be understood through shock chemistry in the outflow and ion-molecule chemistry in the envelopes, we argue that both objects are related in chemical evolution. The  $[\text{HDO}]/[\text{H}_2\text{O}]$  abundance ratio in the warm inner envelope of I16293A of a few times  $10^{-4}$  is comparable to that measured in comets. This supports the idea that the  $[\text{HDO}]/[\text{H}_2\text{O}]$  ratio is determined in the cold prestellar core phase and conserved throughout the formation process of low-mass stars and planets.

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## The Formation of the First Stars I. Mass Infall Rates, Accretion Disk Structure and Protostellar Evolution

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We present a theoretical model for primordial star formation. First we describe the structure of the initial gas cores as virialized, quasi-hydrostatic objects in accord with recent high resolution numerical studies. The accretion rate can then be related to characteristic densities and temperatures that are set by the cooling properties of molecular hydrogen. We allow for rotation of the gas core, assuming angular momentum conservation inside the sonic point of the flow. In the typical case, most mass then reaches the star via an accretion disk. The structure of the inner region of this disk is described with the standard theory of viscous disks, but with allowance for the substantial energies absorbed in ionizing and dissociating the gas. The size of the protostar and its luminosity depend upon the accretion rate, the energetics of the accreting gas, and the ability of the radiation to escape from the stellar accretion shock. We combine these models for the infall rate, inner disk structure, and protostellar evolution to predict the radiation field that is the basis for radiative feedback processes acting against infall (Paper II). For realistic initial angular momenta, the photosphere of the protostar is much smaller and hotter than in the spherical case, leading to stronger radiative feedback at earlier stages in the evolution. In particular, once the star is older than its Kelvin-Helmholtz time, contraction towards the main sequence causes a rapid increase in ionizing and far-ultraviolet luminosity at masses  $\sim 30M_\odot$  in the fiducial case. Since the cores out of which the first stars formed were much more massive than  $30M_\odot$  and since feedback is dynamically unimportant at lower masses, we conclude that the first stars should have had masses  $\geq 30 M_\odot$ .

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# Protostellar Disk Dynamos and Hydromagnetic Outflows in Primordial Star Formation

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Are magnetic fields important in primordial star formation? Assuming that star formation occurs via an accretion disk that is turbulent, initially because of local gravitational instability, we calculate the disk structure for realistic accretion rates. We predict that local gravitational viscosity is able to drive accretion, without the disk fragmenting. We then estimate the rate of dynamo amplification of seed magnetic field. Turbulence in a stratified disk can be helical, with different signs of the helicity in each hemisphere. This provides a key ingredient for production of global scale magnetic fields whose sign of flux is sustained over many orbit times. The resulting fields can drive collimated protostellar outflows that reduce the star formation efficiency from the initial gas cloud, especially once the protostar has contracted to the main sequence, at  $\sim 100M_{\odot}$ . We estimate that the outflows are powerful enough to eject some material from the host dark matter halo and to initiate relatively strong magnetization of the local intergalactic medium. Close to the protostar, the outflow acts to shield the disk and equatorial regions from radiative feedback, such as ionizing photons, and this may enable accretion up to relatively large stellar masses. We conclude that magnetic fields cannot be ignored from models of primordial star formation.

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## Collapse and expansion in the bright-rimmed cloud SFO 11NE

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We report the results of a search for the double-peaked blue-skewed infall signature in the bright-rimmed cloud core SFO 11NE SMM1. Observations of the optically thick  $\text{HCO}^+$  and optically thin  $\text{H}^{13}\text{CO}^+$   $J=3-2$  lines reveal that there is indeed a characteristic double-peaked line profile, but skewed to the red rather than the blue. Modelling of the dust continuum emission and line profiles show that the motions within SFO 11NE SMM1 are consistent with a collapsing central core surrounded by an expanding outer envelope. We show that the collapse is occurring at a similar rate to that expected onto a single solar-mass protostar and is unlikely to represent the large-scale collapse of gas onto the infrared cluster seen at the heart of SFO 11NE SMM1. The outer envelope is expanding at a much greater rate than that expected for a photoevaporated flow from the cloud surface. The modelled expansion is consistent with the bulk cloud re-expansion phase predicted by radiative-driven implosion models of cometary clouds.

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## The origin and structure of clumps along molecular outflows: the test case of CB3

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We investigate the origin of the small, chemically rich molecular clumps observed along the main axis of chemically rich outflows such as CB3 and L1157. We develop a chemical model where we explore the chemical evolution of these clumps, assuming they are partially pre-existing to the outflow, or alternatively newly formed by the impact

of the outflow on the surrounding medium. The effects of the impact of the outflow are reproduced by density and temperature changes in the clump. We find that the observed abundances of CH<sub>3</sub>OH, SO and SO<sub>2</sub> are best reproduced by assuming a scenario where the dense molecular gas observed is probably pre-existing in the interstellar medium before the formation of their exciting (proto)stars and that the clumpiness and the rich chemistry of the clumps are a consequence of a pre-existing density enhancement and of its interaction with the outflow.

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## Complete Depletion in Prestellar Cores

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We have carried out calculations of ionization equilibrium and deuterium fractionation for conditions appropriate to a completely depleted pre-protostellar core, where heavy elements such as C, N, and O have vanished from the gas phase and are incorporated in ice mantles frozen on dust grain surfaces. We put particular emphasis on the interpretation of recent observations of H<sub>2</sub>D<sup>+</sup> towards the centre of the prestellar core L 1544 (Caselli et al. 2003) and also compute the ambipolar diffusion timescale. We consider explicitly the ortho and para forms of H<sub>2</sub>, H<sub>3</sub><sup>+</sup>, and H<sub>2</sub>D<sup>+</sup>. Our results show that the ionization degree under such conditions depends sensitively on the grain size distribution or, more precisely, on the mean grain surface area per hydrogen nucleus. Depending upon this parameter and upon density, the major ion may be H<sup>+</sup>, H<sub>3</sub><sup>+</sup>, or D<sub>3</sub><sup>+</sup>. We show that the abundance of ortho-H<sub>2</sub>D<sup>+</sup> observed towards L 1544 can be explained satisfactorily in terms of a complete depletion model and that this species is, as a consequence, an important tracer of the kinematics of prestellar cores.

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## *Abstracts of recently accepted major reviews*

### ISO Spectroscopy of Gas and Dust: From Molecular Clouds to Protoplanetary Disks

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Observations of interstellar gas-phase and solid-state species in the 2.4–200 μm range obtained with the spectrometers on board the Infrared Space Observatory are reviewed. Lines and bands due to ices, polycyclic aromatic hydrocarbons, silicates and gas-phase atoms and molecules (in particular H<sub>2</sub>, CO, H<sub>2</sub>O, OH and CO<sub>2</sub>) are summarized and their diagnostic capabilities illustrated. The results are discussed in the context of the physical and chemical evolution of star-forming regions, including photon-dominated regions, shocks, protostellar envelopes and disks around young stars.

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<http://www.strw.leidenuniv.nl/~ewine/araa04.pdf>

## *Dissertation Abstracts*

# Exploring the submillimeter sky: molecular line studies at 350 $\mu\text{m}$

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Ph.D dissertation directed by: Prof. Karl M. Menten

Ph.D degree awarded: April 2003

The early stages of massive star formation can only be observed at fairly long wavelengths, since the copious amount of dust and gas around the young star reprocess virtually all its emission into mm, submm and far-IR radiation, while blocking any mid- and near-IR as well as optical emission. Molecular line studies in the submm atmospheric windows provide a wealth of unique information on the physical and chemical conditions in massive star-forming regions. On the one hand, *high-energy rotational and vibrational transitions of complex molecules* allow a study of the hottest, densest regions of a cloud, those that are most affected by the existence of an embedded protostar; on the other hand, *ground-state transitions of light hydrides* (e.g., ammonia, water...) provide a better understanding of these species, which are the building blocks of interstellar chemistry. A complete inventory of the molecular emission, towards a specific source and in a specific frequency range, can only be achieved through an *unbiased spectral survey*. However, at these wavelengths, observations are difficult because: *a)* the atmospheric transmission is such that only high-mountain sites are suited, and *ii)* data are mostly acquired in double-sideband (DSB) form, since no intrinsically-single-sideband devices exist at submillimeter wavelengths.

A proper line identification can only be achieved if the spectra are analyzed in their single-sideband (SSB) form. The conversion from DSB to SSB is obtained by software deconvolution, and its quality depends on several free parameters. The next few years will witness the beginning of operations for several submm-THz facilities, both ground-based (APEX, 2004; ALMA, 2011) and space-borne (Herschel, 2007), facing us with the urgent need for fast and reliable tools of DSB data analysis. With this goal in mind, a primary task is that of optimizing the data acquisition process. **Chapter 1** of this thesis contains a study aimed at optimizing the observing strategy for double-sideband molecular line surveys, in order to achieve, for this kind of data, the best possible single-sideband reconstruction. The work is based on simulations of the acquisition of spectral line surveys with the HIFI instrument on board the Herschel Space Observatory, but our results can be applied to the general case. The reconstruction of the simulated data is obtained through the Maximum Entropy Method. The main factors responsible for degrading the quality of the reconstruction are taken into account: high r.m.s. noise in the data, pointing errors (particularly in the presence of intrinsic chemical structure in the source) and sideband imbalances.

Real life hits back in **Chapter 2**. With the Caltech Submillimeter Observatory, we have carried out an unbiased spectral survey of Orion-KL throughout the 350- $\mu\text{m}$  band (795 to 903 GHz). This is the *first* systematic study of molecular radiation in this frequency range. 541 features, resulting from 929 transitions from a total of 26 species, have been detected. High-excitation transitions from CH<sub>3</sub>OH, CH<sub>3</sub>CN, H<sub>2</sub>CO, HNC and C<sub>2</sub>H<sub>5</sub>CN indicate the presence of a very hot ( $\sim 250$  K) component at the systemic velocity characteristic of the Hot Core. Physical parameters (column density and rotational temperature) relative to a number of species have been estimated by fitting, in the LTE approximation, the whole 100-GHz spectrum, thus taking line blending and optical depth effects into account.

Finally, a study of the line-of-sight distribution of the most famous of hydrides, H<sub>2</sub>O, towards the SgrB2 cloud, is presented in **Chapter 3**. The analysis is based on the detection of the 894-GHz HDO(1<sub>1,1</sub> – 0<sub>0,0</sub>) transition, observed in absorption against the background continuum emission of the SgrB2 cores M and N. Radiative transfer modeling of this feature, together with the published data set of mm and submm HDO and H<sub>2</sub><sup>18</sup>O transitions, suggests that ground-state absorption features from deuterated and non-deuterated water trace different gas components along the line of sight. In particular, while the HDO line seems to be produced by the large column densities of gas located in the SgrB2 warm envelope, the H<sub>2</sub><sup>18</sup>O ground-state transition detected by SWAS and KAO at 548 GHz is instead a product of the hot, diffuse, thin gas layer lying in the foreground of the SgrB2 complex.

<ftp://ftp.mpifr-bonn.mpg.de/outgoing/ccomito/mystuff/thesis/thesis.ps.gz>

# The Relation between Interstellar Turbulence and Star Formation

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Understanding the formation of stars in galaxies is central to much of modern astrophysics. For several decades it has been thought that the star formation process is primarily controlled by the interplay between gravity and magnetostatic support, modulated by neutral-ion drift. Recently, however, both observational and numerical work has begun to suggest that supersonic interstellar turbulence rather than magnetic fields controls star formation.

This review begins with a historical overview of the successes and problems of both the classical dynamical theory of star formation, and the standard theory of magnetostatic support from both observational and theoretical perspectives. We then present the outline of a new paradigm of star formation based on the interplay between supersonic turbulence and self-gravity. Supersonic turbulence can provide support against gravitational collapse on global scales, while at the same time it produces localized density enhancements that allow for collapse on small scales. The efficiency and timescale of stellar birth in Galactic gas clouds strongly depend on the properties of the interstellar turbulent velocity field, with slow, inefficient, isolated star formation being a hallmark of turbulent support, and fast, efficient, clustered star formation occurring in its absence.

After discussing in detail various theoretical aspects of supersonic turbulence in compressible self-gravitating gaseous media relevant for star forming interstellar clouds, we explore the consequences of the new theory for both local star formation and galactic scale star formation. The theory predicts that individual star-forming cores are likely not quasi-static objects, but dynamically evolving. Accretion onto these objects will vary with time and depend on the properties of the surrounding turbulent flow. This has important consequences for the resulting stellar mass function. Star formation on scales of galaxies as a whole is expected to be controlled by the balance between gravity and turbulence, just like star formation on scales of individual interstellar gas clouds, but may be modulated by additional effects like cooling and differential rotation. The dominant mechanism for driving interstellar turbulence in star-forming regions of galactic disks appears to be supernovae explosions. In the outer disk of our Milky Way or in low-surface brightness galaxies the coupling of rotation to the gas through magnetic fields or gravity may become important.

Habilitation thesis at Potsdam University (archived at <http://pub.ub.uni-potsdam.de/2004meta/0011/door.htm>)

The complete pdf file can be downloaded at <http://pub.ub.uni-potsdam.de/2004/0011/klessen.pdf>.

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E-mail contact: [daniel.schaerer@obs.unige.ch](mailto:daniel.schaerer@obs.unige.ch)

The Geneva Observatory in Geneva, Switzerland, announces the availability of a research position at the postdoctoral level, open to applicants of all nationalities.

The successful candidate will work on a project aimed at studying starbursts nearby, at intermediate redshift ( $z \sim 2-3$ ), or in the early Universe ( $z > 7$ ), involving multi-wavelength observations and/or theoretical modeling. The successful applicant will in particular have access to ground-based observational data covering the optical to near-IR (including ESO/VLT data), and state-of-the-art modeling tools. He/she will mostly work in collaboration with Prof. Daniel Schaerer in Geneva.

The Geneva Observatory and the associated Laboratory of Astrophysics of the Swiss Federal Institute of Technology in Lausanne carry out observational, interpretative and theoretical research in the fields of extra-solar planets, stellar evolution, stellar physics, high energy astrophysics, galaxy evolution and dynamics, and observational cosmology.

The appointment will be for one to two years starting around October 1, 2004 (negotiable).

Qualified candidates are encouraged to send their application including a CV and publication list, description of research experience and interests, and contact information of three references preferably via email to Prof. Daniel Schaerer, Geneva Observatory 51, Ch. des Maillettes CH-1290 Sauverny, Switzerland (email: [daniel.schaerer@obs.unige.ch](mailto:daniel.schaerer@obs.unige.ch)). All applications received by 1 May, 2004 will receive full consideration. Informal enquiries with Daniel Schaerer are welcome.

Related information also available from the URL:

<http://obswww.unige.ch/sfr>

## Two PhD student positions at Leiden Observatory, Leiden University, The Netherlands

Deadline for application: **April 20, 2004**

### PhD position 1: Submillimeter Studies of Southern Protostars and Disks

Supervisor: Prof. Dr. E. F. van Dishoeck

A 4-year PhD student position is available starting mid-2004 within the Molecular Astrophysics group at Leiden Observatory. The aim of this project is to use new (sub)millimeter single-dish and interferometric facilities to perform a systematic high-frequency study of the envelopes around low-mass protostars and disks around young stars. The data will complement existing VLT and future Spitzer infrared observations of southern star-forming regions (to be obtained within the context of the Spitzer ‘c2d’ legacy program) and will be important in preparation for future ALMA and HIFI studies. Both line and continuum data will be obtained to investigate the physical and chemical structure of these regions and their evolution to potential planetary systems. The analysis will involve state-of-the-art radiative transfer techniques and chemical-dynamical models. The project is supervised by Prof. E.F. van Dishoeck.

This position is open to students of all nationalities. The starting date for the position is summer-fall 2004, with some flexibility in the precise date. This position is funded by the Netherlands Organization of Scientific Research (NWO) and a Spinoza award.

### PhD position 2: The Formation of Protoplanetary Disks: Theory Meets Observation

Supervisor: Dr. M. R. Hogerheijde

In collaboration with: Dr. C. Terquem, Dr. S. Richling (Institut d’Astrophysique de Paris, IAP)

We expect to receive funding for a 4-year PhD student position through the European Association for Research in Astronomy (EARA), starting mid-2004. The project aims to investigate the formation mechanism of circumstellar disks from collapsing cloud cores through simulations and observations of submillimeter molecular lines. The student will use state-of-the-art molecular excitation / line radiative transfer computations and hydrodynamical simulations of collapsing cores. A methodology will be developed to reliably extract velocity-field information from observations. An observational program on (sub) millimeter single-dish and interferometric telescopes will be defined and carried out to put the methodology into practice. The student will spend one or two periods of up to 3 months at IAP (Paris) to focus on the hydrodynamical simulations in collaboration with Drs. Terquem and Richling. The research will be supervised by Dr. M. R. Hogerheijde.

Because of EU funding rules, this position is open to candidates of all nationalities, *except* for nationals or residents (since April 2003 or earlier) of the Netherlands. Pending final approval of the funding by EARA, a starting date of summer-fall 2004 is foreseen.

**For both positions**, candidates need to have the equivalent of a ‘doctoraal’ (Masters) degree. The research will be carried out in the framework of the Netherlands Research School for Astronomy (NOVA), a national association of university astronomy departments (<http://www.strw.leidenuniv.nl/nova/>). See <http://www.strw.leidenuniv.nl/> for further information about Leiden Observatory.

Applications should include a curriculum vitae (with a list of grades for exams), a brief statement of research experience, and the names of two people who can serve as a reference. The deadline for both applications is **APRIL 20, 2004**. Send applications to:

#### For position 1:

Prof. Dr. E.F. van Dishoeck  
Leiden Observatory  
P.O. Box 9513  
2300 RA Leiden  
The Netherlands  
Tel: +31-71-5275814  
FAX: +31-71-5275819  
e-mail: ewine@strw.leidenuniv.nl

#### For position 2:

Dr. M.R. Hogerheijde  
Leiden Observatory  
P.O. Box 9513  
2300 RA Leiden  
The Netherlands  
Tel: +31-71-5275590  
FAX: +31-71-5275819  
e-mail: michiel@strw.leidenuniv.nl

## Scientist - TPF Coronagraph Mission Study

The Astrophysics Research Element at the Jet Propulsion Laboratory invites applications for a staff scientist position in the research areas of astronomical high contrast imaging and observational studies of extrasolar planetary systems. JPL is NASA's lead center for missions studying extrasolar planetary systems. These include the currently operating Spitzer Space Telescope (SST) and Keck Interferometer, the Space Interferometry Mission (SIM) entering development, and the Terrestrial Planet Finder (TPF) Mission Study. JPL is also developing new mission concepts such as the Eclipse Discovery mission (PI John Trauger) to directly image extrasolar Jovian planets with a 2m class space telescope. JPL hosts the the High Contrast Imaging Testbed (HCIT), a laboratory environment working toward the demonstration of billion-to-one optical contrast at subarcsecond separations. JPL astronomers have access to the Palomar 5m telescope and its state-of-the art AO system; and the Caltech millimeter/submillimeter telescopes at Owens Valley and Mauna Kea. Depending on experience, the appointment will be made at the Scientist, Research Scientist, or Principal Scientist level.

**REQUIRES:** The position requires a Ph.D. in astronomy, physics, planetary science, or optical sciences and at least three years of experience, or equivalent. Candidates must have a record of astronomical research on extrasolar planets, circumstellar disks, brown dwarfs, or nearby stars, and data analysis experience with high contrast adaptive optics or space coronagraphy.

**DESIRE:** JPL desires candidates who can sustain an independent research program in exoplanetary astronomy, publish in refereed journals, and actively participate in collaborations with scientists and engineers in a team environment.

**WILL:** The successful applicant will participate in the development of the TPF coronagraph science mission. They will carry out studies of coronagraph design, engineering, and operational issues, and their impacts on the mission science return. They will work with TPF Science Working Group members and members of the JPL TPF coronagraph design team, in conjunction with Dr. Karl Stapelfeldt. They will collaborate in the development of new mission concepts such as the Eclipse Discovery mission (PI John Trauger) to directly image extrasolar Jovian planets with a 2m class space telescope. They will carry out an active research program in exoplanetary astronomy.

To apply, send a curriculum vitae, a proposed research plan, and three letters of recommendation to Glenn Kubat, M/S T1720-C, JPL Human Resources, 4800 Oak Grove Drive, Pasadena, CA 91109 USA.

Email: Glenn.E.Kubat@jpl.nasa.gov

Applications should arrive at JPL by May 1 2004 to receive full consideration. The position can start in August 2004. Caltech/JPL is an equal opportunity employer. Further information on TPF and other JPL exoplanetary research missions is available on the web at <http://planetquest.jpl.nasa.gov>.

## *New Books*

# Optics of Cosmic Dust. Part I

N.V. Voshchinnikov

The optics of small particles is useful in the interpretation of observational phenomena related to the extinction, scattering and emission of radiation by dust grains in space. Three components of dust modelling — optical constants, light scattering theories and objects' models — are briefly discussed. The author aims to show how the general laws of the optics of dust particles work and to highlight the information about cosmic dust which is reliable and the information which can be false. Part I of the review contains a detailed analysis of the interstellar extinction and polarization (forward-transmitted radiation). Part II will consider the scattered radiation, dust absorption and emission, radiation pressure and dust properties in different objects.

Part I has the following content:

- 1 WHY, WHERE AND HOW
  - 1.1 Three ways of observing dust
  - 1.2 Why do astronomers study dust?
  - 1.3 How do astronomers study dust?
  - 1.4 Where is cosmic dust?
  - 1.5 How did the ideas on cosmic dust change?
    - 1.5.1 Before Trumpler
    - 1.5.2 Before infrared observations (1930–60)
    - 1.5.3 Infrared observations and laboratory astrophysics (1970–90)
    - 1.5.4 ISO revolution and carbon crisis (last decade of XXth century)
  - 1.6 Where does dust come from and how does it evolve?
  - 1.7 Three components of dust modelling
  - 1.8 New observations versus old theories
- 2 KITCHEN OF DUST MODELLING
  - 2.1 Provision
    - 2.1.1 Abundances and depletions
    - 2.1.2 Optical constants
    - 2.1.3 WWW database of optical constants
    - 2.1.4 Mixing the optical constants (Effective Medium Theory)
  - 2.2 Equipment
    - 2.2.1 General definitions
    - 2.2.2 Spheres versus non-spheres
    - 2.2.3 Exact methods
    - 2.2.4 Approximations
    - 2.2.5 Experiments
    - 2.2.6 WWW database of optical properties
  - 2.3 Skill of cooking
    - 2.3.1 Objects' models
    - 2.3.2 Radiative transfer programs
  - 2.4 Is it tasty?
    - 2.4.1 Comparison with observations
    - 2.4.2 Waste products
- 3 FORWARD, ONLY FORWARD
  - 3.1 Interstellar extinction: observations
    - 3.1.1 Extinction curve: general behaviour and variations
    - 3.1.2 Extinction curve: fitting
    - 3.1.3 Absolute extinction: determination from infrared colour excesses
    - 3.1.4 Extinction in diffuse interstellar medium: from infrared to X-rays
    - 3.1.5 Large-scale extinction in the Galaxy
  - 3.2 Interstellar extinction: interpretation
    - 3.2.1 Extinction efficiencies: general behaviour and deviations
    - 3.2.2 Wavelength dependence
    - 3.2.3 The  $\lambda 2175 \text{ \AA}$  feature
    - 3.2.4 Absolute extinction and abundances
    - 3.2.5 Some steps in the modelling of extinction
  - 3.3 Interstellar polarization: observations
    - 3.3.1 Linear polarization and Serkowski curve
    - 3.3.2 Circular polarization
    - 3.3.3 Large-scale polarization in the Galaxy
  - 3.4 Interstellar polarization: interpretation
    - 3.4.1 Polarization efficiency: size/shape/orientation effects
    - 3.4.2 Linear polarization: wavelength dependence
    - 3.4.3 Circular polarization: change of sign
    - 3.4.4 Some steps in the modelling of polarization
- 4 SOME CONCLUSIONS
- 5 APPENDICES
  - 5.1 List of abbreviations
  - 5.2 Dust in the Internet
  - 5.3 Mie scattering by very large homogeneous spheres (numerical code)

Astrophysics and Space Physics Reviews, v. 12, pp. 1–182, 2004  
Figures 45, Tables 13, References 397 ISBN: 1-904868-23-1  
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## Meteorites, Ice, and Antarctica

William A. Cassidy

This is a personal account of the ANSMET meteorite recovery expeditions to Antarctica, which Bill Cassidy led for 15 years. These incredibly productive searches have uncovered thousands of well preserved meteorites, with numerous rare and scientifically valuable specimens, including many from the Moon and Mars. Cassidy describes the field work and discusses the different types of meteorites uncovered, and what we have learned from their study about the early solar nebula.

### **I. Setting the stage**

1. Antarctica and the National Science Foundation
2. How the project began
3. The first three years
4. The beat goes on: later years of the ANSMET program
5. Alone (or in small groups)

### **II. ANSMET pays off: field results and their consequences**

6. Mars on the ice
7. Meteorites from the moon
8. How, and where, in the solar system...?

### **III. Has it been worthwhile?**

Evaluating the collection - and speculating on its significance

Meteorite stranding surfaces and the ice sheet

The future: what is, is, but what could be, might not

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<http://www.cambridge.org>

# Scientific Frontiers in Research on Extrasolar Planets

Edited by Drake Deming and Sara Seager

These are the proceedings of a conference held at the Carnegie Institution in Washington, D.C. on June 18-21, 2002. The book contains the invited and contributed talks as well as poster papers, and is divided into twelve sections:

- A. Statistics from Radial Velocity Surveys
- B. Radial Velocity Planet Searches
- C. Microlensing, Astrometric, and Direct Imaging Planet Searches
- D. Properties of Known Extrasolar Planets and their Parent Stars
- E. Planetary Dynamics
- F. Circumstellar Disk Observations and Modeling
- G. Planet Formation and Migration
- H. Planet Transit Searches
- I. HD 209458b: Observation and Theory
- J. Brown Dwarf and Extrasolar Giant Planet Atmospheres
- K. The Near Future from Ground and Space
- L. Terrestrial Planet Finder and Darwin

The book includes the following Invited Review papers:

Properties of Extrasolar Planets *G.W. Marcy et al.*

Extrasolar Planets: from Individual Detection to Statistical Properties *S. Udry, M. Mayor, D. Queloz*

Microlensing Searches for Extrasolar Planets *B.S. Gaudi*

Metallicities of Stars with Extrasolar Planets *D.A. Fischer, J.A. Valenti*

Planetary Origins and Dynamical Evolution *N. Murray*

Progress in Giant Planet Formation *A.P. Boss*

Status and Prospects of Planetary Transit Searches: Hot Jupiters Galore *K. Horne*

The Kepler Mission: Finding the Sizes, Orbits, and Frequencies of Earth-size and Larger Extrasolar Planets *W.J. Borucki et al.*

HD 209458 and the Power of the Dark Side *D. Charbonneau*

The Significance of the Sodium Detection in the Extrasolar Planet HD 209458b Atmosphere *S. Seager*

Brown Dwarfs and Extrasolar Planets *F. Allard et al.*

Models of Irradiated Extrasolar Giant Planets *A. Burrows, D. Sudarsky*

Evolution & Atmospheric Circulation of "Pegasi Planets" *T. Guillot, A.P. Showman*

Imaging Extrasolar Planets from the Ground *R. Angel*

The Colors of Extrasolar Planets *W.A. Traub*

Terrestrial Planet Finding with a Visible Light Coronagraph *M.J. Kuchner, D.N. Spergel*

Science Proposes, Technology Disposes or Why We Need an Infrared Interferometer *N.J. Woolf*

The Darwin Mission *M. Fridlund*

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# Star Formation Through Time

## A Conference to Honour Roberto J. Terlevich

Edited by Enrique Pérez, Rosa M. González Delgado, and Guillermo Tenorio-Tagle

These are the proceedings of a workshop to celebrate the work of Roberto Terlevich on extragalactic star formation. Friends and colleagues of Roberto met in Granada, Spain on 24 - 28 September 2002 to discuss our current understanding of star formation in galaxies, giant HII regions, active galactic nuclei, and early star formation. The book is divided into five sections containing the following major reviews, together with a number of other papers:

### 1: Regions of Star Formation: Structural and Chemical Issues

20 Years of Fundamental Planes *J. Melnick*

Structural Properties of HII Regions *R.C. Kennicutt, Jr.*

The Role of Shocks and Photoionization in Star Forming Regions *S.M. Viegas*

Seven Problems related to the Determination of the Primordial Helium Abundance *M. Peimbert et al.*

### 2: Star Forming Galaxies and the Environment

Star Formation and the Homogeneity of the Abundances in the ISM of Dwarf Galaxies *E.D. Skillman*

Star-forming Galaxies: from their ISM to the IGM *D. Kunth*

Star Formation History in Rich Clusters of Galaxies *A. Dressler*

### 3: Spheroidal Components

The Nitrogen Conundrum for Old Stellar Populations *D. Burstein*

The Fundamental Properties of Dwarf Elliptical Galaxies in Clusters *R. Guzmán et al.*

### 4: Nuclear Activity and the Starburst-AGN Connection

The Host Galaxies of 26,000 AGN *T.M. Heckman, G. Kauffmann*

The Variability "Telescope": L-M-Mdot in AGN *H. Netzer*

### 5: Early Star Formation

Perspectives on Galaxy Evolution *G. Kauffmann*

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## *Meetings*

### **Massive Star Formation: Near and Far**

**12-15 July 2004**

**17th University College London Astronomy Colloquium Cumberland Lodge, Windsor Great Park**

Colloquium Director:

Professor J E Dyson, University of Leeds UK (jed@ast.leeds.ac.uk)

UCL Organiser:

Professor Alan Willis, UCL (ajw@star.ucl.ac.uk)

Invited speakers include:

Paola Casselli (Arcetri)

John Bally (Colorado)

Melvin Hoare (Leeds)

Ian Stevens (Birmingham)

Tom Abel (PennState)

Pepe Franco (UNAM)

Jonathan Tan (Princeton)

Rob Ivison (Edinburgh)

Further details from Alan Willis

<http://www.starlink.rl.ac.uk/news/news-141423-290104>

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

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

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

Second Terrestrial Planet Finder/Darwin International Conference

## Dust Disks and the Formation, Evolution and Detection of Habitable Planets

Mission Bay, San Diego, California

July 26-29, 2004

<http://planetquest.jpl.nasa.gov/TPFDarwinConf/>

Chas Beichman, SOC Chair, TPF Project Scientist  
Steve Unwin, LOC Chair, TPF Deputy Project Scientist

Registration and abstract submission are now open. Abstract deadline is April 30.

This will be the second annual joint-TPF/Darwin conference. It follows the very successful Heidelberg meeting in April 2003. The main purpose of this conference series is to help develop the field of extra-solar planet research. The conference is hosted by the TPF and Darwin Projects, the Michelson Science Center, and the Spitzer Science Center.

We plan three major science themes: 1. Recent results on exo-zodiacal disks from Spitzer and other space and ground observations. We expect exciting new results from Spitzer, and space and ground instruments on structure, composition, and frequency of debris disks. 2. The link between the physical conditions in the early solar nebula and astrobiology. Spitzer will provide new information on the properties of zodiacal disks in the first 500 million years of a planetary system's existence. 3. Discussion of TPF/Darwin designs, science requirements and technology advances.

The meeting hotel is the Hyatt Regency Islandia, Mission Bay, close to the ocean and the famous Sea World marine wildlife park. More information, including a draft agenda, is available on the conference web site listed above. You can sign up on the web site to receive e-mail news and announcements about the conference. We will add more information as it becomes available, so please check back frequently.

### 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.

# Cool Stars, Stellar Systems, and the Sun

13th Cambridge Workshop

The AG Summer Meeting 2004

July 5 - July 9, 2004

Hamburg, Germany

The Cool Stars Workshops provide a forum where the solar and stellar communities meet to discuss new observations and theoretical models. In particular they attempt to bring together the very detailed views we have of the Sun with the less detailed but vastly more varied observations of the more distant stars. Cool Stars 13 will continue this tradition. We expect this to be a lively meeting with more than 200 participants.

SCIENTIFIC ORGANISING COMMITTEE (SOC): J.H.M.M. Schmitt (chair), F. Allard, M. Asplund, T.R. Ayres, J.J. Drake, A.K. Dupree, F. Favata, R. Garcia-Lopez, M. Giampapa, D.F. Gray, L.K. Harra, C. Helling, C.M. Johns-Krull, C. Jordan, J. Krautter, J.L. Linsky, O. v.d. Lhe, B. Montesinos, R. Pallavicini, M.H. Pinsonneault, S. Randich, D. Queloz, C.J. Schrijver, K.G. Strassmeier, J.A. Valenti, S.A. White

LOCAL ORGANISING COMMITTEE (LOC): P.H. Hauschildt (chair), N. Christlieb, D. Engels, D. Groote, M. Hempel, A. Müller, J.-U. Ness, A. Reiners, J. Robrade, J.H.M.M. Schmitt, A. Schweitzer, S. Vrielmann, R. Wichmann, G. Wiedemann, U. Wolter

TOPICS: The topical areas for the five oral sessions are:

New insights into coronal physics from high resolution X-ray and FUV-spectroscopy. Solar and stellar winds. The impact of IR surveys and spectroscopy on observations and models of low mass stars, brown dwarfs and planets. Formation and properties of young stars and planets. The interiors of the Sun and cool stars: physical processes and observations.

Invited speakers include M. Audard, S.R. Cranmer, U. Cubasch, E.D. Feigelson, G.M. Harper, S. Höfner, R. Jayawardhana, S. Krucker, J.L. Linsky, J.U. Ness, N. Santos, J. Valenti, and B.E. Wood.

There are three types of contributions. Contributed talks: the oral presentations will be selected by the SOC. Poster papers: all poster papers (one per person) accepted will be on display for the duration of the meeting. Splinter sessions: the presentations will be selected by the SOC.

All participants who wish to present an oral or a poster contribution or prepare a splinter discussion at the workshop should submit an abstract before the appropriate deadline (see below). A web-based abstract submission form will be available by March 1, 2004 on the web page. Participants are limited to one contribution each. Posters will be on display throughout the meeting (Monday morning – Friday noon). Proposed oral contributions not selected for the programme can be converted to poster presentations at the author's discretion. The final accepted abstracts as well as the schedule of the conference will be available via our web pages by the first week of June. The SOC specifically invites the community to propose splinter sessions on current, "hot" topics. Proposals for splinter sessions can be made by individuals or groups of individuals. Up to a maximum of eight splinter sessions can be accommodated. Any splinter session proposal should include the following: (1) Title (2) One (at most) page summary of the goal of the session (3) Convenor (4) List of participants, panelists etc. who agree to come to the session (5) Format suggestion that includes a description on how the audience will be involved (6) The proposed duration of the session (1.5 hrs or 3 hrs) (7) Commitment to contribute a summary of the session for the proceedings Splinter sessions will be announced by June 1, 2004. Participants willing to contribute in the splinter sessions must make arrangements directly with the convenor.

Deadlines for abstract submission and registration: **May 15, 2004**

Deadline for financial assistance requests: May 1, 2004

<http://www.hs.uni-hamburg.de/cs13/>

# From Young Disks to Planets: New Observations, Models and Theories

March 7 - 10 2005  
Pasadena, California, USA

We announce an international scientific conference being organized by the Michelson Science Center (MSC) and co-sponsors on March 7-10 2005, at the Sheraton Hotel in Pasadena, California.

The conference will cover topics bracketing the evolutionary stages between circumstellar disk formation, the stage during which the initial conditions for planet formation are set, and the fully formed planetary system. This meeting will emphasize new-generation observations, including long baseline spatial interferometers and space infrared observatories. By bringing together recent findings from techniques which probe various disk regimes and emission mechanisms, as well as the latest theoretical and modelling developments in these areas, we will address the physics and evolution of these pre-planetary environments.

The conference will include one review talk in each topical session, plus invited and contributed talks. Posters may also be contributed and will remain on display for the duration of the conference, and each poster presenter will have a chance to describe their work through 1-minute, 1-viewgraph poster summaries.

A final agenda will be distributed soon, an registration will then be opened. If you have any questions, to express interest, or to request to receive further announcements, please email us at: [disks05@ipac.caltech.edu](mailto:disks05@ipac.caltech.edu).

## TOPICAL SESSIONS:

Global disk physics, chemistry and evolution  
New results from spatial interferometers: optical through radio  
First results from the Spitzer Space Telescope  
Disk imaging from the ground and space  
High resolution spectroscopy across the spectrum  
The inner 1 AU: observations and theory  
Initial conditions for planet formation  
Global properties of exo-planets

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## LOCAL ORGANIZING COMMITTEE:

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Rafael Millan-Gabet (MSC)  
David Ciardi (MSC)  
Kathy Golden (MSC)

<http://msc.caltech.edu/conferences/2005/disks05/> (web site will soon be available)

Email: [disks05@ipac.caltech.edu](mailto:disks05@ipac.caltech.edu)