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Abstracts of recently accepted papers

Constraints on the ionizing flux emitted by T Tauri stars

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We present the results of an analysis of ultraviolet observations of T Tauri Stars (TTS). By analysing emission measures taken from the literature we derive rates of ionizing photons from the chromospheres of 5 classical TTS in the range $\sim 10^{41}$ – 10^{44} photons s^{-1} , although these values are subject to large uncertainties. We propose that the He II/C IV line ratio can be used as a reddening-independent indicator of the hardness of the ultraviolet spectrum emitted by TTS. By studying this line ratio in a much larger sample of objects we find evidence for an ionizing flux which does not decrease, and may even increase, as TTS evolve. This implies that a significant fraction of the ionizing flux from TTS is not powered by the accretion of disc material onto the central object, and we discuss the significance of this result and its implications for models of disc evolution. The presence of a significant ionizing flux in the later stages of circumstellar disc evolution provides an important new constraint on disc photoevaporation models.

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Laboratory and space spectroscopy of DCO⁺

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The rotational spectra of DCO⁺ and its two isotopomers D¹³CO⁺ and DC¹⁸O⁺, produced in a negative glow discharge cell, have been recorded in the 137–792 GHz region, which includes lines from $J = 2 \leftarrow 1$ up to $J = 11 \leftarrow 10$. The determined rotational and centrifugal distortion constants allow to predict the DCO⁺ rotational spectrum up to 1000 GHz with an accuracy of 1 part in 10^8 or better. This is important for kinematic studies of dense molecular cloud cores and for future far-infrared observations. We also report on the first detection of the hyperfine structure of the DCO⁺(1–0) line made at the IRAM 30m antenna, toward the quiescent starless cloud core L1512, in the Taurus Molecular Cloud. We point out that this is the *first observation of the hyperfine splitting due to the deuteron*. This allowed us to quantify the effects of the hyperfine splitting on the line width determination; if the hyperfine structure is not taken into account in the line fit, the DCO⁺(1–0) line width is overestimated by a significant factor (~ 2).

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<http://xxx.lanl.gov/abs/astro-ph/0412456>

<http://www.arcetri.astro.it/~starform/publ2004.htm>

The T Tauri Star Population of the Young Cluster NGC 2264

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An $H\alpha$ emission survey of the young cluster NGC 2264 in the Mon OB1 association resulted in the detection of 490 $H\alpha$ emission stars in a $25\text{arcmin}\times 40\text{arcmin}$ field approximately centered between the O7V multiple star S Monocerotis and the Cone Nebula. The survey was carried out with the wide-field grism spectrograph (WFGS) on the University of Hawaii 2.2 meter telescope on Mauna Kea. X-ray observations made with the European Photon Imaging Camera (EPIC) onboard the European Space Agency's X-ray Multi-Mirror (XMM) satellite observatory will be discussed in a subsequent paper. Optical (BVR_cI_c) photometry was obtained for selected fields to supplement similar data from the literature. Spectra covering the 6000–8000Å region at a resolution of $R\sim 3000$ (adequate for the determination of LiI $\lambda 6708$ line strengths) were obtained for 150 $H\alpha$ and X-ray emission sources with the Gemini Multi-Object Spectrograph (GMOS). Near-infrared spectra (1–2.5 μm) of a number of T Tauri Stars (TTS), X-ray sources, and LH α 25 (W90) were also obtained using SpeX on the IRTF.

Ages and masses for the $H\alpha$ emitters were inferred from the isochrones and evolutionary tracks of D'Antona & Mazzitelli. The median age for the TTS population is about 1.1 Myr, but a considerable dispersion exists for individual objects from 0.1 to 5 Myr. Several fields in the cluster were observed with the WFGS on more than one occasion, permitting an examination of $H\alpha$ variability over long baselines in time. About 90% of the classical T Tauri stars (CTTS) showed changes in $W(H\alpha)$ of at least 10%, while 57% varied at levels of 50% or greater. No evidence was found for a significant pool of dormant $H\alpha$ emitters.

Summing the masses of the TTS and the OB stellar population of NGC 2264, a lower limit for the total stellar mass content of the cluster is about $430 M_{\odot}$. This is less than 1% of the total mass of the atomic and molecular gas believed to be associated with NGC 2264. Evidence for hierarchical structure within the cluster is suggested by the spatial distribution of TTS. Four concentrations of $H\alpha$ emitters are evident; two near S Mon and two near the Cone Nebula. The median age of the TTS in the immediate vicinity of S Mon was found to be greater than that of the TTS near Allen's infrared source (IRS-1), but a significant dispersion is present.

From the rotational data of Lamm et al. and Makidon et al., 241 of the TTS are periodic variables (150 weak-line T Tauri stars WTTS/91 CTTS), while 123 stars are irregular variables (30 WTTS/93 CTTS). A weak-to-moderate positive correlation is found between $H - K$ color and P_{rot} for the CTTS, in the sense that stars having longer periods tend to have larger $H - K$ colors. A similar positive correlation is found between $L_{H\alpha}$ and P_{rot} among the CTTS. No statistically significant correlation is found between P_{rot} and theoretical age or between P_{rot} and L_X . Other topics discussed include: The fraction of $H\alpha$ emitters that are WTTS, $f(WTTS) = N(WTTS)/N(TTS)$, for clusters of different ages, the relative detectability of $H\alpha$ emission using WFGS and narrowband filter imaging techniques, and the correlation of $W(\text{LiI})$ with T_e , age, $H - K$ color, and $W(H\alpha)$.

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WWW database of models of accretion disks irradiated by the central star

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We announce the release of a catalog of physical models of irradiated accretion disks around young stars based on the modelling techniques by D'Alessio et al. The WWW catalog includes ~ 3000 disk models for different central stars, disk sizes, inclinations, dust contents and mass accretion rates. For any of them, radial profiles of disk physical parameters and synthetic spectral energy distributions can be browsed and downloaded to compare with observations. It can be accessed at <http://cfa-www.harvard.edu/youngstars/dalessio/> (US), <http://www.astrosmo.unam.mx/~dalessio/> (Mexico), and at <http://www.laeff.esa.es/models/dalessio/> (Spain).

Star formation in the Vela Molecular Clouds: a new protostar powering a bipolar jet

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We have performed a detailed study of the star-forming region associated with the IRAS source 08448-4343 in the cloud D of the Vela Molecular Ridge. Our investigation covers a wide spectral range from the near IR, through the thermal IR to the mm-band exploiting both imaging and spectroscopic facilities in each spectral regime. A picture emerges of a dust structure which hosts a near IR cluster and multiple well-collimated H₂ jets; these jets originate from different sources lying in a compact region at the cluster centre. The peak of the 1.2 mm map does not coincide with the IRAS peak, thus tracing a less evolved and denser region with a colder dust with respect to that traced by IRAS. This view is also confirmed by the observations of CS transitions from J=2-1 to J=7-6. The mm peak can be associated with the position of a red object, already proposed in previous studies as the driving source of the main jet in the field. This object, extended along more than 0.3 pc, is composed of individual knots whose radial velocities decrease with increasing distance from the central source, which is resolved into at least six 2 μm peaks. The reddest and coldest of these peaks is well aligned with the inner knots of the jet. The spectral energy distribution of the central source resembles that of an intermediate luminosity, Class I protostar, whose youth is discussed in terms of the efficiency of the energy transfer into the jet.

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available at <http://www.mporzio.astro.it/~bruni/>

HI Narrow Self-Absorption in Dark Clouds: Correlations with Molecular Gas and Implications for Cloud Evolution and Star Formation

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We present the results of a comparative study of HI narrow self-absorption (HINSA), OH, ¹³CO, and C¹⁸O in five dark clouds. We find that the HINSA generally follows the distribution of the emission of the carbon monoxide isotopologues, and has a characteristic size close to that of ¹³CO. This confirms earlier work (Li & Goldsmith 2003) which determined that the HINSA is produced by cold HI which is well mixed with molecular gas in well-shielded regions. The OH and ¹³CO column densities are essentially uncorrelated for the sources other than L1544. Our data indicate that the central number densities of HI are between 2 and 6 cm⁻³, and that the ratio of the hydrogen density to total proton density for these sources is 5–27 × 10⁻⁴. Using cloud temperatures and the density of atomic hydrogen, we set an upper limit to the cosmic ray ionization rate of 10⁻¹⁷ s⁻¹. We present an idealized model for HI to H₂ conversion, which includes cosmic ray destruction of H₂ and formation of this species on grain surfaces. We include the effect of a distribution of grain sizes, and find that for a MRN distribution, the rate of H₂ formation is increased by a factor of 1.7.

Comparison of observed and modeled fractional HI abundances indicates ages for these clouds, defined as the time since initiation of HI → H₂ conversion, to be 10^{6.5} to 10⁷ yr. Several effects may make this time a lower limit, but the low values of n(HI) we have determined make it certain that the time scale for evolution from a possibly less dense

atomic phase to almost entirely molecular phase, must be a minimum of several million years. This clearly sets a lower limit to the overall time scale for the process of star formation and the lifetime of molecular clouds.

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Available as <http://www.astro.cornell.edu/share/goldsmith/papers/HINSA2accepted.pdf>

Evolution of oxygen isotopic composition in the inner solar nebula

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Changes in the chemical and isotopic composition of the solar nebula with time are reflected in the properties of different constituents that are preserved in chondritic meteorites. CR carbonaceous chondrites are among the most primitive of all chondrite types and must have preserved solar nebula records largely unchanged. We have analyzed the oxygen and magnesium isotopes in a range of the CR constituents of different formation temperatures and ages, including refractory inclusions and chondrules of various types. The results provide new constraints on the time variation of the oxygen isotopic composition of the inner (≤ 5 AU) solar nebula - the region where refractory inclusions and chondrules most likely formed. A chronology based on the decay of short-lived ^{26}Al ($t_{1/2} = 0.73$ Ma) indicates that the inner solar nebula gas was ^{16}O -rich when refractory inclusions formed, but less than 0.8 Ma later, gas in the inner solar nebula became ^{16}O -poor and this state persisted at least until CR chondrules formed 1-2 Myr later. We suggest that the inner solar nebula became ^{16}O -poor because meter-size icy bodies, which were enriched in $^{17,18}\text{O}$ due to isotopic self-shielding during the ultraviolet photo dissociation of CO in the protosolar molecular cloud or protoplanetary disk, agglomerated outside the snowline, drifted rapidly towards the Sun, and evaporated at the snowline. This led to significant enrichment in ^{16}O -depleted water, which then spread through the inner solar system. Astronomical studies of the spatial and/or temporal variations of water abundance in protoplanetary disks may clarify these processes.

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Shock-induced PDR in the Herbig-Haro object HH 2

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We report mid-infrared ($5-17\mu\text{m}$) and SO, CO, ^{13}CO millimeter line observations of the protostellar jet HH 2 and the parental molecular cloud. We have detected for the first time mid-infrared emission along a protostellar jet. We find that the outflowing gas extends much further away than the Herbig-Haro object HH 2, showing direct evidence that downstream gas has been accelerated by previous outflow events. These gas layers appear to have been detached from the parental cloud, as they are distributed around a cavity, probably dug by protostellar outflow(s). SO emission is

detected in shocked gas regions associated with outflows. The UV field produced in the strong shock region HH 2H-A has produced a low-excitation Photon-Dominated Region at the walls of the cavity, which is detected in the PAH emission bands and in the continuum between 5 and $17\mu m$. This continuum arises from very small grains transiently heated by a FUV field $G \simeq 20G_0$, which probably formed from evaporation of dust grain mantles in shocks.

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Control of Star Formation in Galaxies by Gravitational Instability

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We study gravitational instability and consequent star formation in a wide range of isolated disk galaxies, using three-dimensional, smoothed particle hydrodynamics simulations at resolution sufficient to fully resolve gravitational collapse. Stellar feedback is represented by an isothermal equation of state. Absorbing sink particles are inserted in dynamically bound, converging regions with number density $n > 10^3 \text{ cm}^{-3}$ to directly measure the mass of gravitationally collapsing gas available for star formation. Our models quantitatively reproduce not only the observed Schmidt law, but also the observed star formation threshold in disk galaxies. Our results suggest that the dominant physical mechanism determining the star formation rate is just the strength of gravitational instability, with feedback primarily functioning to maintain a roughly constant effective sound speed.

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Chondrule and Metal Grain Size Sorting from Jet Flows

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We examine the size sorting of chondrules and metal grains within the context of the jet flow model for chondrule/CAI formation. In this model, chondrules, CAIs, AOAs, metal grains and related components of meteorites are assumed to have formed in the outflow region of the inner most regions of the solar nebula and then were ejected, via the agency of a bipolar jet flow, to outer regions of the nebula. We wish to see if size sorting of chondrules and metal grains is a natural consequence of this model.

To assist in this task, we used a multiprocessor system to undertake Monte Carlo simulations of the early solar nebula. The paths of a statistically significant number of chondrules and metal grains were analyzed as they were ejected from the outflow and travelled over or into the solar nebula. For statistical reasons, only distances ≤ 3 AU from the Sun were examined

Our results suggest that size sorting can occur provided that the solar nebula jet flow had a relatively constant flow rate as function of time. A constant flow rate outflow produces size sorting, but it also produces a sharp size distribution of particles across the nebula and a metal-rich Fe/Si ratio. When the other extreme of a fully random flow rate was examined, it was found that size sorting was removed, and the initial material injected into the flow was simply spread over most of the the solar nebula.

These results indicate that the outflow can act as a size and density classifier. By simply varying the flow rate, the outflow can produce different types of proto-meteorites from the same chondrule and metal grain feed stock.

As a consequence of these investigations, we observed that the number of particles that impact into the nebula drops off moderately rapidly as a function of distance, r , from the Sun. We also derive a corrected form of the Epstein stopping time.

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<ftp://ftp.hightett.cmit.csiro.au/pub/downloads/Kurt/SFN/>

Multiepoch VLBA observations of T Tauri South

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In this *Letter*, we present a series of seven observations of the compact, non-thermal radio source associated with T Tauri South made with the Very Long Baseline Array over the course of one year. The emission is found to be composed of a compact structure most certainly originating from the magnetosphere of an underlying pre-main sequence star, and a low-brightness extension which may result from reconnection flares at the star-disk interface. The accuracy of the absolute astrometry offered by the VLBA allows very precise determinations of the trigonometric parallax and proper motion of T Tau South. The proper motion derived from our VLBA observations agrees with that measured with the VLA over a similar period to better than 2 mas yr^{-1} , and is fully consistent with the infrared proper motion of T Tau Sb, the pre-main sequence M star with which the radio source has traditionally been associated. The parallax, $\pi = 7.07 \pm 0.14 \text{ mas}$, corresponds to a distance of $141.5_{-2.7}^{+2.8} \text{ pc}$.

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<http://xxx.lanl.gov/pdf/astro-ph/0501062>

The Thermal Regulation of Gravitational Instabilities in Protoplanetary Disks II. Extended Simulations with Varied Cooling Rates

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In order to investigate mass transport and planet formation through gravitational instabilities (GIs), we have extended our three-dimensional hydrodynamic simulations of protoplanetary disks from a previous paper. Our goal is to determine the asymptotic behavior of GIs and how it is affected by different constant cooling times. Initially, $R_{disk} = 40 \text{ AU}$, $M_{disk} = 0.07M_{\odot}$, $M_{*} = 0.5M_{\odot}$, and $Q_{min} = 1.5$. Sustained cooling, with $t_{cool} = 2 \text{ ORPs}$ (outer rotation periods; $1 \text{ ORP} \approx 250 \text{ yr}$), drives the disk to instability in about 4 ORPs. This calculation is followed for 23.5 ORPs. After 12 ORPs, the disk settles into a quasisteady state with sustained nonlinear instabilities, an average $Q = 1.44$ over the outer disk, a well-defined power law $\Sigma(r)$, and a roughly steady $\dot{M} \approx 5 \times 10^7 M_{\odot} \text{ yr}^{-1}$. The transport is driven by global low-order spiral modes. We restart the calculation at 11.2 ORPs with $t_{cool} = 1$ and $1/4 \text{ ORPs}$. The latter case is also run at high azimuthal resolution. We find that shorter cooling times lead to increased \dot{M} -values, denser and thinner spiral structures, and more violent dynamic behavior. The asymptotic total internal energy and the azimuthally averaged $Q(r)$ are insensitive to t_{cool} . Fragmentation occurs only in the high-resolution $t_{cool} = 1/4 \text{ ORP}$ case; however, none of the fragments survive for even a quarter of an orbit. Ringlike density enhancements appear and grow near the boundary between GI-active and GI-inactive regions. We discuss the possible implications of these rings for gas giant planet formation.

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Study of the Optical Variability of T Tau in 1962–2003

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We present the results of our long-term *UBVR* observations of the star T Tauri performed at Mt. Maidanak Observatory from 1986 until 2003. These data together with previous photoelectric observations of other authors suggest that the long-term variations of the light curve are not periodic, but have a cycle with a time scale of 6–9 yr. The light curve also exhibits slower variations with time scales of $\sim 30 - 40$ yr. We confirm the existence of periodic brightness variations with a period of $P = 2^d.798$ over many years; this process is peculiar in that the phase and shape of the phase curve change from season to season. We analyze the color behavior of the star. We found evidence of a strong flare occurred on September 5, 1999, when the brightness of the star reached $9^m.22$. This is strongest flare recorded during its photoelectric observations.

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<http://www.astrin.uzsci.net/users/smeln/index.html>

Evidence for transient clumps and gas chemical evolution in the CS core of L673

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We present FCRAO maps as well as combined BIMA and FCRAO maps of the high density molecular emission towards the CS core in the L673 region. With the FCRAO telescope, we mapped the emission in the CS ($2 \rightarrow 1$), $C^{34}S$ ($2 \rightarrow 1$), HCO^+ ($1 \rightarrow 0$), and $H^{13}CO^+$ ($1 \rightarrow 0$) lines. The high density molecular emission, which arises from a filamentary structure oriented in the NW-SE direction, shows clear morphological differences for each molecule. We find that HCO^+ has an extremely high optical depth, and that the $H^{13}CO^+$ emission is well correlated with submm sources. The BIMA and FCRAO combined maps recover emission from a lot of other structure which was previously undetected or only marginally detected, and show an overall aspect of a filamentary structure connecting several intense clumps. We found a total 15 clumps in our combined data cube, all of them resolved by our angular resolution, with diameters in the 0.03–0.09 pc range. Their estimated masses range between 0.02 and $0.2 M_{\odot}$, except for the largest clump, which has a mass of $\sim 1.2 M_{\odot}$. We find a clear segregation between the northern and southern region of the map: the northern section shows the less chemically evolved gas and less massive but more numerous clumps, while the southern region is dominated by the largest and most massive clump, and contains the more evolved gas, as traced by emission of late-time molecules. We find that the derived clump masses are below the virial mass, and that the clumps masses become closer to the virial mass when they get bigger and more massive. This supports the idea that these clumps must be transient, and only the more massive ones have a chance to last long enough to form stars. The clumps we detect are probably in an earlier evolutionary stage than the “starless cores” reported recently in the literature. Only the most massive one has properties similar to a “starless core”.

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Star formation in Sandqvist 187 and 188

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We present 1.2 mm continuum data of the filamentary dark cloud Sandqvist 187/188 – also known as the Norma

cloud – taken with SIMBA (SEST Imaging Bolometer Array). The data are complemented by measurements from the *2MASS*, *MSX* and *IRAS* surveys. The extended 1.2 mm emission traces the optical dark cloud down to a visual extinction of $A_V = 3.7$ mag. We derive a mean column density of $N(\text{H}_2) = 1.4 \times 10^{22} \text{ cm}^{-2}$, equivalent to a visual extinction of $A_V = 7.6$ mag and a total mass of the cloud of $340 M_\odot$. We also find six compact millimetre sources, labelled MMS 1 to 6, five of which coincide with known stellar objects. MMS 6, however, only has a very weak *MSX* counterpart at $14.56 \mu\text{m}$ and an absorption feature at $8.28 \mu\text{m}$ consistent with a visual extinction of $A_V > 145$ mag. Dust temperatures, luminosities and gas masses for all compact millimetre sources are given. In an effort to further constrain the uncertain distance to Sandqvist 187/188, we analyse its stellar content based on *2MASS* colours and find an improved lower limit of $440 \pm 50 \text{ pc}$.

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<http://www.astro.ruhr-uni-bochum.de/nielbock/research/index.html>

Evolution of Protobinary: Accretion Rates of Primary and Secondary

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We reexamine accretion onto a protobinary based on two dimensional numerical simulations of high spatial resolution. We focus our attention on the ratio of the primary and secondary accretion rates. Fifty-eight models are made for studying the dependence of the accretion rates on the specific angular momentum of infalling gas j_{inf} , the mass ratio of the binary q , and the sound speed c_s . When j_{inf} is small, the binary accretes the gas mainly through two channels (type I): one through the Lagrangian point L_2 and the other through L_3 . When j_{inf} is large, the binary accretes the gas only through L_2 point (type II). The primary accretes more than the secondary in both the cases, although L_2 point is closer to the secondary. After flowing through L_2 point, the gas flows half around the secondary and through L_1 point to the primary. Only a small amount of gas flows back to the secondary and the rest forms a circumstellar ring around the primary. The boundary between types I and II depends on q . When j_{inf} is very large, the accretion begins after several rotations (type III). The beginning of the accretion is later when j_{inf} is larger and c_s is smaller. Our result that primary accretion rate is higher for a large j_{inf} is qualitatively different from earlier simulations. The difference is mainly due to limited spatial resolution and large numerical viscosity in the numerical simulations thus far.

Accepted by The Astrophysical Journal

<http://www.cfs.chiba-u.ac.jp/hanawa/Ochi2005/>

V1647 Orionis (IRAS 05436-0007) : A New Look at McNeil's Nebula

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We present a study of the newly discovered McNeil's nebula in Orion using the JHK_s-band simultaneous observations with the near-infrared (NIR) camera SIRIUS on the IRSF 1.4m telescope. The cometary infrared nebula is clearly seen extending toward north and south from the NIR source (V1647 Orionis) that illuminates McNeil's nebula. The compact nebula has an apparent diameter of about 70 arcsec. The nebula is blue (bright in J) and has a cavity structure with two rims extending toward north-east and north-west. The north-east rim is brighter and sharp, while the north-west rim is diffuse. The north-east rim can be traced out to ~ 40 arcsec from the location of the NIR source.

In contrast, no cavity structure is seen toward the south, although diffuse nebula is extended out to ~ 20 arcsec. New NIR photometric data show a significant variation in the magnitudes (> 0.15 mag) of the source of McNeil’s nebula within a period of one week, that is possibly under the phase of eruptive variables like FUors or EXors.

Accepted by PASJ Letters

The paper is available as an Astro-ph preprint at <http://arxiv.org/abs/astro-ph/0412455>

The Orion Nebula in the mid-IR

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We present two wide-field ($\approx 5arcmin \times 3.5arcmin$), diffraction limited ($\lambda/D \simeq 0.5arcsec$ at $10 \mu m$), broad-band $10 \mu m$ and $20 \mu m$ images of the Orion Nebula, plus six $7-13 \mu m$ narrow-band ($\lambda/\Delta\lambda \simeq 1$) images of the BN/KL complex taken at the 3.8m UKIRT telescope with the MPIA MAX camera. The wide field images, centered on the Trapezium and BN/KL regions, are mosaics of $35arcsec \times 35arcsec$ frames obtained with standard chopping and nodding technique and reconstructed using a new restoration method developed for this project. They show the filamentary structure of the dust emission from the walls of the HII region and reveal a new remarkable group of arc-like structures $\approx 1arcmin$ to the South of the Trapezium. The morphology of the Ney-Allen nebula, produced by wind-wind interaction in the vicinity of the Trapezium stars, suggests a complex kinematical structure at the center of the Cluster. We find indications that one of the most massive members of the cluster, the B0.5V star $\theta^1 Ori-D$, is surrounded by a photoevaporated circumstellar disk. Among the four historic Trapezium OB stars, this is the only one without a binary companion, suggesting that stellar multiplicity and the presence of massive circumstellar disks may be mutually exclusive. In what concerns the BN/KL complex, we find evidence for extended optically thin silicate emission on top of the deep $10 \mu m$ absorption feature. Assuming a simple two component model, we map with $\simeq 0.5arcsec$ spatial resolution the foreground optical depth, color temperature and mid-IR luminosity of the embedded sources. We resolve a conspicuous point source at the location of the IRC2-A knot, approximately $0.5arcsec$ north of the deeply embedded HII region “I”. We analyze the spectral profile of the $10 \mu m$ silicate absorption feature and find indication for grain crystallization in the harsh nebular environment. In the OMC-1 South region, we detect several point sources and discuss their association with the mass loss phenomenology observed at optical and millimeter wavelengths. Finally, we list the position and photometry of 177 point sources, the large majority of which detected for the first time in the mid-IR. Twenty two of them lack a counterpart at shorter wavelengths, and are, therefore, candidates for deeply embedded protostars. The comparison of photometric data obtained at two different epochs reveals that source variability at $10 \mu m$ is present up to ≈ 1 mag level on a time-scale ~ 2 yr. With the possible exception of a pair of OB stars, all point sources detected at shorter wavelengths display $10 \mu m$ emission well above the photospheric level, that we attribute to disks circumstellar emission. The model of Robberto, Beckwith, & Panagia (2002, ApJ. 578, 897) provides the simplest explanation for the observed mid-IR excess.

Accepted by Astron. J.

Available on astro-ph/0412665

Thermal Processing of Silicate Dust in the Solar Nebula: Clues from Primitive Chondrite Matrices

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The most abundant matrix minerals in chondritic meteorites, hydrated phyllosilicates and ferrous olivine crystals, formed predominantly in asteroids during fluid-assisted metamorphism. We infer that they formed from minerals present in three less altered carbonaceous chondrites that have silicate matrices composed largely of micrometer- and nanometer-sized grains of crystalline forsterite, Mg_2SiO_4 , and enstatite MgSiO_3 , and amorphous, ferromagnesian silicate. Compositional and structural features of enstatite and forsterite suggest that they formed as condensates that cooled below 1300 K at $\approx 1000 \text{ K h}^{-1}$. Most amorphous silicates are likely to be solar nebula condensates also, as matrix, which is approximately solar in composition, is unlikely to be a mixture of genetically unrelated materials with different compositions. Since chondrules cooled at 10-1000 K h^{-1} , and matrix and chondrules are chemically complementary, most matrix silicates probably formed close to chondrules in transient heating events. Shock heating is favored as nebular shocks capable of melting millimeter-sized aggregates vaporize dust. The crystalline and amorphous silicates in the primitive chondrite matrices share many characteristic features with silicates in chondritic interplanetary dust particles suggesting that most of the crystalline silicates and possibly some amorphous silicates in the interplanetary dust particles are also nebular condensates. Except for small amounts of refractory oxides that formed with Ca-Al-rich inclusions at the inner edge of the disk and presolar grains, most of the crystalline silicate dust that accreted into chondritic asteroids and long-period comets appears to have formed from shock heating at $\approx 2\text{-}10 \text{ AU}$. Forsterite crystals around young stars may have a similar origin.

Accepted by *Astrophys. J.*

Preprint available at <http://arxiv.org/abs/astro-ph/0501067>

Synthetic Spitzer IRAC band maps from simulations of protostellar jets

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The band passes for Spitzer images contain numerous molecular hydrogen emission lines. With the additional complication of the non-uniform spectral response, it is necessary to calculate model images in order to analyse observations of molecular outflows. We employ three dimensional hydrodynamic simulations of a range of dense supersonic molecular jets, including various degrees of velocity pulsation and precession, to demonstrate how the observed structure depends on the band. Features in Band 1, which is dominated by emission from vibrational levels, are even more concentrated than in K-band images. In contrast, Bands 2–4 are dominated by rotational lines and bow shock wings appear extended. Especially in Band 4, broken cavity walls can be detectable. An initial comparison with Spitzer data is made.

Accepted by *MNRAS*

High-res pdf+Movies: <http://star.arm.ac.uk/~mds/Jets/jets.html>

Evidence for a hot dust-free inner disk around 51 Oph

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We report on the observation of CO bandhead emission around 51 Oph ($\Delta v = 2$). A high resolving power ($R \simeq 10,000$) spectrum was obtained with the infrared spectrometer ISAAC mounted on *VLT – ANTU*. Modeling of the profile suggests that the hot ($T_{\text{gas}} = 2000\text{--}4000 \text{ K}$) and dense ($n_{\text{H}} > 10^{10} \text{ cm}^{-3}$) molecular material as probed by the CO bandhead is located in the inner AU of a Keplerian disk viewed almost edge-on. Combined with the observation of cooler gas ($T_{\text{gas}} = 500\text{--}900 \text{ K}$) by ISO-SWS and the lack of cold material, our data suggest that the disk around 51 Oph is essentially warm and small. We demonstrate the presence of a dust-free inner disk that extends from the inner truncation radius until the dust sublimation radius. The disk around 51 Oph may be in a rare transition state toward a small debris disk object.

Accepted by A&A Letters

astro-ph/0412514

The Decay of Accreting Triple Systems as Brown Dwarf Formation Scenario

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We investigate the dynamical decay of non-hierarchical accreting triple systems and its implications on the ejection model as Brown Dwarf formation scenario. A modified chain-regularization scheme is used to integrate the equations of motion, that also allows for mass changes over time as well as for momentum transfer from the accreted gas mass onto the bodies. We integrate an ensemble of triple systems within a certain volume with different accretion rates, assuming several prescriptions of how momentum is transferred onto the bodies. We follow their evolution until the systems have decayed. We analyze the end states and decay times of these systems and determine the fraction of Brown Dwarfs formed, their escape speeds as well as the semi-major axis distribution of the formed Brown Dwarf binaries. We find that the formation probability of Brown Dwarfs depends strongly on the assumed momentum transfer which is related to the motion of the gas. Due to ongoing accretion and consequent shrinkage of the systems, the median escape velocity is increased by a factor of 2 and the binary separations are decreased by a factor of 5 compared with non-accreting systems. Furthermore, the obtained semi-major axis distribution drops off sharply to either side of the median, which is also supported by observations. We conclude that accretion and momentum transfer of accreted gas during the dynamical decay of triple systems is able to produce the observed distribution of close binary Brown Dwarfs, making the ejection model a viable option as Brown Dwarf formation scenario.

Accepted by the Astrophysical Journal

Preprint available at: <http://arxiv.org/abs/astro-ph/0501075>

The Insignificance of P-R Drag in Detectable Extrasolar Planetesimal Belts

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This paper considers a simple model in which dust produced in a planetesimal belt migrates in toward the star due to P-R drag suffering destructive collisions with other dust grains on the way. Assuming the dust is all of the same size, the resulting surface density distribution can be derived analytically and depends only on the parameter $\eta_0 = 5000\tau_{eff}(r_0)\sqrt{M_*/r_0}/\beta$; this parameter can be determined observationally with the hypothesis that $\beta = 0.5$. For massive belts in which $\eta_0 \gg 1$ dust is confined to the planetesimal belt, while the surface density of more tenuous belts, in which $\eta_0 \ll 1$, is constant with distance from the star. The emission spectrum of dust from planetesimal belts at different distances from different mass stars shows that the dust belts which have been detected to date should have $\eta_0 \gg 1$; dust belts with $\eta_0 \ll 1$ are hard to detect as they are much fainter than the stellar photosphere. This is confirmed for a sample of 37 debris disk candidates for which η_0 was determined to be > 10 . This means that these disks are so massive that mutual collisions prevent dust from reaching the inner regions of these systems and P-R drag can be ignored when studying their dynamics. Models for the formation of structure in debris disks by the trapping of particles into planetary resonances by P-R drag should be reconsidered. However, since collisions do not halt 100% of the dust, this means that in the absence of planetary companions debris disk systems should be populated by small quantities of hot dust which may be detectable in the mid-IR. Even in disks with $\eta_0 \ll 1$ the temperature of dust emission is shown to be a reliable tracer of the planetesimal distribution meaning that inner holes in the dust distribution imply a lack of colliding planetesimals in the inner regions.

Accepted by A&A

Preprint available at astro-ph/0501038 and also from <http://www.roe.ac.uk/~wyatt/>

Dissertation Abstracts

The Thermal Regulation of Gravitational Instabilities in Disks Around Young Stars

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Ph.D dissertation directed by: Richard H. Durisen

Ph.D degree awarded: May 2004

The discovery of other planetary systems has led astronomers to revise the Solar Nebula theory, especially to question whether gas giant planets form by core accretion. It seems that Jupiter-size planets formed by pure runaway growth require more than the typical protoplanetary disk lifetime to collect their mass from the surrounding material. Gas giant planet formation by gravitational instabilities (GIs) does not have this problem because planets even several times more massive than Jupiter can be formed in just a few disk orbital periods (≤ 1000 yr). In this scenario, the disk succumbs to its own gravity, develops spiral structures and finally fragments into stable, high-density planetary clumps. The efficiency of this planet formation mechanism depends on the detailed physics of protoplanetary disks, such as the thermal conditions of the gas, the role of stellar irradiation, the physical and chemical properties of dust grains and their distribution throughout the disk, to name a few.

GIs are spiral distortions in a self-gravitating disk that appear wherever the local surface density and temperature become favorable for their growth. The restructuring of the disk as it becomes unstable, the thermal processes that sustain the instabilities, and their effect on the long-term evolution of the disk are studied using 3-D hydrodynamic simulations. These show that the cooling and heating processes balance each other, and as a result the disk asymptotes to quasi-equilibrium within a few orbital periods after the GI onset. The final values of the internal energy and the Toomre Q are independent of cooling time, while the asymptotic mass transport rates are inversely proportional to the cooling time. The formation of dense rings is common in these simulations. GIs fragment into clumps when the cooling time is on the order of the local orbital time, but the clumps are short-lived. External radiation can affect the evolution considerably. GIs are an effective angular momentum and mass transport mechanism, and during their onset, they can reproduce the mass transport rates necessary to trigger FU Ori outbursts.

Dissertation text and movies available on <http://westworld.astro.indiana.edu>

New Jobs

Ph.D. Position in Star and Planet Formation at Leiden Observatory

Deadline for application: 1 March 2005

Attention: Dr. Michiel Hogerheijde

Leiden Observatory

P.O.Box 9513

2300 RA Leiden

The Netherlands

Fax: +31-71-527-5819

E-mail submissions and enquiries: michiel@strw.leidenuniv.nl

In the framework of the research program ‘Zooming in on Planet-forming Disks with Emerging Submillimeter Facilities’ that was recently awarded funding by NWO through a VIDI grant, Leiden Observatory invites applications for a 4-year Ph.D. position to work on observational studies of protoplanetary disks under supervision of Dr. Michiel Hogerheijde.

The project will focus on a systematic study of a representative sample of young stars surrounded by disks using submillimeter-wave facilities such as the James Clerk Maxwell Telescope, the (Enhanced) Submillimeter Array, the Combined Array for Research in Millimeter-wave Astronomy, and the Atacama Pathfinder EXperiment. The successful candidate will carry out the observations and interpret the results using state-of-the-art simulation tools. Questions that will be investigated include: What is the structure of planet-forming disks? How do they evolve? How does the structure and evolution depend on the stellar mass? What processes control the planet-formation process and the final properties of the resulting planetary system?

More information about the research program can be found at www.strw.leidenuniv.nl/~michiel/research/

Leiden Observatory is the oldest university astronomy department in the world, and the largest astronomy department in the Netherlands. Leiden is a charming university town with international flair. More information on Leiden Observatory can be found at www.strw.leidenuniv.nl/

The position comes with a competitive salary and full benefits. The starting date is negotiable, but should be no later than August 2005.

Applicants should send a curriculum vitae (with list of exams and grades), a brief statement of research experience and interests, and arrange to have two letters of recommendation sent directly to the above (e-mail) address. **Email applications are preferred.** The successful candidate must have the equivalent of a Master’s Degree by the starting date.

The application review process will begin March 1, 2005 and will continue until the position has been filled.

The position is open to candidates of all nationalities. Candidates who would contribute to the diversity of the research group in terms of gender and/or nationality are particularly encouraged to apply.

New Books

Open Issues in Local Star Formation

Edited by Jacques Lépine and Jane Gregorio-Hetem

These are the proceedings of a meeting held in Ouro Preto, Brazil from April 5 to 10, 2003. Brazil has a growing number of astronomers, with an increasingly vigorous star formation community, and will soon have access to significant observing facilities in Chile. The meeting was therefore a timely occasion to take stock of the current state of star formation studies, inside as well as outside of Brazil.

The book is divided into the following six sections:

I. Stellar Groups and Associations

II. Young Stellar Objects

III. Brown Dwarfs

IV. Disks, Outflows and Jets

V. Early Stages of Star Formation

VI. The ISM Conditions for Star Formation

The book contains 46 chapters based on oral presentations at the meeting, including the following 9 invited talks:

Major Unsolved Problems in Star Formation *Hans Zinnecker*

The Oph-Sco-Lup-Cen-Cru-Mus-Cha Star Formation Region *Jacques Lépine & Marilia Sartori*

The Gas-to-Dust Ratio and Metallurgy of Nearby Dark Clouds probed by X-Ray Absorption Measurements *Thierry Montmerle & My Ha Vuong*

Accretion Powered Emission in Young Stellar Objects *Nuria Calvet & James Muzerolle*

Magnetically Channeled Accretion in T Tauri Stars *J. Bouvier, S.H.P. Alencar & C. Dougados*

Accretion and Ejection *Lee Hartmann*

FU Orionis Eruptions and the Formation of Close Binaries *Bo Reipurth*

Submillimeter Studies of Protostellar Cores *Philippe André*

The Initial Conditions for Star Formation *Diego Mardones*

Additionally, a CD-ROM is enclosed containing the 61 poster papers presented at the conference.

Published by Kluwer Academic Publishers (now Springer)

ISBN 1-4020-1755-3 US\$170 Eur155

Order from www.springeronline.com or

Springer

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Meetings

Workshop on Dust in Planetary Systems September 26-30, 2005 Kaua'i, Hawai'i

SPONSORS:

National Aeronautics and Space Administration
European Space Agency
Lunar and Planetary Institute

CONVENERS:

Donald E. Brownlee, University of Washington

Eberhard Grün, Max-Planck-Institute for Nuclear Physics and University of Hawai'i

The Workshop on Dust in Planetary Systems will be held September 26-30, 2005, at the Radisson Kaua'i Beach Resort Hotel, 4331 Kaua'i Beach Drive, Lihue, Hawai'i

For further information regarding the format and scientific objectives of the meeting, please check the full text of this announcement at:

<http://www.lpi.usra.edu/meetings/dust2005/>

Further details regarding the program, topics for discussion, opportunities for participation, as well as guidelines for abstract and poster preparation, will be included in the second announcement that will be posted on the LPI Web site in April 2005.

To subscribe to a mailing list to receive electronic reminders and special announcements relating to the meeting via e-mail, please submit an electronic Indication of Interest form (available at the Conference website) by February 18, 2005.

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.

First Announcement

Submillimeter Astronomy: in the era of the SMA

a conference at Harvard University, Cambridge, MA June 13-16, 2005

<http://cfa-www.harvard.edu/smast05>

* Registration and abstract submission open January 15, deadline April 15.

The submillimeter wavelength regime provides a unique window on emission from cold dust and highly excited lines from molecules, atoms, and ions. As the bulk of the visible universe is cold, the submillimeter atmospheric windows are as close as we can get to the radiation peak from the ground. With the introduction of large format array detectors, a range of interesting phenomena from debris disks to high-redshift galaxies have been detected and investigated. With the construction of the Submillimeter Array, angular resolution better than an arc second has been achieved. This meeting will focus on what has been learned, and where the future of the field lies, with an eye toward ALMA, the next generation world-wide submillimeter facility.

1. Conference Organization: The conference will consist of three and one-half days of sessions of Invited Talks (30 minutes) and Contributed Talks (15 minutes). As time for talks is limited, posters will be an important part of the presentation. The tentative topics are: high redshift universe, local galaxies, star formation, evolved stars, chemistry, debris disks, and instrumentation.

The conference web site contains all the current information and updates:

<http://cfa-www.harvard.edu/smast05> You can sign up on the web site to receive future announcements.

There will be no formal proceedings volume, but we plan to make the presentations available on the conference website.

2. Invited Speakers (confirmed): Bruce Draine (dust in the submm); Fabian Walter (distant galaxies); Jean Turner (nearby galaxies); Yasuo Fukui (magellanic clouds); Doug Johnstone (star formation); Leonardo Testi (high mass stars); Luis Rodriguez (binary stars); Valentin Bujarrabal (evolved stars); Peter Schilke (line surveys); Geoff Blake (chemistry); Jane Greaves (debris disks); Gary Melnick (space missions); Christine Wilson (interferometers); Karl Menten (single dish telescopes); Frank Shu (summary); Charles Townes (public lecture)

3. Registration: There will be a registration fee of \$100/person (includes abstract book, coffee/snack breaks, plus an evening reception on June 13, 2005). Registration will be done through the conference web site: <http://cfa-www.harvard.edu/smast05>

4. Abstract submission: Participants are encouraged to present their latest results. Abstracts will be submitted through the conference web site starting January 15. The deadline will be April 30. Please indicate your preference for a talk or a poster. We will try to accommodate as many talks as possible.

5. Location: The conference will be held on the campus of Harvard University in Cambridge, MA. June is typically a beautiful season in New England. Temperatures in Cambridge usually reach 70-80F during the day.

6. Scientific Organizing Committee: Pierre Cox, Paul T. P. Ho (chair), Masato Ishiguro, Jeremy Lim, Fred K. Y. Lo, James Moran, Thomas G. Phillips, Anneila Sargent, Juergen Stutzki, Christine Wilson, David Wilner

7. Questions: If you have questions about the conference, please e-mail smast05@cfa.harvard.edu

Short Announcements

Dear ISO astronomer,

We are pleased to announce the on-line availability of the review book

ISO science legacy - a compact review of ISO major achievements

The book will be published by Springer in 2005, as a special issue of the "Space Science Reviews" journal. The papers are however already available, although not in their final homogeneous format, at

<http://www.iso.vilspa.esa.es/science/SSR/>

We thought that now, at the time of the second Call for proposals for the Spitzer Space Telescope, it would be beneficial to the astronomical community to have at hand, in one single volume, a review of the main discoveries owed to the ISO satellite. The book is organised as follows: first, overviews of four major themes investigated with ISO (water in the Universe, crystalline silicates, molecular hydrogen, deep surveys), and then thirteen chapters reviewing ISO science from the solar system to the distant universe. It is not possible to gather in one book all the advances due to ISO, but we hope that this compendium of over 400 pages will give the essence of the original results obtained by the first full-fledged space infrared observatory.

Catherine Cesarsky and Alberto Salama

Guest Editors

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/>.