THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar evolution and molecular clouds

No. 62 — 7 Nov 1997 Editor: Bo Reipurth (reipurth@casa.colorado.edu)

Abstracts of recently accepted papers

On the nature of the ROSAT X-ray selected weak-line T Tauri stars in Orion

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We analyse the nature of the *ROSAT* all-sky survey (RASS) X-ray sources in the direction of Orion identified with stars showing the Li I λ6708 Å line strong in absorption and hence classified as weak-line T Tauri stars (WTTS) in a previous study. The stars are found to be widely spread throughout the entire studied area of $\approx$ 450 squared degrees. We discuss the broad-band UBVRI$_{KC}$ JHKL and narrow-band *uvby-*β photometry as well as the spectroscopy of these stars. From the broad-band photometry and spectroscopy we derive the stellar parameters assuming that all stars are located at 460 pc and are physically associated with the Orion star forming region (SFR). By comparison with theoretical pre-main sequence (PMS) evolutionary tracks, all stars can be classified as WTTS with masses raging from 0.8M$_\odot$ to about 3.4M$_\odot$ and ages from 2×10^5yr to 7×10^6yr. We do not find any correlation between the spatial distribution and age or any other stellar parameter if the above distance for all the stars is assumed. We do find, however, that the stars with higher Li I (λ 6708 Å) line strength tend to concentrate toward the molecular clouds. From the analysis of the *uvby-*β photometric data we find that part of a subsample of the RASS lithium stars are foreground young stars not associated with Orion. We conclude that the sample of lithium RASS stars in Orion is an admixture of different populations of stars located at different distances, namely: true Orion WTTS and a population of foreground and yet young stars. The latter could be associated with the Gould Belt or may be pleiades-age stars.

Accepted by Astron. & Astrophys.

www.na.astro.it/pub/jmae/ori/paper.ps.gz

2.12 μm Molecular Hydrogen Emission From Circumstellar Disks Embedded in the Orion Nebula

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We present narrow–band images of two externally illuminated circumstellar disks embedded in the Orion Nebula. The images were taken with NICMOS Camera 2 as part of the Hubble Space Telescope (HST) Early Release Observations program. Molecular hydrogen emission is confined to the silhouettes embedded in the objects HST 10 (182-413) and HST 17 (183-419). This emission appears to trace the surfaces of nearly edge–on circumstellar disks and is likely to be excited by the intense FUV radiation field produced by nearby O stars. The presence of this emission confirms that FUV radiation penetrates to the disk surface. The absence of H_2 emission in the region between the ionization front

and the disk surface provides evidence that this medium is predominantly atomic. Our observations constitute the first demonstration that the dense circumstellar disks embedded in the proplyds are predominately molecular. While the central star is marginally detected at 2.15 μm in HST 10, the central star of HST 17 is clearly detected.

Accepted by The Astrophysical Journal Letters

ftp://nicmos2.as.arizona.edu/pub/hchen/hst10

Kinematic signatures of violent formation of galactic OB associations from Hipparcos measurements

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Proper motions measured by *Hipparcos* confirm the large anomalous velocities of the OB associations located around the Cygnus Superbubble (Cygnus OB1, OB3, OB7, and OB9), and reveal a clearly organized expanding pattern in Canis Major OB1. At the distances of these associations, the organized velocity patterns imply LSR velocities of up to ~ 60 km s^{-1} for the associations in Cygnus, and about ~ 15 km s^{-1} in Canis Major OB1. The magnitude and spatial arrangement of the expanding motions suggests that very energetic phenomena are the responsible for the formation of the present OB associations. This is independently supported by observations of the associated interstellar medium carried out in other wavelengths.

The gravitational instability scenario proposed by Comerón & Torra 1994 (ApJ 423, 652) to account for the formation of the stars in the Cygnus Superbubble region is reviewed in the light of the new kinematic data. It is found that the energetic requirements set by the highest velocities on the OB association powering the Superbubble, Cygnus OB2, are too large by orders of magnitude. However, the scenario can still account for the formation of most of the stars if, as can be reasonably expected, the stars with the highest measured velocities are actually runaways from Cygnus OB2 itself.

As for Canis Major OB1, we consider their formation in a supernova remnant, as suggested by Herbst & Assousa 1977 (ApJ, 217, 473). The detection of a new runaway star, HIC 35707 (=HD 57682), whose motion is directed away from the derived center of expansion, supports this scenario and provides an independent age for the supernova remnant, assuming that the runaway star was the binary companion of the supernova. Based on a number of arguments, however, we find it unlikely that the stars are a direct consequence of instabilities in the expanding shell. We propose instead that their formation was triggered in preexisting clouds, accelerated and compressed by the supernova explosion.

Accepted by Astron. Astrophys.

Available at: http://www.eso.org/ fcomeron/publicat.html

Wind diagnostics and correlations with the near-infrared excess in Herbig Ae/Be stars

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Intermediate dispersion spectroscopic observations of 37 Herbig Ae/Be stars reveal that the equivalent widths of their [OI]λ6300 and Hα emission lines, are related to their near-infrared colours in the same fashion as the T-Tauri stars. Such a correlation strongly supports the idea that the winds from Herbig Ae/Be stars arise in the same manner as those from T-Tauri stars, i.e. through accretion driven mass-loss. We also find that the [OI]λ6300 line luminosity correlates better with excess infrared luminosity than with stellar luminosities, again supporting the idea that Herbig Ae/Be winds are accretion driven. If one includes the lower mass analogues of the Herbig Ae/Be stars with forbidden line emission, i.e. the classical T-Tauri stars, the correlation between mass-loss rate and infrared excess spans 5 orders of magnitude in luminosity and a range of masses from $0.5M_\odot$ to approximately $10M_\odot$. Our observations therefore extend

the findings of Cohen et al. (1989) and Cabrit et al. (1990) for low mass young stars and, taken in conjunction with other evidence (Corcoran & Ray 1997a), strongly support the presence of circumstellar disks around intermediate mass stars with forbidden line emission. An implication of our findings is that the same outflow model must be applicable to these Herbig Ae/Be stars and the classical T Tauri stars.

Accepted by Astronomy & Astrophysics.

Circularly polarized radio emission from an X-ray protostar

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IRS 5, an embedded young stellar object in the nearby Corona Australis molecular cloud, was recently detected as an X-ray source with the *ASCA* and *ROSAT* satellites. We report here the detection of circularly polarized continuum emission from IRS 5 at centimeter wavelengths. Already known to be a highly variable radio source, the polarization fraction is seen to range from $V/I \simeq 10\%$ to $\simeq 37\%$ on a day timescale. This demonstrates that radio emission from protostars, previously attributed in most cases to ionized thermal outflows, can sometimes arise instead from nonthermal processes; *i.e.* gyrosynchrotron emission from particles accelerated *in situ* by magnetic reconnection flares. Together with the X-ray data and indications of MeV particles in the solar nebula obtained from meteoritic materials, it contributes to the growing evidence for high energy processes during the earliest stages of low mass star formation.

Accepted by Ap. J. Letters

www.astro.psu.edu/users/edf/research/pms.html

Effects of Cooling on the Propagation of Magnetized Jets

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We present multi-dimensional simulations of magnetized radiative jets appropriate to Young Stellar Objects. Hydrodynamic jets with and without radiative losses have been well-studied as have adiabatic MHD jets. Magnetized jets subject to collisionally excited radiative losses have not, as yet, received extensive scrutiny. The purpose of this letter is to articulate the propagation dynamics of radiative MHD jets in the context of the extensive jet literature. Most importantly, we look for morphological and kinematic diagnostics that may distinguish hydrodynamic protostellar jets from their magnetically dominated cousins.

Our simulations are axisymmetric ($2\frac{1}{2}$-D). A toroidal (B_ϕ) field geometry is used. Our models have high sonic Mach numbers ($M_s \approx 10$), but lower fast mode Mach number ($M_f \approx 5$). This is approximately the case for jets formed via disk-wind or X-wind models - currently the consensus choice for launching and collimating YSO jets. Time-dependent radiative losses are included via a coronal cooling curve.

Our results demonstrate that the morphology and propagation characteristics of strongly magnetized radiative jets can differ significantly from jets with weak fields. In particular the formation of *nose-cones* via post-shock hoop stresses leads to narrow bow shocks and enhanced bow shock speeds. The densities in the jet head are higher than what is achieved in radiative hydrodynamic jets. In addition, the hoop stresses produce strong shocks in the jet beam which constrasts with the relatively unperturbed beam in radiative hydrodynamic jets. Our simulations show that pinch modes produced by magnetic tension can strongly effect magnetized protostellar jets. These differences may be useful in observational studies designed to distinguish between competing jet collimation scenarios.

Accepted by Ap.J. Letters

Coherence in Dense Cores. II. The Transition to Coherence

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After studying how line width depends on spatial scale in low-mass-star-forming regions, we propose that "dense cores" (cf. Myers & Benson 1983) represent an inner scale of a self-similar process which characterizes larger-scale molecular clouds.

In the process of coming to this conclusion, we define four distinct Types of line width-size relation ($\Delta v \propto R^{a_i}$), which have power-law slopes a_1, a_2, a_3, and a_4, as follows: Type 1– multi-tracer, multi-cloud intercomparison; Type 2– single-tracer, multi-cloud intercomparison; Type 3– multi-tracer study of a single cloud; and Type 4– single-tracer study of a single cloud. Type 1 studies (of which Larson 1981 is the seminal example) are compendia of Type 3 studies which illustrate the range of variation in the line width-size relation from one region to another.

Using new measurements of the OH and $C^{18}O$ emission emanating from the environs of several of the dense cores studied in NH_3 by Barranco & Goodman (1997; Paper I), we show that line width increases with size outside the cores with $a_4 \sim 0.2$. On scales larger than those traced by $C^{18}O$ or OH, ^{12}CO and ^{13}CO observations indicate that a_4 *increases* to ~ 0.5 (Heyer & Schloerb 1997). By contrast, within the half-power contour of the NH_3 emission from the cores, line width is virtually constant, with $a_4 \sim 0$. We interpret the correlation between increasing density and decreasing Type 4 power law slope as a "transition to coherence." Our data indicate that the radius, R_{coh}, at which the gas becomes coherent (i.e. $a_4 \rightarrow 0$) is of order 0.1 pc in regions forming primarily low-mass stars. The value of the *non-thermal* line width at which "coherence" is established is always less than but still of order of the thermal line width of H_2. Thus coherent cores are similar to, but not exactly the same as, isothermal balls of gas.

Two other results bolster our proposal that a "transition to coherence" takes place at ~ 0.1 pc. First, the OH, $C^{18}O$, and NH_3 maps show that the dependence of column density on size is much steeper ($N \propto R^{-0.9}$) inside R_{coh} than outside of it ($N \propto R^{-0.2}$), implying that the volume filling factor of coherent cores is much larger than in their surroundings. Second, Larson (1995) has recently found a break in the power-law characterizing the clustering of stars in Taurus at 0.04 pc, just inside of R_{coh}. Larson and we interpret this break in slope as the point where stellar clustering properties change from being determined by the (fractal) gas distribution (on scales > 0.04 pc) to being determined by fragmentation processes within coherent cores (on scales < 0.04 pc).

We speculate that the transition to coherence takes place when a dissipation threshold for the MHD turbulence which characterizes the larger-scale medium is crossed at the critical inner scale, R_{coh}. We suggest that the most likely explanation for this threshold is the marked decline in the coupling of the magnetic field to gas motions due to a decreased ion/neutral ratio in dense, high filling-factor, gas.

Accepted by Ap. J.

Preprints available at: http://cfa-www.harvard.edu/ agoodman/vel_coh.html

High Temperature Molecular Cores Near Massive Stars and Application to the Orion Hot Core

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We calculate the temperature structure of hot, high column density, molecular cores for several assumed density distributions, with either internal or external illumination. We show that large ($N[H_2] \gtrsim 10^{23}\,cm^{-2}$), warm ($T \gtrsim 100$ K) columns of molecular gas are more easily produced when cores are heated from within than when cores are heated externally. We compare our results with the conditions inferred from recent high resolution observations of the Orion Hot Core. We find that external heating by the star at the center of the SiO maser disk (Radio Source "I") may partially heat the nearby core, but heating of the more extended ($\sim 10''$) Hot Core likely arises due to a young

star (or stars) embedded in the core. We show that high and low mass cores have physical parameters which lie on a common plane defined by their mass, luminosity and temperature and that we may use such information to determine the physical size of embedded cores even from measurements which do not resolve the structure of a particular core.

Accepted by Astrophys. J.

Photodissociated HI in NGC 2023

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We report the detection of photodissociated HI toward the reflection nebula NGC 2023. The Very Large Array observations reveal compact ($\sim$0.3 pc) emission associated with the source. The observed spectrum has a double−peaked profile that we believe is caused by absorbing foreground neutral gas. We corrected the observed spectrum for the absorption and determined with this absorption-corrected profile an HI column density and mass of $1.7\times\ 10^{21}$ cm^{-2} and 1.2 M$_\odot$, respectively. This column density agrees well with theoretical model predictions. The HI 21cm map shows a morphology very similar to that present in the images of [CII] at 158 μm, HIRES 60 μm IRAS, and POSS optical.

Accepted by Revista Mexicana de Astronomía y Astrofísica

The neutral carbon distribution in a bipolar outflow/molecular disc source configuration: G35.2–0.74N

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Maps are presented of $^3P_1 \rightarrow {}^3P_0$ [CI] and J=2→1 C^{18}O line emission from the interstellar molecular cloud G35.2–0.74N. The maps are interpreted with reference to a previous model for the structure of the cloud in which opposing jets from a central object, embedded in a rotating interstellar disc, precess and drive a bipolar molecular outflow. The C^{18}O emission traces the rotating interstellar disc, but the [CI] emission shows several features. An unresolved component is observed which probably results from dissociation of CO in the centre of the disc by UV radiation from the central source. Background [CI] emission is also observed which shares the rotation of the disc on larger scales. The CI/CO ratio in these components is typically a few percent. High velocity [CI] emission, where CI/CO is high (>0.1–0.4), is observed between the CO molecular outflow and the cavity excavated by the jet. This material has probably been accelerated by the jet but dissociated by far-ultraviolet radiation propagating through the cavity. The CI/CO ratio falls as the shocked outflow later sweeps up CO.

Copies of preprints may be obtained from ltl@star.ukc.ac.uk

Accepted by MNRAS

The Bright Accretion Rings on Magnetic T Tauri Stars

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We model the properties of bright rings on accreting Classical T Tauri stars whose magnetospheres are tilted with respect to the axis of rotation. These rings have interesting geometries and azimuthal intensity profiles depending on β, the inclination angle of the dipole field, ξ, the ratio of the star's radius to the accretion radius, and ϵ, the ratio of the star's luminosity to the total ring luminosity.

As the star rotates, the rings may be occulted periodically, and the apparent brightness of the star may vary as a function of time. With knowledge of i, the observer's inclination, it is possible to predict Δm, the amplitude of magnitude variations due to the occultation. Conversely, measurements of Δm and either i or ϵ can constrain the values of the other variables.

To observe any variation i must be greater than 0. Stars viewed nearly pole-on ($i \approx 10°$) must have $\beta \gtrsim 50°$ to allow any significant variation. On the other hand, with $i \gtrsim 60°$, even a very small $\beta \approx 5°$ can produce a significant Δm. We find that stars which are as bright as their accretion rings ($\epsilon \approx 1$) cannot produce variations greater than ≈ 0.8 magnitudes; to observe 2 magnitude variations $\epsilon \approx 0.1$ is required, independently of i or β.

We predict a distribution of Δm which is consistent with observed populations of T Tauri stars in the Orion Nebula and in the Taurus-Auriga Molecular Cloud.

Accepted by The Astrophysical Journal

High-resolution near-infrared imaging of the Orion 114-426 silhouette disk

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We present the first high-resolution near-infrared images of the edge-on silhouette circumstellar disk, Orion 114-426, made using NICMOS on the *Hubble Space Telescope*. Images taken against the bright nebular background of the ionized hydrogen Paα line at 1.87μm show the major axis of the disk to be approximately 20% smaller than at 0.6μm, from which we deduce the structure of the edge of the disk. Continuum images of diffuse polar lobes above and below the plane of the disk show a morphology and evolution with wavelength consistent with predictions for reflection nebulae in a diffuse envelope with large polar cavities, surrounding a thin, massless, Keplerian disk, centered on an otherwise hidden central star. We make use of our observations and reasonable assumptions about the underlying disk structure to show that the disk mass is at least $10\,M_\oplus$ and plausibly $\geq 5 \times 10^{-4}\,M_\odot$.

To appear in the special NICMOS/STIS ERO edition of the *Astrophysical Journal (Letters),* January 10 1998

Preprint available at `http://xxx.lanl.gov/abs/astro-ph/9710371`

The C/CO Ratio in B335 and the Decaying Dark Matter Neutrino Hypothesis

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$C^{18}O$ J=2–1, $C^{17}O$ J=2–1 and [CI] $^3P_1$–$^3P_0$ emission from the dense cold cloud B335 has been observed and modelled in order to determine the C/CO ratio. The observed ratio is compared with a prediction by Tarafdar (1991) who assumes a mechanism in which the CO dissociation is caused by photons of energy $\sim$ 13.8 eV. These were postulated by Sciama (1990) to result from the decay of dark matter neutrinos. Our value for the C/CO ratio sets an upper limit to the strength of the neutrino decay dissociation process, thus providing a significant datum for interstellar chemistry theory.

Accepted by MNRAS

The 'Blue-Bulge' Infall Signature Towards IRAS 16293-2422

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We present the first detection of the 'blue-bulge' infall signature towards a protostellar source. The blue-bulge infall signature can be observed in the centroid velocity maps of protostellar objects when infall dominates over rotation. This infall signature can be detected under a wide variety of source conditions. The detection of the blue-bulge infall signature toward a protobinary system such as IRAS 16293-2422 suggests that detailed studies of gravitational collapse

toward a large number of protostellar sources may now be possible.

Our CS J=7→6 data appear to be tracing gaseous material in the inner circumbinary core, while the CS J=5→4 and HCO+ J=4→3 appear to trace the outer envelope and static core in addition to the inner circumbinary core. The mass accretion rate through the infall region appears to be consistent with an inside-out collapse model for the source. Using 3-d radiative transfer models based on the rotating, collapse solution of Terebey, Shu and Cassen (1984), we derive the infall parameters of the IRAS 16293 cloud core. Our best fit model suggests that the infall radius of the IRAS 16293-2422 cloud core is $\sim 39''$ (0.03 pc).

Accepted by Astrophysical Journal

Preprint available at http://soral.as.arizona.edu/ gopal/bulgepp.ps

The Proper Motions of Condensations in a Bow Shock Flow

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For over a decade, comparisons of high resolution line profiles with simple, 3/2-D bow shock models have been used to derive the general properties of Herbig-Haro (HH) objects. In particular, the parameters which have been derived are the bow shock velocity, the direction of motion of the object, and the motion of the environment into which the object is moving. This paper presents an analysis of how to derive these parameters from observations of proper motions of the condensations of a HH object. Simple expressions are derived for determining the relevant parameters from measurements of the components of the proper motion velocities along and perpendicular to the projected outflow axis. These prescriptions are then applied to the observed proper motions of HH 1, HH 32 and HH 34, for which we obtain the respective flow parameters.

Accepted by Rev. Mex. Astron. Astrof.

Magnetic Ionization fronts I: Parallel Magnetic Fields

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We solve the continuity equations across an ionization front. By including a plane parallel magnetic field we find significant differences in the allowed velocities of the R- and D-type solutions between the magnetized and non-magnetized cases. These results may have implications for the study of ionization bounded diffuse sources where a moderate or strong magnetic field is expected.

Accepted by Astronomy and Astrophysics

Postscript file available: http://ast.leeds.ac.uk/∼rjrw/publ/magionf1.ps.gz

VLA Detection of the Exciting Sources of HH 83, HH 117, HH 124, HH 192, HH 300, HH 366 and HH 375

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We present sensitive VLA observations at 3.6-cm of nine fields containing molecular outflows or Herbig-Haro objects. In 7 out of the 9 fields observed we detect radio sources inside the error ellipsoid of the IRAS source that is believed to be exciting the outflow: HH 366 in B5, HH 300 in B18w, HH 192 in L1527, HH 83 in L1641, HH 117 in L1598,

HH 124 near NGC 2264 and HH 375 in L1157. These radio sources are quite likely thermal jets produced by the stars that excite the region. In the case of IRAS 04368+2557 we made a map of higher angular resolution at 2 cm that shows that the source is elongated in the direction of the molecular outflow in the region, confirming its nature as a thermal jet. For two flows, HH 376 in L1152 and HH 363 in L1221, we did not detect any radio source coinciding with the infrared driving source. When these results are combined with previous sensitive observations, we conclude that most HH energy sources can be detected at 3.6 cm in surveys reaching rms noise levels of about 20 μJy.

Accepted by Rev. Mexicana Astron. Astrofis.

Physics of Accretion onto Young Stars. III Comparisons with observations

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We present new evolutionary sequences for long lasting accreting low-mass ($0.1\ \mathrm{M}_\odot \leq M \leq 2.5\,\mathrm{M}_\odot$) pre-main sequence stars. The calculations, performed for two different mass accretion rates, show that accretion accelerates the evolution of the star. The star has a smaller radius and goes down its convective track faster than in a standard scheme. Consequently, the age of a star, as given by its location on the Hertzsprung-Russell diagram, is lower than that of a non-accreting star. We discuss ^{2}H and ^{7}Li burning and show how accretion affects the surface abundance of these elements. Notably, we point out that deuterium must be present at the surface of accreting intermediate-mass stars. Finally, we estimate the age, mass and radius of a sample of T Tauri stars located in the Taurus Auriga star forming region.

Accepted by A&A

WWW address : http://www-laog.obs.ujf-grenoble.fr/liens/starevol/evol.html

Vertical Oscillations in Protostellar Disks: I. Formulation of the Problem

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Protostellar disks that are relatively massive evolve under the influence of spiral-type density perturbations. Radiation from induced vertical oscillations could slow the rapid growth of these modes, while allowing continued accretion onto the central star. Here I provide a general mathematical framework for studying disk evolution in this context. A nondimensional scheme is adopted that separates out the relatively short, dynamical time scale associated with vertical oscillations and orbital motion from the much longer, evolutionary time required for alteration of the underlying disk structure. I derive both the axisymmetric and non-axisymmetric modal equations governing the evolution. I also present some general results that will later prove useful, including a perturbative expansion of the disk potential and a careful treatment of the rotation curve near the inner and outer disk edges.

Accepted by Ap.J.

Vertical Oscillations in Protostellar Disks: II. Free Modes and Resonances

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Using the mathematical framework developed in the preceding paper, I analyze vertical oscillations in self-gravitating, protostellar disks. After calculating the equilibrium stratification, I find the set of normal modes and discuss their radiative damping. Global, spiral-type perturbations of the disks induce horizontal motions that drive these oscillations, giving rise to resonances at discrete radii. Disks with plausible distributions of surface density and temperature may contain one or more of these critical regions, always located between the corotation radius and the outer disk edge.

A resonant vertical oscillation, whose amplitude saturates through radiative losses, creates a significant back reaction on the spiral-type disturbance that drives it. I find the associated reaction force analytically, and argue that its net effect is to stabilize the disk against the global perturbation. On the other hand, if such perturbations are to induce longterm accretion onto the central protostar, the disk must be *marginally stable* to their growth. Marginal stability can be maintained if the vertical resonance is always located close to the outer disk edge. This constraint is qualitatively similar to the one suggested for the "maximum Solar nebula" by Shu *et al.* (1990), and is a practical boundary condition for the study of longterm disk evolution.

Accepted by Ap. J.

The Ultracompact H II Region G5.97-1.17 – An Evaporating Circumstellar Disk in M8

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We present new high spatial resolution optical, infrared, and radio observations of G5.97−1.17, an ultracompact HII region 2.″7 distant from the O7 star Herschel 36 in the center of M 8, the Lagoon Nebula. Infrared imaging was obtained using the adaptive optics system ADONIS on the ESO 3.6-m and a thermal-IR camera on the Hale 5-m; optical images taken with the HST WFPC2 were extracted from the ST-ECF data archive; and radio continuum images were made using the VLA. The narrow-band optical images show G5.97−1.17 to be a bowshock-shaped structure with its apex pointed towards Her 36, with the Hα flux distributed over 0.″6 and consistent with the appearance at 2 cm. The optical continuum and near-infrared images show a star displaced from the peak of the bowshock by 0.″125 in the direction away from Her 36. This star exhibits a thermal-IR excess indicating hot circumstellar dust, the presence of which can be reconciled with the optical visibility of the star if the dust is in a disk-like rather than spherical distribution. Therefore, counter to previous suggestions that G5.97−1.17 is an ultracompact HII region intrinsically ionized by an embedded B0 star, our observations strongly suggest that it is actually a young star surrounded by a circumstellar disk which is being photoevaporated by Her 36, similar to the so-called "proplyds" seen near θ^1 Ori C in the Orion Nebula. At a distance of 1.8 kpc, this is the most distant known proplyd. These new observations confirm our previous claims based on earlier adaptive optics and deconvolved WF/PC images.

Accepted by AJ

Available on the WWW at: http://www.tls-tautenburg.de/research/M8.html

NICMOS 2 Micron Continuum and H_2 Images of OMC–1

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The core of OMC–1 has been imaged with NICMOS on the Hubble Space Telescope at 0.2″ resolution in 1% filters at 2.12 and 2.15μm, revealing intricate structures in both continuum and shocked molecular hydrogen line emission. Numerous H_2-emitting clumps surrounding the BN/KL region have been resolved for the first time, several of which exhibit prototypical bow-shock morphologies with V-shaped tips. We interpret these to be lower-excitation analogs of similar structures $\sim 2'$ NW of the core observed with ground based telescopes. Many of the elongated H_2 structures and bow-shock features appear to radiate outward from a region within a few arcseconds of radio source 'I', suggesting

that the H_2 energetics are dominated by one or more outflow sources in this region. However, the orientations of some features are unrelated to this apparent outflow pattern. The deeply embedded, suspected outflow source 'I' remains undetected at 2 μm, although two faint new continuum sources have been detected within $\sim 1''$ of it. The newly resolved H_2 features with bow-shock morphologies are located in regions previously identified as bow-shocks by highly blueshifted components in their line profiles. In contrast, regions of H_2 emission that are diffuse in the NICMOS image have broad, smooth line profiles. Several continuum features have an arc-like appearance, suggesting interactions of winds with the ambient medium. At least 40 stellar or protostellar continuum sources have been detected, including at least one proplyd and four pairs of binary stars.

Accepted by the Astrophysical Journal Letters.

Ice CO-cktails in molecular cloud cores

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Spectra of the 4.67 μm (2140 cm^{-1}) solid-CO absorption feature are presented, towards embedded low mass Young Stellar Objects in nearby molecular cloud cores, mostly in Taurus. The likely composition of the CO-bearing ices is analysed by fitting the observations with laboratory data and the statistical significance of the results is discussed. Excellent fits to the nonpolar component of the CO-ices along the observed lines of sight are produced with irradiated pure CO ices, as previously suggested by Palumbo & Strazzulla (1993). It does not seem to be possible, however, to constrain the composition of the polar component by analysis of the CO band only. The possible origin of the ion irradiation is discussed. The implications of the non-uniqueness of the fit on the determination of the abundance ratio between nonpolar and polar CO-ices are noted. Future observations are suggested to discriminate between the different possibilities for the polar component. Predictions are made for the abundance of CO_2 and methanol in the mantles.

Accepted by Astronomy & Astrophysics

Preprint available: Gzipped Postscript file (181kb) from http://www-star.qmw.ac.uk/∼jpe/research/jpe_preprints.html

Near-infrared images of star forming regions containing masers. Las Campanas observations of 31 southern sources

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We present sensitive high resolution near infrared (NIR) broad band (J, H, and K) observations of a sample of 31 Star Forming Regions (SFRs) which contain H_2O and OH maser sources.

The observations are aimed at the detection and characterization of Young Stellar Objects (YSOs) which may be the source of excitation of the maser emission. In spite of the large number of sources detected in the regions, using positional coincidence and NIR colours we are able to reliably identify K-band sources related to the masing gas in a large fraction of the observed regions.

The NIR infrared sources selected from close positional coincidence with the maser show strong NIR excesses and most probably represent the YSOs still embedded in their parental cocoon where the maser emission occurs.

Accepted by Astronomy & Astrophysics, Supplement Series

http://www.arcetri.astro.it/science/SF/ (ITALY)
http://astro.caltech.edu/∼lt/preprints/preprints.html (USA)

Surface inhomogeneities and line variability on DF Tau

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We have mapped surface inhomogeneities on the classical T Tauri star DF Tau, using the Li I doublet at 670.8 nm, the Ca I lines at 612.2 nm and 643.9 nm and a calcium and iron blend at 646.3 nm. We find compelling evidence that there are hot spots with temperatures of more than 5000 K. Two of the hot spots produce line-profile deformations that can be traced as they move through the cross-correlated profiles. When one of the hot spots crosses the stellar disk, red-shifted absorption components appear in the Na D lines. As these red-shifted absorption features are usually tracers for mass-infall we interpret this hot spot as an accretion shock close to the stellar surface.

Parts of the surface of DF Tau are covered with a hot chromosphere that is visible in the Ca II IR triplet lines and the narrow component of He I. We find no correlation between the veiling and the lines that originate from the hot chromosphere, suggesting that the veiling and the chromospheric emission are produced in physically distinct regions.

Accepted by MNRAS

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Knots, filaments, and turbulence in radiative shocks

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We study the structure and stability of asymmetric colliding flows for the case where one shock is oscillating due to the radiative cooling overstability and the interaction zone undergoes no global acceleration. 2D high-resolution numerical simulations reveal a new structure formation mechanism in the wake of such shocks which has been suppressed in previous simulations due to a too coarse numerical mesh. Small scale structures – filaments and knots – are inevitably formed in such shocks. Downstream of the knots a turbulent zone establishes where cold and hot gas are mixed, probably leading to efficient X-ray emission. The bulk of the cooled gas forms a layer of irregular shape and temporally and spatially variable size. The gas in its interior is in mildly supersonic turbulent motion, having a large density and velocity dispersion. Some observed peculiarities in the optical and UV-spectra may be partly due to these characteristics. This mechanism may also contribute to the appearance of knots and filaments in PNe (e.g. in the Helix nebula), in WR ring nebulae, in other circumstellar nebulae like symbiotics, and in SNR. It has consequences for the dynamics of the ISM.

Video animations are available at http://www.astro.phys.ethz.ch/staff/walder

Accepted by Astronomy and Astrophysics Letter