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From the Editor

We have again had sporadic e-mail problems, but hope that things are once more under control. A few readers have informed me that they did not receive the last issue. When I mail to the about 350 addressees which by now get the newsletter, there are always about 10 to 15 that bounce back. For these addresses I wait another week or 10 days and then I send the newsletter once more. Sometimes a few of these bounce again, and in that case I do not make any further attempts unless I receive a request. If you are missing an issue just let me know and I will send you a copy. Please inform me if your e-mail address changes, that will save a lot of time for everybody concerned.

The special issue with Ph.D. thesis abstracts advertised last month is almost ready and will be mailed later this month.

Abstracts of recently accepted papers

T Chamaeleontis: a "weak-line" YY Orionis star?

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We present new low and high resolution spectroscopy and optical photometry of the star T Cha. From the low resolution spectroscopy we classify T Cha as a G8 type star. We also identify T Cha as the optical counterpart of the ROSAT all-sky survey X-ray source RX J1157.2-7921. On the basis of the physical association with the Chamaeleon cloud complex, the erratic photometric variability and colour behaviour, the presence of Hα emission and of Li λ 6708 absorption line, as well as its position on the HR diagram, we establish unambiguously the low-mass PMS nature of the star. These characteristics, combined with an observed equivalent width of the Hα emission less than 10 Å, suggest that the star can be classified as a weak-line T Tauri star. However, the strong IR excess of the star, resembling more closely those of the classical T Tauri stars, clearly indicates the presence of a circumstellar disk. From spectra obtained at different epochs we find that strong variability is present in the Hα line, with the profile changing from pure emission to an inverse P Cygni on a time scale of one day or less. Actually, T Cha is the first case in which an inverse P Cygni profile is observed at Hα. Hence, here we suggest that T Cha can be considered a case of "weak-line" YY Orionis star.

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The Circumstellar Density Distribution of L1551NE

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We report the results of submillimeter photometry and 800 μm mapping of L1551NE, the second brightest Class I source in the Taurus dark clouds. Simultaneous modelling of the continuum spectrum and the azimuthally averaged 800 μm radial profile of L1551NE indicates a circumstellar envelope with a rather shallow density distribution (ρ(r) $\propto$ r$^{-1/2}$). Such shallow density gradients, although unexpected theoretically, have now been found around a number of other low mass young stellar objects. We suggest that the magnetic fields in these sources may play a role in determining the observed density distributions.

Accepted by Astrophys. J. (Letters)

Fragmentation of Elongated Cylindrical Clouds VI. Comparison with Observations

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A comparison of hydrodynamical simulations of the collapse and fragmentation of elongated clouds with observations of molecular cores, star formation regions and binary and multiple systems is presented. Observations of molecular cloud cores suggest appropriateinitial conditions for numerical simulations of star formation. They include an elongated structure with rotation about an arbitrary axis and low values of β, the ratio of the absolute value of rotational to gravitational energies. The environments of young stellar objects (YSOs) display "warped" disks, and "bridges" of matter between young binaries, both of which are formed in our simulations. The kinematics of star forming regions are explored and a model is proposed where large line widths are explained by the dynamical process of infall and star formation.

Simulations of the formation and continued accretion of non-equal mass binary systems are compared to observed differential reddening and IR companions in pre-main sequence (PMS) binaries. The presence of an infrared companion could also explain the flat spectral energy distribution (SED) of some PMS stars.

The properties of main sequence binaries are discussed with a view to the numerical models. The formation of binary systems from the fragmentation of elongated clouds easily explains the large eccentricities observed and the period-eccentricity relation. A spread in eccentricities arises through dissipative disk-disk interactions at closest approach. All separations greater than 50 AU can be explained by the numerical simulations while separations less than 50 AU are possible (but have not yet been attained) with lower initial β or greater disk-disk interactions.

The formation of multiple systems is also discussed and the observation of non-coplanarity in at least 35% of the multiple systems is explained in terms of the fragmentation of an elongated cloud with rotation about an arbitrary axis. The difference in mass ratios between the inner and outer system can also be explained in terms of the different fragmentation processes involved.

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A Search for the Rotational Transitions of H_2D^+ at 1370 GHz and H_3O^+ at 985 GHz

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We have searched for the 1370 GHz lowest rotational transition of the molecular ion H_2D^+ in NGC 2264, W3, and the IRc2 region of M42. No emission lines were seen from any source, but an absorption feature was detected toward IRc2. If we identify the line as the $1_{01} - 0_{00}$ transition of para H_2D^+ then the total column density is (6±3)x10^{13} cm^{-2} for T≈30 K, and the fractional abundance is 3x10^{-11}. The LSR velocity of 3.7 km s^{-1} and the measured line width of 13 km s^{-1} are consistent with the dynamical parameters of the hot core source. However, the physical parameters deduced from the data (T¡50 K, n_{H_2}¡10^6 cm^{-3}, spatial extent ¿25$''$) differ from those derived from millimeter-wave observations of the hot core condensation. Our interpretation suggests that significant amounts of low-density gas are associated with this region and that the material is cold enough for enhanced deuterium fractionation to occur. A search was also made for the 985 GHz transition of ortho H_3O^+ in W3 and IRc2 with negative results.

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Near-infrared Observations of the HH 111 Region

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We have obtained near-infrared K-band images of the HH 111 region, and detected, besides the HH 111 jet itself, a new optically invisible bipolar jet here called HH 121, from the source region of HH 111, but at large angles to the HH 111 flow axis. Near-infrared long slit spectra of both jets confirm their emission line nature. Radial velocities derived from H_2 lines show that the northern lobe of HH 121 is approaching and the southern is receding, but the velocities are so low that the system is likely to lie almost in the plane of the sky. There is a considerable angle between the two lobes of HH 121. The HH 111 and HH 121 jets intersect within an arcsecond of a VLA source, and we interpret the observations as two bipolar jets emanating from a putative PMS binary, a situation very similar to the HH 1/2 region. Tidal forces could effect significant precession and disturbance of the disk around the lower-mass stellar component, possibly causing the large discrepancy between the flow-axes of HH 111 and HH 121, and between the lobes of HH 121 itself. Near-infrared [FeII] lines have been used to derive electron densities ($n_e \approx 2000$ cm^{-3}) and extinction ($A_V \approx 5 - 6$ mag) in parts of the HH 111 jet, and H_2 lines were employed to derive an excitation temperature of about 2150 K.

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The Bow Shock and Mach Disk of HH 111V

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We present spatially resolved line profiles in Hα and [S II]$\lambda\lambda$6716,6731 across the working surface region in the Herbig-Haro object HH 111V. Data were acquired with the Rutgers/CTIO imaging Fabry-Perot interferometer on the CTIO 4-m telescope at $\sim 1.3''$ FWHM spatial and $\sim$35 km s^{-1} FWHM kinematic resolution. We separate Mach disk emission spatially and kinematically from the bow shock emission. We have used the Hα flux measured at the apex of the bow shock to estimate a preshock density of $\sim$200 cm^{-3}. Our detailed measurements of the electron density as a function of position and velocity across the bow shock, combined with new models of the bow shock emission, show that an ambient magnetic field of $\sim$30 μG inhibits the compression of the postshock gas. Our models indicate that the magnetic field also contributes to extending the cooling distance behind the shock to resolvable scales, as observed in the spatial separation of [S II] and Hα in the emission-line images of Reipurth *et al.* However, the ram pressure at the bow shock HH 111V exceeds the magnetic energy density by a factor of $\sim 10^3$, so the magnetic field is not large enough to change the direction of the flow.

The preshock medium must flow away from the stellar energy source at $\sim$300 km s^{-1} to account for the observed kinematics of the line emission in HH 111V. Hence, this working surface is a secondary ejection moving into the wake of an earlier ejection. HH 111 is the third case (HH 34 and HH 47 are other examples) of a stellar jet where the brightest bow shock moves into the wake of a previous high-velocity ejection. Balancing the ram pressures in the bow shock and Mach disk yields an estimated jet-to-ambient density ratio $\sim$10, similar to our previous estimate for the HH 34 jet (Morse *et al.*).

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A new Herbig-Haro flow in the HH 1/2 complex

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We report the discovery of new faint Herbig-Haro knots in the vicinity of the well-known HH 1/2 bipolar flow. HH 144 forms a well-collimated structure 83 arcsec long with numerous faint knots, while HH 145 is a more disorganized group of knots further to the west. Proper motion measurements of the two brightest knots in HH 144 show a large motion away from the vicinity of VLA 1, the source of the HH 1/2 flow. The alignment of the HH 144 knots suggests, however, that a faint previously known VLA source, VLA 2, located 3 arcsec from VLA 1, is the source of the new flow. This is confirmed by a very deep infrared K-band image, which shows reflection nebulae fanning out from VLA 1 towards HH 1 and from VLA 2 towards HH 144. It thus appears that the HH 1/2 source could be a very young binary, with a projected separation of 1380 AU, in which each component drives an independent HH flow. The axes of these two outflows make a large angle to one another.

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Infrared Luminosity Functions for the Young Stellar Population Associated with the L1641 Molecular Cloud

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This contribution reports the results of an extensive near-infrared imaging survey of L1641, the nearest example of a Giant Molecular Cloud. Our survey, which covers 0.77 square degrees (49 square parsecs) reaches 5σ limits at J (1.25μm), H (1.65μm) and K (2.2μm) of 16.8, 15.8, 14.7 magnitudes, reveals 1) a population of $\approx$ 1500 stars (at 5σ spread throughout the cloud (the *distributed* population); 2) seven small *aggregates* , each comprised of 10-50 stars whose typical projected surface densities ($\rho \approx 25$ stars pc^2) exceed that of the distributed population by factors ranging from 4 to 9; and 3) a heretofore uncatalogued, partially embedded dense cluster ($\rho \approx 25$ stars pc^2) comprised of $\approx$ 150 stars centered on the B4 V star HD 38023. In all cases, the stellar populations are dominated by solar-type PMS stars which appear to contain a mix of objects analogous to weak-line T Tauri stars (objects which lack circumstellar accretion disks) and classical T-Tauri stars (stars surrounded by optically thick accretion disks). Analysis of the (J-H), (H-K) color-color diagram for all stars in our sample, and the (H-K), (R-I) color-color diagram for the optically visible subset of our sample, suggests that the seven aggregates contain a significantly higher proportion of stars ($\approx$ 60%) surrounded by circumstellar accretion disks than do the cluster ($\approx$ 40%) or the distributed populations ($\approx$ 30%).

The difference in disk frequency among these populations apparently reflects a difference in age, as derived from comparison of reddening-corrected J-band luminosity functions with models calculated by assuming 1) that the stellar masses represented within all populations are drawn from a Scalo initial mass function, 2) that the stars comprising these populations follow the evolutionary tracks computed recently by D'Antona and Mazzitelli, and 3) that all stars in a given population are born simultaneously. The aggregates appear to have formed within t $\approx$ 1 Myr of the current epoch, while the mean age of the distributed and cluster populations is estimated to be t $\approx$ 5 Myr. The distributed population also appears to contain a component of stars with ages as great as t $\approx$ 10 Myr. The apparent decrease in accretion disk frequency with increasing mean age is consistent with the hypothesis that most if not all solar-type stars are initially surrounded by disks, and that those disks evolve on timescales on the order of several million years.

The observed shape of the J-band luminosity function for the L1641 south cluster also constrains allowable shapes for the stellar initial mass function. Comparison of its observed luminosity function with models computed with a variety of input initial mass functions, shows that the IMF must be closely similar to the Scalo IMF, which peaks near 0.3 $M_\odot$ and declines rapidly toward lower masses. Initial mass functions which are flat below 0.3 $M_\odot$, or rise toward lower masses are clearly excluded.

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From Bipolar to Quadrupolar: The Collimation Processes of the Cepheus A Outflow

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We present new high-angular ($\sim 2''$) and velocity ($\sim$ 0.3 km s^{-1}) resolution observations in the (J,K) = (1,1) and (2,2) ammonia lines toward Cepheus A using the VLA-D configuration. As previously reported, the high-density gas is mainly distributed in three clumps, Cep A-1, Cep A-2, and Cep A-3. Cep A-1 and Cep A-3 constitute an interstellar elongated structure ($\sim 2.'3\times0.'4$, or $\sim 0.5\times0.08$ pc), with the stellar activity center located at its northwest edge. We find that Cep A-1 and Cep A-3 are located, respectively, between the two main pairs of the blue and red-shifted CO lobes of the quadrupolar molecular outflow. This implies that the interstellar disk-like structure cannot collimate the bipolar outflow near its origin in the east-west direction. The high-velocity outflow and the photons of its powering source seem to be producing significant perturbations of the morphological, kinematical, and temperature structures at the edges of the ammonia condensations. We suggest that the interstellar high-density condensations are *diverting* and *redirecting* the molecular outflow at scales of $\sim$ 0.05–0.5 pc, with Cep A-1 and Cep A-3 splitting in two halves, respectively, the blue and red-shifted lobes of an originally bipolar outflow already collimated in the east-west direction at circumstellar scales. Part of the high-density gas located at the edges of the interstellar ammonia condensations may be in the process of being incorporated into the general high-velocity molecular outflow by a dragging effect. However, the overall observed motions in the interstellar high-density gas could be bound by the observed mass in the region.

HW 2 is embedded in a circumstellar ($\sim 3.''3\times2.''3$, or $\sim 2400\times1700$ AU; p.a. $= 22^\circ$) high-density $\left(n(H_2) \simeq 3\times10^7 \text{ cm}^{-3}\right)$ clump of ~ 2 M$_\odot$. The high rotational temperatures $\left(T_R(22\text{–}11) = 40\text{–}50 \text{ K}\right)$ and the large velocity dispersions in the ammonia emission ($\sigma \simeq$ 3–4 km s^{-1}) found toward this position lead us to favor this object as the powering source of the high-velocity outflow. The observed motions of the circumstellar molecular gas could reflect the bound motions of the gas (e.g., rotation or infall) around a central mass of $\sim$ 10–20 M$_\odot$, or alternatively the perturbation of the gas by the wind of the central source. This circumstellar clump could be related to the circumstellar disk previously suggested from infrared continuum and maser line observations.

We find that gas temperatures as a function of the projected distance r with respect to HW 2 can be fitted by $T_R(22\text{–}11) \propto r^{-\alpha}$, with $\alpha = 0.3$ to 0.6. These indices are quite similar to those expected if heating of the molecular gas is via collisions with hot dust heated by the radiation of the central star(s). The observed luminosity in the region is enough to heat the gas up to the observed temperatures. This analysis suggests that similar VLA studies of radial temperature profiles in other star forming regions may be very useful for understanding heating processes and identifying exciting sources.

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The Structure of Protostellar Accretion Disks and the Origin of Bipolar Flows

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We study the vertical structure of magnetized protostellar accretion disks that power centrifugally driven outflows. The disks are assumed to be threaded by a large-scale, open magnetic field that removes the angular momentum of the accreted matter by driving a wind from the disk surface. The field is coupled to the weakly ionized disk material by ion-neutral and electron-neutral collisions: these collisions provide a diffusion mechanism that allows a steady-state field configuration to be maintained against radial advection and azimuthal shearing. We further assume that the disks are nearly Keplerian, geometrically thin, and axisymmetric, and focus on the parameter regime where the temperature and ion density are effectively constant. Under these assumptions, the fluid equations for the neutrals, the ions, and the electrons as well as the induction equation for the magnetic field can be reduced to a set of ordinary differential equations that describe the vertical structure of the disk at a fixed radius. This formulation complements the global, radially self-similar model studied by Königl.

We construct explicit solutions for the disk structure and identify the parameter regime where they are self-consistent and physically viable. We show that if a wind is to be centrifugally driven from the disk surface then the disk must be confined primarily by magnetic stresses rather than by the tidal field of the central object. Most of the disk material in a self-consistent solution is in quasi-hydrostatic equilibrium, with the thermal pressure gradient balancing the magnetic squeezing. In this region the field is dragged around by the matter and the magnetic stresses act to remove angular momentum from the inflowing neutral gas and to slow it to sub-Keplerian rotation speeds. As the gas density falls off with height, the field comes to dominate the energy density and the field lines behave like rigid wires that are carried around by the material in the disk. Eventually a point is reached where the relative azimuthal speed between the field lines and the neutrals vanishes and the disk becomes Keplerian. We identify this point as the base of the wind and derive a condition on the magnetic field at this location that generalizes the Blandford & Payne criterion for centrifugal acceleration from the disk surface. Beyond this point the field transfers angular momentum back to the matter and drives it out and away from the disk. The solution exhibits a sonic transition close to the surface of the disk and can in principle be extended into a large-scale wind solution that remains valid at greater heights.

We examine how our solutions are affected by a slow radial diffusion of the field lines and by electron-ion drift (corresponding to the Hall term in the generalized Ohm's law). We also discuss the expected stability properties of the disks and the construction of global disk–wind solutions. We argue that disk-driven outflows of this type offer an attractive explanation of bipolar flows in young stellar objects and we show how our solutions can in principle be used to relate the properties of these outflows to those of the associated circumstellar disks. Finally, we point out that our model may also be applicable to other cosmic outflow sources, notably active galactic nuclei.

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The Exciting YSO for the Molecular Outflow at the Core of L1287

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Using infrared imaging, we demonstrate that a bipolar reflection nebula is associated with the nebula GN 00.33.9 at the core of the dark cloud L1287 and that these bipolar extensions are oriented with the molecular gas outflow lobes in this region. The polarization patterns in the high resolution polarimetric maps indicate that the position of the primary source of illumination for these bipolar dust features lies to the north of both RNO 1B and RNO 1C. No near-infrared point source appears at this position in the images. In addition, the colors of the reflection nebulosity suggest the illuminating source is redder than either RNO 1B or RNO 1C. We suggest, therefore, that a previously unidentified YSO, one more deeply embedded than either RNO 1B or RNO 1C, is probably the driving source of the outflow. As the nominal position of *IRAS* 00338+6312 lies within $1.5''$ of the position of this newly identified YSO, we suggest that these are the same object. The colors and wavelength dependent polarization levels in the vicinity of RNO 1C are most consistent with RNO 1C being a protostellar source.

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