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Abstracts of recently accepted papers

On the interaction of a thin, supersonic shell with a molecular cloud

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Molecular clouds (MCs) are stellar nurseries, however, formation of stars within MCs depends on the ambient physical conditions. MCs, over a free-fall time are exposed to numerous dynamical phenomena, of which, the interaction with a thin, dense shell of gas is but one. Below we present results from self-gravitating, 3-D smoothed particle hydrodynamics (SPH) simulations of the problem; seven realisations of the problem have been performed by varying the precollision density within the cloud, the nature of the post-collision shock, and the spatial resolution in the computational domain. Irrespective of the type of shock, a complex network of dense filaments, seeded by numerical noise, readily appears in the shocked cloud. Segregation of the dense and rarefied gas phases also manifests itself in a bimodal distribution of gas density. We demonstrate that the power-spectrum for rarefied gas is Kolomogorov like, while that for the denser gas is considerably steeper. As a corollary to the main problem, we also look into the possibly degenerative effect of the SPH artificial viscosity on the impact of the incident shell. It is observed that stronger viscosity leads to greater post-shock dissipation, that strongly decelerates the incident shock-front and promotes formation of contiguous structure, albeit on a much longer timescale. We conclude that too much viscosity is likely to enhance the proclivity towards gravitational boundedness of structure, leading to unphysical fragmentation.On the other hand, insufficient resolution appears to suppress fragmentation. Convergence of results is tested at both extremes, first by repeating the test case with more than a million particles and then with only half the number of particles in the original test case.

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http://arxiv.org/abs/1010.4932

The Dynamics of the Envelope Surrounding the Protostar HH 211-mm

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We present a study of the structure and dynamics of the dense gas surrounding the HH 211-mm source, using VLA observations of the ammonia (1,1) and (2,2) inversion transitions. We find the envelope around this Class 0 source has an elongated geometry, extending about 10^4 AU in the direction perpendicular to the well-known HH 211 jet, and exhibits a velocity distribution consistent with rotation along the major axis. Our VLA observations indicate that the envelope is mostly in virial equilibrium. However, comparing our data with results from previous studies, it appears that the gas within approximately 0.005 pc of the central protostar is undergoing dynamical collapse. The size of this collapsing radius may constrain the amount of mass that can eventually infall into the forming star. We also find that the envelope is mostly internally heated, most probably by radiation from the central protostar. In addition, we detect evidence of outflow-envelope interaction in the ammonia data. These include a velocity gradient in the dense gas along the outflow axis and significant line broadening that is spatially correlated with the jet and could be the result of outflow-induced turbulence in the envelope.

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Magnetic field structure in a high-mass outflow/disk system

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To characterize the magnetic field structure of the outflow and core region within a prototypical high-mass star-forming region, we analyzed polarized CO(3–2) – for the first time observed with the Submillimeter Array – as well as 880 μm submm continuum emission from the high-mass outflow/disk system IRAS 18089-1732. Both emission features with polarization degrees at a few percent level indicate that the magnetic field structure is largely aligned with the outflow/jet orientation from the small core scales to the larger outflow scales. Although quantitative estimates are crude, the analysis indicates that turbulent energy dominates over magnetic energy. The data also suggest a magnetic field strength increase from the lower-density envelope to the higher-density core.

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http://www.mpia.de/homes/beuther/papers.html

Giant Planet Formation by Disk Instability in Low Mass Disks?

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Forming giant planets by disk instability requires a gaseous disk that is massive enough to become gravitationally unstable and able to cool fast enough for self-gravitating clumps to form and survive. Models with simplified disk cooling have shown the critical importance of the ratio of the cooling to the orbital timescales. Uncertainties about the proper value of this ratio can be sidestepped by including radiative transfer. Three-dimensional radiative hydrodynamics models of a disk with a mass of $0.043 M_\odot$ from 4 to 20 AU in orbit around a $1 M_\odot$ protostar show that disk instabilities are considerably less successful in producing self-gravitating clumps than in a disk with twice this mass. The results are sensitive to the assumed initial outer disk (T_o) temperatures. Models with $T_o = 20$ K are able to form a single self-gravitating clump, whereas models with $T_o = 25$ K form clumps that are not quite self-gravitating. These models imply that disk instability requires a disk with a mass of at least $\sim 0.043 M_\odot$ inside 20 AU in order to form giant planets around solar-mass protostars with realistic disk cooling rates and outer disk temperatures. Lower mass disks around solar-mass protostars must rely upon core accretion to form inner giant planets.

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Preprint available at arXiv

Identification of the Lithium Depletion Boundary and Age of the Southern Open Cluster Blanco 1

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We present results from a spectroscopic study of the very low mass members of the Southern open cluster Blanco 1 using the Gemini-N telescope. We obtained intermediate resolution ($R \sim$4400) GMOS spectra for 15 cluster candidate members with $I \sim$14–20 mag, and employed a series of membership criteria – proximity to the cluster's sequence in an $I/I-K_s$ color-magnitude diagram (CMD), kinematics agreeing with the cluster systemic motion, magnetic activity as

a youth indicator – to classify 10 of these objects as probable cluster members. For these objects, we searched for the presence of the Li I 6708Å feature to identify the lithium depletion boundary (LDB) in Blanco 1. The $I/I-K_s$ CMD shows a clear mass segregation in the Li distribution along the cluster sequence; namely, all higher mass stars are found to be Li-poor, while lower mass stars are found to be Li-rich. The division between Li-poor and Li-rich (i.e., the LDB) in Blanco 1 is found at $I = 18.78 \pm 0.24$ and $I - K_s = 3.05 \pm 0.10$. Using current pre-main-sequence evolutionary models we determine an LDB age of 132±24 Myr. Comparing our derived LDB age to upper-main-sequence isochrone ages for Blanco 1, as well as for other open clusters with identified LDBs, we find good chronometric consistency when using stellar evolution models that incorporate a moderate degree of convective core overshoot.

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Star formation: statistical measure of the correlation between the prestellar core mass function and the stellar initial mass function

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We present a simple statistical analysis of recent numerical simulations exploring the correlation between the core mass function obtained from the fragmentation of a molecular cloud and the stellar mass function which forms from these collapsing cores. Our analysis shows that the distributions of bound cores and sink particles obtained in the simulations are consistent with the sinks being formed predominantly from their parent core mass reservoir, with a statistical dispersion of the order of one third of the core mass. Such a characteristic dispersion suggests that the stellar initial mass function is relatively tightly correlated to the parent core mass function, leading to two similar distributions, as observed. This in turn argues in favor of the IMF being essentially determined at the early stages of core formation and being only weakly affected by the various environmental factors beyond the initial core mass reservoir, at least in the mass range explored in the present study. Accordingly, the final IMF of a star forming region should be determined reasonably accurately, statistically speaking, from the initial core mass function, provided some uniform efficiency factor. The calculations also show that these statistical fluctuations, due e.g. to variations among the core properties, broaden the low-mass tail of the IMF compared with the parent CMF, providing an explanation for the fact that this latter appears to underestimate the number of "pre brown dwarf" cores compared with the observationally-derived brown dwarf IMF.

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Variable circumstellar activity of V351 Orionis

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Context. Emission and absorption line profiles which are formed in the interaction of pre-main sequence (PMS) stars and their circumstellar environment are found to be variable at various timescales.
Aims. We investigate the patterns and timescales of temporal line profile variability in order to explore the dynamical circumstellar environment of the PMS Herbig Ae star V351 Ori.
Methods. We obtained 45 high-resolution (R∼28,000) spectra of V351 Ori at timescales of hours, days, and months. We analysed the $H\alpha$ line profiles and also examined the $H\beta$ $NaD1$ and $NaD2$ line profiles to explore the nature of the spectroscopic variability.
Results. The $H\alpha$ line profiles showed strong variations over all timescales. The shape of the profiles changed over

timescales of a day. Single as well as simultaneous event(s) of blue-shifted and red-shifted transient absorption components (TACs), i.e. signatures of outflow and infall, were also observed in the $H\alpha$ line profiles. The shortest period of variation in the TACs was $\leq$ 1 hour. All transient absorption events were found to decelerate with a rate of a few to fractions of m s^{-2}. The depth and width of the TACs were also changing with time. The presence of elongated red-shifted components at some epochs supports the episodic nature of accretion.
Conclusions. Variable emission and absorption components detected in $H\alpha$ line profiles show the dynamic nature of interaction between V351 Ori and its circumstellar environment. The $H\alpha$ non-photospheric profiles of the star most probably originate in the disk wind. Episodic accretion of gaseous material at a slow rate and outflow of clumpy gaseous material are still occurring in V351 Ori at an age of ∼6.5 Myr. Dynamic magnetospheric accretion and disk wind emerge as the most satisfactory model for interpreting the observed line profile variations of V351 Ori.

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PTF10nvg: An Outbursting Class I Protostar in the Pelican/North American Nebula

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During a synoptic survey of the North American Nebula region, the Palomar Transient Factory (PTF) detected an optical outburst (dubbed PTF10nvg) associated with the previously unstudied flat or rising spectrum infrared source IRAS 20496+4354. The PTF R-band light curve reveals that PTF10nvg brightened by more than 5 mag during the current outburst, rising to a peak magnitude of R∼13.5 in 2010 Sep. Follow-up observations indicate PTF10nvg has undergone a similar ∼5 mag brightening in the K band, and possesses a rich emission-line spectrum, including numerous lines commonly assumed to trace mass accretion and outflows. Many of these lines are blueshifted by ∼175 km/s from the North American Nebula's rest velocity, suggesting that PTF10nvg is driving an outflow. Optical spectra of PTF10nvg show several TiO/VO bandheads fully in emission, indicating the presence of an unusual amount of dense ($> 10^{10}$ cm^{-3}), warm (1500-4000 K) circumstellar material. Near-infrared spectra of PTF10nvg appear quite similar to a spectrum of McNeil's Nebula/V1647 Ori, a young star which has undergone several brightenings in recent decades, and 06297+1021W, a Class I protostar with a similarly rich near–infrared emission line spectrum. While further monitoring is required to fully understand this event, we conclude that the brightening of PTF10nvg is indicative of enhanced accretion and outflow in this Class-I-type protostellar object, similar to the behavior of V1647 Ori in 2004-2005.

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Magnetic Fields in Interstellar Clouds from Zeeman Observations: Inference of Total Field Strengths by Bayesian Analysis

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The only direct measurements of interstellar magnetic field strengths depend on the Zeeman effect, which samples the line-of-sight component B_z of the magnetic vector. In this paper we use a Bayesian approach to analyze the observed probability density function (PDF) of B_z from Zeeman surveys of H I, OH, and CN spectral lines in order to infer a density-dependent stochastic model of the *total* field strength B in diffuse and molecular clouds.
We find that at $n < 300$ cm^{-3} (in the diffuse interstellar medium sampled by H I lines), B does not scale with density. This suggests that diffuse clouds are assembled by flows along magnetic field lines, which would increase the density but not the magnetic field strength. We further find strong evidence for B in molecular clouds being randomly distributed between very small values and a maximum that scales with volume density n as $B \propto n^{0.65}$ for $n > 300$ cm^{-3}, with an uncertainty at the 50% level in the power-law exponent of about ± 0.05. This break-point density could be interpreted as the average density at which parsec-scale clouds become self gravitating. Both the uniform PDF of total field strengths and the scaling with density suggest that magnetic fields in molecular clouds are often too weak to dominate the star formation process. The stochasticity of the total field strength B implies that many fields are so weak that the mass/flux ratio in many clouds must be significantly supercritical. A two-thirds power law comes from isotropic contraction of gas too weakly magnetized for the magnetic field to affect the morphology of the collapse. On the other hand, our study does not rule out some clouds having strong magnetic fields with critical mass/flux ratios.

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http://iopscience.iop.org/0004-637X/725/1/466/pdf/0004-637X_725_1_466.pdf

A Critical Examination of the X-Wind Model for Chondrule and Calcium-rich, Aluminum-rich Inclusion Formation and Radionuclide Production

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Meteoritic data, especially regarding chondrules and calcium-rich, aluminum-rich inclusions (CAIs), and isotopic evidence for short-lived radionuclides (SLRs) in the solar nebula, potentially can constrain how planetary systems form. Interpretation of these data demands an astrophysical model, and the "X-wind" model of Shu et al. (1996) and collaborators has been advanced to explain the origin of chondrules, CAIs and SLRs. It posits that chondrules and CAIs were thermally processed < 0.1 AU from the protostar, then flung by a magnetocentrifugal outflow to the 2-3 AU region to be incorporated into chondrites. Here we critically examine key assumptions and predictions of the X-wind model. We find a number of internal inconsistencies: theory and observation show no solid material exists at 0.1 AU; particles at 0.1 AU cannot escape being accreted into the star; particles at 0.1 AU will collide at speeds high enough to destroy them; thermal sputtering will prevent growth of particles; and launching of particles in magnetocentrifugal outflows is not modeled, and may not be possible. We also identify a number of incorrect predictions of the X-wind model: the oxygen fugacity where CAIs form is orders of magnitude too oxidizing; chondrule cooling rates are orders of magnitude lower than those experienced by barred olivine chondrules; chondrule-matrix complementarity is not predicted; and the SLRs are not produced in their observed proportions. We conclude that the X-wind model is not relevant to chondrule and CAI formation and SLR production. We discuss more plausible models for chondrule and CAI formation and SLR production.

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Measuring the Stellar Accretion Rates of Herbig Ae/Be Stars

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The accretion rate of young stars is a fundamental characteristic of these systems. While accretion on to T Tauri stars has been studied extensively, little work has been done on measuring the accretion rate of their intermediate mass analogs, the Herbig Ae/Be stars. Measuring the stellar accretion rate of Herbig Ae/Bes is not straightforward both because of the dearth of metal absorption lines available for veiling measurements, and the intrinsic brightness of Herbig Ae/Be stars at ultraviolet wavelengths where the brightness of the accretion shock peaks. Alternative approaches to measuring the accretion rate of young stars by measuring the luminosity of proxies such as the Br γ emission line have not been calibrated. A promising approach is the measurement of the veiling of the Balmer discontinuity. We present measurements of this veiling as well as the luminosity of Br γ. We show that the relationship between the luminosity of Br γ and the stellar accretion rate for classical T Tauri stars is consistent with Herbig Ae stars but not Herbig Be stars. We discuss the implications of this finding for understanding the interaction of the star and disk for Herbig Ae/Be stars.

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Chemistry of a protoplanetary disk with grain settling and Lyman α radiation

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We present results from a model of the chemical evolution of protoplanetary disks. In our models we directly calculate the changing propagation and penetration of a high energy radiation field with Lyman α radiation included. We also explore the effect on our models of including dust grain settling. We find that, in agreement with earlier studies, the evolution of dust grains plays a large role in determining how deep the UV radiation penetrates into the disk. Significant grain settling at the midplane leads to much smaller freeze-out regions and a correspondingly larger molecular layer, which leads to an increase in column density for molecular species such as CO, CN and SO. The inclusion of Lyman α radiation impacts the disk chemistry through specific species that have large photodissociation cross sections at 1216 Å. These include HCN, NH_3 and CH_4, for which the column densities are decreased by an order of magnitude or more due to the presence of Lyman α radiation in the UV spectrum. A few species, such as CO_2 and SO, are enhanced by the presence of Lyman α radiation, but rarely by more than a factor of a few.

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Substellar Objects in Nearby Young Clusters (SONYC) II: The Brown Dwarf Population of ρ Ophiuchi

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SONYC – *Substellar Objects in Nearby Young Clusters* – is a survey program to investigate the frequency and properties of brown dwarfs down to masses below the Deuterium burning limit in nearby star forming regions. In this second paper, we present results on the ∼1 Myr old cluster ρ Ophiuchi, combining our own deep optical and near-infrared imaging using Subaru with photometry from the 2-Micron All Sky Survey and the *Spitzer Space Telescope*. Of the candidates selected from iJK_s photometry, we have confirmed three – including a new brown dwarf with a mass close to the Deuterium limit – as likely cluster members through low-resolution infrared spectroscopy. We also identify 27 sub-stellar candidates with mid-infrared excess consistent with disk emission, of which 16 are new and 11 are previously spectroscopically confirmed brown dwarfs. The high and variable extinction makes it difficult to obtain the complete sub-stellar population in this region. However, current data suggest that its ratio of low-mass stars to brown dwarfs is similar to those reported for several other clusters, though higher than what was found for NGC 1333 in Scholz et al. (2009).

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A Multi-Epoch Study of the Radio Continuum Emission of Orion Source I: Constraints on the Disk Evolution of a Massive YSO and the Dynamical History of Orion BN/KL

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We present new λ7 mm continuum observations of Orion BN/KL with the Very Large Array (VLA). We resolve the emission from the Young Stellar Objects (YSO) radio Source I and BN at several epochs. Radio Source I is highly elongated northwest-southeast, and remarkably stable in flux density, position angle, and overall morphology over nearly a decade. This favors the extended emission component arising from an ionized edge-on disk rather than an outwardly propagating jet.
We have measured the proper motions of Source I and BN for the first time at 43 GHz. We confirm that both sources are moving at high speed (12 and 26 km s^{-1} , respectively) approximately in opposite directions, as previously inferred from measurements at lower frequencies. We discuss dynamical scenarios that can explain the large motions of both BN and Source I and the presence of disks around both. Our new measurements exclude a past close encounter between BN and θ^1 Ori C, as proposed by Tan, and support the hypothesis that a close ($\sim$ 50 AU) dynamical interaction occurred around 500 years ago between Source I and BN as proposed by Gomez et al. From the dynamics of encounter we argue that Source I today is likely to be a binary with a total mass on the order of 20 $M_\odot$, and that it probably existed as a softer binary before the close encounter. This enables preservation of the original accretion disk, though truncated to its present radius of $\sim$ 50 AU.
N-body numerical simulations show that the dynamical interaction between a binary of 20 $M_\odot$ total mass (Source I) and a single star of 10 $M_\odot$ mass (BN) may lead to the ejection of both and binary hardening. The gravitational energy released in the process would be large enough to power the wide-angle, high-velocity flow traced by H_2 and CO emission in the BN/KL nebula. Assuming the proposed dynamical history is correct, the smaller mass for Source I recently estimated from SiO maser dynamics ($\gtrsim$7 $M_\odot$) by Matthews et al., suggests that non-gravitational forces (e.g. magnetic) must play an important role in the circumstellar gas dynamics.

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On the source of dense outflows from T Tauri Stars. III. Winds driven from the star-disc shear layer

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Ultraviolet observations of classical T Tauri Stars (cTTSs) have shown that there is a hot ($T_{\rm e} \simeq 80,000$ K) and dense ($n_{\rm e} \simeq 10^{10}$ cm^{-3}) component associated with the large scale jet. This hot component is formed very close to the base of the jet providing fundamental information on the jet formation mechanism. In this series, we have investigated whether this component can be formed in disc winds, either cool or warm. To conclude the series, jet launching from the interface between the magnetic rotor (the star) and the disc is studied. Synthetic profiles are calculated from numerical simulations of outflow launching by star-disc interaction. Profiles are calculated for several possible configurations of the stellar field: dipolar (with surface strengths, B_* of 1, 2 and 5 kG) or dynamo fed. Also two types of discs, passive or subjected to an $\alpha\Omega$-dynamo, are considered. These profiles have been used to define the locus of the various models in the observational diagram: dispersion versus centroid, for the profiles of the Si III] line. Bulk motions produce an increasing broadening of the profile as the lever arm launching the jet becomes more efficient; predicted profiles are however, sensitive to the disc inclination. Models are compared with observations of the Si III] lines obtained with the *Hubble Space Telescope*.
In addition, it is shown that the non-stationary nature of star-disc winds produce a flickering of the profile during quiescence with variations in the line flux of about 10%. At outburst, accretion signatures appear in the profiles together with an enhancement of the wind, producing the correlation between accretion and outflow as reported from RU Lup, AA Tau and RW Aur observations.

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A Catalog of CH_3OH $7_0 - 6_1A^+$ Maser Sources in Massive Star-Forming Regions. II. Masers in NGC 6334F, G8.67−0.36, and M17

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We present Very Large Array observations of the $7_0 - 6_1A^+$ methanol maser transition at 44 GHz towards NGC 6334F, G8.67−0.36, and M17. These arcsecond resolution observations complete a previous, larger VLA survey of this maser transition in high-mass star-forming regions reported by Kurtz et al. We confirm the presence of 44 GHz methanol maser emission in all three sources, detecting eight distinct maser components in NGC 6334F, twelve components in G8.67−0.36 and one in M17.

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An Investigation of the Loss of Planet-Forming Potential in Intermediate Sized Young Embedded Star Clusters

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A large fraction of stars forming in our galaxy are born within clusters embedded in giant molecular clouds. In these environments, the background UV radiation fields impinging upon circumstellar disks can often dominate over the radiation fields produced by each disk's central star. As a result, this background radiation can drive the evaporation of circumstellar disks and lead to the loss of planet forming potential within a cluster. This paper presents a detailed analysis of this process for clusters whose stellar membership falls within the range $100 \leq N \leq 1000$. For these intermediate-sized clusters, the background UV field is often dominated by the most massive stellar member. Due to the steep slope of the initial mass function, the amount of background UV light that bathes clusters of similar size displays significant variance. As a result, we perform a statistical analysis of this problem by calculating distributions of FUV flux values impinging upon star/disk systems for several cluster scenarios. We find that in the absence of dust attenuation, giant planet formation would likely be inhibited in approximately half of systems forming within intermediate-sized clusters regardless of stellar membership. In contrast, the presence of dust can significantly lower this value, with the effect considerably more pronounced in more populated clusters.

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Rotationally modulated variations and the mean longitudinal magnetic field of the Herbig Ae star HD 101412

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Despite the importance of magnetic fields to a full understanding of the properties of accreting Herbig Ae/Be stars, these fields have scarcely been studied until now over the rotation cycle. One reason for the paucity of these observations is the lack of knowledge of their rotation periods. The sharp-lined young Herbig Ae star HD 101412 with a strong surface magnetic field has become in the past few years one of the most well-studied targets among the Herbig Ae/Be stars. We present our multi-epoch polarimetric spectra of this star acquired with FORS 2 to search for a rotation period and constrain the geometry of the magnetic field. We measured longitudinal magnetic fields for 13 different epochs distributed over 62 days. These new measurements and our previous measurements of the magnetic field in this star were combined with available photometric observations to determine the rotation period. We find the rotation period to be $P = 42.076 \pm 0.017$ d. According to near-infrared imaging studies, the star is observed nearly edge-on. The star exhibits a single-wave variation in the longitudinal magnetic field during the stellar rotation cycle. These observations are usually considered as evidence of a dominant dipolar contribution to the magnetic field topology.

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Empirical Constraints on Turbulence in Protoplanetary Accretion Disks

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We present arcsecond-scale Submillimeter Array observations of the CO(3-2) line emission from the disks around the young stars HD 163296 and TW Hya at a spectral resolution of $44\,\mathrm{m\,s^{-1}}$. These observations probe below the $\sim$100 $\mathrm{m\,s^{-1}}$ turbulent linewidth inferred from lower-resolution observations, and allow us to place constraints on the turbulent linewidth in the disk atmospheres. We reproduce the observed CO(3-2) emission using two physical models of disk structure: (1) a power-law temperature distribution with a tapered density distribution following a simple functional form for an evolving accretion disk, and (2) the radiative transfer models developed by D'Alessio et al. that can reproduce the dust emission probed by the spectral energy distribution. Both types of models yield a low upper limit on the turbulent linewidth (Doppler b-parameter) in the TW Hya system ($\lesssim$40 $\mathrm{m\,s^{-1}}$), and a tentative (3σ) detection of a $\sim$300 $\mathrm{m\,s^{-1}}$ turbulent linewidth in the upper layers of the HD 163296 disk. These correspond to roughly $\leq$10% and 40% of the sound speed at size scales commensurate with the resolution of the data. The derived linewidths imply a turbulent viscosity coefficient, α, of order 0.01 and provide observational support for theoretical predictions of subsonic turbulence in protoplanetary accretion disks.

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http://astro.berkeley.edu/~mhughes/download/turbulence_hughes.pdf

Two Wide Planetary-Mass Companions to Solar-Type Stars in Upper Scorpius

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At wide separations, planetary-mass and brown dwarf companions to solar type stars occupy a curious region of parameters space not obviously linked to binary star formation or solar-system scale planet formation. These companions provide insight into the extreme case of companion formation (either binary or planetary), and due to their relative ease of observation when compared to close companions, they offer a useful template for our expectations of more typical planets. We present the results from an adaptive optics imaging survey for wide ($\sim$50-500 AU) companions to solar type stars in Upper Scorpius. We report one new discovery of a $\sim$14 $\mathrm{M_J}$ companion around GSC 06214-00210, and confirm that the candidate planetary mass companion 1RXS J160703.4-203634 detected by Lafrenière et al (2008) is in fact co-moving with its primary star. In our survey, these two detections correspond to $\sim$4% of solar type stars having companions in the 6-20 M_J mass and $\sim$200-500 AU separation range. This figure is higher than would be expected if brown dwarfs and planetary mass companions were drawn from an extrapolation of the binary mass function. Finally, we discuss implications for the formation of these objects.

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The HDO/H_2O ratio in gas in the inner regions of a low-mass protostar

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The HDO/H_2O abundance ratio is thought to be a key diagnostic on the evolution of water during the star- and planet-formation process and thus on its origin on Earth. We here present millimeter-wavelength high angular resolution observations of the deeply embedded protostar NGC 1333-IRAS4B from the Submillimeter Array targeting the $3_{12}-2_{21}$ transition of HDO at 225.6 GHz (E_u = 170 K). We do not (or only very tentatively) detect the HDO line toward the central protostar, contrasting the previous prominent detection of a line from another water isotopologue, $H_2^{18}O$, with similar excitation properties using the IRAM Plateau de Bure Interferometer. The non-detection of the HDO line provides a direct, model independent, upper limit to the HDO/H_2O abundance ratio of 6×10^{-4} (3σ) in the warm gas associated with the central protostar. This upper limit suggests that the HDO/H_2O abundance ratio is not significantly enhanced in the inner $\approx$ 50 AU around the protostar relative to what is seen in comets and Earth's oceans and does not support previous suggestions of a generally enhanced HDO/H_2O ratio in these systems.

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A multi-wavelength census of stellar contents in the young cluster NGC 1624

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We present a comprehensive multi-wavelength analysis of the young cluster NGC 1624 associated with the HII region Sh2-212 using optical $UBVRI$ photometry, optical spectroscopy and GMRT radio continuum mapping along with the near-infrared (NIR) JHK archival data. From optical observations of the massive stars, reddening $E(B-V)$ and distance to the cluster are estimated to be 0.76 - 1.00 mag and 6.0 $\pm$ 0.8 kpc, respectively. Present analysis yields a spectral class of O6.5V for the main ionizing source of the region and the maximum post-main-sequence age of the cluster is estimated as $\sim$ 4 Myr. Detailed physical properties of the young stellar objects (YSOs) in the region are analyzed using a combination of optical/NIR colour-colour and colour-magnitude diagrams. The distribution of YSOs in $(J-H)/(H-K)$ NIR colour-colour diagram shows that a majority of them have $A_V \leq 4$ mag. However, a few YSOs show A_V values higher than 4 mag. Based on the NIR excess characteristics, we identified 120 probable candidate YSOs in this region which yield a disk frequency of $\sim$ 20%. However, this should be considered as a lower limit. These YSOs are found to have an age spread of $\sim$ 5 Myr with a median age of $\sim$ 2-3 Myr and a mass range of $\sim$ 0.1 - 3.0 $M_\odot$. A significant number of YSOs are located close to the cluster centre and we detect an enhanced density of reddened YSOs located/projected close to the molecular clumps detected by Deharveng et al. (2008) at the periphery of NGC 1624. This indicates that the YSOs located within the cluster core are relatively older in comparison to those located/projected near the clumps. From the radio continuum flux, spectral class of the ionizing source of the ultra-compact HII (UC HII) region at the periphery of Sh2-212 is estimated to be $\sim$ B0.5V. From optical data, slope of the mass function (MF) Γ, in the mass range $1.2 \leq M/M_\odot < 27$ can be represented by a single power law with a slope -1.18 $\pm$ 0.10, whereas the NIR data in the mass range $0.65 \leq M/M_\odot < 27$ yields Γ = -1.31 $\pm$ 0.15. Thus the MF agrees fairly with the Salpeter value. The slope of the K-band luminosity function (KLF) for the cluster is found to be 0.30 $\pm$ 0.06 which is in agreement with the values obtained for other young clusters.

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Effects of Turbulence, Eccentricity Damping, and Migration Rate on the Capture of Planets into Mean Motion Resonance

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Pairs of migrating extrasolar planets often lock into mean motion resonance as they drift inward. This paper studies the convergent migration of giant planets (driven by a circumstellar disk) and determines the probability that they are captured into mean motion resonance. The probability that such planets enter resonance depends on the type of resonance, the migration rate, the eccentricity damping rate, and the amplitude of the turbulent fluctuations. This problem is studied both through direct integrations of the full 3-body problem, and via semi-analytic model equations. In general, the probability of resonance decreases with increasing migration rate, and with increasing levels of turbulence, but increases with eccentricity damping. Previous work has shown that the distributions of orbital elements (eccentricity and semimajor axis) for observed extrasolar planets can be reproduced by migration models with multiple planets. However, these results depend on resonance locking, and this study shows that entry into – and maintenance of – mean motion resonance depends sensitively on migration rate, eccentricity damping, and turbulence.

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Young Stellar Groups and Their Most Massive Stars

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We analyze the masses and spatial distributions of fourteen young stellar groups in Taurus, Lupus3, ChaI, and IC348. These nearby groups, which typically contain 20 to 40 members, have membership catalogs complete to $\sim$0.02 $M_\odot$, and are sufficiently young that their locations should be similar to where they formed. These groups show five properties seen in clusters having many more stars and much greater surface density of stars: (1) a broad range of masses, (2) a concentration of the most massive star towards the centre of the group, (3) an association of the most massive star with a high surface density of lower-mass stars, (4) a correlation of the mass of the most massive star with the total mass of the group, and (5) the distribution of a large fraction of the mass in a small fraction of the stars.

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A Chandra Observation of the Obscured Star-Forming Complex W40

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The young stellar cluster illuminating the W40 H II region, one of the nearest massive star forming regions, has been observed with the ACIS detector on board the Chandra X-ray Observatory. Due to its high obscuration, this is a poorly-studied stellar cluster with only a handful of bright stars visible in the optical band, including three OB stars identified as primary excitation sources. We detect 225 X-ray sources, of which 85% are confidently identified as young stellar members of the region. Two potential distances of the cluster, 260 pc and 600 pc, are used in the paper. Supposing the X-ray luminosity function to be universal, it supports a 600 pc distance as a lower limit for W40 and a total population of at least 600 stars down to 0.1 $M_\odot$ under the assumption of a coeval population with a uniform

obscuration. In fact, there is strong spatial variation in K_s-band-excess disk fraction and non-uniform obscuration due to a dust lane that is identified in absorption in optical, infrared and X-ray. The dust lane is likely part of a ring of material which includes the molecular core within W40. In contrast to the likely ongoing star formation in the dust lane, the molecular core is inactive. The star cluster has a spherical morphology, an isothermal sphere density profile, and mass segregation down to 1.5 $M_\odot$. However, other cluster properties, including a $\lesssim$1 Myr age estimate and ongoing star formation, indicate that the cluster is not dynamically relaxed. X-ray diffuse emission and a powerful flare from a young stellar object are also reported.

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Is protostellar heating sufficient to halt fragmentation? A case study of the massive protocluster G8.68-0.37

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If star formation proceeds by thermal fragmentation and the subsequent gravitational collapse of the individual fragments, how is it possible to form fragments massive enough for O and B stars in a typical star-forming molecular cloud where the Jeans mass is about 1$M_\odot$ at the typical densities (10^4 cm^{-3}) and temperatures (10 K)? We test the hypothesis that a first generation of low-mass stars may heat the gas enough that subsequent thermal fragmentation results in fragments $\geq$10$M_\odot$, sufficient to form B stars. We combine ATCA and SMA observations of the massive star-forming region G8.68$-$0.37 with radiative transfer modeling to derive the present-day conditions in the region and use this to infer the conditions in the past, at the time of core formation. Assuming the current mass/separation of the observed cores equals the fragmentation Jeans mass/length and the region's average density has not changed, requires the gas temperature to have been 100 K at the time of fragmentation. The postulated first-generation of low-mass stars would still be around today, but the number required to heat the cloud exceeds the limits imposed by the observations. Several lines of evidence suggest the observed cores in the region should eventually form O stars yet none have sufficient raw material. Even if feedback may have suppressed fragmentation, it was not sufficient to halt it to this extent. To develop into O stars, the cores must obtain additional mass from outside their observationally defined boundaries. The observations suggest they are currently fed via infall from the very massive reservoir ($\sim$1500 $M_\odot$) of gas in the larger pc scale cloud around the star-forming cores. This suggests that massive stars do not form in the collapse of individual massive fragments, but rather in smaller fragments that themselves continue to gain mass by accretion from larger scales.

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Deep XMM-Newton observation of the η Chamaeleontis cluster

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The members of the η Chamaeleontis cluster are in an evolutionary stage in which disks are rapidly evolving. It also presents some peculiarities, such as the large fraction of binaries and accretion disks, probably related to the cluster formation process. Its proximity makes this stellar group an ideal target for studying the relation between X-ray emission and those stellar parameters. The main objective of this work is to determine general X-ray properties of the cluster members in terms of coronal temperature, column density, emission measure, X-ray luminosity and variability.

We also aim to establish the relation between the X-ray luminosity of these stars and other stellar parameters, such as binarity and presence of accretion disks. A study of flare energies for each flare event and their relation with some stellar parameters is also performed. We used proprietary data from a deep XMM-Newton observation pointed at the core of the η Chamaleontis cluster. Specific software for the reduction of XMM-Newton data was used for the analysis of our observation. For the detection of sources, we used the wavelet-based code PWDetect. General coronal properties were derived from plasma model fitting. We also determined variability of the η Chamaeleontis members in the EPIC field-of-view. A total of six flare-like events were clearly detected in five different stars. For them, we derived coronal properties during the flare events and pseudo-quiescent state separately. In our observations, stars that underwent a flare event have higher X-ray luminosities in the pseudo-quiescent state than cluster members with similar spectral type with no indications of flaring, independently whether they have an accretion disk or not. Observed flare energies are typical of both pre-main and main-sequence M stars. We detected no difference between flare energies of stars with and without an accretion disk.

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Formation Process of the Circumstellar Disk: Long-term Simulations in the Main Accretion Phase of Star Formation

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The formation and evolution of the circumstellar disk in unmagnetized molecular clouds is investigated using three-dimensional hydrodynamic simulations from the prestellar core until the end of the main accretion phase. In collapsing cloud cores, the first (adiabatic) core with a size of $\gtrsim 3\,\mathrm{AU}$ forms prior to the formation of the protostar. At its formation, the first core has a thick disk-like structure, and is mainly supported by the thermal pressure. After the protostar formation, it decreases the thickness gradually, and becomes supported by the centrifugal force. We found that the first core is a precursor of the circumstellar disk with a size of $> 3\,\mathrm{AU}$. This means that unmagnetized protoplanetary disk smaller than $< 3\,\mathrm{AU}$ does not exist. Reflecting the thermodynamics of the collapsing gas, at the protostar formation epoch, the first core (or the circumstellar disk) has a mass of $\sim 0.005 - 0.1\,M_{\odot}$, while the protostar has a mass of $\sim 10^{-3}\,M_{\odot}$. Thus, just after the protostar formation, the circumstellar disk is about $10 - 100$ times more massive than the protostar. In the main accretion phase that lasts for $\sim 10^{5}\,\mathrm{yr}$, the circumstellar disk mass tends to dominate the protostellar mass. Such a massive disk is unstable to gravitational instability, and tends to show fragmentation. Our calculations indicate that the substellar mass object may form in the circumstellar disk in the main accretion phase. In addition, the mass accretion rate onto the protostar shows strong time variability that is caused by the torque from the substellar objects and/or the spiral arms in the circumstellar disk. Such variability provides an important signature for detecting the substellar mass companion in the circumstellar disk around very young protostars.

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Non-convergence of the critical cooling timescale for fragmentation of self-gravitating discs

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We carry out a resolution study on the fragmentation boundary of self-gravitating discs. We perform three-dimensional Smoothed Particle Hydrodynamics simulations of discs to determine whether the critical value of the cooling timescale in units of the orbital timescale, $\beta_{\rm crit}$, converges with increasing resolution. Using particle numbers ranging from 31,250 to 16 million (the highest resolution simulations to date) we do not find convergence. Instead, fragmentation occurs for longer cooling timescales as the resolution is increased. These results suggest that at the very least, the critical value of the cooling timescale is longer than previously thought. However, the absence of convergence also raises the question of whether or not a critical value exists. In light of these results, we caution against using cooling timescale or gravitational stress arguments to deduce whether gravitational instability may or may not have been the formation mechanism for observed planetary systems.

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A deep wide-field sub-mm survey of the Carina Nebula complex

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Context: The Great Nebula in Carina is one of the most massive ($M_{*,\rm total} \geq 25\,000\,M_\odot$) star-forming complexes in our Galaxy and contains several stars with (initial) masses exceeding $\approx 100\,M_\odot$; it is therefore a superb location in which to study the physics of violent massive star-formation and the resulting feedback effects, including cloud dispersal and triggered star-formation.
Aims: We aim to reveal the cold dusty clouds in the Carina Nebula complex, to determine their morphology and masses, and to study the interaction of the luminous massive stars with these clouds.
Methods: We used the Large APEX Bolometer Camera LABOCA at the APEX telescope to map a 1.25 deg $\times$1.25 deg ($= 50 \times 50$ pc^2) region at 870 μm with 18″ angular resolution (= 0.2 pc at the distance of the Carina Nebula) and an r.m.s. noise level of ≈ 20 mJy/beam.
Results: From a comparison to Hα images we infer that about 6% of the 870 μm flux in the observed area is likely free-free emission from the HII region, while about 94% of the flux is very likely thermal dust emission. The total (dust + gas) mass of all clouds for which our map is sensitive is $\sim 60\,000\,M_\odot$, in good agreement with the mass of the compact clouds in this region derived from ^{13}CO line observations. There is a wide range of different cloud morphologies and sizes, from large, massive clouds with several 1000 $M_\odot$, to small diffuse clouds containing just a few $M_\odot$. We generally find good agreement in the cloud morphology seen at 870 μm and the Spitzer 8 μm emission maps, but also identify a prominent infrared dark cloud. Finally, we construct a radiative transfer model for the Carina Nebula complex that reproduces the observed integrated spectral energy distribution reasonably well.
Conclusions: Our analysis suggests a total gas + dust mass of about $200\,000\,M_\odot$ in the investigated area; most of this material is in the form of molecular clouds, but a widely distributed component of (partly) atomic gas, containing up to $\sim 50\%$ of the total mass, may also be present. Currently, only some 10% of the gas is in sufficiently dense clouds to be immediately available for future star formation, but this fraction may increase with time owing to the ongoing compression of the strongly irradiated clouds and the expected shockwaves of the imminent supernova explosions.

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Preprints can be obtained from http://www.usm.uni-muenchen.de/people/preibisch/publications.html

Ice chemistry in massive Young Stellar Objects: the role of metallicity

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We present the comparison of the three most important ice constituents (water, CO and CO_2) in the envelopes of massive Young Stellar Objects (YSOs), in environments of different metallicities: the Galaxy, the Large Magellanic Cloud (LMC) and, for the first time, the Small Magellanic Cloud (SMC). We present observations of water, CO and CO_2 ice in 4 SMC and 3 LMC YSOs (obtained with Spitzer-IRS and VLT/ISAAC). While water and CO_2 ice are detected in all Magellanic YSOs, CO ice is not detected in the SMC objects. Both CO and CO_2 ice abundances are enhanced in the LMC when compared to high-luminosity Galactic YSOs. Based on the fact that both species appear to be enhanced in a consistent way, this effect is unlikely to be the result of enhanced CO_2 production in hotter YSO envelopes as previously thought. Instead we propose that this results from a reduced water column density in the envelopes of LMC YSOs, a direct consequence of both the stronger UV radiation field and the reduced dust-to-gas ratio at lower metallicity. In the SMC the environmental conditions are harsher, and we observe a reduction in CO_2 column density. Furthermore, the low gas-phase CO density and higher dust temperature in YSO envelopes in the SMC seem to inhibit CO freeze-out. The scenario we propose can be tested with further observations.

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Deep Near-Infrared Survey of the Pipe Nebula II: Data, Methods, and Dust Extinction Maps

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We present a new set of high resolution dust extinction maps of the nearby and essentially starless Pipe Nebula molecular cloud. The maps were constructed from a concerted deep near-infrared imaging survey with the ESO-VLT, ESO-NTT, CAHA 3.5m telescopes, and 2MASS data. The new maps have a resolution three times higher than the previous extinction map of this cloud by Lombardi et al. (2006) and are able to resolve structure down to 2600 AU. We detect 244 significant extinction peaks across the cloud. These peaks have masses between 0.1 and 18.4 $M_\odot$, diameters between 1.2 and 5.7×10^4 AU (0.06 and 0.28 pc), and mean densities of about 10^4 cm^{-3}, all in good agreement with previous results. From the analysis of the Mean Surface Density of Companions we find a well defined scale near 1.4×10^4 AU below which we detect a significant decrease in structure of the cloud. This scale is smaller than the Jeans Length calculated from the mean density of the peaks. The surface density of peaks is not uniform but instead it displays clustering. Extinction peaks in the Pipe Nebula appear to have a spatial distribution similar to the stars in Taurus, suggesting that the spatial distribution of stars evolves directly from the primordial spatial distribution of high density material.

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A sub-millimeter Mapping Survey of Herbig AeBe Stars

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We have acquired sub-millimeter observations of 33 fields containing 37 Herbig Ae/Be (HAEBE) stars or potential HAEBE stars, including SCUBA maps of all but two of these stars. Nine target stars show extended dust emission. The other 18 are unresolved, suggesting that the dust envelopes or disks around these stars are less than a few arcseconds in angular size. In several cases we find that the strongest sub-millimeter emission originates from younger, heavily embedded sources rather than from the HAEBE star, which means that previous models must be viewed with caution. These new data, in combination with far-infrared flux measurements available in the literature, yield SEDs from far-infrared to millimeter wavelengths for all the observed objects. Isothermal fits to these SEDs demonstrate excellent fits, in most cases, to the flux densities longward of 100 μm. We find that a smaller proportion of B-type stars than A and F-type stars are surrounded by circumstellar disks, suggesting that disks around B stars dissipate on shorter time scales than those around later spectral types. Our models also reveal that the mass of the circumstellar material and the value of β are correlated, with low masses corresponding to low values of β. Since low values of β imply large grain sizes, our results suggest that a large fraction of the mass in low-beta sources is locked up in very large grains.Several of the isolated HAEBE stars have disks with very flat sub-millimeter SEDs. These disks may be on the verge of forming planetary systems.

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Dynamic star formation in the massive DR21 filament

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The formation of massive stars is a highly complex process in which it is unclear whether the star-forming gas is in global gravitational collapse or an equilibrium state supported by turbulence and/or magnetic fields. In addition, magnetic fields may play a decisive role in the star-formation process since they influence the efficiency of gas infall onto the protostar.
By studying one of the most massive and dense star-forming regions in the Galaxy at a distance of less than 3 kpc, i.e. the filament containing the well-known sources DR21 and DR21(OH), we attempt to obtain observational evidence to help us to discriminate between these two views.
We use molecular line data from our ^{13}CO 1→0, CS 2→1, and N_2H^+ 1→0 survey of the Cygnus X region obtained with the FCRAO and high-angular resolution observations in isotopomeric lines of CO, CS, HCO^+, N_2H^+, and H_2CO, obtained with the IRAM 30m telescope, to investigate the distribution of the different phases of molecular gas. Gravitational infall is identified by the presence of inverse P Cygni profiles that are detected in optically thick lines, while the optically thinner isotopomers are found to reach a peak in the self-absorption gap.
We observe a complex velocity field and velocity dispersion in the DR21 filament in which regions of the highest column-density, i.e., dense cores, have a lower velocity dispersion than the surrounding gas and velocity gradients that are not (only) due to rotation. Infall signatures in optically thick line profiles of HCO^+ and ^{12}CO are observed along and across the whole DR21 filament. By modelling the observed spectra, we obtain a typical infall speed of $\sim$0.6 km s^{-1} and mass accretion rates of the order of a few 10^{-3} M$_\odot$ yr^{-1} for the two main clumps constituting the filament. These massive clumps (4900 and 3300 M$_\odot$ at densities of around 10^5 cm^{-3} within 1 pc diameter) are both

gravitationally contracting (with free-fall times much shorter than sound crossing times and low virial parameter α). The more massive of the clumps, DR21(OH), is connected to a sub-filament, apparently 'falling' onto the clump. This filament runs parallel to the magnetic field.
All observed kinematic features in the DR21 filament (velocity field, velocity dispersion, and infall), its filamentary morphology, and the existence of (a) sub-filament(s) can be explained if the DR21 filament was formed by the convergence of flows on large scales and is now in a state of global gravitational collapse. Whether this convergence of flows originated from self-gravity on larger scales or from other processes cannot be determined by the present study. The observed velocity field and velocity dispersion are consistent with results from (magneto)-hydrodynamic simulations where the cores lie at the stagnation points of convergent turbulent flows.

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Chemical Variation in Molecular Cloud Cores in the Orion A Cloud

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We have observed molecular cloud cores in the Orion A giant molecular cloud (GMC) in CCS, HC_3N, DNC, and $HN^{13}C$ to study their chemical characteristics. We have detected CCS in the Orion A GMC for the first time. CCS was detected in about a third of the observed cores. The cores detected in CCS are not localized but are widely distributed over the Orion A GMC. The CCS peak intensity of the core tends to be high in the southern region of the Orion A GMC. The HC_3N peak intensity of the core also tends to be high in the southern region, while there are HC_3N intense cores near Orion KL, which is not seen in CCS. The core associated with Orion KL shows broad HC_3N line profile, and star formation activity near Orion KL seems to enhance the HC_3N emission. The column density ratio of NH_3 to CCS is lower near the middle of the filament, and is higher toward the northern and southern regions along the Orion A GMC filament. This ratio is known to trace the chemical evolution in nearby dark cloud cores, but seems to be affected by core gas temperature in the Orion A GMC: cores with low NH_3 to CCS column density ratios tend to have warmer gas temperature. The value of the column density ratio of DNC to $HN^{13}C$ is generally similar to that in dark cloud cores, but becomes lower around Orion KL due to higher gas temperature.

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Detection of Strong Millimeter Emission from the Circumstellar Dust Disk Around V1094 Sco: Cold and Massive Disk around a T Tauri Star in a Quiescent Accretion Phase?

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We present the discovery of a cold massive dust disk around the T Tauri star V1094 Sco in the Lupus molecular cloud from the 1.1 millimeter continuum observations with AzTEC on ASTE. A compact (r <320 AU) continuum emission coincides with the stellar position having a flux density of 272 mJy which is largest among T Tauri stars in Lupus. We also present the detection of molecular gas associated with the star in the five-point observations in ^{12}CO J=3–2 and ^{13}CO J=3–2. Since our ^{12}CO and ^{13}CO observations did not show any signature of a large-scale outflow or a massive envelope, the compact dust emission is likely to come from a disk around the star. The observed SED of V1094 Sco shows no distinct turnover from near infrared to millimeter wavelengths, which can be well described by a flattened disk for the dust component, and no clear dip feature around 10 μm suggestive of absence of an inner hole in the disk. We fit a simple power-law disk model to the observed SED. The estimated disk mass ranges from 0.03 to >0.12 $M_\odot$, which is one or two orders of magnitude larger than the median disk mass of T Tauri stars in Taurus.

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Distinguishing post-AGB impostors in a sample of pre-main sequence stars

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A sample of 27 sources, cataloged as pre-main sequence stars by the Pico dos Dias Survey (PDS), is analyzed to investigate a possible contamination by post-AGB stars. The far-infrared excess due to dust present in the circumstellar envelope is typical of both categories: young stars and objects that have already left the main sequence and are suffering severe mass loss. The two known post-AGB stars in our sample inspired us to seek for other *very likely* or *possible* post-AGB objects among PDS sources previously suggested to be Herbig Ae/Be stars, by revisiting the observational database of this sample. In a comparative study with well known post-AGBs, several characteristics were evaluated: (i) parameters related to the circumstellar emission, (ii) spatial distribution to verify the background contribution from dark clouds, (iii) spectral features, and (iv) optical and infrared colors. These characteristics suggest that seven objects of the studied sample are very likely post-AGBs, 5 are possible post-AGBs, eight are unlikely post-AGBs, and the nature of seven objects remains unclear.

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Different Evolutionary Stages in the Massive Star Forming Region S255 Complex

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Aims. Massive stars form in clusters, and they are often found in different evolutionary stages located close to each other. To understand evolutionary and environmental effects during the formation of high-mass stars, we observed three regions of massive star formation at different evolutionary stages that reside in the same natal molecular cloud.
Methods. The three regions S255IR, S255N and S255S were observed at 1.3 mm with the Submillimeter Array (SMA) and follow-up short spacing information was obtained with the IRAM 30m telescope. Near infrared (NIR) $H + K$-band spectra and continuum observations were taken for S255IR with VLT-SINFONI to study the different stellar populations in this region.
Results. The combination of millimeter (mm) and near infrared data allow us to characterize different stellar populations within the young forming cluster in detail. While we find multiple mm continuum sources toward all regions, their outflow, disk and chemical properties vary considerably. The most evolved source S255IR exhibits a collimated bipolar outflow visible in CO and H_2 emission, the outflows from the youngest region S255S are still small and rather confined in the regions of the mm continuum peaks. Also the chemistry toward S255IR is most evolved exhibiting strong emission from complex molecules, while much fewer molecular lines are detected in S255N, and in S255S we detect only CO isotopologues and SO lines. Also, rotational structures are found toward S255N and S255IR. Furthermore, a comparison of the NIR SINFONI and mm data from S255IR clearly reveal two different (proto) stellar populations with an estimated age difference of approximately 1 Myr.
Conclusions. A multi-wavelength spectroscopy and mapping study reveals different evolutionary phases of the star formation regions. We propose the triggered outside-in collapse star formation scenario for the bigger picture and the fragmentation scenario for S255IR.

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http://arxiv.org/abs/1011.3575

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), *Abstracts of recently accepted major reviews* (not standard conference contributions), *Dissertation Abstracts* (presenting abstracts of new Ph.D dissertations), *Meetings* (announcing meetings broadly of interest to the star and planet formation and early solar system community), *New Jobs* (advertising jobs specifically aimed towards persons within the areas of the Newsletter), and *Short Announcements* (where you can inform or request information from the community).

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The Evolution of Gas and Dust in Protoplanetary Accretion Disks

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Ph.D dissertation directed by: Cornelis P. Dullemond

Ph.D degree awarded: October 2010

Dust constitutes only about one percent of the mass of circumstellar disks, yet it is of crucial importance for the modeling of planet formation, disk chemistry, radiative transfer and observations. The initial growth of dust from sub-μm sized grains to planetesimals and also the radial transport of dust in disks around young stars is the topic of this thesis. Circumstellar dust is subject to radial drift, vertical settling, turbulent mixing, collisional growth, fragmentation and erosion.

We approach this subject from three directions: analytical calculations, numerical simulations, and comparison to observations. We describe the physical and numerical concepts that go into a model which is able to simulate the radial and size evolution of dust in a gas disk which is viscously evolving over several million years. The resulting dust size distributions are compared to our analytical predictions and a simple recipe for obtaining steady-state dust size distributions is derived. With the numerical model at hand, we show that grain fragmentation can explain the fact that circumstellar disks are observed to be dust-rich for several million years. Finally, we investigate the challenges that observations present to the theory of grain evolution, namely that grains of millimeter sizes are observed at large distances from the star. We have found that under the assumption that radial drift is ineffective, we can reproduce some of the observed spectral indices and fluxes. Fainter objects point towards a reduced dust-to-gas ratio or lower dust opacities.

http://www.ub.uni-heidelberg.de/archiv/11147/

Moving ... ??

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Postdoctoral position in star- and planet formation MPE, Garching, Germany

A 2-year postdoc position (with possibility of extension) is available at the Max-Planck Institute for Extraterrestrial Physics in Garching for observational or theoretical studies of star- and planet formation. The postdoc will be part of an international team studying the physical and chemical evolution of young stellar objects and protoplanetary disks using Herschel spectroscopy (in the context of the WISH and DIGIT key programs) as well as ground-based infrared and submillimeter data. The candidate is also encouraged to pursue a personal research program.

Applications should include a curriculum vitae, publication list, and a brief statement of research experience and interests, and arrange for at least three letters of reference to be uploaded on the website

http://jobs.strw.leidenuniv.nl/2010/dishoeckPD/

by December 20 2010.

Three Postdoctoral Positions in Exozodiacal Dust Disks

Applications are invited for 3 Postdoctoral Fellowships in Astrophysics, 2 at the Laboratoire d'Astrophysique de Grenoble (LAOG, France), and 1 at the LESIA laboratory of Observatoire de Paris (Meudon, France). The successful applicants will participate to the 4-year EXOZODI project funded by the ANR (French National Research Agency) that will start early 2011.

The EXOZODI project aims at understanding the origin of faint exozodiacal dust disks around nearby stars that remained elusive until the first near-infrared interferometric detection in 2006 by our team around the star Vega. Their origin is still an unresolved issue. However, the richness of this subject, its connection to the general dynamical evolution of planetary systems, in particular in the innermost potentially habitable regions, makes it a fast emerging research field.

In the context of this project, we propose the following positions that can start between April and December 2011:
1. Dynamical modeling, Grenoble, 2 years, contacts: J.-C. Augereau & H. Beust
2. Dynamical simulation, Paris, 2.2 years, contacts: P. Thébault & J.-C. Augereau
3. Near-IR interferometry, Grenoble, 2 years, contacts: J.-B. Lebouquin, O. Absil & J.-C. Augereau

Inquiries about the positions and the project shall be addressed to the above listed contact persons. Interested candidates are asked to write a description of their past and present research accomplishments, to provide a CV, a publication list and two letters of recommendation that will be sent directly to the contact persons. Applications to be returned before Feb 1st, 2011.

Email addresses: Jean-Charles Augereau (augereau *at* obs.ujf-grenoble.fr), Philippe Thébault (philippe.thebault *at* obspm.fr), Jean-Baptiste Le Bouquin (Jean-Baptiste.Lebouquin *at* obs.ujf-grenoble.fr), Hervé Beust (herve.beust *at* obs.ujf-grenoble.fr), Olivier Absil (absil *at* astro.ulg.ac.be).

More on the project: http://www-laog.obs.ujf-grenoble.fr/∼augereau

Lecturer position in Astrophysics
University of Exeter

The Astrophysics group at the University of Exeter (http://www.astro.ex.ac.uk/) invites applications for an appointment as a Lecturer in the College of Engineering, Mathematics and Physical Sciences. We are seeking to appoint innovative researchers with international quality publications. The successful applicant will work with members of the Astrophysics group and will contribute to extending the research profile of the group, in areas related or complementary to our research activities, namely star and planet formation, structure and evolution of stars and study of extra-solar planets. We encourage applications in theoretical and computational Astrophysics, particularly in the fields of star and planet formation, hydrodynamical and MHD processes in stars and planets, planetary atmospheres and climate studies. Our activities devoted to the physics and dynamics of stars and planets are based on interdisciplinary research, with links to the Applied Mathematics group at the University of Exeter and to the Met Office of Exeter. The successful applicant will hold a PhD in Physics, Astrophysics or a related area and have an internationally-recognised research programme in an active field of astrophysics research related or complementary to existing Exeter strengths. Appointments will be made in the salary range £31,671 to £38,951 dependent on qualifications and experience.

Application packs are available by searching under the appropriate reference number (C8613622) at

http://www.admin.ex.ac.uk/personnel/jobs

Informal enquiries may be made to Professor Isabelle Baraffe (telephone +44 (0)1392 725123 email: i.baraffe@ex.ac.uk).

CLOSING DATE: 31 December 2010. Interviews will take place by mid-january 2011.

Postdoc positions:
Physics and chemistry of high-mass star-forming regions

The HIFI instrument onboard ESA's *Herschel* Space Observatory is delivering spectacular data on H_2O and other molecules in a wide range of objects from comets to interstellar clouds and active galactic nuclei. At SRON, the PI institute of HIFI, there are now openings for two postdocs to analyze HIFI guaranteed time observations of Galactic star-forming regions. One position is centered around observations of H_2O lines toward high-mass star-forming regions, while the other is more aimed at broad-band spectral surveys.

Besides working on their own HIFI observations and assisting PhD students with their science projects, the successful applicants will also have significant time for an independent research program. experience.

Successful candidates will have a PhD in astronomy and a demonstrated background in millimeter-wave, infrared, or radio astronomy. Knowledge of astrochemistry, molecular spectroscopy, and radiative transfer modeling is an advantage. Excellent communication skills, ability to work in a team and good command of English are essential. Appointments are for 2 years with a possible extension to 3 years, at a competitive salary and excellent benefits. Groningen is a lively university town with 185,000 inhabitants, 20% of which are students, and a correspondingly active cultural life. The Groningen laboratory of SRON shares a building with the University astronomy department (the Kapteyn Institute) where research is conducted in many areas of modern astrophysics.

Applicants should send a curriculum vitae, a publication list and a statement of research interests, and arrange for two letters of recommendation to be sent to Dr. Floris van der Tak (vdtak *at* sron.nl) by January 1, 2011.