THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar evolution and molecular clouds

No. 232 — 22 Apr 2012 Editor: Bo Reipurth (reipurth@ifa.hawaii.edu)

Abstracts of recently accepted papers

Herschel images of Fomalhaut. An extrasolar Kuiper belt at the height of its dynamical activity.

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Context: Fomalhaut is a young ($2 \pm 1 \times 10^8$ years), nearby (7.7 pc), 2 solar-mass star that is suspected to harbor an infant planetary system, interspersed with one or more belts of dusty debris.
Aims: We present far-infrared images obtained with the Herschel Space Observatory with an angular resolution between 5.7 arcsec and 36.7 arcsec at wavelengths between 70 micrometer and 500 micrometer. The images show the main debris belt in great detail. Even at high spatial resolution, the belt appears smooth. The region in between the belt and the central star is not devoid of material; thermal emission is observed here as well. Also at the location of the star, excess emission is detected. We aim to construct a consistent image of the Fomalhaut system.
Methods: We use a dynamical model together with radiative-transfer tools to derive the parameters of the debris disk. We include detailed models of the interaction of the dust grains with radiation, for both the radiation pressure and the temperature determination. Comparing these models to the spatially resolved temperature information contained in the images allows us to place strong constraints on the presence of grains that will be blown out of the system by radiation pressure. We use this to derive the dynamical parameters of the system.
Results: The appearance of the belt points toward a remarkably active system in which dust grains are produced at a very high rate by a collisional cascade in a narrow region filled with dynamically excited planetesimals. Dust particles with sizes below the blow-out size are abundantly present. The equivalent of 2000 one-km-sized comets are destroyed every day, out of a cometary reservoir amounting to 110 Earth masses. From comparison of their scattering and thermal properties, we find evidence that the dust grains are fluffy aggregates, which indicates a cometary origin. The excess emission at the location of the star may be produced by hot dust with a range of temperatures, but may also be due to gaseous free-free emission from a stellar wind.

Accepted by Astronomy & Astrophysics

http://dx.doi.org/10.1051/0004-6361/201118581

Accretion dynamics in the classical T Tauri star V2129 Oph

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We analyze the photometric and spectroscopic variability of the classical T Tauri star V2129 Oph over several rotational cycles to test the dynamical predictions of magnetospheric accretion models. The photometric variability and the radial velocity variations in the photospheric lines can be explained by rotational modulation due to cold spots, while the radial velocity variations of the He I (5876 Å) line and the veiling variability are due to hot spot rotational modulation. The hot and cold spots are located at high latitudes and about the same phase, but the hot spot is expected to sit at the chromospheric level, while the cold spot is at the photospheric level. Using the dipole+octupole magnetic-field configuration previously proposed in the literature for the system, we compute 3D MHD magnetospheric simulations of the star-disk system. We use the simulation's density, velocity and scaled temperature structures as input to a radiative transfer code, from which we calculate theoretical line profiles at all rotational phases. The theoretical profiles tend to be narrower than the observed ones, but the qualitative behavior and the observed rotational modulation of the Hα and Hβ emission lines are well reproduced by the theoretical profiles. The spectroscopic and photometric variability observed in V2129 Oph support the general predictions of complex magnetospheric accretion models with non-axisymmetric, multipolar fields.

Accepted by Astronomy & Astrophysics

Preprints avaliable at http://arxiv.org/abs/1203.6331

The Dust Properties of Bubble HII Regions as seen by Herschel

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Because of their relatively simple morphology, "bubble" H II regions have been instrumental to our understanding of star formation triggered by H II regions. With the far-infrared (FIR) spectral coverage of the *Herschel* satellite, we can access the wavelengths where these regions emit the majority of their energy through their dust emission. At *Herschel* wavelengths 70 μm to 500 μm, the emission associated with H II regions is dominated by the cool dust in their photodissociation regions (PDRs). We find average dust temperatures of 26K along the PDRs, with little variation between the H II regions in the sample, while local filaments and infrared dark clouds average 19K and 15K respectively. Higher temperatures lead to higher values of the Jeans mass, which may affect future star formation. The mass of the material in the PDR, collected through the expansion of the H II region, is between ~ 300 and $\sim 10,000$ Solar masses for the H II regions studied here. These masses are in rough agreement with the expected masses swept up during the expansion of the H II regions. Approximately 20% of the total FIR emission is from the direction of the bubble central regions. This suggests that we are detecting emission from the "near-side" and "far-side" PDRs along the line of sight and that bubbles are three-dimensional structures. We find only weak support for a relationship

between dust temperature and β, of a form similar to that caused by noise and calibration uncertainties alone.

Accepted by A&A

http://arxiv.org/abs/1203.5721

A Significant Population of Candidate New Members of the ρ Ophiuchi Cluster

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We present a general method for identifying the pre-main-sequence population of any star-forming region, unbiased with respect to the presence or absence of disks, in contrast to samples selected primarily via their mid-infrared emission from *Spitzer* surveys. We have applied this technique to a new, deep, wide-field, near-infrared imaging survey of the ρ Ophiuchi cloud core to search for candidate low mass members. In conjunction with published *Spitzer* IRAC photometry, and least squares fits of model spectra (COND, DUSTY, NextGen, and blackbody) to the observed spectral energy distributions, we have identified 948 candidate cloud members within our 90% completeness limits of $J = 20.0$, $H = 20.0$, and $K_S = 18.50$. This population represents a factor of $\sim$3 increase in the number of known young stellar objects in the ρ Ophiuchi cloud. A large fraction of the candidate cluster members (81% $\pm$ 3%) exhibit infrared excess emission consistent with the presence of disks, thus strengthening the possibility of their being *bona fide* cloud members. Spectroscopic follow-up will confirm the nature of individual objects, better constrain their parameters, and allow an initial mass function to be derived.

Accepted by Astrophysical Journal

http://physics.sfsu.edu/∼mbarsony/html/pubs.html

Milliarcsecond structure of water maser emission in two young high-mass stellar objects associated with methanol masers

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The 22.2 GHz water masers are often associated with the 6.7 GHz methanol masers but owing to the different excitation conditions they likely probe independent spatial and kinematic regions around the powering young massive star. We compared the emission of these two maser species on milliarcsecond scales to determine in which structures the masers arise and to test a disc−outflow scenario where the methanol emission arises in a circumstellar disc while the water emission comes from an outflow. We obtained high-angular and spectral resolution 22.2 GHz water maser observations of the two sources G31.581+00.077 and G33.641−00.228 using the EVN. In both objects the water maser spots form complex and filamentary structures of sizes 18-160 AU. The emission towards the source G31.581+00.077 comes from two distinct regions of which one is related to the methanol maser source of ring-like shape. In both targets the main axis of methanol distribution is orthogonal to the water maser distribution. Most of water masers appear to trace shocks on a working surface between an outflow/jet and a dense envelope. Some spots are possibly related to the disc-wind interface which is as close as 100-150 AU to the regions of methanol emission.

Accepted by Astronomy and Astrophysics

DOI: 10.1051/0004-6361/201218999
arxiv.org/pdf/1204.0806

The VLT-FLAMES Tarantula Survey IV: Candidates for isolated high-mass star formation in 30 Doradus

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Whether massive stars ($\gtrsim$30 $M_\odot$) can occasionally form in relative isolation (e.g. in clusters with $M < 100$ $M_\odot$) or if they require a large cluster of lower-mass stars around them is a key test in the differentiation of star formation theories as well as how the initial mass function of stars is sampled. Previous attempts to find O-type stars that formed in isolation were hindered by the possibility that such stars are merely runaways from clusters, i.e., their current isolation does not reflect their birth conditions. We introduce a new method to find O-type stars that are not affected by such a degeneracy. Using the VLT-FLAMES Tarantula Survey and additional high resolution imaging we have identified stars that satisfy the following constraints: 1) they are O-type stars that are not detected to be part of a binary system based on radial velocity (RV) time series analysis; 2) they are designated spectral type O7 or earlier ; 3) their velocities are within 1σ of the mean of OB-type stars in the 30 Doradus region, i.e. they are not runaways along our line-of-sight; 4) the projected surface density of stars does not increase within 3 pc towards the O-star (no evidence for clusters); 5) their sight lines are associated with gaseous and/or dusty filaments in the interstellar medium (ISM), and 6) if a second candidate is found in the direction of the same filament with which the target is associated, both are required to have similar velocities. With these criteria, we have identified 15 stars in the 30 Doradus region, which are strong candidates for being high-mass stars that have formed in isolation. Additionally, we employed extensive Monte Carlo stellar cluster simulations to confirm that our results rule out the presence of clusters around the candidates. Eleven of these are classified as Vz stars, possibly associated with the zero-age main sequence. We include a newly discovered Wolf-Rayet star as a candidate, although it does not meet all of the above criteria.

Accepted by A&A

http://arxiv.org/abs/1204.3628

SMA and *Spitzer* Observations of Bok Glouble CB 17: A Candidate First Hydrostatic Core?

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We present high angular resolution SMA and *Spitzer* observations toward the Bok globule CB 17. SMA 1.3 mm dust continuum images reveal within CB 17 two sources with an angular separation of $\sim 21''$ (~ 5250 AU at a distance of ~ 250 pc). The northwestern continuum source, referred to as CB 17 IRS, dominates the infrared emission in the *Spitzer* images, drives a bipolar outflow extending in the northwest-southeast direction, and is classified as a low luminosity Class 0/I transition object ($L_{\rm bol} \sim 0.5\,L_\odot$). The southeastern continuum source, referred to as CB 17 MMS, has faint dust continuum emission in the SMA 1.3 mm observations ($\sim 6\,\sigma$ detection; ~ 3.8 mJy), but is not detected in the deep *Spitzer* infrared images at wavelengths from 3.6 to 70 μm. Its bolometric luminosity and temperature, estimated from its spectral energy distribution, are $\leq 0.04\,L_\odot$ and ≤ 16 K, respectively. The SMA CO (2–1) observations suggest that CB 17 MMS may drive a low-velocity molecular outflow ($\sim 2.5\,{\rm km\,s^{-1}}$), extending in the east-west direction. Comparisons with prestellar cores and Class 0 protostars suggest that CB 17 MMS is more evolved than prestellar cores but less evolved than Class 0 protostars. The observed characteristics of CB 17 MMS are consistent with the theoretical predictions from radiative/magneto hydrodynamical simulations of a first hydrostatic core, but there is also the possibility that CB 17 MMS is an extremely low luminosity protostar deeply embedded in an edge-on circumstellar disk. Further observations are needed to study the properties of CB 17 MMS and to address more precisely its evolutionary stage.

Accepted by ApJ

http://arxiv.org/abs/1203.5252

Mapping the Linearly Polarized Spectral Line Emission around the Evolved Star IRC+10216

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We present spectro-polarimetric observations of several molecular lines obtained with the Submillimeter Array (SMA) toward the carbon rich AGB star IRC+10216. We have detected and mapped the linear polarization of the CO 3–2, SiS 19–18 and CS 7–6 lines. The polarization arises at a distance of $\simeq$ 450 AU from the star and is blueshifted with respect the Stokes I. The SiS 19–18 polarization pattern appears to be consistent with a locally radial magnetic field configuration. However, the CO 3–2 and CS 7–6 line polarization suggests an overall complex magnetic field morphology within the envelope. This work demonstrates the feasibility of using spectro-polarimetric observations to carry out tomographic imaging of the magnetic field in circumstellar envelopes.

Accepted by The Astrophysical Journal Letters

http://arxiv.org/abs/1204.4381

GREAT [C II] and CO observations of the BD +40°4124 region

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The BD+40°4124 region was observed with high angular and spectral resolution with the German heterodyne instrument GREAT in CO J = 13 → 12 and [C II] on SOFIA. These observations show that the [C II] emission is very strong in the reflection nebula surrounding the young Herbig Ae/Be star BD+40°4124. A strip map over the nebula shows that the [C II] emission approximately coincides with the optical nebulosity. The strongest [C II] emission is centered

on the B2 star and a deep spectrum shows that it has faint wings, which suggests that the ionized gas is expanding. We also see faint CO J = 13 → 12 at the position of BD+40°4124, which suggests that the star may still be surrounded by an accretion disk. We also detected [C II] emission and strong CO J = 13 → 12 toward V 1318 Cyg. Here the [C II] emission is fainter than in BD+40°4124 and appears to come from the outflow, since it shows red and blue wings with very little emission at the systemic velocity, where the CO emission is quite strong. It therefore appears that in the broad ISO beam the [C II] emission was dominated by the reflection nebula surrounding BD+40°4124, while the high J CO lines originated from the adjacent younger and more deeply embedded binary system V 1318 Cyg.

Accepted by Astronomy & Astrophysics, SOFIA/GREAT special issue

http://adsabs.harvard.edu/abs/2012arXiv1203.6457S

Complex Variability of the H-alpha Emission Line Profile of the T Tauri Binary System KH 15D: The Influence of Orbital Phase, Occultation by the Circumbinary Disk, and Accretion Phenomenae

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We have obtained 48 high resolution echelle spectra of the pre-main sequence eclipsing binary system KH 15D (V582 Mon, P = 48.37 d, $e \sim 0.6$, $M_A = 0.6\ M_\odot$, $M_B = 0.7\ M_\odot$). The eclipses are caused by a circumbinary disk seen nearly edge on, which at the epoch of these observations completely obscured the orbit of star B and a large portion of the orbit of star A. The spectra were obtained over five contiguous observing seasons from 2001/2002 to 2005/2006 while star A was fully visible, fully occulted, and during several ingress and egress events. The Hα line profile shows dramatic changes in these time series data over timescales ranging from days to years. A fraction of the variations are due to "edge effects" and depend only on the height of star A above or below the razor sharp edge of the occulting disk. Other observed variations depend on the orbital phase: the Hα emission line profile changes from an inverse P Cygni type profile during ingress to an enhanced double-peaked profile, with both a blue and red emission component, during egress. Each of these interpreted variations are complicated by the fact that there is also a chaotic, irregular component present in these profiles. We find that the complex data set can be largely understood in the context of accretion onto the stars from a circumbinary disk with gas flows as predicted by the models of eccentric T Tauri binaries put forward by Artymowicz & Lubow, Günther & Kley, and de Val-Borro et al. In particular, our data provide strong support for the pulsed accretion phenomenon, in which enhanced accretion occurs during and after perihelion passage.

Accepted by Astrophysical Journal

A Resolved Census of Millimeter Emission from Taurus Multiple Star Systems

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We present a high angular resolution millimeter-wave dust continuum imaging survey of circumstellar material associated with the individual components of 23 multiple star systems in the Taurus-Auriga young cluster. Combined with previous measurements in the literature, these new data permit a comprehensive look at how the millimeter luminosity (a rough tracer of disk mass) relates to the separation and mass of a stellar companion. Approximately one third (28-37%) of the individual stars in multiple systems have detectable millimeter emission, an incidence rate half that for single stars (~62%) which does not depend on the number of companions. There is a strong, positive

correlation between the luminosity and projected separation (a_p) of a stellar pair. Wide pairs ($a_p > 300\,\mathrm{AU}$) have a similar luminosity distribution as single stars, medium pairs ($a_p \approx$ 30-300 AU) are a factor of 5 fainter, and close pairs ($a_p < 30\,\mathrm{AU}$) are $\sim 5\times$ fainter yet (aside from a small, but notable population of bright circumbinary disks). In most cases, the emission is dominated by a disk around the primary (or a wide tertiary in hierarchical triples), but there is no clear relationship between luminosity and stellar mass ratio. A direct comparison of resolved disk sizes with predictions from tidal truncation models yields mixed results; some disks are much larger than expected given the projected distances of their companions. We suggest that the presence of a stellar companion impacts disk properties at a level comparable to the internal evolution mechanisms that operate in an isolated system, with both the multiple star formation process itself and star-disk tidal interactions likely playing important roles in the evolution of circumstellar material. From the perspective of the mass content of the disk reservoir, we expect that (giant) planet formation is inhibited around the components of close pairs or secondaries, but should be as likely as for single stars around the primaries (or wide tertiaries in hierarchical triples) in more widely-separated multiple star systems.

Accepted by Astrophysical Journal

http://arxiv.org/abs/1203.6353

The massive protostar W43-MM1 as seen by Herschel-HIFI water spectra: high turbulence and accretion luminosity

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We present Herschel/HIFI observations of fourteen water lines in W43-MM1, a massive protostellar object in the luminous star cluster-forming region W43. We aim at placing this study in the more general context of high-mass star formation. The dynamics of such regions may either be the monolithic collapse of a turbulent core, or competitive accretion. Water turns out to be a particularly good tracer of the structure and kinematics of the inner regions, allowing an improved description of the physical structure of the massive protostar W43-MM1 and an estimation of the amount of water around it. We analyze the gas dynamics from the line profiles using Herschel-HIFI observations (WISH-KP) of fourteen far-IR water lines (H216O, H217O, $H_2^{18}O$), CS(11–10), and $C^{18}O$(9–8) lines, and using our modeling of the continuum spectral energy distribution. The spectral modeling tools allow us to estimate outflow, infall and turbulent velocities, and molecular abundances. We compare our results to previous studies of low-, intermediate-, and other high-mass objects. As for lower mass protostellar objects, the molecular line profiles are a mix of emission and absorption, and can be decomposed into 'medium', and 'broad' velocity components. The broad component is the outflow associated with protostars of all masses. Our modeling shows that the remainder of the water profiles can be well fitted by an infalling and passively heated envelope, with highly supersonic turbulence varying from 2.2 km/s in the inner region to 3.5 km/s in the outer envelope. Also, W43-MM1 has a high accretion rate, between 4.0×10^{-4} and 4.0×10^{-2} Msun yr^{-1}, derived from the fast (0.4-2.9 km/s) infall observed. We estimate a lower mass limit of gaseous water of 0.11 Msun and total water luminosity of 1.5 Lsun (in the 14 lines presented here). The central hot core is detected with a water abundance of 1.4×10^{-4} while the water abundance for the outer envelope is 8×10^{-8}. The latter value is higher than in other sources, most likely related to the high turbulence and the micro-shocks created by its dissipation. Examining water lines of various energies, we find that the turbulent velocity increases with the distance to the center. While not in clear disagreement with the competitive accretion scenario, this behavior is predicted by the turbulent core model. Moreover, the estimated accretion rate is high enough to overcome the expected radiation pressure.

Accepted by Astronomy & Astrophysics

http://arxiv.org/abs/1204.0397

The Low-mass Stellar Population in L1641: Evidence for Environmental Dependence of the Stellar Initial Mass Function

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We present results from an optical photometric and spectroscopic survey of the young stellar population in L1641, the low-density star-forming region of the Orion A cloud south of the Orion Nebula Cluster (ONC). Our goal is to determine whether L1641 has a large enough low-mass population to make the known lack of high-mass stars a statistically-significant demonstration of environmental dependence of the upper mass stellar initial mass function (IMF). Our spectroscopic sample consists of IR-excess objects selected from the *Spitzer/IRAC* survey and non-excess objects selected from optical photometry. We have spectral confirmation of 864 members, with another 98 probable members; of the confirmed members, 406 have infrared excesses and 458 do not. Assuming the same ratio of stars with and without IR excesses in the highly-extincted regions, L1641 may contain as many as ~ 1600 stars down to $\sim 0.1 M_{\odot}$, comparable within a factor of two to the the ONC. Compared to the standard models of the IMF, L1641 is deficient in O and early B stars to a 3-4σ significance level, assuming that we know of all the massive stars in L1641.

With a forthcoming survey of the intermediate-mass stars, we will be in a better position to make a direct comparison with the neighboring, dense ONC, which should yield a stronger test of the dependence of the high-mass end of the stellar initial mass function upon environment.

Accepted by ApJ

Line identification in high-resolution, near-infrared CRIRES spectra of chemically peculiar and Herbig Ae stars

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Contrary to the late-type stars, our knowledge of atomic transitions in intermediate-mass stars is still very poor. The recent availability of ESO's high-resolution spectrograph CRIRES offers now the opportunity to study numerous spectral features in the near-IR in intermediate-mass main-sequence and pre-main-sequence stars.

The aim of the study is to explore the diagnostic potential of near-IR spectral regions. We carry out the first line identification in a few spectral regions for the two strongly magnetic Ap stars γ Equ and HD 154708, and their potential precursors two pre-main sequence Herbig Ae/Be stars HD 101412 and 51 Oph.

High-resolution CRIRES spectra were obtained in three spectral regions, two regions around $1\,\mu$m and one region around $1.57\,\mu$m containing magnetically sensitive Fe I lines. To study the spectral line variability in the Herbig Ae star HD 101412, the observations were collected on six different rotation phases. All currently available atomic line lists were involved to properly identify the detected spectral features.

The largest number of near-IR spectral features was detected and identified in the well- studied magnetic Ap star γ Equ. Nearly 30% of the spectral lines in the Ap star HD 154708 with one of the strongest magnetic fields known among the Ap stars of the order of 25 kG, remain unidentified due to a lack of atomic data. Only very few lines belonging to the rare earth element group have been identified in both Ap stars. A number of spectral lines including the Ce III and Dy II lines appear magnetically split due to the presence of a strong magnetic field in their atmospheres. The content of the spectra of the Herbig Ae/Be stars HD 101412 and 51 Oph is rather unexciting. Variable behaviour of lines of the elements He, N, Mg, Si, and Fe over the rotation period in the spectra of HD 101412 confirm our previous finding of variability in the optical region. Due to the very fast rotation of 51 Oph, only a few spectral lines have been identified with certainty.

Accepted by A&A

http://arxiv.org/abs/1204.0652

Proper motions of the HH 110/270 system

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We present a study of the HH 110/270 system based on three sets of optical images obtained with the ESO New Technology Telescope, the Subaru Telescope and the Hubble Space Telescope (HST). The ground-based observations are made in the Hα and [S II] emission lines and the HST observations are made in the Hα line only. Ground based observations reveal the existence of nine knots, which have not been previously discussed and offer some important insight into the HH 110/270 history. We perform a kinematic study of the HH 110/270 system and an analysis of its emission properties. We measure proper motions of all the knots in the system. Four of the newly identified knots belong to the HH 270 jet. Their positions indicate that the jet's axis changed its direction in the past. We speculate that similar changes may have occurred many times in the past and this could be part of the reason for the unusual structure of the HH 110 jet. The HST observations allow us to resolve individual knots into their substructures and to measure their proper motions. These measurements show that the knots are highly turbulent structures. Finally we report the discovery of four new HH objects located near the HH 110/270 system.

Accepted by The Astronomical Journal

Infrared Variability of the Gliese 569B System

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Gliese 569B is a multiple brown dwarf system whose exact nature has been the subject of several investigations over the past few years. Interpretation has partially relied on infra-red photometry and spectroscopy of the resolved components of the system. We present seeing limited K_s photometry over four nights, searching for variability in this young low mass substellar system. Our photometry is consistent with other reported photometry, and we report the tentative detection of several periodic signals consistent with rotational modulation due to spots on their surfaces. The five significant periods range from 2.90 hours to 12.8 hours with peak to peak variabilities from 28 mmag to 62 mmag in the K_s band.

If both components are rotating with the shortest periods, then their rotation axes are not parallel with each other, and the rotation axis of the Bb component is not perpendicular to the Ba-Bb orbital plane. If Bb has one of the longer rotational periods, then the Bb rotation axis is consistent with being parallel to the orbital axis of the Ba-Bb system.

Accepted by The Astrophysical Journal

http://arxiv.org/abs/1204.3454

On the nature of the Herbig B[e] star binary system V921 Scorpii: Geometry and kinematics of the circumprimary disk on sub-AU scales

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V921 Scorpii is a close binary system (separation 0.025″) showing the B[e]-phenomenon. The system is surrounded by an enigmatic bipolar nebula, which might have been shaped by episodic mass-loss events, possibly triggered by dynamical interactions between the companion and the circumprimary disk (Kraus et al. 2012). In this paper, we investigate the spatial structure and kinematics of the circumprimary disk, with the aim to obtain new insights into the still strongly debated evolutionary stage. For this purpose, we combine, for the first time, infrared spectro-interferometry (VLTI/AMBER, $\lambda/\Delta\lambda = 12,000$) and spectro-astrometry (VLT/CRIRES, $\lambda/\Delta\lambda = 100,000$), which allows us to study the AU-scale distribution of circumstellar gas and dust with an unprecedented velocity resolution of 3 $\mathrm{km\,s^{-1}}$. Using a model-independent photocenter analysis technique, we find that the Brγ-line emitting gas rotates in the same plane as the dust disk. We can reproduce the wavelength-differential visibilities and phases and the double-peaked line profile using a Keplerian-rotating disk model. The derived mass of the central star is $5.4 \pm 0.4\ M_\odot \cdot (d/1150\mathrm{pc})$, which is considerably lower than expected from the spectral classification, suggesting that V921 Sco might be more distant ($d \sim 2$ kpc) than commonly assumed. Using the geometric information provided by our Brγ spectro-interferometric data and Paschen, Brackett, and Pfund line decrement measurements in 61 hydrogen recombination line transitions, we derive the density of the line-emitting gas ($N_e = 2...6 \times 10^{19}\,\mathrm{m^{-3}}$). Given that our measurements can be reproduced with a Keplerian velocity field without outflowing velocity component and the non-detection of age-indicating spectroscopic diagnostics, our study provides new evidence for the pre-main-sequence nature of V921 Sco.

Accepted by The Astrophysical Journal

http://arxiv.org/abs/1204.1969

Luminosity Functions of Spitzer Identified Protostars in Nine Nearby Molecular Clouds

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We identify protostars in *Spitzer* surveys of nine star-forming molecular clouds within 1 kpc: Serpens, Perseus, Ophiuchus, Chamaeleon, Lupus, Taurus, Orion, Cep OB3, and Mon R2, which combined host over 700 protostar candidates. These clouds encompass a variety of star forming environments, including both low mass and high mass star forming regions, as well as dense clusters and regions of sparsely distributed star formation. Our diverse cloud sample allows us to compare protostar luminosity functions in these varied environments. We combine near- and mid-infrared photometry from 2MASS J, H, and K_s bands and *Spitzer* 3.6, 4.5, 5.8, 8.0, and 24 μm bands to create 1 - 24 μm spectral energy distributions (SEDs). Using protostars from the *c2d* survey with well-determined bolometric luminosities, we derive a relationship between bolometric luminosity, mid-IR luminosity (integrated from 1 - 24 μm), and SED slope. Estimations of the bolometric luminosities for protostar candidates are combined to create luminosity functions for each cloud. Contamination due to edge-on disks, reddened Class II sources, and galaxies is estimated and

removed from the luminosity functions. We find that luminosity functions for high mass star forming clouds (Orion, Mon R2, and Cep OB3) peak near 1 $L_\odot$ and show a tail extending toward luminosities above 100 $L_\odot$. The luminosity functions of the low mass star forming clouds (Serpens, Perseus, Ophiuchus, Taurus, Lupus, and Chamaeleon) do not exhibit a common peak, however the combined luminosity function of these regions peaks below 1 $L_\odot$. Finally, we examine the luminosity functions as a function of the local surface density of YSOs. In the Orion molecular cloud, we find a significant difference between the luminosity functions of protostars in regions of high and low stellar density, the former of which is biased toward more luminous sources. This may be the result of primordial mass segregation, although this interpretation is not unique. We compare our luminosity functions to those predicted by models and find that our observed luminosity functions are best matched by models which invoke competitive accretion, although we do not find strong agreement of the high mass star forming clouds with any of the models.

Accepted by Astronomical Journal

http://arxiv.org/abs/1204.1535

Evidence for top-heavy stellar initial mass functions with increasing density and decreasing metallicity

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Residual-gas expulsion after cluster formation has recently been shown to leave an imprint in the low-mass present-day stellar mass function (PDMF) which allowed the estimation of birth conditions of some Galactic globular clusters (GCs) such as mass, radius and star formation efficiency. We show that in order to explain their characteristics (masses, radii, metallicity, PDMF) their stellar initial mass function (IMF) must have been top-heavy. It is found that the IMF is required to become more top-heavy the lower the cluster metallicity and the larger the pre-GC cloud-core density are. The deduced trends are in qualitative agreement with theoretical expectation. The results are consistent with estimates of the shape of the high-mass end of the IMF in the Arches cluster, Westerlund 1, R136 and NGC 3603, as well as with the IMF independently constrained for ultra-compact dwarf galaxies (UCDs). The latter suggests that GCs and UCDs might have formed along the same channel or that UCDs formed via mergers of GCs. A fundamental plane is found which describes the variation of the IMF with density and metallicity of the pre-GC cloud-cores. The implications for the evolution of galaxies and chemical enrichment over cosmological times are expected to be major.

Accepted by Monthly Notices Of The Royal Astronomical Society

http://esoads.eso.org/doi/10.1111/j.1365-2966.2012.20767.x
http://de.arxiv.org/abs/1202.4755

A Structural Analysis of Star-Forming Region AFGL 490

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We present *Spitzer* IRAC and MIPS observations of the star-forming region containing intermediate-mass young stellar object (YSO) AFGL 490. We supplement these data with near-IR 2MASS photometry and with deep SQIID observations off the central high extinction region. We have more than doubled the known membership of this region to 57 Class I and 303 Class II YSOs via the combined 1-24 μm photometric catalog derived from these data. We construct and analyze the minimum spanning tree of their projected positions, isolating one locally over-dense cluster core containing 219 YSOs (60.8% of the region's members). We find this cluster core to be larger yet less dense than similarly analyzed clusters. Although the structure of this cluster core appears irregular, we demonstrate that the parsec-scale surface densities of both YSOs and gas are correlated with a power law slope of 2.8, as found for other similarly analyzed nearby molecular clouds. We also explore the mass segregation implications of AFGL 490's offset from the center of its core, finding that it has no apparent preferential central position relative to the low-mass members. We present *Spitzer* IRAC and MIPS observations of the star-forming region containing intermediate-mass young stellar object (YSO) AFGL 490. We supplement these data with near-IR 2MASS photometry and with deep SQIID observations off the central high extinction region. We have more than doubled the known membership of this region to 57 Class I and 303 Class II YSOs via the combined 1-24 μm photometric catalog derived from these data. We construct and analyze the minimum spanning tree of their projected positions, isolating one locally over-dense cluster core containing 219 YSOs (60.8% of the region's members). We find this cluster core to be larger yet less dense than similarly analyzed clusters. Although the structure of this cluster core appears irregular, we demonstrate that the parsec-scale surface densities of both YSOs and gas are correlated with a power law slope of 2.8, as found for other similarly analyzed nearby molecular clouds. We also explore the mass segregation implications of AFGL 490's offset from the center of its core, finding that it has no apparent preferential central position relative to the low-mass members.

Accepted by Astrophys. J.

http://arxiv.org/abs/1204.3110

Bayesian fitting of Taurus brown dwarf spectral energy distributions

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We present derived stellar and disc parameters for a sample of Taurus brown dwarfs both with and without evidence of an associated disc. These parameters have been derived using an online fitting tool (http://bd-server.astro.ex.ac.uk/), which includes a statistically robust derivation of uncertainties, an indication of pa- rameter degeneracies, and a complete treatment of the input photometric and spectroscopic observations. The observations of the Taurus members with indications of disc presence have been fitted using a grid of theoretical models including detailed treatments of physical processes accepted for higher mass stars, such as dust sublimation, and a simple treatment of the accretion flux. This grid of models has been designed to test the validity of the adopted physical mechanisms, but we have also constructed models using parameterisation, for example semi-empirical dust sublimation radii, for users solely interested in parameter derivation and the quality of the fit. The parameters derived for the naked and disc brown dwarf systems are largely consistent with literature observations. However, our inner disc edge locations are consistently closer to the star than previous results and we also derive elevated accretion rates over non-SED based accretion rate derivations. For inner edge locations we attribute these differences to the detailed modelling we have performed of the disc structure, particularly at the crucial inner edge where departures in geometry from the often adopted vertical wall due to dust sublimation (and therefore accretion flux) can compensate for temperature (and therefore distance) changes to the inner edge of the dust disc. In the case of the elevated derived accretion rates, in some cases, this may be caused by the intrinsic stellar luminosities of the targets exceeding that predicted by the isochrones we have adopted.

Accepted by MNRAS

http://bd-server.astro.ex.ac.uk/

LABOCA 870 μm dust continuum mapping of selected infrared-dark cloud regions in the Galactic plane

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Context. Imaging surveys of dust continuum emission at (sub)millimetre wavelengths provide a powerful tool to study molecular clouds and the early stages of star formation.
Aims. Through submm dust continuum mapping, we attempt to search for genuine infrared dark clouds (IRDCs) and precursors to massive stars and stellar clusters in the Galactic plane, and to determine their basic physical properties.
Methods. We have mapped four selected about $0.5^{\circ} \times 0.5^{\circ}$-sized fields containing *Spitzer* 8-μm dark regions with APEX/LABOCA at 870 μm. Selected positions in the fields were observed in $C^{17}O(2-1)$ to obtain kinematic information. The obtained LABOCA maps are used in conjunction with the *Spitzer* IR images.
Results. The total number of clumps identified in this survey is 91, out of which 40 (44%) appear dark at 8 and 24 μm. The remaining clumps are associated with mid-IR emission. Seven clumps associated with extended-like 4.5 μm emission are candidate extended green objects (EGOs). Filamentary dust "ridges" were found towards the *Spitzer* bubbles N10/11 in one of our fields. The relative number of IR-dark and IR-bright clumps suggest that the duration of the former stage is about 1.6×10^5 yr. The mass distribution of the total sample of clumps, and that separately constructed for the IR-dark and IR-bright clumps, could be fitted at the high-mass end with the power-law function $\mathrm{d}N/\mathrm{d}\log M \propto M^{-\Gamma}$, where $\Gamma \simeq 0.7 \ldots 0.8$. The $C^{17}O$ observation positions appear to be dominated by non-thermal motions, and the data also revealed some potential sites of strong CO depletion. In G11.36+0.80, which is the best example of a filamentary IRDC in our sample, the clumps appear to be gravitationally bound. The fragmentation of the filament can be understood in terms of a "sausage"-type fluid instability, in agreement with the results for other IRDCs. The fragmentation and the CO depletion timescales in G11.36 appear to be very similar to each other.
Conclusions. Many of the identified clumps are massive enough to allow high-mass star formation, and some of them already show clear signposts of that. In the N10/11 bubble environment, the morphology of the detected dust emission conforms to the triggered high-mass star formation in the system. The clump mass distributions are similar to those found for diffuse CO clumps, and can be explained by the action of supersonic turbulence. The formation of filamentary IRDCs might be caused by converging turbulent flows, and the same process may play a role in exciting the fluid perturbations responsible for the fragmentation of the clouds into clumps.

Accepted by Astronomy and Astrophysics

Kinematics and the origin of the internal structures in HL Tau jet (HH 151)

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Knotty structures of Herbig-Haro jets are common phenomena, and knowing the origin of these structures is essential for understanding the processes of jet formation. Basically, there are two theoretical approaches: different types of instabilities in stationary flow, and velocity variations in the flow.
We investigate the structures with different radial velocities in the knots of the HL Tau jet as well as its unusual behaviour starting from 20 arcsec from the source. Collation of radial velocity data with proper motion measurements of emission structures in the jet of HL Tau makes it possible to understand the origin of these structures and decide on the mechanism for the formation of the knotty structures in Herbig-Haro flows.
We present observations obtained with a 6 m telescope (Russia) using the SCORPIO camera with scanning Fabry-Perót interferometer. Two epochs of the observations of the HL/XZ Tau region in Hα emission (2001 and 2007) allowed us to measure proper motions for high and low radial velocity structures.
The structures with low and high radial velocities in the HL Tau jet show the same proper motion. The point where the HL Tau jet bents to the north (it coincides with the trailing edge of so-called knot A) is stationary, i.e. does not have any perceptible proper motion and is visible in Hα emission only. We conclude that the high- and low- velocity structures in the HL Tau jet represent bow-shocks and Mach disks in the internal working surfaces of episodic outflows. The bend of the jet and the brightness increase starting some distance from the source coincides with the observed stationary deflecting shock. The increase of relative surface brightness of bow-shocks could be the result of the abrupt change of the physical conditions of the ambient medium as well as the interaction of a highly collimated flow and the side wind from XZ Tau.

Accepted by Astronomy and Astrophysics

http://arxiv.org/abs/1203.4074

Mass and luminosity evolution of young stellar objects

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A model of protostar mass and luminosity evolution in clusters gives new estimates of cluster age, protostar birthrate, accretion rate and mean accretion time. The model assumes constant protostar birthrate, core-clump accretion, and equally likely accretion stopping. Its parameters are set to reproduce the initial mass function, and to match protostar luminosity distributions in nearby star-forming regions. It obtains cluster ages and birthrates from the observed numbers of protostars and pre-main sequence (PMS) stars, and from the modal value of the protostar luminosity. In 31 embedded clusters and complexes the global cluster age is 1-3 Myr, matching available estimates based on optical spectroscopy and evolutionary tracks. This method of age estimation is simpler than optical spectroscopy, and is more useful for young embedded clusters where optical spectroscopy is not possible. In the youngest clusters, the protostar fraction decreases outward from the densest gas, indicating that the local star-forming age increases outward from a few 0.1 Myr in small protostar-dominated zones to a few Myr in large PMS-dominated zones.

Accepted by The Astrophysical Journal

http://arxiv.org/abs/1204.1032

Subarcsecond resolution observations of warm water toward three deeply embedded low-mass protostars

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Context. Water is present during all stages of star formation: as ice in the cold outer parts of protostellar envelopes and dense inner regions of circumstellar disks, and as gas in the envelopes close to the protostars, in the upper layers of circumstellar disks and in regions of powerful outflows and shocks. Because of its key importance in the understanding of its origin in our own solar system, following the evolution of water all the way to the planet-forming disk is a fundamental task in research in star formation and astrochemistry.
Aims. In this paper we probe the mechanism regulating the warm gas-phase water abundance in the innermost hundred AU of deeply embedded (Class 0) low-mass protostars, and investigate its chemical relationship to other molecular species during these stages.
Methods. Millimeter wavelength thermal emission from the para-$H_2^{18}O$ $3_{1,3} - 2_{2,0}$ (E_u=203.7 K) line is imaged at high angular resolution ($0\farcs75$; 190 AU) with the IRAM Plateau de Bure Interferometer toward the deeply embedded low-mass protostars NGC 1333-IRAS2A and NGC 1333-IRAS4A.
Results. Compact $H_2^{18}O$ emission is detected toward IRAS2A and one of the components in the IRAS4A binary; in addition CH_3OCH_3, C_2H_5CN, and SO_2 are detected. Extended water emission is seen toward IRAS2A, possibly associated with the outflow.
Conclusions. The results complement a previous detection of the same transition toward NGC 1333-IRAS4B. The detections in all systems suggests that the presence of water on $\lesssim 100$ AU scales is a common phenomenon in embedded protostars and that the non-detections of hot water with *Spitzer* toward the two systems studied in this paper are likely due to geometry and high extinction at mid-infrared wavelengths. We present a scenario in which the origin of the emission from warm water is in a flattened disk-like structure dominated by inward motions rather than rotation. The gas-phase water abundance varies between the sources, but is generally much lower than a canonical abundance of 10^{-4}, suggesting that most water (>96%) is frozen out on dust grains at these scales. The derived abundances of CH_3OCH_3 and SO_2 relative to $H_2^{18}O$ are comparable for all sources pointing toward similar chemical processes at work. In contrast, the C_2H_5CN abundance relative to $H_2^{18}O$ is significantly lower in IRAS2A, which could be due to different chemistry in the sources.

Accepted by Astronomy & Astrophysics

http://arxiv.org/abs/1203.4969

Formation of chondrules in magnetic winds blowing through the proto-asteroid belt

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Chondrite meteorites are believed to represent the building blocks of the solar nebula, out of which our solar system formed. They are a mixture of silicate and oxide objects (chondrules and refractory inclusions) that experienced extremely high temperatures, set in a matrix that remained relatively cold. The prevalence of chondrites suggests that they formed through a very general process, related to stellar and planet formation. The nature of this mechanism, however, remains obscure as astronomical observations of star-forming regions suggest a relatively cold environment. Here we show how refractory objects could have been thermally processed in a radially-extended wind, accelerated magnetically from the surfaces of a protostellar disc. In this scenario, refractory precursor aggregates are heated while being lifted in the wind, growing through amalgamation, and eventually becoming heavy enough to drop back to the disc, where they assemble with the matrix. We show that processing at radial distances of about 1–3 AU can produce temperatures in the appropriate regime to melt chondrules and explain their basic properties, while retaining association with the colder material that provides the chondrite matrix. This mechanism is very general, as these energetic winds are commonly associated with stellar formation.

Accepted by Earth and Planetary Science Letters

Globules and pillars seen in the [CII] 158 μm line with SOFIA

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Molecular globules and pillars are spectacular features, found only in the interface region between a molecular cloud and an HII-region. Impacting Far-ultraviolet (FUV) radiation creates photon dominated regions (PDRs) on their surfaces that can be traced by typical cooling lines. With the GREAT receiver onboard SOFIA we mapped and spectrally resolved the [CII] 158 micron atomic fine-structure line and the highly excited 12CO J=11-10 molecular line from three objects in Cygnus X (a pillar, a globule, and a strong IRAS source). We focus here on the globule and compare our data with existing Spitzer data and recent Herschel Open-Time PACS data. Extended [CII] emission and more compact CO-emission was found in the globule. We ascribe this emission mainly to an internal PDR, created by a possibly embedded star-cluster with at least one early B-star. However, external PDR emission caused by the excitation by the Cyg OB2 association cannot be fully excluded. The velocity-resolved [CII] emission traces the emission of PDR surfaces, possible rotation of the globule, and high-velocity outflowing gas. The globule shows a velocity shift of 2 km/s with respect to the expanding HII-region, which can be understood as the residual turbulence of the molecular cloud from which the globule arose. This scenario is compatible with recent numerical simulations

that emphazise the effect of turbulence. It is remarkable that an isolated globule shows these strong dynamical features traced by the [CII]-line, but it demands more observational studies to verify if there is indeed an embedded cluster of B-stars.

Accepted by Astronomy and Astrophysics, Letters

http://arxiv.org/abs/1203.6307

Cluster-formation in the Rosette molecular cloud at the junctions of filaments

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For many years feedback processes generated by OB-stars in molecular clouds, including expanding ionization fronts, stellar winds, or UV-radiation, have been proposed to trigger subsequent star formation. However, hydrodynamic models including radiation and gravity show that UV-illumination has little or no impact on the global dynamical evolution of the cloud. Instead, gravitational collapse of filaments and/or merging of filamentary structures can lead to building up dense high-mass star-forming clumps. However, the overall density structure of the cloud has a large influence on this process, and requires a better understanding. The Rosette molecular cloud, irradiated by the NGC2244 cluster, is a template region for triggered star-formation, and we investigated its spatial and density structure by applying a curvelet analysis, a filament-tracing algorithm (DisPerSE), and probability density functions (PDFs) on Herschel column density maps, obtained within the HOBYS key program. The analysis reveals not only the filamentary structure of the cloud but also that all known infrared clusters except one lie at junctions of filaments, as predicted by turbulence simulations. The PDFs of sub-regions in the cloud show systematic differences. The two UV-exposed regions have a double-peaked PDF we interprete as caused by shock compression, while the PDFs of the center and other cloud parts are more complex, partly with a power-law tail. A deviation of the log-normal PDF form occurs at Av 9m for the center, and around 4m for the other regions. Only the part of the cloud farthest from the Rosette nebula shows a log-normal PDF. The deviations of the PDF from the log-normal shape typically associated with low- and high-mass star-forming regions at Av 3-4m and 8-10m, respectively, are found here within the very same cloud. This shows that there is no fundamental difference in the density structure of low- and high-mass star-forming regions. We conclude that star-formation in Rosette - and probably in high-mass star-forming clouds in general - is not globally triggered by the impact of UV-radiation. Moreover, star formation takes place in filaments that arose from the primordial turbulent structure built up during the formation of the cloud. Clusters form at filament mergers, but star formation can be locally induced in the direct interaction zone between an expanding HII–region and the molecular cloud.

Accepted by Astronomy and Astrophysics, Letters

http://arxiv.org/abs/1203.6472

Multiwavelength Study of NGC 281 Region

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We present a multiwavelength study of the NGC 281 complex which contains the young cluster IC 1590 at the center, using deep wide-field optical $UBVI_c$ photometry, slitless spectroscopy along with archival data sets in the near-infrared (NIR) and X-ray. The extent of IC 1590 is estimated to be ∼6.5 pc. The cluster region shows a relatively small amount of differential reddening. The majority of the identified young stellar objects (YSOs) are low mass PMS stars having age $< 1-2$ Myr and mass 0.5-3.5 $M_\odot$. The slope (Γ) of the mass function for IC 1590, in the mass range $2 < M/M_\odot \leq 54$, is found to be -1.11 ± 0.15.The slope of the K-band luminosity function (0.37 ± 0.07) is similar to the average value (∼0.4) reported for young clusters. The distribution of gas and dust obtained from the IRAS, CO and radio maps indicates clumpy structures around the central cluster. The radial distribution of the young stellar objects, their ages, $\Delta(H-K)$ NIR-excess, and the fraction of classical T Tauri stars suggest triggered star formation at the periphery of the cluster region. However, deeper optical, NIR and MIR observations are needed to have a conclusive view of star formation scenario in the region. The properties of the Class 0/I and Class II sources detected by using the *Spitzer* mid-infrared observations indicate that a majority of the Class II sources are X-ray emitting stars, whereas X-ray emission is absent from the Class 0/I sources. The spatial distribution of Class 0/I and Class II sources reveals the presence of three sub-clusters in the NGC 281 West region.

Accepted by PASJ

http://arxiv.org/abs/1204.2897

PAHs in protoplanetary disks: emission and X–ray destruction

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We study the PAH emission from protoplanetary disks. First, we discuss the dependence of the PAH band ratios on the hardness of the absorbed photons and the temperature of the stars. We show that the photon energy together with a varying degree of the PAH hydrogenation accounts for most of the observed PAH band ratios without the need to change the ionization degree of the molecules. We present an accurate treatment of stochastic heated grains in a vectorized three dimensional Monte Carlo dust radiative transfer code. The program is verified against results using ray tracing techniques. Disk models are presented for T Tauri and Herbig Ae stars. Particular attention is given to the photo-dissociation of the molecules. We consider beside PAH destruction also the survival of the molecules by vertical mixing within the disk. By applying typical X-ray luminosities the model accounts for the low PAH detection probability observed in T Tauri and the high PAH detection statistics found in Herbig Ae disks. Spherical halos above the disks are considered. We show that halos reduce the observed PAH band-to-continuum ratios when observed at high inclination. Finally, mid-IR images of disks around Herbig Ae disks are presented. We show that they are easier to resolve when PAH emission dominate.

Accepted by A&A

Spatially resolving substructures within the massive envelope around an intermediate-mass protostar MMS 6/OMC-3

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With the Submillimeter Array, the brightest (sub)millimeter continuum source in the OMC-2/3 region, MMS 6, has been observed in the 850 μm continuum emission with approximately 10 times better angular resolution than previous studies ($\sim$0.3″; $\sim$120 AU at Orion). The deconvolved size, the mass, and the column density of MMS 6-main are estimated to be $0''.32\times0''.29$ (132 AU$\times$120 AU), 0.29 $M_\odot$, and 2.1×10^{25} cm^{-2}, respectively. The estimated extremely high mean number density, 1.5×10^{10} cm^{-3}, suggests that MMS 6-main is likely optically thick at 850 μm. We compare our observational data with three theoretical core models: prestellar core, protostellar core + disk-like structure, and first adiabatic core. These comparisons clearly show that the observational data cannot be modeled as a simple prestellar core with a gas temperature of 20 K. A self-luminous source is necessary to explain the observed flux density in the (sub)millimeter wavelengths. Our recent detection of a very compact and energetic outflow in the CO (3-2) and HCN (4-3) lines, supports the presence of a protostar. We suggest that MMS 6 is one of the first cases of an intermediate mass protostellar core at an extremely young stage. In addition to the MMS 6-main peak, we have also spatially resolved a number of spiky structures and sub-clumps, distributed over the central 1000 AU. The masses of these sub-clumps are estimated to be 0.066-0.073 $M_\odot$, which are on the order of brown dwarf masses. Higher angular resolution and higher sensitivity observations with ALMA and EVLA will reveal the origin and nature of these structures such as whether they are originated from fragmentations, spiral arms, or inhomogeneity within the disk-like structures/envelope.

Accepted by ApJ

http://arxiv.org/abs/1204.2543

Spitzer observations of NGC 2264: the nature of the disk population

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Aims: NGC 2264 is a young cluster with a rich circumstellar disk population which makes it an ideal target for studying the evolution of stellar clusters. Our goal is to study the star formation history of NGC 2264 and to analyse the primordial disk evolution of its members.
Methods: The study presented is based on data obtained with the Infrared Array Camera (IRAC) and the Multiband Imaging Photometer for Spitzer (MIPS) on board the Spitzer Space Telescope, combined with deep near-infrared (NIR) ground-based FLAMINGOS imaging and previously published optical data.
Results: We build NIR dust extinction maps of the molecular cloud associated with the cluster, and determine it to have a mass of 2.1×10^3 M_{sun} above an A_V of 7 mag. Using a differential Ks-band luminosity function (KLF) of the cluster, we estimate the size of the population of NGC 2264, within the area observed by FLAMINGOS, to be 1436 $\pm$ 242 members. The star formation efficiency is $\geq\sim 25\%$. We identify the disk population and divide it into 3 groups based on their spectral energy distribution slopes from 3.6 μm to 8 μm and on the 24 μm excess emission: (i) optically thick inner disks, (ii) anaemic inner disks, and (iii) disks with inner holes, or transition disks. We analyse the spatial distribution of these sources and find that sources with thick disks segregate into sub-clusterings, whereas sources with anaemic disks do not. Furthermore, sources with anaemic disks are found to be unembedded (i.e., with $A_V < 3$ mag), whereas the clustered sources with thick disks are still embedded within the parental cloud.
Conclusions: NGC 2264 has undergone more than one star-forming event, where the anaemic and extincted thick disk population appear to have formed in separate episodes: the sources with anaemic disks are more evolved and have had time to disperse and populate a halo of the cluster. We also find tentative evidence of triggered star-formation in the Fox Fur Nebula. In terms of disk evolution, our findings support the emerging disk evolution paradigm of two distinct evolutionary paths for primordial optically thick disks: a homologous one where the disk emission decreases uniformly at NIR and mid-infrared (MIR) wavelengths, and a radially differential one where the emission from the inner region of the disk decreases more rapidly than from the outer region (forming transition disks).

Accepted by Astronomy and Astrophysics (2012, A&A, 540, 83)

http://de.arxiv.org/abs/1203.3754

Professor or Associate Professor in Star and Planet Formation at the University of Exeter

Contact: Isabelle Baraffe (i.baraffe@ex.ac.uk)

The College of Engineering, Mathematics and Physical Sciences invites applications for a Professor or Associate Professor in Astrophysics at the University of Exeter (Reference of the post R11166). This post aims to expand current research performed in the Astrophysics group at the University of Exeter, in areas related or complementary to star and planet formation, hydrodynamical and MHD processes in stars and planets, extra-solar planets and planetary atmospheres (see webpage http://www.astro.ex.ac.uk/). Candidates in theoretical, observational or computational astrophysics and in other interdisciplinary fields related to star and planet formation will be considered. The group has strong links with Applied Mathematics at the University of Exeter and with the Met Office (also in Exeter). Suitable candidates will bring research that will expand and strengthen astrophysics at the University.

We are looking for innovative researchers with an international reputation and with a strong track record of research funding and international quality publications. The successful candidate will have the ability to attract world-class researchers and students and will contribute to relevant areas of teaching as appropriate.

The Professor remuneration will reflect the international quality of the person we seek to appoint. Associate Professor starting salary will be 51,424 - 64,788 per annum on Grade H.

Applicants are encouraged to contact the Dean of the College, Prof Ken Evans (email: K.E.Evans@exeter.ac.uk) to discuss the post further. Informal enquiries can be made to Prof Isabelle Baraffe (tel 01392 725123 email: I.Baraffe@exeter.ac.uk). You may also wish to consult our web site at emps.exeter.ac.uk/research for further details of the College.

For further details and to apply on line visit www.exeter.ac.uk/jobs, searching under reference number R11166

The closing date for completed applications is midnight on 2 July 2012

Postdoctoral Position in Observational Star Formation in Madrid

The Centro de Astrobiologia (CAB, CSIC-INTA, Spain) and the Observatorio Astronomico Nacional (OAN-IGN, Spain) offer one postdoctoral contract (1 + 1 years) in the field of Star Formation. The successful candidate will work under the supervision of Mario Tafalla and a collaborator from the CAB, and will be involved in the study of the earliest phases of stellar birth. There is some flexibility in the exact topic of research, which depending on the interest of the candidate can focus on different aspects of dense core formation and evolution or the physics and chemistry of bipolar outflows. Other lines of work may be considered if they have a natural connection to the above two topics.

In order to apply, the candidate must have a PhD in astronomy, astrophysics, or related discipline (or expect to have one by early July). Experience in star-formation studies, radio astronomical observations, and/or radiative transfer calculations will be highly valued. The contract is available in the framework of the Consolider-Ingenio Research Project "Molecular Astrophysics: The Herschel and ALMA Era" led by José Cernicharo, and will be awarded by the Spanish CAB-CSIC. A brief CV, statement of research interests, and contact information for at least two referees should be sent to Mario Tafalla (m.tafalla@oan.es). The deadline for applications is 31 May 2012, and the starting date of the contract is negotiable but should not be later than 1 December 2012. Bachelor and PhD degrees granted by non-Spanish universities need to be accredited by a Spanish institution, and the interested candidate should contact Mario Tafalla for instructions on how to initiate the process.

The gross annual pre-tax income including health insurance contributions and social security is in the range of 35,000 EUR. Additional funds are available to cover travel expenses and participation in conferences.

For further inquiries, please contact Mario Tafalla (m.tafalla@oan.es).

Principles of Star Formation

Peter H. Bodenheimer

This book provides a detailed discussion of the processes involved in the formation of stars. Starting with molecular cloud properties and the initial conditions for star formation, the book discusses collapse and the formation of protostars, and the evolution of accretion disks and pre-main sequence stars. Other chapters focus on the birth of massive stars, and the formation of the first stars in the Universe. A detailed discussion of the processes leading to the formation of binary stars is also presented. The book finishes with an overview of the formation and early evolution of stars, with an emphasis on the issues that are either controversial or still poorly understood. The book gives more than 500 references to the research literature, allowing the reader to pursue further details. There is substantial discussion of observations throughout the book, but since the author is a distinguished theoretician, the text is weighted towards the theory of star formation. The book will serve very well as a textbook for a graduate course in star formation.

The book contains the following chapters:

Contents

1. Overview
1.1 Basic Questions: Star Formation
1.2 Observations of Objects in Star-Forming Regions
1.3 Star Formation Phases
1.4 Appendix to Chap.1: Derivation of the Free-Fall Time

2. Molecular Clouds and the Onset of Star Forrmation
2.1 Molecular Cloud Properties
2.2 Initial Conditions for Star Formation
2.3 Heating and Cooling
2.4 Magnetic Braking
2.5 Degree of Ionization
2.6 Magnetic Diffusion
2.7 How is Star Formation Initiated?
2.8 Turbulence and Star Formation
2.9 Induced Star formation
2.10 Summary
2.11 Appendix to Chap.2: Note on Numerical Methods
2.12 Problems

3. Protostar Collapse
3.1 Protostellar Initial Conditions
3.2 Isothermal Collapse
3.3 Adiabatic Collapse
3.4 Accretion Phase
3.5 Comparison with Observations
3.6 Summary
3.7 Problems

4. Rotating Protostars and Accretion Disks
4.1 Disk Formation
4.2 Observations of Disks
4.3 Basic Theory of Disk Evolution
4.4 General Results of Disk Evolution
4.5 Disk Dispersal

4.6 Winds and Outflows
4.7 Summary of Disk Evolution
4.8 Problems

5. Massive Star Formation
5.1 Information from Observations
5.2 The Problem of Radiation Pressure
5.3 Full 3D with Radiation Pressure
5.4 Massive Star Formation: Competitive Accretion or Monolithic Collapse?
5.5 Summary
5.6 Appendix to Chap.5: Determination of the IMF
5.7 Problems

6. Formation of Binary Systems
6.1 Observational Data
6.2 Basic Formation Mechanisms
6.3 Capture
6.4 Fission
6.5 Fragmentation
6.6 Summary
6.7 Problems

7. The Formation of the First Stars
7.1 Physics of the First Stars
7.2 Sequence of Events During Formation
7.3 Dark Matter Annihilation in the First Stars
7.4 Summary
7.5 Problems

8. Pre-Main Sequence Evolution
8.1 Physical Relations
8.2 Pre-Main Sequence Evolutionary Tracks
8.3 Comparison with Observations
8.4 Summary
8.5 Problems

9. Summary: Issues in Galactic Star Formation
9.1 Molecular Clouds
9.2 The Initial Mass Function
9.3 Protostar Collapse
9.4 Binary and Multiple Systems
9.5 Star Formation in the Early Universe
9.6 Massive Stars
9.7 Young Stars and Disks
9.8 Rate and Efficiency

Springer 2011, ISBN 978-3-642-15062-3
343 pages, hardcover US$124.00
Available from http://rd.springer.com/book/10.1007/978-3-642-15063-0/page/1

Protostars and Planets VI: Call for Papers!

Deadline 15th September 2012

Protostars and Planets VI
15 - 20 July 2013, Heidelberg Germany
Web-site: www.ppvi.org

The Protostars and Planets series has served the community for more than three decades with state of the art compilations of the current knowledge in the fields of star and planet formation. The previous volume PPV was published in 2007. Since then, the field of protostars and planets has advanced tremendously, from a theoretical as well as observational point of view.

The next Protostars and Planets conference will take place in Heidelberg, Germany, July 15 - 20, 2013. For more details about schedule and location, please visit the conference web-page www.ppvi.org.

A primary outcome of the conference will be the Protostars and Planets VI book of review articles. Although the meeting is still more than one year ahead, the logistics of preparing excellent overview articles and getting them into print in due time requires timely organization. Therefore, we ask you to submit proposals for review chapters and associated talks by October 1st 2012. The respective deadlines and dates are:

April 16th, 2012: Call for review chapter and talk proposals
Sept. 15, 2012: Submit your proposals
Nov. 15th, 2012: Decision on review chapters and talks
April 15th, 2013: Extended skeleton papers to be submitted to the board
December 1st, 2012: Registration to conference opens (including posters)
May 15th, 2013: End of early registration (late registration at elevated registration fee will be possible)
July 15th, 2013: Submission of the final article

We encourage different groups to join forces and present combined reviews where the competing schools of thoughts are discussed in context and where common grounds as well as controversies are explored in an unbiased and objective way. We see this as a very important aspect of the scientific value of the conference and the resulting book. We aim for about 30 chapters with about 30 pages each, and invite everybody in the community to propose a chapter and associated talk for Protostars and Planets VI. As done during previous incarnations of Protostars and Planets, each review chapter will be presented by a talk during the conference. The speaker may be the PI of the chapter but it may also be a Co-I to increase the visibility of various members of the teams. The Scientific Advisory Committee (SAC) encourages such a split approach. As guideline for the structure of the conference and book, the SAC and the editors found it useful to compile the following topics/chapters. We note that this list is not binding and further suggestions and proposals are welcome.

Star Formation
- Formation of molecular clouds and global conditions for star formation
e.g., converging flows, turbulence, HI to H2 conversion, magnetic fields filamentary structures
- Formation of individual stars and clusters
e.g., low- and high-mass star formation, core fragmentation, origin of IMF, magnetic fields
- Origin of stellar multiplicity
e.g., binaries and higher order systems, core fragmentation
- Importance of stellar feedback
e.g., winds, outflows, radiation
- Collapse and formation of protostellar disks
e.g., chemical evolution, main protostellar accretion phase (class 0), outflows, accretion rates, episodic accretion, magnetic fields environmental conditions
- Formation of very low-mass stars, brown dwarfs and free-floating planets
- A unified picture from low- to high-mass and "isolated" to clustered" star formation?

Formation and evolution of protoplanetary disks
- Physical characteristics of disks
e.g., disk sizes, masses, structure, characteristics, transition disks environmental conditions
- Gas evolution in disks
e.g., initial conditions, chemistry, effects of stellar type
- Dust evolution in disks
- Protoplanetary disks in cluster environment
e.g., radiation from O stars, dynamic interaction
- Cosmochemical constraints on disk evolution
e.g., isotopes in solar system, crystals, mixing, stardust
- Disk dynamics
e.g. dead zone, viscosity, stability, turbulence, instabilities
- Disk dissipation
e.g., photoevaporation, disk winds, transition disks

Planet formation and planetary systems
- Planetesimal formation
e.g., dust growth, gravoturbulence
- Terrestrial planet formation
- Giant planet formation
e.g., core accretion and disk instabilities
- Planet-disk interaction
e.g., migration, gaps
- Structure and evolution of debris disks
- Long term dynamical evolution of planetary systems
e.g., isolated and in clusters
- Chemical evolution of planetary systems
e.g., primitive matter in the solar system (refractory, ices, vapor), meteoritics
- Planetary system architecture
e.g. observations, size, mass, composition, orbits, resonances, misalignment
- The solar system in context of planet formation
e.g., asteroids, comets, KBOs, planets: orbits, masses
- Dating of major events in the solar system by isotope studies
- Planetary internal structures
e.g., terrestrial and giants, bloated, core masses, envelope structures
- Planetary atmospheres
e.g., terrestrial and giants
- Population synthesis

Astrophysical conditions for life
- Habitability
e.g., stellar distance to get water, moon, UV/X-rays
- Geochemical landscape for the formation of life
e.g., geochemical cycles, tectonics
- Formation of life
e.g., formation of cells and astrophysical signatures, left-right amino-acids

Scientific Advisory Committee (SAC): Philippe Andre, Javier Ballesteros-Paredes, Isabelle Baraffe, Alan Boss, John Bradley, Nuria Calvet, Gael Chauvin, Therese Encrenaz, Guido Garay, Tristan Guillot, Nader Haghighipour, Shigeru Ida, Ray Jayawardhana, Willy Kley, Alexander Krot, Katharina Lodders, Karl Menten, Michael Meyer, Alessandro Morbidelli, Ralph Pudritz, Bo Reipurth, Dimitar Sasselov, Motohide Tamura, Ewine van Dishoeck, Stephane Udry, Alycia Weinberger

Looking forward to exciting proposals!

Henrik Beuther, Ralf Klessen, Kees Dullemond, Thomas Henning

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).

Latex macros for submitting abstracts and dissertation abstracts (by e-mail to reipurth@ifa.hawaii.edu) are appended to each issue of the newsletter. You can also submit via the Newsletter web interface at http://www2.ifa.hawaii.edu/star-formation/index.cfm
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