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Abstracts of recently accepted papers

PynPoint: An Image Processing Package for Finding Exoplanets

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We present the scientific performance results of PynPoint, our Python-based software package that uses principle component analysis to detect and estimate the flux of exoplanets in two dimensional imaging data. Recent advances in adaptive optics and imaging technology at visible and infrared wavelengths have opened the door to direct detections of planetary companions to nearby stars, but image processing techniques have yet to be optimized. We show that the performance of our approach gives a marked improvement over what is presently possible using existing methods such as LOCI. To test our approach, we use real angular differential imaging (ADI) data taken with the adaptive optics assisted high resolution near-infrared camera NACO at the VLT. These data were taken during the commissioning of the apodising phase plate (APP) coronagraph. By inserting simulated planets into these data, we test the performance of our method as a function of planet brightness for different positions on the image. We find that in all cases PynPoint has a detection threshold that is superior to that given by our LOCI analysis when assessed in a common statistical framework. We obtain our best improvements for smaller inner working angles (IWA). For an IWA of ∼0.29" we find that we achieve a detection sensitivity that is a factor of 5 better than LOCI. We also investigate our ability to correctly measure the flux of planets. Again, we find improvements over LOCI, with PynPoint giving more stable results. Finally, we apply our package to a non-APP dataset of the exoplanet beta Pictoris b and reveal the planet with high signal-to-noise. This confirms that PynPoint can potentially be applied with high fidelity to a wide range of high-contrast imaging datasets.

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http://arxiv.org/abs/1207.6637

How to Find Young Massive Cluster Progenitors

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We propose that bound, young massive stellar clusters form from dense clouds that have escape speeds greater than the sound speed in photo-ionized gas. In these clumps, radiative feedback in the form of gas ionization is bottled up, enabling star formation to proceed to sufficiently high efficiency so that the resulting star cluster remains bound even after gas removal. We estimate the observable properties of the massive proto-clusters (MPCs) for existing Galactic plane surveys and suggest how they may be sought in recent and upcoming extragalactic observations. These surveys

will potentially provide a significant sample of MPC candidates that will allow us to better understand extreme star-formation and massive cluster formation in the Local Universe.

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Triggered star formation around mid-infrared bubbles in G8.14+0.23 H II region

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Mid-infrared (MIR) shells or bubbles around expanding H II regions have received much attention due to their ability to initiate a new generation of star formation. We present multi-wavelength observations around two bubbles associated with a southern massive star-forming (MSF) region G8.14+0.23, to investigate the triggered star formation signature on the edges of the bubbles by the expansion of the H II region. We have found observational signatures of the collected molecular and cold dust material along the bubbles and the ^{12}CO(J=3-2) velocity map reveals that the molecular gas in the bubbles is physically associated around the G8.14+0.23 region. We have detected 244 young stellar objects (YSOs) in the region and about 37% of these YSOs occur in clusters. Interestingly, these YSO clusters are associated with the collected material on the edges of the bubbles. We have found good agreement between the dynamical age of the H II region and the kinematical time scale of bubbles (from the ^{12}CO(J=3-2) line data) with the fragmentation time of the accumulated molecular materials to explain possible "collect-and-collapse" process around the G8.14+0.23 region. However, one can not entirely rule out the possibility of triggered star formation by compression of the pre-existing dense clumps by the shock wave. We have also found two massive embedded YSOs (about 10 and 22 $M_\odot$) which are associated with the dense fragmented clump at the interface of the bubbles. We conclude that the expansion of the H II region is also leading to the formation of these two young massive embedded YSOs in the G8.14+0.23 region.

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http://xxx.lanl.gov/pdf/1207.6842

Chemistry in the First Hydrostatic Core Stage Adopting Three-Dimensional Radiation Hydrodynamic Simulations

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We investigate molecular evolution from a molecular cloud core to a first hydrostatic core in three spatial dimensions. We perform a radiation hydrodynamic simulation in order to trace fluid parcels, in which molecular evolution is investigated, using a gas-phase and grain-surface chemical reaction network. We derive spatial distributions of molecular abundances and column densities in the core harboring the first core. We find that the total of gas and ice abundances of many species in a cold era (10 K) remain unaltered until the temperature reaches $\sim$500 K. The gas abundances in the warm envelope and the outer layer of the first core ($T < 500$ K) are mainly determined via the sublimation of ice-mantle species. Above 500 K, the abundant molecules, such as H_2CO, start to be destroyed, and simple molecules, such as CO, H_2O and N_2 are reformed. On the other hand, some molecules are effectively formed

at high temperature; carbon-chains, such as C_2H_2 and cyanopolyynes, are formed at the temperature of >700 K. We also find that large organic molecules, such as CH_3OH and $HCOOCH_3$, are associated with the first core ($r < 10$ AU). Although the abundances of these molecules in the first core stage are comparable or less than in the protostellar stage (hot corino), reflecting the lower luminosity of the central object, their column densities in our model are comparable to the observed values toward the prototypical hot corino, IRAS 16293-2422. We propose that these large organic molecules can be good tracers of the first cores.

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The Elephant Trunk Nebula and the Trumpler 37 cluster: Contribution of triggered star formation to the total population of an HII region

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Rich young stellar clusters produce HII regions whose expansion into the nearby molecular cloud is thought to trigger the formation of new stars. However, the importance of this mode of star formation is uncertain. This investigation seeks to quantify triggered star formation (TSF) in IC 1396A (a.k.a., the Elephant Trunk Nebula), a bright rimmed cloud (BRC) on the periphery of the nearby giant HII region IC 1396 produced by the Trumpler 37 cluster. X-ray selection of young stars from Chandra X-ray Observatory data is combined with existing optical and infrared surveys to give a more complete census of the TSF population. Over 250 young stars in and around IC 1396A are identified; this doubles the previously known population. A spatio-temporal gradient of stars from the IC 1396A cloud toward the primary ionizing star HD 206267 is found. We argue that the TSF mechanism in IC 1396A is the radiation-driven implosion process persisting over several million years. Analysis of the X-ray luminosity and initial mass functions indicates that > 140 stars down to 0.1 Msun were formed by TSF. Considering other BRCs in the IC 1396 HII region, we estimate the TSF contribution for the entire HII region exceeds $14-25\%$ today, and may be higher over the lifetime of the HII region. Such triggering on the periphery of HII regions may be a significant mode of star formation in the Galaxy.

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Cosmic-ray and X-ray Heating of Interstellar Clouds and Protoplanetary Disks

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Cosmic-ray and X-ray heating are derived from the electron energy loss calculations of Dalgarno, Yan and Liu for hydrogen-helium gas mixtures. These authors treated the heating from elastic scattering and collisional de-excitation of rotationally excited hydrogen molecules. Here we consider the heating that can arise from all ionization and excitation processes, with particular emphasis on the reactions of cosmic-ray and X-ray generated ions with the heavy neutral species, which we refer to as chemical heating. In molecular regions, chemical heating dominates and can account for 50% of the energy expended in the creation of an ion pair. The heating per ion pair ranges in the limit of negligible electron fraction from ~ 4.3 eV for diffuse atomic gas, to ~ 13 eV for the moderately dense regions of molecular clouds and to ~ 18 eV for the very dense regions of protoplanetary disks. An important general conclusion of this study is that cosmic-ray and X-ray heating depends on the physical properties of the medium, i.e., on the molecular and electron fractions, the total density of hydrogen nuclei, and to a lesser extent on the temperature. It is also noted that chemical heating, the dominant process for cosmic-ray and X-ray heating, plays a role in UV irradiated molecular gas.

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Can we predict the global magnetic topology of a pre-main sequence star from its position in the Hertzsprung-Russell diagram?

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Zeeman-Doppler imaging studies have shown that the magnetic fields of T Tauri stars can be significantly more complex than a simple dipole and can vary markedly between sources. We collect and summarize the magnetic field topology information obtained to date and present Hertzsprung-Russell (HR) diagrams for the stars in the sample. Intriguingly, the large scale field topology of a given pre-main sequence (PMS) star is strongly dependent upon the stellar internal structure, with the strength of the dipole component of its multipolar magnetic field decaying rapidly with the development of a radiative core. Using the observational data as a basis, we argue that the general characteristics of the global magnetic field of a PMS star can be determined from its position in the HR diagram. Moving from hotter and more luminous to cooler and less luminous stars across the PMS of the HR diagram, we present evidence for four distinct magnetic topology regimes. Stars with large radiative cores, empirically estimated to be those with a core mass in excess of ∼40% of the stellar mass, host highly complex and dominantly non-axisymmetric magnetic fields, while those with smaller radiative cores host axisymmetric fields with field modes of higher order than the dipole dominant (typically, but not always, the octupole). Fully convective stars stars above $\sim 0.5\,\mathrm{M}_\odot$ appear to host dominantly axisymmetric fields with strong (kilo-Gauss) dipole components. Based on similarities between the magnetic properties of PMS stars and main sequence M-dwarfs with similar internal structures, we speculate that a bistable dynamo process operates for lower mass stars ($< 0.5\,\mathrm{M}_\odot$ at an age of a few Myr) and that they will be found to host a variety of magnetic field topologies. If the magnetic topology trends across the HR diagram are confirmed they may provide a new method of constraining PMS stellar evolution models.

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IRAS 20050+2720: Anatomy of a young stellar cluster

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IRAS 20050+2720 is young star forming region at a distance of 700 pc without apparent high mass stars. We present results of our multiwavelength study of IRAS 20050+2720 which includes observations by *Chandra* and *Spitzer*, and

2MASS and UBVRI photometry. In total, about 300 YSOs in different evolutionary stages are found. We characterize the distribution of young stellar objects (YSOs) in this region using a minimum spanning tree (MST) analysis. We newly identify a second cluster core, which consists mostly of class II objects, about 10' from the center of the cloud. YSOs of earlier evolutionary stages are more clustered than more evolved objects. The X-ray luminosity function (XLF) of IRAS 20050+2720 is roughly lognormal, but steeper than the XLF of the more massive Orion nebula complex. IRAS 20050+2720 shows a lower N_H/A_K ratio compared with the diffuse ISM.

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A Virialized Filamentary Infrared Dark Cloud

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The initial conditions of massive star and star cluster formation are expected to be cold, dense and high column density regions of the interstellar medium, which can reveal themselves via near, mid and even far-infrared absorption as Infrared Dark Clouds (IRDCs). Elucidating the dynamical state of IRDCs thus constrains theoretical models of these complex processes. In particular, it is important to assess whether IRDCs have reached virial equilibrium, where the internal pressure balances that due to the self-gravitating weight of the cloud plus the pressure of the external environmental. We study this question for the filamentary IRDC G035.39-00.33 by deriving mass from combined NIR & MIR extinction maps and velocity dispersion from $C^{18}O$ (1-0) & (2-1) line emission. In contrast to our previous moderately super-virial results based on ^{13}CO emission and MIR-only extinction mapping, with improved mass measurements we now find that the filament is consistent with being in virial equilibrium, at least in its central parsec-wide region where $\sim 1000\,M_\odot$ snakes along several parsecs. This equilibrium state does not require large-scale net support or confinement by magnetic fields.

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The first detection of the 232 GHz vibrationally excited H_2O maser in Orion KL with ALMA

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We investigated the ALMA science verification data of Orion KL and found a spectral signature of the vibrationally excited H_2O maser line at 232.68670 GHz (ν_2=1, $5_{5,0}-6_{4,3}$). This line has been detected in circumstellar envelopes of late-type stars so far but not in young stellar objects including Orion KL. Thus, this is the first detection of the 232 GHz vibrationally excited H_2O maser in star-forming regions. The distribution of the 232 GHz maser is concentrated at the position of the radio Source I, which is remarkably different from other molecular lines. The spectrum shows a double-peak structure at the peak velocities of -2.1 and 13.3 km s^{-1}. It appears to be consistent with the 22 GHz H_2O masers and 43 GHz SiO masers observed around Source I. Thus, the 232 GHz H_2O maser around Source I would be excited by the internal heating by an embedded protostar, being associated with either the root of the outflows/jets

or the circumstellar disk around Source I, as traced by the 22 GHz H_2O masers or 43 GHz SiO masers, respectively.

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SOFIA/FORCAST and Spitzer/IRAC Imaging of the Ultra Compact H II Region W3(OH) and Associated Protostars in W3

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We present infrared observations of the ultra-compact H II region W3(OH) made by the FORCAST instrument aboard SOFIA and by Spitzer/IRAC. We contribute new wavelength data to the spectral energy distribution, which constrains the optical depth, grain size distribution, and temperature gradient of the dusty shell surrounding the H II region. We model the dust component as a spherical shell containing an inner cavity with radius ~ 600 AU, irradiated by a central star of type O9 and temperature $\sim 31,000$ K. The total luminosity of this system is 7.1×10^4 $L_\odot$. An observed excess of $2.2 - 4.5$ μm emission in the SED can be explained by our viewing a cavity opening or clumpiness in the shell structure whereby radiation from the warm interior of the shell can escape. We claim to detect the nearby water maser source W3 (H_2O) at 31.4 and 37.1 μm using beam deconvolution of the FORCAST images. We constrain the flux densities of this object at $19.7 - 37.1$ μm. Additionally, we present *in situ* observations of four young stellar and protostellar objects in the SOFIA field, presumably associated with the W3 molecular cloud. Results from the model SED fitting tool of Robitaille et al. (2006, 2007) suggest that two objects (2MASS J02270352+6152357 and 2MASS J02270824+6152281) are intermediate-luminosity ($\sim 236 - 432$ $L_\odot$) protostars; one object (2MASS J02270887+6152344) is either a high-mass protostar with luminosity 3×10^3 $L_\odot$ or a less massive young star with a substantial circumstellar disk but depleted envelope; and one object (2MASS J02270743+6152281) is an intermediate-luminosity (~ 768 $L_\odot$) protostar nearing the end of its envelope accretion phase or a young star surrounded by a circumstellar disk with no appreciable circumstellar envelope.

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Mid-Infrared Spectral Variability Atlas of Young Stellar Objects

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Optical and near-infrared variability is a well-known property of young stellar objects. However, a growing number of recent studies claim that a considerable fraction of them also exhibit mid-infrared flux changes. With the aim of studying and interpreting variability on a decadal timescale, here we present a mid-infrared spectral atlas containing observations of 68 low- and intermediate-mass young stellar objects. The atlas consists of 2.5–11.6 μm low-resolution spectra obtained with the ISOPHOT-S instrument on board the *Infrared Space Observatory* (*ISO*) between 1996 and 1998, as well as 5.2–14.5 μm low-resolution spectra obtained with the Infrared Spectrograph instrument on board the *Spitzer Space Telescope* between 2004 and 2007. The observations were retrieved from the *ISO* and *Spitzer* archives and were post-processed interactively by our own routines. For those 47 objects where multi-epoch spectra were available, we analyze mid-infrared spectral variability on annual and/or decadal timescales. We identify 37 variable candidate sources. Many stars show wavelength-independent flux changes, possibly due to variable accretion rates. In several systems, all exhibiting 10 μm silicate emission, the variability of the 6–8 μm continuum, and the silicate feature exhibit different amplitudes. A possible explanation is variable shadowing of the silicate-emitting region by an inner disk structure of changing height or extra silicate emission from dust clouds in the disk atmosphere. Our results suggest that mid-infrared variability, in particular, the wavelengthdependent changes, is more ubiquitous than was known before. Interpreting this variability is a new possibility for exploring the structure of the disk and its dynamical processes.

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Preprint: http://arxiv.org/abs/1204.3473
The spectra are available through the VizieR Service at:
http://vizier.u-strasbg.fr/viz-bin/VizieR?-source=J/ApJS/201/11

^{13}CO and C^{18}O $J = 2 - 1$ mapping of the environment of the Class 0 protostellar core SMM 3 in Orion B9

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Context. Observations of molecular spectral lines provide information on the gas kinematics and chemistry of star-forming regions.
Aims. We attempt to achieve a better understanding of the gas distribution and velocity field around the deeply embedded Class 0 protostar SMM 3 in the Orion B9 star-forming region.
Methods. Using the APEX 12-m telescope, we mapped the line emission from the $J = 2 - 1$ rotational transition of two CO isotopologues, ^{13}CO and C^{18}O, over a 4 arcmin $\times$ 4 arcmin region around Orion B9/SMM 3.
Results. Both the ^{13}CO and C^{18}O lines exhibit two well separated velocity components at about 1.3 and 8.7 km s^{-1}. The emission of both CO isotopologues is more widely distributed than the submillimetre dust continuum emission as probed by LABOCA. The LABOCA 870-μm peak position of SMM 3 is devoid of strong CO isotopologue emission, which is consistent with our earlier detection of strong CO depletion in the source. No signatures of a large-scale outflow were found towards SMM 3. The ^{13}CO and C^{18}O emission seen at ~ 1.3 km s^{-1} is concentrated into a single clump-like feature at the eastern part of the map. The peak H_2 column density towards a C^{18}O maximum of the low-velocity component is estimated to be $\sim 10^{22}$ cm^{-2}. A velocity gradient was found across both the ^{13}CO and C^{18}O maps. Interestingly, SMM 3 lies on the border of this velocity gradient.
Conclusions. The ^{13}CO and C^{18}O emission at ~ 1.3 km s^{-1} is likely to originate from the "low-velocity part" of Orion B. Our analysis suggests that it contains high density gas ($\sim 10^{22}$ H_2 molecules per cm^2), which conforms to our earlier detection of deuterated species at similarly low radial velocities. Higher-resolution observations would be needed to clarify the outflow activity of SMM 3. The sharp velocity gradient in the region might represent a shock front resulting from the feedback from the nearby expanding HII region NGC 2024. The formation of SMM 3, and possibly of the other members of Orion B9, might have been triggered by this feedback.

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Evidence of photoevaporation and spatial variation of grain sizes in the Orion 114-426 protoplanetary disk

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Deep HST broad-band images taken with ACS and WFPC2 of the giant ($\sim$ 1000 AU diameter) dark silhouette proplyd 114-426 in the Orion Nebula show that this system is tilted, asymmetric, warped and photoevaporated. The exquisite angular resolution of ACS allows us to map the distribution of dust grains at the northern translucent edge of the disk, dominated by the photoevaporative flow. Using the Mie theory for standard circumstellar disk grains, we find evidence for a spatial gradient in grain size. The typical dust radius, $\simeq 0.2 - 0.7$ μm (less than what reported by previous studies) becomes smaller as the distance from the disk center increases, consistent with the expectations for the dynamic of dust entrained in a gaseous photoevaporative wind. Our analysis of the disk morphology and location within the nebula indicates that this system is photoevaporated by the diffuse radiation field of the Orion Nebula, while being shielded from the radiation coming directly from the central Trapezium stars. We estimate the mass-loss rate from the disk surface and the time-scale for total disk dissipation, which turns out to be of the order of 10^4yr. Such a short time, of the order of 1/100 of the cluster age, indicates that this system is seen on the verge of destruction. This is compatible with the exceptional nature of the disk, namely its combination of huge size and low mass. Finally, we briefly discuss the viability of possible mechanisms that may lead to the peculiar morphology of this system: external UV flux, binary star and past close encounter.

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High-Resolution Spectroscopy during Eclipse of the Young Substellar Eclipsing Binary 2MASS 0535−0546. II. Secondary Spectrum: No Evidence that Spots Cause the Temperature Reversal

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We present high-resolution optical spectra of the young brown-dwarf eclipsing binary 2M0535−05, obtained during eclipse of the higher-mass (primary) brown dwarf. Combined with our previous spectrum of the primary alone (Paper I), the new observations yield the spectrum of the secondary alone. We investigate, through a differential analysis of the two binary components, whether cool surface spots are responsible for suppressing the temperature of the primary. In Paper I, we found a significant discrepancy between the empirical surface gravity of the primary and that inferred via fine analysis of its spectrum. Here we find precisely the *same* discrepancy in surface gravity, both qualitatively and quantitatively. While this may again be ascribed to either cool spots or model opacity errors, it implies that cool spots *cannot* be responsible for *preferentially* lowering the temperature of the primary: if they were, spot effects on the primary spectrum should be preferentially larger, and they are not. The $T_{\rm eff}$ we infer for the primary and secondary, from the TiO-ϵ bands alone, show the same reversal, in the same ratio, as is empirically observed, bolstering the validity of our analysis. In turn, this implies that if suppression of convection by magnetic fields on the primary is the fundamental cause of the $T_{\rm eff}$ reversal, then it cannot be a local suppression yielding spots mainly on the primary (though both components may be equally spotted), but a *global* suppression in the interior of the primary. We briefly discuss current theories of how this might work.

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The chemistry of C_3 & Carbon Chain Molecules in DR21(OH)

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C_3 is the smallest pure carbon chain detected in the dense environment of star forming regions, although diatomic C_2 is detected in diffuse clouds. Measurement of the abundance of C_3 and the chemistry of its formation in dense star forming regions has remained relatively unexplored. We aim to identify the primary C_3 formation routes in dense star forming regions following a chemical network producing species like CCH and c-C_3H_2 in the star forming cores associated with DR21(OH), a high mass star forming region. We have observed velocity resolved spectra of four ro-vibrational far-infrared transitions of C_3 between the vibrational ground state and the low-energy ν_2 bending mode at frequencies between 1654–1897 GHz using HIFI on board *Herschel*, in DR21(OH). Several transitions of CCH and c-C_3H_2 have also been observed with HIFI and the IRAM 30m telescope. Rotational temperatures and column densities for all chemical species were estimated. A gas and grain warm-up model was used to obtain estimates of densities and temperatures of the envelope. The chemical network in the model has been used to identify the primary C_3 forming reactions in DR21(OH). We have detected C_3 in absorption in four far-infrared transitions, $P(4)$, $P(10)$, $Q(2)$ and $Q(4)$. The continuum sources MM1 and MM2 in DR21(OH) though spatially unresolved, are sufficiently separated in velocity to be identified in the C_3 spectra. All C_3 transitions are detected from the embedded source MM2 and the surrounding envelope, whereas only $Q(4)$ & $P(4)$ are detected toward the hot core MM1. The abundance of C_3 in the envelope and MM2 is $\sim 6 \times 10^{-10}$ and $\sim 3 \times 10^{-9}$ respectively. For CCH and c-C_3H_2 we only detect emission from the envelope and MM1. The observed CCH, C_3 and c-C_3H_2 abundances are most consistent with a chemical model with $n_{H_2} \sim 5\times10^6$ cm^{-3}, post-warm-up dust temperature, T_{max}=30 K and a time of $\sim$ 0.7–3 Myr. Post warm-up gas phase chemistry of CH_4 released from the grain at $t \sim 0.2$ Myr and lasting for 1 Myr can explain the observed C_3 abundance in the envelope of DR21(OH) and no mechanism involving photodestruction of PAH molecules is required. The chemistry in the envelope is similar to the warm carbon chain chemistry (WCCC) found in lukewarm corinos. We interpret the observed lower C_3 abundance in MM1 as compared to MM2 and the envelope to be due to the destruction of C_3 in the more evolved MM1. The timescale for the chemistry derived for the envelope is consistent with the dynamical timescale of 2 Myr derived for DR21(OH) in other studies.

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HH 588: A Giant Bipolar Outflow in the BRC 37 Dark Cloud

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We present the results of a 2D spectroscopy of the HH 588 Herbig-Haro objects complex in the BRC 37 dark globule. The spectra of four parts of this complex, including the NE2, NE1, center and SW2 objects, were obtained with the VAGR multi-pupil spectrograph. The kinematical characteristics of the complex components confirm the existence of a giant bipolar outflow from the central infrared source IRAS 21388+5622. The spectral studies also show that the central object has very low excitation and strong [OI] and [SII] emissions, characteristic for the jets from young stellar objects. Other components represent the typical Herbig-Haro objects. It is shown also that the whole HH 588 complex is the irradiated Herbig-Haro flow. This is evident from the relatively high excitation of the NE2 object and from the shape of the whole HH 588 outflow, which represents itself an arc, oriented by its convexity to the center of the IC 1396 HII region.

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From dusty filaments to massive stars: The case of NGC 7538 S

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We report on high-sensitivity and high-angular resolution archival Submillimeter Array (SMA) observations of the large (∼15000 AU) putative circumstellar disk associated with the O-type protostar NGC 7538 S. Observations of the continuum resolve this putative circumstellar disk into five compact sources, with sizes ∼ 3000 AU and masses $\sim 10 M_\odot$. This confirm the results of recent millimeter observations made with CARMA/BIMA towards this object. However, we find that from most of these compact sources eject collimated bipolar outflows, revealed by our silicon monoxide (SiO J=5-4) observations and confirm that these sources have a (proto)stellar nature. All outflows are perpendicular to the large and rotating dusty structure. We propose therefore that, rather than being a single massive circumstellar disk, NGC 7538 S could be instead a large and massive contracting or rotating filament that is fragmenting at scales of 0.1 to 0.01 pc to form several B-type stars, via the standard process involving outflows and disks. As in recent high spatial resolution studies of dusty filaments, our observations also suggest that thermal pressure does not seem to be sufficient to support the filament, so that either additional support needs to be invoked, or else the filament must be in the process of collapsing. An SPH numerical simulation of the formation of a molecular cloud by converging warm neutral medium flows produces contracting filaments whose dimensions and spacings between the stars forming within them, as well as their column densities, strongly resemble those observed in the filament reported here.

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The earliest phases of star formation observed with Herschel (EPoS): The dust temperature and density distributions of B68

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Context. Isolated starless cores within molecular clouds can be used as a testbed to investigate the conditions prior to the onset of fragmentation and gravitational proto-stellar collapse.
Aims. We aim to determine the distribution of the dust temperature and the density of the starless core B68.
Methods. In the framework of the *Herschel* guaranteed time key programme *The earliest phases of star formation (EPoS)*, we have imaged B68 between 100 and 500 μm. Ancillary data at (sub)millimetre wavelengths, spectral line maps of the ^{12}CO(2–1) and ^{13}CO(2–1) transitions as well as a NIR extinction map were added to the analysis. We employed a ray-tracing algorithm to derive the 2D mid-plane dust temperature and volume density distribution without suffering from line-of-sight averaging effects of simple SED fitting procedures. Additional 3D radiative transfer calculations were employed to investigate the connection between the external irradiation and the peculiar crescent shaped morphology found in the FIR maps.
Results. For the first time, we spatially resolve the dust temperature and density distribution of B68, convolved to a beam size of 36.4″. We find a temperature gradient dropping from $(16.7^{+1.3}_{-1.0})$ K at the edge to $(8.2^{+2.1}_{-0.7})$ K in the centre, which is about 4 K lower than the result of the simple SED fitting approach. The column density peaks at $N_{\rm H} = (4.3^{+1.4}_{-2.8}) \times 10^{22}$ cm^{-2} and the central volume density was determined to $n_{\rm H} = (3.4^{+0.9}_{-2.5}) \times 10^{5}$ cm^{-3}. B68 has a mass of 3.1 $M_{\odot}$ of material with $A_K > 0.2$ mag for an assumed distance of 150 pc. We detect a compact source in the southeastern trunk, which is also seen in extinction and CO. At 100 and 160 μm, we observe a crescent of enhanced emission to the south.
Conclusions. The dust temperature profile of B68 agrees well with previous estimates. We find the radial density distribution from the edge of the inner plateau outward to be $n_{\rm H} \propto r^{-3.5}$. Such a steep profile can arise from either or both of the following: external irradiation with a significant UV contribution or the fragmentation of filamentary structures. Our 3D radiative transfer model of an externally irradiated core by an anisotropic ISRF reproduces the crescent morphology seen at 100 and 160 μm. Our CO observations show that B68 is part of a chain of globules in both space and velocity, which may indicate that it was once part of a filament which dispersed. We also resolve a new compact source in the southeastern trunk and find that it is slightly shifted in centroid velocity from B68, lending qualitative support to core collision scenarios.

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Pre-main-sequence population in NGC 1893 region

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In this paper we continued our efforts to understand the star formation scenario in and around the young cluster NGC 1893. We used a sample of the young stellar sources (YSOs) identified on the basis of multiwavelength data (optical, near-infrared (NIR), mid-infrared (MIR) and X-ray) to study the nature of YSOs associated with the region. The identified YSOs show an age spread of $\sim$ 5 Myr. The YSOs located near the nebulae at the periphery of the cluster are relatively younger in comparison to those located within the cluster region. The present results are in accordance with those obtained by us in previous studies. Other main results from the present study are: 1) the fraction of disk bearing stars increases towards the periphery of the cluster; 2) there is an evidence supporting the notion that the mechanisms for disk dispersal operate less efficiently for low-mass stars; 3) the sample of Class II sources is found to be relatively older in comparison to that of Class III sources. A comparison of various properties of YSOs in the NGC 1893 region with those in the Tr 37/ IC 1396 region is also discussed.

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Molecular clumps in the W51 giant molecular cloud

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In this paper, we present a catalogue of dense molecular clumps located within the W51 giant molecular cloud (GMC). This work is based on Heterodyne Array Receiver Programme ^{13}CO J=3-2 observations of the W51 GMC and uses the automated CLUMPFIND algorithm to decompose the region into a total of 1575 clumps of which 1130 are associated with the W51 GMC. We clearly see the distinct structures of theW51 complex and the high-velocity stream previously reported. We find the clumps have characteristic diameters of 1.4 pc, excitation temperatures of 12 K, densities of 5.6 $\times$ 10^{21}21 cm^{-2}, surface densities 0.02 g cm^{-2} and masses of 90 M$_{\odot}$. We find a total mass of dense clumps within the GMC of $1.5 \times 10^5\,$M$_{\odot}$, with only 1% of the clumps detected by number and 4% by mass found to be supercritical. We find a clump-forming efficiency of 14 $\pm$ 1% for the W51 GMC and a supercritical clump-forming efficiency of $0.5^{+2.3}_{-0.5}$%. Looking at the clump mass distribution, we find it is described by a single power law with a slope of $\alpha = 2.4^{+0.2}_{-0.1}$ above $\sim$100$\,$M$_{\odot}$. By comparing locations of supercritical clumps and young clusters, we see that any future star formation is likely to be located away from the currently active W51A region.

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Modes of clustered star formation

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The recent realization that most stars form in clusters, immediately raises the question of whether star and planet formation are influenced by the cluster environment. The stellar density in the most prevalent clusters is the key factor here. Whether dominant modes of clustered star formation exist is a fundamental question. Using near-neighbour searches in young clusters Bressert et al. (2010) claim this not to be the case. They conclude that - at least in the solar neighbourhood - star formation is continuous from isolated to densely clustered and that the environment plays a minor role in star and planet formation. We investigate under which conditions near-neighbour searches in young clusters can distinguish between different modes of clustered star formation. Model star clusters with different memberships and density distributions are set up and near-neighbour searches are performed. We investigate the influence of the combination of different cluster modes, observational biases, and types of diagnostic on the results. We find that the specific cluster density profile, the relative sample sizes, limitations in observations and the choice of diagnostic method decides whether modelled modes of clustered star formation are detected by near-neighbour searches. For density distributions that are centrally concentrated but span a wide density range (for example, King profiles) separate cluster modes are only detectable under ideal conditions (sample selection, completeness) if the mean density of the individual clusters differs by at least a factor of $\sim$65. Introducing a central cut-off can lead to underestimating the mean density by more than a factor of ten especially in high density regions. Similarly, the environmental effect on star and planet formation is underestimated for half of the population in dense systems. Local surface density distributions are a very useful tool for single cluster analysis, but only for high-resolution data. However, a simultaneous analysis of a sample of cluster environments involves effects of superposition that suppress characteristic features very efficiently and thus promotes erroneous conclusions. While multiple peaks in the distribution of the local surface density in star forming regions imply the existence of different modes of star formation, the reverse conclusion is *not* possible.

Equally, a smooth distribution is *not* a proof of continuous star formation, because such a shape can easily hide modes of clustered star formation.

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Evaporating very small grains as tracers of the UV radiation field in photo-dissociation regions

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Context: In photo-dissociation regions (PDRs), polycyclic aromatic hydrocarbons (PAHs) may be produced by evaporation of very small grains (VSGs) by the impinging UV radiation field from a nearby star.
Aims: We quantitatively investigate the transition zone between evaporating very small grains (eVSGs) and PAHs in several PDRs.
Methods: We studied the relative contribution of PAHs and eVSGs to the mid-IR emission in a wide range of excitation conditions. We fitted the observed mid-IR emission of PDRs by using a set of template band emission spectra of PAHs, eVSGs, and gas lines. The fitting tool PAHTAT (PAH Toulouse Astronomical Templates) is made available to the community as an IDL routine. From the results of the fit, we derived the fraction of carbon $f_{\rm eVSG}$ locked in eVSGs and compared it to the intensity of the local UV radiation field.
Results: We show a clear decrease of $f_{\rm eVSG}$ with increasing intensity of the local UV radiation field, which supports the scenario of photo-destruction of eVSGs. Conversely, this dependence can be used to quantify the intensity of the UV radiation field for different PDRs, including unresolved ones.
Conclusions: PAHTAT can be used to trace the intensity of the local UV radiation field in regions where eVSGs evaporate, which correspond to relatively dense ($n_H = [100, 10^5]\,{\rm cm}^{-3}$) and UV irradiated PDRs ($G_0 = [100, 5 \times 10^4]$) where H_2 emits in rotational lines.

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Herschel / HIFI observations of CO, H_2O and NH_3 in Monoceros R2

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Context: Mon R2, at a distance of 830 pc, is the only ultracompact HII region (UC HII) where the associated photon-dominated region (PDR) can be resolved with *Herschel*. Due to its brightness and proximity, it is one of the best

sources to investigate the chemistry and physics of highly UV-irradiated PDRs.
Aims: Our goal is to estimate the abundance of H_2O and NH_3 in this region and investigate their origin.
Methods: We present new observations ([CII], ^{12}CO, ^{13}CO, $C^{18}O$, o-H_2O, p-H_2O, o-$H_2^{18}O$ and o-NH_3) obtained with the HIFI instrument onboard *Herschel* and the IRAM 30 m telescope. We investigate the physical conditions in which these lines arise by analyzing their velocity structure and spatial variations. Using a large velocity gradient (LVG) approach, we model the line intensities and derive an average abundance of H_2O and NH_3 across the region. Finally, we model the line profiles with a non-local radiative transfer model and compare these results with the abundance predicted by the Meudon PDR code.
Results: The variations of the line profiles and intensities indicate complex geometrical and kinematical patterns. In several tracers ([CII], CO 9→8 and H_2O) the line profiles vary significantly with position and have larger line widths towards the HII region. The H_2O lines present a strong self-absorption at the ambient velocity and emission in high velocity wings towards the HII region. The emission in the o-$H_2^{18}O$ ground state line reaches its maximum value around the HII region, has smaller linewidths and peaks at the velocity of the ambient cloud. Its spatial distribution shows that the o-$H_2^{18}O$ emission arises in the PDR surrounding the HII region. By modeling the o-$H_2^{18}O$ emission and assuming the standard $[^{16}O]/[^{18}O] = 500$, we derive a mean abundance of o-H_2O of $\sim 10^{-8}$ relative to H_2. The ortho-H_2O abundance, however, is larger ($\sim 1 \times 10^{-7}$) in the high velocity wings detected towards the HII region. Possible explanations for this larger abundance include an expanding hot PDR and/or an outflow. Ammonia seems to be present only in the envelope of the core with an average abundance of $\sim 2 \times 10^{-9}$ relative to H_2.
Conclusions: The Meudon PDR code, which includes only gas-phase chemical networks, can account for the measured water abundance in the high velocity gas as long as we assume that it originates from a ∼1 mag hot expanding layer of the PDR i.e. that the outflow has only a minor contribution to this emission. To explain the water and ammonia abundances in the rest of the cloud the molecular freeze out and grain surface chemistry would need to be included.

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Ring shaped dust accumulation in transition disks

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Context. Transition disks are believed to be the final stages of protoplanetary disks, during which a forming planetary system or photoevaporation processes open a gap in the inner disk, drastically changing the disk structure. From theoretical arguments it is expected that dust growth, fragmentation and radial drift are strongly influenced by gas disk structure, and pressure bumps in disks have been suggested as key features that may allow grains to converge and grow efficiently.
Aims. We want to study how the presence of a large planet in a disk influences the growth and radial distribution of dust grains, and how observable properties are linked to the mass of the planet.
Methods. We combine two-dimensional hydrodynamical disk simulations of disk-planet interactions with state-of-the-art coagulation/fragmentation models to simulate the evolution of dust in a disk which has a gap created by a massive planet. We compute images at different wavelengths and illustrate our results using the example of the transition disk LkCa15.
Results. The gap opened by a planet and the long-range interaction between the planet and the outer disk create a single large pressure bump outside the planetary orbit. Millimeter-sized particles form and accumulate at the pressure maximum and naturally produce ring-shaped sub-millimeter emission that is long-lived because radial drift no longer depletes the large grain population of the disk. For large planet masses around 9 $M_{\rm Jup}$, the pressure maximum and, therefore, the ring of millimeter particles is located at distances that can be more than twice the star-planet separation, creating a large spatial separation between the gas inner edge of the outer disk and the peak millimeter emission.

Smaller grains do get closer to the gap and we predict how the surface brightness varies at different wavelengths.

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Aspect Ratio Dependence of the Free-Fall Time for Non-Spherical Symmetries

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We investigate the collapse of non-spherical substructures, such as sheets and filaments, which are ubiquitous in molecular clouds. Such non-spherical substructures collapse homologously in their interiors but are influenced by an edge effect that causes their edges to be preferentially accelerated. We analytically compute the homologous collapse timescales of the interiors of uniform-density, self-gravitating filaments and find that the homologous collapse timescale scales linearly with the aspect ratio. The characteristic timescale for an edge-driven collapse mode in a filament, however, is shown to have a square-root dependence on the aspect ratio. For both filaments and circular sheets, we find that selective edge acceleration becomes more important with increasing aspect ratio. In general, we find that lower dimensional objects and objects with larger aspect ratios have longer collapse timescales. We show that estimates for star formation rates, based upon gas densities, can be overestimated by an order of magnitude if the geometry of a cloud is not taken into account.

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The H_2O southern Galactic Plane Survey (HOPS): NH_3 (1,1) and (2,2) catalogues

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The **H_2O** Southern Galactic **P**lane **S**urvey (HOPS) has mapped a 100 degree strip of the Galactic plane ($-70° > l > 30°$, $|b| < 0.5°$) using the 22-m Mopra antenna at 12-mm wavelengths. Observations were conducted in on-the-fly mode using the Mopra spectrometer (MOPS), targeting water masers, thermal molecular emission and radio-recombination lines. Foremost among the thermal lines are the 23 GHz transitions of NH_3 J,K = (1,1) and (2,2), which trace the densest parts of molecular clouds ($n > 10^4\,\mathrm{cm^{-3}}$). In this paper we present the NH_3 (1,1) and (2,2) data, which have a resolution of 2 arcmin and cover a velocity range of $\pm 200\,\mathrm{km\,s^{-1}}$. The median sensitivity of the NH_3 data-cubes is $\sigma_{T_{\mathrm{mb}}} = 0.20 \pm 0.06\,\mathrm{K}$. For the (1,1) transition this sensitivity equates to a 3.2 kpc distance limit for detecting a 20 K, 400 $\mathrm{M_\odot}$ cloud at the 5σ level. Similar clouds of mass 5,000 $\mathrm{M_\odot}$ would be detected as far as the Galactic centre, while 30,000 $\mathrm{M_\odot}$ clouds would be seen across the Galaxy. We have developed an automatic emission finding procedure based on the ATNF DUCHAMP software and have used it to create a new catalogue of 669 dense molecular clouds. The catalogue is 100 percent complete at the 5σ detection limit ($T_{\mathrm{mb}} = 1.0\,\mathrm{K}$). A preliminary analysis of the ensemble cloud properties suggest that the near kinematic distances are favoured. The cloud positions are consistent with current models of the Galaxy containing a long bar. Combined with other Galactic plane surveys this new molecular-line dataset constitutes a key tool for examining Galactic structure and evolution. Data-cubes, spectra and catalogues are available to the community via the HOPS website.

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Forming an O Star via Disk Accretion?

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We present a study of outflow, infall, and rotation in a $\sim 10^5\ L_\odot$ star-forming region, IRAS 18360-0537, with Submillimeter Array (SMA) and IRAM 30m observations. The 1.3 mm continuum map shows a 0.5 pc dust ridge, of which the central compact part has a mass of $\sim 80\ M_\odot$ and harbors two condensations, MM1 and MM2. The CO (2–1) and SiO (5–4) maps reveal a biconical outflow centered at MM1, which is a hot molecular core (HMC) with a gas temperature of 320 ± 50 K and a mass of $\sim 13\ M_\odot$. The outflow has a gas mass of 54 $M_\odot$ and a dynamical timescale of 8×10^3 yr. The kinematics of the HMC is probed by high-excitation CH_3OH and CH_3CN lines, which are detected at sub-arcsecond resolution and unveil a velocity gradient perpendicular to the outflow axis, suggesting a disk-like rotation of the HMC. An infalling envelope around the HMC is evidenced by CN lines exhibiting a profound inverse P-Cygni profile, and the estimated mass infall rate, $1.5 \times 10^{-3}\ M_\odot\,\mathrm{yr^{-1}}$, is well comparable to that inferred from the mass outflow rate. A more detailed investigation of the kinematics of the dense gas around the HMC is obtained from the ^{13}CO and $C^{18}O$ (2–1) lines; the position-velocity diagrams of the two lines are consistent with the model of a free-falling and Keplerian-like rotating envelope. The observations suggest that the protostar of a current mass $\sim 10\ M_\odot$ embedded within MM1 will develop into an O star via disk accretion and envelope infall.

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The Earliest Phases of Star Formation (EPoS): A Herschel Key Program - The precursors to high-mass stars and clusters

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We present an overview of the sample of high-mass star and cluster forming regions observed as part of the Earliest Phases of Star Formation (EPoS) Herschel Guaranteed Time Key Program. A sample of 45 infrared-dark clouds (IRDCs) were mapped at PACS 70, 100, and 160 micron and SPIRE 250, 350, and 500 micron. In this paper, we characterize a population of cores which appear in the PACS bands and place them into context with their host cloud and investigate their evolutionary stage. We construct spectral energy distributions (SEDs) of 496 cores which appear in all PACS bands, 34% of which lack counterparts at 24 micron. From single-temperature modified blackbody fits of the SEDs, we derive the temperature, luminosity, and mass of each core. These properties predominantly reflect the conditions in the cold, outer regions. Taking into account optical depth effects and performing simple radiative transfer models, we explore the origin of emission at PACS wavelengths. The core population has a median temperature of 20K and has masses and luminosities that span four to five orders of magnitude. Cores with a counterpart at 24 micron are warmer and bluer on average than cores without a 24 micron counterpart. We conclude that cores bright at 24 micron are on average more advanced in their evolution, where a central protostar(s) have heated the outer bulk of the core, than 24 micron-dark cores. The 24 micron emission itself can arise in instances where our line of sight aligns with an exposed part of the warm inner core. About 10% of the total cloud mass is found in a given cloud's core population. We uncover over 300 further candidate cores which are dark until 100 micron. These are candidate starless objects, and further observations will help us determine the nature of these very cold cores.

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Kinematics of the CO Gas in the Inner Regions of the TW Hya Disk

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We present a detailed analysis of the spatially and spectrally resolved ^{12}CO J=2$-$1 and J=3$-$2 emission lines from the TW Hya circumstellar disk, based on science verification data from the Atacama Large Millimeter/Submillimeter Array (ALMA). These lines exhibit substantial emission in their high-velocity wings (with projected velocities out to 2.1 km s^{-1}, corresponding to intrinsic orbital velocities >20 km s^{-1}) that trace molecular gas as close as 2 AU from the central star. However, we are not able to reproduce the intensity of these wings and the general spatio-kinematic pattern of the lines with simple models for the disk structure and kinematics. Using three-dimensional non-local thermodynamic equilibrium molecular excitation and radiative transfer calculations, we construct some alternative models that successfully account for these features by modifying either (1) the temperature structure of the inner disk (inside the dust-depleted disk cavity; $r < 4$ AU); (2) the intrinsic (Keplerian) disk velocity field; or (3) the distribution of disk inclination angles (a warp). The latter approach is particularly compelling because a representative warped disk model qualitatively reproduces the observed azimuthal modulation of optical light scattered off the disk surface. In any model scenario, the ALMA data clearly require a substantial molecular gas reservoir located inside the region where dust optical depths are known to be substantially diminished in the TW Hya disk, in agreement with previous studies based on infrared spectroscopy. The results from these updated model prescriptions are discussed in terms of their potential physical origins, which might include dynamical perturbations from a low-mass companion with an orbital separation of a few AU.

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Binary interaction dominates the evolution of massive stars

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The presence of a nearby companion alters the evolution of massive stars in binary systems, leading to phenomena such as stellar mergers, X-ray binaries and gamma-ray bursts. Unambiguous constraints on the fraction of massive stars affected by binary interaction were lacking. We simultaneously measured all relevant binary characteristics in a sample of Galactic massive O stars and quantified the frequency and nature of binary interactions. Over seventy per cent of all massive stars will exchange mass with a companion, leading to a binary merger in one third of the cases. These numbers greatly exceed previous estimates and imply that binary interaction dominates the evolution of massive stars, with implications for populations of massive stars and their supernovae.

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Orbit and Stellar Properties of the Young Triple V807 Tau

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We present new orbital measurements of the pre-main sequence triple system, V807 Tau, using adaptive optics imaging at the Keck Observatory. We computed an orbit for the close pair, V807 Tau Ba−Bb, with a period of 12.312 ± 0.058 years and a semi-major axis of 38.59 ± 0.16 mas. By modeling the center of mass motion of the components in the close pair relative to the wide component, V807 Tau A, we measured a mass ratio of 0.843 ± 0.050 for Bb/Ba. Combined with the total mass from the relative orbit, we derived individual masses of $M_{\rm Ba} = 0.564 \pm 0.018$ $(\frac{d}{140{\rm pc}})^3$ $M_\odot$ and $M_{\rm Bb} = 0.476 \pm 0.017$ $(\frac{d}{140{\rm pc}})^3$ $M_\odot$ at an average distance of 140 pc to the Taurus star forming region. We computed spectral energy distributions to determine the luminosities of the three components. We also measured their spectral types, effective temperatures, and rotational velocities based on spatially resolved spectra obtained at the Keck Observatory. If the rotational axes are aligned, then the projected rotational velocities imply that V807 Tau Ba and Bb are rotating much faster than V807 Tau A. The uncertainty in the stellar effective temperatures and

distance to the system currently limit the comparison of our dynamical mass measurements with predictions based on evolutionary tracks for pre-main sequence stars. We also report preliminary results from a program to map the 3.6 cm radio emission from V807 Tau using the Very Long Baseline Array. With continued monitoring, these observations will provide a precise parallax for placing the dynamical masses on an absolute scale.

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http://arxiv.org/abs/1207.7037
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Substellar Objects in Nearby Young Clusters (SONYC) VI: The planetary-mass domain of NGC1333

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Within the SONYC – *Substellar Objects in Nearby Young Clusters* – survey, we investigate the frequency of free-floating planetary-mass objects (planemos) in the young cluster NGC 1333. Building upon our extensive previous work, we present spectra for 12 of the faintest candidates from our deep multi-band imaging, plus seven random objects in the same fields, using MOIRCS on Subaru. We confirm seven new sources as young very low mass objects (VLMOs), with $T_{\rm eff}$ of 2400–3100 K and mid-M to early-L spectral types. These objects add to the growing census of VLMOs in NGC1333, now totaling 58. Three confirmed objects (one found in this study) have masses below $15\,M_{\rm Jup}$, according to evolutionary models, thus are likely planemos. We estimate the total planemo population with 5-15 $M_{\rm Jup}$ in NGC1333 is $\lesssim$8. The mass spectrum in this cluster is well approximated by $dN/dM \propto M^{-\alpha}$, with a single value of $\alpha = 0.6 \pm 0.1$ for $M < 0.6\,M_{\odot}$, consistent with other nearby star forming regions, and requires $\alpha \lesssim 0.6$ in the planemo domain. Our results in NGC1333, as well as findings in several other clusters by ourselves and others, confirm that the star formation process extends into the planetary-mass domain, at least down to $6\,M_{\rm Jup}$. However, given that planemos are 20-50 times less numerous than stars, their contribution to the object number and mass budget in young clusters is negligible. Our findings disagree strongly with the recent claim from a microlensing study that free-floating planetary-mass objects are twice as common as stars – if the microlensing result is confirmed, those isolated Jupiter-mass objects must have a different origin from brown dwarfs and planemos observed in young clusters.

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The physics of protoplanetesimal dust agglomerates. VII The low-velocity collision behavior of large dust agglomerates

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We performed micro-gravity collision experiments in our laboratory drop-tower using 5-cm-sized dust agglomerates with volume filling factors of 0.3 and 0.4, respectively. This work is an extension of our previous experiments reported in Beitz et al. (2011) to aggregates of more than one order of magnitude higher masses. The dust aggregates consisted of micrometer-sized silica particles and were macroscopically homogeneous. We measured the coefficient of restitution for collision velocities ranging from 1 cm s^{-1} to 0.5 m s^{-1}, and determined the fragmentation velocity. For low

velocities, the coefficient of restitution decreases with increasing impact velocity, in contrast to findings by Beitz et al. (2011). At higher velocities, the value of the coefficient of restitution becomes constant, before the aggregates break at the onset of fragmentation. We interpret the qualitative change in the coefficient of restitution as the transition from a solid-body-dominated to a granular-medium-dominated behavior. We complement our experiments by molecular dynamics simulations of porous aggregates and obtain a reasonable match to the experimental data. We discuss the importance of our experiments for protoplanetary disks, debris disks, and planetary rings. The work is an extensional study to previous work of our group and gives a new insight in the velocity dependency of the coefficient of restitution due to improved measurements, better statistics and a theoretical approach.

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The Torun catalogue of 6.7GHz methanol masers

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We report the observations of 289 methanol maser sources at 6.7 GHz obtained over a two month period with the Torun 32 m telescope. The data form a catalogue of all objects north of $\delta = -22^{\circ}$ brighter than 7.5 Jy in the peak. The positions of sub-arcsecond accuracy are updated for 76% of the objects. We find that about one third of the sources show changes in the peak fluxes by a factor of two or more on time scales of 8.5 – 9.5 years.

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http://cosmos.astro.umk.pl/~msz/?page_id=88

Abstracts of recently accepted major reviews

Building Terrestrial Planets

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This paper reviews our current understanding of terrestrial planets formation. The focus is on computer simulations of the dynamical aspects of the accretion process. Throughout the chapter, we combine the results of these theoretical models with geochemical, cosmochemical and chronological constraints, in order to outline a comprehensive scenario of the early evolution of our Solar System. Given that the giant planets formed first in the protoplanetary disk, we stress the sensitive dependence of the terrestrial planet accretion process on the orbital architecture of the giant planets and on their evolution. This suggests a great diversity among the terrestrial planets populations in extrasolar systems. Issues such as the cause for the different masses and accretion timescales between Mars and the Earth and the origin of water (and other volatiles) on our planet are discussed at depth.

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Computational Star Formation

Edited by João Alves, Bruce G. Elmegreen, Josep M. Girart, and Virginia Trimble

These are the proceedings of IAU Symposium 270, devoted to an examination of recent progress and current problems in the role of numerical simulations to study star formation. The amazing developments in computer technology have provided tools that allow us to probe problems numerically that would have been considered impenetrable just a few years ago. Simulations are now capable of broadly reproducing all of the key aspects of cloud evolution leading to an embedded stellar cluster. Yet, the Devil is in the details, and this book takes a closer look at the many physical processes whose treatment still need to be improved or implemented, such as outflows and feedback, magnetic fields on many scales, advanced chemistry, and detailed radiative transfer in complex gas structures.

The book contains the following overview chapters, in addition to numerous shorter presentations:

Historical Introduction
Historical Perspective on Computational Star Formation *R. B. Larson*
Historical Perspective on Astrophysical MHD Simulations *M. L. Norman*

Individual Star Formation: Observations
Low-mass Star Formation: Observations *N. J. Evans II*
Formation of Massive Stars *M. Beltrán*

Individual Star Formation: Theory
The Formation of Massive Stars *I.A. Bonnell & R.J. Smith*
Recent Developments in Simulations of Low-mass Star Formation *M. N. Machida*

Formation of Clusters: Observations
Internal Structure of Stellar Clusters: Geometry of Star Formation *E. Alfaro & N. Sánchez*
Observations of the IMF in clusters *J. Ascenso*

Formation of Clusters: Theory
Modeling High-Mass Star Formation and Ultracompact HII Regions *R. Klessen et al.*
Theory of Cluster Formation: Effects of Magnetic Fields *F. Nakamura & Z.-Y. Li*
Dependence of Star Formation on Initial Conditions and Molecular Cloud Structure *M.R. Bate*
The Universality Hypothesis: Binary and Stellar Populations in Star Clusters and Galaxies *P. Kroupa*
Simulations of the IMF in Clusters *R.E. Pudritz*
Theories of the Initial Mass Function *P. Hennebelle & G. Chabrier*

Numerical Methods MHD
Magnetic Fields and Turbulence in Star Formation using Smoothed Particle Hydrodynamics *D.J. Price*
Interstellar Turbulence and Star Formation *A.G. Kritsuk, S.D. Ustyugov, & M.L. Norman*

Numerical Methods: Radiative Dynamics
Star Formation with Adaptive Mesh Refinement Radiation Hydrodynamics *M. Krumholz*
SPH Radiative Hydrodynamics Methods *H. Susa*
Ray Casting and Flux Limited Diffusion *A. Nordlund*

Star Formation Feedback
Observations of Star Formation Triggered by HII Regions *L. Deharveng & A. Zavagno*
Observations of Winds, Jets, and Turbulence Generation in GMCs *J. Bally*
Prestellar Cores and the Origin of the IMF: First Results from Herschel *P. André et al.*
Action of Winds Inside and Outside of Star Clusters *J. Palous et al.*
Theory of Feedback in Clusters and Molecular Cloud Turbulence *E. Vázquez-Semadeni*
Ionisation Feedback in Star and Cluster Formation Simulations *B. Ercolano & M. Gritschneder*
Supernova Feedback on the Interstellar Medium and Star Formation *G. Hensler*

Star Formation on Galactic Scales
Scaling Relations between Gas and Star Formation in Nearby Galaxies *F. Bigiel, A. Leroy, & F. Walter*
Observational Comparison of Star Formation in Different Galaxy Types *E. K. Grebel*
Theory of the Star Formation Rate *P. Padoan & A. Nordlund*
Galactic Scale Star Formation: Interplay Between Stellar Spirals and the ISM *K. Wada et al.*

Special Purpose Hardware
GRAPE Accelerators *J. Makino*

Radiation Diagnostics of Star Formation
Radiative Transfer Modeling of Simulation and Observational Data *J. Steinacker, T. Henning, & A. Bacmann*
Radiative Transfer in Molecular Clouds *M. Juvela*

Large Scale Star Formation
Gas Dynamics in whole Galaxies: SPH *C. Dobbs*
Star Formation and Gas Dynamics in Galactic Disks: Physical Processes and Numerical models *E. C. Ostriker*
Star Formation in Interacting Galaxies *C. Struck*

Cosmological Star Formation
Galaxy Formation Hydrodynamics: From Cosmic Flows to Star-Forming Clouds *F. Bournaud*

Computational Star Formation
A Guide to Comparisons of Star Formation Simulations with Observations *A.A. Goodman*
Comparison Between Simulations and Theory: Where We Stand *J.J. Monaghan*
Concluding Remarks: Playing by the Numbers *V. Trimble*

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Transformational Science with ALMA: From Dust to Rocks to Planets Formation and Evolution of Planetary Systems

April 8 - 12, 2013

Hilton Waikoloa Village, The Big Island of Hawaii

http://www.cv.nrao.edu/rocks/index.html

Now that the ALMA Cycle 1 proposal deadline is behind us, why don't we head to Hawaii for the next NAASC meeting? Did you hear that Ewine van Dishoeck will be the Keynote Speaker at the Workshop? Dr. van Dishoeck holds the title of Professor of Molecular Astrophysics at the Leiden Observatory in the Netherlands and is an expert on observational, laboratory and theoretical astrochemistry.

The Atacama Large Millimeter/sub-millimeter Array (ALMA) is the world's most complex ground-based astronomical observatory. While still under construction, ALMA is opening a window into cosmic origins from previously inaccessible cold and dark parts of our universe. With its anticipated 66 antennae in full operations, ALMA will deliver astonishing imaging capabilities and sensitivity that will surpass any other telescope at millimeter and submillimeter wavelengths. The first light observations from ALMA, begun in September 2011, are exciting researchers with new views of gas and dust harboring young stars and planetary systems. We are on the threshold of an explosion of observations that will transform our knowledge and understanding of how solar systems, planets, and life all begin.

In this workshop, investigators from around the world will meet in Hawaii to explore the evolution of material in protostellar disks from formation to dissipation. The Island of Hawaii is home to the largest observatory in the Northern Hemisphere, and is the site of extensive, collaborative, international research efforts. A focus of the workshop will be the processing of the gas and dust components, and the growth of planetesimals. We will also explore chemical changes, and radiative signatures at millimeter and submillimeter wavelengths. We will showcase results from ALMA early science projects and feature synergies with other telescopes that can help to advance this field, particularly those sited on the island of Hawaii.

This workshop will prepare us for the exciting adventures ahead in the new era and will not only focus on the new opportunities in astronomy but also foster new collaborations with geologists, chemists, engineers and biologists to investigate the origins of cosmic material in the universe. This workshop, with its broad, international scope, will allow students and recent post-docs to learn about the cutting-edge, interdisciplinary research opportunities available with ALMA. Most importantly, beginning researchers will participate in the workshop in a substantial, meaningful way by presenting posters and partnering with mentors before and during the workshop. We hope these collaborations will continue well beyond the end of this meeting and a whole new set of researchers will emerge to use ALMA.

Specifically, this workshop will address the following questions:

1. When do circumstellar disks first form and how?
2. How does gas evolve in circumstellar disks?
3. What is the origin of the gaps and holes in "transition disks"?
4. What are the observational signatures of embedded planets in circumstellar disks?
5. What is the process of grain growth and evolution?
6. Can we fully ascertain the physical and chemical processing of planetary materials, and their connections to meteorites, planetesimals, comets, and KBOs?
7. What is the full extent of disk chemistry and what is the detectable limit of molecular material in disks?
8. What do millimeter continuum and spectral line observations tell us about solar system bodies?
9. Polarimetry and magnetic activities in the protostellar envelopes and inner disks.
10. Instruments in Hawaii that could facilitate the sciences featured in this workshop.

First public release of the Hyperion Monte-Carlo dust continuum radiative transfer code

I am very pleased to announce the first public release of the Hyperion Monte-Carlo dust continuum radiative transfer code, which was described in http://dx.doi.org/10.1051/0004-6361/201117150 Robitaille (2011).

The homepage for the code at http://www.hyperion-rt.org has been updated to reflect the release. From this page, you can access the documentation (hosted at http://docs.hyperion-rt.org), download the latest stable version, and learn about reporting issues and contributing to the code.

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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
.

The Star Formation Newsletter is available on the World Wide Web at http://www.ifa.hawaii.edu/users/reipurth/newsletter.htm.

Moving ... ??

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