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Abstracts of recently accepted papers

X-ray flaring from the young stars in Cygnus OB2

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Aims. We characterize individual and ensemble properties of X-ray flares from stars in the Cygnus OB2 and ONC star-forming regions.

Methods. We analyzed X-ray lightcurves of 1003 Cygnus OB2 sources observed with Chandra for 100 ks and of 1616 ONC sources detected in the "Chandra Orion Ultra-deep Project" 850 ks observation. We employed a binning-free maximum likelihood method to segment the light-curves into intervals of constants signal and identified flares on the basis of both the amplitude and the time-derivative of the source luminosity. We then derived and compared the flare frequency and energy distribution of Cygnus OB2 and ONC sources. The effect of the length of the observation on these results was investigated by repeating the statistical analysis on five 100 ks-long segments extracted from the ONC data.

Results. We detected 147 and 954 flares from the Cygnus OB2 and ONC sources, respectively. The flares in Cygnus OB2 have decay times ranging from $\lesssim$0.5 to about 10 h. The flare energy distributions of all considered flare samples are described at high energies well by a power law with index $\alpha = -(2.1 \pm 0.1)$. At low energies, the distributions flatten, probably because of detection incompleteness. We derived average flare frequencies as a function of flare energy. The flare frequency is seen to depend on the source's intrinsic X-ray luminosity, but its determination is affected by the length of the observation. The slope of the high-energy tail of the energy distribution is, however, affected little. A comparison of Cygnus OB2 and ONC sources, accounting for observational biases, shows that the two populations, known to have similar X-ray emission levels, have very similar flare activity.

Conclusions. Studies of flare activity are only comparable if performed consistently and taking the observation length into account. Flaring activity does not vary appreciably between the age of the ONC ($\sim$1 Myr) and that of Cygnus OB2 ($\sim$2 Myr). The slope of the distribution of flare energies is consistent with the micro-flare explanation of the coronal heating.

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The Spitzer c2d Survey of Large, Nearby, Interstellar Clouds. X The Chamaeleon II Pre-Main Sequence Population as Observed With IRAC and MIPS

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We discuss the results from the combined IRAC and MIPS c2d Spitzer Legacy survey observations and complementary optical and near infrared data of the Chamaeleon II (Cha II) dark cloud. We perform a census of the young population of Cha II, in a mapped area of $\sim$1.75 deg^2, and study the spatial distribution and properties of the cloud members and candidate pre-main sequence (PMS) objects and their circumstellar matter. Our census of PMS objects and candidates in ChaII is complete down to the sub-stellar regime ($M \approx 0.03\ M_{\odot}$), at the assumed cloud distance of 178 pc. The population consists of 51 certified and 11 candidate PMS objects, most of them located in the Eastern part of the cloud, but approximately following the dust emission lanes of the c2d extinction map. From the analysis of the volume density of the PMS objects and candidates we find two tight groups of objects with volume densities higher than 25 $M_{\odot}$ pc^{-3} and 5-10 members each. These groups correlate well in space with the regions of high extinction. A multiplicity fraction of about 13$\pm$3% is observed for objects with separations 0.8" $< \theta <$ 6.0" (142 - 1065 AU). No evidence for variability in the IRAC bands between the two epochs of the c2d data set, $\Delta t \sim$6 hours, is detected. Using the results of masses and ages from a companion paper, we estimate the star formation efficiency to be 1-4%, consistent with the estimates for Taurus and Lupus, but significantly lower than for Cha I. This might mean that different star-formation activities in the Chamaeleon clouds reflect a different history of star formation. We also find that the Cha II cloud is turning some 6-7 $M_{\odot}$ into stars every Myr, which is low in comparison with the star formation rate in other c2d clouds. On the other hand, the disk fraction of 70-80% that we estimate in Cha II is much higher than in other star forming regions and indicates that the population in this cloud is dominated by objects with active accretion, with only a minority being systems with passive and debris disks. The circumstellar envelope/disk properties of the PMS objects and candidates are also investigated. Finally, the Cha II outflows are discussed, with particular regard to the discovery of a new Herbig-Haro outflow, HH 939, driven by the classical T Tauri star Sz 50.

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http://peggysue.as.utexas.edu/SIRTF/PAPERS/pap94.pub.pdf

Self-gravitating fragmentation of eccentric accretion disks

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We consider the effects of eccentricity on the fragmentation of gravitationally unstable accretion disks, using numerical hydrodynamics. We find that eccentricity does not affect the overall stability of the disk against fragmentation, but significantly alters the manner in which such fragments accrete gas. Variable tidal forces around an eccentric orbit slow the accretion process, and suppress the formation of weakly-bound clumps. The "stellar" mass function resulting from the fragmentation of an eccentric disk is found to have a significantly higher characteristic mass than that from a corresponding circular disk. We discuss our results in terms of the disk(s) of massive stars at $\simeq$ 0.1pc from the Galactic Center, and find that the fragmentation of an eccentric accretion disk, due to gravitational instability, is a viable mechanism for the formation of these systems.

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Accretion and ejection properties of embedded protostars: the case of HH26, HH34 and HH46 IRS

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We present the results of a spectroscopic analysis on three young embedded sources (HH26 IRS, HH34 IRS and HH46 IRS) belonging to different star-forming regions and displaying well developed jet structures. The aim is to investigate the source accretion and ejection properties and their connection. We used VLT-ISAAC near-IR medium resolution ($R \sim 9000$) spectra (H and K bands) to derive, in a self-consistent way, parameters like the star luminosity, the accretion luminosity and the mass accretion rate. Mass ejection rates have also been estimated from the analysis of different emission features. The spectra present several emission lines but no photospheric features in absorption, indicating a large veiling in both H and K bands. In addition to features commonly observed in jet driving sources ([Fe II], H_2, H I, CO), we detect a number of emission lines due to permitted atomic transitions, such as Na I and Ti I that are only 2-5 times weaker than the Brγ line. Some of these features remain unidentified. Emission from Na I 2.2μm doublet is observed along with CO(2-0) band-head emission, indicating a common origin in an inner gaseous disc heated by accretion. We find that accretion provides about 50% and 80% of the bolometric luminosity in HH26 IRS and HH34 IRS, as expected for accreting young objects. Mass accretion and loss rates spanning 10^{-6}–10^{-8} $M_\odot\,yr^{-1}$ have been measured. The derived $\dot{M}_{\rm loss}/\dot{M}_{\rm acc}$ is $\sim$0.01 for HH26 IRS and HH34 IRS, and $>$0.1 for HH46 IRS. These numbers are in the range of values predicted by MHD jet launching models and found in the most active classical T Tauri stars. Comparison with other spectroscopic studies performed on Class Is seems to indicate that Class Is actually having accretion-dominated luminosities are a limited number. Although the analysed sample is small, we can tentatively define some criteria to characterise such sources: they have K-band veiling larger than 2 and in the majority of the cases present IR features of CO and Na I in emission, although these do not directly correlate with the accretion luminosity. Class Is with massive jets have high $L_{\rm acc}/L_{\rm bol}$ ratios but not all the identified accretion-dominated objects present a jet. As suggested by the SEDs of our three objects, the accretion-dominated objects could be in an evolutionary transition phase between Class 0 and I. Studies of the kind presented here but on larger samples of possible candidates should be performed in order to test and refine these criteria.

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An H_2CO 6 cm Maser Pinpointing a Possible Circumstellar Torus in IRAS 18566+0408

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We report observations of 6 cm, 3.6 cm, 1.3 cm, and 7 mm radio continuum, conducted with the Very Large Array, toward IRAS 18566+0408, one of the few sources known to harbor H_2CO 6 cm maser emission. Our observations reveal that the emission is dominated by an ionized jet at centimeter wavelengths. Spitzer IRAC images from GLIMPSE support this interpretation, given the presence of 4.5 μm excess emission at approximately the same orientation as the centimeter continuum. The 7 mm emission is dominated by thermal dust from a flattened structure almost perpendicular to the ionized jet; thus, the 7 mm emission appears to trace a torus associated with a young massive stellar object. The H_2CO 6 cm maser is coincident with the center of the torus-like structure. Our observations

rule out radiative pumping via radio continuum as the excitation mechanism for the H_2CO 6 cm maser in IRAS 18566+0408.

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Spatially Resolved Molecular Hydrogen Emission in the Inner 200AU Environments of Classical T Tauri Stars[1]

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We present 2.0-2.4μm integral field spectroscopy at adaptive optics spatial resolution ($\sim$0."1) obtained with the Near-infrared Integral Field Spectrograph (NIFS) at Gemini North Observatory of six Classical T Tauri stars: T Tau, DG Tau, XZ Tau, HL Tau, RW Aur and HV Tau C. In all cases, the v=1-0 S(1) (2.12μm) emission is detected at spatially extended distances from the central stars. HL Tau, T Tau and HV Tau C have H_2 emission that extends to projected distances of more than $\sim$200 AU from the stars. The bulk of the H_2 emission is typically not coincident with the location of continuum flux. The observed morphologies vary between emission that is spatially continuous but decreasing away from the star (HV Tau C, DG Tau), and H_2 that shows discrete knots and arcs with 0."2-0."3 ($\sim$28-42 AU) spatial extents (T Tau, XZ Tau). Multiple transitions detected in the K-band spectra show that H_2 level populations are typical of gas in thermal equilibrium with excitation temperatures in the 1800K-2300 K range. Two dimensional maps of the extinction and H_2 excitation temperature were estimated from the high signal-to-noise (S/N) observations of T Tau using maps of the spatially resolved v=1-0 Q(3)/v=1-0 S(1) and v=2-1 S(1)/v=1-0 S(1) line ratios. These maps show that A_v and T_{ex} values in the vicinity of T Tau vary on a significant level on spatial scales of less than 100 AU. Three of the stars have H_2 velocity profiles that are centered at the stellar radial velocity, and three show velocity shifts with respect to the system. RW Aur exhibits high and low velocity H_2 emission, and the observed morphology and kinematics of the high velocity material are consistent with atomic emission from its red-shifted micro-jet. The morphologies detected in H_2 from DG Tau and HV Tau C resemble emission seen in scattered light from stars with inclined or edge-on circumstellar disks. The locations and relative brightnesses of H_2 knots detected within $\sim$1$''$ of T Tau has varied on a timescale of $\sim$3 years. Each of the stars studied here show observed excitation temperatures, spatial extents, and kinematics of the H_2 that are most consistent with shock excited emission from the inner regions of the known Herbig-Haro energy flows or from wide-angle winds encompassing the outflows rather than predominantly from UV or X-ray stimulated emission from the central stars. The data presented in this study highlights the sensitivity of adaptive optics-fed integral field spectroscopy for spatially resolving emission line structures in the environments of bright young stars.

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γ-ray production in young open clusters: Berk 87, Cyg OB2 and Westerlund 2

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Young open clusters are sites of cosmic ray acceleration as indicated by recent detections of the TeV γ-ray sources in the directions of two open clusters (Cyg OB2 and Westerlund 2). In fact, up to now a few different scenarios for acceleration of particles inside open clusters have been considered, i.e. shocks in massive star winds, pulsars and their nebulae, supernova shocks, massive compact binaries. Here we consider in detail the radiation processes due to both electrons and hadrons accelerated inside the open cluster. As a specific scenario, we apply the acceleration process at the shocks arising in the winds of WolfRayet (WR) type stars. Particles diffuse through the medium of the open

cluster during the activity time of the acceleration scenario defined by the age of the WR star. They interact with the matter and radiation, at first inside the open cluster and, later in the dense surrounding clouds. We calculate the broad-band spectrum in different processes for three exemplary open clusters (Berk 87, Cyg OB2, Westerlund 2) for which the best observational constraints on the spectra are at present available. It is assumed that the high-energy phenomena, observed from the X-ray up to the GeVTeV γ-ray energies, are related to each other. We conclude that the most likely description of the radiation processes in these objects is achieved in the hybrid (leptonichadronic) model in which leptons are responsible for the observed X-ray and GeV γ-ray emission and hadrons are responsible for the TeV γ-ray emission.

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Envelope instability in giant planet formation

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We compute the growth of isolated gaseous giant planets for several values of the density of the protoplanetary disk, several distances from the central star and two values for the (fixed) radii of accreted planetesimals. Calculations were performed in the frame of the core instability mechanism and the solids accretion rate adopted is that corresponding to the oligarchic growth regime. We find that for massive disks and/or for protoplanets far from the star and/or for large planetesimals, the planetary growth occurs smoothly. However, notably, there are some cases for which we find an envelope instability in which the planet exchanges gas with the surrounding protoplanetary nebula. The timescale of this instability shows that it is associated with the process of planetesimals accretion. The presence of this instability makes it more difficult the formation of gaseous giant planets.

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An Imaging Survey for Extrasolar Planets around 45 Close, Young Stars with the Simultaneous Differential Imager at the Very Large Telescope and MMT

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We present the results of a survey of 45 young ($\lesssim$ 250 Myr), close ($\lesssim$ 50 pc) stars with the Simultaneous Differential Imager (SDI) implemented at the VLT and the MMT for the direct detection of extrasolar planets. As part of the survey, we observed 54 objects, consisting of 45 close, young stars; two more distant (<150 pc), extremely young ($\leq$10 Myr) stars; three stars with known radial velocity planets; and four older, very nearby ($\leq$20 pc) solar analogs. Our SDI devices use a double Wollaston prism and a quad filter to take images simultaneously at three wavelengths surrounding the 1.62 μm methane absorption bandhead found in the spectrum of cool brown dwarfs and gas giant planets. By differencing adaptive opticscorrected images in these filters, speckle noise from the primary star is significantly attenuated, resulting in photon (and flat-field)noiselimited data. In our VLT data, we achieved H-band contrasts $\gtrsim$ 10 mag (5 σ) at a separation of 0.5$''$ from the primary star on 45% of our targets and H-band contrasts $\gtrsim$ 9 mag at a separation of 0.5$''$ on 80% of our targets. With these contrasts, we can image (5 σ detection) a 7 M_J planet 15 AU from a 70 Myr K1 star at 15 pc or a 7.8 M_J planet at 2 AU from a 12 Myr M star at 10 pc. We detected no candidates with S/N >2 σ which behaved consistently like a real object. From our survey null result, we can rule out (with 93% confidence) a model planet population where N(a) $\propto$ constant out to a distance of 45 AU.

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A massive protostellar core with an infalling envelope

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Context: Due to the short timescales involved and observational difficulties, our knowledge of the earliest phases of massive star formation remains incomplete.
Aims: We aim to explore the physical conditions during the initial phases of high-mass star formation and to detect a genuine massive (mass M $>$ 8 $M_\odot$) protostar at an early evolutionary stage.
Methods: We have launched a multi-wavelength study of young and massive star-forming regions that were identified by the ISOPHOT Serendipity Survey (ISOSS) performed with the ISO space telescope. The follow-up observations include ground-based near-infrared imaging and (sub)mm continuum and molecular line measurements (both single-dish and interferometric), as well as mid- to far-infrared measurements with the Spitzer Space Telescope. The combined spectrophotometric data are used to determine source temperatures T and masses M.
Results: ISOSS J23053+5953 is a massive (M $\sim$ 900 $M_\odot$, luminosity L $\sim$ 2100 $L_\odot$) and cold (T $\sim$ 17 K) star-forming region with two protostellar/protocluster candidates (T $\leq$ 20 K and T $\sim$ 17.5 K, M $\sim$ 200 $M_\odot$ each). The low temperatures are strongly confined by the spectrophotometric Spitzer data in the FIR. Interferometric observations reveal that the colder core (SMM2) has a mass of M = 26 $M_\odot$ within a region of 8700×5600 AU and drives an outflow. It also shows signs of infall in both single-dish and interferometric measurements, and its luminosity can be explained by accretion. We also detect a large-scale jet that is traced by H2 emission.
Conclusions: The cold mm-core ISOSS J23053+5953 SMM2 is a promising candidate for a high-mass protostar in an early evolutionary stage and one of the few objects showing both infall signatures and jets as a sign of accretion.

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Stability and nonlinear adjustment of vortices in Keplerian flows

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Aims. We investigate the stability, nonlinear development and equilibrium structure of vortices in a background shearing Keplerian flow

Methods. We make use of high-resolution global two-dimensional compressible hydrodynamic simulations. We introduce the concept of nonlinear adjustment to describe the transition of unbalanced vortical fields to a long-lived configuration.

Results. We discuss the conditions under which vortical perturbations evolve into long-lived persistent structures and we describe the properties of these equilibrium vortices. The properties of equilibrium vortices appear to be independent from the initial conditions and depend only on the local disk parameters. In particular we find that the ratio of the vortex size to the local disk scale height increases with the decrease of the sound speed, reaching values well above the unity. The process of spiral density wave generation by the vortex, discussed in our previous work, appear to maintain its efficiency also at nonlinear amplitudes and we observe the formation of spiral shocks attached to the vortex. The shocks may have important consequences on the long term vortex evolution and possibly on the global disk dynamics.

Conclusions. Our study strengthens the arguments in favor of anticyclonic vortices as the candidates for the promotion of planetary formation. Hydrodynamic shocks that are an intrinsic property of persistent vortices in compressible Keplerian flows are an important contributor to the overall balance. These shocks support vortices against viscous dissipation by generating local potential vorticity and should be responsible for the eventual fate of the persistent

anticyclonic vortices. Numerical codes have be able to resolve shock waves to describe the vortex dynamics correctly.

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Intermediate to low-mass stellar content of Westerlund 1

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We have analysed near-infrared NTT/SofI observations of the starburst cluster Westerlund 1, which is among the most massive young clusters in the Milky Way. A comparison of colour-magnitude diagrams with theoretical main-sequence and pre-main sequence evolutionary tracks yields improved extinction and distance estimates of A_{Ks} = 1.13±0.03 mag and d = 3.55±0.17 kpc (DM = 12.75±0.10 mag). The pre-main sequence population is best fit by a Palla & Stahler isochrone for an age of 3.2 Myr, while the main sequence population is in agreement with a cluster age of 3 to 5 Myr. An analysis of the structural parameters of the cluster yields that the half-mass radius of the cluster population increases towards lower mass, indicative of the presence of mass segregation. The cluster is clearly elongated with an eccentricity of 0.20 for stars with masses between 10 and 32 Msun, and 0.15 for stars with masses in the range 3 to 10 Msun. We derive the slope of the stellar mass function for stars with masses between 3.4 and 27 Msun. In an annulus with radii between 0.75 and 1.5 pc from the cluster centre, we obtain a slope of $\Gamma = -1.3$. Closer in, the mass function of Westerlund 1 is shallower with $\Gamma = -0.6$. The extrapolation of the mass function for stars with masses from 0.08 to 120 Msun yields an initial total stellar mass of ≈52,000 Msun, and a present-day mass of 20,000 to 45,000 Msun (about 10 times the stellar mass of the Orion Nebula Cluster, and 2 to 4 times the mass of the NGC 3603 young cluster), indicating that Westerlund 1 is the most massive starburst cluster identified to date in the Milky Way.

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Embedded star clusters and the formation of the Oort cloud II. The effect of the primordial solar nebula

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This paper deals with Oort cloud formation while the Sun was in an embedded cluster and surrounded by its primordial nebula. This work is a continuation of Brasser et al. [Brasser, R., Duncan, M., Levison, H., 2006. Icarus 184, 5982], building on the model presented therein, and adding the aerodynamic drag and gravitational potential of the primordial solar nebula. Results are presented of numerical simulations of comets subject to the gravitational influence of the Sun, Jupiter, Saturn, star cluster and primordial solar nebula; some of the simulations included the gravitational influence of Uranus and Neptune as well. The primordial solar nebula was approximated by the minimum-mass Hayashi model [Hayashi, C., Nakozawa, K., Nakagawa, Y., 1985. In: Black, D.C., Matthews, M.S. (Eds.). Protostars and Planets II. Univ. of Arizona Press, Tucson, AZ] whose inner and outer radii have been truncated at various distances from the Sun. A comet size of 1.7 km was used for most of our simulations. In all of our simulations, the density of the primordial solar nebula decayed exponentially with an e-folding time of 2 Myr. It turns out that when the primordial solar nebula extends much beyond Saturn or Neptune, virtually no material will end up in the Oort cloud (OC) during this phase. Instead, the majority of the material will be on circular orbits inside of Jupiter if the inner edge of the disk is well inside Jupiter's orbit. If the disk's inner edge is beyond Jupiter's orbit, most comets end up on orbits in

exterior mean-motion resonances with Saturn when Uranus and Neptune are not present. In those cases where the outer edge of the disk is close to Saturn or Neptune, the fraction of material that ends up in the subsequently formed OC is much less than that found in Brasser et al. [Brasser, R., Duncan, M., Levison, H., 2006. Icarus 184, 5982] for the same cluster densities. This implies that for comets of roughly 2 km in size, the presence of the primordial solar nebula hinders OC formation. A byproduct of some of our simulations are endresults with a substantial fraction of the comets in the UranusNeptune scattered disk. A subsequent followup of this material is planned for the near future. In order to determine the effect of the size of the comets on OC formation efficiency, a set of runs with the same initial conditions but different cometary radii have been performed as well, from which it is determined that the threshold comet size to begin producing significant Oort clouds is roughly 20 km. This implies that the presence of the primordial solar nebula acts as a size-sorting mechanism, with large bodies unaffected by the gas drag and ending up in the OC while small bodies remain trapped in the planetary region, in the models studied.

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Coagulation, fragmentation and radial motion of solid particles in protoplanetary disks

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The growth of solid particles towards meter sizes in protoplanetary disks has to circumvent at least two hurdles, namely the rapid loss of material due to radial drift and particle fragmentation due to destructive collisions. In this paper, we present the results of numerical simulations with more and more realistic physics involved. Step by step, we include various effects, such as particle growth, radial/vertical particle motion and dust particle fragmentation in our simulations. We demonstrate that the initial dust-to-gas ratio is essential for the particles to overcome the radial drift barrier. If this value is increased by a factor of 2 compared with the canonical value for the interstellar medium, km-sized bodies can form in the inner disk (< 2 AU) within 10^4 yrs. However, we find that solid particles get destroyed through collisional fragmentation. Only with the unrealistically high-threshold velocities needed for fragmentation to occur (> 30 m/s), particles are able to grow to larger sizes in disks with low α values. We also find that less than 5% of the small dust grains remain in the disk after 1 Myrs due to radial drift, no matter whether fragmentation is included in the simulations or not. In this paper, we also present considerable improvements to existing algorithms for dust-particle coagulation, which speed up the coagulation scheme by a factor of $\sim 10^4$.

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Continuum Observations at 3 and 12 mm of the High-Mass Protostellar Jet IRAS 16547-4247

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Continuum data at 25 and 88 GHz toward the luminous young stellar object IRAS 16547-4247 (G343.126-0.062) have been obtained with the Australia Telescope Compact Array. The triple emission source identified previously at lower frequencies has been detected at 25 GHz. For frequencies between 1.4 and 25 GHz, the flux density of the central continuum source is well fitted with a power-law dependence that is consistent with thermal emission from a jet. The two outer lobes are radio Herbig-Haro objects exhibiting thermal and nonthermal synchrotron emission. At 88 GHz, one unresolved emission source was detected, centered on the radio jet. At this frequency the emission does not arise from the jet but from the dusty molecular envelope within which the jet is embedded.

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Grain Alignment and Polarized Emission from Magnetized T Tauri Disks

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The structure of magnetic fields within protostellar disks may be studied via polarimetry provided that grains are aligned with respect to the magnetic field within the disks. We explore the alignment of dust grains by radiative torque in T Tauri disks and provide predictions for polarized emission for disks viewed at different wavelengths and viewing angles. We show that the alignment is especially efficient in the outer parts of the disks. In the presence of a magnetic field, these aligned grains produce polarized emission in infrared wavelengths. We consider a simple disk model and provide predictions for polarization that are available to the present-day instruments that do not resolve the disks and will be available to future instruments that will resolve the disks. We find that the polarized emission drops for wavelengths shorter than ~ 10 μm. Between $\sim$10 and $\sim$100 μm, the polarized emission is dominated by the emission from the surface layer, and the degree of polarization can be as large as $\sim$10% for unresolved disks. We find that the degree of polarization at these wavelengths is very sensitive to the size distribution of dust grains in the disk surface layer, which should allow for the testing of the predicted grain-size distributions. The degree of polarization in the far-infrared/submillimeter wavelengths is sensitive to the size distribution of dust grains in the disk interior. When we take a Mathis-Rumpl-Nordsiecktype distribution with maximum grain size of 500-1000 μm, the degree of polarization is around the 2%-3% level at wavelengths larger than $\sim$100 μm. Our study indicates that multifrequency infrared polarimetric studies of protostellar disks can provide good insights into the details of their magnetic structure.

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Circular polarimetry reveals helical magnetic fields in the young stellar object HH 135-136

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Magnetic fields are believed to have a vital role in regulating and shaping the flow of material onto and away from protostars during their initial mass accretion phase. It is becoming increasingly accepted that bipolar outflows are generated and collimated as material is driven along magnetic field lines and centrifugally accelerated off a rotating accretion disk. However, the precise role of the magnetic field is poorly understood and evidence for its shape and structure has not been forthcoming. Here we report imaging circular polarimetry in the near-infrared and Monte Carlo modelling showing that the magnetic field along the bipolar outflow of the HH 135-136 young stellar object is helical. The field retains this shape for large distances along the outflow, so the field structure can also provide the necessary magnetic pressure for collimation of the outflow. This result lends further weight to the hypothesis-central to any theory of star formation-that the outflow is an important instrument for the removal of high-angular-momentum material from the accretion disk, thereby allowing the central protostar to increase its mass.

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Outward Transport of High-Temperature Materials Around the Midplane of the Solar Nebula

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he Stardust samples collected from Comet 81P/Wild 2 indicate that large-scale mixing occurred in the solar nebula, carrying materials from the hot inner regions to cooler environments far from the Sun. Similar transport has been

inferred from telescopic observations of protoplanetary disks around young stars. Models for protoplanetary disks, however, have difficulty explaining the observed levels of transport. Here I report the results of a new two-dimensional model that shows that outward transport of high-temperature materials in protoplanetary disks is a natural outcome of disk formation and evolution. This outward transport occurs around the midplane of the disk.

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The response of self-gravitating protostellar discs to slow reduction in cooling time-scale: the fragmentation boundary revisited

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A number of previous studies of the fragmentation of self-gravitating protostellar discs have involved suites of simulations in which radiative cooling is modelled in terms of a cooling time-scale (t_{cool}) which is parametrized as a simple multiple (β_{cool}) of the local dynamical time-scale. Such studies have delineated the 'fragmentation boundary' in terms of a critical value of $\beta_{cool}(\beta_{crit})$ such that the disc fragments if $\beta_{cool} < \beta_{crit}$. Such an approach however begs the question of how in reality a disc could ever be assembled in a state with $\beta_{cool} < \beta_{crit}$. Here we adopt the more realistic approach of effecting a gradual reduction in β_{cool}, as might correspond to changes in thermal regime due to secular changes in the disc density profile. We find that the effect of gradually reducing β_{cool} (on a time-scale longer than t_{cool}) is to stabilize the disc against fragmentation, compared with models in which β_{cool} is reduced rapidly (over less than t_{cool}). We therefore conclude that the ability of a disc to remain in a self-regulated, self-gravitating state (without fragmentation) is partly dependent on the disc's thermal history, as well as its current cooling rate. Nevertheless, the effect of a slow reduction in t_{cool} appears only to lower the fragmentation boundary by about a factor of 2 in t_{cool} and thus only permits maximum 'α' values (which parametrize the efficiency of angular momentum transfer in the disc) that are about a factor of 2 higher than determined hitherto. Our results therefore do not undermine the notion that there is a fundamental upper limit to the heating rate that can be delivered by gravitational instabilities before the disc is subject to fragmentation. An important implication of this work, therefore, is that self-gravitating discs can enter into the regime of fragmentation via secular evolution and it is not necessary to invoke rapid (impulsive) events to trigger fragmentation.

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Stringent Criteria for Stable and Unstable Planetary Orbits in Stellar Binary Systems

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The existence of planets in stellar binary (and higher order) systems has now been confirmed by many observations. The stability of planetary orbits in these systems has been extensively studied, but no precise stability criteria have so far been introduced. Therefore, there is an urgent need for developing stringent mathematical criteria that allow us to precisely determine whether a planetary orbit in a binary system is stable or unstable. In this Letter, such criteria are defined using the concept of Jacobi's integral and Jacobi's constant. These criteria are used to contest previous results on planetary orbital stability in binary systems.

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A near-infrared interferometric survey of debris disk stars I: Probing the hot dust content around ϵ Eridani and τ Ceti with CHARA/FLUOR

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Context. The quest for hot dust in the central region of debris disks requires high resolution and high dynamic range imaging. Near-infrared interferometry is a powerful means to directly detect faint emission from hot grains.

Aims. We probed the first 3 AU around τ Ceti and ϵ Eridani with the CHARA array (Mt Wilson, USA) in order to gauge the 2 μm excess flux emanating from possible hot dust grains in the debris disks and to also resolve the stellar photospheres.

Methods. High precision visibility amplitude measurements were performed with the FLUOR single mode fiber instrument and telescope pairs on baselines ranging from 22 to 241 m of projected length. The short baseline observations allow us to disentangle the contribution of an extended structure from the photospheric emission, while the long baselines constrain the stellar diameter.

Results. We have detected a resolved emission around τ Cet, corresponding to a spatially integrated, fractional excess flux of $0.98 \pm 0.21 \times 10^{-2}$ with respect to the photospheric flux in the K'-band. Around ϵ Eri, our measurements can exclude a fractional excess of greater than 0.6×10^{-2} (3σ). We interpret the photometric excess around τ Cet as a possible signature of hot grains in the inner debris disk and demonstrate that a faint, physical or background, companion can be safely excluded. In addition, we measured both stellar angular diameters with an unprecedented accuracy: $\Theta_{\rm LD}(\tau\,{\rm Cet}) = 2.015 \pm 0.011$ mas and $\Theta_{\rm LD}(\epsilon\,{\rm Eri}) = 2.126 \pm 0.014$ mas.

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The Initial Cluster Mass Function of Super Star Clusters in Irregular and Spiral Galaxies

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The initial cluster mass function (ICMF) is a fundamental property of star formation in galaxies. To gauge its universality, we measure and compare the ICMFs in irregular and spiral galaxies. Our sample of irregular galaxies is based on thirteen nearby galaxies selected from a volume-limited sample from the fifth data release of the Sloan Digital Sky Survey (SDSS). The extinctions, ages, and masses were determined by comparing their u'g'i'z' magnitudes to those generated from starburst models. Completeness corrections were performed using Monte Carlo simulations in which artificial clusters were inserted into each galaxy. We analyzed three nearby spiral galaxies with SDSS data in exactly the same way to derive their ICMF based on a similar number of young, massive clusters as the irregular galaxy ICMF. We find that the ICMFs of irregular and spiral galaxies for masses $> 3x10^4 M_\odot$ are statistically indistinguishable. For clusters more massive than $3x10^4 M_\odot$, the ICMF of the irregular galaxies is reasonably well fit by a power law $dN(M)/dM\ M^{-a_M}$ with $a_M = 1.88 \pm 0.09$. Similar results were obtained for the ICMF of the spiral galaxy sample but with $a_M = 1.75 \pm 0.06$. We discuss the implications of our result for theories of star cluster formation, which

appears to be independent of metallicity and galactic shear rate.

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The minimum gap-opening planet mass in an irradiated circumstellar accretion disc

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We consider the minimum mass planet, as a function of radius, that is capable of opening a gap in an α-accretion disc. We estimate that a half-Jupiter mass planet can open a gap in a disc with accretion rate $\dot{M} \lesssim 10^{-8}$ M$_\odot$ yr^{-1} for viscosity parameter $\alpha = 0.01$, and solar mass and luminosity. The minimum mass is approximately proportional to $\dot{M}^{0.48}\alpha^{0.8}M_\star^{0.42}L_\star^{-0.08}$. This estimate can be used to rule out the presence of massive planets in gapless accretion discs. We identify two radii at which an inwardly migrating planet may become able to open a gap and so slow its migration; the radius at which the heating from viscous dissipation is similar to that from stellar radiation in a flared disc, and the radius at which the disc becomes optically thin in a self-shadowed disc. In the inner portions of the disc, we find that the minimum planet mass required to open a gap is only weakly dependent on radius. If a migrating planet is unable to open a gap by the time it reaches either of the transition radii, then it is likely to be lost on to the star. If a gap-opening planet cuts off disc accretion allowing the formation of a central hole or clearing in the disc then we would estimate that the clearing radius would approximately be proportional to the stellar mass.

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Variations in Stellar Clustering with Environment: Dispersed Star Formation and the Origin of Faint Fuzzies

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The observed increase in star formation efficiency with average cloud density, from several percent in whole giant molecular clouds to $\sim 30\%$ or more in cluster-forming cores, can be understood as the result of hierarchical cloud structure if there is a characteristic density as which individual stars become well defined. Also in this case, the efficiency of star formation increases with the dispersion of the density probability distribution function (pdf). Models with log-normal pdf's illustrate these effects. The difference between star formation in bound clusters and star formation in loose groupings is attributed to a difference in cloud pressure, with higher pressures forming more tightly bound clusters. This correlation accounts for the observed increase in clustering fraction with star formation rate and with the observation of Scaled OB Associations in low pressure environments. "Faint fuzzie" star clusters, which are bound but have low densities, can form in regions with high Mach numbers and low background tidal forces. The proposal by Burkert, Brodie & Larsen (2005) that faint fuzzies form at large radii in galactic collisional rings, satisfies these constraints.

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Expanded Very Large Array Observations of the 6035 MHz OH Masers in ON 1

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This Letter reports on initial Expanded Very Large Array (EVLA) observations of the 6035 MHz masers in ON 1. The EVLA data are of good quality, lending confidence in the new receiver system. Nineteen maser features, including six

Zeeman pairs, are detected. The overall distribution of 6035 MHz OH masers is similar to that of the 1665 MHz OH masers. The spatial resolution is sufficient to unambiguously determine that the magnetic field is strong (about -10 mG) at the location of the blueshifted masers in the north, consistent with Zeeman splitting detected in 13441 MHz OH masers in the same velocity range. Left- and right-circularly polarized ground-state features dominate in different regions in the north of the source, which may be due to a combination of magnetic field and velocity gradients. The combined distribution of all OH masers toward the south is suggestive of a shock structure of the sort previously seen in W3(OH).

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The AU Microscopii Debris Disk: Multiwavelength Imaging and Modeling

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Debris disks around main-sequence stars are produced by the destruction of unseen parent bodies. AU Microscopii (GJ 803) is a compelling object to study in the context of disk evolution across different spectral types, as it is an M dwarf whose nearly edge-on disk may be directly compared to that of its A5 V sibling β Pic. We resolve the disk from 8-60 AU in the near-IR JHK' bands at high resolution with the Keck II Telescope and adaptive optics, and develop a data reduction technique for the removal of the stellar point-spread function. We measure a blue color across the near-IR bands, and confirm the presence of substructure in the inner disk. Some of the structural features exhibit wavelength-dependent positions. Recent measurements of the scattered-light polarization indicate the presence of porous grains. The scattering properties of these porous grains have a strong effect on the inferred structure of the disk relative to the majority of previously modeled grain types. Complementing prior work, we use a Monte Carlo radiative transfer code to compare a relatively simple model of the distribution of porous grains to a broad data set, simultaneously fitting midplane surface brightness profiles and the spectral energy distribution. Our model confirms that the large-scale architecture of the disk is consistent with detailed models of steady state grain dynamics. A belt of parent bodies from 3540 AU produces dust that is then swept outward by stellar wind and radiation. We infer the presence of very small grains in the region exterior to the belt, down to sizes of $\sim$0.05 μm. These sizes are consistent with stellar mass-loss rates $\dot{M}_\star \ll 10^2 \dot{M}_\odot$.

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A Ring of Warm Dust in the HD 32297 Debris Disk

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We report the detection of a ring of warm dust in the near-edge-on disk surrounding HD 32297 with the Gemini North Michelle mid-infrared imager. Our N'-band image shows elongated structure consistent with the orientation of the scattered-light disk. The F(11.2 μm) = 49.9 $\pm$ 2.1 mJy flux is significantly above the 28.2 $\pm$ 0.6 mJy photosphere. Subtraction of the stellar point-spread function reveals a bilobed structure with peaks 0.5″0.6″ from the star. The disk is detected out to the sensitivity limit at $\sim$1″, and the flux in each lobe is symmetric to within 10%. An analysis of the stellar component of the spectral energy distribution (SED) suggests a spectral type later than A0, in contrast to commonly cited literature values. We fit three-dimensional, single-size grain models of an optically thin dust ring to our image and the SED using a Markov chain Monte Carlo algorithm in a Bayesian framework. The best-fit effective grain sizes are submicron, suggesting the same dust population is responsible for the bulk of the scattered light. The inner boundary of the warm dust is located 0.5″0.7″ ($\sim$65 AU) from the star, which is approximately cospatial with the outer boundary of the scattered-light asymmetry inward of 0.5″. The addition of a separate component of larger, cooler grains that provide a portion of the 60 μm flux improves both the fidelity of the model fit and consistency with the slopes of the scattered-light brightness profiles. The peak vertical optical depths in our models [$\sim (0.31) \times 10^{-2}$]

imply that grain-grain collisions likely play a significant role in dust dynamics and evolution. Submicron grains can survive radiation pressure blowout if they are icy and porous. Similarly, the inferred warm temperatures (130200 K) suggest that ice sublimation may play a role in truncating the inner disk.

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A 1.3 cm wavelength radio flare from a deeply embedded source in the Orion BN/KL region

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Aims: Our aim was to measure and characterize the short-wavelength radio emission from young stellar objects (YSOs) in the Orion Nebula Cluster and the BN/KL star-forming region. Methods: We used the NRAO Very Large Array at a wavelength of 1.3 cm and we studied archival X-ray, infrared, and radio data. Results: During our observation, a strong outburst (flux increasing >10 fold) occurred in one of the 16 sources detected at a wavelength of 1.3 cm, while the others remained (nearly) constant. This source does not have an infrared counterpart, but has subsequently been observed to flare in X-rays. Curiously, a very weak variable double radio source was found at other epochs near this position, one of whose components is coincident with it. A very high extinction derived from modeling the X-ray emission and the absence of an infrared counterpart both suggest that this source is very deeply embedded.

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A Low-Mass H_2 Component to the AU Microscopii Circumstellar Disk

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We present a determination of the molecular gas mass in the AU Microscopii circumstellar disk. Direct detection of a gas component to the AU Mic disk has proven elusive, with upper limits derived from ultraviolet absorption line and submillimeter CO emission studies. Fluorescent emission lines of H_2, pumped by the O VI λ1032 resonance line through the CX (11) Q(3) λ1031.87 Å transition, are detected by the Far Ultraviolet Spectroscopic Explorer. These lines are used to derive the H_2 column density associated with the AU Mic system. The derived column density is in the range $N(H_2) = 1.9 \times 10^{17}$ to 2.8×10^{15} cm^{-2}, roughly 2 orders of magnitude lower than the upper limit inferred from absorption line studies. This range of column densities reflects the range of H_2 excitation temperature consistent with the observations, $T(H_2) = 800$-2000 K, derived from the presence of emission lines excited by O VI in the absence of those excited by Lyα. Within the observational uncertainties, the data are consistent with the H_2 gas residing in the disk. The inferred $N(H_2)$ range corresponds to H_2-to-dust ratios of $\lesssim \frac{1}{30}$: 1 and a total $M(H_2) = 4.0 \times 10^{-4}$ to 5.8×10^{-6} $M_\oplus$. We use these results to predict the intensity of the associated rovibrational emission lines of H_2 at infrared wavelengths covered by ground-based instruments, HST NICMOS, and the Spitzer IRS.

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SWAS Observations of Water in Molecular Outflows

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We present detections of the ground-state $1_{10} \rightarrow 1_{01}$ transition of ortho-H_2O at 557 GHz in 18 molecular outflows based on data from the *Submillimeter Wave Astronomy Satellite* (SWAS). These results are combined with ground-based observations of the J=1-0 transitions of ^{12}CO and ^{13}CO obtained at the *Five College Radio Astronomy Observatory* (FCRAO). Data from *Infrared Space Observatory* (ISO) for a subset of the outflows are also discussed. Assuming the SWAS water line emission originates from the same gas traced by CO emission, we find that the outflowing gas in most outflows has an ortho-H_2O abundance relative to H_2 of between about 10^{-7} and 10^{-6}. Analysis of the water abundance as a function of outflow velocity reveals a strong dependence. The abundance of ortho-H_2O increases with velocity and at the highest outflow velocities some of the outflows have relative ortho-H_2O abundances of order 10^{-4}. However the mass of very high velocity gas with such elevated H_2O abundances represents less that 1% of the total outflow gas mass. The ISO LWS observations of high-J rotational lines of CO and the 179.5 μm transition of ortho-H_2O provide evidence for a warmer outflow component than required to produce either the SWAS or FCRAO lines. The ISO line flux ratios can be reproduced with C-shock models with shock velocities of order 25 km s^{-1} and preshock densities of order 10^5 cm^{-3}; these C-shocks have post-shock relative water abundances greater than 10^{-4}. The mass associated with the ISO emission is also quite small compared with the total outflow mass, and is similar to that responsible for the highest velocity water emission detected by SWAS. Although the gas responsible for the ISO emission has elevated levels of water, the bulk of the outflowing gas has an abundance of ortho-H_2O well below what would be expected if the gas has passed through a C-shock with shock velocities greater than 10 km s^{-1}. Gas-phase water can be depleted in the post-shock gas due to freeze-out onto grain mantles, however the rate of freeze-out is too slow to explain our results. Therefore we believe that only a small fraction of the outflowing molecular gas has passed through shocks strong enough to fully convert the gas-phase oxygen to water. This result has implications for the acceleration mechanism of the molecular gas in these outflows.

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Spitzer IRS Spectra and Envelope Models of Class I Protostars in Taurus

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We present *Spitzer* Infrared Spectrograph spectra of 28 Class I protostars in the Taurus star-forming region. The 5 to 36 μm spectra reveal excess emission from the inner regions of the envelope and accretion disk surrounding these predecessors of low-mass stars, as well as absorption features due to silicates and ices. Together with shorter- and longer-wavelength data from the literature, we construct spectral energy distributions and fit envelope models to 22 protostars of our sample, most of which are well-constrained due to the availability of the IRS spectra. We infer that the envelopes of the Class I objects in our sample cover a wide range in parameter space, particularly in density and centrifugal radius, implying different initial conditions for the collapse of protostellar cores.

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Results from Droxo: I. The variability of fluorescent Fe 6.4 keV emission in the young star Elias 29. High-energy electrons in the star's accretion tubes?

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Aims. We study the variability of the Fe 6.4 keV emission line from the Class I young stellar object Elias 29 in the ρ Oph cloud.

Methods. We analysed the data from Elias 29 collected by XMM-Newton during a nine-day, nearly continuous observation of the ρ Oph star-forming region (the Deep Rho-Oph X-ray Observation, named DROXO). The data were subdivided into six homogeneous time intervals, and the six resulting spectra were individually analysed.

Results. We detect significant variability in the equivalent width of the Fe 6.4 keV emission line from Elias 29. The 6.4 keV line is absent during the first time interval of observation and appears at its maximum strength during the second time interval (90 ks after Elias 29 undergoes a strong flare). The X-ray thermal emission is unchanged between the two observation segments, while line variability is present at a 99.9% confidence level. Given the significant line variability in the absence of variations in the X-ray ionising continuum and the weakness of the photoionising continuum from the star's thermal X-ray emission, we suggest that the fluorescence may be induced by collisional ionisation from an (unseen) population of non-thermal electrons. We speculate on the possibility that the electrons are accelerated in a reconnection event of a magnetically confined accretion loop, connecting the young star to its circumstellar disk.

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The relationship between the prestellar core mass function and the stellar initial mass function

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Stars form from dense molecular cores, and the mass function of these cores (the CMF) is often found to be similar to the form of the stellar initial mass function (IMF). This suggests that the form of the IMF is the result of the form of the CMF. However, most stars are thought to form in binary and multiple systems, therefore the relationship between the IMF and the CMF cannot be trivial. We test two star formation scenarios - one in which all stars form as binary or triple systems, and one in which low-mass stars form in a predominantly single mode. We show that from a log-normal CMF, similar to those observed, and expected on theoretical grounds, the model in which all stars form as multiples gives a better fit to the IMF.

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Survival of icy grains in debris discs

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Aims. We put theoretical constraints on the presence and survival of icy grains in debris discs. Particular attention is paid to UV sputtering of water ice, which has so far not been studied in detail in this context.

Methods. We present a photosputtering model based on available experimental and theoretical studies. We quantitatively estimate the erosion rate of icy and ice-silicate grains, under the influence of both sublimation and photosputtering, as a function of grain size, composition and distance from the star. The effect of erosion on the grain's location is investigated through numerical simulations coupling the grain size to its dynamical evolution.

Results. Our model predicts that photodesorption efficiently destroy ice in optically thin discs, even far beyond the sublimation snow line. For the reference case of β Pictoris, we find that only $\gtrsim$5 mm grains can keep their icy component for the age of the system in the 50-150 AU region. When taking into account the collisional reprocessing of grains, we show that the water ice survival on grains improves (grains down to $\simeq$20 μm might be partially icy). However, estimates of the amount of gas photosputtering would produce on such a hypothetical population of big icy grains lead to values for the O I column density that strongly exceed observational constraints for β Pic, thus ruling out the presence of a significant amount of icy grains in this system. Erosion rates and icy grains survival timescales are also given for a set of 11 other debris disc systems. We show that, with the possible exception of M stars, photosputtering cannot be neglected in calculations of icy grain lifetimes.

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First images of 6.7-GHz methanol masers in DR21(OH) and DR21(OH)N

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The first images of 6.7-GHz methanol masers in the massive star-forming regions DR21(OH) and DR21(OH)N are presented. By measuring the shapes, radial velocities and polarization properties of these masers it is possible to map out the structure, kinematics and magnetic fields in the molecular gas that surrounds newly-formed massive stars. The intrinsic angular resolution of the observations was 43 mas ($\sim$ 100 AU at the distance of DR21), but structures far smaller than this were revealed by employing a non-standard mapping technique. By plotting the positions of the Gaussian-fitted maser emission centroids in each velocity channel, the internal velocity gradients of the masers were investigated at very high spectral and spatial resolution. This technique was used in an attempt to identify the physical structure (e.g. disc, outflow, shock) associated with the methanol masers. Two distinct star-forming centres were identified. In DR21(OH) the masers had a linear morphology, and the individual maser spots each displayed an internal velocity gradient in the same direction as the large-scale structure. They were detected at the same position as the OH 1.7-GHz ground-state masers, close to the centre of an outflow traced by CO and class I methanol masers. The shape and velocity gradients of the masers suggests that they probably delineate a shock. In DR21(OH)N the methanol masers trace an arc with a double-peaked profile and a complex velocity gradient. This velocity gradient closely resembles that of a Keplerian disc. The masers in the arc are 4.5% linearly polarized, with a polarization angle that indicates that the magnetic field direction is roughly perpendicular to the large-scale magnetic field in the region (indicated by lower angular resolution measurements of the CO and dust polarization). The origin and nature of these maser structures is considered within the context of what is already known about the region. The suitability of channel-by-channel centroid mapping is discussed as an improved and viable means to maximise the information gained from the data.

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Star Spot Induced Radial Velocity Variability in LkCa 19

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We describe a new radial velocity survey of T Tauri stars and present the first results. Our search is motivated by an interest in detecting massive young planets, as well as investigating the origin of the brown dwarf desert. As part of this survey, we discovered large-amplitude, periodic, radial velocity variations in the spectrum of the weak line T Tauri star LkCa 19. Using line bisector analysis and a new simulation of the effect of star spots on the photometric and radial velocity variability of T Tauri stars, we show that our measured radial velocities for LkCa19 are fully consistent with variations caused by the presence of large star spots on this rapidly rotating young star. These results illustrate the level of activity-induced radial velocity noise associated with at least some very young stars. This activity-induced noise will set lower limits on the mass of a companion detectable around LkCa 19, and similarly active young stars.

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Lithium abundances of very low mass members of Chamaeleon I

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Aims. We present the first study of the lithium abundances of very low mass objects in Chamaeleon I close to the hydrogen burning mass limit based on atmospheric models and high-resolution spectroscopic observations. The studied objects, Cha Hα 2, 3, 4, 5, 6 and 8, are very young brown dwarf candidates and very low mass stars on the verge of lithium depletion.

Methods. For this analysis, we have computed a new "GAIA-cond" class model grid over effective temperatures from 2600 K to 3100 K, surface gravities from log(g) = 3.5 to 5.5, and lithium abundances from logϵ = 0.0 to 3.7, for two different line profile setups introduced in previous work. Calculated synthetic spectra are compared with high-resolution UVES / VLT echelle spectra of the objects.

Results. We find good descriptions of the lithium resonance doublet lines at 6708 Åand of the surrounding pseudo-continuum and determine a consistent set of lithium abundances (log(ϵ) = 1.55). However, the derived lithium abundances are lower than the meteoritic one (log(ϵ) = 3.31) and that of higher mass stars in Cha I (log(ϵ) = 3.1/3.4 for LTE-/non-LTE-calculations). By modeling the TiO-line, we demonstrate that veiling does not make the lithium lines appear weaker. We can also rule out that the results are spoiled by the presence of spots.

Conclusions. A possible explanation for these results would be that the objects are either more massive, or much older, than previously thought, so that the lithium depletion has already started. Although the uncertainties of the masses and ages are large, they are not large enough as to explain the observed lithium depletion. Therefore, the most likely explanation is either a lack of understanding of the details of the formation of the lithium line, or a lack of understanding of the internal structure of the very young low-mass objects.

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IRAC Observations of CO J = 4 → 3 High-Velocity Cloud in the 30 Doradus Complex in the Large Magellanic Cloud

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We present the results of ^{12}CO J = 2 → 1 observations of the X-raybright giant shell complex 30 Doradus in the Large Magellanic Cloud (LMC) using the Antarctic Submillimeter Telescope and Remote Observatory (AST/RO). This is the one of the largest H II complexes in the Local Group. We compare the ^{12}CO J = 2 → 1 observations against previously made ^{12}CO J = 4 → 3 observations and analyze the spatial distribution of young stellar objects (YSOs) within the cloud using the Spitzer IRAC observations of the 30 Doradus complex. Both peaks of ^{12}CO J = 2 → 1 and J = 4 → 3 emitting clouds coincide with the densest region of the filaments in which multiple shells are colliding. The YSOs are clustered in the southern ridge of the warm and dense molecular gas clouds traced by ^{12}CO J = 4 → 3, indicating a filamentary structure of star formation throughout 30 Doradus. We also find an excess of Class I YSO candidates close to the clouds, which likely represent the most recent phase of star formation in this region. This is a region where the triggered star formation has actually occurred, and newly formed stars may have produced such a high-velocity outflow through interacting with the surrounding molecular cloud material.

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Clumpy photon-dominated regions in Carina. I. [CI] and mid-J CO lines in two $4' \times 4'$ fields.

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The Carina region is an excellent astrophysical laboratory for studying the feedback mechanisms of newly born, very massive stars within their natal giant molecular clouds (GMCs) at only 2.35 kpc distance. We use a clumpy PDR model to analyse the observed intensities of atomic carbon and CO and to derive the excitation conditions of the gas. The NANTEN2-4m submillimeter telescope was used to map the [CI] $^3P_1 - ^3P_0$, $^3P_2 - ^3P_1$ and CO 4–3, 7–6 lines in two $4' \times 4'$ regions of Carina where molecular material interfaces with radiation from the massive star clusters. One region is the northern molecular cloud near the compact OB cluster Tr 14, and the second region is in the molecular cloud south of ηCar and Tr 16. These data were combined with ^{13}CO SEST spectra, HIRES/IRAS 60 μm and 100 μm maps of the FIR continuum, and maps of 8 μm IRAC/Spitzer and MSX emission. We used the HIRES far-infrared dust data to create a map of the FUV field heating the gas. The northern region shows an FUV field of a few 10^3 in Draine units while the field of the southern region is about a factor 10 weaker. While the IRAC 8 μm emission lights up at the edges of the molecular clouds, CO and also [CI] appear to trace the H_2 gas column density. The northern region shows a complex velocity and spatial structure, while the southern region shows an edge-on PDR with a single Gaussian velocity component. We constructed models consisting of an ensemble of small spherically symmetric PDR clumps within the 38″ beam (0.43 pc), which follow canonical power-law mass and mass-size distributions. We find that an average local clump density of $2\,10^5$ cm^{-3} is needed to reproduce the observed line emission at two selected interface positions. Stationary, clumpy PDR models reproduce the observed cooling lines of atomic carbon and CO at two positions in the Carina Nebula.

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Obscured clusters. I. GLIMPSE 30 - A young Milky Way star cluster hosting Wolf-Rayet stars

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Context. Young massive clusters are usually deeply embedded in dust and gas. They represent excellent astrophysical laboratories for the study of massive stars. Clusters with Wolf-Rayet (WR) stars are of special importance, since this enables us to study a coeval WR population at a uniform metallicity and known age.

Aims. We started a long-term project to search the inner Milky Way for hidden star clusters and to study them in detail. GLIMPSE 30 (G30) is one of these clusters. It is situated near the Galactic plane ($l = 298.^\circ756$, $b = -0.^\circ408$) and we determine its physical parameters and investigate its high-mass stellar content especially WR stars.

Methods. Our analysis is based on SOFI/NTT $J_S H K_S$ imaging and low resolution ($R \sim 2000$) spectroscopy of the brightest cluster members in the K atmospheric window. For the age determination we applied isochrone fits for MS and Pre-MS stars. We derived stellar parameters of the WR stars candidates using a full nonLTE modeling of the observed spectra.

Results. Using a variety of techniques we found that G30 is very young cluster, with age t $\approx$ 4 Myr. The cluster is located in the Carina spiral arm, it is deeply embedded in dust and suffers reddening of $A_V \sim 10.5 \pm 1.1$ mag. The distance to the object is $d = 7.2 \pm 0.9$ kpc. The mass of the cluster members down to 2.35 $M_\odot$ is $\sim$ 1600 $M_\odot$. The cluster's MF for the mass range of 5.6 to 31.6 $M_\odot$ shows a slope of $\Gamma = -1.01 \pm 0.03$. The total mass of the cluster obtained by this MF down to 1 $M_\odot$ is about 3×10^3 $M_\odot$. The spectral analysis and the models allow us to conclude that at least one Ofpe/WN and two WR stars can be found in G30. The WR stars are of the WN6-7 hydrogen rich type with progenitor masses of more than 60 $M_\odot$.

Conclusions. G30 is a new member of the family of young Galactic clusters hosting WR stars. It is a factor of two to three less massive than some of the youngest super-massive star clusters like Arches, Quintuplet and the Central cluster and is their smaller analog.

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Multi-line (sub)millimetre observations of the high-mass proto cluster IRAS 05358+3543

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Since most high- and intermediate-mass protostars are at great distance and form in clusters, high linear resolution observations are needed to investigate their physical properties. To study the gas in the innermost region around the protostars in the proto-cluster IRAS 05358+3543, we observed the source in several transitions of methanol and other molecular species with the Plateau de Bure Interferometer and the Submillimeter Array, reaching a linear resolution of 1100 AU. We determine the kinetic temperature of the gas around the protostars through an LVG and LTE analysis of their molecular emission; the column densities of CH_3OH, CH_3CN and SO_2 are also derived. Constrains on the density of the gas are estimated for two of the protostellar cores. We find that the dust condensations are in various evolutionary stages. The powerhouse of the cluster, mm1a, harbours a hot core with T$\sim$220 (75<T<330) K. A double-peaked profile is detected in several transitions toward mm1a, and we found a velocity gradient along a linear structure which could be perpendicular to one of the outflows from the vicinity of mm1a. Since the size of the double-peaked

emission is less than 1100 AU, we suggest that mm1a might host a massive circumstellar disk. The other sources are in earlier stages of star formation. The least active source, mm3, could be a starless massive core, since it is cold (T<20 K), with a large reservoir of accreting material (M$\sim$ 19M$_{\odot}$), but no molecular emission peaks on it.

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Discovery of an M9.5 Candidate Brown Dwarf in the TW Hydrae Association: DENIS J124514.1-442907

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We report the discovery of a fifth candidate substellar system in the $\sim$510 Myr TW Hydrae association: DENIS J124514.1-442907. This object has a NIR spectrum remarkably similar to that of 2MASS J1139511-315921, a known TW Hydrae brown dwarf, with low surface gravity features such as a triangular-shaped H band, deep H_2O absorption, weak alkali lines, and weak hydride bands. We find an optical spectral type of M9.5 and estimate a mass of $\lesssim$ 24 M_{Jup}, assuming an age of $\sim$ 510 Myr. While the measured proper motion for DENIS J124514.1-442907 is inconclusive as a test for membership, its position in the sky is coincident with the TW Hydrae association. A more accurate proper-motion measurement, higher resolution spectroscopy for radial velocity, and a parallax measurement are needed to derive the true space motion and to confirm its membership.

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The Stellar Population of the Chamaeleon I Star-forming Region

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I present a new census of the stellar population in the Chamaeleon I star-forming region. Using optical and near-IR photometry and follow-up spectroscopy, I have discovered 50 new members of Chamaeleon I, expanding the census of known members to 226 objects. Fourteen of these new members have spectral types later than M6, which doubles the number of known members that are likely to be substellar. I have estimated extinctions, luminosities, and effective temperatures for the known members, used these data to construct an H-R diagram for the cluster, and inferred individual masses and ages with the theoretical evolutionary models of Baraffe and Chabrier. The distribution of isochronal ages indicates that star formation began 3-4 and 5-6 Myr ago in the southern and northern subclusters, respectively, and has continued to the present time at a declining rate. The IMF in Chamaeleon I reaches a maximum at a mass of 0.1-0.15 M$_{\odot}$ and thus closely resembles the IMFs in IC 348 and the Orion Nebula Cluster. In logarithmic units where the Salpeter slope is 1.35, the IMF is roughly flat in the substellar regime and shows no indication of reaching a minimum down to a completeness limit of 0.01 M$_{\odot}$. The low-mass stars are more widely distributed than members at other masses in the northern subcluster, but this is not the case in the southern subcluster. Meanwhile, the brown dwarfs have the same spatial distribution as the stars out to a radius of 3° (8.5 pc) from the center of Chamaeleon I.

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Transient growth and coupling of vortex and wave modes in self-gravitating gaseous discs

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Linear transient phenomena induced by flow non-normality in thin self-gravitating astrophysical discs are studied using the shearing sheet approximation. The considered system includes two modes of perturbations: vortex and (spiral density) wave. It is shown that self-gravity considerably alters the vortex mode dynamics; its transient (swing) growth may be several orders of magnitude stronger than in the non-self-gravitating case and two to three times larger than the transient growth of the wave mode. Based on this finding, we comment on the role of vortex mode perturbations in a gravitoturbulent state. We also describe the linear coupling of the perturbation modes, caused by the differential character of disc rotation. The coupling is asymmetric: vortex mode perturbations are able to excite wave mode perturbations, but not vice versa. This asymmetric coupling lends additional significance to the vortex mode as a participant in spiral density waves and shock manifestations in astrophysical discs.

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A HST study of the environment of the Herbig Ae/Be star LkHα 233 and its bipolar jet

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Context. LkHα 233 is a Herbig Ae/Be star with a collimated bipolar jet. As such, it may be a high-mass analogue to the classical T Tauri stars and their outflows.

Aims. We investigate optical forbidden lines along the LkHα 233 jet to determine physical parameters of this jet (electron density $n_{\rm e}$, hydrogen ionisation fraction $x_{\rm e}$, electron temperature T_e). The knowledge of these parameters allows us a direct comparison of a jet from a Herbig star with those from T Tauri stars.

Methods. We present the results of HST/STIS and WFPC2 observations of LkHα 233 and its environment. These are the first observations of this object with a spatial resolution of $\leq 0.''1$ at optical wavelengths. Our STIS data provide spectroscopic maps that allow us to reconstruct high angular resolution images of the bipolar jet from LkHα 233 covering the first $\approx$ 2000 AU from the star in the blueshifted outflow lobe and $\approx$ 4000 AU in the redshifted lobe. These maps are analysed with a diagnostic code that yields $n_{\rm e}$, $x_{\rm e}$, T_e, and mass density $n_{\rm H}$ within the jet.

Results. The WFPC2 images in broad-band filters clearly show the presence of a dark lane caused either by a circumstellar disk or a dust torus. The circumstellar environment of LkHα 233 can be interpreted as a conical cavity that was cleared by a bipolar jet. In this interpretation, the maximum of the optical and near-infrared brightness distribution is not coincident with the star itself which is, in fact, deeply extincted. In the blueshifted lobe n_e is close to or above the critical density for [SII] lines ($2.5 \times 10^4 {\rm cm}^{-3}$) in the first arcsecond and decreases with distance from the source. The ionisation $x_e \approx 0.2 - 0.6$ gently rises for the first 500 AU of the flow and shows two re-ionisation events further away from the origin. The electron temperature $T_{\rm e}$ varies along the flow between $10^4\,{\rm K}$ and $3 \times 10^4\,{\rm K}$. The $n_{\rm H}$ is between 3×10^3 and $10^5\,{\rm cm}^{-3}$, and the mass flux $\dot{M} \approx 10^{-8} - 10^{-7} {\rm M}_\odot {\rm yr}^{-1}$. The (radial) outflow velocities are $\approx 80 - 160\,{\rm km\,s}^{-1}$ and appear to increase with distance from the source. In the redshifted lobe the excitation conditions are quite different: $T_{\rm e}$, $n_{\rm e}$, $x_{\rm e}$, and $n_{\rm H}$ are all lower than in the blueshifted lobe, but of the same order of magnitude.

Conclusions. All these derived parameters are just beyond or at the upper limits of those observed for classical T Tauri star jets. This may indicate that the flows from the higher mass Herbig stars are indeed scaled-up examples of

the same phenomenon as in T Tauri stars.

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The distance to the Orion Nebula

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We have used the Very Long Baseline Array to measure the trigonometric parallax of several member stars of the Orion Nebula Cluster showing non-thermal radio emission. We have determined the distance to the cluster to be 414 ± 7 pc. Our distance determination allows for an improved calibration of luminosities and ages of young stars. We have also measured the proper motions of four cluster stars which, when accurate radial velocities are measured, will put strong constraints on the origin of the cluster.

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Dynamics of the Giant Planets of the Solar System in the Gaseous Protoplanetary Disk and Their Relationship to the Current Orbital Architecture

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We study the orbital evolution of the four giant planets of our solar system in a gas disk. Our investigation extends the previous works by Masset & Snellgrove and Morbidelli & Crida, which focused on the dynamics of the Jupiter-Saturn system. The only systems we found to reach a steady state are those in which the planets are locked in a quadruple mean-motion resonance (i.e., each planet is in resonance with its neighbor). In total, we found six such configurations. For the gas-disk parameters found in Morbidelli & Crida, these configurations are characterized by a negligible migration rate. After the disappearance of the gas, and in the absence of planetesimals, only two of these six configurations (the least compact ones) are stable for a time of hundreds of millions of years or more. The others become unstable on a timescale of a few Myr. Our preliminary simulations show that, when a planetesimal disk is added beyond the orbit of the outermost planet, the planets can evolve from the most stable of these configurations to their current orbits in a fashion qualitatively similar to that described in Tsiganis et al.

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The dynamics of Jupiter and Saturn in the gaseous protoplanetary disk

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We study the possibility that the mutual interactions between Jupiter and Saturn prevented Type II migration from driving these planets much closer to the Sun. Our work extends previous results by Masset and Snellgrove [Masset, F., Snellgrove, M., 2001. Mon. Not. R. Astron. Soc. 320, L55L59], by exploring a wider set of initial conditions and disk parameters, and by using a new hydrodynamical code that properly describes for the global viscous evolution of the disk. Initially both planets migrate towards the Sun, and Saturn's migration tends to be faster. As a consequence, they eventually end up locked in a mean motion resonance. If this happens in the 2:3 resonance, the resonant motion is particularly stable, and the gaps opened by the planets in the disk may overlap. This causes a drastic change in

the torque balance for the two planets, which substantially slows down the planets' inward migration. If the gap overlap is substantial, planet migration may even be stopped or reversed. As the widths of the gaps depend on disk viscosity and scale height, this mechanism is particularly efficient in low viscosity, cool disks. The initial locking of the planets in the 2:3 resonance is a likely outcome if Saturn formed at the edge of Jupiter's gap, but also if Saturn initially migrated rapidly from further away. We also explore the possibility of trapping in other resonances, and the subsequent evolutions. We discuss the compatibility of our results with the initial conditions adopted in Tsiganis et al. [Tsiganis, K., Gomes, R., Morbidelli, A., Levison, H.F., 2005. Nature 435, 459461] and Gomes et al. [Gomes, R., Levison, H.F., Tsiganis, K., Morbidelli, A., 2005. Nature 435, 466469] to explain the current orbital architecture of the giant planets and the origin of the Late Heavy Bombardment of the Moon.

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A SCUBA survey of bright-rimmed clouds

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Bright-rimmed clouds (BRCs) are potential examples of triggered star formation regions, in which photoionisation driven shocks caused by the expansion of HII regions induce protostellar collapse within the clouds. The main purpose of the paper is to establish the level of star formation occuring within a known set of BRCs. A secondary aim is to determine the extent, if any, to which this star formation has been promulgated by the process of photoionisation triggering. A primary set of observations is presented obtained with submillimeter SCUBA observations and archival data from near-IR and mid- to far-IR have been explored for relevant observations and incorporated where appropriate. SCUBA observations show a total of 47 dense cores within the heads of 44 observed BRCs drawn from a catalogue of IRAS sources embedded within HII regions, supportive of the scenario proposed by RDI models. The physical properties of these cores indicate star formation across the majority of our sample. This star formation appears to be predominately in the regime of intermediate to high mass and may indicate the formation of clusters. IR observations indicate the association of early star forming sources with our sample. A fundamental difference appears to exist between different morphological types of BRC, which may indicate a different evolutionary pathway toward star formation in the different types of BRC. Bright-rimmed clouds are found to harbour star formation in its early stages. Different evolutionary scenarios are found to exist for different morphological types of BRC. The morphology of a BRC is described as type 'A', moderately curved rims, type 'B', tightly curved rims, and 'C', cometary rims. 'B' and 'C' morphological types show a clear link between their associated star formation and the strength of the ionisation field within which they are embedded. An analysis of the mass function of potentially induced star-forming regions indicate that radiatively-driven implosion of molecular clouds may contribute significantly toward the intermediate to high-mass stellar mass function.

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http://www.gb.nrao.edu/∼lmorgan/Preprints/SCUBA_BRC_Survey.pdf

Interacting Jets from Binary Protostars

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We investigate potential models that could explain why multiple proto-stellar systems predominantly show single jets. During their formation, stars most frequently produce energetic outflows and jets. However, binary jets have only been observed in a very small number of systems. We model numerically 3D binary jets for various outflow parameters. We also model the propagation of jets from a specific source, namely L1551 IRS 5, known to have two jets, using recent observations as constraints for simulations with a new MHD code. We examine their morphology and dynamics, and produce synthetic emission maps. We find that the two jets interfere up to the stage where one of them is almost destroyed or engulfed into the second one. We are able to reproduce some of the observational features of L1551 such as the bending of the secondary jet. While the effects of orbital motion are negligible over the jets dynamical timeline, their interaction has significant impact on their morphology. If the jets are not strictly parallel, as in most observed cases, we show that the magnetic field can help the collimation and refocusing of both of the two jets.

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Turbulent Torques on Protoplanets in a Dead Zone

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Migration of protoplanets in their gaseous host disks may be largely responsible for the observed orbital distribution of extrasolar planets. Recent simulations have shown that the magnetorotational turbulence thought to drive accretion in protoplanetary disks can affect migration by turning it into an orbital random walk. However, these simulations neglected the disk's ionization structure. Low ionization fraction near the midplane of the disk can decouple the magnetic field from the gas, forming a dead zone with reduced or no turbulence. Here, to understand the effect of dead zones on protoplanetary migration, we perform numerical simulations of a small region of a stratified disk with magnetorotational turbulence confined to thin active layers above and below the midplane. Turbulence in the active layers exerts decreased, but still measurable, gravitational torques on a protoplanet located at the disk midplane. We find a decrease of 2 orders of magnitude in the diffusion coefficient for dead zones with dead-to-active surface density ratios approaching realistic values in protoplanetary disks. This torque arises primarily from density fluctuations within a distance of one scale height of the protoplanet. Turbulent torques have correlation times of only ~ 0.3 orbital periods and apparently time-stationary distributions. These properties are encouraging signs that stochastic methods can be used to determine the orbital evolution of populations of protoplanets under turbulent migration. Our results indicate that dead zones may be dynamically distinct regions for protoplanetary migration.

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Unveiling the nature and interaction of the intermediate/high-mass YSOs in IRAS 20343+4129

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Context. IRAS 20343+4129 was suggested to harbor one of the most massive and embedded stars in the Cygnus OB2 association, IRS 1, which seemed to be associated with a north-south molecular outflow. However, the dust emission peaks do not coincide with the position of IRS 1, but lie on either side of another massive Young Stellar Object (YSO), IRS 3, which is associated with centimeter emission.

Aims. The goal of this work is to elucidate the nature of IRS 1 and IRS 3, and study their interactions with the surrounding medium.

Methods. The Submillimeter Array (SMA) was used to observe with high angular resolution the 1.3 mm continuum and CO (2-1) emission of the region, and we compared this millimeter emission with the infrared emission from 2MASS.

Results. Faint millimeter dust continuum emission was detected toward IRS 1, and we derived an associated gas mass of $\sim$0.8 $M_{\odot}$. The IRS 1 Spectral Energy Distribution (SED) agrees with IRS 1 being an intermediate-mass Class I source of about 1000 $L_{\odot}$, whose circumstellar material is producing the observed large infrared excess. We have discovered a high-velocity CO (2-1) bipolar outflow in the east-west direction, which is clearly associated with IRS 1. Its outflow parameters are similar to those of intermediate-mass YSOs. Associated with the blue large-scale CO (2-1) outflow lobe, detected with single-dish observations, we only found two elongated low-velocity structures on either side of IRS 3. The large-scale outflow lobe is almost completely resolved out by the SMA. Our detected low-velocity CO structures are coincident with elongated H_2 emission features. The strongest millimeter continuum condensations in the region are found on either side of IRS 3, where the infrared emission is extremely weak. The CO and H_2 elongated structures follow the border of the millimeter continuum emission that is facing IRS 3. All these results suggest that the dust is associated with the walls of an expanding cavity driven by IRS 3, estimated to be a B2 star from both the centimeter and the infrared continuum emission.

Conclusions. IRS 1 seems to be an intermediate-mass Class I YSO driving a molecular outflow in the east-west direction, while IRS 3 is most likely a more evolved intermediate/high-mass star that is driving a cavity and accumulating dust in its walls. Within and beyond the expanding cavity, the millimeter continuum sources can be sites of future low-mass star formation.

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Stellar contents and star formation in the young star cluster Be 59

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We present $UBVI_C$ CCD photometry of the young open cluster Be 59 with the aim to study the star formation scenario in the cluster. The radial extent of the cluster is found to be $\sim$ 10 arcmin (2.9 pc). The interstellar extinction in the cluster region varies between $E(B-V) \simeq 1.4$ to 1.8 mag. The ratio of total-to-selective extinction in the cluster region is estimated as 3.7 ± 0.3. The distance of the cluster is found to be 1.00 ± 0.05 kpc. Using near-infrared colours and slitless spectroscopy, we have identified young stellar objects (YSOs) in the open cluster Be 59 region. The ages of these YSOs range between $<$ 1 Myr to $\sim$ 2 Myr, whereas the mean age of the massive stars in the cluster region is found to be $\sim$ 2 Myr. There is evidence for second generation star formation outside the boundary of the cluster, which may be triggered by massive stars in the cluster. The slope of the initial mass function, Γ, in the mass range $2.5 < M/M_{\odot} \leq 28$ is found to be -1.01 ± 0.11 which is shallower than the Salpeter value (-1.35), whereas in the mass range $1.5 < M/M_{\odot} \leq 2.5$ the slope is almost flat. The slope of the K-band luminosity function is estimated as 0.27 ± 0.02, which is smaller than the average value ($\sim$0.4) reported for young embedded clusters. Approximately 32% of Hα emission stars of Be 59 exhibit NIR excess indicating that inner disks of the T-Tauri star (TTS) population have not dissipated. The MSX and IRAS-HIRES images around the cluster region are also used to study the emission from unidentified infrared bands and to estimate the spatial distribution of optical depth of warm and cold interstellar

dust.

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Do We Need to Know the Temperature in Prestellar Cores?

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Molecular line observations of starless (prestellar) cores combined with a chemical evolution modeling and radiative transfer calculations are a powerful tool to study the earliest stages of star formation. However, conclusions drawn from such a modeling may noticeably depend on the assumed thermal structure of the cores. The assumption of isothermality, which may work well in chemo-dynamical studies, becomes a critical factor in molecular line formation simulations. We argue that even small temperature variations, which are likely to exist in starless cores, can have a nonnegligible effect on the interpretation of molecular line data and derived core properties. In particular, "chemically pristine" isothermal cores (low depletion) can have centrally peaked $C^{18}O$ and $C^{34}S$ radial intensity profiles, while having ringlike intensity distributions in models with a colder center and/or warmer envelope assuming the same underlying chemical structure. Therefore, derived molecular abundances based on oversimplified thermal models may lead to a misinterpretation of the line data.

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Molecular Line Radiative Transfer in Protoplanetary Disks: Monte Carlo Simulations versus Approximate Methods

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We analyze the line radiative transfer in protoplanetary disks using several approximate methods and a well-tested accelerated Monte Carlo code. A low-mass flaring disk model with uniform as well as stratified molecular abundances is adopted. Radiative transfer in low and high rotational lines of CO, $C^{18}O$, HCO^+, DCO^+, HCN, CS, and H_2CO is simulated. The corresponding excitation temperatures, synthetic spectra, and channel maps are derived and compared to the results of the Monte Carlo calculations. A simple scheme that describes the conditions of the line excitation for a chosen molecular transition is elaborated. We find that the simple LTE approach can safely be applied for the low molecular transitions only, while it significantly overestimates the intensities of the upper lines. In contrast, the full escape probability (FEP) approximation can safely be used for the upper transitions ($J_{up} \gtrsim 3$), but it is not appropriate for the lowest transitions because of the maser effect. In general, the molecular lines in protoplanetary disks are partly subthermally excited and require more sophisticated approximate line radiative transfer methods. We analyze a number of approximate methods, namely, LVG, vertical escape probability (VEP), and vertical one ray (VOR) and discuss their algorithms in detail. In addition, two modifications to the canonical Monte Carlo algorithm that allow a significant speed up of the line radiative transfer modeling in rotating configurations by a factor of 1050 are described.

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Protoplanetary dynamics I. Dynamical modes of isothermal protoplanets

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This paper is the first in a series of publications which investigate the stability properties of the complete set of isothermal protoplanetary equilibrium solutions. To perform a non-linear stability analysis, we introduce a fluid dynamics numerical model. We inspect the entire solution set and find five basic dynamical modes: oscillation, pulsation, transition, ejection and collapse.

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Laser Guide Star Adaptive Optics Integral Field Spectroscopy of a Tightly Collimated Bipolar Jet from the Herbig Ae Star LkHα 233

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We have used the integral field spectrograph OSIRIS and laser guide star adaptive optics at Keck Observatory to obtain high angular resolution ($0.06''$), moderate spectral resolution (R $\simeq$ 3800) images of the bipolar jet from the Herbig Ae star LkHα 233, seen in near-IR [Fe II] emission at 1.600 and 1.644 μm. This jet is narrow and tightly collimated, with an opening angle of only 9°, and has an average radial velocity of $\sim$100 km s^{-1}. The jet and counterjet are asymmetric, with the redshifted jet much clumpier than its counterpart at the angular resolution of our observations. The observed properties are in general similar to jets seen around T Tauri stars, although it has a relatively large mass flux of $1.2 \pm 0.3 \times 10^{-7}$ M$_\odot$ yr^{-1}, near the high end of the observed mass flux range around T Tauri stars. We also spatially resolve an inclined circumstellar disk around LkHα 233, which obscures the star from direct view. By comparison with numerical radiative transfer disk models, we estimate the disk midplane to be inclined i = 65° ± 5° relative to the plane of the sky. Since the star is seen only in scattered light at near-infrared wavelengths, we detect only a small fraction of its intrinsic flux. Because previous estimates of its stellar properties did not account for this, either LkHα 233 must be located closer than previously believed, or its true luminosity must be greater than previously supposed, consistent with its being a $\sim$4 M$_\odot$ star near the stellar birth line.

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Tracing the origins of permitted emission lines in RU Lupi down to AU scales

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Context. Most of the observed emission lines and continuum excess from young accreting low mass stars (Classical T Tauri stars – CTTSs) take place in the star-disk or inner disk region. These regions have a complex emission topology still largely unknown.
Aims. In this paper the magnetospheric accretion and inner wind contributions to the observed permitted He and H near infrared (NIR) lines of the bright southern CTTS RU Lupi are investigated for the first time.
Methods. Previous optical observations of RU Lupi showed a large Hα profile, due to the emission from a wind in the line wings, and a micro-jet detected in forbidden lines. We extend this analysis to NIR lines through seeing-limited high spectral resolution spectra taken with VLT/ISAAC, and adaptive optics (AO) aided narrow-band imaging and low spectral resolution spectroscopy with VLT/NACO. Using spectro-astrometric analysis we investigate the presence of extended emission down to very low spatial scales (a few AU).

Results. The HeI λ10830 line presents a P Cygni profile whose absorption feature indicates the presence of an inner stellar wind. Moreover the spectro-astrometric analysis evidences the presence of an extended emission superimposed to the absorption feature and likely coming from the micro-jet detected in the optical. On the contrary, the origin of the Hydrogen Paschen and Brackett lines is difficult to address. We tried tentatively to explain the observed line profiles and flux ratios with both accretion and wind models showing the limits of both approaches. The lack of spectro-astrometric signal indicates that the HI emission is either compact or symmetric. Our analysis confirms the sensitivity of the HeI line to the presence of faint extended emission regions in the close proximity of the star.

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Observable Consequences of Planet Formation Models in Systems with Close-in Terrestrial Planets

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To date, two planetary systems have been discovered with close-in, terrestrial-mass planets ($< 5 - 10\,M_\oplus$). Many more such discoveries are anticipated in the coming years with radial velocity and transit searches. Here we investigate the different mechanisms that could form "hot Earths" and their observable predictions. Models include: 1) *in situ* accretion; 2) formation at larger orbital distance followed by inward "type 1" migration; 3) formation from material being "shepherded" inward by a migrating gas giant planet; 4) formation from material being shepherded by moving secular resonances during dispersal of the protoplanetary disk; 5) tidal circularization of eccentric terrestrial planets with close-in perihelion distances; and 6) photoevaporative mass loss of a close-in giant planet. Models 1-4 have been validated in previous work. We show that tidal circularization can form hot Earths, but only for relatively massive planets ($> 5\,M_\oplus$) with very close-in perihelion distances (< 0.025 AU), and even then the net inward movement in orbital distance is at most only 0.1-0.15 AU. For planets of less than $\sim 70\,M_\oplus$, photoevaporation can remove the planet's envelope and leave behind the solid core on a Gyr timescale, but only for planets inside 0.025-0.05 AU. Using two quantities that are observable by current and upcoming missions, we show that these models each produce unique signatures, and can be observationally distinguished. These observables are the planetary system architecture (detectable with radial velocities, transits and transit-timing) and the bulk composition of transiting close-in terrestrial planets (measured by transits via the planet's radius).

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Optical spectroscopic classification and membership of young M dwarfs in star-forming regions

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The spectral type is a key parameter in calibrating the temperature which is required to estimate the mass of young stars and brown dwarfs. We describe an approach developed to classify low-mass stars and brown dwarfs in the Trapezium Cluster using red optical spectra, which can be applied to other star-forming regions. The classification uses two methods for greater accuracy: the use of narrow-band spectral indices which rely on the variation of the strength of molecular lines with spectral type and a comparison with other previously classified young, low-mass objects in the Chamaeleon I star-forming region. We have investigated and compared many different molecular indices and have identified a small number of indices which work well for classifying M-type objects in nebular regions. The

indices are calibrated for young, pre-main-sequence objects whose spectra are affected by their lower surface gravities compared with those on the main sequence. Spectral types obtained are essentially independent of both reddening and nebular emission lines.

Confirmation of candidate young stars and brown dwarfs as bona fide cluster members may be accomplished with moderate resolution spectra in the optical region by an analysis of the strength of the gravity-sensitive Na doublet. It has been established that this feature is much weaker in these very young objects than in field dwarfs. A sodium spectral index is used to estimate the surface gravity and to demonstrate quantitatively the difference between young (12 Myr) objects, and dwarf and giant field stars.

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An optical spectroscopic HR diagram for low-mass stars and brown dwarfs in Orion

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The masses and temperatures of young low-mass stars and brown dwarfs in star-forming regions are not yet well established because of uncertainties in the age of individual objects and the spectral typetemperature scale appropriate for objects with ages of only a few Myr. Using multi-object optical spectroscopy, 45 low-mass stars and brown dwarfs in the Trapezium Cluster in Orion have been classified and 44 of these confirmed as bona fide cluster members. The spectral types obtained have been converted to effective temperatures using a temperature scale intermediate between those of dwarfs and giants, which is suitable for young pre-main-sequence objects. The objects have been placed on a HertzsprungRussell (HR) diagram overlaid with theoretical isochrones. The low-mass stars and the higher mass substellar objects are found to be clustered around the 1 Myr isochrone, while many of the lower mass substellar objects are located well above this isochrone. An average age of 1 Myr is found for the majority of the objects. Assuming coevality of the sources and an average age of 1 Myr, the masses of the objects have been estimated and range from 0.018 to 0.44 $M_{\odot}$. The spectra also allow an investigation of the surface gravity of the objects by measurement of the sodium doublet equivalent width. With one possible exception, all objects have low gravities, in line with young ages, and the Na indices for the Trapezium objects lie systematically below those of young stars and brown dwarfs in Chamaeleon, suggesting that the 820 nm Na index may provide a sensitive means of estimating ages in young clusters.

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Dusty disks at the bottom of the IMF

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'Isolated planetary mass objects' (IPMOs) have masses close to or below the Deuterium-burning mass limit ($\sim 15\,M_{\rm Jup}$) – at *the bottom of the stellar initial mass function*. We present an exploratory survey for disks in this mass regime, based on a dedicated observing campaign with the Spitzer Space Telescope. Our targets include the full sample of spectroscopically confirmed IPMOs in the σ Orionis cluster, a total of 18 sources. In the mass range $8 \ldots 20\,M_{\rm Jup}$, we identify 4 objects with $> 3\sigma$ colour excess at a wavelength of $8.0\,\mu m$, interpreted as emission from dusty disks. We thus establish that a substantial fraction of IPMOs harbour disks with lifetimes of at least 2-4 Myr (the likely age of the cluster), indicating an origin from core collapse and fragmentation processes. The disk frequency in the IPMO sample is $29\pm^{16}_{13}\%$ at $8.0\,\mu m$, very similar to what has been found for stars and brown dwarfs ($\sim 30\%$). The object SOri 70, a candidate $3\,M_{\rm Jup}$ object in this cluster, shows IRAC colours in excess of the typical values for field T dwarfs (on a 2σ level), possibly due to disk emission or low gravity. This is a new indication for youth and thus an extremely

low mass for SOri 70.

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The Spitzer Survey of the Small Magellanic Cloud: Discovery of Embedded Protostars in the H II Region NGC 346

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We use Spitzer Space Telescope observations from the Spitzer Survey of the Small Magellanic Cloud (S^{3}MC) to study the young stellar content of N66, the largest and brightest H II region in the SMC. In addition to large numbers of normal stars, we detect a significant population of bright, red infrared sources that we identify as likely to be young stellar objects (YSOs). We use spectral energy distribution (SED) fits to classify objects as ordinary (main-sequence or red giant) stars, asymptotic giant branch stars, background galaxies, and YSOs. This represents the first large-scale attempt at blind source classification based on Spitzer SEDs in another galaxy. We firmly identify at least 61 YSOs, with another 50 probable YSOs; only one embedded protostar in the SMC was reported in the literature prior to the S^{3}MC. We present color selection criteria that can be used to identify a relatively clean sample of YSOs with IRAC photometry. Our fitted SEDs indicate that the infrared-bright YSOs in N66 have stellar masses ranging from 2 to 17 $M_\odot$, and that approximately half of the objects are stage II protostars, with the remaining YSOs roughly evenly divided between stage I and stage III sources. We find evidence for primordial mass segregation in the H II region, with the most massive YSOs being preferentially closer to the center than lower mass objects. Despite the low metallicity and dust content of the SMC, the observable properties of the YSOs appear consistent with those in the Milky Way. Although the YSOs are heavily concentrated within the optically bright central region of N66, there is ongoing star formation throughout the complex, and we place a lower limit on the star formation rate of 3.2 $\times 10^{-3}$ $M_\odot$ yr^{-1} over the last $\sim$1 Myr.

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The proper motion of the Arches cluster with Keck Laser-Guide Star Adaptive Optics

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We present the first measurement of the proper motion of the young, compact Arches cluster near the Galactic center from near-infrared adaptive optics (AO) data taken with the recently commissioned laser-guide star (LGS) at the Keck 10-m telescope. The excellent astrometric accuracy achieved with LGS-AO provides the basis for a detailed

comparison with VLT/NAOS-CONICA data taken 4.3 years earlier. Over the 4.3 year baseline, a spatial displacement of the Arches cluster with respect to the field population is measured to be 24.0 ± 2.2 mas, corresponding to a proper motion of 5.6 ± 0.5 mas/yr or 212 ± 29 km/s at a distance of 8 kpc. In combination with the known line-of-sight velocity of the cluster, we derive a 3D space motion of 232 ± 30 km/s of the Arches relative to the field. The large proper motion of the Arches cannot be explained with any of the closed orbital families observed in gas clouds in the bar potential of the inner Galaxy, but would be consistent with the Arches being on a transitional trajectory between x1 and x2 orbits. We investigate a cloud-cloud collision as the possible origin for the Arches cluster. The integration of the cluster orbit in the potential of the inner Galaxy suggests that the cluster passes within 10 pc of the supermassive black hole only if its true GC distance is very close to its projected distance. A contribution of young stars from the Arches cluster to the young stellar population in the inner few parsecs of the GC thus appears increasingly unlikely. The measurement of the 3D velocity and orbital analysis provides the first observational evidence that Arches-like clusters do not spiral into the GC. This confirms that no progenitor clusters to the nuclear cluster are observed at the present epoch.

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A Jet Associated With the Classical T Tauri Star RY Tauri

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High spatial resolution images have been taken on the Gemini North telescope of the classical T Tauri star RY Tauri. The Hα image, with the continuum properly subtracted, shows a jet extending out to at least 31" at a position angle of about 295° from the star. A counterjet extending to at least 3.5′ in the opposite direction is also visible. The knots in the inner part of the jet are probably less than 10 years old. This new Herbig-Haro bipolar jet has been labeled HH 938. Comparison with previous HST images revealed a probable tangential motion of the brightest knot by about 165 km/s. The orientation of the disk, as given by the average position angle of published polarization measurements, is $\approx 20°$, or almost perpendicular to the direction of the jet. Because of the proximity of its inner knots to the star and their very young dynamical age, this jet is a very good candidate to study jet emission mechanisms.

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Spitzer imaging of the jet driving the NGC 2264 G outflow

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We present new infrared imaging of the NGC 2264 G protostellar outflow region, obtained with the InfraRed Array Camera (IRAC) on-board the *Spitzer* Space Telescope. A jet in the red outflow lobe (eastern lobe) is clearly detected in all four IRAC bands and, for the first time, is shown to continuously extend over the entire length of the red outflow lobe traced by CO observations. The redshifted jet also extends to a deeply embedded Class 0 source, VLA 2, confirming previous suggestions that it is the driving source of the outflow (Gómez et a. 1994). The images show that the easternmost part of the redshifted jet exhibits what appear to be multiple changes of direction. To understand the redshifted jet morphology we explore several mechanisms that could generate such apparent changes of direction. From this analysis, we conclude that the redshifted jet structure and morphology visible in the IRAC images can be largely, although not entirely, explained by a slowly precessing jet (period ≈ 8000 yr) that lies mostly on the plane

of the sky. It appears that the observed changes in the redshifted jet direction may be sufficient to account for a significant fraction of the broadening of the outflow lobe observed in the CO emission.

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The formation of star clusters II. 3D simulations of magnetohydrodynamic turbulence in molecular clouds

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We present a series of decaying turbulence simulations that represent a cluster-forming clump within a molecular cloud, investigating the role of magnetic fields on the formation of potential star-forming cores. We present an exhaustive analysis of numerical data from these simulations that include a compilation of all of the distributions of physical properties that characterize bound cores including their masses, radii, mean densities, angular momenta, spins, magnetizations and mass-to-flux ratios. We also present line maps of our models that can be compared with observations. Our simulations range between 5 and 30 Jeans masses of gas, and are representative of molecular cloud clumps with masses between 100 and 1000 $M_\odot$. The field strengths in the bound cores that form tend to have the same ratio of gas pressure to magnetic pressure, β, as the mean β of the simulation. The cores have mass-to-flux ratios that are generally less than that of the original cloud, and so a cloud that is initially highly supercritical can produce cores that are slightly supercritical, similar to that seen by Zeeman measurements of molecular cloud cores. Clouds that are initially only slightly supercritical will instead collapse along the field lines into sheets, and the cores that form as these sheets fragment have a different distribution of masses than what is observed. The spin rates of these cores (wherein 2040 per cent of cores have $\Omega t_{ff} \geq 0.2$) suggests that subsequent fragmentation into multiple systems is likely. The sizes of the bound cores that are produced are typically 0.020.2 pc and have densities in the range $10^4 - 10^5$ cm^3 in agreement with observational surveys. Finally, our numerical data allow us to test theoretical models of the mass spectrum of cores, such as the turbulent fragmentation picture of Padoan & Nordlund. We find that while this model gets the shape of the core mass spectrum reasonably well, it fails to predict the peak mass in the core mass spectrum.

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Debris disks around Sun-like stars

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We have observed nearly 200 FGK stars at 24 and 70 microns with the Spitzer Space Telescope. We identify excess infrared emission, including a number of cases where the observed flux is more than 10 times brighter than the predicted photospheric flux, and interpret these signatures as evidence of debris disks in those systems. We combine this sample of FGK stars with similar published results to produce a sample of more than 350 main sequence AFGKM stars. The incidence of debris disks is $4.2^{+2.0}_{-1.1}$% at 24 microns for a sample of 213 Sun-like (FG) stars and $16.4^{+2.8}_{-2.9}$% at 70 microns for 225 Sun-like (FG) stars. We find that the excess rates for A, F, G, and K stars are statistically indistinguishable, but with a suggestion of decreasing excess rate toward the later spectral types; this may be an age effect. The lack of strong trend among FGK stars of comparable ages is surprising, given the factor of 50 change in stellar luminosity

across this spectral range. We also find that the incidence of debris disks declines very slowly beyond ages of 1 billion years.

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Multiple Sources Toward the High-Mass Young Star S140 IRS 1

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S140 IRS 1 is a remarkable source where the radio source at the center of the main bipolar molecular outflow in the region is elongated perpendicular to the axis of the outflow, an orientation opposite to that expected if the radio source is a thermal jet exciting the outflow. We present results of 1.3 cm continuum and H_2O maser emission observations made with the Very Large Array in its A configuration toward this region. In addition, we also present results of continuum observations at 7 mm and reanalyze observations at 2, 3.5, and 6 cm (previously published). IRS 1A is detected at all wavelengths, showing an elongated structure. Three water maser spots are detected along the major axis of the radio source IRS 1A. We have also detected a new continuum source at 3.5 cm (IRS 1C) located $\simeq 0.6''$ northeast of IRS 1A. The presence of these two young stellar objects (IRS 1A and 1C) could explain the existence of the two bipolar molecular outflows observed in the region. In addition, we have also detected three continuum clumps (IRS 1B, 1D, and 1E) located along the major axis of IRS 1A. We discuss two possible models to explain the nature of IRS 1A: a thermal jet and an equatorial wind.

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Formation of Protoplanets from Massive Planetesimals in Binary Systems

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More than half of all stars reside in binary or multiple star systems, and many planets have been found in binary systems. From a theoretical point of view, however, whether or not the planetary formation proceeds in a binary system is a very complex problem, because secular perturbation from the companion star can easily stir up the eccentricity of the planetesimals and cause high-velocity, destructive collisions between planetesimals. Early stages of the planetary formation process in binary systems have been studied by a restricted three-body approach with gas drag, and it is commonly accepted that accretion of planetesimals can proceed due to orbital phasing by gas drag. However, the gas drag becomes less effective as the planetesimals become more massive. Therefore, it is uncertain whether the collision velocity remains small and planetary accretion can proceed once the planetesimals become massive. We performed N-body simulations of planetary formation in binary systems, starting from massive planetesimals of size $\sim$100500 km. We found that the eccentricity vectors of planetesimals quickly converge to the forced eccentricity due to the coupling of the perturbation of the companion and the mutual interaction of planetesimals, if the initial disk model is sufficiently wide in radial distribution. This convergence decreases the collision velocity, and as a result accretion can proceed much in the same way as in isolated systems. The basic processes of the planetary formation, such as runaway and oligarchic growth and final configuration of the protoplanets, are essentially the same in binary systems and single star systems, at least in the late stage, where the effect of gas drag is small.

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Evaporation and condensation of spherical interstellar clouds. Self-consistent models with saturated heat conduction and cooling

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Aims. The fate of interstellar clouds embedded in a hot tenuous medium depends on whether the clouds suffer from evaporation or whether material condensates onto the clouds. The knowledge of the evaporation or condensation rates of interstellar clouds at rest is therefore of prime importance for their further evolution. Analytic solutions for the rate of evaporative mass loss from an isolated spherical cloud embedded in a hot tenuous gas are deduced by Cowie & McKee (1977, ApJ, 211, 135). Their approach is limited to the integration of the time-independent energy conservation equation for the heat-conductive interface. Therefore it is crucial to test the validity of the analytical results for more realistic interstellar conditions. This requires that the full hydrodynamical equations must be treated taking the whole cloud into account with a sufficiently large hot-gas reservoir.

Methods. By two-dimensional numerical simulations in an Eulerian, explicit hydrodynamical grid the evolution of interstellar clouds with different internal density structures and surrounded by a hot plasma is simulated. Self-gravity, interstellar heating and cooling effects and heat conduction by electrons are added. We use the classical thermal conductivity of a fully ionized hydrogen plasma proposed by Spitzer and a saturated heat flux according to Cowie and McKee in regions where the mean free path of the electrons is large compared to the temperature scaleheight.

Results. Using pure hydrodynamics and taking only the classical heat flux into account, we can reproduce the Cowie and McKee analytical results. If we allow for heat flux saturation the evaporation rate is reduced, but in the simulations even to about one order of magnitude below the predicted saturated one. This happens because the saturated heat flux is density dependent and due to the mixing of the two phases, the warm cloud material on one side and the hot intercloud medium, also the density distribution changes drastically there during the simulation. And this cannot be considered in the analytical study. This main result still holds if we add self gravity or choose another cloud density structure while keeping the cloud radius and temperature of the cloud edge constant. As a further issue the evolution changes, however, totally for more realistic conditions when interstellar heating and cooling effects stabilize the self-gravity. The clouds' evaporation then turns into condensation, because the additional energy input due to heat conduction can be transported away from the interface and radiated off very efficiently from the cloud's inner parts.

Conclusions. The assumption of pure classical heat conduction is invalid for the description of the evolution of interstellar clouds in a hot tenuous gas. The consideration of a limited saturated heat flux is inevitable for this kind of simulations and leads to a dramatic decrease of the evaporation rate. And even more realisticly with radiative cooling heat conduction leads to condensation in contradiction to analytical predictions which require evaporation. This has two consequences: Interstellar clouds are stabilized against evaporation. On the other hand this provides an efficient way to accrete and mix intercloud material into clouds.

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NH_3 Observations of the Infrared Dark Cloud G28.34+0.06

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We present observations of the NH_3 (J,K) = (1,1) and (2,2) inversion transitions toward the infrared dark cloud G28.34+0.06, using the Very Large Array. Strong NH_3 emission is found to coincide well with the infrared absorption feature in this cloud. The northern region of G28.34+0.06 is dominated by a compact clump (P2) with a high rotation

temperature (29 K), large line width (4.3 km s^{-1}), and is associated with strong water maser (240 Jy) and a 24 μm point source with far IR luminosity of 10^3 $L_\odot$. We infer that P2 has embedded massive protostars although it lies in the 8 μm absorption region. The southern region has filamentary structures. The rotation temperature in the southern region decreases with the increase of the integrated NH_3 intensity, which indicates an absence of strong internal heating in these clumps. In addition, the compact core P1 in the south has small line width (1.2 km s^{-1}) surrounded by extended emissions with larger line width (1.8 km s^{-1}), which suggests a dissipation of turbulence in the dense part of the cloud. Thus, we suggest that P1 is at a much earlier evolutionary stage than P2, possibly at a stage that begins to form a cluster with massive stars.

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Abstracts of recently accepted major reviews

Toward Understanding Massive Star Formation

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Although fundamental for astrophysics, the processes that produce massive stars are not well understood. Large distances, high extinction, and short timescales of critical evolutionary phases make observations of these processes challenging. Lacking good observational guidance, theoretical models have remained controversial. This review offers a basic description of the collapse of a massive molecular core and a critical discussion of the three competing concepts of massive star formation:

- monolithic collapse in isolated cores
- competitive accretion in a protocluster environment
- stellar collisions and mergers in very dense systems

We also review the observed outflows, multiplicity, and clustering properties of massive stars, the upper initial mass function and the upper mass limit. We conclude that high-mass star formation is not merely a scaled-up version of low-mass star formation with higher accretion rates, but partly a mechanism of its own, primarily owing to the role of stellar mass and radiation pressure in controlling the dynamics.

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Dissertation Abstracts

Polycyclic Aromatic Hydrocarbons in Disks around Young Solar-type Stars

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Ph.D dissertation directed by: Prof. dr. Ewine van Dishoeck

Ph.D degree awarded: October 2007

This thesis presents a study of the dust around solar-type young stars, in particular focussing on the Polycyclic Aromatic Hydrocarbons (PAHs). VLT-ISAAC, -VISIR, -NACO and Spitzer mid-infrared spectroscopy and imaging surveys are presented and combined with 3D radiative transfer models to constrain the presence and location of PAH emission toward embedded young stellar objects and circumstellar disks around young solar-type stars. The following main questions are addressed. What happens to PAHs in the embedded phase of a forming star? Are PAHs present in low-mass young star systems? Does the PAH emission originate from the envelope or from the disk? What do they tell us about disk structure and evolution and grain growth? What can we say about the evolution of PAHs during star formation and their typical size? In Chapter 2, we present a survey with Spitzer of PAH features in a sample of intermediate and low-mass stars with disks, and compare the results with model predictions of PAH emission from flaring disks. In Chapter 3, we present VISIR images and a spectrum of IRS 48, a young M-type star with very strong PAH features, which appears to have a 60 AU radius gap in the disk as seen in large grains at 18.9 μm but with PAHs originating from inside the gap. In Chapter 4, we present an ISAAC, VISIR and NACO survey of the spatial extent of PAH features in protoplanetary disks, and compare with model predictions. In Chapter 5, we present an ISAAC and Spitzer survey of PAH features toward embedded young stars, and compare the results with model predictions. The main conclusions of this thesis can be summarized as follows:

- PAHs are shown to be present in several T Tauri disks, but at an abundance 10-100 times lower than standard interstellar values. The detection rate of only 11-14% is small compared to that toward intermediate-mass stars ($\sim$54%). At our average derived PAH abundance, PAH emission features around stars with $T_{\rm eff} \leq 4200$ K fall below the Spitzer IRS detection limit. The 11.2 μm PAH feature is most easily detected, with the 7.7 and 8.6 μm bands readily masked by silicate emission.
- High spatial resolution spectroscopy confirms that the PAH features detected toward young stars are directly associated with the circumstellar disk and not due to the presence of a tenuous envelope.
- A new class of disks with weak mid-IR continuum emission and very strong PAH features is found. This class represents a small percentage ($\sim$5%) of the total population of disks surveyed. Among disks around low-mass stars with PAH detections, it represents a large fraction. This is partially due to a detection effect, where the lower disk continuum between 5–15 μm due to absence of dust results in higher feature-to-continuum ratios for the PAH features. These disks are believed to harbour gaps and/or holes with strong PAH emission originating at, or inwards from, the outer edge of the gap. This evidence for separation of small and large grains implies that their populations evolve differently.
- PAHs are not detected toward the majority ($\geq$ 97%) of a sample of 80 embedded sources. Comparison with model calculations show that this detection rate is consistent with a PAH abundance at least 20–50x lower than in the ISM. Variability in luminosity, UV excess and/or envelope mass can change this conclusion to a typical factor of 10–20. In these cold dense environments, two possibilities for lowering the abundance of a species are recognized: coagulation or dust growth and freeze-out of the PAHs onto larger grains. Thus, PAHs likely enter the protoplanetary disks frozen out on grains.

http://hdl.handle.net/1887/12414

Postdoctoral Research Position – Star Formation

Applications are invited for a postdoctoral research position at the University of Michigan, to start on Sept. 1 2008 or earlier. The successful candidate will work with Prof. Edwin Bergin on observational studies of the physics and chemistry of star forming regions. Applicants should have experience in observational studies of star-forming cores and/or protoplanetary disks at centimeter, millimeter, submillimeter and/or infrared wavelengths. In particular, a demonstrated expertise in molecular line observations of dense molecular regions is desired.

Dr. Bergin is the principal investigator of HEXOS - *Herschel observations of EXtra-Ordinary Sources: The Orion and Sgr B2 Molecular Clouds* - a Herschel Guaranteed Time Key Program. The HEXOS program consists of velocity revolved full spectral scans from 480–1250 GHz and 1490–1910 GHz of several sources in these two clouds. The successful applicant will become a member of the KP team and work with Dr. Bergin and team members on the reduction, analysis, and archiving of HEXOS data. She/he may also work on theoretical analyses of these data in concert with Dr. Bergin and other members of the KP team. Herschel is an ESA mission with NASA participation with a launch date that is currently late 2008 with nominal science operations a few months thereafter.

The position is for two years, with extension to a third year possible, and includes research support. Applicants with a Ph.D. should send a curriculum vitae, a description of research interests, and a list of publications, and should arrange for three letters of recommendation to be sent directly to the address below. Please indicate the preferred starting date. Applications received prior to 20 January 2008 will receive first consideration.

Women and Minorities are encouraged to apply. The University of Michigan is an equal opportunity/affirmative action employer.

Department of Astronomy
University of Michigan
500 Church St.
825 Dennison Building
Ann Arbor, MI 48109-1042
U.S.A.

Email Submission Address: ebergin_AT_umich.edu
Email Inquiries: ebergin_AT_umich.edu
Department Web page: http://www.astro.lsa.umich.edu

Tenure Track Assistant Professor in Observational Astronomy (Star Formation) - Stony Brook University

The Department of Physics and Astronomy at Stony Brook seeks applications for a tenure track assistant professor in observational astronomy, with a focus on galactic and/or extragalactic star formation. The ideal candidate will be able to make use of such facilities as ALMA, Herschel, and JWST. The current interests of the astronomy group can be found at http://www.astro.sunysb.edu/

The department is especially interested in recruiting highly qualified women and minority candidates at early stages in their careers and is sensitive to the issues of dual careers. Stony Brook faculty and students conduct experimental and theoretical research in a broad range of topics in physics and astronomy both in facilities on our campus and at laboratories around the world. The successful candidate will have a Ph.D. degree in astronomy, physics, or a related field and relevant postdoctoral experience and publications. S/he will be expected to carry out an independent research program and to attract federal grant support for it. S/he will contribute to the teaching activities in the department

at both the undergraduate and graduate levels.

The application process will be conducted electronically. Interested candidates should go to the web page

http://www.physics.sunysb.edu/Physics/recruit/AST-2008/apply.php

Instructions are given there for uploading all application materials as pdf files to a secure web site.

By 31 December 2007 each candidate should have submitted all application materials electronically, including the names, institutions, and email addresses for three references. The candidate should also have arranged for each of these three references to submit letters electronically. Each candidate will be notified by email when his/her application file is begun and again when it is complete.

For further information or for alternative submission, please email pam.burris *at* stonybrook.edu. Equal Opportunity/Affirmative Action Employer.

Joint Yale–Universidad de Chile Postdoctoral Position in Star Formation

The Department of Astronomy at the Universidad de Chile and the Yale Astronomy Department invite applications for a joint Yale–U. de Chile post-doctoral research position in observational star formation. The successful applicant will collaborate with Professors Guido Garay, Diego Mardones and Leonardo Bronfman (Universidad de Chile) and with Prof. Héctor Arce (Yale University) on studies of star forming regions using millimeter, sub-millimeter and infrared data as well as radiative transfer codes.

The post-doctoral fellow is expected to spend 3/4 of the time in Chile and 1/4 of the time at Yale, thus he or she will be able to have PI status for the 10% observing time reserved for Chilean astronomers on all astronomical facilities in Chile. The successful applicant will also have direct access to Yale resources including the WIYN telescope, the SMARTS telescopes, and the Palomar-QUEST large-area survey.

Postdoctoral positions are awarded for a two-year period, renewable for a third, and offer competitive salary and benefits, and travel and research funds. Candidates must hold a Ph.D. in astronomy or related field by date of appointment. The selected candidates are expected to start their position no later than July 2008.

Applications consisting of a cover letter, curriculum vitae, publication list, and a brief (2-3 page) description of research interests and accomplishments should arrive by December 21, 2007. Applicants should also arrange for three letters of recommendation to arrive by the same date. Email submission of all materials, including letters, to susan.delong *at* yale.edu. Yale University particularly encourages applications from women and members of underrepresented minority groups. AAE/EOE

Postdoctoral Position in Numerical Simulations of Star and/or Planet Formation

Astrophysics Group, University of Exeter

We are looking for a postdoctoral researcher in the fields of star or planet formation, to work with Professor Matthew Bate in the Astrophysics Group. The Group's work focuses on both theoretical and observational star and planet formation. Our research was rated excellent in the last UK Research Assessment Exercise. Exeter is also the coordinating node of the EC-funded Marie Curie Research Training Network, CONSTELLATION, on the Origin of the Initial Mass Function, a consortium of 12 institutions across Europe.

You will have an appropriate first degree and a PhD (or equivalent). You should also have a strong record of publication in astrophysical hydrodynamical, magnetohydrodynamical and/or radiative transfer numerical simulations. You will

be expected to make use of the University of Exeter's supercomputer which will be available from January 2008.

The position is a fixed-term, three-year appointment (associate research fellow/research fellow) with a starting salary up to £30,913 pa on scale £22,332 to £35,837 pa (depending on level of appointment), 36.5 hours per week.

The closing date for receipt of applications is 18 January, 2007.

Informal enquiries can be made by e-mailing mbate *at* astro.ex.ac.uk. An application form is available on request, and applicants should send this, along with a description of their current research and future plans (3 pages), a brief curriculum vitae including the names and contact details of three references, and a list of refereed publications to Professor Matthew Bate, School of Physics, University of Exeter, EX4 4QL, United Kingdom. Electronic submissions may be made to the above email address.

Equal Opportunities Employer

Star Formation Postdoctoral Fellowship

UNIVERSITY OF FLORIDA
Attention: Jonathan Tan
Dept. of Astronomy
211 Bryant Space Science Center
PO Box 112 055
Gainesville, FL 32611-2055, USA
Tel: 352 392 2052 ext 254
Fax: 352 392 5089
Email Inquiries: (Jonathan Tan) jt *at* astro.ufl.edu
URL1: http://www.astro.ufl.edu/starformation.html
URL2: http://www.astro.ufl.edu/theory

The Department of Astronomy at the University of Florida (UF) invites applications for a Star Formation Postdoctoral Fellowship. The successful applicant will submit a research proposal to work in one or more of the following areas: local Galactic star and star cluster formation, global star formation activity of disk galaxies, star formation near AGN and the Galactic Center, and star formation in the early universe. Both observational and theoretical applications will be considered. Research proposals with potential for collaborations with the UF star formation and/or theory groups are encouraged.

UF faculty involved in star formation research include Steve Eikenberry, Elizabeth Lada, Jonathan Tan, and Charlie Telesco. Theoretical work includes analytic and numerical calculations of massive star and star cluster formation, giant molecular cloud formation, and galactic scale star formation (Tan). Observational programs involve a wide range of star formation topics and facilities, including GEMINI-FLAMINGOS-2 surveys of embedded star clusters (Lada) and the Galactic Center (Eikenberry), and a variety of Gran-Telescopio Canarias (10m optical/IR) projects.

The position is an annual appointment, renewable for up to three years based on satisfactory performance, starting in or around Aug. 2008, with a salary of $45,000. Applicants should have a recent PhD., preferably in a star formation related field. Further information is available from Jonathan Tan (jt *at* astro.ufl.edu).

Application materials (CV, bibliography, statement of research interests and plans [no more than 3 pages plus 2 pages for figures], and three letters of reference [candidates are responsible for having their reference letters sent to UF]) should be mailed to the above address or emailed to Jonathan Tan (jt @ astro.ufl.edu) by 15th January 2008.

The University of Florida is an Equal Opportunity Institution.

Postdoctoral Research in Extrasolar Planet Detection and/or Planet Formation Theory

Email submissions/inquiries: eford+postdoc08 *at* astro.ufl.edu
Postal addreess for submissions:
Prof. Eric B. Ford
University of Florida
211 Bryant Space Science Center
P.O. Box 112055
Gainesville, FL 32611
United States

The University of Florida's Astronomy Department invites applications for a Postdoctoral Research Associate. The successful candidate will collaborate with Eric Ford on research relating to extrasolar planets and/or planet formation. Possible research programs include formation and evolution of planetary systems, statistical analyses of planetary systems and planet searches, and observational techniques for studying planetary systems. The successful applicant will be encouraged to develop new initiatives in-line with their own research interests and to participate in the department's intellectual activities. Closely related research at UF currently includes exoplanet searches, planetary dynamics, star formation, planetary atmospheres, and instrumentation. UF has deployed a large computer cluster and is a partner in the 10.4m Gran Telescopio Canarias Observatory.

Position includes a competitive salary, health benefits, and research funds. The anticipated start date is Fall 2008. The appointment is is renewable annually based on satisfactory performance, needs of the Department and College, and available funding. Ph.D. in relevant field by starting date required.

Interested applicants should submit a CV, publications list, summary statement of research accomplishments, interests and plans, and names and email addresses of three references. Candidates are responsible for ensuring that their references send a letter of recommendation directly. All application materials should be mailed or emailed to Eric Ford (eford+postdoc08@astro.ufl.edu). For full consideration, applications should be received no later than January 4, 2008. Women and underrepresented minorities are strongly encouraged to apply.

The University of Florida is an Equal Opportunity Institution

Postdoctoral Position in Extrasolar Planet Searches

University of Florida
Department of Astronomy
211 Bryant Space Science Center
P.O.Box 112055
Gainesville, FL 32611, USA
Email Inquiries: jge *at* astro.ufl.edu
URL: http://www.astro.ufl.edu/ jge

Applications are invited for a postdoctoral position to work with Prof. Jian Ge on Doppler planet search projects using new generation multi-object Doppler instruments with 120 object capability at the Sloan Digital Sky Survey (SDSS) 2.5 meter telescope and single object high precision (1m/s) Doppler instruments at KPNO 2.1 meter and Li Jiang 2.4meter telescopes. The planet survey at the SDSS telescope, called Multi-object APO Radial Velocity Exoplanet Large- area Survey (MARVELS), is part of the SDSS III survey program in 2008-2014.

Ph.D. in Astronomy or Physics is required by start date. The successful applicant will work on developing optimized codes for data reduction and analysis, participate in observations, data reduction and analysis, and publications. There are also opportunities to be involved in other areas of research such as project development, proposal writing, and new red and near IR Doppler instrument development, and supervising students. Expertise in IDL data reduction software development and also stellar astrophysics is preferred. This is a one-year appointment and is renewable for up to two

additional years, contingent upon performance and the continuation of funding. Salary will be commensurate with qualifications and experience.

To apply, please submit a curriculum vita, a statement of research interests, and have three letters of reference sent to Professor Jian Ge at the address above. For full consideration, complete applications should be received by Dec. 15th, 2007.

University of Florida is committed to affirmative action, equal opportunity and the diversity of its work force.

Two Postdoctoral Positions in the SDSS-III planet survey

University of Florida
Department of Astronomy
211 Bryant Space Science Center
P.O.Box 112055
Gainesville, FL 32611, USA
Email Inquiries: jge *at* astro.ufl.edu
URL: http://www.astro.ufl.edu/∼jge

Two postdoctoral positions will be available at University of Florida to work on the Multi-object APO Radial Velocity Exoplanet Large-area Survey (MARVELS) using the Sloan Digital Sky Survey (SDSS) 2.5-meter telescope as part of the SDSS III survey program in 2008-2014. MARVELS will use new generation multiple object Doppler instruments with 120 object capability to search a total of tens of thousands of V=8-12 FGK main sequence, subgiant and giant stars for detecting and characterizing hundreds of giant planets.

Ph.D. in Astronomy, Physics, or a related field is required by the start date. The successful applicants will take a lead or get involved in developing the MARVELS data pipeline, selecting targets, designing survey plates, scheduling observations, processing survey data, archiving and distributing survey data. Expertise in IDL programming and data processing, and also stellar astrophysics is preferred. The positions are expected to be 2-year commitments but are subject to annual renewal. Salary will be commensurate with qualifications and experience.

To apply, please submit a curriculum vita, a statement of research interests, and have three letters of reference sent to Professor Jian Ge at the address above. For full consideration, complete applications should be received by Dec. 15th, 2007.

University of Florida is committed to affirmative action, equal opportunity and the diversity of its work force.

Postdoctoral Position in Theoretical Star Formation Studies

The University of Toronto invites applications for a postdoctoral position in star formation studies, to work on the theory or simulation of star formation, protostellar disks or outflows, or the interaction of stars with the interstellar medium.

The start date is flexible, but preference will be given to applicants who can start relatively soon. The initial appointment of up to two years may be renewed for an additional year contingent on performance and funding. Salary and benefits are competitive. The successful applicant will benefit from proximity to the Canadian Inst. for Theoretical Astrophysics, as well as access to local computing resources (including an existing 10 teraflop machine with an anticipated hundredfold upgrade).

Please send a curriculum vitae, a brief description of scientific qualifications and interests (not to exceed three pages), and reqest three letters of recommendation. Electronic submission to Chris Matzner)matzner *at* astro.utoronto.ca) is preferred. Applications will be considered as soon as they are received.

From Suns to Life

Edited by

M. Gargaud, P. Claeys, P. López-García, H. Martin, T. Montmerle, R. Pascal, J. Reisse

This review emerged from several interdisciplinary meetings and schools gathering a group of astronomers, geologists, biologists, and chemists, attempting to share their specialized knowledge around a common question: how did life emerge on Earth? Their ultimate goal was to provide some kind of answer as a prerequisite to an even more demanding question: is life universal? The resulting state-of-the-art articles were written by twenty-five scientists telling a not-so linear story, but on the contrary, highlighting problems, gaps, and controversies. Needless to say, this approach yielded no definitive answers to both questions. However, by adopting a chronological approach to the question of the emergence of life on Earth, the only place where we know for sure that life exists; it was possible to break down this question into several sub-topics that can be addressed by the different disciplines.

The main chapters of this review present the formation and evolution of the solar system; the building of a habitable planet; prebiotic chemistry, biochemistry, and the emergence of life; the environmental context of the early Earth; and the ancient fossil record and early evolution. The concluding chapter provides the highlights of the review and presents the different points of view about the universality of life. Two pedagogical chapters are included; one on chronometers, another in the form of a frieze, which summarizes in graphical form the present state of knowledge about the chronology of the emergence of life on Earth, before the Cambrian explosion. The chapters are

Springer verlag

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Euro 124.95 from Springer or US$159 from Amazon:

http://www.springer.com/east/home/generic/search/results?SGWID=5-40109-22-173679624-0

or

http://www.amazon.com

Announcement of the ESO workshop:

Star Formation across the Milky Way Galaxy

Santiago de Chile, March 3-6, 2008

Motivation: Star-formation in the Milky Way is an ubiquitous phenomenon. It occurs on many different scales and in diverse environments ranging from isolated cores, to small groups and modest associations, up to massive clusters and super star clusters. Our knowledge about the onset, dominant modes and typical outcomes of star formation is, however, in general biased by the limited observational accessibility of star formation sites at their various distances and locations within the galaxy. Ongoing large scale surveys like GLIMPSE, SCUBA, ATLASGAL and UKIDSS trace gas, dust, and young stellar populations across our galaxy and provide new insight in the galactic distribution of star-forming regions and young clusters, and the spatial and environmental variation of the star formation history, efficiency and the initial mass function down to sub-stellar masses. A revised picture of galactic star-formation is slowly emerging. This is required in order to understand the physics of young stellar objects, and star-formation at large, which are key science topics for future projects like ALMA and E-ELT. We therefore want to gather an up-to-date and comprehensive view of galactic star-formation by tracing ongoing and recent star-formation across the Milky Way. The workshop aims to link communities that usually focus on specific scales and environments, and we will discuss star-formation activity spatially spanning from the solar neighborhood, nearby star forming regions and OB associations, to spiral arms, to the galactic disk, around the central bar and bulge, towards the galactic center. Our ultimate goal is to identify similarities, differences and the dominant modes of the star-formation process and its typical outcomes across the Milky Way and beyond.

Topics and Invited Speakers: The workshop will be grouped around highlight talks that cover progressively the spatial scale, i.e. starting from local star formation towards increasing distances. The spatial coverage of the Milky Way will be complemented by topical sessions that will highlight overarching concepts and observations. Invited Speakers include:

Fred Adams, Michigan, USA Joao Alves, Granada, Spain John Bally, Colorado, USA Nate Bastian, London, UK Leo Blitz, Berkeley, USA Bruce Elmegreen, Yorktown Heights, USA Mark Gieles, ESO/Chile Preben Grosbol, ESO/Garching Phil Lucas, Hertfordshire, UK Piero Madau, Santa Cruz, USA, TBC Tom Megeath, Toledo, USA Jorge Melnick, ESO/Chile Thierry Montmerle, Grenoble, France Sergei Nayakshin, Leicester, UK Livia Origlia, Bologna, Italy Francesco Palla, Florence, Italy Fred Schuller, Bonn, Germany Andrea Stolte, Los Angeles, USA Hans Zinnecker, U Potsdam, Germany

Please see the conference web-site for details and registration information

http://www.sc.eso.org/santiago/science/MilkyWayStarFormation/

Moving ... ??

If you move or your e-mail address changes, please send the editor your new address. If the Newsletter bounces back from an address for three consecutive months, the address is deleted from the mailing list.

FIRST ANNOUNCEMENT

Astronomical Polarimetry 2008
Science from Small to Large Telescopes
6-11 July 2008
Fairmont Le Manoir Richelieu, La Malbaie, Quebec, Canada

We are pleased to announce the convening of a Conference on uv - optical - infrared - mm/submm (OIM) Astronomical Polarimetry, in the wonderful Charlevoix region by the St-Lawrence River in July 2008. It is located about 400 km (4 1/2 hours drive) from Montreal, and 150 km (2 hours drive) from the Quebec airport.

The aim of the Conference is to bring together workers in all areas of OIM astronomical polarimetry to discuss the most recent results in this exciting and crucial field, and to consider the potential for polarimetry with telescopes of all sizes. The meeting will concentrate on ground-based polarization measurements, and will include a session devoted to new and novel instrumentation. The remaining sessions will be organized according to the astronomical source rather than to wavelength regime or specific technique. Neither Radio polarimetry nor Solar polarimetry are within the conference remit, but each will be the subject of review talks which will set the scene for two of the conference sessions.

If you are interested in attending this meeting, please let us know. Note that registration pages on the conference web site will open for business around 7-Jan-2008. *** Emails sent to the conference address (given at the bottom of this note) will give a useful indication of the likely interest. Space may be limited, so we would strongly encourage you to do this at this point.

SCIENCE AREAS

Sessions will be divided into two, with approximately 80 percent of the time guaranteed for current results and 20 percent for presentations on future directions, facilities etc. Proceedings, including posters, will be published. Details of the division between oral and poster presentations will be given in the second announcement. The following science areas will be covered:

Techniques and Instrumentation
Theory and Modelling
Solar system
Interstellar Dust and Gas
Star Formation
Circumstellar Disks and Extrasolar Planets
Stars and Stellar Magnetism
Galaxies, Radio Galaxies and AGN
High-redshift and Cosmological Polarimetry

DATES AND DEADLINES

Second Announcement and Web site opens for registration: 7-Jan-2008
Commencement of Registration: 7-Jan-2008
Third Announcement: 1-Apr-2008
End of Early Registration: 23-May-2008
Abstract Deadline: 1-May-2008
Late Registration Deadline: 6-June-2008

SCIENCE ORGANIZING COMMITTEE

Andy Adamson (Joint Astronomy Centre); Colin Aspin (Institute for Astronomy) ; Stefano Bagnulo (Armagh Observatory, Northern Ireland); Pierre Bastien (Universite de Montreal; chair); Chris Davis (Joint Astronomy Centre); Martin Giard (Centre d'Etude Spatiale des Rayonnements, Toulouse); Martin Houde (University of Western Ontario); Jim Hough (University of Herfordshire); Anny-Chantal Levasseur-Regourd (Univ. P. and M. Curie, Paris VI); Nadine Manset (Canada-France Hawaii Telescope); Franois Mnard (Obs Grenoble); Motohide Tamura (National Astrophysical Observatory of Japan); Doug Whittet (Rensselaer Polytechnic Institute)

Conference web site: www.astro.umontreal.ca/astropol2008 – Contact email address: pol2008 *at* astro.umontreal.ca

The Universe under the Microscope - Astrophysics at High Angular Resolution

21-25 April 2008 – Physikzentrum Bad Honnef, Germany

High angular resolution techniques at infrared and centimeter to millimeter wavelengths have become of ever increasing importance for astrophysical research in the past decade. These new techniques will enable us to address issues such as directly measuring the properties of exoplanets, imaging the surfaces of stars, examining stellar dynamics in extremely dense cluster cores, disentangling the processes at the bottom of black hole accretion flows in the jet launching region, or testing general relativity in the strong gravity regime near the event horizon of supermassive black holes. This conference aims at an interdisciplinary approach by bringing together astrophysicists from the three great branches of the field, instrumentation, observation, and theory, to discuss the current state of research and the possibilities offered by the next-generation instruments.

Topics:

High mass star formation

Optical and infrared interferometry

Physics of jets and accretion flows

Discs around young stars

Sub-millimeter interferometry/VLBI

Supermassive black holes

The center of the Milky Way

The central 100 pcs of galaxies

Detailed information can be found on: **https://www.ph1.uni-koeln.de/AHAR08**

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 or at http://www.eso.org/gen-fac/pubs/starform/ .