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Abstracts of recently accepted papers

Detection of Molecular Hydrogen Orbiting a “Naked” T Tauri Star

Jeffrey S. Bary¹, David A. Weintraub¹ and Joel H. Kastner²

¹ Vanderbilt University, P.O. Box 1807, Station B, Nashville, TN 37235, USA

² Carlson Center for Imaging Science, Rochester Institute of Technology, 54 Lomb Memorial Drive, Rochester, NY 14623, USA

E-mail contact: jeff.bary@vanderbilt.edu

Astronomers have established that for a few million years newborn stars possess disks of orbiting gas and dust. Such disks, which are likely sites of planet formation, appear to disappear once these stars reach ages of $5\text{-}10 \times 10^6$ yr; yet, $\geq 10^7$ yr is thought necessary for giant planet formation. If disks dissipate in less time than is needed for giant planet formation, such planets may be rare and those known around nearby stars would be anomalies. Herein, we report the discovery of H₂ gas orbiting a weak-lined T Tauri star heretofore presumed nearly devoid of circumstellar material. We estimate that a significant amount of H₂ persists in the gas phase, but only a tiny fraction of this mass emits in the near-infrared. We propose that this star possesses an evolved disk that has escaped detection thus far because much of the dust has coagulated into planetesimals. This discovery suggests that the theory that disks are largely absent around such stars should be reconsidered. The widespread presence of such disks would indicate that planetesimals can form quickly and giant planet formation can proceed to completion before the gas in circumstellar disks disperses.

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Variability of Southern T Tauri Stars (VASTT) III: The Continuum Flux Changes of the TW Hya Bright Spot

Celso Batalha¹, Natalie M. Batalha², Silvia H.P. Alencar³, Dalton F. Lopes¹ and Eduardo S. Duarte¹

¹ Observatório Nacional/CNPq, Rua General José Cristino, 77, Rio de Janeiro, RJ 20920-400, Brazil

² NASA Ames Research Center, Planetary Systems Branch, Moffett Field, CA 94035-1000, USA

³ Universidade de São Paulo, IAG, Departamento de Astronomia, Rua do Matão, 1226, São Paulo, 05508-900, Brazil

E-mail contact: celso@on.br

We have collected low resolution spectrophotometric data of the classical T Tauri star TW Hya in an effort to detect and to follow the excess continuum emission (veiling) and the line changes at $\lambda < 5100$ Å. The de-veiled and calibrated flux distribution resembles that of a 30 Myr K7-M1 star, of radius $R/R_{\odot} = 0.8$, mass $M/M_{\odot} = 0.7$ and $\log g = 4.5$. The anticorrelation between the veiling (in the B-band) and the observed Balmer jump, found by previous authors based on large samples of classical T Tauri stars, is confirmed in TW Hya. The line emission luminosities of the H, CaII and HeI lines correlate with one another throughout the series, supporting the claims that the bulk of the line emission is formed in a single region or their growth is controlled by a common mechanism. Surprisingly, the line emission fluxes do not correlate with the veiling at 4250 Å (B-band). The line luminosities are in general less than 1% of the continuum luminosities.

The veiling time series presents a cyclic behavior at 4.4 ± 0.4 days. We collected all of the archival photometric data and analyzed the B-band observations using different algorithms. We found solutions at either the 4.4-day timescale

or one half of this value. The latter data sets yield double-peaked light curves when folded at the 4.4-day timescale. We interpret the 4.4-day solution as the rotation period of the star.

The veiling and the line emission measurements yield accretion luminosities for the series. We model the impacted area in the photosphere by an isothermal gas of a given density, temperature and size whose parameters change as the star rotates. Estimations of the total spot area (δ), as a percentage of the stellar projected area, lie within the range $2.5 < \delta < 6.0$. The accretion luminosity of the impacted region does not remain constant throughout the series. The mass accretion rate (\dot{M}_{acc}) that governs the luminosity, varies within $1.0 \times 10^{-9} M_{\odot} \text{yr}^{-1} < \dot{M}_{acc} < 4.8 \times 10^{-8} M_{\odot} \text{yr}^{-1}$. The spot luminosity and the associated \dot{M}_{acc} are tightly correlated to the projected spot area, and change their absolute values as the star spins. If most of the accretion is channeled to a single spot, its colatitude will be larger than 70° , indicating that the magnetic dipole is largely inclined.

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Accretion in stellar clusters and the collisional formation of massive stars

Ian A. Bonnell¹ and Matthew R. Bate²

¹ School of Physics and Astronomy, University of St Andrews, North Haugh, St Andrews, Fife, KY16 9SS, UK

² School of Physics, University of Exeter, Stocker Road, Exeter EX4 4QL, UK

E-mail contact: iab1@st-and.ac.uk

We present results from a numerical simulation of gas accretion in a cluster containing 1000 stars. The accretion forces the cluster to contract, leading to the development of a high-density core with a maximum density 10^5 times the mean stellar density. This density is sufficient for a significant number of stellar collisions to occur, resulting in the most massive stars being formed through a combination of gas accretion and stellar mergers. In the simulation, nineteen mergers occur, generally where a binary is forced to merge due to the interaction with another star in a small-N group. These small-N groups form due to the self-gravity of the gas and constitute the highest density regions in the cluster. Binary formation in these groups is common, occurring through dynamical three-body capture. The massive stars are thus generally in binary systems, which can be relatively wide. The self-gravity of the gas also forms significant structure in the vicinity of the cluster core, while continuing infall forms a circumbinary disc around the most massive star. This structure may be the source of collimation for the observed outflows from young massive stars. Finally, the resultant IMF from the combination of gas accretion and stellar mergers is indistinguishable from a Salpeter mass function.

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<http://star-www.st-and.ac.uk/astronomy/Welcome.html>

The Initial Mass Function in the Taurus Star Forming Region

César Briceño¹, Kevin Luhman & Lee Hartmann², John Stauffer³ and Davy Kirkpatrick⁴

¹ Centro de Investigaciones de Astronomía (CIDA), Apartado Postal 264, Mérida 5101-A, Venezuela

² Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA 02138, USA

³ SIRTf Science Center, Caltech MS 220-6, Pasadena, CA 91125, USA

⁴ Infrared Processing and Analysis Center, MS 100-22, 770 South Wilson Avenue, Caltech, Pasadena, CA 91125, USA

E-mail contact: briceno@cida.ve

By combining a deep optical imaging (I, z') survey of 8 deg^2 in the Taurus star-forming region with data from the Two-Micron All-Sky Survey (2MASS) and followup spectroscopy, we have performed a search for low-mass Taurus members that is complete to $0.02 M_{\odot}$ for reddenings of $A_V \lesssim 4$. We report the discovery of nine new members with spectral types of M5.75-M9.5, corresponding to masses of $0.1\text{-}0.015 M_{\odot}$ by recent evolutionary models. The new M9.5 member is the least massive brown dwarf found to date in the Taurus star-forming region. We derive an Initial Mass Function (IMF) for the fields surveyed in this work and in our previous studies, which encompass 54% of the known Taurus membership. We compare the Taurus IMF with a similarly derived one for the Trapezium Cluster and to mass functions for the M35 and Pleiades open clusters. While the IMFs in all of these regions flatten near $\sim 0.8 M_{\odot}$, the

mass function in Taurus is more narrow and sharply peaked at this mass. Our survey indicates that Taurus has $\sim 2\times$ fewer brown dwarfs at 0.02-0.08 M_{\odot} than the Trapezium. We discuss the implications of these results for theories of the IMF, and suggest that the lower frequency of brown dwarfs in Taurus relative to the Trapezium may result from the low-density star-forming environment, leading to larger minimum Jeans masses.

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Millimeter and Infrared observations of deuterated molecules

Cecilia Ceccarelli^{1,2}

¹ Observatoire de Bordeaux, BP 89, 33270 Floirac, France

² Observatoire de Grenoble, BP 53, 38041 Grenoble, France

E-mail contact: ceccarel@observ.u-bordeaux.fr

This contribution reviews the observations of deuterated molecules in the millimeter to far infrared wavelengths. It starts by reviewing the few observations in the literature of the two major reservoirs of deuterium, namely HD and atomic D, from which estimates of the elemental D/H ratio can be obtained. Then follows a review of the observations of less abundant molecules, where large degrees of deuteration ($\geq 1\%$) have been observed for almost 30 years. Singly deuterated molecules were the first to be observed and studied. More recently, doubly deuterated formaldehyde and ammonia have been discovered to be extremely abundant ($\geq 1\%$ with respect to H_2CO and CH_3OH respectively), much more abundant than the singly deuterated species squared and any present model would predict. The importance of these observations is described in length, both in terms of the comprehension of the mechanisms leading to the observed deuteration and of the possible applications of the theory. Particular emphasis is given to the most recent observations of doubly deuterated molecules and to the many questions that they arise.

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<http://www.observ.u-bordeaux.fr/>

Mid-Infrared Imaging of NGC 6334 I

James M. De Buizer¹, James T. Radomski², Robert K. Pina² and Charles M. Telesco²

¹ Cerro Tololo Inter-American Observatory, National Optical Astronomy Observatories, Casilla 603, La Serena, Chile

² Department of Astronomy, University of Florida, Gainesville, FL 32601, USA

E-mail contact: jdebuizer@ctio.noao.edu

We present high-resolution ($<0.5''$) mid-infrared Keck II images of individual sources in the central region of NGC 6334 I. We compare these images to images at a variety of other wavelengths from the near infrared to cm radio continuum and speculate on the nature of the NGC 6334 I sources. We assert that the cometary shape of the UCHII region here, NGC 6334 F, is due to a champagne-like flow from a source on the edge of a molecular clump and not a due to a bow shock caused by the supersonic motion of the UCHII region through the interstellar medium. The mid-infrared emission is concentrated into an arc of dust that defines the boundary between the UCHII region and the molecular clump. This dust arc contains a majority of the masers in the region. We discuss the nature of the four near-infrared sources associated with IRS-I 1, and suggest that one of the sources, IRS1E, is responsible for the heating and ionizing of the UCHII region and the mid-infrared dust arc. Infrared source IRS-I 2, which has been thought to be a circumstellar disk associated with a linear distribution of methanol masers, is found not to be directly coincident with the masers and elongated at a much different position angle. IRS-I 3 is found to be an extended source of mid-infrared emission coming from a cluster of young dusty sources seen in the near-infrared.

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<http://www.ctio.noao.edu/~debuizer>

Abundances of Molecular Species in Barnard 68

James Di Francesco¹, Michiel R. Hogerheijde¹, William J. Welch¹, & Edwin A. Bergin²

¹ Radio Astronomy Laboratory, 601 Campbell Hall, University of California, Berkeley, Berkeley, CA, 94705-3411

U.S.A.

² Harvard-Smithsonian Center for Astrophysics 60 Garden Street, MS 42, Cambridge, MA 02138, U.S.A.

E-mail contact: jdifran@astron.berkeley.edu

Abundances for 5 molecules ($C^{18}O$, CS, NH_3 , H_2CO , and C_3H_2) and 1 molecular ion (N_2H^+) and upper limits for the abundances of 1 molecule (^{13}CO) and 1 molecular ion (HCO^+) are derived for gas within the Bok globule Barnard 68 (B68). The abundances were determined using our own BIMA millimeter interferometer data and single-dish data gathered from the literature, in conjunction with a Monte Carlo radiative transfer model. Since B68 is the only starless core to have its density structure strongly constrained via extinction mapping, a major uncertainty has been removed from these determinations. All abundances for B68 are lower than those derived for translucent and cold dense clouds, but perhaps only significantly for N_2H^+ , NH_3 , and C_3H_2 . Depletion of CS toward the extinction peak of B68 is hinted at by the large offset between the extinction peak and the position of maximum CS line brightness. Abundances derived here for $C^{18}O$ and N_2H^+ are consistent with other, recently determined values at positions observed in common.

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<http://astron.berkeley.edu/~jdifran/prof/b68.ps>

Two massive star-forming regions at early evolutionary stages

G. Garay¹, K. J. Brooks², D. Mardones¹, R. P. Norris³ and M. G. Burton⁴

¹ Departamento de Astronomía, Universidad de Chile, Casilla 36-D, Santiago, Chile

² European Southern Observatory, Casilla 19001, Santiago 19, Chile

³ Australia Telescope National Facility, P.O. Box 76, Epping 1710 NSW, Australia

⁴ Department of Astrophysics and Optics, School of Physics, University of New South Wales, NSW 2052, Australia

E-mail contact: guido@das.uchile.cl

We report sensitive ATCA radio continuum observations toward IRAS 15596–5301 and 16272–4837, two luminous objects ($\mathcal{L} > 2 \times 10^4 L_\odot$) thought to represent massive star forming regions in early stages of evolution (due to previously undetected radio emission at the 1σ level of 2 mJy per beam). Also reported are 1.2 millimeter continuum and a series of molecular line observations made with the SEST telescope.

The radio continuum observations toward IRAS 15596–5301 reveal the presence of three distinct compact sources, with angular sizes of $2.7''$ to $8.8''$ (FWHM), all located within a region of $30''$ in diameter. Assuming that these are regions of ionized gas, we find that they have diameters of 0.06–0.2 pc, electron densities of $8 \times 10^2 - 2 \times 10^3 \text{ cm}^{-3}$, and that they are excited by early B-type stars. The 1.2-mm observations show that the dust emission arises from a region of $42'' \times 25''$ (FWHM) with a total flux of 5.8 Jy, implying a mass of $1.4 \times 10^3 M_\odot$. The line observations indicate that IRAS 15596–5301 is associated with a molecular cloud with a FWHM angular size of $37''$ (~ 0.4 pc radius at the distance of 4.6 kpc), a molecular hydrogen density of $\sim 4 \times 10^5 \text{ cm}^{-3}$ and a rotational temperature of ~ 27 K. We suggest that the massive dense core associated with IRAS 15596–5301 contains a cluster of B stars which are exciting compact HII regions that are in pressure equilibrium with the dense molecular surroundings.

No radio continuum emission was detected from IRAS 16272–4837 up to a 3σ limit of 0.2 mJy. However, the 1.2-mm observations show strong dust emission arising from a region of $41'' \times 25''$ (FWHM) with a total flux of 13.8 Jy, implying a mass of $2.0 \times 10^3 M_\odot$. The line observations indicate the presence of an elongated molecular cloud with FWHM major and minor axes of $61''$ and $42''$ (0.50×0.35 pc in radius at the distance of 3.4 kpc), a molecular hydrogen density of $\sim 2 \times 10^5 \text{ cm}^{-3}$ and a rotational temperature of ~ 27 K. The high luminosity ($2.4 \times 10^4 L_\odot$) and lack of radio emission from this massive core suggest that it hosts an embedded young massive protostar that is still undergoing an intense accretion phase. This scenario is supported by the observed characteristics of the line profiles and the presence of a bipolar outflow detected from observations of the SiO emission. We suggest that IRAS 16272–4837 is a bona-fide massive star forming region in a very early evolutionary stage, being the precursor of an ultra compact HII region.

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Spectroscopic Detection of a Stellar-like Photosphere in an Accreting Protostar

Thomas Greene¹ and Charles Lada²

¹ NASA's Ames Research Center, M.S. 245-6, Moffett Field, CA 94035, USA

² Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA

E-mail contact: tgreene@arc.nasa.gov

We present high-resolution ($R \simeq 18,000$), high signal-to-noise $2 \mu\text{m}$ spectra of two luminous, X-ray flaring Class I protostars in the ρ Ophiuchi cloud acquired with the NIRSPEC spectrograph of the Keck II telescope. We present the first spectrum of a highly veiled, strongly accreting protostar which shows photospheric absorption features and demonstrates the stellar nature of its central core. We find the spectrum of the luminous ($L_{bol} = 10 L_{\odot}$) protostellar source, YLW 15, to be stellar-like with numerous atomic and molecular absorption features, indicative of a K5 IV/V spectral type and a continuum veiling $r_k = 3.0$. Its derived stellar luminosity ($3 L_{\odot}$) and stellar radius ($3.1 R_{\odot}$) are consistent with those of a $0.5 M_{\odot}$ pre-main-sequence star. However, 70% of its bolometric luminosity is due to mass accretion, whose rate we estimate to be $1.6 \times 10^{-6} M_{\odot} \text{ yr}^{-1}$ onto the protostellar core. We determine that excess infrared emission produced by the circumstellar accretion disk, the inner infalling envelope, and accretion shocks at the surface of the stellar core of YLW 15 all contribute significantly to its near-IR continuum veiling. Its projected rotation velocity $v \sin i = 50 \text{ km s}^{-1}$ is comparable to those of flat-spectrum protostars but considerably higher than those of classical T Tauri stars in the ρ Oph cloud. The protostar may be magnetically coupled to its circumstellar disk at a radius of $2 R_{*}$. It is also plausible that this protostar can shed over half its angular momentum and evolve into a more slowly rotating classical T Tauri star by remaining coupled to its circumstellar disk (at increasing radius) as its accretion rate drops by an order of magnitude during the rapid transition between the Class I and Class II phases of evolution.

The spectrum of WL 6 does not show any photospheric absorption features, and we estimate that its continuum veiling is $r_k \geq 4.6$. Its low bolometric luminosity ($2 L_{\odot}$) and high veiling dictate that its central protostar is very low mass, $M \sim 0.1 M_{\odot}$.

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Flows, Fragmentation, and Star Formation. I. Low-mass Stars in Taurus

Lee Hartmann

Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA 02138, USA

E-mail contact: hartmann@cfa.harvard.edu

The remarkably filamentary spatial distribution of young stars in the Taurus molecular cloud has significant implications for understanding low-mass star formation in relatively quiescent conditions. The large scale and regular spacing of the filaments suggests that small-scale turbulence is of limited importance, which could be consistent with driving on large scales by flows which produced the cloud. The small spatial dispersion of stars from gaseous filaments indicates that the low-mass stars are generally born with small velocity dispersions relative to their natal gas, of order the sound speed or less. The spatial distribution of the stars exhibits a mean separation of about 0.25 pc, comparable to the estimated Jeans length in the densest gaseous filaments, and is consistent with roughly uniform density along the filaments. The efficiency of star formation in filaments is much higher than elsewhere, with an associated higher frequency of protostars and accreting T Tauri stars. The protostellar cores generally are aligned with the filaments, suggesting that they are produced by gravitational fragmentation, resulting in initially quasi-prolate cores. Given the absence of massive stars which could strongly dominate cloud dynamics, Taurus provides important tests of theories of dispersed low-mass star formation and numerical simulations of molecular cloud structure and evolution.

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<http://cfa-www.harvard.edu/cfa/youngstars/>

Fine Structure in the Circumstellar Environment of a Young, Solar-like Star: the Unique Eclipses of KH 15D

William Herbst¹, Catrina M. Hamilton^{1,2}, Frederick J. Vrba³, Mansur A. Ibrahimov⁴, Coryn A. L. Bailer-Jones⁵, Reinhard Mundt⁵, Markus Lamm⁵, Tsevi Mazeh⁶, Zodiac T. Webster⁷, Karl E. Haisch⁸, Eric C. Williams¹, Andrew H. Rhodes¹, Thomas J. Balonek⁹, Alexander Scholz¹⁰, and Arno Riffeser¹¹

¹ Astronomy Dept., Wesleyan U., Middletown, CT 06459, USA

² Physics Dept., Connecticut College, Box 5424, New London, CT 06320, USA

³ U.S. Naval Obs., Flagstaff Station, Box 1149, Flagstaff, AZ 86002-1149, USA

⁴ Ulugh Beg Astronomical Institute of the Uzbek Academy of Sciences, Astronomicheskaya 33, 700052 Tashkent, Uzbekistan

⁵ Max-Planck-Institut für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany

⁶ School of Physics and Astronomy, Raymond and Beverly Sackler Faculty of Exact Sciences, Tel Aviv University, Tel Aviv, Israel

⁷ Astronomy Dept., U. C. Berkeley, 601 Campbell Hall, Berkeley, CA 94720-3411, USA

⁸ NASA Ames Research Center, Mail Stop 245-6, Moffett Field, CA 94035-1000, USA

⁹ Dept. of Physics and Astronomy, Colgate U., 13 Oak Drive, Hamilton, NY 13346-1398, USA

¹⁰ Thüringer Landessternwarte Tautenburg, Sternwarte 5, D-07778 Tautenburg, Germany

¹¹ Universitäts-Sternwarte München, Scheinerstr. 1, D-81679 München, Germany

E-mail contact: wherbst@wesleyan.edu

Results of an international campaign to photometrically monitor the unique pre-main sequence eclipsing object KH 15D are reported. An updated ephemeris for the eclipse is derived that incorporates a slightly revised period of 48.36 d. There is some evidence that the orbital period is actually twice that value, with two eclipses occurring per cycle. The extraordinary depth (~ 3.5 mag) and duration (~ 18 days) of the eclipse indicate that it is caused by circumstellar matter, presumably the inner portion of a disk. The eclipse has continued to lengthen with time and the central brightness reversals are not as extreme as they once were. V-R and V-I colors indicate that the system is slightly bluer near minimum light. Ingress and egress are remarkably well modeled by the passage of a knife-edge across a limb-darkened star. Possible models for the system are briefly discussed.

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New Tests of Magnetospheric Accretion in T Tauri Stars

Christopher M. Johns-Krull^{1,2} and April D. Gafford^{1,3}

¹ Space Sciences Laboratory, University of California, Berkeley, CA 94720, USA

² Department of Physics and Astronomy, Rice University, 6100 Main St., MS-61, Houston, TX 77005, USA

³ Department of Physics and Astronomy, San Francisco State University, San Francisco, CA 94132, USA

E-mail contact: cmj@rice.edu

We examine 3 analytic theories of magnetospheric accretion onto classical T Tauri stars under the assumption that the magnetic field strength does not vary appreciably from star to star. From these investigations we derive predicted relationships among the stellar mass, radius, rotation period, and disk accretion rate. Data from 5 studies of the accretion parameters of CTTSs are used to test the predicted correlations. We generally find that the data do not display the predicted correlations except for that predicted by the model of Shu et al. (1994) as detailed by Ostriker and Shu (1995) and extended here to include non-dipole field topologies. Their identification of the trapped flux as an important quantity in the model appears to be critical for reconciling the observed data to the theory. While the data do generally support the extended Ostriker and Shu predictions, only one of the two studies for which the requisite data exist show the highest correlation when considering all the relevant parameters. This suggests great care must be taken when trying to use existing observations to test the theory.

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Dusty Rings: Signposts of Recent Planet Formation

Scott J. Kenyon¹ and Benjamin C. Bromley²

¹ Smithsonian Astrophysical Observatory, 60 Garden Street, Cambridge, MA 02138, USA

² Department of Physics, University of Utah, 201 JFB, Salt Lake City, UT 84112, USA

E-mail contact: skenyon@cfa.harvard.edu

Many nearby stars are surrounded by a bright ring or disk of cold dust. Our calculations show that these disks and rings of dust are signposts of recent planet formation. Bright rings appear because dust associated with the formation of a planet absorbs and scatters light from the central star. The calculations explain the rings observed so far and predict that all nascent solar systems have dusty rings.

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Disk–Halo Model for Flat-Spectrum T Tauri Stars

Nobuhiro Kikuchi¹, Taishi Nakamoto² and Koji Ogochi³

¹ Earth Observation Research Center, National Space Development Agency of Japan, 1-8-10 Harumi, Chuo-ku, Tokyo 104-6023, Japan

² Center for Computational Physics, University of Tsukuba, Tsukuba, Ibaraki 305-8577, Japan

³ Information Technology of Japan Inc., Mito, Ibaraki 310-0803, Japan

E-mail contact: kikuchi@eorc.nasda.go.jp

We explore the origin of the flat spectrum seen in some T Tauri stars by considering a three-component structure: a central star, a circumstellar disk, and a dusty halo. The radiative energy transport is faithfully treated by solving the angle- and frequency-dependent radiative transfer equation in two space dimensions assuming axisymmetry, and hence the radiative equilibrium temperature in the disk and halo is determined simultaneously. The disk is effectively heated by the scattering and reprocessing of stellar radiation through the halo. The large mid- to far-infrared excess originates from the photosphere of the warmed disk, resulting in a flat spectrum, as observed. The halo which we consider is observed as a compact reflection nebula, and is discriminated from extended, disk-like envelopes around flat-spectrum T Tauri stars. We show that the overall spectral shape of flat-spectrum T Tauri stars can be reproduced by the present *disk-halo* model.

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Close Binaries in the η Cha Cluster

Rainer Köhler¹ and Monika G. Petr-Gotzens²

¹ Center for Astrophysics and Space Sciences, University of California San Diego, Gilman Drive 9500, La Jolla, CA 92093-0424, USA

² Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany

E-mail contact: rkoehler@ucsd.edu, mpetr@mpifr-bonn.mpg.de

We used speckle interferometry and adaptive optics observations to search for multiple systems among 13 stars in the η Chamaeleontis cluster. We discovered two previously unknown sub-arcsecond binaries. Placing the components in infrared color-magnitude diagrams shows that most members of η Cha are coeval. Repeated observations of the binary RECX 1 allow us to determine a preliminary orbit and derive a system mass of about $2 M_{\odot}$.

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Available at <http://hex.ucsd.edu/koehler/Papers/index.html>

Analyses of UV spectra of T Tauri stars observed with HST: the estimation of interstellar extinction and relative contribution of accretion shock to emission continuum formation.

A.S.Kravtsova, S.A.Lamzin

Sternberg Astronomical Institute, Moscow, 119992 Russia

E-mail contact: lamzin@sai.msu.ru

We analysed ultraviolet (1200-3100 Å) HST/STIS spectra of 8 Classical T Tauri stars (T Tau, RY Tau, CO Ori, EZ Ori, GW Ori, GX Ori, V1044 Ori, SU Aur) and derived upper limits of interstellar extinction A_V for them. In all cases upper limits appeared to be lower than A_V found from optical observations by different authors and we discuss possible reasons of this discrepancy.

We also estimated luminosity, mass and radius of T Tau and RY Tau as well as bolometric luminosities of their veiling continuum emission, which is presumably originated due to disk accretion process. It appeared that the main portion of veiling emission is concentrated longward 1 μm .

For these two stars we also derived the ratio of CIV 1550 line flux to that of veiling continuum emission and found that it is ~ 100 times less than value predicted by Lamzin (1998) and/or Calvet & Gullbring (1998) accretion shock models. We conclude therefore that in the case of T Tau and RY Tau continuum emission is originated predominantly in the accretion disk and/or boundary layer rather than in the accretion shock. It means that only tiny portion of accreted matter passes through the stellar magnetosphere and accretion shock while the main portion reaches the star in equatorial region passing through the boundary layer. Previously we reach the same conclusion in the case of DR Tau (Kravtsova & Lamzin, 2002).

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On the mass function of star clusters

Pavel Kroupa¹, Christian Boily²

¹ Institut fuer Theoretische Physik und Astrophysik, Universitaet Kiel, D-24098 Kiel, Germany

² Observatoire astronomique de Strasbourg, 11 rue de l'université, 67000 Strasbourg, France

E-mail contact: pavel@astrophysik.uni-kiel.de

Clusters that form in total $10^3 < N < 10^5$ stars (type II clusters) lose their gas within a dynamical time as a result of the photo-ionising flux from O stars. Sparser (type I) clusters get rid of their residual gas on a timescale longer or comparable to the nominal crossing time and thus evolve approximately adiabatically. This is also true for massive embedded clusters (type III) for which the velocity dispersion is larger than the sound speed of the ionised gas. On expelling their residual gas, type I and III clusters are therefore expected to lose a smaller fraction of their stellar component than type II clusters. We outline the effect this has on the transformation of the mass function of embedded clusters (ECMF), which is directly related to the mass function of star-cluster-forming molecular cloud cores, to the “initial” MF of bound gas-free star clusters (ICMF). The resulting ICMF has, for a featureless power-law ECMF, a turnover near $10^{4.5} M_\odot$ and a peak near $10^3 M_\odot$. The peak lies around the initial masses of the Hyades, Praesepe and Pleiades clusters. We also find that the entire Galactic population II stellar spheroid can be generated if star formation proceeded via embedded clusters distributed like a power-law MF with exponent $0.9 < \beta < 2.6$.

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The Photoionization of a Star-Forming Core in the Trifid Nebula

B. Lefloch¹, J. Cernicharo², L. F. Rodríguez³, M.A. Miville-Deschênes⁴, D. Cesarsky⁵, A. Heras⁶

¹ Laboratoire d'Astrophysique, Observatoire de Grenoble, BP 53, F-38041, Grenoble Cedex 9, France

² IEM, CSIC, Serrano 121, E-28006 Madrid

³ Instituto de Astronomía, UNAM, Campus Morelia, A.P. 3-72, Morelia, Mich. 58089, México

⁴ ENS, LRA, 24 rue Lhomond, Paris, France

⁵ Max-Planck Institut für Extra-Terrestrische Physik, 85741 Garching, Germany

⁶ ESTEC/SCI-SAF, P.O. Box 209, NL-2200 AG Noordwijk The Netherlands

E-mail contact: lefloch@obs.ujf-grenoble.fr

We have carried out a comprehensive multiwavelength study of Bright-Rimmed Globule TC2 in the Trifid Nebula, using the IRAM 30m telescope, the VLA centimeter array and the Infrared Space Observatory (ISO). TC2 is one of the very few globules to exhibit signs of active ongoing star formation while being photoevaporated by the Ly-c flux of the exciting star of the nebula ($\sim 10^{10} \text{ cm}^{-2} \text{ s}^{-1}$). The globule consists of a cold dense core of mass $27 M_{\odot}$ surrounded by a lower density envelope of molecular gas. The impinging Ly-c photons induce the propagation of an ionization front into the globule. The evaporation of the ionized gas forms a thin layer of density $n_e = 1 - 2 \times 10^3 \text{ cm}^{-3}$ around the globule, which could be mapped with the VLA. The globule is illuminated mainly on its rear side, by a FUV field of intensity $G_0 \simeq 1000$. It creates a Photon-Dominated Region (PDR) below the surface, which was mapped and characterized with the ISOCAM Circular Variable Filter and the Short Wavelength Spectrometer (SWS) onboard the Infrared Space Observatory. The physical conditions derived from the analysis of the far-infrared lines [OI] $63\mu\text{m}$, $145\mu\text{m}$ and [CII] $158\mu\text{m}$, and the continuum emission are in good agreement with some recent PDR models. The emission of the PAHs band at $6.2, 7.7, 8.6$ and $11.3\mu\text{m}$ is detected over the whole globule. The relative intensity variations observed across the globule, in the PDR and the photoionized envelope, are consistent with the changes in the ionization fraction. In the head of TC2, we find a second kinematic component which is the signature of the radiatively-driven collapse undergone by the globule. This component indicates that the PDR propagates at low velocity inside the body of TC2. The molecular emission suggests that the star formation process was probably initiated a few 10^5 yr ago, in the large burst which led to the formation of the nebula. The globule has already evaporated half the mass of its envelope. However, the ionization timescale of the globule is long enough (~ 2 Myr) to let the newly born objects reach smoothly the ultimate stages of protostellar evolution. The impact of photoionization on the star formation process appears limited.

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The precession of the giant HH34 outflow: a possible jet deceleration mechanism

E. Masciadri^{1,2}, M.E. de Gouveia Dal Pino³, A. Raga⁴ and A. Noriega-Crespo⁵

¹ Instituto de Astronomía, UNAM, Apdo. Postal 70-264, 04510 México, D. F., México

² Max-Planck Institut für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany

³ Instituto Astronomico e Geofisico (IAG-USP), Universidade de São Paulo, Cidade Universitaria, R. do Matao, 1226, São Paulo, SP 05508-090, Brasil

⁴ Instituto de Ciencias Nucleares, UNAM, Apdo. Postal 70-543, 04510 México, D. F., México

⁵ SIRTf Science Center, California Institute of Technology, IPAC 100-22, Pasadena, CA 91125, USA

E-mail contact: elena@astroscu.unam.mx - starting from october: masciadri@mpia.de

The giant jets represent a fundamental trace of the historical evolution of the outflow activity over timescales of $\sim 10^4$ yr, i.e. a timescale comparable to the accretion time of the outflow sources in their main protostellar phase. The study of such huge jets provides the possibility of retrieving important elements related to the life of the outflow sources. In this paper, we study the role of precession (combined with jet velocity-variability and the resulting enhanced interaction with the surrounding environment) as a deceleration mechanism for giant jets using a numerical approach. This thesis was proposed for the first time by Devine et al. (1997) but it could not be numerically explored until now because it is intrinsically difficult to reproduce, at the same time, the large range of scales from ~ 100 AU up to a few parsecs. In the present paper, we obtain predictions of $H\alpha$ intensity maps and position-velocity diagrams from 3D simulations of the giant HH 34 jet (including an appropriate ejection velocity time-variability and a precession of the outflow axis), and we compare them with previously published observations of this object. Our simulations represent a step forward from previous numerical studies of HH objects, in that the use of a 7-level, binary adaptive grid has allowed us to compute models which appropriately cover all relevant scales of a giant jet, from the ~ 100 AU jet radius close to the source to the ~ 1 pc length of the outflow. A good qualitative and quantitative agreement is found between the model predictions and the observations, indicating that a precession of the jet axis can indeed be the probable cause of the deceleration of the giant jets. Moreover, we show that a critical parameter for obtaining a better or worse agreement with the observations is the ratio ρ_j/ρ_a between the jet and the environmental densities. The implications of this result in the context of the current star formation models are discussed.

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The absence of the 10 μm silicate feature in the isolated Herbig Ae star HD100453.

G. Meeus¹, J. Bouwman², C. Dominik³, L.B.F.M. Waters³, A. de Koter³

¹ Astrophysikalisches Institut Potsdam (AIP), An der Sternwarte 16, D-14482 Potsdam, Germany

² Service d'Astrophysique, CEA Saclay, F-91191 Gif-sur-Yvette, France

³ Astronomical Institute Anton Pannekoek, University of Amsterdam, Kruislaan 403, NL-1098 SJ Amsterdam, The Netherlands

E-mail contact: gwendolyn@aip.de

We analyse the optical and IR spectra, as well as the spectral energy distribution (UV to mm) of the candidate Herbig Ae star HD100453. This star is particular, as it shows an energy distribution similar to that of other isolated Herbig Ae/Be stars (HAEBEs), but unlike most of them, it does not have a silicate emission feature at 10 μm , as is shown in Meeus (2001). We confirm the HAEBE nature of HD100453 through an analysis of its optical spectrum and derived location in the H-R diagram. The IR spectrum of HD100453 is modelled by an optically thin radiative transfer code, from which we derive constraints on the composition, grain-size and temperature distribution of the circumstellar dust. We show that it is both possible to explain the lack of the silicate feature as (1) a **grain-size** effect - lack of small silicate grains, and (2) a **temperature** effect - lack of small, hot silicates, as proposed by Dullemond (2001), and discuss both possibilities.

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On the Interferometric Sizes of Young Stellar Objects

J. D. Monnier¹ and R. Millan-Gabet¹

¹ Harvard-Smithsonian Center for Astrophysics, Cambridge, USA

E-mail contact: monnier@umich.edu

Long-baseline optical interferometers can now detect and resolve hot dust emission thought to arise at the inner edge of circumstellar disks around young stellar objects (YSOs). We argue that the near-infrared sizes being measured are closely related to the radius at which dust is sublimated by the stellar radiation field. We consider how realistic dust optical properties and gas opacity dramatically affect the predicted location of this dust destruction radius, an exercise routinely done in other contexts but so far neglected in the analysis of near-infrared sizes of YSOs. We also present the accumulated literature of near-infrared YSO sizes in the form of a “size-luminosity diagram” and compare with theoretical expectations. We find evidence that large ($\gtrsim 1.0 \mu\text{m}$) dust grains predominate in the inner disks of T Tauri and Herbig Ae/Be stars, under the assumption that the inner-most gaseous disks are optically-thin at visible wavelengths.

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A dynamical study of the circumstellar gas in UX Orionis

A. Mora¹, A. Natta², C. Eiroa¹, C.A. Grady³, D. de Winter⁴, J.K. Davies⁵, R. Ferlet⁶, A.W. Harris⁷, B. Montesinos^{8,9}, R.D. Oudmaijer¹⁰, J. Palacios¹, A. Quirrenbach¹¹, H. Rauer⁷, A. Alberdi⁸, A. Cameron¹², H.J. Deeg¹³, F. Garzón¹³, K. Horne¹², B. Merín⁹, A. Penny¹⁴, J. Schneider¹⁵, E. Solano⁹, Y. Tsapras¹² and P.R. Wesselius¹⁶

¹ Departamento de Física Teórica C-XI, Universidad Autónoma de Madrid, Cantoblanco 28049 Madrid, Spain

² Osservatorio Astrofisico di Arcetri, Largo Fermi 5, I-50125 Firenze, Italy

³ NOAO/STIS, Goddard Space Flight Center, Code 681, NASA/GSFC, Greenbelt, MD 20771, USA

⁴ TNO/TPD-Space Instrumentation, Stieltjesweg 1, PO Box 155, 2600 AD Delft, The Netherlands

⁵ Astronomy Technology Centre, Royal Observatory, Blackford Hill, Edinburgh, EH9 3HJ, UK

⁶ CNRS, Institut d’Astrophysique de Paris, 98bis Bd. Arago, 75014 Paris, France

⁷ DLR Department of Planetary Exploration, Rutherfordstrasse 2, 12489 Berlin, Germany

⁸ Instituto de Astrofísica de Andalucía, Apartado de Correos 3004, 18080 Granada, Spain

⁹ LAEFF, VILSPA, Apartado de Correos 50727, 28080 Madrid, Spain

¹⁰ Department of Physics and Astronomy, University of Leeds, Leeds LS2 9JT, UK

¹¹ Department of Physics, Center for Astrophysics and Space Sciences, University of California San Diego, Mail Code 0424, La Jolla, CA 92093-0424, USA

¹² Physics & Astronomy, University of St. Andrews, North Haugh, St. Andrews KY16 9SS, Scotland, UK

¹³ Instituto de Astrofísica de Canarias, La Laguna 38200 Tenerife, Spain

¹⁴ Rutherford Appleton Laboratory, Didcot, Oxfordshire OX11 0QX, UK

¹⁵ Observatoire de Paris, 92195 Meudon, France

¹⁶ SRON, Universiteitscomplex “Zernike”, Landleven 12, P.O. Box 800, 9700 AV Groningen, The Netherlands

E-mail contact: alcione.mora@uam.es

We present the results of a high spectral resolution ($\lambda/\Delta\lambda = 49000$) study of the circumstellar (CS) gas around the intermediate mass, pre-main sequence star UX Ori. The results are based on a set of 10 échelle spectra covering the spectral range 3800 – 5900 Å, monitoring the star on time scales of months, days and hours. A large number of transient blueshifted and redshifted absorption features are detected in the Balmer and in many metallic lines. A multigaussian fit is applied to determine for each transient absorption the velocity, v , dispersion velocity, Δv , and the parameter R , which provides a measure of the absorption strength of the CS gas. The time evolution of those parameters is presented and discussed. A comparison of intensity ratios among the transient absorptions suggests a solar-like composition of the CS gas. This confirms previous results and excludes a very metal-rich environment as the cause of the transient features in UX Ori. The features can be grouped by their similar velocities into 24 groups, of which 17 are redshifted and 7 blueshifted. An analysis of the velocity of the groups allows us to identify them as signatures of the dynamical evolution of 7 clumps of gas, of which 4 represent accretion events and 3 outflow events. Most of the events decelerate at a rate of tenths of ms^{-2} , while 2 events accelerate at approximately the same rate; one event is seen experiencing both an acceleration and a deceleration phase and lasts for a period of few days. This time scale seems to be the typical duration of outflowing and infalling events in UX Ori. The dispersion velocity and the relative absorption strength of the features do not show drastic changes during the lifetime of the events, which suggests they are gaseous blobs preserving their geometrical and physical identity. These data are a very useful tool for constraining and validating theoretical models of the chemical and physical conditions of CS gas around young stars; in particular, we suggest that the simultaneous presence of infalling and outflowing gas should be investigated in the context of detailed magnetospheric accretion models, similar to those proposed for the lower mass T Tauri stars.

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Exploring Brown Dwarf Disks in ρ -Oph

A. Natta¹, L. Testi¹, F. Comerón², E. Oliva^{1,3}, F. D’Antona⁴, C. Baffa¹, G. Comoretto¹, S. Gennari¹

¹ Osservatorio Astrofisico di Arcetri, INAF, Largo E. Fermi 5, I-50125 Firenze, Italy

² ESO, Karl-Schwarzschild-Strasse 2, D-85748 Garching Bei München, Germany

³ TNG and Centro Galileo Galilei, INAF, P.O. Box 565, E-38700, Santa Cruz de La Palma, Spain

⁴ Osservatorio Astronomico di Roma, INAF, via Frascati 33, I-00044 Roma, Italy

E-mail contact: natta,lt@arcetri.astro.it

This paper discusses evidence for and properties of disks associated to brown dwarfs in the star-forming region ρ -Oph. We selected nine objects from the ISOCAM survey of Bontemps et al. (2001) that have detections in the two mid-infrared bands (6.7 and 14.3 μm), relatively low extinction and low luminosity. We present low-resolution near-infrared spectra in the J, H and K bands, and determine for each source spectral type, extinction, effective temperature and luminosity by comparing the spectra to those of field dwarfs and to the most recent model stellar atmospheres. The results indicate that eight objects have spectral types M6–M7.5, effective temperature of 2600–2700 K, one has a later spectral type (M8.5) and lower temperature (about 2400 K). The derived extinctions range between $A_V \sim 2$ and 8 mag. The location of the objects on the HR diagram, in spite of the uncertainties of the evolutionary tracks for young

objects of substellar mass, indicates that all the objects are very young and have masses below about $0.08 M_{\odot}$. The coolest object in our sample has mass in the range $8\text{--}12 M_{Jup}$ ($0.008\text{--}0.012 M_{\odot}$). In all cases, the mid-infrared excess is consistent with the predictions of models of disks irradiated by the central object, showing that circumstellar disks are commonly associated to young brown dwarfs and planetary-mass objects. Finally, we discuss possible variations of the disk geometry among different objects, as well as the possibility of using these data to discriminate between various formation scenarios.

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HST NICMOS Images of the HH 7/11 Outflow in NGC1333

A. Noriega-Crespo¹, A. Cotera², E. Young² and H. Chen²

¹ SIRTf Science Center, Caltech 220-6, Pasadena, CA, 91125, USA

² Steward Observatory, University of Arizona, 933 N. Cherry Av, AZ, 85721, USA

E-mail contact: alberto@ipac.caltech.edu

We present near infrared images in H_2 at $2.12\mu\text{m}$ of the HH 7/11 outflow and its driving source SVS 13 taken with *Hubble Space Telescope* NICMOS 2 camera, as well as archival $H\alpha$ and [S II] optical images obtained with the WFPC2 camera. The NICMOS high angular resolution observations confirm the nature of a small scale jet arising from SVS 13, and resolve a structure in the HH 7 working surface that could correspond to Mach disk H_2 emission. The H_2 jet has a length of 430 AU (at a distance of 350 pc), an aspect ratio of 2.2 and morphologically resembles the well known DG Tau optical micro-jet. The kinematical age of the jet (~ 10 yr) coincides with the time since the last outburst from SVS 13. If we interpret the observed H_2 flux density with molecular shock models of $20\text{--}30 \text{ km s}^{-1}$, then the jet has a density as high as 10^5 cm^{-3} . The presence of this small jet warns that contamination by H_2 emission from an outflow in studies searching for H_2 in circumstellar disks is possible. At the working surface, the smooth H_2 morphology of the HH 7 bowshock indicates that the magnetic field is strong, playing a major role in stabilizing this structure. The H_2 flux density of the Mach disk, when compared with that of the bowshock, suggests that its emission is produced by molecular shocks of less than 20 km s^{-1} . The WFPC2 optical images display several of the global features already inferred from groundbased observations, like the filamentary structure in HH 8 and HH 10, which suggests a strong interaction of the outflow with its cavity. The H_2 jet is not detected in [S II] or $H\alpha$, however, there is a small clump at $\sim 5''$ NE of SVS 13 that could be depicting the presence either of a different outburst event or the north edge of the outflow cavity.

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Detection of doubly-deuterated methanol in the solar-type protostar IRAS16293–2422

B. Parise¹, C. Ceccarelli^{2,3}, A.G.G.M. Tielens⁴, E. Herbst⁵, B. Lefloch³, E. Caux¹, A. Castets², I. Mukhopadhyay⁶, L. Pagani⁷, L. Loinard⁸

¹ CESR CNRS-UPS, BP 4346, 31028 - Toulouse cedex 04, France

² Observatoire de Bordeaux, BP 89, 33270 Floirac, France

³ LAOG -BP 53, F-38041-Grenoble cedex 09, France

⁴ SRON, P.O. Box 800, NL-9700 AV Groningen, the Netherlands

⁵ Department of Physics, The Ohio State University, 174 W. 18th Ave. Columbus, OH 43210-1106, USA

⁶ College of Natural Sciences, Dakota State University, Madison, SD 57042-1799, USA

⁷ LERMA & FRE 2460 du CNRS, Observatoire de Paris, 61 Av. de l'Observatoire de Paris, 75014 Paris, France

⁸ Instituto de Astronomía, UNAM, Apdo Postal 72-3 (Xangari), 58089 Morelia, Michoacán, México

E-mail contact: parise@cesr.fr

We report the first detection of doubly-deuterated methanol (CHD_2OH), as well as firm detections of the two singly-deuterated isotopomers of methanol (CH_2DOH and CH_3OD), towards the solar-type protostar IRAS16293–2422. From the present multifrequency observations, we derive the following abundance ratios: $[\text{CHD}_2\text{OH}]/[\text{CH}_3\text{OH}] = 0.2 \pm 0.1$, $[\text{CH}_2\text{DOH}]/[\text{CH}_3\text{OH}] = 0.9 \pm 0.3$, $[\text{CH}_3\text{OD}]/[\text{CH}_3\text{OH}] = 0.04 \pm 0.02$. The total abundance of the deuter-

ated forms of methanol is greater than that of its normal hydrogenated counterpart in the circumstellar material of IRAS16293–2422, a circumstance not previously encountered. Formaldehyde, which is thought to be the chemical precursor of methanol, possesses a much lower fraction of deuterated isotopomers ($\sim 20\%$) with respect to the main isotopic form in IRAS16293–2422. The observed fractionation of methanol and formaldehyde provides a severe challenge to both gas-phase and grain-surface models of deuteration. Two examples of the latter model are roughly in agreement with our observations of CHD_2OH and CH_2DOH if the accreting gas has a large (0.2-0.3) atomic D/H ratio. However, no gas-phase model predicts such a high atomic D/H ratio, and hence some key ingredient seems to be missing.

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Stellar Companions to Stars with Planets

J. Patience^{1,3}, R. J. White¹, A. M. Ghez¹, C. McCabe¹, I. S. McLean¹, J. E. Larkin¹, L. Prato¹, Sungsoo S. Kim¹, J. P. Lloyd², M. C. Liu², J. R. Graham², B. A. Macintosh³, D. T. Gavel³, C. E. Max³, B. J. Bauman³, S. S. Olivier³, P. Wizinowich⁴, D. S. Acton⁴

¹ UCLA Department of Physics and Astronomy, Los Angeles, CA 90095-1562, USA

² UC Berkeley Department of Astronomy, Berkeley, CA 94720, USA

³ IGPP, Lawrence Livermore National Lab, L-413, 7000 East Ave., Livermore, CA 94550, USA

⁴ W. M. Keck Observatory, 65-1120 Mamalahoa Highway, Kamuela, HI 96743, USA

E-mail contact: patience@igpp.ucllnl.org

A combination of high-resolution and wide-field imaging reveals two binary stars and one triple star system among the sample of the first 11 stars with planets detected by radial velocity variations. High resolution speckle or adaptive optics (AO) data probe subarcsecond scales down to the diffraction limit of the Keck 10-m or Lick 3-m, and direct images or AO images are sensitive to a wider field, extending to 10" or 38", depending upon the camera. One of the binary systems – HD 114762 – was not previously known to be a spatially resolved multiple system; additional data taken with the combination of Keck adaptive optics and NIRSPEC are used to characterize the new companion. The second binary system – Tau Boo – was a known multiple with two conflicting orbital solutions; the current data will help constrain the discrepant estimates of periastron time and separation. Another target – 16 Cyg B – was a known common proper motion binary, but the current data resolve a new third component, close to the wide companion 16 Cyg A. Both the HD 114762 and 16 Cyg B systems harbor planets in eccentric orbits, while the Tau Boo binary contains an extremely close planet in a tidally-circularized orbit. Although the sample is currently small, the proportion of binary systems is comparable to that measured in the field over a similar separation range. Incorporating the null result from another companion search project lowers the overall fraction of planets in binary systems, but the detections in our survey reveal that planets can form in binaries separated by less than 50 AU.

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Hydrodynamical simulations of the decay of high-speed molecular turbulence. I. Dense molecular regions

Georgi Pavlovski¹, Michael D. Smith¹, Mordecai-Mark Mac Low² and Alexander Rosen¹

¹ Armagh Observatory, College Hill, Armagh BT61 9DG, Northern Ireland, U.K.

² Americal Museum of Natural History, Department of Astrophysics, 79th St. at Central Park West, New Yourk, NY 10024-5192, USA

E-mail contact: gbp@star.arm.ac.uk

We present the results from three dimensional hydrodynamical simulations of decaying high-speed turbulence in dense molecular clouds. We compare our results, which include a detailed cooling function, molecular hydrogen chemistry and a limited C and O chemistry, to those previously obtained for decaying isothermal turbulence.

After an initial phase of shock formation, power-law decay regimes are uncovered, as in the isothermal case. We find that the turbulence decays faster than in the isothermal case because the average Mach number remains higher, due to the radiative cooling. The total thermal energy, initially raised by the introduction of turbulence, decays only a

little slower than the kinetic energy.

We discover that molecule reformation, as the fast turbulence decays, is several times faster than that predicted for a non-turbulent medium. This is caused by moderate speed shocks which sweep through a large fraction of the volume, compressing the gas and dust. Through reformation, the molecular density and molecular column appear as complex patterns of filaments, clumps and some diffuse structure. In contrast, the molecular fraction has a wider distribution of highly distorted clumps and copious diffuse structure, so that density and molecular density are almost identically distributed during the reformation phase. We conclude that molecules form in swept-up clumps but effectively mix throughout via subsequent expansions and compressions.

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Bright CO ro-vibrational emission lines in the class I source GSS 30 IRS1: Probing the inner disk of a young embedded star

K. M. Pontoppidan¹, F. L. Schöier¹, E. F. van Dishoeck¹ and E. Dartois²

¹ Leiden Observatory, P.O.Box 9513, NL-2300 RA Leiden, The Netherlands

² Institut d'Astrophysique Spatiale, Bât. 121, Université Paris XI, 91405 Orsay Cedex, France

E-mail contact: pontoppi@strw.leidenuniv.nl

We present a 4.5 – 4.85 μm $R = 5000$ spectrum of the low mass class I young stellar object GSS 30 IRS1 ($L = 25 L_{\odot}$) in the ρ Ophiuchus core, observed with the infrared spectrometer (ISAAC) on the *Very Large Telescope* (VLT-UT1). Strong line emission from the ro-vibrational transitions of ^{12}CO and ^{13}CO is detected. In total more than 40 distinct lines are seen in the covered region. The line emission is spatially extended and detected up to $2'' = 320$ AU from the central source but is spectrally unresolved ($\Delta v < 30 \text{ km s}^{-1}$). This is the first time strong emission in the fundamental ro-vibrational band from CO has been observed from an embedded young stellar object. The line fluxes were modeled using a 1-dimensional full radiative transfer code, which shows that the emission is fully consistent with a gas in LTE at a single well constrained temperature ($T = 515 \pm 5 \text{ K}$). Furthermore, the ratios between lines from the two detected isotopic species of CO show that the ^{12}CO lines must be optically thick. However, this is inconsistent with the observed spatial extent of the emission, since this implies such low CO column densities that the lines are optically thin. A likely solution to the discrepancy is that the lines are emitted by a smaller more dense region and then scattered in the bipolar cavity present around the central star. This gives a rough estimate of the total molecular gas mass of 1 – 100 M_{\oplus} and a physical extent of $\sim 20 - 100$ AU. We propose that the most likely origin of the line emission is post-shocked gas in a dense dissociative accretion shock from the inner 10 – 50 AU of a circumstellar disk. The presence of a shock capable of dissociating molecules in the disk will have implications for the chemical evolution of disks around young low mass stars.

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The X-ray luminosities of Herbig-Haro objects

A. C. Raga¹, A. Noriega-Crespo², P. F. Velázquez¹

¹Instituto de Ciencias Nucleares, UNAM, 70-543, 04510 México, D. F., México

² SIRTf Science Center, Caltech 220-6, Pasadena, CA, 91125, USA

E-mail contact: alberto@ipac.caltech.edu

The recent detection of X-ray emission from HH 2 and HH 154 with the Chandra and XMM-Newton satellites (respectively) have opened up an interesting, new observational possibility in the field of Herbig-Haro objects. In order to be able to plan further X-ray observations of other HH objects, it is now of interest to be able to estimate their X-ray luminosities in order to choose which objects to observe. This paper describes a simple, analytic model for predicting the X-ray luminosity of a bow shock from the parameters of the flow (i. e., the size of the bow shock, its velocity, and the pre-shock density). The accuracy of the analytic model is analyzed through a comparison with the predictions obtained from axisymmetric, gasdynamic simulations of the leading working surface of an HH jet. We

find that our analytic model reproduces the observed X-ray luminosities of HH 2 and HH 154, and we propose that HH 80/81 is a good candidate for future observations with Chandra.

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The time-dependent ejection velocity histories of HH 34 and HH 111

A. C. Raga¹, P. F. Velázquez¹, J. Cantó², E. Masciadri²

¹Instituto de Ciencias Nucleares, UNAM, Ap. 70-543, 04510 D. F., México

²Instituto de Astronomía, UNAM, Ap. 70-264, 04510 D. F., México

E-mail contact: raga@astroscu.unam.mx

The southern lobe of HH 34 and the western lobe of HH 111 show remarkable similarities. Both objects have a chain of well aligned knots, ending in well defined bow shocks (HH 34S and HH 111V, respectively). In this paper, we derive the past ejection velocity histories from previously published radial velocity measurements of the HH 34 and HH 111 jets. This is done under the assumption that the flows are ballistic. From these reconstructed ejection velocity variabilities, we compute axisymmetric gasdynamic simulations of the two flows, and find that we do obtain large working surfaces at the positions of the HH 34S and HH 111V bow shocks for the time at which these objects are being observed. This appears to be quite definite proof that these bow shocks are indeed the result of an ejection velocity time-variability. Also, there is the observational fact that the HH 34S bow shock is huge, being wider than HH 111V by a factor of ~ 3 . We find that we can reproduce this difference in size by choosing an appropriate value for the density of the ambient medium. Finally, from our small sample of two reconstructed ejection velocity variability histories, we attempt to make some statements about the general nature of these variabilities, and their implications on the possible ejection/collimation mechanisms.

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Spectroscopic Pre-Main Sequence Binaries II. Haro 1-14c and Parenago 2494

Bo Reipurth¹, Harri Lindgren², Michel Mayor³, Jean-Claude Mermilliod⁴, and Noel Cramer³

¹ Institute for Astronomy, University of Hawaii, 2680 Woodlawn Drive, Honolulu, HI 96822, USA

² Lund Observatory, Box 43, S-221 00 Lund, Sweden

³ Observatoire de Genève, CH-1290 Sauverny, Switzerland ⁴ Institut d'Astronomie de l'Université de Lausanne, CH-1290 Chavannes-des-Bois, Switzerland

E-mail contact: reipurth@ifa.hawaii.edu

In the course of a long-term radial velocity survey of about 100 southern pre-main sequence stars, we have discovered two spectroscopic pre-main sequence binaries. One is the weak-lined T Tauri star Haro 1-14c in the Ophiuchus clouds, which has a spectral type of K3 and is a member of the visual Haro 1-14 binary with a separation of 12.9 arcseconds. Haro 1-14c is a single-lined spectroscopic binary with a very long period of 591 days. The other is Parenago 2494, a weak lined T Tauri star with a spectral type of K0 located in the Orion cluster. It is a double-lined spectroscopic binary with a period of 19.5 days. Our photometric monitoring shows that P2494 is a low-amplitude variable with a period of 5.77 days. We have determined accurate orbital elements for both binaries. We further discuss 5 low-amplitude velocity variable stars, which are possibly additional spectroscopic PMS binaries.

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Shock tracers in molecular cloud G1.6-0.025

S.V. Saliu, A.M. Sobolev and N.D. Kalinina

Astronomical Observatory of Ural State University, Lenin street 51, Ekaterinburg 620083, Russia

E-mail contact: Svetlana.Saliu@usu.ru Andrej.Sobolev@usu.ru

The paper describes observations of molecular cloud G1.6-0.025 in series of lines $CH_3OH\ 2_K-1_K$, $CH_3OH\ J_0-J_{-1}\ E$

and single lines CH_3OH $5_{-1} - 4_0$ E, SiO ($2 - 1$), SiO ($3 - 2$), $HNCO$ $7_{-7} - 6_{-6}$. Maps of extended cloud with $V_{lsr} \sim 50$ km/s, high-velocity clump with $V_{lsr} \sim 160$ km/s and newly found clump with $V_{lsr} \sim 0$ km/s are presented. The extended cloud and high velocity clump have inhomogeneous structure. Line widths of all clouds are characteristic of the Galactic Center with the values about 20 — 35 km/s. Emission with velocities in the range -10 — 75 km/s and 40 — 160 km/s is observed toward some directions which are close to the boundaries of the clumps. This implies connection between the clumps and the extended cloud. Emission from the extended cloud in CH_3OH $5_{-1} - 4_0$ line probably contains great contribution from a compact maser sources. NLTE modelling of methanol emission shows that both the extended cloud and the high velocity clump have relatively low density $< 10^4$ cm $^{-3}$; specific column density of methanol in the extended cloud is $\geq 6 \times 10^8$ cm $^{-2}$ and in the high velocity clump is $4 \times 10^8 - 6 \times 10^9$ cm $^{-2}$; kinetic temperatures of the extended cloud and the high velocity clump are estimated as < 80 K and 150 — 200 K, correspondingly. Possible mechanisms of connection between the extended cloud and the clumps with $V_{lsr} \sim 0$ km/s and ~ 160 km/s are briefly discussed.

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The young intermediate-mass stellar object AFGL 490 – A disk surrounded by a cold envelope

K. Schreyer¹, Th. Henning², F.F.S. van der Tak³, A.M.S. Boonman⁴, E.F. van Dishoeck⁴

¹ Astrophysical Institute and University Observatory (AIU), Friedrich Schiller University Jena, Schillergäßchen 2–3, D-07745 Jena, Germany

² Max-Planck-Institut für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany

³ Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121 Bonn, Germany

⁴ Leiden Observatory, P.O. Box 9513, 2300 RA Leiden, The Netherlands

E-mail contact: martin@astro.uni-jena.de

AFGL 490 is a key target of the class of deeply embedded intermediate-mass young stellar objects in a transition stage to Herbig Be stars ($L = 2.2-4.0 10^3 L_{\odot}$). In this paper, we present a comprehensive set of single-dish line data which characterize the envelope of the source. In addition, observations of CS $J = 2 \rightarrow 1$ and the corresponding continuum at 97.98 GHz have been obtained with the Plateau de Bure (PdB) interferometer, which are sensitive to the small-scale structure around the stellar source.

The PdB line data show a bar-like elongated gas structure of 22 000 AU \times 6 000 AU size with a position angle of $\approx -45^\circ$. This bar represents the flattened inner envelope surrounding a disk-like structure (radius ≤ 500 AU) for which we find evidence very close to the young B star.

Due to strong (self-)absorption in the velocity range $v_{lsr} = -12.5 \dots -15$ km s $^{-1}$, only the outer line wings can be used to study the gas motion. Maps of the integrated red and blue line wing emission show two well-separated gas blobs around AFGL 490, which are interpreted as a disk. The 3 mm continuum interferometer map shows a point source at the position of AFGL 490 with a flux of 240 mJy. This flux translates into a total mass of 3–6 M_{\odot} of the disk which is comparable to the stellar mass of about 8 M_{\odot} . This configuration is unstable and will disappear in 10^3-10^4 years due to gravitational instabilities.

Photometric data from ISOPHOT and spectroscopic data from ISO-SWS have been obtained. Together with submillimetre continuum data a very complete spectral energy distribution of the envelope could be compiled.

Analysis of the data shows that the central region of AFGL 490 has a steeper density gradient compared with the outer molecular envelope. All data clearly point to a low temperature (25–35 K) of this envelope.

To determine the chemical state of the object, we determined the abundances of 13 molecules towards AFGL 490. The molecular line and ISO-SWS data are used to derive the gas-solid abundance ratios for H $_2$ O, CO, and CO $_2$. The chemical results, such as the relatively low gas-to-solid ratios and the low CH $_3$ OH excitation, emphasize the presence of a cold molecular envelope.

We found evidence for other outflow systems in the envelope around AFGL 490. Red-shifted and blue-shifted gas blobs with a separation of about 20 000 AU were detected. Their centre is located roughly 3'' to the south of AFGL 490, and their morphology implies that a deeply embedded low-mass object drives a jet which enters the denser envelope material at such a large distance. Two further outflow systems in the close neighbourhood of AFGL 490 could be identified. All these data point to the formation of a group of low-mass stars around AFGL 490. It is very remarkable

that these outflows do not influence the global physical and chemical structure of the envelope.

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<http://www.astro.uni-jena.de/Users/martin/publi.html>

Molecular Clouds and Infrared Stellar Clusters in the Far-Outer Galaxy

Ronald L. Snell¹, John M. Carpenter² and Mark H. Heyer¹

¹ Department of Astronomy, LGRT 619, University of Massachusetts, Amherst, MA 01003, USA

² Department of Astronomy, California Institute of Technology, MS 105-24, Pasadena, CA 91125, USA

E-mail contact: snell@astro.umass.edu

We present a study of the molecular cloud content and star formation activity in the far-outer Galaxy at galactocentric radii greater than 13.5 kpc. The properties of star forming regions associated with far-outer Galaxy clouds are examined within a 60 deg² area toward the second galactic quadrant based on the FCRAO CO Survey of the Outer Galaxy, the *IRAS* Point Source Catalog, and follow-up ¹³CO(J=1-0) and *K'*-band near-infrared imaging. This region contains 63 far-outer Galaxy molecular clouds; the most massive clouds have molecular masses of $\sim 10^4 M_{\odot}$. The *K'*-band imaging of 10 *IRAS* point sources associated with the far-outer Galaxy clouds resulted in the detection of 11 stellar clusters with galactocentric distances between 13.5 and 17.3 kpc. Several of these clusters are comparable to the well-studied clusters found within 1 kpc of the sun in terms of the number of stars. We have also examined a much larger sample of far-outer Galaxy molecular clouds using the entire FCRAO CO survey. The mass spectrum of 246 far-outer Galaxy clouds found within a 300 deg² area has a power-law slope of -1.88, similar to, although slightly steeper than that found for molecular clouds inside the solar circle. Global measures of the star formation activity, as traced by the ratio of far-infrared luminosity to molecular cloud mass, indicate that these far-outer Galaxy clouds are equally active sites of massive star formation as molecular clouds associated with the W3/W4/W5 region and clouds found in the inner Galaxy. Therefore, despite the different environment expected in the far-outer Galaxy, the cloud mass spectrum and star formation activity per unit mass are similar to that found throughout the Galaxy. Finally, based on 2MASS data, we identify 31 additional candidate far-outer Galaxy star forming regions within the larger survey area.

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Orbital migration and the frequency of giant planet formation

David E. Trilling¹, Jonathan I. Lunine² and Willy Benz³

¹ Department of Physics and Astronomy, University of Pennsylvania, 209 S. 33rd St., Philadelphia, PA 19104, USA

² Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721, USA

³ Physikalisches Institut, Universitaet Bern, Sidlerstrasse 5, CH-3012 Bern, Switzerland

E-mail contact: trilling@hep.upenn.edu

We present a statistical study of the post-formation migration of giant planets in a range of initial disk conditions. For given initial conditions we model the evolution of giant planet orbits under the influence of disk, stellar, and mass loss torques. We determine the mass and semi-major axis distribution of surviving planets after disk dissipation, for various disk masses, lifetimes, viscosities, and initial planet masses. The majority of planets migrate too fast and are destroyed via mass transfer onto the central star. Most surviving planets have relatively large orbital semi-major axes of several AU or larger. We conclude that the extrasolar planets observed to date, particularly those with small semi-major axes, represent only a small fraction ($\sim 25\%$ to 33%) of a larger cohort of giant planets around solar-type stars, and many undetected giant planets must exist at large ($>1\text{-}2$ AU) distances from their parent stars. As sensitivity and completion of the observed sample increases with time, this distant majority population of giant planets should be revealed. We find that the current distribution of extrasolar giant planet masses implies that high mass (more than 1-2 Jupiter masses) giant planet formation must be relatively rare. Finally, our simulations imply that the efficiency of giant planet formation must be high: at least 10% and perhaps as many as 80% of solar-type stars possess giant planets during their pre-main sequence phase. These predictions, including those for pre-main sequence stars, are testable with the next generation of ground- and space-based planet detection techniques.

Accepted by A&A

ISO-LWS observations of C⁺ and O⁰ lines in absorption toward Sgr B2

Charlotte Vastel¹, Edward Polehampton², Jean-Paul Baluteau³, Bruce Swinyard², Emmanuel Caux⁴ and Pierre Cox⁵

¹ Downs Laboratory of Physics, 320-47, California Institute of Technology, Pasadena, CA 91125, USA

² RAL, Chilton, Didcot, Oxon, UK

³ LAS, CNRS & Université de Provence, BP 8, F-13004 Marseille, France

⁴ CESR CNRS-UPS, BP 4346, F-31028 - Toulouse Cedex 04, France

⁵ IAS, Université de Paris-Sud, F-91405 Orsay Cedex, France

E-mail contact: vastel@submm.caltech.edu

High spectral resolution Fabry-Pérot observations of the [OI] 63.2 and 145.5 μm and [CII] 157.7 μm fine structure lines are presented for the center of the Sagittarius B2 complex (Sgr B2). The data were obtained with the Long Wavelength Spectrometer on board the Infrared Space Observatory (ISO). Both the [OI] 63.2 μm and the [CII] 157.7 μm lines are detected in absorption. The upper state level of atomic oxygen at 145.5 μm is in emission. Whereas the [OI] 63.2 μm line is seen in absorption over the entire wavelength range -200 to 100 km s^{-1} , the [CII] 157.7 μm line displays a more complex profile: absorption occurs at velocities $< 20 \text{ km s}^{-1}$ and emission comes from the Sgr B2 complex at velocities greater than 20 km s^{-1} . Using observations of the CO isotopes and of the HI lines, absorption components can be associated with many clouds along the Sagittarius B2 line of sight. From these data, we were able to disentangle three different layers which contain atomic oxygen. These layers, as predicted by PDR models, are characterized by different forms of carbon in the gas phase, i.e. the C⁺ external layer, the C⁺ to C⁰ transition and the CO internal layer. We derive lower limits for the column densities of atomic carbon and oxygen of the order of $\sim 10^{18} \text{ cm}^{-2}$ and $3 \times 10^{19} \text{ cm}^{-2}$, respectively. An O⁰/CO ratio of around 2.5 is computed in the internal cores of the clouds lying along the line of sight, which means that $\sim 70\%$ of gaseous oxygen is in the atomic form and not locked into CO. The fact that the [CII] 157.7 μm line is detected in absorption implies that the main cooling line of the interstellar medium can be optically thick especially in the direction of large star-forming complexes or in the nuclei of galaxies. This could partially account for the deficiency in the [CII] 157.7 μm line which has been recently found toward infrared bright galaxies in ISO data.

Accepted by Astrophysical Journal

Supernova Remnant OH Masers: Signposts of Cosmic Collision

Mark Wardle¹ and F. Yusef-Zadeh²

¹ Research Centre for Theoretical Astrophysics, School of Physics A28, University of Sydney, NSW 2006, Australia

² Department of Physics and Astronomy, Northwestern University, Evanston, IL 60208, USA

E-mail contact: wardle@physics.usyd.edu.au

A supernova explosion, the final death throes of a massive star, creates an expanding bubble of hot gas that overruns up the surrounding medium. When a supernova remnant encounters a dense interstellar cloud, the compression may trigger gravitational collapse and the formation of a new generation of stars. This event can be detected through intense stimulated emission in the 1720-megahertz transition of the hydroxyl radical, OH, which yields unique insights into the physical processes and conditions occurring during the interaction.

Accepted by Science)

<http://www.physics.northwestern.edu/research/zadeh/papers.html>

MC3D - 3D Continuum Radiative Transfer, Version 2

Sebastian Wolf

California Institute of Technology, 1200 E California Blvd, Mail Code 220-6, Pasadena CA 91125, USA

E-mail contact: swolf@ipac.caltech.edu

A revised and greatly improved version of the 3D continuum radiative transfer code MC3D is presented. It is based on the Monte-Carlo method and solves the radiative transfer problem self-consistently. It is designed for the simulation of dust temperatures in arbitrary geometric configurations and the resulting observables: spectral energy distributions,

wavelength-dependent images, and polarization maps. The main objective is the investigation of “dust-dominated” astrophysical systems such as young stellar objects surrounded by an optically thick circumstellar disk and an optically thin(er) envelope, debris disks around more evolved stars, asymptotic giant branch stars, the dust component of the interstellar medium, and active galactic nuclei.

Accepted by “Computer Physics Communications”

Preprint available at: <http://arxiv.org/abs/astro-ph/0207374>

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, not reviews nor conference notes), *Dissertation Abstracts* (presenting abstracts of new Ph.D dissertations), *Meetings* (announcing meetings broadly of interest to the star formation and interstellar medium community), *New Books* (giving details of books relevant for the same community), *New Jobs* (advertising jobs specifically aimed towards persons within our specialty), and *Short Announcements* (where you can inform or request information from the community).

Latex macros for submitting abstracts and dissertation abstracts are appended to each issue of the newsletter.

The Star Formation Newsletter is available on the World Wide Web at <http://www.ifa.hawaii.edu/reipurth> or at <http://www.eso.org/gen-fac/pubs/starform/>.

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Dissertation Abstracts

Structure Formation in Disk Galaxies via Gravitational Instability

Woong-Tae Kim

Thesis work conducted at: University of Maryland, USA

Current address: Department of Astronomy, University of Maryland,
College Park, MD 20742, USA

Address as of September 1, 2002: Harvard-Smithsonian Center for Astrophysics,
60 Garden Street, Cambridge, MA 02138, USA

Electronic mail: kimwt@astro.umd.edu

Ph.D dissertation directed by: Eve C. Ostriker

Ph.D degree awarded: August 2002

Disk galaxies abound with intermediate-scale structures in a close geometrical association with spiral arms. Various mechanisms have been proposed as candidates for their origin, but a comprehensive theory should encompass nonlinear effects as well as fundamental physical agents such as self-gravity, magnetic fields, galactic differential rotation, and spiral arms, all of which are known to exist in disks galaxies. Allowing for all these physical elements in this thesis, we use three sets of local, magnetohydrodynamic simulations to investigate the susceptibility of galactic gas disks to the formation of self-gravitating condensations. Our objectives are to understand how self-gravitating modes grow in various environments and thus to assess their consequences for galactic structure formation.

The first set of simulations is for razor-thin, featureless disk models. In such disks, swing amplification that arises under outer galaxy rotation curves is subject to threshold behavior as a consequence of nonlinear effects, with systems of $Q < Q_c \sim 1.2 - 1.4$ undergoing gravitational runaway, where the Toomre stability parameter Q is defined by $Q \equiv \kappa c_s / \pi G \Sigma$ in terms of the epicyclic frequency κ , the sound speed c_s , and a total gas surface density Σ . Destabilizing, nonlinear secondary processes include parallel fragmentation of filaments, collisions of sheared patches, and rejuvenated swing amplification. Although our finding for Q_c is similar to the observed star formation threshold values, the long formation time of clouds makes pure swing amplification an unlikely mechanism for the regulation of galactic star formation. On the other hand, regions of weak shear as in inner galaxies are unstable to magneto-Jeans instability (MJI) in which magnetic tension forces resist the stabilizing Coriolis force, possibly explaining starburst activity in central parts of galaxies.

The second set of simulations is for razor-thin disks with stellar spiral potentials. MJI occurring in shearing and expanding flows off spiral arms develops spur structures in the direction perpendicular to the arms. Spurs are regularly distributed along the arms at an interval about two or three times the local Jeans length at the spiral density peak. In highly nonlinear stages, spurs fragment into dense clumps with masses corresponding to the local Jeans mass at the density peak, possibly evolving into bright arm and interarm H II regions.

The final set of simulations is for three-dimensional, featureless disks. We show that the Parker instability, even combined with self-gravity and galactic shear, is not the main formation mechanism for intermediate-scale structures. By producing in the saturated state mild velocity fluctuations at only 10% of sound speed, the Parker instability is insufficient to generate the observed level of interstellar turbulence as well.

Putting together all the results of our numerical study, we conclude that MJI is at least partly responsible for the formation of intermediate-scale structures in disk galaxies.

New Jobs

Postdoctoral Position

The Centre for Astrophysics of the University of Porto (CAUP) accepts applications for a postdoctoral position for 1 year, starting in September 2002. Depending upon future financing, this period can be extended up to 3 years. This post-doctoral position is opened under the Project entitled "Stellar Astrophysics" that covers the following topics:

- star formation
- activity and variability in Young Stellar Objects
- solar activity
- stellar winds, jets and HH objects
- stellar atmospheres
- internal structure of stars.

CAUP is an upcoming Research Institute with a staff of 19 researchers, several Ph.D. students and two Master Programs (involving more than 40 students). It is located at the University Campus of Campo Alegre, sharing a building with the town Planetarium. CAUP has an extensive set of collaborations with international partners on research and teaching projects. Portugal is a full member of ESO and ESA, which grants to CAUP researchers access to their observing facilities.

Any inquiries about this position may be directed to jlima@astro.up.pt. Applicants should forward to Dr. João Lima, at the address below, the following elements:

- Curriculum Vitae;
- list of publications;
- a brief description of past experience and of research interests;
- proposed working plan;
- the name/address of 3 referees.

The evaluation of the applications will be based on the scientific merit of the candidate and on the proposed working plan. The monthly salary will be 1.495 Euros, net. There will also be a settlement allowance of 1.000 Euros, paid once at the beginning of the grant. Travel allowances for conferences/observing trips are usually accommodated within the budget of the Project.

All complete applications sent between 25th July and 16th August 2002 will be considered.

Applications should be sent to:

Dr. João Lima
Centro de Astrofísica da Universidade do Porto
Rua das Estrelas
P-4150-762 Porto, PORTUGAL
Tel: +351-226 089 830
Fax: +351-226 089 831
email: jlima@astro.up.pt
URL: <http://www.astro.up.pt>

Meetings

FIRST ANNOUNCEMENT

Open Issues in Local Star Formation and Early Stellar Evolution April 05-10, 2003, Ouro Preto, Brazil

Pre-registration: <http://www.astro.iag.usp.br/~ystars/>

Scientific Organising Committee:

Celso Batalha (Brazil), Nuria Calvet (USA), Ramino de la Reza (Brazil), Bruce Elmegreen (USA), Gabriel Franco (Brazil), Jane Gregorio-Hetem (Brazil), Charles Lada (USA), Jacques Lépine (Brazil), Bo Reipurth (USA), Carlos Alberto Torres (Brazil), Hans Zinnecker (Germany).

[Email contact: ystars@astro.iag.usp.br]

Scientific Rationale: This meeting will focus on (i) the physics of young stellar objects, which are being observed with increasing angular resolution provided by the new generation of telescopes, and (ii) the processes that triggered large scale star-formation in the solar neighborhood. However, the scientific presentations will not be limited to these main topics. Many new interesting results related to Star Formation are being obtained around the world, from observations, theory and numerical simulations. Since the field of Star Formation is moving quickly, meetings on related topics are still far from saturation.

The motivation for organizing a Colloquium on Star Formation at Ouro Preto in 2003 is the growing interest of the Brazilian community in this field. This interest was triggered in part by the Pico dos Dias Survey (PDS). The PDS discovered a large number of new T Tauri and Herbig Ae/Be stars together with isolated groups of T Tauri stars. Different groups of researchers devoted efforts to understand the mechanisms of star-formation, and attempted to confront the available models with the observed space motions. Other members of the community have directed their research towards individual objects, studying their spectral energy distribution, the evolution of circumstellar disks, the mechanism of outflows, and performing simulations of Herbig-Haro objects. We expect the first light of the SOAR (4m) telescope in 2003. This telescope, installed close to Gemini-South, which is already operating, is expected to boost the research of young stellar objects in Brazil by delivering high-quality data.

We are expecting a very lively meeting and we hope to encourage discussion of new ideas in the field of Star Formation.