THE STAR FORMATION NEWSLETTER

An electronic publication dedicated to early stellar evolution and molecular clouds

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Meteorites and the formation of stars

The processes which formed the Sun and our planetary system 4.5 billion years ago are obscured by the haze of time. Studies of meteorites have achieved notable successes in unravelling the events of this distant past. Yet, at this moment the very same processes occur in molecular clouds as close as a few hundred light-years. Obviously the study of the early solar system through meteorites and the observations of newborn stars have potentially a great deal in common. For reasons of different scientific techniques, terminologies, journals and conferences, the interface between the two topics has been sadly limited. Efforts to change this situation should be made, particularly since the recent enormous advances in both fields brought by increasingly sophisticated instrumentation have pushed meteorite and star formation studies towards each other, and it is finally realistic to expect that the two disciplines can successfully cross fertilize.

This issue of the Star Formation Newsletter is attempting a small step in this direction by calling your attention to the journal *Meteoritics & Planetary Science* which often carries articles of interest to the star formation community. It has just been renamed from *Meteoritics*, and the new name reflects the new editorial policy of the journal with its much broader interface to the planetary/protoplanetary community. If your library does not already subscribe to this journal, and if you wish it to do so, all necessary information is given in this Newsletter.

Two books on meteorites and planetary formation are presented in the Book Section, and finally we carry information on a forthcoming symposium which straddles the boundary between star formation and the early solar system.

Bo Reipurth

Abstracts of recently accepted papers

Magnetic braking of T Tauri stars

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We construct models for the rotation rates of T Tauri stars whose spin is regulated by magnetic linkage between the star and a surrounding accretion disc. Our models utilise a time-dependent disc code to follow the accretion process and include the effects of pre-main-sequence stellar evolution. We find that the initial disc mass controls the evolution of the star-disc system. For sufficiently massive discs, a stellar field of ~ 1 kG is able to regulate the spin rate to the observed values during the classical T Tauri phase. The field then acts to expel the disc and the star spins up at constant angular momentum as a weak-line system. Lower mass discs are ejected at an early epoch and fail to brake the star significantly. We extend the model to close binary systems, and find that the removal of angular momentum from the disc by the secondary significantly prolongs the inner disc lifetime. Such systems should therefore be relatively slow rotators. We also discuss the implications of our model for the spectral energy distributions and variability of T Tauri stars.

Accepted by MNRAS

Herbig-Haro Jets, CO Flows, and CO Bullets: The Case of HH 111

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We have carried out high spatial resolution (12″) CO J=2-1 observations at the IRAM 30m telescope of the molecular outflow in the HH 111 jet complex. The Herbig-Haro jet is found to coincide with a highly collimated CO flow, with two distinct velocities, possibly providing kinematic evidence that the CO flow surrounds the Herbig-Haro jet. A second well defined bipolar molecular flow, at large angles to the principal flow axis, coincides with the HH 121 infrared flow that emanates from the (presumably binary) VLA driving source; the region thus harbors one of the rare quadrupolar molecular flows. Extremely high-velocity CO is found towards the principal HH working surface at the same velocity as the optically emitting gas, whereas this emission is weak towards the herbig-Haro jet. Since the inclination of the HH jet is known from optical observations to be 10 degrees to the plane of the sky, we conclude that there is CO in the flow with space velocities of up to 500 km/sec! Further out, and precisely along the flow axis, we have discovered three equidistant CO bullets, with space velocities of about 240 km/sec, and which are not detected in the optical. We interpret these bullets as working surfaces, caused by earlier eruptions of the energy source, which are now moving through an ambient medium so tenuous that no observable shock interaction takes place. Finally, we discuss the physical relation between the Herbig-Haro jet and the low velocity molecular outflow. We favor the view that HH jets and CO bullets, which represent different manifestations of the same physical phenomena, are driving the low velocity molecular outflow.

Accepted by Ap.J. Letters

Near-IR imaging and spectroscopy of DR 21: a case for supersonic turbulence

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New, H_2 v=1-0 S(1) narrow-band and K-band images of one of the most massive and most energetic YSO outflows known, DR 21, are presented. We also present H_2 line profiles at positions across both outflow lobes. The complex, turbulent nature of the outflow is clearly evident in both the images and the line profiles. Remarkable asymmetries in the line profiles and oscillations in the line peak velocities are measured, particularly in the southwestern outflow lobe. We model the profiles with both planar and unresolved, bow shaped shocks. Also, from our data, and from a consideration of earlier work, two outflow episodes are inferred: an early jet produces a narrow cone-like flow towards the southwest, and a late core-dispersal phase generates the supersonic turbulence, observed here through wide, oscillating profiles from planar shock waves. These two phases are being increasingly recognised in other outflows from deeply-embedded stars.

A preprint, in PostScript format, can be obtained via the internet from http://atlas.cp.dias.ie/astro/preprints/ or by ftp or traditional post from one of the authors.

Accepted by Astronomy & Astrophysics

The Sagittarius B2 Star-forming Region: III. High Resolution H52α and H66α Observations of Sgr B2 Main

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The Galactic center star-forming region Sagittarius B2 Main (Sgr B2 (M)) has been observed with the Very Large Array in the continuum (7 mm and 1.3 cm) and in the radio recombination lines H 52α, H 66α and He 66α. The H 66α ($\sim$0.25″ resolution) and H 52α ($\sim$2.5″ resolution) data provide high spatial resolution kinematics of the ionized gas associated with the massive stars. Both high spatial resolution and sensitivity to large scale structures are essential to

thoroughly sample the HII regions in Sgr B2 (M) where source sizes of the 36 HII regions range from unresolved (<0.3″) to extended (∼10″). H 66α recombination line emission has been detected toward 23 of the 36 continuum sources in Sgr B2 (M). The mean velocity of the detected sources is 62±2 km s^{-1}. He 66α line emission is detected toward 9 of the 36 continuum sources. The 1.3 cm helium and hydrogen data are used together as a high resolution probe of Y^+ values and variations within Sgr B2 (M). An average singly ionized helium abundance of $< Y^+ >$=10.3±1.2% is derived. Of the sources where a Y^+ value is determined, only Sgr B2 F has an anomalously low value ($Y^+ \leq$5%).

The recombination line data are examined in detail toward several of the most unusual sources. A very broad radio recombination line ($\Delta V_{H66\alpha}$ ∼64 km s^{-1}, $\Delta V_{H52\alpha}$ ∼59 km s^{-1}) is measured and high electron temperatures ($T^*_{e(H66\alpha)}$=26,400 K) are derived for Sgr B2 F. The broad lines and high temperatures may be due to a non-equilibrium environment at the edge of an expanding HII region. Assuming that the F and G HII regions have expanded in a dense molecular environment, they appear to be young, with an average age of $< \tau >=0.7\pm0.3\times10^4$ yr. This lower limit on the age is consistent with the dynamical age of the nearby massive molecular outflow observed by Lis et al. (1993). A doubly-peaked H 66α line has been detected toward the UCHII region Z10.24. This source may be either a very young (τ <100 yr) shell source or the ionized base of a molecular outflow. The small number of morphological cometary HII regions in Sgr B2 (<5%), and the observed velocity gradients in those regions that do have a cometary morphology indicate that the moving star bow shock model cannot account for any of the HII regions in Sgr B2 (M).

Accepted by The Astrophysical Journal

The masing environment of star forming object IRAS 00338+6312: Disk, outflow, or both ?

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We present results of a multi-epoch 0.″1 angular resolution study of the 22 GHz H_2O maser emission towards the young stellar outflow source IRAS 00338+6312. The overall maser emission consists of about a dozen individual spectral features that form a systematic position-velocity structure indicative of a pattern expected from a protostellar disk. Since it is a priori not clear whether the H_2O maser emission originates in a disk or the associated outflow, we consider both possibilities.

Accepted by Astron. Astrophys.

A copy of the paper is available via the internet http://www.ita.uni-heidelberg.de/publications/index.html

Simultaneous multicolour photometric and polarimetric observations of four T Tauri stars

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We present simultaneous multicolour photometric and polarimetric observations of the T Tauri stars RY Tau, V1121 Oph, DI Cep and BM And. Significant variabilities on time-scales of days in the degree of polarization and/or in the position angle were recorded for DI Cep and BM And. None of the stars reveiled changes in the polarization properties on time-scales shorter than one day. One star, BM And, showed anti-correlations between its brightness level and degree of polarization, consistent with a period of ∼ 4 days. The change of its position angle of ∼ 25° implies the presence of a strongly variable intrinsic polarization relative to a constant interstellar polarization component. We speculate that it is caused by irradiation of a hot spot. The presence of a hot source is also indicated by the photometric measurements. DI Cep increased its brightness by 0.5 magnitudes during four nights while its degree of polarization and the position angle showed only modest variations. V1121 Oph showed a wavelength dependent rotation of its polarization vector with an increase in the position angle of ∼ 43° from the U band to the I band.

Accepted by Astronomy & Astrophysics

Jet Bow Shocks and Clumpy Shells of H_2 Emission in the Young Stellar Outflow Cepheus A

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New narrow-band infrared H_2 and continuum images taken in subarcsecond seeing with the CFHT resolve the shells of molecular hydrogen discovered by Bally and Lane (1991) in Cepheus A into dozens of tiny clumps. The molecular gas lies exterior to HH objects that are visible in [S II] and Hα images of the region. Additional wide field images show that the H_2 emission is distributed primarily to the east and west of the luminous cluster of massive stars that marks the center of Cepheus A. The molecular emission to the east appears as an irregular jet, while that to the west concentrates in shells.
The various mechanisms proposed to heat molecular gas in young stellar outflows predict distinct spatial and kinematic signatures for the optical and H_2 emission that can be compared with observations. In Cepheus A, shocks appear to be responsible for most of the H_2 emission, though fluorescence could excite a diffuse bow-shaped feature that has a bright optical counterpart. We propose that wakes from the bow shocks in the HH objects heat and accelerate the H_2 into the observed shells, while the molecular clumps form as a result of cooling instabilities behind the bow shocks.

The paper is available on the WWW at the address: **http://sparky.rice.edu/~hartigan/pub.html**

Accepted by Astron. J.

Analytical two dimensional solutions for hydrodynamic astrophysical flows

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A new class of steady state, analytical, two-dimensional, non-separated variables solutions for helicoidal hydrodynamic (HD) outflows from rotating stellar objects is derived selfconsistently from the set of the governing (Eulerian) equations of continuity. The fluid is assumed to be compressible, inviscid and non-polytropic. The families of solutions describe either accelerating or decelerating stellar winds with weak collimation (quasi-spherical) which vanishes with the radial distance. We present four cases of solutions with their velocity maxima either at the poles or at the equator of the central body and some of them can be understood as inflows or as stellar shell formations. One of the solution families, showing an accelerating supersonic outflow, is applied to typical parameters of T Tauri stars keeping the observational outflow velocities and mass loss rates. Under this example, the applicability of these solutions is examined. The new solutions are compared with previous analytical 2-D models.

Accepted by Astronomy & Astrophysics

Magnetic Reconnection and Star Formation in Molecular Clouds

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We present a simple numerical model for the internal dynamics of a molecular cloud, based on the premise that a molecular cloud consists of a low β plasma permeated by a spectrum of marginally non-linear Alfven waves. In such circumstances the gas is forced to be mostly in the form of high density condensations or 'clumplets'. The model involves the dynamics of these dense clumplets of gas, threaded by field-lines. We find that in general the random velocities of the clumplets lead to the intersection, and therefore to the reconnection, of field lines. In a 3-D geometry this process appears to lead inevitably to the formation of closed loops of field, which are then able to annihilate. We conclude that we have hereby identified a process which results, throughout the cloud, in the steady generation of dense material which has been freed from the direct influence of the permeating magnetic field. It seems likely that this essentially field-free gas would be able to agglomerate within the cloud, and so initiate star formation.

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The effect of extinction on the K–band luminosity functions of embedded stellar clusters

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The K–band (2.2 μm) is the most efficient band available for the detection of young stars embedded in molecular clouds. Consequently, many efforts to determine the initial mass function (IMF) of embedded stellar populations have focused on constraining the IMF with the K–band luminosity function (KLF). One caveat is that the shape of the KLF can be affected by a large and varying extinction from the surrounding molecular core. We examine here the effects of extinction on the KLF. We find that the resulting KLF is the convolution of the intrinsic KLF and a function describing the fraction of stars per interval of A_K. Applying this result to a power–law KLF, we find that extinction does not affect the shape of a power–law KLF. If the KLF is not a power–law, the extinction can radically its form. We examine three idealized deviation from a power–law: a cutoff, a plateau, and a peak. In all of these cases, the resulting KLF shows little resemblance to the original KLF. This has important implications for recent attempts to date young clusters from the shape of their KLF and for searches for faint low mass stars and brown dwarfs in molecular cores. Finally, we address the problem of estimating the number of stars in a dense molecular core that obscures part of the embedded population. We present a simple method for calculating the fraction of embedded stars which are detected given the KLF and an estimate of the total extinction through the core.

Accepted by A. & A.

Adaptive Optics Imaging of GG Tau: Optical Detection of the Circumbinary Ring

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High angular resolution images of GG Tau have been obtained in the I, J, H, and K bands with the University-of-Hawaii adaptive optics system. The close binary pair is found to be near periastron, and rotates clockwise. It consists of a K7-M0 star with an M4 companion. Masses inferred from dynamical motion are larger than the spectral type suggest. The companion appears to be younger than the main star. Both stars seem to be surrounded with a warm unresolved disk. Images reveal a circumbinary ring also recently detected at millimetric wavelengths. The ring seems to be produced by light scattered by the edge of a cavity inside a much larger disk. At the cavity edge, the disk thickness is estimated to be one tenth of the cavity radius. Light which illuminates this cavity edge appears to be reddened by absorbtion through the inner disks. Azimuthal variations of the illumination indicate that the inner disks must be lumpy.

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Three Dimensional Magnetohydrodynamical Simulations of Vertically Stratified Accretion Disks

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We present three-dimensional magnetohydrodynamical simulations of the nonlinear evolution of the magnetorotational instability (Balbus & Hawley 1991) in an initially isothermal, vertically stratified accretion disk. The simulations are local in the plane of the disk, but are global in the vertical direction in the sense that the computational domain encompasses several scale heights. We find that the instability generates and maintains magnetohydrodynamic turbulence in stratified disks. The properties of the saturated, turbulent state are similar to those reported for nonstratified homogeneous boxes, e.g. the power-law spectral distribution is consistent with Kolmogorov. The angular momentum transport rate is proportional to the magnetic pressure; if the average rate is scaled to the equatorial pressure, as in a

standard "α-disk" model, the constant of proportionality is $\alpha approx.0.01$ for most of our simulations. This value may be limited somewhat by the numerical resolution of our simulations. We find buoyancy does not play an important role as a saturation mechanism. The nonlinear evolution of disks that begin with a variety of initial magnetic field geometries and strengths is similar. In particular, models in which the most unstable wavelengths are initially well resolved saturate at and maintain roughly the same magnetic energy density, suggesting dynamo action in the disk.

We use the simulations to study the effect of the instability on the vertical structure of magnetic accretion disks. After saturation, the disk consists of a weakly magnetized core surrounded by a strongly magnetized corona. Changing the vertical boundary conditions does not significantly alter this structure. The vertical flux of magnetic energy is small compared to the local magnetic energy generation and dissipation rates. The disk is stable to Parker and buoyancy modes. Models evolved with an adiabatic equation of state undergo substantial heating due to nonlinear dissipation, resulting in an increase in the scale height of the disk. The vertical structure produced by the instability, particularly the presence of a strongly magnetized corona, may have relevance to the production of MHD winds from disks.

Accepted by Ap. J.

Circumstellar extinction of pre-main-sequence stars

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The extinction curves arising from the combined effect of absorption and scattering of stellar radiation in dust shells around pre-main-sequence stars have been investigated. Monte Carlo simulations of the polarized radiation transfer in an inhomogeneous spheroidal shell have been used to determine the scattered radiation. The results are presented as the normalized curves for circumstellar extinction $A(\lambda) - A(0.3\,\mu\mathrm{m})$ in the wavelength range from 0.1 μm to 1 μm. The dependence of these curves on the parameters of silicate-graphite dust mixture and the shell shape, orientation and structure is examined.

It is found that the circumstellar extinction of disk-like shells seen pole-on is the most influenced by scattered radiation that leads to the flattening of the extinction curves. Variations of the dust grains and dust shell parameters can produce similar effects on the extinction curves which are difficult to distinguish from each other. Then, the wavelength dependence of polarization can be used to estimate the properties of circumstellar shells.

Our theoretical models are used to interpret the observations of the extinction in the ultraviolet and visual, and the visual polarization of three Herbig Ae/Be stars: AB Aur, HD 259431 and HD 200775. We found that the minimum size of grains is ≥ 0.01 μm. The slope of the grain size spectrum changes in the interval from 3.2 to 5.0. In the shells around AB Aur and HD 200775, there is an excess and a depletion of silicate particles, respectively. The shell aspect ratio varies from 2.0 (AB Aur) to 5.0 (HD 200775). Apparently, the dust shell of AB Aur is seen nearly to pole-on ($i \approx 30^0$), while the other two stars approximately edge-on.

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Searching for Infall: Aperture Synthesis HCO^+(1–0) and SiO(2–1) Observations of the G45.47+0.05 Region

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We report 5″ resolution observations of the HCO^+(1–0) and SiO(2–1) lines toward the G45.47+0.05 ultracompact HII region obtained with the OVRO millimeter array. We find no evidence for the spherical infall suggested by inverse P-Cygni profiles observed in high excitation NH_3 lines at 40″ resolution. Instead, we find multiple velocity components in HCO^+ and SiO emission that suggest the presence of a proto-cluster of OB stars. We speculate that emission and absorption from separate sites of activity in the region conspire to mimic the inverse P-Cygni infall signature. However,

the observations do not entirely rule out a collapse localized to the ultracompact HII region since absorption in the HCO^+(1–0) line from low excitation foreground gas may mask emission at velocities associated with infalling material. A new VLA 8.4 GHz D array observation shows that the nearby "cometary" ultracompact HII region G45.45+0.06 lies within the northwest wall of an ionized shell with $\sim 30''$ diameter. Unfortunately, this bright source within the VLA field of view precluded a search for faint centimeter continuum sources associated with the molecular line peaks.

Accepted by The Astrophysical Journal for the May 10, 1996 issue

Announcements

FIRST Model Payload Presentation

Venue: Newton 2, ESTEC, Noordwijk Date: 1 February 1996, at 09.15 hours

The Far Infrared and Submillimetre Space Telescope *(FIRST)* is the fourth cornerstone mission in the "Horizon 2000" ESA science programme. At the present time industrial system definition studies of two different spacecraft options are underway. Both feature a passively cooled 3 m diameter Cassegrain telescope and the same cryogenically cooled science payload. A model payload to be accomodated by both spacecraft has been provisionally defined; it consists of three instruments:

• A heterodyne instrument, the "HET", for very high resolution spectroscopy in approximately the $500 - 1200$ GHz $(250 - 600\ \mu)$ range.

• An imaging photoconductor instrument, the "PHOC", for spectroscopy and photometry in the $85 - 200\ \mu$ range.

• An imaging bolometer instrument, the "BOL", for spectroscopy in the $200 - 400$ and photometry in the $200 - 900$ μ ranges.

On 1 February 1996, beginning at 09.15 hours, there will be a presentation (scheduled to last until lunchtime) of the model payload as follows:

J. Steinz/G. Pilbratt: Overview and schedule of the *FIRST* project
R. Genzel/G. Pilbratt: Science drivers and spacecraft constraints
N. Whyborn: A description of the design and capabilities of the HET
A. Poglitsch: A description of the design and capabilities of the PHOC
M. Griffin: A description of the design and capabilities of the BOL

In the afternoon there will be ample opportunity to interact with, and provide feedback to, the members of the team behind the model payload. The meeting will last until the end of the afternoon.

All interested are welcome to attend this presentation

The number of people who have been directly involved in the model payload definition up to now is relatively small. The Announcement of Opportunity (AO) for the science instruments for *FIRST* is presently scheduled to be issued in 1997. For any institute with an interest to become a member of a future *FIRST* instrument consortium this meeting will provide a good opportunity to interact actively with the people presently involved in the Payload Working Group. Feedback from any potential *FIRST* user regarding desired scientific capabilites of the the instruments is strongly encouraged.

There will be no registration fee or any other cost associated with attending. However, regrettably ESA cannot provide support for personal costs (e.g. for travel) in connection with attending this presentation.

Please take note that for practical reasons it is important that you announce your intention to attend to Göran Pilbratt, *FIRST* project scientist, preferably by email (gpilbratt@astro.estec.esa.nl), or by phone/fax (+31 71 565 3621/4690), who can also provide you with a copy of the Payload Definition Document and answer your questions. For up-to-date information consult the WWW under URL `http://astro.estec.esa.nl/SA-general/Projects/First/first.html`. Welcome !

Dissertation Abstracts

On The Global Stability of Magnetized Accretion Disks

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Ph.D dissertation directed by: Ralph E. Pudritz and Peter G. Sutherland

Ph.D degree awarded: 11/95

We investigate the global stability of a differentially rotating fluid shell threaded by magnetic fields to linear perturbations. This system models an accretion disk far from its vertical boundaries. To focus on the direct interaction between the magnetic field and differential rotation, the stability analysis employs an equilibrium model of homogeneous and incompressible fluid which allows these phenomena to be studied in isolation. Depending on the degree of internal pressure support, disks may be either "thick" or "thin" and both possibilities are considered here. The magnetic field exterior to the fluid has an effect on the radial boundary motion, and we derive the appropriate boundary conditions.

The first interaction of interest is the axisymmetric instability of Velikhov and Chandrasekhar. It has both local and global manifestations, the latter of which can be stabilized for all perturbations if and only if the equilibrium magnetic field strength is above a certain threshold value, which we calculate in our model for a wide range of equilibrium parameters. The growth rates of the unstable modes are always less than, but comparable to, the corresponding local growth rates. The former are also considerably higher for free boundaries than for the rigid configurations considered by other authors. The connection between the global and local characters of the instability is fully elucidated.

These results are generalized from a purely vertical field to the case when an azimuthal magnetic field is present. In most cases, the azimuthal field tends to stabilize the VC instability, although strong fields (Alfvén speed of order the characteristic rotational speed) are required for complete stabilization. We find an additional strong field instability that arises when the azimuthal Alfvén speed exceeds the characteristic rotational speed. For freely-bounded configurations, this instability resembles the sausage instability for interpenetrating fields in plasma physics.

Other interesting interactions appear in the presence of nonaxisymmetric perturbations. The global, dynamical instability of Papaloizou and Pringle, previously known to exist only in non-magnetized models of thick disks, is shown to have a magnetic counterpart. Indeed, this instability grows much more rapidly than in the corresponding hydrodynamic case. There also exist two additional types of unstable modes not present in hydrodynamic disks. The basic instability mechanism for these modes appears to be wave over-reflection between the boundaries and one or more of the singular Alfvén radii that can lie within the shell. These Alfvén resonances have a similar role to the corotation resonance in the purely hydrodynamic disk. We find, as in the axisymmetric case, that highly localized modes are fastest growing; however, they do not exceed the axisymmetric growth rates for any of the system parameters examined.

Although all of the instabilities we found grow on the dynamical timescale, they may not be catastrophic to accretion disks. Indeed, the highly localized nature of the fastest growing modes suggests that these modes do not lead to large-scale breakup, but rather serve to "stir up" the fluid locally. Thus our results support the oft-mentioned conjecture that these magnetic instabilities could lead to turbulence. The globally unstable modes we found have quite different implications, among them the possibility that large-scale magnetic field generation (which we demonstrate in the linear growth regime) could obviate the need for the α-effect in standard dynamo theory.

Journals and Books

Meteoritics and Planetary Science

(formerly Meteoritics)

Published since 1953, this is the journal of the Meteoritical Society, currently appearing with six issues per year. The journal covers a broad range of subjects like meteorites, cosmochemistry, the early solar nebula, interstellar dust, planetesimals, asteroids, and planetary science.

E-mail address for the journal: meteor@comp.uark.edu

Postal address for the journal:

Meteoritics and Planetary Science
Department of Chemistry and Biochemistry
University of Arkansas
Fayetteville, AR 72701
USA

1996 subscription rates for institutions (i.e. multi-reader facilities) are:

US/Canada/Mexico	US$230
Others	US$245, including air-mail.

A 30% discount is available on back issue orders accompanied with new subscriptions.

Individuals receive the journal as a benefit of membership of the Meteoritical Society. They may join by contacting the Treasurer:

Dr. J. I. Goldstein
College of Engineering
125 Marston Hall
University of Massachusetts
Amherst, Massachusetts 01003
USA

Membership dues for 1996 are:

Members	US$60
Student members	US$35

Payment must be by a check drawn on a US bank.

Meteorites: Messengers from Space

by F. Heide and F.Wlotzka

This is a new updated edition of one of the most famous popular books on all aspects of the study of meteorites. The first german edition, "Kleine Meteoritenkunde" was written by Professor Fritz Heide and appeared in 1934. After three german editions, and one english translation which was completely sold out after just a few years, Frank Wlotzka from the Max-Planck-Institute für Chemie in Mainz has undertaken to bring the content of this little book up to date. The result is an excellent introduction to the science of meteoritics.

The book consists of 3 chapters and an Appendix with the following contents:

1 Fall Phenomena

Light Phenomena - Sound Phenomena - The Main Meteorite Groups - Effects on Landing - Meteorite Showers - Hypervelocity Impacts - Number and Distribution of Meteorite Falls - The History of Meteoritics - Observations of Importance for a Meteorite Fall - How can a Meteorite be Recognized?

2 The Meteorites

Cosmic Dust - The Size of Meteorites - The Shape of Meteorites - Surface Characteristics - Mineralogy and Classification of Meteorites - The Chemical Significance of Meteorites - The Cosmic Abundance of the Elements - Isotope Anomalies - Organic Compounds

3 The Origin and Formation of Meteorites

Meteorite Ages - The Origin of Meteorites - The Formation of Chondrites - Planetesimals and the Formation of Achondrites - Regolith, Primordial Rare Gases, and the Solar Wind - The Planets - Conclusions

4 Appendix

Meteorite Collections and Research - Exchange Value of Meteorites - Etching of Iron Meteorites - Detection of Nickel - Meteorite Falls from 1985 through 1993 - Literature - Composition of Meteorites and the Earth's Crust

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Solar System Evolution

by Stuart Ross Taylor

This is a book that describes our current understanding of the origin and evolution of the solar system, biased towards a cosmochemical and geochemical point of view. The book is not attempting to present a travel guide to the solar system, but rather each chapter appears as a semi-technical review, with extensive notes and references to the literature.

The book consists of 7 chapters with the following contents:

1 Planetary Formation: A Historical Perspective

The Nature of the Problem - Pre-Copernican Views and the Copernican Revolution - Tidal Theories - Solar Accretion Theories - Nebular Theories - Titius-Bode Rule - Giant Gaseous Protoplanets - Differences between Inner and Outer Planets - Formation of Giant Planets - Accretion from Dust or from a Hierarchy of Objects - Planetesimals - Fractionation in Precursor Planetesimals - An Accretionary Sequence

2 The Solar Nebula

The Initial Concept - The Origin of the Universe - Big Bang Scenarios and Element Synthesis - The Scale and Structure of the Universe - Galxies - Molecular Clouds and Interstellar Dust - Separation of Nebulae - Dust Disks around Stars - Nebular Collapse, Nebular Lifetime, and Angular Momentum Transfer - Star Formation and Evolution - Early Violent Stellar Activity: T Tauri Stars and FU Orionis Stars - The Formation and Composition of the Sun - Massive vs. Small Nebulae - Nebular Structure and Temperature - Nebular Composition: CI Chondrites and Comets as Samples - The Noble Gases - Volatile Elements (C, H, O, N) and Nebular Chemistry - Homogeneity or Heterogeneity? - Heliocentric and Vertical Zoning - Asteroid Belt Zonation - Gas Loss from the Inner Nebula - Volatile Element Depletion in the Early Nebula

3 The Meteorite Evidence

The Most Ancient Samples - Presolar Material - Refractory or Calcium-Aluminum Inclusions (CAIs) - Matrix - Chondrules - Chondrites and Other Primitive Meteorites - Chronology - Composition of the Nebula - "Condensation Sequence" - Comets - Asteroidal and Cometary Dust - Fractionated Meteorites and Parent Bodies - The Asteroid Belt as a Source - Meteorites as Planetary Building Blocks

4 The Role of Impacts

A Reluctant Conversion - Surface Histories of the Planets and Satellites - Effects of Cratering - Impacts and Planetary Obliquities - Formation of Planetary Nebular Disks - Addition and Removal of Planetary Atmospheres - Lunar Cratering and Origin - Mercury - The Early Intense Bombardment - Large Impact Basins - Lunar Cataclysms? - Early Cratering Flux on the Terrestrial Planets - Early Cratering Flux in the Outer Solar System - The Impactor Population in the Early Solar System - Cratering Flux since the Heavy Bombardment - Effects on Biological Evolution - Large Collisions and Planetary Accretion: A Summary

5 The Planets

A Difficult Task - Giant and Terrestrial Planets - Mercury - Venus - Earth - Mars - Compositional Differences among the Terrestrial Planets and Meteorites - Core-Mantle Relationships - Crustal Development on the Terrestrial Planets - Terrestrial Planetary Atmospheres and Hydrospheres - The Asteroid Belt - The Giant Planets - Planet X - The Long-term Stability of the Solar System

6 Rings and Satellites

Miniature Solar Systems? - Planetary Subnebulae - Ring Systems - Satelitte Classification - Regular Satellites - Captured Satellites: Phobos and Deimos - Galilean Satellites I: Io and Volcanism - Galilean Satellites II: Ganymede and Planetary Expansion - Galilean Satellites III: Europa and Callisto - Saturnian Satellites - Titan - Uranian Satellites - Triton, Nereid, and the Other Neptunian Satellites - Pluto and Charon - The Moon - Evolution of the Moon - Hypotheses of Lunar Origin - Large Impact Model for the Origin of the Moon

7 The New Solar System

The End of Clockwork Solar Systems - The Collapse of Grand Unified Theories - Our Present Understanding

Cambridge University Press

1992, reprinted 1994. 307 pp. ISBN 0-521-37212-7
Hardback price £ 37.50

Payment by check or major credit cards

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The Star Formation Newsletter is a vehicle for fast distribution of information of interest for astronomers working on star formation and molecular clouds. You can submit material for the following sections: *Abstracts of recently accepted papers* (only for papers sent to refereed journals, 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 fromt he 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. You can either access it via the ESO Portal (http://http.hq.eso.org/eso-homepage.html) or directly in two ways: by issue number (http://http.hq.eso.org/star-form-newsl/star-form-list.html) or via a wais index (wais://http.hq.eso.org:2010/starform). You can also access it through the University of Massachusetts Astronomy World Wide Web server, the URL for its home page is http://www-astro.phast.umass.edu/

Meetings

From Stardust to Planetesimals

to be held

June 24-26,1996

in

Santa Clara, California, USA

Presented by the Astronomical Society of the Pacific and NASA Ames Research Center

Over the last decade, our understanding of the formation and early evolution of the solar system has advanced considerably due to progress that has been made simultaneously on many fronts. Stardust has been isolated in meteorites and interplanetary dust particles (IDPs), providing us with sample materials which predate the solar system and which offer clues to the processing that has occurred. At the same time, infrared studies have led to a better characterization of the composition of interstellar dust, which is now readily accepted as an important component of the interstellar medium. Infrared observations have also provided a much better view of the star formation process and the role of dust therein.

Recently, the presence of Kuiper belt planetesimals has been confirmed and spectroscopy of these rather pristine objects may soon become available. Analysis of data from the Comet Halley flybys has yielded a wealth of information on the composition of this comet. Both of these observational advances have changed our understanding of planetesimal processing. The launch of the Infrared Satellite Observatory, the opening of 10 meter class telescopes, and, in the longer term, the Rosetta mission promise to continue to broaden and deepen our understanding of the evolution from stardust to planetesimals. It is therefore timely to organize a meeting focussed on the processes that connect stardust and planetesimals. This is a highly interdisciplinary subject and progress requires exchange of information and ideas between the many subfields involved. The goal of this meeting is, therefore, to bring together astronomers interested in star and planet formation, planetary scientists studying early solar system relics, laboratory scientists studying the processing of analogs, and scientists analyzing meteorites and IDPs, grain by grain.

The symposium will consist of invited reviews and poster papers. The second circular will include a call for poster papers to be presented at this meeting.

For further information write to Yvonne Pendleton, M/S 245-3, NASA Ames Research Center, Moffett Field, CA 94035-1000, USA or send e-mail to stardust@galileo.arc.nasa.gov. For online registration and more information see http::/wwwspace.arc.nasa.gov/ stardust

SCIENTIFIC ORGANIZING COMMITTEE:

Yvonne Pendleton (Chair), Peter Bodenheimer, Alan Boss, Don Brownlee, John Kerridge, Mike Mumma, Jane Luu, Tobias Owen, Ted Snow, Xander Tielens.

Topics:

Formation of Planetary Systems
The Role of Dust in Star and Planet Formation
Interstellar Dust and Large Molecules
Processing of Interstellar Dust and Cometary Bodies
Laboratory Studies of Interstellar, Nebular and Planetesimal Processes
IDPs in the Solar Nebula
Stardust, IDPs and Meteorites
Evolution and Origin of Primitive Planetesimals
Primitive Planetesimals in our Solar System

The 59th Annual Meteoritical Society Meeting

to be held

July 22-26, 1996

in

Berlin, Germany

The scientific sessions will be held in the central building of Humboldt University, located on the famous avenue "Unter den Linden", which starts at the Brandenburger Tor and ends near the university. Sessions wil be held monday morning through friday noon, except for wednesday afternoon. General sessions will deal with new results from meteorite, lunar, and planetary research. In addition, special symposia will be held on timely subjects such as organic matter in meteorites, early stages of accretion, and impact and mass extinction on Earth.

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Infrared Space Interferometry Workshop

Astrophysics & The Study of Earth-like Planets

to be held

11-14 March 1996 in **Toledo, Spain**

The purpose of the meeting is to bring together scientists and engineers to discuss designs for infrared interferometers in space. The primary scientific justification for IR interferometry in space is the detection and study of Earth-like planets via medium-resolution spectroscopy of molecular bands around 10 microns. In addition, a mid-IR spatial interferometer will make fundamental contributions to the understanding of the birth of stars, galaxy formation and early evolution, etc.

Topics include:

- Detection of Earth-like Planets and the Search for Life
- Exo-planetary Atmospheres
- Impact on Galactic and Extragalactic Astrophysics (i.e. dusty disks around MS stars, young stellar objects, AGNs, birth & evolution of galaxies)
- Interferometric Techniques: Technological Challenges
- Ground-based and Space Precursors: VLTI, ISO, VSOP, etc.

The Scientific Advisory Committee is formed by:

R. Angel, S. Beckwith, T. de Graauw, C. Eiroa, T. Encrenaz, T. Fukushima, A. Leger, J. M. Marcaide, J. M. Mariotti, A. Penny, R. Rodrigo, C. J. Schalinski, M. Shao, H. Thronson (chair), S. Volonte.

The Workshop is hosted by Universidad Autonoma de Madrid, Laboratorio de Astrofisica Espacial y Fisica Fundamental, and Instituto de Astrofisica de Andalucia.

The Local Organizinig Committee is formed by A. Antxon, C. Eiroa (chair), M Guitart (secretary), B. Montesinos, H. Thronson.

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Cantoblanco, 28049 Madrid
Spain

Deadline for registration is January 20, 1996

All information about the Workshop is also available by anonymous ftp to laeff.esa.es in the pub/irinter directory

It explains the meteorite record by forming planets in two distinct steps. The inner terrestrial protoplanets accreted early and were internally heated by strong radioactive decay; this dried them out and split the inner, dry from the outer, wet planetary population. This has several implications for the distribution and necessary formation conditions of planets like Earth in extrasolar planetary systems.Â â€œThe early-formed and dry inner Solar System and the later-formed and wet outer Solar System were therefore set on two different evolutionary paths very early on in their history. This opens new avenues to understand the origins of the earliest atmospheres of Earth-like planets and the place of the Solar System within the context of the exoplanetary census across the galaxy.â€ "Some people think that the star formation rate of the galaxy is constant," says Heck. "But thanks to these grains, we now have direct evidence for a period of enhanced star formation in our galaxy seven billion years ago with samples from meteorites. This is one of the key findings of our study." Heck notes that this isn't the only unexpected thing his team found. Meteoritic evidence shows that the Solar system at birth contained significant quantities of short-lived radioisotopes (SLRs) such as 60Fe and 26Al produced in supernova explosions and in the Wolf-Rayet winds. Explaining how they travelled from these origin sites to the primitive Solar system before decaying is an outstanding problem.Â We find that SLRs are abundant in newborn stars because star formation is correlated on Galactic scales, so that ejecta preferentially enrich atomic gas that will subsequently be accreted onto existing GMCs or will form new ones. Thus new generations of stars preferentially form in patches of the Galaxy contaminated by previous generations of stellar feedback. Export citation Request permission. Copyright. Most meteorites are far older than the oldest rocks on Earth -- up to almost 4.6 billion years old, compared to less than 4 billion years for the oldest Earth rocks. Rain, wind, and the motions of Earth's crust have altered the rocks on our planet. But the parent asteroids of most meteorites have remained relatively unchanged since their formation, so they preserve bits of the earliest history of the solar system. Studying these objects helps scientists understand the formation of Earth and the other planets. Meteor Meanings. Meteoroid A small bit of rock or metal orbiting the Sun. Meteor A bit of debris that forms a bright streak of light as it vaporizes upon entering Earthâ€™s upper atmosphere.