Hipparchos

The Hellenic Astronomical Society Newsletter

Hellenic Astronomical Society

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Message from the President

Almost exactly 9 years ago, on May 25, 1994, the Hellenic Astronomical Society (Hel.A.S.) was recognised by the Court of Justice in Athens. Sixty-six founding members had signed the Constitution of the Society. The first appointed Council, chaired by Professor B. Barbanis, initiated the procedure for the first elections, which took place on June 2, 1994.

The 1st Hellenic Astronomical Conference, organised and chaired by Professor P. Laskarides, at the Eugenides Planetarium of Athens, had served as a milestone for the first, uncertain steps of our Society toward maturity. Professor Laskarides had served in the first Council of Hel.A.S. and much to my delight, I note that he is a candidate for taking the rein of the Society soon. –Paul, I wish you an everlasting strength, health and good luck. I know that you have the administrative skills and power to look after our society and bring it well beyond its present status.

We live in a world, which certainly grows richer on average. People on the whole live longer and are better educated. However, new inequalities and instabilities are growing at the same time. The faster the pace, the stronger the instabilities, a scheme that is well known to Plasma Physicists! In such a world, astronomers seem to float above the streams of turbulence that prevail on the world we live in. Looking above, gazing at the heavens, seem to forget the sadness, the poverty and the wrath, which keep growing among the rafts and rowboats fighting to keep up with the rising tide of wealth that is better exploited by the owners of luxurious yachts and ocean liners. Astronomers should urge the world to look through their telescopes and admire the harmony of the dynamics of the heavens and the static chaos of the stars. This could refresh the vision of those that shape the future of our earth and eventually create a new smooth flow in the evolution of our society. The Hellenic Astronomical Society could play a vital role in establishing a tighter link between those that drive ferryboats and those that float in rowing boats.

Looking back towards those eight years that I was involved with our Society, I would like to thank you all for the nice times that we had together, the many letters and messages that you sent me, the help that many of you offered and the warm words that left your hearts and softened the hardships that I encountered, while growing eight years older.

The President of Hel.A.S.
J.H. Seiradakis

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Hellenic Astronomical Society

1. New Amazing Imaging Capabilities aboard the HST (by M. Plionis)

A new imaging camera, the *ACS* (*Advanced Camera for Surveys*) was recently (March 2002) installed in the Hubble Space Telescope. It consists of three electronic cameras (the *Wide-Field Camera* with a 3.37 arcmin field of view and a 0.049 arcsec pixel size, the *High-Resolution Channel*, with a ~0.5 arcmin field of view and 0.027 arcsec pixel size and the *Solar Blind Camera* which is a far-ultraviolet camera with roughly a 0.5 arcmin field of view and a 0.032 arcsec pixel size) and sets of filters covering a broad range of the spectrum, from the ultraviolet to the near infrared. The main scope of this instrument will be deep imaging surveys of clusters of galaxies, the environment of AGNs and the study of planetary nebulae. According to the Space Telescope Science Institute and the Johns Hopkins University, which constitute the Institutions from which the main ACS science and engineering teams come from (ESA and other Institutes are also involved), the new instrument will increase the discovery capability of HST by a factor of 10! In fact, the first observing runs have indeed proven that such is the case, since it observed twice the number of background galaxies in the legendary Hubble Deep Field, our deepest view of the Universe to date, in 1/12 of the exposure time used with the previous camera. This is due to the higher resolution of the *Wide-Field* camera, armed with two 2K X 4K CCD detectors, but also because of its higher sensitivity in the B band. A few amazing images have already been released (see below and last pages) that reveal the complex structure of colliding galaxies as well as beautiful nebulae.

The upper 2.5 light-years of the Cone nebula (NGC 2264) as seen by ACS-HST. This image is constructed from images taken in blue, near-IR and Ha. Credit:NASA, H. Ford (JHU), G. Illingworth (USCS/LO), M.Clampin (STScI), G. Hartig (STScI), the ACS Science Team and ESA.

2. Progress report on the 2.3m Aristarchos Telescope Project (by E. Harlaftis & P. Hantzios)

There have been significant developments since the last progress report on the telescope, as expected by the nature of the project. By October 2001, Zeiss acknowledged that they would be able to deliver the telescope by autumn 2002. After providing concessions to NOA (guarantee extension, provision of source code and some mechanical modifications), a 1-year extension was given to Zeiss. A 6-member NOA committee (Prof. Goudis, Dr. Dapergolas, Dr. Harlaftis, Mr. Zacharopoulos, Mr. Matsopoulos, Mr. Fisher) inspected the telescope at the Zeiss factory in Jena, Germany, at the end of October. By that time, the building contractors and Zeiss had started the installation of the enclosure which unfortunately came to a halt by the coming of the winter season. The following picture shows the state of the progress made with the building during last summer until the arrival of winter (control room and main structure of building finished). Shipment of the enclosure by Zeiss is expected any day now, in order to complete the telescope building. The last inspection was undertaken by E. Harlaftis and the engineers Dr. S. Worswick and Mr. Fisher between 20-22 March 2002. The mirrors have been aluminised, the telescope was reported by Zeiss to track under computer control and there was significant progress on the completion of the software while telescope tests were continuing. As a result of the inspection, three reports were submitted to NOA with technical details covering the project (on issues of concern, improvements, tests, and time-schedule). We have already made provisions for the

ARISTARCHOS telescope site, Neraidorahi Peak, Chelmos Mountain. The control room is beneath the building. Picture courtesy : G. Tsekouras, Director of Kalavryta Ski center. November 2001

factory acceptance tests which should happen during summer, according to Zeiss. Finally, many design improvements have been accomplished since March 2000 which were successfully negosiated through the Governing Board of NOA

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Review Article: On cosmical plasma outflows in winds, jets, γ-ray bursts, etc

By Kanaris Tsinganos, University of Athens

A rather common astrophysical phenomenon is the outflow of plasma from the environment of stellar or galactic objects in the form of either an uncollimated wind, or, collimated jets. Stellar mass loss (stellar winds) has been observed from all types of stars across the Hertzsprung-Russell diagramm. Jets are observed in association with a wide spectrum of stellar or galactic objects, such as, young stellar objects, older mass losing stars and planetary nebulae, symbiotic binaries, black hole X-ray transients, low- and high-mass X-ray binaries, supersoft X-ray sources and cataclysmic variables, active galactic nuclei, blazars and possibly γ-ray bursts. In the theoretical front, we have unified winds and jets as similar magnetohydrodynamic phenomena. The combined effect of the magnetic field and rotation in the central object may produce winds from inefficient magnetic rotators and jets from efficient magnetic rotators. A very modern challenge to the theory of relativistic magnetohydrodynamics is explaining gamma-ray bursts as relativistic jetted sources.

At the dawn of the Space Age in the late fifties, a conceptual revolution in theoretical astrophysics was the prediction by Eugene Parker that an extremely hot solar corona cannot be confined by solar gravity, but expands supersonically into interplanetary space to fill the whole solar system. It has been one of the rare instances in astronomy where a theoretical prediction was immediately verified by *in situ* observations via space probes in what now is known as the *solar wind*. The generalisation to the similar expansion of a stellar corona is evident, establishing thus the notion of the *stellar wind*. On the other hand, despite the fact that more than eighty years have elapsed since the first

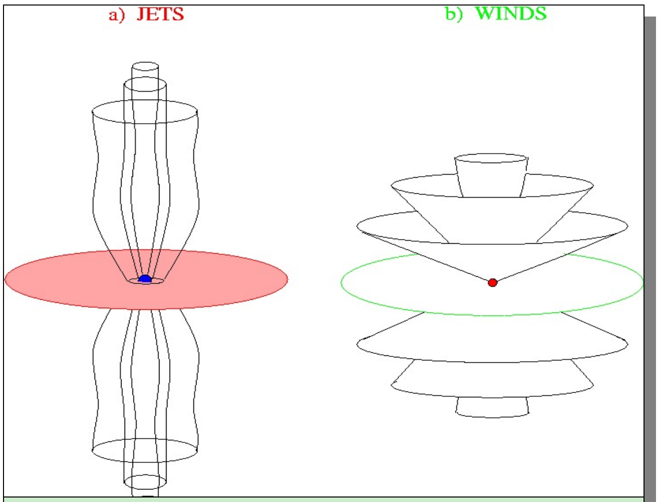

Figure 1: The dichotomy of jets-winds: schematic plot of the two classes of plasma outflows, jets (a) and winds (b), according to Sauty & Tsinganos (1994).

collimated plasma outflow (jet) was observed in association with the giant elliptical galaxy M87 by Curtis (Pub. Lick Obs., 13, 31, 1918), and despite that by the end of the last century, modern observations including those recently with the Hubble Space Telescope, have revealed that the Universe is replete with analogous outflows from all kinds of objects, ranging from the rich varieties of stars to the galaxies and quasars, it is only now that we start understanding some aspects of the physical mechanisms involved in the acceleration, collimation, stability, termination, radiation, etc. which are at work in such collimated outflows. The basic reason for delayed theoretical progress in understanding these cosmic plasma outflows is the fact that while the uncollimated solar wind can be described to zeroth order by the simpler hydrodynamic equations, the collimated jet-type outflows need to be described by the much more complex set of the coupled nonlinear magnetohydrodynamic (MHD) equations, relativistic or classical. In addition, while winds can be treated as basically spherically symmetric outflows, i.e., 1-D phenomena, jets are inherently at least 2-D phenomena.

Hence, a *first* difficulty in describing collimated plasma outflows has to do with the scarcity of 2-D exact solutions of the full MHD equations (Tsinganos 1982, ApJ, 252, 775). It is only recently that we have been able to systematically outline a method for the general construction of such exact solutions for axisymmetric MHD outflows (Vlahakis & Tsinganos, 1998, MNRAS, 298, 777). Hence, all existing cases of jet- or, wind-type exact MHD solutions can be unified by a systematic analytical treatment wherein all available today examples of exact solutions emerge as special cases of a general formulation. At the same time new families with various asymptotical shapes emerge as a by-product of this systematic method. Basically the method involves a nonlinear separation of the variables, wherein the dependence of all physical quantities in the spherical coordinates (r, θ) of the radial distance r and the meridional angle θ separate in a fashion similar to that in the familiar Schrödinger equation when we deal with solutions for the wave function in the context of the Hydrogen atom. Two broad classes exist, one has the geometry of the radial self-similarity and the other of the meridional self-similarity. This method unifies all existing MHD outflow solutions, such as the Parker description of the solar wind, or the Blandford & Payne (1982, MNRAS, 199, 883) model for jets while at the same time it reveals new classes.

A *second* difficulty has to do with the fact that jets extend over large spatial scales. For example, in the case of AGN jets range from the subparsec to the Mpc distances. Also, the flow has to start subsonically from an accretion disc or a stellar atmosphere with very low speeds and end up with high supersonic speeds which sometimes are also relativistic. As is well known, the MHD partial differential equations have a mixed elliptic/hyperbolic character. And, a physically accepted solution has to pass through several mathematical singularities called critical points. One cannot numerically integrate the system because the code blows up at these

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critical points. Instead, one has to carefully tune the solutions to satisfy various criticality conditions in order to correctly pass through all relevant critical points. Here we have to confront the following vicious cycle, or the "chicken vs. the egg" question: The construction of an acceptable solution requires the previous knowledge of the location of the critical points, while in order to know the exact location of the critical points we need to know the particular solution! This is the reason why very few global MHD solutions for jets have been constructed. One of the first such few solutions has been constructed in a really ingenious way by Nektarios Vlahakis, as part of his PhD thesis (Vlahakis 1998) and has been subsequently applied to model astrophysical jets (Vlahakis, Tsinganos, Sauty and Trussoni, 2000, MNRAS, 318, 417).

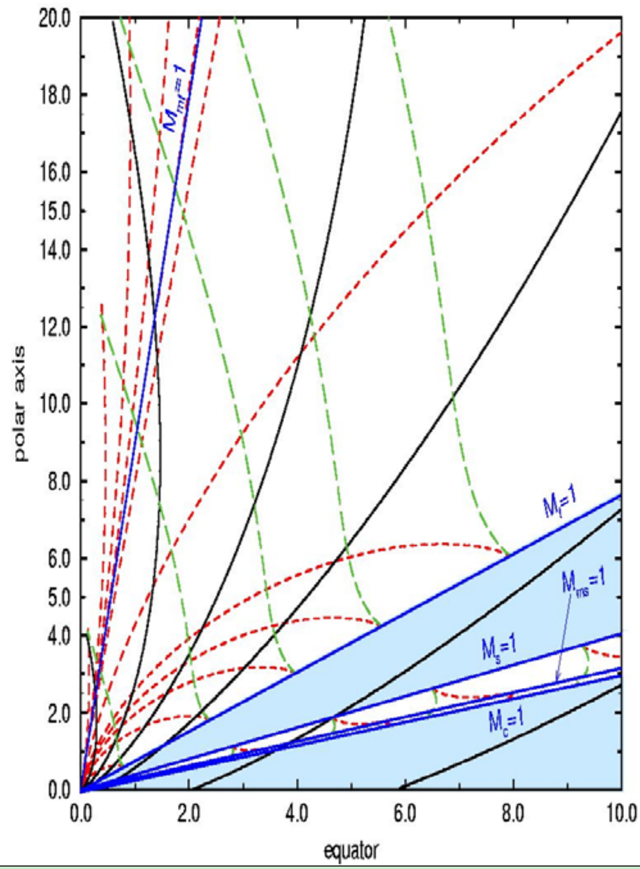

Figure 2: The poloidal plasma flow in one quadrant of the space around a gravitating central object starts subsonically by first crossing the first shadowed area where the governing partial differential equations for the flow are of elliptic type and no characteristics exist, then through the white area where the equations are hyperbolic and characteristics do exist, back through the shadowed elliptic area. Finally, the outflow ends supersonically in the last unshadowed area around the polar axis while at the same time the fieldlines bend towards the axis by magnetic pinch forces to form a tightly collimated jet. In this path the plasma crosses the so-called limiting characteristics which represent mathematical singularities of the MHD equations similar to the event horizon around rotating black holes governed by the relativity equations (Sauty et al. 2002).

A *third* question has to do with the observed *dichotomy* of MHD outflows which sometimes appear to have the form of a more or less spherically symmetric expansion in the form of a wind, or, they attain asymptotically a cylindrical shape, in the form of a jet. Blandford & Payne (1982, MNRAS, 199, 883) demonstrated analytically that cold astrophysical plasma jets may be accelerated magnetocentrifugally from Keplerian accretion disks, *if* the poloidal fieldlines are inclined by an angle of 60^o, or less, to the disk midplane (but see also, Contopoulos & Lovelace (1994, ApJ 429, 139 and Cao, 1997, MNRAS, 291, 145). This study introduced the classical "bead on a rigid rotating wire" picture, although these solutions are limited by the fact that they contain singularities along the system's axis and also terminate at finite heights above the disk. In an unchecked so far numerical simulation, Sakurai (1990, Comp. Phys. Reps, 12, 247) extended in MHD the classical Parker's model for an equatorial solution (Weber & Davis 1969, ApJ, 148, 217) to all space around the star by iterating numerically between the Bernoulli and transfield MHD equations; thus he found a polewards deflection of the poloidal fieldlines not only in an initially radial magnetic field geometry, but also in a split-monopole one appropriate to disk-winds. The methodology of meridionally self-similar exact MHD solutions with a variable polytropic index was introduced in Low & Tsinganos (1986, ApJ, 302, 163) in an effort to model the *heated* axisymmetric solar wind. An important analytical study by Heyvaerts & Norman (1989, ApJ, 347, 1055) has shown that the asymptotics of a particular magnetic fieldline in polytropic outflows is parabolic if it does not enclose a net current to infinity; and, if a fieldline exists which does enclose a net current to infinity, then, somewhere in the flow exists a cylindrically collimated core. Later, Bogovalov (1995, Sov. Astr. Letts, 21, 4) showed analytically that there *always* exists some fieldline in the outflowing part of a *rotating* magnetosphere which encloses a finite total poloidal current and therefore the asymptotics of the outflow *always* contains a cylindrically collimated core. However, besides the general conclusion of Heyvaerts & Norman and the special but problematic radially self-similar solution of Blanford & Payne and Contopoulos & Lovelace's, no exact MHD solution crossing all relevant critical points existed to describe collimated jet-type flows. In a novel approach and as part of the frequently cited PhD thesis of Christophe Sauty (Sauty 1994) the shape of the fieldlines from the base of the outflow to infinity for nonconstant polytropic index cases, has been determined self-consistently. This analysis also provided a simple *criterion* for the transition of the asymptotical outflow shape from conical (in inefficient magnetic rotators) to cylindrical (in efficient magnetic rotators). It has also been conjectured that as a young star spins down loosing angular momentum, its collimated jet-type outflow becomes gradually a conically expanding wind (Sauty & Tsinganos, 1994, A&A, 287, 893). Nevertheless, the degree of the collimation of the solar wind at *large* heliocentric distances remains still observationally unconfirmed, since spacecraft observations still offer ambiguous evidence on this question. Another interesting property of collimated outflows has emerged from

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Review Article: *The localization of the emission region in pulsar magnetospheres*

By Kiriaki Xiluris-Lauria, Astronomy Dept., University of Virginia, USA

A major uncertainty in pulsar physics is the actual location of the radio emission region. If what we register with our radio telescopes is an electric storm where does it occur in the pulsar magnetosphere?

To J.H.Seiradakis who taught me pulsars

Pulsar radio emission is thought to originate from charged particles that stream along the magnetic field lines above the pulsar magnetic poles. An emission beam pattern constantly emerges above the polar caps and if our line-of-sight intersects this beam, a pulse is received once per stellar rotation. Though the periodicity of the pulses is extremely precise (currently predictable down to 100nsec accuracy in millisecond pulsars), their shapes and polarization are heavily variable, almost chaotic. Yet, once several hundred pulses are coherently averaged, they produce an *average pulse profile* that maintains remarkable stability over decades. Fig. 1 shows a time series of 1420-MHz total power data taken with the Arecibo telescope in 1998. A periodicity of 226.6 msec was detected in this stream of data. Once the time series was folded modulo the detected periodicity the average profile of a new pulsar named PSR J1907+0918 emerged, as displayed in the lower panel. Note that the average pulse profile can be decomposed into a number of Gaussian function components, which correspond to the preferred location of the emission occurrence as a function of pulse phase.

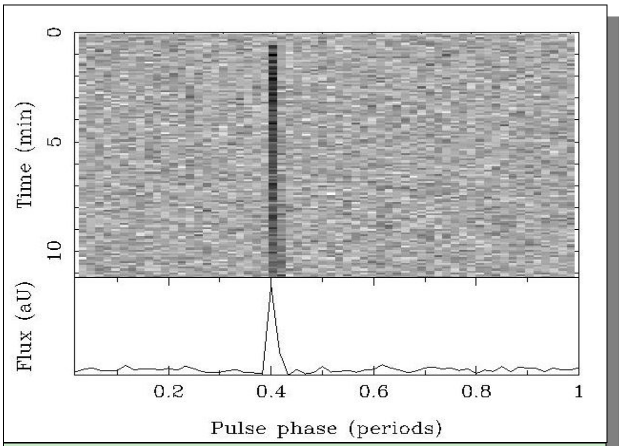

Fig. 1.: Search code output showing the initial detection of PSR J1907+0918. The gray scale image shows time domain sub-integrations of data folded modulo P=226.6 ms. The pulsar is clearly visible in these sub-integrations and in the average pulse profile shown below. (Lorimer & Xilouris ApJ, 2000)

A certain width can be assigned to each component and consequently to the whole profile. It is remarkable that the profile shape, its components, their width, their relative intensity and separation, as well as their polarization properties and times-of-arrival have retained stability for almost three decades for the majority of the 1000 or so pulsars that we presently know of. This amazing stability implies that the effects of the magnetic field certainly dominate the motion of charged particles in the magnetosphere. Therefore, the pulse profile and its properties can be safely associated with the properties of the magnetic field at least in the radio emission region.

Pulsar radio emission is broadband in nature, spanning from 25MHz to 32GHz (Kramer, Xilouris et al., AA, 1996) and even to 80 GHz (Kramer et al., AA, 1997). Early in pulsar research it was noticed that the average profile width as well as the component separation is *broadened with decreasing radiofrequecny*. This is shown in Fig. 2a where the profile width of PSR B1133+16 is given as function of frequency. Note that the profile at the VHF part of the spectrum is ~ 30° while at meter and mm-wavelengths it has narrowed to ~ 10°. The effect of the profile broadening suggests that the radiation might be emitted from slightly different altitudes above the polar caps, in other words, that there is some sort of *magnetospheric stratification*. The detailed form of such a stratification (came to be known as *radius to frequency mapping, RFM*) depends on the physics of the actual emission mechanism involved. Nevertheless, it mandates that the mm-wavelengths should arise from regions closer to the polar caps than the VHF frequencies. Theoretical attempts to explain RFM, use a power-law dependency of the emission altitude $R_{emi}(\nu)\sim\nu^{-\xi}$ on frequency. The exponent ξ ranges from 0, namely no RFM at all, (Barnard and Arons, 1986 *refraction mode*l) to 2/3 (Ruderman & Sutherland 1975, *vacuum gap model*). Theoretical predictions are also made for the profile broadening with frequency $W(\nu)\sim\nu^{-k}$. The vacuum gap model requires a power-law with exponent $\approx$0.35, while for the *curvature maser* model the suitable range is 0.14<k<0.29 (Beskin et al. 1988). A more recent approach, the *cyclotron instability model,* requires k$\approx$0.17 (Machabeli & Usov, 1989), while for the refraction model the frequency dependence is less clear.

In the vacuum gap model, the emitted radiation is related to the plasma frequency at the emission region and therefore to the local particle density. In addition, if a dipolar field is assumed, the spreading of the open field lines with increasing altitude can account for the observed frequency dependence of the profile width if an RFM is assumed (Cordes 1975). An alternative model involves propagation effects including refraction and birefringence of the plasma above the polar caps (Barnard & Arons, ApJ, 1986; McKinnon, ApJ 1997). In the refraction model, all radiation is emitted from the same altitude and the profile broadening is due to propagation effects rather than any stratification in the magnetosphere. In this model, the emission is created at a single altitude but not all emission escapes the magnetosphere directly. Instead, one polarization mode

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first propagates through the plasma and escapes at a certain altitude. The extent of the open field line region at this particular frequency-dependent altitude will then be the factor that determines the observed profile width. Both models predict a frequency dependence of the emission altitude, however, the vacuum gap model refers to the altitude where radiation is created, while the refraction model refers to the altitude where radiation escapes the magnetosphere. Many techniques have been developed since the early pulsar days, to probe the very existence and nature of a magnetospheric stratification and also to provide an estimate of emission altitudes. A review of what has been accomplished follows in the next sections.

From profile width to altitude

The most straightforward technique is to convert the measured profile width (W) into emission altitudes (R_{emi}). This is a two-step approach that requires the following assumptions:

- *The magnetic field, at least in the radio active region, is purely dipolar,*
- *The emission pattern is purely circular, and is organized in a conical beam centered around the magnetic pole, the angular radius of the cone being ρ,*
- *The width of the profile is determined by the intersection of the line-of-sight with the conical beam,*
- *The filling factor of the emission pattern is 1, namely, the boarder of the profile truly represents the last open dipolar field line,*
- *The viewing geometry described by the magnetic inclination α (the angle between the rotation and the magnetic axis), and the pulsar-earth orientation β (described as the closest angular approach of the line-of-sight to the magnetic axis, impact angle) is known,*
- *While we have stated earlier that pulsar emission is broadband, some sort of narrow band nature should exist to account for the stratification of the emission.*

Let us assume that the emission beam originates in the part of the magnetosphere where the dipolar magnetic field dominates. Simple geometry of the dipolar field (Goldreich &Julian, ApJ 1969) prescribes the relationship between the profile width (W) and the angular radius of the emission beam ρ as :

$$\sin^2 \frac{W}{4} = \frac{\sin^2 \frac{\rho}{2} - \sin \frac{\beta}{2}}{\sin(\alpha) \cdot \sin(\alpha+\beta)}$$

If the viewing geometry (parameterized with α and β) is known and the profile width is measurable, then the angular radius of the conical beam ρ, can be determined. A simplification of the above expression for small ρ and β (as is the case for pulsars) leads to:

$$W = \frac{2 \cdot \sqrt{\rho^2 - \beta^2}}{\sqrt{\sin\alpha \cdot \sin(\alpha+\beta)}}$$

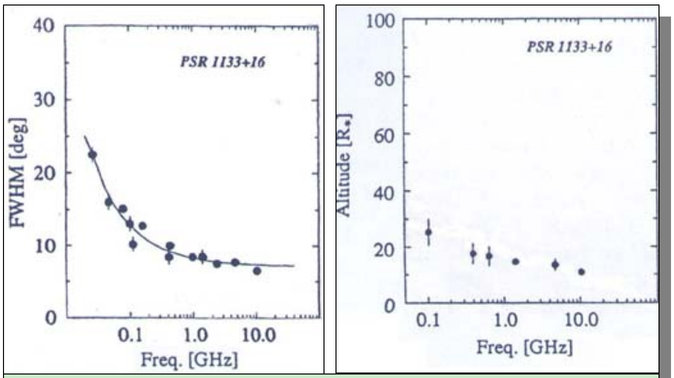

Fig2.a,b : mapping profile width into altitude (Xilouris et al.1996)

Once the angular radius is derived, the emission altitude can be deduced from the expression:

$$\rho = \sqrt{\frac{9\pi R_{emi}}{2Pc}}$$

This also originates from the geometry of a dipolar field. Note that the angular radius ρ and the rotational period P of the pulsar are quantities that are related. Converting the above expression into degrees and simplifying for small angles we derive the following expression:

$$\rho = 1.24^\circ \cdot \sqrt{\frac{R_{emi}/R_*}{P}}$$

where R_{emi} is in units of 10^6 cm and the emission altitude is then given in terms of stellar radii, R_*, above the polar caps. Note that this simplification provides a lower limit to the estimation of altitude. Having given just enough background let us apply this method to PSR B1133+16. In Fig. 2a one can see the profile width as measured between 45 MHz and 32 GHz. In Fig. 2b the width is mapped into altitude. The viewing geometry for this pulsar was derived from polarization data and is consistent with an α of 147° and β of 3. We determined that the radio emission for this star is originating in a thin, 10 R_* slab, which is located ~10-20 R_* above its polar cap. A similar analysis was performed for eight pulsars, those that we were able to detect up to 32 GHz, covering in this way the broadest frequency range known to date. It is worth noting here that, 1) the profiles of pulsars narrow smoothly and continuously with frequency, or, said differently, there is no need to postulate different emission processes for different parts of the radio spectrum; 2) we do not see any evidence for deviations from a dipolar field configuration throughout the radio emission region (had there been contributions to the emission from higher order fields, the profiles would exhibit a discrete change with frequency); 3) the frequency dependence of the profile widths scales as $W(\nu) \sim \nu^{-0.66}$ somewhat stronger than what it has been predicted theoretically; 4) with the exception of one pulsar with $R_{emi} \sim 5R_*$ and a second with $R_{emi} \sim 60R_*$, the general trend is that the whole radio spectrum originates at ~10-20 R_* above the polar cap; 5) the derived RFM scales as $\nu^{-0.02}$ at frequencies between 1-10 GHz, while contributions from low frequencies turn this into

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$R_{emi} \sim \nu^{-0.2}$, close to what the curvature maser model predicts. The method we have followed is certainly model dependent and has a few inherited uncertainties that might bias the results. Signal-to-noise limitations made us use the 10% profile width and therefore underestimating altitudes. However, as long as the distance of the profile boundary to the last open field line is frequency independent, the results will only be affected by a scaling. Secondly, we have made use of the viewing geometry, which comes from polarization data. Disentangling the co variances between α, and β while estimating ρ, is non trivial and leads to uncertainties that propagate to the emission altitude estimation. Here, we safely conclude that if any stratification exists, it must be a very weak one.

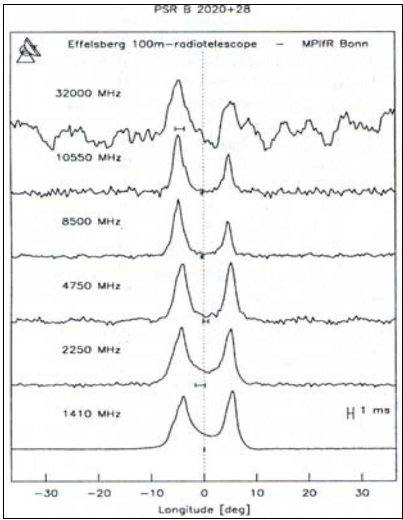

Fig. 3.: *Effelsberg data ranging from 1.4 GHz to 32 GHz for PSR B2020+28. The profiles align perfectly between 1-10GHz, consistent with a simultaneous arrival at all frequencies after interstellar dispersion removal was applied.* There was no need to introduce additional time delays to the data. (Kramer, Xilouris et al. AA, 1997).

The timing approach

If truly the emission altitude is frequency dependent, then one expects that a time delay exists between the time-of-arrival of a pulse between two frequencies, merely due to a difference in path length. This *retardation* delay implies that the high frequency pulses would arrive later than the low frequency ones. Also, due to the rotation of the neutron star the radiation beam is bended towards the rotational direction. Therefore, an outside observer will receive a pulse earlier depending on the value of this deflection (*aberration*) angle. Particles outflowing the open magnetic field lines will give rise to a toroidal component of the magnetic field near the light cylinder R_{LC} (a surface where particle corotation fails). As a result, the field lines will be swept backwards, namely, bend towards a direction opposite to the sense of rotation. This magnetic *sweepback* angle gives rise to yet another frequency dependent time delay. Finally, an external to the pulsar time delay is introduced that has to do with pulses propagating through the interstellar medium and suffering a frequency dependent *dispersion* delay. The frequency dependence of this delay follows a cold plasma law ($\sim\nu^{-2}$), and is reasonably well understood. Conceivably, if one is able to simultaneously receive pulses at different frequencies, or refer the time-of-arrival of multifrequency data to a standard frame of reference, one can search for signatures of the previously mentioned time delays and put the RFM hypothesis under a serious test. Phillips & Wolszczan, ApJ 1992, used high precision multifrequency timing data between 25MHz and 4.8GHz, to assess the precision with which arrival times follow a cold plasma law and also to provide an estimate for additional time delays. Their results indicated that the cold plasma law holds true for at least a 200:1 frequency range and also placed an upper limit to extra time delays of the order of 1msec. For comparison the light travel time in a typical magnetosphere is 100msec. They also showed that the emission region is compact ($<20R_*$), and is situated close to the stellar surface ($R< 12R_*$). They placed an upper limit to the RFM exponent of ξ <- 0.66, which if at all, favors the vacuum gap model. We have conducted a similar experiment expanding the frequency coverage from 1 to 32 GHz (Kramer, Xilouris et al. AA, 1997). The profiles at each frequency perfectly aligned with each other, limited only by the resolution and the signal-to-noise of the observations. The profiles aligned with only the interstellar dispersion taken into account as the only source of time delay. The imposed upper limit to extra time delays from our data was 300μsec, at best, for the pulsars in our sample. Most recently however, we performed a similar experiment using millisecond pulsars as probes (Kramer et al. ApJ, 1999). The data in this study were taken between 200 MHz and 4.6 GHz. New instrumentation allowed for accuracy down to 50μsec. Down to this level, one can safely argue that all frequencies are emitted from one altitude or at best there is a very weak frequency dependence. The simultaneous arrival at frequencies between 200MHz and 4.6GHz, sets a limit to the size of the emission region corresponding to a light travel distance of only 2.4 kilometers. A stricter limit was set by dual frequency timing observations of the fastest millisecond pulsar PSR B1937+21 (Cordes & Stinebring, ApJ 1984). Here the emission region is located right at the stellar surface and its radial extent is 4km. The RFM index derived is < 0.12, closer to the refraction model, if anything. A recent study (Gil et al., ApJ 2002) uses simultaneous dual frequency observations of PSR B0329+54. The great advantage of such an experiment is that it is free of interstellar dispersion, and therefore any measured extra delays are suspicious. The authors claimed detection of extra time delays. This technique, once well established, should provide the first and direct proof for a stratification in the magnetosphere.

The scintillation approach

Another method for estimating emission altitudes uses interstellar scintillation to measure the spatial resolution between emission components of a pulsar profile. Smirnova et al., ApJ, 1996, improved this approach and resolved emission sources in four pulsars. The characteristic dimensions of sources associated with diffraction patterns is $4\sim8\cdot10^{8}$ cm. Using a dipolar field geometry they calculate the emission altitudes.

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Their results indicate that emission originates from 40-90% of the light cylinder radius R_{LC} and in one case is located outside the light cylinder. The authors developed a model that involves non-dipolar magnetic fields and were able to reconcile their results with emission from very near the stellar surface.

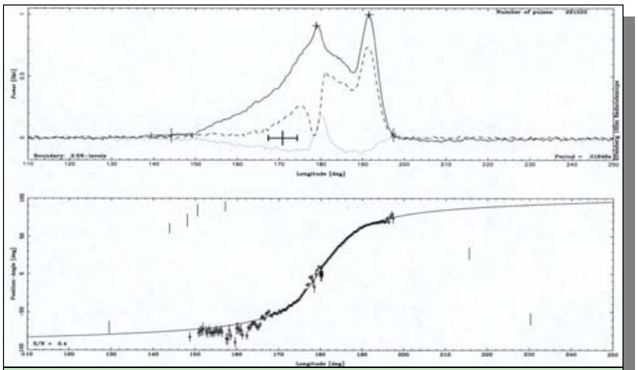


Figure 4.: The polarization profile of PSR J1023+1001 Upper panel: total power (solid line) Lower pane: the polarization position angle (dotted line). The centroid of the total power profile leads by 0.4msec indicating Remi=35R. (Xilouris et al. 2002)*

The polarization approach

Early on in pulsar research attention was brought to the polarization properties of the emitted radiation. In particular, observations of the Vela pulsar showed that the position angle of the linear polarization vector swings nearly 180° in an S-shaped manner. This organized sweep led Radhakrishnan & Cooke, 1969 to associate the polarization with particle motion along magnetic field lines. The *rotating vector model* can explain easily the observed S shape of the position angle, as the projection in the sky of dipolar magnetic field lines. Blaskiewicz et al., ApJ 1991, extended the rotating vector model to include first-order special relativity effects. This study provided a model independent way of estimating emission altitudes. Their theory predicts a time lag between the total intensity profile (Fig. 4, top panel solid line) and the polarization position angle profile (Fig. 4 lower panel). The centroid of the total intensity profile leads by Δt the pulse phase at which the first derivative of the polarization angle curve is at zero. The relation between this lag Δt and the emission height is given by:

$$R_{emi} \sim c.\Delta t/4$$

Polarization measurements of 18 pulsars between 430MHz and 1.4GHz resulted in emission altitude estimates that range between 30 ~ 40 R_*. The RFM exponent of 0.2, favors the curvature maser model. We expanded this study to frequencies between 1-10GHz (von Hoensbroech & Xilouris, 1997). An example is shown in Fig. 4 for the millisecond pulsar PSR J1020+1001. Our results indicate that for pulsars with small β the average emission altitude is 40R_*, while in cases where the line-of-sight does not cut such central trajectories (larger β) the average altitude is closer to ~ 30R_*.

The altimeter

Rankin ApJ 1990, examined the pulse widths of pulsars with interpulses (pulsars with α=90°) and concluded that their beam size scales with their rotational period following a simple law:

$$\rho \sim 2 \cdot 2.45^{\circ} \cdot P^{-1/2}$$

This is in good agreement with the predictions of a dipolar field dominating the emission region. Kramer et al. ApJ, 1999 studied both normal and millisecond pulsars and based on profile widths and polarimetry constructed an altimeter shown in Fig 5. The left-hand-side abscissa shows the pulsar beam size while the right side indicates the emission altitude in units of R_{LC}. Note that normal pulsars emit from altitudes consistent with 0.1-5% R_{LC}. The previously mention ρ-P relation (marked with the dashed line in Fig. 5) places a lower limit in their beam size. Pulsars slow down with age, and eventually become radio quiet. If this simplistic altimeter indicates anything close to reality, then normal pulsars stop emitting when particles are trapped below about 0.01%R_{LC} and their beams become smaller that ~1^{o}. Millisecond pulsars however, seem to have beams that are much narrower than predicted by the ρ–P relation. Deviations start becoming evident around P=100 msec and more prominent for pulsars that spin faster than 10msec. Note that the maximum ρ=90° occurs somewhere in the vicinity of P=1-2msec, pretty close to the current period limit that we have detected, at least for radio pulsars. Assuming dipolar fields and R_*~10km we also mark a solid line that corresponds to emission directly at the stellar surface. Three millisecond pulsars paradoxically fall in the region below this line that corresponds to the neutron star interior. Evidently, the beam-Period relation does not describe recycled pulsars as well as normal pulsars, perhaps due to the very nature of their genesis. Though our assumptions about purely dipolar fields or a period independent radius might not hold true.

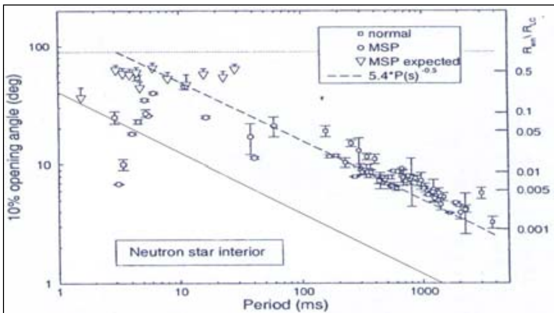


Fig. 5: The beam-period relation does not seem to describe msec pulsars as well as normal pulsars. (Kramer, et al. 1999).

The search for the emission location certainly continues, since the questions that we are left with are more than those we started. Believe and research therefore till the truth comes to you! This is an evolving document and for updates please see www.astro.virginia.edu/~kx8u/review. ◘

GREECE – MEMBER OF THE *A&A* BOARD OF DIRECTORS

Greece, represented by the *National Committee for Astronomy in Greece (GNCA)*, is a member of the joint European enterprise of scientific organizations, which publishes the international scientific journal, *Astronomy and Astrophysics (A&A). The journal was* founded in 1969 through the merger of six national astronomical journals in Europe and was extended by the incorporation of a seventh journal in 1992. It has the administrative support of the *European Southern Observatory (ESO).* The consortium of the European scientific organizations represent the following 17 countries: Austria, Belgium, Czech Republic, Denmark, Estonia, Germany, Greece, Finland, France, Hungary, Italy, The Netherlands, Poland, Slovak Republic, Spain, Sweden, Switzerland. Each country contributes to the expenses of the enterprise according to its national income. GNCA, in close collaboration with the *General Secretariat of Research and Technology (GSRT),* pays Greece's contribution, which for 2002 amounts to €3530.

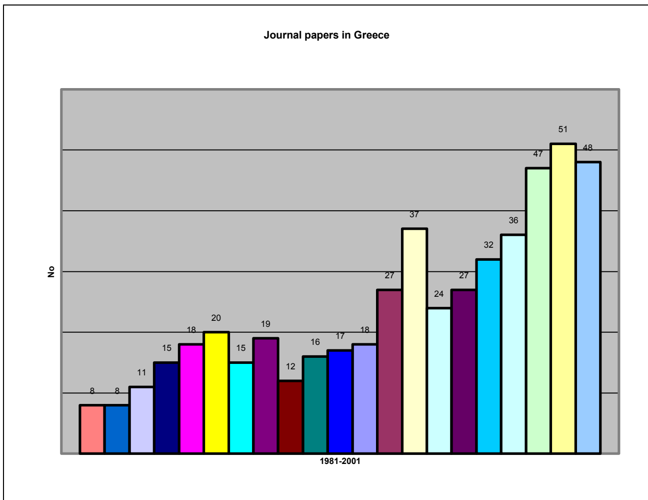
The scientific organizations appoint the *Board of Directors*, which consists of representatives from each member country with the important addition of the ESO representative. The representatives for Greece in the Board of Directors have been Professor G. Contopoulos (1974 – 1996), who negotiated Greece's entry to the consortium, and Professor J. Ventura (1996 – today). Once a year the Board of Directors convenes and plans the journal's policy for the following year. In 2002 the meeting took place in Torun, Poland. Following a cordial invitation by the Greek representative, the next meeting will be held at Heraklion, Crete.

For the last 20 years, A&A remains the main journal for Greek astronomers, as shown in Table I. The chart in the right shows graphically the evolution of the research papers submitted by Greek astronomers to astronomy journals as a function of time. In 1983 the number of papers submitted to the main journals exceeded 10. In 1999, more than 10 papers were published in each of the 3 main astronomy journals (MNRAS, ApJ, A&A) with a total number close to 50. Although, approximately, half of the scientific papers published by Greek astronomers were not published in A&A, Greece still benefits from its membership in the A&A consortium. A&A charges $100 per page to authors from non-member states. Assuming a minimum of 3–4 pages per A&A article, the costs in 2001 alone would have been €6,500 – €8500 (about twice Greece's annual contribution). Naturally at this point, we would like to encourage more papers to be published in A&A. Also, the provision of feedback by the authors is very important with regard to the quality of the A&A journal. Such feedback from the community can then be passed through the Greek representative to the Board of Directors for discussion.

Feedback from the scientific community has actually led to a major restructuring of A&A as of January 2001. This resulted in substantial changes both in the journal's appearance as well as to its editorial policy, while the overall submission to publication time has also been markedly reduced in recent years.

Table I. Papers published in the following 4 journals: AJ, ApJ, MNRAS and A&A (data from the electronic SCI with keyword "Greece" between the years 1981-2001)

Year	**AJ**	**ApJ**	**MNRAS**	**AA**	**Total**
1981	-	1	-	7	8
1982	-	4	-	4	8
1983	-	-	4	7	11
1984	-	1	2	12	15
1985	-	3	1	13	18
1986	1	5	1	13	20
1987	-	8	1	5	15
1988	2	5	-	12	19
1989	3	2	2	5	12
1990	2	3	-	10	16
1991	-	3	1	13	17
1992	-	3	2	13	18
1993	-	2	1	24	27
1994	-	4	3	30	37
1995	2	-	2	20	24
1996	1	7	6	13	27
1997	1	3	11	17	32
1998	2	2	13	18	36
1999	1	12	18	16	47
2000	2	10	16	22	51
2001	2	11	15	20	48
TOTAL	**18**	**89**	**99**	**294**	**500**



Scientific papers published by Greek astronomers between 1981 and 2001

Emilios Harlaftis [1,4], *Joseph Ventura* [2],
John H. Seiradakis [3,4]
[1] *National Observatory of Athens,*
[2] *University of Crete*
[3] *University of Thessaloniki*
[4] *National Committee for Astronomy/General Secretariat of Research and Technology*

EDITOR'S COMMENT

Having lived and worked in Mexico for the last five months, I have found out, to my amazement, that the Mexican government, although the government of a so-called 3rd world country, provides a lot of support to the Research & Technology sector. For example in the 2001 budget, 0.4% of the GNP was allocated to R&T, a value very similar to that of the so-called 1st world country, Greece. Furthermore, it seems that it does value the work and efforts of researchers and University teachers, the salaries of which are very respectable. Let me be more precise. In the Mexican system the salary of academics comes from three sources, each contributing roughly equally to the total salary. One comes directly from the state and constitutes the "basic salary", the second comes from the state supported *CONACYT* (something like the French *CNRS*) but in order to be eligible to receive it you should demonstrate, on the basis of well defined criteria, that you are an active researcher (publishing at some minimum rate) and finally the last part, the so-called *beca* comes from the Institution to which each academic belongs and again it is given on the basis of active participation on educational and research activities. In this way the system rewards those that perform well academically, it gives strong incentives to actively participate in research and education although it also allows one to sit-back and do little but at least at a minimum wage. I have to note that it is quite rare that an academic will not receive all three parts of his salary. There are basically 4 academic levels, like in Greece, and as an example the net salary of the lowest level, after tax reduction, is 2200~2500 Euros (depending on how rich is the institute which determines the level of *beca*), while in Greece it is ~1050 Euros (for researchers) and ~1300 Euros for University teachers. Taking further into account the cost of living in Mexico, this difference becomes even larger. In the same time a crude estimation of the publication production rate (in Astrophysics) shows that it is quite similar with roughly 3 refereed papers per staff member in the period 2000-2001. So what can one say regarding the insulting, to say the least, policy of the Greek government, that insists in differentiating between researchers and University teachers while paying both incredibly low salaries? No further comment !!!

Regarding the Previous Issue's "Editor Comment"

We received the following letter from Prof. Voglis and we publish it as it is, together with the Editor's response.

Dear Mr. President,

We were surprised to see the "Editor's comment' in the last issue of "Hipparchos" (December 2001) about the activity of the Astronomical Institutes of Greece.

An assessment of the Astronomical Research in Greece can be reliable only if it is carried out by an Independent International Committee of Experts in various fields of Astronomy. Such an assessment is welcome indeed.

Since, as the editor himself also writes in his comment, "the State has already initiated such a procedure for the state controlled Institutes", how can unauthorized persons evaluate the Astronomical Institutes? Such assessments may not be objective and may misleadingly preoccupy any future judgments.

It is worth emphasizing that establishing criteria of evaluation is a difficult task that should be done with much care. The results may be unstable under differences in the criteria.

For example, an arbitrary truncation of the impact factor can make the results vary considerably and give quite different impressions. The results could be more stable if one used all the journals of the Citation index. (In fact, the Citation index has already eliminated a large number of journals of secondary importance).

The 'Editors comment' claims that this "discussion is not meant to be a judgment of the quality". Nevertheless, the numbers are meant to be quoted in any future reference, and in any case this article sets a wrong basis for any future discussion.

We believe that the editor acted without realizing the inappropriateness of his conduct. However, it is a fact that his action resulted in a mistreatment of the Research Center for Astronomy of the Academy of Athens (and perhaps of other Institutes as well).

As this matter is a major issue of policy for HEL.A.S, we apply to you and we ask you to take care, so that this letter is published in the next issue of Hipparchos.

On behalf of the staff members,

Nikos Voglis

Director of the Research Center for Astronomy and Applied Mathematics of the Academy of Athens

Editor's Response:

I welcome the letter of Prof. Voglis as a contribution to the discussion that was meant to open with the previous "Editor's comment" and I agree with many of the points raised. Indeed the definition of objective criteria for the evaluation of research is a difficult task but my comment by no means was meant to be a judgment or an evaluation of the different Institutes and University Sections. I clearly state so in the last paragraph. I also agree with Prof. Voglis that an arbitrary truncation of the Journal impact factor can give misleading impressions. I want to emphasize that the publication rates presented in my comment are not meant for ``future reference'', but rather as indicative and open to discussion. This was the reason why I clearly stated all the criteria under which I estimated the publication rates, so that they can be refuted if such is the opinion of different colleagues, and furthermore I also stated that the truncation of the Journal impact factor, at the value of 1, was "rather arbitrary". Therefore, the only point on which I strongly disagree with Prof. Voglis is that my conduct was inappropriate.

Finally, my only conclusion in the previous "Editor's

Continued at page 11

BOOK REVIEWS

Many of us have known Prof. Paul Laskarides as a very good teacher, since we first met him as students at the University of Athens, and some of us are familiar with his books on observational astronomy, exercises of Astronomy and his classic book on stellar atmospheres.

Paul has recently published a new smashing book, entitled "***On the traces of UFO, testimonies, theories, and views on the problem of life in the Universe***", by Diavlos Publications, Athens. The 516 pages book is divided in two parts and 29 chapters, that cover thoroughly all aspects of this very popular subject.

The reader will find many testimonies, views and theories, with suitable comments on all aspects. The book describes extensively all different types of UFO sightings and encounters, presents the protagonists and many not as well known figures and aspects of the problem.

Paul has used extensive bibliography, classic such as Sagan, Asimov, Hynek, Menzel and Papagiannis, as well as many articles and electronic literature. The book presents all aspects of the subject, from many different points of view.

I believe we should all read this nice and well written book, in order to be in a position to answer the relevant questions that we frequently face from students and the public. I am absolutely sure that the book will be a best seller by the end of the year.

Congratulations, Paul!

A new interesting, 730 pages, book written by Stratos Theodossiou and Manos Danezis, colleagues and good friends at the National and Kapodistrian University, entitled "***At the traces of ICHTHYS***", is published by Diavlos Publications, Athens. This large volume covers many astronomical and philosophical aspects of the symbolic image of the fish "ICHTHYS", from the proto-christianic era, combining them with theological views and practices over the years to the present era, in a very attractive way.

It took only 2200 years for computers to evolve from Archimedes first two mechanical computers, constructed in Syracuse to reproduce the motion of the planets and the Sun, {which Marcelus took as lute in Rome and set it to work there} to present day computers with languages and packages suitable for symbolic computations. "*Mathematica*" is a program suitable for different type of computations and unique in symbolic calculations. I know students who in one day do more (and exact) calculations with Mathematica than Great Gauss did in all his life (and he did a lot).

"***Mathematica and applications***" is a new book by Stephanos Trachanas, well known to all of us for his struggle for good and inexpensive books. At the University of Athens there is a *Trachanas fan club* consisting of almost all our physics students and I am also sure his books are very popular amongst physics and mathematics students in all Greek universities.

Trachanas "***Mathematica and applications***" is published by University Publications of Crete, as his previous and very popular books. In 370 pages Stephanos presents *Mathematica* for physicists and mathematicians in four parts and 12 laboratory exercises, structured with many exercises each. The book is suitable as a textbook and I sincerely hope that such courses will be adopted in Greek science curriculae.

My friend Vangelis Spandagos (Aithra publications, Athens, e-mail: aithra@otenet.gr), well known mathematician, writer and publisher of more than 140 books, has recently published nine ancient Greek books concerning astronomy, mathematics and physics by various writers. These books contain the original text, translations and extensive comments by Spandagos himself. It is the first time that these important books are published by a Greek publisher, while Vangelis comments are well written and worth reading. Greek astronomers with an interest on the history of astronomy will find important and unknown aspects of the status and evolution of our science in these books. These rare books are:

(1) Theodossius "***Spherica***",
(2) Euclides "***Phenomena***", is, in my opinion, one of the very first books of physics (mechanics),
(3) "***On cylinder section and conic section***" by Serinos,
(4) "***On the magnitudes and distances of the Sun and the Moon***" by Aristarchos,
(5) "***The synagoge***" by Pappos of Alexandria,
(6) "***Arithmetic, Introduction***" by Nicomachos Gerasinos,
(7) "***Comments to the first Elements of Euclides***" by Proclos,
(8) "***Introduction to the study of Celestial Phenomena***" by Geminos of Rodhes (I very much liked the personal views of Geminos on Astrology, since he has the best counter arguments),
(9) "***Katasterismes***" by Eratosthenes.

All these books are an important contribution to the Greek literature, as they give access to the original text. Their prices vary between 11 and 17 euros.

More books next time...

X. Moussas,
National and Kapodistrian University, Athens,
xmoussas@cc.uoa.gr

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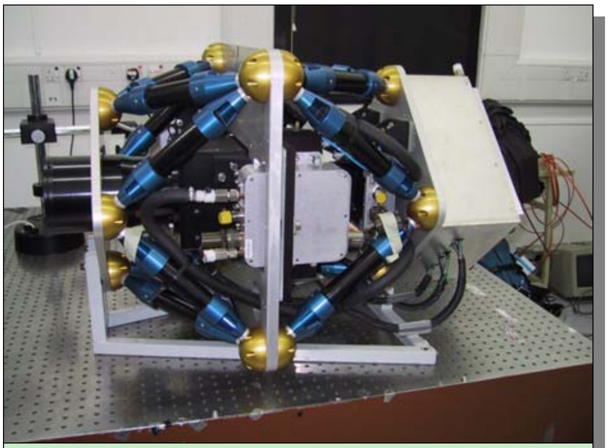
Comment'', was that there is an increase of the publication rate in all Institutes, which indicates a healthy and active research community, a conclusion to which we should all subscribe to.

Manolis Plionis,
Editor of Hipparchos

ULTRACAM: A Visiting Instrument for the 2.3m ARISTARCHOS Telescope

The 2.3m ARISTARCHOS telescope is approaching completion and shipment to its station at the peak of Neraidorahi on the mountain of Chelmos is awaited. At first light, the ARISTARCHOS telescope will not be equipped with any scientific instrumentation other than a standard imaging detector, a nitrogen-cooled SiTe 1kx1k CCD. The need for state-of-the-art instrumentation was recognized as early as 1997. Against this, an intitiative was taken with a Joint Research and Technology programme between Greece and Britain with the aim to host a new PPARC-funded instrument, ULTRACAM at the new Greek telescope (PIs : Harlaftis/NOA and Dhillon/Sheffield, 2001-2002). ULTRACAM is an ultra-fast, triple-beam camera using the latest in CCD technology, built by Sheffield, the Astronomy Technology Centre and Southampton (~300,000 £). The instrument has just had successful commissioning and its first science runs on the 4.2m WHT telescope at La Palma (11-19 May 2002). ULTRACAM is the first instrument of its type in the world and its main features are

- High-speed read-out (standard CCD cameras take ~1 minute). The 3 CCDs are 1024x1024 Marconi 47-20 CCD chips with San Diego State University (SDSU) controllers. Using frame-transfer techniques, the dead time can be as little as 5 msec for exposures longer than 1.73 secs. New techniques have enabled Peltier-cooling with dark noise only at 0.1 e^- per sec per pixel.
- Simultaneous measurement of 3 colours, essential for all non-periodic variability studies and for precise colours.
- Extended wavelength coverage with the use of dichroic optical elements to split the light beam into blue, green and red light (Sloan-type filters)
- Minimum maintenance to allow unattended operation (no nitrogen needed, no moving parts, remote-control through a web page)
- optimized algorithms for pipeline data reduction and real-time light curves



ULTRACAM on the optical bench at the 4.2m WHT, May 2002. The electronics hardware was built by the Astronomy Technology Centre/PPARC, Edinburgh (1998-2002)

During the construction phase of the instrument, we optimized its mechanical and optical characteristics so that it can be ported on the 2.3m ARISTARCHOS telescope with ease. The principle was that the instrument is permanently mounted on the telescope and be ready for remote observation. This is particularly attractive operationally. Therefore, the weight was split so that the detectors/optical system is mounted on one of the cassegrain side ports (max load of 100 kgs) and the electronics box on the antidiametrical port for balance. The mechanical and optical dimensions were worked out to meet the constraints of the telescope's instrument ports. An f/8 optical collimator was designed (ATC/Sheffield/NOA), ordered and constructed (SPECAC/NOA/Sheffield) in order to match the f/8 telescope beam to the instrument optics. Optical fibres and other service cables were defined and installed to the telescope (notably, this resulted in the installation of an instrument cable wrap on the telescope by Zeiss for which no provision had been made before). The instrument can be permanently hosted on the telescope as a common-user instrument against some minor exchange of telescope time to the Universities of Sheffield and Southampton.

Composite 3-colour ULTRACAM image of the globular cluster M13 (2-sec exposure with 4.2m WHT, 17 May 2002).

Any observing programme can be achieved down to B=24 mag with 1800 sec exposure for a point source(S/N=6 with grey moon, seeing 1", and airmass 1; see S/N calculator at ULTRACAM's web page). Example observing programmes are monitoring optical afterglows of Gamma-Ray Bursters, quasar gravitational lenses, AGNs and variable stars. However, the instrument's particular strength lies in the high temporal resolution simultaneously in 3 colours. The use of ULTRACAM with the 2.3m ARISTARCHOS telescope will result in a significant upgrade of the scientific potential of the 2.3 ARISTARCHOS telescope and will appeal to a much larger user community. The instrument is available for shipment to Greece as soon as the telescope has first light. For more information on the instrument see ULTRACAM's page **http://www.shef.ac.uk/~phys/people/vdhillon/ultracam/index.html**

E. Harlaftis, National Observatory of Athens
V. Dhillon, University of Sheffield
T. Marsh, University of Southampton

Continued from page 4

studies of various self-similar solutions, namely that in the largest portion of them cylindrical collimation is obtained only after some oscillations of decaying amplitude in the jet-width appear (Vlahakis & Tsinganos 1997, MNRAS, 292, 591, Fig. 1a).

A *fourth* issue, nevertheless, is that observations seem to indicate that jets may inherently be variable. Thus, time-dependent simulations may be useful for a detailed comparison with the observations. Bogovalov & Tsinganos (1999, A&A, 305, 211 and 2000, A&A, 356, 989), presented time-dependent simulations of jet formation to large distances from a central source by using a new method for the continuation of the small simulation box solution to very large distances. They also examined the efficiency of magnetic rotators of various strengths in transforming rotational energy to directed kinetic energy and how a wide range of rotation rates affects the poloidal geometry of a magnetic field, (Fig. 3).

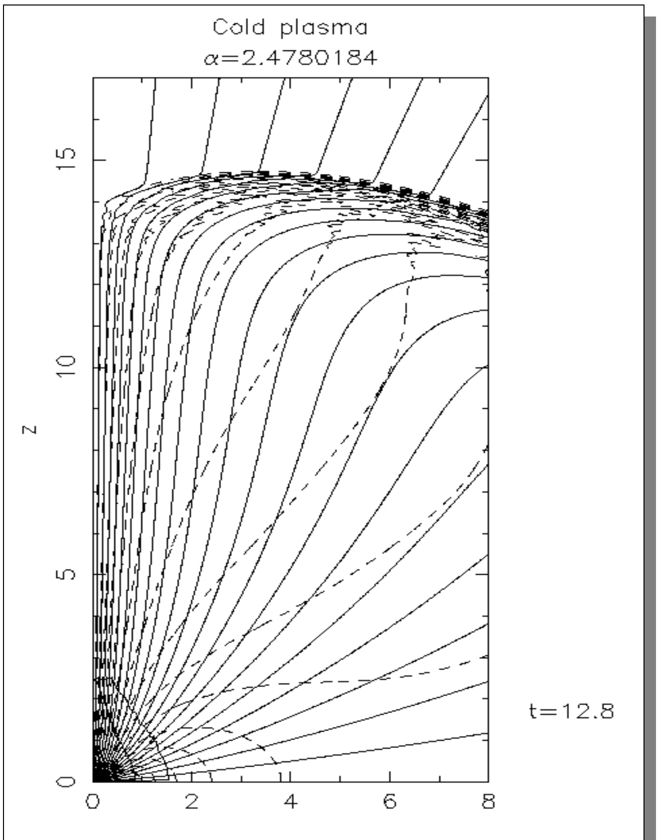


Figure 3: A near zone snapshot on the poloidal plane (Z, r) from the simulation showing the change of the shape of the poloidal magnetic fieldlines from an initially uniform with latitude radial monopole and before a stationary state is reached. Distances are given in units of the Alfven radius R_a and time in units of the Alfven crossing time $t_a = R_a/V_a$.

Another open and challenging modern question is to apply the relativistic MHD theory for the modeling of outflows producing gamma-ray bursts. Cosmological gamma-ray bursts (GRBs) seem to be one of the most energetic phenomena in the universe, after the Big Bang. Their energy output corresponds to a sizeable fraction of a solar mass converted entirely into energy in a few seconds. Their high photon energy and short duration implies that the decelerating flow which produces the gamma-rays is moving towards the observer with Lorentz factors about $10^2 - 10^3$ in order to avoid photon-pair interaction, i.e., their speed differs from c by one part in ten to one hundred thousands (Lithwick, Y., & Sari, R. 2001, ApJ, 555, 540). In other words, they are the most (special and general) relativistic objects we know of. Also the central engine must be capable to collimate the outflow to opening angles at most a few degrees, as afterglow fitting shows (e.g., Panaitescu, A., & Kumar, P. 2001, ApJ, 554, 667). Contrary to the fireball model, a Poynting-flux dominated outflow, naturally explains the collimation, alleviates the baryon contamination problem (as it corresponds to smaller luminosity), and also diminishes the photospheric emission (which is non-negligible in the fireball model, e.g., Daigne, F., & Mochkovitch, R. 2002). Thus, it provides the most plausible mechanism of energy extraction.

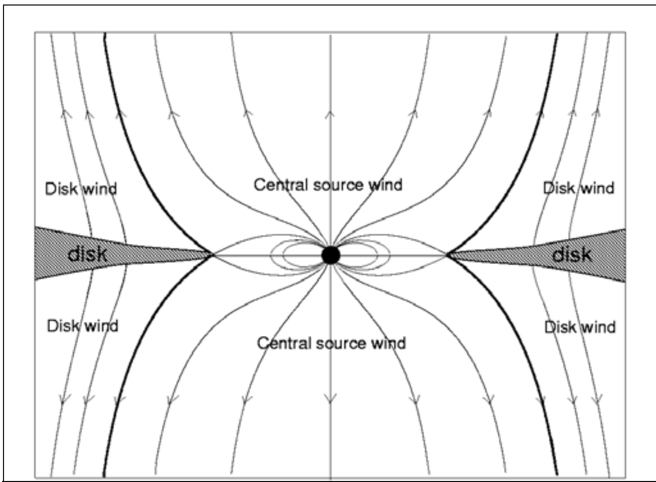


Figure 4: Illustration of a model where a slowly rotating central source emits a roughly radially expanding at the base outflow which is forced to collimate by the wind from the fast rotating inner edges of the surrounding accretion disk.

The difficult frontier of the study of relativistic MHD outflow has already been scratched by the radially self similar model of Vlahakis & Konigl (2001, ApJL, 563, L129) which has cylindrical asymptotics. In this preliminary but important study it has been demonstrated through exact self-similar solutions that the thermal force (which dominates the initial acceleration) and the Lorentz force (which dominates further out and contributes most of the acceleration) can convert up to about 50% of the initial total energy into asymptotic baryon kinetic energy. However, it will be very helpful to examine with other models which do not become asymptotically cylindrical how the flow is accelerated and Poynting energy is transferred to kinetic energy. The efficiency of this mechanism is of crucial importance in examining the energetics of the central engine. This approach, will also examine how the flow is collimated and predict the final opening angle.

Continued from page 2
in April. We are waiting now for the start of the summer season which should see the finishing phases of the telescope and building projects!

3. "Theory, Observation & Simulation of Turbulence in Space Plasmas" (by L.Vlahos)

A new Research Training Network "Theory, Observation and Simulation of Turbulence in Space Plasmas", has been funded by the European Commission for 4 years, starting in March 2002.

The network will provide extensive training through summer schools, smaller topical workshops, and exchanges of personnel between the groups, so that there will be significant opportunities for travel. We also anticipate that successful applicants will move between groups during their appointment.

The network invites applications for 6 (six) post-docs to work on a range of projects relating to all aspects of turbulent plasmas in the Sun and solar wind. We anticipate filling these positions beginning in August 2002, and they will be available for 2.5 to 3 years depending on the group.

The main scientific themes of the network are:

- The analysis of observations of solar and interplanetary magnetohydrodynamic (MHD) turbulence.
- The development of theoretical models and numerical simulations of turbulent plasmas, both at the Sun and in the solar wind.
- The generation of "observables" from these models that permit a direct forward comparison between model and data.
- The development of integrated theories for the production and propagation of energetic particles in turbulent systems.

There are six research groups involved:

Imperial College, London, UK. (Leader and network coordinator: Peter Cargill: p.cargill@ic.ac.uk)

Universita degli Studi di Firenze, Florence, Italy. (leader Marco Velli: velli@arcetri.astro.it)

Aristotle University of Thessaloniki, Greece (leader LoukasVlahos: vlahos@astro.auth.gr)

Institute d'Astrophysique, Orsay, France (leader Jean-Claude Vial: vial@ias.u-psud.fr)

University of Oslo, Oslo, Norway (leader Viggo Hansteen: viggo.hansteen@astro.uio.no)

Universita degli Studi della Calabria, Italy (leader Francesco Malara: malara@fis.unical.it)

Further information, including the specific scientific goals of each of the teams is available on the network web site (http://www.sp.ph.ic.ac.uk/rtn). Applicants are strongly encouraged to apply to any of the above institutions (e-mail to team leader), with a copy to the network coordinator(p.cargill@ic.ac.uk). Applications should include a CV, list of publications, and the names of two scientists familiar with their work. Salaries will be commensurate with the appropriate national rates for Newly graduated post-docs. Applicants must either be a national of a EU or associated member state, or have resided in the EU for at least 5 years, and be under 36 years of age. Postdocs will be required to work in a country of which they are not citizens. All network teams are committed to a policy of equal employment opportunity.

4. Astronomical seminars during the academic year 2001-02 in Thessaloniki (by H. Varvoglis & N.Stergioulas)

The Section of Astrophysics, Astronomy and Mechanics of the University of Thessaloniki organizes each year a series of seminars on topics related to the research fields of the Section. The seminars organized during the academic year 2001-2002 addressed a wide range of research topics, from General Relativity to Dynamics. In what follows we give a list of the titles of the talks and the corresponding speakers, in order to present indirectly the topics where the Thessaloniki group has an active research interest.

1. **The Cosmological and Physical Consequences of the Preon Structure of Dark Matter (**Prof. *Vladimir Burdyuzha*, Lebedev Physical Institute, Moscow)
2. **Coronal Holes and the Solar Wind (**Dr. *Spyros Patsourakos*, Naval Research Lab, Washington)
3. **The Relaxation Time in N-Body Systems (**Dr. *Christos Vozikis,* Aristotle University of Thessaloniki)
4. **Chaos, Escape and Gaps in the Asteroid Belt** *(Kleomenis Tsiganis*, Aristotle University of Thessaloniki)
5. **Towards a Complete Description of Spacetimes Containing Neutron Stars (**Dr. *Uli Sperhake*, Aristotle University of Thessaloniki)
6. **Sunspot Oscillations Observed with THEMIS (**Dr. *Kostas Tziotziou*, Observatoire de Paris, Meudon)
7. **Gravitational waves from pulsating stars and stars in binary systems (**Dr. *Emanuele Berti*, Aristotle University of Thessaloniki)
8. **Isochrone Resonances and Non-Twist Phenomena in Hamiltonian Systems (**Dr. *George Voyatzis*, Aristotle University of Thessaloniki)
9. **Spectral evolution of classical double radio sources (***Konstantina Manolakou,* Max-Planck-Institut für Kernphysik, Heidelberg*)*
10. **Numerical simulations of linear and non-linear dynamo action (**Dr. *Vassilis Archontis*, Niels Bohr Institute, Copenhagen)
11. **Rotating Relativistic Stars and Numerical Relativity (**Dr. *Nikolaos Stergioulas*, Aristotle University of Thessaloniki)
12. **Statistical Description of Chaotic Dynamical Systems and Applications to Celestial Mechanics (**Dr. *Harry Varvoglis*, Aristotle University of Thessaloniki)

It should be noted that, besides the above, other talks related to Astronomy were given in the General Seminar of the Physics Department as well. The

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most relevant, to the members of our Section, talks were the following:

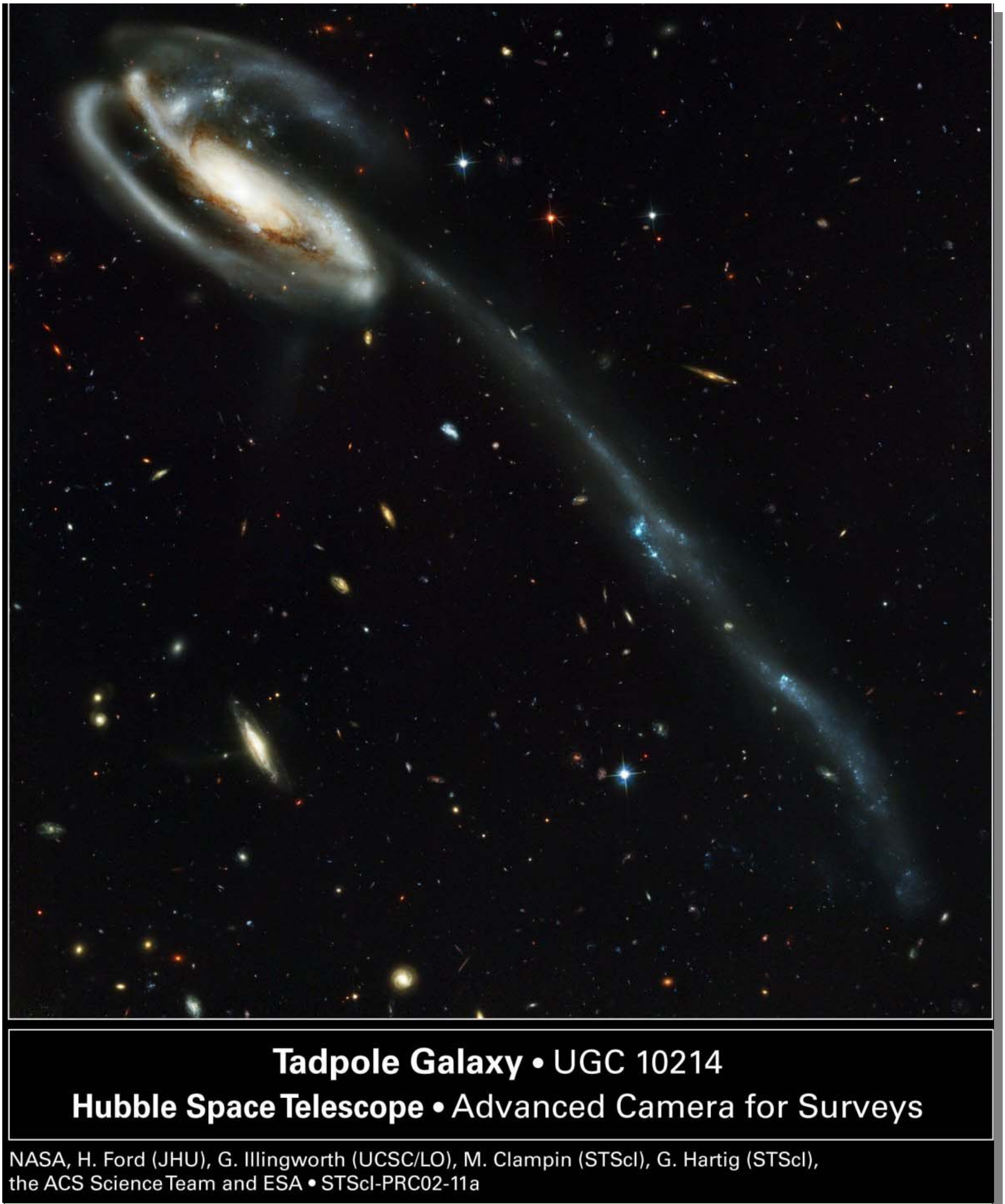
- **Origin and early evolution of the solar system** (Dr. *Alessandro Morbidelli*, Observatoire de Nice, France)
- **In search of the primordial matter of the Big Bang (** Prof. *Apostolos Panagiotou*, University of Athens)
- **The death and afterlife of a star** (Prof. *Jocelyn Bell – Burnell*, University of Bath, U.K.)
- **Cosmology in 2002: Understanding our Universe** (Prof. *Roy Maartens*, Portsmouth University, Portsmouth)

5. International Conferences in 2003 (by M. Plionis)

1. **Clusters of Galaxies: Probes of Cosmological Structure and Galaxy Evolution** (26-31 January at Carnegie Observatories, Pasadena, USA). *http://www.ociw.edu/ociw/symposia/symposium3*
2. **Origin and Evolution of the Elements** (16-21 February at Carnegie Observatories, Pasadena, USA). *http://www.ociw.edu/ociw/symposia/symposium4*
3. **Gravitational Lensing: Strong, Weak, and Micro** (6-11 April at Grimentz, Switzerland). Info: gmeylan@stsci.edu
4. **Future Directions in Asymptotic Giant Branch Star Research** (10-11 April 2003 at Leiden, The Netherlands). *http://www.strw.leidenuniv.nl/~agbworkshop/*
5. **Supernovae (10 Years of SN1993J)** (22-26 April, Valencia, Spain). *http://www.uv.es/2003supernovae*
6. **The Multiwavelength Approach to Unidentified Gamma-Ray Sources** (19-23 May, The University of Hong Kong, Hong Kong, China). http://www.physics.hku.hk/~2003conf/
7. Astrophysics of Dust (26-30 May, Estes Park, Colorado, USA). *http://www.physics.utoledo.edu/~aod03/*
8. **The Riddle of Cooling Flows in Galaxies and Clusters of Galaxies** (31 May - 4 June, Charlottesville, VA, USA). *http://www.astro.virginia.edu/coolflow/*
9. **Multiwavelength Cosmology** (16-20 June, Mykonos Island, Greece). Info: mplionis@astro.noa.gr
10. **Where Cosmology and Fundamental Physics Meet** (23-26 June, Marseille France). *http://www.astrsp-mrs.fr/marseille2003/*
11. **28th. International Cosmic Ray Conference** (31 July - 7 August, Tsukuba, Japan). *http://www.icrr.u-tokyo.ac.jp/icrc2003/*

For continued updates see *http://cadcwww.dao.nrc.ca/meetings/meetings.html*

An ACS image of a pair of interacting galaxies in the constellation of Coma Berenices at a distance of $300x10^6$ light years. According to the hierarchical structure formation scenario such collisions are believed to occur frequently at the high-redshift Universe between the first gravitationally collapsed structures. Indeed, deep images of the Universe, like the HDF and these newly acquired ACS images seem to point in such a direction.
Image Credit: NASA, H. Ford (JHU), G. Illingworth (USCS/LO), M.Clampin (STScI), G. Hartig (STScI), the ACS Science Team and ESA.



This composite color image of the galaxy UGC 10214 (dubbed Tadpole) at a distance of ~420 x10^6 light years, was taken by the new and amazing Advanced Camera for Surveys (ACS), aboard NASA's Hubble Space Telescope, and was constructed from images taken in near-infrared, orange, and blue filters. The distorted shape of the galaxy is caused by a small blue compact galaxy visible in the upper left corner of the image, which seems to have shot through the large Tadpole galaxy. As a result a long tidal tail of gas, young stars and star clusters, each containing hundreds of thousands of stars, is produced that stretches out more than 280,000 light-years.

For more see: ***http://oposite.stsci.edu/pubinfo/2002t.html***

Image Credit: NASA, H. Ford (JHU), G. Illingworth (USCS/LO), M.Clampin (STScI), G. Hartig (STScI), the ACS Science Team and ESA.