D I S S E R T A T I O C V M
NVNCIO SIDEREO III | 3

P R A G A E — M M V I 16. V I I I. — S E R I E S T E R T I A

The Inaugural Ceremony

Petr Lála

The 26th General Assembly was formally opened yesterday, during a well attended Inaugural Ceremony at the main Congress Hall. It was a quite balanced mixture of speeches, performances and lectures, skillfully moderated by Jan Palouš, Chair of the National Organizing Committee.

The Ceremony began with opening words by outgoing IAU President Ronald Ekers and with the Czech Republic anthem performed by Prague Lesser Town Singers.

The official addresses included a message from the president of the Czech Republic Václav Klaus, and speeches delivered by the Counselor of the City Hall of Prague, President of the Academy of Sciences of the Czech Republic Václav Pačes and by Deputy Rectors of the Masaryk University in Brno, Charles University in Prague and Rector of the Czech Technical University also in Prague.

The golden thread all through the speeches was the dedication of local authorities and institutions to provide the best environment for GA deliberations in order to justify the trust of IAU in deciding to convene the GA in Prague for a second time.

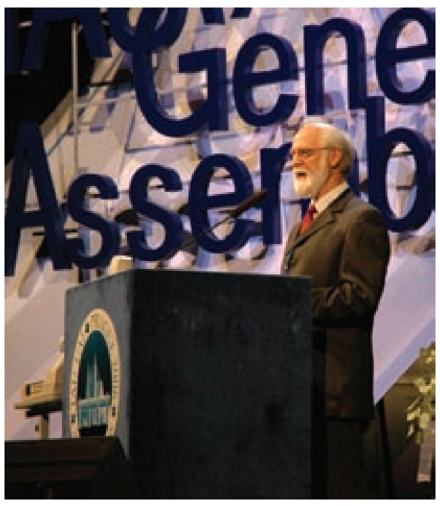
The audience was also welcomed by Luboš Perek, doyen of Czech astronomers. In a nutshell, he shared his recollections on personalities and developments in between the GA in Prague in 1967 and 2006. (The text of his presentation can be found in this issue of Nuncius Sidereus.)

The Children's Traditional Ensemble Rosénka and Prague Lesser Town Singers performed before and after the presentation of the Peter Gruber Foundation Cosmology prize for 2006 to John Mather and the Cosmic Background Explorer (COBE) team and of two fellowships for young astronomers.

Last but not least, Alena Hadravová gave an interesting lecture describing the role of Prague *genius loci* in the development of astronomy from the Middle Ages to the present time.

The Inaugural Ceremony was followed by the first session of the General Assembly and later on by a cocktail welcoming all visiting guests. ❐

"TO PLUTO BE OR NOT UB_{313}, THAT IS THE QUESTION!"

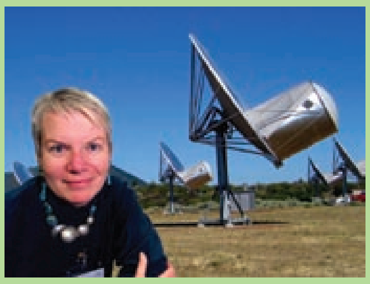


ABSTRACT OF TODAY'S INVITED DISCOURSE

Today's Invited Discourse at 6:15 p.m. in the Congress Hall

The Evolution of Life in the Universe: Are We It?

Jill Tarter, SETI Institute



In his book "Many Worlds", Steven J. Dick has chronicled the millennia of discourse about other inhabited worlds, based upon deeply held religious or philosophical belief systems. The popularity of the idea of extraterrestrial life has waxed and waned and, at its nadir, put proponents at mortal risk. The several generations of scientists now attending this General Assembly of the International Astronomical Union at the beginning of the 21st century have a marvelous opportunity to shed light on this old question of habitable worlds through observation, experimentation, and interpretation, without recourse to belief systems and without risking our lives (though some may experience rather bumpy career paths). The newly-named and -funded, multi-disciplinary field of astrobiology is extremely broad in its scope and is encouraging IAU members to learn and speak the languages of previously disparate disciplines in an attempt to answer the big picture questions: "Where did we come from?" and "Are we alone?" These are questions that the general public (our ultimate paymasters) understand and support, and these are questions that are attracting students of all ages to science and engineering programs. These questions also push the limits of instrumentation to explore the cosmos remotely across space and time, as well as to examine samples of interplanetary space returned to the laboratory and samples of distant time teased from our own Earth.

Within my personal event horizon, the other planetary systems long-predicted by theorists have been revealed, along with many whose structure was not predicted. The 'just-so' conditions requisite for the comfort of astronomers have been understood to be only a very narrow subset of the conditions that nurture extremophilic microbial life. Thus the potentially habitable real estate beyond Earth has been greatly expanded and within the next few decades it may be possible to detect the biosignatures or technosignatures of any inhabitants.

John Downland

What poor astronomers are they

What poor astronomers are they take women's eyes for stars,
and set their thoughts in battle 'ray, to fight such idle wars,
when in the end they shall approve
'tis but a jest drawn out of love.

But yet it is a sport to see how wit will run on wheels,
while will cannot persuaded be, with that which reason feels;
that women's eyes and stars are odd,
and Love is but a feigned god.

But such as will run mad with will, I cannot clear their sight,
but leave them to their study still, to look where is no light.
'Till them too late we make them try,
they study false astronomy!

John Downland (1563–1626), was unsurpassed in his day as a lute virtuoso, and the composer of 88 lute songs. Since the early twentieth century, Dowland's excellence as a songwriter has been well established; many of his compositions for lute – long shrouded in obscurity – have become well known.

Today's programme: (wednesday 16/8)

- Symposia S235, S236, S237
- Joint Discussions JD01, JD02, JD03, JD04, JD05
- Special Session SPS1
- Peter Gruber Foundation Cosmology Prize Winner Lecture
- Invited Ddiscourse – Jill Tarter

Interview with John C. Mather

2006 Gruber Cosmology Prize recipient

Michael Prouza

You started your work on the COBE proposal as a post-doc in 1974. The satellite was eventually launched in 1989. Do you consider a 15-year development to be adequate or was it possible to have COBE ready sooner?

As it turned out 15 years was barely enough, though in retrospect it seems to be a long time. We had such a huge number of technical challenges that we were fortunate to get the project done in 15 years. None of the technologies were as mature as we believed, and the scientists and engineers were doing this kind of project for the first time. If you read the book (The Very First Light) you will get a sense of the incredible accomplishment of the team.

When did you actually begin to believe that this mission would go and fly? When did you receive the first real funding dedicated directly for the development of individual instruments?

After the first science team was chosen in 1976, I always believed that this project would fly, because it was unique, the only possible way to answer the critical questions about the Big Bang. Also, Nancy Boggess, my counterpart at NASA HQ, was articulate and determined to make the mission happen. She was responsible for three major missions in the infrared: IRAS, COBE, and Spitzer, and all have been brilliant successes, despite complaints and opposition from other areas of astronomy. We were approved for flight in 1982, I think, after it was clear that our precursor satellite, the IRAS, was past its major difficulties. IRAS was launched successfully on January 25, 1983.

What results did you expect? Did you guess that COBE would find any (and what type of) anisotropy?

I expected about what we found: a nearly-perfect blackbody spectrum, anisotropy at the level we found, and a near and far IR background radiation field. Theorists had agreed shortly before the COBE launch that the anisotropy must exist because of the galaxy correlation functions. Many theorists were surprised that the background spectrum was so perfect, but I wasn't – there are a lot of photons per atom, and there were no plausible energy sources to modify the spectrum after decoupling. I also was expecting the near and far IR background excess found by DIRBE, because I thought a lot of galaxies are dusty and they would convert a lot of starlight into IR and far IR.

What was your favorite cosmological model in 1974 and what is it now?

Good question. I don't remember 1974 well enough but I don't think there was much to think about. We knew the universe must be slowing down because of gravity (that was wrong) and we had no clue about inflation. When inflation was first suggested much later, a common reaction was that it was silly because it was just cooked up to solve a problem, and there would never be a way to test it. Dark Matter was beginning to be discussed but could be argued away as experimental error. Dark Energy and even the Cosmological Constant were not popular. I was an agnostic. My view was and is that Nature doesn't care a bit what we think is "simple" or "elegant", and especially in astronomy, where energy flows from hot to cold favor the development of complexity. The same energy flows favor life, which is pretty complex, and would never have been predicted from basic principles.

How many dimensions has our universe to your opinion?

I don't have a serious opinion about that. I can see only three and I think I remember the fourth. The subatomic ones are not tangible but I would not be surprised at many many.

The precise knowledge of cosmic microwave background (CMB), based on the pioneering work of the COBE team, is the current cornerstone of the observational cosmology. Are you able to name at least one topic in experimental cosmology that can prove to be comparably fruitful in the future? (E. g. as advice to current young postdocs or graduate students, where to look for interesting opportunities.)

Well, the current bandwagons are three: dark energy and dark matter, and the polarization of the CMB. A huge investment is going into astrophysical studies of dark energy, because there's no other way. The dark matter is also exciting but almost as hard to study. The CMB polarization has the potential to tell us about the scalar/tensor nature of the Big Bang forces and inflation, so that's also pretty exciting.

COBE, WMAP and Planck: Which of these satellites will be considered as the most important by future historians of science in 2106? Why?

Darned if I know. WMAP has found out an awful lot more about the anisotropy than COBE did, and I have my doubts that Planck will be as much improvement as its builders hoped. COBE found out that there was something to study, so it opened the field and started an industry, so it's important historically. Which is more important, Christopher Columbus or Albert Einstein? They're not really comparable.

You are currently the Senior Project Scientist for the James Webb Space Telescope (JWST). What will be the most important observation targets of this telescope? What discoveries may we anticipate?

Do you think that June 2013 is the final date of launch, or some further delay is still possible? (Why?)

The JWST will be pointed at every target of interest to astronomy, because it's a general purpose user facility. We think the main topics will be: 1) the first light in the universe, from Population III stars or whatever; 2) the assembly of galaxies, from whatever parts may exist; 3) the formation of stars and planetary systems, and 4) the conditions for life. We anticipate finding out a lot about each topic. We should see galaxies and first stars that are much earlier and farther away than any we have yet seen, we hope to see planets around other stars and have a chance to measure their chemical and physical properties, and we might even see a few Earth-like ones in transit against their home stars. Exoplanet studies were barely dreamed of when JWST was first conceived. Now there's a serious proposal to build an external occulter, flying 25,000 km away from JWST, that would block starlight and reveal Earthlike planets quite well. See "New World Observer" and Webster Cash at the University of Colorado.

June 2013 is definitely the launch date for JWST. My crystal ball is perfect. More seriously, anyone can see that NASA's budget is in crisis, and nobody can predict what that means. We have no technical worries now that would lead to a launch slip, and we have budgeted a prudent and ample reserve of funds to handle things we can't specifically identify late in the program. So 2013 is quite possible.

Will you dare to predict any name of potential future recipients of the Cosmology Gruber Prize?

No, thanks.

I have read in one of your interviews that your first scientific experience was the observation of Mars opposition in 1954, at age eight. Have you also observed the last closest Mars approach last November? What was the telescope used then and what was used now?

In 1954 we had a 2-inch diameter refractor my dad bought at Sears Roebuck. It was a great disappointment for Mars. I didn't try hard to see Mars the last time it came close but now my wife has bought me a nice 8-inch Celestron that works quite well. Mars is still awfully small and suburban Washington is not a great place for private astronomy. Space telescopes are a lot better! ❐

Gruber Cosmology Prize

The Cosmology Prize of the Peter Gruber Foundation was established in 2000. The prize, consisting of gold medal and $250,000 cash prize is awarded annually to an outstanding astronomer, cosmologist, physicist, mathematician, or philosopher of science, selected from an international pool of candidates by a board of distinguished peers in their fields. Since 2001, the Cosmology Prize is co-sponsored by the International Astronomical Union. The list of previous recipients of the prize is following: 2000 – Phillip James E. Peebles & Allan R. Sandage, 2001 – Sir Martin Rees, 2002 – Vera Rubin, 2003 – Rashid Alievich Sunyaev, 2004 – Alan Guth & Andrei Linde, and 2005 – James E. Gunn.

Dr. John C. Mather biography

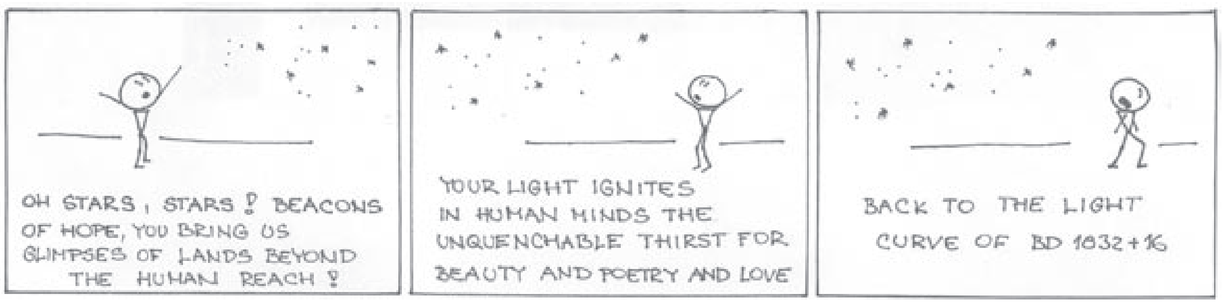
Dr. John C. Mather, Senior Astrophysicist, Goddard Fellow, and Senior Project Scientist for the James Webb Space Telescope (JWST), is responsible for ensuring the scientific success of the JWST. He has been Goddard's lead scientist for JWST since studies were initiated Oct. 30, 1995. He is a member of the Infrared Astrophysics Branch. Previously, he served as Project Scientist for the Cosmic Background Explorer satellite (COBE), and as Principal Investigator for the Far Infrared Absolute Spectrophotometer (FIRAS) on COBE. He organized the first proposal for the COBE in 1974 and led the scientific effort through the completion of the mission. As FIRAS PI he measured the cosmic microwave background radiation spectrum to the unprecedented precision of a part in 100,000, showing that it matches the spectrum of a perfect blackbody and must have originated in the primordial Big Bang of the universe. He served as Head of the Infrared Astrophysics Branch from 1988–1989 and from 1990–1993.

Dr. Mather began his career at NASA's Goddard Institute for Space Studies as a Research Associate of the National Academy of Sciences. He received a Bachelor of Arts degree in Physics from Swarthmore College in Swarthmore, Pennsylvania, and a PhD in Physics from the University of California at Berkeley.

An Astronomers' Data Manifesto: Mining science from Archives

Ray Norris

Did you know that three times as many papers (and citations) result from data retrieved from the Hubble archive as those based on the original data? So, in principle, observatories can quadruple their science by making their archive data public. Try telling that to a politician concerned with bangs-per-buck. It may not be news. All OECD science ministers have signed a principle, which says that all publicly-funded data should be placed in the public domain. And at the last IAU GA in Sydney, we all voted to support a resolution urging our publicly-funded observatories to do so. So why are most archive data (with some notable exceptions) still hidden from the bright light of the internet? Funding? Or poor systems to access them cost-effectively? If we want to maximise our science per dollar, we need to find better ways of doing this. Join the search at Special Session SPS6: "Astronomical Data Management" on Tuesday afternoon, August 22.



First science with SALT:

Observations of an eclipsing polar

Accreting gas onto compact stars is a common occurrence in astronomy; it's one of the indirect ways in which we detect black holes, especially through their X-ray emission by the accreting gas. It's also believed to be the fundamental cause of the Type Ia supernova explosions by which we have recently measured the acceleration of the universe. The study to be described below is of a polar, an example of a compact object accreting gas from a nearby companion. Polars have the added feature that the compact object has a very strong magnetic field. They are the most readily accessible objects we know for studying gas accretion in strong magnetic fields.

Darragh O'Donoghue, South African Astronomical Observatory

The Southern African Large Telescope (SALT) was inaugurated in November 2005. One of the capabilities which SALT and its instruments has, and which very few large telescopes have, is the ability to take very rapid pictures of stars. This is intended to enable us to study the rapid brightness changes in exotic stars. One such class of stars are called "polars". These are binary stars: two stars orbiting each other. Polars are amongst the closest binaries we know: the orbit of the two stars would fit inside the Sun! The polar which SALT has studied takes only one and a half hours to complete an orbit. Despite being a pair of stars, they are so close, you would see them as only one star in a telescope.

In the binary system which SALT has studied, one of the stars is like the Sun, only cooler, redder and about 1/3 of the mass and radius of the Sun. The other star is a very dense white dwarf star: its mass is similar to the Sun's, but it is squeezed into the size of the Earth (whose diameter is about 1 per cent that of the Sun). The white dwarf's gravity is very large: white dwarf gas the size of a dice would weigh as much as a small truck.

The amazing thing about these binaries is that the white dwarf is gravitationally sucking the outer layers off its companion. The white dwarf also has a huge magnetic field (30 million times the Earth's magnetic field) which channels the gas coming off the cool star down to its magnetic poles. Figure 1 is an artist's impression of what a typical such binary system might look like: the cool, red star is in the background with the stream of gas being sucked off it (shown in white) and finding its way down to the white dwarf shown at lower right.

Figure 1. The artist Bob Watson's painting of a "polar".

Imagine now looking at a binary system like this from "behind" the cool, red star with your viewing angle such that the red star, once in orbit, eclipses the white dwarf and cuts off your view of it. If you had a telescope like SALT, and a camera on it like its camera SALTICAM, which can make brightness measurements every 100 milliseconds, you would see the brightness of the system dim because the light from the gas crashing on to the magnetic poles of the white dwarf completely outshines the light from everything else. Figure 2 illustrates of your view of the system at the start of eclipse (left) when the red star is just about to eclipse the one magnetic pole, labeled Spot 2, and at the end of the eclipse (right) when the red star has just uncovered Spot 2.

Figure 3 is a sequence of brightness measurements and the evidence for what has just been described can be seen there sequence. If you look closely at Figure 3, you will see it has a first sudden brightness drop (Spot 2 disappearing), followed about 25 s later by a second sudden brightness drop (Spot 1 disappearing). Towards the end of the sequence there are sudden rises in brightness corresponding to the earlier sudden drops as the spots are uncovered. The gas stream between the stars also gives some light, and this accounts for the rounded shape of the bottom of the eclipse.

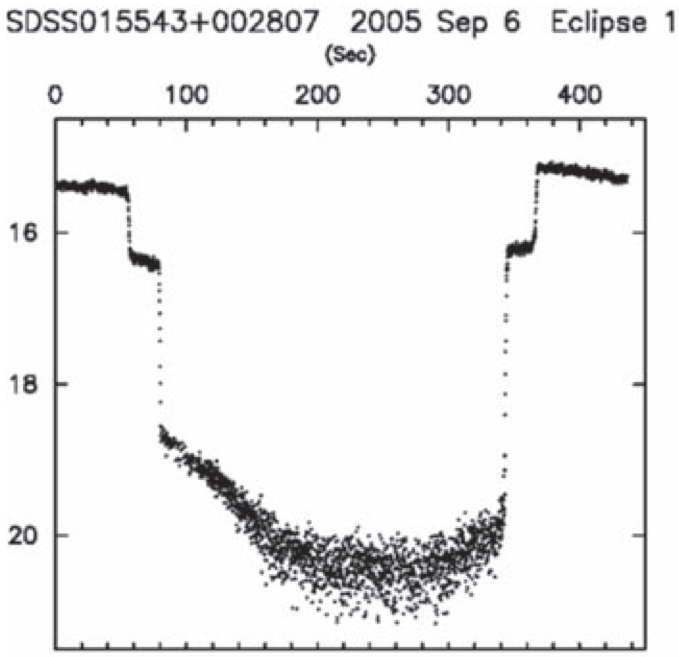


Figure 3. Sequence of brightness measurements of the polar. Each point is a 112 millisecond exposure.

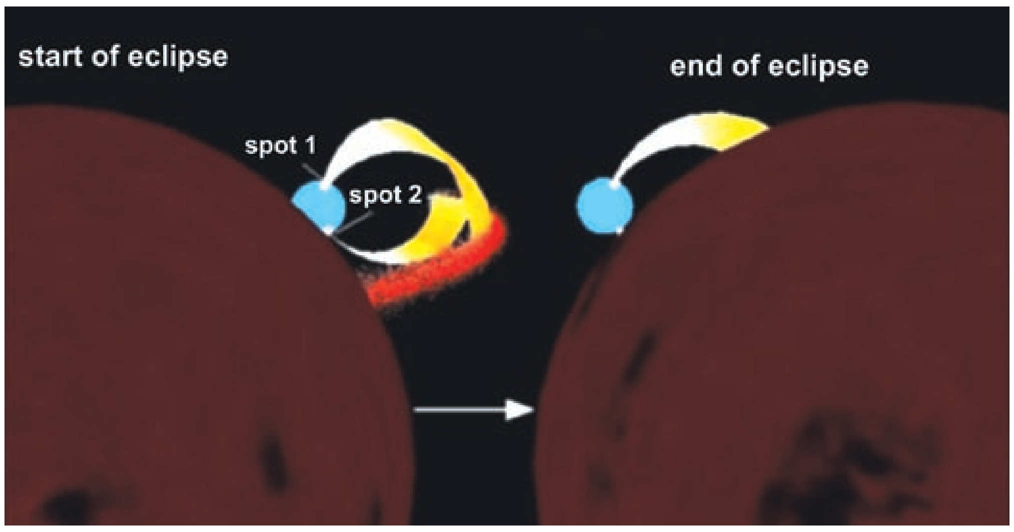
This sequence of measurements is better than anything that has been obtained before, and has been described in full scientific detail in the first scientific paper (or report) on the science from SALT.

These results have been accepted for publication in the scientific peer-reviewed journal Monthly Notices of the Royal Astronomical Society. An electronic preprint of the article is available online at **http://xxx.lanl.gov/archive/astro-ph**, entry number *0607266*.

SALT is especially suited to studying objects of the kind just described. Amongst the world's currently largest telescopes, it has a significant advantage over all the others for this kind of research, which will undoubtedly enable its astronomers to probe the mysteries of this kind of star.

For further information, contact Dr. Darragh O'Donoghue: +27 214 470 025, dod@saao.ac.za At the IAU General Assembly in Prague, contact Prof. Phil Charles or Dr. David Buckley. ❐

Figure 2. Earth observer's view of a polar at the start (left) and end (right) of eclipse.



Address at the Inaugural ceremony

Welcome after 39 Years

Luboš Perek

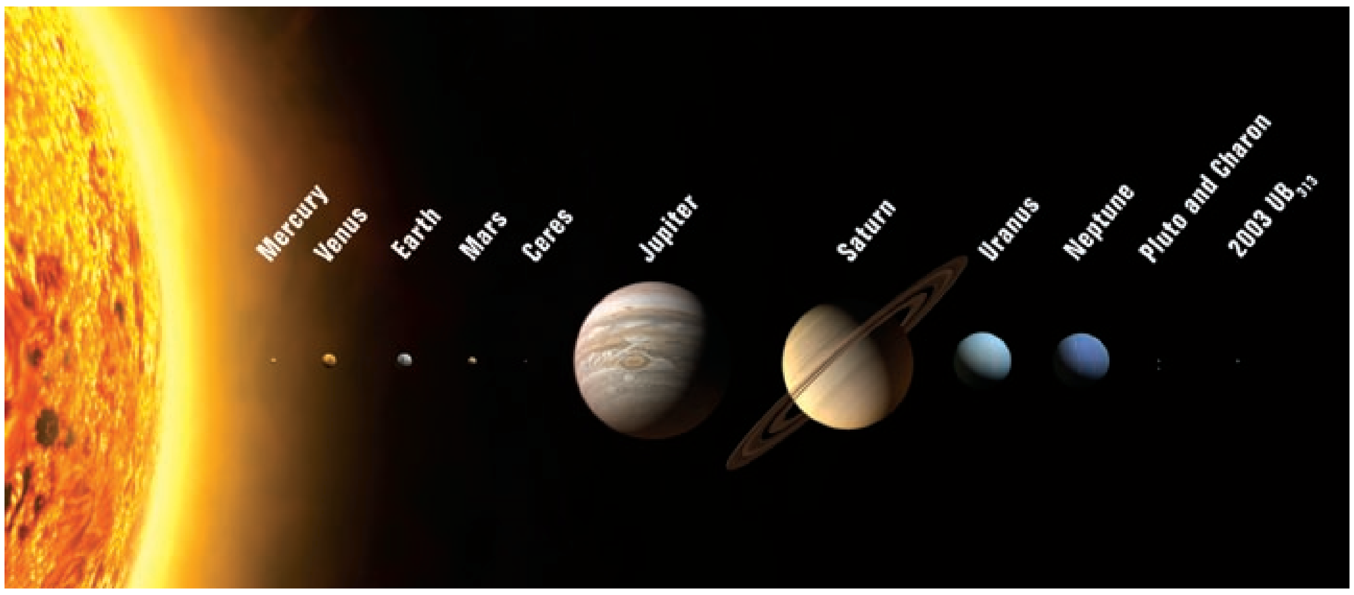
Ladies and Gentlemen,

at the thirteenth General Assembly of the IAU, held 39 years ago, I had the privilege to invite the audience to meet again soon in Prague. Thirty nine years is a short time in astronomy but in human life it means two generations. Many things have changed in that time. All branches of astronomy made substantial advances thanks to space research, to computer technology, and, in first place thanks to a larger number of human brains working in the field. It is impossible to give an account of all new discoveries and of new understanding of old problems. Be referred to 200 volumes of IAU Symposia and 200 volumes of IAU Colloquia which appeared in those 39 years.

There are things, however, which have not changed. Among them is the individual membership in the IAU, an important support of personal contacts across space and time. As regards space, we greet astronomers from 75 countries. As regards time, connecting past with the present, we have in Prague four former presidents of the IAU. The youngest, in terms of service, is Franco Pacini, whose name is closely connected with rotating neutron stars. He was preceded by Lodewijk Woltjer, a supporter of the Very Large Telescope at Mount Paranal. Yoshihide Kozai stands for lunisolar perturbations of satellite orbits. The oldest in service is Adriaan Blaauw. He put all runaway stars into their place in an improved cosmic distance scale. More than half a century ago, I had the honor and pleasure to share an office with Adriaan at the Leiden Observatory, where the atmosphere consisted not of air or oxygen but of pure astronomy.

Seven former General Secretaries, who devoted part of their lives to the IAU, are among us, starting with my predecessor, Jean-Claude Pecker, my lifelong friend, who attended more IAU congresses than anybody else. My successor, Kees de Jager, made the Sun his permanent residence. Further Jean-Paul Swings, supporter of Mars exploration. Derek Mc Nally, fighter against adverse environmental impacts, Johannes Andersen, director of the Nordic Optical Telescope, and Hans Rickman, observer of the comet impact on Jupiter.Names of all former presidents of commissions, professors, and colleagues who connect the past with the present are too many to be listed here and now. They are all welcome, as well as all those who will become friends and colleagues at this Assembly.

Ladies and Gentlemen, next time, please, do not wait 39 years. You are welcome any time.



IAU Planet Definition Committee

The IAU has been the arbiter of planetary and satellite nomenclature since its inception in 1919. The various IAU Working Groups normally handle this process, and their decisions primarily affect the professional astronomers. But from time to time the IAU takes decisions and makes recommendations on issues concerning astronomical matters affecting other sciences or the public. Such decisions and recommendations are not enforceable by any national or international law; rather they establish conventions that are meant to help our understanding of astronomical objects and processes. Hence, IAU recommendations should rest on well-established scientific facts and have a broad consensus in the community concerned.

Ron Ekers, President of the IAU

The boundary between (major) planet and minor planet has never been defined and the recent discovery of other "Trans-Neptunian Objects" (TNOs), including some larger than Pluto, triggered the IAU to form a working group on "Definition of a Planet" from its Division III members. While there was general agreement on all the scientific issues related to Solar System dynamics and physical properties of planets, the IAU Division III Working Group could not agree on aspects that were related to social and cultural issues, such as the status of Pluto. In order to include these broader aspects, the IAU Executive Committee (EC) formed a new committee whose membership had backgrounds in history, science publishing, writing and education as well as in planetary science.

Terms of Reference

The Planet Definition Committee of the IAU Executive Committee was charged with:

(i) discussing the broader social implications of any new definition of a planet and recommending a course of action that balances the scientific facts with the need for social acceptance of any change;

(ii) addressing the status of Pluto, and of the newly discovered TNOs in the light of recommendation (i);

(iii) considering whether the current naming procedures for planets and minor planets have exacerbated the problem of defining a planet and recommending whether revisions are needed; and

(iv) attempting to frame these recommendations as a resolution, or resolutions, that could be put before the Prague GA in August 2006 for possible adoption.

The Path to Defining Planets

Owen Gingerich, Harvard-Smithsonian Center for Astrophysics/IAU EC "Planet Definition" Committee chair

Celestial nomenclature has long been fraught with controversy. Galileo proposed to name the large satellites of Jupiter the "Medicean planets"; William Herschel named his new planet after the English monarch, George III; Hevelius honoured the defender of Vienna with "Scutum Sobieski"; and Bode named a northern constellation after the comet hunter Charles Messier. None of these appellations have stood the test of time except for the fragment "Scutum".

At its inaugural meeting in 1922, the IAU standardized the constellation names and abbreviations. More recently IAU Committees or Working Groups have certified the names of asteroids, satellites, and planetary and satellite features. Until now, however, the IAU has never named a planet, and it has been unclear whether there are potential planets to be named.

How, in fact, should the word "planet" be defined?

This was the controversial question facing the committee established by the IAU Executive Committee with the charge to recommend a definition for an IAU resolution. The seven members represented a spectrum of opinion and expertise. We all knew that modern scientific advances have taught us that the Solar System is a far more complicated place than William Herschel and his contemporaries ever imagined, not only containing an assortment of planets, asteroids, and comets, but rocks, gravel, dust, and ions. We met in Paris for a vigorous discussion of both the scientific and the cultural/historical issues, and on the second morning several members admitted that they had not slept well, worrying that we would not be able to reach a consensus. But by the end of a long day, the miracle had happened: we had reached a unanimous agreement.

On the scientific side, we wanted to avoid arbitrary cut-offs simply based on distances, periods, magnitudes, or neighbouring objects. One physical criterion seemed pre-eminent: was the object shaped by hydrostatic equilibrium, that is, was it basically a round object? This criterion became the basis of our proposed definition. Objects with mass above 5×10^{20} kg and diameter greater than 800 km would normally be considered to be in hydrostatic equilibrium, but borderline cases would have to be established by observation. Even among these round Solar System objects there is a distinct difference between the major planets, whose orbits lie near the ecliptic plane, and those smaller objects with more eccentric, tilted orbits. Had astronomers realized in 1930 that Pluto was smaller than our Moon and with a mass well under 1 % that of the Earth, perhaps some special designation would have been devised for it. On the cultural/historical side, combined with contemporary science, our committee felt that the time was ripe to recognize Pluto as the prototype of a different sort of planet. Consequently, we propose to distinguish between the eight classical planets discovered before 1900, and a new class of Trans-Neptunian Objects, for which we recommend the name "plutons."

The question immediately arises about the status of Pluto. Although Pluto remains a planet by the proposed definition, it will generally be preferable to call it a pluton to emphasise its role as the prototype for a physically distinct category of planetary bodies.

Specialists will at once recall that there are over a hundred so-called "plutinos," Trans-Neptunian lumps of rock, ice, and snow, each with the period 248 years (thus in a 3/2 resonance with the period of Neptune). These faint objects are in general not plutons. Plutons are at present very rare objects: Pluto, Charon, 2003 UB_{313}, and perhaps several more, and anyone who finds a new pluton should be appropriately celebrated.

Savvy astronomers will notice that our definition also makes Ceres a planet, and if Pallas, Vesta, and Hygeia are found to be in hydrostatic equilibrium, they will also have to be considered planets. Without making a formal definition, we suggest that it might be convenient simply to refer to these small round members of our inner Solar System as "dwarf planets."

Did our committee think of everything, including extra-solar system planets? Definitely not! Science is an active enterprise, constantly bringing new surprises. Undoubtedly some future IAU committee will have to revisit this question and define the upper limit for "planet", probably well before 2106! ❐

The Process of making a Resolution on the Definition of a Planet

Robert Williams, Space Telescope Science Institute, Vice President of the IAU

Statements of scientific importance are expressed by the IAU in resolutions of the General Assembly. Although resolutions are non-binding they do represent the consensus scientific judgment of the members, and are arrived at by a process that involves member input and debate. As explained in the accompanying articles the question of the definition of a planet is of great interest within the Union and among the public, and Division III and the Executive Committee are attempting to set forth criteria that define planets and provide for a nomenclature for the different Solar System objects.

A Working Group under Division III was established to formulate a recommendation on the definition of a planet that could be put before the Executive Committee. Although that Working Group did not achieve a clear consensus, it did succeed in defining the important criteria and framing the discussion of issues to be considered. The EC studied the Division III Working Group report and decided to form its own advisory group, the Planet Definition Committee, to attempt to resolve the issue in a manner that had a solid scientific basis and which might achieve consensus support among members of the Union. Prof. Gingerich has described the work of the Planet Definition Committee, whose report has been received by the EC and used as a basis for framing the draft resolution that is now being put before the General Assembly. The current draft of the resolution "The Definition of a Planet" that has been approved by the EC and the Resolutions Committee appears with these articles.

The process by which resolutions are considered by the IAU is set forth in the Working Rules. It involves consideration by the Resolutions Committee and the Executive Committee, and discussion by the General Assembly before a vote taken in the second business meeting of the GA. Because of the potential impact of this resolution the EC is undertaking extra measures to assure full discussion of the draft during the General Assembly that will allow for possible revisions to the current version before it is presented to the GA at the closing business meeting. They include a discussion and debate of the resolution by Division III-Planetary Sciences at its scheduled meeting this Friday, 18 August. In addition, the EC is convening an extraordinary plenary session of the General Assembly to take place next Tuesday, 22 August, during the lunch break, which will be devoted entirely to a discussion of the draft resolution, and after which a "sense of the meeting" vote will be taken on the resolution as presented. We are fully aware of the potential

Members of the Planet Definition Committee

Dr. Richard Binzel is Professor of Earth, Atmospheric and Planetary Science at MIT and a specialist in asteroids and outer Solar System small bodies, and is also a well known and respected educator and science writer.

Dr. André Brahic is Professor at Université Denis Diderot (Paris VII) and is Director of the Laboratory Gamma-gravitation of the Commissariat a l'Energie Atomique. He specializes in planetary rings, and has co-discovered the rings and arcs of Neptune. For the French-speaking public, André Brahic is one of the best known popularisers of science and astronomy, having authored a number of books.

Dr. Owen Gingerich (chair), Professor of Astronomy and History of Science Emeritus at the Harvard-Smithsonian Center for Astrophysics, is an esteemed historian of astronomy with a broad perspective, and a prize-winning educator.

Dava Sobel is the author of the very successful books *Longitude*, *The Planets*, and *Galileo's Daughter*. She has a solid background in, and knowledge of, the history of science, astronomy in particular.

Dr. Junichi Watanabe is an Associate Professor and also Director of the Outreach Division of NAOJ. He is a Solar System astronomer and highly appreciated in Japan as interpreter and writer of astronomy for the public and students. He has strong connections with amateur astronomers, science editors, school teachers and journalists.

Dr. Iwan Williams, Queen Mary University of London, is an expert on the dynamics and physical properties of Solar System objects. He is the current President of IAU Division III (Planetary Systems Sciences).

Dr Catherine Cesarsky, Director General of ESO and President-Elect of the IAU, took part in the work of the committee, bringing in the perspective of the IAU Executive as well as that of an astronomer at large.

difficulty in achieving a consensus on this complex issue, and we wish to provide ample opportunity for input from members in the formulation of the final resolution to be considered next week.

The key events that bear on the substance of the final resolution to be presented at the closing business meeting, and in which all IAU members are encouraged to participate, are (1) the discussion at the meeting of Division III on Friday, 18 August at 11:00 am in Club B, and (2) the Plenary Session on the Definition of a Planet on Tuesday, 22 August at 12:45 pm in Forum Hall. The Closing Session of the GA will be held Thursday 24 August at 14:00 in the Congress Hall and here the final resolution will be presented, discussed, and voted upon.

The EC reiterates our desire to benefit from members' input into this issue by your participation in these events, which are an important part of the IAU's mission to communicate the discoveries of astronomy to the public. ❒

Resolution 5 for GA-XXVI: Definition of a Planet

Contemporary observations are changing our understanding of the Solar System, and it is important that our nomenclature for objects reflect our current understanding. This applies, in particular, to the designation "planets". The word "planet" originally described "wanderers" that were known only as moving lights in the sky. Recent discoveries force us to create a new definition, which we can make using currently available scientific information. (Here we are not concerned with the upper boundary between "planet" and "star".)

The IAU therefore resolves that planets and other Solar System bodies be defined in the following way:

(1) A planet is a celestial body that (a) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape[1], and (b) is in orbit around a star, and is neither a star nor a satellite of a planet.[2]

(2) We distinguish between the eight classical planets discovered before 1900, which move in nearly circular orbits close to the ecliptic plane, and other planetary objects in orbit around the Sun. All of these other objects are smaller than Mercury. We recognize that Ceres is a planet by the above scientific definition. For historical reasons, one may choose to distinguish Ceres from the classical planets by referring to it as a "dwarf planet."[3]

(3) We recognize Pluto to be a planet by the above scientific definition, as are one or more recently discovered large Trans-Neptunian Objects. In contrast to the classical planets, these objects typically have highly inclined orbits with large eccentricities and orbital periods in excess of 200 years. We designate this category of planetary objects, of which Pluto is the prototype, as a new class that we call "plutons".

(4) All non-planet objects orbiting the Sun shall be referred to collectively as "Small Solar System Bodies".[4]

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[1] This generally applies to objects with mass above 5×10^{20} kg and diameter greater than 800 km. An IAU process will be established to evaluate planet candidates near this boundary.

[2] For two or more objects comprising a multiple object system, the primary object is designated a planet if it independently satisfies the conditions above. A secondary object satisfying these conditions is also designated a planet if the system barycentre resides outside the primary. Secondary objects not satisfying these criteria are "satellites". Under this definition, Pluto's companion Charon is a planet, making Pluto-Charon a double planet.

[3] If Pallas, Vesta, and/or Hygeia are found to be in hydrostatic equilibrium, they are also planets, and may be referred to as "dwarf planets".

[4] This class currently includes most of the Solar System asteroids, near-Earth objects (NEOs), Mars-, Jupiter- and Neptune-Trojan asteroids, most Centaurs, most Trans-Neptunian Objects (TNOs), and comets. In the new nomenclature the concept "minor planet" is not used.

Planet Definition Q & A Factsheet

The following Question and Answer sheet may help readers to interpret the "IAU Resolution 5 for GA-XXVI" .

Q: What new terms are proposed as official IAU definitions?
A: There are two new terms being proposed for use as official definitions of the IAU. The terms are: "planet" and "pluton".

Q: What is the proposed new definition of "planet"?
A: An object is thus defined as a planet based on its intrinsic physical nature. Two conditions must be satisfied for an object to be called a "planet." First, the object must be in orbit around a star, while not being itself a star. Second, the object must be large enough (or more technically correct, massive enough) for its own gravity to pull it into a nearly spherical shape. The shape of objects with mass above 5×10^{20} kg and diameter greater than 800 km would normally be determined by self-gravity, but all borderline cases would have to be established by observation.

Q: Does an object have to be in orbit around a star in order to be called a "planet"?
A: Yes.

Q: Based on this new definition, how many planets are there in our Solar System?
A: There are currently 12. Eight are the classical planets Mercury through Neptune. Three (Pluto, Charon, and 2003 UB_{313}) are in a newly defined (and growing in number) category called "plutons", for which Pluto is the prototype. One is Ceres, which may be described as a dwarf planet.

Q: What is a dwarf planet?
A: A dwarf planet is a term generally used to describe any planet that is smaller than Mercury. Note that the term "dwarf planet" is simply a descriptive category and not an IAU definition. Terms such as "terrestrial planets" and "giant planets" are additional examples of descriptive categories that are not IAU definitions.

Q: What is a "pluton"?
A: A pluton is a new category of planet now being defined by the IAU. A "pluton" is an object satisfying the technical (hydrostatic equilibrium shape in the presence of self-gravity) definition of "planet." Plutons are distinguished from classical planets in that they reside in orbits around the Sun that take longer than 200 years to complete (i.e. they orbit beyond Neptune). Plutons typically have orbits with a large orbital inclination and a large eccentricity.

Q: Is Ceres a planet?
A: Yes. Ceres is found to have a shape that is in a state of hydrostatic equilibrium under self-gravity. Therefore Ceres is a planet because it satisfies the IAU definition of "planet." [Published reference for shape of Ceres: P. Thomas *et* al. (2005), Nature **437**, 224–227. Dr. Peter Thomas is at Cornell University. Historically, Ceres was called a "planet" when it was first discovered (in 1801).

Q: Is Ceres a "pluton"?
A: No.

Q: Why is 2003 UB_{313} a planet?
A: Recent Hubble Space Telescope images have resolved the size of 2003 UB_{313} showing it to be as large as, or larger than Pluto. Any object having this size, and any reasonable estimate of density, is understood to have sufficient mass that its own gravity will pull it into a nearly spherical shape determined by hydrostatic equilibrium. Therefore, 2003 UB_{313} is a planet because it satisfies the IAU definition of "planet."

Q: Is 2003 UB_{313} a "pluton"?
A: Yes.

Q: What is an object called that is too small to be a "planet"?
A: All objects that orbit the Sun, which are too small (not massive enough) for their own gravity to pull them into a nearly spherical shape are now collectively referred to as "small Solar System bodies." This collection includes the category of objects we continue to call asteroids and comets. This collection also currently includes, near-Earth objects (NEOs), Mars- and Jupiter-Trojan asteroids, most Centaurs and most Trans-Neptunian Objects (TNOs). In the new system of IAU definitions, the term "minor planet" is no longer used.

Q: Is the term "minor planet" still to be used?
A: No. The term "minor planet" is no longer to be used for official IAU purposes. Under the new definition of "planet", nearly all objects currently called "minor planets" are not planets. For IAU purposes, a definition and name is needed that clearly distinguishes between objects that are officially recognized as planets and those that are not.

Q: When is an object too large to be called a "planet"?
A: The new definitions proposed by the IAU seek only to define the lower boundary between an object that is a "planet" or a "small Solar System body." At this time there is no official IAU definition in place or proposed that defines the upper limit for when an object is, for example a "planet" or a "brown dwarf." This limit is generally thought to be about 13 times more massive than Jupiter, but is subject to discussion.

Q: Is the new definition for "planet" intended to apply also to objects discovered in orbit around other stars?
A: Yes.

Q: Are objects that have planetary sizes and masses, but which are free floating in space (and not orbit a star) officially "planets" by the IAU definition?
A: No. At this time there is no official IAU definition in place that addresses this class of objects. ❒

Table 2: Planet candidates as per 24 August 2006 to be given future consideration if "Resolution 5 for GA-XXVI" is passed.

Object	Unofficial diameter estimate
2003 EL_{61}	2000×1000×1200 km
2005 FY_9	1500±300 km
(90377) Sedna	1200-1800 km
(90482) Orcus	1000±200 km
(50000) Quaoar	~1000 km
(20000) Varuna	600±150 km
(55636) 2002 TX_{300}	<700 km
(28978) Ixion	500±100 km
(55565) 2002 AW_{197}	700±100 km
(4) Vesta	578×560×458 km
(2) Pallas	570×525×500 km
(10) Hygiea	500×400×350 km

Table 1: Overview of the planets in the Solar System as per 24 August 2006 if "Resolution 5 for GA-XXVI" is passed.

Object	IAU definition	IAU planet category	Descriptive category	Unofficial mean diameter estimate
Mercury	Planet		Classical	4,879 km
Venus	Planet		Classical	12,104 km
Earth	Planet		Classical	12,746 km
Mars	Planet		Classical	6,780 km
Jupiter	Planet		Classical	138,346 km
Saturn	Planet		Classical	114,632 km
Uranus	Planet		Classical	50,532 km
Neptune	Planet		Classical	49,105 km
Ceres	Planet		Dwarf	952 km
Pluto	Planet	Pluton	Dwarf	2,306±20 km
Charon	Planet	Pluton	Dwarf	1,205±2 km
2003 UB_{313}	Planet	Pluton	Dwarf	2,400±100 km

Other objects that appear large enough so that their shape satisfies the definition of "planet" will be further considered on a case by case basis.

Proposals for IAU Resolutions

Traditionally, the decisions and recommendations of the Union on scientific and organizational matters of general and significant importance are expressed in the Resolutions of the General Assembly. Resolutions should address astronomical matters of significant importance for the international astronomical community as a whole. The following Resolutions will be submitted for consideration at the second session of the IAU General Assembly on Thursday August 24, 2006.

Oddbjørn Engvold, IAU General Secretary

Resolution 1

Adoption of the P03 Precession Theory and Definition of the Ecliptic

Proposed by: IAU Division I WG on "Precession and the Ecliptic"

Supported by: Division I

The following persons will be available for consultations and, if necessary, to speak on the above resolution at the General Assembly on August 24, 2006:

Proposer:	James L. Hilton (USA)	Email: jhilton@aa.usno.navy.mil
Substitute:	Nicole Capitaine (France)	Email: nicole.capitaine@obspm.fr
Seconder:	Patrick Wallace (UK)	Email: ptw@star.rl.ac.uk
Substitute:	Jan Vondrak (Czech Republic)	Email: vondrak@ig.cas.cz

The XXVIth International Astronomical Union General Assembly,

Noting

1. the need for a precession theory consistent with dynamical theory,
2. that, while the precession portion of the lAU 2000A precession-nutation model, recommended for use beginning on 1 January 2003 by resolution B1.6 of the XXIVth IAU General Assembly, is based on improved precession rates with respect to the lAU 1976 precession, it is not consistent with dynamical theory, and
3. that resolution B1.6 of the XXIVth General Assembly also encourages the development of new expressions for precession consistent with the IAU 2000A precession-nutation model, and

Recognizing

1. that the gravitational attraction of the planets make a significant contribution to the motion of the Earth's equator, making the terms *lunisolar precession* and *planetary precession* misleading,
2. the need for a definition of the ecliptic for both astronomical and civil purposes, and
3. that in the past, the ecliptic has been defined both with respect to an observer situated in inertial space (inertial definition) and an observer co-moving with the ecliptic (rotating definition),

Accepts

The conclusion of the IAU Division I Working Group on Precession and the Ecliptic published in Hilton *et* al. 2006, *Celest.Mech.* **94**, 351, and

Recommends

1. that the terms *lunisolar precession* and *planetary precession* be replaced by *precession of the equator* and *precession of the ecliptic*, respectively,
2. that, beginning on 1 January 2009, the precession component of the IAU 2000A precession nutation model be replaced by the P03 precession theory, of Capitaine *et* al. (2003, *A&A*, **412**, 567-586) for the precession of the equator (Eqs. 37) and the precession of the ecliptic (Eqs. 38); the same paper provides the polynomial developments for the P03 primary angles and a number of derived quantities for use in both the equinox based and CIO based paradigms,
3. that the choice of precession parameters be left to the user, and
4. that the ecliptic pole should be explicitly defined by the mean orbital angular momentum vector of the Earth-Moon barycenter in an inertial reference frame, and this definition should be explicitly stated to avoid confusion with other, older definitions.

Note

Formulae for constructing the precession matrix using various parameterizations are given in Eqs. 1, 6, 7, 11, 12 and 22 of Hilton *et* al. (2006). The recommended polynomial developments for the various parameters are given in Table 1 of the same paper, including the P03 expressions set out in expressions (37) to (41) of Capitaine *et* al. (2003) and Tables 3–5 of Capitaine *et* al. (2005).

References

Capitaine, N. Wallace, P.T., & Chapront, J. 2003, *A&A*, **412**, 567
Capitaine, N. Wallace, P.T., & Chapront, J. 2005, *A&A*, **432**, 355
Hilton, J.L., Capitaine, N., Chapront, J., Ferrandiz, J.M., Fienga, A., Fukushima, T., Getino, J., Mathews, P., Simon, J.-L., Soffel, M., Vondrak, J., Wallace, P., & Williams, J. 2006, Celest. Mech. **94**, 351.

Action to be taken by the General Secretary upon adoption of the Resolution

Adoption of the P03 Precession Theory and Definition of the Ecliptic

The following institutions should receive formal notification of the action:

Her Majesty's Nautical Almanac Office, Institut de mécanique céleste et de calcul des éphémérides, Institute of Applied Astronomy of the Russian Academy of Sciences, International Association of Geodesy (IAG), International Earth Rotation and Reference Systems Service (IERS), International Union of Geodesy and Geophysics (IUGG), International VLBI Service for Geodesy and Astrometry (IVS), Japanese Maritime Safty Agency (JMSA), Nautical Astronomical Observatory of Japan (NAOJ), Nautical Almanac Office of the United States Naval Observatory

Resolution 2

Supplement to the IAU 2000 Resolutions on reference systems

Proposed by: IAU Division I WG on "Nomenclature for Fundamental Astronomy"

Supported by: IAU Division I

The following persons will be available for consultations and, if necessary, to speak on the above resolution at the General Assembly on August 24, 2006:

Proposer:	Nicole Capitaine (France)	Email: nicole.capitaine@obspm.fr
Substitute:	Patrick Wallace (UK)	Email: ptw@star.rl.ac.uk
Seconder:	Dennis D. McCarthy (USA)	Email: mccarthy.dennis@usno.navy.mil
Substitute:	Sergei Klioner (Germany)	Email: klioner@rcs.urz.tu-dresden.de

Recommendation 1:

Harmonizing the name of the pole and origin to "intermediate"

The XXVIth International Astronomical Union General Assembly,

Noting

1. the adoption of resolutions IAU B1.1 through B1.9 by the IAU General Assembly of 2000,
2. that the International Earth Rotation and Reference Systems Service (IERS) and the Standards Of Fundamental Astronomy (SOFA) activity have made available the models, procedures, data and software to implement these resolutions operationally, and that the Almanac Offices have begun to implement them beginning with their 2006 editions, and
3. the recommendations of the IAU Working Group on "Nomenclature for Fundamental Astronomy" (IAU Transactions XXVIA, 2005), and

Recognizing

1. that using the designation "intermediate" to refer to both the pole and the origin of the new systems linked to the Celestial Intermediate Pole and the Celestial or Terrestrial Ephemeris origins, defined in Resolutions B1.7 and B1.8, respectively would improve the consistency of the nomenclature, and
2. that the name "Conventional International Origin" with the potentially conflicting acronym CIO is no longer commonly used to refer to the reference pole for measuring polar motion as it was in the past by the International Latitude Service,

Recommends

1. that, the designation "intermediate" be used to describe the moving celestial and terrestrial reference systems defined in the 2000 IAU Resolutions and the various related entities, and
2. that the terminology "Celestial Intermediate Origin" (CIO) and "Terrestrial Intermediate Origin" (TIO) be used in place of the previously introduced "Celestial Ephemeris Origin" (CEO) and "Terrestrial Ephemeris Origin" (TEO), and
3. that authors carefully define acronyms used to designate entities of astronomical reference systems to avoid possible confusion.

Recommendation 2:

Default orientation of the Barycentric Celestial Reference System (BCRS) and Geocentric Celestial Reference System (GCRS)

The XXVIth International Astronomical Union General Assembly,

Noting

1. the adoption of resolutions IAU B1.1 through B1.9 by the IAU General Assembly of 2000,
2. that the International Earth Rotation and Reference Systems Service (IERS) and the Standards Of Fundamental Astronomy (SOFA) activity have made available the models, procedures, data and software to implement these resolutions operationally, and that the Almanac Offices have begun to implement them beginning with their 2006 editions,
3. that, in particular, the systems of space-time coordinates defined by IAU 2000 Resolution B1.3 for (a) the solar system (called the Barycentric Celestial Reference System, BCRS) and (b) the Earth (called the Geocentric Celestial Reference System, GCRS) have begun to come into use,
4. the recommendations of the IAU Working Group on "Nomenclature for Fundamental Astronomy" (IAU Transactions XXVIA, 2005), and
5. a recommendation from the IAU Working Group on "Relativity in Celestial Mechanics, Astrometry and Metrology",

Recognizing

1. that the BCRS definition does not determine the orientation of the spatial coordinates,
2. that the natural choice of orientation for typical applications is that of the ICRS, and
3. that the GCRS is defined such that its spatial coordinates are kinematically non-rotating with respect to those of the BCRS,

Recommends

that the BCRS definition is completed with the following: "For all practical applications, unless otherwise stated, the BCRS is assumed to be oriented according to the ICRS axes. The orientation of the GCRS is derived from the ICRS-oriented BCRS."

Action to be taken by the General Secretary upon adoption of the Resolution

Supplement to the IAU 2000 resolutions on reference systems

The following institutions should receive formal notification of the action:

International Union of Geodesy and Geophysics (IUGG), International Association of Geodesy (IAG), International Earth Rotation and Reference Systems Service (IERS), International VLBI Service for Geodesy and Astrometry (IVS), International Laser Ranging Service (ILRS), International GNSS Service (IGS), International DORIS Service (IDS)

Resolution 3

Re-definition of Barycentric Dynamical Time, TDB

Proposed by: IAU Division I WG on "Nomenclature for Fundamental Astronomy"

Supported by: IAU Division I

The following persons will be available for consultations and, if necessary, to speak on the above resolution at the General Assembly on August 24, 2006:

Proposer:	Nicole Capitaine (France)	Email: nicole.capitaine@obspm.fr
Substitute:	Patrick Wallace (UK)	Email: ptw@star.rl.ac.uk
Seconder:	Dennis D. McCarthy (USA)	Email: mccarthy.dennis@usno.navy.mil
Substitute:	Sergei Klioner (Germany)	Email: klioner@rcs.urz.tu-dresden.de

The XXVIth International Astronomical Union General Assembly,

Noting

1. that IAU Recommendation 5 of Commissions 4, 8 and 31 (1976) introduced, as a replacement for Ephemeris Time (ET), a family of dynamical time scales for barycentric ephemerides and a unique time scale for apparent geocentric ephemerides,
2. that IAU Resolution 5 of Commissions 4, 19 and 31 (1979) designated these time scales as Barycentric Dynamical Time (TDB) and Terrestrial Dynamical Time (TDT) respectively, the latter subsequently renamed Terrestrial Time (TT), in IAU Resolution A4, 1991,
3. that the difference between TDB and TDT was stipulated to comprise only periodic terms, and
4. that Recommendations III and V of IAU Resolution A4 (1991) (i) introduced the coordinate time scale Barycentric Coordinate Time (TCB) to supersede TDB, (ii) recognized that TDB was a linear transformation of TCB, and (iii) acknowledged that, where discontinuity with previous work was deemed to be undesirable, TDB could be used, and

Recognizing

1. that TCB is the coordinate time scale for use in the Barycentric Celestial Reference System,
2. the possibility of multiple realizations of TDB as defined currently,
3. the practical utility of an unambiguously defined coordinate time scale that has a linear relationship with TCB chosen so that this coordinate time scale remains close to Terrestrial Time (TT) at the geocenter for an extended time span,
4. the desirability for consistency with the T_{eph} time scales used in the Jet Propulsion Laboratory (JPL) solar-system ephemerides and existing TDB implementations such as that of Fairhead & Bretagnon (*A&A* **229**, 240, 1990), and
5. the 2006 recommendations of the IAU Working Group on "Nomenclature for Fundamental Astronomy" (IAU Transactions XXVIB, 2006),

Recommends

that, in situations calling for the use of a coordinate time scale that is linearly related to Barycentric Coordinate Time (TCB) and remains close to Terrestrial Time (TT) at the geocenter for an extended time span, TDB be defined as the following linear transformation of TCB:

$$TDB = TCB - L_B \times (JD_{TCB} - T_0) \times 86400 + TDB_0,$$

where $T_0 = 2443144.5003725$,

and $L_B = 1.550519768 \times 10^{-8}$ and $TDB_0 = -6.55 \times 10^{-5}$ s are defining constants.

Notes

1. JD_{TCB} is the TCB Julian date. Its value is $T_0 = 2443144.5003725$ for the event 1977 January 1 00h 00m 00s TAI at the geocenter, and it increases by one for each 86400 s of TCB.
2. The value L_B is equal to $L_C + L_G - L_C \times L_G$, where L_G is given in IAU Resolution B1.9 (2000) and L_C has been determined (Irwin & Fukushima, 1999, *A&A* **348**, 642) using the JPL ephemeris DE405. When using the JPL Planetary Ephemeris DE405, the defining L_B value effectively eliminates a linear drift between TDB and TT at the geocenter. When realizing TCB using other ephemerides, the difference between TDB and TT at the geocenter may include some linear drift which is not expected to exceed 1 ns per year.
3. The difference between TDB and TT at the surface of the Earth remains under 2 ms for several millennia around the present epoch.
4. The independent time argument of the JPL ephemeris DE405, which is called T_{eph} (Standish, *A&A*, **336**, 381, 1998), is for practical purposes the same as TDB defined in this Resolution.
5. The constant term TDB_0 is chosen to provide reasonable consistency with the widely used TDB – TT formula of Fairhead & Bretagnon (1990).

n.b. The presence of TDB_0 means that TDB is not synchronized with TT, TCG and TCB at 1977 Jan 1.0 TAI at the geocenter.

6. For solar system ephemerides development the use of TCB is encouraged.

Action to be taken by the General Secretary upon adoption of the Resolution

Re-definition of Barycentric Dynamical Time, TDB

The following institutions should receive formal notification of the action:

International Union of Geodesy and Geophysics (IUGG), International Association of Geodesy (IAG), International Earth Rotation and Reference Systems Service (IERS), International VLBI Service for Geodesy and Astrometry (IVS), International Laser Ranging Service (ILRS), International GNSS Service (IGS), International DORIS Service (IDS)

Resolution 4

Endorsement of the Washington Charter for Communicating Astronomy with the Public

Proposed by: Ian Robson (Co-Chair of the IAU WG on "Communicating Astronomy with the Public")

The Washington Charter was one of the outcomes of the 2nd International Conference on Communicating Astronomy with the Public held in Washington DC in October 2003. Council endorsed the Washington Charter in March 2004. Nineteen other societies, organizations and facilities have endorsed the Charter, including the BAA and PPARC. At the Communicating Astronomy with the Public 2005 meeting in Garching last June a revised version of the Charter was proposed. This softened the language and also tidied up some of the phraseology. This was endorsed by the attendees and accepted by the IAU Working Group. The revised version is appended.

The IAU General Assembly is requested to confirm endorsement of the Revised Washington Charter.

The Washington Charter for Communicating Astronomy with the Public

As our world grows ever more complex and the pace of scientific discovery and technological change quickens, the global community of professional astronomers needs to communicate more effectively with the public. Astronomy enriches our culture, nourishes a scientific outlook in society, and addresses important questions about humanity's place in the universe. It contributes to areas of immediate practicality, including industry, medicine, and security, and it introduces young people to quantitative reasoning and attracts them to scientific and technical careers. Sharing what we learn about the universe is an investment in our fellow citizens, our institutions, and our future. Individuals and organizations that conduct astronomical research – especially those receiving public funding for this research – have a responsibility to communicate their results and efforts with the public for the benefit of all.

Recommendations

For Funding Agencies:

Encourage and support public outreach and communication in projects and grant programs.Develop infrastructure and linkages to assist with the organization and dissemination of outreach results. Emphasize the importance of such efforts to project and research managers. Recognize public outreach and communication plans and efforts through proposal selection criteria and decisions and annual performance awards. Encourage international collaboration on public outreach and communication activities.

For Professional Astronomical Societies:

Endorse standards for public outreach and communication. Assemble best practices, formats, and tools to aid effective public outreach and communication. Promote professional respect and recognition of public outreach and communication. Make public outreach and communication a visible and integral part of the activities and operations of the respective societies. Encourage greater linkages with successful ongoing efforts of amateur astronomy groups and others.

For Universities, Laboratories, Research Organizations, and Other Institutions:

Acknowledge the importance of public outreach and communication. Recognize public outreach and communication efforts when making decisions on hiring, tenure, compensation and awards. Provide institutional support to enable and assist with public outreach and communication efforts. Collaborate with funding agencies and other organizations to help ensure that public outreach and communication efforts have the greatest possible impact. Make available formal public outreach and communication training for researchers. Offer communication training in academic courses of study for the next generation of researchers.

For Individual Researchers:

Support efforts to communicate the results and benefits of astronomical research to the public, convey the importance of public outreach and communication to team members. Instill this sense of responsibility in the next generation of researchers

Authored by CCAP. Washington DC, October 2003 - Revised by CAP 2005, Garching bei München. June 2005.

Playing with magnets in the Milky Way

A topic that has been in the background of Galactic astronomy for more than 50 years is now becoming the focus of research efforts for more and more astronomers. The coming decade may finally bring an understanding of the Galactic magnetic field on all scales, from the global field geometry to the smallest fluctuations. This will have ramifications for our understanding of a range of problems, including cosmic ray acceleration and propagation, star formation, the pressure and energy balance of the interstellar medium, and the dynamics of the medium on all scales.

John Dickey, University of Tasmania, Australia

The existence of an interstellar magnetic field was deduced from large scale patterns in the polarization of starlight early in the last century. This led to the pioneering theoretical efforts of Fermi, Chandrasekhar, and Munch, who showed how variations in the position angle of the polarization could be used to deduce the order of magnitude of the field strength. Soon after, Davis and Greenstein formulated a mechanism for grain alignment that has motivated a wide range of theories of grain magnetization. Gradually over the subsequent half century more and more different kinds of observations have given us new pieces of the puzzle. Now this field is gathering momentum for a final push to fit all the pieces into a complete picture. This will be a triumph for Galactic astronomy that will interest a broad spectrum of scientists and the general public as well. Everybody likes to play with magnets, in one way or another.

Optical measurements of starlight polarization are still an important tool for studying the Galactic magnetic field, and the same grains that polarize the starlight by their selective absorption also emit preferentially in linear polarization in the mid- and far-infrared. This has been used to map the fields in dust clouds, and in external galaxies. Optical and infrared polarization trace the fields in the plane of the sky. The line of sight component of the field can be traced in the radio, through the Zeeman effect and by Faraday rotation. Both of these techniques have made great progress in the past decade, with promise of major advances to come.

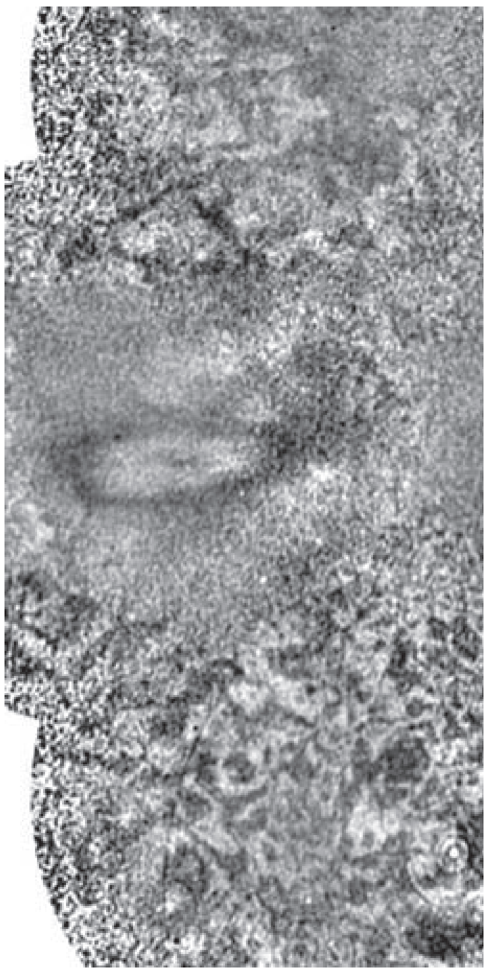
Faraday rotation studies have advanced as many more background sources have become available. The Parkes and Jodrell Bank multibeam surveys for pulsars have been particularly helpful, because for pulsars the dispersion measure and rotation measure can be independently observed, and so the field strength can be separated from the electron density on the line of sight. The pulsar surveys are now sensitive enough to detect pulsars over a large area of the Galactic disk, so our picture of the large scale geometry of the field is improving. Meanwhile, sensitive new surveys of extragalactic continuum sources at low Galactic latitudes have given hundreds of new rotation measures on lines of sight passing entirely through the disk.

A new twist on an old technique for study of the magnetic field is mapping the polarization of the diffuse synchrotron emission by cosmic ray electrons. This was done by radio astronomers in the 1950's and 60's, but in the last decade there has been a renaissance of interest in the Galactic synchrotron polarization through interferometer surveys with resolution of about 1′, which show amazing patterns and structures in the diffuse linearly polarized emission. Some of these are intrinsic to the emission, but most of this structure is imposed by changing Faraday rotation in the intervening medium. Studying the rotation measure of this emission gives a way to trace the ordered and disordered spatial structure of the field on a wide range of scale lengths.

On large scales, the ordered component of the field lies in the disk, pointing azimuthally around the Galactic center, or perhaps in a spiral with pitch angle of about ten degrees. Above and below the disk there seems to be a vertical (poloidal) component as well. On smaller scales, the field has some structures related to well understood phenomena, like supernova remnants, and other structures that seem to have no counterparts at any other wavelengths. An example, the Penticton Lens (from Gray *et* al. 1999, Ap. J. **514**, 221), is shown on the figure.

Ever since Fermi, theorists have recognized that the magnetic field could be dynamically significant, even dominant if the energy density in the field exceeds the kinetic energy of the interstellar gas. An application of this is in the cascade of interstellar turbulence, a process that we assume propagates the energy of random motions to progressively smaller scales, where ultimately they are dissipated. A very influential theoretical study of such a turbulence cascade in a magnetized interstellar medium was done some 15 years ago by Ferriere, Zweibel, and Shull. They showed that the energy dissipated on the small scales by the magnetic field could be the dominant heating process for parts of the interstellar medium. Many more recent theoretical studies of this question have advanced our understanding a long way, but there is still no consensus on whether or when the magnetic field dominates interstellar dynamics, or even how it was generated in the first place.

The Square Kilometer Array, a proposed centimeter-wave telescope for the next decade, will reveal cosmic magnetism with unprecedented detail and precision. Various "phase 1" SKA projects are underway for the latter years of this decade. These will go a long way to answering our questions about the Galactic magnetic field. Those answers may cause us to rethink everything from star formation to the evolution of galaxies. ❐



The Penticton Lens, an elliptical structure in the shimmering pattern of linearly polarized Galactic synchrotron emission. Shown is a detail from the Canadian Galactic Plane Survey image published by Gray et al. (1999). The lens has no counterpart in other ISM tracers. Many other structures in the diffuse Stokes Q and U emission have been found in recent years.

Staroměstské náměstí (Old Town Square)

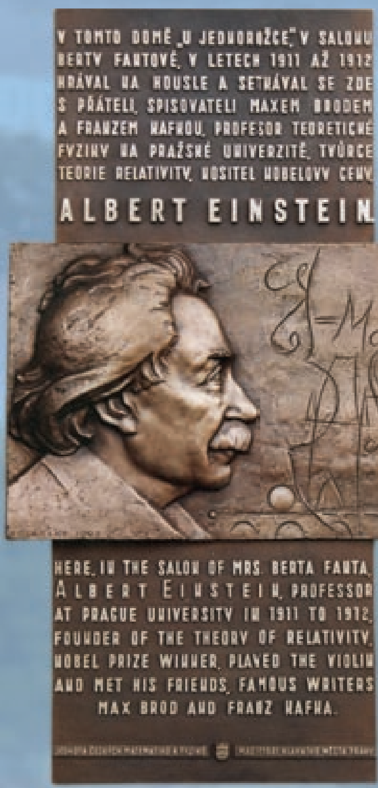
Alena Šolcová, Michal Křížek, Jana Olivová

Today you are invited to see one of the most famous and important places in Prague – **Staroměstské náměstí** or **Old Town Square** in the very historical centre of the city. Since the 11th and the 12th centuries, when it was a crossroad of merchant roads and the main marketplace, the Square has witnessed both the most glorious and the most tragic events in the history of the Czech nation and state.

It is easy to get to Staroměstské náměstí from the Congress Centre Take the underground (called "Metro" in Prague and marked "M") and go to the station "Muzeum". There you can get off and walk a couple of blocks down the Wenceslass Square to Můstek. From there, you can walk to Staroměstské náměstí (Old Town Square) – it takes some ten minutes. You could also change at "Muzeum" to Line "A", get off at "Staroměstská" Metro station and walk directly to Old Town Square.

The most admired and sought-after monument there is obviously the *Astronomical Clock* on the Old-Town Hall, also known as the *Prague Orloj*. It consists of three units: moving statues of the 12 apostles that appear on the hour in two small windows in the upper part of the Clock, the astronomical clock itself and a round calendar with the signs of the zodiac. The mathematical model of the Astronomical Clock was developed by Czech astronomer and mathematician, professor of Prague University **Jan Ondřejův called Šindel** [Iohannes Andreae dictus Sindel – the minor planet *(3847) Šindel*]. The astronomical clock was constructed around the year 1410 by clock-maker **Mikuláš of Kadaň** under Šindel´s astronomical supervision. In about 1490, a calendar dial was placed under the astronomical dial. In the centuries which followed, the complex mechanism was further enhanced and new statues – both moving and stationary – were added.

The astronomical dial is an astrolabe on the clock face using a stereographic projection with the centre on the North Pole of the celestial sphere. The dial shows various ways of measuring time over the course of centuries. The outer circles bear gold Arabic numerals showing old Czech hours counted from the sunset of the previous day. Roman numerals mark what is called the German (Italian) time introduced in the reign of Rudolf II. Black Arabic numerals mark uneven planet hours, the length of which changes during the year. Three rotating pointers show the place of the Sun on the ecliptic, the movement and phases of the moon as well as the rising, culmination and setting of individual signs of the Zodiac. The pointer decorated with a small gold star indicates celestial time.



After you get seen enough of the Prague Astronomical Clock, look down at the pavement and you will see the *Prague Meridian* which was formerly used by Prague denizens to determine the time. It was defined by the shadow cast by the column of Our Lady at noon. The column unfortunately was destroyed in 1918 but the place where it was located as well as its shadow are marked with five squares on the pavement. The metal plaque reads: *"Meridianus quo olim tempus Pragense dirigebatur"* (The meridian according to which the time used to be defined). Later time began to be measured more exactly at the Astronomical Tower of Klementinum which you will be invited to visit later.

Staroměstské náměstí (Old Town Square) and the surrounding streets also commemorate a number of outstanding scientists and artists who lived in Prague, including Tycho Brahe, Albert Einstein, Christian Doppler, Ernst Mach and Franz Kafka.

The Church of Our Lady before Týn is the final resting place of great Danish astronomer **Tycho Brahe**. He is buried in front and to the right of the altar. The nearest pillar holds a tombstone made of rose Slivenec marble portraying Tycho Brahe in relief and accompanied with the following inscriptions in Latin: "*Esse potius, quam haberi*" (Rather to be somebody than only to give such an impression) and "*Nec fasces, nec opes, sola artis sceptra perennant*" (Neither power, nor riches, only the sceptre of knowledge persists).

Tycho Brahe (1546–1601) is probably the best observer of the heavens before the invention of telescope. The minor planet *(1677)* was given his name – *Tycho Brahe*. His activities in Prague where he arrived at the invitation of Emperor Rudolf II in 1599 will be the subject of our next invitation to walks around the city.

A memorial plaque honouring prominent scientist and Nobel Prize holder **Albert Einstein** [minor planet *(2001) Einstein*] can be found at Staroměstské náměstí No. 17/551. That is the house where he used to play the violin and engage in philosophic discussions in the Salon of Berta Fanta between 1911 and 1912.

A Dominican on the next Storch House No. 16/552 recalls the half-a-year long visit paid to Prague by **Giordano Bruno** in 1588. A memorial plaque placed at the Observatory and Planetarium of the Capital of Prague recognizes his work.

Professor of physics **Ernest Mach** [minor planet *(3949) Mach*] lived in the house No. 19/549 situated on the right of the Einstein memorial plaque. ❐

Brief information

❍ **Prague Information Service** provides all sorts of tourist information about Prague, from accommodation and numerous cultural events to foreign language divine services and weather. It outlines the history of Prague, draws attention to its historical monuments, offers sightseeing tours and tips for visits. The information can be found at **http://www.pis.cz/** in English, German, French, Italian and in Spanish.

❍ **Corrected programme of Comission 45 meeting:**
Wednesday August 16, 14:00–15:30 & 16:00–17:30, Club B
14:00 Scientific Session
Spectral classification in the southern hemisphere: old fashioned technique or the best one for astrophysical insight?
talk by H. Levato
14:30 Business and Discussion on Stellar Classification
Report of President
Presentation of New Organizing Committee
Presentation of New President and Vice President
Discussion on Transforming this Stellar Classification commission to make it more relevant to the great increase in surveys
15:30 Coffee
16:00 Working Group on Standard Stars Meeting
Report of Chairperson and Newsletter Editor
Discussion on Evolving the WG and the Standard Star Newsletter with the times
Appointment of Chairperson and Newsletter Editor

Secret diary of secret agent F.R.Og

August 15th: Life of a secret agent is so hard. Nobody appreciates it. Astronomers didn't vote for my changes in Statutes. The Czech police took a photo of my car in front of the Congress Palace and the picture appeared in the GA newspaper. And moreover, I've got a note from H. Yla (a big boss in the Scientific Board) telling me that I wouldn't recognize a science even if it fell on my head. Imagine this, she expects me to sit at symposia and listen to Earthlings' predendrobitic astrophysics. Astrolabes, epicycles and subluminal velocities. Oh my!

Nomenclature Filler

3. From Confusion to Clarity: Providing a "paper trail"

Hélène R. Dickel

A designation consists of an *acronym* and a *sequence*.
The *acronym* is an alphanumerical string of characters that specifies the catalog or collection of sources. It may be constructed from catalog names (e.g., NGC, BD), the names of authors (RCW), instruments or observatories used for large surveys (3C, 51W, CXO), etc. Once a paper is published, the acronym will appear in the *Interactive Dictionary of Acronyms* at **http://cdsweb.u-strasbg.fr/viz-bin/Dic** along with the reference, thus providing a paper trail.
The *sequence* (or numbering) is an alphanumeric string of characters, normally only numerical, that uniquely determines the source within a catalog or collection. It may be a sequence number within a catalog (e. g., HD 224801), a combination of fields, or it may be based on coordinates.

Wednesday 16/8
8 °C / 46 °F morning minimum
26 °C / 79 °F afternoon maximum
Some clouds, a shower possible in the afternoon
SE winds 4 m/s (10 mph)

Thursday 17/8
11 °C / 52 °F morning minimum
27 °C / 81 °F afternoon maximum
Partly sunny and nice
S winds 5 m/s (13 mph)

Cause for Celebration – *Mike Dopita*

For one astronomer, the IAU General assembly represents a long-awaited homecoming. Prof. Mike Dopita, at the Australian National University in Canberra, Australia has finally returned to the land of his father, with his Czech passport in pocket. Mike's father, Frantisek Ladislav Dopita, hailed from Olomouc, but fled the German occupation on skis in the winter of 1940 to eventually join the French Foreign legion in Beirut. From there he was shipped to Marseille, where he arrived just in time for the events of June 1940. Fleeing once more he ended up with the Free Czech Army in the UK, where he met Mike's mother. After the war they both returned to a little town called Rotava in Bohemia, where Mike was born on Czech Independence Day, to the sound of brass bands and celebration. The creeping establishment of communist rule meant that, as an ex-Captain in the Free Czech Army, Frantisek was targetted for some "special consideration". Fleeing once more with the whole family, including a one-year old Mike, he returned to the UK. In 1953 he was "naturalized" along with Mike as a British citizen (the English appear to be of the opinion that not to be English is an unnatural state). Many years later, after the fall of communism, Frantisek was finally "re-habilitated" as a Czech citizen, and in celebration Mike also reclaimed his Czech citizenship. So here he is, at the age of 60, in Prague as a Czech / an Englishman / an Australian, finally closing the wheel of history and the tangled fortunes of the twentieth century. ❐

Right: Prof. Mike Dopita

Dissertatio cum Nuncio Sidereo III is the official newspaper of the IAU General Assembly 2006. Contacts: **e-mail** – nuncius@ig.cas.cz, **address** – Nuncius Sidereus III, Kongresové centrum Praha, a.s., 5. května 65, 140 21 Praha 4. **Editor-in-chief**: Jiří Grygar, **deputy editor**: Petr Lála, **secretary**: Pavel Suchan, **assistant secretary:** Kateřina Vaňková **editors**: Soňa Ehlerová, Daniel Fischer, Jana Olivová, Michael Prouza, Petr Scheirich, Michal Sobotka, Michal Švanda, **technical editors**: David Ondřich, Jan Verfl, **English corrector**: John Novotney, **cartoonists**: Ladislav Šmelcer, Lubomír Vaněk. **Published by**: Icaris, Ltd., Nám. dr. Holého 8, 180 00 Praha 8. **Printed by:** Apolys, Ltd., Kolbenova 40, Praha 9. Any views expressed in articles are those of the authors and do not necessarily reflect the views of the Editorial Board or IAU. **Online version** http:///www.astronomy2006.com/ga-newspaper.php.