Remarkable New Planets

The discovery of nine new extrasolar planets will be announced today during the opening session of Symposium 202. Some of these new planets are indeed remarkable, and they display a wide range of properties, including large orbital eccentricities, close-in orbits, and masses as low as that of Saturn. Indeed, one star harbours two Saturn-mass planets, both in tight orbits. The bounty brings the total of known extrasolar planets to 47.

Two particularly remarkable planets are among those to be announced. An international consortium of astronomers led by Dr. Bill Cochran has found Doppler evidence for a Jupiter-mass planet orbiting 3.2 AU from the star Epsilon Eridani, one of the nearest neighbours of the Sun, and featured in science fiction novels. The Doppler period of seven years has been noticed by two other teams, one in the Canada-France-Hawaii telescope and at the Lick Observatory. The McDonald Observatory velocities, along with new atmospheric diagnostics, provide compelling support for the reality of the planet. "Detecting a planet orbiting Epsilon Eridani, a star very similar to our own Sun and only 3.22 parsecs from Earth, is like finding a planet in our own backyard," said Cochran. The angular separation between the star and the planet is a full arcsecond, implying that images of the planet may be possible with next-generation techniques. The detection of the planet is difficult, because Epsilon Eridani is a well-known magnetically active star, leaving open the possibility that photospheric motions could cause the Doppler wobble.

The other remarkable new planet orbits the star HD 83443 which apparently has a system of two Saturn-sized planets. Discovered by the team led by Michel Mayor and Stephane Udry, the new system was detected by high-precision Doppler measurements with the CORALIE spectrograph at the 1.2-metre Euler Swiss telescope (ESO-La Silla) as part of the Geneva planet-search project. Until now, the only full system of planets known around a main sequence star was that around Upsilon Andromedae, containing three planets. Updated orbital parameters for this triple-planet system will be presented at this meeting, by Paul Butler and Debra Fischer, who will also announce three other new planets -- all large gas giants moving in highly eccentric orbits.

In the coming year, the number of known sub-Saturn-sized planets will continue to grow. Additional systems of multiple planets are emerging from the surveys of the groups led by Mayor and Marcy, which will permit comparisons of their architecture to that of our Solar System.

Geoff Marcy
University of California, Berkeley, USA

Welcome to the 24th General Assembly of the IAU!

The General Assemblies are the glue which keeps the IAU together, and this is the third time that we have met in the United Kingdom. Cambridge hosted the second General Assembly met in Cambridge in 1895, under the presidency of W. W. Campbell, the predecessor of mine from the Lick Observatory, there were only 189 participants, three-quarters of the total membership. When the IAU met again in the U.K. in Brighton in 1970, that General Assembly was the largest ever in terms of participants: 2,255, more than half the total membership. Were we to see the same fraction of members today our hosts would have had to plan for an attendance in excess of 4,500!

After an interval of 30 years, we are again meeting in the U.K., this time in the historic "industrial north" of the country, famous as the seed of the industrial revolution which swept up throughout the world. And that the meeting is in Manchester in 2000, the year of the Olympic Games, is particularly fitting, for the IAU General Assemblies were also General Scientific Congresses in the late 19th century, founded by Sir George Airy, brother of the Astronomer Royal.

This General Assembly is the 24th in the series, which were first held in 1895 in Cambridge. As the meeting reticulates -- in modern terms of social, cultural and scientific! -- we will learn much that is new -- socially, culturally and scientifically!
Welcome... 
...to the UK

On behalf of the National Organizing Committee, I would like to welcome you to the 24th General Assembly of the International Astronomical Union. We are delighted and honoured that the IAU invited the Royal Society and the Royal Astronomical Society to hold this General Assembly in the UK in the year 2000.

One of the strengths of astronomy is that it is still possible to hold an assembly of a significant fraction of the international professional community. In addition to the exchange of scientific ideas, new collaborations and friendships arise out of these meetings, strengthening the bonds between astronomers worldwide. In a world of increasing specialization, the General Assembly also offers the opportunity to hear about recent advances over a broad range of astronomy.

Few nations can afford to have completely national programmes, and the UK relies on international collaboration in both ground and space-based astronomy. In future, many hope that the UK will be able to join the European Southern Observatory.

In recent years surveys have been made of the activities and demographic trends in UK astronomy (see Astronomy and Geophysics, Vol. 41). It is pleasing that there is still growth in the number of permanent academic staff. This reflects the interest of the young in astronomy; an increasing number of universities now teach astronomy in conjunction with physics degrees. There has been an even larger increase in the number of post-doctoral research assistants. Many of these are welcomed as young researchers in posts abroad, thus further strengthening international links.

We were pleased by the results of an international review of UK physics, including astronomy, which highlighted research in cosmology and solar physics. The UK has a long tradition of excellent astronomical research, which continues to the present day. The profile of astronomy in the UK can only be raised by the presence of the 24th General Assembly. We hope that the science discussed will serve as an inspiration to all, including the research students generously supported by the Particle Physics and Astronomy Research Council. We also hope that you will enjoy the social events, including the concert by the Royal Liverpool Philharmonic Orchestra this coming Friday.

Carole Jordan
Chair, National Organizing Committee

...and to Manchester

We are glad to see you in Manchester for the two weeks of science and friendly interaction which characterize General Assemblies of the IAU. This is the culmination of more than four years of preparation by the LOC. Our strongest wish is that you will find the visit stimulating and the accommodation comfortable.

A wide choice of scientific meetings is outlined in the Final Programme book included in your Registration pack. We hope you soon become familiar with the venues located on the University of Manchester Campus and the adjacent Royal Northern College of Music. Signposting has been erected to help you. We have been able to place the poster displays close to the lecture theatres where the various sessions are held. The Abstract Book is your guide to the Symposium and Joint Discussion presentations.

A highlight of General Assemblies is the Inaugural Ceremony, which in this case commences at 2:00 pm on Wednesday, August 9. It contains welcome speeches with a special musical programme; it will be held in the outstanding new Bridgewater Hall, which will also accommodate the Invited Discourses and the Symphony Concert on Friday, August 11, specially performed for our meeting.

A social programme includes visits to local places of interest - including Jodrell Bank where you are invited to have tea. An informal reception is offered on Monday, August 7 in the Refectory, and a Civic Reception is being given by the Lord Mayor following the Inaugural Ceremony.

While you are here we hope you discover the many interesting faces of the City of Manchester: several guides have been included in your Registration pack. As for all large modern cities, please remain aware of security. Again welcome.

Rodney Davies & Dennis Walsh
Co-Chairmen of the Local Organizing Committee

Global Structure and Evolution of the Solar Interior

Once upon a time the Sun was thought merely to be a simple example of a main-sequence star. And even today, by the standards of many other astronomical objects, it is very simple indeed. That is why astrophysicists have been able to understand it so well, and to make very precise inferences about its internal structure. It has enabled them to address questions in physics of a subtlety that is scarcely rivalled elsewhere in astronomy.

By seismological investigation the sound speed has been measured throughout most of the interior with a precision of 0.01 per cent; the variation of the rate of rotation has been determined, rather less precisely, in the outer 50 per cent (by radius), and large-scale subphotospheric meridional flow and smaller-scale flow around and under sunspots has been detected.

Aside from the intellectual challenge of measuring the inside of a star, there are other important reasons why one should wish to investigate the global structure of the Sun. One is to study the properties of matter under conditions too extreme to reproduce in a controlled manner on Earth. Another is to study the dynamics of a particular star as a means of understanding the structure and evolution of stars in general. An example of the first is the estimation of the sizes of interacting atoms and compound ions in a dense plasma through their van der Waals-like influence on the equation of state. An outstanding example of the latter is the dynamo of the solar cycle, which is also critical to our understanding of solar-terrestrial relations. What are the dominant processes that drive and control the cyclic variation?

Are they confined to the convection zone and its immediate environment, or can we expect to find solar PHYSICISTS believe, or do they extend to the very core of the Sun? Does the magnetic field play an essential role in the dynamo, or is it merely a passive trace of fluid motion deep in the Sun's interior? New clues for unravelling the dynamical processes will be discussed in the opening session of IAU Symposium 203. We observe that sunspots block the light emitted from the photosphere, causing temporary diminution of the total irradiance. Yet why is it that the mean solar irradiance is greater at sunspot maximum than it is at sunspot minimum? It is not difficult to guess a mechanism, but only with a combination of detailed and accurate irradiance observations and concurrent seismological diagnosis can we test the plausibility of the guess.

The newly discovered 1.3-year oscillation near the base of the convection zone now appears to extend much more deeply into the radiative interior. Is this a key to understanding the longer 11-year cycle, or is it a wholly separate phenomenon? Issues such as these demonstrate clearly that the early simplicity of stellar physics is but a foundation for the rich scientific enquiry that lies ahead.

Douglas Gough
Institute of Astronomy, University of Cambridge, UK

Rodney Davies (right) and Dennis Walsh (left) Co-Chairmen of the LOC, with the famous Lovell Telescope at Jodrell Bank in the background.
IAU Symposium

New Cosmological Data and the Values of the Fundamental Parameters

It has perhaps often been said that cosmology is entering into a new era, but that must surely be true as a description of the current situation. Recent advances in instrumentation and techniques mean that cosmology is moving rapidly from what might be called a ‘data starved’ science, into one which is at last ‘data rich’. High quality large data sets are now becoming available in several different areas, and at the same time a new theoretical paradigm, of a Universe dominated by vacuum energy as well as matter, is becoming standard. In this context, the aim of Symposium 201 is to bring together experimenters, theorists, observers and interpreters from around the world, to present and discuss the latest data, and to look critically at this new paradigm, and whether it really fits with and is justified by the data. The values of the fundamental parameters, such as the expansion rate, age and density of the Universe, are a significant focus for the meeting, since our relative lack of knowledge of them in the past has been an important indicator of our state of knowledge in cosmology. There is now a real chance of these parameters being measurable to an accuracy of a few percent in the near future - a very significant change.

The meeting begins with a review of the current status of cosmology by Malcolm Longair, and then covers the topics of the early Universe, cosmic microwave background astronomy, large scale structure, determination of the Hubble Constant, evidence for a non-zero cosmological constant, dark matter, the overall density and geometry of the Universe, how to ‘put it all together’ and the role of new experiments and ideas in cosmology. We are very fortunate in having some of the key researchers in each of these areas at the meeting.

Some expected highlights and points for discussion include:

1. There has been tremendous development recently in early Universe physics, and there is a real chance of being able to use the spatial spectrum of cosmic microwave background (CMB) anisotropies to test ideas such as the origin of the Universe in a ‘singular instant’ and even aspects of M-theory.

2. Experimental advances in CMB astronomy mean for the first time that high resolution maps of significant areas of the sky are becoming available. The results from the balloon-borne BOOMERANG and MAXIMA experiments have confirmed an overall picture of a spatially flat Universe (one at critical density). However, there is possible evidence of a clash between what the CMB power spectrum shows, and standard nucleosynthesis values of the baryon density of the Universe. Results from new interferometer CMB experiments could shorty resolve this.

3. Large scale structure surveys such as the APM, 2dF and U.S. Sloan survey are starting to yield their first results, which will be discussed at the meeting. Big improvements in our knowledge of the matter power spectrum and of the evolution of clustering should follow. The size of such data sets, and the new and forthcoming CMB data sets mean that we will need special techniques for analyzing and exploiting these data.

4. Values for the Hubble Constant and of the overall density of the Universe (Omega) are at least starting to converge between different techniques, although the estimates of Omega using clusters of galaxies remains somewhat controversial and the nature of the dark matter remains unknown. New results on gravitational lensing, where first detections of weak lensing from large scale structure have recently been reported, will also be discussed in these sessions.

5. Some of the most exciting results in cosmology recently have come from the observations of Type Ia supernovae, which have given strong evidence for a non-zero cosmological constant. These results will be discussed in detail by members of the two teams responsible for the discoveries, and there should be good opportunity for examining the underlying assumptions in the method, and whether they are justified.

6. Are the various cosmological indicators concordant with each other and what are the best values of the parameters when data sets are combined? These topics will be discussed on the final day, along with descriptions of the new instrument which cosmology needs to refine current answers.

On the final afternoon, we are lucky to have Martin Rees providing an assessment of ‘New theoretical insights and outstanding problems’, Virginia Trimble giving a review of the posters presented at the meeting, and Jim Peebles to make stimulating concluding remarks.

Anthony Lasenby
Cavendish Astrophysics Group, University of Cambridge, UK

IAU Symposium

Planetary Systems in the Universe:
Observation, Formation and Evolution

Planets orbiting other stars are a hot topic, and form an exciting part of Symposium 202 on planetary systems, which runs from Monday to Thursday of the first week. We expect several announcements of new discoveries, and media coverage. Leading authorities will review the latest advances in and future prospects for our understanding of all aspects of the ‘observation, formation and evolution’ of planetary systems. Substantial time has been allocated for discussion of these topics and of the 109 poster papers, which concentrate on particular bodies of work. An interesting aspect is that all the discoverers of extrasolar planets are attending the symposium.

We are now in a rapid growth phase for our knowledge of the Solar System, and in our theoretical understanding of planetary systems. One of the pleasures of this field is that we know so comparatively little, so that each new technical development in observational capacity brings unexpected results which recast the whole field - as for example the discovery of Jupiter-mass planets close into their parent stars. Planetary systems science seems to be entering into its ‘golden age’, possibly as fruitful as that of cosmology in the 20th century.

But what should such a symposium cover? The problem is that there are so many aspects - star and planet formation, dust disks, comets, asteroids, the history of the Solar System, planetary interiors and atmospheres, magnetohydrodynamics of the solar nebula, and the origin and distribution of life on planets. When a group of us decided to propose this symposium to the IAU, we decided to concentrate on areas of rapid and allied progress - planet discovery, dust rings, formation and orbital evolution theory, and future searches. These are complemented by constraints from our Solar System and from brown dwarf observations. We decided not to cover biology. Even at this early stage in planetary systems science the field is now too active for one meeting to cover all aspects.

By keeping this focus in mind, we hope that the people who have decided to attend, and whose expertise cover many disciplines, will be interested in the talks and posters outside their particular areas, and that true interdisciplinary fertilisation will occur. In addition to this aim of spreading knowledge, we also hope that the participants will find the discussions useful in guiding their future work, especially in the definition of future search programmes.

So how is the symposium structured? The first day is mostly on the present searches for planets - the successful radial velocity programmes, and the microlensing transit and imaging programmes. From late Monday to the end of Tuesday, Solar System constraints and the theory of the formation and orbital evolution of planets, together with planet structure theory will be discussed. The following day the discussion will be of the theory and observation of proto-planetary and planetary disks. From Thursday morning to Thursday afternoon, future search programmes will be covered, including ground- and space-based missions.

Alan Penny
Chair SOC
Rutherford Appleton Laboratory, UK

... for Symposium 203 see page 4
Recent Insights into the Physics of the Sun and Heliosphere: Highlights from SOHO and Other Space Missions

The highly successful SOHO (ESA/NASA), Yohkoh (JAS), and TRACE (NASA) missions have given us a ‘new view’ of our star. Studies of solar processes are a key to understanding the physics of stars in general; studies of solar activity are also critical for our understanding of ‘space weather’ in the vicinity of the Earth, and for the prediction of Earth-based consequences of solar events.

These missions are providing high resolution imaging and spectroscopy of the solar atmosphere, detailed measurements of the mass outflow from the Sun, and techniques for studies of the solar interior. This coordinated attack on solar physics has provided a breathtaking view of the Sun, with its highly complex, dynamic atmosphere, its dramatic flare and mass ejection processes, and its interior structure. The 24th General Assembly in Manchester is a timely international meeting to bring together the new results from these missions.

The first session is concerned with helioseismology - the study of the solar interior through the analysis of vibrations of the surface. SOHO is leading the way into a new era in this field, and this will be summarized at the start of the session. Scientists have been able to ‘map’ the differential rotation of the Sun's 'surface' is at 6000 degrees, Celsius. Talks will focus on the outstanding mysteries of the Sun, such as (1) why is the solar corona so hot (millions of degrees) when the 'surface' is at 6000 degrees, and (2) how does the solar atmosphere generate the solar wind? Also high on the list of outstanding questions are those concerned with the processes leading to solar flares. In these sessions, we also hope to consider to understanding the basic processes which occur in a stellar atmosphere.

The SOHO mission has moved to the north-western corner of the University Campus, adjacent to the laboratory (marked no. 3 on the University map on page 20 of the Final Programme book). The Bridgewater Hall, an enormous area. Much of the work being presented is in an early stage, so please feel free to contact any of the Editorial team. Our aim is to make Northern Lights a really useful and worthwhile part of the 2000 General Assembly.

Table 1 (mod.) Modified Arrangements for Display of Poster Papers

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Room Changes

Due to the unfortunate flooding of Theatre B in the Roscoe Building, all sessions of Joint Discussion '5 Mixing and Diffusion in Stars' and the Special Session on 'Astronomy for Developing Countries' have been moved to the Cordingley Theatre in the Architecture Building. This building is located in the north-western corner of the University Campus, adjacent to the North-West Car Park.

We are most grateful to those people who contributed material at very short notice for this first issue. We welcome comments and general assistance, such as reporting on meetings and other activities. If you feel so inclined, please contact any of the Editorial team. Our aim is to make Northern Lights a really useful and worthwhile part of the 2000 General Assembly.

Editorial

Our aim is to make Northern Lights a really useful and worthwhile part of the 2000 General Assembly.

Networking Lunch for Women Astronomers

Who - Any interested GA24 participants, including male astronomers and non-astronomer partners.

How - If you have already notified us of your interest, you should find a ticket in your mailbox located in the Whitworth Hall. Otherwise, please pick up a ticket from the box below.

Catering - We will provide a light buffet lunch. There is no charge, but you are encouraged to bring a picnic if you wish.

Organizers - Myfanwy Boyle, Althea Wilkinson, Philippa Browning

Free Concert

The main cultural event of the General Assembly will be the concert by The Royal Liverpool Philharmonic Orchestra, conducted by Vernon Haddrick, on Friday, August 11th at 1:00pm at The Bridgewater Hall.

The programme will include the Elgar Cello Concerto (bombed, Alice Neary), and pieces by Arnold, Elgar, Delius, Vaughan Williams and Walton.

This concert will be free to all Participants and Registered Guests.

Books on sale at the Hotel.
The discovery of 51 Pegasi's 'hot Jupiter' in 1995 launched a new era: the extrasolar gas giant planets known, but around other solar-type stars. Announced on Monday, at Symposium 202 (Planetary Bodies in the Universe with none of them resembling Jupiter and Saturn in terms of their orbital eccentricities, unlike our Solar System's gas giant planets. The hot Jupiters, with orbital periods of a few days, have now been joined by 'hot Saturns'. The short orbital periods of these objects present a challenge to theorists, as do the orbital eccentricities of the longer-period planets.

There are only two ways of forming gas giant planets: top-down or bottom-up. The latter mechanism is the conventional explanation for forming Jupiter and Saturn — a solid core forms first on a circular orbit by collisional accumulation of planetesimals, and then a gaseous envelope is accreted from the protoplanetary disk. Alternatively, the disk might break-up directly into clumps that could form gas giant planets, if the disk's gas is cold enough. This mechanism naturally leads to planets in eccentric orbits (see diagram). However, neither of these mechanisms can explain the formation of hot Jupiters at < 0.3 AU without invoking ad hoc physics or parameters. Instead the hot Jupiters have taught us that at least some gas giant planets experience significant orbital migration following their formation at distances of several AU from their stars. Two mechanisms are favoured: interactions with the disk's gas, and close encounters with other planets leading to gravitational slingshots. The latter mechanism is unlikely to be able to explain orbital periods as short as three days, whereas disk interactions are so inevitable and robust that leaving any planets behind at all after the disk disperses is a major problem for theorists.

Ice giant planets like Uranus and Neptune must be formed by collisional accumulation of ice and rocky planetesimals, but models of the formation of Uranus at ~20 AU require such long periods of time (billions of years) that theorists have begun to suggest making the ice giant planets at the Jupiter-Saturn region, and then migrating them outward to their current locations.

However, since formation times for gas giant planets at ~5 AU already require several million years or more (comparable to or longer than inferred protoplanetary disk lifetimes), it is unclear if moving the problem of the formation of the ice giant planets elsewhere will really help. Nevertheless, the surprising discoveries of extended planets to date have already revolutionized theoretical ideas about planet formation, and will undoubtedly continue to do so as the discoveries push down toward Earth-mass planets.

The Brown Dwarf Desert

In there a very definite distinction between planetary bodies and brown dwarfs? According to the latest results announced on August 7 at Symposium 202 the answer is 'yes'. Examine a histogram of the masses of bodies below a mass of about 10 times that of Jupiter (~0.1M☉) and there is a distinct gap, known as the 'brown dwarf desert'. More than fifty planetary bodies orbiting other stars are now known, but very few fall into the gap between the most massive known planetary body, and the lowest-mass brown dwarf. The 'desert' is indeed almost unpopulated. It seems strange now to recall that not too many years ago no brown dwarfs had been identified, and that their very existence was doubted.

Precision cosmology!

At the opening session of Symposium 201 (New Cosmological Data and the Values of the Fundamental Parameters), M. Sato (University of Cambridge), who gave the introductory reviews, heralded the dawn of a "new realm of precision cosmology". In particular, he emphasized the importance of the interplay between the various fields and that of astrophysics. "It is no longer acceptable to use standard candles unless we can explain to three orders of magnitude why they are starting to become different, how they are formed," he commented. Many of the recent observational results, showing a degree of agreement unheard of in the not too distant past, were discussed. Particular importance was being given to the results of the BOOMERANG and MAXIMA experiments, which will feature strongly in the days to come. These results agree with each other and with inflationary predictions, and are also within two standard deviations of values for Ω determined by studies of primordial nucleosynthesis. A possible note of caution is provided by comparisons with the limits implied by gravitational lensing at large redshifts. These are currently in agreement with the other data, but further studies may prove otherwise. The icing on the cosmologists' cake is being provided by the latest calculations of the age of the oldest stars which places them at approximately 11-12 thousand million years old. This figure follows the adjustments of the local distance scale after the Hipparcos mission, and when combined with the latest value of 13-14 thousand million years for the age of the Universe, seems to put an end to the problem of the oldest stars appearing older than the Universe. The stage was then set for the first of the more than fifty speakers who will take the stage over the next two weeks, all of whom may agree with the rosy picture presented above. Watch this space...
The Story of Jodrell Bank

On a cold, foggy day in December 1945, a young research scientist from the University of Manchester sat huddled over a coke stove in a gardener's shed in a muddy field in Cheshire. He was there to experiment with an ex-army radar system installed at a small botanical research station run by the University. Its location, about 30 km south of Manchester, was a little-known rural backwater called Jodrell Bank.

Fifty-five years later, that remote site is home to Jodrell Bank Observatory and the surrounding countryside is dominated by the world's second-largest, fully-steerable radio telescope. That scientist, Sir Bernard Lovell, remains one of Britain's most accomplished astronomers and the history of Jodrell Bank, with which he is synonymous, is a fascinating story of post-war determination.

Prior to the war, Bernard Lovell had been studying cosmic rays at the University of Manchester. During the war years he became involved in the development of the first military radar systems. On the very first day of the conflict, Lovell had witnessed sporadic, unexplained echoes on the coastal radar's cathode-ray tube at Staxton Wold, Yorkshire and had wondered if these might be caused by the passage of cosmic rays through the atmosphere. After the war, he returned to Manchester with the hope of investigating this possibility. He acquired some ex-army radar equipment which was set up in the quadrangle of the University's Physics Department.

Lovell soon found that the equipment was of no use in the centre of Manchester. The radar's cathode-ray tube was awash with interference from the electric trains running past the Physics Department. Permission was given for Lovell to move his equipment, for a two-week period, to the University's small botanical research station south of the city. In early December 1945 the three trailers arrived at the remote spot, and were set up next to the botanists' huts.

It was not long before Lovell found that the sporadic echoes were not, in fact, from cosmic ray showers. They were from the plasma trails of meteors. Lovell had soon outstayed his two-week period at the botanical station at Jodrell Bank, but he remained, acquired some co-workers and moved more equipment into the surrounding fields. Over the next few years they studied the meteor echoes in some detail, and were able to show that many meteorites originate in the dust-tails of comets.

In 1947 the scientists obtained a small grant to build a 218-ft (66.4-metre) parabolic reflecting aerial made of wire mesh, easily the largest radio antenna in the world at that time. With this transit instrument they tried, once again, to detect cosmic ray showers. But by this time the equipment was proving more useful in other areas of research, and Lovell soon gave up the idea of studying cosmic ray showers with radar techniques and turned his attention to radio astronomy.

The 218-ft radio antenna at Jodrell Bank was put to work studying astronomical sources and amongst other discoveries, made the first detection of radio waves from another galaxy, M31. The success of this instrument led Lovell and his colleagues to conceive of a telescope of similar size that would be fully steerable. The enormous, 250-foot parabolic instrument into the botanists' fields was about to become permanent.

Eventually, Lovell engaged a consulting engineer based in Sheffield, Charles Husband, to draw up plans for an ambitious radio telescope. It was originally designed to work at long wavelengths with a wire mesh surface, but the 1951 discovery of the 21-cm hydrogen line resulted in a redesigned solid steel surface. After extensive negotiations, the Department of Scientific and Industrial Research agreed to help fund the project. Construction of the telescope was begun in September 1952 and completed in 1957. With the telescope still not entirely operational, an event occurred which instantly propelled the project into the public eye. On 4th October 1957 the Soviet Union launched the first artificial satellite, Sputnik 1, into earth orbit. The advanced state of the Soviet space programme shocked military leaders worldwide, including those in the United States. The US, in a response, began what would become the space race.

The enormous, over £5 million Lovell telescope was added to the array. The Multi-Element Radio Linked Interferometer Network and still represents Jodrell Bank's primary research instrument. MERLIN routinely matches the angular resolution of the HST, and Jodrell Bank astronomers are active researchers in many other wavebands. The observatory now operates a total of nine radio telescopes and includes an active optical astronomy group.

As Jodrell Bank approaches its half-century, it still remains at the forefront of astronomical research. Over the coming years several major developments are planned, including the provision of optical-fibre links for the MERLIN array and the replacement of the surface of the huge Lovell telescope. Visits to Jodrell Bank Observatory are available free to IAU delegates.

Alastair G. Gunn
University of Manchester
Jodrell Bank Observatory
Dennis Sciama Remembered

With this meeting of the IAU taking place in Manchester, it seems appropriate to say here a few words about the late Dennis Sciama, who was born in Manchester in 1926 and who died at the end of 1999, having played a pivotal role in the development of modern cosmology and relativistic astrophysics both through his research and through being the mentor of a large number of research students and colleagues who then went on to become leading figures in their own right. It is sad that he was not here with us at Symposium 201; undoubtedly, he would have made valuable contributions to it.

He was a research student of Paul Dirac in Cambridge just after the Second World War, working on Mach’s principle — the idea that the natural laws of physical laws are affected by the state of the whole Universe. He became passionately involved with developments in cosmology and relativity theory, interacting particularly with Hermann Bondi, Thomas Gold, Fred Hoyle and Felix Pirani and becoming, for a while, a committed advocate of the Steady-State theory of the Universe, until eventually abandoning it in the face of mounting contrary observational evidence and switching allegiance to the Big Bang picture which then became standard. He then became a pioneer of investigating astrophysical processes in the evolving and expanding universe, making full use of his extremely broad knowledge of basic physics, to make fruitful links between different areas.

His interests spanned studies of anisotropies in the microwave background, the structure and evolution of radio sources and quasars, X-ray astronomy, the physics of the interstellar and intergalactic medium, astroparticle physics and the nature of dark matter. Perhaps most significant of all was his advocacy of relativistic astrophysics, the study of black holes and the interaction between quantum theory and general relativity. The group which he led in Cambridge in the 1960s (including George Ellis, Stephen Hawking, Martin Rees and Brandon Carter) and his links with Roger Penrose, were immensely influential in this. After Cambridge, he subsequently led groups in Oxford (1970s and early 1980s) and at SESA in Trondheim (1980s and 1990s), carrying on the earlier traditions and creating an ever-expanding ‘family’ of students and collaborators. Well-known students from these later years include John Browne, James Binney, Philip Candelas and David Deutsch.

He will be remembered particularly for the warm friendship and excitement he brought to our subject. He had the privilege of having known him, and who will continue to carry on with something of the style and enthusiasm which he brought to our subject.

John Miller
University of Oxford, UK

Planet of Tau Boötes: Reflection Spectrum Not Confirmed

Tau Boötes is one of the stars definitely known to be attended by a planet. It had been reported that the reflection spectrum of the planet had been observed — and this would have been the first optical confirmation of a planet orbiting another star. However, at Symposium 201, Planetary Systems and the Universe on August 7, it was announced that new observations had not been confirmatory.

Andrew Coller-Williams (University of St. Andrews, UK) and colleagues had been able to have targets for which he communicated to these around him, for his charismatic lecturing and for his books (The Unity of the Universe, The Physical Foundations of General Relativity, Modern Cosmology and the Dark Matter Problem) which have been of great importance for introducing many people to these subjects. He leaves a legacy of a large group of present and former students who share the privilege of having known him, and who will continue to carry on with something of the style and enthusiasm which he brought to our subject.

The Origin of Planets

At the end of the 20th century, theories of planetary origin have centred around two main concepts. The first of these, the nebular hypothesis, is dominant in that it has the greatest number of adherents, generates the greatest number of published papers and, presumably, predicts funding. This idea has been around for thirty years and still no clear-cut, generally accepted mechanism has emerged that will produce giant planets on a suitable timescale. In a recent BBC television series The Planets, one solar nebula theorist admitted that, “...according to our theories, Uranus and Neptune do not exist.” We have a number of papers on this theme at the present meeting and even one that considers the pros and cons of the planetary model against direct detection in a disk.

The second concept invokes the idea that planets are produced by interactions between stars and protostars within a forming stellar cluster. This was first suggested in 1964 when it was shown that a compact star could capture material from a tidal filament drawn out from a diffuse protostar. More recently (e.g. Paper II, 01), it has been convincingly shown by detailed SPH modelling that the captured material could be in the form of giant planetesimals whereas such interactions have been extensively studied by A. Whitworth and his co-workers. These involve either dynamical interactions between disks around stars, or the tidal interaction of one star on the disk of another. In both cases SPH modelling, beautifully illustrated on p.15 of the booklet Astronomy in the UK included in your conference bag, reveals the formation of planetary companions to stars.

The choice is between two competing mechanisms. The first, which has been popular for thirty years, is replete with complex mechanisms and still generates many questions than answers. The second is based on SPH models without fuss and difficulty in various ways and calls on no more theoretical aids than tidal effects, collisions, storms of matter and gravitational instability.

I wonder what William of Occam would have chosen?

Michael Woolfson
University of York, UK

Networking the Solar Network

The ESNN works on several lines of research, operating in parallel. At optical wavelengths, the highest resolution instruments are ground-based, and we are using the Vacuum Telescope and the Swedish Vacuum Telescope with the latest image deconvolution techniques to obtain unprecedented resolution of solar granulation and sunspots. At shorter wavelengths – in the hot chromosphere and even better transition region and corona – we are using space-based data from SOHO and TRACE (The Transition Region and Coronal Explorer) and LASCO (The Large Angle and Spectrometric Coronagraph) onboard the Solar Heliospheric Observatory (SOHO); Eucli.mod (The Fourier Spectrometer) onboard the Solar and Heliospheric Observatory (SOHO); and TRACE (The Transition Region and Coronal Explorer) and SDO (The Solar Dynamics Observatory) onboard the Solar Dynamics Observatory (SDO).

On the theoretical track, we are developing numerical techniques to model the propagation of waves through magnetic structures in the solar atmosphere, in the hope that we can learn how to use observations of such waves to determine the configuration and strength of solar magnetic fields. Already we have made some progress with the realization that non-vertical fields inhibit the growth of wave amplitude into the non-linear regime, so that in the presence of short-wavelength waves or shocks may be useful diagnostics of the orientation and strength of the underlying field.

Colin Rosenthal
University of Oslo, Norway

Kyoto Model Lives ... at least until 2000?

Cosmic Infrared and Near-Infrared Traces: The Kyoto Model

Astrophysicists trying to tell the world how exciting their work is, tend to be a precarious, narrow path between seeming to be unable to make up their minds about the age of the Universe, how stars form or whatever, and seeming to claim, as new and fundamental, ideas almost as old as some of your Vice Presidents. Our current understanding of the basic cosmological parameters either avoids both sins or commits them both simultaneously, depending upon your point of view.

A symposium at the 1997 General Assembly was one of the many of the same issues at IAU Symposium 201 this week, ended with a panel discussion in which several of us put up with our ‘best bet’ values of the cosmic baryon density and s.c. forth. Admittedly, some of us put up with our record as doubting the correctness of the entire hot Big Bang story. And indeed, representatives of both camps are with us here in Manchester.

In the intervening years, new results have been announced from studies of Tyco 1 supernovae at moderate redshift, and more recently the mapping of fluctuations within the cosmic microwave back-end on scales of about 1’. We have been amazed and on the whole pleased, to see that the new ‘next’ parameters are coming very close the ‘Kyoto model’: that is a density parameter of gravitating matter Dm ≈ 0.3 divided among baryons with Dm = 0.1, dark mass neutrinos with Dm = 0.02, and cold dark matter with Dm ≈ 0.25, and a density parameter of vacuum energy De = 0.7, or H = 65 km/sec/Mpc. All of us will come to the end of S201 with rather similar numbers. Just remember the old sailors adage: constant bearing means collision.

Virginia Trimble
University of California, USA
Let the presses roll...

With the first issue of Northern Lights ready for printing, Associate Editor, Patrick Moore, pressed the button to start the presses and, in the corner of the office, John Mason, inspected the first copy as it came hot off the press.

Don’t forget to pick up your copy of the newspaper each day from one of the many collection points. These are located in Whitworth Hall beside the mailboxes, and by the coffee serving points in all of the meeting venues. If you happen to miss an issue then back issues can be collected from the newspaper office located in the Crawford Building, Seminar Rooms A and B.

Come in and see us if you have an item for the paper. Our editorial team has been augmented by Julie Semmence, who has joined us as Administrative Assistant.

IAU Press Office

The IAU Press Office will be open throughout the General Assembly. In charge of the Press Office is Jacqueline Mitton.

The office is located in Seminar Rooms D and E of Crawford House, next to the Northern Lights office. The Press Office is available to all delegates for contacts with the news media (journalists, TV, radio, etc.). Delegates who need any assistance in this respect should contact the Press Office direct.

The Press Office telephone numbers are 0161 275 9439 and 0161 275 9438. The fax number is 0161 273 6380.

Public Understanding of Science Lecture

The IAU General Assemblies always include several public lectures, given by distinguished astronomers. The first of these is being delivered this evening by Professor David Hughes in the Reid Theatre of UMIST (University of Manchester Institute of Science and Technology) at 7pm. His title is ‘Deep Impact: Asteroids and Comets’, a subject very much in the public mind.

Patrick Moore will be in the Chair.

Welcome Reception

A welcoming reception for all delegates and guests was held at the Staff House, University of Manchester, on the evening of August 7. These gatherings are always enjoyable, particularly when there is no set agenda; it provides a splendid opportunity to make new friends and to renew old acquaintances.

Predictably, there were guests from all countries; some of whom had been to many IAU General Assemblies, and those who are arriving for the first time. These included Presidents, Vice-Presidents and IAU officials, both past and present. Staff House, where the event was held, is ideal for this type of function; it is spacious and well equipped, without sacrificing any of its intimacy.

All in all, this was a most pleasant and memorable reception, so typical of the excellent atmosphere which has so far marked the 24th General Assembly – and will no doubt continue to do so until we part in just under two weeks’ time.

Astronomical Data Centres like CDS and NASA/ARC have agreed on certain standards for the preparation of tabular data which they prepare for public accessibility through their centres. You, as an author, could facilitate their work and increase the ease of use of your data tables if you stick to these conventions. See http://vizier.u-strasbg.fr/doc/catdifx.html.

Documentation also has a standard format allowing simultaneous searches through hundreds of such tables using web tools. If, for your research, you’d like to see more of these tables available on the WWW, why not send your data tables to those centres in the appropriate form and together with standard documentation?

Heinz Andernach
ESA, IUE Observatory
Villanueva, Spain
for Commission 5 WG on Astronomical Data

Want to Keep Fit?

If you’re becoming a couch potato, sitting in GA meetings all day, then get in shape.

The Armitage Centre close to the Fallowfield Hall of Residence can offer sports and keep fit facilities to delegates attending the IAU conference upon production of their card or badge as follows:

**Tennis:**
- £2.80 per court per hour
- £2.80 per court per 45 min
- £4.20 per court per hour

**Squash:**
- £24 per court per hour
- £24 per court per 45 min
- £24 per court as per five-a-side
- £21 per hour

All above subject to availability.

For delegates wishing use the fitness suite it is essential that they undergo a 45-minute induction session. These will be FREE OF CHARGE and will take place on the following days:

- Tuesday, August 8: 4-5 pm and 9-10 pm - TODAY
- Thursday, August 10: 4-5 pm and 9-10 pm
- Only up to six people per session can be accommodated, and this will be done on a first-come, first-served basis. They will then pay £3 each time they use the facility.

The Armitage Centre is open Monday to Friday from 9.15 am - 11 pm, and on Saturday and Sunday from 10am - 8pm.

Please wear loose clothing, i.e. track suit/shorts and trainers.

Locating Mailboxes

To locate anyone’s mailbox in the Whitworth Hall, you do not necessarily have to look up their name on one of the two computers provided. If its name appears in the Participants List booklet (included in the conference bag), where they are printed in alphabetical order, then the four digit Registration number to the left of the name is also the mailbox number.

Don’t forget that it is the mailbox BELOW the number which is the correct one.

Owens Park Bar

For the benefit of all those people staying at the Halls of Residence, there will be a bar open at Owens Park from 7pm until 11pm Monday to Saturday, and from 7pm to 10.30pm on Sundays.

How to set up a data table

Did you know that the mission of IAU Commission 5 Task Group on Astronomical Designations is to promote clear and unambiguous designations of astronomical sources? See http://auaisan.rssi.ru/IAU/SUBDIVISION/TC_5/for details.

The Naming Game

Look out for future news items from the TG on Designations each day under “The Naming Game” heading.

Helle R. Dickel
University of Illinois, USA
Netherlands Foundation for Research in Astronomy
Chair, Commission 5 TG on Astronomical Data
New Programme for the Oschin Telescope

The Palomar 48-inch (1.2-metre Oschin) telescope has had a long and profitable career. Now it is about to begin a new phase of activity – the electronic Survey (PCAS) – started in the early 1980s and providing a statistical base for asteroid studies. Notable discoveries from this time period were 1979 VA(4015) Wilson-Harrington, the first evidence of an asteroid evolving from a comet to an asteroid over a thirty year period (1949-1979), and the stunning discovery of 1982 DB (4660 Nereus), the most accessible asteroid for low-cost spacecraft missions (current and future target object). Impressive detailed images of Comet Halley were taken in the spring of 1986 using the Schmidt.

The NEAT, a project of the PCAS programme, is in the process of upgrading NASA-funded the 48-inch (1.2m) Oschin Telescope at Palomar Observatory. This telescope has conducted the two Palomar sky surveys (1948-1956 and 1985-2000) and numerous other limited programmes including asteroid surveys by the author and Tom Gehrels of the University of Arizona, using its wide field of view. The Palomar-Leiden Survey of Faint Asteroids was carried out in the early 1980s and provided a statistical base for astroidal surveys. Notable discoveries from this time period were 1979 VA(4015) Wilson-Harrington, the first evidence of an asteroid evolving from a comet to an asteroid over a thirty year period (1949-1979), and the stunning discovery of 1982 DB (4660 Nereus), the most accessible asteroid for low-cost spacecraft missions (current and future target object). Impressive detailed images of Comet Halley were taken in the spring of 1986 using the Schmidt.

The PCAS programme, an offshoot of the FCAS programme, is in the process of upgrading (NASA-funded) the 48-inch (1.2m) Oschin Telescope at Palomar Solar System Survey which led to the discovery of Chiron. The new programme will, it is hoped, contribute at least 5% to the NASA goal of discovering 90% of the near Earth asteroids (NEAs) larger than 1 km by 2009. These are NEAs primary targets.

With the addition of a computer-controlled pointing and sequencing system, and a large format multi-CCD camera, NEAT will begin a large scale asteroid survey late 2000. An enhanced and enlarged version will be the result of a large CCD array to be added to the 48-inch (1.2m) Oschin Telescope by the end of 2000.

The 48-inch Oschin Schmidt Telescope at the Palomar Observatory, which is about to join the hunt for NEAs, with Eleanor Helin (inset).

S Marks the Spot

At Symposium 203 (Recent Insights into the Physics of the Sun and Heliosphere) Sarah Gibson (Catholic University of America) yesterday presented the most recent results from studies of active regions of the Sun known as 'sigmoids'. These S-shaped disturbances are "good for sitting and starting at", for they are believed to kick off many of the other, more familiar features of solar activity. Best seen in the X-ray region of the spectrum, and well within the grasp of instrumentation on the Yohkoh satellite, the studies presented were part of the outpouring of data from the third Whole Solar Month campaign. A representative sequence of images was shown, with the S-shape altering to a cusp during eruption before returning to the standard formation as the disk was crossed. Work has also been done on modelling the conditions around the sigmoid, and support is found for a view in which high altitudes are hotter than lower ones. This results in an upflow of material at the ends of the S, and when combined with the large scale of these features – covering a significant fraction of the solar disk – this may result in their high levels of activity. Whatever the final outcome of this work – and much more detail can be found on the relevant poster (B203.105) – it seems certain that sigmoids are features to watch out for in forthcoming SOHO, TRACE and Yohkoh observing campaigns.

Data from Balloons

The first talks on the second day of Symposium 201 focused on both ongoing and future missions to map the cosmic microwave background (CMB). Much of the excitement was centred around the two balloon-borne experiments: BOOMERANG and MAXIMA. Both teams have announced and published data in recent months which seem to support the idea of a geometrically flat Universe. In other words, the total amount of mass in the Universe appears to be exactly on the critical value, as predicted by inflation.

Confidence has been further bolstered with the electronic publication of a jointly authored paper confirming that both groups' results are consistent. This was highlighted by Paul Richards (University of California), who did comment that in order to obtain the fit it was necessary to reduce the values found by MAXIMA by one standard deviation (8%) and increase those from BOOMERANG by one standard deviation (2%). The mood of the meeting was that the necessity for this small adjustment would be removed by the addition of future data, for example from the second full flight of BOOMERANG, which is now being analysed. The paper can be located via the preprints service at hep/0007333.
The IAU
Inaugural
Ceremony

The Inaugural Ceremony, which takes place today at 2 pm sharp in Manchester's historic Bridgewater Hall, is one of the main highlights of the 24th General Assembly. There are distinguished speakers, as one would expect, and there are also two musical items. First, to initiate the whole proceedings, an organ recital by Paul Walton, and then, before the First Session of the General Assembly, an interlude by the Zeneka Brass Quintet. These musical items are described separately on this page by Sir Bernard Lovell, himself a skilled organist.

After reading physics as an undergraduate he began research in geophysics, and started thinking about the origin of the Earth's magnetic field, but soon decided that solar magnetism was more interesting. After spells at MIT and at Culham, developing computational magnetohydrodynamics, he returned to Cambridge as a Lecturer in the Department of Applied Mathematics and Theoretical Physics (and a Fellow of Clare College), and has been there ever since, apart from sabbaticals in the United States, Munich and, recently, in Japan. In due course he became a Reader and Professor of Mathematical Astrophysic, and for five years the SRC Senior Fellowship. He comments that after sitting on many Committees, being President of the RAS is not just an honour, but a pleasure.

His research extends into many fields. At present its central aim is to explain the structure and origin of magnetic fields in the Sun and other stars. He is also engaged in modelling stellar dynamics and explaining the origin of episodes of reduced solar activity such as the Maunder Minimum, as well as in exploring the relationship between solar activity and climatic change. Since the IAU is holding its General Assembly in England for the first time in thirty years, it is surely appropriate for the first speaker to be the President of the RAS.

Literature at Bedford College, London University; after graduating she went to Malaysia as an English teacher with Voluntary Service Overseas. On return to the UK she taught English in Mercers' School, and after gaining an MA in Linguistics at Manchester University was for three years engaged in teacher training. From 1977 she lectured in Linguistics at Manchester University, obtaining her PhD in 1989. Her academic interests have always concerned children's language development, and in addition to writing books and papers she was for fourteen years editor of the International Journal of Child Language. In 1991 she was appointed to the Chair of Educational Linguistics at Manchester University. In 1994 she was made a Pro-Vice-Chancellor with responsibility for teaching and learning across the University, and in 1997 became a senior Pro-Vice-Chancellor, with responsibility for academic development.

Our Inaugural Ceremony would not be complete without welcoming the Chief Scientific Advisor to the UK Government and Head of the UK Office of Science and Technology, Professor Sir Robert May, Fellow of the Royal Society, holds this position on leave from his Royal Society Research Professorship in the Department of Zoology, Oxford University, and at Imperial College London. Previously he was Chair of the 1997 Professor of Zoology at Princeton University (1973-1988) and Professor of Physics at Sydney University (1969-1973). Trained as both a physicist and an applied mathematician, for the past twenty years or so he has been interested in and working on ways in which populations and communities are structured. It is therefore a particular pleasure for him at our Inaugural Ceremony, particularly in view of the presence year of the first speaker.

To complete our panel of distinguished speakers, we have Professor Robert Kraft, President of the International Astronomical Union. He is Professor Emeritus of Astronomy and Astrophysics and Astronomer Emeritus, University of California, and has written many books on stars and their evolution, and he has been closely involved with the International Astronomical Union from its inception, and has served as its President and as President of the International Astronomical Union in those of other galaxies. He and his research associates have also been studying the chemical composition of stars in the halo of our Galaxy in those of other galaxies. He and his research associates have also been studying the chemical composition of stars in the halo of our Galaxy in those of other galaxies. He and his research associates have also been studying the chemical composition of stars in the halo of our Galaxy in those of other galaxies.

The first of the main speakers is Professor Nigel Weiss, President of the Royal Astronomical Society. He grew up in the North West, but has spent most of his life in Cambridge.
Joint Discussion
Atomic and Molecular Data Needs in Astronomy

Advances in astronomy depend on the detection of photons to observe new phenomena and to test and refine theoretical models. Over the last thirty years, techniques for the detection of these elusive particles have enabled us to explore the Universe from gamma-ray to radio wavelengths. At the same time, the development of computing power has enabled us to make complex models of astrophysics and to make subsequent predictions. As a result, we have powerful probes of many environments which allow for substantial advances in our understanding of the Universe. The interpretation of astronomical observations relies to a great extent on the availability of accurate atomic and molecular data. The aim of Joint Discussion 1, which has been organized by Commission 14 under the chairmanship of François Rostas (Observatoire de Paris-Meudon) and which begins today, is to discuss the data needs of recent or forthcoming space missions and to encourage consistent and comprehensive approaches to data provision for these missions.

By Pawal Geballe, National Radio Astronomy Observatory, USA

ISO Spectrum of ice bands in the young stellar object W33A.

Solar System debate hots up

"When we discovered extraterrestrial planets we lost understanding of our own Solar System" said Paul Aronowsky (Stockholm Observatory) in Tuesday morning’s lively session of Symposium 202. The main emphasis of the standard theory of planet formation was Jupiter and used the melting of ice in the solar nebula to define Jupiter’s position. The theory predicted a gap which opened up in the solar nebula to forecast the mass of Jupiter and assumed the planet’s orbital eccentricity was zero - it was "obvious."

Now we have exoplanets and that theory is in disarray. Jupiters are everywhere - not just at 5 AU. They are usually eccentricities at large distances from their parent stars. This match provides additional support for models of cool stars and brown dwarfs which has been seen in the past. The discovery made during the past decade and a half, various proposals have been advanced, including CO, O, CO2 and SO with oxygen-passivated silicon nanoparticle, which is difficult to uncover. For example, accurate transition wavelengths and oscillator strengths for several millions of transitions. The development of X-ray spectroscopy using satellite observatories such as XMM-Newton, Chandra and Cluster requires data for a range of complex models of astrophysics, heavy elements. Since accurate abundances often depend on the observation of lines having very small oscillator strengths, the provision of data usually requires significant computational effort. More recently, the interpretation of astronomical observations relies to a great extent on the availability of accurate atomic and molecular data. The aim of Joint Discussion 1, which has been organized by Commission 14 under the chairmanship of François Rostas (Observatoire de Paris-Meudon) and which begins today, is to discuss the data needs of recent or forthcoming space missions and to encourage consistent and comprehensive approaches to data provision for these missions.

Historically, the early development of astrophysics relied on the provision of atomic data at visible wavelengths. Stellar atmosphere calculations require, for example, accurate transition wavelengths and oscillator strengths for several millions of transitions. The development of X-ray spectroscopy using satellite observatories such as XMM-Newton, Chandra and Cluster requires data for a range of complex models of astrophysics, heavy elements. Since accurate abundances often depend on the observation of lines having very small oscillator strengths, the provision of data usually requires significant computational effort. More recently, the interpretation of astronomical observations relies to a great extent on the availability of accurate atomic and molecular data.

In the following session, Shigera Ida (Tokyo Institute of Technology) gave a presentation entitled 'Terrestrial Planet Formation: the Solar System and Other Systems'. Various theories of planet formation were summarized. In our Solar System there are two 'gas-giants' (Jupiter and Saturn), two 'ice-giants' (Uranus and Neptune) and a number of terrestrial-type planets. When planets were formed from the original disk, large bodies formed first; this is why Jupiter and Saturn accumulated as much mass as possible, forming Uranus and Neptune did not. In the region of terrestrial planet formation, other factors have to be considered notably orbital crossings and giant impacts. The speaker concluded that the thickness of the planet-producing disk was of paramount importance. The disks could be either massive, medium, or light. Calculations indicated that a massive disk would produce many gas-giants; a medium disk would result in a Solar System similar to ours, while a light (i.e. less massive) disk would produce a large number of terrestrial planets and probably no gas-giants at all. In this case our own Solar System would be completely different from a Solar System with a 'medium' disk, and systems of this kind are likely to be very common in the Galaxy.
These acronyms, which hold great promise for 21st century astronomical research, are also the headliners under which the European Southern Observatory (ESO) presents itself at a 50 square metre exhibition in the entrance foyer of the Royal Northern College of Music. The exhibition contains large information panels, videos and a model of the Very Large Telescope Array on Paranal. Three of the 8.2-metre VLT unit telescopes - called Antu, Kueyen and Melipal (Mapuche names for celestial objects) - are now in operation, while the fourth telescope, Yepun, will see first light soon.

High on the ESO agenda is the implementation of the VLT Interferometer (VLTI), with its 1.8-metre auxiliary telescopes and optical delay lines currently under construction. Documentation about ESO and its projects is available at the exhibition, including the most recent issue of the Messenger – published only a few days ago - with a 10-page presentation of the 100-metre OWL telescope project. Information about the ALMA project can be obtained at the joint ALMA Information Stand, located at the ground floor of the Royal Northern College of Music.
Cluster II: A Successful Launch

Rumba and Tango join the cosmic dance troupe

I had to take time off from the General Assembly yesterday to attend a competing attraction in London - the European Space Agency's reception to witness the launch of the second pair of the Cluster satellites. Hundreds of Cluster scientists, science journalists, ESA, PPARC and BNSC officials crowded into the historic, splendid hall of the Royal Society to view the video link from the Baikonur Cosmodrome. The Soyuz-Fregat launch vehicle stood on the launch pad, and the launch preparation crews scuttled away to a safe distance when their part in the process was finished. It was a scorching hot summer afternoon in Kazakhstan, with temperatures well over 40°C. As the rocket motors ignited, a worrying cloud of smoke rose up from the base of the rocket, and disturbing memories passed across my mind. But the launchers lifted off its supports, they swung away; and at 12.13hrs British Summer Time the rocket rose gracefully above the Cosmodrome.

We all applauded and popped open the champagne. For the bureaucrats, the industrialists and the rocket scientists, Cluster was now all safely launched and their part was ended. Over the next two weeks the orbits of the four Cluster spacecraft - Rumba and Tango launched yesterday, and the first pair, Salsa and Samba, launched on July 16 - will be slowly brought together. There will then be a three-month period during which all four spacecraft will be thoroughly checked out, before beginning their two-year investigation of solar-terrestrial interactions. For the scientists their real work was just beginning as their investigations got under way. We are likely to hear the results at the 25th General Assembly in Sydney.

Paul Murdin
British National Space Centre

Inaugural Ceremony

As was to be expected, the Inaugural Ceremony, at the Bridgewater Hall, was enjoyed by all those who were fortunate enough to be present. It was preceded by an organ recital by one of Britain's leading young musicians, Paul Walton, whose programme included compositions by Sir William Herschel and what could be more appropriate than a contribution by the very first true astronomer in the world? Sir William Herschel and what could be more appropriate than a contribution by the very first true astronomer in the world? Sir William Herschel?

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As was to be expected, the Inaugural Ceremony, at the Bridgewater Hall, was enjoyed by all those who were fortunate enough to be present. It was preceded by an organ recital by one of Britain's leading young musicians, Paul Walton, whose programme included compositions by Sir William Herschel and what could be more appropriate than a contribution by the very first true astronomer in the world? Sir William Herschel?
Astronomers Sign International Agreement to Plan Square Kilometre Array

Leading astronomers from Europe, North America, Asia and Australia will today sign an agreement jointly to plan a huge new radio telescope, the Square Kilometre Array (SKA), which will come into operation in the middle of the next decade. The SKA will be an exciting new instrument that will set a new standard for radio astronomy. This will be an exceptional opportunity to inaugurate the next stage of development of this truly global discipline.

The signing ceremony will take place at 17.30hrs in the Bragg Lecture Theatre in the Science Building at the end of the joint session on "Future Observational Multi-Wavelength capabilities in Astrophysics" organized by the Working Group on Future Large Scale Facilities (WGFLSF) and IAU Division XI (Space and High Energy Astrophysics). The last part of the programme is a round-table discussion about the process of international co-operation and coordination.

Radio astronomers regard the SKA as a paradigm for the organization of future global astronomy projects. The SKA was the first radio astronomy project to have been 'from global' following the guidelines for successful international collaboration discussed at the 1994 IAU General Assembly in The Hague. The current concept has grown out of discussions over the past six years within the URSA/IUE Large Telescope Working Group and the OECD Global Science Forum. An International SKA Steering Committee (ISCC) has now been constituted to promote and to oversee the planning of the project. The signing of a formal Memorandum of Understanding will establish the ISCC for a period of five years.

Dr. Jim Moran, the Australian SKA consortium chair, said: "This is a very important day for radio astronomy. It is a major achievement to sign this international agreement to set up and plan the Square Kilometre Array. The SKA will have a simple but unique instrumental configuration, and will be able to measure to a precision of 1 part in 10 million in the radio frequency domain. This will enable us to map the distribution of matter in the universe with unprecedented accuracy.""The SKA will be a unique instrument - it will operate at frequencies from 1 to 300 GHz and will have a collecting area of 10,000 square kilometers. This will allow us to observe the faintest 21-cm emission from atomic hydrogen in distant galaxies with 0.1 arcsecond resolution.""The SKA will, therefore, be the world's premier instrument for astronomical imaging.""The SKA will be a uniquely sensitive radio telescope with a high level of resolution and a large collecting area. The SKA will be able to resolve to a precision of 1 part in 10 million in the radio frequency domain. This will enable us to map the distribution of matter in the universe with unprecedented accuracy.""

The SKA is the only truly global radio astronomy project and the result of a collaborative effort between astronomers and institutions from all over the world. The SKA will be a unique instrument - it will operate at frequencies from 1 to 300 GHz and will have a collecting area of 10,000 square kilometers. This will allow us to observe the faintest 21-cm emission from atomic hydrogen in distant galaxies with 0.1 arcsecond resolution. The SKA will be a major advance over those operating at most other wavelengths, because they can see through cosmic dust. The SKA will be a premier instrument for astronomical imaging.

The SKA will be a uniquely sensitive radio telescope with a high level of resolution and a large collecting area. The SKA will be able to resolve to a precision of 1 part in 10 million in the radio frequency domain. This will enable us to map the distribution of matter in the universe with unprecedented accuracy. The SKA will be a premier instrument for astronomical imaging.
Joint Discussion

Massive Star Birth

Joint Discussion 3 will consider the birth processes of massive stars, those with initial masses greater than ten solar masses. While similar phenomena are found in low mass star formation (accretion disks, outflows, etc.) additional physics must be considered given the ionization by Lyman continuum photons, stellar winds from the hot star(s), and their deeper gravitational potentials. JD3 will bring together experts from several disparate astronomical communities.

The birth places of massive stars are in molecular cloud cores, but stars newly born within these regions are initially optically shrouded by the dust in the natal cloud. Massive stars, those of types O and B, are typically formed together in loose, or tight, groupings of associations or clusters. These hot and luminous stars have a profound effect on their local environments from their extensive Lyman continuum luminosity and strong stellar winds. Due to the large gravitational potentials of the central stars, all dynamical processes occur on shorter time scales than those near low mass protostars. Consequently, the neighborhood of massive protostars is a very dynamic place in which gas velocities, densities and temperatures are expected to change by orders of magnitude within a radius less than 10^3 km.

In an oversimplified early evolution scenario one would imagine that the photons dissociate, excite, and ionize the local material and the stellar winds blow this away from the formation sites. Thus the initial birth processes are highly time dependent, and dynamical effects from the ensemble of hot stars probably play a major role in the overall formation processes.

Observations of the earliest, most deeply embedded stages of massive star formation are only just becoming feasible with submillimeter and infrared telescopes. These objects are still so young that little or no radio continuum is detected. They are characterized by strong water masers and a rich, time-dependent chemistry in their surrounding envelopes. The formation of these “hot cores” and their evolution to the HII region stage is still poorly understood, for molecular core clouds one would like to evaluate the importance of observer and dust distribution if the reflection spectra of the small grains.

Ultra-compact (UC) HII regions represent a well known early phase in the evolution of massive stars. Stabilized cores are far too many of them to be consistent with the expectations from classical Strömgren theory; thus this phase lasts on average about 100 times longer than expected from the sound crossing times. Numerous postulates for the lifetime of UCHII regions have been proposed but no general consensus has yet emerged.

A very general issue to be considered is the similarities and differences between massive and low mass star formation. So far, the evidence for the presence of disks around young massive stars has been controversial. Also, the role of the ionizing photons from massive hot stars is poorly understood in terms of star formation. For example, on what time scale would they photo-evaporate stellar disks? How do they affect the surrounding envelopes, and how many photons are “leaking out”? During the UCHII region phase there are still many unresolved issues.

While many of the overall properties of the dust and gas in giant HII regions are well known from radio and IR observations, it is only recently that individual exciting stars have been identified and classified through near-IR photometry and spectroscopy. There is strong evidence from observations of M17 that the earliest type O stars are free of their natal dust clouds.

Spectra of Extrasolar Planets

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- It should be borne in mind that the reflection spectrum of theExtrasolar Planet proved to be spurious. However, a great deal was learned from this episode. We need new and better observations, but with modern-type equipment the prospects are bright, and we should be able to obtain data concerning the composition and temperatures of the atmosphere.
- As the speaker very wisely stressed, major modelling will be required to interpret extrasolar planetary reflection spectra.

Peter Conti, University of Wisconsin, USA

Edward Churchwell, University of Colorado, USA

Co-Chairmen of SOC
Great Success for Radio Astronomy

A nearby extrasolar Earth-like planet reflected sunlight like a 10µm dust particle, appearing as a tiny bright spot in our atmosphere from a distance of 4000 km. The planet was found in an extrasolar planetary system, either in the visible or infrared, where we could have observed the planet. The result was total success: ALL the frequencies were at the quoted position and the new resolution was shown in the accompanying figure. The line profile shows the schematic variation of vegetation, atmospheric absorption, frequency allocation, and astronomical windows containing attenuation minima occur in the range 71-275 GHz, and 195-275 GHz. The new radio astronomy allocations now extend across most of the windows, and for the central window in particular, the improved protection is enormous. Many hundreds of molecular lines have been detected within the entire band, and most of these, even if redshifted, are now covered by allocations.

As a consequence of the bargaining to increase the allocations, some of the allocated frequencies will have to be shared with other services, which are not yet operational. However, it is commonly believed that sharing will not be a problem at these high frequencies where ground-level atmospheric attenuation is high.

We believe that WRC-2000 has provided a great legacy for the future of high-frequency radio astronomy. (The results of WRC-2000 were also reported in Science (2006), 286, 2107-2108, and in an article by Thomas Gergely in the current NRAO Newsletter.)

John Whitehead, Australia Telescope National Facility
Jim Cohen, Jodrell Bank Observatory

Direct Observations of Planetary Systems

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John Whitehead, Australia Telescope National Facility
Jim Cohen, Jodrell Bank Observatory

 Welcomed at the Town Hall
New Roads into Space: WSO/UV

Space astrophysics was born under the auspices of the Cold War. The new world order of the 21st century might require some revision of the ways in which astronomers retain access to those windows of the electromagnetic spectrum which can only be accessed through space missions. To evaluate the consequences of this, the concept of a World Space Observatory (WSO) has been developed during the nine UN/ESA Workshops for Basic Space Science for the developing countries. This was discussed yesterday in the Joint Session of Division XI with the WG on Future Large Scale Facilities.

Over the years during which such ideas have evolved and matured, some seven space agencies have expressed their interest in the concept of a WSO. As such lofty concepts can be discussed easily but are more difficult to implement, a small international group of scientists met last year to clarify a mission concept for a WSO. They came to the conclusion that a WSO/UV would represent an excellent study model. This would represent a mission with very broad scientific impact and would, at the same time, allow early and open participation of all countries in the mission. Apart from the obvious scientific interest in a WSO/UV as defined with a 1.7-metre telescope, a spectroscopic resolution of 5 x 10^4, and an image quality of 0.1 arcsecond in the UV, the open nature of the project would allow an unprecedented sharing in the study of the Universe by a broader public on a worldwide scale. No capabilities of similar nature are foreseen for the next decade, so that the contributions of WSO/UV to the results of our current major missions and ground-based telescopes will be very important. An assessment study of the WSO/UV has been made in the long-term planning of the European Space Agency. This has shown that a WSO/UV mission can be practicable and feasible, and could be launched in 2006. The fully integrated approach to the mission development, including hardware, software, mission operations, science operation and user activity simultaneously, presents a realistic challenge.

Further information on WSO/UV may be obtained from the author.

Willem Warmsteke ESA/VILSPA

Death of a Comet

Comets are known to be short-lived members of the Solar System, but few die as suddenly and spectacularly as Comet LINEAR is doing. At one stage, in mid-July, it was on the fringe of naked-eye visibility, but then broke up, and by July 27 the bright core was no longer to be seen. The disintegration of the comet, first reported by Mark Kidger and his colleagues at the Roque de los Muchachos Observatory on La Palma, was at first thought to be complete, but Comet LINEAR had many more tricks up its sleeve!

Astronomers at the Space Telescope Science Institute in Baltimore hastily re-programmed Hubble to begin a search, and at once a small ‘armada’ of mini-comets came into view, left behind by the dying comet. Hal Weaver (Johns Hopkins University) commented that he was ‘stunned’ when half a dozen of these mini-comets, with tails, appeared on his screen. They were clustered in the tip of an elongated stream of dust, an isolated bright object in front of the main cluster was taken to be the parent nucleus for the smaller fragments. Yet how could an object the size of a mountain disintegrate in only two weeks? Carey Lisse, of STScI, commented: “I would have been more amazed if Hubble had seen no pieces. The comet’s break-up was too violent and too fast for it to vaporize completely. How do you pulverize something as large as this?”

Hubble could follow the comet for a while, and there was a second ‘window’ of availability in early August, but after about the 15th of the month the comet will no longer be accessible from Hubble. However, observations with large ground-based telescopes are being energetically carried out. Time was obtained on the VLT (Very Large Telescope) at Cerro Paranal in Chile, and on the early evening of August 6, three short-exposure photographs were taken with the multi-mode FORS instrument on Antu, one of the VLT’s eight-metre telescope units. More than a dozen mini-comets were recorded, image processing suppressed the bright part of the comet’s tail in order to give a better view of the faint condensations.

Studies of the behaviour of these condensations will give a unique insight into the structure and composition of the cometary dust and ices. As pieces of the original nucleus lose their material they will fade and vanish, and may well disintegrate completely, so that observations with the VLT are being planned while the fragments are still bright enough to be observed. It is generally assumed that the comet will not survive. It may well have come from the Oort Cloud, and was making its initial return to perihelion. If so, its first visit to the inner Solar System will also be its last!
Environmental impacts on astronomy have become increasingly severe at the radio and optical wavelengths. As outlined by General Secretary Johannes Vaagland, the IAU General Assembly on Wednesday, the IAU has been a meeting of astronomers' ability to observe the Universe. A major step was a meeting held at the Joint Discussion 13 on 'Preserving the Astronomical Sky' (the proceedings of which are being published soon). Besides the usual technical sessions, this meeting was successful in its political goal of persuading the United Nations to adopt policies favourable to astronomy's needs. Eventually we hope that these policies can be part of a new United Nations Treaty for outer space. Until then, the United Nations policy (not yet in a treaty) includes references to (1) developing international radio quiet zones, (2) the need for environmental impacts (in astronomy as well as on other sciences) to be assessed in any space projects that are approved, and (3) nations acting to control pollution of the sky by light and radio. The unique existence of energy conservation, the natural environment, right time safety and comfort, and national economic as well as science.

Commission 50 (Protection of Existing and Proposed Sites) has recently established a Working Group on Light Pollution under the chairmanship of Malcolm Smith, Director of the Cerro Tololo Inter-American Observatory (CTIO) in Chile. Smith is ideally situated because over the past decade, Chile has become a key astronomical nation, site of numerous major present and future facilities, such as CTIO, Gemini, ESO, VLT, La Silla, Paranal, etc. In addition, European and American radio observatories are developing the world's largest radio telescopes for a new generation of radio and optical radio telescopes, which will provide maps of unprecedented resolution (to within 0.01 arcseconds).

The Working Group on Light Pollution will hold a meeting on Monday (see back page) to discuss the many issues relating to protection of the sky. It will include astronomers, geomorphologists, geologists, geometers, geomagnetists, statisticians, experts on the atmospheric dispersion of light, etc. Please join us. Further information is available via the website of the International Dark-Sky Association (www.darksky.org).

Woodruff Sullivan
University of Washington, USA
President, Commission 50

light pollution issues

The Trans-Neptunian Population

When Edgeworth and Kuiper first conjectured the existence of a belt of small bodies beyond Neptune, they were certainly imagining a disk of planetesimals preserving the pristine conditions of the protoplanetary disk. But, since the first discoveries of Kuiper Belt Objects in 1992, astronomers have realized that the orbital distribution of the bodies discovered so far is not trivial: the Kuiper Belt is not a disk of particles on quasi-circular and coplanar orbits, as was generally expected. Even at the present day, more than 300 bodies have been discovered. In the inner belt (semi-major axes smaller than 40 AU), the known objects have large eccentricities and are associated with first order mean motion resonances with Neptune (mainly the Plutinos, in the 2/3 resonance). Beyond 42 AU the classical belt begins, where the discovered objects are not specifically related to any mean motion resonance. In addition to these two belts, theoretical considerations and the discovery of the object 1999 TF₆₅ argue for the existence of a third belt of small bodies, which evolve under the effects of sporadic close encounters with Neptune, forming a sort of scattered disk.

The peculiar orbital distribution of the currently known objects provide decisive clues for an improved understanding of the formation and primordial evolution of the outer Solar System. The overabundance of objects in the 2/3 resonance and the large eccentricities of a significant fraction of the bodies in the classical belt must be the result of some process which is not violating the primordial era. Three main scenarios have been proposed that indicate the sweeping of the Belt by mean motion resonances due to the radial migration of Neptune, the displacement of an exterior secular resonance due to a gradual mass loss of the Trans-Neptunian regions, and the primordial existence of a 'Large Scattered Planetesimal' in orbits crossing the Kuiper Belt.

The current status of this conjecture for the Kuiper Belt also provides new hints on the origin and the evolution of the Trans-Neptunian regions, the Kuiper Belt and the giant planets. The discovery of large Kuiper Belt objects bigger than 100 km should reveal the presence of a sharp 40 AU the total mass of the Belt up to 48 AU seems to be 0.3 Earth masses (Mₑ). This is not very far from its estimated primordial mass of about 30 Mₑ, which seems to imply that collisional effects among Kuiper Belt objects are not rare. The analogy between Kuiper and extratropical dust belts seems clear. The study of these objects provides complementary information on the large vs. small-size end of the distribution of bodies in disks.

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The Trans-Neptunian Population

Our understanding of transport processes in stars is still in its infancy. First, consider over-shooting. There is now ample evidence, e.g. from the best-observed binary stars and fits of models to observed colour-magnitude (C-M) diagrams, that some amount of mixing must occur beyond the classical boundary of the convective core set by the Schwarzschild criterion. Such mixing can be achieved by convective penetration; however, despite impressive progress on the theoretical front, a rigorous prediction of the extent of overshooting has not yet been achieved. As a result, most stellar evolutionary calculations have simply opted to extend convective core sizes by an amount (usually measured as a fraction of a pressure scale height) that produces reasonable consistency with observations. To what extent are these overshooting models to the right? To what extent are these models realistic? To what extent are these models satisfactory? To what extent does the overshooting}

...
Joint Discussion
Applied Historical Astronomy

It is a truism that astronomy is the oldest of the sciences. But less appreciated is the fact that historical data can be of service to modern astronomy. Joint Discussion 6 which takes place today in the Computer Science Building will survey the whole range of these data, including eclipses, occultations, comets, meteors, planetary and lunar observations, sunspots, aurora, and supernovae. During this one-day meeting you will learn:

- why very few datable cuneiform astronomical records survive from Mesopotamia to the mid-eighth century B.C.
- where the earliest surviving series of solar eclipse observations were taken.
- the sources of Arab and Indo-Persian observations.
- the lessons learned from Galileo's and Lalande's observations of Neptune.
- how information in historical sunspot records may be of great importance in determining the long-term behaviour of the solar magnetic field.
- what historical auroral records tell us about the long-term variation of solar activity and the Earth's magnetic field.
- what 449 ancient and medieval eclipse observations tell us about changes in the Earth's rotation over the past 2,500 years.
- how ancient observations are the only sources for modelling the long-term behaviour of periodic comets.
- the frequency of injection of giant comets into the inner Solar System, and whether such a body could have been present not one thousand, but ten thousand years ago.
- how historical observations of supernovae are useful for the modern astrophysical interpretation of their remnants.

Precision Cosmology? Not Yet!

Malcolm Longair began Symposium 201 on Monday by saying that we were entering an era of precision cosmology. However, ideally we would like to measure cosmological parameters not only to high precision, but also to control systematic effects; i.e. measure them to high accuracy as well as precision. The results being presented at this Symposium do show clear and very encouraging evidence that new experiments and observations are being carried out with higher precision than previously possible, and are, moreover, being designed from the outset to minimize, test and correct for systematic effects. This is welcome progress, since historically systematic errors have dominated all measurements of cosmological parameters.

Several recent measurements of the Hubble Constant (H_o) were reported at the meeting on Wednesday. Two talks were given presenting results from the HST key project. This group has used HST to measure distances to galaxies, and has determined H_o using five different methods. The combined value for this different methods, based on a new calibration of the Cepheid period-luminosity relation, is 74 ± 3 ± 7 km/sec/Mpc. The error bars refer to statistical and systematic uncertainties respectively.

New results were also reported by Alan Heavens (Carnegie Observatories) on surface brightness (also one of the methods used by the key project group). A Cepheid calibration of this method gives H_o = 77 ± 4 ± 7. Paul Schechter (MIT) presented results on H_o from time delays of gravitational lenses. For three well-modelled lens systems, correcting for internal galaxy motions and cosmology, he reported a value of H_o = 62, but cautioned against believing statistics for three objects.

Two talks summarised the status of CMEs before they occur, research is being undertaken by another instrument on SOHO, the Coronal Diagnostic Spectrometer (CDS). Several CME onsets have already been identified with these new techniques, as on 1999 July 25, when CDS saw a magnetic loop rising through the solar atmosphere at 10 km/sec for two hours before a CME. A magnetic explosion then occurred, releasing the CME and also causing a flare. Richard Harrison (Rutherford Appleton Laboratory, UK) has commented: "At least we begin to see tell-tale events which precede eruptions on the Sun. Yet the link between CMEs, flares and dangerous outbursts of particles is still very vague."

Applied historical astronomy is a vibrant field, with the majority of historical observations undoubtedly remaining to be discovered. JD6 has been organized by Committee 6 (History of Astronomy), with support from Divisions I, II and III, and Commissions 4, 19 and 20. If you wish to hear more about the work of Commission 41, please attend our Business Meeting on August 15, at 1:00pm in the Blackett Theatre, Schuster Laboratory. We welcome new members.

Steven J. Dick
U.S. Naval Observatory
President, Commission 41
Rotational Braking, Angular Momentum Transport and Light Element Abundances

The observed depletion of lithium in the Sun has puzzled astronomers for many decades. As the base of the solar convective zone (CZ) is not hot enough to deplete lithium, this requires mixing below the CZ which is not predicted by the standard solar model. In the last decade, non-standard, turbulence-based models have linked this mixing process to the transport and dissipation of angular momentum.

Rapid rotation is a remnant of the star formation process, but older solar-type stars are typically slow rotators. To explain this, the models predict that after the surface of a rapidly rotating zero-age-main-sequence star is spun-down by surface winds, the star is left in a state of differential rotation with the interior spinning more rapidly than the surface. Angular momentum is transported via turbulence resulting from the shear forces between the layers and dissipated from the surface. Simultaneously, the turbulence results in a slow mixing current which leads to the depletion of surface lithium. These models offer an attractive explanation for the observed depletion.

However, three pieces of observational evidence strongly contradict the predictions of the model. Firstly, while the models predict that the present-day Sun has a rapid rotation, recent improvements of petrology and astrophysical data reveal that the solar interior is rotating slowly as a rigid body down to 0.6 Rs⊙. Secondly, the models predict that the slow, deep mixing results in the simultaneous depletion of lithium and, the more robust but yet fragile, beryllium. A re-analysis of the Fe II lines in the UV have shown that the solar beryllium abundance equals the meteoritic value, indicating that mixing down to beryllium has not occurred over the entire history of the Sun. Finally, the models predict that short-period, tidally-locked binaries with a different rotational history from their single-star counterparts, will have far higher lithium abundances than single stars that predict this contrasts this point will be presented during joint Discussion 5 this morning.

It appears therefore that the transport of angular momentum proceeds far more efficiently than predicted by turbulence transport, perhaps via magnetic fields or internal gravity waves which are currently being investigated theoretically. In the Sun, the depletion of lithium may possibly result from localized turbulence at the base of the CZ. An understanding of the complete pattern of lithium observations remains elusive.

Sushilka C. Balachandran
University of Maryland, USA

MHD Seismology of the Solar Corona

During Symposium 203, Valery Nakariakov (University of Warwick, UK) discussed recent developments in studies of MHD wave motion in the solar corona, and introduced a new method for the determination of one of the previously uncertain physical parameters of the corona - the field strength - based upon analyses of coronal loop oscillations observed with EUV imaging telescopes on board the SOHO and TRACE spacecraft. The structure, dynamics and evolution of the corona have long been known to be controlled by the solar magnetic field, which is generated by dynamo processes in the Sun's interior. However, due to the complexity of the surface it becomes measurable in sunspots, and extends out into the corona and the solar wind. Spectacular images of the corona were shown during the presentation. It was found that the field strength in the loop analyzed was from 20-30 G, very close to the value expected from extrapolation of the surface value. The technique is based upon a delicate combination of high-precision EUV imaging and analysis of the position and intensity of MHD waves. It opens up new perspectives in studies of the physics of the solar corona.

An Accelerating Universe?

It is strongly recommended that IAU delegates do not wear their identification badges when walking around Manchester. This indicates that they are visitors to the city, and are potentially more vulnerable.

Catch a Shooting Star Tonight

Editor’s Pick

The Sky Polarization Observatory (SFOt) Programme: Etore Carretti (Italy)

Public Lectures at GA24

UMET are running a series of lectures for the public during GA24. These lectures have been advertised widely to schools, amateur astronomical societies and on local radio. Entrance IS BY TICKET ONLY and all available tickets have been allocated to the general public. Attendance by participants at GA24 is free, but comes with a health warning! Ticket holders will be admitted to the lecture theatre as a priority. Only if seats are still available, just before the start of the lecture, will those without tickets be admitted.

We hope that you will appreciate our desire to give the genuine public some feeling for the excitement of astronomy during GA24.

Helene R. Dickel
University of Illinois, USA
T Netherlands Foundation for Research in Astronomy, Chair, Commission 5 TG Astronomy
Coronal Heating and Solar Wind Acceleration

The exact origins of the solar corona and wind remain controversial following a lively session of Symposium 253 on Thursday. The hot corona exists because the outer solar atmosphere is thermally unstable to ‘mechanical’ (most likely magnetic) energy inputs originating deep in the Sun. Expansion of this hot gas into the near vacuum of interplanetary space produces the solar wind and governs cometary gas tails. That much is clear.

What remains obscure is the‘mechanical’ (most likely magnetic) energy inputs, particularly whether they occur smoothly and steadily. The plethora of loops constituting the solar photosphere was left, and then came Bailv’s Beads. Totality was imminent – or was it? To the consternation of Williams and his team, the Sun started to reappear. The observers were outside the zone of totality...

A composite image bringing out the fine structure of the solar corona over a wide range of intensity at the total solar eclipse of 1999 August 11.

Adaptive Optics meets Infrared Spectroscopy

In June 2000, the very first mating of the recently-commissioned high-resolution Near Infrared Spectrometer (NIRSPEC) on the Keck II 10-metre telescope and the Keck Adaptive Optics (AO) system was achieved. So successful was this combination that it was released to the general community the following month.

Upper left: an image of the core of NGC6240 at 2.2 µm (K band) using the Keck AO system. Upper right: the same field observed with the NICMOS instrument on the Hubble Space Telescope. Lower panel: a section of a spectrum obtained with NIRSPEC + AO showing methane absorption from shocked molecular hydrogen gas, in both nuclei and between them.

The Man who Missed the Eclipse

Did you miss the total solar eclipse of last August? So did an American astronomer, the Rev. Samuel Williams, in 1780, but for a rather different reason, as recalled by Myko Strawbridge (NASA JPL) at Joint Discussion 5 (Applied Historical Astronomy) yesterday.

At that stage the fledgling United States was at war with Britain, and it was clear that an American eclipse expedition would have difficulty in reaching the chosen observing site, Penobscot Bay. Representations were made to the British authorities. “Please will you stop your war and let us through?”. Amazingly, permission was granted, and Williams, with around a dozen colleagues, reached Penobscot, where they set up their equipment. For some days there was thick fog, and no observations could be made. Williams’ diary records that on one occasion he adjusted the clock and ‘lengthened the pendulum’, which admittedly does not inspire a feeling of great confidence.

However, eclipse day was brilliantly clear, and the clocks and other instruments seemed to be working well. The Moon began to creep on to the Sun; still no problems. A tiny sliver of the photosphere was left, and then came Bailey’s Beads. Totality was imminent – or was it? To the consternation of Williams and his team, the Sun started to reappear. The observers were outside the zone of totality...

How had this happened? Presumably because of an error in the calculations. But it is all very strange, and it is worth adding that some years later Williams was driven out of Harvard for falsifying some documents relating to personal debts. Altogether it is a decidedly murky episode, and the full story may never be told.
Jodrell Bank is at the heart of the MERLIN array of radio telescopes. First operational in 1980 and extended in 1991, the array now stretches 217 km across, from the Welsh borders in the west to Cambridge in the east.

the University of Manchester has a new multi-beam receiver. Projects with which it has been involved, often in collaboration with other institutes, include the Very Long Baseline Array (VLBA) aperture synthesis array for CMB studies recently installed on Mount Teide. Through the Low Frequency Instrument (LFI) for the Planck Surveyor satellite; and a 4-beam HI system, now in routine use on the Lovell Telescope.

Other multi-beam focal-plane arrays are planned. It will capitalise on the capabilities of the upgraded LT a seven beam system to cover the band 4-8 GHz will be built. This will be used, among other projects, to perform fast and deep surveys of the Milky Way to study and locate regions of star-formation through the detection of molecular masers and thermal emission. In addition, an ambitious 100-element radio-fibre receiver called the One Centimetre Receiver Array (OCRA) is being planned. OCRA is designed to make use of all-sky surveys at 30 GHz; its main purpose will be a 'blind' survey for Sunyaev-Zel'dovich decameters. It is expected that OCRA will advance astronomy at 1-cm wavelength as much as the SCUBA bolometer array at the James-Clark Maxwell Telescope has advanced sub-mm wavelength astronomy.

Looking to the long-term, JBO hopes to play a pivotal role in the development of the next-generation radio telescope, the Square Kilometre Array (SKA). This will be a global project from the start; its organization is being set up now and technology workshops are defining the systems required; the most recent - "Technological Pathways to the Square Kilometre Array" - was held at JBO on 3-5 August, 2000. JBO plans to contribute to SKA through its proven expertise in radio astronomy, digital processing and software and the burgeoning techniques of astronomical survival in frequency bands contaminated by Radio Frequency Interference.

The University of Manchester has a proud tradition of astronomy, centred around the Jodrell Bank Observatory (JBO) which Sir Bernard Lovell founded in 1945 and which is part of the University of Manchester. With the IAU General Assembly being held in Manchester it is appropriate to describe the ambitious plans that JBO and the MERLIN/VLBI National Facility have for the future. Recent articles in the British press have speculated about the future of JBO. The origins of the uncertainty lies in the desire of UK astronomers to join the European Southern Observatory (ESO) to find the money, there will have to be cuts in budgets, and possibly even closure, of some of the current British observatories. A statement on July 25th by Lord Sainsbury, the Science Minister was most helpful. He was quoted as saying that "The Particle Physics and Astronomy Research Council (PPARC) has reassured me that it has no plans to close Jodrell Bank. No decision has been taken by the Research Council about joining the ESO. However, if we did join then Jodrell Bank's radio frequency capability would complement the ESO's optical and infrared telescopes. PPARC has confirmed that it has no plans to change Jodrell Bank's funding."

The first of JBO's development plans is a comprehensive upgrade of the Lovell Telescope (LT) for which the University of Manchester was recently awarded £2.5M from the Joint Infrastructure Fund (JIF). The upgrade will be complete towards the end of 2002; its primary aim is to enable the telescope to work well in the frequency range 5-8 GHz and possibly higher. Once upgraded, the LT will play a key role in many different areas of astronomy. Added to MERLIN it will more than double sensitivity at a key operating frequency; it will enhance the capabilities of the world's most sensitive VLBI array, the European VLBI Network; it will also continue to provide superb single-dish spectral-line and continuum capabilities.

MERLIN is a world-class imaging telescope, funded by PPARC, that is unique in providing routine imaging capabilities at 0.1 arcsecond resolution complementary to those of the Hubble Space Telescope. Gemini, Subaru and other new generation optical and mm-wave telescopes (see figure at right). MERLIN consists of six radio telescopes distributed over central England; connected via narrow-band (28 MHz) microwave links and controlled from JBO. A proposal will be submitted to PPARC later this year to transform MERLIN by vastly increasing its sensitivity. The e-MERLIN project involves replacing the microwave links with optical fibres capable of supporting bandwidths of up to 4 GHz replacing the existing correlator with a new much more capable broadband system, and adding new receiver bands. When linked with the upgraded LT e-MERLIN will be 30 times more sensitive than the present array and will provide an enormous increase in capability to the astronomical community, especially in such areas as cosmology, star-formation across the Universe, active galactic nuclei and stellar evolution.

JBO is also contributing to the ALMA project. Building on expertise developed in the astronomical use of optical fibres and the establishment of an optical fibre laboratory at Jodrell Bank, staff are currently engaged in developing concepts for the fibre systems for ALMA. Other ALMA-related developments are planned.

Many of JBO's current developments and future technological plans are centred around an international development funded by the European Community, the Joint Radio Frequency Interference.
oh be a fine girl kiss me (right now sweetheart) ... lovingly tender

this rather antiquated mnemonic has served to teach stellar spectral types for nearly a century, but now we have brown dwarfs and the spectral types L and T we could do with something new and perhaps a little racier. we invite you to submit suggestions to northern lights, and next week we will publish the best entries.

in the meantime if you want to find out what L and T dwarfs are all about there is a meeting devoted to their theory, properties and issues of spectral classification. the joint session of commissions 45 and 29 on ultra cool dwarfs is being held today in Rosco 3.2 from 9am, see pages 44-45 of your final programme.

although astronomers have been searching the skies for brown dwarfs for decades, it is only in the last few years, with more sensitive detectors and new near-infrared all-sky surveys, that these cool objects have popped out from the background. the first detections came in 1995, with the identification of lithium.

lithium, a light alkali element, is depleted in objects more massive than 65 jupiter masses (MJ), so identification of this line pegs the object as a brown dwarf. there has been some debate over this method of identification, but for objects less massive than 60-65 MJ and warmer than spectral type L6-7, it appears to be an accurate substellar feature. nonetheless, it should be stressed that the L spectral class does not define an object as being a brown dwarf nor as a "lithium object." the L spectral class arises because of the discovery of a large number of cool faint objects with spectroscopic features fundamentally different from M dwarfs, in particular the emergence of strong neutral atomic lines of alkali metals together with the replacement of metallic oxides TiO and VO with the metallic hydrides CH4 and FeH. l is chosen because of available letters for new spectral classes and its alphabetical proximity to M.

at roughly the same time, a search around young nearby stars came across a companion object to the MIV star Gl 229B. this object was truly bizarre, showing strong absorption bands of CH4 in the near-infrared, the same features seen in the planets Jupiter and Saturn and even the moon Titan. clearly this was a very cool object, and further investigation pinned down a temperature of around 1000K, far cooler than any star or brown dwarf identified at that time. this object, Gl 229B, continues to be a benchmark for brown dwarf research, and is the prototype object of the class T dwarfs, or methane brown dwarfs. for four years no similar objects to Gl 229B were identified, until May 1999, when Sloan, 2MASS, and the NTT Deep Field announced discoveries of field methane dwarfs in sky surveys, all turned out to be very similar to Gl 229B.

a breakthrough in understanding these objects came with the discovery of a field T dwarf that turned out to be a distant fourth member of the Gl 570ABC system. at 5.9 pc, Gl 570 was about a 2.5 times intrinsically fainter than Gl 229B, which translates into a Teff = 70±20 K. this provides a second point in the temperature scale; however, like many of the other T dwarf discoveries, this object's near-infrared spectrum is nearly identical to Gl 229B's. there are some slight variations, but they are subtle.

on the warm end, the link to L dwarfs has effectively been closed, by the detection of objects that show both CH4 and CO at K and L bands. however, the near-infrared colours are similar to main sequence giant stars, and it appears that such objects will be hard to tease from survey data. it is as yet unclear how rapidly the transition occurs, which will depend greatly on the rapidity of CH4 formation and, perhaps more importantly, the degree of mixing in the upper atmosphere, which will tend to delay CH4 saturation.

work on the observational and theoretical properties of L and T dwarfs is progressing rapidly. the session today will try to address most of existing problem areas together with developing new areas, for example variability, the deuterium test, the multiplicity of brown dwarfs and identification of cooler objects. although the current work is advancing well to reveal the properties of brown dwarfs, how large their population is, and the physics of their thin atmospheres ... we could do with a new mnemonic.

Hugh Jones
Liverpool (MU)

Coltech
Trans-Neptunian Objects: A Hot Topic

With the population of trans-Neptunian objects (TNOs) having more than tripled since the last General Assembly, any statement more than five years old in this subject is classical, said Brett Gladman (Observatoire de Nîmes, France) in IDA. But the beginnings of the realization that there was something odd about the outer Solar System started with the discovery of Pluto, pointed out Alan Stern (Southwest Research Institute, USA). Its eccentricity and its high inclination are characteristic of the TNOs and mark them as dynamically hot, even though in temperature they are cold, so far from the Sun.

Pluto and its satellite Charon are a binary planet and the only viable model for Charon’s formation is a giant impact, similar to the formation of Earth’s Moon. If this is so there must have been a large number of possible impactors for one to find Pluto and collide with it in such a big rebirth. Given the population of TNOs, the Kuiper Belt (30-50 AU) is even now as collisional as the asteroid belt once was — there is a greater volume but more objects.

The accretion process that generated the TNOs in the early history of the Solar System would have gone on to build up fewer but larger objects but the number of planets was stopped at nine when the population of TNOs became hot. The trans-Neptunian zone out to 50 AU is currently dynamically evolving by the influence of the gas giant planets — concentrated into resonances like the Plutinos or pushed into planet-crossing orbits like the Centaurs or the short period comets.

What lies beyond 50 AU? Alan Stern speculated that it is a zone which is collisionally evolving, maybe still accreting, and there could be a small number of largish bodies — even Earth-sized — still to find to the limit of 100 AU. — Planets X, Y and Z? Alternatively, there could be a large number of low-mass planets orbiting in the Kuiper disk relating to the dust disks seen orbiting round exoplanets in the space age stars.

To spontaneous applause Robert Millis (Lowell Observatory) paid tribute to David Jewitt’s persistence in searching for Kuiper Belt objects long after everyone else had given up, with the reward of finding the first, 1992 QLI. This discovery, said Stern, formed a context for the oddities of Pluto. It is not a rogue planet, and with its fellow TNOs, it makes a natural connection between our home Solar System and the evolution of planetary disks in other stars.

Paul Murdin
British National Space Centre

About those old plates...

What old plates? Oh – the ones in our plate vans? Been there for years. We were thinking of tossing them out because someone wants the space for computers. Wait… don’t toss them yet. They’ve been accumulating value for upwards of fifty years. They contain a wealth of information about long-term changes of the Sun – a heliochronology that is perfectly feasible, but it faces two important problems: (a) obsolete equipment and (b) superannuating expertise. Fortunately, sufficient of both will remain to get the projects under way.

Photographic archives are an enormous, rich and invaluable heritage. We would like to have that information on-line, ready to use for outreach and teaching. Wouldn’t you? Come to our meeting on Monday afternoon, August 14 in the Bragg Theatre, Schuster Building, and tell us what to do with this unique resource.

Elizabeth Griffin
Working Group for Spectroscopic Data Archives, Division IV

The Universe: Larger Than We Thought?

Stars burn brightly; while planets are cool. They are also infinitely distant.

From the London Times, August 5

synarchist

Saturday Refreshments

Unfortunately, morning coffee and afternoon tea will NOT be available in the Schuster Laboratory today. So, would all participants attending meetings in the Schuster Laboratory please go to the neighbouring Roscoe Building for their refreshments.

You (may) Have Mail!

Some delegates have complained that messages left in mailboxes in the Outpost Hall earlier in the week are still there. PLEASE remember to check your mailbox every day. The mailboxes are located on the left-hand side of the entrance as you go through the doors into the main registration area.

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The Naming Game

Did you know that the new FITS “object” keyword now supports 68 characters (instead of only 8 characters)? The new revised FITS standard, 100-2.0 (dated 29 March 1999) is available at http://fits.gsfc.nasa.gov

Helene R. Dickel
University of Illinois, USA

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Helene R. Dickel
University of Illinois, USA

& Netherland Foundation for Research in Astronomy

Chile, Commission 5 TG

Designations

Did you miss the 1999 Leonids?

On 1999 November 18 a brilliant display of Leonid meteors was seen over Europe and the Middle East; the hourly rate reached one meteor per second for a brief period.

Unfortunately the moon missed the meteor storm, because of bad weather. However, you will have a chance to see the results at the present General Assembly.

The National Astronomical Observatory of Japan has set up its Exhibition in the Royal Northern College of Music, and is pleased to show GA delegates a video of the Leonids recorded on video by the NHK high-sensitivity HDV camera. The video also includes general scenes, the whole presentation lasts for about 20 minutes. Details can be checked at the Northern College of Music. Contacts: Jun-Ichi Watanabe or Takao Fukushina of the Public Relations Centre at the National Astronomical Observatory of Japan.

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Those IAU delegates and guests who took part in this weekend's trip to Ireland will have seen what is certainly the most unconventional telescope in the world – and also one of the most significant. This is the 72-inch reflector built by the third Earl of Rosse at Birr Castle in County Offaly, some way from Athlone, and completed in 1845. Lord Rosse became interested in astronomy at an early age, and after graduating from Trinity College Dublin he decided to construct a large telescope. His first major success came with a 36-inch reflector, conventionally mounted and set up in the Castle grounds. The mirror was of speculum metal, an alloy of copper and tin; at that period it would have been well nigh impossible to cast a glass disk of such a size. Lord Rosse’s first task was to build a forge, into which the metal was poured; when cooled, the “mirror” was figured. During this process Lord Rosse developed what may be regarded as the first mechanical grinding device. Next came an even greater experiment: the construction of a 72-inch mirror, far larger than any mirror previously made - but how to mount it? Engineering techniques of the day were simply unequal to the task of making a mounting for the huge tube which could reach the whole of the sky. So the tube was mounted between two massive stone walls, and pivoted at the bottom, so that it could swing in altitude but for only a limited distance to either side of the meridian. The observer had to wait for the Earth’s rotation to bring the target object into the required position. The optical system was Newtonian, so that the observer had to ascend a ladder to reach the viewing cage; there was no drive, so that the position of the telescope had to be moved by hand and required a team of assistants; and there was no finder. Yet at once it became clear that the telescope was a success. It had an immense light-grasp; and, under normal conditions, a single narrow line of highly ionized oxygen from a young supernova remnant could be seen by eye; other nebulæ showed no resemblance to any other contemporary instrument could hope to do.

Lord Rosse looked at the nebulae which had been catalogued by Charles Messier. Some of them were spiral, resembling huge Catenary wheels. One of the first to be examined was M51, in Canes Venatici - the Whirlpool. As Lord Rosse called it. His drawing of it compares well with modern photographs, and other spirals were soon found, though other ‘nebulae’ showed no structure and were clearly gaseous. Astronomers from all over the world came to use the great telescope, known popularly as the ‘Leviathan’ and all were warmedly greeted; it was said that nobody ever came to Lord Rosse for help or advice and went away unsatisfied. Undoubtedly the first thirty years of the telescope’s existence were the most fruitful, and in the course of time it was overtaken by glass-mirrored, more conveniently mounted telescopes. The telescope was dismantled in 1909; the mirror was sent to the Science Museum in London, and the tube was left lying between its stone walls.

Today it is good to report that the telescope has been completely restored, and will be on full operation again before the end of 2000. The story of the Birr Castle telescope is unique, and nothing comparable can ever happen again. It will be good to turn the telescope to the sky, and see the Whirlpool Galaxy just as Lord Rosse saw it for the first time, more than 150 years ago.
Special Session: Astronomy for Developing Countries

In a new departure at General Assemblies, the IAU Executive Committee has approved the holding of a Special Session—something more than a Joint Discussion but less than a Symposium—on the topic 'Astronomy for Developing Countries'. This meeting arose from a joint proposal by the Working Group for the Worldwide Development of Astronomy and Commissions 5, 38, and 46: it is the longest meeting on this topic that the Executive Committee has yet approved, although many of the same sponsoring Commissions have helped to organize shorter sessions at the three immediately previous General Assemblies.

We have already attracted much interest, and hope to see a good crowd at the meeting. (At the Melbourne Theatre, Architecture Building (PLEASE NOTE the change of venue from Sydney, where it was held last year—our 1997 Programme), which begins today and continues tomorrow and Wednesday.)

As well as a summary of Highlights of Astronomy, we intend to publish our proceedings in a separate volume of the ASP Conference Series which will be the same size as the symposia volumes from this Assembly which will also be published by ASP. Our hope is that the volume of proceedings will serve as a manual both for those who are attending our meeting in their own countries and for those from other countries who are trying to help them. To do this, we will try to examine what is going on in developing countries now and what we can do to strengthen those local initiatives. We have speakers from every continent (except Antarctica) and from countries in a wide range of economic and astronomical development.

We will learn at first hand what it is like to try to do astronomy without a telescope, possibly without even a computer, and with limited access to books. We may ask how can distance learning help? Can access to modern databases substitute for the ability to travel and to obtain one's own observations? What is it like to be one of only a few (perhaps less than half-a-dozen) astronomers in a country? Should people in such circumstances even attempt to study astronomy at all? How much money should any country spend on it? We will grapple with all these questions and perhaps more as well, and we expect to hear a large variety of answers to them.

The last part of Wednesday morning will be devoted to a panel discussion moderated by Rajesh Kochhar. We solicit written questions in advance, and they may be given either to him or to the undersigned. Of course, all General Assemblies offer many interesting sessions in various fields, and few of us have yet learned how to be in two or more places at once. Our Special Session, Astronomy for Developing Countries, has to compete for attention with several other important meetings, but we hope that many of you will be able to come to all parts of this ground-breaking event. Perhaps you have some special insight to contribute, or you may learn from us some way in which you can help colleagues who are less fortunately situated with their studies than you are yourself.

Alan H Ratten
National Research Council, Canada

Maori Astronomy

Interesting notes on some Maori observations were given during Joint Discussion 5 (Applied Historical Astronomy) last Friday by Wayne Orchiton (Australia, formerly Director of the Carter Observatory at Wellington, New Zealand).

New Zealand was first settled by the Polynesians, and there are no records of any kind before a thousand years ago at most. Early information depends upon myths, rock art, decorated artifacts and astronomically oriented structures, often by no means easy to interpret.

One Maori record refers to a phenomenon that is not likely to have been seen by any European observers. An explanation of how it might happen will be given by Dr. John Waitangi, New Zealand National Museum.

Owhiro, in the region of Wellington, is believed to have been an important astronomical center. Two important phenomena are known to have occurred there.

First, the large crater may have been formed, but the evidence is not convincing. Perhaps the most important is the discovery of (15760) 1992 QBl, an object of great magnitude 22. Is there a significant difference between the scattered population of distant objects and the Centaurs? Not a great deal, I think, and for many purposes they can be combined.

What is the distinction, when one has an object like 1999 Td2, in a low-inclination orbit ranging from 12 to 200 AU from the Sun? Possibly a working distinction is to group them into those with perihelion distances in the range 30-38 AU (wherein the Centaurs are generally less than 22 AU, but smaller), but that could change.

Allowing for the fact that the close objects are apparently brighter than those at greater distances, we can estimate that perhaps two-thirds of the total population of distant objects are Centaurs. Although Pluto seems to be quite populous, they may account for only 12% of the population with the SDOs then weighing in at 9%. The orbital inclination of these bodies to the ecliptic range up to more than 30 degrees, which in practice means that we could find them not just near the ecliptic, but well populated several times in the sky. Several of the highest-inclination objects are among the Cubewanos, giving rise to the appearance of two distinct sub-populations there.

Perhaps the trans-Neptunian belt differs from what Leonard envisaged in 1930. But it also differs from what Edgeworth and Kuiper were talking about around 1950. And while Fred Whipple, writing in 1964, was also understandably short on the details, he did draw the trans-Neptunian belt in just about the right place, included Pluto as a member, and estimated that many of the others awaiting our detection would be 100-km objects at apparent magnitude 22.

Brian G Marsden
Harvard-Smithsonian Centre for Astrophysics, USA

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Joint Discussion 8

Oxygen Abundances in Old Stars and Implications to Nucleosynthesis and Cosmology

In Joint Discussion 8, to be held in the Concert Hall of the Royal Northern College of Music today, attention will be paid to the problem of oxygen abundance in metal-poor stars. This is a controversial issue; some investigators find an over-abundance relative to iron of a factor of more than 10, whereas others find a factor of 3 to 5 at most.

These varying results are derived from different lines in different stars (e.g. giants and dwarfs). In cases in which it is possible to derive oxygen abundances from different sets of lines for the same star, discrepancies are often found. This demonstrates the need for a more detailed analysis of each set of lines in terms of atomic and molecular constants, model atmospheres in 1D, 2D and 3D calculations, and dynamic effects and continuum opacity. The derivation of oxygen abundances, using high signal-to-noise spectra obtained with large telescopes, based on the forbidden [OII] lines, permitted OI lines, ultraviolet OIII lines and infrared OH lines, will all be discussed.

The implications of the oxygen overabundance in metal-poor stars are very important. There are several reasons for this: (1) The estimated ages of globular clusters can change by several gigayears, and this would affect the derived age of the Universe, since globular clusters are the oldest extant objects. (2) Models of the early enrichment of the light elements Li, Be and B by spallation of CNO nuclei suggest a higher amount of oxygen overabundance. (3) The constraints to the IMF slope are important at early times; these in turn affect the higher mass supernovae. All these points will be discussed during the meeting today.

Beatriz Barbuy
University of Sao Paulo, Brazil

Joint Discussion 9

Cold Gas and Dust at High Redshift

After opening remarks by Chairman David Wilner (CfA), the first presentation of Joint Discussion 14, which deals with matters relating to gas and dust in high-redshift galaxies, will be given by M. Fall (STScI, Baltimore), who will address issues relating to gas infall and outflow during star formation and metal production in galaxies as functions of redshift.

Paola Andreani (Osservatorio di Trieste) reviews the observational status of dust at different cosmological epochs, from the local Universe to z=1, and shows how it will soon be possible to disclose the entire history of evolving dusty objects and, therefore, of star formation. She is followed by Frank Briggs (Kapteyn Institute, Groningen) who will discuss the importance of atomic hydrogen (HI) and the radio telescopes such as those at Westerbork, GMRT, and the Extended VLA, which will measure the HI content and general deployment of gas-rich galaxies since the period when they began to assume their present form. Amy Burger (University of Hawaii) deals with star formation and AGN activity in dust-shrouded distant galaxies, and presents results obtained with SCUBA, the bolometer array on the James Clerk Maxwell Telescope at Mauna Kea. Frank Bertoldi (Max-Planck Institut für Radioastronomie, Bonn) summarises current deep imaging and pointed observations made with MAMBO (Max-Planck-Institut Bremen), at the IRAM 30-metre telescope.

Millimetre and submillimetre results relating to molecular gas and dust in ultra-luminous IR merger galaxies will be reviewed by Dennis Downes (Institut de Radio Astronomie Géodétique). These data may be relevant for interpreting observations of high-z sources. Chris Carilli (NRAO) will show how centimetre (cm) observations can be used to study cold gas at high-redshift, through observations of HI 21-cm absorption and molecular lines in absorption and emission. Observations of such emission using the VLA at cm wavelengths will be presented. David Elbaz (CEA Saclay) will present results of the ISO mid- and far-Infrared surveys performed with ISOCAM and ISOPHOT, which have revealed a population of faint luminous infrared galaxies many more than expected.

Byebei Kavabe (Nobeyama Radio Observatory, Japan) discusses about the Japanese Large Millimetre and Submillimetre Array (LMSA) and the European Atacama Large Millimetre Array (ALMA), which are to be set up at very high, dry site in the northern Chile. Finally, Andrew Blair (IOA, Cambridge) will show that, although based on observations made with COBE, SCUBA and ISO, we now have a reasonably working knowledge of the submillimetre wave and far infrared background radiation intensity and of the source counts of luminous high-redshift dusty galaxies. Important details remain unclear. He will review the prospects for the new, more capable ground-based submillimetre-wavelength cameras (BOLOCAM, SHARC-II and the Japanese Large Millimetre and Submillimetre Array, ALMA), which are to be set up at a very high, dry site in the northern Chile. Finally, Andrew Blair (IOA, Cambridge) will show that, although based on observations made with COBE, SCUBA and ISO, we now have a reasonably working knowledge of the submillimetre wave and far infrared background radiation intensity and of the source counts of luminous high-redshift dusty galaxies. Important details remain unclear. He will review the prospects for the new, more capable ground-based submillimetre-wavelength cameras (BOLOCAM, SHARC-II and the Japanese Large Millimetre and Submillimetre Array, ALMA), which are to be set up at a very high, dry site in the northern Chile. Finally, Andrew Blair (IOA, Cambridge) will show that, although based on observations made with COBE, SCUBA and ISO, we now have a reasonably working knowledge of the submillimetre wave and far infrared background radiation intensity and of the source counts of luminous high-redshift dusty galaxies. Important details remain unclear. He will review the prospects for the new, more capable ground-based submillimetre-wavelength cameras (BOLOCAM, SHARC-II and the Japanese Large Millimetre and Submillimetre Array, ALMA), which are to be set up at a very high, dry site in the northern Chile. Finally, Andrew Blair (IOA, Cambridge) will show that, although based on observations made with COBE, SCUBA and ISO, we now have a reasonably working knowledge of the submillimetre wave and far infrared background radiation intensity and of the source counts of luminous high-redshift dusty galaxies. Important details remain unclear. He will review the prospects for the new, more capable ground-based submillimetre-wavelength cameras (BOLOCAM, SHARC-II and the Japanese Large Millimetre and Submillimetre Array, ALMA), which are to be set up at a very high, dry site in the northern Chile.

Joint Discussion 10

Cluster Mergers and Their Connection to Radio Sources

Our understanding of the dynamical second evolutionary state of clusters of galaxies is undergoing major changes. Clusters are no longer believed to be simple, relaxed structures but are characterized by substructure in Abell clusters. Continuation at the present time, and in the future, is undergoing major changes. Galaxies is undergoing major changes. Moreover, clusters can contain large quantities of relativistic electrons out of the present head-tail radio galaxies (3) secondary particle production. The role played by the environment on the formation and structure of radio galaxies will also be discussed. Cluster radio galaxies show typical morphologies very different from those of isolated radio galaxies. The dominant structures of cluster radio galaxies are the wide-angle-tailed and narrow-angle-tailed, which result from the interaction between radio sources and the intergalactic medium. A possibility is that these sources, which are associated with dynamically complex environments, are shaped by merger-induced gas bulk motions. This science is rapidly evolving, owing to the amount of new information which is becoming available with the new generation X-ray satellites, optical telescopes, and submillimetre-wavelength observatories.

JD10 has been organized by Division X (Radio Astronomy) with support from Divisions VIII and X. It will summarise the state of the art and stimulate debate among the communities of radio, optical and X-ray specialists for a fruitful exchange. The JD includes both talks and posters. An oral review of the posters in also planned.

Luigino Feretti
Istituto di Radioastronomia CNR, Italy

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The Far Ultraviolet Spectroscopic Explorer (FUSE) satellite was launched in 1999 to perform a three-year mission to answer questions about the origin of the light elements and the physical processes controlling the structure and evolution of galaxies. The far ultraviolet spectral interval between the photoionization limit of atomic hydrogen (911 Å) and 1200 Å is one of the few regions of the electromagnetic spectrum between X-rays and optical light that is essentially unprobed by astronomers. High resolution spectroscopy at these wavelengths is technically challenging but holds great promise for shedding new light on age-old questions about the origins of the Universe and the chemical elements of stars, planets, and life form. The last major instrument to explore this spectral region was the Copernicus mission in the 1970s, and this was limited to stars within 1 kpc of the Sun.

The first scientific results from the FUSE mission are being described today in Joint Discussion 1. Many of the results presented were just recently published in 22 papers in a special issue of the Astrophysical Journal Letters (2000 July 20).

FUSE covers the wavelength range 905 Å to 1187 Å with high spectral resolving power (~20,000, or a velocity resolution of ~15 km/sec). The sensitivity of the FUSE instrument is over 10,000 times greater than that of the Copernicus mission and is sufficient to perform observations of faint objects at high galactic latitudes as well as bright quasars as background light sources. The far ultraviolet spectral region is extremely important to astrophysical diagnostics that are not accessible elsewhere. These include the Lyman series of atomic hydrogen and deuterium, the electron ground-state absorption bands of molecular hydrogen (H2) and the HD molecule, the transitions of highly ionized atoms O VI (1032, 1038 Å) and S VI (933, 945 Å) which are formed at very high temperatures (T ~ 300,000 K) than any resonance lines observable at longer ultraviolet or optical wavelengths, and resonance lines of lower ionization stages of many abundant elements (C II, N II, P II and S III-IV).

The scientific highlights to date include the following:

- FUSE has found that hot gases traced through O VI absorption is detected in many different environments, including the disk of the Milky Way galaxy, the Milky Way halo, high velocity clouds, the Magellanic Clouds, and the low-redshift intergalactic medium. The FUSE data for the Galactic halo strongly supports the picture that supernova explosions and related stellar phenomena is the disk into the halo, resolving a major uncertainty in the origin of the Milky Way's hot corona.

- An initial attempt to observe the He II absorption at moderate redshifts (z = 2 - 3) has been successful. FUSE is also refining estimates of the amount of baryonic material in the low-z Universe through measurements of the H I Lyman series in 1200-Å distance clouds.

- FUSE detects molecular hydrogen in previosly unexplored low-density environments of the Galactic halo, high velocity clouds, planetary nebulae, and the Magellanic Clouds. The ubiquity of H2 suggests that molecules evolve in relatively harsh environments.

- FUSE has also detected H2 and HD in translucent clouds and on denser sightlines through diffuse interstellar.

- The FUSE results for the interstellar gas of the Milky Way and the Magellanic Clouds are obtained from observations of massive OB stars. These spectra also reveal important new findings about the stars themselves. Comparison of two similar O stars in the SMC and LMC shows that the star in the higher metallicity LMC has a smaller terminal velocity and much stronger OVI absorption from its stellar wind. The presence of strong O VI in the LMC is puzzling and indicates that the time-dependent structures in the wind produce much of the O VI.

- The absence of comparable structures in the SMC is probably due to either the reduced oxygen abundance or to the lower wind speeds resulting from a reduced metallicity.

The FUSE observatory is operated for NASA by the Johns Hopkins University, which was responsible for its design and construction. FUSE is a joint project of the US, Canada, and France.

New Cosmology Prize

The Cosmology Prize of the Peter Gruber Foundation has been created to honour scientific advances in our perception and understanding of the Universe. The Prize carries a cash award of US$ 150,000 and is the first major international award dedicated to any branch of astronomy. It is given annually to an outstanding astronomer, physicist, or mathematician, selected internationally by a Board of distinguished peers in the field.

To inaugurate the Cosmology Prize, the Peter Gruber Foundation will today, Monday, August 14, announce the award of the Prize for the year 2000 to two outstanding recipients. The announcement will be made at 12:30 pm in the Council Chamber, Whitworth Hall, in the presence of representatives of the Foundation and the IAU. All interested IAU members and other participants at the General Assembly are invited to attend this event.

At the same time, the IAU and the Peter Gruber Foundation announce the conclusion of an Agreement by which the IAU will provide the expertise and personal contacts of professional astronomers worldwide for the nomination and selection of future Prize Winners. Under this agreement, calls for nominations will be made through the IAU Information Bulletin and web site, and members of the selection Board will be nominated by the IAU and other relevant international scientific Unions.

The inaugural Prizes for the year 2000 will be officially conferred at the Postdoctoral Academy of Sciences in the Vatican later this year. Future Prizes will be awarded at the IAU General Assembly or, in non-GA years, in places of historical importance in the development of our understanding of the Universe.

In addition to honouring accomplished achievements, the Agreement also has a forward-looking aspect. With the aim to promote the continued recruitment of young talent into the field, the Peter Gruber Foundation will also fund a new fellowship programme for promising young astronomers, operated by the IAU. Within a total envelope of US$ 75,000 per year, 2-3 such fellowships will be awarded at each GA, and on the Web.

The first fellowships will be awarded in 2001. Unlike other national and international organisations, the IAU has never been associated with any award programme. The purpose of the Prize, the Executive Committee therefore reviewed the proposed Agreement and made the recommendation. It was found that the nature and magnitude of the Prize, the procedures for awarding it, and the associated support for the next generation of scientists - high on the list of the Union's priorities - higher than the IAU's priorities of lighter items. The association would be appropriate. Accordingly, the EC approved the agreement at its meeting on Monday, August 7. I trust that participants will join me in saluting the vision and good will of the Foundation in offering this significant support of our science.

Johannes Andersen
General Secretary

Neptune Before 1846

Several observations of Neptune have been recorded, well before the identification of the planet by Galle and D'Arrest at the Berlin Observatory in 1846. In 1613 Galileo, using his primitive 'optick tube', was making observations of the four outer planets. When we now call the Galileans. He often added nearby stars, and one of these is now known as the 18th century Neptune. Galileo even noted that the separation between it and an adjacent star changed from one night to the next. The positions as given by Galileo are self-consistent, though there are slight discrepancies with modern measurements.

Views of Neptune by J de Lalande in 1795 are also genuine. Lalande first saw Neptune at the age of 22. Later, on a moonless night in 1796, Lalande was invited by some of his colleagues who were observing Venus but this was the first time that Lalande saw Neptune. With the moon out of the way, Lalande was able to observe the planet and make the first accurate measurements of its position in the sky.

On Monday, August 7, the desk situated in Whitworth Hall will be opened to invited guests for the first time in their history. The desk is the official venue of the IAU for the Congress, and is the place where all the Congress information is available.

Music is always a part of IAU General Assemblies. One of the highlights of the IAU Conference on the Eastern Hemisphere is the Elgar Cello Concerto in E Minor played by Alice Neary, which was well received by all. The Elgar Cello Concerto is an example of a piece of music that has been played by musicians for centuries and has been recorded by many different performers.

A Memorable Concert

Music is always a part of IAU General Assemblies. One of the highlights of the IAU Conference on the Eastern Hemisphere is the Elgar Cello Concerto in E Minor played by Alice Neary, which was well received by all. The Elgar Cello Concerto is an example of a piece of music that has been played by musicians for centuries and has been recorded by many different performers.

The orchestra itself was superb, and as an orchestral subcontractor, it was enjoyed by all those who were present.

Did you know that the revised IAU Research Nomenclature now has “Helpful Hints” which includes current practice in subnomenclature? See http://cdweb.u-strasbg.fr/IAU/spectrH3.6 for details.

Helene R. Dickel
University of Illinois, USA
& Netherland Foundation for Research in Astronomy
Commission 5 TG
Designations
New Planetary Names

At a meeting of the Working Group for Planetary System Nomenclature yesterday, new names were introduced. On the asteroid Eros, following the pass by the spacecraft NEAR (Shoemaker), 37 craters, one region and one dorum were named. The names are fairly predictable; they include Cupid, Don Juan and Don Quixote. The satellite of Asteroid 45 Eugenia was named Petit-Prince commemorating the son of the Empress Eugenie.

There are three new names for satellites of Uranus. Satellites 1999 U3 becomes XVIII Prospero; 1990 U1 becomes XIX Setebos, and 1999 U2 becomes XX Stephano. (The numbers are given in order of confirmation dates.) The new satellite of Jupiter (XVII) will be given the name of one of Jupiter’s numerous lovers, but the name must end in e, because the satellite belongs to the retrograde group and all these have names ending in e (Ananke, Carme, Pasiphaë and Sinope).

Several names for lunar craters were added, subject to the approval of the Committee Chairman, who was unable to be present. For example, the large ruined ring between Pluto and Pico was named Bliss, after the second English Astronomer Royal; Bliss has not previously been commemorated anywhere. On 31 July 1999 the Prospector probe landed inside a 50.9 km crater at 87.7° South, 42.8° East.

Cosmology Prize Winners Announced

The inaugural winner of the Cosmology Prize of the Peter Gruber Foundation, the first award ever dedicated to cosmology, was announced yesterday in the IAU Council Chambers by Peter Gruber, founder of the award. In a surprise move, two awards were announced, each a prize of US$150,000. The recipients are Dr. Phillip J.E. (Jim) Peebles, Albert Einstein Professor of Science, Princeton University, and Dr. Allan R. Sandage, Staff Astronomer Emeritus, Observatories of the Carnegie Institution of Washington.

Jim Peebles has devoted his career to the study of the physical processes which have shaped the structure of our Universe, ranging from the creation of the lightest chemical elements to the formation of galaxies and the cosmic distribution of matter. His remarkable text books have instructed several generations of students and astronomers.

Allan Sandage has been in the forefront of the observational quest to understand stars, galaxies, and the Universe during the past half century. With relentless energy, he has pursued the value of the Hubble constant and the geometry and age of the Universe. He has compiled several extensive atlases of galaxies. Both the photographs and his discussion of each galaxy reveal his wisdom and understanding and are required reading for serious students of galaxies.

The Peter Gruber Foundation and the IAU will continue to collaborate on the yearly award of the International Peter Gruber Foundation’s Cosmology Prize and a Fellowship programme. The Advisory Board for the inaugural prize consisted of Dr. John Barrow and Sir Martin Rees, Cambridge University; Dr. George Coyne, S.J., Vatican Observatory; Dr. Owen Gingerich, Harvard University; and the author.

Vera Rubin
Carnegie Institute of Washington, USA.

Amateurs, Professionals and A White Dwarf

Amateur and professional astronomers have combined in a useful study of a flaming white dwarf star—the fainter component of the famous cataclysmic variable SS Cygni. Outbursts occur on average every 49 days; the outburst observations, EUVE and RXTE (the Rossi X-ray Timing Explorer) were turned toward SS Cygni. The initial amateur optical response by the staff of the EUVE and RXTE to the triggering was detected in its very earliest stages by amateur observers of the American Association of Variable Star Observers (AAVSO) in Kansas, California and Hawaii. They alerted AAVSO Director, Janet Mattei, and she called Christopher Mauche (Lawrence Livermore National Laboratory) and Peter Wheatley (University of Leicester, UK) who head, respectively, the teams dealing with EUVE (the Extreme Ultraviolet Explorer) and RXTE (the Rossi X-ray Timing Explorer). Within twelve hours of the dramatic switch at the beginning of the outburst from X-ray to extreme ultraviolet emission, the white dwarf outburst starts in the optical band in the outer part of the accretion disk and the star, from 100 million degrees to 100 thousand degrees. The increased density round the boundary layer allows the region to cool.

The full outburst of SS Cygni was followed by 150 amateur observers around the world, including many in the UK.

Light curve in three wavelengths of the outburst of SS Cygni.
Two new Symposia begin today...

IAU Symposium

The Extragalactic Infrared Background and its Cosmological Implications

Observations carried out with the Cosmic Background Explorer (COBE), in the early 1990s, are currently yielding the first reliable measurements of the strength and spectrum of the ubiquitous diffuse cosmic infrared background. This radiation reaching us from the cosmos reflects the history of the Universe since the first stars and galaxies began to shine. The origin of this background is being vigorously debated, making Symposium 204, which begins today in the Concert Hall of the Royal Northern College of Music, both timely and instructive.

To launch the Symposium, P. James E. Peebles (Princeton University) - one of the two inaugural winners of the Cosmology Prize of the Peter Gruber Foundation - will present a talk entitled 'Keeping the Book on the Universe', which will summarize our current knowledge of the Universe. In the three-and-a-half days which follow, contributors will have the opportunity to advance our understanding of the background through presentations of new results and lively debate of clashing viewpoints.

Powerful optical telescopes on the ground and in space now permit us to count individual galaxies out to great distances and to measure their brightnesses. Does the sum of the infrared emitted by these galaxies add up to the background observed by COBE? Or is there something more diffuse component we have not yet identified? To resolve such questions, galaxies ranging out to the greatest distances, highest redshifts, and earliest stages in the evolution of the Cosmos are being invented. The latest available results will be presented today.

Those who are doubtful about such approaches, are beginning to pursue whether the highest energy photons observed in the Cosmic background an energy ten trillion (10^{15}) times greater than visible light. Yet such 'monster' photons seem incapable of traversing distances greater than a few hundred million light years. The nature of these photons must be observed at these energies to date. Markarian 501, lies only 400 million light years away - a mere stones-throw in our Universe. Along their way, the gamma-ray photons collide with infrared background photons to annihilate spectacularly with the production of electron-positron pairs. In principle, the entire spectrum of the infrared background might be independently determined by measuring the distance to these gamma-rays and the energies penetrate the background.

This afternoon’s discussions will highlight the emerging debate between gamma-ray and infrared astronomers. The Wednesday and Thursday morning sessions will be devoted to surveys conducted at many wavelengths ranging from the infrared to the thousand-times-longer submillimetre regime. These combined surveys will be the most prominent sources, perhaps the most powerful contributors to the background, appear to be galaxies in collision. We will discuss the nature of the observed energy output? Is it the formation of massive supergalaxies, high luminous density, or any other potential attraction? Is it the accretion of giant black holes in the nuclei of these active galaxies? A spirited debate is in progress.

With comparable sub-arcsecond angular resolution across most of the electromagnetic spectrum, astronomers now have access to complementary data on a broad range of astronomical targets including young stars, jets, and protoplanetary disks; stellar winds from evolved stars; and their effects on the surrounding ISM; planetary nebulae; colliding winds in binary systems; microquasars; novae; supernovae; starbursts; young galaxies; and even entire galaxies in the Hubble Deep Field; and gravitational lenses. The smallest physical scales probed range from sub-parsec to stars, sub-galactic systems to sub-solar system at the centre of our Galaxy, and from a fraction of a parsec in the nucleus of galaxies at low redshift to a few parsec at high redshift.

With sub-arcsecond data from the new observatories facilities now becoming available, the standard for the first time, it is timely to hold a Symposium to explore the relationships between the various constituents and physical processes in galaxies throughout the observable Universe. (The 24th General Assembly’s location at the University of Manchester is most appropriate for this Symposium, since it is home to the Jodrell Bank Observatory, which is at the heart of the MERLIN array of radio telescopes, and an international institution in radio interferometric and optical intensity interferometric techniques.

The scientific programme will cover six broad areas: the central parsec of galaxies including our own Galaxy; the central kiloparsecs of galaxies; star formation and outflow processes in our Galaxy; supernova remnants and the ISM; molecules and external galaxies, and stars and stellar atmospheres. Invited talks will be presented in the oral contributions and posters. Beautiful Chandra images of galaxies and galactic supernovae will be shown.

Looking to the future, presentations on plans for new instruments for high angular resolution will be made, including VELI arrays on the ground at Palomar, MA0.5, 25 m, and the VLT; NGST, large diameter optical telescopes; and also ‘free flight’ gamma-ray instrumentation, and optical astrometry in space.

Richard Schilizzi
Joint Institute for VLBI in Europe, Netherlands

A Visual Treat

The third Invited Discourse of GA24 will be given this evening by Michael Perryman (European Space Agency). His topic is 'The Three-Dimensional Structure of our Galaxy'. It is a big subject, rich in history, to which the HIPPARCOS results have added a lot of new details. What promises to make this an evening lecture not to be missed is the way that Dr Perryman has chosen to illustrate his talk. HIPPARCOS has done something which is, fundamentally, pretty spectacular - it has measured how stars are distributed, and how they are moving, through space. So why not show just this - why not illustrate their 3-d distributions and their space motions?

The problem, of course, is how to conjure up the 3-d effects in front of a large audience. Michael did exactly that in his George Darwin lecture to the Royal Astronomical Society last year. Dual polarized light beans were projected on to a reflecting screen, and the audience was equipped with the necessary polarizing glasses. Those who were present didn’t say that the visual effect was stunning, and that it really brought home to them what was meant by measuring the distance to the stars. We asked Dr Perryman which fields look most dramatic; “seeing how the stars in the Hyades will move in three dimensions over the next 60,000 years and...” he said. And he set this as an exercise for members of this Symposium to consider the consequences of ‘moving stars’.

But an infinite number of worlds exist, some very similar to ours, others very different.” So wrote Epicurus to Herodotus, 2000 years ago. There were also the words used by Michael Mayor to open his Invited Discourse about extragalactic planets at the Bridgehead Water evening in the University of Cambridge. The planets we know (as of August 13), and more are being discovered almost each evening. The speaker dealt first with the history of extragalactic planet discovery. “In the last few years we have become aware of stars that orbit white dwarfs. This one discovery from the past 30 years. The question is now what are the planets orbiting white dwarfs. Some are giants, but some are less massive than Jupiter. There are two multi-digit planets. Over 2,000 have been found in the Solar System. There are of course several methods of finding extragalactic planets: astrobiology, microlensing, and transits, and, in the future we hope for more exciting advances from the Darwin space mission.

It is interesting to compare the words of Epicurus with those of Giordano Bruno, little more than 300 years ago. “The stars are not just suns, but also ‘floating’ in an infinite Universe, surrounded by planets similar to our own but billions of these are inhabited.” Will we have real proof that Bruno was right?
There are three Resolutions of Type B to be voted on under Agenda Items 10.2 at the Second Session of the General Assembly on Wednesday, August 16, 2000 at 14.00hrs in the Bridgewater Hall. The Resolutions are set out in full in English below.

D McNally  
Chairman: Resolutions Committee

B1.1 Maintenance and Establishment of Reference Frames and Systems

The International Astronomical Union

Noting
1. that Resolution B2 of the XXIIIrd General Assembly (1997) specifies "the fundamental reference frame shall be the International Celestial Reference Frame (ICRF) constructed by the IAU Working Group on Reference Frames."
2. that Resolution B2 of the XXIIIrd General Assembly (1997) specifies "That the Hipparcos Catalogue shall be the primary realisation of the International Celestial Reference Frame (ICRF) at optical wavelengths", and
3. the need for accurate definition of reference systems brought about by unprecedented precision, and

Recognising
1. the importance of continuing operational observations made with Very Long Baseline Interferometry (VLBI) to maintain the ICRF,
2. the importance of VLBI observations to the operational determination of the parameters needed to specify the time-variable transformation between the International Celestial and Terrestrial Reference Frames,
3. the progressive shift between the Hipparcos frame and the ICRF, and
4. the need to maintain the optical realisation as close as is possible to the ICRF

Recommends
1. that IAU Division I maintain the Working Group on Celestial Reference Systems formed from Division I members to consult with the International Earth Rotation Service (IERS) regarding the maintenance of the ICRS,
2. that the IAU recognise the International VLBI Service (IVS) for Geodesy and Astrometry as an IAU Service Organization,
3. that an official representative of the IVS be invited to participate in the IAU Working Group on Celestial Reference Systems,
4. that the IAU continue to provide an official representative to the IVS Directing Board,
5. that the astrometric and geodetic VLBI observing programs consider the requirements for maintenance of the ICRF and linking to the Hipparcos optical frame in the selection of sources to be observed (with emphasis on the Southern Hemisphere), design of observing networks, and the distribution of data, and
6. that the scientific community continue with high priority ground- and space-based observations (a) for the maintenance of the optical Hipparcos frames and frames at other wavelengths and (b) for links of the frames to the ICRF.

B1.2 Hipparcos Celestial Reference Frame

The International Astronomical Union

Noting
1. that Resolution B2 of the XXIIIrd General Assembly (1997) specifies, "That the Hipparcos Catalogue shall be the primary realisation of the International Celestial Reference System (ICRS) at optical wavelengths",
2. the need for this realisation to be of the highest precision,
3. the proper motions of many of the Hipparcos stars known, or suspected, to be multiple are adversely affected by uncorrected orbital motion,
4. the extensive use of the Hipparcos Catalogue as reference for the ICRS in extension to fainter stars,
5. the need to avoid confusion between the International Celestial Reference Frame (ICRF) and the Hipparcos frame, and
6. the progressive shift between the Hipparcos frame and the ICRF,

Recommends
1. that Resolution B2 of the XXIIIrd General Assembly (1997) be amended by excluding from the optical realisation of the ICRS all stars flagged C, G, O, V and X in the Hipparcos Catalogue, and
2. that this modified Hipparcos frame be labelled the Hipparcos Celestial Reference Frame (HCRF).

B1.3 Definition of Barycentric Celestial Reference System and Geocentric Celestial Reference System

The International Astronomical Union

Considering
1. that the Resolution A4 of the XXIst General Assembly (1991) has defined a system of space-time coordinates for (a) the solar system (now called the Barycentric Celestial Reference System (BCRS)) and (b) the Earth (now called the Geocentric Celestial Reference System (GCRS)), within the framework of General Relativity,
2. the desire to write the metric tensors both in the BCRS and in the GCRS in a compact and self-consistent form,
3. the fact that considerable work in General Relativity has been done using the harmonic gauge that was found to be a useful and simplifying gauge for many kinds of applications,

Recommends
1. the choice of harmonic coordinates both for the barycentric and for the geocentric reference systems,
2. writing the time-time component and the space-space component of the barycentric metric $g_{ij}$ with barycentric coordinates $(t, x)$ ($t = \text{Barycentric Coordinate Time (TCB)}$) with a single scalar potential $w(t, x)$ that generalises the Newtonian potential, and the space-time component with a vector potential $w'(t, x)$ as a boundary condition it is assumed that these two potentials vanish far from the solar system, explicitly,

\[ g_{00} = -1 + \frac{2\omega}{c^2} - \frac{2\omega^2}{c^4}, \]
\[ g_{ii} = -\frac{4}{c^2} w^i, \]
\[ g_{i0} = \frac{2}{c^2} w^i, \]

with

\[ w(t, x) = G \int d^3x' \frac{\sigma(t, x')}{|x-x'|}, \]
\[ w'(t, x) = G \int d^3x' \frac{w(t, x')}{|x-x'|}, \]

where $\sigma$ and $\sigma'$ are the gravitational mass and current densities respectively,

3. writing the geodetic metric tensor $G_{\alpha\beta}$ with geodetic coordinates $(T, X)$ ($T=\text{Geodetic Coordinate Time (TCG)}$) in the same form as the barycentric one but with potentials $W(T, X)$ and $W'(T, X)$; these geodetic potentials should be split into two parts - potentials $W_1$ and $W_2$, arising from the gravitational action of the Earth and external parts $W_{\text{ext}}$ and $W_{\text{ext}}'$ due to tidal and inertial effects; the external parts of the metric potentials are assumed to vanish at the geocenter and admit an expansion in positive powers of $X$, explicitly,

\[ G_{00} = -1 + \frac{2W}{c^2} - \frac{2W^2}{c^4}, \]
\[ G_{ii} = -\frac{4}{c^2} W^i, \]
\[ G_{i0} = \frac{2}{c^2} W^i, \]

\[ G_{\alpha\beta} = \delta_{\alpha\beta} \left( 1 + \frac{2}{c^2} W \right). \]
the potentials $W$ and $W^a$ should be split according to

\[ W(T,X) = W_E(T,X) + W_{\text{ext}}(T,X), \]

\[ W^a(T,X) = W_E^a(T,X) + W_{\text{ext}}^a(T,X). \]

The Earth's potentials $W_E$ and $W^a_E$ are defined in the same way as $w$ and $w^a$ but with quantities calculated in the GCRS, with integrals taken over the whole Earth, explicitly, for the kinematically non-rotating GCRS (T=TCG, t=TCB, $\mathbf{r}^E = \mathbf{r}^E(t)$, and a summation from 1 to 3 over equal indices is implied).

Finally, the local gravitational potentials $W_E$ and $W^a_E$ of the Earth are related to the barycentric gravitational potentials $w_E$ and $w^a_E$ by

\[ W_E(T,X) = w_E(x_1) \left(1 + \frac{2}{c^2} \mathbf{v}^2 \right) - \frac{4}{c^2} \mathbf{v}_E \mathbf{w}_E(x_1) + O(c^{-4}). \]

\[ W^a_E(T,X) = \delta_{ij} (w^a_1(x_1) - v_E^i w^a_j(x_1)) + O(c^{-4}). \]

References


B1.4 Post-Newtonian Potential Coefficients

The International Astronomical Union

Considering

1. that for many applications in the fields of celestial mechanics and astrometry a suitable parametrization of the metric potentials (or multipole moments) outside the massive solar system bodies in the form of expansions in terms of potential coefficients are extremely useful, and

2. that physically meaningful post-Newtonian potential coefficients can be derived from the literature.

Recommends

1. expansion of the post-Newtonian potential of the Earth in the Geocentric Celestial Reference System (GCRS) outside the Earth in the form

\[ W_E(T,X) = \frac{G M \mathbf{r}}{R} \left[1 + \frac{8}{3} \mathbf{v}_E \mathbf{w}_E(x) \right], \]

2. expression of the vector potential outside the Earth, leading to the well-known Lense-Thirring effect, in terms of the Earth's total angular momentum vector $S_E$ in the form

\[ W_E^a(T,X) = \mathbf{Q} \times \mathbf{S}_E. \]

B1.5 Extended relativistic framework for time transformations and realisation of coordinate times in the solar system

The International Astronomical Union

Considering

1. that the Resolution A4 of the XXIst General Assembly (1991) has defined systems of space-time coordinates for the solar system (Barycentric Reference System) and for the Earth (Geocentric Reference System), within the framework of General Relativity,

2. that the Resolution B1.3 entitled 'Definition of Barycentric Celestial Reference System and Geocentric Celestial Reference System' has renamed these systems the Barycentric Celestial Reference System (BCRS) and the Geocentric Celestial Reference System (GCRS), respectively, and has specified a general framework for expressing their metric tensor and defining coordinate transformations at the first post-Newtonian level,

3. that, based on the anticipated performance of atomic clocks, future time and frequency measurements will require practical application of this framework in the BCRS,

4. that theoretical work requiring such expansions has already been performed,

Recommends

that for applications that concern time transformations and realisation of coordinate times within the solar system, Resolution B1.3 be applied as follows:

1. the metric tensor be expressed as
The relation between TCB and Geocentric Coordinate Time (TCG) can be expressed to sufficient accuracy by

\[ \text{TCB} - \text{TCG} = c \left[ \frac{1}{2} \left( \sum_{i=1}^{n} \sum_{A} \Delta w_{i}(t,x,A) \cdot r_{A} \right) \right] \] 

where \( w_{i}(t,x,A) \) is the barycentric velocity of body A, and \( r_{A} \) is the barycentric coordinate for body A. As for the function \( \Delta w_{i}(t,x,A) \), it is sufficient to express it as

\[ \Delta w_{i}(t,x,A) = \frac{G M_{A}}{r_{A}^{2}} \left[ -2 r_{A} + \sum_{A} \left( \frac{\Delta A_{i}^{A} r_{A}^{3}}{r_{A}^{3}} - \frac{\Delta A_{i}^{A}}{r_{A}} \right) \right] \]

where \( \Delta A_{i}^{A} \) is the barycentric coordinate acceleration of body A. In these formulae, the constants \( S_{i} \) are defined, Jupiter (5.6 \times 10^{13} \text{ m/s}^2 \text{kg}) and Saturn (5.4 \times 10^{13} \text{ m/s}^2 \text{kg}) in the immediate vicinity of these planets.

The International Astronomical Union

Recognising

1. that the International Astronomical Union and the International Union of Geodesy and Geophysics Working Group (IAU-RUGG WG) on 'Non-rigid Earth Nutation Theory' has met its goals by
   b. completing the comparison of new non-rigid Earth transfer functions for an Earth initially in non-hydrostatic equilibrium, incorporating mantle anelasticity and a Free Core Nutation period in agreement with observations,
   c. noting that numerical integration models are not yet ready to incorporate dissipation in the core, and
d. noting of the effects of other geophysical and astronomical phenomena that must be modelled, such as ocean and atmospheric tides, that need further development;

2. that, as instructed by IAU Recommendation C1 in 1994, the International Earth Rotation Service (IERS) will publish in the IERS Conventions (2000), a precession-nutation model that matches the observations with a weighted rms of 0.2 milliarcsecond (mas);

3. that semi-analytical geophysical theories of forced nutation are available which incorporate some or all of the following – anelasticity and electromagnetic couplings at the core-mantle and inner core-outer core boundaries, annual atmospheric tide, geodetic nutation, and ocean tide effects;

4. that ocean tide corrections are necessary at all nutation frequencies; and

5. that empirical models based on a resonance formula without further corrections also exist;

Accepts

the conclusions of the IAU-RUGG WG on Non-rigid Earth Nutation Theory published by

Dehant et al., 1999, Celest. Mech. 72(4), 245-310 and the recent comparisons between the various possibilities, and

Recommends

that, beginning on 1 January 2003, the IAU 1976 Precession Model and IAU 1980 Theory of Nutation, be replaced by the precession-nutation model IAU 2000A (MHB2000, based on the transfer functions of Mathews, Herring and Boffett, 2000 - submitted to the Journal of Geophysical Research) for those who need a model at the 0.2 mas level, or its shorter version IAU 2000B for those who need a model only at the 1 mas level, together with their associated precession and obliquity rates, and their associated celestial pole offsets, to be published in the IERS Conventions 2010, and

Encourages

1. the continuation of theoretical developments of non-rigid Earth nutation series,

2. the continuation of VLBI observations to increase the accuracy of the nutation series and the nutation model, and to monitor the unpredictable free core nutation, and

3. the development of new expressions for precession consistent with the IAU 2000A model.

B.7 Definition of Celestial Intermediate Pole

The International Astronomical Union

Noting

the need for accurate definition of reference systems brought about by unprecedented observational precision, and

Recognising

1. the need to specify an axis with respect to which the Earth’s angle of rotation is defined,

2. that the Celestial Ephemeresis Pole (CEP) does not take account of diurnal and higher frequency variations in the Earth’s orientation,

3. that the Celestial Intermediate Pole (CIP) be the pole, the motion of which is specified in the Geocentric Celestial Reference System (GCRS) (see Resolution B1.3) by motion of the Tisserand mean axis of the Earth with periods greater than two days,
2. that the direction of the CIP at J2000.0 be offset from the direction of the pole of the GCRS in a manner consistent with the IAU 2000A (see Resolution B1.6) precession-nutation model.

3. that the motion of the CIP in the GCRS be realized by the IAU 2000A model for precession and forced nutation for periods greater than two days plus additional time-dependent corrections provided by the International Earth Rotation Service (IERS) through appropriate astro-geodetic observations,

4. that the motion of the CIP in the International Terrestrial Reference System (ITRS) be provided by the IERS through appropriate astro-geodetic observations and models including high-frequency variations,

5. that for highest precision, corrections to the models for the motion of the CIP in the ITRS may be estimated using procedures specified by the IERS, and

6. that implementation of the CIP be on 1 January 2003.

Notes
The forced nutations with periods less than two days are included in the model for the motion of the CIP in the ITRS.

The Tisserand mean axis of the Earth corresponds to the mean surface geographic axis, quoted B, in Seidelmann, 1982 (Celest. Mech.)

As a consequence of this Resolution, the Celestial Ephemeris Pole is no longer necessary.

B1.8 Definition and use of Celestial and Terrestrial Ephemeris Origin

The International Astronomical Union

Recognising

1. the need for reference system definitions suitable for modern realisations of the conventional reference systems and consistent with observational precision,

2. the need for a rigorous definition of sidereal rotation of the Earth,

3. the desirability of describing the rotation of the Earth independently from its orbital motion, and

Noting

that the use of the “non-rotating origin” (Guinot, 1979) on the moving equator fulfills the above conditions and allows for a definition of UT1 which is insensitive to changes in models for precession and nutation at the microarcsecond level,

Recommends

1. the use of the “non-rotating origin” in the Geocentric Celestial Reference System (GCRS) and that this point be designated as the Celestial Ephemeris Origin (CEO) on the equator of the Celestial Intermediate Pole (CIP),

2. the use of the “non-rotating origin” in the International Terrestrial Reference System (ITRS) and that this point be designated as the Terrestrial Ephemeris Origin (TEO) on the equator of the CIP.

3. that UT1 be linearly proportional to the Earth Rotation Angle defined as the angle measured along the equator of the CIP between the unit vectors directed toward the CEO and the TEO,

4. that the transformation between the ITRS and GCRS be specified by the position of the CIP in the GCRS, the position of the CIP in the ITRS, and the Earth Rotation Angle,

5. that the International Earth Rotation Service (IERS) take steps to implement this by 1 January 2003, and

6. that the IERS will continue to provide users with data and algorithms for the conventional transformations.

Note

The position of the CEO can be computed from the IAU 2000A model for precession and nutation of the CIP and from the current values of the offset of the CIP from the pole of the ICRF at J2000.0 using the development provided by Capitaine et al. (2000).

The position of the TEO is only slightly dependent on polar motion and can be extrapolated as done by Capitaine et al. (2000) using the IERS data.

The linear relationship between the Earth's rotation angle and UT1 should ensure the continuity in phase and rate of UT1 with the value obtained by the conventional relationship between Greenwich Mean Sidereal Time (GMST) and UT1. This is accomplished by the following relationship:

θ (UT1) = 2π (0.77905723732640 + 0.00237361911354468 x [Julian UT1 date - 2451545.0] + LG)

References


B1.9 Re-definition of Terrestrial Time TT

The International Astronomical Union

Considering

1. that IAU Resolution A4 (1991) has defined Terrestrial Time (TT) in its Recommendation 4,

2. that the intricacy and temporal changes inherent in the definition and realisation of the geodetic are sources of uncertainty in the definition and realisation of TT, which may become, in the near future, the dominant source of uncertainty in realising TT from atomic clocks,

Recommends

1. that TT be a time scale differing from TCG by a constant rate: dTT/dTCG = LCG/LG, where LG = 6.969290134 x 10^-10 is a defining constant.

Note

CG was defined by the IAU Resolution A4 (1991) in its Recommendation 4 as equal to LG/LG^2 where LG is the geopotential at the geoid. LG is now used as a defining constant.

B2 Coordinated Universal Time

The International Astronomical Union

Recognising

1. that the definition of Coordinated Universal Time (UTC) relies on the astronomical observation of the UT1 time scale in order to introduce leap seconds, the unpredictability of leap seconds affects modern communication and navigation systems,

2. that astronomical observations provide an accurate estimate of the secular deceleration of the Earth's rate of rotation,

Recommends

1. that the IAU establish a Working Group reporting to Division I at the General Assembly in 2003 to consider the redefinition of UTC,

2. that this study discuss whether there is a requirement for leap seconds, the possibility of inserting leap seconds at pre-determined intervals, and the tolerance limits for UT1-UTC,

3. that this study be undertaken in cooperation with the appropriate groups of the International Union of Radio Science (URSI), the International Telecommunications Union (ITU-R), the International Bureau for Weights and Measures (BIPM), and relevant navigational agencies.

B3 Safeguarding the information in photographic observations

The International Astronomical Union

Consequent upon

its Recommendation C13 (1991) of the XXIst General Assembly to create accessible archives of the large quantities of observational material collected during the 20th Century and currently stored on photographic plates,

Recognising

that unless action is taken this unique historical record of astronomical phenomena will be lost to future generations of astronomers,

Considering

the important efforts made by the Working Groups on (i) Sky Surveys, (ii) Carte du Ciel plates and (iii) Spectroscopic Data Archives, as well as by the Centre for European Plates recently launched at the Royal Observatory of Belgium, in locating and cataloguing plates, in defining the tools needed to safeguard them, and in negotiating the means to preserve their recorded information in digital form in the public domain,

Realising

that the cataloguing, storage and safeguarding of the photographic plates is an important aspect for the implementation of the possible future digitisation processes needed for selective media transfer of high quality data,

Recommends

the transfer of the historic observations onto modern media by digital techniques, which will provide worldwide access to the data so as to benefit astronomical research in a way that is well matched to the tools of the researcher in the future.
12

Joint Discussion

Highlights of Planetary Exploration from Space and from Earth

The last few years have seen great strides in our understanding of the Solar System, resulting from ever more sophisticated instrumentation on the ground and in space. JU14, which takes place today and tomorrow in Theatre 1, Crawford House, will summarize some of the most exciting new discoveries, with an emphasis on the Jovian system, Titan, and Mars.

The Galileo mission to Jupiter has resulted in huge increases in our understanding of Jupiter and its satellites. The Galileo probe accomplished the first direct sampling of a Jovian planet atmosphere, with implications for the formation of Jupiter and Jovian planets both in this Solar System and elsewhere. Meanwhile, images and near-IR spectra from the Galileo orbiter have provided a context for the probe results, and Earth-based studies of Jovian aurora have provided a new window on processes in Jupiter’s upper atmosphere and magnetosphere.

13

Joint Discussion

HIPPARCOS and the Luminosity Calibration of the Nearer Stars

Trigonometric parallaxes of stars have been determined through photographic astrometry at many observatories during the last century, following the first successful visual measurements by Henderson, Bessel and Struve in the 1820s. The quantity and precision of these data are not adequate to meet many current needs, despite the great effort involved, but the ESA astrometric satellite HIPPARCOS has transformed the situation by providing a large and relatively complete set of parallaxes - measurements of a quality comparable to the best ground-based measurements.

Any large new data set requires study by many astronomers before it can be fully assimilated by the community. Techniques to handle the data must be robust and the properties of the data set, such as random and systematic errors and any selection effects, need to be understood. The first morning session of JD13, which takes place today in the Rutherford Theatre, Schuster Building, is devoted to this aspect of the HIPPARCOS material.

The bulk of the stars for which data are available are necessarily those which are relatively common, that is the ordinary stars of the main sequence and the giant branch. Much of our data on stellar classification – spectral types and multicolour photometry – have been obtained for these same stars. The second and third sessions are devoted to the assessment of luminosity calibration in the light of the new parallaxes which, for the first time, are sufficient to show some of the finer detail in the Hertzsprung-Russell diagram for field stars.

The final session tackles the question of the use of stars in the red giant to clump as distance indicators – the technique has given results at variance with those of more traditional methods – and the application of the HIPPARCOS-based luminosity estimates to the astrophysics of several types of variable stars.

John Spencer
South African Astronomical Observatory

The Infrared Astronomical Satellite (ISO) has extended our wavelengths of observation into the far-infrared, revealing surprising diversity, and evidence for highly variable clouds and aurorae have provided a new window on processes in Jupiter’s upper atmosphere and magnetosphere. Images and spectra of the atmosphere of Jupiter have provided a hundred-fold increase in resolution over earlier data, revealing many surprises, including ultra-high-temperature volcanism on Io, bizarre geology on Europa that provides evidence for a subsurface ocean, and a mysterious blanket of deep dust on Callisto.

Saturn’s large moon Titan, whose dense nitrogen envelope is in some ways the most Earth-like known extraterrestrial atmosphere, is soon to receive intense scrutiny from the Cassini/Huygens mission, which will probe its atmosphere directly in 2004. However, we are already learning much about Titan from Earth, as we begin to penetrate the dense atmospheric haze with high-resolution infrared imaging and spectroscopy. We now have near-infrared maps of its surface, revealing surprising diversity, and evidence for widespread rocks of andesitic (relatively silicon-rich) composition in the northern hemisphere.

These results and others will be presented and discussed during JD12.

John Spencer
South African Astronomical Observatory
Joint Discussion

The Origins of Galactic Magnetic Fields

The meeting will start with a discussion of the extragalactic and pregalactic magnetic fields which must provide an initial condition in any picture. The observational status of galactic magnetic fields is the subject of the second part of JD14, while both the Milky Way and external galaxies will be discussed. This will be followed by presentations on the theory of galactic magnetic fields.

The last part of the meeting is devoted to the most controversial issue: the linear theory of turbulent dynamos: the non-linear behaviour of mean-field dynamos and their possible suppression by turbulent magnetic fields. Both the pros and cons of mean-field dynamos will be presented by their proponents, and confronted with the numerical and observational evidence.

David Moss
University of Manchester, UK

Results from Joint Discussion 2
Models and Constants for Sub-Microradian Astrometry

The accuracy of astrometric measurements has increased substantially over the last twenty years. VLBI observations at radio wavelengths and the HIPPARCOS space mission have resulted in improvements in position of several orders of magnitude. This has led to the establishment of the International Celestial Reference Frame (ICRF) based on the positions of extragalactic radio sources and the adoption of the International Celestial Reference System (ICRS).

The present estimated accuracy (~200 μas for the positions of the individual radio sources making up the ICRF) requires refinements for the ICRS. Several IAU Working Groups in the area of 1) the International Celestial Reference System, 2) the Centaur of Celestial Mechanics and Astronomy, 3) the IAU Commissions, are preparing a Refinement for Space-Time, Reference Systems and Metrology, 4) Astronomical Standards and 5) Non-Rigid Earth Nutation Theory were formed three years ago to address the needs for achieving computational accuracies of sub-microradians.

An IAU Colloquium 'Towards Models and Constants for Sub-Microradian Astrometry' was held in Washington DC in March 2000. This Colloquium drafted resolutions which were the results of the efforts of the working groups. These ten resolutions were presented at JD12 and were approved, with minor revisions, by the representatives. These resolutions appear in the pull-out centre supplement in today's issue of Northern Lights.

For the improvements in astronomical accuracies appears very promising with the future founded and proposed space missions, FAME, SIM and GAIA.

Kenneth J Johnston
US Naval Observatory

Did you know that you may suggest designation topics for the Commission 5 Task Group on Designations to consider? All you have to do is attend their Business Meeting during the afternoon session today in room Roscoe 3.4.

The Naming Game

Philip C Keenan (1908-2000)

Philip C Keenan, who died this April, in a portrait made in 1978.

Philip C Keenan, who died this April, in a portrait made in 1978.

A familiar figure at IAU meetings will be missed this year. Philip C. Keenan, Professor Emeritus of Astronomy at Ohio State University and a leading authority on the spectra of late-type stars, died in April this year at the age of 92.

Keenan was best known for his work on spectral classification. The Atlas of Stellar Spectra, published in 1943 in collaboration with W W Morgan and E Kellman, established the MK system as the universally adopted system for the classification of stellar spectra. In it they introduced the Roman-numeral MK luminosity classes which is still used today, and argued strongly for a system which is defined on the basis of fundamental stars, not measurements.

As so as the HIPPARCOS Catalog was published, Keenan used the improved absolute magnitudes resulting from its parallaxes to test his own luminosity subdivisions for late-type giants. The results were announced in his last published paper, which appeared in the Astrophysical Journal in 1999 with the collaboration of Cecilia Barnbaum; this appeared 66 years after his first ApJ paper.

Joint Discussion 13, which takes place today, will consider "BIPACD, the Lunar Magnitude Calibration of the Nearest Stars". To a large extent it will focus on the work of Cecilia Barnbaum who inspired this choice of topic.

Keenan was a member of IAU Commissions 29 and 45, and played an active role in their activities. His papers are known for the remarkable quality of their illustrations of stellar spectra. His Atlas of Spectra of the Sun and its Planets (with C W Morgan; with C (with R McNeil, 1976) is a marvellous example of this attention to detail.

Philip Keenan's interests were extremely broad; in his early years at the Yerkes Observatory he wrote both observational and theoretical papers on a variety of topics, including an early series of papers on the photometry of 'extra-galactic nebulae'. During his later years he developed a serious interest in the history of Latin-American astronomy and published a number of historical papers as well as a book The Chilean National Astronomical Observatory, 1852-1965, in collaboration with S Pinto and H Alvarez.

Despite his loss of hearing, his visual acuity never suffered. At the age of 92 he was insisting on himself that he could make finer and more consistent luminosity distinctions than his first. He was known for his careful work and he decided therefore to re-examine the luminosity classifications of several hundred G and K stars. He was on track to complete the project in time to present the results at this General Assembly. The work, however, was stopped abruptly when he slipped and fell getting on a city bus ("The stupidest thing I've ever done," he said). Following surgery to repair a broken pelvis, he was forced to spend winter in a nursing home, mostly in good spirits but becoming increasingly impatient to get back to his microscope and his spectra. Unfortunately he never recovered from the accident; his bones healed, but his strength did not return.

Philip Keenan will be remembered as a small, quiet, elderly man with a pleasant but often self-deprecating sense of humour. Indeed, he seemed elderly for at least the last forty years of his life, and so frail that his longevity surprised everyone, even himself. He never married, and he had no living relatives at the time of his death. His family was instead made up of his astronomical colleagues, his devoted former students, his flowers, his rare books and his stars.

Robert T Wing
Ohio State University
Tom Lloyd Evans
South African Astronomical Observatory

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XCVIII IAU GENERAL ASSEMBLY
MANCHESTER 2000

Commission 41: Special Session
Inventory and Preservation of Astronomical Archives, Records and Artifacts

Wednesday, August 16: Roscoe 3.2
Chair: Steven Dick

0900hrs The Inventory of IAU Archives, and the ESO Archives
Adriaan Blauw (Netherlands)

0915hrs Roybal Astronomical Society Library and Archives
Peter Hingley (UK)

0930hrs Norman Lockyer Observatory Archives
George Wilks (UK)

0945hrs "Alidade" and the iconographic base for the astronomical archives preserved in France
Suzanne Debarbat (France)

1000hrs Observatoire Royal Archives
Wolfgang Dick (Germany)

1015hrs Specola 2000: A Programme for the Preservation and Inventory of the Archives of the Italian Astronomical Observatories
Giacomina Bientina (Italy)

1030hrs Status of the Euler Edition and Archives
Andreas Verdun (Switzerland)

1045hrs Russian Archives
Alexander Gurshatin (Russia)

1100hrs Preservation and Digitization of Observatory Publications
Brenda Corbin (USA), Donna Coletti (USA)

1115hrs Preserving the Material Heritage of Astronomy
The International Catalogue of Sources of the American Institute of Physics
David DeLavaun (UK)

1130hrs Inventory and Preservation of Archives in Australia and New Zealand
WI Orchard (Australia)

1150hrs The Nha R Seung Museum of Astronomy
Il-Seong Nha (Korea)

1200hrs Archives in India
S M Anand (India)

1220hrs Astronomical Records from China
Li Chuan (China)

1230hrs Astronomical Archives in Japan
T Nakamura (Japan)
Io’s Super-Hot Volcanoes

Io, Jupiter’s innermost large satellite, is like nowhere else in the Solar System. Highlights of our new view of Io were summarized in talks by Ashley Davies, Melissa McGrath and the author during Joint Discussion 12 (Highlights of Planetary Exploration from Space and from Earth) yesterday.

Intense tidal heating, resulting from Io’s proximity to Jupiter and its orbital resonance with other Jovian satellites, which forces its orbit to be eccentric, produces a surface heat flux forty times that of the Earth. The result is volcanic activity on a massive scale. Because the volcanism continually supplies volatiles (dominantly sulphur dioxide - $SO_2$) to Io’s surface, and supports a tenuous nanobar atmosphere, about a tonne of material per second escapes Io altogether, producing a dense plasma which fills the Jovian magnetosphere.

The past few years have seen rapid progress in our understanding of Io, due to discoveries by the Jupiter-orbiting Galileo mission, and improvements in ground-based and Earth-orbiting instrumentation, particularly HST. This progress has culminated in three close flybys of Io by Galileo since October 1999. The flybys have increased the resolution of our best Io images fifty-fold, and have provided unprecedented infrared maps of volcanic thermal emission and surface composition, in addition to providing new details of Io’s interaction with the Jovian magnetosphere.

Perhaps the most remarkable discovery from Galileo has been that many of Io’s volcanoes produce magmas hotter than any seen at terrestrial volcanoes. This probably indicates unusual magma compositions, perhaps silicate magmas poor in silicon and rich in iron and magnesium, similar to the ‘komatiite’ lavas which were common on the early Earth but are almost unknown today. Io may thus give us a window into the Earth’s early history. Galileo has caught many of these high-temperature eruptions in the act, including dramatic high-resolution images of fire-fountaining activity and spreading, glowing lava flows at the volcano Tvashtar. Galileo observations of a lower-temperature but more powerful volcano, Loki, indicate that its caldera is covered with fresh, hot, lava at the astonishing rate of 150 square kilometres per day, though it’s not yet clear how this is achieved.

Galileo has also provided insights into the generation of Io’s remarkable volcanic plumes, in which gas and dust is thrown up to several hundred kilometres above the surface. Some of the plumes appear to result from the vapourization of surface materials, such as $SO_2$ frost, by advancing lava flows, rather than being ejected directly from volcanic vents. HST has also contributed to our understanding of Io’s plumes: Hubble spectra of one of the largest plumes, Pele, reveal abundant $SO_2$ gas in addition to the expected $SO_2$ gas. Colourful red deposits seen around many Ioian volcanoes may result from breakdown of the unstable $SO_2$ gas into red $S_2$ and $S_3$ molecules after condensation on to Io’s surface.

Black Holes: A Closer Look

At Symposium 103 (Galaxies and their Constituents at the Highest Angular Resolutions) yesterday, Linda Dressel (Space Telescope Science Institute) presented the most direct and complete high-resolution determinations of supermassive black hole mass and the density of surrounding material to the velocity measurements obtained. This revealed a 1.5–2 x 10$^8$ solar mass black hole in the inner part of the disk, and a density of about 1000 solar masses per cubic parsec in the outer part. Further observations of other relatively nearby galaxies should follow soon. Obtaining a large sample of central engine mass determinations is a crucial first step toward understanding the physics of AGN central engines, including the puzzling difference between radio-loud and radio-quiet AGNs.
The Smallest Radio Sources

The old children’s nursery rhyme “twinkle, twinkle, little star” applies not just to the optical twinkling of stars in the Earth’s atmosphere but also to the scintillation of the smallest, most distant radio quasars in the ionized interstellar medium of our Galaxy.

Intra-day variability (IDV) at radio wavelengths was first discovered a decade and a half ago. This IDV was initially thought to be intrinsic to the sources themselves, as with IDV at X- and gamma-ray wavelengths. However, the implied brightness temperatures were far too hot, up to $10^{13} \text{K}$, so alternative mechanisms not intrinsic to the sources were sought. Of these, interstellar scintillation, BS, proved the most promising, but there seemed no easy way to determine conclusively if the mechanism was intrinsic or extrinsic.

The dichotomy has now been settled in favour of scintillation, primarily through two sets of observations. The first sought and measured a highly significant time delay of $\sim 5$ min in the appearance of the variability pattern at 5GHz in the extremely variable source PKS0655-365 between two widely spaced radio telescopes, the Australia Telescope Compact Array (ATCA) and the VLA. The second followed the change in the character of the pattern of variability at Westerbork, over the course of a full year of the source J1819+3845 as the Earth moved around the Sun. The variability pattern was seen to slow-down then speed up, just as expected for scintillation.

Interstellar scintillation leads to far less extreme source conditions than if the variations were intrinsic. However, there remain several serious problems:

- the sources are still too hot, with brightness temperatures of $\leq 5 \times 10^{10} \text{K}$, not easily explained by relativistic beaming;
- there are far too many IDV sources being found, and there is good evidence to indicate that most, if not all AGN contain weak microarcsecond cores;
- these IDV sources also show exceptionally high levels of circular polarization, and both the circularly polarized and linearly polarized flux also show IDV!

The measurement of radio source IDV means that sensitive flux density measurements with single radio source structures on an angular scale that cannot presently be reached by VLBI from the Earth or from space.

The 12 hour discovery observations made on 1996 June 8 of the variations in PKS 0655-385, observed with the ATCA at 8.6, 4.8, 2.6 and 1.4 GHz, from top to bottom. The measurement of radio source IDV means that sensitive flux density measurements with single radio source structures on an angular scale that cannot presently be reached by VLBI from the Earth or from space.

David Journeay
Australian Telescope National Facility/CSIRO

Surprising Results from Archival Research

V523 Cassiopeiae [WR16, CSV 5867, GSC 3257-167] has figured prominently in studies of very short period K-type non-degenerate eclipsing binaries over the past 15 years. Both amateur and professional observers have heavily observed it over the past 37 years. These timings suggest that the orbital period of the system is continuously increasing, which is not unusual for W UMa binaries of this type. Recently, David B. Williams of the AAVSO obtained 56 timings of “low light” by examining archived photographic plates from Harvard/SAO. While it is not possible to measure times of minimum light from the plates, these times of low light correspond well with eclipses. The timings cover the interval from 1903 to 1942 and greatly extend the baseline over which the period behavior of V523 Cas may be studied. Combined with the already available 403 epochs of minimum light and seven other timings of the 1996 observations, some 460 eclipse timings, spanning 152,000 orbits and 99 years were accumulated.

A least-squares fit to all available timings (see accompanying figure), revealed an unexpected result: a sinusoidal variation overlaying the continuous period increase. The quadratic term, $1.03 \times 10^{-11}$ d/E$^2$, is due to mass accretion onto the primary component or some as-yet-unexplained physical process causing the components to continuously separate. However, the sinusoidal behavior with an amplitude of 0.027 x 0.068 (light time 6.39 AU) is seen only in systems that have a third star present in the system. Assuming that this is the case, and that the inclination from our orbital solution for the close pair is the same as for the larger orbit, the mass of the third star was found to be $0.36 M_{\odot}$. Its orbital period is $103 \pm 16$ years. The distance modulus yields a distance of $77 \pm 3$ pc. The third member, at magnitude 15 compared to the contact binary's magnitude 11, should be near greatest separation now, $-0.3$ arcseconds. With adaptive optics on a large telescope and good seeing it should be possible to resolve the companion, if it exists. This result underlines the importance of preserving plate archives.

Ronald Samec
Bob Jones University, USA

With Thanks...

By this stage of the General Assembly it should be clear to everybody that the planning and preparations for the meeting have required an enormous amount of detailed work. From the time of the initial site visit four years ago, the bulk of this work has fallen on Rod Davies and Dennis Walsh, the Co-Chairs of the Local Organizing Committee. They have worked tirelessly with their colleagues at the University of Manchester to produce a well-organized and smoothly running meeting. In particular, Christine Bolton and her staff in the University of Manchester Conference Office have provided invaluable experience. On behalf of the National Organizing Committee, I would like to thank Rod and Dennis and all their colleagues who have ensured that we have had such an enjoyable time in Manchester.

I would also like to thank the members of the NOC who have worked in all manner of ways. In particular, our thanks are due to Sir Bernard Lovell for organizing the excellent concert and to Patrick Moore (and members of UMIST) for his work on the popular public lectures. The Executive Secretary of the RAS, John Lane, has given me practical support and advice on a variety of issues.

Each General Secretary of the IAU has to be responsible for one General Assembly. On this occasion we are grateful to Johannes Andersen who, with the IAU Secretariat, has worked hard to ensure that the high standards of the IAU were met. You will have all met the friendly and helpful staff of World Event Management who have dealt efficiently with the registration process.

I would like to thank our three major sponsors, the Royal Astronomical Society, the Particle Physics and Astronomy Research Council and the Royal Society, for their financial support. Also, the University of Manchester has borne many costs and has provided lecture theatres and rooms free of charge; we have enjoyed the scientific, sessions in comfortable, often recently refurbished surroundings.

Finally, thank you, the participants, for attending and contributing, to the scientific success of the Symposium and the Joint Discussions.

Carole Jordan
Chair, NOC

Closing Dinner

Will delegates attending the Closing Dinner in the Jarvis Piccadilly Hotel this evening, please note that they should arrive at 1915hrs for 1945hrs and NOT at 1800hrs as stated in the Final Programme.
Winter and Spring at the Pulkovo Observatory

The Pulkovo Observatory in St. Petersburg, Russia's oldest astronomical observatory, was known during the 19th century as 'the astronomical capital of the world'. Sadly, the Observatory has been passing through a difficult period in its history, due to financial constraints. However, observational work is continuing - mainly astronomy - notably double star measurements and studies of the satellites of the giant planets with the 26-inch refractor, now equipped with an ST6 CCD matrix. The astrometric work is also in regular use, carrying out its traditional programme of making photographic observations of asteroids and galaxies, as well as determinations of stellar proper motions. We are regularly observing the Russian 6-metre telescope, with emphasis upon observations of Edgeworth-Kuiper Belt objects.

We have welcomed twenty scientists from the former Institute of Theoretical Astronomy, and we also collaborate successfully with astronomers all over the world. If it has recently been 'winter' at the Pulkovo Observatory, we hope that 'spring' is now on its way.

Oleg P Bykov
Pulkovo Observatory

Lunar Astronomy

In the meeting of the Division X WG on 'Astronomy from the Moon', considerations relating to the selection of suitable sites for manned bases were outlined by Shigemi Kaito (National Astronomical Observatory of Japan). He stressed that everything depended upon the choice of site. A polar crater, with its floor in permanent shadow, would be ideal for some branches of research, because of the stable thermal conditions and the lack of background 'noise'. There would be an excellent energy supply via a nearby high peak, which would be in permanent sunlight; communications with Earth would also be good, since the Earth would always be in view from the top of the peak. From latitudes 80° to 90° there would also be easy communications, though there would, of course, be great diurnal temperature variations.

Changing of the Guard

After serving for almost one-third of a century as Director of the IAU Central Bureau for Astronomical Telegrams, Brain Marsden is stepping down at the end of this General Assembly.

The new Director of the CBAT is Daniel Green, who has been on the CBAT staff since 1980, for most of that time as Associate Director.

Since Green has in fact prepared most of the IAU Circulars in recent years, it is not anticipated that the change will be other than transparent. Marsden will in any case continue to be associated with the CBAT as Director Emeritus and as President of Commission 6. He will also continue as Director of the Minor Planet Center.
Another Dimension

Yesterday evening’s Invited Discourse on the ‘Three-Dimensional Structure of our Galaxy’ by Michael Perryman (European Space Agency) was a visual treat. The lecture set out to explain the main features of our Galaxy’s 3-d structure as we understand them today, and did so with remarkable success. The speaker described how the HIPPARCOS results have strengthened our ideas, and set it for research, and fewer have them for the future.

Sitting in the darkened auditorium of the Bridgewater Hall, the visual effects were truly spectacular. Even the simple reconstruction of the 2-d stellar motions on various fields on the sky brought the subject immediately to life. Seeing the motions of stars in the solar neighborhood, the reconstructed motions of stars moving through the galactic disk, stars moving up and down in the disk’s potential, simulated motions of planetary systems, and the effects of a massive black hole at the center, were truly astonishing.

The HIPPARCOS team is encouraged to attend. The Working Group’s tasks are:

i) to promote the early discussion and dissemination of information on potential large scale astronomical projects;
ii) to make available and maintain an inventory of planned large scale projects in astronomy;
iii) to further contacts and cooperation between different projects;
iv) to identify areas of duplication and areas where clearly desirable efforts are lacking.

There will be an open Business Meeting of the WGCLS in Roeo 3.3 today, commencing at 11:00hrs. Anyone interested in contributing to the better coordination of the development of large facilities, is encouraged to attend.

Ron Ekers
Chair, WGCLS

Women’s Lunch

A very successful lunch was held during the first week of the General Assembly to discuss the issues affecting women astronomers. About sixty GA participants (including men and women) attended and a wide range of facts and figures, viewpoints and opinions were aired. Wendy Freedman presented some of the latest statistical findings from the USA which show that proportionately more men than women are advancing at almost every stage of the careers ladder, particularly at the very highest levels. Sankako Maeda presented similar statistics from Japan which reveal, amongst other things, that about half of all married Japanese women astronomers endure years of separation from their husbands due to the problem of finding two jobs in the same locality. This is one of many well known problems which affect female astronomers worldwide.

There then followed a lively discussion. On the bright side, we heard that in both Italy and India there are departments or institutions very adequately good for female astronomers. However, in France, a country widely believed to have a good culture for women astronomers, we heard that the number of young women entering the profession is declining. This trend was predicted some years ago.

There was strong support for a more formal meeting to address many of the issues discussed at the next GA in Sydney. These issues are not new, and they affect women from many cultures and nationalities. The challenge for General Secretaries and Chairs is to find new ways forward, enabling more women to contribute fully to the pursuit of scientific knowledge.

Heinz Andermarch ESA, RSE Observatory Villanueva, Spain
Comission 5 WG on Astronomical Data

WORKING GROUP

Future Large Facilities

The IAU Executive Committee approved the formation of the WGCLS in August 1995, and Harvey Butcher was chair until the 23rd General Assembly in Kyoto in 1997. At Kyoto the following membership was adopted: Prof R D Ekers (Chairman), Dr I A. Appenzeller, Dr D H Butcher, Dr N S Kandshale, Dr I Lequeux, Dr J L Linkly, Dr F. Facini, Dr F Pradier, Prof G Swamp, Dr Masimo Tarenghi, Prof Okuda.

The Working Group’s tasks are:

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Ron Ekers
Chair, WGCLS

8 The Naming Game

Did you know that several journals allow celestial objects to be marked by the author to facilitate integration of objects and their associated data into public astronomical databases (NED, SIMBAD, etc)? See http://www.journals.uchicago.edu/aua/ (section 5.5.3) or name given in “<text>” for AAS journals – section 2.153 (p.10) of comprehensive author guide.

For example:

• |object|<catalog ID> - (for A&A journal - section 5.3.13) or |objectname|-<catalog ID> (for IAU or JUG) where catalog ID specifies the particular catalog for the “identifier” or name given in “<text>” (for AAS journals – section 2.153 (p.10) of comprehensive author guide).

See http://www.journals.uchicago.edu/aua/

Helene R. Dickel
University of Illinois, USA & Netherlands Foundation for Research in Astronomy
Chair, Commission 5 TG Designations

Bargain Basement

Please note that additional GA24 conference bags and abstract books are available for sale as follows:

Conference Bags (suitable for carrying a lap-top computer)
£5

Abstract Books
Available from World Event Management (WEM), Committee Room ‘A’, Ground Floor, Whithworth Building.
£3

Hurry while stocks last!
MAXIM's Goal:  
To Image a Black Hole

X-ray astronomers should be enjoying improvements in resolution at any given aperture. Because the surface brightness of blackbodies rises as the fourth power of temperature, compact X-ray sources have many millions of times the surface brightness of compact visible light sources. The VLBI, reduced in scale to the X-ray domain, would be about the size of a dinner plate. If X-ray astronomers could build interferometers of modest scale, images of unprecedented resolution would result.

Recently, at the University of Colorado, we have shown that synthetic aperture telescopes with good efficiency are possible using grazing incidence optics. It turns out that X-ray observatories using grazing optics in an analogue of Michelson's stellar interferometer are achievable with today's technology.

The potential for X-ray interferometry is being developed within the context of MAXIM, the Micro-Arcsecond X-ray Imaging Mission (see http://maxim.gsfc.nasa.gov). The MAXIM scientists have unanimously agreed that the goal of X-ray interferometry should be to image a black hole. The event horizons in the nearby stars and the broad line regions of AGNs are described today at Symposium 205 (Galaxies and Their Constituents at the Highest Angular Resolutions).

With luck, X-ray interferometry will become a powerful new tool of the astronomical community during the second decade of the 21st Century.

Webster Cash
University of Colorado

Surprisingly, all the technology needed to build and stabilize such an observatory exists today. MAXIM Pathfinder, a smaller X-ray interferometer of diameter 1.4 metres, is also being defined. Technically, the Pathfinder is a stepping-stone mission with a resolution of 100 micro-arcseconds, which is being designed to help us learn the realities of X-ray interferometry before moving on to the more ambitious black hole mission. MAXIM Pathfinder is very exciting in its own right; it will be able to capture pictures of the corona of the nearby stars and the broad line regions of AGNs.

MAXIM is now part of NASA's strategic planning, and will be described today at Symposium 205 (Galaxies and Their Constituents at the Highest Angular Resolutions). With luck, X-ray interferometry will become a powerful new tool of the astronomical community during the second decade of the 21st Century.

Webster Cash
University of Colorado

MAXIM Pathfinder Mission will feature two spacecraft flying in formation. The front craft carries the X-ray interferometer. The rear craft, many kilometers away, carries the detector.

MAXIM's Goal: To Image a Black Hole

Space missions to Mars have met with mixed fortunes. Some have failed because of unavoidable technical problems, others because of human error. On the other hand, some have been very successful indeed, and one of these is NASA's Mars Global Surveyor (MGS) launched towards Mars on 7 November 1996. It entered an elliptical orbit around the planet on 11 September 1997, and is still functioning excellently. Some of the most important results obtained to date were summarized by Arden Albee (California Institute of Technology) during yesterday's session of Joint Discussion 12.

The initial aim of the mission was to make a variety of observations, with global coverage, over a complete Martian year (687 Earth days or 688 Mars days or sols). From its arrival at Mars until March 1999, MGS acquired scientific data from decreasing-sized orbits as it alternated between aerobraking and nadir-pointing phases. MGS has now confirmed the presence of a Martian magnetic field. The field was known to be extremely weak, but significant remnant magnetization of the crust was confirmed, and this indicates that there was once a much hotter interior with a vigorous core dynamo. However, it seems that this dynamo was 'turned off' before the end of the Great Bombardment period. There is no measurable global magnetic field now, and in this respect Mars differs from Mercury.

Great attention was also paid to the gravity field and topography of Mars. Reliable global models indicate a relatively thick crust with meso-isostatic compensation in the rough, older southern hemisphere, and a thinner crust with a range of uncompensated gravity anomalies in the smoother, younger north. MGS data has resulted in the best topographic model obtained for any planet. There is a 30-km range of topography, and a pole-to-pole slope which apparently controlled the transport of water in the early history of Mars. There is also a relatively flat, northern depression which, it has been suggested, may once have been water-filled — a large, ancient ocean. Certainly, there was extensive volcanism during early to mid-Marsian history, as demonstrated by the presence of thick, layered sequences of strata in Valles Marineris and elsewhere.

The rocks in the southern hemisphere differ in general from those of the north — southern basalts and northerns areandesites. The widespread occurrence of plagioclase and pyroxene, coupled with the lack of weathered hydrated materials, indicates the absence of pervasive weathering. Several coarse-grained hematite deposits were found, possibly indicative of deposition in a surface hydrothermal environment. No identifiable areas of carbonates, sulphates or quartz have been detected.

It is known that the two Martian polar caps are not identical, the northern residual cap consists of water ice, while the southern cap contains more carbon dioxide ice. A reliable estimate of the total volume of water in the present caps indicates that there is not enough to fill a hypothetical ancient ocean to any appreciable depth. There is, however, clear evidence of a sapping origin of many channels from the probable melting of ground ice, and possible evidence for recent liquid water on the surface in various spatially-isolated regions.

Detailed and long-continued surveys have provided evidence for continuing geologic processes; there are many dust-devils as well as dust-storms, streaks, dunes and sand sheets. There are also many tiny plateaux and associated minor features. Mars is undoubtedly an active world and changes are taking place all the time. Much has been learned from MGS, and it will, is hoped, continue operating for some time yet — perhaps even until the time of our next General Assembly!
Of all the main bodies in the Solar System, only Pluto has so far been left unvisited by spacecraft. This omission will, it is hoped, be remedied by the launch of the Pluto-Kuiper Express (PKE) mission. Alan Stern was Chairman of the Outer Planets Working Group which first planned the mission, some years ago; he is now Director of the Department of Space Studies at the Southwest Research Institute in Boulder, Colorado. He came into the Northern Lights office earlier this week, to give us the latest news about the mission.

NL. First, when is PKE due to be launched — and when will it arrive?

AS. It is due for launch in December 2004, and should arrive at its destination on Christmas Eve 2012 — if all goes well.

NL. Are sufficient funds available?

AS. Well, NASA has already spent US$40 million in developing the concept, and that is about 10% of the total cost, so more is needed. It is worth noting that I have so far spent 12 years working on funding problems, and this is longer than the eight years needed for the spacecraft to cross the entire Solar System.

NL. Presumably you are anxious to send PKE before Pluto's perihelion is passed as the Sun? Perihelion was passed as the Pluto-Kuiper Belt observed at the two observatories, Jodrell Bank and Arecibo, in September 1998, did not get off to a very auspicious start when, just 10 days into the observations, Hurricane George swept through the Caribbean and damaged the Arecibo Telescope, curtailing that observing session. Happily though, the damage was not too serious, and since then observations have run smoothly, but as yet there has been no call from ET. After 40 years, should we be disheartened? No. To be honest, it is only recently that we have been capable of having a realistic chance of detecting a signal, and even then from only one of our near neighbourhood in the Galaxy. Advanced civilizations would have to be very common indeed, and deliberately wishing to make their presence known to us, for us to have a high probability of detecting them so far. The search is only just beginning in earnest.

At the moment, searches like project PHOENIX are our only chance of detecting life outside our own Solar System. Let's hope that some day they might be successful, for it would surely be one of the most exciting discoveries ever made. But it may be that, after many years of listening, using even more advanced receivers and a new generation of large telescopes, no signals are found. If so, we may well come to the realization that our planet Earth and our human race are, if not unique (for we could never be sure of that), then at the very least rare and rather special. I think that this perhaps would be an even more valuable thing for us to know.

AS. Without adequate funding, nil! But we are hoping to improve this situation by collaborating with European Space Agency (ESA) to join the mission, the chances of success are very high, because this is a relatively simple mission — a straightforward flyby. The results should be better than those obtained by Voyager 2 during its pass of Triton.

NL. What about the launch vehicle?

AS. We could use a Delta, launch from the Shuttle, or — with a slower trajectory — an Atlas-3. It is also very important to remember that exploration of the Kuiper Belt is a fundamental part of the mission; it is hoped to make flybys of one or more Kuiper Belt objects.

NL. It is indeed a most important and exciting project. Thank you very much.

We now look forward eagerly to December 2004. By next General Assembly we will no doubt be able to say more; let us hope that the funding problems will be solved, and that there will be full support from Europe.

The 26th IAU General Assembly, 2006

As the Union grows and conference venues need longer lead times for reservations and preparations, the task is becoming into a system of selecting the venue of future General Assemblies six years before the event. At its meetings ending Tuesday, August 13, the Executive Committee considered the two proposals received to host the 26th General Assembly in 2006, following an invitation to all member states to submit such proposals.

The two proposed venues were both fully adequate to host a memorable General Assembly, both proposals had the strong and enthusiastic backing of the astronomical communities and research organizations in the host countries, and the choice was an exceedingly difficult one. An extended deliberation took place and a very wide range of factors that might be relevant for the choice of venue was considered.

In conclusion, the Executive Committee decided to recommend to the Second Session of this General Assembly to accept the invitation by the Mexican National Committee for Astronomy and the Astronomical Institute of the Czech Academy of Sciences, under the auspices of the Academy, to hold the 26th General Assembly of the IAU in Prague, Czech Republic, in the summer of 2006. The precise dates will be decided and communicated at a later time. See you in Prague in 2006!

Johannes Andersen
General Secretary, IAU

SETI at Jodrell Bank

The Lovell Telescope at Jodrell Bank has joined with the 305-metre Arecibo Telescope in Puerto Rico to take part in what the European Space Agency joins the mission, things will become much easier in many ways. If funding is obtained, and we have a good launch, the chances of success are very high, because this is a relatively simple mission — a straightforward flyby. The results should be better than those obtained by Voyager 2 during its pass of Triton.

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Johannes Andersen
General Secretary, IAU
**Name a Minor Planet**

Following a fairly routine adoption of revised terms of reference for the Committee on Small Body Nomenclature (CSBN) and minor bodies names committee of Division III, a lively discussion ensued over policy for naming minor planets. It was noted that minor planet names are traditionally chosen by the discoverers of the objects, and that objects chosen tend very strongly to concentrate within the cultural and geographic regions of the discoverers themselves rather than more broadly representing all regions and cultures of the world. From here, the discussion turned to considering whether the IAU should include in the practice of “selling names”, a matter of recent notoriety with regard to companies selling “star names”. It was generally agreed that while such a practice might provide financial benefits, the legitimate research purposes, it should be regarded as unethical to offer a minor planet name on a pro quO basis. It was however agreed that policy should remain flexible, to allow for recognition of benefactors of minor planet research, in the same way as can be seen in the names of many buildings on any university campus.

Brian Marsden, Director of the Minor Planet Center said in an off the record meeting that the CSBN had not been informed of any proposal to name a minor planet after either living or deceased fictitious persons or places (from literature, legends, etc.) allowable, but names of pets are discouraged (hence Pluto should not be a minor planet name). Commercial entities or product names could be considered, but subject to the above restriction on pro quO “selling” of names. For example, a minor planet was named Loral, to honour that company’s pioneering work in developing atmospheric (CD) Citation are limited to a length of four lines in the published Minor Planet Circulars, which translates to about 300 characters including spaces. A citation should include the geographical location and dates relevant to the name proposed, and a brief explanation (qualification) of the choice of the person, object or place named. A self-evident introductory phrase such as “in honor of” should be avoided for the sake of brevity. To help reduce the editorial workload, the CSBN requests proposers to review examples of past citations (http://cdswww.harvard.edu/iau/info/astrom.html#newnames) and adhere closely to the content and format restrictions that must be imposed. Suggestions for names with a proposed citation may be submitted to the Minor Planet Centre directly at mpc@etsc.harvard.edu.

Contributed by Alan W. Harris, with assistance from Julio Fernandez, Brian G. Marsden, Gareth V. Williams, and Daniel W. E. Green.

**Below the Clouds of Jupiter**

Cloud features north of Jupiter’s equator imaged by the Galileo spacecraft.

The latest results from the Galileo entry probe were presented by Susan Atraya (University of Michigan), during Joint Discussion 12 (Highlights of Planetary Exploration from Space and from Earth) the results obtained were not what was expected, because by shear chance the probe entered at the edge of an exceptional region - termed a “micron hot spot” (these features are dark patches which reflect relatively little sunlight, but emit infrared radiation coming from below). Most of the results came from Galileo’s main spectrometer. Thick clouds of ammonia, hydrogen sulphide and water and their compounds had been expected, but were not found. The local meteorology indicated that very dry downwelling air depleted the condensible volatiles in the region sampled by the probe.

The ratios (to hydrogen) of the heavy elements sulphur, nitrogen, carbon and the rare gases argon, krypton and xenon were found to be 2-3 times the solar values, which has important implications for theories of the formation of Jupiter. Preliminary analysis has shown no heavy hydrocarbons in excess of 10 ppt, but the data are not complete; work is continuing, and the speaker stressed the importance of sending further atmospheric entry probes, both for Jupiter and (if practicable) also for the other giant planets.

**Goodbye Manchester Hello Sydney**

Australia will host the 23rd IAU General Assembly in 2003, with six associated Symposia, numerous Joint Discussions and a host of other meetings. It will be held from 13th-26th July 2003 at Darling Harbour, Sydney’s harbourside cultural and international conference centre.

Sydney is Australia’s largest city, and one of the most beautiful in the world. The people of Sydney are friendly, cosmopolitan and enthusiastic about their city and about Australia as a place to live, work, play and enjoy. Sydney is, of course, hosting the 2000 Olympic Games.

Sydney’s famous Opera House and beautiful harbours are within walking distance of the conference centre, while surrounding beaches and coastline, and the nearby countryside and mountains will entice visitors to explore further afield. The city is also the nation’s airline hub for Alice Springs and the Outback, the Great Barrier Reef and the tropical north, at its best in July.

The National Organizing Committee is planning a scientific congress to address a broad range of current issues and lively topics in astronomy. A series of special interest tours throughout the conference period will enable delegates to visit many of the country’s astronomical facilities. We are also planning a number of tours which will offer opportunities to enjoy Australia’s unique environment and culture. These tours will be led by Australian experts to help you experience the beautiful environments of Central and Northern Australia, the Great Barrier Reef and the rainforest and wilderness regions of Tasmania. Registration forms and many other details for planning your trip to Australia will be available by July 2002 on our www site. This site which outlines the details of the Sydney congress is at: http://www.aa2003.org.

Over the next two years the www site will be continually updated as the planning progresses. There will be information on accommodation facilities, congress plans, scientific programmes and details of the special interest tours available for you. You will also be able to pay all costs associated with your Australian visit at the www site.

To help the organizing committee plan the congress and the many and varied outings and tours take the time to visit the website, complete and submit the expression of interest form online to receive future notices about the 2003 General Assembly Down Under! See www.iau-ga2003.org.

Catherine Ross
ICMS, Australia

**A Candle in the Dark**

During the Inaugural Ceremony on Wednesday, August 9, Sir Robert May drew attention to the importance of maintaining public support for science. He joked about the confusion between astrology and astronomy in Whitehall. When it comes to media attention, astronomy and astrology are two very different things.

Bart O’Keeffe attempted to draw attention away from astrology, and later Carl Sagan, in his book The Demon-Haunted World (Ballantine Books) denounced a book - Two voices crying for public sanity. And now the Harry Potter phenomenon proves that the world of magic has young readers transfixed.

In Australia, a large regional newspaper has just scrambled an astronomy column, which it has carried for 33 years (as a counter to the daily astrology column) - nonsense in favour of increased space for a local psychic! Carl Sagan saw organized scepticism as one way to expose anti-science, whether it be creationism, crop-circles, psychics or horoscopes.

The ‘Skeptics’ (spelled with a k) creed is to seek the evidence. Following this approach the Australian Skeptics have exposed psychic charlatans, unless pseudo-scientific devices and triggered successful prosecutions of ‘quack’ medical operators. At the same time, they positively encourage real science by sponsoring an annual AU$10,000 ‘Eureka Prize’ for critical thinking, and are one of the three major sponsors of the Exploratory Science Centre at the Mount Stromlo Observatory.

It is difficult for professional societies to attack pseudo-science, but individuals can follow Carl Sagan’s lead and get behind the nearest of the hundred or so Skeptics Societies around the globe. Think about it...

Colin Keay
University of Newcastle, Australia
Promoting Astronomy in Africa

The African continent is very poorly represented in the IAU. As of 1999, the total IAU membership among African countries amounts to 44 persons, or 1.1% of the total IAU membership. The African membership is distributed as follows: Algeria (48%), Egypt (41%), followed by Nigeria, Algeria, Morocco and Mauritius, each having 2 or fewer members. Not surprisingly, these countries are among the more prosperous nations on the continent. One should bear in mind, however, that all above statistics reflect the presence of nationally organized astronomical communities. There are many individual scientists distributed throughout Africa who are involved in astronomy and education, and in some cases also research, who are not IAU members.

The Working Group on Space Sciences in Africa is an organization which was founded by African participants at the 6th UN/ESA Workshop on Basic Space Science in Bonn in 1996. This Working Group aims to promote the development of basic space science (including astronomy and astrophysics) in African countries through a variety of methods. The Working Group works in collaboration with IAU Commission 46 (Astronomy Education and Development) and the UN Office of Outer Space Affairs.

The WCSSA publishes a newsletter called African Skies/Cieux Africains, which is distributed by the UN Office of Outer Space Affairs to over 1000 addresses, mostly in Africa. At present, the Working Group has individual members in Algeria, Burundi, Central African Republic, Chad, Congo, Egypt, Ethiopia, Ghana, Nigeria, Senegal, Libya, Malawi, Mauritania, Mauritius, Mozambique, Morocco, Namibia, South Africa, Sudan, Togo, Tunisia, Uganda, Zambia and Zimbabwe.

A considerable number of these individuals are university physics lecturers with an interest (and in some cases formal training) in astronomy. The Working Group is particularly interested in assisting those among its members who wish to introduce astronomy courses into their physics curricula and to participate in astronomical research.

The Working Group's activities include: publication of the newsletter African Skies/Cieux Africains, facilitation of access by African students to summer/vinter schools organized by various astronomical observatories, distribution of astronomy books/journals donated by astronomers, and seeking funding for fellowships to enable its members to visit astronomical institutions for extended periods. The Working Group is also attempting to coordinate efforts to assist governments in Africa to educate the public on safe methods of viewing the total solar eclipses in 2001 and 2002.

There is presently a dearth of large-scale facilities in Africa, which means that many African astronomers are forced to move elsewhere in order to pursue their careers in astronomy. However, this situation will change dramatically over the next 5-10 years because of a number of exciting projects currently in planning or under development. These include the Southern African Large Telescope (a 10-metre class optical/near-infrared telescope being built in Sutherland, South Africa), the High Energy Stereoscopic System (an array of gamma-ray telescopes being built near Garoed, Namibia), and the World Space Observatory (an ultraviolet space telescope project in the planning stage, designed to involve participation by the developing countries. These facilities are all complementary, and each has potential to stimulate (necessary) local infrastructural or technological developments.

There are 14 IAU members and 3 invited participants from African countries registered at this General Assembly. They come from Algeria (2), Egypt (3), South Africa (11) and Zimbabwe (1). The three major facilities mentioned above have great potential to stimulate astronomical development on the continent. Hopefully this will be reflected in increased participation by African countries in future IAU General Assemblies.

For further information about the Working Group on Space Sciences in Africa, please contact Peter Martinez (Box 559) or send an email message to wsaga@usa.ac.za.

Peter Martinez,
South African Astronomical Observatory

New Asteroid Names

Did you know that even the simplest form of a designation requires an acronym in addition to a number (which may be the number of the first publication, or be based on a position)? See http://cdsweb.u-strasbg.fr/how.html for details.

Public Lectures at GA24

UMIST are running a series of lectures for the public during GA24. These lectures have been advertised widely to schools, amateur astronomical groups, and the general public. Attendance by participants at GA24 is welcome, but comes with a health warning! Ticket holders will be admitted to lectures as they are available. Only one place is still available, just before the start of the lecture, to those without tickets will be admitted.

We hope that you will appreciate our desire to give the genuine public some thing to be excited about the excitement of astronomy during GA24.

Reorganization of Italian Astronomy

Italian astronomy has developed very fast during the past decade. We recall here some major achievements: the construction of two 32-metre VLBI dedicated radio telescopes in Medicine and Noto, to be followed by another 64-metre radio telescope in Sardinia; the 3.6-metre Italian Galileo National Telescope on La Palma; the 1.5-metre telescope of the Telescopio Nazionale Galileo and the German-Italy-USA Large Binocular Telescope (both at the site of the abandoned ESO 25-metre telescope); the public launch of the BeppoSax satellite in finding the X-ray afterglow of gamma-ray bursts; and the COMET project to support the existing observatories, with a special emphasis on large national and international projects. It will also have a close relationship with the Italian astronomical community.

A similar coordination effort is also underway in the National Research Council, which is merging the astrophysical programs carried out by the three bodies dedicated to radio astronomy, space science, and Solar System research, respectively.

Lucia Pacificelli
National Research Council Representative

The End?

The Second Session of the 24th General Assembly and the Closing Ceremony were held in Bridgewater Hall yesterday afternoon, two days before the final events actually take place. It was well attended, and there were as many delegates present as there had been at the previous night's Invitational Dinner. The keynote of excitement and keen appreciation was perhaps rather less marked.

The works were read and approved; only one required discussion (in fact, the time taken for this particular debate about the same as the time taken for a photon to go from the Earth to the Sun and back again). There were excellent speeches, enjoyed by those who paid close attention to them, and there were various announcements; since the next General Assembly, in 2003, is to be held in Sydney, David Malin gave a brief preliminary welcome to Australia. There was a draw for an unsold souvenir rocket, and the announcement that the winner was Kenneth Johnston from the Sun and the Moon Publishing Company, who received a prolonged applause. It was also confirmed that the 26th General Assembly will be held in Prague, in the Czech Republic.

Votes of thanks were given; the final speeches made, and the retiring President, Robert Kraut, officially closed the 24th General Assembly, ending with the hope that he will see us all again in Sydney in three years' time.
Bubble-Blowing Galaxies

Fifty million light-years away, in the constellation of Cetus, lie the two colliding galaxies NGC 4038 and 4039, known as the Antennae Galaxies because of the spectacular antennalike streamers issuing from them. They are also producing huge bubbles of expanding X-ray emitting gas, which come into contact with each other and merge, forming what may be called ‘superbubbles’. These were described during Symposium 205, by Giuseppina Fabbricant (CIA) who, with Andrea Zeezas and Stephen Murray, has used NASA’s Chandra X-ray observatory to capture this phenomenon in unprecedented detail.

The observations provide a nearby example of the conditions when our Universe was young and galaxies were forming. ‘Galaxies were much closer then,’ explained Fabbricant. ‘Collisions like the ones which produced the Antennæ image, taken on 1999 December 1, shows the central regions of the two colliding Antennæ Galaxies. In addition to the superbubbles, which show up as bright patches, there are dozens of bright point-like sources – neutron stars and black holes – produced by the flurry of supernova activity. The X-rays from these sources are generated by gas which is heated to tens of millions of degrees Celsius as it streams from nearby companion stars onto the neutron stars and black holes.’

“What we are witnessing with the Antennæ is the birth of a new generation of stars and the death of the old. This is a moment of star birth, death and renewal.”

Free Precession of a Neutron Star

A team at Jodrell Bank Observatory, University of Manchester, has used the 26-metre Lovell Telescope to determine that a young, isolated pulsar is undergoing free precession. The Jodrell Bank scientists (Ingрид Stairs, Andrew Lyne and Setam Shemar) have been studying 13 years’ worth of data from the pulsar PSR B1528-31. This pulsar rotates 2.5 times per second, but, unlike any other, shows periodic variations in both its pulse times of arrival and its profile shapes. The variations have a fundamental period of about 1000 days. In particular, the changes in pulse profile shape and the pulse slow-down rate are highly correlated, demonstrating a direct link between the inclination of the pulsar to the line of sight and the torque on the pulsar.

The natural explanation for these phenomena is that the pulsar is precessing on a timescale of about 1000 days. Such a wobble may be expected to arise if the pulsar is slightly deformed, by about 0.1mm in the 10 km radius, so that its spin vector is misaligned with its angular momentum vector; its effects are illustrated in the diagram. Free, untorqued precession is, however, expected to be damped out on very short timescales by the interaction of the neutron superfluid vortices within the pulsar with the neutron star’s solid crust. Further theoretical work on this interaction will be needed to explain the long-lived precession observed in PSR B1528-31.

This work appeared in a Letter to Nature on August 3, 2000 (Nature 406, 484). A press release describing the work, along with an illustration and animation, can be found at http://www.jb.man.ac.uk/news/neu trostar/.

Optical/IT Interferometry: New Developments

The next five years will see significant advances in high-resolution astronomy in the optical and infrared. With eight interferometers already producing results (five in the USA, and one each in Australia, France and the UK) and the Keck and VLT interferometers set to come on-line within the next two years, astronomers are looking forward to milliarcsecond angular resolution.

The scientific programmes will address a broad range of astrophysics. These include: measuring fundamental stellar parameters, imaging the surfaces of stars and their environments, exploring stellar nurseries on AU scales, searching for extrasolar planets, and probing the nuclei of active galaxies. Crucial to these efforts will be the technique of phase referencing, which has now been demonstrated at the Palomar/Templeton Interferometer, a precursor to the Keck Interferometer.

Hints of the potential of interferometry have come from the spectacular images of the spiral dust nebula of Wolf-Rayet 104 and the expanding dust cocoon around the nearby carbon star IRC+10216. These images were obtained by Peter Tuthill (University of California Berkeley) and colleagues by masking the aperture of a single Keck telescope, and illustrate the importance of having a large number of array elements. The next generation of ground-based arrays is a designing with this in mind, including the 15-element Large Optical Array (LOA) proposed by a consortium of UK universities.

Even more ambitious plans are space interferometers such as SIM (Space Interferometry Mission), an approved NASA mission to detect Earth-like planets, using microarcsecond astrometry. A long-term goal is to launch an array of telescopes to image such planets, as well as the environments of black holes and accretion discs around protostars.

Tim Bedding
University of Sydney, Australia
SETI: Science Fact, Not Fiction

It's a lot easier to find aliens in Hollywood than in the Milky Way. We've been trying various search strategies for forty years now without success; is it time to give up? Absolutely not! We've hardly begun.

In SETI we have a good strategy (searching for manifestations of distant technologies), and after forty years, we are finally getting world class tools with which to pursue at least one type of search. The Allen Telescope Array is a joint project of the SETI Institute and the University of California Berkeley Radio Astronomy Laboratory on a 1000-hectare area of 1 hectare (10,000 square meters, about the same as the VLAs), provide continuous frequency coverage from 0.5 to 11 GHz, image a large field of view (a few square degrees at 1 GHz), and simultaneously synthesize multiple high resolution beams on the sky. To make it affordable (yes that's important), even with the generosity of Paul G. Allen and Nathan Myhrvold.

If you'd like to contribute, SETI has a web site where you can donate and try your hand at SETI@home; you can also receive updates on what's happening in SETI.

Strange Hypergiant

Exactly 400 years ago, on 1606 August 15, the Dutch globe- and map-maker Willem Janssen Blaeu (1577-1628) discovered a new bright magnitude star in the constellation Cygnus. The light of this star was faint but bright enough to be seen and marked on the world's first star catalogue. This was the first nova to be reported since Tycho's Star of 1572. 'Nova' to be reported since Tycho's Star of 1572.

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The 400th anniversary of the discovery of P Cygni is certainly an appropriate time to discuss the progress made towards understanding this fascinating object. We will be interested to see how the lessons learned from its study are not lost, and that these results can be applied to the study and understanding of similar objects, together with the nature and evolution of massive stars in general.

Africa's Giant Eye

The Southern African Large Telescope (SALT) is a 10-metre class telescope for optical/ infrared astronomy based on the design of the Hobby-Eberly Telescope (HET) at McDonald Observatory, Texas. The design is a tilted-Arecibo concept with a segmented spherical primary mirror and a spherical aberration corrector on a tracker beam at the prime focus. The telescope will be located at the Sutherland observating station of the South African Astronomical Observatory (SAAO). Construction will start soon after the Ground Breaking Ceremony on 2000 September 1, and the telescope will be commissioned by December 2004.

SALT will benefit from the experience of the HET, and there are a number of design changes. The telescope will be tilted at 37 degrees to the vertical to enable access to the Small Magellanic Cloud. Edge sensors will be placed on the segmented spherical primary mirror to maintain mirror alignment. An improved design of spherical aberration corrector will allow better image quality, an increased 8 arcmin field, and an image pupil covering the whole primary mirror area. The initial instrumentation suite planned to include a prime focus imaging spectrograph constructed by University of Wisconsin and a fibre-fed high-dispersion echelle spectrograph constructed by University of Canterbury, New Zealand.

The present partnership in SALT includes South Africa, HET Board, Poland, University of Wisconsin-Madison, Rutgers University, Carnegie Mellon University, Goettingen University, University of Canterbury New Zealand and most recently a consortium of five UK institutions. SALT is being developed to support a design of 10-metre class telescope. The total cost of SALT over a 15-year period, including a 10-year operations phase, is estimated at $30 million. The contributions of all partners presently total $25 million. Thus there is still an opportunity for additional partners to participate in this project. Please contact Bob Stobie (rsf@sao.ac.za) if you are interested in SALT or in finding out more at www.salt.ac.za.

Further information on SALT can be found at the web sites www.salt.ac.za and www.sao.ac.za.

From the New IAU President

Astronomers of my generation have been lucky. Scientific progress during my lifetime has been so rapid that the twentieth century has even been compared with the time when Galileo and others first turned telescopes to the sky. We have lived through the discoveries of exotic objects such as quasars, pulsars and black holes, radio astronomy has been developed, and surveys have become possible, and of course we have watched the first men walking on the Moon. We have sent automatic probes out to all the planets in the Solar System apart from Pluto, and we have now proved the existence of planets orbiting other stars. My generation was also fortunate in another way; the rapid progress in our science was accompanied by the deliberate growth and frequent challenge of searching for life as-we-yet-know-it; from microbes to the E. Hebrus. It is also noted that public interest in astronomy is now greater than ever before. Against this, we have the problem of light pollution; the skies are becoming so bright that many people are deprived of the joy of observing the stars. Let us hope that this situation will improve; the sky is part of our heritage just as is a sunlit mountain or a green forest.

I am convinced that astronomy is an important science with a bright future. It is notable that public interest in astronomy is now greater than ever before. Against this, we have the problem of light pollution; the skies are becoming so bright that many people are deprived of the joy of observing the stars. Let us hope that this situation will improve; the sky is part of our heritage just as is a sunlit mountain or a green forest.

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The Black Hole at the Galactic Centre...

Radio Studies of Sagittarius A* (Sgr A*)

Observations of the curvature in stellar orbits near Sagittarius A* (Sgr A*) have revealed the presence of a massive black hole in the Galaxy. The black hole is part of the central region of the Milky Way and is the closest black hole to our own Solar System.

The New Liverpool Telescope

Measurements of the proper motions and radial velocities of stars in the central cluster of the Milky Way have revealed the presence of a 2.5 million solar mass black hole at the position of the compact radio source Sagittarius A* (Sgr A*). The overall stellar motions do not deviate strongly from isotropy, and are consistent with a spherical isothermal stellar cluster. However, small deviations from isotropy are found for the sky-projected velocity components of the young, nearby stars in the central cluster of the Milky Way. The radio source is consistent with the event horizon of the black hole, and there is no detectable radiation from it. The NTT radio and especially VLBI techniques further strengthen the results.
Hendrik van de Hulst: 1918-2000

All of us at the IAU will be saddened to know of the death of one of the greatest astronomers of the twentieth century, Hendrik van de Hulst. He was born in Utrecht, and graduated from the University there. He is also brilliant at shortening lightning speed on an ancient overlength copy to fit available space.

He was told he couldn’t use the only lift, because he was a passenger lift and he was clearly carrying goods!

The production of Northern Lights needed a lot of effort, and Pam Rivers, Chris Banks, and Marina helped with small tasks.

The morning paper run has not seen its last hour.

Many IAU delegates will have witnessed the excellent newspaper distribution service provided by our Editorial Assistant, Chris Lintott – aided by a borrowed supermarket trolley and a kiosk. Taking delivery of the papers every morning at 8:15am, Chris has had only 45 minutes to make the drop at all seven distribution points before the start of the morning sessions at 9am. If ever pushing a shopping trolley around an obstacle course becomes as Olympic sport, Chris will be in with a good chance of a medal; the long ramp up the side of the Computer Science Building presented a particular challenge.

The morning paper run has not been without other difficulties. In the Computer Science Building, Chris was not allowed to use the only lift, because he was told it was a goods lift and he was clearly a passenger. However, in the lift, he was told he couldn’t use the only lift, because it was a passenger lift and he was clearly carrying goods!

There is no smoke like that of Patrick Moore, our Associ ate Editor, in producing accurate news stories of the right length, knocked out at lightning speed on an ancient typewriter, which he bought for £1. He is also brilliant at shortening lightning speed on an ancient overlength copy to fit available space.

During the 74th Executive Committee meeting on August 17, it was decided to approve IAU sponsorship for the following meetings in 2001:

IAU Symposia

Extragalactic Star Clusters, Pucón, Chile, March 2001
Cosmic Masers: From Protostars to Black Holes, Rio de Janeiro, Brazil, March 2001
Planetary Nebulae: Their Evolution and Role in the Universe, Canberra, Australia, November 2001

During the 74th Executive Committee meeting on August 17, it was decided to approve IAU sponsorship for the following meetings in 2001:

IAU Colloquium: AGN Surveys, Byurakan, Armenia, June 2001
Radial and Nonradial Pulsa tions as Probes of Stellar Evolution, Leuven, Belgium, July 2001
IAU Regional Meeting: X Multi-American Regional Meeting, Cordoba, Argentina, September 2001
In addition, two other meetings will be accepted, pending discussions between the IAU and the organizers:

Oldjbourne, England: IAU Assistant General Secretary

Northern Lights: IAU newspaper distribution for the Internet Age

NORTHERN LIGHTS: IAU newspaper distribution for the Internet Age

The official daily newspaper of the 24th General Assembly has had a particularly fortunate in having the support of a marvellous team. There is no smoke like that of Patrick Moore, our Associate Editor, in producing accurate news stories of the right length, knocked out at lightning speed on an ancient typewriter, which he bought for £1. He is also brilliant at shortening lightning speed on an ancient overlength copy to fit available space.

There is no smoke like that of Patrick Moore, our Associate Editor, in producing accurate news stories of the right length, knocked out at lightning speed on an ancient typewriter, which he bought for £1. He is also brilliant at shortening lightning speed on an ancient overlength copy to fit available space. Our authorities are happy to enjoy this traditional aspect of the Chinese government. Against the background of great developments, the Chinese Astronomical Society has informed the Executive Committee of its intention to invite the IAU to hold the 27th IAU General Assembly in Shanghai in 2009. This date has been selected because we need time to prepare for an event of this magnitude, but also because of a total solar eclipse of long duration on 2009 July 22, which will pass precisely through the Shanghai-Nanjing area. Modern conference and other facilities are being developed in Shanghai at a tremendous rate, and will be more than adequate to host a General Assembly by 2009.

Cheng Fang
President, Chinese Astronomical Society
Nanjing University, China

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Stage: Manchester

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