The Stellar Sequence. The spectral sequence of stars, with classification into seven basic types from O to the coolest, M type stars. The sequence is now being expanded as a result of new technology. *Sky and Telescope, September 2000*

New Japanese Telescope. Stunning photographs from Japan's Subaru telescope, which has the world's largest single telescope mirror. *Astronomy, September 2000*

Beyond the Rainbow. Visible light and its invisible partners in the in the electromagnetic spectrum - radio waves, infrared light, ultraviolet light, X-rays and gamma rays. *Astronomy, September 2000*

Strange Universe - Light Speed. It is possible to travel to the centre of our Milky Way Galaxy and return in just a few years, while thousands of years pass by on Earth (and you always thought it was impossible to travel faster than the speed of light). *Astronomy, September 2000*

Quiz Night

Don't forget to come and join us for the Quiz night on 12th December. The quiz is just for fun and Jessica Harris, who is setting the questions, would like to see as many people as possible there to enjoy the evening. Bring along some food and drink to share.

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Sagittarius

The Newsletter of the Astronomy Section of La Société Guernesiaise

October - December 2000

Forthcoming events

The Space Station
Talk by Frank Dowding
Tuesday, 21st November
8 pm at the Observatory

Quiz and Shared Supper
Tuesday, 12th December
7.30 pm at the Observatory

Lunar Eclipse
Tuesday, 9th January
5.43 - 10.57 pm
(Totality 7.49 - 8.51 pm)
viewing from the Observatory

In addition, the Section meets at the Observatory every Tuesday evening, and Friday if clear for observing.

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The Latitude Connection
IAU 2000

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Centre inserts

Star chart
Moon phases
Sunset and sunrise times

Perseids

We held our annual barbecue and Perseid meteor count on August 11th, the anniversary of the eclipse. The weather was on our side and about twenty people attended the barbecue. The full moon did not help with the meteor count and the sky was hazy in parts but those meteors we did see were bright and fast. There was one notable meteor that travelled from west to east leaving a train - it was not a Perseid but it was the brightest of the night. By the end of the evening we had seen probably fifteen meteors. We also had the bonus of Mir making an appearance. It's brightness is almost equal to that of Jupiter.

We were joined by Anne-Marie of Radio Guernsey who interviewed various members throughout the the evening. She followed up her visit with a half-hour long programme the following Monday plus a three minute "taster" on the early programme. It was based around the Perseids but covered a variety of topics and as a result we received several enquiries about the observatory.

Debby Quertier

Summer visits

The observatory was included in the "What's On" section of the Guernsey Tourist Guide as being open to the public on Tuesday evenings after 9.30 pm. As a result we had a lot of visitors each Tuesday, even on cloudy nights. Most weeks there were half a dozen or more people and one week the number exceeded fifty! Amongst our visitors were students who had just completed astronomy-related degrees and who hoped to do some practical observing.

One observatory visitor was Sami Gazey, who is working on the SOFIA (Stratospheric Observatory For Infrared Astronomy) Project, a collaboration between NASA and the German space agency to mount and use an infra-red telescope on a 747 jet. Sami e-mailed us some details and we shall watch the progress of the project via the media and the internet (see http://sofia.arc.nasa.gov) with interest.

Our visitors included locals and we hope that our membership will increase as several have shown interest in joining the Section.

Debby Quertier

Astronomical Prague

by David Le Conte

During a recent visit to Prague I sought out the tomb of Tycho Brahe, the 16th century Danish astronomer. He moved from Denmark to Prague in 1597, shortly before his death in 1601. The house where he lived is still there, at 1 Novy Svet, not far from Prague Castle, where there is a statue of him and Johannes Kepler. Kepler worked for him and, after his death, used his observational data to deduce his laws of planetary motion. Brahe achieved the greatest accuracy in a time before the invention of the telescope, by the use of giant instruments such as quadrants.

He was clearly a well-respected man during his lifetime, because his tomb lies close to the altar of the magnificent Church of Tyn. The horizontal stone is a simple affair with his name boldly inscribed, but adjacent to it is a vertical life-size monument featuring his figure and an inscription including the date of his death, 24 October 1601. Tycho, of course, was famous not just for his astronomical observations but also for his silver nose, which replaced his real one which he lost in a duel. Close inspection of the monument clearly shows it. I bet it got cold on winter nights!

While in Prague I also visited the ancient Strahov Monastery in the Castle, and was fascinated by the Theological Library which contains not just thousands of old books but also a number of terrestrial and celestial globes, many dating from the 16th and 17th centuries. It was interesting to speculate that perhaps Brahe and Kepler had also seen them and maybe even used them.

The main astronomical attraction in Prague for most people is a remarkable clock, constructed in the 1410, with later additions. The attraction is its performance every hour, when the apostles process across two windows added during the 19th century. The main part of the clock, however, shows not just the time of day as we know it but also "Bohemian hours", "Babylonian hours", the positions of the Sun and Moon in the zodiac, and more. The date is indicated on a huge separate dial which shows every day of the year.

David Le Conte

The Latitude Connection - Coincidence or Correlation?

by Geoff Falla

Jupiter is the largest of the solar system's planets, and one of its most prominent features is the Great Red Spot, an oval shape varying in colour and visibility but almost always present since it was first noticed by astronomers over three hundred years ago. The spot is located near the the edge of Jupiter's South Equatorial Belt and always close to twenty two degrees south latitude.

The reason for the spot's apparent permanence, and why it is found at this latitude, has long been a matter for conjecture. It is usually regarded as just a phenomenon of Jupiter's meteorology, but there is reason to believe that it may be more than just an atmospheric phenomenon. It has been noted that material forming the spot rises in the centre and spirals outwards, elongated into an oval shape as Jupiter rotates in the remarkably short time of less than ten hours.

When the Voyager 2 spacecraft produced the first detailed views of the planet Neptune in 1989, during a grand tour of all the outer planets, astronomers were surprised to find that this planet also had its own large atmospheric spot. This was named the the Great Dark Spot, and is at a similar latitude to the Great Red Spot on Jupiter's surface.

The British amateur astronomer WT Hay, who was better known as the stage and screen comedian Will Hay, was interested in astronomy from an early age

and became a skilful observer. In August 1933 he discovered a prominent white spot on Saturn. The spot was not far from the the equator and was considered to be eruptive in nature, with material being thrown up from below the surface of the gas layer.

We do not have to look far in the solar system to find evidence of other eruptive features at similar latitudes north or south of the equatorial zones, even in the case of the inner planets. On Mars the largest known volcano in the solar system, Olympus Mons, is located at around latitude twenty degrees north. This huge volcano is over fifteen miles high and several miles wide. Earth's largest volcanic structures, in Hawaii, are nowhere near as large but are almost precisely at the very same latitude as the Martian volcano. The Earth's surface has a number of volcanic "hot spots" which are related to the flow of material from the interior. These areas have been found to remain stationary over geological time, separate from crustal movements. Perhaps there is some basic mechanism in the rotation of the planets and interior circulation processes which favour eruptive phenomena at these particular latitudes.

Even in the case of the planetary moons another example can be found on one of Jupiter's four major moons. The innermost moon Io has been found to be the most volcanically active body discovered in the solar system. When the Voyager 1 mission made a flyby of this moon in 1979 astronomers were surprised to see active volcanoes with plumes of material being ejected over a hundred miles above the surface, evidently as a result of the gravitational forces and heat generated by its proximity to Jupiter. The most prominent and active of these volcanoes was found to be located at nineteen degrees south, while the hottest volcanic spot on Io was found at the same corresponding latitude north of the equator.

The favoured zones appear to be some way towards the mid latitudes, typically at what seems to be a recurring latitude around twenty degrees north or south of the equator.

The speed of planetary rotation is at a maximum on the equator, decreasing towards the poles. This also applies in the case of atmospheric circulation in the gas layers of the giant outer planets. But whatever geological or atmospheric processes are involved there seems to be less activity at the equator or adjacent areas. The favoured zones appear to be some way towards the mid latitudes, typically at what seems to be a recurring latitude around twenty degrees north or south of the equator.

The Sunspot cycle, which varies over an average eleven year period, indicates the changing level of solar activity which in turn affects our own climate. Sunspots are never seen at the Sun's equator or within a few degrees of it. At the beginning of each cycle the smallest spots are seen to appear at the higher latitudes, around thirty to forty five degrees north or south of the equator. As the cycle progresses the active areas increase and migrate towards the equator, until at maximum they reach these apparently more favoured latitudes. What prevents the activity and sunspots from appearing at the equator itself?

It would be interesting if other examples were to be found on the surfaces of our solar system's planets or moons, to learn whether there is a definite pattern in these observations and the processes involved, or whether it is all just a rather remarkable coincidence.

Geoff Falla

Geese, the Moon and Noctilucent Clouds

With a lunar eclipse in prospect next January ***David Le Conte*** *recounts some odd behaviour during last January's lunar eclipse*

A few years ago my wife and I enjoyed a a remarkable sight at the Montrose Basin in Scotland, in the company of my wife's sister and her husband, who are avid bird watchers. It was the roosting of some 25,000 geese at dusk. They flew in in huge skeins from the fields all over that part of Scotland to gather on the safe waters of the Basin; there were so many that it took 45 minutes for them all to arrive. The sight was made even more dramatic by the almost full moon.

Now my brother-in-law, who is a member of the Scottish Wildlife Trust, has sent me an account of observations made by one of the Trust members, Karen Spalding, of the behaviour of the geese during the total lunar eclipse on the 21st January 2000. She says that because of the full moon there were very few geese on the Basin, as they were staying in the fields to feed. However, the eclipse caused a dramatic change in their behaviour, and hundreds flew back to the Basin when the moon was at its darkest.

He also sent me some photographs taken three days earlier, on the 18th January, of noctilucent clouds, which had been reported in the Scottish newspapers. I was surprised to note how bright they were, never having seen them myself. Noctilucent means "night-shining", and these rare, delicate, tenuous, blue-white and sometimes iridescent clouds are seen in twilight, when the Sun is between 6 and 16 degrees below the horizon, during the summer from high temperate latitudes, such as Scotlamd.

Noctilucent clouds occur at altitudes of about 85 km - five times higher than the highest normal clouds. It is believed that they are made of tiny particles of water vapour condensing on nuclei of meteoric and possibly volcanic origin. They may be mistaken for cirrostratus, but they are not visible during daylight. They are seen at night because, being so high, they are illuminated by the Sun when the rest of the sky is dark.

David Le Conte

IAU 2000

***David Le Conte** attended the International Astronomical Union conference at Manchester in August. Here is his diary of events.*

The General Assemblies of the International Astronomical Union are held every three years. The last one to be held in Britain was 30 years ago, and I therefore took the opportunity to attend the IAU GA2000 held in Manchester in August. Members of the Astronomy Section will recall the Royal Astronomical Society's National Astronomy Meeting, NAM99, which was held in Guernsey last year. In 2000, because of the IAU meeting, the RAS decided not to hold a NAM, but instead was heavily involved in the organisation of the major IAU meeting.

And major it was, with some 2000 delegates from 87 countries. Attendance is only open to IAU members and those invited to attend by the IAU. I attended as an invited participant, through the RAS.

The Conference was organised into 5 *Symposia*, 14 *Joint Discussions*, 3 *Invited Discourses*, plus *Posters*, various special meetings, 4 public lectures, several exhibitions, a concert, and the *General Assembly* itself. In all there were some 500 talks and 700 posters.

Although the conference lasted two weeks, I attended just the first week, arriving late on the Monday afternoon, and leaving on the Saturday afternoon. This is my diary of my experiences.

Day 1

By the time I arrived, the first days sessions were over, so all I could do was check in at the registration desk at the University, being handed an attractively large but very heavy brief case containing the conference program, abstracts of papers, and various other items of information. My digs were located about a mile and a half south of the University, in a hall of residence, so I just had time to get there, get cleaned up and changed after the lengthy 'plane and train journey from Guernsey, and head back to the University.

The first evening was marked by a reception held to launch the huge new Encyclopedia of Astronomy and Astrophysics. The large room was filled with people, but I managed to meet some old acquaintances, most of whom had attended NAM99, notably Heather Couper, Nigel Henbest, Iwan Williams, and John Lane. I also met Ken Phillips, who had not attended NAM, as he had been conducting an experiment in Bulgaria, taking rapid CCD images of the eclipsed Sun in order to determine a mechanism for the transfer of energy into the solar corona. Pam Spence, the President of the Federation of Astronomical Societies, also had a chat, and urged members of the Astronomy Section to attend the next FAS Convention, which, for the first time, is being held at the Rutherford Appleton Laboratory.

I also found myself unexpectedly being interviewed by Patrick Moore, who, with John Mason, was editing the daily conference newspaper. I was also interviewed by a Manchester newspaper reporter.

After a brief stroll around Manchester City Centre, I decided to have an early night, pausing only to send and receive emails, and to type up this report on my laptop.

Day 2

On my second day I decided to plunge into the deep end, by attending a session on cosmology. The two talks I heard were on two recent observational experiments to determine the cosmic microwave background (CMB): *Boomerang* and *Maxima*. The first, a balloon-borne telescope, flew in December 1998 for 10 days in Antarctica, and is due to fly again in one and a half years time. It is capable of determining differences in space temperature to 150 micro-Kelvins in one second. The similar Maxima telescope produced similar results from its first flight, and these two, together with other experiments, show that the large-scale structure of the universe is "flat", consistent with results from supernovae observations. Further observations are planned, with instrument development taking place at a rapid rate. It was pointed out that the sensitivity of detectors doubles every 11 months.

This implied that as much as 95% of the systems yet to be discovered may have planets like the Earth.

I then moved onto a session on extrasolar planets. The first talk, by Willy Benz of the University of Bern, was about planet migration as related to the development of planetary systems. Small planetesimals, up to about 10 metres diameter, will tend to drift into the parent star within 100 years. Large ones, including planets, can occupy stable orbits, but drift is possible, to the extent of 5 AU in just one million years. There is no evidence for a migration of Jupiter, but that Neptune had migrated. It was pointed out that the orbits of Pluto and the Kuiper belt objects are in a 3:2 resonance with that of Neptune. He concluded that about one-third of planets survive without falling into the star, and that about 30 planets formed for every 100 stars. Therefore about 10% of stars should have planets.

Shigiru Ida of the Tokyo Institute of Technology analysed the formation of the solar system, and extended his ideas to the formation of other such systems. He estimated that the mass of our system's disc was 0.02 solar masses, and that typical disc masses range from 0.01 to 0.1 solar masses. He said that planetesimals form in a ring-like structure, and he had modelled the formation of planets from such structures, assuming a wide variety of initial conditions. He concluded a massive disc would result in many gas giant planets, a medium disc would produce a planetary system like our solar system, and a light disc would produce many earth-like planets. This implied

that as much as 95% of the systems yet to be discovered may have planets like the Earth.

In the afternoon I took the opportunity of a tour to Jodrell Bank. Although I had visited the Observatory before, this was a behind-the-scenes tour. We were welcomed by Dr Phil Diamond, Director of the MERLIN and VLBI facility. Members may recall that MERLIN had a display at last year's NAM in Guernsey. MERLIN is a network of radio telescopes across Britain, giving the same resolution as the Hubble Space Telescope (HST). The European VLBI (Very Long-Base Interferometer) Network stretches all the way to China. Both are controlled by Jodrell Bank. We were shown the MERLIN/VLBI room, the Lovell Telescope control room, the Lovell observing room, the 25-metre MkII telescope, the 42-foot pulsar monitoring telescope, and, of course, the world-famous 250-foot Lovell Telescope.

The resolution of MERLIN is so good that they claim that it determines where the HST is pointing, and that they advised the HST researchers that a particular galactic source in the Hubble Deep Field had been incorrectly identified. They showed us a radio image of the M82 galaxy containing many supernova remnants not optically visible.

The control room gives a view of the enormous Lovell Telescope, while the observing room is where the incoming data from the telescopes is handled, including equipment used for the SETI (Search for Extraterrestrial Intelligence) programme. The Lovell telescope was not in operation, as it is having major upgrade work done to it. We did, however, see the data from the Crab Nebula pulsar coming in. and this was explained by Michael Kramer. The pulsar spins 33 times per second, and is slowing down as it loses energy. But every now and then it suddenly speeds up again, and one of these "glitches" had happened a few days previously. Every second the pulsar loses 1038 ergs of energy - enough to provide the entire energy needs of the Earth for a lifetime. The mechanism by which pulsars produce coherent radio emissions is not yet understood. The fastest pulsar known spins once every 1.5 milliseconds, and 1 millisecond is the theoretical limit for such a city-sized object to spin before it breaks up.

After tea in a marquee in the shadow of the great telescope, there was time for a short visit to the Jodrell Bank Science Centre, which has 140,000 visitors a year, including 50,000 children. I also took a stroll through the arboretum, which contains a solar system trail, with the planets indicated in accordance to their distance from the Sun.

Then it was time to return to Manchester, to attend an evening public lecture by Dr David Hughes on asteroids and comets, chaired by Patrick Moore. The lecture was a most entertaining one, with the lecturer starting off by challenging Don Yeomans of JPL, who was in the audience, over the latter's contention that comets and asteroids were essentially different manifestations of the same kind of object. Referring to the Titus-Bode Law, Dr Hughes said that not much attention had been paid to it until Uranus was discovered in the 18th century. The discovery made people think that perhaps there was something in the "Law" after all, and they started searching for an object between Mars and Jupiter, as predicted by the Law. So far about 10,000 asteroids have been discovered, but there are undoubtedly many more to be found. About three "great comets" appear per century; they have been traditionally associated with the "four Ds": Doom, Disease, Death and Disaster.

He emphasised the differences between comets and asteroids. The inclinations of the latter are typically about 8°, and their eccentricities are about 0.2. Therefore asteroids tend to hit each other. Depending on the mass of the asteroids and the impact of the collision, asteroids may be cratered, broken up and reassembled, or broken up and dispersed. Large objects, about 320 km across, have sufficient gravity to form spherical shapes, but smaller ones can be any shape. The dangers which asteroids pose to the Earth are very real. Asteroids create craters 28 times their own diameter. About every 700,000 years a crater 20 km across will be produced, and a crater of 20-30 km diameter would mean the end of civilisation. All asteroids larger than 120 km across can be detected, but only some of the smaller ones have been found. It has been estimated that there may be some 1000 million 1 km asteroids. It is believed that asteroids formed because Jupiter perturbed proto-planets into elliptic orbits, and they therefore collided and broke each other up. Just inside the orbit of Jupiter is an area designated as the "snow line" beyond which bodies tend to be icy (this term was widely used in discussions on the formation of extra-solar planetary systems as well as our own solar systems).

The dangers which asteroids pose to the Earth are very real

About 700 comets have been seen, and they are the remains of the building blocks of the solar system. Comet Halley has a size of 16 x 8 km, and loses about 2 metres depth of its surface, and has a life of about 2500 orbits left.

Day 3

On the morning of the third day I decided to attend sessions on solar physics. This included the presentation of several papers on solar dynamics, including one by Claire Parnell of the University of St Andrew's on "blinkers" which are small bright emission events whose origins are unknown. This was followed by a paper by Ken Dere of the US Naval Research Laboratory on coronal mass ejections observed by the SOHO spacecraft. Between 1996 and 1998 32 of these events had been observed (with the peak of the solar cycle many more have recently been seen). They are still not clearly understood, but clearly have a marked effect on the Earth, as evidenced by aurorae.

The afternoon was taken up by the Opening Ceremony and first session of the General Assembly of the IAU. This took place in Bridgewater Hall, Manchester's concert hall, and included musical performances on organ and

chamber orchestra. It was an impressive event with formal speeches, and the election of new countries to IAU membership.

In the evening there was a Reception hosted by the Lord Mayor at the Town Hall, a magnificent edifice built during Manchester's 19th century pre-eminence in the Industrial Revolution. I then visited Godlee Observatory, which is run by the Manchester Astronomical Society. This is a fine observatory, high on the main UMIST building, and is equipped with a giant 200 mm refractor and a 300 mm Newtonian reflector. The members (Guy Duckworth, President, Tony Cross and Bob Parkinson) were very welcoming, and extended a warm welcome to any of our Section members visiting Manchester. They meet on Thursdays, and from September to March have a talk on the third Thursday of the month.

If there are no leap seconds then UTC time would be off by 2 minutes within a century

Day 4

On day 4 I attended a session entitled "Models and Constants for Sub-Microarcsecond Astrometry", which discussed a number of proposals for improved reference frames as observational accuracies have increased from 100 milliarcseconds to better than one microarcsecond in the last 20 years. The group also considered the future of Coordinated Universal Time (UTC). Currently, UTC is kept within 0.9 seconds of UT1 by the insertion of "leap seconds", with the second defined in terms of the Ephemeris Second, which is based on the length of the tropical year 1900, which itself is based on 19th century astronomical observations. However, the Earth's rotation rate is decelerating, because of tidal effects and the change in the Earth's figure due to the melting of glaciers. Therefore, the frequency of leap seconds will inevitably increase, resulting in public annoyance, and possibly affecting communications and GIS navigation systems. If there are no leap seconds then UTC time would be off by 2 minutes within a century. Ideally, the insertion of leap seconds should be predictable well in advance, or preferably not at all. International Atomic Time (TAI) does not have leap seconds, but it is not very accessible. There is a number of options, including a redefinition of the second or an increase in the 0.9 second limit for the difference between UTC and UT1. The IAU will have to make a decision as to what to do, and agreed to set up a working party to prepare recommendations.

I was particularly interested in a solar physics paper presented by Ken Phillips of the Rutherford Appleton Laboratory on a possible mechanism for the heating of the solar corona by short-period (<10 sec) modulations. He carried out an experiment during the 1999 total eclipse in Bulgaria, and at one time we were envisaging that a collaborator at St Andrew's University would make related observations from our site in Alderney. In the event, the collaborator decided not to participate in it, but the observations with specialist equipment (SECIS - the

Solar Eclipse Coronal Imaging System) were successful, and the data is still being analysed. The instrument obtained 12,728 images in the 2 min 33 sec of totality, producing some 6.5 gigabytes of data! Ken said that when he first saw the floating prominence which marked this eclipse he thought it must be a flaw.

The sessions on extrasolar planetary systems were very popular, with packed halls containing over 300 people. There was a lot of papers on this subject, with many theories and observational methods being discussed. There is, so far, observational evidence for some 47 extrasolar planets, and the search is on for Earth-size planets. Indeed, it is accepted that recent observations of the diminution of star-light, interpreted as the transits of planets have proved their existence, as in the case of star HD209458. With about 400 stars within 10 parsecs of the Sun, it is expected that there might be 100 such planets.

planet searching is an accepted scientific priority

During the summary of this interesting session it was stated that planet searching is an accepted scientific priority. Both the public and the scientific response has so far been very good. It was felt that the technology should set the pace of exploration, but that an eye should be kept on the science. The planets so far discovered have generally high eccentricity, and are typically half Jupiter's mass, with an upper limit of about 10 Jupiter masses. There is a consensus, although no proof, that planets form in discs, and there are many images of gas discs with a radius of a few hundred astronomical units around young stars with ages from 106 to 107 years. It is noted that the chondrites found in meteorites are of a similar age. It was felt that the method of formation of planetary systems should be known in ten years.

In the evening a very lively lecture entitled "An Accelerating Universe? The Evidence from Supernovae" was given at Bridgewater Hall by Bob Kirshner of the Harvard Smithsonian Center for Astrophysics. He focused on Type I supernovae, which are believed to be exploding white dwarfs, possibly in a binary system (as opposed to Type II supernovae which are massive stars with a collapsing core). The true brightness of a Type I supernova can be found from its light curve, so its distance can be determined, and it can be used as a "standard candle". These supernovae occur about once per century per galaxy. However, they appear fainter than would be expected in a uniformly expanding universe, and this faintness can be explained if the expansion of the universe has accelerated.

Day 5

Day 5 was devoted to applied historical astronomy. About 100 people attended what was described as the first international meeting on this subject. It is the use of historical astronomical observations to solve real present day questions. An overview was given by F Richard Stephenson, who has used ancient eclipse records to deduce the rate of change of the Earth's rotation. He commented that such historical records

constituted the only positive contribution which astrology has made to world culture.

David Brown described Babylonian observations between the Tigris and the Euphrates. The earliest reference to a heavenly body was in the 3rd millennium BC and referred to the planet Venus.

Stephenson then spoke about East Asian observations. The earliest known reference to a solar eclipse was by the Chinese in 720 BC, and the earliest reference to a meteor shower was in 687 BC. Halley's Comet was first recorded in 240 BC: "Broom star at east, then north; seen for 16 days".

The earliest known reference to a solar eclipse was by the Chinese in 720 BC

In ancient times, with less population and light pollution, the stars were much more obvious, and people were, therefore, more familiar with them. There was also an intense interest in astronomy. The Chinese had 283 constellations, each with its own terrestrial counterpart. Ptolemy's catalogue had only 80 constellations, and there was little agreement with the Chinese versions, except for the Plough, Orion and Scorpio (which the Chinese called a dragon). The twelve signs of the zodiac are identified with Buddhism.

Wayne Orchiston of the Anglo-Australian Observatory spoke about historical observations in the southern hemisphere. Many of the artefacts left by ancient peoples present a problem of interpretation. For example, it is difficult to know if some rock art is intended to be astronomical. This gives people like Von Daniken free rein to publish unscientific conclusions.

Professor Ansari from India spoke about Indo-Persian sources, including references to eclipses and comets.

Mike Standish of Caltech dealt with the use of early planetary and lunar observations for the improvement of ephemerides. In an interesting talk, he referred to Galileo's observing notebook of 1612 which records the positions of Jupiter's moons, and in January 1613 Galileo actually observed Neptune near the star SAO 119234 in a line with Jupiter, and noted that it had moved the following night, but did not record it as a planet. However, current emphemerides show Neptune in a line with the star and Jupiter, but at a different distance, casting doubt on Galileo's scale (unless our ephemeris is wrong).

JM Brooke of the University of Manchester analysed historical sunspot records made by the Greenwich photoheliograph from 1874, and those by Carrington from 1853 to 1861, especially their change with solar latitude. He showed that multiplying the number of spots by the latitude gives a periodic cycle of 90 years, and he referred to a wave of the solar magnetic dynamo travelling at walking pace across the surface of the Sun.

Leslie Morrison gave an interesting talk about the Earth's rotation as deduced from ancient eclipse records. For example, a Babylonian record of 136 BC shows a 50° longitude displacement from that expected by a uniformly rotating Earth, equivalent to 3 hours in time. Many similar observations have been analysed, including, since 1620, timed lunar occultations. These show that the observed data of the last 2500 years cannot be explained by tidal friction alone.

Dennis McCarthy of the US Naval Observatory reported on the Earth's orientation since AD 1600. Since 1900 the Earth's pole has moved 3 seconds of arc. There is a significant non-tidal deceleration of the Earth's rotation, and the figure of the Earth has been changed by the redistribution of ice and other effects.

Don Yeomans of comet fame spoke about the use of ancient Chinese data to create cometary models, and Mark Bailey of Armagh Observatory spoke about three recent discoveries which have implications for our view of the solar system: the existence of large comets, near-Earth objects, and a better understanding of meteor streams. He said that a "new" giant comet arrives within Jupiter's orbit about once every 400 years, and about 1% of these get captured into short-period orbits. "Centaurs" are large comets orbiting between Saturn and Neptune, and about 23 are known. The source region for these comets is the Edgeworth-Kuiper belt, and about 300 objects in that belt have been observed. The first near-Earth object observed was Amor (1898), and many more are being found. Sun-grazing comets from the Kreutz family are now being discovered at the rate of about one per week, despite having orbital periods of between 400 and 800 years. Comet Halley itself can be expected to fall into the Sun in the next 100,000 years. He concluded that in a period of 10,000 years we can expect: 100 Tunguska-type objects, 25 Jupiter-crossing giant comets, 0.2 comets of the Halley type, 0.1 Jupiter-family giant comets, and 0.1 Earth-impinging objects! He surmised that the obsession which ancient societies had for events in the sky might be evidence of greater activity in prehistoric times.

Don Hoyt of Raytheon reported on historic sunspot records, having found some 100,000 more such observations than Rudolf Wolf (1874), by about 450 observers. David Hughes of the University of Sheffield associated long-period comet fluxes as an indicator of historic astronomical activity. Comets were recorded about every four years. His analysis showed that comets brighter than magnitude 2.5 had 100% chance of being seen, whereas those with a magnitude of 4 had only a 50% chance.

Historical observations of aurorae from 1101 onwards were discussed by David Willis of the University of Warwick. The first drawing of a sunspot was by John of Worcester on 8th December 1128, and an aurora was seen by the Koreans 5 days later. The last speaker was David Green of Cambridge, who spoke about remnants of historical supernovae, of which there are about 224 known.

A summary of the day's interesting discussions was made by Willy Sullivan. He noted that it was amazing to think that a scribe three millennia ago recording the fact that the Sun went dark, or observing a "broom star" could enable us now to work out the physics of the Earth's deceleration, tidal effects, core/mantle coupling, and the rotation of comets.

Day 6

On my final day, before catching my train, I dropped in briefly on a session about trans-Neptunian objects, and heard a couple of papers related to the currently hot topic of the formation of the solar system and other planetary systems. The conference was due to continue for a further week, and I was somewhat sorry to have to leave it in the middle. However, I reflected on the fact that I had experienced an intensive and stimulating week, in the company of the world's foremost astronomers, many of whom I had known only by their books and articles. The next such meeting will not take place until 2003, in Sydney, and who knows when another will be held in Britain. With hundreds of meetings taking place that week it was impossible to cover it all. I had learned a lot, but more than that had met many people and had seen a snapshot of everything that is considered important in modern-day astronomical research.

David Le Conte

Astronomy and Space - References for further reading

compiled by Geoff Falla

The Ring Nebula. A summary of what is currently known about the Ring Nebula - M57. The structure of this planetary nebula in the constellation Lyra is more complex than previously thought. *Sky and Telescope, July 2000*

Gamma Ray Research. The Compton Gamma Ray Observatory, launched in 1991, was due to end its mission in early June. Details of the obsrvatory's research achievements, with the mission observing a total of about 400 gamma ray sources. *Sky and Telescope, July 2000*

Last Meteorite of the 20th Century. A brilliant fireball was observed from all over Ireland on the night November 28th, 1999. Details of the recovery of fragments of the meteorite from around Leighlinbridge, Wexford. *Astronomy and Space, July 2000*

Constellation Scorpius. Details of some of the most interesting objects to be seen in this constellation low in the southern sky, including the red giant star Antares. *Astronomy and Space, July 2000*

Mars - Recent Discoveries. Discoveries made by the Mars Global Surveyor, including evidence of surface water flows, is changing the long-established view that Mars is a dead world. Evidence that active volcanoes and underground water have continued to exist into the recent past, which will further encourage the search for evidence of life on the planet. *Astronomy, July 2000*

The Universe - Just Six Numbers. The concept that the crucial recipe for the Universe, its expansion and the development of galaxies, stars and planets, is determined by just six numbers. The subject of a new book by Sir Martin Rees. *Astronomy, July 2000*

Mars - Missing the Mark. An analysis of the failure of several recent missions to Mars. The loss of the Climate Orbiter and Polar Lander spacecraft in 1999 is forcing NASA to rethink its policy for the future. *Astronomy, July 2000*

Dark Matter. It is estimated that much of the Universe consists of invisible dark matter. New imaging of distant galaxies and light distortion produced by gravitational effects is beginning to map the distribution of dark matter. *Astronomy Now, July 2000*

Mars in Focus. New photographs from Mars Global Surveyor. The north and south polar caps, an eclipse shadow produced by the Martian moon Phobos, and a topographical map of the planet. *Astronomy Now, July 2000*

Giant Telescopes. A survey of the world's largest telescopes - reflectors and refractors, progress on the new facilities in Chile and Hawaii, and the prospect of even larger telescopes in the future. *Sky and Telescope, August 2000*

Deep Sky Objects. A selection of one observer's deep sky objects, some well known favourites but others much less familiar to us. *Sky and Telescope, August 2000*

Mars - Recent Surface Changes. More detailed photographs indicating gullies formed by recent water flows, described by one science writer as "probably the most important thing ever discovered in our solar system". Also photos of small landslides discovered during the current mission. *Astronomy and Space, August 2000*

Unveiling the Flat Universe. The most detailed map yet of the cosmic microwave background using a balloon-borne experiment has established that the Universe is "flat". Results also support the idea that some "dark energy" is causing the Universe to expand at an increasing rate. *Astronomy, August 2000*

Rounding the Earth. The work of the ancient astronomers, including how the circumference of the Earth was measured, long before the epic voyage of Columbus. *Astronomy, August 2000*

A Century of Comets. The best comets of the 20th century, what is currently known about them and how some have come to an untimely end. *Astronomy, August 2000*

Solar Eclipse 2001 Preview. The next total solar eclipse is on solstice day, June 21st 2001. Details of the track, which crosses the south Atlantic and southern Africa, into the Indian Ocean. *Sky and Telescope, September 2000*