MERCURY

Newsletter of Stirling Astronomical Society

Vol. 15 No. 1 January 2001

THE ROYAL GREENWICH OBSERVATORY

On the l9th of May, 1999, the Chief Executive of the Institute of Physics unveiled a plaque at Herstmonceux Castle in Sussex to commemorate Richard van der Riet Woolley, the eleventh Astronomer Royal from 1956 to 1971. Up to Woolley's time the Astronomer Royal was the Director of the Observatory wherever it was sited, and Woolley was responsible for the removal of RGO from its original site at Greenwich to Herstmonceux Castle in 1958.

This accolade to Woolley has prompted some thoughts about the RGO in general. Established by Charles II in l675 at Greenwich, RGO's main purpose was originally to assist navigators to determine the longitude of ships at sea. The King appointed John Flamsteed as the first Astronomer Royal, a post he held from 1675 to 1719. RGO became a major Observatory, and in 1884 an International Conference fixed the meridian through Greenwich as the zero of longitude.

The tenth Astronomer Royal was Harold Spencer-Jones, who was Director of RGO from l933 to 1955. He was largely responsible for initiating the move to Herstmonceux, as by the 1950s observing at Greenwich had become very difficult. His rather sudden retirement in 1955 put Woolley in charge of the removal. Subsequently the Isaac Newton telescope, a 98 inch reflector, was installed at Herstmonceux. But in the 1970s a decision was made to move all major British observational work to the clear skies of La Palma in the Canaries, where there was already a large Observatory at an altitude of 7,900 ft. In 1990 the administrative offices for the new RGO were moved to the Institute of Astronomy at Cambridge University, where it was run to earth in 1992 by our Director of Observations. (see Mercury vol 7, No 3). Britain operates three telescopes at La Palma: the William Herschel which is a 160 inch altazimuth reflector, the Jacobus Kapteyn which is a 40 inch reflector for wide-field photography, and the Isaac Newton. Both Woolley and Spencer-Jones wrote books. *A Key to the Stars,* published in 1934, is a popular account by Woolley, especially for those "without mathematics or physics". In contrast, *General Astronomy* by Spencer-Jones, first edition l922, 2nd edition 1934, was written for a different readership. Both books are probably now out of print.

HS

BRITISH ROBOT TO LAND ON MARS. Beagle 2 will be the first British robot to land on another planet when it is planned to arrive on Mars in 2003. It is being built by a consortium led by Colin Pillinger of the Open University and will be delivered by Mars Express, a European spacecraft. Beagle 2 is designed to probe the Martian soil for possible signs of life, past or present, by testing for organic chemicals normally associated with life.

GHOSTS OF THE PAST

The 20th Century will be remembered as the time when knowledge and understanding of physics and astronomy developed at an unprecedented rate. Many people played a part in these developments, and some became famous for outstanding achievements which are described in textbooks the world over. Many of the most fundamental discoveries in physics took place in the early decades of the 20th Century, and it is interesting to look back at some of the famous names of those early years, to see what they were like as persons, and what stories lay behind their achievements. There are, of course, degrees of fame, and whilst the ultimate accolade may be a Nobel Prize, not to be awarded one may simply mean there are not enough to go round. Some of these famous names will be discussed in the next few issues, starting with:

J. J. THOMSON (1856-1940) was born in Manchester. On leaving school J.J. commenced a certificate course in Engineering at Owen's College, but he later changed to Mathematics and obtained a scholarship to Cambridge as a result. At Cambridge he obtained a first class degree in Mathematics and was placed second Wrangler in the order of merit. During his studies he was 'coached'? by Dr. Routh, noted for his 1822 treatise on Rigid Dynamics. After graduating in 1880, J.J. lectured in Mathematics until 1884, when he was appointed Cavendish Professor of Experimental Physics at Cambridge, following the resignation of Lord Raleigh. The appointment of a 'maths man' with little experience of practical physics reportedly caused surprise and agro amongst those who felt better qualified, but it turned out to be an inspired choice. His main line of research was the electrical conductivity of gases at reduced pressure, and he became famous for his part in the discovery of the electron. He demonstrated that 'cathode rays' could be deflected from a straight path by a transverse electric field, as if they were negatively charged particles having a ratio of charge to mass at least 1000 times greater than for the lightest particle then known. For this he was awarded a Nobel Prize for Physics in 1906.

J.J. had a son, George Paget, who in 1937 shared a Nobel Prize with the American Clinton Davisson for demonstrating that electrons could be deflected by a crystal lattice to form an interference pattern similar to that of hard X-rays, and so must behave as waves. It is ironic that his father, 40 years earlier, had demonstrated that electrons behave like particles. Just what J.J. said to G.P. is not recorded!

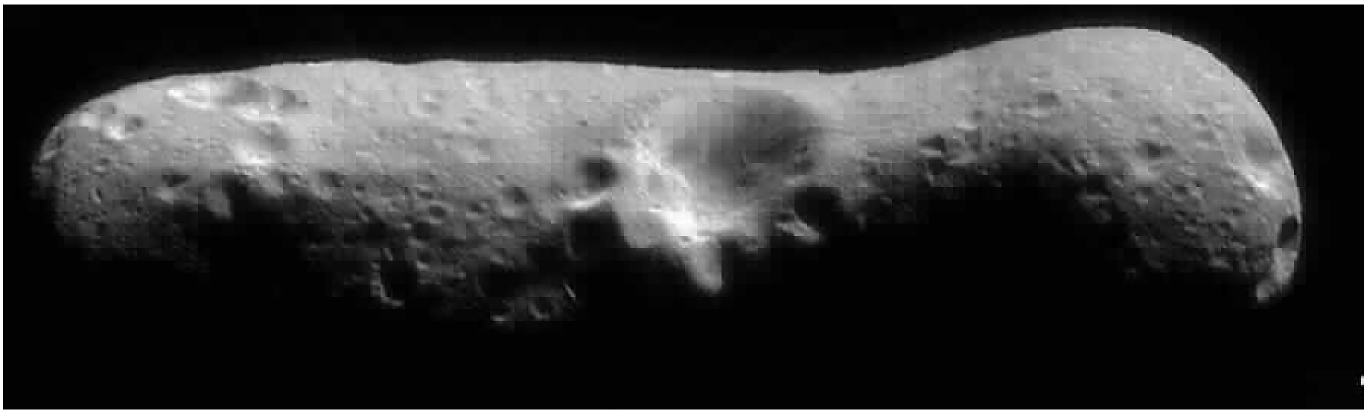
In his spare time J.J. wrote a book on " Application of Dynamics to Physics and Chemistry"?, lectured to the Royal Society on "The Dynamics of a Golf Ball" (l910), and accumulated 23 honorary degrees from various Universities. He retired as Professor in 1919 and became a very active elder statesman. in his later years. J.J. regularly attended physics meetings, and was present at a talk on "The Expansion of the Universe" given by Edwin Hubbell himself. Once, during some remarks on the discovery of Triton, a second isotope of hydrogen, by Oliphant and others in 1934, J.J., who first actually discovered that isotopes existed, commented that he thought. he himself had discovered Triton in 1910!

In his spare time J. J. wrote a book. on " Application of Dynamics to Physics and Chemistry", lectured to the Royal Society on "The Dynamics of a Golf Ball" (l910), and accumulated 23 honorary degrees from various Universities. He retired as Professor in 1919 and became a very active elder statesman. In his later years. J. J. regularly attended physics meeting, and was present at a talk on "The Expansion of the Universe" given by Edwin Hubble himself. Once, during some remarks on the discovery of triton, a second isotope of hydrogen, by Oliphant and others in 1934, J.J., who had originally first discovered isotopes, commented that he thought. he had discovered triton in 1910!

ERNST (later LORD) RUTHERFORD (1871-1937) was appointed Professor in succession to J.J. in 1919. Rutherford came to Cambridge from New Zealand on an 1851 Exhibition scholarship in 1893, and was one of J.J.'s early research students. When he returned to Cambridge as Professor after spells as Professor at McGill and Manchester, he was already a well-known experimentalist and had been awarded a Nobel Prize in 1908. This was, surprisingly, for Chemistry. The citation read "For investigations into the disintegration of elements and the chemistry of radioactive substances". In stature Rutherford was well-built, and sometimes spoke in loud voice, which could upset some of the delicate instruments in use, so that "Talk Softly Please" notices were the order of the day. He had a steam locomotive named after him, *Lord Rutherford of Nelson*, in honour of his opening the London Midland and Scottish research facility at Derby in 1935.

Rutherford also had a nickname, 'The Crocodile', bestowed on him by Peter Kapitza, a Russian colleague working on the production of very low temperatures and the liquefaction of helium. In Russian folklore a crocodile knows everything! Rutherford was behind Royal Society funding to build Kapitza a new laboratory, and to mark this, the outer brick wall was decorated with the outline of a crocodile! Kapitza himself was awarded a Nobel Prize in 1978.

HS



THE EROS ASTEROID. This picture of Eros, the first of an asteroid taken from an orbiting spacecraft, is a mosaic of four images obtained by the NEAR spacecraft on February 14, 2000, immediately after the spacecraft’s insertion into orbit around the asteroid. The view is down over the north pole of Eros at one of the largest craters on the surface - it measures 6 km across. Inside the crater walls are subtle variations in brightness that hint at some layering of the rock in which the crater formed. Narrow grooves that run parallel to the long axis of Eros cut through the south-eastern part of the crater rim. A house-sized boulder is present near the floor of the crater; which appears to have rolled down the bowl-shaped crater wall. A large number of boulders is also present on other parts of the asteroid’s surface. The whole surface of the asteroid is heavily cratered, indicating that Eros is relatively old.

Built and managed by The Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, NEAR was the first spacecraft to be launched in NASA's Discovery Program of low-cost, small-scale planetary missions.

WHAT ELSE IS THERE IN OUR SOLAR SYSTEM BACKYARD?

After Pluto was discovered in 1930 there was speculation about a tenth "Planet X". Uranus and Neptune, discovered in 1781 and 1846, seemed to have slight wobbles in their orbits around the Sun - were they being perturbed by the gravitational tugs of one or more large unseen planets? Pluto was too small to account for the wobbles - was there another Planet X causing them?

This speculation ended in 1992 after Voyager 2 had flown past Uranus in 1986 and then Neptune in 1989. Accurate radio tracking of how these two planets caused deviations in Voyager 2's path enabled space scientists to derive more accurate measurements of their masses. Previous values were found to be out by a few parts in a thousand, enough to make the apparent wobbles of these two planets disappear in the theoretical calculations.

But also in 1992 a new small planet was actually discovered beyond Pluto. All the larger planets are now thought to have been formed by the collision and amalgamation of smaller bodies. It is therefore not surprising for there to be residual smaller bodies farther out left over from this. Is Pluto the largest and brightest of these smaller bodies left over at the edge of the Solar System? In the early 1950s Kuiper suggested that there should be thousands of these bodies in a band at the edge of the Solar System - it was named the Kuiper Belt even before the first one was found. Now, only eight years since the first "trans-Neptunian object" was identified, the score stands at 288 minor planets known to be out there, and additional ones are being added to the list all the time. They are so far away that it takes light reflected from their surfaces several hours to reach us.

Pluto is quite a small planet - only 1500 miles in diameter. It has a moon Charon, discovered in 1978, about half its size. The known minor planets out there are thought to range from sixty to several hundred miles across, based on the sunlight they reflect. Their orbits are interesting - many have orbital periods that are simple multiples of Neptune's. They complete two orbits for every three of Neptune's, or three for every four, and so on. A similar effect ensures that Pluto and Neptune do not collide, although their orbits cross.

A different set of objects way out there is the Centaurs. The first, Chiron, was discovered in 1977 and many more have been sighted since then. Some show signs of cometary activity, such as releasing gas when their orbits come slightly closer to the Sun. Are these, and perhaps the minor planets as well, actually giant comets - large lumps of rock and ice - too far away from the Sun to be activated?

The Centaurs have orbits that can take them close to the outer major planets and can thus be affected gravitationally by them, if they do not actually collide with one. Their orbits are thus unstable, and one may occasionally fall into the inner Solar System, producing a really stupendous comet. The spectacular Hale-Bopp comet had a solid core only 25 miles across, compared with hundreds of miles for some of the Centaurs. There are old astronomical records that could be explained by a Centaur falling in this way.

With the aid of the new generation of large telescopes, astronomers are thus finding that the fringes of the Solar System are by no means almost empty, as was once thought. The task of finding out about what objects are actually out there, and how they coexist together, is still only in its early stages.

DHA

MAGNETIC FIELDS IN THE MIDDLE OF NOWHERE

Lines of magnetic force twist and wind through interstellar space and arch over millions of light-years of intergalactic space. Astronomers are now coming to realise that they are important shaping forces of the Universe. Even the enormous distances between clusters of galaxies are pervaded by magnetic fields of unknown power and origin.

In the past, magnetism has been generally neglected in astronomy because it is hard to measure and difficult to understand. As magnetic fields are totally invisible, their presence can only be inferred by such 'compasses' and 'iron filings' that nature has haphazardly provided, such as dust grains and charged particles. By aligning dust grains or diverting the paths of electrons, a magnetic field can cause the emission of polarised radio waves or skew the polarisation of light passing through a region of space, rather like a weak pair of polarising sunglasses.

In this way, we now know that the Milky Way has a magnetic field of about five microgauss directed along the its spiral arms. In comparison, the Earth's north-pointing field is about half a million microgauss. A galactic compass from Earth's position in the galaxy would point towards the constellation Cygnus. Other galaxies have been found to have similar magnetic fields.

Intergalactic magnetic fields are embedded in plasmas, and plasmas have been shown by X-ray telescopes to be less than a hundredth as dense in inter*galactic* space outwith galaxies as in inter*stellar* space within galaxies. It was quite a surprise to astronomers therefore, when it was announced in 1990 that data had been obtained showing that the intergallactic magnetic field in the interstices of the Coma cluster of galaxies is nearly as strong as the Milky Way's interstellar field. Since then twenty four other galaxy clusters have been found to have similar strength magnetic fields. These fields are likely to be significant factors in galaxy formation and other celestial occurrences.

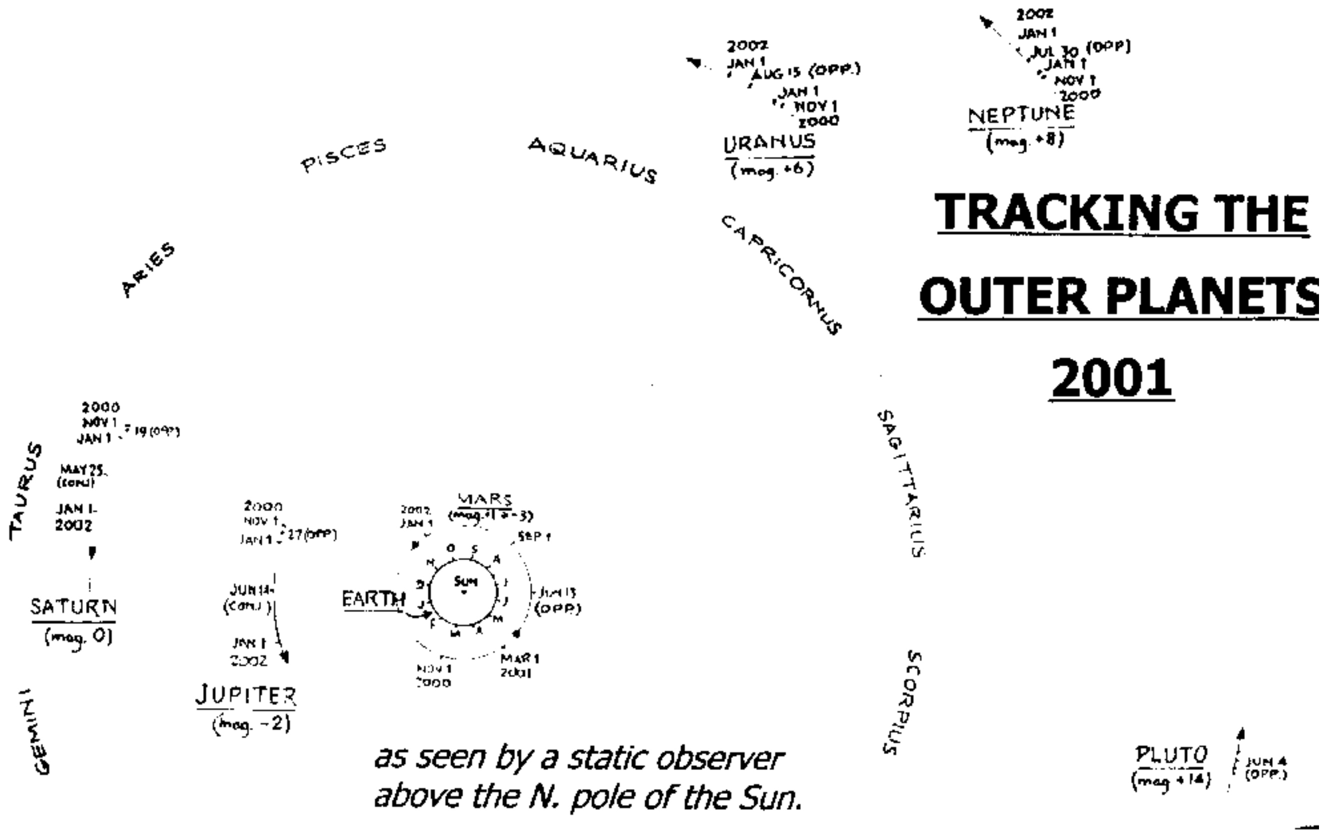
Using a special low-frequency radio receiver installed on the Very Large Array telescope at Sorocco, New Mexico, within the last two years magnetic fields of 0.01 to 0.1 microgauss have been discovered just outside the Coma galaxy cluster, and cannot at present be explained. For them to be formed, a galactic field must somehow be generated from scratch, amplified, ejected into intergalactic space and further amplified there. Ordinary galaxies would seem to lack the energy to magnetise the huge spaces between them. The best suggestion at present for an adequate energy source is super-massive black holes. Understanding both the causes and effects of cosmic magnetic fields is now a major challenge to

NEW PLANETS GALORE. The discovery of nine new planets outside the Solar System was announced at a recent meeting of the International Astronomical Union. This brings the total to at least fifty since the first one was discovered just over five years ago. One of the new planets orbits Epsilon Eridani which is only 10.5 light years from us. Two are low mass planets orbiting around the same star, thus forming another solar system. Previously only one other solar system besides ours was known, centred on Upsilon Andromedae. Other solar systems may very well be much more common than was previously thought.

OPPOSITION and **CONJUNCTION**

Outer planets move more slowly in their orbits around the Sun, compared with the Earth. From the Earth, we appear to overtake each of the planets in turn, on the date known as its **opposition** (marked OPP in the diagram). The planet is then due south at local midnight. Because Earth and planet are abreast but moving at different speeds, the planet appears to us to be moving *backwards* for a month or so. The planet traces a 'retrograde loop' against the starry background.

Six months later, the Earth is on the far side of the Sun from the planet - its **conjunction** *(*CONJ). A line from the Earth to the Sun extends to intersect the planet, which is concealed for a month or so in the Sun's glare.



WHEN AND WHERE TO LOOK FOR A SELECTED OUTER PLANET

a) During the three months or so around **opposition,** the planet is visible more or less all night.

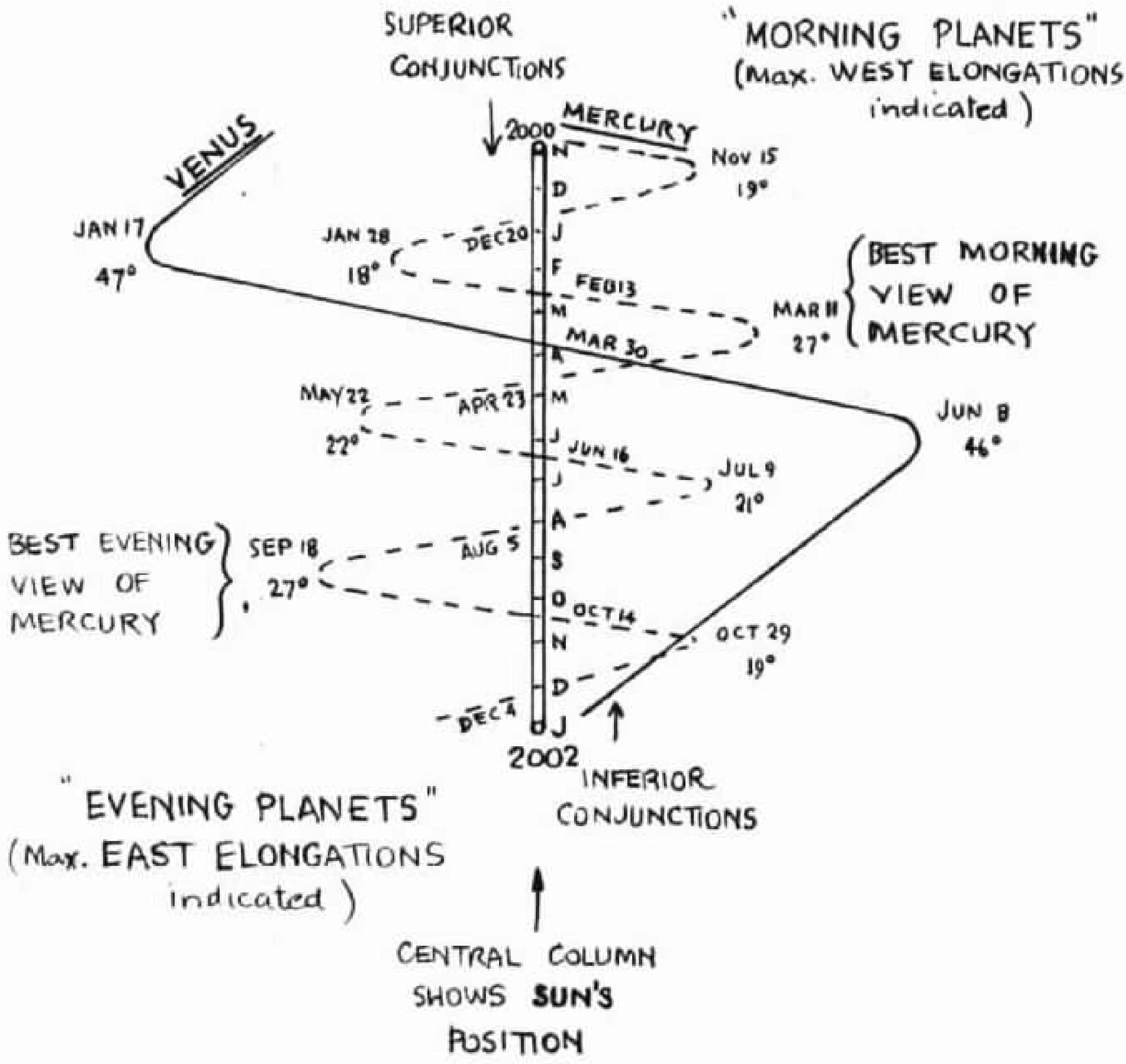
b) **Before conjunction**, it is an **evening** object, moving closer to the setting Sun, evening by evening.

c) **After conjunction**, it is a **morning** object, moving away from the rising Sun, mmorning by morning.

GALAXY MAPPING. One of the great challenges in cosmology is to unravel what happens at cosmic distances where matter goes from being clumpy on relatively small scales (atoms, planets, stars, galaxies, clusters of galaxies) to the comparative smoothness of very large scales beyond this. Now an ongoing galaxy mapping project has detected the transition, which begins to occur at a scale of about 300 million light-years. The arrangement of matter at scales beyond this reflects the overall density of the Universe. These findings come from an ongoing red shift survey which is a joint project between Edinburgh University and the Australian National University. They eventually intend to plot the positions of 250,000 galaxies in two slices of the sky, each about 75 degrees across, 8 to 15 degrees thick and 4 billion light-years deep, twice as deep as what has been attempted before.

MOTION OF MERCURY AND VENUS IN 2001

As seen from the moving Earth



SUPERIOR CONJUNCTION is the date on which the Planet passes BEHIND the Sun.

INFERIOR CONJUNCTION is the date on which the Planet passes in FRONT of Sun.

SUN	January		February		March	
Date	14	28	11	25	11	25
Rises (approx)	08.22	08.02	07.34	07.01	06.26	05.49
Sets (aprox)	15.56	16.25	16.55	17.26	17.55	18.24

MOON	January				February			
Phase	FQ	FM	LQ	NM	FQ	FM	LQ	NM
Date	2	9	16	24	1	8	15	23
Rises	11.58	15.25	00.00	08.25	10.50	17.02	01.33	07.42

PLANETS **Magnitude**

MERCURY

Jan.	In low SW sky, end of evening twilight. last 10 days	-0.9/0.0
Feb.	For 4 days only low in SW sky, then unsuitable for observation	0.1/0.9
Mar.	Unsuitable for observation	

VENUS

Jan.	Magnificent in low SW sky, early evening	0.4
Feb.	Magnificent in low SW sky, early evening	-4.6
Mar.	In low W evening sky; also low ENE sky, morning last 10 days	

MARS

Jan.	In SE sky, early morning, moving from Virgo into Libra	+1.2
Feb.	In SE sky, early morning, moving from Libra into Scorpio	+0.8
Mar.	In early morning, moving ino Orphiuchus	+0.5/-0.1

JUPITER

Jan.	In S sky until early hours of morning, in Taurus	-2.6
Feb.	In S sky until just after midnight, in Taurus	-2.4
Mar.	In SW sky until just before midnight, in Taurus	-2.2

SATURN

Jan.	In S sky until early hours of morning, in Taurus	0.0
Feb.	As January until end of month, then sets before midnight	+0.1
Mar.	Evenings for a short time after sunset	+0.2

CONJUNCTIONS (with Moon unless otherwise stated

January

Date	Time	
4	09.00	Earth at perihelion
6	02.00	Saturn, 2 deg.N
26	05.00	Mercury, 3 deg.N
28	20.00	Venus, 6 deg.N

February

Date	Time	
26	17.00	Venus, 10 deg.N

March

1	19.00	Saturn, 2 deg.N
2	10.00	Jupiter, 3 deg.N

CONSTELLATIONS (near meridian at 22.00)

1 January	**1 February**	**1 March**
Ursa Major Perseus	Draco Orion	Cephus Leo
Ursa Minor Triangulum	Camelopardus Canis Minor	Camelopardus Canis Minor

THE TEMPERATURE OF TIME. Some Indian scientists have managed to obtain an estimate for the temperature of the Universe when it was only 3 billion years old. They looked at the way light from a very distant quasar was absorbed by a cloud of gas that lay along the line of sight. This provided enough information for them to estimate the temperature of the Universe at the distance of the quasar. Since the light left the quasar some twelve billion years ago, this corresponds to the temperature at that time, when the Universe was only 3 billion years old, a fifth of its present age. Their temperature estimate is between 6 ^{0}K and 14 ^{0}K, that is, -267 ^{0}C to -259 ^{0}C. The Big Bang theory predicts that the temperature of the Universe at that time was about 9.1 ^{0}K, in close agreement. The present temperature of the Universe (of the background radiation) is 2.73 ^{0}K.

BLACK HOLES

Observations of quasars and other anomalously luminous galaxies have led to the conclusion that only super-massive black holes, with masses of millions or billions of Suns could power them. With the aid of the Hubble Space Telescope and the Very Long Baseline Array Radio Telescope, it has been shown that stars and interstellar gas clouds near the centre of many galaxies are moving abnormally fast under the influence of a colossal unseen body, which must be a super-massive black hole.

The count of super-massive black holes has now reached thirty four, and some interesting results have emerged. They appear not only in anomalously luminous galaxies, but also in some normal elliptical galaxies as well, including our own Milky Way. Completely flat galaxies seem to lack a black hole at their centre. The mass of each black hole turns out to be roughly proportional to the mass of its host elliptical galaxy, at about 0.15 percent of the galaxy's total mass. The mass of a black hole has also been found to be related to the average velocity of the stars in its elliptical galaxy, including those beyond its direct influence.

This raises the question of what came first, the black hole or the galaxy? Did the black hole come into being first and determine the mass of the galaxy forming around it, or did the galaxy form first and subsequently determine the size of its black hole? Or did they both form tat rthe same time? This puzzle is currently unanswered and is the subject of speculation and hypothesising by astronomers. It should be resolved in due course from further data obtained from other galaxies using the Hubble and the Chandra X-ray satellite, and from further information from ground-based telescopes about the black hole at the centre of the Milky Way.

DHA

EINSTEINS CONSTANT? It has been proposed that the speed of lightin a vacuum, the universal constant, c, be renamed Einsteins constant, in a similar way to Newtons constant of gravitation, g, and Plancks constant of quantum mechanics, $\hbar$. It is more fundamental than being just a property of light, as it comes into relationships between space and time and between matter and energy (E = mc2), and even into questions of cause and effect. Calling it Einsteins constant would also reduce confusion when discussing the optics of all other media in which light travels at lower speeds, such as in air, water and

UN-TWINKLING A STAR!

Anyone who looks up at the sky knows that stars usually twinkle. It is not the stars themselves that twinkle, but their light that is made to flicker and shimmer by its passage through the atmosphere. This effect is caused by a combination of turbulence in the atmosphere and changes in air density, temperature and humidity. These affect the speed of light differentially, and so cause it to continually bend in different ways, so producing the twinkling effect.

So however good a telescope is, this twinkling results in the image of a star being distorted. Astronomers go to great lengths with countermeasures to reduce this distortion. They build observatories in very dry places where the humidity is low, and at as high an altitude as possible where there is less atmosphere to contend with between the telescope and the star. The ultimate for this is of course the Hubble Space Telescope in orbit outside the Earth's atmosphere. However, the size of an orbiting telescope is limited by what can be launched into orbit, and by the enormous costs involved. This has led to a search for alternative solutions to the problem of twinkling stars.

Large telescopes use large mirrors which have to be made and maintained to an incredible degree of accuracy. Even tilting a large mirror to point to a different area of sky causes stresses which make it bend slightly, adding another factor of distortion to the image. One way to counteract this is to make the mirror very thick and hence more rigid, and also of course heavier. As astronomers demanded larger and larger telescopes this solution became impracticable and a fresh approach was needed. In the latest large telescopes the mirror is supported by hundreds of small pistons, known as actuators. Varying the pressure on selected pistons changes the shape of the mirror by small amounts. The aim is to cancel out the effect of the mirror bending, and this has proved to be very successful in avoiding image distortion from this cause.

A similar approach is now being applied to the atmospheric twinkling problem, in developing an optical system, known as adaptive optics, which can counteract atmospheric distortion. The performance required is formidable. Twinkling is rapid and continuous and so an optical system to counteract it needs to be able to flex in response many times a second to keep the image steady. As well as the speed of reaction, there is also the matter of the extent of each reaction, i.e. knowing just what varying correction is needed all the time.

To measure what atmospheric distortion is occurring, a reference or guide star is needed near the actual star (or other celestial object) being viewed. Knowing the guide star's undistorted real appearance, this can be compared with its viewed distorted image to work out what distortions are occurring and what is needed to correct them. These corrections are then applied to the distorted image of the actual star being viewed. All this of course requires a lot of very fast computer power but the main limitation is not this, but the frequent lack of suitable familiar, bright guide stars. Because atmospheric distorting conditions vary across the sky (stars do not twinkle in unison!) the guide star has to be close to the viewed star. For adaptive optics to be effective, only about one percent of the sky area is close enough to a suitable guide star for a viewed star to be in.

An answer to this has now been found. Create an artificial guide star in exactly the right place for every observation! The Lawrence Livermore National Laboratory in the USA has installed laser equipment at the Lick Observatory in California, with the laser tuned to a wavelength of 589 nanometres, which is a wavelength at which sodium atoms are stimulated to emit light. It so happens that sodium atoms occur throughout the upper layers of the Earth's atmosphere. This means that when the laser beam is pointed at the sky close the real star to be observed, sodium atoms in its path emit light vigorously and shine like an artificial guide star about sixty miles above the Earth's surface. It is sufficiently bright to be seen by the naked eye and can be placed wherever it is needed, and so brings all the sky within range of using adaptive optics to eliminate twinkling.

So far the resulting reduction in image distortion has enabled the resolution of the Lick telescope to be at least doubled by using this technique, and further development is hoped to achieve resolutions comparable to that of the Hubble telescope. A much more ambitious telescope using this technique is being planned. The Lick telescope has a three metre mirror, but the new telescope will have an eight metre mirror and a computer fifteen times faster than the Lick's, and it will use a constellation of three artificial guide stars to give it a much wider field of view. If this succeeds, even larger telescopes are expected to follow, as the main constraint on their workable size will have been removed.

As far as astronomers are concerned, Mozart's first musical composition at the age of five, "Twinkle, twinkle, little star", will no longer apply!

DHA

Stirling Astronomical Society

OFFICERS AND COMMITTEE FOR 2001

President	Harry Stout
Chairman	Douglas Cooper
Secretary	Hamish MacPhee
Treasurer	Iain Smith
Director of Observations	Ken Mackay
Membership Secretary	Albert MacKenzie
Librarian	Maurice Dixon
Committee Members	Terry Aitchison
	Alan Cayless

REMAINING PROGRAMME, 2000-2001

12 January	Mapping the nearest stars - Dr John Cooke
27 January	Members' evening
9 February	(Title to be announced) - Dr Andy Longmore
23 February	Members' evening
9 March	The Universe might need to be replaced - Dr Alan Heavens
23 March	Members' evening
13 April	The waltzing Universe - Dr Mark Casali
23 April	Members' evening
18 May	A tour of the Universe through X-rays - Dr Omar Almaini
25 May	Members' evening

Lectures are held at the Smith Museum, Dumbarton Road, and Members' Evenings at the Mayfield Centre, St Ninians. Both start at 7.30 p.m.

WANTED!!

Contributions to ***Mercury*** from members, for members, and about what members are doing!

Such as -

- Articles
- Reports of meetings
- Observations (astronomical and verbal!)
- Telescope activity
- Comments
- Interesting information

Please send your contributions to (or first discuss them with)

either:-

Derek Allen, 1 Ogilvie Road, Stirling FK8 2HK

Tel: 01786 472771 E-mail:derek.allen@btinternet.com

or:-

Harry Stout, 17 Anderson Road, Dunblane FK15 9AJ