GNOMON

Newsletter of the Association for Astronomy Education

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This issue of 'Gnomon' has been sponsored by The Royal Astronomical Society

This enables the newsletter of the Astronomical Society of the Pacific, 'The Universe in the Classroom', to be included as pages 5-8 of this issue.

EDITORIAL COMMENT

The Old Royal Observatory (ORO) at Greenwich has been completely refurbished. Rain water penetrating the old lead roof was endangering the original 17th century plaster ceiling of the Octagon Room: this has been repaired and its appearance is now close to the original, the work having been carried out in consultation with English Heritage. Other parts of the Observatory have also been repaired, including the famous Greenwich Time Ball on the east tower of Flamsteed House. The restoration of Flamsteed House is now complete, the works having cost over £1. million.

On the administrative side there is a new ticket area in the Meridian Building, public WCs in vaults below the main courtyard, and facilities for the disabled (for the first time at the ORO). This brings the total cost of the operation to £2.million. Substantial grants were provided by the Museum and Galleries Improvement Fund and the Wolfson Foundation.

Virtually a brand new museum has been created: there are sixteen new galleries showing Man's progress in mapping space and time. A small "static" planetarium in one of the galleries provides an overview of the heavens. Other highlights are a new presentation of the Meridian Line, a giant *Accurist*-sponsored digital clock showing Greenwich Mean Time to the nearest one-hundredth of a second, hands-on science stations for children explaining the principles of astronomy and navigation using video and computer technology, a new Time Gallery and, in the Telescope Dome, the largest refracting telescope in the UK.

The highlight of a tour of the ORO (or so it seems to me) is the Harrison Room, housing the final version (and earlier designs) of his famous chronometer which enabled longitude at sea to be accurately determined. This special exhibition has been sponsored by *The Economist*.

* * *

A visit to the ORO is a must for anyone with the slightest interest in astronomy, and I would certainly advise AAE members to "make the pilgrimage". With children, this could be a family day out (fine weather would help). For those not familiar with the capital, I would suggest a four-mile river trip from Tower Bridge, but there are other routes. I found car parking easy in Greenwich Park just outside the Observatory, but this was on a weekday.

Further information about the ORO can be obtained by telephoning 081-858 4422

* * *

The great debate on the controversial issue of GMT and time zones has raised its head once again. An article by Dr. Fiona Vincent on this subject is published in this issue: there have been calls for a single unified time zone for the whole of Europe. What seemed ludicrous to me, on a visit to northern Spain, at a longitude *west* of zero, was to be obliged to put my watch *forward* by one hour, when *back* one hour is the logical direction!

NEW AAE COUNCIL ELECTED ON 15th MAY 1993

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Assistant Secretaries: Teresa Grafton (Minutes); Nik Steggall (Publications)
Treasurer and Membership Secretary: Bob Kibble
Resource Centre Representatives: Teresa Chilton, Alec Bowden, Ian Griffin
Members: Alan Pickwick, Tony Lacey, Steve Tidey, Jo Reale

CHARITABLE STATUS: *The Annual General Meeting on 15th May decided that the Association should seek charitable status. An approach to the Charity Commissioners will now be made.*

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0-10.....£1.00 per copy
11-50.....£0.75 per copy
51- .....£0.50 per copy

Back numbers, not less than one year old, half these prices.

There will generally be a 10% discount to AAE members on all publications and advertising rates.

Practising teachers may claim their subscriptions as an allowance against income tax, thereby effectively reducing their contributions.

Addresses for Correspondence:

Secretary: Eva Hans, The Planetarium, South Tyneside College, St. George's Avenue, South Shields, Tyne and Wear NE34 6ET - for all general enquiries. (Tel: 091 4560403, ext. 477)

Treasurer and Membership Secretary: Bob Kibble, 34 Acland Crescent, Denmark Hill, London SE5 8EQ (Tel: 071-274 0530) - for all financial and subscription enquiries.

Editor: Eric Zucker, 35 Gundreda Road, Lewes, East Sussex BN7 1PT - for all enquiries concerning the Newsletter. (Tel 0273 474347)

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* These may be of any size which may conveniently be inserted into the newsletter. There may also be an additional charge for posting if the inserts are heavy.

The prices are for *one* issue.
A 25% reduction is made for advertising in all four issues.

MUCKING ABOUT WITH THE CLOCKS

by Dr. Fiona Vincent, Mills Observatory, Dundee.

Early this year an old argument re-surfaced. Should we in Britain keep to Greenwich Mean Time (GMT), or should we switch to Central European Time (CET) and keep our clocks one hour fast?

The "Daylight Extra" Campaign wants us to go European. There seem to be two main planks to their argument. Putting the clocks forward would give us more daylight in the evenings, thus reducing accidents in the evening rush-hour. It would also simplify dealings with businesses elsewhere in the continent of Europe.

There are, of course, counter-arguments. More light in the evenings means more darkness in the mornings - and commuters tend to be in more of a hurry in the mornings. Some of us remember when the Government experimented with "continuous Summer Time" for three years in the 1960's. During this period, statistics show that child casualties doubled in the 7-8am period; interestingly, there was also a slight increase between 6-7pm!

The European argument also has flaws. At present three countries in the European Community use GMT as their basic time-system (Ireland, Portugal and the UK). Most of the others keep CET - that is, GMT plus one hour. But Greece is ahead by yet another hour; so also are Turkey and various East European countries, which are in the queue to join the EC. So Europe already uses three time-zones. Mainland America has four, and seems to find it no drawback. More relevant are the different working-practices in the different countries: try phoning a Frenchman at lunchtime!

The truth is, there is a "natural" time-system for each country to keep: that system where 12 noon occurs when the Sun is more or less due south. The Sun is not actually a very good time-keeper; owing to the ellipticity of the Earth's orbit, among other effects, the Sun may be about 15 minutes "early" or "late" on different dates throughout the year. Averaging out these variations gives us Local Mean Time for any given place.

GMT - Greenwich Mean Time - is only strictly correct for places with the same longitude as Greenwich. In East Anglia, Local Mean Time is nearly ten minutes ahead of GMT; in Northern Ireland and the Western Isles of Scotland, Local Mean Time is half an hour behind GMT. But GMT is close enough to being the "natural" time for all of Britain. In the same way, CET is the "natural" time for countries further east like Denmark, Germany or Italy.

Having the Sun due south at 12 noon means that the hours of daylight are divided equally between morning and afternoon. In summer, when the days are long, many people waste the daylight in the early morning. We have therefore got into the habit of putting the clocks forward in summer: if effect, we steal an hour from the morning, and add it to the evening when more people are prepared to make use of it. This is the reason for British Summer Time, or BST (B****y Silly Time). It's a nuisance for everyone to have to change their clocks twice a year, and it's irritating for astronomers who have to subtract the hour in order to find out what's happening in the sky. But it's a fairly harmless diversion.

In winter, things are very different. There is only a limited quantity of daylight available - especially in the north of the country. On Midwinter's Day, the Sun is above the horizon for 7½ hours in London, for just over 6½ hours in Edinburgh, and for only 5½ hours in Shetland. If we depart from GMT, are we really making the best use of that very limited daylight?

It's not just school-children who are put at risk by extra darkness in the mornings. Builders traditionally start early in the mornings, so there is one powerful lobby in favour of the status quo. Much of a farmer's work has to be done early in the mornings, so the agricultural industry is also against any changes.

It's all right for a southern country like France or Spain to keep a time which is one hour later than "natural"; they have plenty of daylight, even at midwinter. We northerners have to be more careful. Of all the Scandinavian countries, only Iceland keeps anything other than "natural" time. I have heard suggestions that, even if England gives in to "Daylight Extra" pressure, Scotland should retain GMT!

Even for the English, is there not an emotional argument here too? "No instrument should be made to lie," wrote A. P. Herbert many years ago, "especially not the great Clock of Westminster or the great Bell, Big Ben, which it governs." Are we in Britain to abandon Greenwich Mean Time, the fundamental basis for all time-systems around the world? Are we to leave it in the keeping of the Irish and the Portuguese?

Time - as they say - will tell.

CAMBRIDGE INNOVATIVE PRODUCTS LIMITED

"OUR PLANET IN MOTION"

THE CAMBRIDGE ORRERY

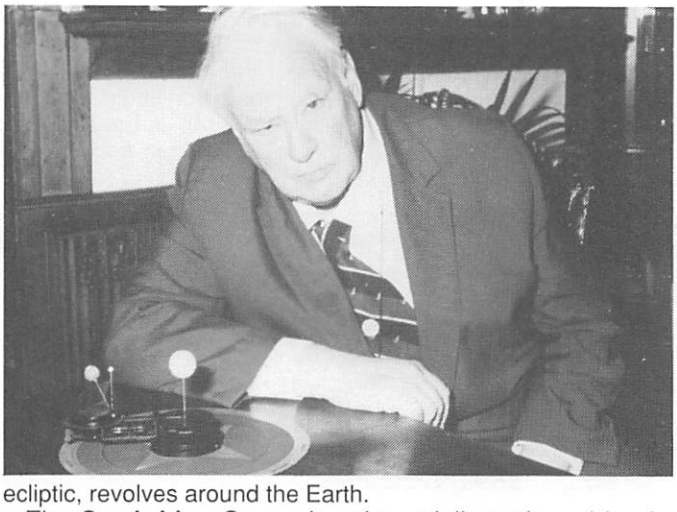
Practical astronomy has moved forward considerably with the launch of 'The Cambridge Orrery' which explains the mysteries of the Earth in Space.

The **Cambridge Orrery** is the **world's first affordable model** which demonstrates the rotation of the Earth on its axis and the orbits of the Earth and Moon around the Sun. Orreries are named after the Earl of Orrery who had the first one built in 1712.

This patented three dimensional model, which can be operated manually or by clockwork, explains with the greatest clarity a host of fascinating facts about our home in space, including:

* the orbits of the Earth and Moon
* the Earth's rotation
* day and night
* the seasons
* phases of the Moon
* eclipses of the Sun and Moon
* the ocean tides
* solstices and equinoxes
* the constellations

The Orrery is 10 inches in diameter and comprises a base disc marked with months of the year, constellations of the Zodiac, solstices and equinoxes and, above this, the main mechanism showing three bodies, the Sun, the Moon, and the Earth. The Earth spins on its correctly inclined axis and orbits the Sun while the Moon, with its orbit correctly inclined to the



ecliptic, revolves around the Earth.

The **Cambridge Orrery** is substantially endorsed by the famous astronomer **Patrick Moore** who has produced a companion book and audio cassette to accompany the product. The book is illustrated by Paul Doherty, the famous astronomy

artist. A special 'Two-for-the-Price-of-One' offer is included with the **Cambridge Orrery** which allows the purchaser a reduction on the price of admission to **The London Planetarium**. This takes the form of a coupon printed on the packaging.

The **Cambridge Orrery** will appeal to a wide audience of all ages, but is particularly aimed at education. For parents and children alike, the scale of the universe makes the subject difficult to comprehend. Every child in Britain will undertake a project on astronomy at some point in their education. A study of the Earth in Space is now part of the National Curriculum and Astronomy is also a GCSE subject. Patrick Moore's eminently readable book and the audio tape have been produced with these requirements in mind.

Schools have reacted positively to the Orrery and so will parents who want to help their children learn. Pieter Morpurgo, Producer of the BBC's 'The Sky at Night' programme, says **"It meets a long-standing need for a practical, affordable, introduction to some of the key elements of astronomy".**

Patrick Moore comments **"This is highly educational as well as entertaining. Its principal benefit is that it really shows how our Solar System works."**

The retail price is £24.95 inc. VAT with special discounts being available for educational institutions. AAE members will be given a 10% discount: please give your membership number when ordering.

For further information about "Our Planet In Motion" please contact either Michael Norton (marketing) or Keith Dunning (technical) on 0480 460080 or fax 0480 301254

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ASTRONOMY EDUCATION QUESTIONNAIRE UPDATE

Out of the 58 replies received; 67% of societies have given talks to schools during the last 12 months. The number of talks given varies quite substantially from just 1 to over 40. Some societies have close links with a more formal educational forum (planetarium, museum, exhibition centre) and these give talks on a regular and frequent basis. Taking just the societies without these facilities, there is a strong bias towards contact with primary rather than secondary level children: 84% gave talks to primary schools, 20% to secondary. Many societies add that they give talks to cubs, brownies, scouts and guides. This is important, an area of education that societies can become involved in, but the questionnaire was more concerned with societies' involvement in schools.

43% of the societies who returned the questionnaire have arranged viewing sessions for children, again more for the primary age than older. A heartfelt comment was the difficulty in arranging these sessions because of the weather.

Only 19% of the societies have given talks to teacher groups, though a few societies have responded to individual teachers who made the initial contact. 64% of the societies have supplied information/help to schools: some loan telescopes and produce information packs, while others just answer individual inquiries.

Out of the societies that have had some contact with schools during the last 12 months, 45% indicate it was the schools initiating the contact, 31% say their society made the first move and 24% say it was a bit of both.

Only 6 societies out of the 58 replies said they had had no contact with schools at all. The main reason given was they had not been approached, though 2 societies indicate that lack of time and lack of resources is also a factor, 3 societies out of the 58 do not want to further their commitment to schools: 1 already does a great deal, 1 has a limited contact but says they cannot afford more time and 1 says education should remain the domain of teachers.

Only 7 societies circulate their newsletters to schools, 2 in a very limited way. The main reasons for not doing so are the expense and having no newsletter in the first place(!): 3 societies indicate that sending schools their newsletters is a good idea and will consider it for the future, 2 societies write that they have "mail shotted" local schools but have elicited little or no response.

Most societies would like some help. 74% responded that they would like ideas for talks/demonstrations to give to schools and accounts/examples of what other societies are doing in this field. 69% would like an overview of astronomy in the National Curriculum. Other help requested includes slides, visual aids, handouts, cheap posters to sell, demonstration models, ideas of how to approach schools and funds.

71% of the societies have members who are (or were) teachers, but this does not appear to affect how active the society is with schools. On several forms there are wry comments that these teachers are too disillusioned/tired/overworked to want to be involved with astronomy as an extra curriculum activity.

Finally, all the societies had heard of the FAS, but 20 (34%) had not heard of the AAE.

In conclusion, the overall impression I have from the response to the questionnaire is that many societies would welcome some help. Individuals within the many societies are doing as much as their personal circumstances can allow; often they feel they are working in a vacuum, so it is important that they are given some support, even if it is only contact with like-minded people. There is certainly some scope for the FAS and AAE to assist the societies in their endeavours; perhaps by producing straightforward guidelines as to what is required in astronomy by the National Curriculum, suggesting some ideas for talks and producing some aids for these talks.

Pam Spence.

FOR THE NEWCOMER

Light from a star has to pass through the Earth's atmosphere before it is observed at the Earth's surface. The

ATMOSPHERIC EXTINCTION

atmosphere absorbs some of the starlight, and so the star appears dimmer than it really is. This effect is called atmospheric extinction.

PLANETARIUM VACANCY

There is a one-year internship coming up at the Buehler Planetarium at Davie, South Florida. This is a 12 metre / 93 seat Zeiss Planetarium plus 5 metre Goto plus Starlab. The internship starts on 1st July 1993 for 12 months. Salary US $16,000. Requirements are a BSc in Astronomy or Physics or related science plus 2 years Planetarium Administration experience.

If you are interested, please contact:
Dr David Menke, Buehler Planetarium, Broward Community College, 3501 SW Davie Road, Davie, Florida 33314, USA
Sending him your resumé (CV).

Undine Concannon
Planetarium Adminstrator,
The London Planetarium

SPACE - LINK

This feature is provided by Nik Steggall

RUSSIAN COSMONAUT VISITS BRITAIN

DURING December 1992, the second National Astronomy and Spaceflight Show was held at the Town Hall, Sutton Coldfield near Birmingham. The AAE attended this show with a stand showing the activities and publications of the association. Both the show itself and the AAE stand were well attended. The added bonus to the show was the attendance of pilot cosmonaut Mikhail Lisun who brought with him a selection of space food and spacesuits for display. Mikhail was also on the stand of the AAE supporting the aims of the association.

In the evening Mikhail gave a talk on the cosmonauts corps, his life as a cosmonaut and spaceflight in Russia and the former Soviet Union.

WHAT IS MICROGRAVITY?

MICROGRAVITY investigations have been conducted on many space missions over the years. But in the early days of spaceflight other terms were used to describe the environment of spaceflight. Common terms included zero g (zero gravity) and weightlessness. Unfortunately, both terms were misleading. Zero g implies that gravity goes away in Earth orbit and weightlessness implies the weight disappears. On the contrary, gravity is still present in Earth's orbit. In a typical Space Shuttle orbit, gravity is the gravitational pull of Earth and is still more than 90% of the pull at the Earth's surface. Weight doesn't go away in orbit, but the ability to measure it does.

The term microgravity (μg) can be interpreted in a number of ways depending upon context. The prefix micro (μ) is derived from the original Greek mikros, meaning "small". Another common usage of micro is found in quantitative systems of measurement, such as the metric system, where micro means one part in a million. Earth creates a gravitational field that acts to attract an object with a force inversely proportional to the square of the distance between the centre of the object (spacecraft etc) and the centre of the Earth. When measured on the surface of the Earth, the acceleration of an object acted upon only by Earth's gravity is commonly referred to as one g or one Earth gravity. Microgravity is an acceleration environment that is small when compared to the acceleration of gravity at the Earth's surface.

Microgravity is created in two ways. One is to travel away from the Earth because gravitational pull diminishes with distance. For example, to reach a point where the Earth's gravitational pull is reduced to one-millionth of that of the surface, you would have to travel into space a distance of 6.37 million kilometres from the Earth (almost 17 times further away than the Moon). No humans have yet travelled further away from the Earth than the distance of the Moon, so this approach is impractical except for automated spacecraft. However, a more practical microgravity environment can be created through the act of free fall.

We will use a simple example to illustrate how free-fall can achieve microgravity. Imagine riding in a lift to the top floor of a very tall building. At the top, the cables supporting the lift break, causing the lift and you to fall to the ground. (In this example we discount the effects of air friction on the falling lift.) Since you and the lift are falling together, you will float inside the lift. In other words, you and the lift are accelerating downwards at the same rate. If a scale was present, your weight would not register because the scale would be falling too.

WHY INVESTIGATE MICROGRAVITY?

SO why investigate the microgravity environment. During 1992 and 1993, a number of Spacelab mission's have flown aboard the Space Shuttle conducting investigations into the living processes and the fundamental states of matter such as solids, liquids and gases and the forces that affect them in microgravity. Such investigations are important because gravity is a dominant factor in the living, chemical and physical processes on Earth.

Many basic processes are influenced by gravity. If gravity's effects could be eliminated, how would liquids of unequal densities mix? Could new alloys be formed? Could large crystals with precisely controlled crystalline and chemical perfection grow? What would happen to the flame of a candle? How will growing plants orient themselves? What will happen to fluid distribution in the bodies of animals? There are many theories and experiments that predict the answers to these questions but the only way to answer and fully understand them as well as a host of others is to eliminate gravity as a factor of effectivity.

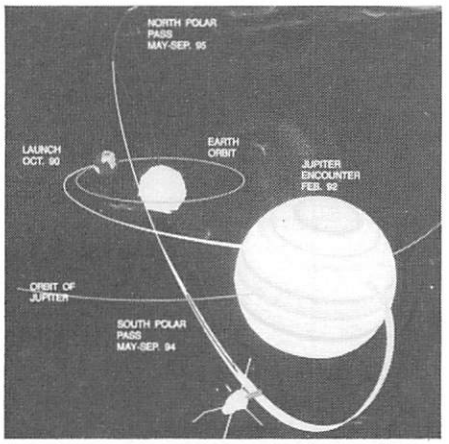
ULYSSES: PROGRESS REPORT

ESA's Ulysses spacecraft was launched by the US Space Shuttle Discovery on October 6, 1990. It became the first spacecraft to explore and circumnavigate the poles of the Sun. In February 1992, Ulysses approached Jupiter and used the gravitational pull of the giant planet to swing itself out of the ecliptic plane. The ecliptic plane is the imaginary 'disc' in which all the planets of the Solar System orbit around the Sun.

Ulysses is now more than 4.9 astronomical units (735 million km) from the Sun and 20 degrees south of the ecliptic plane on its way to fly over the south polar region of the Sun between May and September next year. One year later, in September 1995, Ulysses will have passed over the north pole of the Sun completing its nearly 5-year long journey over the unknown.

Cosmonaut Mikhail at the Batley and Spenborough Astronomical Society, with 11-year-old Joanne Tonge, the daughter of a member.

BOOK REVIEW



Path of Ulysses: the solar polar probe (European Space Agency).

Reproduced by kind permission of the author.

The Sky at Night 10, by Patrick Moore, published by John Wiley & Sons, 1992, ISBN 0-471-93763-0, 200 pp, £9.95 paperback.

You can't go wrong with any book by Patrick Moore, and the latest, based on the BBC series, is no exception. This one covers developments in astronomy over the last four years. Patrick Moore has visited most of the world's most important observatories and space stations over this period, and this book contains accounts of the work going on there.

This book is not a textbook, nor is it necessarily to be read sequentially from cover to cover. It consists of a series of accounts of BBC Sky at Night programmes in chronological order from 1988 till 1992. The 36 chapters include items such as: the geology of Mars, the novice observer, radio stars, problems with Pluto, Voyager 2, Daylight Star, 200 years at the Armagh Observatory, Rosat, cosmic ray astronomy, Saturn's white spot, Hubble, the ghost planet, among the asteroids.

I always look for the index when reviewing a book of this type, as this enables a snap judgement of its appeal to be made. This book is no exception to the category of "good indexes", as this one runs to four pages and has about 500 entries.

It is a joy to flick over the pages and to notice that there is a photograph on almost every page; it is difficult to put the book down once you start reading. The photograph above, taken from the chapter headed "Target Jupiter", shows the path of the Ulysses solar probe from its launch in 1990 until 1995.

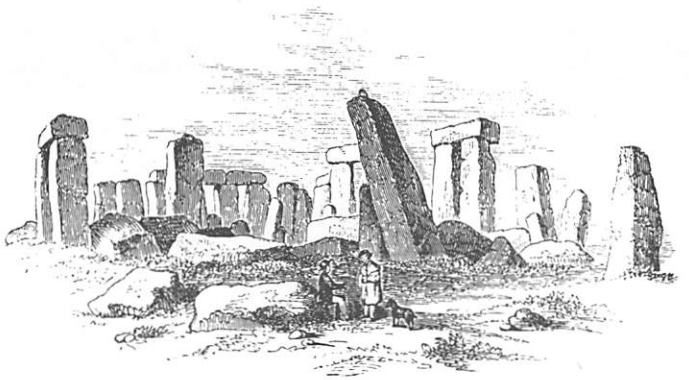
A review such as this affords a suitable opportunity to comment on the BBC TV series. Why are they broadcast so late (round about midnight)? This deprives youngsters of the chance to watch television's premier programme on astronomy. I get the feeling that someone at the BBC thinks that, because observational astronomers work at unsocial hours, this must also be the time for the broadcasts. Could we have them around 8.o'clock please?

As I am a firm believer that everyone should read every book by Patrick Moore, it is tautological to recommend this book to any particular class of reader. Happy reading!

Eric Zucker

ASTRONOMY AND STONEHENGE

by Robert Mills



Stonehenge 100 years ago.

The Royal Astronomical Society, cooperating with English Heritage, has set up a team of astronomers with the object of preparing explanatory material for use in the new Visitors' Centre. The team includes Dr. Derek McNally and Robert Mills, both of whom, incidentally, are AAE members. It is hoped that the coming together of astronomers and archaeologists will prove a fruitful exercise, bearing in mind the 600,000 visitors to the monument each year.

The astronomical team are particularly interested in Stonehenge as a solar/lunar observatory. The establishment of a Visitors' Centre with astronomical undertones should be of concern to the AAE. (As a matter of interest, Robert Mills lives only 5 miles away from Stonehenge.)

* * *

The people of Stonehenge were concerned with the worship of the Sun and Moon as were many other early civilizations. The Sun figured as a God and the Moon as a Goddess, so that eclipses of the Sun and Moon became events of great importance and communal excitement. Efforts to understand and predict eclipses occupied the attention of savants and leaders of their day. Anyone who could predict an eclipse could rise to a position of great eminence.

From recent studies of Stonehenge, it became clear that Stonehenge was much more than a device for forming a calendar to mark the seasons and days of the year from a circle of stones. This was the practice on many monolithic sites.

An eclipse occurs when the Earth, Sun and Moon are perfectly in line. If the Earth lies between the Sun and the Moon we have a lunar eclipse. If the Moon lies between the Sun and the Earth we have a solar eclipse.

As shown in Fig. I. the apparent paths of the Sun and the Moon as seen from the Earth appear to intersect at the points marked N' and N", the nodes of the Moon's orbit. The Sun's apparent path in the sky is regular throughout the year, but the Moon's path changes from day to day and from year to year in a complex manner, which Newton admitted gave him a headache. The main reason for this complexity is that the Moon's orbit round the Earth is inclined to the plane of the ecliptic at an angle of about 5° which causes the angle between the extreme positions of the Moon's rising to vary from 60° to 100° as in the figure. (Fig.II).

The early observers at Stonehenge found that it was possible to mark the positions of the Sun, Moon and the nodes and to keep track of them on a large circle of 87.7m in diameter. This was done by dividing the circle into 56 equal parts by means of 56 holes (known as Aubrey holes) with hole number 1 to represent the Sun at the Summer solstice (Fig. III). The number 56 must have been arrived at by a stroke of genius as would have come from a Newton or Galileo of 2000 BC, as it elegantly enables the Sun to follow an annual path of 364 days, the Moon to go round the circle in 28 days and the nodes to complete the circuit in 18.6 years, by the following simple procedure, using markers to represent Sun, Moon and nodes, as suggested by Professor Sir Fred Hoyle, in his book "On Stonehenge"

1. The Sun marker moves anticlockwise, 2 holes every 13 days and so completes its circuit in one year of 364 days.

2. The Moon marker also moves anticlockwise, but 2 holes every day, and so completes the circuit in a lunar month of 28 days. There were 13 months in a year.

3. The nodes move clockwise, 3 holes every year, and so complete their circuit in 56/3 years (18.6 years) which is the Saros.

If the markers are initially placed with the Sun, Moon and nodes together to represent a total eclipse, then, by following the procedures 1, 2 and 3, the markers will again all be

together for an eclipse after 18.6 years.

A total eclipse of the Sun observed from any particular place is a rare event. For example we have only two total solar eclipses in the British Isles in this 20th century, one in 1927 and another due in 1999. Eclipses of the moon however are much more frequent, because the Earth is much larger than the Moon, and its shadow is widely spread out, and so total or partial eclipses of the Moon occur once or twice each year, and could have been approximately predicted using near alignments of markers.

Fig.IV depicts the apparent paths followed by the Sun and the Moon as they move across our celestial hemisphere. The Sun is shown at its two extreme positions at the Summer and Winter solstices. The Moon's paths are shown by dotted lines and illustrate the effect of the rapid changes in the Moon's declinations over half a metonic cycle of 9.3 years, between the extreme positions given by ± (24°+ 5°) and ± (24°- 5°). It is these swings of declination that account for the ranges of Azimuths of the risings mentioned above. Maximum range in the risings of the Moon is from Az 40° to 140° and the minimum from 60° to 120°, ie max.range is 100° and min.range 60°. These figures can readily be checked using a calculator on the simple relation,

$\cos Az = \frac{\sin \delta}{\cos \phi}$ where δ is the declination and ϕ is the latitude.

(51° Stonehenge)

H. Robert Mills

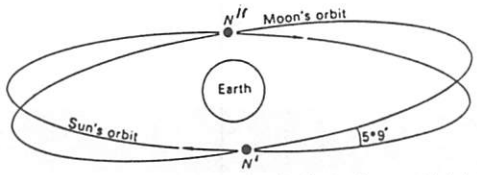


Fig. I. The paths of the Sun and Moon on the sky lie in planes which intersect at an angle of 5'9'. The points of intersection N.N' of the paths are the nodes of the Moon's orbit.

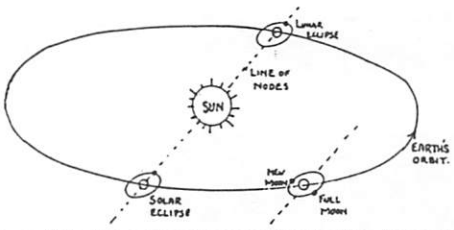


Fig., II. An eclipse of the Sun or Moon occurs when the Sun, Moon and Earth lie in a straight line, as in the Figure. If the plane of the Moon's orbit is exactly in the plane of the ecliptic, a solar eclipse would take place at each new Moon. The two planes are however inclined at an angle of about five degrees, intersecting at the nodes of the Moon's orbit. So, eclipses are observed only when the Sun is at or near a node and the Moon is near the same node (solar eclipse) or the opposite one (Lunar eclipse).

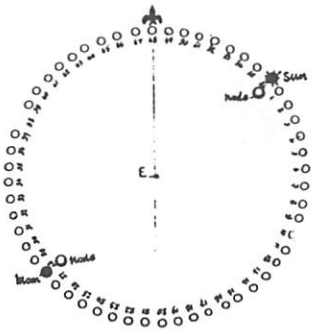


Fig. III. An eclipse, of the Sun or Moon occurs when the Sun, Moon, Earth and the Moos nodes are aligned with the observer on the Earth at E.

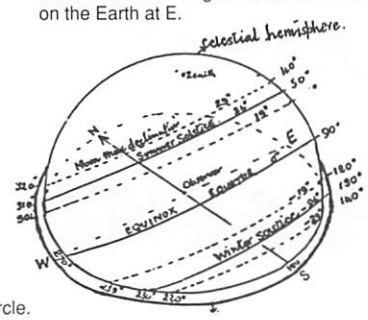
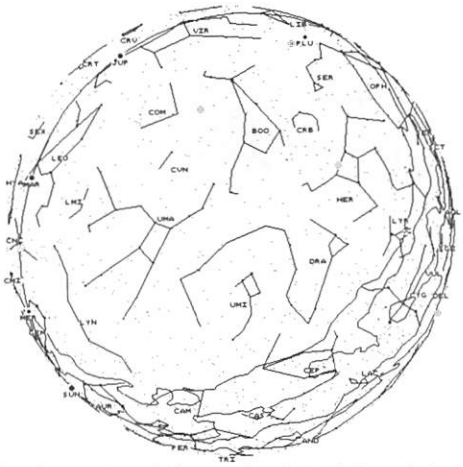


Fig. IV. The horizon or Azimuth circle.

SHORT NIGHTS IS ICUMEN IN . . .

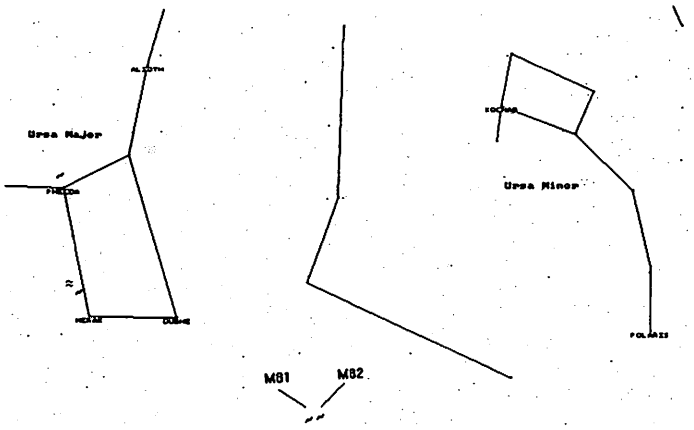
by Roger O'Brien

. . . and you can sing "cuckoo!", too, if the fancy takes you that way. If you have access to a telescope, try to look at the galaxy, M81, in Ursa Major. Spanish amateur astronomer, F. Garcia, was watching this galaxy on the night of 26th March, 1993 and he realised something had changed. There were three bright points in the starfield, not two. There are only two explanations that come readily to mind: a nova in our galaxy or a supernova in M81. It was soon confirmed that the latter case was correct. The supernova had been caught in the very act for it was still brightening from 14th magnitude at discovery to 11th three days later. It was a star exploding. Large stars tend to have cool surfaces (they are called red giants or supergiants), but the explosion provides the energy to maintain the temperature as the surface inflates to something like the size of Uranus' orbit and that surface emits as much light as a substantial galaxy (like M81).



OF course, it can't last long. The wreck of the star expands to the point where the surface layers both thin and cool. The light curve peaks and the brightness drops away - more slowly than it rose, but still quickly. By watching the fading carefully, astronomers can tell a great deal about the processes at work. They know that there are two major types of supernova, called (with great originality) Types I and II. Type I explosions are thought to be the final end of certain types of binary white dwarf stars, which have obtained extra layers of matter from their companion stars. Eventually there is enough extra matter to restart a runaway process of nuclear burning and the entire star is destroyed. The ejected cloud will have a mass similar to that of the Sun and will contain a rich blend of elements, but very little hydrogen. This is, perhaps, the ultimate thermonuclear bomb.

TYPE II explosions are probably rarer and occur, when a much more massive star reaches the end of its nuclear burning phase. At its core, there is an inert mass of iron (the most stable element and the end point of the chain of nuclear reactions). Although this core is almost inconceivably hot, it is no longer producing energy and it cools a little and begins to contract. Outside the core there are other layers, dominated successively by silicon, oxygen, carbon, helium and hydrogen. Most of the mass of the star is still hydrogen but too far from the core and, so, too cool to react and form helium. The core gives in to gravity and collapses abruptly (in nanoseconds). The constituent atoms are so crushed that they become, in effect, one gigantic atomic nucleus with an atomic weight of something like a googolplex (at a guess). All the energy that previously kept electrons rushing about through a matrix of protons and neutrons has been converted into neutrinos and gamma rays. So much energy in fact that several solar masses of outer layers can no longer press down on the core, but are hurled out into space. Somewhere near the centre of the explosion and possibly moving away from there at as much as hundreds of kilometres a second is the old core, now a neutron star and, probably, a pulsar.



The supernova in M81 is a Type II and astronomers call it SN1993J - the tenth supernova discovered this year. It is not easy to see because M81 is millions of light years from us, but it is worth a try. All over the world, amateur and professional astronomers will be observing the remnants as they fade. Already they think they have identified the progenitor (the star that exploded) and it seems to have been a supergiant of a type between G5 and KO i.e. a massive star that had evolved well off the Main Sequence and reached a sufficiently unstable stage to allow it to blow up. The Main Sequence is a well populated strip across a graph, which shows stars plotted for surface temperature against brightness. Most stars are on the Main Sequence because that is where their details plot for most of the time they are stars. They join the Main Sequence shortly (in astronomical terms) after their nuclear furnaces ignite and then settle down to a stable phase where they produce as much energy in their cores as they shed from their surfaces. Our Sun is a fairly typical Main Sequence star at the upper end of the "dwarf" range. It will become a red giant in several thousands of millions of years, but it is not a supernova candidate. A more massive star evolves much more quickly and may become a supernova.

One odd fact has emerged from studies of this supernova and the famous SN1987A (in the Large Magellanic Cloud): neither was a red supergiant immediately before exploding. Stars like Betelgeuse are usually cited as prime candidates for supernova explosions, but perhaps this theory needs re-examining. Perhaps red supergiants can get rid of enough mass to settle down through a series of novae to become planetary nebulae with white dwarfs at the centre. This is pure speculation: the answer is not known. Astronomers are trying very hard to find out. So, let me again urge everyone to try to find a way of looking at the first supernova in about 60 years to be seen in a nearby galaxy THAT IS VISIBLE FROM THE NORTHERN HEMISPHERE.

M81 is to be found near "The Plough", the brightest part of Ursa Major. It looks like a star 5 minutes of arc south west of the nucleus of M81. There are two other brightish stars in the neighbourhood and the supernova forms a right angled triangle with them. Ursa Major is easy to find in summer and high up in the evenings. Spare a glance, too, for M82. This is another, fainter galaxy and looks like a fuzzy line a short distance away from the oval blob of M81. The latter is a beautiful spiral galaxy, but M82 is a disturbed galaxy with tremendous clouds of gas and dust surging through it. It is an odd and unusual specimen and really quite easy to find. You can locate M81 and M82 with good binoculars on dark nights away from artificial lights, but you will need a telescope to see more than fleeting impressions of brighter patches as your focal vision drifts off these objects (this is called 'averted vision').

CURRICULUM CORNER

Compiled by

Bob Kibble

For better or verse

Do you ever write letters, stories or poems? Have you tried to write poems about your hobbies or stories about astronomy and space? Some people think that writing and poetry is only allowed during English lessons. How unexciting. Why not make up a story or poem about a visit to another planet or about being an astronomer? You don't have to be Shakespeare to do this. Anyone can write poetry. Here are some limericks to get you started:

I once saw a face on the Moon / As round as a party balloon / By by Saturday it had faded away / I do hope I see it again soon.

Light travels the fastest they say / A light year in three sixty five days / But travel that far and the nearest star is still three more light years away.

Now try some yourself. If you send your best limericks, poems or short stories to me I'll print them in a future Gnomon for the whole world to read.

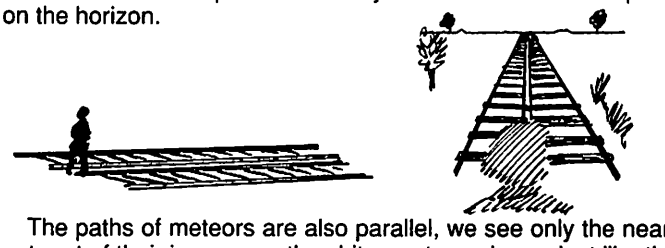
Have you seen a Shooting Star?

Everybody has heard of a shooting star but have you actually seen one? They are not really stars of course but tiny particles of dust falling to Earth and burning up as they pass through the Earth's atmosphere. Astronomers call them **Meteors**. There are tonnes of dust in space. Every day some dust particles are attracted by the Earth's gravity and fall through the atmosphere. You might be lucky enough to see one of these meteors on any clear night. We call them 'sporadics' because you can't predict them. However there are times when we can predict that there will be lots of meteors and one of these times is in August.

One of the best times to 'catch a shooting star' or see a meteor is during the summer holidays. From 23 July to 20 August the Earth will pass through the path of the comet Swift-Tuttle. All comets leave a trail of dust behind as they move around the Sun and the dust from Swift-Tuttle will be falling to Earth during this period. Your best chance to see a meteor will be the nights of August 10, 11, 12, 13. If you are camping out on these nights or staying away from city lights why not plan to catch sight of a meteor. Wear warm clothing as the summer nights can be surprisingly cold. Just scan the entire sky, there is no need to look anywhere in particular but you must be patient and keep looking. The meteor trails will appear to come from a point in the night sky in the constellation of Perseus. We call this meteor shower the 'Perseid' shower.

Extension work: Take a star map and pencil with you when you go out to wait for the Perseids. You can copy one from an astronomy book. As you spot a meteor, quickly sketch its path with a pencil on the star chart. By the end of the evening you will notice that all the trails appear to come from a common place. We call this place the 'Radiant Point' or 'Radiant'. Can you locate the position of the Radiant for the Perseid shower?

Why do meteors appear to come from a single point? This is an obvious question. The answer lies in a optical illusion. The spreading of meteors from a point is only a trick of perspective. Imagine you are looking along a straight railway track. The lines are parallel but they seem to come from a point on the horizon.



The paths of meteors are also parallel, we see only the nearest part of their journey as they hit our atmosphere. Just like the railway lines and all parallel lines, the paths appear to come from a point.

Continued from page 11

Something to think about. When you are out in the dark sky with a few friends or perhaps Mum, Dad or the cat for company, think about the thousands of other keen astronomers just like you all looking at the sky, watching for meteors. You might just feel part of a world-wide astro family.

Good luck, and keep warm.

MICROGRAVITY: A CLASSROOM ACTIVITY

by Nik Stegall.

Create a microgravity environment in the classroom by punching a small hole in the side and near the bottom of a can. Fill the can with water (through the big hole at the top) and seal the hole with your finger. Position the can over a suitable basin, or in the garden (somewhere to collect water).

Remove your finger and observe the water streaming out of the hole (Fig.1).

Fill the can again and drop it (vertically). Observe the water stream again.

Repeat yet again, but this time throw the filled can through the air - it will travel in a parabolic arc. You must make sure the can remains upright (vertical) for this experiment (Fig.2). Observe the water stream, if any, during the flight.

This is a good simulation of the parabolic trajectory followed by the KC-135 aircraft of NASA demonstrating "weightlessness" of prospective spacemen. (*Note:* recycle the can after use!)

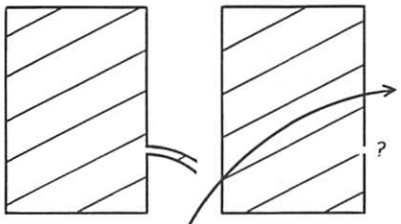


Fig. 1 Fig. 2

HOW TO REMEMBER THE PLANETS IN THE SOLAR SYSTEM

S - The sun comes first a ball of gas.

M - And then it is Mercury 9th from last

V - Then comes Venus

E - Earth and

M - Mars

J - Jupiter next above the stars

S - Saturn

U - Uranus and

N - Neptune comes next. Nearly the coldest but the coldest not yet.

P - The coldest is Pluto, not very nice. If you walk on there, you will turn to ice.

by Lyndsey Patchett
Grangetown Primary School
Yr. 6. D.J (Sunderland)

Sky Diary Summer 1993

By Eva Hans

Solstice :	June	21d	09h	00m
Equinox :	Sept	23d	00h	22m

MOON

New Moon	First Quarter	Full Moon	Last Quarter
	June 26d 22h 43m		
July 19d 11h 24m	July 26d 03h 25m	July 03d 23h 45m	July 11d 22h 49m
Aug 17d 19h 28m	Aug 24d 09h 57m	Aug 02d 12h 10m	Aug 10d 15h 19m
Sept 16d 03h 10m	Sept 22d 19h 32m	Sept 01d 02h 33m	Sept 09d 06h 26m

MERCURY
Mercury is visible low in the west after sunset until July 6th. It reappears as a morning object in the east from July 24th to August 21st then reverts to the evening sky from Sept 9th

VENUS
Venus is a morning object visible in the east before sunrise.

MARS
Mars is in the evening sky moving from Leo into Virgo.

JUPITER
Jupiter is an evening object in Virgo.

SATURN
Saturn is well placed for observation in the morning sky in Aquarius until it comes to opposition on August 19th when it will be visible all night (due south at midnight). After opposition it becomes an evening object.

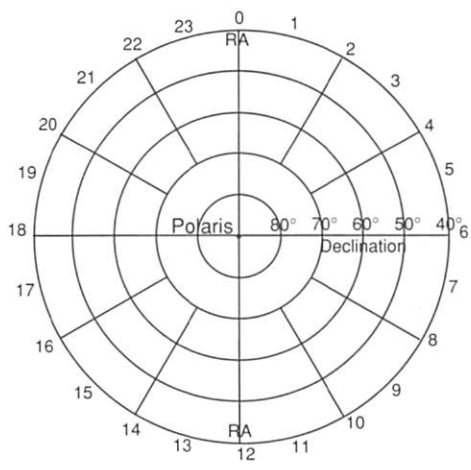
METEORS
The best meteor shower of the year, the Perseids, taking place in August. Try to find a dark observing site away from town lights, and enjoy a free celestial firework display. The maximum will probably occur on the night of August 11th to 12th but it is well worth watching for a few nights on either side of this date. Fortunately this year moonlight should not be a problem as the Moon is at last quarter on August 10th. Anyone interested in learning more about meteors and meteor watching send a SAE marked "meteors" to: The Planetarium, South Tyneside College, St. Georges Avenue, South Shields, Tyne and Wear NE34 6ET, TEL: 091 456 0403 EXT 477

LATITUDE AND LONGITUDE IN THE SKY

A place on the earth can be found from its Longitude and Latitude. In a similar way a star is found from its Right Ascension (RA measured in hours and minutes) and Declination (measured in degrees north or south of the celestial equator.)

Find the RA and Declination of each of the stars below and mark their positions on the chart with clear dots. Try to name the three constellations.

RA	*Dec*	*RA*	*Dec*	*RA*	*Dec*
11hr	62°	0hr	58°	20¾hr	34°
11hr	57°	1hr	61°	20½hr	45°
12hr	54°	½hr	56°	20⅛hr	40°
12¼hr	57°	1½hr	60°	19⅝hr	45°
12¾hr	56°	1¾hr	63°	19½hr	28°
13½hr	55°				
13¾hr	49°				



Acknowledgments to Douglas Clish for this item.