



GNOMON

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A grant from The Royal Astronomical Society enables "The Universe in the Classroom", the Newsletter of The Astronomical Society of the Pacific, to be sent to members with issues of "GNOMON".

EDITORIAL COMMENT

Readers may have seen articles in the popular press which attempt to debunk the American Space programme. They purport to show that the whole thing was a massive fraud, that it never took place, and that episodes were all part of a gigantic film studio scenario set up by the "authorities" in order to hoodwink the public.

That such twaddle could ever be believed by an intelligent readership seems incomprehensible to those brought up to apply scientific methods to the problems of everyday life.

We asked Tony Lawton, past President of the British Interplanetary Society, to comment on the subject, and his article appears on page 2 of this issue of GNOMON.

Readers' views on the subject are welcome.

* * * *

A number of correspondents have sent in their ideas on the tunnel through the Earth problem in the Autumn issue of GNOMON (GNOMON Snippets). Even without maths we have had suggestions that (a) the air pressure at the Earth's centre would be enormous, and (b) the air pressure would be zero, or very low. Nearly all readers realised that there were two conflicting factors: (1) as we approach the centre, the pressure builds up - as it has to support a higher column of air than at the Earth's surface, and (2) gravity falls off, its value at the centre being zero.

MEMBERSHIP of the AAE costs £7.50 a year for individual members, £15 for corporate membership and £5 for retired persons. For more information, contact Nik Steggall (address letters to: AAE, Royal Astronomical Society, Burlington House, Piccadilly, London W1V 0NL). Members receive 4 issues of GNOMON a year.

GNOMON - definition from the Concise Oxford Dictionary:

Pillar, rod, pin or plate of sundial, showing time by its shadow on marked surface; column, etc. used in observing sun's meridian altitude

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

All communications (except those to the Editor) should be addressed to:

The Association for Astronomy Education,
The Royal Astronomical Society,
Burlington House, Piccadilly,
LONDON. W1V 0NL.

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Lewes, East Sussex BN7 1PT - for all enquiries concerning the Newsletter.
(Tel 01273 474347)

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Publication Dates:

These are the equinoxes and the solstices, that is four times a year. Copy deadlines are two months *before* these dates.

TRASHING THE TRIUMPHS OF THE PAST

by Tony Lawton, President of the British Interplanetary Society, 1991-94

This is the term I give to articles or books which appear from time to time purporting to go behind the scenes and report on "what really happened" on such occasions or events as (say) the Apollo Moon landings.

It is an "art" form that is particularly pervasive in the United States, and in the interests of "constructive" journalism is sometimes repeated and reported on in the British press.

This year (1994) has seen the celebration of the first manned landing on the Moon and it is somewhat of a shock to realise that it took place 25 years ago!

It is therefore not surprising that this event has come in for its share of "trashing", but even the most cynical hearts have found it difficult to believe recent press articles that are said to "reveal" all the "real" secrets behind this great and risky achievement. Of the various articles appearing in the press, one claims that "Buzz" Aldrin was so jealous of Neil Armstrong being the first to set foot on the Moon that he refused to take any photographs of Armstrong during the subsequent activities. Consequently all the photographs of manual activity are of Aldrin and all of them were taken by Armstrong!

This was the conclusion reached by harassed NASA analysts who were being pressured to release these wonderful and unique pictures to a worldwide network which was hungry for news.

Their theory seemed to be backed up by the film numbers allocated to Aldrin yielding a series of unexposed frames.

I do not believe the "jealousy theory" for one moment. I have personally met Aldrin and he strikes me as a man of the very highest integrity. As Commander of the Apollo 11 mission it was Armstrong's right, privilege and *duty* to be the first to step on to the lunar surface. Aldrin's military training would naturally allow him to respect a commander's post. In such a hostile environment there is no room for petty jealousies, with danger and possible death such close neighbours.

A few years ago an article was published by H.A.P. Arnold in the British Interplanetary Society's "Spaceflight". Arnold is a well-known and respected photographic expert and authority on matters pertaining to astronomy, astronautics and spaceflight. He spent a considerable time analysing *all* of the Apollo 11 photographs and he was not under pressure to produce answers. He concluded that at least one of the photographs was of Armstrong and therefore must have been taken by Aldrin.

There could be a very simple explanation of what really happened. As the qualified engineer of the expedition, Aldrin's main task was to set up the scientific experiments in which Armstrong assisted and took photographs. The early work schedules of the first Apollo landings were hopelessly over-taxed. The time allotted for surface work and walks was limited to two hours. When that time was up, the astronauts had to return to the module. Mission Control was insistent and adamant on this point, for at that time no one really knew how long a man could experience lunar surface environments without suffering long term radiation damage. So a cramped time schedule allowing one photograph could be the true explanation. But the "petty jealousy" stories continue to circulate . . .

Another "purple sunset" article has made an even more extravagant claim - that the Apollo 11 moon landing took place in a Hollywood film studio as part of a huge "scam" engineered by NASA and paid for by the US Federal Government!

This really beggars belief, but such is the journalistic stuff of "triumph trashing". This very elaborate and fantastical thesis is based on a few elementary questions and observations, such

as: "No stars appear in many of the NASA photographs taken on the lunar surface".

Several other points are made in a similar vein and have been answered time and time again by NASA - but still this "conspiracy scam" story goes on, much to NASA's exasperation.

However, in fighting back one should ask these "doubters" such questions as:

"If this were a scam, how does one explain the enormous amount of data obtained from the experiments sited on the lunar surface long after the last astronauts had departed?" Data continued for another 4 years.

"How does one explain the detailed nature of the returned laser signals reflected back from the lunar surface?" These have measured the Earth-Moon distance to an accuracy of 10 cm or less. Not only does this confirm the already-known elliptical orbit of our satellite but also shows that the Moon's body expands or bulges towards the Earth at perigee, and resumes a more normal shape at apogee, thus giving rise to Moonquakes.

Since the articles go on to flatly state that all the Apollo vehicle landings were conducted in a Hollywood studio and the Moon rocks were "synthesised by NASA" and are faked from Earth materials, what are we to make of the *whole edifice of the science of modern Planetology*? Such books, courses, syllabus teaching, etc., now circulating worldwide will have been based on a gigantic lie - and a morally outrageous one at that, for it will be repeated time and time again to successive generations of would-be geologists, selenologists and planetologists.

It is when hard technical and physical facts are laid alongside these foolish "scam" assertions that the latter's weaknesses are fully exposed. Some of the authors of these books are equipped with degrees which seem impressive but the books are singularly short of hard elementary facts - one even claims a "reasonable lunar atmosphere"! In fact, any gaseous residue will be confined to the heavier noble gases (xenon, krypton, radon etc.) and certainly will not be the density or composition of our Earth's envelope.

The ordinary person in the street is not moved by scientific arguments, for the simple reason that he or she has little or no scientific interests, having been turned off long ago by such terms as "dull, boring, tedious" etc.

But the possibility of a giant scam brings out all our base instincts rather like the recent scandal stories concerning the British Royal Family.

Shakespeare summed it up neatly in *Julius Caesar*: "The fault, dear Brutus, is not in our stars, but in ourselves, that we are underlings". That was written in a time when astrology was rife - clearly the Bard thought it rubbish and that human weakness and ignorance were largely to blame for most of our troubles.

The modern position is largely unchanged; we prefer to believe the wildest conspiracy theories rather than true facts and figures which, if explained in simple terms, could be made to arouse the interests of Joe or Josephine Bloggs and give them sufficient knowledge to condemn these fringe books as being without foundation, fiction masquerading as fact.

It is up to us - the AAE - and all our interest-affiliated organisations to help spread information and teaching of the right blend of truth and flavour of interest that will help disperse the bitter cynicism of the "Triumph Trashers".

BOOK REVIEW

THE GREAT ASTRONOMICAL REVOLUTION, by Patrick Moore, published by Albion Publishing, November 1994, pp 232, ISBN 1-898563-18-7 Hardback £17.50 and ISBN 1-898563-19-5 Paperback £9.95.

Patrick Moore breaks new ground with this scholarly researched book. It was originally published as "Watchers of the Skies" in 1973, and this book is a revised version. This is not a book about stars and planets, or astronomical instruments, but, as the book's subtitle (1534-1687 and the Space Age Epilogue) makes clear, it is about the times and customs of that particular era. To quote from the opening chapter: "This

book is the story of a revolution. It was not quick, and except in its later stages it was not violent; moreover it happened a long time ago, and was virtually complete well before the end of the 17th century. And yet it resulted in probably the most radical change in outlook that mankind has ever known". During this period, man was shifted from his self-appointed position at the centre of the Universe, to a small planet, one of several in the Sun's family.

Here are some of the chapter headings: "The questioners; Copernicus the Doubter; The Master of Hven; Circles or Ellipses; Galileo, the Experimenter; the Storm Gathers; the Dialogue; Con-

frontation; Aftermath. The book closes with an epilogue.

Most readers will be unaware of many characters in the story. For example, who are Nicolaus Krebs, Gellius, Bishop Dantyszek and Lucian of Samosata? If you would like to know, you will find the answers in this book - and a lot more.

The book is well illustrated, many of the pictures being (presumably contemporary) woodcuts, which have their own charm. There are a few errors of minor significance - an errata slip makes corrections. I thoroughly recommend this book to our readers - also a very welcome Christmas present.

Eric Zucker

SORTING OUT THE STARS

By Dr. Anne Cohen, President of AAE

What follows is a worksheet for upper band GCSE students who need to look at the colours, temperatures and brightnesses of the stars. It is basically a simplified data set, enabling a Hertzsprung-Russell diagram to be plotted for seven well-known main-sequence stars. This establishes the line known as the "Main Sequence". Then a red giant and white dwarf are added to demonstrate that these are different in many respects.

The plotting requires a logarithmic scale for Luminosity. I have found that this does not present a problem for pupils who are comfortable with multiples of ten. Log paper is not required, as inaccurate plotting between the powers of ten does not significantly change the graph.

To get a normal-looking version of the H-R diagram in which the main sequence slopes from upper left to lower right, you will need to plot the temperatures along the x-axis from right to left. Again I have not found this to be a problem for children who understand that hotter objects glow red-hot, then white-hot etc. and that this is related to wavelength, which would then be increasing along the x-axis in the normal way. (If you plot temperature from left to right, then your graph will look like a mirror image of those in the books).

Finally, to get all the information on one graph, you can plot large circles for the most massive stars, and tiny circles for dwarf stars. (Not very quantitative, but it works well). These circles can be coloured to represent the colour of the star.

The main relationships between colour, temperature, mass and intrinsic brightness jump out at the student, and it is immediately obvious that red giants do not fit the pattern. I do this activity as part of a session on the evolution and death of stars, and accompany it with a variety of slides of planetary nebulae, open star clusters and supernova remnants.

(Please do not write to the Editor complaining that the temperatures of the stars are wrong. They are somewhat idealised, and heavily rounded!)

MAIN LIFETIME STARS:

Name	Surface Temperature in °C	Luminosity (in Sun's)	Approximate Mass (in Sun's Mass)
Barnard's Star (red)	2800°C	0.001	0.16
Altair (white)	8000°C	9	1.7
Vega (blue/white)	9900°C	50	2.0
Alpha-Eridani (blue)	15 000°C	8000	10.0
Alpha-Centauri (yellow)	6200°C	1.5	1.0
Spica (blue)	26 000°C	100 000	20.0
Sun (yellow)	5700°C	1.0	1.0

- 1) Plot these stars on a graph which has temperature along the x-axis and luminosity up the y-axis. NB the Luminosity scale must go up in powers of ten. (Think why this must be).
- 2) (a) Is there a link between the brightness and temperature? Or colour?
(b) Is there a link between mass and temperature?
- 3) The line down the diagram is called the Main Sequence. All stars which are in their main lifetime of hydrogen fusion lie on this line. However stars at the beginning and end of their lives behave differently.

Plot these unusual stars:

	Temp	Luminosity	Mass
Betelgeuse:	2800°C	14 000	20
White Dwarf:	10 000°C	0.001	1

- 4) What colour is Betelgeuse? What colour is the white dwarf?
- 5) Find out about these two types of star, and why they are unusual.

FROM NASA EDUCATIONAL BRIEFS FOR THE CLASSROOM

WHITE DWARFS

Stars are usually measured in comparison with our Sun's mass. A star whose remaining mass is about that of our Sun condenses to approximately the size of Earth. The star's contraction is halted by the collective resistance of electrons pressed against each other and their atomic nuclei. Matter in this collapsed star is so tightly packed that a piece the size of a sugar cube would weigh thousands of kilograms. Gravitational contraction would also have made the star white hot. It is appropriately called a white dwarf.

Astronomers have detected white dwarfs in space. The first discovery was a planet-sized object that seemed to exert a disproportionately high gravitational effect upon a celestial companion, the so-called dog star Sirius, which is about 2.28 times our Sun's mass. It appeared that this planet-sized object would have to be about as massive as our Sun to affect Sirius as it did. Moreover, spectral analysis indicated the star's colour was white.

Based upon these and other studies, astronomers concluded that they had found a white dwarf. However, it took many years

after this discovery in 1914 before most scientists accepted the fact that an object thousands of times denser than anything possible on Earth could exist.

BLACK HOLES

When a star has a mass of 3 solar masses or more, and it uses up all its nuclear fuel, it may collapse on itself even more than a white dwarf. Its gravity may become so large that nothing can escape from it, not even light. Such a star is called a Black Hole.

BLACK HOLES AND OUR UNIVERSE

Our universe is theorized to have begun with a bang that sent pieces of it outward in all directions. As yet, astronomers have not detected enough mass to reverse this expansion. The possibility remains, however, that the missing mass may be locked up in undetectable black holes that are more prevalent than anyone realises.

If enough black holes exist to reverse the universe's expansion, what then? Will all of the stars, and galaxies, and other matter in the universe collapse inward like a star that has exhausted its nuclear fuels? Will one large black hole be created, within which the universe will shrink to the ultimate singularity?

Extrapolating backward more than 10 billion years, some cosmologists trace our present universe to a singularity. Is a singularity both the beginning and end of our universe? Is our universe but a phase between singularities?

These questions may be more academic than we realise. Scientists say that, if the universe itself is closed and nothing can escape from it, we may already be in a black hole.

* * * *

[This subject is changing almost daily, with more and more discoveries about the Universe.]

QUESTIONS AND ACTIVITIES FOR THE CLASSROOM.

1. How does a black hole get its name?
2. In the absence of actual detection, how do we find evidence of black holes? Is this method used for other celestial objects?
3. How do stars die? How much mass is needed in each way?
4. According to the Relativity Theory how are space and time affected by a black hole?
5. What is the Schwarzschild radius?
6. What role do so-called worm holes play in black holes?
7. What is the Penrose Process?
8. Conduct a class discussion on the origin and end of the universe and why the universe itself may be a black hole.
9. A scientist has proposed that an advanced civilization could be established just outside of a black hole's event horizon and harness and use energy from material swept toward the hole. Discuss the possibilities of and precautions that must be observed in such an establishment.
10. When stars or other material fall into an existing black hole, how do they increase the radius of the black hole's event horizon?

GCSE STARS SHINE

*From the Hampshire Observer (October 1994)
by Robin Gorman, Hampshire Astronomy Group*

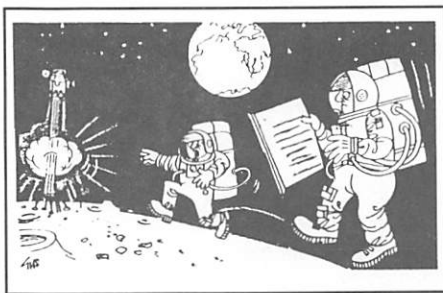
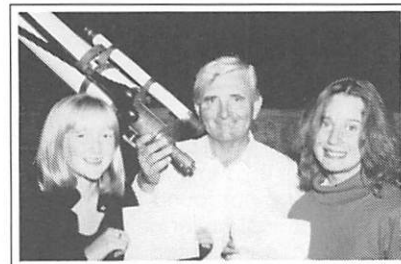
Congratulations are extended to HAG members Caroline Kirman (14) and Natalie Wheellan (15) who have passed their Science-Astronomy GCSEs with grades B and C respectively. They were keen to enter the exam after attending the Astronomy for Beginners evening class held at the observatory. Robin Gorman was so impressed with their enthusiasm that he volunteered to tutor them, as no schools or colleges in the area offered the course.

They have become two of the youngest pupils to pass this exam which is taken by around 500 students each year. This was of such interest to *The News* (Portsmouth) that they made the front page with a colour picture.

Caroline built her own 6 1/4" telescope as part of the course and plans to go on to a career in astronomy. Natalie hopes to become a musician but thinks she will now have a life-time interest in Astronomy.

It is certain that all members wish them well in the future.

Robin Gorman



SPACE - LINK

*Compiled
by Nik Steggall*

THE AMATEUR RADIO SATELLITE ORGANISATION OF THE U.K.

AMSAT-UK, the Radio Amateur Satellite Organisation of the United Kingdom, is an organisation run by amateurs and is part of the worldwide AMSAT organisation. AMSAT-UK exists by donations of which most is put to use in the building and design of amateur satellites and the command stations worldwide.

Phase 3D satellite is the next major satellite construction effort that various AMSAT groups around the world are undertaking. It is believed to be the most challenging project the Amateur Radio community have ever attempted. The targeted launch date is April 1996.

What is Phase 3D? Phase 3 refers to the class of amateur satellites built to relay broad bands of amateur frequencies in real time from high elliptical orbits to provide world-wide coverage. The Phase 1 group of amateur satellites is typified as

OSCARS 1 and 2 carrying only beacons and designed to last only a few weeks. The first of these was launched in 1961. Later spacecraft such as OSCARS 6, 7 and 8, were examples of Phase 2 satellites. While built to last for a period of a year or more, a distinguishing characteristic of these satellites is their relatively low orbit, which affords limited time access and restricted coverage potential.

The Phase 3 program was initiated during the 1970's to alleviate these limitations. The first Phase 3 spacecraft (Phase 3A) was lost in an Ariane failure in 1980. Two more Phase 3 satellites were constructed and successfully launched, also on Ariane vehicles. The first of these Phase 3B is operating as OSCAR 10 and supporting amateur communications.

However due to a failure of its on-board computer brought about by radiation damage OSCAR 10 is no longer able to be maintained in the proper orientation to afford optimum service.

The third Phase 3 satellite, Phase 3C, became OSCAR 13 following its launch in 1988. It is still functioning after five years in orbit. However its life is now known to be limited. Because of hitherto obscure interactions between the spacecraft, the Earth, the Moon and the Sun, OSCAR 13 is slowly de-orbiting. Studies using main-frame computers predict that the satellite will re-enter the atmosphere about three years from now.

Therefore, if Amateur Radio is to continue to have the benefit of a high altitude world-wide coverage satellite, this fourth Phase 3 series, Phase 3D, must be built and launched. AMSAT-UK have set up a Phase 3D fund to complete the satellite, get it

to the launch site and command it after launch. Anyone who would like to donate to this fund or to obtain further information regarding the Phase 3D project or AMSAT-UK should write with an SAE to: AMSAT-UK, Hon. Treasurer, 94 Herongate Road, Wanstead Park, London, E12 5EQ, United Kingdom.

Part of the above item was taken from OSCAR NEWS, the official journal of AMSAT-UK, Number 103 - October 1993.

* * * *

To all new membership applications and members who have not sent a donation to the Phase 3D Fund:

Please note that we are now very short of cash to complete the satellite, get it to the launch site, AND command it after launch for your enjoyment.

The launch date is April 1996.

If we miss that date:

A: We will have no replacement for OSCAR 13 which is earth entering early 1996.

B: We will not be able to get another launch for a few years after the above date.

Please dig deep into your pockets and at least send a few pounds.

Don't be a free-loader.

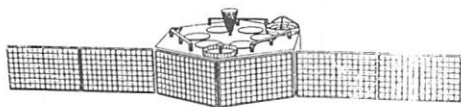
To date only 12% of the membership have donated to this latest satellite. Remember, money for amateur satellites does NOT come from your national radio societies, Government Funds, Schools and Education Funds or the radio trade, *but only from members of AMSAT world-wide.*

G3AAJ : 1st October 1994

AMSAT-UK PHASE 3D CONSTRUCTION FUND

This fund has been set up to enable those interested to donate monies for use in the construction of the Phase 3D satellite. This satellite will be more sophisticated than previous projects and will require dedicated funding to enable the builders to plan ahead with confidence.

All monies received will be held in the A-UK P3D Fund and



used for specific parts of the project. The A-UK committee will decide how

monies are used from requirements submitted by the spacecraft builders.

Please send all donations to: AMSAT-UK, Hon. Treasurer, 94 Herongate Road, Wanstead Park, London, E12 5EQ. United Kingdom, from whom further details may be obtained.

Please mark Cheques: 'AMSAT-UK' & cross 'A/C Payee Only'.

ULYSSES DISCOVERS THE MYSTERIES OF THE SUN'S SOUTH POLE

The Ulysses spacecraft orbiting the Sun from pole to pole is currently making a pass over the Sun's south pole. Started in June it will be completed by November. So far it has been a total success and has already yielded a first clutch of surprise results concerning this unexplored region.

Scientists at the European Space Agency concluded that the south polar region displayed unexpected magnetic and dynamic characteristics. This probably means that the thinking on the magnetic structure of the Sun will have to be revised.

The first thing that surprised the scientists was the low cosmic radiation activity above the south pole and the remarkable apparent absence of a south magnetic pole. Richard Marsden, ESA's project scientist, explained; "We expected the Sun to have a relatively simple magnetic field, such as the Earth's or that of a magnetised iron bar. We thought we were going to find a local increase in the field's intensity. But the probe did not detect any such thing and all the evidence so far suggests that the Sun has no south magnetic pole".

Could it be that the Sun has no south magnetic pole? Or is one suddenly going to appear before Ulysses completes its pass? These are amongst the many questions that scientists working on Ulysses are asking. They are keenly looking forward to comparing the results with those that will be coming through next year when Ulysses passes over the Sun's north magnetic pole.

It is however already clear that the structure of the solar magnetic field in the southern polar region is not as predicted by the models. In particular, the instruments on board Ulysses have detected a new type of very slowly varying electromagnetic waves, with oscillation periods of 10 to 20 hours. The experts' theory is that this is due to an unexpected phenomenon that conveys the solar magnetic field into space through the solar wind.

It is still too early to say what effect these new findings are going to have on the overall understanding of the Sun and the interplanetary wind it generates. Although there is no doubt of the complexity of the phenomena observed, which involve the combined effects of the solar wind, magnetic field, electromagnetic waves and fast moving bursts of particles. Further insights will probably be gained when Ulysses passes over the Sun's north pole in 1995 and if the mission is extended, when it makes two further polar passes in 2000-2001, during a period of intense magnetic activity.

INTERNATIONAL SPACE STATION SAVED

On June 29, 1994 the U.S. House of Representatives defeated an amendment to terminate the Space Station programme. The decision to continue to build the International Space Station will mean that it will be a new station. Daniel S. Golden, Administrator of NASA, said that the station will be "made bigger, better, and more powerful and more capable by our collaboration with our international partners in Russia, Europe, Canada and Japan. It's a stronger programme, guided by a restructured management team which is keeping the programme on track, on schedule and on cost".

In preparation to the International Space Station, NASA and the Russian Space Agency (RSA) signed a \$400 million contract which will continue with the ongoing cooperative programme under the Human Space Flight Agreement. This agreement provides for a U.S. astronaut flight to the MIR space station for three months and a Space Shuttle to dock with MIR in 1995.

The new contract provides for:

U.S. astronauts to spend up to 21 extra months onboard MIR. This will give a new generation of American astronauts and scientists their first experience with long duration space flight.

The Space Shuttle will dock up to nine additional times with MIR, delivering astronauts and research instruments. During this, NASA will gain fundamental experience in joint operations namely in risk reduction, command and control, docking the Shuttle with large structures in space, performing technology experiments and executing a joint research programme.

The implementation of a joint research programme onboard MIR, including astronauts/cosmonauts and US/Russian experiments. The Russian Spektr and Priroda research modules will be extensively used.

The Russians will provide flight-proven equipment, including several docking mechanisms for use with MIR and later with the International Space Station.

Joint development of Solar Thermal Dynamics, a newer and more efficient way to generate electrical power in space.

Joint technology demonstrations of systems that may be used on the International Space Station.

Demonstrations of joint operations and activities such as Extra-vehicular Activity (EVA).

READERS' ADVERTS

"An A-Z of Cosmonautics" by V. Gor'kov and Yu Avdeev. 192 pages children's book covering the world of cosmonautics. Price £10.00 including postage and packing (Overseas please add 10% for p&p).

Available from: N.E. Steggall, 38 Victoria Crescent, Birkdale Road, Dewsbury, West Yorkshire, WF13 4HJ, England.

COSMONAUTICS

Nik Steggall of Space Associations, in conjunction with the Memorial Museum of Cosmonautics, Moscow, has compiled a comprehensive list (over one hundred) of cosmonautic memorabilia and also publications. Also in preparation is a catalogue of first day covers signed by Russian cosmonauts. If you are interested in this list, please contact Nik Steggall: 38 Victoria Crescent, Birkdale Road, Dewsbury, West Yorkshire, WF13 4HJ (tel: 0924-454718).

NEWS FROM THE OLD ROYAL OBSERVATORY AND THE NATIONAL MARITIME MUSEUM GREENWICH

16 November 1994 — One of the world's most important clocks - a year-going regulator by Thomas Tompion, "the father of English clockmaking" - is returning to the Old Royal Observatory in Greenwich after an absence of 275 years. The clock will be returned to its original setting in the Octagon Room, designed by Sir Christopher Wren specifically to house Tompion's clocks, and will be available for viewing from 24 November 1994.

Before 1676, it was assumed that the Earth rotated at an even rate, but no one could be sure. Confirmation of this assumption was needed before astronomers, geographers and navigators could trust their astronomical readings and use them as the basis for map-making and navigation.

To settle the matter, the first Astronomer Royal commissioned the world's then most accurate clocks from Thomas

Tompion. The clocks were revolutionary in their design, employing the world's first "dead-beat" escapement, having 13 foot pendula and running for a year without rewinding. Using Tompion's clocks, Flamsteed was able to prove that, for mapping purposes, the Earth did rotate at a constant rate.

Flamsteed's findings were used as the basis of all measurements of time and space for over 250 years. His discoveries, with the aid of the Tompion Clocks, are the basis of the formulation of longitude and the reason why the Prime Meridian (0° Longitude) passes through Greenwich today.

It was not until the 1930's with the invention of the quartz crystal movement, that scientists were able to detect minute variations in the Earth's rotational speed.

Tompion's clocks were sold by Flamsteed's widow at his death in 1719. Their whereabouts are largely unknown between 1744 and the mid-19th century, at which time one of the clocks had been bought by the first Earl of Leicester and was installed at their ancestral home of Holkham Hall.

The Holkham Hall clock was bought by the Museum with the aid of very generous sponsorship by the Friends of the National Maritime Museum, the National Art Collections Fund, the National Heritage Memorial Fund, the Save & Prosper Educational Trust, the Worshipful Company of Clockmakers, the J. Paul Getty Jr Charitable Trust, the Monument Trust, Christie Manson & Woods, Ltd., The Peter Moores Foundation, the Royal Astronomical Society and a number of private and corporate donors interested in the history of Britain and the sea.

Further details: phone 081-858 4422

LETTER

We are always interested in the activities of overseas members, as often our only contacts are in the pages of this Newsletter. So we were delighted to receive the following letter from Karenza Burk from Australia.

Dear Editor,

I have just received the latest (Autumn) 'Gnomon'. I could really have used the 'Universe' publication on Shoemaker-Levy-9 had it come in time!

Like many people, worldwide, I had the thrill of seeing the impact sites, in an ancient 5" refractor at the Ballarat Observatory. Showing members of the public (many children) was gratifying. To point out where to look, I used the 'clock-face' method ("look towards 4.o'clock" etc). It worked. Most people, except small children saw the tiny, faint smudges.

As this clashed with the 25th anniversary of the Moon landing, it was not possible to fit in another open day. I have quite a collection of items from the 20th anniversary. These will now have to go into storage as the general opinion seems to be to bury the Moon-landing anniversaries until at least the 50th. I'll be 84 by then and don't think I'll be setting up exhibitions!

Glad to see the letter from Eric Jackson. The Pipehenges at the Anglo-Australian Observatory, Parkes, and the private observatory mentioned, followed my slide-show and distribution of leaflets at the 1993 Sky and Space Astrofest.

At last, a move is being made here to supply teachers with astronomy education kits. More later, as it is still in the very

early planning stages. It sounds as if 'How the Universe Works' would be an excellent buy - especially as I have been asked to attend a meeting of teachers on October 26th. This is because - at last - astronomy is being built into the national and State education guidelines. Do you know if this book has been distributed overseas? If not, how could we get hold of it?

(Editor's Note: this has been referred to our Publications Secretary).

Interesting to note that the Australian guidelines are also under the general heading of 'Earth and Beyond'! In fact, upon reading your outline, on page 7 of the Autumn GNOMON, the guidelines are very similar.

Also on page 7, the question about people 'falling off' is partly answered by Eric Jackson on page 3. When demonstrating Pipehenge, we (my husband and I) always use a globe of Earth reversed, with Australia on 'top'. Children accept this. Physically holding the globe 'upside down' demonstrates the idea of 'up' being a local phenomenon to each person - especially if you stick a small human figure on the globe and turn it around.

Well, that's it for now - until something else reportable happens!

Regards to all,

Karenza Burk
RMB 210, Creswick, Victoria,
Australia.
1994 September 20

ROGER O'BRIEN'S COLUMN

SEASON OF BAD SKIES AND GOOD SCIENCE

It is coming up to winter and cold, dark nights. Some of those nights will be clear and, whether you use your unaided eyes or binoculars or a telescope, there is plenty to look at. The group of constellations centred on Orion offers a huge variety to observe. Saturn, my favourite planet will slip pretty quickly out of view in the south west. Meanwhile, Mars will be moving through Leo, which constellation will carry the red planet higher in our sky. Mars is not the easiest of objects, but it is well worth the effort if you have access to a telescope.

I cannot turn from the night sky without reminding readers that Andromeda is still high up in winter. The great M31 galaxy

is the most distant object that the eye can see without aid. It is at least 2,300,000 light years distant. It is a giant spiral galaxy, even bigger than our own Milky Way.

This autumn, besides generally being pretty bad for observing, was a time of discoveries.

WHITE DWARF - A MISSING LINK

Dr Martin Barstow, of Leicester University, led a team of astronomers using the Extreme Ultraviolet camera aboard ROSAT (Roentgen satellite, which is German for X-ray satellite) to discover that RE 1738+665 is a white dwarf of peculiar interest. First it is very hot at 90,000K, which is 20,000

degrees above the typical temperature of such stars. It has an atmosphere of pure hydrogen and fits neatly into a gap in an observed pattern between very hot hydrogen rich stars at the centres of planetary nebulae and the, probably, older white dwarfs, which are cooler though still having hydrogen rich atmospheres. Other very hot white dwarfs are different again as they have substantial quantities of helium in their atmospheres.

It may be worth a quick reminder that 'planetary nebula' is a very misleading term. It is a cloud of gas thrown off the surface of a medium-sized, ageing star, when its core contracts to become a new, hot, white dwarf star. The ultraviolet radiation from the white dwarf makes the hollow bubble of gas (formerly its own outer layers) glow until the gas disperses and the central star cools.

STILL MORE SATELLITES OF SATURN

The Voyager probes encountered Saturn in 1981, but their data are still a rich seam to mine. Drs Carl Murray and Mitchell Gordon at Queen Mary College, London, believe they have located up to eight good candidates for satellites. Confirmation could come from ground-based observations next year or, more likely, from the Cassini probe, which will reach Saturn in 2004. The last time a British astronomer discovered a planetary satellite was in 1908, when Philibert Melotte at the Royal Greenwich Observatory found Pasiphae - one of Jupiter's smaller and more distant moons.

WHAT DOES A BLACK HOLE WEIGH?

Probably about 12 times as much as the Sun is the answer. Dr Phil Charles of Oxford University leads a team, which has succeeded in the feat of weighing a Black Hole. They have studied the binary system V404 Cygni, in which an ordinary star - a bit less than three-quarters as massive as the Sun - orbits a more massive, invisible companion. The Japanese Ginga satellite had already detected X-ray outbursts from this source and optical observers had seen a nova there in 1938. By careful analysis of the way the spectrum of the ordinary star changes as it orbits, the team have deduced the ratio of the masses of the two objects. The stellar theorists now have a pretty problem to explain the evolution of this rather ill-matched pair.

PEEK-A-BOOK GALAXY

I was delighted to report the discovery earlier this year of a dwarf galaxy being ripped to shreds by tidal stresses as it passed very close to our Galaxy. Now, an international team of scientists has found a new, big galaxy in Cassiopeia. This is not a promising area of sky because the Milky Way spills its rich star fields all over it.

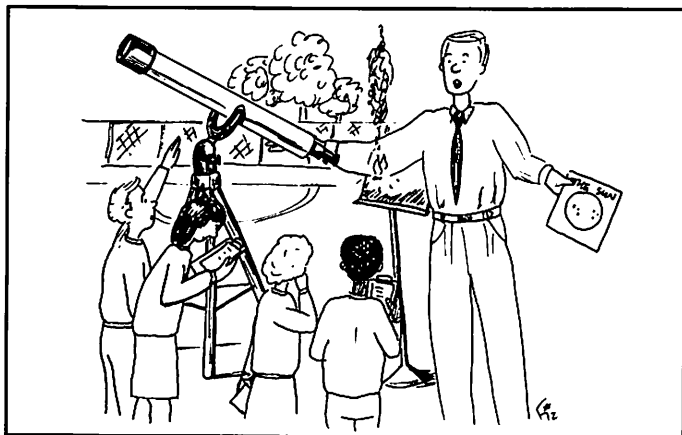
The Dwingeloo Obscured Galaxy Survey (DOGS) is a project to use the Dwingeloo radio telescope to look right through our Galaxy and discover what lies behind. The new galaxy is a barred spiral and it has been christened Dwingeloo 1.

AND, NOW, A FAR OUT GALAXY

8C1435+635 is the unexciting catalogue number of a radio source, which seems to be the most distant object yet known to be a galaxy (as opposed to a quasar or something similarly exotic). Another international team did this work. They used data from the IRAS satellite (1983) and the surveys that came out of that catalogue. They found two groups of objects that were good candidates for being very distant. The problem is that survey positions are often not very precise so the next step was to get much more accurate positions from the Very Large Array of radio telescopes at Socorro in New Mexico. From this work, they could prepare a 'finder' chart to guide observers, using the William Herschel telescope, who would take the spectrum of the object.

This reveals two things: first, it is a galaxy and, second, its light is redshifted by the enormous factor of 4.25. This means that ultraviolet light emitted by the galaxy is seen by us in the infrared part of the spectrum. This remarkable object has received subsequent attention from the UK's MERLIN radio telescope network and from the USA's big Keck optical telescope.

Despite its huge distance in both time and space (the universe was about eight percent of its present age, when the light we see was emitted) this seems to be a fairly ordinary galaxy. It does not even appear to be a proto-galaxy, which is the astronomers' name for the collapsing cloud of gas that has not yet quite sorted itself out to be a young galaxy.



CURRICULUM CORNER

Points of View by Bob Kibble

Last Summer I wrote an article about understanding the tides by considering frames of reference. One such frame was that of an observer on Mars. But how unreal is this for pupils and what problems does the learner encounter when asked to 'look at things from this viewpoint'? Reflecting on my teaching of astronomy I want to consider some of the pitfalls when using models to provide points of view within the universe.

Consider figure 1 which I use extensively to illustrate celestial situations when teaching. It shows an Earth-based view of the sky. The first thing to strike me is that my pen-on-whiteboard or ink-on-paper sketch is a reversal of what pupils will see at night. My sketch shows dark stars on a white sky. Secondly I wonder how many of my students will go home to encounter a clear horizon such as this or even a clear night! A third problem

arises when one considers that this sketch is on a flat surface and tries to represent what is in fact a hemisphere of night sky. Even a curved horizon can only be a minimal help to students trying to imagine the directions shown as W and E on my sketch. Finally the sketch is fixed in time and can't easily convey the changing scene. I suppose



Fig. 1

this is one situation where my planetarium friends win hands down being able to overcome most of these problems. In the meantime teachers beware.

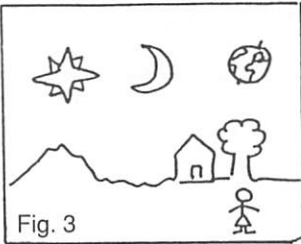
Fig 2 shows another common model used in astronomy teaching. I borrow our globe from the Geography department. What are we asking students to cope with when we use this seemingly harmless artefact? The most obvious problem is that, apart from lunar mission photographs, no student has ever had such a view of their Earth. Spinning the sphere is also asking for a viewpoint which contradicts everyday experience. What can happen in this case is that students start to learn all there is to be learnt about the globe, latitude, tropics etc but never manage to make the conceptual link between the colourful sphere on the shelf in the classroom and the street where they live. Look at paintings of the sky done by primary age children and you are likely to see the Sun and Moon accompanied by a third mystery object looking remarkably like the Earth.



Fig. 2

Finally to supplement my

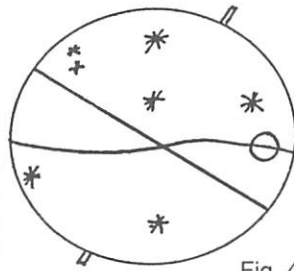
lessons I have made my own version of a model of the celestial sphere. An inflatable beachball costing £4



from a DIY store is much cheaper than the £200 or so for the plush plastic equivalent. However what challenges are posed when this is displayed? Not only am I asking students to take a beyond the earth view, I am sending them to a vantage point beyond the stars, wherever that is.

So how best to teach using models which demand an unreal viewpoint?

Perhaps the way forward is to allow time for students to reflect on the situation in a group. By asking questions like 'so what do you think this model shows?' or 'what do you think this part represents?' the significance of the model can be appreciated at a slower pace so that it is not so much a complete artefact but more a picture built up through discussion. I have found that by taking the discussion further by asking for example 'What could we use this model for?' or even 'Why might this model be misleading?' students start to appreciate some of the limitations of a novel point of view.



Bob Kibble

Sky Diary Winter 1994-95

By Eva Hans

Solstice: 1994 Dec 22^d 02^h 23^m
Equinox: 1995 Mar 21^d 02^h 14^m

MOON PHASES:

	New Moon	First Quarter	Full Moon	Last Quarter
Jan	1 ^d 10 ^h 56 ^m	Jan 8 ^d 15 ^h 46 ^m	Jan 16 ^d 20 ^h 26 ^m	Dec 25 ^d 19 ^h 06 ^m
Jan	30 ^d 22 ^h 48 ^m	Feb 7 ^d 12 ^h 54 ^m	Feb 15 ^d 12 ^h 15 ^m	Jan 24 ^d 04 ^h 58 ^m
Mar	1 ^d 11 ^h 48 ^m	Mar 9 ^d 10 ^h 14 ^m	Mar 17 ^d 01 ^h 26 ^m	Feb 22 ^d 13 ^h 04 ^m

There are no eclipses this quarter; however there will be an occultation of the bright star SPICA by the Moon on Mar 19d 00h. An occultation occurs when the Moon, in its easterly passage through the constellations of the zodiac, passes in front of a star (or planet).

MERCURY

Mercury is an evening object until Jan 29th when it becomes too close to the sun to be visible. It reappears in the morning sky from Feb 10th.

VENUS

Venus is very prominent in the morning sky - It is in conjunction with Jupiter on Jan 14th (Venus is the brighter planet).

MARS

Mars is in the morning sky in the constellation of Leo. It passes 4°N of Regulus on Jan 28th and reaches opposition on Feb 12th when it can be seen all night. The distinctive reddish colour of the planet should be easily seen.

JUPITER

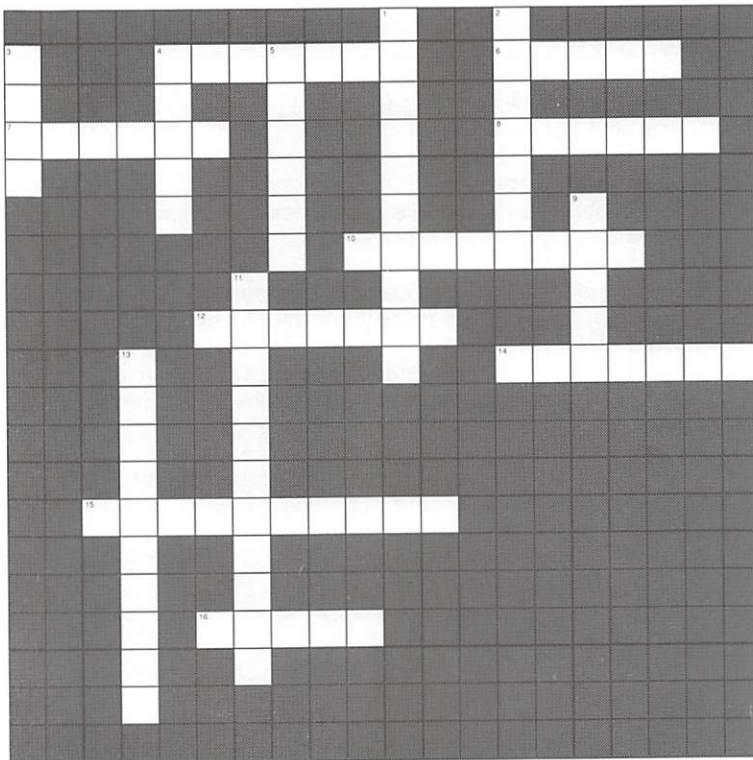
Jupiter is in the morning sky moving from Scorpius into Ophiuchus and passing 5°N of Antares on Jan 23rd.

SATURN

Saturn is in the evening sky until mid February when it becomes too close to the Sun for observation. It reappears in the morning sky from mid March. Saturn remains in Aquarius throughout this period.

For a free chart of the phases of the moon for 1995 please send a large sae to:
EVA HANS, THE PLANETARIUM, SOUTH TYNESIDE COLLEGE, ST. GEORGES AVENUE, SOUTH SHIELDS, TYNE AND WEAR NE34 6ET.
TEL: 091 456 0403 EXT 477.

FANTASY OF FLIGHT



ACROSS

- Man who invented the telescope.
- King Etena is said to have flown to heaven on the back of it.
- In Cyrano book "Voyages to the Moon and the Sun" a machine powered by a _____ was used.
- Man who attempted lunar flight by using bottles filled with dew.
- The Egyptians called it the "Heavenly Nile".
- Great science-fiction classic of space flight published in 1634.
- Persian mythical king was carried into the clouds on his throne by four eagles.
- With their arithmetic they acquired knowledge about the periods of the sun, moon, and planets.
- Over 1500 years before Christ, the Egyptians recorded seeing this planet.

DOWN

- Polish astronomer who stated that the earth orbited around the sun.
- Winged messenger of the gods.
- Novel, "Across the Zodiac", hero travelled to this planet.
- Domingo Gonsales was carried to the moon by their migration flight.
- Daedelus' son who flew too near the sun.
- He proposed a lighter-than-air ship in 1670.
- Frenchmen with first successful balloon flight June 5, 1783.
- His followers first suggested that the earth was round or sphere.