GNOMON

Newsletter of the Association for Astronomy Education

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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

For technical reasons, "The Universe in the Classroom", the widely praised Newsletter of the ASP, will in future be sent out (with GNOMON) as a *separate periodical* and not incorporated into GNOMON as has been the policy in the past. Members of AAE will therefore receive two periodicals for their subscriptions: it will be noted that issues of "The Universe" sometimes run to more than the usual four pages.

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We have received the first copy of a new astronomical periodical called SPECTRUM. This replaces both GEMINI and the UKIRT newsletter, which are now discontinued. It will appear every three months. SPECTRUM is the newsletter of the combined Royal Observatories, the RGO in Cambridge and the ROE in Edinburgh, as well as the Isaac Newton telescope group on La Palma and the Joint Astronomy Centre on Hawaii. The AAE receives copies of SPECTRUM in exchange for GNOMON. Members who would like to receive copies of SPECTRUM should write to: SPECTRUM, Royal Greenwich Observatory, Madingley Road, Cambridge CB3 0HA, England, and ask to be put on the mailing list. There is no charge for this journal, but please mention your membership of AAE.

The format of this excellent newsletter is similar to the Institute of Physics' publication "Physics World".

* * *

An outline of the activities of London astronomical societies is published monthly (except during vacations) by the Astronomy Forum at the University of North London (known as PONLAF). This should be useful to AAE members living or working in London and south-east England. The programmes are being sent out to these members with their copies of GNOMON. There may be some overlap of information as GNOMON is a *quarterly* periodical. If you would like to receive copies and you are not on our list, please let me know. Further information from Matthew Hepburn, PONLAF, University of North London, Holloway Road, London, N7 8DB (tel.: 071-607 2789).

Eric Zucker

AAE ANNUAL GENERAL MEETING, 1994

AT THE ROYAL OBSERVATORY, EDINBURGH

About 25 people attended the AAE's Annual Meeting on May 14th, held this year at the beautiful location of the Royal Observatory, Edinburgh (ROE) which is celebrating 100 years of astronomy at Blackford Hill this year.

The morning was taken up with a business meeting, during which minor amendments to the Constitution required by the Charities Commission in order for the AAE to attain charity status, were discussed. The amended Constitution will now go back to the Charity Commissioners. The Treasurer, Bob Kibble, announced an improvement in the number of members.

Delegates then enjoyed a buffet, followed by an interesting short talk given by Dr John Peacock, Head of Research at the ROE. He discussed the links between the ROE and its instruments in Hawaii, primarily the 1.8m United Kingdom Infrared Telescope (UKIRT) and he gave a brief overview of some of the theoretical cosmological problems in astronomy which are tackled at Edinburgh, which employs over 100 scientists, about half of whom are technicians.

A series of simultaneous workshops followed. Delegates were given access to the ROE's coelostat where, thanks to unusually clear, sunny weather, an 18-in projected image of the Sun's disc could be viewed. As we are approaching solar minima the surface was fairly clear of spots, except for one reasonably large pair. The coelostat

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GNOMON - definition in the **Reader's Digest dictionary:**
An object, such as the style (projecting arm) of a sundial, that casts a shadow used as an indicator. From the Greek: one who knows, indicator, interpreter, from *gignoskein.*

Subscription Rates:

Individual Members	£7.50
Retired Members	£5.00
Corporate Members (e.g. schools, colleges etc.)	£15.00

Corporate Members will receive three copies of *Gnomon.*

Extra Copies:

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: Teresa Grafton, The London Planetarium, Marylebone Road, London NW1 5LR - for all general enquiries. (Tel: 071-486 1121)

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)

Publications: Nik Steggall, 38, Victoria Crescent, Birkdale Road, Dewsbury, W. Yorks WF13 4HJ

Advertising Charges:

Whole page	£120
Half page	£60
Quarter page	£30
Inserts	£75*

* 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.

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also showed small sections of the solar spectrum, displaying, amongst other things, the double absorption line of sodium.

Elsewhere, delegates were able to put the PC program Dance of the Planets through its paces, and see an animated computer program about black holes and gravitational lensing. Local teachers also had the opportunity during a brainstorming session to get the answers to some of their most pressing questions about teaching Astronomy in the National Curriculum.

We were also allowed behind the scenes to inspect the Plate Library, where all images taken by UKIRT are analysed. The work is undertaken by a computerised machine known as COSMOS (COordinate Shape Magnitude Orientation Size) which can scan an image containing up to two million images!

Later there was some free time to explore the new Visitors Centre, the well-stocked gift shop and the 36-in telescope which sadly is no longer in use. The instrument, however, is one of the highlights of the tour given to visiting school parties, who delight in seeing their teachers put into the observing chair which is then elevated up to the eyepiece!

Sue Tritton is to be commended for organising an enjoyable visit for the AAE to one of the UK's premier centres of astronomical research; we all look forward to next year's meeting.

The results of the elections to Council were as follows:

President:	Dr. Anne Cohen
Vice-Presidents:	Dr. Mike Dworetsky Julian Ravest Alex Lovell
Secretary:	Teresa Grafton
Treasurer:	Bob Kibble
Assistant Secretary (Publications):	Nik Steggall
Assistant Secretary (Minutes):	Steve Tidey
Ordinary Members:	Joseph Reale Tony Lacey Alan Pickwick Sue Tritton
Resource Centre Representatives:	Eva Hans (South Tyneside College Planetarium) Teresa Chilton (Jodrell Bank Science Centre) Paul Deardon (Liverpool Museum and Planetarium)

The Editor is appointed by the Council, not the AGM.

This article was compiled by Steve Tidey and Eva Hans.

BOOK REVIEWS

SIMPLY SPACE: Northamptonshire Science Resources, Earth and Space Activities for Key Stages 1, 2 and 3. Published by Northampton Inspection and Advisory Service, ISBN 0-947590-17-X, soft back, £18.00.

The book is printed on A4 paper in landscape orientation. It is spirally bound so opens up flat for photocopying. It is not very robust for the price.

The team of writers are all involved in Primary School Education or Astronomy Education.

I found the introductory section very useful but hope that the remarks to teachers with limited knowledge of Astronomy will not distance them from the work and make them feel that it is more difficult than it is.

There are good flow charts illustrating the sequence of steps to follow during a scientific investigation and well laid out schematics showing classification of ideas and links between the ideas to be included in the learning sequence upon which the book is based. These are referred to later to show the stages which a class should have completed before proceeding to the next section. They may take time to study and follow through but are worth the effort.

The page layout is clear and simple with information, drawings and a panel for activities which could, in many cases, be used as a work card for the pupils. This also includes a warning indicating if there is any possible danger to avoid.

Throughout the book each section starts with relevant extracts from the Programme of Study for the Key Stage work which is to follow. This saves the teacher having to look elsewhere for this important information but unfortunately the curriculum is being changed again so this may not be correct. It is an excellent idea to identify areas where the subject matter is linked with National Curriculum Statements of Attainment with Maths and Geography.

The pupils are made to think and reason by means of activity cards, board games and sorting games all of which can be freely photocopied by teachers. The activities are also stimulating and "fun" which is conducive to learning without realising it!

I like the idea of the "My year mobile" which means that the progress of the Earth round the Sun can be followed throughout the year. The experiments demonstrating the effect of the angle of the Sun's rays arriving on the Earth were new to me. A lamp shining at different angles can be used to show the spread of light over squared paper, and the temperature of sand warmed by the light can be measured using a thermometer.

The early work on shadows should have been included before introducing day and night. The fact that light travels in straight lines has not been emphasised, though it needs to be understood for shadows and eclipses and in explaining why the Earth is half in sunlight and half in darkness. To demonstrate day and night the teacher is told to remove the globe of the world from its stand and support it in an upright position which is unfortunate as first ideas often stick firmly in a young mind. I am not sure about giving the class true and false cards to sort out - I know that this is designed to make them think but wrong ideas can be taken on board as being correct. Pupils in secondary school consider their teacher wrong if information given then is not the same as that introduced in primary school.

Teaching about eclipses before explaining movements of the Sun, Moon and Earth in relation to each other seems to be putting the cart before the horse.

The work on stars is well explained with good activities including using glow-in-the-dark stars. I am sure that children would enjoy making constellations using them.

Models of the Solar System always present problems but various good ideas are suggested.

The section "Background Knowledge" at the end of the book would be very helpful to anyone with limited knowledge of Astronomy.

To accompany the book there is a set of board games and cards (identical with those in the book) ready made up with protective plastic covering. This would save a teacher hours of work and costs £23.30.

There is also a complete kit for £220 inc p&p containing the book, the board games, the work cards and 60 items of equipment needed for the activities in the book. It includes: four globes all the same size; a safe plastic round lamp (which does not get too hot) to represent the Sun; forehead thermometers; a digital thermometer; sets of shapes to represent the Sun, the Moon and its phases, the planets; plus many other items. Some are consumables - like luminous stars. A Science Centre could find the kit useful for training teachers, but schools might find it expensive.

In summary, I feel that a lot of thought and work has gone into the preparation of this book. It is full of good ideas and if I were a teacher without any knowledge of the subject I would buy it myself to make my life easier!

Reviewed by Christine Sheldon, Hon. Secretary of the FAS, retired secondary school science teacher, Member of Worcester, Cotswold and Stratford-upon-Avon Astronomical Societies.

COLLINS DICTIONARY OF ASTRONOMY, published by Harper Collins in April 1994, paperback, 520 pages, ISBN 0-00-470370-0, £8.99.

I have before me *three* dictionaries of astronomy: (i) A Dictionary of Astronomy, edited by Valerie Illingworth and published by Macmillan in 1981 (paperback); (ii) A Concise Dictionary of Astronomy compiled by Jacqueline Mitton in 1991 (OUP) (hardback); and (iii) Collins Dictionary of Astronomy, also edited by

Valerie Illingworth (soft back) and published in 1994. The subject of the current review may be regarded as the successor to the Macmillan version which is now out of print. My copy of the earlier work is now well-thumbed and turned down at the edges, and so a replacement is very welcome. Needless to say, after an interval of some thirteen years, there are many more astronomical terms, and some more contemporary definitions.

The OUP dictionary is unrelated to the other two, and was reviewed by me in GNOMON (11, 2, Winter 1991) (q.v.). Nevertheless, one is tempted to compare critically the two later compilations. Let me say straight away that both dictionaries are admirable, and at a cursory glance are very similar, in format and style.

I must confess that I am an unrepentent lexicophile, and I enjoy using dictionaries not only as works of reference, but also reading them, not necessarily from cover to cover, but like a book of short stories. Using the many cross-references one can skip from definition to definition - and then do the same for the other books.

Only a few words are found to be missing (in both dictionaries). Taking one word at random, why is "asterism" missing from the Collins edition, but not from the other two? Also of interest: I see the *Boötes* of the earlier two dictionaries has lost its diaeresis. It this a ruling from the IAU?

Home libraries usually have more than one dictionary on their shelves, and I would thoroughly recommend that the latest Collins version be added to the collection. Happy reading!

Eric Zucker

SPACE - LINK

Compiled by Nik Steggall

NEW PERSPECTIVES ON SPACE

A new video from the British National Space Centre (BNSC), Britain's space agency, entitled "New Perspectives on Space" has recently been made available. Running for 10 minutes, the video attempts to answer many questions such as what is in space? Why go there? Why are there such telescopes as HUBBLE and ROSAT? Can we look down, as well as up? Earth observations, what are "SATCOMS"? How is Britain involved? Have we got a space *agency?* All these and many more questions are answered.

This video will be of value to schools, local authorities and also those interested in putting space data and technology to work. Copies of "New Perspectives On Space" are available from: CFL Vision, P.O. Box 35, Wetherby, Yorkshire LS23 7EX. Please quote ref UK 6279.

THE BRITISH NATIONAL SPACE CENTRE

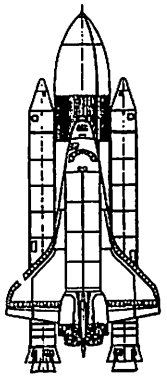
The BNSC produce a number of publications regarding Britain's active and successful role in space. Topics covered are Earth Observation, using space as a tool, space science, satellite communications, space technology.

Further information can be obtained by contacting the Information Office, British National Space Centre, Dean Bradley House, Horseferry Road, London SW1P 2AG, United Kingdom, or telephone 071-276 2376.

HIPPARCOS: MISSION ACCOMPLISHED

After more than three years of efficient and successive operations, communications with EAS's scientific satellite Hipparcos were terminated on 15 August 1993. The Hipparcos satellite, a purely European undertaking and the first space experiment dedicated to the highly accurate measurements of star positions, distances and space motions, was launched in August 1989. Targeted for an operational lifetime of two and a half years, more than three years of high quality star measurements were eventually accumulated and all of the original scientific goals of the mission have been fully accomplished.

Extremely accurate positions of more than 100,000 stars, precise measurements (in most cases for the first time) and accurate determinations of the stars' velocity through space have been derived. The resulting HIPPARCOS Star Catalogue, expected to be completed in 1996, will be of unprecedented accuracy, achieving results some 10-100 times more accurate than those routinely determined from ground-based astronomical observatories. A further star catalogue, the Tycho Star Catalogue of more than a million stars, is being compiled from additional data accumulated by the satellite. These catalogues will be of enormous value in astronomers' attempts to understand and describe the properties and evolution of stars and the dynamic motion of these stars within our galaxy. In the process Hipparcos has discovered many thousands of new binary star systems and measured the precise light variations of many hundreds of thousands of stars over its operational lifetime. Hipparcos has also provided an accurate and independent validation of the predictions of General Relativity.



Space Shuttle

(Hipparcos information originated from the European Space Agency.)

NOTICE!!! AN EXERCISE IN SPACE PLANNING

Because of budgetary cut-backs, the funds for personnel hiring have been drastically cut. You will be able to select only *ten* people to staff the station in the beginning. List them, giving reasons for their selection. Each person would be expected to stay on the station for at least six months.

If funds become available, some of you will be able to select *five* more individuals. Those decisions will depend on the reasons you state for the five additional staff you decide to take if possible. Be sure that your statements are convincing!

Further information from Nik Steggall (address on p.1 of GNOMON).

POTENTIAL PERSONNEL FOR SPACE STRUCTURE

1. Medical doctor
2. Nurse
3. Lawyer
4. Teacher
5. Cook
6. Military person
7. News media representative
8. Librarian
9. Policeman
10. Computer expert
11. Communication expert
12. Minister
13. Politician
14. Astronaut
15. Janitor
16. Administrator
17. Fireman
18. Psychiatrist
19. Pharmacist
20. Aeronautical engineer
21. Mechanical engineer
22. Astronomer
23. Geologist
24. Meteorologist
25. Rocket expert
26. Mathematician
27. Entertainment director
28. Historian
29. Mechanic
30. Others (be specific)

S A T

SHUTTLE AWARENESS TEST

The following quiz requires only one answer per question - either true or false. The questions are designed to illustrate certain points about the space transport system known as the shuttle.

1. T F The shuttle will never fly to the moon.
2. T F The muffler for the launch of the shuttle is made of water.
3. T F You can breathe one of the two components used by the three main engines of the shuttle.
4. T F The robot arm of the shuttle can lift up to 32 tons in space but cannot lift itself on the ground.
5. T F The shuttle can carry up to seven people into space.
6. T F The toilet on the shuttle uses no water.
7. T F The cargo bay of the shuttle is long enough to park a school bus and a family car.
8. T F The payload specialists who will go into space will not be trained as astronauts.
9. T F In orbit, the shuttle can go from one side of this country to the other in about 12 minutes.
10. T F The space shuttle could land at any major airport.

BONUS QUESTION:

T F The drinking water for the crew is made while in space.

Answers: No. 1 is true. All the rest of the numbers (2 through 10) are true. The bonus question is the opposite of false!

THE IMPACT OF SUMMER

by Roger O'Brien

I PUT up my computer sky chart for 1994, June 21 as a starter for writing this article. The moon is pretty near full and hovering over the southern horizon at an altitude of 15°. This means that you'll have to wait about a week to get a chance to see properly one of the most famous stars in the sky - Antares. The name means the "rival of Mars". It is a richly red star and dominates the constellation of Scorpio.

PLUTO is lurking nearby in Serpens Caput, but it is not an easy object to find or be sure you have found. There is controversy about whether it is a true planet or the largest of a group of planetesimals, forming the inner rim of the "Kuiper belt". Of course, Pluto does have a moon (a plus mark for planetary status). The moon is called "Charon" after the ferryman who conveyed the dead across the River Styx into the realm of Pluto, god of the underworld.

FOR several years the orbit of Charon carried it across the visible face of Pluto. This enabled a very crude mapping of both objects to be done by analysing the image data gathered during these eclipses. Pluto is redder and somewhat paler than its dark grey moon. Pluto has light polar caps and a bright and dark equatorial spot. At a diameter of 1,190km, Charon is by far the largest moon, in comparison with its primary, in the Solar System. Pluto is only 2,300km across. The two are locked in a tight gravitational embrace and the moon's period of revolution is the same as the planet's period of rotation: 6 days, 9 hours, 22 minutes.

THIS summer's planet is Jupiter, which will be edging slowly east out of Virgo. It is a good planet for casual observation since it is very bright and easy to find and a telescope shows a noticeable disc with horizontal banding. Even with binoculars, it is quite easy to pick out the four "Galilean" satellites. At least one of these, Ganymede, would be visible to the naked eye, if Jupiter's light did not swamp it out.

IN July, a train of bits of comet Shoemaker/Levy 9 will crash into Jupiter. The largest explosions will take place less than an hour before the local Jovian dawn. The Earth is always on the "day" side of Jupiter. The space probe, Galileo, will get a first class view and should send back pictures despite its useless High-Gain Antenna. There have been articles in the Press concerning the results of these impacts. I do not believe that the disintegrated debris of a modest comet can do anything significant to a planet the size of Jupiter. I can't see any way the event could threaten us. The table shows a list of impacts at times when Jupiter is above our horizon. The explosions may generate a thousand times the light Jupiter receives from the Sun so we may see a little of it reflected from moons in the planet's shadow.

QUITE near Jupiter is the bright star - Spica - another of those white-hot, young, first magnitude stars. It is the brightest star in Virgo and at the end of a wide arc, which you can trace all the way along the tail of the Great Bear (or the handle of the Plough) past the bright yellow Arcturus down to Spica. The area between Jupiter and Antares is filled with another undistinguished zodiacal constellation - Libra. It is interesting to see how the zodiac changes its orientation on the sky during the summer. In June, the line of ecliptic (which is the apparent path of the Sun in the sky and the approximate centre of the Zodiac) crosses the horizon in the south-east and rises through Virgo to a maximum of perhaps 40° between Virgo and Leo. By August, the Zodiac and the Ecliptic lie almost flat along the southern horizon.

Date	Time ±40 min	Moons
16	19:00	
17	15:00	
18	19:00	
19	21:00	Europa, Callisto
20	15:00	
21	15:00 18:00 21:00	Callisto

SOMEWHAT east of the Zenith and the constellations of Boötes and Ursa Major lies Hercules. Although a large constellation, it lacks any striking grouping of bright stars. One asterism (a pattern of a few stars) is called the "keystone" because its four not very bright stars resemble the outline of such a stone. Between two of the keystone's stars you can find a faint slightly blurry star. This is actually a globular cluster: a beautiful object, a cluster of about a million stars arranged in a compact ball about 50,000 light years from the Earth.

MOVING still further east, you will find a small parallelogram of modest stars near a brilliant blue-white one. This constellation is Lyra and the bright star is Vega. On the far side of the parallelogram in the middle of its shorter side is the "Ring" nebula (catalogued as M57). It is a shell of gas that used to be the extended photosphere of the red giant. The degenerate core of the giant remains as a small, dim, but very hot, blue star in the middle of the "ring". This is not an easy object, but it is very satisfying when you find that little smokey ring in the field of view.

IN 1983, the Infra-Red Astronomy Satellite (IRAS) discovered that Vega, though long thought to be a typical class A star, gives out more infrared radiation than expected. Analysing the radiation leads astronomers to think that it comes from a dusty cloud at a distance of about 80 Astronomical Units from Vega. The "astronomical unit" is the average distance from the Earth to the Sun. Vega is a young hot (10,000°K) star and it is very stable. It does not eject clouds of sooty or dusty matter in the way that Antares probably does. The dusty disk has been with Vega since it formed. Very interesting and rather unexpected and a lot of astronomers are still trying to work out what effect this discovery has on their models of how planetary systems form.

DWARF FACES IMMOLATION IN SAGITTARIUS

by Roger O'Brien

RATHER a Wagnerian headline, I know, but all the good ones for this story are spoken for. "Milky Way eats Galaxy" was probably the best. But it is a good story so I shall tell it again. Rodrigo Ibata, a research student, was working away at his thesis with Dr. Mike Irwin of the Royal Greenwich Observatory (RGO) and Dr. Gerry Gilmore of the Institute of Astronomy in Cambridge. His main objective was to observe the velocities of stars in selected fields in the southern part of the Milky Way's central bulge, which is in the constellation of Sagittarius.

THIS sort of project is the meat and drink of postgraduate research and it is not generally expected to find anything startling. In this case, the exception was the rule. Rodrigo discovered some anomalies. When he plotted the velocities from one of his fields, they did not form a good approximation to a smooth Gaussian curve, but showed an unexpected, indeed unwanted, "spike" off to one side of the main peak. There were too many stars moving at higher than average speeds in that area.

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Continued from page 4

The first reaction has to be "Is there some kind of mistake?" Patient rechecking and investigation of neighbouring areas did not make the spike go away. In fact, the spike became clearer: so much clearer that it ceased to be "noise" disturbing the pattern and became a "signal" in itself. It is hard to convey how much work is involved at this stage. A lot has already been done, but it has hardly started. The astronomers must now try to find the extent of the area of anomalous velocities. It is necessary to examine very carefully the reference sources - the survey plates taken by the UK Schmidt Telescope (which is in Australia). At least there is now an Automatic Plate Measuring facility at Cambridge to reduce the sheer labour of this work. Meanwhile, the Anglo-Australian Telescope provides an invaluable, if somewhat ill-named, instrument: AUTOFIB. This uses fibre optic links to take simultaneous spectra of many stars (it is quite the reverse of a device for being economical with the truth). Yet another task comes in now - to estimate the distances of these anomalous stars.

When all this has been done, there still remains the problem "What is it?" The best model is of a dwarf spheroidal galaxy, which, with globular clusters in attendance, is very close to the rim of the Milky Way's disk. It is not yet clear whether it has passed its closest approach or will soon (in astronomical terms) crash into the outlying spiral arms. The dwarf is already drawn well out of shape. It is greatly elongated, by the immense tidal forces of the Milky Way.

Why is this the best model?

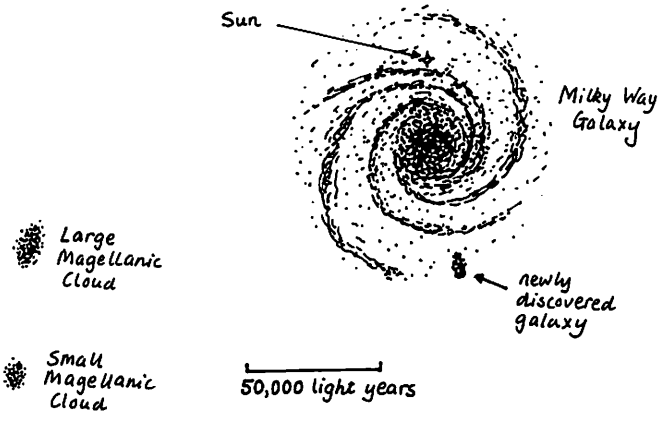
A DWARF spheroidal galaxy will contain a few million stars, mainly of elderly red types. Its normal size is around a 1000 light years in diameter. It might have its own satellite globular clusters and the whole ensemble will move in an orbit round the Galaxy at a characteristic velocity. This galaxy is composed of the right types of stars. It is at the same distance, 80,000 light years, as the globular cluster, M54, and both are travelling away from us at 153km per second. This does not necessarily mean that it is travelling away from the Milky Way since its transverse velocity has yet to be determined. It is possible that three other globular clusters in this general area of sky are also associated with the newly discovered galaxy. M54 is in the same line of sight as the larger of the two clumps into which the dwarf is being drawn.

THE size of the Sagittarius dwarf is, at first sight, a problem. It is about 10,000 light years from one end to the other. However, this simply indicates the extent to which the tidal forces produced by the Milky Way's gravity have disrupted it. Dr. Mike Irwin points out that it is already something like six times the stable size its own gravity would give it. Whether it has already passed or is approaching its closest encounter, it will be wrenched asunder and disperse slowly to be lost among the stars of the much larger Galaxy.

IT is important to realise the scale of things. The Large Magellanic Cloud was previously thought to be the closest neighbour to our Galaxy. It is right in our backyard at 170,000 light years. Rodrigo's galaxy is less than half that distance from us and still closer (at only 50,000 light years) to the centre of the Milky Way.

AS Dr. Paul Murdin said during the European and National Astronomy Meeting at Edinburgh (ENAM), it is a most attractive postscript to put at the end of your PhD thesis - by the way I've discovered the nearest satellite galaxy to our own. The only sad part is that the Sagittarius dwarf spheroidal is hidden from amateur observation by being behind the dense starfields of the Milky Way's central bulge. It can only be detected by the statistical methods I have tried to detail. It was a really exciting discovery to open ENAM and my congratulations to Rodrigo Ibata and his supervisors.

Location in space of newly discovered galaxy in relation to the Milky Way and the Large and Small Magellanic clouds.



Please note the following deadlines for articles and letters for GNOMON: 21 April, 21 July, 31 October, 21 January.

A SUN ELEVATION INDICATOR

by Harry Ford

Here at the Old Royal Observatory I get calls from architects asking about the height of the Sun at some site they are working for midsummer or midwinter, at midday.

They think of course that such problems can only be solved by computers or mathematical tables and spherical trigonometry. We astronomers can produce a simple calculator which will do the job very well.

As in the drawing, there are two plates in the PLANE OF THE MERIDIAN divided into DEGREES.

1. This is a round disk with indicator arrows for LATITUDE (place) and ALTITUDE OF SUN. The altitude of the Sun changes during the year by 23.6° above or below the CELESTIAL EQUATOR which is at 90° to the POLE as shown.
2. The outside scales are degrees of LATITUDE and ALTITUDE each side of the ZENITH.

To use the indicator just dial the latitude of the place and read the latitude of the Sun for any midday of the year.

It is instructive for any student to see by fiddling around with the scales how the Sun at the EQUATOR will only ever be a little way from the ZENITH no matter what time of year, and how at the POLE the Sun always seems to be above or below the HORIZON. The gadget supplements the diagrams to be found in textbooks explaining aspects of spherical astronomy.

The indicator only works, of course, for the Sun at midday along the **PLANE OF THE MERIDIAN**. What about mornings or afternoons? For this of course we would need the full armillary sphere.

The Planetarium
Old Royal Observatory
National Maritime Museum
Greenwich
London SE10 9NF

Footnote: To save space diagrams have not been reproduced in this article, but may be obtained direct from The Planetarium at the ORO.

MODELS OF THE NIGHT SKY

by Tony Lacey

Having recently retired from the hurly-burly world of mainstream education and taken up the more sedate life of a student of baroque instrument making, I have had the opportunity to return to the "real stuff" of actually teaching astronomy. One of course deals with astronomy and cosmology in general, making comparisons between belief systems in different cultures and at different times.

Over the five or six million years that Man has looked at the night sky there was little need to have any understanding of the heavens until the advent of agriculture some 10 to 20 thousand years ago. Early civilisations all established a sufficiently accurate calendar for this purpose and later as observations accumulated some went on to develop a model of the heavens. Such a model should explain:

1. The general appearance of the Earth and sky
2. The apparent motion of the Sun
3. The motion of the Moon and its phases
4. The annual cycle of the stars
5. The seasons
6. Eclipses
7. Unusual events such as comets, novae and meteor showers.

In addition some cultures developed religious/scientific models which explained:

1. The origin of all things
2. The origin of the solar system
3. The life history of stars and galaxies
4. Other observable phenomena such as structure of galaxies, pulsars, quasars etc.

In the distant past religious ideas were used to explain most or nearly all of the features of the night sky and other questions about the universe were not yet posed in scientific form. By the 16th century Aristotelian ideas gave a reasoned explanation of much of the night sky but left the more unusual events and a universal cosmology in the hands of religion. This model was sufficiently developed to give reasonable predictions of planetary positions but, while there was some evidence of a lack of celestial perfection as demanded by Aristotle, there was also a lack of accurate observations which could be used to overcome some powerful arguments which proved that the Earth could not move. The chief of these was the absence of stellar parallax over a year. In the 17th century the work of Newton, Galileo and others combined to take all of the observable universe into the province of mathematical and predictive sciences: this left only ultimate origins and some special features in the hands of a "prime mover" or a "celestial clockmaker".

Currently science attempts explanations of all of the observed phenomena reducing them to a complex collection of related sets of equations of inconceivable difficulty and largely defying complete solution except in isolation and under special circumstances. Those of particular religious persuasions are left to their own beliefs which do not often contain any specific cosmological implications except the creation itself. This triumph of scientific rationalism over belief is at the cost of excluding all that science can not or will not cope with, such things as the "interconnectedness of all things", astrology, fundamentalism and intuitive knowledge. Viable but non-standard theories cause extreme behaviour in the scientific community and can sometimes be refused serious consideration at all. The relative success of the scientific method is also at the cost of excluding most of humanity from comprehending the current and ever changing scientific models. As a result popular belief and understanding can sharply diverge from the scientific view, Aristotelian ideas flourish, astrology is widely accepted, belief in UFO's, visitors from outer space, is common and extreme theories about ancient monuments or the sinister role of government security forces abound.

There is a very considerable job for astronomy teachers to do in making this popular but difficult subject shed light on the nature of science and in making its main messages clearer to the public.

282, Rutland Road
West Bridgford
Nottingham NG2 5EP

FAS HANDBOOKS, 1994

Some handbooks are still available from Nik Steggall (address on p.1 of GNOMON) at £3.50 each, less 10% for AAE members.

THE LONDON PLANETARIUM

Marylebone Road, London NW1

(tel: 071-486 1121)

FORTHCOMING EVENTS:

Every Wednesday from September 5 to October 26:

The Sky this Month

A live talk on the night sky for the month ahead - includes information on planets, star patterns, spectacular objects beyond the range of human sight, position of Sunrise and phases of the Moon.

Follow the night through with the aid of the Planetarium's perfect conditions (no light pollution!).

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FAS ANNUAL MEETING 1994

This took place in Coventry on May 7. After the business meeting in the morning, members heard three excellent lectures on the present state of space travel, little green blobs and quarks!

Pam Spence was elected to the post of President and Chris Sheldon was re-elected Secretary.

DUBLIN SCIENCE EXPO: AIMS AND OBJECTIVES

In December 1993 the decision was taken to develop Dunsink Observatory as a national public resource and science education centre. Founded by Trinity College in 1783, the observatory is probably best known as the home for his entire working life of William Rowan Hamilton, Ireland's greatest mathematician. Since 1947 Dunsink has been part of the School of Cosmic Physics of the Dublin Institute for Advanced Studies and it has served the research needs of Irish astronomers in a time of rapid scientific advance. However, as most astronomical observations are now made from space or at high altitude sites such as those in the Canary Islands and Chile, Dunsink is no longer needed for observational work. The main purpose of the new facility, known as Dublin Science Expo, will be to explain scientific ideas through the medium of astronomy.

Initially, the target audience will be school groups but families and tourists will be catered for also. The ground floor of the main observatory building and James South's 12-inch refractor will be opened to the public and a video theatre for up to 100 people will be set up in the Meridian Room. Exhibits in the main rooms and the hallway will illustrate topical events in astronomy and space science. While the subject matter of the principal exhibits will be closely linked to the school science curriculum, every effort will be made to demonstrate the relevance of science to modern life and the contributions of Irish scientists both past and present.

Work has already started on refurbishment of the observatory and on the task of moving the library from the ground floor to the upper floor where it will form a national astronomical archive. The Office of Public Works is advising on structural alterations needed to provide access for coaches and facilities for visitors such as cloakrooms and a shop. It is hoped to have the first phase of the Expo operational by September 1994. The completion of the link road to the Blanchardstown intersection of the M50 motorway will eventually provide convenient access from the Dublin road network.

The long-term development of the Expo will involve liaison with the appropriate local and national organisations and will include a search for funding, including commercial sponsorship. Apart from the architectural and scenic attributes of the site, Dunsink has considerable historical significance. As the space available for development in the main observatory building is limited it will be desirable to add further attractions such as a planetarium and a hall of science.

Dr. Ian Elliott, Project Manager
Dublin Science Expo
Dunsink Observatory
Dublin 15
Fax: (01) 838 7090

LETTER

Dear Editor,

I am writing to inform you of Starbase Four BBS, the first Astro/UFO BBS. The BBS offers 1 gigabyte of Astronomical Data to download and also has up-to-date Astronomical Information from around the world. This board can be accessed by anyone with a computer, modem and telephone line.

Starbase Four has been running for one year now and has 600 regular users from around the globe. Recently it has expanded by linking in to a Novell Network and offering a double BBS facility. This Double BBS allows users to access a dedicated Astronomical BBS but also access a dedicated MUFONET research board (UFO). Mufon is a world wide UFO investigation organisation based in Texas, USA, and I have taken on the role as the UK's Network co-ordinator.

Please give the board a try: I am sure you will find something there for every reader. If you have any questions please do not hesitate to contact me at the address below.

Coming soon: a direct gate into Internet via a UNIX machine and fast line.

Yours faithfully,

Pete Willamson
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Whittingdon
Shropshire
SY11 4DR

RELATIVITY AND THE TIDES

by Bob "Canute" Kibble

Understanding the tides requires an appreciation of what actually happens, the observations, followed by a satisfying explanation. The observations are complex with some places on Earth experiencing tides of a few cm change and others of several metres. Most of us are happy to simplify this to two high tides per day. Tide tables can be used to plot tidal data and elicit these patterns. This article is not about such observations but will offer an explanation which teachers may wish to develop.

Following yet another unsuccessful battle of tidal explanations I set myself the task of a literature search to seek out a satisfying and convincing story. Following research into undergraduate texts on astronomy and gravity,[1] it became clear to me that the solution to understanding tides was to be found in relativity, frames of reference and vectors. Not the most obvious starting place you might think. I found the article in SSR by John Harris,[2] a useful pointer towards a new approach and can recommend it to you.

Looking back I realise now that my journey along the wrong track started because I believed that the key to understanding the tides was to be found in a synthesis of centripetal forces, the idea of the barycentre and the inverse square law of gravity. Tread not this path I say unto thee for it leadeth up the proverbial garden! Far better to spend your time considering a little relativity. A diversion to explore the concept of "Frames of Reference" is needed.

Consider the commonly experienced "train at the station" situation. You wave farewell to Aunt Maude from the train. She waves to you from the platform. The train starts to move and you, for a moment, think that the station and Aunt Maude are moving (see Fig. 1a).

Viewed from your frame of reference in the carriage Aunt Maude appears to be moving to the west. To consider life from Maude's frame of reference you must subtract your velocity vector from both you and Maude as shown in Fig. 1b. This results in Maude seeing you moving to the east, Fig. 1c. Both views are equally valid. By subtracting Maude's velocity from the situation in Fig. 1a her velocity is reduced to zero and the

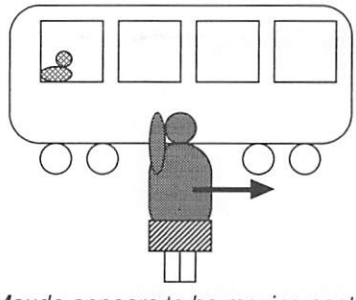

Fig. 1a. Aunt Maude appears to be moving east as viewed from your frame of reference on the train.

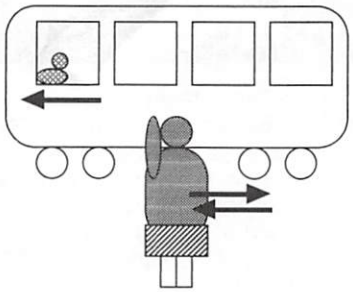

Fig. 1b. Changing the stationary frame of reference by subtracting Maude's velocity from your frame and Maude's.

world can be viewed from her, now stationary, frame, Fig. 1c.

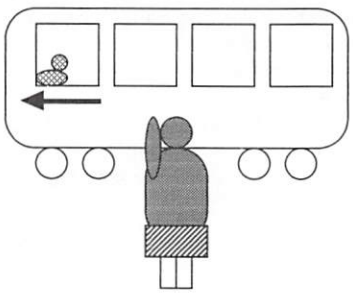

Fig. 1c. From Maude's frame of reference you are moving west.

Now let's apply this idea to the vectors representing forces on the Earth due to the Moon. In Fig. 2a the forces on the

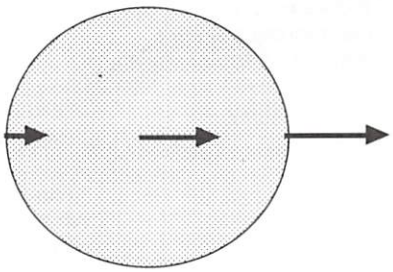

Fig. 2a. The Moon's attraction decreases with distance. The forces as observed by Maude the Martian.

water nearest the Moon, on the Earth and on the far water are represented by arrows of different lengths. This diagram is the view seen by Aunt Maude, the well-known Martian relative and train spotter. It is a distant view from a frame of reference, let us say on Mars, which for our argument is considered a stationary platform. As seen from afar the oceans and the solid Earth are all being forced to the right, towards the Moon. They all accelerate in this direction.

Let's call the Moon's attraction on a kg at the centre of the Earth the "average"

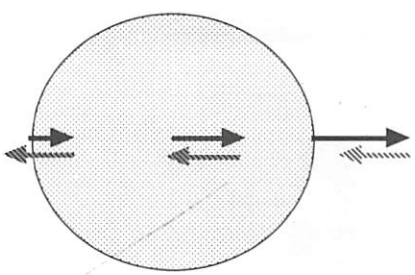

Fig. 2b. Changing the frame of reference to an Earth-centred observer.

Sky Diary Summer 1994

By Eva Hans

SUMMER 1994

Solstice: June 21d 14h 48m
Equinox: Sept 23d 06h 19m

PHASES OF THE MOON:

New Moon	First Quarter	Full Moon	Last Quarter
		June 23d 11h 33m	June 30d 19h 31m
July 8d 21h 37m	July 16d 01h 12m	July 22d 20h 16m	July 30d 12h 40m
Aug 7d 08h 45m	Aug 14d 05h 57m	Aug 21d 06h 47m	Aug 29d 06h 41m
Sept 5d 18h 33m	Sept 12d 11h 34m	Sept 19d 20h 00m	

PLANETS:

Mercury is in the morning sky from July 4th to August 5th and reappears as an evening object from August 23rd.

Venus is in the evening sky.

Mars is in the morning sky. It passes 5°N of the red star Aldebaran in Tauraus on July 18th.

Jupiter is in the evening sky in Virgo at the begining of summer but passes into Libra in mid-August.

Saturn is a morning object until September 1st when it reaches opposition and can be seen for the whole night. It remains in Aquarius.

OCCULTATION OF MARS

There is an occultation of Mars by the Moon on July 5th. Unfortunately it is not visible from the UK but if any members are lucky enough to be holidaying in S. Africa, S. India, Sri Lanka, Thailand, Malaysia or Indonesia they may have a chance to see it. An occultation occurs when the Moon passes in front of a planet or bright star.

METEORS

Perseids (meteor shower)

Dates visible:	July 23rd to August 25th
Best night:	August 12th-13th
Best direction:	before midnight NE after midnight E
Hourly rate:	80

You may obtain a free Perpetual Planet Calendar by sending a large s.a.e. to The Planetarium, South Tyneside College, St George's Avenue, South Shields, Tyne and Wear NE34 6ET (tel 091 456 0403 ext 477).

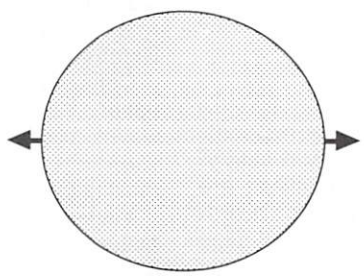

Fig. 2c. The tide generating forces relative to the Earth observer.

force. For the Earth observer, placed at the centre of the Earth, the tidal situation can be observed by considering their Earth frame of reference to be stationary. To do this we need to subtract the "average" force from the situation. This is done in Fig. 2b. The result, shown in Fig. 2c, shows the resulting forces as seen from the Earth-based observer, i.e. us. These forces are away from the centre of the Earth and are best described as "Tide generating forces".

You may ask "but can there really be an outward force (centrifugal!) if this is a circular motion situation?" The answer is simply - what circular motion? As seen from our frame of reference the Earth is stationary. Isn't this exactly how it appears? The two outward tidal bulges are only outward relative to a "centre of Earth" observer! From Mars, Aunt Maude sees us and the oceans free-falling towards the Moon.

In this simple analysis the train example uses velocity vectors whereas the tides employ force vectors. Vector subtraction works for all vectors but some pupils may need this point clarified. My sketches have been simplified by using only forces along the line of Earth-Moon centres. Additional vectors may be added[2] to show the effect at different positions on the Earth.

REFERENCES

1. Zeilik and Smith, *Introductory to Astronomy and Astrophysics* 2nd Edn. Saunders College Pub. New York, 1987.
2. Harris, J., *Gravitational Forces and the Tides*, in SSR June 1993 74 (269).