NEWSLETTER

of the

Association for Astronomy Education

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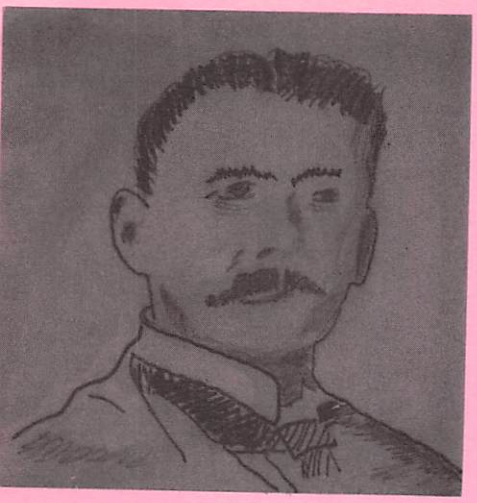
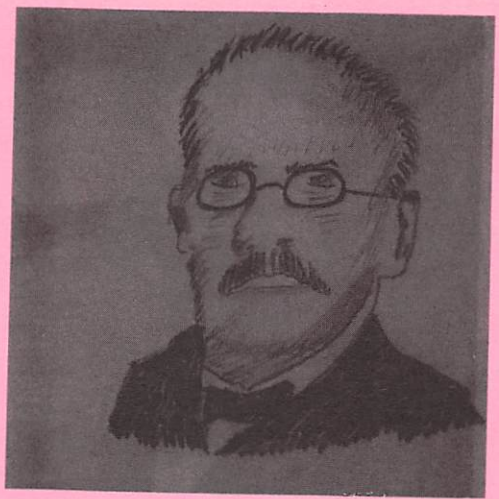
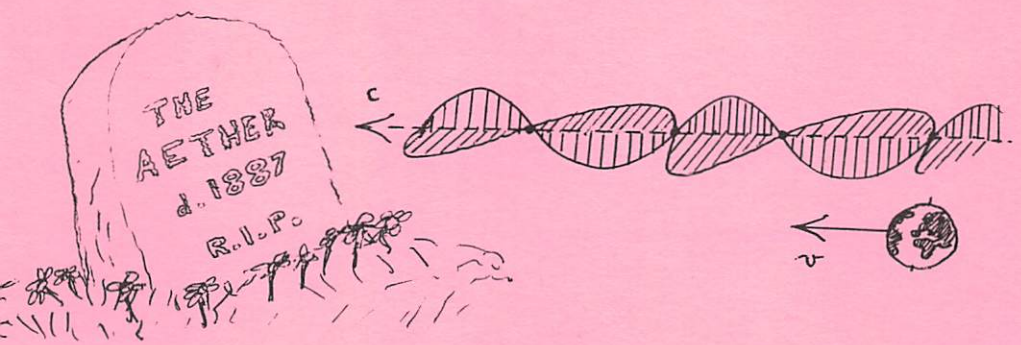


A. A. MICHELSON
(1852 – 1931)



E. W. MORLEY
(1838 – 1923)



AIMS OF THE AAE

The Association was founded in 1980 to promote the teaching of Astronomy at all levels in our educational system.

Membership is open to anyone who is interested in the promotion of astronomy education. Teaching establishments which have an interest in Astronomy (schools, colleges, polytechnics, universities, planetaria, museums) are eligible to affiliate to the Association.

NEWSLETTER

This is published 3 times a year (once a term) and is free to members.

ADVERTISING

Members of the AAE may insert personal advertisements in the Newsletter free of charge, as long as they are of reasonable length.

Commercial rates are as follows:

Full page	£12.00
Half page	£6.00
Quarter page	£3.00

If you wish to advertise in the Newsletter, please contact the Editor at the address on page 27.

ARTICLES FOR PUBLICATION

The Newsletter is a forum for the exchange of ideas and views. Members' contributions are welcome. Please send them, preferably typed, to the Editor at any time.

SUBSCRIPTION RATES (from 1 September to 31 August)

Individual membership	£5.00
Individual membership (retired member)	£4.00
Primary school affiliation	£4.00
Secondary school affiliation	£7.00
Other affiliations (University, Polytechnic, Library, Planetarium, etc.)	£10.00

Remittances should be sent to the Treasurer, Mr. R.V.J.Butt, The King's School, Canterbury, Kent, CT1 2ES, and cheques should be payable to the Association for Astronomy Education.

NEW MEMBERS

The Association welcomes new members - existing members can help in this respect by recruiting colleagues or friends who are interested in Astronomy education. Please show or lend this Newsletter to a friend who may be interested in joining. Extra copies may be obtained (while stocks last) from the Editor at a cost of £1. each.

EDITORIAL

We are pleased to publish in this issue a letter from a member expressing strong disapproval of the non-metric units which have appeared in several articles in the Newsletter. Similar disapproval has also been expressed by a few other members.

While in no way trying to make excuses for using units such as feet and miles, perhaps a few words of explanation may be useful. When the survey on "orders of magnitude" (see Newsletter, September 1986, Vol. 6 No. 1) was carried out, the answers given were always in Imperial units, never in metric ones. These answers were voluntarily supplied, without any outside pressure. Furthermore, maybe old units died slowly as, despite the imposition of the internationally accepted SI units, in common speech Imperial units abound. This is doubtless due to our history - apart from scientific work, we still live in an Imperial world. The width of a 'standard' door is 30 inches, not 75 cm (or 0.75 m); the speed limit is 30 miles per hour, not 0.013 km s^{-1}; a man weighs 11 stone, not 70 kg (although the latter is becoming more common). Some peculiarities of our units include those used in buying wood from a timber yard (e.g. 1 m of 2" x 1", and cloth (1.5 m of 54"). A road traffic sign in a busy road in south London for a long time displayed the message: traffic lights 150 yards ahead. One day it was changed to read: traffic lights 137 m ahead. (Later, the sign disappeared altogether!)

However, the Système International d'Unités (SI for short) has been accepted by the scientific community at large, and our correspondent is right to point out these glaring anomalies in the Newsletter. One must be very careful to be consistent, however, as all metric units are not necessarily SI. Thus the use of cm is frowned upon, as one should use powers of 10 raised to indices which are only multiples of 3 (i.e. 10^3, 10^6, 10^{-3}, 10^{-6} etc.) Thus 10^{-3}m (= 1 mm) is correct usage, but 10^{-2}m (=1 cm) is not, although it is grudgingly acceptable.

Perhaps astronomers are more reactionary than other scientists, as a glance at contemporary literature shows that the Ångström Unit (1Å = 10^{-10}m) for wavelength measurement is still in use. Infra-red astronomers do refer to wavelengths in the micrometre (μm) range, but in speech use the older term 'microns', or just 'μ'.

Again, the 2 500 mm telescope at Mt. Wilson is still better known as the 100". Boris Barlow, in the preface to his excellent book "The Astronomical Telescope" says: "Many of the world's most famous telescopes were made to the old pre-metric Paris inch of nearly 27 mm, or to the Imperial inch of 25.4 mm. (Whoever heard of the 5.08 reflector at Palomar?) I accordingly use the system of measurement

(mainly to identify aperture and focal length) by which the relevant instruments are best known. The SI system (sic) otherwise prevails."

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The Council at its meeting on 21 February 1987 discussed the points raised in the letter. Its advice was that, where necessary, both SI and Imperial units should be quoted, for example: the radius of the Earth is 4000 miles (6 400 km)

The views of readers on this problem (is it really a problem?) would be most welcome.

NEW COUNCIL POSTS

The Treasurer, Mr. Raymond Butt, will relinquish his post at the AGM in May. He has been the Association's Treasurer ever since it was founded six years ago, which is no mean task

The Council will propose to the meeting the name of Mr. L.B. Anslow to succeed Mr. Butt. Mr. Anslow is a schoolteacher from Farnham, Surrey.

Another (new) post which the Council will propose to the meeting is that of vice-chairman, who will deputize for the President in his absence. Miss Undine Concannon of the London Planetarium and an existing Council member will be proposed for this post.

Alternative proposals may, of course, be made from 'the floor' at the AGM.

ANNUAL MEETING AT THE NATIONAL MARITIME MUSEUM, GREENWICH, SATURDAY, 9 MAY 1987 from 10.30 a.m. - 15.30 p.m.

10.30 - 11.00	Registration, coffee and biscuits
11.00 - 12.00	AGM (business meeting)
12.00 - 12.30	Discussion and exhibition
12.30 - 13.30	Lunch
13.30 - 14.30	Short talks on planetaria
14.30 - 15.30	Guest speaker: Prof. S.R. Malin (Magnetism in the Solar System)
15.30 - 16.00	Open discussion, tea and biscuits

Registration fee £2 (which does not include lunch). Please send cheques not made out to AAE but made out to

Capt. P. Richards-Jones,
Crosstrees,
9, Old Oak Avenue,
Chipstead, Surrey, CR3 3PG.

Further details of this event are being circulated separately to members. Non-members may attend on payment of the Registration fee.

BACUP, AMATEUR ASTRONOMY CENTRE

111 Todmorden Road, Bacup, Lancs. Tel: 0706 877020
Contact: Ms. Linda Simonian

FACILITIES Observatory, Camera Obscura, Planetarium [Proposed - scientific reference library, closed-circuit TV/video/telescope link]
Suitable for all age groups

OPENING HOURS Weekends only, from 10.30 am.

BOOKING ARRANGEMENTS Adult £1
Group ticket £10 (max.30). Book in advance by telephone

HATFIELD POLYTECHNIC OBSERVATORY

Bayfordbury, Lower Hatfield Road, Hertford SG13 8LD. Tel: 0992 558451
Contact: Mrs. Gerrie Sherratt

FACILITIES Observatory with 20-inch, 14-inch & 12-inch reflecting telescopes, and numerous smaller instruments.
Talks on request. Occasional public lectures

COURSES 8-10 week courses (one evening a week) on general or specific subjects, usually in Autumn or Spring terms; advertised in LEA Schools' Bulletin, local papers and mailing list
Teachers can join individual units of degree course
Teachers with Honours Degree in Maths, Science or Engineering subjects can join part-time MSc course 'Astronomy and Aeronautics'

SPEAKERS Available on payment of expenses

MATERIALS/EQUIPMENT Slides of constellations loaned (may be sold in future)
Small telescopes loaned by Herts. Science Centre at Hatfield Polytechnic, Hatfield, Herts.

OPENING HOURS October to March, Mondays only, 7-9 pm.

BOOKING ARRANGEMENTS Admission charge may be introduced in future
Groups (max.15) should book in advance by post

JODRELL BANK VISITOR CENTRE

Lower Withington, Macclesfield, Cheshire. Tel: 0477 71339
Contact: Dr. Anne Cohen

FACILITIES Space Age Exhibition, Radio Telescopes, Gardens & Arboretum
Planetarium - half-hour shows for different age groups
Lectures by arrangement. Occasional afternoon talks on A-Level Physics & Astronomy for groups by request
Suitable for anyone over 5. Nursery Classes by arrangement

DISABLED: Ramps to all areas, but 8 wheelchairs only in Planetarium

EATING: Snacks & light meals. Picnic area

MATERIALS/EQUIPMENT Free Teachers' Workpacks & leaflets on radio telescopes
Books, films, posters, slides on loan or sale

OPENING HOURS March to October, every day, 10.30 am. to 5.30 pm. (Last admission 4.30 pm.)
November to March, weekends only, 2 to 5 pm. Weekday visits for schools by arrangement only

BOOKING ARRANGEMENTS Adult £2 Child £1
Child group rate for 25 or more (Winter weekdays only) 90p, one free teacher per 20, other adults £2. Provisional booking should be made by telephone and confirmed by letter

LIVERPOOL MUSEUM PLANETARIUM

National Museums & Galleries on Merseyside, William Brown Street, Liverpool L3 8EN
Tel: 051-207 0001
Contact: Martin Suggett

FACILITIES Exhibition on astronomy & space, and other non-scientific galleries
Planetarium shows for public, and school groups of different ages
Suitable for all ages

DISABLED: Should request facilities in advance

EATING: Snack bar. No facilities for packed lunches

COURSES Occasional one-day courses on planetarium shows, Astronomy for Teacher TV programme orientation, projects, moonrock; all advertised in LEA bulletin

SPEAKERS Available, but only rarely, at no charge

MATERIALS/EQUIPMENT Free booklists & information sheets on projects, special astronomical events. Also programme transcripts
Books & slides on sale, some slides loaned

OPENING HOURS Tuesday to Friday, planetarium shows from 10 am. to 3 pm. for schools. Public shows at 3.15 pm., and 1 - 4 pm. weekends.
Museum closed Mondays

BOOKING ARRANGEMENTS Adult 50p Child 25p
Group rate £10 (max.67). Advance booking essential, preferal by telephone

LONDON PLANETARIUM

Marylebone Road, London NW1 5LR. Tel: 01-486 1121
Contact: Undine Concannon

FACILITIES Schools shows for different age groups during term. Half-hour shows for public regularly throughout the day
Astronomers' Gallery. Also Madame Tussaud's wax exhibition
Suitable for anyone over 7 (under-fives not admitted)

DISABLED: Access to Astronomers' Gallery, Mme.Tussaud's & toilets, if notified in advance, but not to Planetarium

EATING: Snack bar, and facilities for packed lunches if booked in

COURSES Occasional evenings devoted to familiarising teachers with Planetariu

MATERIALS/EQUIPMENT Free sample worksheets, and information sheets on books, A/V sources, astronomical societies, telescopes etc.
Teachers' Pack free to schools making advance bookings
Selected books, slides, planispheres, posters and other smal items for sale. Slides sometimes loaned to schools

OPENING HOURS Every day 10.30 am. to 5.30 pm. 30-minute show given every 40 minutes. Schools programmes at 11 am. Monday to Friday during term

BOOKING ARRANGEMENTS Adult £2.10 Child £1.30
Group rate for 10 or more £1.05, one free teacher per 10, other adults £1.05. Groups should make provisional booking telephone and confirm by letter

LONDON SCHOOLS PLANETARIUM & ADVISORY CENTRE

Wandsworth School, Sutherland Grove, London SW18 5PT. Tel: 01-788 4253
Contact: Peter Richards-Jones, Judith Turpin

FACILITIES Planetarium open to London schools only. Small Exhibition, and Observatory with small reflecting & refracting telescopes
Suitable for 8-18 year olds

EATING: Facilities for packed lunches

COURSES Half- or full-day courses for teachers four times each term, on Astronomy in Schools; advertised in ILA Science Courses leaflet

MATERIALS/EQUIPMENT Free information on classroom projects, astronomy teaching modules, resource lists. Free Teachers' Packs
Postcards & wallcharts sold

OPENING HOURS Monday to Friday during term, from 9.15 am

BOOKING ARRANGEMENTS Free to London schools only, but groups (max 30) should book in advance by telephone

LONDON, NATIONAL MARITIME MUSEUM incl. OLD ROYAL OBSERVATORY

Greenwich, London SE10 9NF. Tel: 01-958 4422 (DA), 01-858 1167 (CS)
Contact: David Anderson (Education), Carole Stott (Astronomy)

FACILITIES Exhibitions, permanent & temporary. Observatory with largest (28-inch) refracting telescope in Britain. Planetarium. Films & lectures.
Aso Greenwich Park (and Cutty Sark, Gypsy Moth IV and other historic buildings nearby)
Greenwich Astronomy Day in November. Special Activity Weeks/Fortnights.
Suitable for anyone over 5

EATING: Self-service restaurant. Facilities for packed lunches

COURSES Occasional teachers' courses and information sessions

MATERIALS/EQUIPMENT Free information on Greenwich Time, Seasons, Calendar, Royal Observatory, and special astronomical events
Free Teachers Workpacks.
Books, slides, posters and postcards etc. sold

OPENING HOURS Winter: Monday to Saturday, 10 am. to 5 pm. Sunday 2 to 5 pm.
Summer: Monday to Saturday, 10 am. to 6 pm. Sunday 2 to 6 pm.
Museum closed December 24-26, and some bank holidays.
Planetarium shows for schools twice daily during term; and public lectures during school holidays

BOOKING ARRANGEMENTS Museum or Observatory Adult £1 Child 50p (under 7 free)
combined ticket Adult £1.50 Child 75p
Groups of 10 or more 10% discount, teachers free
Special Schools Annual Ticket £10 admits group of 30 on unlimited number of visits in one year.
Groups should make provisional booking by telephone, and confirm by letter.

LONDON, UNIVERSITY OF LONDON OBSERVATORY

Mill Hill Park, London NW7 2DS. Tel: 01-959 6911
Contact: Mrs. V. Peerless

FACILITIES Observatory, for schools by arrangement only
Suitable for 16 year olds upwards

SPEAKERS Available for schools on payment of expenses

MATERIALS/EQUIPMENT Royal Astronomical Society 'Astronomy' magazine (£1)

OPENING HOURS October to March, 1st & 3rd Fridays at 2.30 pm. for schools, 6.30 pm and 7.30 pm. for general public

BOOKING ARRANGEMENTS Free. Groups (max.15) should bookin in advance

PLYMOUTH POLYTECHNIC PLANETARIUM

Drake Circus, Plymouth, Devon. Tel: 0822 21312
Contact: Dr. Percy Seymour

FACILITIES Planetarium (medium Zeiss, 26 foot dome)
Seats 63

SPEAKERS Available for schools on payment of expenses

(OPENING HOURS
(and BOOKING ARRANGEMENTS Schools: Wednesday mornings, 10-11 a.m.
Maximum number 63. £5. per school

Scouts, Guides, PTAs, etc.:
Tuesday and Wednesday evenings,
7.15-8.30 p.m.
1-20 £5; 21-40 £10; 41-60 £15.

PRESTON, LANCASHIRE POLYTECHNIC

School of Physics & Astronomy, Preston, Lancs. PR1 2TQ. Tel: 0772 22141/57181
Contact: Professor Ian Robson

FACILITIES Exhibition on current topics. Weather Station. Jeremiah Horrocks Observatory, Moor Park, Preston, and Alston Observatory, Alston Hall, Nr. Preston.
Lectures. BSc courses, Evening and Part-time day courses
Suitable for school groups 7-15 years, and for anyone over 7

COURSES Bi-annual 6-week courses on Astronomy; advertised in LEA Newsletter and County Courses booklet

SPEAKERS Available on payment of expenses

MATERIALS/EQUIPMENT Posters, slides & software loaned. Free information on topical items, starcharts. Teachers' Workpacks usually free

OPENING HOURS Monday to Friday 10.30 am. to 12.30 pm. and 2 to 4 pm.
Weekends by request

BOOKING ARRANGEMENTS Free to schools. Other groups £2.50 per group (max.30)
All groups should book in advance by telephone

WOLVERHAMPTON, BILSTON COMMUNITY COLLEGE

Westfield Road, Bilston, Wolverhampton, West Midlands WV14 6ER. Tel: 0902 42871
Contact: David Harris

FACILITIES Provides lecture service for local organisations, incl. schools

COURSES Occasional courses on general astronomical topics

SPEAKERS Available on payment of expenses

OPENING HOURS 9 am. to 5 pm.

SCOTLAND

DUNDEE, MILLS OBSERVATORY

Balgay Park, Glamis Road, Dundee DD2 2UB. Tel: 0382 67138
Contact: Dr. Fiona Vincent

FACILITIES Exhibition, including tape-slide show
Public Observatory. Planetarium by arrangement
Summer workshops for children. Occasional facilities for astrophotograph
Suitable for anyone over 8

EATING: Picnic area

COURSES Evening classes on general astronomy during winter

SPEAKERS Available for local schools at no charge. (Contact Christopher Dingwall, Extension Services Officer, Dundee Museums, Albert Square, Dundee)

MATERIALS/EQUIPMENT Books, posters, planispheres, model kits, postcards etc. sold
Books, sometimes slides, loaned
Free information on the Observatory, and monthly Observing Notes

OPENING HOURS — October to March, Monday-Friday 3-10pm., Saturday 2-5 pm.
April to September, Monday-Friday 10am-5pm, Saturday 2-5pm

BOOKING ARRANGEMENTS — No charge.
Groups (max.30) should book in advance by telephone

EDINBURGH, LEITH HILL NAUTICAL COLLEGE PLANETARIUM

24 Milton Road East, Edinburgh EH15 2PP. Tel: 031-669 8461
Contact: Dr. David Gavine

FACILITIES — Planetarium. Slide lectures on astronomy & meteorology
Suitable for all ages

OPENING HOURS — Evenings during College terms by arrangement

BOOKING ARRANGEMENTS — Groups (max.25) free

GLASGOW UNIVERSITY OBSERVATORY

Acre Road/Maryhill Road, Glasgow G20 0TL. Tel: 041-946 5213
Contact: Dr. David Clarke

FACILITIES — Observatory, Planetarium and Teaching Laboratories attached to Department of Astronomy. Visits by arrangement only
Annual Open Day for Schools.

COURSES — Extra-mural courses for adults

OPENING HOURS — Outside University teaching hours by arrangement

BOOKING ARRANGEMENTS — Group ticket £20 (max.20) Booking must be made in advance by telephone and confirmed by letter.

NORTHERN IRELAND

ARMAGH PLANETARIUM

College Hill, Armagh, N. Ireland. Tel: 0861 523689
Contact: Terence Murtagh

FACILITIES — Exhibition with permanent & temporary displays, including video/telescope link. Planetarium

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POLYTECHNIC OF NORTH LONDON - Astronomy lectures

A lecture programme for 1987 was included with the last AAE Newsletter sent to members in the London Area. The Polytechnic Astronomy Forum ('PONLAF') is affiliated to the AAE and members are cordially invited to come along to these lectures. A 50p charge is made which covers refreshments (10p if under 18). Lectures are normally held in Room 11/3 of the Tower Block (almost opposite Holloway Road Underground Station); they start at 6.30 p.m.

The lectures are:

1 May	Dr. D. McNally on interstellar molecules
15 May	Dr. S. Clube (Oxford University) on Giant Comets and Catastrophes
5 June	Prof.C. Wickramasinghe (co-worker with Fred Hoyle) on Life in Space
3 July	Alan Drummond (former FAS president) on the Andromeda Galaxy
2 October	J.L.White(BAA Librarian) on Astronomical cycles
6 November	Maurice Gavin on some American Observatories
4 December	John Ebdon (London Planetarium Director) on the proper place for space.

(Further particulars from the Editor)

A MOST NOTABLE CENTENARY : 1887-1987

THE MICHELSON-MORLEY EXPERIMENT

By Eric Zucker

This year (1987) on 8, 9, 11 and 12 July we shall celebrate one of the most momentous scientific experiments ever performed; it has been described as "the most significant negative experiment in the history of Science".

The experiment was performed at the Case School of Applied Science at Cleveland, Ohio, USA, by two eminent scientists, Professors Michelson and Morley, and is now known as the Michelson-Morley Experiment. Its aim was to measure the speed of the Earth relative to the "luminiferous aether", the medium which was believed to permeate the entire Universe and to carry waves of light. The existence of such a medium was postulated by the ancient Greeks - the aether was the medium through which the planets moved in their celestial orbits. The aether was not strictly necessary to those protagonists of the "corpuscular theory of light", such as Isaac Newton, by whom light was considered as the emission of a stream of particles by a luminous body. This view was opposed by Christian Huygens (end of 17th century) who supported the "wave theory of light". In the wave theory, the aether is a necessary medium required to carry the waves.

Before the Michelson-Morley experiment, the great names associated with the study of optics included Fizeau, Young, Fresnel and Lord Rayleigh, who had made important contributions to the state of knowledge. In 1864, James Clerk Maxwell published his famous equations which showed that light consisted of electromagnetic waves, that is, the waves had both electric and magnetic properties. These waves were carried by the aether, a medium which was believed to be at rest throughout the Universe. The aether was believed to have peculiar properties, including perfect elasticity but with some rigidity. It was, in fact, the optical analogue of the air, which is able to carry sound waves.

It appeared from Maxwell's equations that it should be possible to measure the speed of the Earth relative to the aether, as, for example, the planet revolved in its orbit around the Sun. In principle, an optical experiment could be set up to detect this motion, but the equations showed that its detectability depended on the ratio $(v/c)^2$ where v was the speed of the Earth in its orbit, and c was the speed of light in vacuo. This ratio was so extremely small as to be considered beyond the limits of detection.

There the matter remained until the entry into the field of a US naval officer, Albert Michelson, who was to spend most of his life devoted to the experimental determination of the speed of light and to the velocity of the Earth through the aether.

Albert Abraham Michelson was born on 19 December, 1852, at Strelno, Prussia (now Strzelno, Poland). He was brought to America by his parents when he was 2 years old, entered the US

Naval Academy at the age of 17, where he graduated in 1873. From 1875 to 1879 he was a science instructor at the Academy. His interest in the speed of light was noted in 1878, and, in order to gain more knowledge of the theories of optics, he spent two years (1880-82) in Europe (Berlin, Heidelberg and Paris) studying under such great scientists as Helmholtz and Cornu.

On his return to the US, he determined the speed of light (and obtained c = 299 853 km s^{-1}), a figure which remained unchanged for about 30 years. He subsequently was appointed Professor of Physics at the Case School of Applied Science.

In 1887, helped by his colleague Edward Morley, he carried out the Michelson-Morley Experiment. Edward Williams Morley, born on 29 January 1838 at Newark, New Jersey, was a chemist; he was Professor of Chemistry at the Western Reserve University at Cleveland, and later Professor of Chemistry at the Cleveland Medical College.

Later (1889-92), Michelson became Professor of Physics at Clark University, Worcester, Massachussetts and from 1892 to 1929 he was Professor of Physics at the University of Chicago. He was President of the National Academy of Sciences from 1923-27.

Professor Michelson, who was also the first American to receive the Nobel Prize for Science, died in 1931.

Professor Morley died in 1923.

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It is not the intention of this article in the AAE Newsletter to describe in detail the experiment, which is given in so many textbooks (see, for instance, "Fundamental Principles of Modern Physics" by Eisberg). The purpose of this article is simply to call attention to the centenary and to give brief biographical notes on the experimenters.

However, the basic idea was to measure the speed of light relative to the aether using an apparatus (an interferometer) which itself was being carried through the aether on the Earth. This movement by the Earth created an "aether wind", equivalent to that experienced by a person leaning out of a window of a moving train. In one direction the light waves should be helped (or hindered) by the aether wind, whereas in a direction perpendicular to this, there would be a "side wind". By taking a beam of light and splitting it into two perpendicular beams, then reflecting these two beams and superimposing them, an interference pattern could be obtained. If the whole apparatus were then rotated through 90°, the rôles of the two interfering beams would be interchanged, and this should result in a measurable shift in the interference pattern.

The notable result of the experiment, carried out on July 8, 9, 11 and 12, 1887, was that the effect of a moving aether on the speed of light was zero, i.e. no absolute motion of the aether could be detected. To all intents and purposes, the aether did not exist.

Only 18 years later was the true implication of the experiment understood, when Einstein postulated the Special Theory of Relativity in which it is assumed that the speed of light is a constant, independent of the motion of the light source. We shall, no doubt, be celebrating this centenary in 2005.

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REVIEWERS REQUIRED

If any member is willing to undertake reviews of astronomical software for the Sinclair Spectrum computer, please contact the Association's Public Relations Officer, Geraint Day (17b Armstrong Street, Swindon, Wiltshire SN1 2AA). From time to time we may receive Sinclair Spectrum software for review purposes.

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STARS AND PLANETS : BBC computing disc
by Maurice Gavin, Eclipse Software, Worcester Park.

A Mark 2 version of the disc has been issued since the reviewer received his copy, which corrects previous errors. The disc thus represents excellent value at 66 p per program!

For your readers' information the programs are translations from the 50 examples in my book "ZX Spectrum Astronomy" (Sunshine Press), some copies of which I can make available at reduced cost to your readers.

This disc and my book may be obtained from Eclipse Software, 79, Ardrossan Gardens, Worcester Park, Surrey, KT4 7AX. (Price of disc, £7.95)

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ANACHRONISM
by Colin Jack

In Aristotle's time the Cosmos spun
On crystal spheres of chiming harmony
With God the mainspring
Of this celestial clockwork.

Came Newton
And the Universe ticked along quite well by itself
While God made the occasional adjustment
To keep the wheels turning.

In these days
Of liquid crystal quartz digital watches
There's not much call
For clock menders.

A SIMPLE PILLAR SUNDIAL

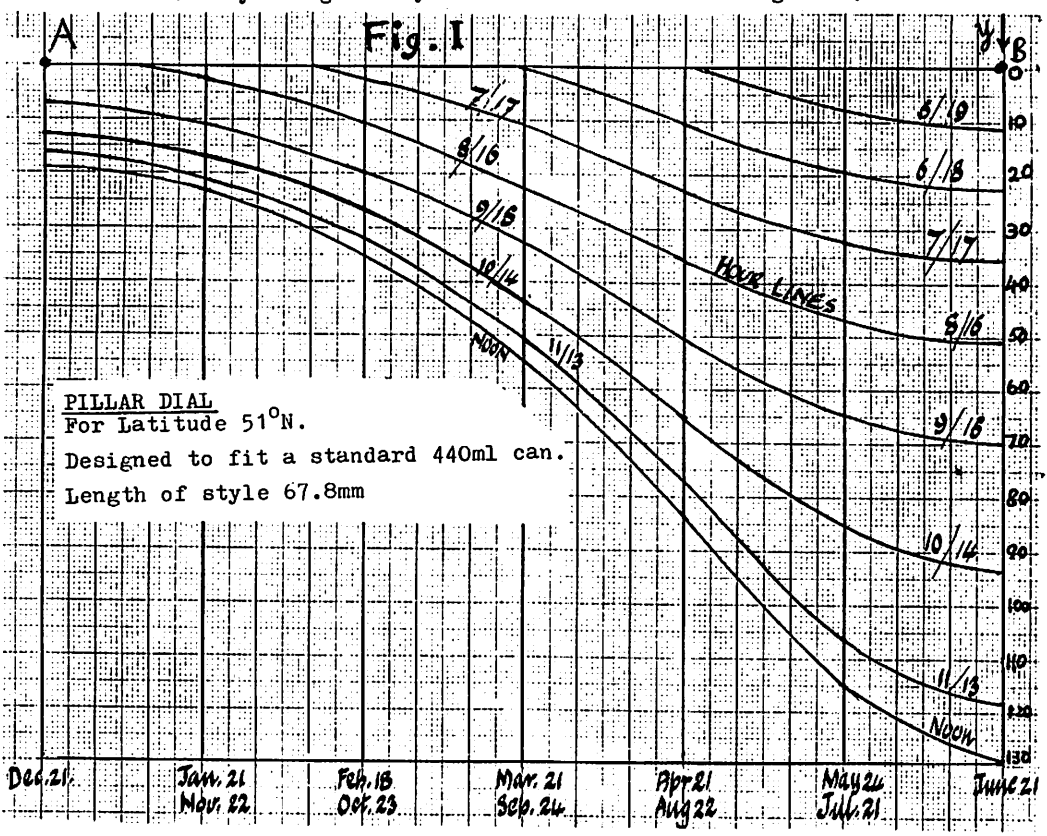
by Cmdr. H.R. Mills, 83 Firs Road, Winterslow, Salisbury, SP5 1SW.

Fig. I shows the hour lines for a Pillar dial that conveniently has the dimensions of a standard 440 ml "drinks" can. This diagram may be photocopied and wrapped round the can with AB running round its top edge. The hour lines have been plotted on centrimetric graph paper from the data in Table I. The Sun's declination (col. 2) corresponding to the dates of the year (col. 1) are plotted along the x-axis. The quantities along the y-axis are calculated from the relation $y = 67.8 \tan a$ (mm) where 'a' is the Sun's altitude, which itself is calculated from the relation

$$\sin a = \sin \phi \sin \delta + \cos \phi \cos \delta \cos h$$

for values of the Hour Angle h from 0° to 105° at 15° intervals.

Fig. II shows the style of this sundial, which projects 67.8 mm over the edge of the can. The style (knitting needle, pencil, etc.) is fixed by Blutac so that it passes over the centre of the can and in a vertical plane passing through the date marked along the bottom of Fig. II. To observe, the can with the style in place is turned so that the style lies in the vertical plane through the Sun, and the style's shadow lies vertically along the cylinder of the Pillar. (Fig. III)



. Pillar dial coordinates for curves (corresponding altitudes of the Sun in brackets) Lat. 51°.

Date	Sun's declination in degrees	Times and Hour Angles (Noon) 00	(11–13) 15	(10–14) 30	(9–15) 45	(8–16) 60	(7–17) 75	(6–18) 90	(7–19) 105
	x axis	y ordinates = 67·8 tan (alt)							
21st Jun	23.44	130 (62.45)	117·9 (60.1)	93·4 (54.015)	69·8 (45.84)	50·5 (36.71)	35 (27.29)	22·0 (18.00)	11 (9.19)
21st Jul 24th May	20.6	115·6 (59.60)	106·0 (57.40)	85·5 (51.59)	64·6 (43.62)	46·6 (34.49)	31·9 (25.21)	19·3 (15.86)	8·3 (6.95)
22nd Aug 21st Apr	11.83	83·1 (50.82)	77·9 (48.96)	65·1 (43.85)	50·2 (36.50)	35·8 (27.85)	22·8 (18.58)	10·5 (9.17)	0
23rd Sept 21st Mar	0	54·9 (39.0)	51·8 (37.44)	44·1 (33.02)	33·7 (26.42)	22·5 (18.34)	11·2 (9.37)	0	
24th Oct 18th Feb	−11.7	35·0 (27.29)	32·9 (25.95)	27·5 (22.09)	19·6 (16.15)	10·3 (8.64)	2·2 (1.826)	0	
22nd Nov 22nd Jan	−19.9	23·5 (19.09)	21·9 (17.87)	17·3 (14.35)	10·6 (8.85)	2·1 (1.80)	0 —		
21st Dec	−23.44	18·9 (15.54)	16·8 (13.94)	13·2 (11.00)	6·8 (5.7)	—			

TABLE I

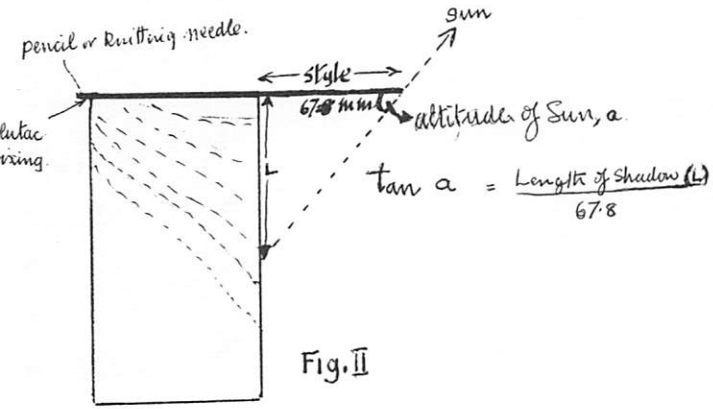


Fig. II

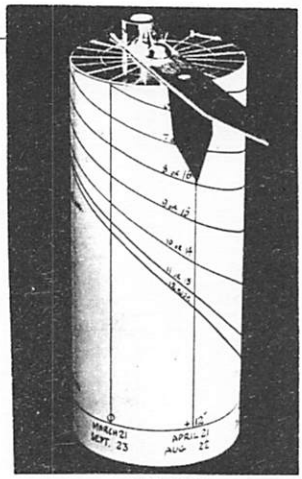
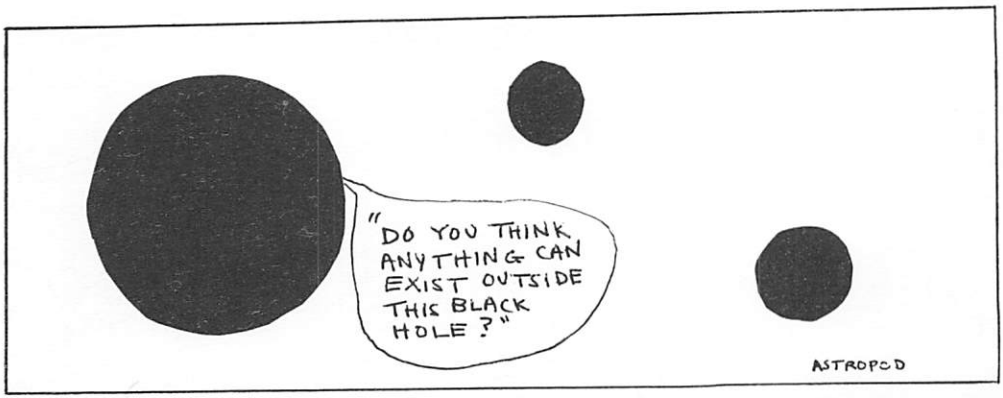


Fig. III



BAP

British Astronomical Promotion?
Bent Astral Perceptions?
Or just a flat roll?

You may not know that a BAP lurks in the membership of the A.A.E. It is a small specialist group of planetarians, or members of the British Association of Planetaria. In fact the A.A.E. developed from this association, which was inaugurated by Terence Murtagh at Armagh in 1978; and while both share the same aim, there are problems and areas of interest specific to the planetarium field.

So in 1986, Martin Suggett invited fellow-planetarians to Liverpool, with the aim of getting to know each other better, of gaining an overall view of the UK planetaria, and of discussing individual and common needs and ways of meeting them. It was a surprise to some of us to discover just how many planetaria there are (17 at present), from the classroom-sized with a sole teacher/technician/troubleshooter in charge, to the larger, more commercial type. They are found in schools, technical colleges, universities, museums, observatories and, oddest of all, a wax exhibition! The diversity of the parent institutions means that everyone's problems are different; but enough common ground exists for a regular pooling of ideas to be useful.

Following the success of the Liverpool visit, and the suggestion that each year we should meet at a different venue, the London Planetarium hosted this year's meeting. This time we concentrated on technical demonstrations and discussions. A variety of projectors and effects was on display, from sunset clouds to orbiting comets, and from aurorae to black holes. Not all of these are expensive or sophisticated - the London Planetarium's most effective asteroid is produced by a lump of solder on a pin, reflected off a mirror! Members brought along several effective, but simple, devices, which could easily be made in any classroom. (Resourcefulness is a prime requirement for anyone involved in planetarium show-making, just as it is for a good teacher anywhere). The ultimate example of this must surely be Harry Ford, now at Greenwich Planetarium, who has built two star projectors together with their domes (apparently assisted only by his wife)

After lunch, during which Madame Tussaud's Boardroom took on the appearance of a tasteful cocktail lounge, the subject was merchandise. The aim is to explore ways of co-operating to produce items such as posters, postcards etc. of good quality, but cheaper than the equivalent American products. Armagh Planetarium already operates a successful mail order scheme, and the London Planetarium will be setting up a similar scheme from this summer.

Almost all the UK planetaria are members of the A.A.E. If you have one near you, visit and support it; you will surely find that children will gain as much knowledge and excitement from one planetarium visit as they will from a whole term of teaching in class!

Undine Concannon
The London Planetarium

LIST OF UK PLANETARIA

Aberdeen	Technical College, Gallowgate, Aberdeen AB9 1DN
Armagh	Armagh Planetarium, College Hill Avenue, Armagh, N.Ireland
Bacup	Amateur Astronomy Centre, 111 Todmorden Road, Bacup, Lancs.
Dundee	Mills Observatory & Planetarium, Balgay Park, Dundee, DD2 2UB
Edinburgh	Leith Hill Nautical College, 24 Milton Road East, Edinburgh EH15 2PP
Glasgow	University of Glasgow Observatory, Acre Road/Maryhill Road, Glasgow G20
Glasgow	College of Nautical Studies, 21 Thistle Street, Glasgow G5 9XB
Leicester	University of Leicester, Dept. of Astronomy, University Road, Leicester LE1 7RH
Liverpool	Liverpool Museum, William Brown Street, Liverpool L3 8EN
London	City of London Polytechnic, 100 Minories, Tower Hill, London EC3N 1JY
London	London Planetarium, Marylebone Road, London NW1 5LR
London	London Schools Planetarium, Sutherland Grove, London SW18
London	Old Royal Observatory, Greenwich, London SE10
Macclesfield	Nuffield Radio Astronomy Laboratories, Jodrell Bank, Macclesfield, Cheshire
Plymouth	Plymouth Polytechnic, School of Maritime Studies, Drake Circus, Plymouth PL4 8AA
Rickmansworth	Masonic School, Chorleywood Road, Rickmansworth WD5 4HF
South Shields	South Tyneside College, St.Georges Avenue, South Shields, Tyne & Wear

CELESTIAL BODIES STUDIED BY NEW SPACE ASTRONOMY TECHNIQUES

by Nicholas E. Steggall, Space Associations, 38 Victoria Crescent, Birkdale Road, Dewsbury, West Yorkshire, WF13 4HJ.

An orbiting satellite has been used to study celestial objects in a new space radio-astronomy technique. During July and August an international team of scientists conducted experiments on this new technique, which has been termed very long baseline interferometry (VLBI). The scientists, led by Gerald S. Levy from JPL, were able to conduct the VLBI by combining data from radio telescopes on the ground with data from an antenna on NASA's Tracking and Data Relay Satellite System (TDRSS).

The effect of combining these resources was that investigators obtained better resolution of three quasars than is possible in ground-based radio studies carried out at the same wavelengths. The resolution which was obtained by the orbiting VLBI experiment was equivalent to that of a radio telescope having a size of 1.4 Earth diameters.

The quasars that were studied are designated 1730-130, 1741-038 and 1510-089. Quasars are among the most distant objects known in the universe.

Prior to the satellite linked VLBI experiment, scientists had linked widely separated antennae on the ground with VLBI techniques to produce high resolution radio-astronomy studies of celestial objects.

The ground-based observatories involved in the experiment were NASA's Deep Space Networks' 210 foot antenna in Australia and the Institute of Space and Astronautical Sciences' 64 metre antenna at Usuda, Japan. The performance of the 64 metre antenna was checked out by the 80 foot antenna at the Radio Research Laboratory in Kashima, Japan.

The outcome of this experiment's success demonstrates the feasibility of a proposed orbiting VLBI mission, said the researchers. Such a mission would use an orbiting spacecraft and would be dedicated to radio astronomy observations. The results from this mission may give data on many celestial phenomena, including the nature of galactic nuclei, the overall distance scale of the Universe and the formation of new stars.

THE SCOUTS' ASTRONOMER BADGE

by Nicholas E. Steggall, Space Associations (address above)

One of the badges that the scouts can gain is their astronomer badge. There are seven sections involved in the syllabus which must be covered over a period of one year. The Batley & Spenborough Astronomical Society have been conducting this badge for their area for a number of years at their observatory. The scouts meet at the observatory at least four times a year for each of the seasons, with the scout leaders conducting whatever background work in necessary in-between.

The first two sections can be carried out together as they are both interwoven with each other. The winter parts of these contain

the most work in this section so the winter meeting can be devoted to these.

Section 1. Recognize the prominent constellations visible through the year:
WINTER: Orion, Aries, Auriga, Taurus (Pleiades and Hyades), Canis Major, Canis Minor and the circumpolar constellations of Ursa Major and Cassiopeia.
SPRING: Leo, Bootes.
SUMMER: Cygnus, Lyra, Aquila, Delphinus.
AUTUMN: Pegasus.

Section 2. Recognize and show an elementary knowledge of the following stars:
WINTER: Sirius, Procyon, Betelgeuse, Saph, Rigel, Aldebaran, Hamel, Capella.
SUMMER: Deneb, Vega, Altair.
AUTUMN: Merka, Dubha.

The third section is explained on the first meeting and by the end of the year these diaries can contain some interesting observations depending upon the interest of the writer.

Section 3. Keep a diary of your observations through the year. This would include sightings of meteor showers, changes of planetary positions and eclipses.

The fourth section can be conducted on the second 'Spring' meeting when there are only two constellations for the scouts to learn. It is best with this section that each astronomical term is precise without being too elaborate otherwise the meaning to the younger scout may be lost.

Section 4. Know the meanings of elementary astronomical terms eg. axial rotation, synodic and siderial periods, opposition, conjunction, meridian, ecliptic, celestial equator.

The fifth section describing the solar system can achieve some interesting results due to the striking close-up photographs of the planets made by the various spacecraft that have visited them. A comprehensive series of slides is a great help when this section is undertaken. The old saying goes 'a picture is worth a thousand words'.

Section 5. Give a general description of the solar system, the individual planets and the Galaxy.

The final meeting can be mainly devoted to section 6. Again with a good slide selection or photographs about man's activities in space, this can bring out the budding astronaut. Section 7, concerning their diaries, can also be brought into the discussion at this point to see what the scouts have noticed in the news over the past year.

Section 6. Have a good knowledge about landings made or planned on other bodies in the solar system since 1969, and about man's activities in space.

Section 7. In addition to the observations made in the diary, keep a record of these activities during the years in question, and say how these will contribute towards future space missions.

During the first meeting it is advisable to go through the sections of the badge so that it is known what is entailed in the syllabus as well as what they must concentrate upon and what to look out for, sections 3 and 7 running with each other through the year. Sections 4, 5 and 6 can be dedicated to a meeting each so that the badge is spread out over the year and the amount of work is not overpowering to start with. This causes a high drop-out rate if not checked. Assessment for the badge can be made on the last

evening or at a special meeting shortly after.

A 'Star Gazer' Badge

Along similar grounds to the scouts' astronomer badge is the Guides' 'Star Gazer' badge. This entails keeping a log or notebook over a period of three months giving observations of stars, the Moon and planets visible (if any). There is a section where the guide has to demonstrate with diagrams, drawings or models the relative positions and size of the Sun, Moon, Earth and other planets, showing their movements. This can be achieved by the guides making a basic orrery.

With regard to the constellations and stars, the guides are asked to point out in the sky:

a. At least four constellations visible all year round;
b. At least four constellations not visible all year round;
c. At least four first magnitude stars, knowing to which constellations they belong and at what time of year they are visible.

The final part of the badge is a question which asks the guides to find a compass direction from the stars. This can be simply answered by finding the Great Bear constellation, the two pointers and Polaris. Hence, they have found north. If they wish to make a more accurate bearing and they have a wristwatch with hands, they can use the minutes divisions in the place of the degree sections on the compass rose.

LETTERS

Dear Editor,

Thank you for my first copy of the AAE Newsletter (Vol. 6, No. 1). While finding the material interesting and encouraging, I have to say that I was both amazed and saddened at the anachronistic presentation of quantitative information through the Newsletter.

I quote:

p. 12 $8\frac{1}{2}$" mirror and garden dimensions in <u>feet</u>.

p. 13 17,000 (the comma is deprecated)

p. 17 250 ft, 300 feet, followed in the same article by 'cm' (at least metric!) and $13\frac{1}{4}$ Km instead of '$13\frac{1}{4}$ km' (kilo- is lower-case k).

p. 19 25 ft, 40 ft dome, 30-acre arboretum.

p. 22 86,000 miles, 7,600 miles.

p. 23 'velocity of light' instead of 'speed of light'

'186,000 miles per second' instead of '300 000 km s^{-1},

or '3×10^8 m s^{-1},

'hr' instead of 'h'

The 'orders of magnitude' all in Imperial units.

I find this most depressing. Astronomy is a <u>science.</u> Science has been metricated for many years. In an educational context it is particularly important to present quantities in coherent metric units. Our children are reared in a school environment which is metric and it is up to professional bodies such as AAE to set an example and adopt sound house rules in this regard.

I am sorry to start out as a new member on this sour note but I am keen to see high standards in all of science education, including astronomy.

In conclusion I should like to say how much I look forward to future Newsletters (metric ones of course!) and hope that I may be able to take a full part in the group's activities.

Yours faithfully,

Keith Atkin, BSc(Hons), MSc, MInstP, CPhys, FBIS.
(Lecturer in Physics and Astronomy, Richmond College, Sheffield)

Dear Editor,

A Siting Problem - Vol. 6 No. 1 p. 12

It is difficult to be precise in locating a telescope/observatory with sketchy information eg spread of tree; aspect to east and west etc. However on the information provided the intersection of the polar and declination axes should be at point x eg 24 feet from the tree and 4 ft above the lawn. This ensures the maximum usable area of the sky is observable (see drawing below).

There is no advantage on moving further away from the house (toward the tree) to gain more of the important southern horizon as the amount is negligible against the loss of sky between zenith and pole.

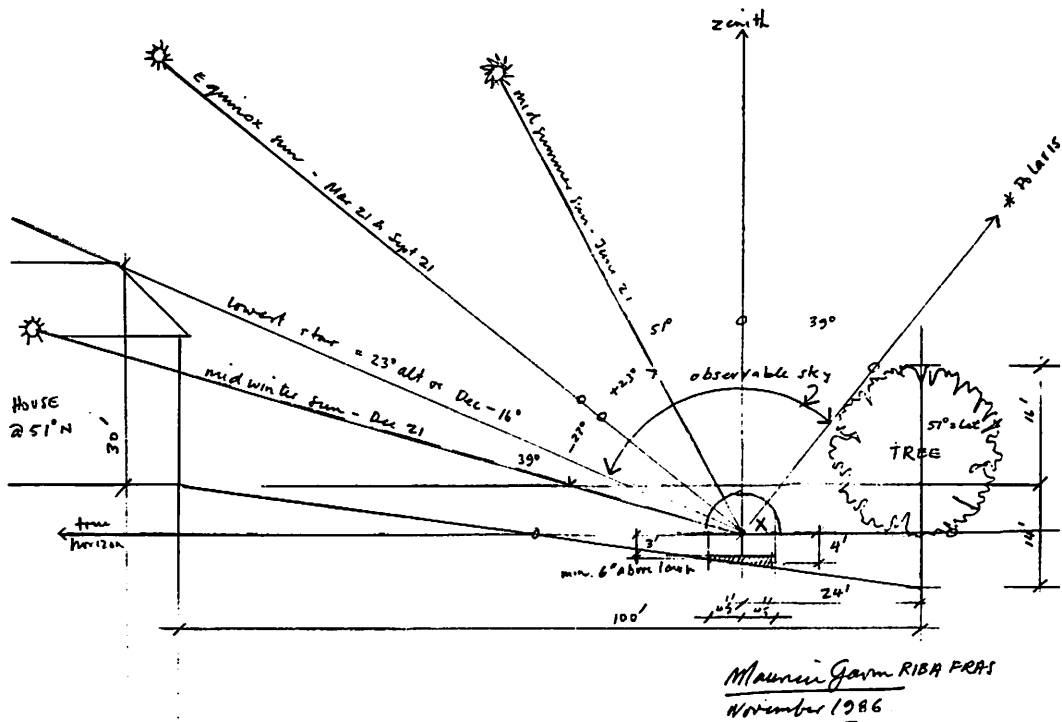
The sky north of the pole is circumpolar so this region will be accessible sometime during the year.

As an architect (by profession) and an astronomer, I've made a special study of this sort of problem.

Maurice Gavin, RIBA, FRAS.

Worcester Park, Surrey.

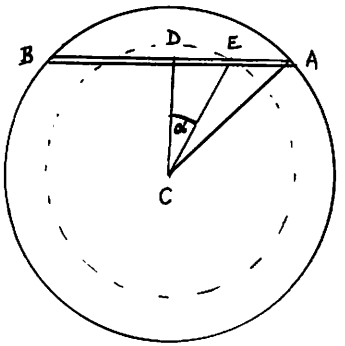
P.S. Why is AAE not metric?



Dear Editor,

I enjoyed the article "A Tunnel through the Earth" (Newsletter, Vol 6 No. 2, p.4) which provided a fascinating exercise for upper school mathematics classes as it involves our planet, gravity, simple harmonic motion and the velocity of an artificial satellite in orbit around the Earth.

The rider is even more fascinating, particularly for those who regard the words "it can be proved" as a challenge. The motion of an object (man) through a tunnel connecting any two points A and B can be shown to be SHM:



Force on man towards centre of Earth at any point C in the tunnel =

$$G\,m.\,\frac{4}{3}\pi(EC)^3\rho\,/\,(EC)^2$$

$$= G\,m.\,\frac{4}{3}\pi(EC)\rho$$

where ρ is the density of the Earth.

Resolving this force along ED, force on man $= G\,m.\frac{4}{3}\pi(EC)\rho.\sin\alpha$

$$= G\,m.\frac{4}{3}\pi\rho.(DE)$$

Calling the displacement from the centre of the tunnel x (=DE), then the force on the man along the tunnel directed towards the point D is

$$m\frac{d^2x}{dt^2} = -G\,m.\frac{4}{3}\pi\rho\,x$$

$$\frac{d^2x}{dt^2} = -\left(\frac{GM}{a^3}\right)x$$

which is SHM of period $T = 2\pi\sqrt{\frac{a^3}{GM}}$ as before. Inserting numerical values for the constants, we get T = 84.6 minutes, or the travel time in the tunnel is 42.3 minutes.

The velocity v of an artificial satellite close to the Earth's surface is found from the equation $\frac{mv^2}{a} = \frac{GMm}{a^2}$ equating gravitational attraction to centripetal force. This gives $v = \sqrt{\frac{GM}{a}}$; but $v = \frac{2\pi a}{T}$ also. On substitution we get $T = 2H\sqrt{\frac{a^3}{GM}}$ as before.

H.R. Mills, Salisbury, Wilts.

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