NEWSLETTER

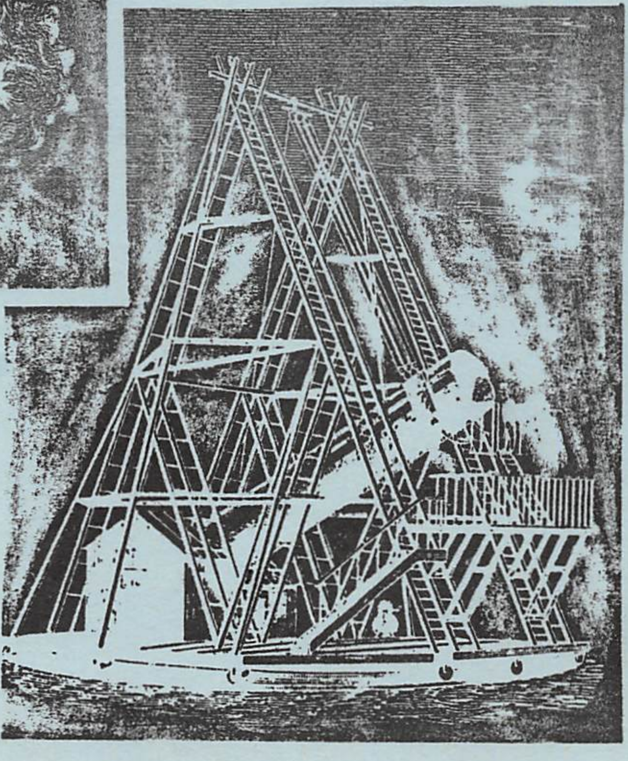
of the

Association for Astronomy Education

Vol.5, No.2 January, 1986

HERSCHEL
Sir WILLIAM
(1738–1822)

Telescope constructed by
Herschel in 1773
which he used for his
survey of the heavens



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EDITORIAL

A happy 1986 to all our readers. May I begin with an appeal. Please put pen to paper and send articles for your Newsletter. The compilation of this issue has proved most difficult. Thanks, however, are due to Geraint Day and Peter Richards-Jones who unfailingly produce their termly batch of material - they should not be left to 'go it alone'! Many thanks also to Mr. H. R. Mills for his steady supply of project material; yet another excellent article is to be found in this issue. I intend to resign the Editorship after this year's summer volume (Vol.5 No.3) has been distributed and I shall feel much happier if I know that my successor has a reliable nucleus of regular contributors. (Incidentally, we are now looking for a new editor - any volunteers?)

I would like to recommend Colin Jack's booklet of original poems (advert page 9). They make interesting reading and at 50 pence per copy represent excellent value. One of the collection appears in this issue.

Finally, with Halley's comet fast disappearing behind the sun for a few weeks, we may be permitted to turn our attention to the other current major space investigation - i.e. the Voyager II fly-by of the planet Uranus on the 24th January. No doubt this probe will reveal many facts about this distant giant of the Solar System, and, by the time you receive this newsletter a few of these will already have been made public. However, included in this issue you will find a description of that planet, giving as reasonably accurate a picture as our present knowledge permits. In a few months time we can re-read the article and realise just how wrong we were!

C. S. Goodman

SECRETARY'S NOTES

Hello,

The notes for this newsletter are going to be short, mainly because this issue includes a note on the A.G.M. and the minutes as well. So you will have at your finger-tips all the items that I would have mentioned. One thing I will mention however, is that we now have some ten resource centres throughout the country - very pleasing indeed. In the next newsletter this number will be confirmed and I will ask the editor to publish it, together with council members. Meanwhile have a happy New Year and be kind to each other.

Peter

Minutes of the Association for Astronomy Education A.G.M. held on 8th June, 1985 at The London Schools' Planetarium

1120 h. - The meeting was opened by the President, D. Gold, as chairman. Apologies were received from Prof. A. Roy, Mrs. I. Allison, Messrs. G. Day, D. Harris and P. Seymour, Dr. D. Clarke, Mr. T. Murtagh, Dr. I. Nicholson, Dr. F. Vincent and Dr. E. Robson, the foregoing being members of the Council.

Item 1 - The chairman discussed the minutes of the last A.G.M. which after nominal discussion on certain items, were duly passed by the members and signed by the president.

2 - The chairman opened a discussion on 'astronomy in the curriculum'. Mr. Kibble, a teacher, who was in the working group for Secondary School Curriculum Research (SSCR) indicated that nothing had been done so far in the name of astronomy, probably because nothing by way of subject matter had been presented to the SSCR working group. It appeared that past representations only had not been sufficient. Dr. McNally stated that it was high time that Dr. Doyle who was re-organising science teaching in secondary education, via a government appointed committee, should be approached with a module by the A.A.E. for the inclusion of astronomy in the curriculum. After a brief discussion, a Working Party was formed, Chaired by Mr. Kibble with Dr. Derek McNally co-chairing as counsellor/adviser. Other members of the team are Messrs. T. Methane, T. Kreamer, G. Endacott and I. Stott, all of whom are practising teachers. The terms of reference for the working party are as stated above.

3 - Chairman's Report - Then came the Chairman's address, his theme being the success of the resource centres to date. He discussed the present system of combining the position of heads of resource centres with area chairmen.

The main point was that both jobs could be adequately done by one person and an 'area chairman' could be appointed if and when required. Certain centres were already working under this scheme with great success. It was a truism that local centres attracted members in that area as they had some common ground with which to relate.

The Chairman reviewed the past year's courses at Alston Hall and Glasgow which were not happily subscribed to. It was generally felt that teachers would not pay for courses themselves where education was concerned. From the floor, Messrs. Black and Endacott suggested that the L.E.A.'s might be approached by the A.A.E. on each occasion of a course and they might help in the costs. This was discussed at length. A question from the chair as to the venues. Should they change continually or remain in one place, for example Alston Hall? was the object of another lengthy discussion without any satisfactory conclusion. It was also felt that not enough advertising was done in order to recruit new members.

4 - Secretary's Report -The secretary took up the theme of advertising and indicated that the Association, through the hard work of Geraint Day, had in the past year obtained mentions in numerous journals including international ones. This had resulted in a number of enquiries from the continent and the U.S.A. and one new member living in Frankfurt. He further reported on the excellent leaflet compiled by Undine Concannon and Eric Zucker. It was hoped that all present would take some and spread the word in the right quarters. There was also a reprint of the Association's brochure which was presently at the printers. The lunar maps issued by B.P. and with the A.A.E. stamp were still being sent to resource centres on demand and therefore advertised the A.A.E. as well as B.P. quite well. Short of spending money on advertising, we were doing as much as possible.

The secretary then indicated the names of the combined resource and area centres.

Armagh Planetarium . . . . T. Murtagh
Dundee Observatory and Planetarium . . . Fiona Vincent
Glasgow University Observatory . . . . . Dave Clarke
London Planetarium . . . . Undine Concannon

(continued)

London Schools' Planetarium . . . . . P. Richards-Jones
Preston Polytechnic Observatories . . . . . . Ian Robson

He advised the meeting that others were in the pipeline.

5 - Treasurer's Report - The treasurer then gave his report and explained certain items in the two account papers which had been circulated. These were for two years, as the A.G.M. this year was after the end of the financial year, unlike previous years, and thus enabled the presentation of two completed accounts for '84 and '85. After certain queries which were satisfactorily answered by the treasurer, the accounts were duly accepted, being proposed by the Chair and seconded by K. Kreamer.

6 - The secretary advised the meeting that there were two vacancies on council - the constitution allowed fourteen ordinary council members. The two council nominations had shown their willingness to stand:

Nicholas E. Freville - proposed by the Secretary, seconded by the Treasurer;
Prof. V. Barocas - proposed by the Secretary, seconded by the Chairman.

There being no objections, the motion was carried. A list of councillors will be included in one of the future newsletters.

7 - A.O.B. - Several minor matters were generally discussed but as there was a shortage of time, the Chairman called an end to the meeting in order to break for lunch and continue with the rest of the day's programme.

The meeting closed at 1235 hours.

* * * *

"OBSERVATIONAL ASTRONOMY" COURSE

The Wolverhampton Astronomical Society and the A.A.E. will be running a weekend course with the above title on March 7th and 8th. It will be at Alston Hall, near Preston. One of the speakers will be Victor Clube of the Royal Observatory, Edinburgh. There will be a general session in which course participants will be able to discuss their own interests. Please phone Dave Harris (on 0902 341754) if you want to book a place (or even more than one).

Geraint Day (Public Relations Officer)
16.1.86

IMPORTANT NOTICE

LIST OF RESOURCES FOR ASTRONOMY EDUCATION

It has been apparent for some time that a list of materials for teaching and learning astronomy would be of value to A.A.E. Members.

Thus, at the January meeting of the A.A.E. Council, it was decided to set something in hand. It is intended to produce a list of resources. This list will include publications, audiovisual materials, computer software and astronomical establishments such as planetaria.

We are aware that our resource centres in particular issue lists of items that may be of interest to teachers as well as to those more generally interested in matters celestial. So we are especially appealing for the resource centres to send in their own lists to assist in our own compilation.

The A.A.E.'s Public Relations Officer, Geraint Day, will be co-ordinating this effort. Please send any lists that you use to him at the address given below. If any individual Members of the Association would like to suggest particular items for inclusion, please send the details in. Please try to give as full a description as you can (e.g. date and place and firm of publication).

The address:

17b Armstrong Street, Swindon, Wiltshire, SN1 2AA

(Geraint Day)

* * * *

"AMATEUR ASTRONOMY IN SCOTLAND"

One of the resource centres will play host to a one-day symposium on 31st August 1986, entitled "Amateur Astronomy in Scotland". Speakers on the Saturday will include Dr. David Gavine and Harry Ford. Tea and coffee will be provided at lunchtime, but participants should bring their own food. For further details contact: Mills Observatory, Balgay Park, Glamis Road, Dundee, DD2 2UB (telephone 0382 67138)

Geraint Day

16.1.1986 (Public Relations Officer)

COMETARY CATASTROPHES IMAGINED

Now that Halley's Comet has had a fair amount of exposure in the media, there will have been time for the spread of gloom and doom tales of the end-of-the-world variety. I've already seen one book that purports to show how the apparition of this Comet is inextricably linked with human disasters.

The worst sort of event involving a comet would be a collision of the nucleus with the Earth. The Tunguska event of 1908 probably involved part of Comet Encke. That caused widespread devastation over largely uninhabited landscape: nearly anywhere else and there would probably have been very many casualties.

Bodies such as comets and asteroids have undoubtedly struck the Earth and other planets over the life of the Solar System. Ideas about when the next such collision will occur have led to speculations and studies as to what would happen and what, if anything, could be done to avert a major catastrophe.

Astronomy is fortunate in that it is very readily "turned into" science fiction, by which I mean that there are many excellent stories that may be used to illustrate an astronomical concept. Teachers may like to refer to some recent novels that deal with the subject of impact with the Earth. I have selected four (Baxter, 1978; Fodor & Taylor, 1979; Niven & Pournelle, 1978; North & Coen, 1979). None is particularly suitable for young children, particularly Baxter's novel.

Niven and Pournelle's novel deals with the impact of a comet; the others are about asteroids.

For scientific accuracy I prefer Fodor and Taylor (two practising planetary scientists) and Niven and partner. Baxter's book has some interesting passages dealing with perhaps-recognisable research institutions. The work of Coen and North had the most effort put into it, in that it is based on the screenplay of a "spectacular film" starring Sean Connery and the late Natalie Wood. Millions of dollars were spent on the film. The makers needn't have bothered; it is a fine example of scientific inaccuracy and (surprisingly these days) the special effects are none too special. If you can get hold of a video copy it may be worth showing for an exercise in "spot the mistakes".

There are no doubt other works in this vein, and before Comet P/Halley departs towards its aphelion there will probably be more talk - and print - of the end of the world. It will be useful to discern fact from fiction.

References:
Baxter, John, "The Hermes Fall", Granada Publishing, London, 1978.
Fodor, R. V. & Taylor, G. J. "Impact!", Leisure Books, New York City, 1979.
Niven, Larry & Pournelle, Jerry, "Lucifer's Hammer", Futura Publications, London, 1978.
North, Edmund H. & Coen, Franklin, "Meteor", Hamlyn, Feltham, 1979.

Geraint Day

22.12.1985

HINTS ON THE EXAMINATION PRACTICALS

A constant source of concern to candidates for the "O" level, seems to be "how much work should be presented for each project"? Naturally, such an unknown quantity can have a detrimental effect not only on a candidate but the examination as well.

Looking at the syllabus of the practicals, the only iniquity to my mind is that of four extensive sections, from which the candidate must present three projects and they needs must be from separate sections. However, I suspect that this is in order to obtain a good coverage of the total subject.

I must immediately offer a most important tip, so that future candidates may not 'lose out' as some have done in the past by making wrong assumptions. If, for instance, a candidate has presented a project concerning sun-spots then later at the examination finds a question on sun-spots in the paper, DO NOT think that the examiner will remember and penalise the candidate for not being more versatile if he attempts it. Rather they should thank their 'lucky stars' and answer that question straightaway thus ridding themselves of examination 'golliwobbles' with a familiar first question. This may sound simple advice, but how do we know what the candidates write until after it is all over?

Practical Project I

Having used sunspots as an example, let us continue on that particular theme (section C,11.). I am frequently asked, 'How many observations should I do'? The answer of course is in the syllabus, quote, 'sufficient to deduce the rotation of the Sun' unquote. A minimum of two observations would of course be insufficient to accurately determine rotation and to observe the changes in the character of the spots. Therefore, three or four might well suit, especially if there are three or four days between them, thus allowing a reasonable portion of the rotation to be observed. However, it must not be forgotten that presentation means a great deal so let us use the sunspot project as an example yet again . . .

i - the aims and objectives must be clearly set out

ii - draw decent sized circles to represent the Sun - (don't forget the grids!)

iii - the axis (poles) should be angled as accurately as possible so that the equator may be drawn in. This allows the correct line (parallel) of latitude to be followed when positioning the spot on the several occasions.

iv - don't forget to date each drawing and include an inset of the spot itself so that the changes can be noted. In addition draw a composite so that all the observations (dated) may be seen at a glance.

v - having presented the aims and objectives, give the conclusions.

Practical Project II

A night time project: Candidates are inclined to be over cautious at the thought of going out on cold nights time after time. Belay the thought. Here is a project that may be done not only in one evening, but in only half an hour of actual observing. It does need a telescope, of course, but the system may be used as a yardstick and the basic principles tailored to other projects.

Orion nebula - (section B.7)

i - set the aims and objectives

ii - observe the nebula and sketch it at the telescope. Using first a low power then increasing, say, by doubling the power twice more. Each sketch shows the different appearance of the nebulosity, and the change of delta Orionis into a quadruple system known as the 'Trapezium'.

iii - comment on each observation.

iv - make fair copies of the observations and conclude the project.

DO NOT forget to send the rough sketches drawn at the telescope with the fair project. These are proof of the real observation.

Well I hope that these examples will help to indicate the manner in which the projects may be tackled. The practicals are not meant to deter prospective candidates; quite the reverse, they are in a sense to help the less academic enthusiast gain some 25% of the examination's total marks.

I will be pleased to answer any more queries through the editor.

P. R-J.

* * *

A SIMPLE DEVICE FOR MEASURING THE ALTITUDE AND AZIMUTH OF ANY CELESTIAL BODY VISIBLE TO THE NAKED EYE

In the figure opposite (Fig.I) DCO is a quadrant of a circle of radius 286.5mm cut from a piece of good soft-board 10mm thick. DC and OC are two radii; the angle DCO is 90° and the curved length DEO is 286.5x /2 = 450mm. A strip of centimetric graph paper 10mm wide and 450mm long is marked at 5mm intervals so that each interval represents 1°. The strip is fixed to the quadrant with the 0° at O and the 90° mark at D. This forms the graduated altitude scale of the instrument.

The quadrant is mounted on a wooden base 360mm x 120 mm x 15mm as shown in the figure. A line AB is marked along the centre of the base. CM is a plane mirror attached to the base. S is a spirit level that is used to ensure that the mirror and the base are horizontal when making an altitude observation. This is important. A strip of black PVC insulation tape fixed across the centre of the mirror CM as shown in the figure. The edge CM marks the line on the mirror from which the reflected ray of light from the star emerges.

To make an observation, point the line AB in the horizontal direction of the required star, and look for the reflected image of the star in the mirror. The mirror is about 400mm square and provides a convenient field of view for spotting or selecting the star. Move the eye so as to bring the reflected ray of light on to the edge CM of the black strip, and a few centimetres from C. Now use a fine needle or pin held horizontally across the graduated strip to locate exactly the point E which gives the altitude of the star OCE in degrees. The eye for comfortable observation should be at a distance for clear vision from E (250mm).

To facilitate azimuth observations, an orienteering type of compass can be fixed to the base with its 'bearing' arrow parallel to the line AB. The compass can then read the bearing or azimuth of the star or body under observation, provided the appropriate correction has been made for the magnetic variation of the place, and no iron or steel nails or screws have been used in assembling the model.

Altitude and azimuth observations are what the ancient 'naked eye' astronomers were essentially concerned with, and what beginners today require when told where to look for any celestial object at a particular time. Instructive projects for school astronomy groups suggest themselves particularly if the instrument is used in conjunction with the set of alt-az curves shown in Fig.II (overleaf) connecting altitudes, azimuths, declinations and hour angles.

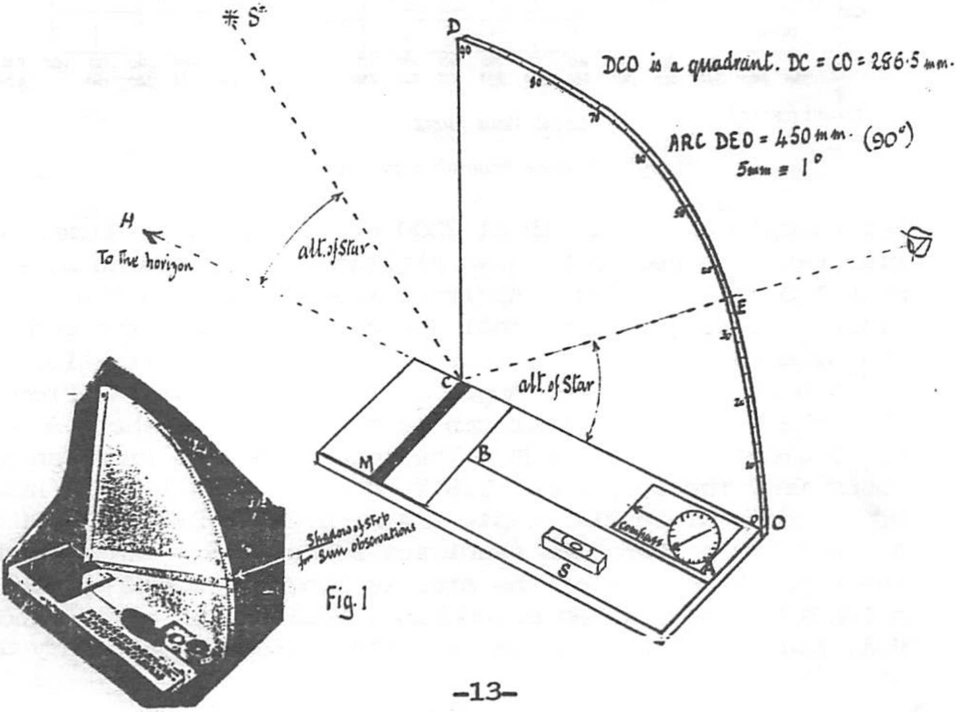


Fig.1

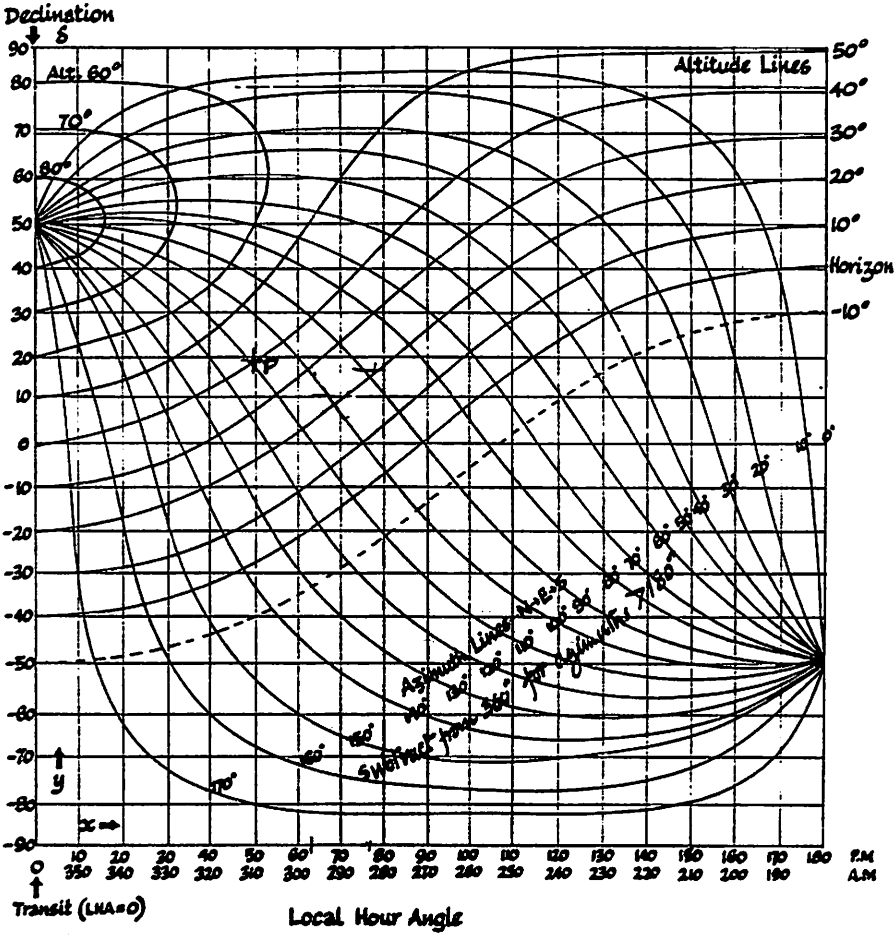


Fig. II . Altitude-azimuth curves for latitude 51°N

For example on April 7th at 2200 hrs Local Mean Time, a star was observed to have an altitude of 40° and an azimuth 110° (Lat. 51°N). Applying these values to the graphs, it will be seen that the 40° altitude curve and the Azimuth 110° curve intersect at point P declination 19° and at a Local Hour Angle of 311° or 20 h 42'. From this the R.A. of the star can be found because the R.A. = Local Sidereal Time - LHA. The Local Sidereal Time can be found from the relation: L.S.T. = Local Mean Time + (number of days since 21st Sept. X 4 minutes) = 22h 00 + (198 x 4 ÷ 60) hrs = 35hrs 12m (subtract 24hrs), LST = 11h 12m and the Right Ascension of the star is 11h 12m - 20h 42' (-24h) = 14h 30'. The star observed had a declination of 19° and R.A. 14h 30m. These values fit with reasonable accuracy the star Arcturus.

For those who use calculators with trig. functions the declination can be calculated in a few seconds using the relation derived from spherical trigonometry:

$\sin\delta = \sin\phi \sin a + \cos\phi \cos a \cos az = \sin 51 \sin 40 + \cos 51 \cos 40 \cos 11$ - giving declination $19^{\circ}33'$.

Similarly the azimuth can be calculated by formula:

$$\cos az = \frac{\sin\delta - \sin\phi \sin a}{\cos\phi \cos a} = \frac{\sin 19.55 - \sin 51 \sin 40}{\cos 51 \cos 40}$$

giving azimuth = 110° as found by observation.

These relations are derived from spherical trigonometry but are in effect just calculator programmes used in positional astronomy and astro-navigation, and provide the co-ordinates for the curves in Fig.II.

<u>The Altitude and Azimuth of the Sun</u>

On no account should the sun or its reflection be observed directly. The Sun's altitude is conveniently observed by turning the model so that the plance of the quadrant lies in the direction of the sun. The position of the shadow of the edge CM and hence the sun's altitude is then observed by holding a small piece of paper at the graduated scale of the quadrant. Having found the altitude and azimuth of the sun, these values can be used on the alt-az set of curves to find the sun's declination and Hour Angle. The Sun's hour angle is of course the local sun time, and for the local mean time, must be corrected for the equation of time, and the longitude (see graph - Fig.III).

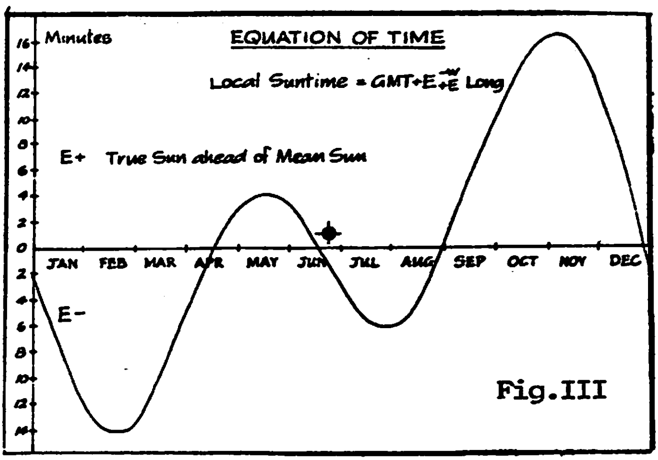


Fig.III

URANUS AND ITS SATELLITES

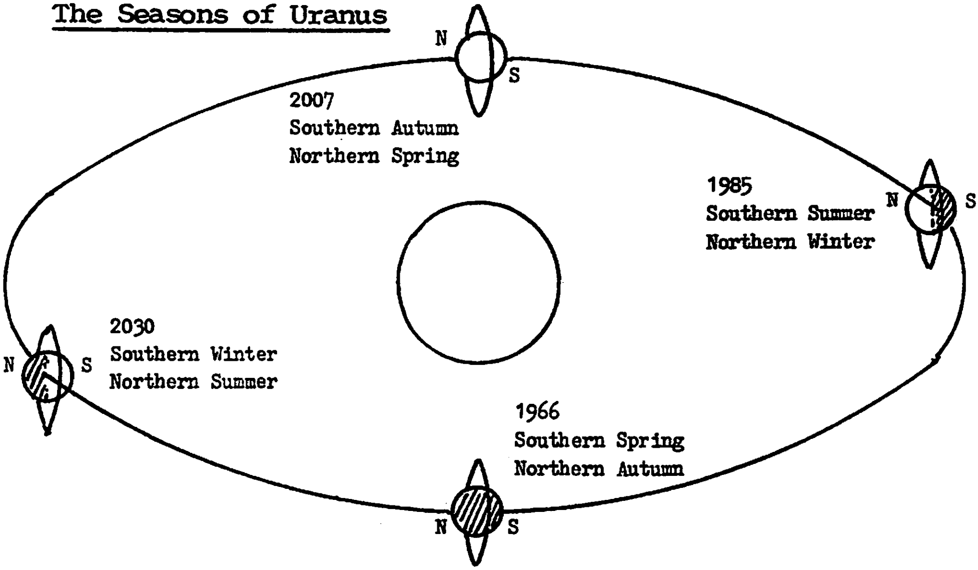
In 1774 William Herschel commenced his monumental 'review of the heavens'. On March 13th, 1781 between 10 and 11 p.m. during one of his 'sweeps' he stumbled on an object in the constellation of Gemini that did not appear on his maps. He observed that the object had a tiny disc, moved slowly and concluded that it was a small comet. Within a few months, however, other astronomers had proved it to be a planet. Johann Bode christened it Uranus.

A search of earlier records quickly revealed that it had been seen at least twenty-three times prior to its 'discovery', (Flamsteed, the first Astronomer Royal, had actually catalogued it as a star in 1690), and that its path for a complete orbit (84 years) was available.

Uranus's mean distance from the sun is 2868 million kilometres; its diameter is approximately 52,000 kilometres (15 earth radii), and its apparent magnitude at opposition is 5.7, so that, at that time, under ideal conditions, it is visible to the naked eye. Its angular diameter, however, never exceeds 4 seconds of arc so it would take a magnification of 500 to see it as we see the moon. Its rapid spin (commonly accepted as about 15½hrs per rotation) has produced a marked polar compression which, as yet, is not accurately known. Its albedo is roughly 60% making it "whiter than snow" and suggests that it is either covered with cloud or coated with ice. Its pronounced green hue, as observed from the earth, indicates a thick layer of methane cloud as this gas absorbs both red light and infrared radiation. Its orbit is nearer to the plane of the ecliptic than that of any other planet but its spin axis is tilted at the remarkable angle of 98° making its rotation strictly speaking, retrograde. Seasons are, therefore, most unusual.

At each solstice the axis points towards the sun, so that one pole has the sun constantly overhead whilst the other is in darkness. The sun stays above the polar horizon for 42 years and each season is 21 years in length. As seen from the earth either the equator or the pole can be near its centre. When it is a pole its satellites appear to have concentric orbits (moving as the hand of a clock). At the time of the equinoxes, when the earth is in the equatorial plane, the satellites appear to move to and fro along a straight line.

The Seasons of Uranus



Because its axis of rotation is inclined 98° to the plane of the ecliptic, Uranus "lies on its side" in space and its seasons are unlike those of the other planets. It is now summer in the southern hemisphere, and the south pole lies in continuous sunlight while the north pole is exposed to constant darkness. The reason each season does not last exactly 21 years is that Uranus' orbit is somewhat eccentric; when it is farther from the Sun, Uranus travels more slowly and its seasons last longer; when it is near the Sun, Uranus travels faster and the seasons are shorter.

Uranus Data

Distance from Sun	19.1819 Astronomical Units
Diameter	52,300 km
Year	84.0139 years
Day	15 to 17 hours
Number of known moons	5
Axial tilt	97.92°
Temperature	58 K
Apparent visual magnitude	5.5 (maximum)
Colour	Green
Mass	14.54 Earth masses
Density	1.2 gm/cm^2
Oblateness	0.02
Albedo	40% to 50%

Orbital eccentricity 0.0472; Orbital inclination 0.77°; Orbital speed 6.81 km/sec

Escape velocity 21 km/sec	Number of known rings 9
Planet discovered by	William Herschel: March 13th, 1781
Named by	Johann Bode

Uranus is believed to have a 'rocky' core three times the mass of the earth, with a radius of 6500 kilometres. This is probably surrounded by a mantle of water, methane and ammonia ices out to a radius of 18,000 kilometres. Its high mass has enabled it to retain all its gases. Hydrogen and helium are almost certainly the main constituents of this atmosphere but methane could account for over 3%, although this figure is far from certain. What is certain is that Uranus' upper atmosphere is very clear and sunlight penetrates to a great depth. It also has an excess of carbon and a deficiency of ammonia. Although some astronomers report a belted structure, the planet is expected to be almost featureless owing to the absence of the more severe weather conditions that prevail on Jupiter and Saturn. It has no source of internal heat to stir up active convection processes and Neptune is just as hot as Uranus (58K).

Ring Data

Ring	Semi Major Axis (km)	Eccentricity	Inclination (°)	Width (km)	Comments
6	41880	0.00101	0.066	less than 2	Narrow; eccentric
5	42280	0.00185	0.050	less than 2	Narrow; eccentric
4	42610	0.00115	0.022	less than 2	Narrow; eccentric
α	44760	0.00078	0.017	varies from 5 at periapsis to 10 at apoapsis	At widest, this ring exhibits two components separated by 4 km.
β	45700	0.00043	0.006	varies from 5 at periapsis to 11 at apoapsis	Similar to ring but does not exhibit "double-dip" structure
η	47210	close to zero	close to zero	narrow: 5 broad: 55	Has two components a narrow one and a broad diffuse one
γ	47670	close to zero	0.006	3	Fairly opaque
δ	48340	0.00006	0.012	2 to 3	Fairly opaque; a diffuse component extends 12km inside
ϵ	51190	0.00794	close to zero	varies from 20 at periapsis to 96 at apoapsis	Widest, most massive, and most eccentric ring

In March 1977 Uranus eclipsed the ninth magnitude star SAO 158687. Forty minutes prior to this event the star winked out. It did so again four minutes later and subsequently three more times. After the main occultation these eclipses were repeated on the other side of the star. It was assumed that Uranus had five concentric rings. We now know that it has at least eleven very narrow rings, none more than 100km wide, mostly less than 10km wide. These rings extend outwards from 1.6 to 1.95 times the planet's radius. The rings are widely spaced, have a low albedo (2 to 3%, the colour of powdered coal), and are very different from those of Jupiter and Saturn. The wide gaps between the rings are relatively free of debris, probably swept clear by moonlets orbiting inside the rings or between them.

Uranus has five known Satellites (see Satellite Data overleaf), all very small, four of which behave in a very orderly fashion. The outer four all revolve precisely in the plane of the planet's equator and have almost circular orbits. In order of increasing distance from Uranus they are Miranda, Ariel, Umbriel, Titania and Oberon. Miranda is the smallest (500km); Titania and Oberon are the largest (and by far the densest) with diameters of nearly 1600km.

Voyager 2, which was launched in August 1977 and has already passed Jupiter and Saturn, will encounter Uranus on January 24th. It carries its own propulsion system (three nuclear power sources called "radioisotope thermoelectric generators", generally referred to as RTGs). These have sufficient power to keep the spacecraft operational until early into the twenty-first century. It carries ten scientific instruments including wide and narrow angle TV cameras, infra-red and ultra-violet spectrometers, magnetometers and a photo-polarimeter together with other instruments for measuring the flux of charged particles and radio emersion.

Voyager 2 will pass within 29,000km of Miranda, 127,000km of Ariel and 107,080km of the planet itself, which will appear 55 times larger than the full moon as seen from the earth. Flyby time will be 5½ hours. During the 24 hours of closest approach it is hoped to take nearly 300 photographs with resolution down to 20km.

After encounter the satellite will speed on towards Neptune for eventual encounter on 14th August, 1989. Thereafter it will move into interstellar space passing within 0.8 light years of Sirius after a third of a million years.

SATELLITE DATA

SATELLITE	MIRANDA	ARIEL	UMBRIEL	TITANIA	OBERON
Discoverer	Gerard Kuiper	William Lassell	William Lassell	William Herschel	William Herschel
Year of discovery	1948	1851	1851	1787	1787
Apparent visual magnitude	16.5	14.4	15.3	14.0	14.2
Distance from Uranus (km)	129,400	191,000	266,300	435,900	853,500
Revolution period (days)	1.414	2.520	4.144	8.706	13,463
Diameter (km)	500?	1330	1110	1600	1630
Orbital eccentricity	0.027	0.003	0.005	0.002	0.001
Orbital inclination (°)	4.22	0.31	0.36	0.14	0.10
Albedo	50%	30%	19%	23%	18%
Density	3?	1.3	1.4	2.7	2.6
Mass (Moon = 1)	0.002?	0.021	0.014	0.080	0.082

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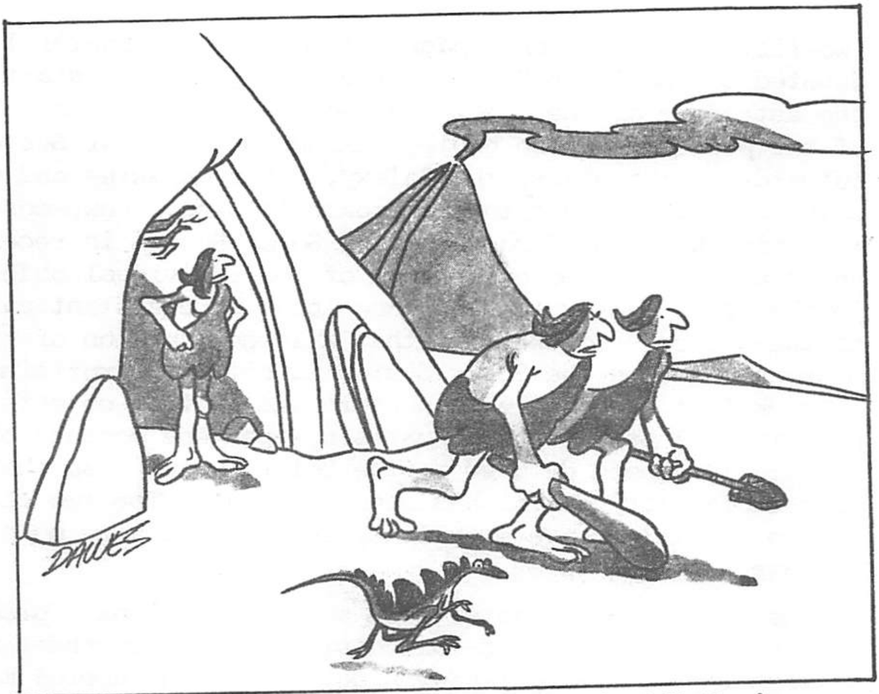
(See a copy from Herschel's notes of March 1781 on page 25)



Invent the wheel! Discover fire! Name the Constellations!
It's just nag, nag, nag!

BOOK REVIEWS . . .

UNIVERSE

by William J. Kaufmann, III 594 pp

W. H. Freeman and Company 1985

ISBN 0-7167-1673-9 board £29.95

Having just bought a colour television, I can appreciate the difference between a colourful view of the world and my former monochrome one. Unlike most astronomy text-books, "Universe" makes use of colour in photographs and diagrams spread throughout the body of the text. The result is very attractive, but doubtless adds to the cost.

"Universe" is meant as an undergraduate text for U.S. college courses. Thus it would be suitable in either a British elementary undergraduate course in astronomy or even at "A" level.

Two-fifths of the book's pages (13 of its 29 chapters) are devoted to the Solar System. The approach is to start at the astronomy of the night sky, working through the motions of the planets, to the bodies making up the Solar System, outwards to the stars, the Galaxy, other galaxies and cosmology. I think that this approach is fine. Now, more attention has been focused on the Solar System in recent years and perhaps more is known of the individual objects in the Sun's family than we know about more distant parts of the cosmos. So the fact that a large fraction of the book is spent on the Solar System is not too surprising. I think that the chapters on stars and stellar objects have fared less well by comparison - perhaps because of the greater space devoted to the Solar System - so that some explanatory detail has been left out. The two chapters on cosmology are excellent, though, and very much up to date.

At the end of each chapter is a set of questions, graded "Review", "Advanced" and "Discussion". Many of these are challenging and thought-provoking, so provide useful material for at least the able students.

Appendices give numerical details on the planets, their satellites, and on the nearest and brightest stars. There is a ten-page glossary, answers to numerical questions and an extensive index. Also included are several short articles by astronomers active in research.

It is a very well presented book that should be attractive to many. A major drawback for the British market (apart from the cost) is the use of non-S.I. units (including miles on occasion) throughout. Perhaps an edition will be produced using S.I. units.

Geraint Day

19.12.1985

<u>UNIVERSE IN THE CLASSROOM</u>

by Andrew Fraknoi 269 pp

W. H. Freeman and Company 1985

ISBN 0-7167-1692-5 paper £10.95

Andrew Fraknoi has produced "A Resource Guide for Teaching Astronomy and Instructor's Manual for <u>Universe</u> by

William J. Kaufmann, III". (For a review of "Universe" itself, see the preceding item).

The product is very fine. Its twenty-nine chapters follow those of the textbook of Kaufmann, although its usefulness is only slightly diminished if that text is not being used.

We are presented in each chapter with a wide variety of notes, and references to teaching materials. Thus each chapter of this Guide contains the following sections:-

- teaching hints (this section is the one most closely tied to the "Universe" book) - including suggestions on topics that may need special attention;
- topics for discussions and relevant papers - suggestions for extra topics based on the subject matter of the "Universe" chapter;
- references to science fiction, history, music and other fields are made, as well as to the scientific literature;
- reading material for the student - lists of references that may be of use;
- reading material for the instructor - references to more advanced background-materials;
- audiovisual aids - slides, and films and video tapes;
- laboratory exercises - for practical work;
- sample examination questions (multiple choice);
- sample examination questions (essay).

Most of the references are to material produced in the U.S.A. This need not be a serious drawback except for the audiovisual materials (even then, some of the items referred to should be available from the U.K.) Inter-library loans facilities may be used to get hold of papers and books not available locally.

The examination questions might be useful for teachers looking for suitable items to use in their own courses (from "O" level upwards). The multiple-choice questions are unusual in that several contain distractors meant to inject "a bit of humour into the tension-filled atmosphere of the exam". An example (from page 215):-

> "The presence of a supermassive black hole at the centre of our Galaxy is deduced from observation of....."

Poem from 'Alchemy' by Colin Jack

WHAT ARE THE STARS?

What are the stars that shine, seafarer
What do you see in the sky?
The stars are the flames of burning beacons
To steer our courses by.

What are the stars that shine, little sister
What do you see in the sky?
The stars are the Sandman's glittering grains
Which are our lullaby.

What are the stars that shine, wise chieftain
What do you see in the sky?
The stars are the campfires of the spirits
Of warriors when they die.

What are the stars that shine, believer
What do you see in the sky?
The stars are the light of Heaven shining
Through the vault on high.

What are the stars that shine, bereaved one
What do you see in the sky?
The stars are a million glistening tears
I still have left to cry.

What are the stars that shine, my love
What do you see in the sky?
The stars are the jewels that decorate
This place wherein we lie.

What are the stars that shine, astrologer
What do you see in the sky?
The stars are tales that tell our lives
Our how and where and why.

What are the stars that shine, astronomer?
Tell us what is in the sky.
The stars are . . . .

Quite simply,
Sources of thermonuclear energy
Which generate their heat and light
By the fusion of protons
Converting matter into awesome power.
Much like some of our own devices really ....

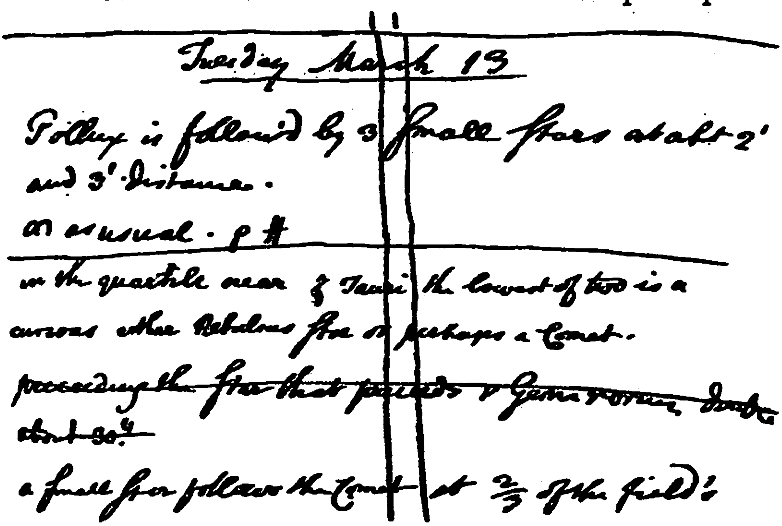
From ancient times the stars reflect
Our image in the sky.
How strange that they should mirror still
The way we live and die.

* * * * *

A NOTE FROM WILLIAM HERSCHEL

It is said that Frederick the Great thought everything of importance had already been discovered in science. In view of the great advances of the post-Newtonian era, few astronomers of the time would have disagreed. It thus came as a bombshell when William Herschel discovered a new planet. A detail from Herschel's portrait is a reminder of his wish to name his discovery after his patron, George III.

His notes for March 1781 show that he at first thought he had found a "curious Nebulous star or perhaps a Comet."


Tuesday March 13
Pollux is followed by 3 small stars at abt 2' and 3' distance.
as usual. p #
in the quartile near ζ Tauri the lowest of two is a curious either Nebulous star or perhaps a Comet.
~~preceding the star that precedes η Geminorum double about 30°~~
a small star follows the Comet at 2/3 of the field.

CRUXWORD No.4

ACROSS

4 Shortened bovine (3)

6 A distant moon (6)

7 Dwarf nova in Cygnus (2)

9 7½cwt of spuds on Jupiter (3,3)

10 and 2 Down Martian attendants (6,6)

11 Luminous fire Saint (4)

15 5th brightest star in the sky (4)

17 His 3 laws are important (6)

19 Lo ice confused for star atlas (5)

20 Variable in Lyra instrumental in finding distances (2)

22 Cigar around the sun (6)

23 Reticulum (3)

DOWN

1 Famous northern W, shortened (3)

2 See 10 Across

3 A comet's spike or ---- tail (4)

4 During this eclipse one can see 23 Across (5)

5 Macdonald Observatory belonged to this (3)

8 Body said to give off music (5)

11 Barnard's initials (2)

12 Remote mixed-up falling body (6)

13 Spectral types before F (2)

14 Non-wet confused astronomer (6)

16 One Bear is this (5)

18 Taste the famous telescope (4)

19 Shortened Hunting Dogs (3)

21 P. Moore's wartime service (3)

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