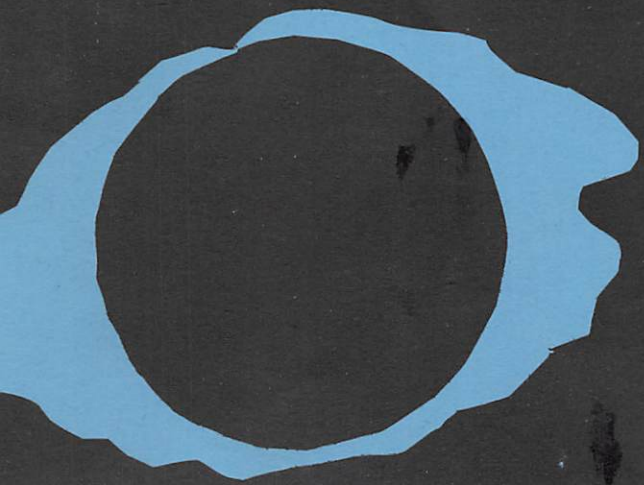
NEWSLETTER

of the

Association for Astronomy Education

VOL. 6, No. 2 ISSN 0950-5083 January, 1987.



$$p + p \rightarrow D + \beta^+ + \nu$$
$$D + p \rightarrow He^3$$
$$He^3 + He^3 \rightarrow He^4 + 2p$$

$$C^{12} + p \rightarrow C^{13} + \beta^+ + \nu$$
$$C^{13} + p \rightarrow N^{14}$$
$$N^{14} + p \rightarrow N^{15} + \beta^+ + \nu$$
$$N^{15} + p \rightarrow C^{12} + \alpha$$

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

Despite a vigorous campaign by eminent astronomers and most astronomical organizations, including the AAE, the government has now finally approved the removal of the RGO from Herstmonceux to Cambridge. Whether this really is the last word remains to be seen, but all the signs point that way. It has been emphasized that, although the RGO will be in close proximity to the University, it will retain its independent identity and name, and there will be advantages to be gained from a closer working relationship between the two institutions. We await the outcome with concerned interest.

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We would like to thank those regular contributors whose efforts go towards the publication of the Newsletters. Our thanks are also due to those correspondents who send in their individual articles, some of which appear in this issue. The main function of the Newsletter is to keep the membership aware of the activities and ideas of their colleagues, and to this end contributions from readers are always welcome. So please, dear readers, continue to send in your articles, letters, etc. The Newsletter is published (at present) 3 times a year (once a term). and the copy deadline is about 6 weeks before publication in mid-January, April and September. So if you miss one deadline, please do not worry as the chances are your article will appear in the next issue. For this reason, contributions will be gratefully received at any time, preferably typed.

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If this Newsletter finds itself in the hands of members who have forgotten to pay their annual subscriptions, which were due last September, may I appeal to them to send them to the Treasurer as soon as possible, as it is a costly expense to send out reminders. We regret that we cannot continue to send out Newsletters to members in arrears.

QUALITY OF PHOTOGRAPHS

We must apologize for the poor quality of the photographs in the September issue. This was due to technical reasons (use of the wrong type of plate), subsequent to the change of printer. We sincerely hope we have sorted out this difficulty, and that it will not happen again.

ARTICLES ON COMPUTING

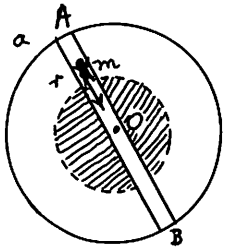
Two such articles appear in this issue and, although there is some overlap, it was thought fit to publish both. In future, if there is duplication and if there is sufficient time, the authors will be put in touch with each other in order to consider the possibility of a joint article. Members might like to estimate the probability of this occurring!

A TUNNEL THROUGH THE EARTH

Suppose a tunnel could be constructed through the centre of the Earth, connecting, for example, Britain and Australia. Consider the motion of a man who jumped into the tunnel. How long would it take him to reach the other end of the tunnel?

The answer, assuming the Earth to be a uniform sphere and neglecting various unpleasant circumstances encountered on the journey, is about three quarters of an hour.

As the length of the tunnel is about 8,000 miles, this gives an average speed of about 11,000 miles per hour. The proof of this is as follows (see diagram):



O denotes the centre of the Earth (sphere)
Radius of Earth is 'a'
Mass of Earth is M

The gravitational force on the man (mass m) at some general point distant r from the centre is due only to that portion of the Earth which is shaded in the diagram. This is because the unshaded portion exerts no force on the man (the gravitational equivalent of one of Faraday's Ice Pail experiments, in which it is shown that there is no electric field inside a closed conductor).

$\therefore$ force on man = m × acceleration

$$= m \times \left(- \frac{d^2r}{dt^2} \right)$$ (The minus sign is due to the acceleration being measured in the opposite direction to the distance r)

$$= Gm \times \frac{\text{mass of shaded portion}}{r^2}$$ (from Newton's law of gravitation)

$$= Gm \left(\frac{r^3}{a^3} \right) M \Big/ r^2$$ (as the mass of the shaded portion is the fraction $\frac{r^3}{a^3}$ of the total mass M)

$$\therefore \quad \frac{d^2r}{dt^2} = - \left(\frac{G M}{a^3} \right) r$$

which represents simple harmonic motion (S.H.M.) of period

$$T = 2\pi \sqrt{\frac{a^3}{G M}}$$

Thus the motion of the man is S.H.M. to and fro' along the tunnel. If the man drops from rest into the tunnel, he accelerates to reach his maximum velocity when passing the centre of the Earth, then decelerates and just reaches the far end of the tunnel

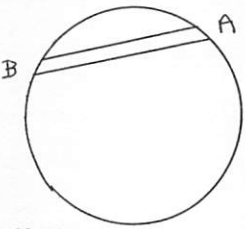
(with zero velocity). Unless steps are then taken to take hold of the man, he will fall back into the tunnel, retracing in reverse his previous motion.

The time taken to completely traverse the tunnel is one half of the complete period T, i.e. $\pi\sqrt{\frac{a^3}{GM}}$.

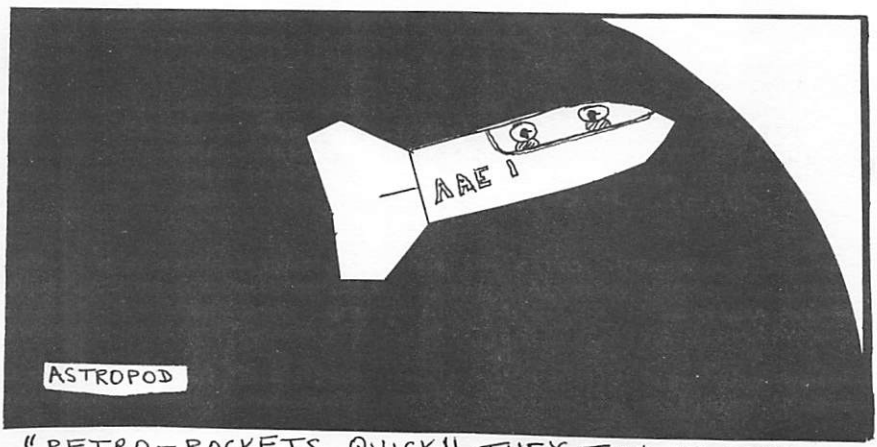
Taking a = 6400 km ($= 6{\cdot}4 \times 10^6$ m), M = 6×10^{24}kg and G = $6{\cdot}7 \times 10^{-11}$ m^3 kg^{-1} s^{-2}, we get for the travel time 42·3 minutes.

It may be observed that the man's oscillatory motion along the tunnel is, in fact, the projection on to this straight line of the motion of an artificial satellite orbiting the Earth at a very low height above its surface. The period of such a satellite is 84·6 minutes.

As a rider to the above, it can be proved that the motion of a man dropped down a tunnel connecting any two points A and B is still simple harmonic, and having the same travel time 42·3 minutes - as long as the tunnel is perfectly smooth (no friction). In this case, the man slides to and fro' along the tunnel.



With such a constant travel time linking any two points A and B on the Earth's surface (assuming ideal conditions), an underground railway system constructed on this principle presumably would issue flat-rate tickets for all journeys (as on the Paris Metro!)



"RETRO-ROCKETS, QUICK!! THEY TOLD US THE UNIVERSE WAS INFINITE!!"

ASTRONOMY WITH NON-CELESTIAL CHERUBS

by Peter Quinn

We would like to thank Peter Wade, editor of REFLECTIONS, journal of the Lancaster and Morecambe Astronomical Society, for permission to reprint this article.

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Having, with the advent of Comet Halley, become smitten with the whole subject of Astronomy and Cosmology, I determined to convey this enthusiasm to my class of nine and ten year olds. However, since primary education in Britain does not allow for evening classes, the problems of introducing comets and constellations into the daytime classroom were somewhat problematical! There were several things working in my favour - the pupils had already absorbed some Halleymania via the media. The B.B.C. TV schools programme "Zig Zag" was generating interest in the topic of space, and children generally seem to have an innate fascination for the mysteries of the Universe.

But how to furnish concrete stimuli? As a believer in experience being the basis of learning, I decided that the practical element of the project would have to be done in their own backyards - literally.

Armed with their personal sky map of the Square of Pegasus and Water Jar in Aquarius, they did their homework early in January. As a result, I am fairly confident that 14 children plus a few parents managed to find the fuzzy blur from scattered vantage points in Carnforth. The unfortunates who didn't either did not possess binoculars or preferred the greater realism of "EastEnders". Still, they will get another chance when they're 86 or so.

Back in school during hours of daylight, all sorts of associated themes were taking educational shape - mathematical work on ellipses, dramatic artwork using some of the left over Xmas glitter, creative writing, a tragi-comedy of a puppet play "King Harold and the Comet" and a creditable facsimile of the Bayeux Tapestry produced by our sewing group.

All these explorations formed the basis of our class assembly for the whole school. The pupils all responded most encouragingly. Some now bring in newspaper cuttings (they were especially moved by the Challenger tragedy), or they ask dad to tape "The Sky at Night" so they might view it later. They were most curious to know what Giotto would discover within the comet.

Importantly, they (well, some) are still venturing out to study the night sky, and like to tell me of the planets, constellations, satellites and UFOs they have spotted. It is rewarding to think that quite a few of them may have generated a lifelong interest in the 'starry heavens' and (who knows?) perhaps one among them will follow in the footsteps of Hubble, Herschel and Halley. Maybe I should have a word with those whose surnames begin with 'H...

BOOK REVIEWS

SPACE SCIENTIST SERIES by Heather Couper and Nigel Henbest.
Published by Franklin Watts, London, 1985 and 1986.
Hardback £5.25 each 32 pages each.

The "Space Scientist" series of children's books comprises, at present, six volumes (three by Heather Couper and three by Heather Couper and Nigel Henbest jointly). The individual titles in the series are:

The Planets	ISBN 0 86313 266 9
Comets and Meteors	ISBN 0 86313 267 7
The Stars	ISBN 0 86313 268 5
The Sun	ISBN 0 86313 269 3
The Moon	ISBN 0 86313 472 6
Galaxies and Quasars	ISBN 0 86313 473 4

Each book has about 30 pages of good quality paper with an easily readable typeface and is lavishly and colourfully endowed. I do not know whether this practice is specifically mine, although I rather suspect not, but when asked to review a book, at first I pick it up and flick rapidly through the pages, getting a first impression in a few seconds. I must emphasise that this is only for first impressions, but I have frequently (but not always) found these fleeting impressions a fairly accurate representation of my considered views after a more traditional reading.

Subjecting these six volumes to my "flicking-over" test, I was thoroughly impressed by the content and presentation, in particular the highly coloured drawings, graphs and tables. The illustrators are rarely mentioned in reviews, but I must commend the work of the artists who have so delightfully embellished these books: Rhoda Burns, Rob Burns, Eagle Artists, Michael Roffe, Ron Jobson, and the book designer, David Jefferis.

The authors have done a good job in bringing together in this series most of our present-day ideas in Astronomy, told in simple language. There is no mathematics, but many useful tables, for example, a list of dates of lunar eclipses from October 1986 to December 1992, colour-temperature relations of stars, etc. A certain amount of artistic licence is to be expected in books of this type, and thus we find drawings of planets and the Moon show these objects as three-dimensional spheres and not as discs (as the full Moon appears to us on Earth). Indeed, such licence is the only way a sensation of depth can be portrayed (unless one uses the pop-up book technique).

If I have one niggle, it is the diagram of the rather peculiar behaviour of white light passing through a prism (The Stars, page 12) and being dispersed into a spectrum showing the red light deviated in the wrong direction. But this is a minor point, and I would thoroughly recommend these books to the 9-year olds (plus or minus a year or so) for whom they are intended - as well as those many older adults who take delight in well-produced children's books.

Eric Zucker.

BRITISH ASTRONOMICAL ASSOCIATION

ROYAL ASTRONOMICAL SOCIETY

Preliminary Announcement

of a

Discussion Meeting

on

THE INTERACTIONS BETWEEN AMATEUR AND PROFESSIONAL ASTRONOMERS

to be held at the

SCIENTIFIC SOCIETIES LECTURE THEATRE
23 Saville Row, London, W1

on Saturday, 1987 March 14

from 11 am to 5.30 pm

The principal purpose of the meeting is to explore the ways in which amateur and professional astronomers may assist each other to carry out astronomical research and to promote astronomy. For most of the topics listed in the draft programme it is hoped that at least one amateur and one professional astronomer will summarise his/her views on how each group could contribute to and benefit from interaction with the other group. Then others will be invited to contribute additional points and to comment on the suggestions that have been made. It is hoped that each invited speaker will provide in advance a summary list of relevant facts and ideas so that following speakers can avoid duplication and can be better prepared to comment on points raised by others.

The meeting will be open to members of the BAA, RAS and other astronomical societies. The draft programme is as follows:

10.30	Coffee.	Display of posters
11.00	A.	Introduction
11.05		Moon, planets and satellites
11.45		Comets, asteroids, meteors
12.30		Lunch
14.00		Artificial Satellites
14.20	B.	Sun
14.40		Stars
15.10		Galaxies
15.30	Tea	
16.00	C.	A wide-ranging discussion on such topics as: Information requirements. Data distribution. Facilities and equipment. Computing. Education and training. Public demonstrations.

Suggestions for the programme should be sent to one of the following:

Miss Heather Couper
British Astronomical Association
Burlington House
Piccadilly
London W1V ONL

Dr George A Wilkins
Royal Greenwich Observatory
Herstmonceux Castle
Hailsham
East Sussex BN27 1RP

The BAA and RAS extend a welcome to AAE members to attend this meeting.

FILMS AND VIDEOS ON ASTRONOMY

The AAE Council is engaged in producing a catalogue of films and videos (mostly the latter) which are suitable for teaching purposes. This catalogue may be regarded as a supplement to the existing catalogue produced by Frances Thompson of Plymouth Polytechnic, and is being compiled with the assistance of the British Universities Film and Video Council (BUFVC). Most of the material is suitable at secondary school level (the BUFVC is concerned with higher education), but many of the film/videos which are assessed and would be rejected for higher education are quite appropriate for schools. It has also been pointed out that many products specifically made for higher education could be used by schools with the sound turned off, the relevant commentary being supplied by the teacher.

The compilation of the catalogue is a lengthy task, but it is hoped to 'serialize' the list in future issues of the Newsletter. The list will give the name and address of the body from which the videos and films may be hired.

L.Z.

AAE CURRICULUM WORKING GROUP

I should like to thank those who wrote to me following my piece in the last Newsletter. I shall be sending them a copy of the finished document 'Astronomy in Schools' early in the New Year.

The final pages are being typed (November) and should be on display at the Association for Science Education A.G.M. at Cardiff in January, where I shall be putting up a member's exhibition to promote the A.A.E.

Further developments will appear in AAE Newsletters.

Bob Kibble

LUNAR CURIOSITIES - a correction

Peter Ecker, author of this article in the last issue, apologizes for an error on p. 10 in the paragraph beginning "Fig. III shows the northern summer situation". It goes on to say that "the transit times are similar to those of the northern summer". This should have read "of the northern winter".

POEMS

We would like to thank Colin Jack for supplying us with his book of poems, and permission to publish them in the Newsletter. This issue contains "An Astronomer's Lament for the sale of his telescope". Readers wishing to purchase a complete booklet of Colin's poems may do so by sending 60p to him at 38, Grange Drive, Penketh, Warrington, Cheshire, WA5 2JN.

AN ASTRONOMER'S LAMENT FOR THE SALE OF HIS TELESCOPE

by Colin Jack

'Exchange and Mart'
Technical Section subheading 'Scientific Instruments'
'For Sale : One Astronomical Telescope
All the usual trimmings'.
One devoted owner.

I unbolted it from its pillar
And carried it like a baby
To the man's car
Tucked it carefully inside
Brushed the gleaming white tube
Once, lightly, with my fingertips
And walked back to the house.
Later a friend asked me
What I got for it
And I told him, a broken heart
Fingering the compensation payment
In my pocket.

I am getting used to being an amputee
Though the squat pedestal of concrete
Still remains in the garden
To remind me.

My wife keeps asking me
To remove it altogether
But it can wait for a while yet.
Anyway the children use it
To jump off
Leave drinks and sweets on
Or persuade ants and worms
To parade on it for examination.
It can stay there a little longer.

Sometimes at night
I slip out and look at it
Touch it even, if no-one is around.
In the moonlight
It looks like a white tombstone
But I can feel it resonating
In sympathy with the Cosmos
Aligned perfectly North to South
With the turning axis
Of the Pole Star.
Like an ancient monolith
At Stonehenge
Easter Island
Or the Egyptian desert
Long abandoned
But still watching the wheeling stars
Still holding the memory
Of what it was built for.

EDUCATIONAL PACKAGES FOR SCHOOLS AND AMATEUR GROUPS

by S.B. Tritton, Royal Observatory, Edinburgh
(reprinted by permission of the author)

During the production run of film copies for the ESO/SERC Southern Sky Survey there were some films which did not reach the stringent quality control standards laid down for copies made from the original UKST photographs. These rejected films, with only very minor flaws, are almost indistinguishable from those accepted for inclusion in the Atlas, and it was decided that these should be made available to the wider astronomical community in the form of educational packages. There are so far five different packages, each containing ten films and we have tried to ensure that each package includes a selection of solar system, galactic and extragalactic objects. Each package has a small accompanying booklet which gives details about the more interesting objects which can be found on each film. There are suggestions for exercises which could be done, such as galaxy classification, star counting and discovering asteroids but no specific exercises are included although some of the films are suitable as additional material for the Undergraduate Teaching Packages. The main purpose of these packages however, is to provide a cheap and convenient way for organisations such as schools and amateur Astronomical Societies to demonstrate modern astronomical material to a wider public.

The photographs accompanying this paper are all taken from film copies which are included in the educational packages.

Full details of all the various teaching packages can be obtained from UK Schmidt Telescope Unit, Royal Observatory, Blackford Hill, Edinburgh EH9 3HJ, Scotland. In summary, the various packages available are:

1. Edinburgh Astronomy Teaching Package for Undergraduates.
The package consists of eight specially selected film copies, made from UKST original plates, together with a set of notes suggesting exercises which can be undertaken using the films. The exercises are on Asteroids, a Comet, Globular Clusters, the Galactic Plane, the Vela Supernova Remnant, the Large Magellanic Cloud and Clusters of Galaxies.

2. Edinburgh Astronomy Spectroscopic Teaching Package.
"The UKST Objective Prisms" - a manual containing illustrations of over 400 objective prism spectra as seen on UKST plates taken using the objective prisms (dispersions 600Å/mm to 2400Å/mm near Hγ) was produced in March 1985. Eight film copies of five UKST plates taken with the objective prism, together with matching direct films, make up this package which includes a copy of the manual noted above and details of suggested exercises prepared by M.T. Brück of Edinburgh University and S.B. Tritton of the UK Schmidt Telescope Unit suitable for use in University teaching laboratories.

3. Edinburgh Astronomy Educational Package for Schools.
Film copies, originally made as part of the ESO/SERC Southern Sky Survey, but which failed the very stringent quality control criteria applied to atlas films, have been made into teaching packages. Each package consists of 10 films of different areas of the sky and each film is accompanied by a brief descriptive sheet listing the more interesting objects visible on the film. Five separate packs are available.

The costs are: 1. £60; 2. £70; 3. £30 per set.

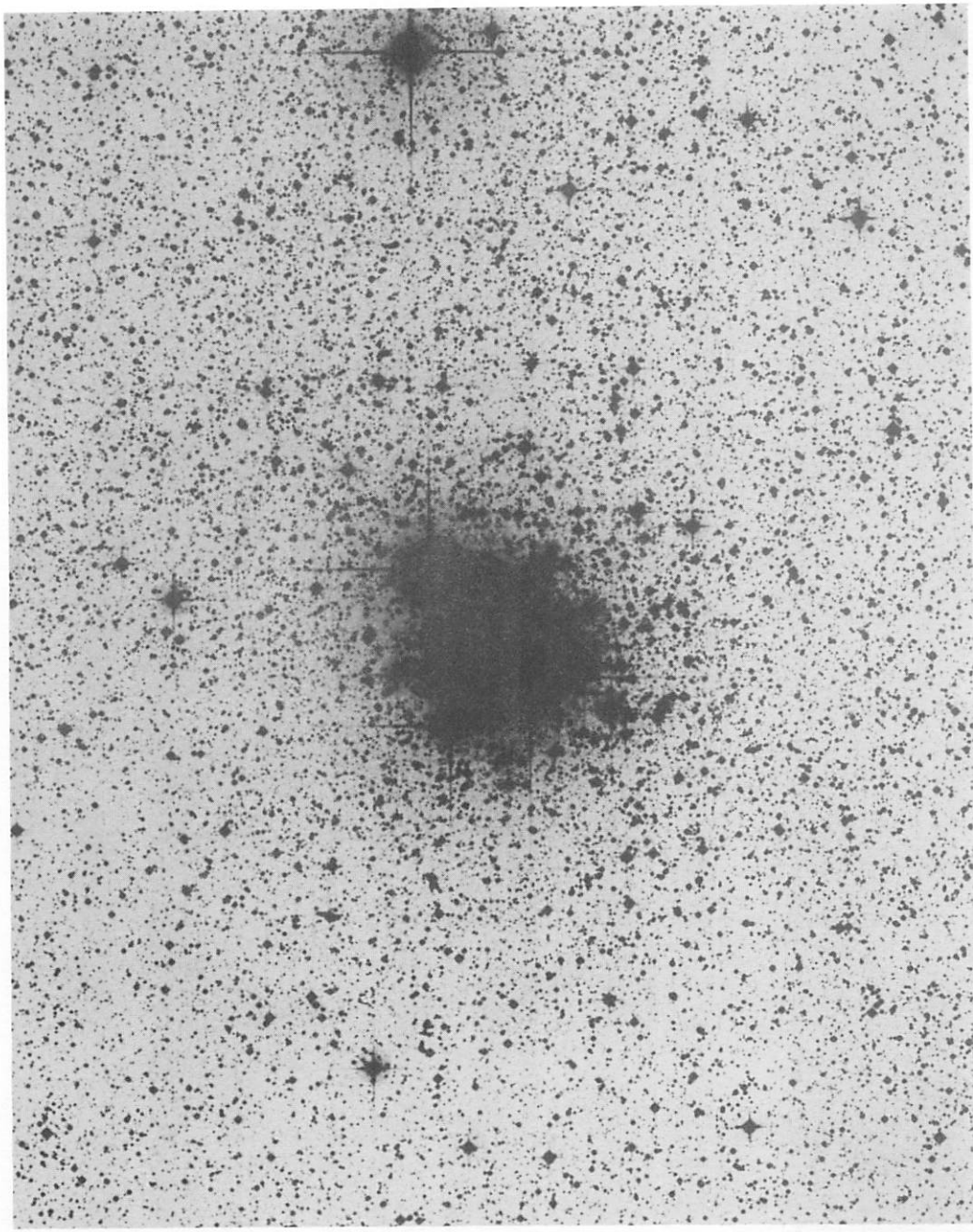

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PLATE 1

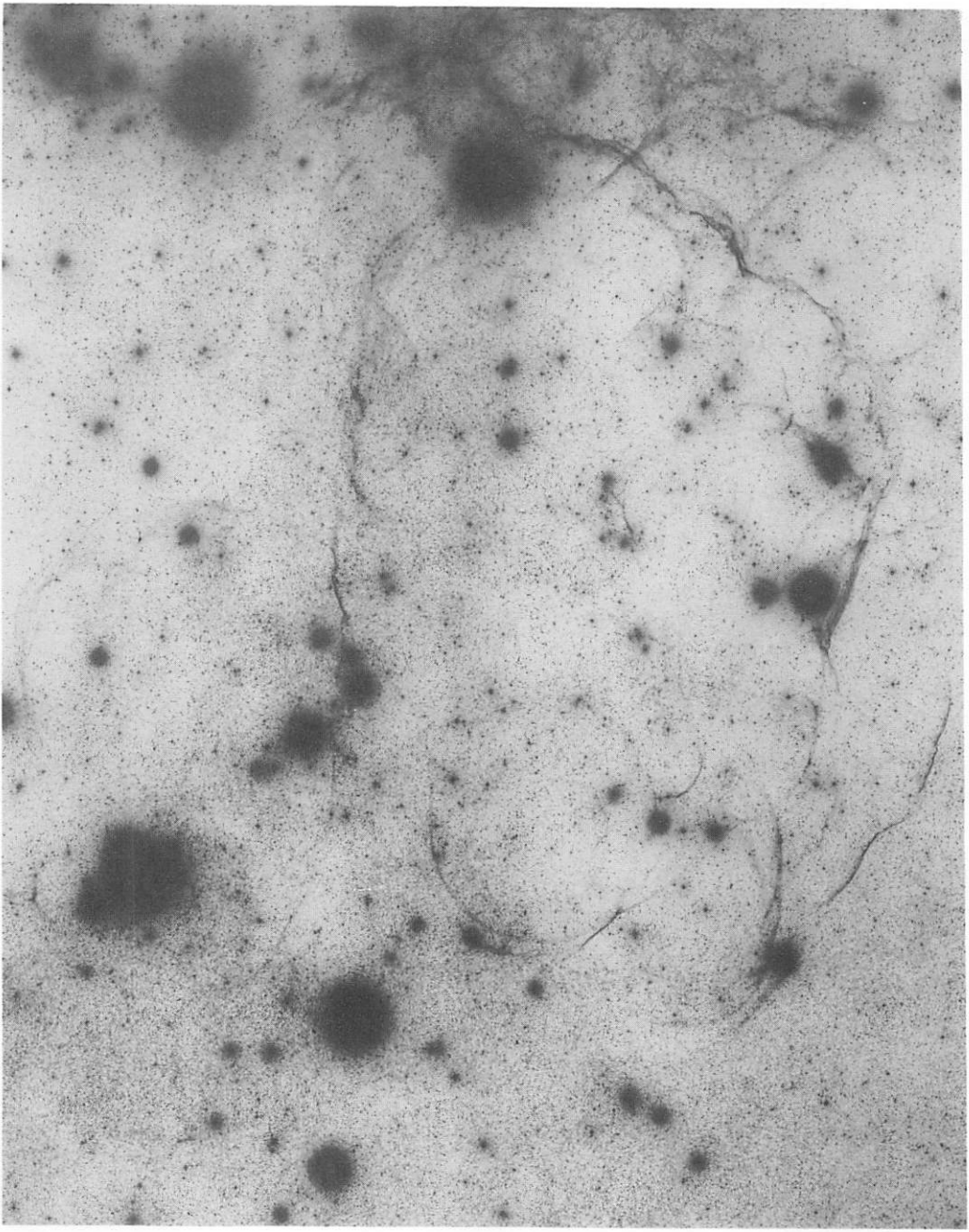

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PLATE 2

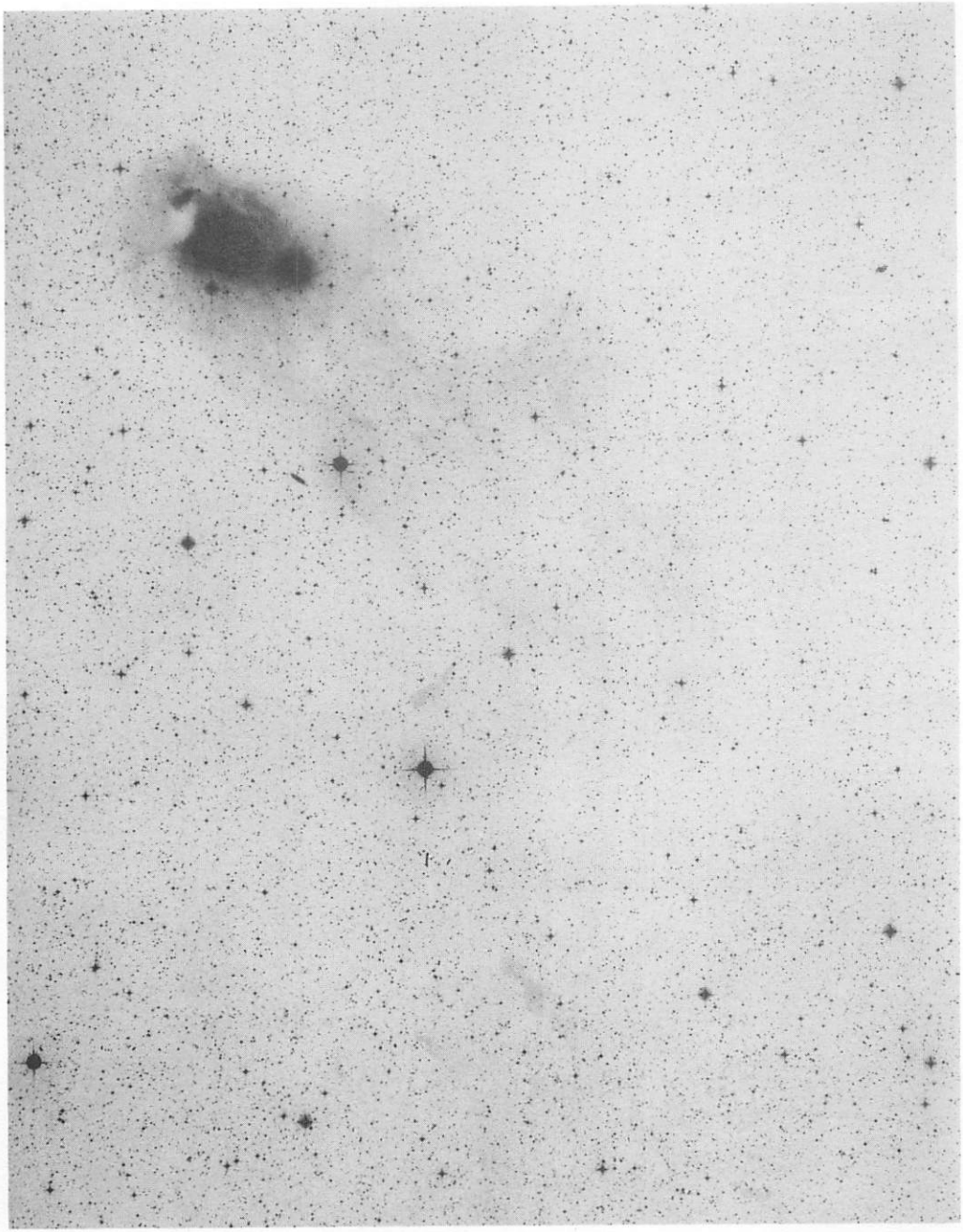

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PLATE 3

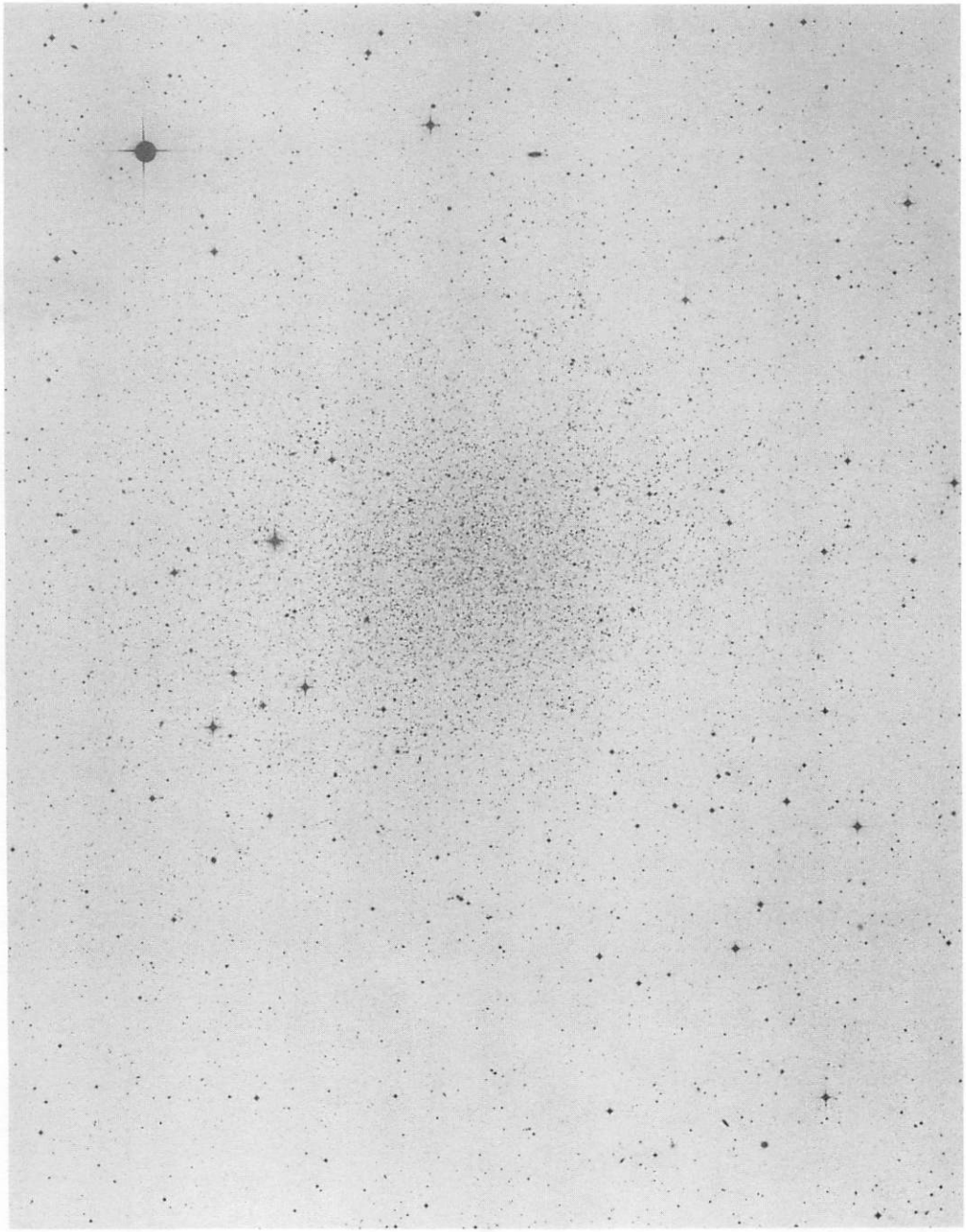

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PLATE 4

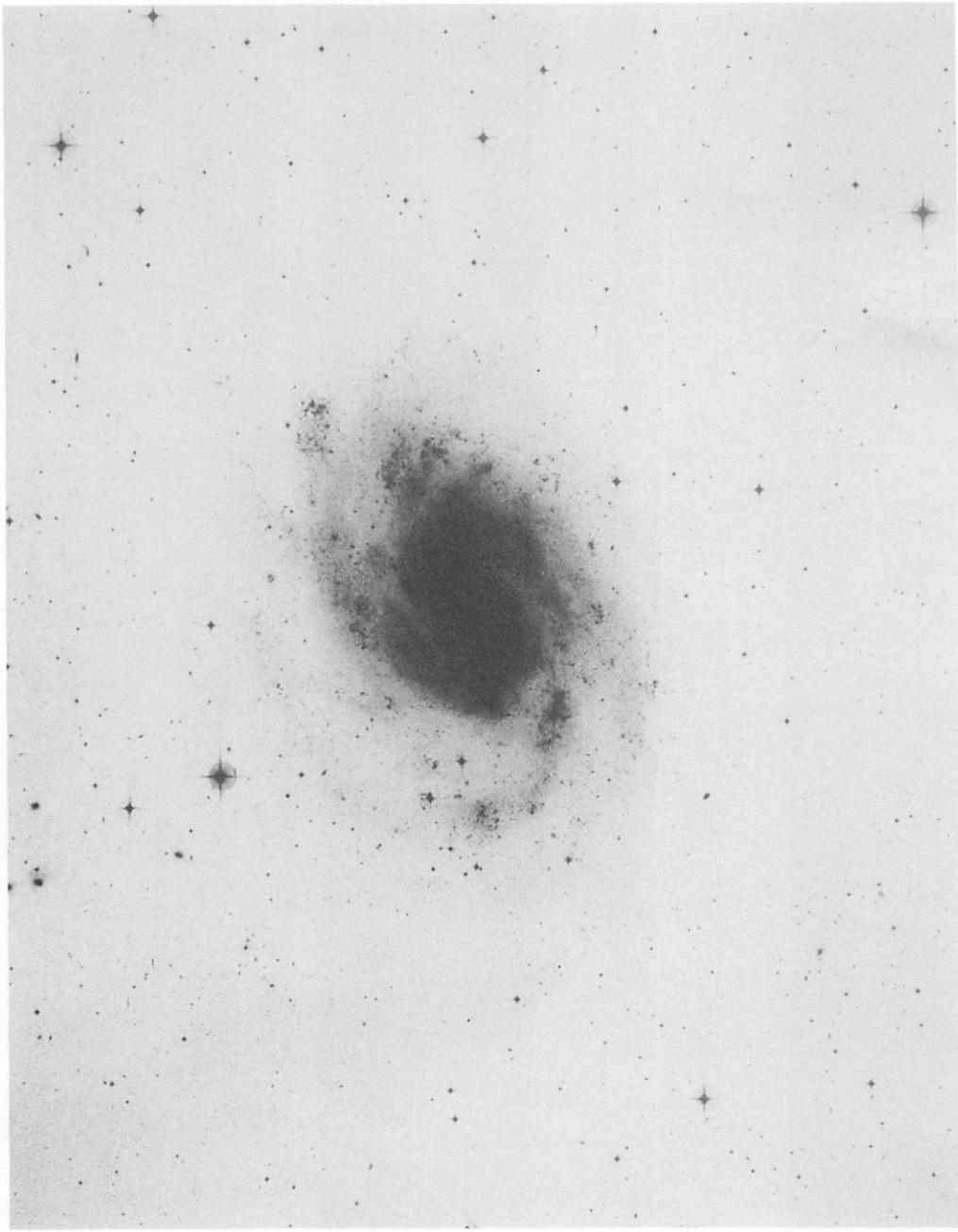

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PLATE 5

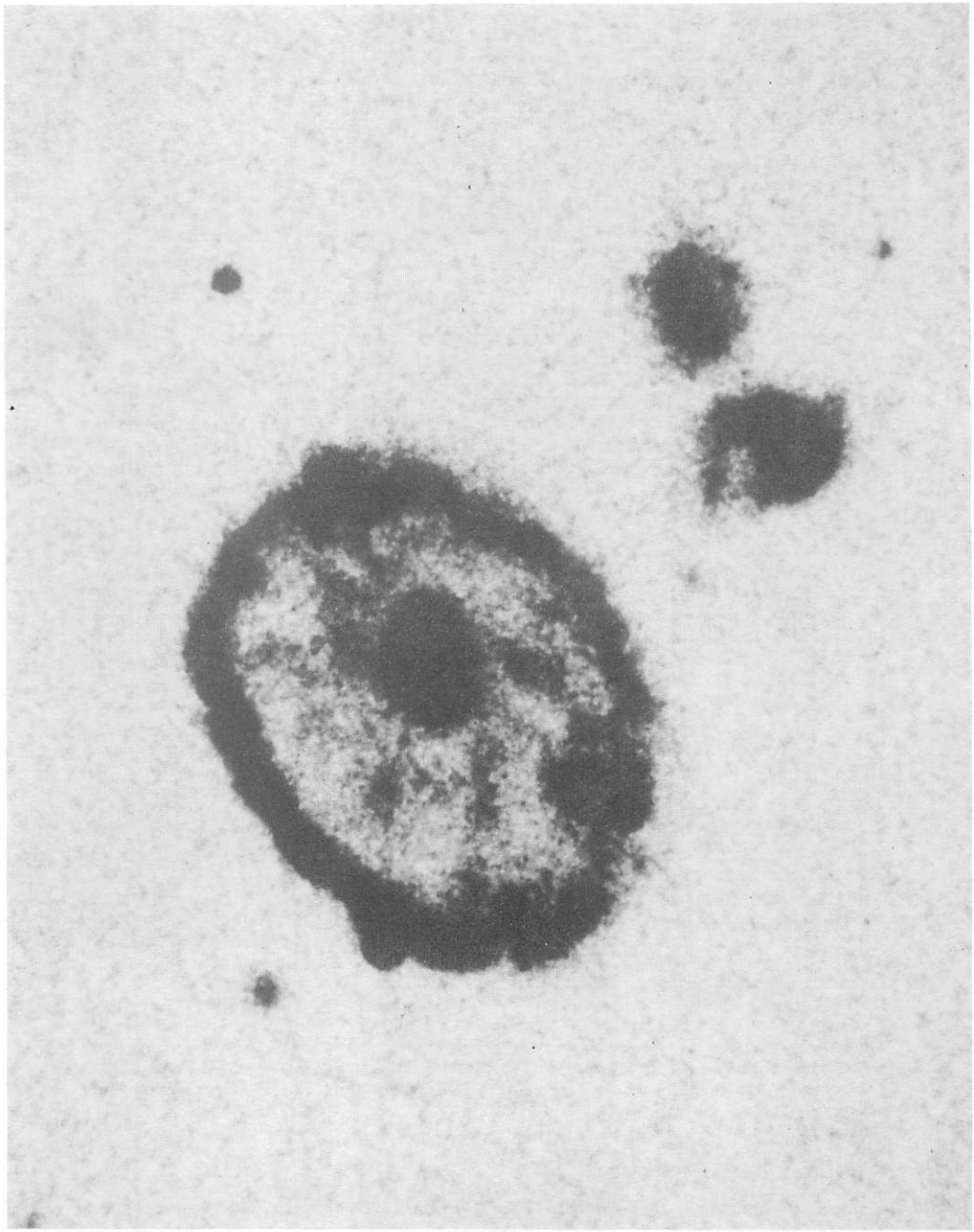

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PLATE 6

Plate 1. An Open Star Cluster, The "Jewel Box".
Located in the Southern Milky Way near the Southern Cross and the dark cloud known as the "Coal Sack" lies one of the most beautiful star clusters. The "Jewel Box" was so called after Sir John Herschel described the cluster as "appearing like a superb piece of jewelry". The cluster (NGC 4755) is very young in astronomical terms being only a few million years old. Most of the brightest stars are blue in colour; an indication that the cluster is very young as blue stars complete their evolutionary history much more quickly than less luminous stars like the Sun. Several of the stars in the cluster are amongst the most luminous in the Galaxy with luminosities equivalent to over 50,000 suns.

Plate 2. The Vela Supernova Remnant.
This photograph shows part of the Vela supernova remnant, the result of the massive explosion of a star many thousands of years ago. Material flung outwards from the star at thousands of kilometres per second collided violently with the interstellar gas in the surrounding space, generating shock waves. These shock waves have spread out many light years from the remains of the original star, the Vela pulsar, which has itself recoiled from its original central position. Light pulses have been detected from this pulsar although it is too faint to be recorded on the photograph. Radio astronomers have measured its distance to be 500 parsecs (about 1500 light years).

Plate 3. Cometary Globule 12 and NGC 5367.
This dramatic cometary globule, so called because of its appearance, lies in an area of sky some 20° above the plane of our Milky Way Galaxy. The dense cloud of cool gas and dust near the head of the globule contains a cluster of young stars (known as NGC 5367) recently condensed from the gas. The stars were probably formed after the cloud was compressed by a supernova blast wave which also formed the tail. The globule is about 1800 light years away and the tail is about 60 light years in length.

Plate 4. The Sculptor Dwarf Elliptical Galaxy.
The collection of faint stars on this photograph, somewhat resembling a very large and rarified globular star cluster, is one of only seven known dwarf elliptical galaxies. At a distance of about 270,000 light years, only slightly more distant than the Magellanic Clouds, the Sculptor dwarf galaxy is one of the intrinsically faintest galaxies known and can only be detected because of its closeness to us. Such galaxies are expected to be very common but they cannot be detected at greater distances because of their faintness. They also appear to be composed of old stars and contain none of the gas and dust from which new stars can be born.

Plate 5. A Spiral Galaxy: NGC 300.
Looking rather as our own Milky Way Galaxy might appear to distant observers situated in an external galaxy, NGC 300 is one of our closer neighbours in intergalactic space at a distance of about eight million light years. NGC 300 appears to us almost face on and is one of the most beautiful galaxies with its spiral arms being clearly indicated by the presence of bright young stars and glowing areas of hot gas.

Plate 6. The Cartwheel Galaxy.
This peculiar galaxy, given an obvious name from its appearance, is only 1.2 mm in diameter on the original photograph. The Cartwheel Galaxy is a member of the rare class of ring galaxies which are thought to occur as the result of a collision between two galaxies. In this case the smaller of the two companion galaxies is thought to have collided with a larger spiral galaxy about 300 million years ago. The collision caused a ripple in the spiral galaxy; the ripple, marked by the hot glowing gas and bright blue young stars of the rim of the cartwheel, has spread outwards for over 30,000 parsecs (100,000 light years). The larger companion galaxy is actually very much more distant than the Cartwheel and its companion. It only appears to be close because it is in the same line of sight.

COMPUTERS IN ASTRONOMY

By Dave McAdam

Our thanks are due to B.S. Russell, editor of LYRA, the newsletter of the Wolverhampton Astronomical Society, for permission to reproduce this article.

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Amateur astronomers are increasingly using computers in the pursuit of their hobby. Various conversions can be performed with ease on any home micro. Examples are:- RA and Dec to Celestial Lat/Long, or Galactic coordinates. GMT to Sidereal Time or Julian Date conversions. Rising/culmination/setting times of stars, constellations or other objects. The celestial coordinates of solar system bodies and the Moon can also be quickly determined for any particular date and time.

Once the calculations have been programmed in BASIC and checked, the user can then begin to build them into more sophisticated programs with the inclusion of "Menu" selection and so on.

The use of my BBC followed this path and resulted in sets of programs which are called up from disk to perform specific tasks mainly related to analysing the orbits of minor planets or comets in relation to the Earth and other major planets. My interest in doing this stems from attempting to photograph such newly discovered objects in the hope that astrometric positions may be derived from the negatives.

To calculate a succession of positions for an object (known as an Ephemeris), seven orbital parameters are required. (see box) The three dimensional aspect of the orbit in relation to the orbit of the Earth is defined by the inclination, the longitude of the ascending node and the argument of perihelion.

Orbital Parameters

Ω The Longitude of the Ascending Node is the angle from the First point of Aries to the point on the Ecliptic where the object crosses from South to North.

ω The argument of perihelion is the angle from the ascending node to the point of perihelion measured in the plane of the orbit.

ι The Inclination is the angle between the orbital plane and the ecliptic: 0-180 degrees. Orbital inclinations greater than 90 degrees are termed retrograde.

a The Semi-Major Axis is half of the greatest diameter of the ellipse.

e The Eccentricity is the ratio between the distance from the center of the ellipse to a foci and the semi-major axis.

M The Mean Anomaly is the angle from perihelion which the object would make at a particular time if the orbit were circular.

P The Period of one orbital revolution.

n The mean daily angular motion.

In addition, T usually denotes the time of perihelion passage and q the perihelion distance in astronomical units, (au). During calculation, E is the Eccentric Anomaly and υ is the True Anomaly.

The Epoch is the time at which the parameters have the given values: Continual slight changes occur due to perturbations by other solar system bodies of reasonable mass.

The shape of the orbit is then defined by the eccentricity, the mean daily motion and the semi-major axis, although, for a body in the Sun's gravitational field, the last two quantities and also the period are simply related so that only one of these is absolutely necessary.

Finally, the mean anomaly for a particular instant of time or the time of perihelion is required to set the starting point of the calculations.

The same parameters for the Earth are also required but are simplified by the fact that the inclination (by definition) is zero. The longitude of the ascending node is therefore meaningless and the argument of the Earth's perihelion is taken straight from the first point of Aries.

The method of finding a position in the sky starts with Kepler's equations and then cartesian X,Y,Z coordinates are found for both the object and the Earth, first centered on the Sun and then converted to Geocentric coordinates. The obliquity of the Ecliptic is then taken into account and the final figures of RA and Declination produced. The Earth to object distance (delta) is often of interest and can also be tabulated for printout. The magnitude can also be calculated fairly easily, but I have omitted this from my programs up to now. Comets require a slightly different procedure to other objects in this last respect, because of the non-linear characteristic due to the production of their tails.

Once the BASIC sequences for producing the sets of X,Y,Z coordinates were in existence, it was a relatively small step to store them in numeric arrays and use them to plot a diagram on the monitor. This has a certain amount of novelty value but gives an overall picture (literally!) of the way an object moves in relation to the moving Earth when the points are plotted in real-time.

As well as storing programs on disk or tape, computers will store data in the form of a file. The user can work out a suitable format to suit a variety of subjects. Note, however, that a tape file can only be accessed sequentially, whereas disks allow random access to any part of the data and also operate at greater speed.

I set up a file for storing star positions, magnitudes and spectral type and a short entering program was devised to allow easier entry of the numbers. The resulting file contains nearly 6400 stars down to mag 6.25 and takes up about 31 kbytes of disk space.

Some programs were then written to display areas of the sky on the monitor to different scales with spectral types plotted in different colours. Although this provides a nice display on which constellations can be picked out it does not perform any function which a good star chart could not do better. The real usefulness of the original star file is in producing charts showing the paths of Solar System objects on the printer-plotter in conjunction with the ephemeris programs. Within the space of about 30 minutes of receiving the orbital parameters of a new discovery, a finder chart can be produced ready to pin to my observing table to be used as a guide for astrophotography.

Another area where a home micro can be very useful in Astronomy is to take in data from an external transducer instead of through the keyboard. This usually requires some constructional effort (even if the computer has a suitable interface) as well as programming knowledge and may therefore be a bit deterring to many people.

There are, however, several British amateur astronomers who routinely do photoelectric photometry where the photometric signal is fed straight into a computer and then stored on tape or disk. Here, tape is probably just as suitable as disk because the amount of data from an observing run would not be very great and would probably have to be used serially anyway.

Finally, one last use of a home computer for astronomy can be mentioned: at least one British amateur is developing a system for automatic control of a telescope in the hope that the photographic search for supernovae in external galaxies can be done with more efficiency than is possible manually. This, of course, is quite a project even for a well equipped amateur but is still something that the average present-day computer will take in its stride.

CODICIL : SOME DIFFICULTIES

On starting to grapple with the (foreign!) language of BASIC, the beginner is prone to miss many small errors of programming. Some of these illicit error messages, depending on the sophistication of the particular version in use, whereas "hidden" errors can remain which only show up occasionally under certain sets of circumstances.

Most systems work to an accuracy of 7 to 9 significant figures on "real" numbers, for example, adding 1 to 1,000,000,000 will still produce 1 exponent 9 (1E9). The rounding up or down of such large, or small, numbers can then produce erroneous results whereas the middle-of-the-range answers turn out OK.

One error of this kind I have found the BBC produces is in the use of the trig functions COS and SIN. When the angle comes close to a 90 degree quadrant during computation, the rounding of the intermediate figures can sometimes exceed 1.000 so that an attempt is made to find the square-root of a negative quantity. Programs using varying angles will work correctly most of the time but will occasionally stall with the message "-ve root at line xxxx". The answer is to put an IF-THEN statement at a strategic point to trap this occurrence.

Another source of difficulty is when a BASIC listing from one computer is to be transferred to a different machine. An example here is the function INT which discards any fractional part of the number leaving the integer part intact. The programmer should check how the machine does INT when the number is negative, because either rounding up instead of down or vice-versa will give a difference of 1 in the answer.

Generally, the beginner to programming should bear in mind that computers have no intelligence and will only perform the

instructions they are given. If they do unexpected things, it is because the user's program has either told them to do it or, more often, NOT told them to do otherwise.

\+ + + + + + + +

BBC single line Calendar to Julian Date conversion.

```
10 INPUT'"Y,M,D?"Y%,M%,D%
20 J%=-7*(INT((M%+9)/12)+Y%)/4
30 A%=M%-9:S%=SGN(A%):A%=ABS(A%)
40 J1%=Y%+S%*INT(A%/7):J1%=-INT(J1%/100)+1)*3/4
50 J=J%+INT(275*M%/9)+D%+J1%
60 J=J+1721029+367*Y%:PRINT"=J.D.";J
70 GOTO 10
```

NB: The % sign denotes an integer in BBC BASIC and therefore automatically discards any fractional part from a calculation.

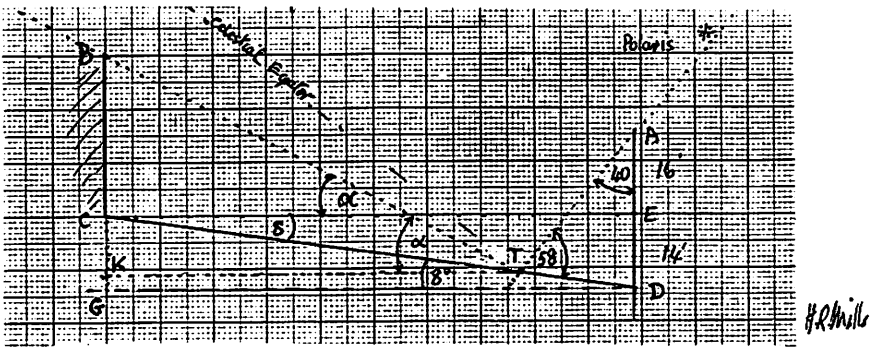
A PROBLEM OF SITING

A few suggestions have been received on the telescope siting problem in the September 1986 issue. The most detailed solution was received from Cmdr. H.R. Mills, and his suggestion is given below:

The diagram gives the solution based on the desirable condition that Polaris can be seen just above the tree DA. CD = 100', ED = 14' and CE is horizontal. The angle ECD = 8° (arcsin 14/100). Thus angle ATD = 50° + 8° = 58°. Then by the sine formula:

AD/sin 58° = TD/sin 40°, so TD = 22.73'. This can readily be checked graphically or by a calculator. TC = 77.26'.

At the point T the pole star is visible, but the roof of the house to the south will obscure stars that have a declination less than -11° (as the angle the roof-top makes with the telescope mirror is, by calculation, 28° which is 11° below the celestial equator.



Software Review:

Stars and Planets

ECLIPSE Software,
79, Ardrossan Gardens,
Worcester Park, Surrey. KT4 7AX

Format: BBC 40 track disc.
Price: £7.95

This collection consists of a mixture of five simulation and seven ephemeris programs. I have used them myself and allowed a group of senior members of the school Astronomical Society to investigate the programs before collecting their comments. This review is a distillation of our combined response and not the views of any single individual.

Several of the programs require the user to input the date and repeat the input each time the routine is run. After a few runs this becomes rather tedious, especially when an impossible date is accidently entered and accepted by the computer. There are also spelling mistakes and grammatical errors which should have been corrected before the disc was offered to the public. These annoying features lead one to suspect the accuracy of computation. However, if one ignores them and concentrates on the astronomical content a different picture emerges.

I will consider the routines individually:

JULIAN calculates the Julian Date. I have checked the computation for dates chosen at random and found that there is an error of four or five days for dates in January and February.

EPHEMERIS produces a neat table of Right Ascension and Declination for the planets, each of which is quoted to the nearest second (of time and arc respectivly). I feel that this implies an accuracy which is not justified; checks of output, again at random, produce differences of tens of minutes or perhaps a degree when compared with data tabulated in the Handbook of the British Astronomical Association. This may not be a problem for observations using a small telescope in school. Escape fails to rerun the program (as indicated on the sleeve). When the tabulated results were sent to the printer, spurious form feeds wasted rather a lot of paper.

AZALT calculates values of Altitude and Azimuth from Right AScension and Declination. The prompts for year, month, day, GMT, longitude and latitude flash unpleasantly and repeat for each object. It would have been better if the program had asked "another object?" and retained the data that did not change. I was surprised to be asked to enter "DEC(hrs,mins,secs)" and

astounded to find, on checking the calculations, that it actually meant "DEC(°,',")"! This is a serious error which should be corrected. On checking the results with data (supplied by the Mining Survey Section of Imperial College) the figures showed errors of up to a degree.
It would have been convenient to have been able to save the output of EPHEMERIS to use as input for this routine.

JUPITER'S MOONS gives a telscopic view (south at the top) of the four Galilean satellites in relation to the planet and each other, at intervals of up to 24 hours. It is a nice idea, useful and well presented.

STARTRAK plots the position of an object at hourly intervals over a period of 24 hours as seen from any part of the world. As the routine runs it displays both local and GST, altitude and azimuth. The object may be chosen from a list of "popular" stars or input by the user. Another well presented and useful routine.

MOONDAY draws the phase of the Moon (for any date between 1930 and 2099 inclusive) and gives its age. Although the simulation for a New Moon sometimes shows rather more illumination than one would see in practice, this (when used in conjunction with MOON) could be a neat way of demonstrating the Moon's phases to a junior form.

ASTEROID invites one to find an asteriod which has moved between two otherwise identical fields of 139 "stars" by moving a box using the cursor keys. The computer rewards the player with "WELL DONE" if successful. However, if the computer disagrees it displays "NOT THERE"; it does not show the "correct" answer or invite the player to "try again". I found it rather frustrating, slightly addictive and uncomfortable to look at.

MOON shows the relative position of the Earth and Moon in Sunlight with an inset of the Moon's phase. It indicates when eclipses are possible and should prove invaluable with Junior classes. I would have prefered the routine to have run more quickly - perhaps it would be faster in machine code.

KEPLER'S ORBITS enables the user to experiment with different velocities to investigate the motion of a body in the gravitational field of a more massive body. A suggested range of velocities with which to start would have been helpful. It is a useful demonstration, especially for the satellites work in Nuffield GCSE Physics.

MARS illustrates how the moons of Mars would appear to a Martian. A nicely written, well presented routine which is speeded up by continued pressure on the key indicated (not frozen as the instructions suggest).

SATURN'S RINGS displays Saturn and its ring system from any angle of view. Again rather slow but liked by the boys.

HALLEY plots the position of this well known comet from 15th July 1985 to 20th March 1986 on a grid of RA against Declination. This would have been useful a couple of years ago, especially if plotted on an Altitude-Azimuth grid.

INFORMATION supplies information and instructions, in an apparently random order, for eleven of the twelve routines.

To summarise, the simulations are good, but sometimes painfully slow; routines to dump the screen displays to printer or to save them to disc for later recall (to save time in the teaching situation) would have been useful enhancements. The ephemerides must be treated with caution. Provided one takes the time to thoroughly investigate the routines before using them with a class, "Stars and Planets" is good value for money.

M. C. Black.

LETTER TO THE EDITOR

Dear Sir,

The summer holidays have given me time to reflect on the success of an "Astronomy Week" which was organised by teachers in Powys to commemorate the return of Halley's Comet last year.

This rural county has a large number of small primary schools and the children live a long way from any large town. During Astronomy Week, however, they were able to visit a Planetarium as they were given a talk inside the Starlab Inflatable Planetarium in their own school hall!

I would highly recommend this device to members of the AAE.

The system is available for hire from: The Planetarium, College Hill, Armagh, N. Ireland. If the week is organized to make maximum use of the facility, the total cost is about 30p per child!

The Armagh Planetarium staff are most helpful and were willing to supply books, posters, postcards, etc. on a sale-or-return basis; but the children's enthusiasm was such that nothing was returned and extra materials had to be dispatched.

If you want a spectacular event to encourage Astronomy in your area, may I suggest that Starlab would be the answer.

Yours sincerely,
F.R.J. Banks.

Builth Wells, Powys. August, 1986.

Comment: Many AAE members have had experience of the inflatable planetarium, and share Mr. Banks' views. I am sure these will be gratefully received in Armagh.

Many readers have written in thanking the AAE for its newsletter I apologise if I have not answered them all individually. Ed.

RESOURCE CENTRES OF THE AAE

The following is a current list of Resource Centres whose facilities are available to members (on application). These range from the loan of slides to public lectures. In the next issue (April) we shall publish details of what the centres offer; for the present, this list is simply for information.

Amateur Astronomy Centre, Bacup, Lancs.
Hatfield Polytechnic Observatory, Bayfordbury, Herts.
Jodrell Bank Visitor Centre, Macclesfield, Cheshire.
Liverpool Museum Planetarium, Liverpool
London Planetarium, Marylebone Road, London, N.W.1.
London Schools Planetarium and Advisory Centre, Sutherland Grove, S.W.18.
National Maritime Museum and Old Royal Observatory, Greenwich, S.E.10.
University of London Observatory, Mill Hill, N.W.7.
Plymouth Polytechnic Planetarium, Plymouth, Devon.
Lancashire Polytechnic, Preston, Lancs.
Bilston Community College, Wolverhampton.
Mills Observatory, Dundee.
Leith Hill Nautical College Planetarium, Edinburgh.
University of Glasgow Observatory, Glasgow.
Armagh Planetarium, Armagh, N. Ireland.

THE FEDERATION OF ASTRONOMICAL SOCIETIES (F.A.S.)

Formed in 1974 as a union of astronomical societies and groups, working together for their mutual benefit.

Aims include compiling lists of people prepared to give talks; encouraging the teaching of Astronomy in educational establishments; giving advice on problems commonly encountered by astronomical societies.

The FAS produces a newsletter 5 or 6 times a year, and other publications from time to time. The Secretary of the individual society is responsible for making FAS material available to its members.

For further information, contact your local Astronomical Society, or the FAS Secretary (Dave Powell, 1 Tal-y-bont Road, Ely, Cardiff, CF5 5EU), enclosing a stamped and addressed envelope.

COVER : TWO VIEWS OF SOLAR ENERGY

(1) The Sun God Ra maintained his energy for daytime by closing his eyes at night;

(2) The nuclear reactions converting hydrogen into helium (fusion) result in the emission of energy.

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