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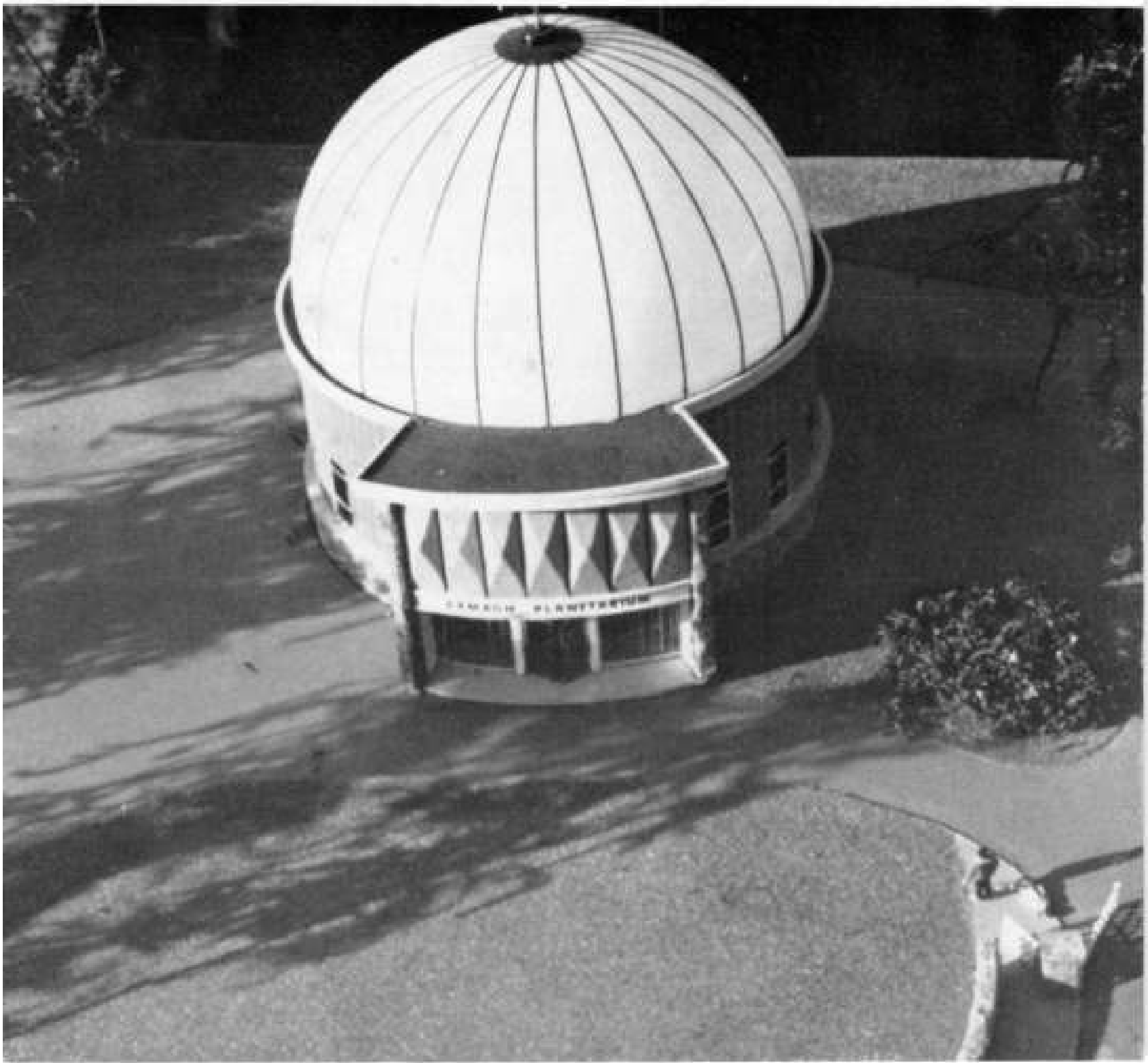
JOURNAL OF THE JUNIOR ASTRONOMICAL SOCIETY

Armagh's future Planetarium See page 78.



VOLUME 14 NO 2 JANUARY 1967

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The Junior Astronomical Society

For people of all ages interested in astronomy as a hobby. Annual subscription of 15s. includes 4 issues of *Hermes*. Full details may be obtained from the Secretary.

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comment

Your New President. At the Societies Annual General Meeting held at Caxton Hall, London, on 29 October, 1966, we all had pleasure in welcoming a new President. Michael J. de Faubert Maunder and myself have been colleagues now for nearly ten years and I am, therefore, probably as qualified as any to say something about him. At twenty-eight years of age he must be the youngest President the Society has seen. He holds an Honours, Special Degree in Chemistry and is an Associate of the Royal Institute of Chemistry. Married, he is employed in London as a Research and Analytical Chemist at the Laboratory of the Government Chemist and his astronomical interests include cosmology, space science and naked-eye observational work. He has part-ticipated in variable-star work in addition to the observation of meteors and artificial Earth Satellites. His written work is well known. Indeed, many of you will recall reading the popular series *Trend* in this journal. Michael was its leading author. As one whose grandfather, the late E. W. Maunder, was a past President of the British Astronomical Association, we promise all our whole-hearted support and wish him every success in the two years that lie ahead.

We also welcome J. L. White, FRAS and Brian Stevens to the JAS Council. The former is a contributor to this issue and has, for many years now, been Librarian to the British Astronomical Association. Brian Stevens hails from my own native Somerset. Many of you will know of him as the very excellent and established author of our series, *The Great Discoverers*. We also extend a warm welcome to Mr. Leslie Green, FCA, our new Treasurer. For some time now, he has been acting as Assistant Treasurer to Mr. Cyril Tomes. To the latter, in addition to our past President, Miss E. R. Atwell, we offer our most sincere thanks.

Two-Thousand Members? Our new President takes over at a time when membership of the Society has reached an all time peak of over 1,200. The distribution of *Hermes* is at present a best ever figure of 1,500. These figures obviously speak for themselves. Expansion continues rapidly and it is not surprising to note that those with an interest in astronomy beyond our shores are getting to hear of us. New Zealand and South Africa are two countries which have been prominent in this respect recently. To all our international colleagues may I say this: you are more than welcome to join in our activities; tell your friends about *Hermes* and Britain's Junior Astronomical Society; tell them of the service we provide and above all, encourage them to join us too. To the children of the nineteen-sixties, such terms as Lunar Orbiter and Great Red Spot are commonplace. Their quest for learning goes further. They make enquiries and their eventual search for available literature and practical help brings them to the JAS. As an organisation (and the leading one of its kind in the British Isles) we are still in our infancy. The future must be a prosperous one. A period of constructive development lies ahead and I would be so bold as to suggest that very soon now overall membership will surpass the two-thousand mark.

Wherever you may be, on behalf of Council and Section Directors, may I again take this opportunity of wishing you all a most successful New Year.

GEORGE TEIDEMAN

from the president

Accurate measurement of time is one of the main preoccupations of astronomers, professional and amateur alike. The human memory is notoriously bad at estimating and remembering periods of time and my own memory is no exception in this respect. It is with some humility that I remember that it is ten years since I joined the Croydon Group (as it was then), and still feel as though it were a few days ago. Even more sobering are my recollections of the first "Project Perseids," over seven years ago, in which your Editor and I were heavily committed in the organisation. Sometimes, when looking back on that week-end, I wish that time could stretch so that the memory were further back in time with all the ghastly happenings forgotten! However, on a more serious note it is with considerable pleasure that I have watched "Project Perseids" go from strength to strength, and at the time of writing this, "Project Leonids" will reach its culmination in a few days. Perhaps our efforts were not so insignificant if they have inspired others to these further and more ambitious Projects like trips to Skye and Iceland.

Michael J de Faubert Maunder
BSc, ARIC

The new JAS President

Whilst on the subject of "Project Perseids," I think it is highly significant that nearly all the members participating in this first one are still with the JAS and have, as individuals, contributed considerably to the Society. When I was asked to take on the job of President, it was with some regret that I discovered that the JAS had been afflicted with the same problems as other Societies, namely a rapid turn-over in membership. Why is there this disparity between members who joined many years ago and remained, and the bulk of members today who pay one subscription and never renew it? Is it in fact a National trend, or are we as a Society failing you as members? I hope it is largely the former.

One of my main problems in the next two years is quite simple: it is of convincing you that the JAS is your Society, not mine, not Council's, nor any member of it. If the Society is failing its members, the remedy is obvious: the members should make their views known. The Council is not there for its own benefit, but if no members views on any particular matter are available it is very easy to give this false impression. I have a number of ideas for consolidation of the Society, but these are only possible because of the hard work and enthusiasm of Miss Atwell and past Presidents, and with your help. Why not write to tell me what you think of the Society and how you think it should progress?

Do you agree with me for instance, that the time has come to re-emphasise the educational functions of the JAS with membership of the BAA and RAS as ultimate goals? That there is a pressing need for Beginner's and Regional meetings in addition to those held quarterly at Caxton Hall, and that some administrative advice should be available, on request, to the officers of affiliated Groups, etc.? Personally I don't mind how critical you are of me or any matter in connection with the JAS, and I'm sure I speak for the Council when I say that it is only by constructive criticism that any Society can progress. Perhaps I should make it clear that a Council meeting is **strictly** CONFIDENTIAL, any correspondence addressed to me or the Secretary for discussion at "Council" is put to the meeting regardless of our own personal views on the matter. So please don't worry that only ideas acceptable to either of us will be put forward, or that Council will discuss your letter with anyone else. I wonder if it has been a doubt on these points that has prevented correspondence in the past, if so, I hope I have removed such an idea.

So there YOU have a challenge as well as MYSELF. For my part I wish to maintain the high standard of the JAS as upheld by previous Presidents and for your part I hope you will help me to help you.

MICHAEL J. de FAUBERT MAUNDER

brown's moon by J. G. Porter, PhD, BSc, FRAS

The year 1966 has been a year of centenaries. The Battle of Hastings doesn't rouse me to much enthusiasm, and I have been more interested in another centenary—that of Ernest William Brown, whose lunar theory we use in our almanacs. Brown's name and work has touched my own life at many points—in the BAA, the Nautical Almanac Office and at Yale University—and it is not surprising therefore that I am impressed by the story of a man who spent forty years of his life on the very difficult problem of the Moon's motion. E. W. Brown was born at Hull in 1866 and distinguished himself at Cambridge, where he first became interested in lunar theory. In 1891 he took up an appointment at Haverford College in Pennsylvania, and here he continued his studies of lunar theory (his book on the subject is one of the great classics of celestial mechanics), and by 1908 he had published his theory in five parts of the *Memoirs* of the Royal Astronomical Society. In 1907 he was appointed Professor of Mathematics at Yale University, and in the same year he received the Gold Medal of the RAS, and began his work on the compilation of the famous *Tables of the Moon.*

In the lunar theory, the position of the Moon is expressed as a series of trigonometric functions of the various angles, the longitudes of the Sun, Moon and planets, with multiples of the sums and differences of these angles. In Brown's theory there are about 1,400 seperate terms, and these include every known gravitational effect, including perturbations by the planets and the shape of the Earth. To make the summation of these terms easier for the computer, Brown condensed them into 180 tables, from which values can be taken for any date, and the total found. This is still not easy work, but the tables are a masterpiece, a model of what such tables should be (and there are some shockingly bad ones in print) and everything has been thought of. There is even a section on the necessary alterations that should be made if the elements of the Moon's orbit were found to be different at some future date. These *Tables of the Moon* are contained in five large volumes, which were printed by Yale University in 1919, and were first used in the N.A. for 1923. To form the ephemeris of the Moon given in the N.A. the positions are calculated for every half-day, and then interpolated to every hour. The calculation of a single position with the use of these *Tables* would take a good computer six or seven hours, but even though the *Tables* arrange for the more speedy calculation of an ephemeris, it is quite a job for a human computer to keep pace with the Moon. So the work is done by machines, and in the early days punched-card machines were used to add up the many hundreds of small terms. This work was so rapid that these partial totals were completed up to the year 2000—a result that pleased Brown immensely.

The Moon has always caused trouble to computers because it seems to be speeding up. This acceleration of the lunar motion was first noticed by Halley at the end of the seventeenth century as a result of his study of ancient eclipses. Halley did not attempt an explanation and it was only in the early nineteenth century that the subject was fully examined. Yet after a great deal of argument among the experts, it became clear that gravitational theory failed to explain the whole of the effect, and so arose the idea that tidal friction is causing the Earth to slow down. In the early years of the present century it was shown that about half the effect can be accounted for by the friction of the tides in the Bering Straits and the Irish Sea, but there is, of course, no way in which all of these effects could be calculated theoretically. But they can be allowed for to some extent, and this is why Brown, like his predecessors, included an extra (non-gravitational) term (called the Empirical Term) in his *Tables*. Yet in the 1930's it was clear that even Brown's *Tables* did not represent the place of the Moon with complete accuracy, and the reason became clear when crystal and atomic clocks began to be used for accurate time keeping. These clocks, which can measure time to a thousandth of a second, showed that the slowing down of the Earth is not a regular process, but that there are also seasonal fluctuations (probably caused by the movements of air and water over the face of the Earth as the seasons change) and sudden irregular changes which can only be due to changes in the internal structure of the Earth.

Brown recognised that there was still much to be done in connection with the Moon's motion, and he urged the need for more accurate measures of the Moon's position. The simplest method is to observe occultations, and so a world-wide programme of observations was begun. Brown also organised the reduction of these observations through the Computing Section of the BAA, and the results were used by him and his colleague Brouwer to deduce very accurately the errors in the Moon's longitude, and hence the rate of slowing of the Earth each year. This work still continues longitude, and hence the rate of slowing of the Earth each year. This work still continues, though Brown and Brouwer are no longer with us, and the N.A. Office machines have taken over the work of reduction from the BAA.

The slowing down of the Earth becomes apparent in two distinct ways. Firstly, our system of time measurement is lagging behind the steady unchanging rate that is the basis of the laws of gravitation. Our observations are made in Universal Time, which is ultimately obtained by observations of the Sun, and therefore depends on the rate of rotation of the Earth. On the other hand the theory assumes that time changes quite uniformly, and all our calculations use this uniform or Newtonian time.

Nowadays this is called Ephemeris Time (ET), and it differs from UT by amounts which depend on the changes in the Earth's rate of rotation. The second effect is that the Moon really is moving faster, the reason being that the Earth and Moon form one single interlocked system whose energy must remain constant. If the Earth rotates more slowly, it will lose energy, and this is passed on to the Moon, which gains energy and so moves faster. One result of this is that the Moon moves outwards into a larger orbit, so the distance of the Moon from the Earth is increasing.

The actual slowing of the Earth is very small indeed, and the regular part causes the length of the day to increase by about one six hundredth of a second every century. This doesn't sound much, but this is an acceleration and its total effect depends on the square of the time interval. Thus over one century the average increase in the length of the day will be 1/1,200 sec, and since there are 36,525 days in a century, the total effect will be 1/1,200 of 36,525, or about 30 seconds. After two centuries it will be four times as much, or about 2 minutes, and after 2,000 years it will amount to 200 minutes. No wonder Halley found that the times of his ancient eclipses were more than two hours in error!

Brown died in 1938, but his *Tables* were used up to 1960, from which time the ephemeris of the Moon has been calculated on high-speed computors from the actual terms given in Brown's theory. But one important alteration has been made. Since it is impossible to predict the sudden changes in the Earth's rate of rotation, it is best to ignore altogether this part of the acceleration, which cannot be accounted for by gravitational theory. So Brown's Empirical Term has been removed, and the formalae have been adjusted to make ET the same as UT in 1900. Thus the modern *Astronomical Ephemeris*, which has taken the place of the *Nautical Almanac*, gives the positions of the Sun, Moon and stars at 0h. Ephemeris Time.

The little calculation above gave only the effect of the steady (or secular) acceleration, but since 1900 there have been several sudden changes, and today the difference ET minus UT is about 36 seconds. Don't let this worry you—there is very little difference in the positions of the Sun and planets, but the Moon, which moves so much more quickly (half a second of arc in a second of time) shows the effect very clearly. So the Moon is used to measure the difference between ET and UT and that is why it is still important to measure its position repeatedly—and the best and simplest way to do this is still by observing occultations.

Caught on the Hop. Who would have thought it? The new Circulars service was a sell-out right from the word go. Over twice as many members as we had anticipated sent in subscriptions—almost a quarter of you—so that the first issue was out of print as soon as it had been distributed. On behalf of the harassed production team, I would like to apologise to those of you whose first Circular may have been below quality, or whose subscriptions were received just too late. We were unable to cope with you all!

The demand has meant one thing: we are now able to offer you far superior production of the Circulars than would otherwise have been the case. By the time we have 500 people taking Circulars—and that will be much sooner than anyone dared hope—it will be possible to increase their quality almost to the high standards set by *Hermes*. And still for 5/- a year!

But if you haven't yet subscribed—the list remains open. Your subscription runs from the first Circular you receive. The next is due out in February.

the great discoverers

by B.Stevens

Galileo Galilei. In these days of the twentieth century, the last person whom one might expect to be celebrated in verse is an astronomer, regardless of his skill or reputation. It is thus a tribute to Galileo's service to astronomy that he was praised by no less a poet than John Milton in those lines in *Paradise Lost* referring to Man's recent discoveries concerning the Moon. Indeed, such is Galileo's fame that he has become one of the select band of astronomers whose names are known to all, regardless of their comparative interests in the subject of astronomy.

GALILEO
(1564-1642)

Born in Pisa in 1564, Galileo was sent at the age of seventeen to study medicine at Pisa University where he also learnt the prevailing Aristotelian philosophy dealing with the nature of the universe: a philosophy which was in direct contrast with the now overwhelmingly accepted Copernican system. The young man soon became noted for his unwillingness to accept without question statements which were not based on direct evidence but merely on the supposed authority of Aristotle and his long dead followers. This questioning mental attitude of Galileo combined with an irrepressible bias towards mechanical construction, explains why Galileo like Halley (see *Hermes*, Vol. 14, No. 1) was a genius of many talents. Of course, it may truly be said against him that many of the then revolutionary discoveries made by Galileo through his telescope are fundamentals of astronomy which anyone with similar equipment could have seen and commented in a manner as equally effective as that of himself. Nevertheless, it is certain that he did as much as anyone else up to the time of Bradley (see *Hermes*, Vol. 13, No. 3) to prove as correct the theory of Copernicus. It will also be seen that his non-astronomical discoveries made a substantial contribution to science in their own right.

Not the least of these latter discoveries was made after he had been at Pisa for two years. Galileo is alleged to have observed the oscillations of a candelabrum in the cathedral of Pisa, and to have been struck by the fact that the oscillations, no matter what their range, were accomplished in equal times. He is said to have verified this by timing the swings against his pulse. He concluded that by means of this equality of oscillation the simple pendulum might be made an invaluable agent in the exact measurement of time. All through his life he tried to build a true pendulum clock, and actually designed one, though it is unlikely that he ever built it.

Galileo's introduction to the principles of methematics led to his construction of a hydrostatic balance and the composition of a treatise on the specific gravity of solid bodies. These achievements secured him the appointment of professor of methematics at Pisa University, and here he laid the foundations of dynamics by his formulation of the law of accelerated motion in the case of bodies falling freely towards the Earth: and the law that all bodies, even invisible ones like air, have weight. In other words all falling bodies, great or small, descend with equal velocity. This was in opposition to the Aristotelian dogma that a heavier body must fall faster than a lighter one in proportion to its weight. Galileo is said to have demonstrated this by experiments made from the top of the leaning tower of Pisa. Although it is pleasant to conjure up the mental picture of this man dropping stones onto the heads of unsuspecting passers by, one is tempted to conclude that this, like the oscillations of the candelabrum, is just another of the myths which have grown up about him. The most famous is yet to come.

The emnity of the Aristotelians, exasperated by the cutting sarcasms of the successful demonstrator, caused him to resign his chair at Pisa and to become Professor of Mathematics at the University of Padua where his lectures attracted crowds of students from all over Europe.

It was at Padua that Galileo taught and worked from 1592 to 1610. By this time he had become sure in his own mind that Copernicus had been right in saying that the Earth moves round the Sun, but as yet he had made no astronomical discoveries himself. However, an account of an instrument for enlarging distant objects, invented by a Dutchman, Hans Lippersney, seems to have reached him whilst on a visit to Venice in May, 1609; and, to quote Galileo's own words, written in his famous book *Sidereus Nuncius:*

> "*At length, by sparing neither labour nor expence, I succeeded in constructing for myself an instrument so superior that objects seen through it appear magnified nearly a thousand times, and more than thirty times nearer than if viewed by the natural powers of sight alone.*"

As has been previously pointed out, Galileo's discoveries with this diminutive instrument were of the essentially fundamental kind which required only the necessary equipment, good eyesight, and no great depth of genius beyond common sense. Instead of giving a long list of facts known to even the most amateur of amateur astronomers, it is more rewarding (and interesting) to explore the suggestion that Galileo was not the first man to use a telescope in this way. Other contenders for this honour include Roger Bacon, an Italian named Porta, and a mysterious Englishman named Leonard Digges, about whom we know nothing apart from the fact that he died in 1571 and the vague possibility that he might have built some kind of optical instrument. Apart from these there are two other men who certainly began telescopic work at about the same time as Galileo and produced their own results. One was an Englishman, Thomas Harriot (who once acted as tutor to Sir Walter Raleigh); the other a German, Simon Mayr (or Marius). It will probably never be known which of these men is the true founder of optical astronomy, but as Galileo did at least produce tangible results it is only fair to give most of the credit to him.

Many people were doubtful as to the correctness of some of our subject's discoveries, which, in fact, threw into ridicule all of the previously uncriticised doctrines. The superstitious (with the support of the Catholic Church) even accused him of bewitching his telescopes. Trouble with the reactionary Church began in 1613 with the publication of the *Historia e Dimostrazioni intorno alle Macchie Solari*, in which he boldly professed his adhesion to the Copernican view. This provoked against him the censure and warning of the ecclesiastical authorities. It has been maintained that he brought this upon himself not so much because of his physical discoveries but because of the way in which his blunt satirical tongue and irascible disposition attacked the upholders of Biblical and Ptolemaic orthodoxy. On this occasion, however, Galileo's reason seems to have overcome his irascibility for, on 26 February, 1616, he swore to obey Pope Paul V's injunction not to hold, teach, or defend the condemned doctrines.

Our subject, however, could not hold his peace and, in 1632, published the "*Didogo sopra i due massimi Sistemi del Mondo*," a work written in the form of a dialogue between three fictitious interlocutors; the one in favour of the Copernican system; the second an advocate of the Ptolemaic and the third a well meaning but stupid supporter of the Aristotelian school. As if this were not bad enough, Pope Urban VIII was led to believe that Galileo had satirized him by casting him as the third interlocutor. By what means this enlightenment was acheived and what degree of truth lay behind the charge are not known, but the result of the unfortunate affair was that the work was given to the jurisdiction of the Inquisition and that Galileo himself, despite his 70 years and ill health, was summoned to appear before this somewhat inhospitable body. It is important to realise that in the seventeenth century the power of the Church and of the Pope was considerably stronger than it is now and those who opposed the Church could not expect to avoid the inevitable consequences of their actions, as Galileo found to his cost when, after a wearisome trial and imprisonment, he was condemned to abjure by oath on his knees the truths of his scientific creed.

This leads on to perhaps the greatest myth about Galileo, a legend that has been current since the year 1761 to the effect that on concluding his recantation he exclaimed (sotto voce), "*Eppur si muove*" (nevertheless it does move). Pleasant as it is to picture the stubborn old man muttering defiance beneath his beard under the very noses of his accusers, this episode is undoubtedly just another part of the myth of Galileo. The interesting question at this point is whether or not torture was used to force his so-called admission of guilt. He was certainly subjected to the exemen rigorosum, the last stage of which is actual torture, but the official documents of the trial make no mention of this last stage having been reached. On the other hand, it has been asserted that the records of his trial have been tampered with. In any case, Galileo was an old man, and old men have usually too much wisdom to fight against impossible odds.

But the Inquisition had not finished with Galileo. He was further sentenced to an indefinite term of imprisonment; a punishment that was only commuted by Pope Urban at the request of Ferdinand, Duke of Tuscany. It would appear that to tell the truth was a punishable offence in those days. In his retreat at Arcetri, near Florence, he pursued his researches with unflagging ardour, even when he was blind and deaf.

In fact, just before he went totally blind in 1637 he made yet another astronomical discovery, that of the Moon's monthly librations, even though he was expressly forbidden by the Church authorities to carry on with his astronomical work. He was stubborn to the very end. He died in 1642 and was buried in the Church of Santa Croce in Florence.

Galileo was a man too apt to claim too much for himself, thus obscuring other men's reputations; but the readiness he showed to forgive ennobled a naturally irascible temperament. By his refusal to accept statements on the authority of others; by his use of mathematics; by his processes of exact reasoning to deduce new results from established ones; Galileo laid the foundations of rational scientific method.

observing the constellations

by P. Lancaster Brown, FRAS

Fair Leda's twins, in time to stars decreed,
One fought on foot, one curbed the fiery steed.

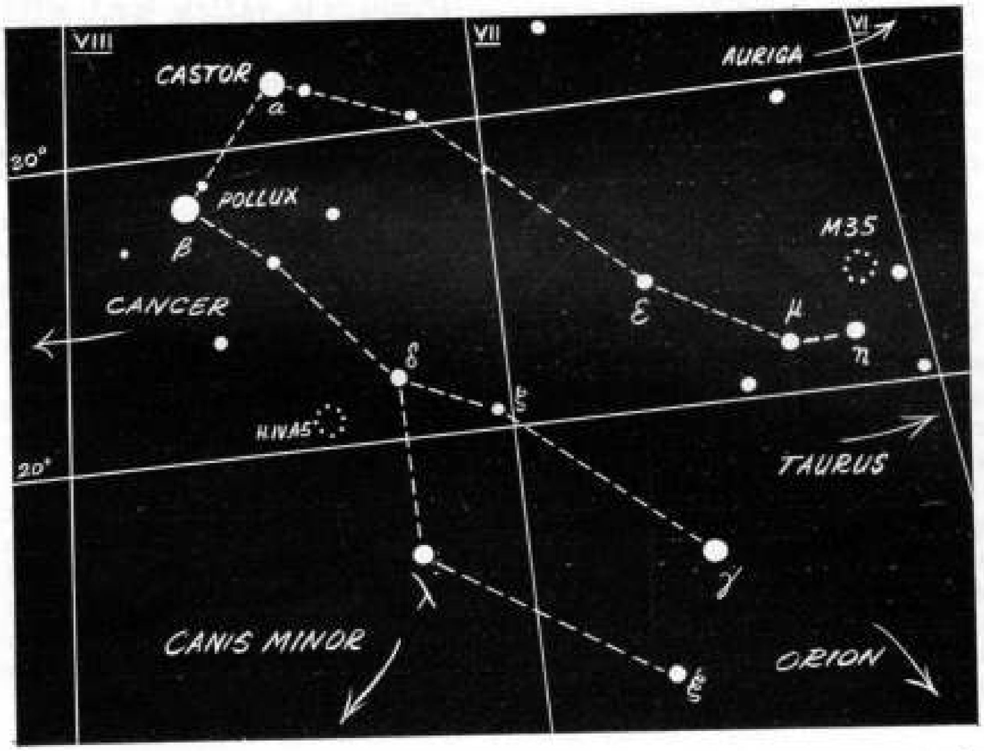
Thus the constellation of Gemini is considered to have had its origins in the classic story of the twin sons of Jupiter and Leda which the stars Pollux and Castor represent. However, there is some evidence to suppose that this constellation bore the name of "The Twins" before it had been agreed which particular pair of brothers they represented. While most authorities might agree that Castor and Pollux are among the most conspicuous adjacent stars in the entire heavens and are, therefore, very representative of the idea of twins, others say that the name 'Twins' was first suggested, not by the close proximity of these two stars, but the resemblance of the whole group as seen in the west after culmination—so conspicuous that no ancient maker of constellations could possibly overlook it. Castor and Pollux were regarded by both Greeks and Romans as the patrons of navigators and this is referred to in *The Adventures of St. Paul* (*Acts XXVIII*, 2).

While perhaps there may be doubts about the origins of Gemini, there can certainly be no doubts about the constellation's great visual beauty and distinctiveness. Gemini is easily located by projecting a diagonal line through Delta and Beta Ursae Majoris and is situated along the diagonal at a point approximately half-way between the bowl of the dipper and Sirius (Alpha Canis Majoris). Although it is visible in the British Isles for most of the year (in the autumn, winter and spring months) perhaps it is seen at its majestic best in the clear, cold frosty skies of January and February when, at midnight, it rides high in the southern heavens.

If there were such things as league divisions or tables for constellations, then Gemini would surely be a premier division member—since apart from its importance as one of the twelve zodical constellations, it is also very close by the plane of the Milky Way and in addition it is rich in historical associations.

Alpha Geminorum (Castor) is a binary system, magnitudes 2·0 and 2·9 (Colours: bright white and pale white) distance 1·9″. It is one of the finest double stars in the entire sky and was positively identified as being a truely binary pair, as against a chance optical configuration, by Sir William Herschel in 1802, although it had been Bradley who first drew attention to a change in position (of approximately 30°) between the years 1718 and 1760. The period of revolution is 420 years, the distance between the stars has lessened in recent years and it requires at least a 3″ O.G. and a moderately high power to split them. In 1895, it was discovered that the fainter member of the pair was also a spectroscopic binary revolving in 2·9 days. Again, a few years later, the brighter member was also found to be a spectroscopic system with a revolution period of 9 days. To make it even more interesting it was also discovered that a faint red star of magnitude 9 and 73″ distance is also a member of this system and is itself an eclipsing binary with a period of less than one day. Thus Castor can be considered as a rather unique sextuple star system.

Although Castor literally heads the constellation of Gemini and has the Alpha designation, it is in fact fainter than its twin Pollux (Beta) and there is general agreement that there has been a true inversion of their brightness during the last three hundred years.



Beta Geminorum (Pollux) magnitude 1·2 and a yellow-orange colour (in contrast the whiteness of Castor) is not a binary system, but it has a number of faint optical companions which are difficult objects in small instruments. With Castor it forms a useful measuring rod since the two stars are approximately 4½° apart.

Gamma Geminorum (Almeisan) magnitude 2·2, is a brilliant white star situated close by the galatic equator. Even with binoculars this field is a magnificial sight and is strewn with myriads of minute stars. It is of interest that very nearby Gamma, Max Wolf of Heidelberg first detected the famous Halleys Comet as a tiny photographic smudge on 11 September, 1909, when the comet last returned to the Sun after its 75 year journey in space.

Delta Geminorum (Wasal or Wesat) is an optical double, magnitudes 3·5 and 8·0 and is a fairly easy test object for a 2" O.G. with a medium power. Delta is practically on the ecliptic and it was near this star that the Pluto was detected and recognised as the tenth planet in February, 1930 (by Clyde Tombaugh, a one-time farm boy and amateur astronomer who had just become a professional), after an intermittent 25 year photographic search conducted by the staff of Lowell Observatory.

Epsilon Geminorum (Mebsuta) is another double pair magnitudes 3·4 and 9·5. The distance of the companion star is about 2' of arc and consequently is a relatively easy object in as little as a 2" O.G.

Zeta Geminorum (Mekbuda) is an ideal subject for binocular study being both a double and a variable star (magnitude variation 3·7—4·5. The companion star is magnitude 7 at a distance of 1½'. The brightness variations were first detected by Julius Schmidt in 1847. It is a Cepheid type variable with a period of 10 days, 3 hours, 43 minutes.

Gemini is certainly a constellation which has provided a "backcloth" for important astronomical discoveries of the past. It was near Eta (Propus), both a binary and variable star (magnitudes 3·2—4.2 and 9), that Sir William Herschel discovered the planet Uranus on 13 March, 1781. The variability of Eta was another of Julius Schmidt's discoveries in 1865, who found the period to be about 230 days. It is of the variety of variables known as semi-regulars and is a suitable object for study with the naked eye or wide angle binoculars.

For the observer equipped with binoculars, another object worthy of attention is the long period variable star known R Geminorum which is located approximately at the apex of an equilateral triangle with Delta and Zeta forming the base. This variable was discovered by the British observer J. R. Hind in 1848, and can just be glimpsed with the naked eye at maximum brightness (magnitude 5·9), but it must not be confused with the star known as 44 Geminorum, another 6th magnitude star situated very close by. At minimum R Geminorum sinks to magnitude 14·1 and requires a 12" aperture to see it. The period is 370 days and is a similar kind of star to the famous Mira (o Ceti).

Possibly one of the most exquisite sights in the entire constellation is the star cluster Messier 35 (situated north of Eta Gem.). This cluster may be glimpsed with the naked eye as a nebulous smudge on a clear moonless night. Even the simplest optical aid reveals its majestic splendour and in opera glasses or binoculars it has been likened to "a piece of frosted silver over which a twinkling light is playing." In larger instruments it presents a gorgeous field of stars ranging from magnitude 9 to 16, in an area about 40' in diameter.

Apart from the glorious star fields to be found in this constellation, mention must be made of the important meteor shower known as the Geminids which reaches maximum about 13 December each year. The radiant (which moves eastwards approximately 1° per day) lies close to Castor at shower maximum. Under favourable conditions, perhaps fifty or more (but often less) swift moving meteors may be seen. The Geminids are of considerable interest since their orbits are smaller than any other known meteor streams (or comets to which they are probably related). Their orbital periods are only 1·65 years and they approach the Sun's surface to within 0·14 astronomical units during the course of their highly eccentric paths. The Geminid meteors appear to originate from extraordinarily dense particles which are decelerated far less in our atmosphere than most meteors. These dense particles are probably the remnants of an extinct comet whose lighter components spirelled into the Sun long ago.

Before leaving Gemini, perhaps a word might be said about the possibilities of observing asteroids. Since Gemini is a zodical constellation, many asteroids pass through it from time to time and are often observed accidently by variable star observers who can readily spot a stranger in their familiar fields. With a small instrument 2"—4" a surprisingly large number of asteroids can be seen when near opposition, but for serious work a good star atlas is essential showing stars down to the 9th magnitude. An ideal one is *Atlas Eciplicalis* which records stars to magnitude 9·5 in the zones +30° to −30° declination, and is now generally available in Great Britain through the Academic Press. If one aspires a really serious asteroid observations with larger instruments, then a copy of Dr. Hans Vehrenbergs photographic star atlas, showing stars to magnitude 13, is practically a must. Ephemerides of all the brighter asteroids near opposition are now given in the annual *handbook* of the BAA, which is available to non-members, price 10/-.

the red shift by D. Lenihan

The Red Shift is generally thought to be the Doppler effect applied to light, i.e., radiation from a receding source has a longer wave-length than that from a stationary body. This discovery goes back to 1842 when the Austrian physicist Christian Doppler was studying acoustical effects—he also suggested that the different colours of the stars was due to this effect. In 1868 Sir William Huggins found that the wavelength of lines in the spectrum of Sirius were displaced towards the red end by 1/10,000 the wavelength of the lines in a similar spectrum produced in the laboratory. In the following years many stars had their red or blue shifts measured, but in 1912 V. M. Slipher of the Lowell Observatory found that spiral galaxies also have red shifts, which are very much larger than those of stars.

This was the first hint that the spirals were extra-galactic. In 1914 Slipher published a list of the velocities of thirteen galaxies, in which velocities of up to 500mi/sec were shown. Then in 1929 E. P. Hubble presented conclusive proof that the spirals were extragalactic, and from Slipher's list showed that the velocity of reccession of a galaxy is proportional to its distance. This is known as Hubble's law, and the reciprocal of this constant, 10^{10} years, is known as Hubble's constant. This law gave rise to the present concept of an expanding universe and has two important implications:

1. This is the only Law which would have the same form with respect to another galaxy as origin, i.e., our galaxy is not in any central position; an observer situated in any other galaxy would arrive at exactly the same law.
2. If the expansion of the universe is unaccelerated, then 10^{10} years ago, all galaxies were relatively close to one another. This value also agrees closely with the age of our galaxy.

Until recently no one had seriously questioned Hubble's interpretation of the Red Shift as a Doppler effect and no well-established departures have been found from the linear relationship between Red Shift and distance. Arguments against the theory have included:

1. Radiation gradually "ages" its wavelength, slowly increasing as time goes on. In this case even if all the galaxies were stationary, the light which had come the greatest distance would arrive with the greatest Red Shift.
2. Atoms at the time of departure were larger and produced light of longer wavelengths.

3. The constants in physics are, in fact, not constant over long periods of time.

With the recent discovery of quasi-stellar objects, serious consideration was given to an explanation of the Red Shift as a gravitational effect.

These peculiar objects were discovered by Martin Ryle of Cambridge in the course of the 3C survey, which was intended to provide accurate positions for radio sources so that optical telescopes could identify them with visual objects. In 1960 the Q.S.O. 3C48 was identified with a faint ultra-violet intense star, and in the following two years the sources 3C196 and 3C286 were also identified with faint u-v intense stars. Spectra of these sources were taken in 1962, but were found to be totally unidentifiable.

The first clue to the mystery of these objects came in early 1963 when an occultation of Q.S.O. 3C273 by the Moon was observed with the 210 foot radio-telescope at Parkes by C. Hazard of Sydney. Since the position of the Moon in the sky is well known, the co-ordinate of the source could be determined with great accuracy. Hazard was surprised to find that 3C273 consisted of two components separated by 20″. The position of one source coincided with a mag. 13 star, while the other source was on the tip of a faint jet which pointed away from the star. Spectra of 3C273 were taken at the 200″ Mt. Palomar telescope and this time it was easy to interpret; it showed the normal hydrogen lines but shifted towards the red end by 16% of their normal wavelength. With this clue Matthews and Greenstein identified the spectrum of 3C48, which was found to be red shifted by 37%. Since 3C48 and 3C273 were relatively bright but had small red shift it could be assumed that the fainter Q.S.O.'s had much larger red shifts. With this clue, 3C254 was found to have a red shift of 73%. 3C287 was then found to have a red shift as great as 106%. The greatest known shift at present is the 212% of the Q.S.O. 1116 + 12.

Now objects with red shifts in the order of 20—30% are very faint and distant galaxies, but the quasi-stellar objects do not have the diffuse and extended image such a galaxy would be expected to show. Thus if the red shift of the Q.S.Os. is a Doppler effect, they must be extremely luminous and very small. Therefore in 1963 Schmidt and Greenstein put forward the theory that the red shift might have a gravitation origin.

Light leaving the body of a large mass will suffer a loss of energy in overcoming the body's gravitational field, and by the Relativity Theory this loss will show up as a red shift. In order to obtain a red shift similar to those of 3C48 or 3C273, a body with, say, the mass of the Sun, would have to have a diameter of less than 10 kilometers. In fact some massive stars in our galaxy, for example the white dwarfs, do show gravitational red shifts, but these are small compared with the red shifts of 3C273.

If we assume the red shift to be a Doppler effect then using Hubble's Law we can calculate the distance of the source and hence find the sources intrinsic luminosity. For 3C273 we find the distance to be 1,500 million light years, and the luminosity turns out to be about 100 times that of a normal galaxy! Also since the jet spans an angle 20″, it must be at least 130,000 light years long.

A number of theories have been put forward to account for this vast amount of energy emitted by the Q.S.Os. Fred Hoyle proposes the collapse of a single body of 10^8 solar masses; Gold suggests a chain reaction of collisions and collapse within a dense star system, while Alfvén and Teller suggest the annihilation of matter and anti-matter.

Even more surprising than their vast amount of energy is the fact that the quasi-stellar objects vary in brightness. For example 3C273 varies between mag. 12·3 and 12·9 with a period of 13 years, although it can occasionally rise to mag. 11·5. 3C48 varies in rather less than two years, while 3C345 has a period of only 20 days. Even more suprising is 3C2 which when photographed in 1951 had been faint and red, but in 1964 had trebled its luminosity and was now decidedly blue. These periods of fluctuation give us an indication of the size of the source. If we consider a source 15 l.y. in diameter, light from the back of the source will take 15 years longer to reach us than light from the front. Therefore large luminosity variations will only be observable over periods greater than 15 years. This suggests that the diameter of 3C273 is about 25 l.y. This seems extremely small when one remembers that 3C273 is 100 times more luminous than a normal galaxy. One explanation is that only one small component of the Q.S.O. increases in brightness.

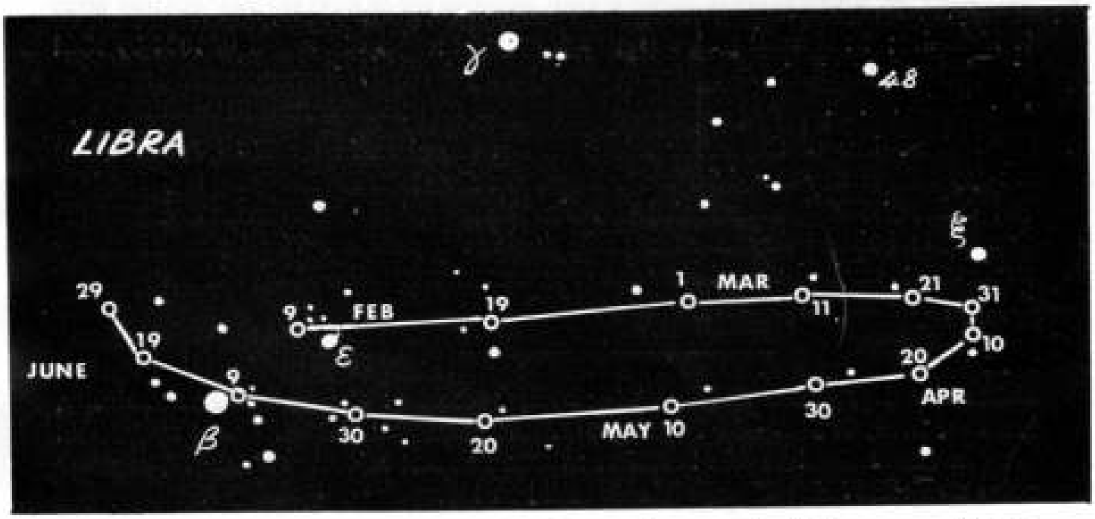
Perhaps the next decade will end the conflict between the gravitational and cosmological theories of the red shift, or a completely new theory might be proposed.

minor planets in 1967

J. L. White, FRAS

The only asteroid easily observable this year is Vesta, which reaches its maximum magnitude of 5·6 when it comes to opposition on the 15 May. Because of its southern declination, 9 deg, it is not the most favourable occasion for observers in the British Isles, where its greatest altitude is less than 30 deg.

Although often described as visible to the naked eye, only the very keen-sighted, searching in the clearest, darkest sky, are likely to identify the planet among equally bright stars. Binoculars will certainly reveal it, but a telescope enables its motion to be followed with ease and certainty, often during the course of a single night. For this reason the accompanying star field is shown inverted; the faintest stars shown are about eighth magnitude.



The planet will be one degree South of Beta Librae on the 5 February, and half a degree South on the 11 June; on-third of a degree South of Epsilon on the 10 February, and one degree South on the 31 May; one degree South of star 37 on the 19 February and one degree North on the 20 May. These stars are shown on *Norton's Star Atlas* and the *New Popular Star Atlas* (Gall and Inglis, 7s. 6d.), and given clear skies the planet cannot be missed on these occasions.

Vesta, the goddess of fire, was the fourth asteroid to be discovered, by Wilhelm Olbers, a physician of Bremen, in 1807. It was named by Friedrich Gauss, the great German mathematician, who computed the orbit of Ceres, the first of the asteroids, discovered in 1801 by Giuseppe Piazzi at Palermo.

Its diameter, 240 miles, is less than that of Ceres, 480, and Pallas, 350, but its brightness shows its surface must be of a different nature from the others. Its eccentricity is ·09, and its distance from the Earth can vary from 105 to 148 million miles, its magnitude at opposition sometimes being below 7. It is inclined to the ecliptic by 7·14 deg, and thus can reach over 30 deg declination, and when this much South of the equator it is only a few degrees above the horizon in England, even when on the meridian. Its sidereal period is 3·63 years, and the next opposition occurs in August, 1968. All these facts should persuade anyone who has never seen a minor planet to make sure of locating Vesta this year, for an equally favourable opportunity will not occur for some time.

Ceres, the goddess of corn and harvest, was at opposition on the 22 December last, at magnitude 6·6. It reaches declination 29 deg North in March and is well worth searching for, even without a special chart. On the 9 February it will be one degree East of Nath (Beta Tauri) and a fifth of a degree South; it will hardly move during the few days before and after this date. On the 8 April it will be within two or three minutes of arc of Kappa Aurigae, magnitude 7·6. Ceres has a sidereal period of 4·6 years, an eccentricity of ·08 and an inclination of 10·6 deg.

Pallas, the goddess of wisdom, was discovered by Olbers in 1802 while he was looking for Ceres. Its eccentricity is ·24, its inclination 34·8 deg, and its sidereal period 4·61 years. It was last at opposition in October, 1966, and its highest magnitude this year is 7·4 in December. On the 31 October it will be one degree North of Lambda Sextantis, magnitude 8.

Juno, The Queen of the gods, has also high eccentricity, ·26, and its inclination is 13·02 deg; its sidereal period is 4·33 years, and it was discovered in 1804 by Karl Harding at Lilienthal. It comes to opposition on the 27 January, when it reaches magnitude 7·9. There are no close approaches to easily identified stars in Hydra.

Epheremides of these four minor planets are given in the *BAA Handbook* at ten-day intervals. Also given are ephemerides for (7) Iris, (9) Metis, (10) Hygieia, (14) Irene, (18) Melpomeme, and (42) Isis. Four of these are very far South of the equator, and all are very near tenth magnitude at opposition. Those possessing only small telescopes and no suitable charts cannot expect to be able to identify any of them among the surrounding stars of similar magnitude.

Future Meetings of the Society. These will be held at Caxton Hall, Westminster, London, SW1, in 1967—28 January, 29 April, 29 July and 28 October, at 6.0 p.m. We can assure all who make the effort to attend a most enjoyable evening. Do please come along and bring all your friends with you too.

JAS Subscriptions: 1966/67. Those of you whose current subscription is still outstanding, please, at your earliest convenience, forward it to the Assistant Secretary, Miss E. R. Atwell at No. 10 Moreton Road, South Croydon, Croydon, Surrey. Please note this change of address.

lunar transient phenomena by Patrick Moore, FRAS

On 3 November, 1958, the Russian astronomer, N. A. Kozyrev, was studying the lunar crater Alphonsus with the aid of the 50-inch Zeiss reflector at the Crimean Astrophysical Observatory. Earlier, photographs taken by D. Alter in the United States had suggested that there might be temporary obscurations of a local nature inside Alphonsus, and this is why Kozyrev was paying special attention to the area; it was not sheer chance, as was suggested later.

Suddenly Kozyrev detected a reddish glow close to the central peak. He followed it visually, and was able to take spectrographic pictures which showed clearly that there had been some sort of outbreak—and in so doing, he obtained the first conclusive proof of the reality of what have now become generally referred to as transient lunar phenomena, or TLPs for short.

Kozyrev's observations caused great controversy at the time. (It was even suggested, by some astronomer with more malice than intelligence, that the whole observation had been faked!) But though some of the interpretations might be challenged, the observation itself cannot; and unlike some of the critics, I have seen the original plates. Kozyrev showed them to me when I visited Russia a year or so later.

Subsequently, J. Greenacre and his colleagues at Flagstaff saw shortish-lived reddish patches in the area of Aristarchus, and here too there can be no possible error in the observations. From being the notions of mere amateurs, lunar TLPs became 'respectable,' and energetic searches for them were begun.

Of course, there have always been great differences of opinion with regard to the Moon. My own views have always been clear-cut, I am convinced that the main craters are volcanic (though many small meteorite pits must exist too), and I have never had the slightest faith in the soft-dust theory due to T. Gold and R. A. Lyttleton. The dust idea never fitted the facts, and of course it is now of historical interest only, but the question of crater origin is still open. We may know before long.

Also, there was the matter of changes on the Moon. Quite apart from the classical case of Linné, there had been reports of local obscurations and red glows, which were not taken seriously in the pre-1958 period. This was because they came almost entirely from amateurs; but there was nothing surprising in this, because the amateurs were the people who were looking at the Moon through telescopes. Remember, too, that the eminent professional theorist is often very much of an amateur at pure lunar observing.

After the Kozyrev and Greenacre reports, it seemed worth making a systematic check to see whether any other colour phenomena could be tracked down. One promising idea was that of the Moon-Blink apparatus, in which areas of the Moon are observed in rapid succession with a red and a blue filter. A red patch will be suppressed by the red filter, but will show up as a dark patch in the blue, so that rapid alternation to and fro will yield a 'blink" in the affected area. There is some analogy, though only a very loose one, with the principle of the blink-microscope used, among other things, to locate Pluto in 1930.

The American Moon-blink apparatus, sponsored by NASA, was complex and expensive, but it did seem to be useful. In Britain, we decided to try something much less elaborate—simply a rotating filter arrangement fitted on to the telescope. Specimen 'blinkers' were made by Peter K. Sartory, of the BAA Lunar Section, and we began work, more in hope than in expectation.

On the evening of 1966—30 April, I received a telephone call from Sartory. He reported that he was observing a strong blink inside the crater Gassendi, but could see no colour (at the time he was using an 8½-inch reflector). Sartory lives in Surrey; at the moment I am at Armagh, in Northern Ireland, and by courtesy of the Director, Dr. E. M. Lindsay, I have full use of the Armagh 10-inch Grubb refractor (as well as my own 12½-inch, and 8½-inch reflectors). Together with my colleague, T. J. C. A. Moseley, I had the Armagh refractor turned toward Gassendi within ten minutes, and we recorded two reddish patches. It was only later that we checked up, to find that our positions and timings were identical with those of Sartory. Further TLPs in Gassendi were seen on 1 and 2 May, and these were seen also by P. Ringsdore, Secretary of the Lunar Section, with his 8½-inch reflector at Ewell, Surrey.

I have always been somewhat wary of colour TLPs, but these were, in my view, too prominent to be overlooked. Of course they were not glaring, but they were distinctly visible. And having seen at least two more similar phenomena since, I am bound to maintain that the Moon is not totally inert.

The Gassendi observations caused considerable interest, and by now we have an extensive observational programme in full swing. We are also co-operating with the United States workers, and at Kwasan Observatory, in Japan (which I visited a few weeks ago) Professor Miyamoto, the eminent selenographer, now has a Blinker working on the 12-inch Cooke refractor which was used for drawing up the Japanese lunar atlas.

At the Lunar and Planetary Laboratory in Arizona, Miss Barbara Middlehurst began an analysis of all reported TLPs, going back to the early days of lunar observation, and found a connection with the time of lunar perigee and apogee. Independently, I was working on the same lines, using only observations which I regarded as relatively reliable; and my conclusions were the same—as we found when Miss Middlehurst paid a visit to Armagh Observatory during the past summer. Mrs. Winifred Sawtell Cameron, of NASA, believes that there is also a link with the Earth's magnetic tail that is to say, the time of full Moon.

Quite a number of confirmed TLPs have now been found, and the results have been published, in outline form, in the Lunar Section *Circulars*, though no weighting or analysis has been attempted yet. It seems that the Blink principle is remarkably sensitive; a relatively small telescope—an 8½-inch, say—can show a Blink even when the colour itself is not visible. This was established early in the programme. Sartory, with his 8½-inch, was able to detect the Gassendi blink, but could not see the colour; with our larger aperture at Armagh, we could see the redness. We did not then have a blink apparatus, though we have now fitted one.

Assuming that the TLPs are real (and personally I have no qualms about this), what causes them? Luminescence was one suggestion, which would mean a link with solar activity, but it now seems that the energy would be insufficient. Weak volcanic activity is another idea, but some of the TLPs cover large areas (as, for instance, a 'wedge' in Gassendi which was well substantiated), and we cannot suppose that the Moon is a violently active world. Gaseous emission, in which glows occur, seems to be more probable. But whatever be the cause, the TLPs themselves are of tremendous interest.

There is one point which cannot be over-emphasized. In research of this sort, an unconfirmed observation is of little value, what is needed is confirmation by an observer at another site, working quite independently, and with no possibility of unconscious prejudice. Also, a careless observation is not only useless—it is actually harmful, and one must be very careful to avoid jumping to conclusions. Remember the Martian canals . . . nobody except Schiaparelli could see them clearly until 1885, but as soon as they were confirmed by Perrotin and Thollon, at Nice, everybody started seeing them, and Mars was covered with a systematic network even though we may now be confident that the straight, artificial-looking canals do not exist. And if we start getting vague, hasty reports of TLPs, it will be hopeless to make any reliable analysis. I think that greater care is needed here than in any other branch of lunar observation.

We are still in the early stages, but the work is going on, and anyone with adequate equipment can join in, provided that they know their Moon and are prepared to spend many fruitless hours before catching even a glimpse of anything unusual. Making a blink apparatus is not difficult, and neither does it cost much; the only expense lies in the filters themselves (Wratten 80B and 25). And, let us repeat, TLPs have been seen visually as reddish patches, though I am dubious as to whether a telescope of less than 10-inch aperture will suffice. It is desirable to cover wide areas in all parts of the Moon, but of course there are various craters which are notoriously 'Suspect'; Aristarchus, Alphonsus, Gassendi, Plato, Grimaldi and the like. Negative observations are also of value. There is much work to be done, and the Moon seems to become more and more fascinating as time goes by.

galaxies and nebulae

M.J.Hendrie, FRAS

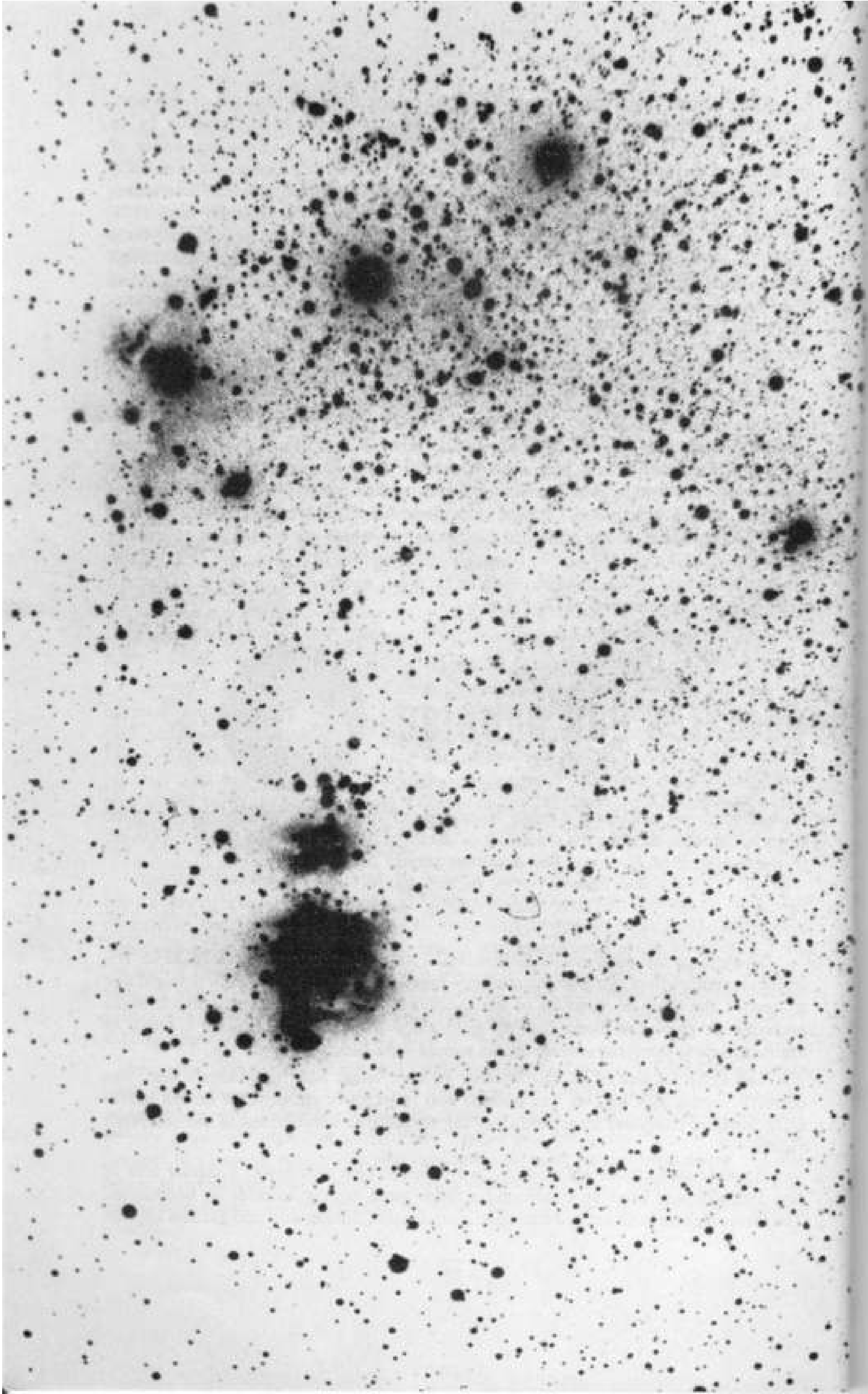
As many readers will have spotted there was an unfortunate confusion over some zeros in the table showing the diameters of the three spiral galaxies in the Local Group in the last issue of *Hermes*. The diameters should have read:

Our Galaxy	...	100,000 light years
M 31 (NGC 224)	...	130,000 light years
M 33 (NGC 598)	...	60,000 light years

This makes the Andromeda Galaxy M 31 larger than our own and M 33 in Triangulum smaller than our own, as correctly mentioned in the text. Readers might like to correct the table on page 18 of the October issue. I am sorry that this mistake appeared in print and hope that no friendships have been broken as a result of arguments as to what the correct figures should have been.

The apparent size of M 33, covering an area larger than the Moon's disc, was correctly shown although, as was pointed out, its exact extent depends on the instrument used, darkness and transparency of the sky and the sensitiveness of the observer's vision.

Another well known object of quite a different type also covers a similar area of sky, but although brighter in the centre fades more rapidly towards its boundaries. The Great Nebula in Orion is a true nebula or cloud of shining dust and gas and appears



much the same size as M 33 because it is so much closer to us, only some 1,500 light years; M 33 is 2·3 million light years. The real extent of the bright central part of M 42, the number of the Great Nebula in Messier's Catalogue, is about 20 light years (M 33 is 60,000 light years). Only in the last 50 years or so have the relative distances and quite dissimilar nature of these two types of objects become generally recognised.

The *Handbook* of the BAA for 1964 gives a list of Messier Objects showing M 42 as having a visual magnitude of 4. The fainter smaller nebula M 43 is shown as of the ninth magnitude. M 42 is a splendid object in quite a modest telescope and may show a greenish tint. The general outline and extent of the visual object can be seen with a low power giving a field of view of a degree or more but the four brightest stars which make up the "trapezium" (theta (θ) Orionis on charts) can be seen with a high power in a telescope of three-inches aperture. These stars lie in the heart of the nebula, near the dark "fish's mouth."

The accompanying photograph by the writer was taken on Kodak Oa-J emulsion sensitive to blue and green light with a Wray wide-angle aerial survey lens of 12-inches focal length and at f/4·5. The exposure was two hours. The area shown is only about one sixth of that covered by the original photograph which easily contains the whole figure of Orion. The photograph is overexposed for the central regions of the nebula and shows faint outlying parts not seen visually. The nebulosity about the stars of the belt especially zeta (ζ) Orionis, the left hand star of the belt, can be seen. The famous Horsehead Nebula is visible just to the South of this star, but on a very small scale. The relative scarcity of stars in the left hand part of the photograph is real and is caused by clouds of obscuring matter of which the Horsehead Nebula is a part. In fact clouds of dust and gas cover much of the constellation of Orion on photographs taken at mountain observatories where the sky is very clear and dark.

The hot stars embedded in the clouds cause it to shine locally and these parts are visible to us. Where dark clouds overlie the bright regions or hot and cool clouds intermingle, the dark shapes such as the Horsehead Nebula occur.

Because of its large apparent size the Great Nebula has received a great deal of attention from astronomers. It contains about 100 solar masses of gas of which hydrogen is by far the largest constituent. Other elements identified so far include helium (probably 30%), and smaller quantities of nitrogen, oxygen, neon, iron and sulphur. Optically it is possible to use filters to isolate the emissions of various elements and show which parts of the nebula shine by the light of each element. Hundreds of faint stars are revealed on infra-red photographs which do not appear at all on photographs taken in blue light. These stars are thought to be only about one million years old. The T Tauri type stars found associated with the nebulosity are thought to have nebulous shells around them and to be new stars which have not yet settled down to a steady existence.

Observations at radio wavelengths enable astronomers to observe what is happening within and beyond the dark obscuring clouds and to record the motions of the gas clouds. These show that there is a more or less globular cloud of gas centred on the bright visual nebula and on its central stars of the "trapezium." These hot blue stars may be only some 20,000 years old since they condensed into hot mature stars and if so the nebula would not have been shining before then. Astronomically this is very recent indeed. Confirmation for these views comes from the outward motions of the gases of the nebula revealed by radio observations and the radial motions of the bright stars in the "trapezium", which would have been close together 20,000 years ago.

This is a very complicated area of sky and may be expected to yield further exciting discoveries. Perhaps the new stars form and excite the surrounding gases and new "great nebulae" appear from time to time and replace those parts of the much greater clouds covering much of Orion which have ceased to be conspicuous. Observing stars close to their time of formation should be of great value to astronomers.

Nebula	*RA* (1950)	*Dec.* (1950)	*Vis mag*	*Apparent size*
NGC 1976, M 42	5h 32·9m	−05° 25′	4	66′ × 60′
NGC 1982, M 43	5h 33·1m	−05° 18′	9	20′ × 15′

observatories and telescopes

by J.H.Mathers

The Isaac Roberts 20-inch Reflector

Isaac Roberts, who became one of Europe's most outstanding stellar photographers of the nineteenth century, was born in rugged North Wales in 1829. Education being what it was in those days, he left school and was out to work as an apprentice in the building trade when he was only fourteen years old. Instead of stagnating as many would, his restless mind and boundless energy drove him on to study science in his spare moments. In time he came to grips with many branches of science, including chemistry, meteorology, physics and geology, in all of which he became absorbed; but it was astronomy that finally drew him to fame.

By the time he was approaching middle age he had amassed a personal fortune by developing his business interests, so that he could then spend his full time studying the subjects of his desire. He became accepted in the higher scientific circles and in 1882 was elected a Fellow of the Royal Astronomical Society, which marked the beginning of his astronomical career. With his rare insight he realised that photography, which was then developing rapidly, would soon become the astronomer's principal tool. Deciding to help in this field he set up an observatory at Maghull near Liverpool and there installed in 1883 a seven-inch refractor by Cooke. It was here that he began to develop his techniques of photographing clusters and nebulae; extremely difficult objects which had received little photographic attention up to that time.

In 1885 he realised that his present instruments were not large enough for the work he had in mind so, at much personal expense, he had a 20-inch silver on glass reflector built by Sir Howard Grubb which—apart from Dr. Common's 36-inch—was the largest photographic telescope in existence. With this versatile instrument he produced many plates of stellar objects and again in 1885 (which was a good year for Roberts) he was awarded the Gold Medal of the RAS for obtaining the first photograph to detect the nebulosity surrounding the Pleiades. In October 1886 he improved on this and wrote: *The nebulosity extends in streamers and fleecy masses until it seems almost to fill the space between the stars.* Isaac Roberts' nearest competitors were Dr. Common and the famous Henri brothers in Paris. The Henris were well-known opticians and had constructed the Paris 13-inch refractor. It was with this that they produced their plates, and they succeeded in photographing the Pleiades nebulosity very shortly after the Englishman, though their plate did not show quite as much detail. This rivalry (and competition of this sort is inherent in man; even today amateurs compete against each other) was not so much England against France, or even Roberts against the Henris, but was in part a manifestation of the reflector versus refractor controversy, which was very topical at the time owing to the Paris Congress in 1885 concerning the Astrographic Charts. Although Roberts was at this time a little ahead, the Henris came back in 1888 with a superb photograph of the Pleiades which recorded 2,426 stars during a four hour exposure. To compare Roberts' achievements with those of Dr. Common, we find that with an exposure of an hour on the 20-inch, the former recorded an area of nebulosity around M 42 which was six times greater than the latter could do with a half hour exposure on the 36-inch.

Dr. Isaac Roberts
(1829-1904)

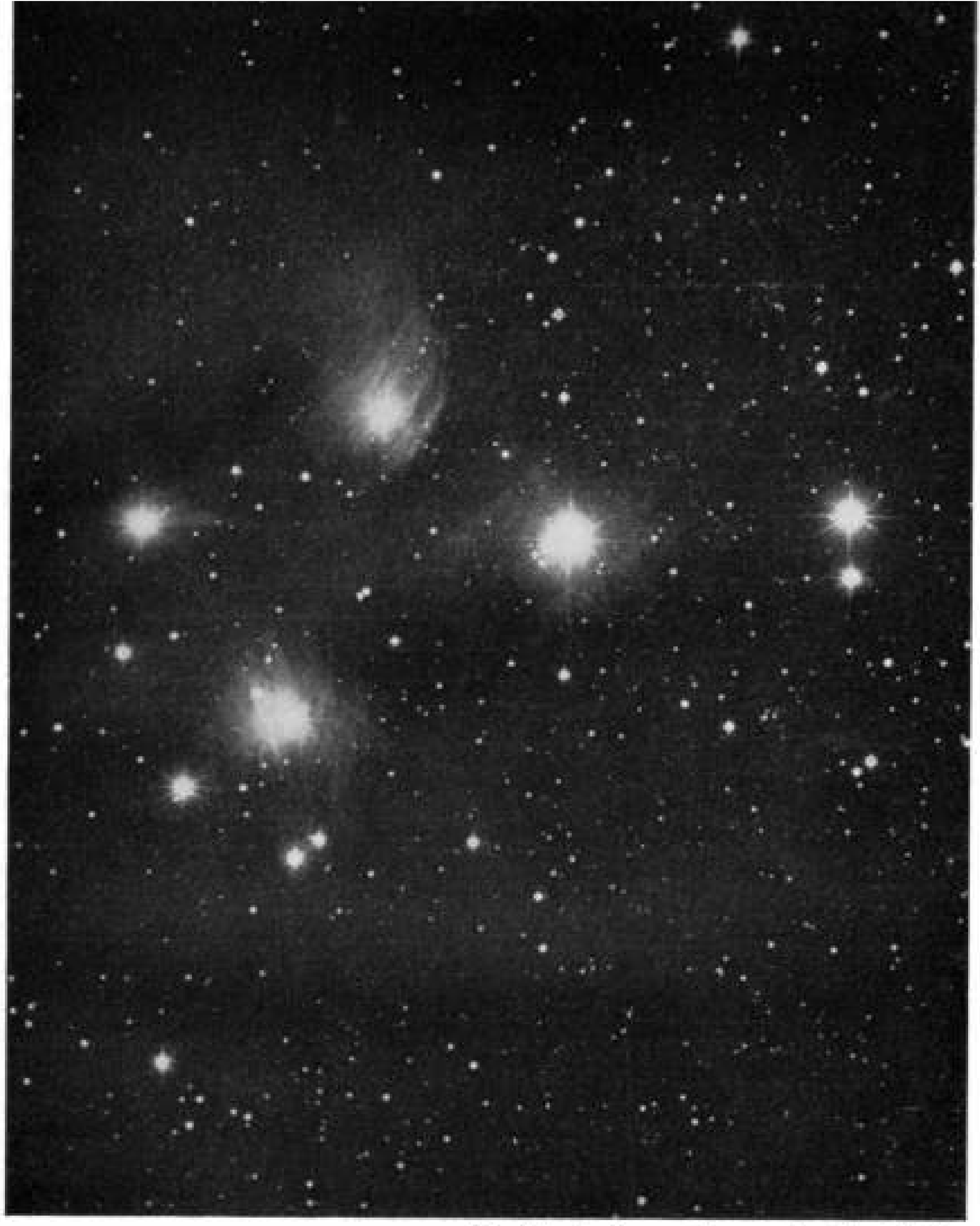
In 1890 he found that the City of Liverpool was unsuitable for the detection of faint objects owing to sky fogging, so he made preparations to move to the Sussex town of Crowborough in order to carry on his work. Using his experience at the Maghull Observatory he developed and built a very complete set up, the centre piece of the array being the great 20-inch. On it he mounted the 7-inch Cooke for guidance and a 5-inch refractor (and numerous others) for finding. His clock-drive was one of the most accurate of the time; "One of the secrets of his success was that by many improvements of his own invention, Dr. Roberts was enabled to keep the telescope rigidly opposite the precise portion of the sky for several hours at a time, thus surmounting the many difficulties which often render it impossible to retain the star or nebula in the centre of the field" (from a newspaper obituary notice). It was with this instrument that Dr. Roberts produced his finest work and helped to keep England in the forefront of astronomical advance. And, of course, he remained an amateur all his life.

In 1890 he was rewarded for his labours with a Fellowship of the Royal Society, then as now the most coveted scientific prize in this country, and in 1892 was awarded a D.Sc., by the University of Dublin. In 1893 he published his book (now becoming very rare but worth hunting for) *Photographs of Stars, Star Clusters and Nebulae*. Glancing through this book sums up his triumph in a moment. His photograph of the Pleiades (reproduced here) for instance, compares favourably with the well known one from the 36-inch Lick, and all his other photographs are of similar standard.

Dr. Roberts died in 1904. The question arises: what happened to the great 20-inch, and where is it now? The telescope was dismantled and put into store, but it was later bought by J. G. Bower of Earlham House, Norwich. Whether it was used seriously by him I rather doubt, but anyhow, it was acquired by the Science Museum in 1936, and after the war was on loan to the Royal Greenwich Observatory. With Herstmonceux's expansion programme, the telescope became outdated and the Museum have restored it and erected it on the roof of their building in London. I went up there to see the instrument and to find out if it is being used or not.

In the newest part of the building (past the JAS Exhibit, incidentally) there leads upwards a spiral staircase with the notice 'Astronomical Observatory' proudly displayed. Up this we went, and unlocked and passed through the barrier; this started a stampede of small boys who wanted, understandably, to follow us but my guide swiftly closed the flood gates. If the general public were let in at will, he said, they would no doubt have fun treating the massive German mounting as a kind of bi-axial merry-go-round. And there it stood; this telescope about which I had heard so much; which had produced such high quality work. It looks remarkably modern, allowing for its new coat of paint in the usual battleship grey colour, and Roberts must have been well up in the telescope design of his day. The main instrument can be used either as a Cassegrain or as a Newtonian, and its primary works at *f*5, giving the high light concentration which Roberts needed. He used the primary focus for his plate holder, although this is not in use at the present day. I gained the impression that the Museum had several pieces of photographic equipment from the telescope for which they had not found an explanation. The mounting is very high, and using the Newtonian focus must be a hazardous business, so usually the more accessible Cassegrain focus is used. An unusual feature is a sliding ring just above the mirror cell which can be moved round to expose a slot which gives access to the mirror cover. The whole mirror system is joined to the tube only by three ½-inch threaded rods, and the glass mirror is supported on a nine-point suspension. The drive is not the original, which was said to be so accurate, but a later one. It is motivated by weights and lasts about 1½ hours but can be re-wound while the telescope is still being driven. Apart from this the telescope is almost exactly as Roberts used it, complete with 7-inch guide telescope and 5-inch finder.

I had half expected to find an instrument which was mounted sensibly and which was used by the public, but though in theory this is so, there are certain snags. One is the mounting. The pedestal is the original, but in its present location it merely sits on two steel girders so that if you push against it you can make it rock to and fro. Clearly it is virtually useless like this; the assistant was afraid to push it too hard in case it fell over. The dome, which was built for the Museum by Grubb Parsons in 1961, has a slit which is less than three feet wide. It cannot, therefore, accommodate both the 20-inch and the 7-inch at the same time, and one would frequently have to move the dome round. Presumably cost gained the upper hand here. But the thing which really prevents it being used to any extent to educate the public (apart from heat haze from the buildings) are the tight security regulations in force in the Museum. To use it at all requires a great deal of form filling and screening, and even then the person has to be locked in all night in case he should decide to walk off with some valuable object. Even the night watchmen are locked in. Through all this Red Tape



Dr. Robert's famous photograph of the Pleiades

(which seems to have the Museum Staff tied just as tightly as anyone) one person at least has managed to penetrate; H. N. D. Wright. I admire the patience of this man who for the sake of observing Saturn's Rings with a large aperture, or doing some more work on his *Revised Visual Star Atlas*, goes to such lengths.

This telescope, then, with its history and pedigree, and which could still be useful in amateur research or as a really suitable, educational public instrument, is locked away amongst redundant steam engines, five-hundred year old clocks and water operated flour mills, as if totally outdated. It may be a reminder of the time when the rich amateur scientist made the pace, or when England was in the lead in photography, but wouldn't it be a more fitting memorial to mount it somewhere more accessible so that it can still be used?

solar section notes

by N.R.Heath

Section Report for 1965/6 Session. The Section has had a quite successful first year and has a membership of about 40 at the time of writing. This total is steadily increasing and includes a large percentage of observationally active members.

Observations and results. The Section's observation programme is designed to obtain the maximum reliable information on the Sun that is possible for modest equipment and involves the following general topics:

(*a*) Observations of the photosphere (apparent Solar surface) by photography projection, solar wedge or polarising eyepiece to obtain the numbers of spots, their groupings, their position, their appearance and indeed to detect changes or unusual events in spot groups. This may be done with any telescope above 2½-inch aperture, though the maximum aperture in use on this is 8-inch. Equatorials are of course preferable to altazimuth mountings but there is little to choose between reflectors and refractors.

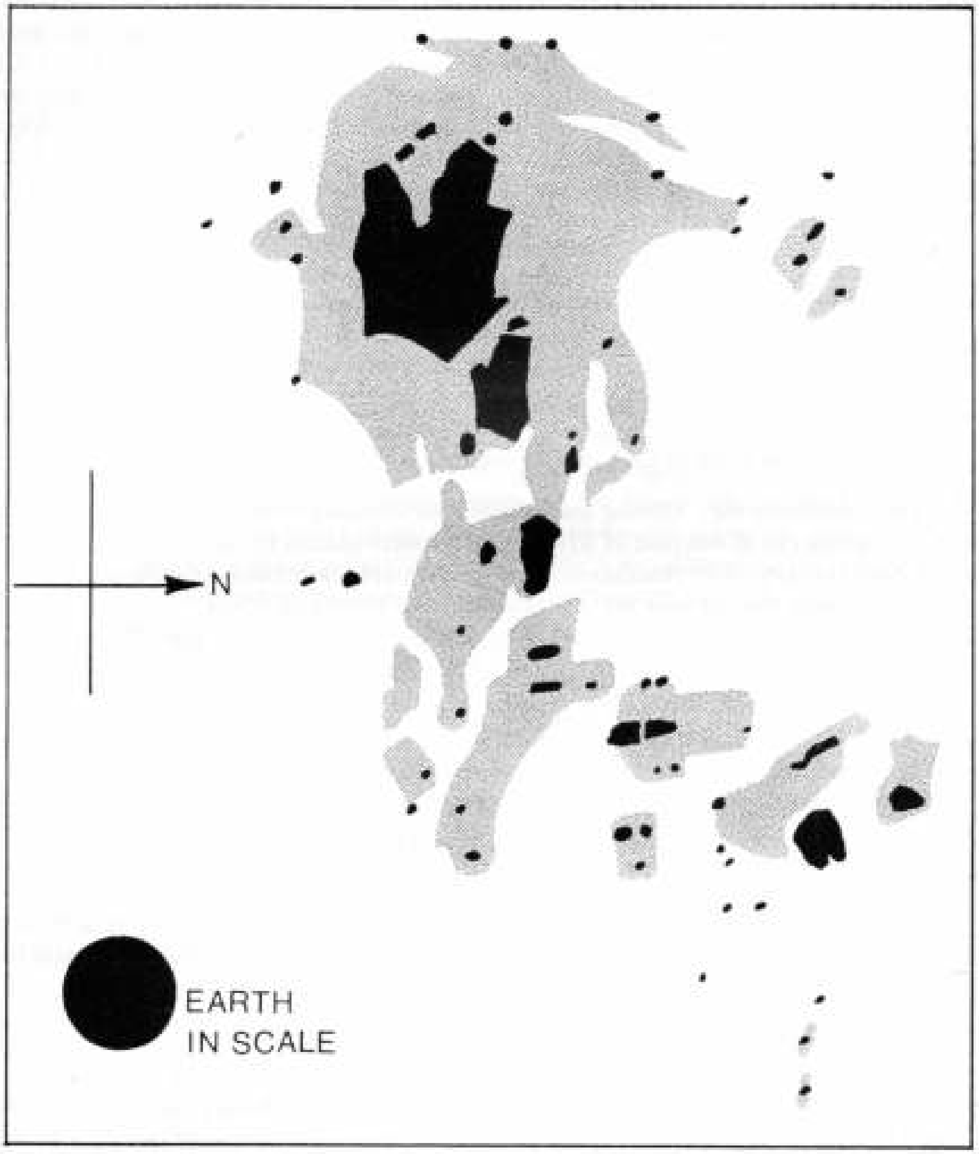
(*b*) Observations of prominences using prominence spectroscopes to obtain the numbers, position, type and life time of prominences, as well as their general appearance. This Section has not really had enough time to get going properly but I hope to be able to report activity in this field by the end of the current session. Suitable telescopes are in the 2½-inch—8-inch aperture range, outside which the solar image would either be too faint and small or too intense for useful work.

(*c*) Observations in other fields. Some members are showing interest in radio work, and others in the more complex types of spectroscopic observations. I wish them luck and look forward to seeing their results.

Part (*a*) has yielded observations to cover 220 days of the first eight months of 1966, and it is to be hoped that this total will increase to 100% coverage as more observations come in. One or more of the following observers have sent in observations for each day:

P. Bowers	R. Brown	R. Burch
M. J. Harris	N. R. Heath	H. E. Huckle
S. Karpel	P. M. Kenrick	M. Lyons
R. A. Mackenzie	A. D. Mayer	A. Mayne
J. B. Murray	K. J. H. Phillips	K. Rea
Loh Chee-Seng	I. Ridpath	P. Stott
A. W. K. Thomas	P. B. Withers	G. N. Fennimore
P. Smith	T. S. Graves	M. Simmons

The evidence of these observations shows that the solar activity has been rising throughout the year, though at times reluctantly and not so fast as at the beginning of the last cycle. A low maximum is therefore anticipated. This does not of course mean that there will be little to do, on the contrary, there will be a great deal of interesting and useful observations to be made in the coming years. Sunspot types have been noticed to change slightly during the year from groups of small spots to a combination of such groups and groups where there is one dominant spot with a few small attendants.



Umbral areas—Cool 4,500°K.

Pen-Umbral areas— 5,200°K.

Photosphere or "Solar Surface"—6,000°K.

3-inch o/g. × 160
20th March, 1966
Drawn by N. R. Heath

Some groups have been seen several times as the rotation of the Sun carries them into and out of view, one of which groups certainly lasted three months and may be identifiable with a bright patch of faculae seen in the month after the last definite identification of the group. The illustration shows the group as it appeared on 20 March, 1966, at which time it was about 80,000 miles long, nearly the diameter of Jupiter. The black areas are at a temperature of about 4,500° Kelvin (absolute Centigrade); the grey areas are at a temperature of about 5,200° K and the white areas are about 5,800° K; they are called umbrae, penumbrae, and photosphere respectively. In fact the umbrae are not really black but they appear so because they are emitting much less light than the photosphere. Several changes were detected in this spot during the course of a day, and on the 20 March a record number of observations, 10, for one day were received and the spot was also reported as clearly visible to the naked eye by J. Bacon and N. Tatham.

The past Activity of the Sun. Observations have been received from R. I. Henderson, G. L. Boots, K. J. H. Phillips, Loh Chee-Seng and P. Smith in large numbers for the period 1958 to 1965 and have enabled a general outline of solar activity to be compiled back as far as the last maximum of activity. It is not intended to attempt to go any further back in time, but more data is needed to consolidate what we have. Observations of position and detail drawings of important spots would be very welcome.

Circulars, Portfolio, etc. During the session two circulars were issued to the Section, a third is going out at the time of writing and a fourth should be out before this edition of *Hermes* appears. The circulars contain Section announcements, results of observation and usually one or two inserts. These are summarised below:

(1) Details of the method of making charts of the Sun, or photographs of the whole solar disc, with instructions for deducing latitude and longitude of all spots from such observations.

(2) Tables of the position of the Sun's axis and dates of commencement of solar rotations.

(3) Some hints on making a prominence spectroscope, making prominence observations, and the nature of prominences.

(4) A comprehensive list of members.

In the future it is hoped to have a correspondence column and a section to answer beginners questions and to anticipate difficulties in observation. So far the cost of these circulars and inserts is being met by voluntary subscriptions.

The Section Observing programme is supplied to all members.

To aid observation and co-ordination of results, blanks for 6-inch charts of the Sun, suitable for use with the normal charting method have been produced; a blank table for latitude and longitude values goes with these blanks to permit the clear listing of such results, and a blank sheet to take several prominence observations has also been made. Specimen copies have been sent to all members with circulars, and quantities are supplied to all observers.

The Section has a portfolio that circulates from member to member and eventually back to the Director. This folio contains observations, articles, photographs, cuttings, etc., of relevance to the Section's interests and seems to be a success. A second folio is to be started as soon as there is enough material, because the first folio takes a very long time to circulate.

New members are always welcome and should contact the Director at either of the following addresses:

39 Littleton Road, Harrow, Middlesex.

St. Catherine's College, Oxford.

space exploration

by R.S.Scagell

Making rings around the Moon. We've come a long way since we saw the first pictures of the Moon from a spacecraft, taken by *Lunik*-3 in 1959. The Moon is now accumulating its own family of satellites, such as the Soviet *Luna* series and the American *Lunar Orbiters*. The latter are providing us with a wealth of minute detail, and are paving the way for the first man on the Moon.

Some of the photographs taken by *Lunar Orbiter*-1 were printed in the last issue of *Hermes*. As I said at the time, things began to happen just as we went to press, all of which landed us in a turmoil. Yet again, photographs from *Lunar Orbiter*-2 are coming in thick and fast. General details of the *Lunar Orbiters* are by now well known. The craft are orbited in an ellipse with its lowest point just 28 miles above the Moon, and the highest point 1,150 miles. The low point seems incredible to we Earthlings, accustomed to perigees of something like 100 miles, but this is a result of the Moon's comparatively low gravitational pull. This is extremely helpful from this point of view, since a craft at a mere 28 miles altitude can photograph the most minute details of the surface.

Incidentally, this raises an interesting problem in nomenclature. Just what do we call the upper and lower points of a lunar orbit? In the case of the Earth and Sun, they are apogee, aphelion, perigee and perihelion. There are similar variants such as apomartium and perijove, dealing with Mars and Jupiter, but so far no one has really decided just what to use when talking about the Moon. Amongst the words used for the lowest points are pericynthian, periselenium, periselen, periselene, and perilune. The last of these sounds distinctly treacherous, and of the rest, periselene seems to be gaining most favour. So—periselene and aposelene it will be as far as I am concerned.

Lunar Orbiter-1 is dead on the other side of the Moon. It was killed off on 29 October when it was ordered to fire its velocity control engine, which caused it to crash. A necessary manœuvre, to prevent it interfering with *Orbiter*-2. It had done its job admirably, despite a fault in an electronic component which compensated for the motion of the spacecraft. This was too sensitive, and resulted in the blurring of some of the high resolution photographs. Learning by this mistake, the circuits of *Orbiter*-2 were changed to allow for this.

The move seems to have worked. The high resolution photographs from *Orbiter*-2 are the best yet, apart from those actually taken on the surface of the Moon itself. Resolution in the order of three feet has been obtained, equal to that from the best of the *Ranger* series. This definition, from an altitude of 28 miles, is only possible using photographic rather than television techniques. The best way to achieve this would be to bring back the exposed film to Earth where it can be processed under exacting laboratory conditions. But this just isn't possible, allowing for any fair degree of success, so we must devise some method of processing the film aboard the spacecraft, and transmitting the information back to Earth.

Lunar Orbiter uses the Kodak Bimat process. The secret of this is a processing film or web which has been prepared by soaking it in photographic chemicals. If the exposed negative film is pressed into contact with the Bimat web, after a few minutes the negative film is processed. Undeveloped silver ions pass by diffusion-transfer onto the web, where they form a positive image. Normally, this would be used, but in the case of *Lunar Orbiter*, it is just wound onto a spool and left, since the image quality is not as high as in the case of the negative. The negative film used is Kodak Special High Definition Aerial Film. Although this is a comparatively slow film, it has exceptionally fine grain and good resolving power. It is also relatively unaffected by radiation. Once the film has been processed, it is dried and passed onto the readout system. Readout is accomplished by using a spot of light just five thousandths of a millimetre in diameter. The film is 70 mm wide, and the spot makes 17,000 scans one tenth of an inch wide across the width of the film. This accounts for the lines dividing the framelets on the photograph. On the original film, each framelet was just under 70 mm long, and one-tenth of an inch wide. The spot of light is picked up by a photomultiplier on the other side of the negative, and resulting in a signal which varies with the density of the film. This is then transmitted back to Earth.

There are two lenses, of focal lengths 3¼ and 24 inches. Both operate at *f*/5·6. The 24-inch lens is a high resolution lens, and the 3¼-inch a medium resolution lens. They take pictures simultaneously, at shutter speeds of 1/25, 1/50 or 1/100 sec, thus providing us with both general views and detailed coverage of each area photographed.

There are 13 areas under consideration for the site of the first American manned lunar landing. The job of Orbiter is to photograph these so that a decision can be made as to which is the best one. The requirements are a reasonably flat area of country, which is at the same time interesting. It is not much use landing in the middle of an area which is the same for miles around.

Other experiments aboard the Orbiters are radiation and meteor detectors. *Orbiter*-1 detected no meteors at all, but *Orbiter*-2 picked up one on Tuesday, 15 November. This was the first meteor to be detected from the vicinity of the Moon.

Luna-12. Just as we went to press for the last issue of *Hermes*, *Luna*-11 seemed likely to send back photographs. In fact, nothing happened, and we can assume that this was a failure. However, *Luna*-12, Launched on 22 October, was more successful and pictures were transmitted back to Earth. The Soviet process seems to be rather cruder than that adopted by the Americans. In the Soviet technique, photographs are also processed aboard the spacecraft. However, they are sent back to Earth by means of television and this tends to give a much coarser result than the refined method used by the *Orbiters*.

With the fast pace of events which is now apparent when talking about the exploration of space, it becomes increasingly more difficult to keep these articles topical, since at least a month elapses between the writing of an article and its publication in *Hermes*. Now that circulars are available, more immediate news will be printed in them. Although photographs will not be printed in every issue, in the interests of economy, they will be included wherever possible.

We are now witnessing the preparations for one of the greatest voyages of all time—the first manned journey to the other world which makes up our double planet. In time, this journey will be regarded as commonplace, and will have been made by thousands or millions of people (and who knows how many JAS members amongst them?). Keep up with the news with JAS and make **sure** you receive your copy of *Hermes*.

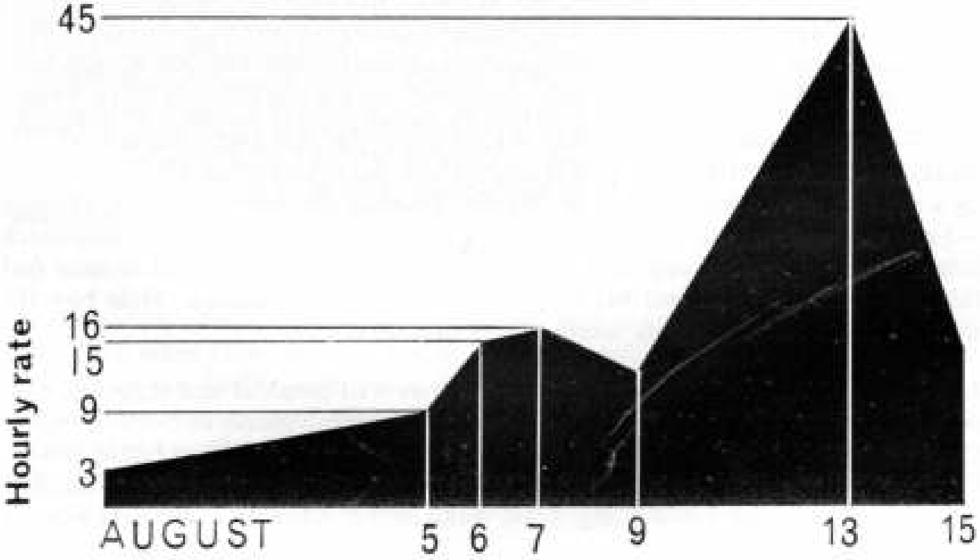
meteor section notes

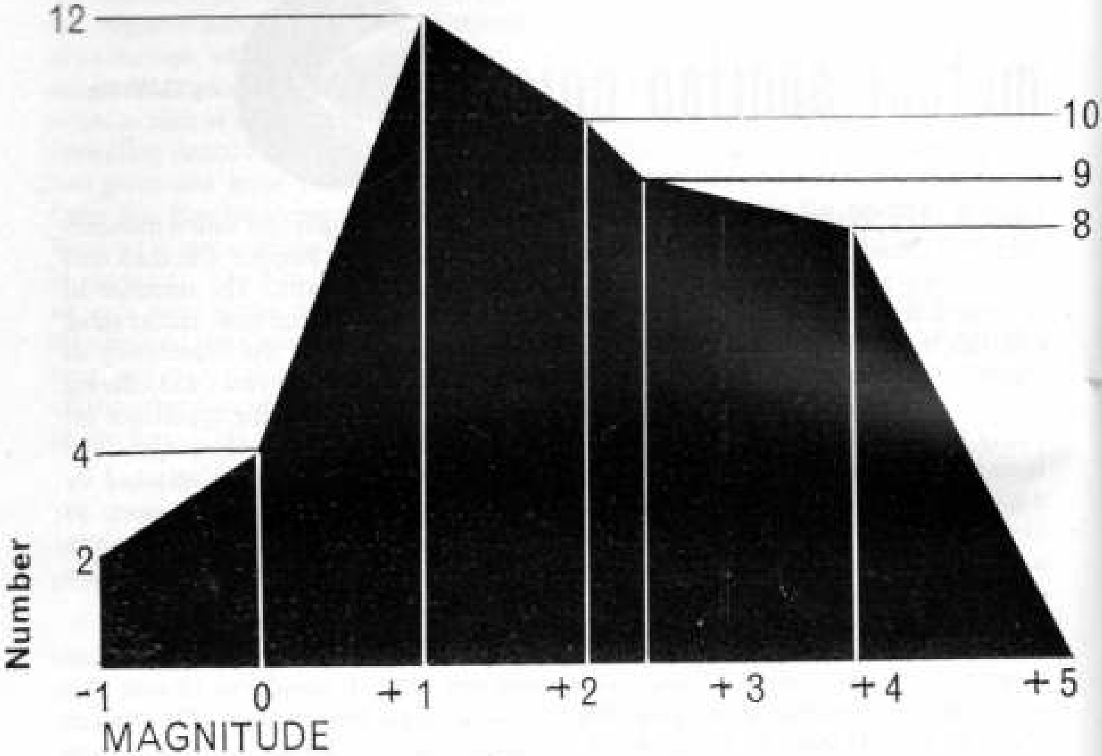
by G.White

General. The Section at present is going from strength to strength and with a membership of 90 members, is obviously providing a big attraction. Regular Circulars and Publications are distributed in addition to Section Report Sheets. The response to the practical observational work and the organised Projects has been most encouraging and this in itself is a healthy factor. Such projects provide one the opportunity of meeting others interested in this field of observation; of exchanging views and offering constructive criticism and at the same time, getting a spot of camping experience in! Many a meteor expedition has been known to lose their tent on a windy night and burn their supper in the process! The first 1959 *Project—Perseids* was attacked by a swarm of huge blood-sucking ants! The Section is now expanding its interest in meteor photography and one member K. S. G. Stucker, has recently embarked upon colour photography. Much patience will be needed here but the possibilities are obviously tremendous.

The 1966 Perseids. JAS members all over the country kept a careful watch for these meteors during the period 27 July—17 August this year. I would like to take this opportunity of thanking all of you who sent me in your observations. Christopher Sharp of West Horsley in Surrey was fortunate enough to conduct his observations from Nerezine on Losinj Island, one of the group of Kvarner Islands off the Istrian Peninsula in the Northern Adriatic. Here, as you will imagine, observing conditions were ideal.

The graph in Fig. 1 demonstrates a steady increase in the hourly rate until 13 August. On this date a maxima of 45 was obtained by the main JAS observing team at Staplefield in Sussex; a second team at Farthing Downs, Surrey, actually recorded

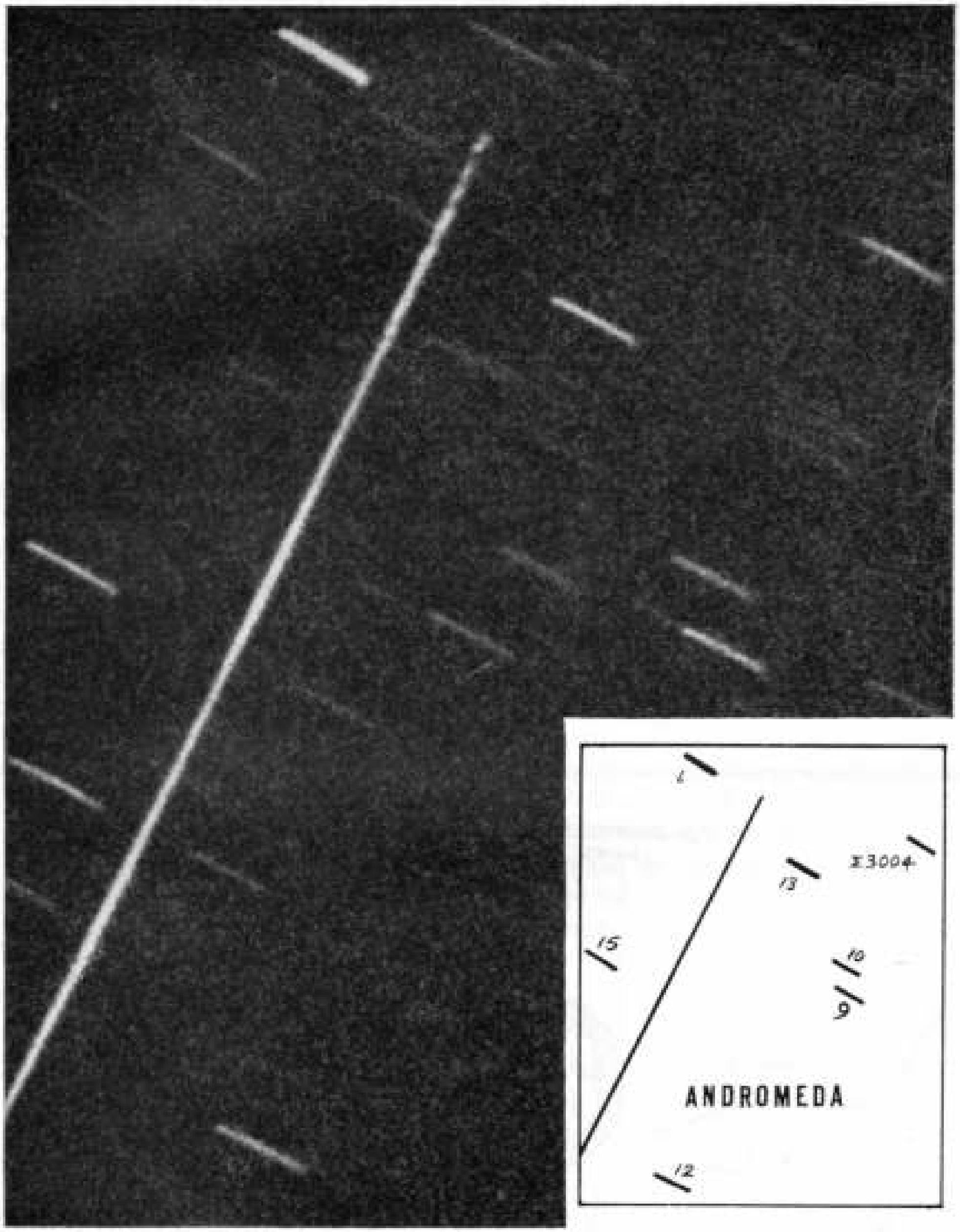




a maximum of 50 for the night of 13–14 August. Our graph represents an analysis of the results received from observers throughout the country. Attempts were also made to accurately determine radiant positions and record magnitude estimates. Unusual phenomena associated with the Perseids were noted (i.e., sparks, trails, etc. . . . .) and in particular, I should mention a −6 fireball which was recorded by one member, John Murray of Cambridge. Many other interesting facts emerged from the observations, mainly connected with detecting personal biases of the observers, and analysis is still going on.

The meteor trail reproduced here was taken by Michael Waghorn of Croydon, Surrey, using 35 mm HP3 film, and indeed, its believed to be the first of its kind taken by a JAS member. John Marsh of Croydon recorded the meteor visually as being −3 magnitude, 2 seconds duration, 25 degrees long, green in colour with a train which lasted for one second. It appeared on 14 August at 01·04 hrs UT you will all agree that this is a first class effort and Michael deserves every congratulation. Note how the trail brightens twice along its length and finally breaks up.

Leonids : 1966. For this famous shower, we were well prepared and organised with teams standing by at Farthing Downs, Surrey; Hampstead Heath in North London; Cambridge University; Oxford University; Liverpool and Exmoor in North Devon. However, at the time of writing (18 November), no concrete results are yet available. If sufficient results are forthcoming, I will make further reference in the next issue of *Hermes*.



Conclusion. A comprehensive programme for 1967 is at present being worked out and I hope many more of you will join in with the fun. Our aim must be to obtain constructive and useful results which may be submitted to the Director of the British Astronomical Association's Meteor Section. Meteor observation will also inevitably add to your knowledge of the constellations and sky background and is, therefore, well worth attempting. For further details, don't hesitate to contact me. Please send a S.A.E. Those wishing to receive future Section publications, please send me six 4d. stamps for postage.

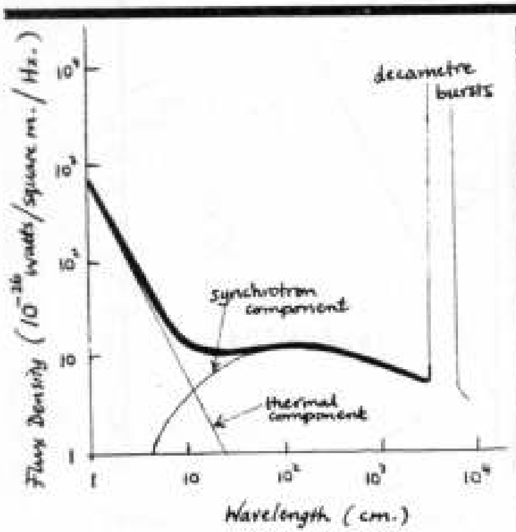
jupiter section notes

by R. I. Henderson

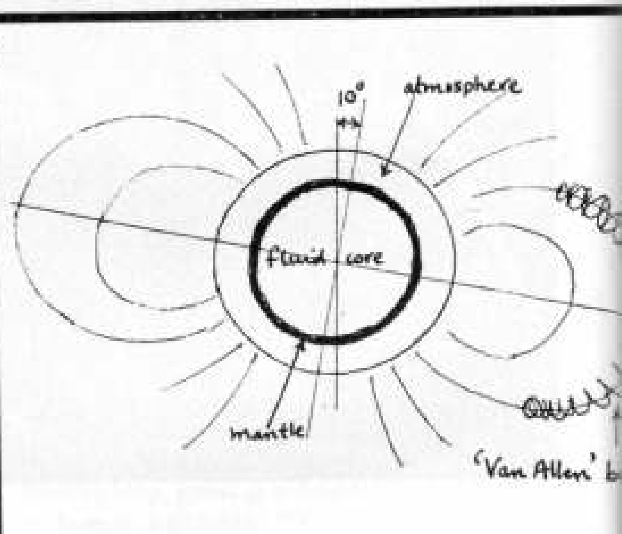
At the time of writing very few observations have been received and so it is a waste of time for me to try and prepare any sort of Section Report as such. I hope, of course, that by the time you read this I will have been buried under a heap of used blanks and transit sheets. So perhaps now is the time for a general summary of our knowledge of Jupiter.

We have known since 1955 that Jupiter emits bursts of radio energy at decametre wavelengths, mostly around 15 metres. The cause of these bursts is still unknown but recent observations by A. G. Smith of the University of Florida and others have confirmed that the occurrence of this decametre emission is related to the position of Io, and probably to the positions of the other nearby satellites too.

In 1958 Sloanaker and Boland of the United States Naval Research Laboratory found that Jupiter was emitting far more radiation in the 10 cm (decimetric) band than could be explained by thermal emission, and studies by many radioastronomers since then have revealed that the strength of the radiation remains at a fairly high value from 3 cm down to 168 cm. This unusual emission has been attributed to synchrotron radiation, i.e., to the motion of electrons spiralling at relativistic speeds in the magnetic field of Jupiter.



RADIO SPECTRUM OF JUPITER



Diagrammatic representation of Jupi

Moreover the radiation is strongly polarized and originates from a region which is about three times the optical diameter of Jupiter in the E—W direction and about equal to the planetary diameter in the N—S direction. The plane of polarization oscillates through approximately 22° while the strength of the emission varies with a period of 09h 55m 29·35s. Morris and Berge (California I.T.) explained this by assuming that the magnetic axis of Jupiter is inclined at 11° to the axis of rotation.

Detailed observations of both the decimetre and decametre radiations suggest that the field is not symmetrical about the magnetic axis and has a very complex structure.

Astronomers have long been trying to relate radio observations to the surface features of Jupiter and so far without any success; but a new and very interesting theory by Prof. R. Hide concerning the nature of that old favourite the Red Spot throws new light on the problem. According to Hide the G.R.S. is no more than a 'Taylor column' caused by a protruding feature on the solid mantle of Jupiter. ('Taylor columns' are columns of stationary fluid produced in a rotating body of fluid vertically above any object or depression in the bottom.) This explains why the Red Spot does not drift in latitude (as would be expected of a floating feature in the atmosphere) but it makes no attempt to explain away the drift in longitude of the G.R.S. In fact, from Hide's theory we see that the rotation period of the G.R.S. is in fact the rotation period of the solid mantle. Now by all previous theories this was not possible, as it was presumed the rotation period of the solid surface must be constant. But recent radio observations, by Prof. A. G. Smith and Dr. J. N. Douglas (Yale), indicating that a lengthening of the radio rotational period of Jupiter goes hand in hand with a shortening of that of the Red Spot, fit in neatly if it is assumed that the rotational speed of the magnetic core decreases when that of the solid mantle increases. The total angular momentum of the centre of Jupiter can, in this way, remain unaltered and there is no problem about conservation of energy.

There remains to be explained why and how such exchanges of energy can take place between core and mantle. If we take the core as being fluid, as S. K. Runcorn (Newcastle) has proposed, then considerable turbulence can occur, continually altering the magnetic field. If we suppose that the fluid core rotates relative to the mantle once in 4,000 days, then the changing field strength will induce varying currents in the mantle—and this 'magnetic linkage' will keep the total K.E. of the system constant, producing the see-saw-like changes of speed between core and mantle.

Cunning, eh? Whether the theory will stand the test of time is largely up to optical observation of the Red Spot. This is where the JAS can help out, of course: I will therefore be very pleased to receive any transits of the G.R.S. this apparition.

society notices jas

More JAS helpers urgently needed. Those of you wishing to assist in JAS organisation etc., please contact the Secretary. Many more helpers are needed and we would appreciate all offers.

Vacancy for Librarian. Derek Fry in Leeds has recently resigned and applications are invited for the post. An interesting and rewarding job; an invaluable service in the JAS. Please contact the Secretary.

Sky and Telescope. These subscriptions are now being held by Mr. Brian Stevens of 53 Orchard Vale, Ilminster, Somerset. Available at the reduced rate of £2 13s. 0d. per annum to JAS members only. Subscription renewals should also be sent to Mr. Stevens. All forms of payment should be addressed to the Junior Astronomical Society.

spectrum

by Ian Ridpath

Double Vision. Acute watchers of B.B.C.-2's fortnightly *Horizon* will have noticed the name of Karl Sabbagh appear on the credits.

SPECTRUM decided to phone him.

"Didn't you have a brother John who used to work for the JAS?"

"Well, actually, he and I are the same person." Collapse of the Liaison Office.

So who is the dichotomous Mr. Sabbagh?

"Karl John Sabbagh," said the *New Scientist*, "is a BBC TV producer. He was the London correspondent of *Al Nadwa*, a Mecca newspaper, until earlier this year. He studied at King's College Cambridge, where he obtained his degree in Experimental Psychology."

"John Sabbagh speaks Arabic," said Patrick Moore.

And Karl Sabbagh said: "The difference in name? No particular reason; I've always been known by two names.

"I joined the BBC after three years at Cambridge reading Maths and Experimental Psychology. The BBC has a General Trainee scheme whereby they take graduates and send them round different departments of the BBC (sound and TV) to work and train at the same time. At the end of about eighteen months they are expected to apply for any vacancy that interests them within the BBC and compete with other employees who feel like a different or better job.

"I did the scheme and then applied for the job I now hold—Production Assistant on BBC-2 *Horizon*. The latter is a review of the sciences (which includes Astronomy) and as I have always been interested in the varied aspects of science this is an ideal job for me. The job of a Production Assistant is to help in the production of a programme by thinking up ideas, researching, filming them, and directing in the studio where necessary. The techniques involved are many and I'm still a beginner but it's a stimulating job.

"Age—24. Joined the JAS in 1957. I didn't really leave, just faded out. This happened when I went to Cambridge; I'm sure most people find it difficult to stay on if they're away at University. The function of a JAS Group is to preserve an atmosphere and a company that encourages and enlivens the activities of those interested in Astronomy. It certainly did this for me when I lived in Streatham but as it's the personal aspect that's important I feel the JAS had outlived its usefulness once I moved away from a Group.

"When I was in the Croydon Group I was Secretary for a time and wrote pages of deathless prose after each meeting that must by now be buried in the bottom of somebody's drawer. I also took part in a memorable expedition to watch the Perseids from the South Downs with George Teideman (I wonder whatever happened to him?), Jim Kent and several other unforgettable figures. The latest JAS exploits are very praiseworthy. Expeditions-cum-holidays are always fun, and can be surprisingly rewarding in data. The publicity of this in the scientific press shows you're doing good work.

Karl Sabbagh listening to a B.B.C. tape!

"My ambitions? In Astronomy: to remember all that I have forgotten and own a 12-inch reflector. In BBC: not to get the sack. In life: to write a best-seller. Am I likely to realise any? Astronomy—yes. BBC—possibly. Life—No.

"To the outsider the BBC is obsessed with initials. The Director General is the D.G., Broadcasting House is B.H., Assistant Head of Current Affairs programmes, Television is A.H.C.A. (Tel) and so on. I know of a memo sent to a friend of mine, supposedly from Publicity Officer (Presentation Organisation) Current Affairs Technical Engineering Personnel Establishment (Tel). The memo was about volcanoes and was signed PO(PO)CATEPETel."

Semper Spode. The Leonids slipped through the net by twelve hours, and under cover of cloud. Observers in their thousands waiting in Britain for the predicted high maximum had to be content with the tail end of a display which reached 5,000 meteors an hour over the Americas.

It's made all the more annoying by the fact that perhaps at no time in the past have amateurs all over the country co-operated in an observing programme to such a great extent. The most exciting response of all came from an appeal to, virtually, the general public through Patrick Moore's television broadcasts. 10,000 people responded, and over 2,000 reports were received for analysis. Amongst the regular observers, stations as far apart as Shropshire, the Isle of Man, Cambridge and London were ready to compare results.

From the University of Cambridge, almost fifty observers combined into a comprehensive skywatch party. The Liverpool University Group on the Isle of Man were equipped with seven cameras, including an arrangement to record enduring trains, two telescopes and "many other bits of equipment"—including radio receivers to listen in to Sheffield University radar echoes from the ionised meteor trails. Fittingly, they appear to be the only station to have had three beautifully clear nights—even the Zodiacal Light was visible. Their best hourly rate (130) is the highest recorded in this country.

At the Old Royal Observatory, Greenwich, the terraces outside the Caird Planetarium dome were used to keep watch. Their picture window was handy for continuing watch through inclement weather. Three cameras were sited at the Old Observatory, each with ten reels of film. One small portable telescope was kept ready for photographic use, whilst the 6·7-inch Sheepshanks refractor was also available if conditions proved suitable. The Planetarium dome was used as the control centre, giving the advantage of being able to provide a picture of the night sky for briefing observers. A tape recorder was in attendance for rapid recording.

Chris Daniel, in charge of the Greenwich party, sends us a graph of the 1866 Leonid activity seen at Greenwich. On that occasion, meteors were appearing at the rate of 120 per minute. This year, their sum total was a bare two Leonids, seen through a break in the clouds.

At least, those of you who froze in your back gardens were not alone. The barren wastes of Hampstead Heath saw several luckless groups waiting for breaks in the cloud. In common with most of the country they were forced to abandon the watch, although some hardies set up a camp for the night.

Astronomers can only be optimists. Surely Spode's Law needs no further verification?

Voila Tout. Does the red shift mean the Universe is expanding?

My relativistic friends would say no; but to a simple man, it might appear as if it was expanding.

The Astronomer Royal, at Aylesbury Astronomical Society,
18 November, 1966.

Planetarium Progress. Patrick Moore writes: Progress at the Armagh Planetarium has been slower than hoped, because of building delays which seem to be inevitable nowadays. But the projector has arrived from Japan; the outer dome is ready; the inner dome has come from America, and various projects are under way.

The actual building has made considerable advances, as is shown by the photograph in the second JAS *Circular*. It is hoped that the Planetarium will be ready in mid-1967, and in any case it will certainly be open long before this time next year.

Eclipse Hunt. What an eclipse! Spacemen to picture it from orbit, millions of dollars' worth of rocketry sent into the upper atmosphere, balloons, big jets and a satellite watching from the skies, and people travelling the globe to join the thousands of scientists and spectators clustering along the central line right across South America into the South Atlantic. A bare two minutes of totality last 12 November, yet it's been called history's most observed eclipse.

Colin Hunt travelled out there to join them. He's the only Englishman who went. And an amateur at that. His host, Mr. Potts of the Esso Petroleum Company, was arranging things from the Brazilian end to such a fine degree that it was all rather a shame when Colin's equipment overbalanced at the critical moment. But he's taken it very well. The VIP treatment beforehand made it even more of a sensation. Being English does seem to mean something even these days.

The story is best appreciated by lovers of real-life fairy tales. Says Colin: "Mr. Potts wouldn't be returning from New York until the day after my arrival, but he'd arranged for Brigadier Jerônimo Bastos to escort me through the customs with (as he said) 'diplomatic immunity.' Senhor Braga, a Travel Agent, would be there to handle the papers and to assist at Passport Control. A third gentleman, someone told me, was Brigadier Armando Troia, of the Brazilian Space Agency's Eclipse Project.

"What was said at Customs I don't know, but the chalk mark was applied without any baggage being opened, no papers were called for, and not a single question was asked. I was through the barriers like a shot from a gun, and ushered into a waiting car. Chauffeur driven and escorted by two Brigadiers and a Travel Agent, I entered Rio de Janeiro in triumph. I was given a palatial suite in the Gloria Hotel, with three balconies and two bedrooms. It's certainly something I shan't forget for a long time."

Of course, it was all too good to be true. The weather accordingly deteriorated, although the hospitality didn't. For a whole week, neither Sun nor stars were visible.

On 9 November, the party had progressed to Pôrto Alegre. "I was almost the last to leave the aircraft," recounts Colin. "Hearing Mr. Potts say, 'Here HE is,' I turned, informally dressed and probably looking dishevelled, to peer straight at a television camera. I didn't see myself as others saw me—if, indeed, they did.

"The following day we continued by air to Bagé by chartered DC-3. The town had already developed eclipse fever, and dense glass screens were to be seen in many shop windows. Several of us were received by the Mayor of Bagé in the City Hall. Our hotel was besieged by youthful enthusiasts in quest of autographs. I signed 'Colin Hunt—Inglaterra' so many times it's a wonder I didn't do the same on my Traveller's Cheques."

Miraculously, the weather broke. The day of tatality dawned fine—the fifth eclipse in succession which Colin went seeking overseas, all graced by clear skies. Something had to go wrong. And of course it did. His telescope mounting collapsed just as totality was imminent, leaving no hope of photography or even proper observation. Did the Press who interviewed him in Bagé foresee the terrible anti-climax? "They asked various questions as to how many eclipses I had chased, and what Societies I belonged to in Britain. Then they asked permission for a facetious question—Which would I rather photograph: an eclipse, or Brigitte Bardot? I told them that B.B. might at least give me a second chance, but an eclipse wouldn't."

sky diary

by H.N.D. Wright, FRAS

mid-January to mid-April, 1967 All times GMT

Principal Phases of the Moon

	JANUARY	FEBRUARY	MARCH	APRIL
New		9d 10h 44m	11d 04h 30m	9d 22h 20m
Full	26d 06h 40m	24d 17h 43m	26d 03h 21m	24d 12h 03m

The Moon: (There will be no eclipses visible from Britain either of the Sun or Moon in 1967)

The Brighter Planets

MERCURY is at a most favourable situation for the year in the evening sky for observers in Northern latitudes around. Greatest Elongation East of 18 degs. from the Sun being reached on 16 February. For a few days Mercury will be setting almost two hours after the Sun, but the brightness diminishes as the appearance proceeds to a crescent phase, and the best period is probably 15 to 18 February. Using the time-drift method, described for both equatorial and altazimuth mounted telescopes in the two previous issues of *Hermes*, the planet could be located on a bright sky, and followed for as long as weather and altitude conditions permit. At the morning elongation of 31 March, which is very unfavourable for British observers, there is no such easy guide to finding the planet in daylight.

VENUS is in the evening sky throughout this period, steadily becoming more conspicuous. In mid-April, setting time is $3\frac{1}{2}$ hours after the Sun, and, apart from the Moon moving toward First Quarter at this time, Venus will be the brightest object in the evening sky, well outshining Jupiter, situated further to the East.

MARS will already be easily apparent as a distinctly orange-tinted object of first magnitude in the morning sky at the beginning of the year. The planet remains in the extensive constellation of Virgo during this period, the brightness steadily increasing as Mars approaches a rather distant opposition on 15 April, at around 57 million miles from Earth. The term implies that the planet is opposite to the Sun in the sky, and is consequently in the South at midnight then, at magnitude $-1 \cdot 3$, and at an altitude of about 30 degs. above the Southern horizon. Those observers with moderate aperture telescopes may get some good views of the planet, though Mars is at best a tricky object visual observation.

JUPITER is at opposition on 20 January, near the Western border of Cancer. As mentioned above for Mars, this means that the planet is in the South at midnight, but in the case of Jupiter at an altitude of 59 degs. from the horizon! This should prompt those using refractors to equip their instruments with a diagonal or pentaprism arrangement of some kind to avoid the back-breaking and neck-straining necessary otherwise to observe an object at this high angle. At the end of April Jupiter will be in line with the stars Castor and Pollux in Gemini, and will then spend a few weeks in the latter constellation before returning again into Cancer. There are three occasions in January when both satellites I and II and their shadows can be seen in transit across the globe of Jupiter together: 16 Jan 22h 23 Jan 23h 31 Jan 01h

SATURN sets at 22h in mid-January, and will be observable only during the early evening hours. The rings will now gradually become visible once more in small telescopes, and observers can supply useful information by noting the date on which instruments of a given size can just enable the eye to detect the faint re-appearing line of the rings. In February Saturn slowly becomes involved in the evening twilight, moving toward conjunction with the Sun on 23 March.

constellations near the meridian at 22 hrs.

mid-January	Perseus; Auriga; Taurus; Orion; Eridanus and Lepus.
mid-February	Auriga; Taurus; Gemini; Orion; Canis Minor; Monoceros; Lepus and Canis Major.
mid-March	Gemini; Cancer; Leo; Canis Minor; Hydra; Monoceros; Canis Major.
mid-April	Ursa Major; Leo; Leo Minor; Hydra; Crater; Sextans.

Obviously ahead of its time. Quite recently, astronomical determinations of the Earth : Moon mass-ratio μ were largely superseded by more direct determinations of the Moon's mass from the perturbations exerted by it on the motion of man-made spacecraft. Thus from the perturbations suffered by the American Mariner 2 at the commencement of its journey to Venus in 1922 Anderson and Null (1963) obtained the value of μ.

Z. Kopal, *An Introduction to the Study of the Moon.*

Circulars. There are still some copies of the December circular left, containing three of the pictures from *Lunar Orbiter*. These are available at 6d. each, post free. Please send two threepenny stamps to R. S. Scagell, 1 Milverton Drive, Ickenham, Uxbridge, Middlesex, for your copies.

Man Reaches Mars. A book prize is offered for the best speculative illustration received by 1 April, 1967, depicting Man's first landing on Mars. The best picture will also be reproduced in *Hermes*.

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Harrow/Pinner district. Anyone interested in a local Astronomical Group please contact: Margaret Banks, 4 The Avenue, Rayners Lane, Pinner, Middlesex. Tel. PIN 9455.

Back copies of "Hermes" and "Selen" wanted. Write to Peter B. York, 128 Derinton Road, Tooting, London, SW 17.