HERMES

JOURNAL OF THE JUNIOR ASTRONOMICAL SOCIETY

VOLUME 9 NUMBER 3 APRIL 1962

Editor:
JOHN LYTHEER, F.R.A.S.

Assistant Editor:
P. G. MURDIN

ARTICLES

REGULAR FEATURES

PRICE TO NON-MEMBERS OF THE J.A.S.: 3s.

VOLUME 9 NUMBER 3 APRIL 1962

HERMES

JOURNAL OF THE JUNIOR ASTRONOMICAL SOCIETY

Comment

So much has been said and written about Colonel Glenn's successful orbits of the earth that little remains for me to add. As I write the Russians have expressed the hope that they and the Americans will co-operate in space research. Such co-operation would obviously call for a long period of detailed planning but even agreement in principle would represent a tremendous step forward. Some amateur astronomers, particularly those studying the Moon and planets are beginning to feel that as lunar landings cannot now be very far off their work is losing its value. In one sense, this may be true. But experience has shown that when one particular line of research has been taken over by professionals using costly equipment, really enthusiastic amateurs have quickly found some new line of approach which they can usefully pursue. After all, thousands of motorists today enjoy the 'exploration' only made possible by the production of finely detailed road maps!

That Questionnaire

Ken Stocker, who recently volunteered to shoulder the total burden of analysing the 410 questionnaires which you returned has now finished his task. He has prepared a detailed report for the Council which will provide plenty of scope for discussion. I hope to be able to include most of it in a later issue of *Hermes*. One fact, however, is well worth brief discussion now. Of the 410 members included in the survey no less than 358 possess optical instruments of one sort or another and about 25 per cent of the total membership of the JAS has access to a telescope owned by somebody else! In addition to 153 pairs of binoculars and 221 small refractors there are 46 refractors of 3 in. aperture or larger, 81 small reflectors, 52 reflectors of 6 in. or larger and impressive numbers of cameras, spectroscopes, stop-watches and so on.

This is indeed an impressive total of optical equipment and ably demonstrates that the JAS could attempt some really big project. No doubt the Council will consider the possibilities of organising some observation scheme that most of you would enjoy working in.

The challenge

In my January Comment, I challenged the Groups to produce information on one or other of their practical projects. So far this has gone unanswered. A friend with whom I was discussing my disappointment a few days ago said "I expect they are far too busy producing their Group journals to write for *Hermes*". I wonder . . . Croydon Group certainly aren't.

John Lytheer

Letters to the Editor

Croydon Meteor Camera

Sir—It is very gratifying to learn that the camera lens that I loaned to the Croydon Group of the JAS has now been incorporated into a meteor camera, and that we may look forward to some results from its operation during 1962. The Pentac lens has done good service in meteor photography, and is used extensively for that purpose in Canada as well as by some members of the BAA Meteor Section. Another useful lens for the amateur meteor photographer is the Ross Xpres Wide Angle, of 5-in focal length and working at f/4.0.

Some practical points should be mentioned in connection with the Croydon camera in order to derive the maximum performance from it. First, the plate size should be as large as possible—the Pentac will cover a whole plate, 8½-in × 6½-in, in useful definition for meteor work, and of course the larger the plate area, the the greater the number of meteors will be photographed in a given time. The plate should be faster than HP3, which I have found to be too slow for meteor work. My own preference is for HPS, which is extremely fast and has high reciprocity failure, which is a useful characteristic for this type of work. The focus must be absolutely spot on, and the squaring-on must be accurate too, as otherwise the fainter trails will be lost—and most of the trails are quite faint.

I am not sure that I like the look of the mounting of the camera, which would probably vibrate considerably in windy conditions; personally, I do not mount my cameras at all, but rest them on the ground and prop them up with a brick or a piece of concrete. One has to be careful, of course, not to kick the lot over when walking about in the dark! Finally, I think a heater should be fitted as a dew-cap is not always adequate, and it is infuriating to find that potential results have been lost through condensation on the lens.

It is unfortunate that most of the major showers this year will be spoiled by moonlight, but at least the early Perseids should yield some good results, as the shower is quite strong for about ten days before maximum. Routine work on the photography of sporadic meteors is a heartbreaking business, not to be undertaken unless one has a good supply of plates, money, patience and fortitude.

I wish the Croydon Group every success in its programmes of meteor work, both visual and photographic, during the coming year, and I shall always be pleased to hear of the results and to give advice if it is wanted. May the meteors come thick and fast!

Yours faithfully

H. B. Ridley,

Hampshire — *Director, Meteor Section, BAA*

Discs

Sir—I wish to make a 6-in mirror. Should I obtain a disc of ordinary Plate glass or would Low Expansion glass make a better mirror?

Yours faithfully

W. J. Smith.

Carlisle

Mr. Henry Wildey writes—Ordinary Plate glass is made in large sheets and to produce a disc a square must first be cut and hacked into a circle. Finally the edge must be ground with abrasives. Low Expansion discs are produced by pressing the molten glass into a steel mould thus needing very little labour. Although Low Expansion glass costs more this extra cost is balanced by the labour needed to shape Plate so that discs of each are approximately the same price. With small mirrors no difference in performance could be detected but Low Expansion glass is preferable as its extra hardness means that it can take finer grinding and a superior polish without sleeking. As it is only affected slightly by temperature figuring into the required parabola is greatly simplified.

Fireballs

Sir—I was most interested in Miss Stebbing's article on fireballs, but I do not really see any connection with the eccentric world of flying saucers, astrologers, flat-earthers and their kind.

There is a serious danger in simply quoting reports from such papers, because they look so plausible. Take, for instance, Miss Stebbing's entry for November 6, 1957. This comes from the *Flying Saucer Review*, and describes how a red-hot egg-shaped object passed over New Mexico and stopped the engines of eleven cars. With the greatest respect, I would describe this report as balderdash. I am quite ready to be proved wrong if witnesses (reliable witnesses!) can be produced; but I doubt it.

All branches of science attract the eccentric fringe, and astronomy probably more than most. It is quite harmless, and it certainly adds to the gaiety of nations; but I can only repeat that in my humble view, fireballs and flying Saucers are about as closely linked as are earwigs and sparking plugs.

Yours faithfully

Patrick Moore.

East Grinstead

Miss Stebbing writes—May I refer Mr. Moore to the last paragraph of my article where I make the humble suggestion that most UFO's are natural phenomena. I cannot enlighten Mr. Moore on the New Mexico report. Like him, I was not on the scene at the time. It may or may not be "balderdash", but the fact that this particular report was included as one of the few unexplained objects in *Flying Saucers and the US Air Force* by Major Lawrence Tacker (allegedly the Air Force's official position with regard to UFO's) suggests that here, indeed, was an authentic report which was regarded as a puzzle to Air Force officials.

Book Review

THE MOON by FRANKLYN M. BRANLEY, Faber & Faber, London, 1961. 114 pages, price 21s.

THIS book claims to give a general introduction to the Moon. To do this it must surely cover all the main aspects of lunar science, clearly, correctly, and concisely.

The introductory chapter, entitled Moonlight, contains information not often found in general books on the Moon. Four of the five chapters on lunar dynamics are also very good, the exception being that on tides. Like others that do not expound the mathematical theory of tides, it gives an elementary and completely wrong explanation of their cause.

There are only two chapters dealing with the Moon's surface; one about its features, the other on its temperatures. The latter, however, deals only with visual measurements of temperature and does not mention radio observations or their implications. The chapter on the lunar surface detail mentions only the craters, maria, mountains, rays and rills, leaving out many other important features. There are also a few incorrect statements such as, "Probably all the craters are circular". This chapter ends with a list of craters, with their positions marked on two photographs.

The remaining chapters, in my opinion, are fairly good. Admittedly some will disagree with me about the chapter on travelling to the Moon, they must remember that this is not a book on astronautics!

The illustrations and photographs are, in the main, extremely good. The exceptions are the impressions of the lunar surface from the lunar surface, in which many near-vertical slopes are shown. In fact, gradients over 45° are rare.

As it does not give a general account of the major aspects of lunar science this book cannot be recommended on its merits as an introduction for beginners; it could, however, be read with profit in conjunction with another introductory lunar text-book such as Moore's "*Guide on the Moon*" or Wilkin's "*Our Moon*".

John C. Marsh.

Long Term Stellar Changes

by J. W. KENT

MOST of you reading this will know that many stars in the sky vary in brightness over a period of time which may be measured in minutes, days, months or even years; but not all of you may be aware of secular variables. These are stars, all visible to the naked eye, which are supposed to have slowly faded or brightened during the course of hundreds of years, a time-scale which makes it very difficult to verify, especially as the modern magnitude system only came into use about 1850. About the only way that these secular variables can be found is by careful comparison of the brightness of stars in old catalogues with their modern values, after making due allowance for the different magnitude systems used. Recently, I have come across some information which I think may shed some new light on secular variables. Of course, I could be wrong, but few will deny that the results are interesting.

As I am a member of the JAS Variable Star Section, I keep my eyes open for anything that may be useful to naked-eye variable star observers. One of the things I have been doing with this in mind during the past year or so, is to look through old issues of astronomical periodicals to see if they contain any information useful to the Section. The main things I hoped to find were old observations of the stars in our programme, and possible additions to the programme itself. If I may digress a moment, there was little or no trace of observations made since 1900, which makes the JAS variable star programme even more important than it might otherwise be.

Besides looking for observations, I also noted the details given in the various lists of variable stars that I came across. Apart from the more usual members of these lists, two stars in particular were given as suspected variables with a range of about half a magnitude—*Alpha* and *Eta Ursae Majoris*. This interested me a lot as these stars are bright and are not often mentioned in more recent variable star lists, and so I decided to try and find out what their discoverer, the French astronomer Lalande said about them. Unfortunately, I could not find any book by him published around 1786, the year of discovery, in Leeds University Library, but there was one dated 1771 which contained a good deal of interesting information—and a star catalogue.

It was such a roundabout route that I got onto the problem of secular variables. As mentioned above, *L'Astronomie*, as the book is called, contains descriptions of contemporary observatories and general information on the astronomy of the time, in particular a chapter on "New and changing stars", and the catalogue of naked-eye stars with their magnitudes and positions. By comparing the magnitudes in *L'Astronomie* with modern values in the *Astronomical Ephemeris*, I hoped to find any of the bright stars which had changed in brightness in the past two hundred years.

Since I was only interested in the brighter stars that we can see from this country, I did not use any stars south of Declination $-30°$, nor any which did not have a Greek letter. In addition, any stars such as *Alpha Orionis* and *Gamma Cassiopeiae*, given in the *Astron. Ephem.* as being variable were rejected. These restrictions gave me a list of 207 stars ranging in magnitude from 0.1 to 4.7 on the modern system and from 1 to 5 on Lalande's system.

The main difficulty, other than the use of a different magnitude system, was that Lalande only gave the brightnesses of stars to the nearest half magnitude, which meant I had to find a way to get the modern equivalents of the old magnitude classes. Fig. 1 shows how I did it. Along the side are the magnitude classes used by Lalande while along the bottom are the present-day magnitudes given to the stars in the *Astron. Ephem.* For each one of the 207 stars in my list, the

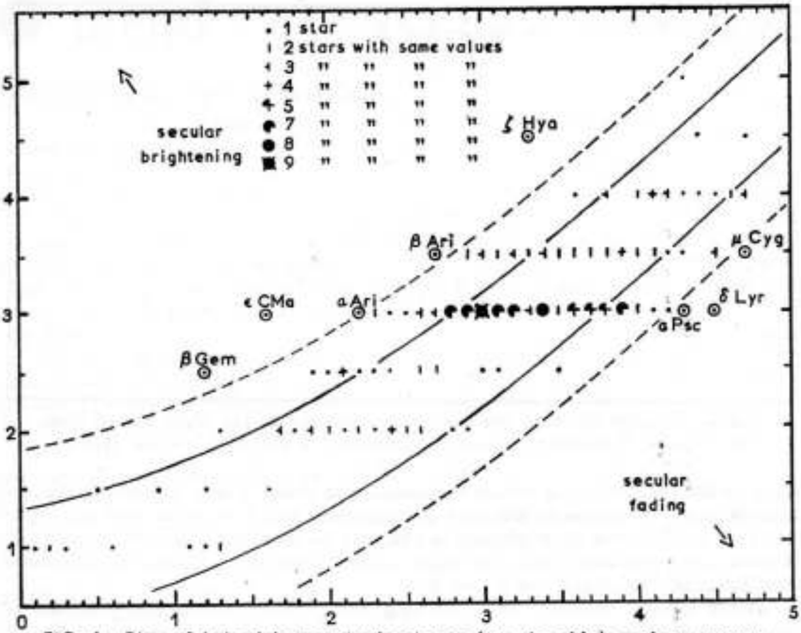


FIG. 1 Plot of Lalande's magnitude classes (up the side) against present magnitudes from the Astronomical Ephemeris (along the bottom) for 207 stars, showing supposed 'secular brightening' or 'secular fading' of eight named stars.

magnitude given to it in Lalande's catalogue was plotted against its magnitude in the *Astron. Ephem;* where more than one star had both values the same, the number of stars (up to nine) is shown by the size of the point used.

A line was drawn through the middle of the points to see where and by how much the two magnitude scales differed. This line is not shown on the diagram, but if it were, it would run just half-way between the two central solid lines. In general, the curve shows that for stars brighter than mag. + 1.5, the modern magnitude for a star is smaller than Lalande's, while below mag. + 1.5, the modern equivalent is numerically larger than Lalande's.

If the people who made the observations for the catalogue were consistent, then there should be no error of more than a quarter of a magnitude. This is because a star at say mag. + 2.25 could be put into either class 2 or 2-3, but nobody would put it into class 1-2 or class 3. However, to allow for errors, we can accept an error of up to half a magnitude. Stars which differ from the mean value by more than this amount look very suspicious, and the difference *may* be due to an actual change in brightness. This half magnitude limit is shown by the solid lines in Fig. 1, and the stars whose points do not lie between them *may* have undergone a genuine change in brightness.

Besides the two solid lines, two broken lines are shown, each a whole magnitude above or below the mean curve. Any stars which lie outside *these* thus differ from the value they ought to have by more than a magnitude. In this case, there are eight stars which fall outside the curves, each of which is ringed and named. These stars are thus a whole magnitude or more away from their expected value and can almost certainly be said to have changed in brightness. For

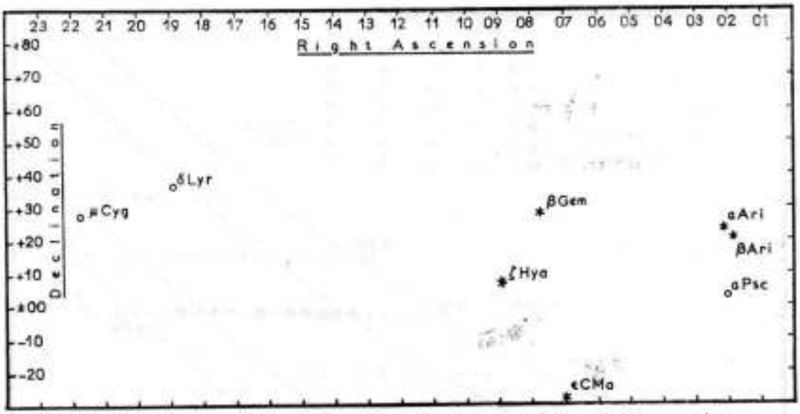


FIG. 2 Diagram showing the positions in the sky of the eight named stars from Fig. 1. * indicates 'secular brightening'; o indicates 'secular fading'.

comparison, the difference between *Gamma* and *Delta Ursae Majoris* (when the latter is at its brightest) is less than a magnitude and I am sure you will agree that such a difference in brightness is not easy to overlook. Thus there seems to be little room for doubt that the eight named stars have changed in brightness since Lalande's catalogue was drawn up.

More out of curiosity than anything else, I next plotted the positions of these eight stars on the stellar sphere, and obtained the result shown in Fig. 2. In this diagram, a secular brightening is shown by a six-pointed star and secular fading by a circle. By far the most striking thing about the arrangement of the stars is that brighter stars are confined to less than eight hours in Right Ascension and 60° in Declination, less than a sixth of the area of sky covered. Similarly with the "secular faders", though *Alpha Piscium* does spoil the picture a little bit. What is even more interesting is that when all the stars lying outside the solid lines are plotted in this way, the same result, more or less, is obtained. If the left and right halves of the diagram are considered separately, we find the following results:

RA	12h to 24h	00h to 12h
Stars brighter	25	22
Stars fainter	23	9

In other words, there is a group of stars centred on the Equator and RA 0600h which seem to have brightened in the past two hundred years, and a corresponding group at RA 1800h which have faded. Admittedly the number of brighter stars greatly exceeds the number which have faded, but this could be due to the fact that the mean curve on Fig. 1 was drawn too low, so that too many stars were put in the bright class.

So much for the results I obtained; but what is the explanation? At first I thought that it was just due to the relative motion of the Sun among the stars, that is the Sun is moving towards a point near RA 0600h, but according to Norton's Star Atlas, the Sun is making for RA 1800h, Dec. 34° N, almost in exactly the opposite direction. Another possibility is that dust clouds are involved, but then dust clouds are not likely to affect large areas of sky opposite one another even if we were travelling through or into the dust. Yet another possibility is that it is all due to observer error. Most of the observations of stars around RA 0600h would presumably be carried out on spring evenings, while the stars near RA 1800h would be observed during the autumn—it may, in fact, be a seasonal effect.

None of these suggestions really satisfies me and I am beginning to wonder if there is a reasonable explanation at all. It may be that what I have done with Lalande's catalogue is against all the rules and my results are not worth the paper they are written on. There is, however, just one last point I would like to make. One of the more likely secular variables mentioned in Norton's Star Atlas is *Alpha Geminorum* (*Castor*), and it is generally supposed to have faded over the centuries until it is now fainter than *Beta Geminorum* (*Pollux*). But the same effect would be noted if *Pollux* had become brighter with time, as is, in fact, indicated by the results obtained above. Which is correct? As an observational astronomer I cannot say—that is something for the armchair astronomers to sort out.

Telescoptics

by J. HYSOM

Aberrations in optical systems

ABERRATIONS are distortions of the image formed by an optical system. They are always present even in the finest of telescopes or microscopes. Optical designers try to design instruments in such a way that the aberrations are reduced to the point where they do not noticably affect performance. In the case of astronomical telescopes the standards set are high. As often as not the instrument is required to give theoretical resolution. What does this mean? It means that for any size of telescope (diameter of OG or mirror) there is a natural limit to the detail it will show. You can do anything you like—adjusting, cleaning, changing eyepieces and so on—yet the final result will be the same; for a given size of telescope objective you will only be able to pick out detail down to a certain angular size. What finally sets the limit is the wave nature of light itself. We could, if we like, express the resolving power of a telescope in terms of the ratio between the diameter of the objective and the wavelength of light.

In the middle of the visual spectrum there are something like 50,000 waves of light per inch. With a 1-in telescope we thus have a ratio of 50,000:1. Compare this to the giant 250-ft radio telescope working at 10-cm (4 inches) and you will see why the discrimination or resolving power of even a 1-in telescope is so much higher than this giant. In order that a telescope should give theoretical resolution the designer has to compute the ideal curves for an object glass or mirror system. It is also neccessary for the optician to work the lens or mirror to an accuracy which is a fraction of the mean wavelength of the radiation with which the instrument will be used. Hence the use of opticians of terms for surface accuracy such as $\frac{1}{4}$-wave $\frac{1}{8}$-wave or 1/20 wave. With a radio telescope $\frac{1}{4}$-wave may mean that the bowl has to be accurate within one inch of the ideal shape; with an optical telescope however, the required accuracy will probably be of the order of 2-millionths of an inch!

Mirrors must be worked to greater accuracy than lenses because reflection doubles surface errors whilst refraction tends to lessen them. A $\frac{1}{2}$ or $\frac{1}{4}$-wave surface may be allowable in a refractor but $\frac{1}{8}$-wave is called for in a reflector. Reflectors have their virtues though. At one stroke one of the greatest of the optical designer's head-aches is removed when reflecting surfaces are employed—he has done away with the need to achromatize. For reflectors are perfectly achromatic. Careful choice of suitable optical glasses and curves can effectively reduce chromatic (colour) aberrations in refractors.

Tolerable aberration

What is a tolerable amount of aberration? In all cases of optical design aberrations are considered tolerable when, in total, they do not cause any appreciable difference in the size or shape of the smallest detail that the instrument is required to record. With a visual astronomical telescope this means that they should be less than the ultimate size of the detail (i.e. less than the size of a star's false disk). With an OG aberrations are reduced by a combination of glasses, curves and spaces between lenses. As a mirror system offers less scope for corrections non-spherical curves are used. Various combinations of concave and convex mirrors with parabolic, hyperbolic, elliptical and spherical curves are used to produce suitable images.

Catadioptric systems

In the last thiry years or so a new type of instrument has evolved. This makes use of the good design points of both refractor and reflector by combining the two. An instrument that uses both curved lenses and mirrors is known as catadioptric. The commonest form of this type is that invented by Bernard Schmidt in 1930 and bears his name. Later forms are those developed by Bouwers and Maksutov during the war. The basic principle is to use a spherical mirror and to nullify its aberrations by placing a compensating lens—a deep meniscus—in front of it. All curves are spherical. The amount of colour produced is only a few per cent of that given by the equivalent achromatic doublet and the field of view is wider also.

Lunar Section Notes

by R. E. ELLIS

THE VEXED question of the existence of a lunar atmosphere has been the centre of many a discussion and elaborate thesis. The problem still remains open to speculation and will probably remain so until the necessary instruments have been landed upon the moon. Up until the present time the problem has been tackled by many astronomers in many different ways. The following notes will ouline several of the methods used.

Mention was made in the last issue of *Hermes* of the work carried out by Dr. Alter in photographing various areas of the moon in both infra-red and ultra-violet light. In some instances the infra-red photographs contained more detail than those taken at the violet end of the spectrum. This is one effect which could be accounted for by the presence of a thin atmosphere but the evidence is not conclusive. In this search for the moon's atmosphere the amateur astronomer has not been left out and V. A. Firsoff, a prominent selenographer and author, has carried out extensive visual observations with the use of filters. As it is well known the endeavour to obtain evidence of the moon's atmosphere through the observation of occulations has yielded negative results but Firsoff has had a certain measure of success. Using a blue filter he reports of an occulation in which the star, as it neared the limb of the Moon, exhibited a definite fluctuation in brilliance before finally disappearing. His observations at present however lack confirmation. The use of filters has also lead him to the detection of a certain reddening appearance of the peaks which may chance to lie on the terminator. The appearance is suggestive of our own earthly sunset in which the sun, due to its low altitude, is reddened by the atmosphere and thus reddens the appearance of objects.

Radio astronomy has also made its contribution to this problem as on January 24, 1956 when the Crab nebula was occulted by the moon. The Crab nebula is an intense radio source and the occultation was calculated to last 59.21 minutes. The observation was made by Elsmore, Costain and Whitfield at Cambridge and a wavelength of 3.7 metres was used. The occultation was observed to last for 56.6 minutes with an error of 0.26 minutes. The difference has been attributed to the refraction of the radio waves as they pass through the assumed tenuous atmosphere surrounding the moon.

A large amount of theoretical work has also been brought to bear on this problem. This has involved laws governing the motion of gas molecules together with the moon's gravitational force and surface temperature. Results in this field have been contributory and would appear to depend a great deal on the opinion of the scientist carrying out the investigation rather than mathematics.

Can JAS members contribute in anyway to this aspect of lunar research? A large number of amateur astronomers in America have carried out an extensive moon-watch programme in order to detect the paths of meteorites as they burn up within the lunar atmosphere. They have had a fair measure of success but the work requires great patience and persistent observation by each member taking part. M. Phipps of the Birmingham Group is endeavouring to contact as many JAS members as possible in order to carry out a similar programme in this country and anyone who feels that they would like to contribute to these observations should contact him.

Variable Star Section Notes

by K. BRACKENBOROUGH

Work done, October 1960—March 1961

THE JAS Variable Star Section has been operating for some time, and many observations have been made. This brief report summarises its activities from the period October 1960—March 1961; it is not possible to go beyond this date as there are still a few observations to be submitted for analysis. It is true to say that the section is successful. It has provided a programme for stellar astronomers to follow, which can be carried out without telescopic aid. This means that wherever observers live, in town or country, observations can be made. A wealth of information has now been compiled of the 11 stars under observation by the section and although there have been many beginners making observations these have been of some use.

During this period the section had 21 active, some very active, observers and a total of 2,267 observations were made. From the 11 suspected or irregular naked-eye variables listed, each observer chose 4 in which to specialise. The nearby comparison stars were easily committed to memory and even slight fluctuations were observable without need for recourse to star atlases or reference books.

Observers who made over 100 observations must be congratulated on their fine efforts. They were:

K. Phillips, Ashford, Middlesex.	358
D. Beglan, Thornton Heath, Croydon.	350
I. Duff, North Shields, Northumberland.	299
H. Robinson, Southampton.	259
D. Duvall, Farnham, Surrey.	178
D. Purchase, Berkhampstead, Hampshire.	130
Boys of Cumnor House School Haywards Heath.	110

Thanks must be given to all the observers who have spent many hours observing and reporting.

Three issues of *Betelgeuse*, the JAS Variable Star Section's bulletin, have been published, and a few issues of *No.* 3 are still available to interested members. It has been decided to conduct the business of the section through the pages of *Hermes*, which will bring the advantages of a wider circulation. Observers will also benefit from more frequent reports.

Due to lack of space only five of the stars under observation have been included in the following notes, it is hoped to include the others in our next report.

GAMMA CASIOPEIAE. Over 490 observations have been made of this star, the most popular under observation by the section. A complete report is published in *Betelgeuse No.* 3.

ALPHA CASSIOPEIAE. In 1831 a well-known astronomer gave a period of 80 days for this star. It is now a well-known Irregular Variable and this has been supported by members of the section. Over 450 observations of it were made and on some nights as many as seven different observers estimated its magnitude. One member made it constant at 2.3 General fluctuations were from mag. 2.2 to mag. 2.6, although this small margin is hardly enough to be conclusive. There seems to be a slight variation in magnitude from night to night.

BETA PEGASI. 8 members contributed 119 observations of this star, which proved to be the most interesting under observation. The general trend indicated a period of about 40 days with a minimum occuring 8 or 9 days after the maximum. Maximum magnitudes were observed on November 2, December 12, January 8, and February 10, although the last date is uncertain due to the setting of the star in twilight. I would like to confirm these suspicions on this star's possible period and so observation will be of value.

MU CEPHEI. Although faint, this star is popular with observers; 144 observations by 9 members showed variations from 3.8 to mag. 4.5. Even over only two nights, this made the star the most difficult to analyse. There were general trends of the magnitude rising—the most apparent being the rise from March 1 to March 21, 1961 when a maximum of 4.0 was recorded—even 3.8 by D. Fry and K. Phillips.

ALPHA ORIONIS—BETELGEUSE. A total of 280 observations were made by ten members on this star and the lack of nearby comparison stars of similar colour did not deter them. The only fact of interest, to which all observers agreed, was the slow rise to maximum which took place from mid-November until December 16, 1960. The observed maximum recorded was mag. 0.4. This was retained with minor fluctuations until February 1961 when it slowly dropped in brightness to 0.6. This was confirmed by more than one observer. The star was then getting into the dusk skies making further observation impossible.

I would be pleased to have any comments on this report for the Variable Star Section. Complete lists of Variables under observation, comparison stars and report sheets are available on request. (Don't forget a 3d. stamp—Ed.) Stars scheduled for observation in the coming months can be found in *SKY DIARY*.

Jupiter's Satellites and the Speed of Light

by M. J. GALE

No doubt last summer and autumn most of you managed to see the planet Jupiter and perhaps see its satellites. Jupiter has twelve satellites ranging from globes larger than the Moon to tiny spheres 15 miles in diameter. These are quite spread out, orbiting between 100,000 and 15,000,000 miles from Jupiter. By means of the four major satellites—Europa, Io, Ganymede and Callisto—Claus Roemer, a Danish astronomer, first put forward a figure for the speed of light.

Since the speed of light is so very great, 186,325 miles per second, it is impossible for it to be measured merely by flashing a light and timing how long it takes to travel from one place to another, as Galiles attempted to do, although some very ingenious terrestrial methods have been invented to calculate the immense speed. Roemer noticed, while engaged in recording the eclipses of one of the satellites, that a certain eclipse when Jupiter was at opposition did not occur as expected when Jupiter was at superior conjunction. The difference in times was $16\frac{1}{2}$ minutes. He suggested that the time lapse was due to the extra distance which the light had to travel—the diameter of the Earth's orbit, 186,000,000 miles

Since velocity = distance/time,

the velocity of light is $c = 186{,}000{,}000/(16\frac{1}{2} \times 60)$ miles per sec.

$= 186{,}000$ m.p.s.

This was an extremely good result, considering that the experiment was performed in 1676.

● trend

A review of new ideas in astronomy

LET-DOWN BY THE CEPHEIDS

One of the troubles which astronomy has always had is finding distance accurately. Ever since the days of the Ptolematic system, however, mathematical extrapolations have been made regarding the distances of celestial bodies, extrapolations which depend on the astronomer's faith in the regularity of Nature, or "the harmony of the Universe" as the Ancients might have put. In Aristotelian science these regularities were based on the "magical" properties of numbers: squares, "perfect" numbers, "lucky" numbers, etc. Nowadays we use the regular "laws" of Nature to calculate. They may be laws of Trigonometry, statistics, or astrophysics. A particular example of the latter is the law of the Cepheid variables.

As it was discovered by Miss Henrietta Leavitt at Harvard early in the century, the longer the period of the Cepheid variable, the brighter it is. It proved possible to formulate this more satisfactorily in the form of a law: $M = A - BT$, where T is the period of the Cepheid, M is its absolute magnitude and A and B are constants whose sizes could be determined more or less accurately. And if we know the absolute magnitude of a star and its apparent magnitude, M, we can easily find its distance, D, in parsecs from the formula $M = m + 5 - 5 \log D$. (See for example C. Payne-Gaposchkin, *Introduction to Astronomy*, Eyre and Spottiswoode, 1956, pp. 268 and 366.)

We thus have in principle a method for finding the distance of an object in which there are Cepheid variables.

There are, however, complications. In particular, as was found by astronomers to their cost, the constants A and B in the period-luminosity law are different for the two stellar populations, the two different types of stars which are found in the spiral arms and the nuclei of galaxies respectively. Now it appears that the form of the law may be different *for each galaxy*!

The doubt has come from investigations by the Royal Greenwich Observatory into Cepheids in the Magellanic Clouds. The period-luminosity law derived by the Astronomer Royal for Cepheids in the Large Cloud differs significantly from that derived by Arp for the Small Cloud. The difference is such that for a 20-day Cepheid there is an error in M of 0.75 of a magnitude, corresponding to an error in the distance of a *factor* 1.4!

The confusion that will result if this conclusion, which was reported to the meeting of the Royal Astronomical Society on January 12, 1962, is confirmed can only be guessed at. Once before the Cepheids have let astronomers down. If they do so again, then they will be very wary of using them in the future.

THE EXPANDING GALAXY

At the same meeting of the RAS, the Secretary, M. Ovenden, read a paper by F. J. Kerr on galactic neutral hydrogen as revealed by 21-cm radiation.

There have been two detailed studies of the Milky Way at 21-cms, one by Dutch astronomers, the other by Australian, each group covering about half of the Galaxy (since one observatory is in the northern hemisphere, the other south). The agreement between the two surveys is fair but not good. (See, eg. *Sky and Telescope*, 18, 365 (1959), or *M.N.R.A.S.*, 118, no. 4 (1958).) Kerr claims to have improved the agreement by adding an expansion term to the rotation of the Galaxy, which results in a distortion of the one side with respect to the other.

There is, of course, radio observational evidence that the central nucleus of the Galaxy and the arm nearest us on the inside are expanding outwards and it is from these observations that Kerr has taken his calculations.

Around the Groups

Peter S. Litton

BIRMINGHAM. Attendences at the monthly meetings, held in the Midland Institute on the first Saturday of each month are showing improvement. Regular weekly observing sessions continue, a planetarium is being built, and it is hoped to construct and fire rockets! Film shows are popular and I expect that most Groups would like more details of titles, sources, hire-charges and guidance on their usefulness.

CROYDON and LONDON NE & E. On February 24, members of the NE & E London Group visited the home of Mr. and Mrs. Best in Croydon where a lively joint meeting was held. Six speakers, three from each Group, provided an interesting background to what developed into a heated debate. The argument was sparked off by Terry Pearce who suggested that the typical, faint 'markings' recorded by some observers on the planet Venus were neither real or dark but contrast effects produced by brighter areas. David Beglan did not agree and showed drawings made by impeccable observers. No final conclusion was reached.

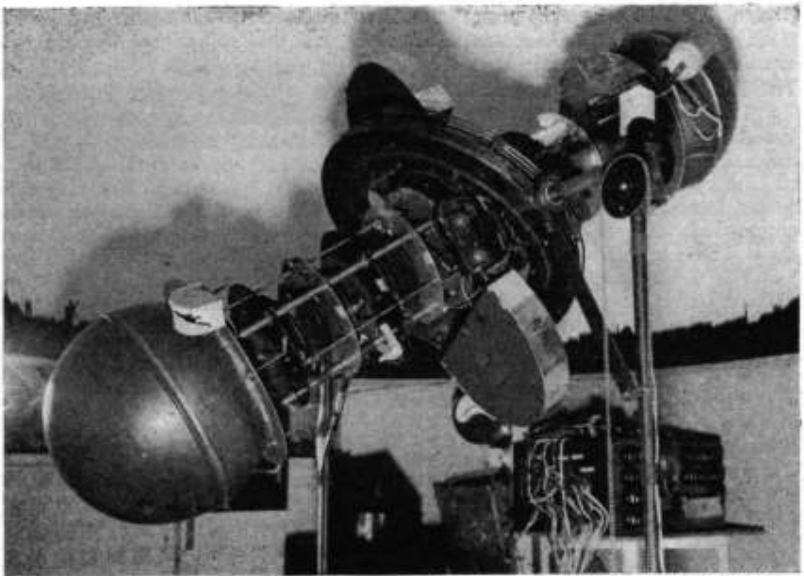
DUNDEE. This group has started building an observatory. It has, in fact, been functioning for some time and has already collected quite an extensive record of observations.

GLASGOW. I was delighted to receive a copy of the first issue of *Spectra*, this Group's journal. The majority of members are interested in the Solar System and photographic work is very popular. More than £80 worth of photographic equipment and materials have been donated to the Group and there is a useful collection of small refractors and reflectors.

GLOUCESTER. On March 31 this group held a joint meeting with the South Wales Group. A number of observational projects are under way although adverse weather conditions have been delaying things rather badly.

SOUTH WALES. Susan Lewis has sent me a full report of the Public Meeting held in the Schools Reception Room at the National Museum of Wales in Cardiff on January 27, 1962. This was organised by the Group and the chair was taken by Colin Reeves. The first speaker, Mr. H. N. D. Wright, compiler of *Hermes Sky Diary* spoke on *Telescopes* and with the aid of slides, descibed every stage of telescope making. He went on to discuss "objects in order of ease of observation" and pointed out that work on the lunar surface was an important field for amateur astronomers. He also showed slides of Venus, Mars, Jupiter and Saturn and commented on the conjunction of the seven main planets in Capricorn which coincided with a total eclipse of the Sun on February 4—5. Mr. K. Stocker gave an interesting talk on Astro-photography, illusrating it with slides from high-speed colour film. He mentioned three ways of studying the sky—looking, drawing and photographing. "Of these", he said, "the last is of most permanent use to astronomy". Warning of the danger of sending film for development to non-specialists he advised those attempting astro-photography to master the art of developing for themselves. Mr. Stocker also pointed out that there were eight fields in which amateurs could help. These were: artificial satellite, auroral, meteor, stellar, lunar, constellation, cometary and planetary photography. Lunar photography was well within the capabilities of anyone with ingenuity, patience and a telescope of more than 2½ in. aperture. The South Wales group express their thanks to Messrs. Wright and Stocker for making the long trip and giving the JAS such impetus in Cardiff.

Mr. D. Cotton, 23 Corniche Road, Port Sunlight, Bebington, Cheshire, would like to hear from JAS members living in his vicinity.



Peter Garrard's projector. The spheres forming the ends of the dumb-bell project the stars visible from the Northern and Southern hemispheres. Sun, Moon and Planet projectors are housed in the central column and some of the ancillary equipment can be seen.

My Theatre of the Skies

by PETER R. GARRARD

ANYONE invited to see this home-made planetarium would be astonished at his first sight of it. for it is built entirely in a bedroom of modest size. The dome is eight feet in diameter and its inside "projection surface" is formed from 121 sections of white card, fitted neatly together and glued onto a wooden framework, the top of which touches the ceiling.

After the visitor had gathered his wits from the first shock, he would be directed into the auditorium. Great care is needed here in order to avoid disturbing the dome, since the headroom is only four feet!

When seated on a very low stool, the spectator sees a familiar spectacle—the evening sky just after sunset when it is still vividly blue and the magnificent fire in the West is just beginning to subside. These effects are obtained by ordinary car headlight bulbs situated all round the base of the dome behind a freize of plywood cut to the outlines of objects seen on any typical skyline—houses, hills, trees, etc.

This romantic atmosphere is retained for a few minutes to enable the observer's eyes to become accustomed to the scene. Then the demonstration begins. The blues and reds fade from the heavens until only the eerie shapes on the horizon are visible. Suddenly a bright point of light appears in the dark blue void; then others a little less bright; then more; and more: the last light of day is giving way to night as stars appear in their thousands and the dome dissolves.

Slowly and silently the stars wheel over the observer's head tracing out the paths which they follow in nature. Actually, of course, there are not thousands of stars to be seen with the naked eye; even on the clearest of nights the figure is about 2,000. In my planetarium only a few hundred are produced. Surprisingly there is no loss of realism and the fainter stars are not missed when one is learning the constellations!

The Planetarium Instrument

The projector responsible for producing this impressive sight, is shaped like a dumb-bell 54 inches long with a large central bearing or housing. It uses 23 car and torch bulbs and five electric motors, but it has no lens systems except in the lunar projection unit. The ends of the dumb-bell are two copper spheres twelve inches in diameter. Stars from the first to the fifth magnitudes are in the globes, each one of which represents a celestial hemisphere. The star holes were made with tiny drills between 40 and 13 thousandths of an inch across.

The instrument is also able to project images representing the five naked-eye planets, in the same way as the stars. In fact all light required to represent point objects is projected through pinholes. In the case of the planets, however, two pinholes are needed since the bulb is so close to the image forming aperture. The second aperture is placed at the lamp in order to narrow the filament, thereby producing a thin beam of diffused light which shines through the first pinhole giving a sharper image on the dome.

Sun, Moon and planets

The projectors for the planets and the mechanism which moves them occupy the whole space on the axis of the dumb-bell between the star globes. Each planetary projector is a tube pivoted between two plates; each plate has a pivot or bearing on it in a certain position and revolves at a calculated speed. The off-centre pivot represents the planet and this moves round the centre at the appropriate speed. This pivot's position and the speed of the plates are relative. The central pivot represents the Earth. In this way, the planets are projected with speeds such that their movements on the dome represent their celestial movements as seen from Earth. The problems of obaining the right gear ratios to get the movements of the planets in the right proportions was partially solved by the use of Meccano gearing. Special gears had to be made to meet practically every ratio, nevertheless; but the ratios were worked out to include as many Meccano gears as possible.

Also in the "bar" of the planetarium instrument are projection units for the Sun and Moon. The Sun unit consists of two tubes fixed together and rotating centrally. One gives an image of the Sun and the other projects that faint and elusive phenomenon of the early morning and late evening sky, the Zodiacal Light. (See *Hermes*, vol. 9 page 33.)

The lunar projector is a little more complicated. Here it is necessary to achieve the changing phases as the Moon passes round its orbit. The unit, a rather fat-looking cylinder, houses a lens, a lamp and a cowl which revolves about a stationary mirror the size of a halfpenny. The lens focuses light reflected by the mirror from the bulb to the dome. The light can be cut off by the cowl as it revolves centrally round the mirror. The manner in which the beam is obstructed produces an effect similar to the waxing and waning of the moon.

Mechanical construction

The heart of the projector itself is the big central bearing. As the weight of the dumb-bell is so great, the bearing had to be reinforced with a steel band of 18 inches diameter welded round its edge. The dumb-bell is inclined at an angle of 23½° to the bearing, the outer part of which rotates the dumb-bell about its own axis. By this means the phenomenon of the Precession of the Equinoxes may be demonstrated.

To show both these important movements, powerful motors are used to turn the equally strong gear rings and bearings, these being well greased for smooth, silent operation. It takes about 20 minutes to turn the projector through one day, and about 15 minutes to show the complete precessional cycle of 25,800 years.

The whole instrument is supported by a horizontal East-West axis resting on two vertical supports which can be rotated to show the skies of any desired latitude.

The planetarium operates on a.c. mains electricity. The 240v supply is stepped down by means of two transformers to 12v. One transformer is used for the five motors, and the other for lighting. A description of the electrical features would hardly be complete without a few words on the slip-ring system. Slip-rings are used to get the current onto the various rotating parts of the projector which carry lamps and motors. There are two main sets of copper slip-rings, one on the central bearing and the other on the bar of the dumb-bell itself. In each case there is a set of shoes or collecting arms to pick up the current and terminal block combined. One of the rotating plates in each planetary projector is used to collect the current from a fixed arm.

Although slight fluctuations occur with the planets, the steadiness of the images is quite good when one remembers that the current has been passed through three sets of home-made slip-rings. It is most important, however, for the sake of realism, that the star sphere as a whole does not flicker. The electrical contacts have been made carefully and, in fact, no flickering occurs.

The planetarium has taken approximately two and a half years to build—the author being 14 at the start—and proved to be well worth the time, money (£60) and effort involved in its construction.

SKY DIARY

H. N. D. Wright FRAS

All times in GMT

Principal Phases of the Moon

	April	May	June
New	4d 19h 45m	4d 04h 25m	2d 13h 27m
Full	20d 0h 33m	19d 14h 32m	18d 02h 02m

Occultations of stars by the Moon at convenient hours (Magnitude 6.5 and brighter, all disappearances)

Date	Time	Star	Mag	Moon's Altitude degs	Position Angle* degs
April 14	23h 18.6m	Regulus	1.3	40 SW	119
June 7	22h 29.9m	7 Leonis	6.2	12 W	124

* Angle round the limb of the Moon measured from the North Point of the disk, through E, S and W.

Considering this very poor showing of the more readily observable occultations, keen types might like to try the following more difficult instances. Firstly, there is a daylight occultation of Aldebaran on April 8. The Moon is a 3.8 day old crescent at the time, so that the disappearance is the thing to watch for. This occurs at 13h 07.9m, with a Position Angle of 118°, and with the Moon at 45° altitude in the SE. Needless to say, access to a fairly large telescope will be necessary to see anything of this particular disappearance.

Not nearly so difficult is a disappearance outside the magnitude requirements quoted above. This is the star BD + 19° 1784 of magnitude 6.8. Those observers with some experience of observing occultations should have no difficulty here, if seeing is good. The date is April 11, and disappearance is at 22h 07.4m, with a Position Angle of 88°. Moon at 34° altitude in the WSW.

Then there is a re-appearance of the star Gamma Librae in the after-midnight hours on April 21-22. The best way to remember the date and time is thus: April 21d 24h 46.3m. Position Angle is 352°, and the magnitude 4.0. Moon at 25° altitude in SSE.

Availability of the brighter planets for observation

MERCURY reaches its most favourable position as an evening object for this year during this period. After passing Superior Conjunction on April 16 (far side of the Sun), the planet moves steadily into the evening sky, and may just be spotted low in the WNW for a short while after sunset. However, the best opportunity to see Mercury against a reasonably dusky sky is during the second week of May, when the angular distance from the Sun reaches 22°, and setting time about two hours after sunset. Greatest Elongation East occurs on May 13, and around this time Mercury is only some 6° West of the brilliant Venus. The Moon, as a little over one-day old crescent, passes a few degrees South of the two planets on May 5, in the constellation of Taurus. Mercury will not be readily seen during June, Inferior Conjunction (between Earth and Sun) occurring on June 7.

VENUS is becoming steadily more conspicuous in the evening sky. At the end of April it will be seen between the star clusters Hyades and Pleiades in Taurus, and is then setting over two hours after the Sun. The apparent size of the planet remains small during the period, as Venus is still very distant from Earth. The phase narrows a little, and is of gibbous appearance (like the Moon shortly before or shortly after Full). A fairly rapid motion East against the stars is maintained, and Gemini is entered on May 22. From this time onward, the period from sunset to the setting of Venus shortens again, due to the decreasing Declination of the planet. This in spite of the fact that the angular distance from the Sun is steadily increasing. On June 15 Venus will be seen forming a 'line-up' with the stars Castor and Pollux in Gemini, and for the remainder of the month is moving through Cancer, to reach the borders of Leo at the end of June.

MARS remains a very difficult object observationally during these months. Firstly, it is South of the Sun in Declination, moving through the constellations of Pisces and Aries, entering Taurus at the end of June. Secondly, it is still very distant from Earth, and has an apparent diameter only about the same as that of Uranus, about 4 seconds of arc. This also means that it is not very brilliant, in fact, not much brighter than second magnitude. All this and the bright dawn sky of summer, too! Observers of this planet must be patient for the time being.

JUPITER is now situated in the constellation of Aquarius, so that it will be noticeably better for altitude over the position during the last two years. It is steadily improving observationally in the morning sky. The early risers should have no difficulty in finding the Giant Planet, with a magnitude of around -2. In mid-May it is rising fully two hours before the Sun, and in mid-June over $3\frac{1}{2}$ hours in advance

SATURN will be found in the constellation of Capricorn throughout this year, and is therefore much less well-placed than Jupiter for altitude. The rings are now closing again, and more of the actual globe of the planet is being revealed. Saturn rises about one hour before Jupiter, but is very much fainter, at magnitude $+0.7$ in June. Greatest Elongations of Titan, the brightest satellite, occur as follows: West Elongation—April 18, May 20, June 21. East Elongation—April 26, May 28, June 29.

URANUS may be located a little over two degrees NW of Regulus in early April, moving slowly Westwards. Reaches a stationary point among the stars in early May about one degree North of the star Nu Leonis. The planet will appear only about half as bright as this star. By the beginning of June Uranus has 'retraced its steps' as it were, and is moving Eastward in the general direction of Regulus.

Constellations near the meridian at 22.00h

Mid-April	Ursa Major, Leo Minor, Coma Berenices, Canes Venatici, Leo, Virgo, Corvus, Crater, Sextans, Hydra.
Mid-May	Boötes, Canes Venatici, Coma Berenices, Virgo, Corvus.
Mid-June	Hercules, Corona Borealis, Boötes, Serpens Caput, Libra, Scorpio.

Naked-eye variables in JAS programme

Delta Ursae Majoris, Alpha Herculis, Alpha and Gamma Cassiopeiae.

HEATH PRESS LTD., 54 HIGH STREET, THORNTON HEATH

SOCIETY NOTICES

1962	OPEN MEETING	
APRIL 14	2 p.m.	Great Hall, Caxton Hall, London, S.W.1.
	GENERAL MEETING	
JULY 21	6 p.m.	Tudor Room, Caxton Hall, London, S.W.1.
	ANNUAL GENERAL MEETING	
OCTOBER 20	6 p.m.	Tudor Room, Caxton Hall, London, S.W.1.

An observation of Linné by Patrick Moore

A MEETING of the JAS was held at Caxton Hall, Westminster, on January 6, 1962 at 18.00h GMT at which Mr. R. E. Ellis, Director of the JAS Lunar Section delivered a lecture entitled *The Moon*. Mr. Ellis particularly described changes and suspected changes which have taken place on our satellite and which tend to make a lie of the description of the Moon as a dead world. The first recorded "change" occurring on the lunar surface was that of Linné, which was drawn by Madler and Beer in 1830—37 as a crater about 8 miles in diameter. Schmidt later announced the crater's disappearance, in its place being just a white spot. More recent observations show it as a lunar dome with a small crater at its summit. It is generally thought that changes in illumination cause the appearance of this feature to alter.

In support of this Mr. P. Moore described an observation which he made in the middle of 1961 in which he was observing what he thought was the crater Bessel with his 8½-in. reflector when he suddenly realised that it was Linné. It appeared to be a crater about 8 miles in diameter. Mr. Moore phoned a friend and asked him to look at Linné without telling him what to look for and he immediately confirmed the crater-like appearance. Later entirely independent confirmation came from another source.

"There is no doubt that Linné is a dome with a summit craterlet," said Mr. Moore, "but I think that this observation shows that under some illuminations, presumably similar to those at which Madler observed, the object takes on the *appearance* of a small crater."

A FULL LIST of Officers and Council of the JAS appeared in *Hermes* Vol. 9, No. 2, Jan. 1962. The Secretary, E. W. Turner F.R.A.S. is now at 44 Cedar Way, BASINGSTOKE, Hants. H. N. D. Wright F.R.A.S. takes over as Director of the Occulation Section and K. S. G. Stocker F.R.A.S. becomes Director of the newly-formed Photographic Section.

THE ADDRESS of the Editor is 1, Temple Avenue, Shirley, CROYDON, Surrey.