HERMES

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Contents of this issue

JAS

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THE JUNIOR ASTRONOMICAL SOCIETY is an organisation formed to promote and encourage an interest in Astronomy, and to provide instruction and assistance for beginners in the study of this science. All enquiries will be warmly received, and should be addressed to the Hon. Secretary, Mr. E. W. Turner.

Its journal, *HERMES*, is published four times a year and is free to all members.

Introducing

HERMES

F. H. G. BEST

HERMES is represented as a young man; but he was one of the elder gods, having mighty power over human life and thought. His father was Zeus, the king of the gods, and (under his Roman name of Jupiter) the greatest of the planets. His mother was Maia the titaness, the daughter of Atlas: she is one of the stars of the Pleiades. Hermes is called 'Ready helper', 'Giver of good things', for he was anciently a god of the Earth, causing grain and fruits to grow abundantly. But in Homer his character has already changed: since he was so closely associated with the mysterious realm below the earth, it is he who conducts the dead to the shadowy kingdom of the underworld at the behest of the gods. Then, by a natural association, he becomes the messenger of the gods. In this capacity he was regarded as the protector of roads and travellers. Hence he becomes the lord of traders and merchants, and his elusiveness and adroitness are frequent themes in ancient literature. But he had nobler attributes than these: he was also the god of eloquence, learning, and wit. In later art, he appears as a young man, wearing the broad-brimmed hat of a traveller, shod with the winged sandals of a messenger, and bearing his staff of office, the caduceus, a rod entwined with two serpents.

In the grand and obscure Egyptian mythology, Hermes was *Thoth*, the ibis-headed scribe of the gods, who records with his palette and reed-pen all the wise judgments of the gods. When the departed soul is weighed in the balance of Truth, it is Thoth who writes the unerring result. In later heiroglyphic, Thoth is given the name and title of *Hermes Trismegistus*—"The thrice-greatest Hermes." To him was attributed the authorship of a vast number of ancient works—Iamblichus numbers them in myriads—which included treatises on alchemy, astronomy and geography, among many others. Some of these survive in a fragmentary form. I hope Hermes was their author, but perhaps it is doubtful. In the middle ages, Hermes Trismegistus was regarded as the mysterious origin of all magic, alchemy and astrology, and *Hermes* was literally a name to conjure with.

The Romans called Hermes *Mercury*. Mercury was originally an Italian god of merchandise and trade, just as Hermes was. In the early days of Rome, there were frequent failures of the crops, owing to the fact that the Romans were fighting to extend their power instead of cultivating their farms. The worship of the Greek Earth-god Hermes was therefore introduced into Rome, in the hope that he

(*Continued on p.2*)

VOLUME 8 NUMBER 1 OCTOBER 1960

EDITORIAL

Gilbert E. Satterthwaite

AT LAST—the first issue of *Hermes;* the first issue of the new-look Journal I have been aiming at ever since I became your Editor more than three years ago. In my very first Editorial I spoke of my hopes of an improved Journal, both in appearance and content, but pointed out that owing to our limited funds this would inevitably take time. I hope that you have been satisfied with our progress in the last three years (you have had, throughout this period, an average of more than twice the number of words per issue than were possible previously). This is the second change of format, and I hope that we can now rest, satisfied with the present design, and concentrate on getting more and better articles. Both of these depend to some extent on you—if you write *useful* and *accurate* articles *well*, then they will be published, and if you encourage your friends to join us we shall devote much of the added income to improving the Journal.

Despite its new title our Journal remains the publication of the J.A.S., of course, and hence the volume numbering is continued. The July issue, however, completes Volume 7, so that we can both start a new volume with the first issue ot *Hermes* and avoid the overlapping of each volume into the next session that we have always had hitherto.

We have long felt that our Journal would benefit from a change of name, and I hope that the new title will soon become a personality to all of you. Our new President has contributed a fine introduction to *Hermes* to which I can add nothing, save to say a very sincere thank you to our new printers, to Miss ANGELA PIERCY for a great deal of labour in the production of our excellent new cover, to my Assistant, PAUL MURDIN, and the Advertisement Manager, JOHN LYTHEER, for all their hard work, and to the other Officers and Council for their support throughout this period of development; without them, *Hermes* would never have been possible.

Introducing Hermes *(continued)*

might think fit to provide more abundant crops. But as Hermes was also the god of trade, he was quickly associated with the Roman Mercury, who took on all his attributes. In later literature they are regarded as one god.

We have called our revitalised Journal *Hermes* for several reasons. We may think of Hermes, under his alternative name of Mercury, as the swift-footed and elusive messenger of the gods, twinkling slyly in the twilight as he hurries from side to side of the Sun. But it is the messages of the gods that he bears, and we

(Continued on p.9)

Great Astronomers of the Past — I

Caroline Herschel

ROSSIE ATWELL

Much has been written of two members of the great Herschel family—Sir William and Sir John—but less is known of Sir William's sister Caroline; in this article her life and work are recounted, and using her as a supreme example the authoress ends with a spirited challenge to us—the ladies in particular, one feels—to follow in Caroline Herschel's distinguished footsteps.

CAROLINE HERSCHEL was born in March, 1750, in Hanover. Her origin was quite humble. She was born into a poor family, her father, ISAAC HERSCHEL, being a musician in the Hanoverian Guards; he earned barely enough to provide for his wife ANNA and their growing family. It was a large family, six children surviving into adulthood. Caroline was educated at the Garrison school, the best that could be afforded, but their intelligent and understanding father helped and encouraged the children in the study of science and philosophy. In fact, it was probably he who first sowed the seeds of an interest in astronomy, for Caroline has recorded that her father took her into the street on a clear, frosty night to show her some of the constellations.

All the children except SOPHIA, the elder sister, inherited considerable musical ability from their father, and as they grew up and left school William and his elder brother JACOB obtained musical posts with the Guards and when hostilities began and the regiment was posted abroad the three Herschels—Isaac, Jacob and William—went with them. However, a military career was not the choice of the two brothers, and eventually they left the service and in 1757 came to England. They were practically penniless and for the first year or so were hard pressed to make a living. In 1759 Jacob was offered a position in the Court Orchestra at home in Hanover, so William was left on his own in England. He was not the type, however, to feel lonely and desperate; he obtained various musical posts in different parts of the country and established himself as a very accomplished and versatile performer, and to a lesser extent as a composer. In 1766 he settled in Bath and took up the post of organist at the then New Octagon Chapel.

Bath was a very fashionable place in those days with its gay winter-season concerts, balls and the theatre, and William, besides being organist at the Chapel, had many concert engagements. He also taught a number of private pupils, so in one way and another he was doing quite well. But this is intended to be the story of Caroline—so what had been happening to her meanwhile?

In 1767 Isaac Herschel died. Caroline had been very devoted to her father and was very like him in temperament and intelligence. The next five years for her were something of a miserable existence. The family being very poor, Caroline rapidly became little more than an unpaid servant. Being both intelligent and accomplished she longed to make something of her life; she yearned for independence and the right to lead her own lfie. It has been said of her that had she lived a century later she would probably have been a suffragette, for although she was a frail-looking little thing—she was only a little over five feet tall and of slight build—she was made of tough stuff and full of fortitude and determination. At home, however, she led a rather Cinderella-like existence, being overworked and not appreciated. She was clever with her needle and wanted to take lessons in dressmaking, but she was allowed to do so only on condition that she made clothes for her brother Jacob. Her mother had no patience at all with her thirst for knowledge, and refused to let her take lessons in French; Anna Herschel held the narrow-minded view that a woman's place was in the scullery, and there poor Caroline spent most of her time. Fortunately, however, this Cinderella was eventually rescued by her Prince Charming, in the shape of her brother William,

William was distressed when he heard of his sister's life at home, and having heard that she had a fine soprano voice he decided to bring her to England to have her trained as a singer. At this news she was, of course, overjoyed. Here was a chance of independence at last, and she would be with her favourite and dearly loved brother William—the only one of her brothers who had ever been really kind to her. But there was great opposition at home. Her mother was horrified and brother Jacob very annoyed at the thought of losing the family slave. William, however, was not so easily beaten; he agreed to pay the family a yearly sum to provide a servant to take Caroline's place. He then went to Hanover to fetch her. Their journey to England was not exactly uneventful; the channel crossing was very rough, the boat ran into severe storms, lost her mainmast and finally entered port almost a wreck. Then, as they were on their way to London by stage coach, the horse took fright and overturned the coach and Caroline was tipped into a ditch ! Fortunately she escaped with only bruises. After eleven days journeying they arrived in Bath a little the worse for wear!

Caroline was not allowed much holiday before commencing her studies, and she was soon having lessons in English and arithmetic from William and two, and sometimes three, singing lessons a day. Besides this she also had to learn the intricacies of English housekeeping, cooking and shopping; thus her life in Bath left her with even less free time than she had had in Hanover, but with the difference that her labours in Bath were those of love, and she was with her beloved William. At first, of course, she suffered a great deal from homesickness and loneliness, as William was so busy himself that she saw him only at mealtimes; however her occupations kept her busy and she made good progress with her singing—in time she was getting engagements to sing solo parts in oratorios, such as Handel's *Messiah*. It is possible that had she been less devoted to her brother and continued her musical career she might have achieved considerable renown. As it was, her brother's scientific interests were developing rapidly, so she became more and more involved in his work and finally sacrificed her own interests entirely to become William's devoted assistant.

It is interesting to note that William's latent interest in astronomy began to blossom forth from the time of his sister's arrival in England. Caroline records that they would discuss astronomical matters and he would take her out and teach her to find her way among the constellations. I would like to suggest that Caroline was the main source of inspiration that finally set him on his astronomical career.

William was deeply interested in optics and began to construct his own telescope. By this time he had been joined in Bath by his brother ALEXANDER who was mechanically minded, and soon the two brothers had the entire household turned into a workshop grinding and polishing speculum mirrors. Caroline did not, at first, take too kindly to this domestic upheaval and all the resultant mess, but she soon found herself pressed into service and eventually became as keen a worker as her brothers. William never spared himself and once spent sixteen hours non-stop finishing off a mirror, and Caroline was obliged to feed him by putting the food into his mouth herself. She often read to him whilst he was working in this way. She also became his secretary and spent many hours copying documents for him. When William was busy observing she was always at hand to record the details, or make coffee or do any other thing he required; on many an occasion she stayed up all night and in her own words "undertook with pleasure what others might have thought a hardship".

In 1781 William discovered the planet URANUS, and this event, coupled with the fact that William was acquiring quite a reputation as an instrument maker, marked the decline of the musical careers of both William and Caroline. In 1782 they moved to Datchet, near Windsor, and having received Royal Patronage, William was enabled to devote all his time to astronomy. The money he received from this Patronage was only about half his earnings as a musician, but ne was able to supplement his income by the sale of the telescopes he made. Also Caroline received a grant of fifty pounds per annum as his assistant.

Caroline is said to have been horrified when she first saw their new home at Datchet, for it was a ruin of a place and overgrown with weeds. She also had servant trouble, for the girl they had engaged ended up in prison! Caroline never got on very well with servants, she always distrusted them.

Now that William was freed from his musical commitments he was able to devote a great deal of time to observing, with Caroline always his faithful assistant. They worked as a team, William at the telescope and Caroline at a nearby table recording his observations and the times; she would sometimes spend the rest of the night copying and classifying the results. It was at about this point in her life that Caroline began observing herself; she was given a small refractor and began to sweep the skies for comets. She eventually became so good at this that she achieved considerable success—ending with eight cometary discoveries to her credit.

It was at Datchet that William made one of his finest instruments, the 20-ft. telescope; he was so impatient to use it that he started to do so before it had been properly mounted. Caroline warned him that it was unsafe to use, and then herself became a casualty. The telescope was supported in some way by a couple of large hooks, and in the dark Caroline fell and impaled herself on one of them. However even this did not lessen her enthusiasm. It was very damp where they lived and William began to suffer from ague, so they moved again—first to Old Windsor and then to their final home, *Observatory House* at Slough. The stable buildings were converted into a residence for Caroline and were afterwards known as *Observatory Cottage*. There was a flat roof available where she was able to set up her telescope and continue her comet-seeking. It was here that she made her first discovery, while her brother was away visiting the family in Hanover. He had written to her, teasing her and asking her if she had found any comets, and by a happy chance she had!

William and Caroline became the friends of a Mr. and Mrs. Pitt who lived near Slough. John Pitt was an invalid and died in 1786, and William began to take an increased interest in Mary Pitt and two years later they were married. Apparently Mary was a charming person, kind-hearted and well-liked, but at first poor Caroline resented most bitterly this intrusion into the household. She adored her brother and her whole life was built around him; she had given up her music for him and now found herself displaced in his affections; she moved into lodgings on her own. Caroline was however too intelligent to remain embittered for long; she grew to love Mary and they eventually became great friends and William and Caroline became a working team once more, for many years making valuable contributions to the study of astronomy. At last William's health broke down and he died in 1822, aged 83. Caroline, of course, was broken-hearted, and as her own health was not too good at that time she thought that she would not long outlive him; she resolved to return to her native Hanover. She could not bear the thought of life in England without William, her whole purpose in life seemed to have gone. But she was a tough little character, about twelve years younger than her brother, and although 72 when she left England she was to live for another 25 years.

In Hanover she found herself in a land of strangers and suffered much from loneliness; she often wished she had never left England. However, she was not the type to sit and brood over things, so she began the enormous task of cataloguing all William's discovered nebulae and clusters. When the work was completed she sent it to her nephew, John Herschel, who found it invaluable; although never published it earned for Caroline, in 1828, the Gold Medal of the Royal Astronomical Society. In 1835 she was elected an Honorary Member of the R.A.S., a great honour as in those days full membership was open only to men. In 1838 she was made a member of the Royal Irish Academy, and in 1846 the King of Prussia awarded her the Gold Medal of Science.

She died at last in 1848, two months before her 98th birthday; she was lively in mind and body to the last.

And so ends the story of a great lady of science; I'm sure her story can be an inspiration to us all, both men and women. We can't all be Caroline Herschels—but we can have a jolly good try!

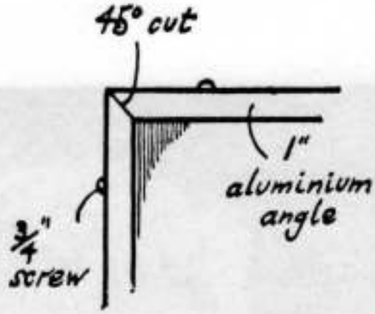
45° cut
1" aluminium angle
3/4" screw

Fig. I.

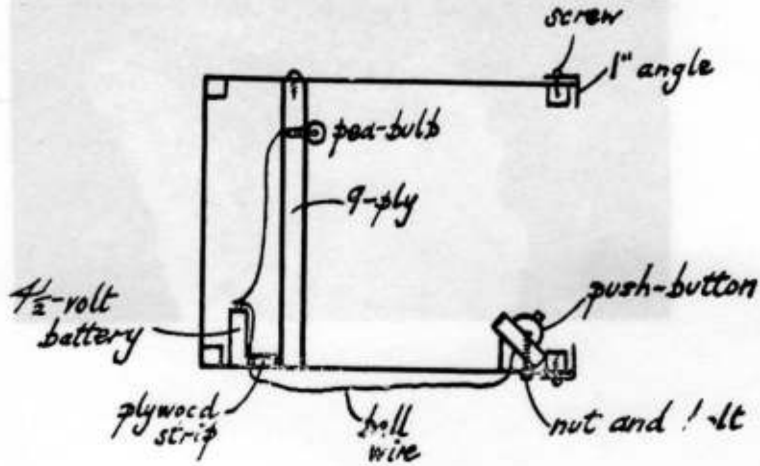
screw
1" angle
pea-bulb
9-ply
4½-volt battery
push-button
plywood strip
bell wire
nut and bolt

Fig. 2.

Astronomy Models

ALAN HEMMINGS
Clifton College, Bristol

The models to be described in this and the next few issues of* Hermes *are all of permanent value and were made by boys of Clifton College Preparatory School Astronomy Club, the oldest being thirteen years and the youngest ten.

THREE clean, sound, tea-chests—each measuring $16 \times 16 \times 20$ in.—will be needed. Clean out every bit of paper and tea, withdraw superfluous nails, remove the metal strips round the mouth of the chest but leave all the other corner-strips, and glasspaper inside and out. Give the outside one or two coats of dark varnish stain.

To make the front edges neat, cut four lengths of one-inch aluminium angle to fit, making them a little longer than you would think necessary. Saw from the end of each a $45°$ triangle so that the corners fit flush (see Fig. 1). Three $\frac{1}{2}$-in. round-head brass screws fix each to the front. Holes to take the screws will first be drilled so that they go through the sides of the tea-chest (now to be referred to as a box), not the front edge. Wire wool will remove scratches from the metal and give a good finish.

I. A MODEL OF THE GLOBULAR STAR CLUSTER IN HERCULES, MESSIER 13

Give the inside of a box thus prepared one or two coats of matt black paint. On one outside wall place the point of a compass 6 in. from the back and 8 in. from the top edge. Now draw six concentric rings, making the radius successively about $\frac{3}{4}$ in. longer. With a fine bradawl make a hole at the central point, then 12 to 14 equally-spaced on each of the rings. Reproduce exactly this pattern of holes on the opposite wall of the box.

Obtain about 250 beads of diameter 3 to 4 tenths of an inch. These may be of any material coloured white. Suitable wooden beads can be supplied by Dryad Handicrafts of Northgates, Leicester. Thread them on to a string, hang them up, and give them one or two coats of white enamel or luminous paint, taking care that they do not touch each other. Next cut as many pieces of matchstick, each a little shorter than the length of the hole through the bead. Now you will need one or two reels of strong black thread. From the inside, pass the end of a two-yards-long thread through the hole nearest the back of the box. Tie the outside end round a short piece of wire so that it will not slip through again. Attach a needle to the free end.

From now on the star cluster begins to take shape. Thread on two of the stars and wedge them with a piece of matchstick each. Now put the needle through the opposite hole, and back into the box through the next hole. Thread on two or three more stars. Continue in this way, keeping the thread taut as you go, and working always from the back outwards. Don't complete each ring in turn or very soon you will be shut out. Join on more pieces of thread as needed, trying to make the knots come outside the box. When the last hole has been used, secure the end of the thread, stand back and survey your work. The skill lies in distributing the stars through three dimensions so that the cluster is densest at the centre.

A neat label for the model can be made on one of those lettering machines found on railway stations. Tack the label to the wooden frame inside the front of the box. The model is more effective in a darkened room. Fix a battery behind the box, a push-button on a block of wood mounted at 45° just behind the label, and a torch bulb behind the block, connect them all, and you can make the stars glow dramatically.

2. A PUSH-BUTTON CONSTELLATION MODEL

Prepare a box as for the previous model to the point of giving the inside one or two coats of matt black paint. Decide which three constellations the model is to show, say, the Plough, Cassiopeia and Orion. Take a piece of paper 16 × 12 in. and on it, using a star map and pencil, make dots to represent the Plough. Enlarge the scale so that it measures about 9½ in. from end to end. Next transfer the other two constellations to the paper. Cassiopeia will be about 5 in. long and Orion, from *Betelgeuse* to *Rigel*, will be 8 in. Distribute the dots well over the paper, at the same time jumbling them up so that it is difficult to tell which belongs to which constellation. Transfer the dots to a piece of 9-ply wood of the same size as the paper.

Select the side of the box to be the base of the model and on it, inside, 2½ in. from the back, tack a strip of plywood measuring 11 × 11 in. (any thickness). Now wedge the large piece of plywood vertically and centrally into the box so that its base is against the strip of plywood. It may need to be made slightly shorter, but there should be a tight fit. A ¾-in. brass screw driven through the top of the box into the edge of the 9-ply will secure it.

Buy 20 pea-bulbs with holders (and a few spares) from a hobbies shop. Take out the large piece of wood and drill a hole where each of the dots is so that the bulb-holder will fit firmly into it. Before fitting the bulbs, give the wood one or two coats of matt black paint.

The easiest way of attaching the bell-push wire (a different colour for each constellation, preferably) to a bulb is to splay out the strands of wire and wedge them between the bulb and the holder, having previously threaded the end of the other wire through the hole at the bottom of the holder and turned a very small length of it through 90° so that the bulb will eventually wedge it securely. Ensure that the two wires do not touch each other.

Obtain three neat circular bell-pushes—a different colour for each if you like, and screw them to a piece of deal (painted black) measuring 11 × 2½ × ½ in. Drill small holes to pass the wires through the deal and through the base of the box. Fix the deal to the base at an angle of 45° by means of two wedges of wood and two long thin bolts (see Fig. 2). Remember that screws as well as nails are liable to split the wood unless holes have first been drilled to take them, although it is easy to make the holes too wide and too deep so that the screw has too little to grip on. If the latter happens, it is usually possible to plug the hole with a bit of matchstick. Another useful tip is to put the various pieces of wood into position before drilling holes and fixing them. In this way it is often possible to foresee and prevent a mistake which would have cost time, material and patience. Name-plates in metal can be tacked above the push-buttons. Make the three all of the same length by leaving spaces at the beginning and end of the shorter words.

Pass the wires under the box to the back and up through more holes in the base to a $4\frac{1}{2}$-volt bell battery standing between the strip and the back, and complete each constellation circuit.

Carefully fix in the board carrying the bulbs and the model is ready. The effect is best in a darkened room.

3. A ROCKET-LAUNCHING SITE

No astronomer nowadays can afford to be scornful of rocketry. A third tea-chest can be made to house a realistic model of a launching site. Instead of painting the inside black, use a grey undercoat. The inside walls can then be painted with a representation of a lunar or terrestrial landscape.

A simple gantry of wire can be fitted into holes in a square of wood which is in turn fixed by a screw to the base of the box. Another block of wood, suitably painted, represents a block-house, and a third piece has fixed to it a splendidly coloured rocket made of balsa wood and equipped with metal fins. A piece of wire can be pushed into the nose-cone and some white string between gantry and rocket is the fuelling pipe. Fill the spaces between the blocks with liquid plaster. This dries very quickly and can be painted with white or green powder colour to give a very realistic appearance.

Variations and refinements will suggest themselves for this and other models. An ingenious model-maker could arrange three lighting systems—(i) daytime (two or three bulbs hidden at the top of the box); (ii) fuelling at night (a pea-bulb at the top of the gantry and one in the block-house); and (iii) Blast Off (a red bulb at the base of the rocket).

Introducing Hermes *(continued)*

may hope that our Journal *Hermes* may also bring messages of wisdom which will give pleasure and profit to all of us. Most of all, perhaps, we may think of Hermes Trismegistus, the master who recorded all wisdom and learning in his treatises. We cannot hope to emulate him, but we may hope that our *Hermes* will be able to impart to its readers more and more knowledge of the most noble and sublime of the sciences.

Earth Satellite Observations

R. D. EBERST

Since the advent of artificial satellites, only three years ago, some fifty objects have been placed in orbit around the Earth. Many of these are visible to the naked eye, and several more can be seen with the aid of instruments such as binoculars or elbow telescopes. If these satellites are accurately tracked, deductions can be made about the shape of the Earth and its gravitational and magnetic fields, from the orbital characteristics of the satellites and the signals they transmit.

In order to give scientific research stations a position for a satellite at any given time, it is necessary for the satellites to be tracked using high accuracy optical instruments. For these instruments to find the satellite (i.e., to know when and where to look), it is necessary to have predictions of the expected paths of satellites near the observing stations. These predictions are based on visual observations which the amateur is capable of making.

Having received predictions, the observer should choose a transit suitable for tracking the object. His main considerations are that the sky is dark enough, and the satellite is not eclipsed by the Earth's shadow. The predictions should enable him to plot the points on the Earth directly beneath the satellite. If he measures the distance between his observing station and the sub-satellite point, he can, by using the predicted heights of the satellite, calculate the elevation for that particular point. Repeating this procedure for several points along the track, will enable the observer to plot these positions on a planisphere, preferably one marked in bearing (azimuth) and elevation (altitude). The expected apparent path through the stars can be found, especially noting close approaches to stars and star-groups.

If the observer uses binoculars or a small telescope, two methods of finding the satellite may be used:

(i) Scanning backwards and forwards along the expected track until the satellite is sighted. This method has the disadvantage that, unless one is very well acquainted with the constellations, one can easily be unable to identify the stars or even wander off the track altogether.

(ii) The second method is to pick one well known group of stars, which is along the expected path and to wait at that position until the satellite enters the field of view. This method has the disadvantage that, if the satellite is only visible for short periods and has long invisible periods interposed, the satellite may pass across the chosen field below the threshold of visibility. Also, if predictions are at all inaccurate, the satellite may be adove or below the expected track and not enter the field of view.

Let us assume, however, that the satellite has been found. The observer has to make a note of its precise position at a measured time (in G.M.T.). For timing, a stop-watch should be used in conjunction with time signals. Radio enthusiasts can use WWV or MSF or the six pips broadcast by the B.B.C., the last pip being the operative one. The Post Office's 'speaking clock' service (dial TIM) is also useful. Note should be made of the time that the stop-watch is started.

The satellite is followed until it passes near known, or identifiable, stars. Three types of observation are typified by the following examples:

(i) $\frac{1}{4}$ of the way from π to ρ Persei.
(ii) $1\frac{1}{2}°$ vertically above (or below) δ Leonis.
(iii) Occulted ζ Lyrae.

In the case of the third type mentioned above, the R.A. and Dec. are identical with those of the star which suffers the occultation. In the first case, the R.A. and Dec. can be obtained by consulting a good star atlas.

As an example, a transit of Sputnik IV is described:

Date: June 1st, 1960. Latitude of observer: 51° 29′ 21″ N.
Longitude of observer: 00° 33′ 56″ W.

The two stop-watches were started at 00 h 18 m 00 s (using MSF). The sky was scanned for some five minutes before the expected time of transit, in case the satellite should come earlier than expected.

The satellite was picked up near γ Coronae Borealis. It passed into Ursa Major, the first observation of the satellite being made when it was $\frac{1}{2}°$ vertically above 56 Ursae Majoris. (It was recognised as 56 UMa because of its proximity to Ψ Ursae Majoris). The stop-watch was stopped at the instant of the satellite obtaining that position. The satellite was followed along the track and it was obvious that it was going to pass between two 5th magnitude stars near β Ursae Majoris. (These stars were later identified from the star atlas as 37 and 36 UMa).

The second stop-watch was stopped as the satellite was on the line joining the two stars, and it was estimated that it was 2/5ths of the way from 36 to 37 UMa .

Returning to the observatory, the stop-watch times were noted and written down:

(i) 00 h 07 m 11·8 s; (ii) 00 h 07 m 29·3 s.

The second stop-watch is known to gain 0·8 seconds per hour. Therefore a correction of —0·1 seconds is added and the actual times of observations noted:

	h m s		h m s
(i)	00 07 11·8	(ii)	00 07 29·3
	00 18 00·0		00 18 00·0
			—00·1
	00 52 11·8 G.M.T.		00 25 29·2 G.M.T.

The right ascension and declination of the observations are measured from the star

(*Continued on p.13*)

The Cepheid Revolution

E. A. BEET

This article is a sequel to that by F. E. Richardson, which appeared in The Junior Astronomer, *Vol. 7, Nos. 2/3. It describes the application of the period–luminosity law to the determination of stellar distances using Cepheid variables, and describes the circumstances that led, in 1952, to a doubling of the inter-galactic distances previously accepted.*

IN THE July number of *The Junior Astronomer* you will have read about Cepheid variables and will now be familiar with the 'period–luminosity law'. In that article it was pointed out that if the observer of the lamps knew that his first set were at a distance of one mile he would be able to estimate the distance of any other. The astronomer's equivalent of the candle-power or wattage of the lamp is the *absolute magnitude*, the magnitude that a star would have if it were at a distance of ten parsecs. Now the first set of Cepheids, in the Lesser Magellanic Cloud, were in the magnitude range 13–18 and the law related these magnitudes to the periods of variability. Unfortunately, unlike the electric lamps, their distance was not known. Known Cepheids are too far away to permit the direct measurement of distance by trigonometrical methods, but SHAPLEY was able to use a group, in a moving cluster, of which he found the distance by an indirect method based on what can be called the 'average behaviour' of stars. Now stars, like people, differ among themselves, and any particular star or group may not be average specimens. If you propose to insure your life the insurance company will look up your 'expectation of life' based on average behaviour, and this number is made from the statistics of a very great number of people; for statistical 'average behaviour' a very large number of specimens must be used if the result is to be safely valid. Shapley found that by comparing his cluster with the Magellanic group used for the period–luminosity law an 18th magnitude star in the latter had an absolute magnitude of just over 0, so that a scale of absolute magnitudes could be written into the law. Unfortunately his measured group was not a very large number, only about a dozen in fact, so an element of uncertainty existed. Shapley hoped that his probable error did not exceed a quarter of a magnitude, though some of his contemporaries considered it to be as great as a magnitude and a half.

Once this zero point had been fixed an astronomer, on finding a Cepheid, was able to measure its period, look up the corresponding absolute magnitude, and by comparing this with its observed mean magnitude estimate its distance. In 1918 Shapley applied this method to Cepheids that he had found in 69 globular clusters, and this research led ultimately to our knowledge that the diameter of the Galaxy is about 100,000 light-years. Shortly afterwards Cepheids were found in the spiral arms of the Andromeda nebula, and applying the law and Shapley's zero to these enabled HUBBLE in 1924 to show that the nebula was extra-galactic at about 900,000 light-years; later values were slightly less, 750,000. This was the basis of our knowledge of extra-galactic distances in general.

Now the variables in the globular clusters have short periods; they are commonly called cluster variables and belong to what is now known as Population II. The Andromeda specimens have longer periods; these are classical Cepheids and belong to Population I. It was known that the nebula contained globular clusters, and when the 200-in. telescope was completed BAADE expected to be able to detect Cepheids in these also. He couldn't; they were still too faint. "The very first exposure on M 31 showed at once that something was wrong." The classical Cepheids were brighter by one and half magnitudes, and therefore twice as distant as had been thought. Distances depending on the cluster Cepheids still hold, our Galaxy is still 100,000 light-years in diameter, but all extra-galactic objects are twice as far and twice as large as their previously accepted values. The 'revolution' was in 1952; thus the distances of the other galaxies as quoted in books written since that date are double those shown in older works.

Earth Satellite Observations (*continued*)

atlas. Estimates of stellar magnitude may be included.

(i) R.A.: 11h 22m; Dec.: 44·3°N.; Mag.: 2·0;
(ii) R.A.: 10h 29·5m; Dec.: 56·8°N.; Mag.: 2·5;

Satellite	*Popular Names*	*Maximum Magnitude*
1959 Epsilon 2	Discoverer V Capsule	+6
1959 Iota 1	Explorer VII	+7
1960 Beta 1	Tiros I Rocket	+5
1960 Beta 2	Tiros I Satellite	+6
1960 Gamma 1	Transit 1B Rocket	+2
1960 Gamma 2	Transit 1B Satellite	+6
1960 Epsilon 2	Sputnik IV Satellite	+2
1960 Epsilon 3	Sputnik IV Cabin	+2
1960 Eta 1	Greb	+8 estimated
1960 Eta 2	Transit IIA Satellite	+7 estimated
1960 Eta 3	Transit IIA Rocket	+4

Acknowledgement is made to Miss M. Davis who edited and advised on this article, and to the Director of the Radio Research Station who gave permission for this article to be written.

Some Other Worlds

STEWART ROBERTSON

Our Sun is surrounded by a retinue of nine major worlds and thousands of smaller ones called asteroids or planetoids. But other worlds have been believed to exist in the Solar System, or believed to be going round another star. A few of them are discussed in this article.

THE FIRST of these bodies was named *Vulcan*, after the God of Fire. It was first observed by a doctor who saw it as a spot crossing the Sun's disc. Other people claimed to have seen it as well. It was said to have a 'year' of 13 weeks and be only 13 million miles from the Sun. Its existence has been dismissed because of the lack of evidence. If it did exist, its surface would be molten, making life impossible. Vulcan would be a dead world.

A planet with the lovely name of *Clarion* was supposed to exist between Mars and Jupiter. Someone said that its inhabitants had come for him in a Flying Saucer (at this time the sky was full of them!) and taken him to their world. Unfortunately the planet Clarion has never been seen by a reputable astronomer!

The search for a trans-Plutonian planet continues. PICKERING noticed that several comets had their aphelia (points of their orbits furthest from the Sun) near the four major planets Jupiter, Saturn, Uranus and Neptune. He also saw that about sixteen known comets had their aphelia about 7,000 million miles from the Sun and he said that it indicated the presence of an unknown body which he named 'Planet P'. He worked out its orbit and maintained that it was larger than either Uranus or Neptune. He later published a paper about Planet P and in it wrote:

"When I first recognised its importance from its comets, I mentally reserved for it the name *Pluto*, as the son of Saturn and the brother of Jupiter and Neptune, but unfortunately that small object named Pluto came round and perturbed Neptune 10 years before the leisurely 'P' arrived and perturbed Uranus and so received the name. Pluto should be renamed *Loki*, the God of Thieves. A suitable name for 'P' will be difficult to find when that planet is discovered."

In 1942 K. A. STRAND at the Swarthmore College in Pennsylvania found peculiarities in the orbit of the double star 61 Cygni which indicated the presence of a third body. Strand himself calculated the size of this body 'C' and estimated its mass as 15–16 times that of Jupiter. This is far too low for a star, so it is considered to be a planet. 70 Ophiuchi is also said to have a planet.

Project Ozma

ROY C. LEES

In this article the new American programme for applying the latest techniques of radio astronomy to listening for intelligent signals from sources outside the solar system is described, and some of the author's speculations on its probable results are recorded.

EVER since Man has realized that the Earth is not the only world in the Universe he has longed to know the answer to one big question: is there intelligent life elsewhere in the Universe? It now seems that we may learn the answer, thanks to two scientists, F. DRAKE and W. WALTMAN, who with the aid of the 85-foot radio telescope at the National Radio Astronomy Observatory, Green Bank, West Virginia, U.S.A., are making what the U.S. National Science Foundation describes as "mankind's first systematic search for signals from intelligent beings on other planets".

This search has been named 'Project Ozma', after the queen of the mythical land of Oz, a place described as "very far away, difficult to reach and populated by strange and exotic beings", but to Drake and his team of seven it is known as 'Project Little Green Men'.

Dr. Drake, who is 29, has been trying to establish contact with beings on other worlds for five years now, but it was only last year that the American Government finally caught up with his enthusiasm and gave him ten million dollars with which to run Project Ozma. It was just before dawn on Wednesday, April 6 this year that Dr. Drake first turned the 85-foot radio telescope towards the heavens to listen for signs of intelligent life on planets circling two stars, ϵ Eridani and τ Ceti, each roughly about 11 light-years distant. It was the work of OTTO STRUVE, a generation ago, that made Drake choose these stars for the first in his search, for Struve, through his optical telescopic observations, was the first to discover that single stars rotate. It was noticed that the rotation period varied with different types of stars and that the Sun is a star of the slower rotating type. Struve theorized that the slow rotation of the Sun is due to the planets of the Solar System taking up the rotational speed of the Sun. He also reasoned that the other stars with rotation periods similar to the Sun must possess systems of planets too.

The two nearest stars with rotation periods similar to the Sun are, as I have said, ϵ Eridani and τ Ceti. Epsilon Eridani is a star with a *K 2* spectrum 10·8 light-years away; its apparent visual magnitude is 3·8 while its absolute magnitude is 6·2 and its luminosity is 0·25 (the Sun's being 1·0). Tau Ceti is a star with a *G 4* spectrum (like that of our own Sun which is classified as *Go*); it is 11·8 light-years distant from the Solar System and has an apparent visual magnitude of 3·6; its absolute magnitude is 5·8 and its luminosity is 0·36. If Drake and his team d not get any signals from these two particular stars, they will try others, perhaps th stars 61 Cygni and 70 Ophiuchi, as these two are also believed to possess planet 61 Cygni is a binary system and the two components, A and B, revolve aroun their common centre of mass in about 700 years. In 1944 K. A. STRAND (Sweden announced that the smaller of the two stars, 61 Cygni B, was "wobbling in its orbit around the common centre of mass. The mass of the disturbing bod was calculated and it worked out to be about 15 times as heavy as Jupiter. Th planet detected circling around the star 70 Ophiuchi has been found to be onl 12 times as heavy as Jupiter. Both of these planets are probably cold, dark worl possibly with poisonous atmospheres of methane, hydrogen and ammonia, like th giant planets of our own Solar System. It is quite likely that they are membe of planetary systems themselves. If they are it is quite possible that one or tw planets in the systems are pleasantly Earth-like!

Drake intends not only to listen for radio signals but also to send out some c his own. He will be sending out the simple mathematical question: what is two plu two, but he may have to wait 22 years for the answer as both τ Ceti and ϵ Eridan are about 11 light-years away. However, this does not necessarily mean tha Drake will not receive any signals from these two stars in the immediate future: fo if either of these stars does possess planets and if any of these planets are the home of beings with intelligence as great as ours or greater, then they must have notice the sudden upsurge of terrestrial radio broadcasts about eleven years after the became powerful enough and of the right frequency to be noticed outside th Earth's atmosphere, which was in 1938. Now 1938 plus 11 is 1949 and this is th year our alien friends will have first become aware that intelligent beings inhabit a planet circling the star we call 'Sun'. If either of these two distant population acted immediately upon detecting our radio transmissions and sent a signal o message straight back to us, then we ought to pick up their signal eleven years afte 1949, which is 1960—this year!

Dr. Drake intends to listen for and to send radio signals on the 21 centimeter wave length as this is the wavelength emitted by hydrogen atoms and any intelligent beings ought to know this wavelength as there is so much hydrogen in the Universe. In later years, when we have radio telescopes outside the Earth's atmosphere, it will be better to use radio waves of long wavelength which normally are reflected by the underside of the ionosphere. Any intelligent beings in the Universe will immediately recognize them as being artificially produced, although unless these beings have space travel they will never receive our signals due to the fact that the signals will be reflected off the upper side of the alien's Heavyside Layer.

Now we ask ourselves, what will the aliens look like? Some scientists think that they will be quite human in appearance, maybe with a few small differences in height, build and colour of skin. On the other hand however there are the scientists who believe that our alien friends will be anything but human. Among this group of scientists is the Nobel Prize winning geneticist HERMANN J. MULLER, who believes that some of the forms alien beings might take are: (a) upright two-legged animals with heavy tails and two arms, like kangaroos; (b) multi-legged creatures with tentacles like elephant's trunks, and (c) animals with six legs

(*Continued on p.*17)

The Faint Star in the Plough

PATRICK MOORE

EVERYONE is familiar with the Plough. Its seven stars form one of the most striking patterns in the sky; the rest of the constellation in which it lies, Ursa Major (the Great Bear) is much less prominent.

Of the seven Plough stars, six are of about the second magnitude. The seventh, *Megrez* (δ Ursae Majoris) is ranked as 3·4, so that it is much fainter; the difference is obvious at the most casual glance. It is rather surprising, then, that the old astronomers such as Ptolemy stated that *Megrez* was as bright as its companions.

We do not have to rely only on Ptolemy's word; other observers of olden times agreed with him, and on the whole there seems little doubt that *Megrez* has faded by a magnitude or so during the last 1,000 or 2,000 years. This does not mean that it is dying out; more probably it is a variable star of a particular kind. Even now it is suspected of fluctuations in light, and it is worth watching.

Other "secular variables"—stars which have brightened or faded in recorded times—are known. It was originally said, for instance, that Castor was brighter than Pollux. Nowadays Pollux is the brighter by nearly half a magnitude, and it seems that Castor has diminished. The same is true of *Acamar* (θ Eridani), a southern star never visible in Britain, which has dropped from the first magnitude to the third; *Denebola* (δ Leonis) has also decreased. On the other hand *Alhena* in Gemini, not far from *Castor* and *Pollux*, seems to have brightened up from the third magnitude to above the second.

We do not know the reason for these long-term variations, but stars which have behaved in this way are of great interest. Perhaps the full reason will be discovered some day.

Project Ozma (*Contiued*)

and two arms. Whatever shape the aliens may be, most scientists think that they will be oxygen-breathing life forms, but this need not necessarily be so. Our own plants "breathe" carbon dioxide and it is quite feasible that there are intelligent beings elsewhere in the Universe, who are more like plants than animals, for on our own world there are several microscopic species of plants which live in water and can swim around freely just as well as their microscopic animal neighbours. Some of our alien friends may be totally aquatic. They may still breathe oxygen, not direct from the air like ourselves, but out of the water by means of gills like fish, and there may be some types of aliens who breathe chlorine or fluorine instead of oxygen. It is also possible that there are alien life forms based on the element silicon instead of carbon, like ourselves.

It may be centuries before we learn if there are intelligent beings elsewhere in space, but it is just possible that we will know within the next few years. Unfortunately nothing is being done in Britain towards contacting alien civilizations, at Jodrell Bank or anywhere else; but in America Dr. Drake has been promised a new 140-foot radio telescope by the government to help extend his researches even further, for the new radio telescope will be able to detect signals coming from up to 50 light-years away.

SOCIETY & GROUP ACTIVITIES

THE BIRMINGHAM GROUP

The Birmingham Group has, since its founding in 1959, proceeded to flourish in spite of the many difficulties confronting it. The Inaugural Meeting was held in January this year, and from the half-dozen who attended, the membership has grown to over a dozen. Meetings have been held at regular (if long) intervals, and although we have as yet had no distinguished visitors as have other Groups, some interesting debates and lectures have been organised by various members.

The Group offers several publications: the most notable is the magazine *Project:Stars*, appearing quarterly and costing 9d. per copy. This contains astronomical articles and papers of all kinds and from various sources, sky diaries, planet and Moon predictions, telescope hints, notes and news, and is edited by myself. We also issue monthly Circulars and periodic Reports.

We have no funds as such, but any costs are taken from the slight profit made by the sale of the magazine. In this way, we intend to equip the Group with some valuable and useful telescopic gear. (That is at least what we hope It can only be achieved by an increased circulation of *Project: Stars* so anyone wishing to assist the Group can do so, and benefit himself at the same time, by subscribing to the magazine!)

By far the most important advance is the formation of observing sections and the Group Committee. In the days B.C. (Before Committee!) the Group was run by the Leader, myself, but as the burden of various duties increased, it was decided to form a Committee, consisting of the Directors of the four observing sections, i.e. Solar Section, Moon and Planet Section, Stellar Section and Space Section. My capacity now is that of Secretary, and Editor.

All observing is controlled by the aforementioned Section Directors, as in the B.A.A. (that's where we got the idea, in fact). A few members contribute serious work, but the majority observe just for fun. Telescopes range from 2-in. refractors to my own 10-in. reflector, and one enthusiast is building an 8-in. Schmidt camera; there are also oddments like meteor and wide-field satellite cameras, solar projectors, and so on. The Group H.Q. is my own private observatory, where the 10-in. and other apparatus are housed; observing sessions are arranged from time to time. We hope to organise a meteor expedition in the future and would be glad of assistance from other groups with similar ideas.

If my name has appeared overmuch in this report, it is not of my choosing; the fact is that in a small group like ours, there is no point in having a preponderance of officials, since one man can do a great deal of the work by himself. Mention must be made of my chief helper, Anthony White, who has contributed much to our Group and its work.

Thus we may summarise: our Group is small, but it just manages to keep its head above water; we would always welcome guests both to our meetings and to headquarters, in "splendid isolation". In conclusion, we must thank Mr.

(*continued on page* 20)

RECOMMENDED BOOKS

THE AMATEUR ASTRONOMER, by PATRICK MOORE. Lutterworth Press, London; 3rd and revised edn., 1960. 317 pages, 16 plates. Price 25s.

ALL books on science rapidly date as new discoveries are made and results from current research become known. It is therefore pleasing to find that Patrick Moore has not allowed those portions of his book which have been subject to changes since the second edition appeared in 1958 to detract from the mass of more stable and reference information therein. In this third edition he includes up-to-date facts and data and discards that no longer of use. A few very minor discrepancies have crept in chiefly where during revision a word or figure has been amended since the last edition but the reference to it has not.

The chapter dealing with the moon is amended to mention features recorded by Lunik III and the outbreak of activity inside the crater Alphonsus reported by KOZYREV in 1958. Attention is drawn to this crater in place of Alpetragius in the list of objects of interest in the S.E. quadrant map. A chart of the other side of the moon is produced, but it would have enhanced the book further had it been possible to include also a copy of the actual photograph taken by the rocket.

The illustrations remain unchanged except for a correction to the title of plate XIV. Certain planetary, stellar and other data has in some cases been amended and extended, and Appendices IV (elongations of the inferior planets), V (oppositions of planets) and IX (forthcoming eclipses), are extended to the year 1970. The Bibliography contains some additional references for further reading.

These and a number of other small amendments appear to bring the work completely up-to-date and it is heartening to find that this attractive book, so rich in information, is still available at its original low price of twenty-five shillings.

There can be no greater surprise nor treasured gift which one could present to an amateur astronomer than a copy of this excellent book—except perhaps a telescope to go with it!

E. W. T.

TRUE BOOK ABOUT THE MOON, by H. P. WILKINS. Muller, London, 1960. 141 pages. Price 8s. 6d.

DR. H. P. WILKINS, well known to all members of the J.A.S., completed his last book about the Moon only a few weeks before he died last January. It is included in the *True Book* series published by Frederick Muller Ltd., and is excellent value.

Starting from the very beginning, Dr. Wilkins describes the various features of the Moon, giving hints on how to observe them; he describes the "other side" as photographed from Lunik III; he deals with possible changes on the Moon, and ends with a section about space-travel.

The book is entertaining as well as being informative, and the illustrations, by Patricia Cullen, are good. This book may be whole-heartedly recommended as an introduction to lunar study.

P. A. M.

SOVIET MOON ROCKETS (Soviet Booklet No. 62) *Soviet Booklets*, (London, 1960.) Price 1s. 3d.

THIS 66-page booklet gives a concise report on the flight and achievements of the Lunik II and Lunik III space rockets. Problems of launching, guidance and tracking, and the results obtained by the rockets, are clearly described, and in the appendix Professor PETROVICH discusses some of the problems of the future exploration of the moon, in particular by automatic rocket observatories.

The report on Lunik III and the prospects of the new branch of astronomy now opened by it makes fascinating reading and will stimulate the imagination.

The booklet contains a great deal of interesting information which cannot be obtained so cheaply in any other way. There are 10 explanatory diagrams and 27 photographs, two being of the other side of the moon.

E. W. T.

Report of the BIRMINGHAM GROUP *(continued)*

PATRICK MOORE, Mr. J. LYTHEER, Mr. E. W. TURNER and Mr. PAUL MURDIN, for whose advice and encouragement we are eternally grateful.

One more word: there must be many J.A.S. members living in or near Birmingham whom I have not contacted. Anyone residing in the Midlands wishing to join the Group should not hesitate to write to me. We need more support and YOU are the people to give it.

MICHAEL D. PHIPPS

SOCIETY NOTICES

THE JUNIOR ASTRONOMICAL SOCIETY