HERMES

JOURNAL OF THE JUNIOR ASTRONOMICAL SOCIETY

VOLUME 8 NUMBER 4 JULY 1961

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PRICE TO NON-MEMBERS OF THE J.A.S. : 2s. 6d.

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Comment

SINCE THE INVENTION of the telescope the Moon has been under constant scrutiny. Early Lunar maps were rather crude by present standards but through years of patient work a fairly comprehensive, though by no means complete, record of the Moon's surface features has been built up. Recently the camera has helped Selenography enormously. Two natural factors, however, still tend to hinder the production of really accurate fine-detail maps. The Moon's libration and the continuously moving angle of Solar illumination combine to make interpretation of the ever-changing shadows of small features very difficult.

Lunar observers are always excited by the possibilities of seeing a meteoric impact or recording some change in surface detail. The lone observer, witnessing an unusual occurrence or distinguishing, for a fleeting moment, some tiny unmapped detail, might well assume an optical effect and fail to record the event. On the other hand, a planned programme carried out by a number of enthusiasts, might achieve useful results if their observations were pooled. There are, of course, many possible plans. One might concentrate entirely on a fairly large area like the Mare Crisium. Or one could take a number of individual craters and learn to know them so well that anything unusual would be quickly spotted. Whatever the plan, it would call for careful thought and plenty of work. Mr. R. E. Ellis, of Eastbourne, who suggests the formation of a J.A.S. Lunar Section, has produced a practical scheme which offers plenty of scope for keen observers. You will find his suggestions, which give you the chance to show that the J.A.S. can produce co-operative results, outlined in this issue.

The number of Group Journals now in vigorous circulation increases rapidly. The latest to reach me—*Albedo*—comes from the Glamorgan and Monmouthshire Group. Colin Reeves and local members are to be congratulated on producing an interesting and informative publication. Incidentally, I would like to receive copies of *all* Group Journals so that I can keep track of what is going on.

Speaking of tracks, I understand that Jimmy Kent recently observed the passages of no less than six artificial satellites and associated hardware, within a period of twenty-six hours. Is this a record?

Members of "Operation Airglow" expedition to Skye will be busy making final preparations. I wish them a successful trip, good observing weather, interesting results, and plenty of fun.

Keen types intending to observe the near total Lunar eclipse on August 26 may like to know that my diary indicates that this will be during a Friday/ Saturday night. Times are given on page 65.

John Lytheer.

The Algol System

A. J. A. Raw

PERHAPS ONE of the most interesting and indeed unusual objects to be seen in the sky during the winter months is the eclipsing binary Algol or Beta Persei. The first man to observe the curious behaviour of this star was an Italian mathematician by the name of MONTANARI in 1669. He was, however, unable to explain the peculiar change in brightness of this star and it was left to a young astronomer, GOODRICKE, to solve its mystery.

Goodricke was born a deaf-mute in 1764 and by the age of sixteen had developed a keen interest in astronomy. It was not long before he made his discovery. Observing Algol one autumn evening he noticed that something peculiar was happening to it—it was fading slowly from its usual magnitude of about 2.3. Several hours later it had dropped to magnitude 3.5, then brightened slowly again to 2.3. This puzzled Goodricke, but the next year he published a paper stating his theory. He suggested that Algol was composed of two stars, one dimmer than the other, and that the dimmer one periodically eclipsed the brighter.

This hypothesis was generally accepted in official circles, but it remained speculative until 1889 when H. C. VOGEL demonstrated its truth. Using a spectroscope, measurements of the velocity in the line of sight were made and it was shown that the bright star was travelling round an orbit in the period named. Therefore another invisible mass must be controlling its motion. Also the minimum brightness is reached when the bright one is furthest from us, thus is hidden by its dark companion.

When speaking of a dark companion in eclipsing variables we often mean a star of about half the luminosity of the brighter. In this system, however, the companion is exceptionally dark and is believed to give out about a tenth of the light of the brighter one. However, when compared with our sun, Algol B (fainter one) is only just less luminous, A being many times brighter.

It has been suggested that Algol was known to the ancients as a variable on account of its name, which means "The Demon". Also mythology says that it marks the severed head of the Gorgon, which is borne across the sky by Perseus, so it appears that Algol was considered an evil star. Scholars are inclined to disagree with this nowadays and to say that the ancients were unaware of its variability.

It is not difficult to find Algol in the winter sky. I propose to give two methods:

1.—Draw an imaginary line across the heavens from Saiph (Kappa Orionis); through Aldebaran (Alpha Tauri), and it will pass near Algol. The angular distance from Saiph to Aldebaran roughly equals that from Aldebaran to Algol.

2.—If Saiph is in mist (as it frequently is) use a line through Gamma and Delta Cassiopeiae which will pass near Alpha Persei and from this find Algol.

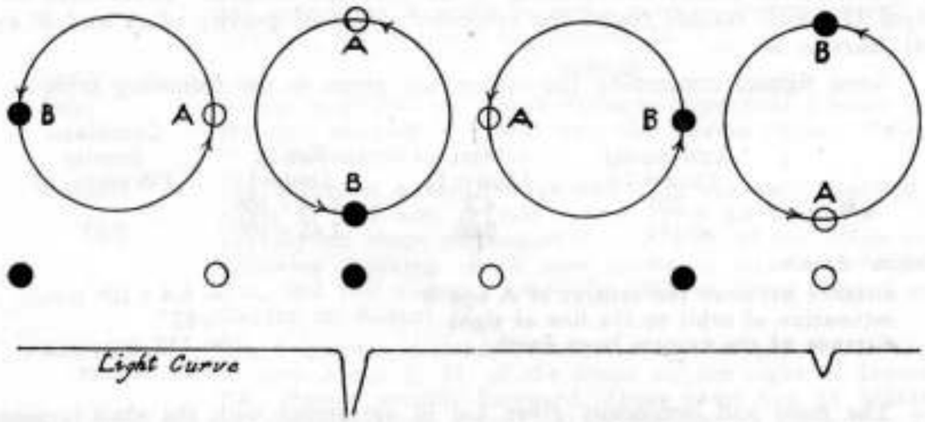
At maximum it is equal in brightness to Gamma Andromedae, and remains like this for 2 days 11 hours, then it drops to minimum in only 5 hours, its light then equalling that of Epsilon Cassiopeiae. The cycle is then repeated, Algol taking the same time to return to maximum.

HERSCHEL was next to tackle Algol finding that he could not split in with his telescopes; this is not surprising as modern work has shown the stars to be only 6,000,000 miles apart.

The system is very complex indeed, the brighter component having a surface temperature of 12,000° K, and a diameter of 2,140,000 miles, the other being larger (diameter 2,450,000 miles) but dimmer. The difference in their spectra is also interesting—Algol A being of B8, and the other of a later type —K or M.

Stars of the B spectrum are bluish-white and have surface temperatures ranging from 25,000° K to 11,000° K. Algol A is as stated 12,000° K, and so is low down the list as a "B" star (B8). They are commonly known as helium stars for the obvious reason. Hydrogen is also prominent. The K class (which Algol B is thought to belong to) is composed of orange stars with temperatures ranging from 3,000° K to 6,000° K. Metallic lines are strong at the lower end of the scale, and hydrogen lines get weaker as the temperature level drops.

Here another interesting point arises, how can the radius of Algol be measured? The answer was given by McLAUGHLIN's ingenious method. Near the middle of the eclipse only a crescent of the bright star is showing; this will be on one side of the star just before mid-phase and on the other after it. Now the rotation of the star causes one side to approach us and one to recede. Thus if we make measurements of the star's radial velocity at mid-eclipse, when it is moving across the line of sight, we can determine the speed of rotation. The period of rotation equals the period of revolution since the two components are so close together that tidal force between them probably holds the same faces permanently opposite to each other. Multiplying the period by the rotational speed gives the circumference of the star and hence its radius.



A pair of binary stars in circular orbit. Relative sizes and luminosities. distance apart , orbital eccentricity and inclination of orbit to line of sight, can all affect period and magnitude variation.

From all this it is simple to see the reason for the light fluctuations. Starting at maximum, the stars are side by side. B (the fainter) passes in front of A eclipsing it, thus cutting off most of the light (mag 3.5). B passes on and they are again side by side. A now eclipses B and the result is a diminution in magnitude of about 0.05. The cycle is then repeated.

The second decrease of 0.05 is naturally impossible to detect without accurate instruments. The eclipse is only partial, the angle of inclination of orbit being about 82°.

From the diagram shown, it can be seen that there is a time lag when no eclipse is taking place, and the system shines with its maximum light. The calculation of these intervals is complicated by two important phenomena:—

(i) *Reflection Effect*

It is obvious that the systems in which the two stars are nearest together will have the best chance of showing eclipses, because the orbit does not have to be so precisely tilted to suit the position of our Earth in space. The close type of eclipsing binaries are often separated by no more than their own diameter. They are bound to illuminate each other, and so the hemispheres which are face to face will shine more brilliantly than the other sides. This difference is quite a considerable one, and so will, on moving round in orbit exhibit variations in brightness akin to the phases of our moon. Because of this, the end of the main eclipse is followed by a gradual brightening of the system until the second eclipse begins and the light fades slightly.

(ii) *The Ellipsoidal Effect*

Because of the proximity of these two stars to each other, enormous gravitational effects surround them, and so the shape of the stars will be distorted. Thus in addition to the variation of light due to eclipse and the Reflection Effect, there will be a variation which will depend on the aspect of the elongated objects. The apparent sections are smallest when we see them end on at the time of eclipse. Halfway between eclipses we see prolate spheroids broadside on, and they are consequently brighter.

To complicate the system still further, Algol A and B revolve together around another more distant companion Algol C, one revolution every 1.9 years. This satellite has never been seen but is believed to be at a distance of about 270,000,000 miles from Algol, with a luminosity of about a twelfth of the former, and of course has nothing to do with the eclipses. There may be an Algol D which rotates round the common centre of gravity of A and B every 200 years or so.

Some figures concerning the system are given in the following table:

	Luminosity (Sun=1)	Mass (Sun=1)	Radius (miles)	Combined density (Water=1)
A	200	4.3	2.14×10^6	
B	10	0.86	2.45×10^6	0.07

Orbital details:

distance between the centres of A and B	$= 6.4 \times 10^6$ miles
inclination of orbit to the line of sight	$= 82°$
distance of the system from Earth	= 115 light-years = 34 parsecs.

The mass and luminosity given are in agreement with the mass-luminosity relation which these stars seem to obey. Also the B.8 types usually have a luminosity in this region. The relation was found by EDDINGTON in 1924. He found that if the absolute magnitude of a star is plotted against the logarithm of the mass the points are found to lie in a smooth curve, increasing luminosity corresponding to increasing mass. For example a star of absolute magnitude of -2.5 has about twelve times the mass of the sun; and one of magnitude 0.0 four times that of the sun (Sun's absolute magnitude is 4.8). This relationship is independent of spectrum or temperature of the star. Two stars of the same luminosity but of different spectra have roughly equal masses. The observed masses differ from those read from the curve by about 20 per cent on average.

About 800 eclipsing binaries have been discovered to date and so Algol is by no means unique in that respect, for example Delta Librae is similar; but of all these Algol is best known to amateurs and was first to be discovered.

Great Astronomers of the Past—III

Nicholaus Copernicus

B. R. H. Tombleson

NICHOLAUS COPERNICUS was born at Torun on the banks of the Vistula in Poland on the 19th February, 1473, at 4.48 o'clock in the afternoon. So we are told by two contemporary astronomers (and astronomers are noted for accuracy) but caution suggests that we add to the statement "plus or minus a month or two".

The world into which he was born was a world of great men and great extremes. It was the commencement of a whole new era, and yet, any deviation from the teachings of Aristole was still likely to be rewarded with death at the stake. As to the science of Astronomy at this time, the authorities were still Aristotle and Ptolemy. In fact the science had hardly changed for 2,000 years.

Aristotle had lived from 384 to 322 B.C. He was a pupil of Plato, who, at 40, became tutor to Alexander the Great. His works, on a wide variety of subjects, have come down to us mainly through translation from Greek to Arabic and from Arabic into Latin, no doubt losing much in the process. Aristotle held that the Earth was the centre of the universe, and was stationary, with the sun, planets and stars revolving around it. His influence in Europe was inconsiderable until about the twelfth century A.D., but by the fifteenth century his ideas were regarded as the only authentic summary of the sciences. He was so comprehensive a genius that he became almost an idol in the middle ages. This was unfortunate for astronomy, since little progress could be made until the idol was overthrown. Copernicus was to take an important part in removing him from his pedestal.

Ptolemy of Alexandria lived during the first half of the second century A.D. His great work on astronomy, the Almagest (literally the Greatest) sets forth the theory that the sun and stars revolve around the spherical Earth which is stationary, and that the other planets revolve around the sun. The Almagest includes a history of astronomy and a catalogue of about a thousand stars. Ptolemy was a compiler rather than an original observer; his work sums up the Greek's knowledge of astronomy and is virtually our only source of the early history of this subject. It is important to remember that the Greeks considered certain geometrical forms more "perfect" than others. The circle was the most perfect of all and as the heavens were also regarded as perfect, no motion other than circular motion was considered possible. This belief was held until the time of Kepler and even Copernicus based all his theories on circular motions for all heavenly bodies.

We do not know what school Copernicus attended in his youth. He lost his father when he was 10 years old. At 19 he entered the University of Cracow. There he probably lived in the building where most of the university's astronomical documents were stored. The Church favoured the study of astronomy and mathematics; they were needed for the more exact determination of Church holidays for at that time the calendar was badly astray. Astronomy was also needed by sea-farers for their increasingly bold voyages and by the general public for astrological predictions.

In the summer of 1496 Copernicus left Cracow and travelled to Italy where he continued his studies at Bologna under Maria di Novara, a pupil of Regiomontanus. Novara was a splendid observing astronomer and Copernicus quickly learned to master both the mathematical calculations and the discipline of careful observation. At this period all astronomers were astrologers and Novara earned his living in the same way. Copernicus, by casting out the Earth from the centre of the universe and turning the sun from a planet into a star theoretically exterminated astrology.

When Copernicus was 24 years of age, in 1497, he was made a canon at Frauenberg. In those days, and particularly in that district, canons were not only well paid but had sovereign rights and jurisdiction over everything. Every new canon who did not already possess a degree, was required after one year in residence to go for three years to a university with his income assured. Copernicus duly entered a college at Bologna where he studied law without any great distinction. But before his three years' study leave expired he was in Rome lecturing on mathematics and carrying out astronomical observations. On its expiry, in 1500, he did not hurry back but returned without undue haste the following year to Frauenberg without his degree. He was granted two years further leave to study medicine. During the following years he took various degrees and returned home at the age of 33 with a very thorough education—in mathematics, astronomy, canon law, medicine and the humanities.

Back in Poland, Copernicus went to the episcopal castle at Heilsberg, ten miles from Frauenberg, as Bishop Watzelrode's personal physician. In fact he became his secretary, protege, companion and councillor, escort and assistant, private scientist, medical adviser, and potential successor. For the next six years he had ample time to study politics and pursue his astronomical studies. Then in 1512 Bishop Watzelrode died and soon afterwards Copernicus went to Frauenberg where he was to spend the remaining 30 years of his life.

It was probably in 1506 that Copernicus began to develop and write down his astronomical system. In his Commentariolus, thought to have been produced in 1509, he sketched out for a few scientific friends, the lines on which astronomy could be improved. The work does not cite any of his own observations of star positions but seems to have been based on the Alphonsine Tables, which had been compiled very many years earlier. It is certain, however, that he was well aware of inaccuracies in the Tables for he had discovered a number himself. In the Commentaries he sums up his ideas in seven propositions:—

1. There is no one centre of all the celestial circles and spheres.
2. The centre of the Earth is not the centre of the universe, but only of gravity and of the Lunar sphere.
3. All the spheres revolve round the sun as their mid-point, and therefore the sun is the centre of the universe.
4. The ratio of the Earth's distance from the sun to the height of the firmament is so much smaller than the ratio of the Earth's radius to its distance from the sun that the distance from the Earth to the sun is imperceptible in comparison with the height of the firmament.
5. Whatever motion appears in the firmament arises not from any motion of the firmament but from the Earth's motion. The Earth performs a complete rotation on its fixed poles in a daily motion while the firmament and the highest heavens remain unchanged.
6. What appears to us as motions of the sun arise not from its motion but from the motion of the Earth with which we revolve about the sun like any other planet. The Earth has then more than one motion.
7. The apparent retrograde and direct motion of the planets arises not from their motion but from the Earth's. The motion of the Earth alone, therefore, suffices to explain so many inequalities in the heavens.

Copernicus then goes on to describe the order of the spheres, the apparent motion of the sun, the motions of the moon, those of the "upper" three planets, Mars, Saturn and Jupiter, those of Venus and, finally, those of Mercury.

At that time, scientific papers were circulated in manuscript among learned friends. If Copernicus expected applause for his new ideas he was disappointed. The work was received in stony silence.

In 1515 he was invited by the Pope to assist in reforming the calendar. Copernicus realised the inadequacy of knowledge as to the exact length of the year and declined the invitation but immediately started a series of observations of the sun to determine the declination of the ecliptic and the length of the (apparent) solar orbit. Instruments of astronomy were very elementary and most of his work was probably done with a sundial and a triquetrum made by himself. The triquetrum was a wooden wicket, marked with ink and fixed to a post in such away that it could be turned like the leaf of a folding door. After his death this instrument passed to Tycho Brahe who expressed astonishment that Copernicus could have produced such accurate results with it. He also had an astrolabe made for him after the specification of Ptolemy.

The following 20 years of Copernicus's life are quite well documented. During that time he not only continued his observations but rose to be an important man of public affairs. He was always very fit and even at the age of 69, a ripe old age in those days, he undertook a long and arduous journey to Prussia.

In July 1539, there arrived at Frauenberg a young professor of mathematics of the University of Wittenberg named Rheticus. He came uninvited and without introduction for he had heard of Copernicus and wished to study the new theory and meet its author for himself. Because of trends in the political and religious affairs at that time Copernicus ran a certain risk in receiving and talking to Rheticus. Immediately on arrival, Rheticus plunged into the study of the theory with all the fiery zeal of youth. For ten weeks he studied the text and questioned his teacher. When he thought that he had grasped most of the details he published an account of the theory. This account created something of a sensation and pressure was now exerted on Copernicus by his friends to publish his work on the planetary theory and submit it to the judgment of the learned.

All his life Copernicus had observed, studied, checked and re-checked his results, and had never been quite ready to publish them. Now, when nearly 70 years old he yielded to the pressure. A draft was prepared for the printer (probably by Rheticus) and in the early spring of 1541 the work was ready for printing.

The first edition is in six books and comprises 203 pages, 196 of which are Copernicus' text. A preface of six pages includes a dedication to Pope Paul III and the famous (or infamous) Ossiander preface. Ossiander had been entrusted by Rheticus with the final preparation of the book. Although he knew that Copernicus regarded hypotheses as the foundations of science and considered his own hypothesis to be correct and necessary, yet Ossiander's preface contrived to make it appear that he only put it forward as one of many possible explanations of the observed facts. The preface is not signed and for a long time most readers thought that Copernicus himself had written it. It was Kepler who discovered that Ossiander was the author and branded him as a fraud.

When Copernicus saw the galley proof of the preface he became violently angry; this brought on a hemorrhage and was followed by paralysis of the right side. At the beginning of 1543 the end was near. Copernicus died on 24th May, 1543. On that day, the first printed copy of his book was handed to him on his deathbed.

Copernicus was a great man, a gentle man, a man of wide culture and interests. As philosopher and mathematician he was outstanding, and he was a patient and accurate observer; but he was not a great observer; the poor quality of his instruments, the fog and mists of his Baltic home, and his many public activities prevented that. It is difficult for us to realise the immense mental and physical courage needed in that age to propound theories so directly opposed to the teachings of the great Aristotle and the Church of Rome. His scientific caution is shown by the thirty-six years he allowed himself to perfect and publish his work; his diplomatic tact is evidenced by his dedication of his work to the Pope.

A Lunar Section For The J.A.S.

R. E. Ellis

Most of you with telescopes will, of course, have given the Moon a good look over at some time or another. Some of you I know take more than just an occasional glance and sketch some of the features visible at the eyepiece. A number of you belong to groups and, of course, you are able to take your sketches along and compare them with those drawn by your friends. Some of you are isolated and your drawings, perhaps, get pasted into a scrapbook and no further steps taken because there is no centre to send them to.

The Lunar Section will enable all those members interested in our near neighbour in space to work together on a definite programme. The programme outlined very briefly below will, I hope, cater for a variety of interests concerning observations of the moon. Whether you possess a 2in. or a 10in. telescope or perhaps no telescope at all, there is a part of the programme in which you could take an active part.

In the limited space I have available, it is impossible to go into full details of each part of the programme, but a bulletin giving complete details will be sent to you if you write to me at the address given at the end of the article.

The programme is divided into five sections, each of a widely differing nature and covering a range of telescope sizes.

Section A—Distribution. This Section will play its part towards the wider research being carried out by members of the B.A.A. under the direction of Dr. Gilbert Fielder. It will entail the plotting of certain features onto basic outline charts of the Moon, the features being (i) bright craters under 12 miles diameter, (ii) ghost craters and (iii) dark spots such as those in *Alphonsus.* The charts will be supplied to members who would like to contribute to this section, one being required for each of the three sections. Any of this work could be done with a telescope of 2in. aperture.

Section B—Charting Limb Regions. For more experienced members or very keen juniors, and requiring an apperture greater than 3in. Again charts of certain regions will be supplied for plotting the features visible at the eyepiece. The importance of this section cannot be over emphasized.

Section C—Drawings of specific areas and craters. Outlines of certain formations of the Moon would be supplied and members would sketch in the details. The drawings would be collated and finished charts produced; if of sufficient standard and value these might be published together with the names of those who took part and notes on the formation for future reference.

Section D—Drawings of any formation. This section will cater for those who do not wish to take part in a set programme but would like to observe any feature they fancy. If you would send me your drawings together with notes of the observation, they would be filed and kept for collation with other drawings should any two or more members happen to observe the same formation. If possible individual work will be published in the proposed bulletin of the Section.

Section E—Written notes. Notes contributed by members, with or without drawings, for publication in the bulletin of the Section. This would cater for those who do not possess telescopes but still take an active interest, studying the Moon from photographs and books, who may possibly write an article on a lunar topic based on their studies.

I hope this very brief outline of the Lunar Project has given you sufficient information to arouse your interest. The results of any useful work accomplished by the section would be communicated to the B.A.A., who take an interest in all our activities.

The success of any venture depends on the number of members taking part and I hope that many of you will co-operate in some section of the programme. The value of working together cannot be over emphasized, and the knowledge that one is taking part in serious practical work is a great stimulus to anyone's interest in the study of astronomy.

As the number of individual drawings increases it should be possible to publish a list of drawings on file so that any members wishing to study any particular crater could obtain copies and notes for their own use. In fact the usefulness of the Section could be extended indefinitely as it becomes a central pool of information about the Moon.

If you are interested please write to me for the full details of the programme. My address is:—

R. E. Ellis, 1 Haystoun Close, Eastbourne, Sussex.

Ancient Summer Constellations

E. W. Turner

THE SKY now softly shines with the mellow stars of summer, parted by the gleaming band of the Milky Way. Antares, the principal star of the constellation Scorpio the Scorpion, flashes redly near the southwest. It is an enormous star with a diameter of 370 million miles. The meaning of its name is derived from its resemblance to the red planet Mars—Antares—the rival of Mars (Greek "ares"—Mars). The path of Mars around the sky brings it nearby to this star once every 1.8 years, and their similarity in colour is then very evident. The Arabians knew it as the Heart of the Scorpion, and the neighbouring constellation Sagittarius is shown as an Archer with arrow drawn and aimed at it. Antares was considered an important star, being one of the guardians of Heaven. Early Egyptian temples (7,000—5,000 B.C.) were orientated to its rising, also temples of the Grecian Empire (4,000—2,500 B.C.).

Scorpio is one of the few constellations bearing a direct resemblance to the object it represents. A curve of three bright stars with a number of fainter ones immersed in the Milky Way form its head and claws, Antares its heart, and a "hook" of stars (not visible in this country) outline its body which ends in two bright stars set close together representing its sting raised to strike. When seen from southern climes Scorpio outshines Orion. In its full glory Scorpio possessed the stars of the adjoining constellation to the west as claws, but lost them about 1 B.C. when they were taken to form Libra the Balance. Although the group has represented a crocodile and a serpent it was mostly as a scorpion that the ancient world knew. The early Greeks related how Orion died from its sting, and even now, in heavenly immortality, the Giant is wary of the Scorpion, keeping on the opposite side of the sky and setting just as his slayer rises! The Sorpion still uses its sting—to awaken the stargazer to the glorious and wonderful richness of the Milky Way in his direction where lies the central regions of our galaxy.

Above Scorpiô is the extensive constellation Ophiuchus the Serpent Bearer, with Serpens the Serpent writhing in his grip. Old charts show Ophiuchus with the serpent coiled about him in an equal everlasting struggle. Greek mythology describes Ophichus as Aesculapius, the first great physician and god of medicine, whose skill at surgery and healing could even restore the dead to life. Unfortunately this latter service much annoyed Pluto (the Ruler of the Underworld) who, worried at the decline in the population of Hades, persuaded Jupiter to kill Aesulapius by a thunderbolt and transport him to the heavens out of the way! As to how Ophiuchus became entangled with a serpent is not clear, but such creatures were often associated with him as symbols of wisdom and herbal healing. Ophiuchus was known some 2,000 B.C. and some believe the Serpent to be the star group referred to in the Book of Job—"By His Spirit He hath garnished the Heavens. His hand hath formed the crooked serpent". And the serpent is shown crooked, just where Ophiuchus grips his striking coils. The rest of the serpent is hard to follow near the south-west of the bearer where it twists into the Milky Way which appears in this region to be split into one. Although Ophiuchus is not one of the 12 zodiacal constellations, the sun actually spends 18½ days within its boundaries prior to moving into Sagittarius.

Some 4,000 years ago ancient India regarded the constellation Sagittarius the Archer as a symbol of war, the group being then depicted as a horse. Inscriptions on later Babylonian monuments describe it amongst other things as the King of War, but Grecian legend combines both horse and king into a Centaur (half man, half horse) with war-bow, and arrow drawn and aimed at the scorpion, which it slew in revenge for Orion's death. A number of legends hover around this ancient figure, one describing how the Centaur taught Hercules astronomy until one day Hercules was insulted by his tutor and promptly killed him! The constellation is prominent by the eight main stars forming two rough quadrilaterals, one in the Milky Way. The Arabians called the four latter stars the "Going Ostriches" and the group to their East, the "Returning Ostriches", the "going" ostriches drinking from the celestial river (Milky Way) and the "returning" ostriches coming away with their thirst quenched! Sagittarius is well seen in the early autumn, when with Aquila and Scutum it lies drenched in the Milky Way which streams down into the South-west like a shimmering path of luminous dust.

Also placed in the Milky Way is an historic constellation whose outline has been found engraved on an Euphratean uranographic stone dated circa 1,200 B.C.—Aquila the Eagle. Many lands recognised this group as an eagle, and it was stamped on coinage of ancient regimes along the Black Sea from early times to the Roman era. In the later times (circa 94 B.C.) the coinage presents Cancer on the obverse side, illustrating the rising of the crab upon the setting of the eagle, and vice versa. In Greek legend Aquila was the eagle which Jupiter kept for doing odd jobs, from striking people with his thunderbolts (it was the eagle who killed Ophiuchus on Jupiter's orders) to the abduction of youths from earth to render him domestic service in his great heavenly abode.

The sky in this area is rich in other creatures, Cygnus the Swan, Vulpecula the Fox, Equuleus the Little Horse, and Delphinus the Dolphin, to quote a few. A little diamond of stars with one as a "tail" outlines the Dolphin; a queer neighbour for the ferocious eagle, as it was regarded by the ancients as a symbol of peace and benevolence. To the Greeks Delphinus was the Sacred Fish which carried the famous musician Arion to safety on its back after a pirate crew had tried to murder him and steal his wealth.

A little to the north of the eagle is a faint and inconspicuous group of four stars—Sagitta the Arrow. This also lies in a pleasing area of the Milky Way, pointing Eastwards. In one story it represents the arrow with which Apollo slew the dreaded Cyclops. In another it is the arrow which killed Aquila. It was also known to the Persians, Hebrews, Arabians and Romans. When taken as pointing westwards it becomes the two-headed Roman war-arrow.

● trend

A review of new ideas in astronomy

A SOLUTION OF THE COSMOLOGICAL PROBLEM?

ONE of the easiest tests that can be applied to the Universe that we live in, to determine whether it is of the evolutionary type or in a steady state, is to find out the density of galaxies at different distances from us. This is equivalent to observing the density at different times in the past, since the light from the galaxies takes a time, in many cases millions of years, to reach us. If we find that the density of galaxies is constant, then the steady-state model is the right one; if the density increases with distance, i.e. past time, then the evolutionary model is correct (for a more complete explanation of this, see the article by J. Heywood in *The Junior Astronomer*, January 1959).

Up to now astronomers have not been able to see far enough into the past to determine conclusively whether or not the density does change. But with the discovery by radio astronomers of the discrete sources has come hope that the greater strength of the radio emission from such sources would enable astronomers to see over longer distances. This had already proved to be the case before RYLE and CLARKE published their paper recently in the *Monthly Notices* of the Royal Astronomical Society. They managed to extend the observational frontier even further, observing sources with their Cambridge radio telescope that are about six times as faint as those previously observable. And in their view:

> *These observations . . . appear to provide conclusive evidence against the steady-state model.*

Professor HOYLE is, however, modifying the basic assumptions of his steady-state theory, and at a recent meeting of the Royal Astronomical Society he claimed considerable success in making his model conform with the observations. But there is no doubt that the steady-state model, as it was originally conceived, is dead, and with it appears to have gone the beautiful simplicity that attracted so many adherents.

"An examination of the steady-state model in the light of some recent observations of radio sources" by M. Ryle and R. W. Clarke, *Monthly Notices*, 122, 349 (1961).

WATER ON VENUS

IN A recent paper BRIAN WARNER, well known for his work on Venus and the Moon and now preparing a doctor's thesis on astronomical spectroscopy at University College, London, has come down heavily in favour of the opinion that the clouds on Venus are made of water droplets. Reviewing the situation up to 1959, Warner says that it was then evident that the most probable substance forming the Cytherean clouds must be water.

But recently ROSS and MOORE, using a spectrograph and a 16-inch reflector attached to a 172-feet diameter balloon which flew them to a height of 80,000 feet, showed that there is probably a "considerable" quantity of water in the Cytherean atmosphere. Warner goes on to estimate this amount and finds a value of the order 10^{18} to 10^{20} grammes, about the same as on Earth (10^{19} grammes).

"The Clouds of Venus" by Brian Warner, *J. Brit. Astron. Ass.*, 71, 200 (1961).

Recommended Books

1001 QUESTIONS ANSWERED ABOUT ASTRONOMY, by JAMES S. PICKERING. Lutterworth Press, London, 1960. 420 pages. Price 17s. 6d.

DR. J. S. PICKERING, Assistant Astronomer at the famous Hayden Planetarium in America, has produced a book on new lines. It takes the form of various questions, such as "How do we know the temperature of a star?", to which answers are given. The idea is attractive, and the writing is clear and lucid. The illustrations, too, are very satisfactory. In short, the book is a distinct success, and is well worth buying.

P. A. M.

STRUCTURE OF THE MOON'S SURFACE, by GILBERT FIELDER, Pergamon Press, London, 1961. 263 pages. Price 50s.

SEVERAL BOOKS have been published recently in connection with the Moon, particularly notable is V. A. Firsoff's excellent *Surface of the Moon.* Yet this new volume, by Gilbert Fielder—Director of the Lunar Section of the British Astronomical Association, and an astronomer at London University—falls into a different category. It is technical, though much of it is understandable by the beginner, and it fills a very important gap in the literature.

Fielder deals with all aspects of the lunar surface, and also discusses associated problems, such as the existence or non-existence of an atmosphere. He writes clearly, and imparts a tremendous amount of information. There are extensive references, and the illustrations are good.

This is a book which should become a standard. Certainly it should be in the possession of every lunar student, and the author deserves warm congratulations. By writing it he has rendered astronomy a notable service.

P. A. M.

SKY DIARY and NOTES FOR OBSERVERS

July—October, 1961

by H. N. D. Wright

(All Times in G.M.T.)

THE MOON

Lunar Occultations at Convenient Hours (Magnitude 6.5 and brighter).

(R) = Reappearance (D) = Disappearance.

Date	Time	Star	Mag.	Moon's Age Days	Position Angle* degs.
Sept. 16	19h. 54.7m.	24 Scor. (D)	5.0	6.7	28
21	22h. 03.4m.	44 Cap. (D)	6.0	11.8	112
26	22h. 19.6m.	Xi^2 Cet (R)	4.3	16.8	220
28	23h. 43.0m.	Gamma Tau. (R)	3.9	18.9	285
Oct. 20	21h. 55.5m.	Chi Aqr. (D)	5.1	11.1	123

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

Two reappearances of fairly bright stars have been included in the list for those who may care to try this type of observation. **Aldebaran** is occulted by the Moon again in daylight on September 29th, but disappearance is at the bright limb. **Venus** is occulted shortly after sunrise on October 7th. The Moon is a slender crescent only $2\frac{1}{2}$ days before New at the time. Disappearance at the bright limb is at 06h. 31.0m., and reappearance at the dark limb 07h. 56.1m. Position Angles 104° and 298° respectively.

Near-Total Eclipse on August 26.

If skies are clear in the early hours of August 26th, this should be a spectacle worth staying up for. The eclipse begins at 1.35 a.m., with the umbra of Earth's shadow making contact at the Moon's N.E. limb. At mid-eclipse, which is at 3.08 a.m., over 99% of the lunar disk will be in shadow. The eclipse finishes at 4.41 a.m., only a little over 20 minutes before sunrise.

THE PLANETS

MERCURY

July: A close conjunction with the Moon takes place on July 11 at 6 a.m., Mercury being ½° N. of the Moon (1½ days from New at the time). The planet is occulted to observers in Central Africa and S. Asia on this occasion. Greatest Elongation West occurs on July 19, when Mercury is at an angle of 20° from the Sun, but rising only 1½ hours before sunrise. The planet remains visible (telescopically) in the morning sky for the remainder of the month.

August: May be found with some difficulty at the beginning of the month in the dawn sky, retiring into the daylight. On August 8, rising time is only 40mins. before the Sun. Superior Conjunction is on August 14, and the planet will not be observable for the remainder of the month.

September: Mercury will be moving toward a very unfavourable evening elongation during most of the month. Though it is at an angle of 26°, it will be difficult to find. At the most it sets only half an hour after the Sun, though those observers who can bring a telescope to bear at this low angle should watch the close approach to the star **Spica** on September 21. Mercury is by far the brighter of the two.

October: Will be visible in the sunset sky for only the first few days of the month, as it starts to move quickly toward Inferior Conjunction, which occurs on October 22.

VENUS

July: At the middle of the month Venus is rising fully 3 hours before the Sun, situated in Taurus near the **Hyades** cluster. Passes 3° N. of **Aldebaran** on July 16.

August: The planet is a conspicuous object in the early morning sky, rising at 1.15 a.m. in mid-August. Will be seen N.E. of the 25½ day-old Moon on August 7, and N.W. of the Moon on the following morning. It is now shrinking steadily in apparent size, and still shows a markedly gibbous phase. Venus enters Cancer on August 27.

September: The brightness is steady at magnitude −3.4, and the planet will be seen about 2° N. of the Moon on the night of September 7-8. Moving steadily Eastward, Venus enter Leo on September 13, and passes less than ½° N. of **Regulus** on September 22.

October: Venus is still rising almost 2½ hours before the Sun in mid-October. As noted in the list above, the planet is occulted by the Moon on October 7. The apparent diameter of Venus at this time has shrunk to a mere 12 secs. of arc.

MARS

July: Mars will be seen close to the 4-day old Moon on the evening of July 16. An occultation takes place on this occasion, but unfortunately about 4 hours after the Moon has set to British observers. The planet by this time has faded to a second magnitude object.

August: Now a second magnitude object, and still moving steadily Eastward on the star background in the evening sky. Enters the constellation of Virgo on August 5, and is in close conjunction with Beta Virginis on the 11th. The apparent diameter is now only about the same as that of Uranus (4 secs of arc). By the end of August Mars is setting only 1 hour after the Sun.

September: As an indication to the position of Mars, the Moon is 6° N.E. of the planet on the evening of September 12.

October: The so-called "red" planet continues to move into the daylight sky, and will be very difficult to find in October, setting only a half-hour after sunset at the middle of the month.

JUPITER AND SATURN

July: Jupiter is at opposition on July 25, just 5° S. of the star Beta Cap. Though still rather low, reaching only 18° altitude at culmination, the planet is conspicuous at magnitude −2.3.

Opposition of Saturn occurs on July 19, 6 days before Jupiter, as it is lying some 5 to 6° W. of the latter. Magnitude is +0.3, or about 1/16th the brightness of Jupiter on this occasion. The largest satellite, **Titan,** is at the Western extremity of its path as seen from Earth on July 4 and 20, and Eastern elongation on July 12 and 28. This is the best time to detect this object for those with small instruments.

August: These two giant planets are at their best for observation this year, being in the South at around 10 p.m. Their "best" only amounts to about 17° clear of the horizon, but the position is steadily improving. Both Earth and Sun are now close to the plane of Jupiter's equator and this enables mutual phenomena of the satellites to be observed. These commence on August 7, with an occultation of Satellite II by Satellite III. This takes place at 21h. 58m.

Titan, the largest satellite of Saturn, is at greatest angle W. of the planet on August 5 and 21, and E. on the 13th and 29th.

September: Both planets are still as well-placed as can be expected, situated near the Eastern boundary of the constellation of Sagittarius. On September 19, Saturn is setting a little before midnight and Jupiter a few minutes after midnight. The most convenient of the observable mutual phenomena of the Jovian satellites is as follows:

Sept. 19 Eclipse II by III 22h. 43m. — 23h. 06m.
(planet low in S.W.)
Sept. 25 Eclipse II by I 21. 16m. — 21h. 48m.
(planet 15° altitude in S.S.W.)
Sept. 26 Occultation II by III 21h. 16m.
Sept. 29 Occultation II by I 19h. 52m.
(planet 17° altitude in S.)

Jupiter "without" satellites

For 1½ hours on September 27, the four Galilean satellites of Jupiter are in such a position with respect to Earth, that the planet appears as a lone object, without the familiar bright star-like attendants East or West of it. At this time, J.I is occulted and eclipsed, J.II and III are in transit across the disk of Jupiter, and J.IV is in eclipse. This phenomenon commences at 16h. 0m., with J. IV disappearing into eclipse, and finishes at 17h. 30m., with J.III reappearing after transit to the West of the planet. J.I emerges from eclipse at 19h. 29m., and the eclipse of J.IV finishes at 20h. 40m. The shadow of J.III enters onto the disk at 18h. 52m., and the shadow of I.II will also be on the disk at this time. These "moon-less" occasions for Jupiter are very rare, so that although this occurs in daylight this time, those with access to fairly large telescopes should make the effort to see something, especially as the satellites

	reappear from their various "hidden positions", when darkness allows easier observation of these events. For Saturn, Eastern elongation of Titan occur on September 13 and 29, and Western elongations on September 5 and 21.
October:	Observation of Jupiter and Saturn will need to be carried out in the early evening, as the setting time is down to around 10 p.m. in October. Two occultations of one Jovian satellite by another are readily observable this month.
	October 24 Occultation II by I — 17h. 33m. (planet 17° altitude in S.)
	October 31 Occultation II by I — 20h. 06m. (planet low in S.W.)
	Greatest Eastern elongations of Saturn's satellite Titan occur on October 15 and 31, and Western elongations on October 7 and 23.

URANUS

July/August:	Will not be seen. Conjunction with the Sun on August 19.
September:	May be located in the Eastern sky shortly before dawn, rising time at the end of September being about 3½ hours before the Sun.
October:	Uranus will be particularly easy to find this month as it passes close to the first-magnitude star **Regulus.** At the beginning of the month, the planet is about ¾° N.W. of **Regulus.** On the 12th, Uranus passes less than ¼° N. of the star. By the end of October, the Eastward motion of the planet has carried it ¾° E. of **Regulus.** Uranus is then rising soon after midnight.

METEORS—the Perseid Shower

This meteor shower is normally at a maximum of activity on August 12th. As New Moon occurs on the 11th this year, these meteors should be particularly well seen. They are active from the end of July to the middle of August, and remember that the best time to observe is from 1 a.m. to 3 a.m. The normal radiant lies some 9° N.N.W. of Alpha Persei.

CONSTELLATIONS near the meridian at 10 p.m. at middle of each month.

July:	Draco (Head of); Lyra; Hercules; Corona Borealis; Serpens; Ophiuchus; Libra; Scorpio; Sagittarius.
August:	Cygnus; Lyra; Vulpecula; Sagitta; Delphinus; Aquila; Serpens Cauda; Sagittarius.
September:	Lacerta; Cygnus; Vulpecula; Sagitta; Delphinus; Pegasus (Western portion); Capricornus; Aquarius.
October:	Pegasus; Andrcmeda; Aquarius; Pisces; Cetus (Western portion).

ARTIFICIAL SATELLITE SAMOS 2 (1961 Alpha I).

THIS SATELLITE has been observed on several occasions by one of our keen-eyed members, Jim Kent. He reports it as of magnitude 2½-3 at maximum, and fading steadily as it moves North. Due to a peculiarity of its orbit, it is always visible at its best shortly after midnight, and always moving roughly South to North across the sky. Another interesting fact which Jim Kent has pointed out is that a particular passage repeats itself almost exactly after an interval of six days. So if the satellite is observed at any time, one knows that exactly six days hence, weather permittitng, the satellite will be seen at the same time, and in the same part of the sky. The steady fading effect is due to what is called "phase angle". As the satellite moves North, it is moving toward the Sun's position around midnight (below the Northern horizon), and therefore the illuminated area of the satellite gradually lessens from our view-point It is exactly similar, though on a smaller scale, to the steady drop in brightness of the Moon as it moves from Full to New. H. N. D. W.

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

Printed in Great Britain by THE HEATH PRESS LTD., Thornton Heath, Surrey
and Published by THE JUNIOR ASTRONOMICAL SOCIETY

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