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Memoirs.

SYDNEY SAMUEL HOUGH, M.A., F.R.S.,

H.M. Astronomer at the Cape of Good Hope.

1870-1923.

Mr. Sydney Samuel Hough was born at Stoke Newington, London, on the 11th June, 1870. From his earliest years he was noted for his mathematical ability, and on proceeding to Christ's Hospital School he highly distinguished himself, gaining, amongst other prizes, the Thompson Gold Medal for Mathematics in 1886, the Tyson Gold Medal for Mathematics and Astronomy in 1887, and an Open Foundation Scholarship at St. John's College, Cambridge, where he had a most distinguished career, graduating in 1892 as Third Wrangler. Among further University honours which fell to his share were: Smith's Prize in 1894; Isaac Newton Studentship and Fellow of St. John's College in 1895.

After taking his degree, Mr. Hough devoted himself largely to research work in astronomical subjects, *e.g.*, the question of variation of latitude. Under the guidance of Sir George Darwin he undertook a dynamical investigation which may be described as an extension of Laplace's work on the theory of the tides contained in the "Mécanique Céleste." He succeeded in obtaining a more complete solution of the problem of tides than had been previously obtained. He also assisted Sir George Darwin in his work on "Periodic Orbits."

In 1898 Mr. W. H. Finlay resigned his position as Chief Assistant at the Cape Observatory. In seeking a successor, Sir David Gill strongly urged upon the Admiralty the desirability of choosing a man who would ultimately succeed to the post of H.M. Astronomer. The choice fell upon Mr. Hough, and he arrived at the Cape on 25th October, 1898. He threw himself into the work of the Observatory with such earnestness, ability and interest that he rapidly acquired a familiarity with those departments of practical astronomy in which he had no previous experience. In 1900, and again in 1904, during Sir David Gill's absence in England, he was left in charge of the Observatory.

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On these occasions he showed such admirable administrative qualities that no doubts remained as to his fitness for the Directorship of the Observatory. Consequently, on Sir David's retirement on 19th February, 1907, Mr. Hough was appointed his successor on the following day, and Sir David was able to write that he was confident that he was leaving the Observatory in good hands.

Mr. Hough succeeded to the directorship of a splendidly equipped Observatory. Following the traditions of the Observatory, he always considered that amongst his manifold duties, the most important was the improvement of star places and the problems connected therewith. With this end in view the new Reversible Transit Circle, the Heliometer and Astrographic Telescope were assiduously worked, and the results published in extensive star catalogues, giving the positions of the principal Southern Stars with an accuracy leaving little to be desired. He was never more happy than when immersed in the mass of figures which these publications involved. His investigation of the division errors of the Reversible Transit Circle is a model of what such an investigation should be. He made a long series of observations of the major planets with the heliometer, and up to near the end was always ready to take his turn with that instrument.

Mr. Hough's work was recognized from time to time. In 1899 he was elected a Fellow of the Royal Astronomical Society; in 1902 a Fellow of the Royal Society; and in 1905 he was awarded the Hopkins Prize by the Cambridge Philosophical Society for the most important memoir of a mathematico-physical character published by a graduate of the University during the three preceding years. On the formation of our Society he was unanimously elected its first President. Members will remember with gratitude his lucid addresses and his ever ready willingness to place his vast knowledge at their disposal.

In 1906 Mr. Hough married Miss Gertrude Annie Lee, formerly Vice-Principal of the Good Hope Seminary at Cape Town, and a scholar of high mathematical attainments. It was a sad blow to him when Mrs. Hough became a victim to the influenza epidemic in 1918. There were no children of the marriage.

Mr. Hough was shy and reserved. But to those who could break through this reserve a most genial nature was revealed, full of quiet humour. He was fond of a quiet dinner party, with congenial companions. His only relaxation was walking and a game of tennis. Although deeply interested in public affairs, he took no part in them, and seemed quite content and happy in devoting his whole energy to astronomical service in general, and to the management of the Cape Observatory in particular.

Last year he went to Rome to attend the meeting of the International Astronomical Union. He returned full of en-

· The late Clement Jennings Taylor, in his Observatory, "Herschel View," Claremont.

thusiasm for what had been accomplished at that meeting. While there he had the honour of being elected British Vice-President of the International Union for the current three years.

Soon after his return a dread disease manifested itself. A surgical operation was performed, but as soon as he had recovered from this the disease broke out in another place. He was advised to go to England for further treatment, but from the first the case seemed hopeless. The patient himself was the most optimistic person, and he bore his great suffering with patient cheerfulness and fortitude. Never for a moment did he give up hope of returning to South Africa, where his heart was, but it was not to be. His friends cannot but feel thankful that the period of suffering was not prolonged. On the 8th July he passed away at his brother's residence, Gerrard's Cross, and was buried on 14th July at Chingford, where stands the long-disused meridian mark of the Greenwich Transit Circle—a most appropriate resting-place. By his death South Africa loses a distinguished scientist. He will be sadly missed by his friends and by astronomical workers throughout the world.

W. H. C.

CLEMENT JENNINGS TAYLOR, F.R.A.S.

1861-1922.

Mr. Clement Jennings Taylor was President of the late Cape Astronomical Association for the year 1916-17, having joined the Association on the 16th May, 1913. He was the discoverer of a comet in 1916 (Taylor 1916 a). His annual papers on the "Progress of Astronomy" were much appreciated. Though abounding in quaint humour, they were nevertheless painstakingly prepared with a view to affording accurate and up-to-date information, and they invariably testified to the author's devout belief in a Divine purpose in all things. It gave him the greatest pleasure to allow any visitors the use of his 10-inch reflector at "Herschel View," Claremont. Although not a member of the Cape Astronomical Association at the time of his death, on the 30th June, 1922, he continued to take a kindly interest in its proceedings and remembered it in his will. Hailing from Lincolnshire, England, Mr. Taylor came to Cape Town at an early age as the representative of a British commercial firm, but soon afterwards became one of those hardy adventurers who were attracted to the Kimberley Diamond Fields in their early days. He returned to the Cape Peninsula at the beginning of the nineties with his wife, after losing in infancy their only child, and carried on business as a cloth merchant. His widow survives him. He is buried at Plumstead Cemetery, Cape Province, and on his gravestone there are reproduced the words that confronted one on entering his observatory, "The Heavens declare the glory of God."

C.L.O'B.D.

THE DISTANCE, BRIGHTNESS AND DIMENSIONS OF A STAR.

By D. G. McIntyre.

[The following notes comprise the answers to two questions put to the writer at meetings of the Cape Astronomical Association. They are intended for beginners, and the only mathematical medium employed is a little very elementary algebra. At the time they were written (about December, 1919) the accepted apparent magnitude of the sun was —26.57 (*vide B.A.A.J.*, vol. xxix, p. 135). This value has been retained in preference to the more recent —26.7, as it facilitates the argument, without affecting the conclusions. The section from Stellar Dimensions onwards and the tables have been added to the original notes.]

I.—The Distance of a Star.

Two methods are at present in vogue for determining the distance and allied characteristics of a star. The first may be described as the inductive or survey method, the second as the deductive or analogic method. These notes concern themselves primarily with the inductive, though brief reference will be made to the deductive method at the end. Where the two methods overlap they are found to be beautifully in accord.

An Astronomical Unit.

The base-line from which the solar system has been triangulated is the earth's radius. For gauging the distance of the stars a much longer measuring rod is required, and we utilize the sun's mean distance from the earth. This distance is called an astronomical unit, and we have:

One astronomical unit = 92,900,000 miles.
= 149,500,000 kilometres.

Parallax.

Parallax may be defined as the amount of change in the apparent direction of a distant object arising from change in the position of an observer. Such a change in apparent direction of the nearer stars is measurable from opposite extremes of the earth's orbit. Having measured such changes in the case of a particular star, it is possible to compute the difference of that star's direction as seen from the sun and that part of the earth's orbit from which the apparent direction will be changed by the greatest amount. It is equal to the angle subtended by the radius of the earth's orbit (one astronomical unit) as seen from that star. Or, conversely, we may say that

> *The parallax of a star* (stellar parallax) *is the angle subtended by a line, one astronomical unit long, placed at the distance of that star.*

A Second of Arc.

This parallactic angle is measured in seconds of arc. Let us, first of all, endeavour to gain some idea of what a second of arc represents.

The circumference of a circle is 3.1416 times the length of its diameter, or twice 3.1416 times the length of its radius. There are $360 \times 60 \times 60$ (*i.e.*, 1,296,000) seconds of arc in the entire circumference: there are, therefore, in that part of the circumference equal to the radius

$$\frac{1296000}{3.1416 \times 2} \text{ seconds, or } 206{,}265''.$$

From this it follows that a line of unit length will have to be viewed from a distance of 206,265 times that length to subtend an angle of 1''.*

Stellar Parallax converted into Distance.

Now unit length in the case of stellar distances is the astronomical unit. From what we have learnt about a second of arc, a line one astronomical unit long will have to be 206,265 astronomical units away from us to subtend an angle of 1''.

And to subtend an agle of π'' it will have to be situated $\frac{206{,}265}{\pi}$ astronomical units away.

From our definition of parallax we know that this angle (π) is also the parallax of a star situated at the same distance to which our line has been removed. Hence we have (writing π for parallax):

$$\text{Distance of star} = \frac{206265}{\pi} \text{ astro. units.} \qquad (1)$$

$$= \frac{206265}{\pi} \times 92{,}900{,}000 \text{ miles.}$$

An examination of formula (1) will show that the larger the parallax (π) the nearer the star. Dr. Innes, in 1917, discovered that a faint star in Centaurus had the largest known parallax.[1] This, the nearest known star, is now called "Proxima Centauri," and its parallax is 0''.784. Substituting 0.784 for π in (1), we get

$$\text{Distance of Proxima Centauri} = \frac{206265}{0.784} \text{ astro. units.}$$

$$= 24{,}440{,}000{,}000{,}000 \text{ miles.}$$

*This (along with what follows) is not strictly accurate, but is a sufficiently close approximation for very small angles. It hinges on the trigonometrical device whereby, for such angles,

Length of arc $n'' = \sin n''$ (radius being unity).

Where, in these notes, angular and linear measure appear to be confused, this property of small angles should be borne in mind.

Stellar Parallax converted into Light Years.

By a beautiful laboratory experiment (the main principle of which is indicated in many popular works on astronomy) the velocity at which light travels through space has been determined. The measured rate is 186,324 miles per second of time.[2]

From this it follows that light will travel one astronomical unit in $\frac{92{,}900{,}000}{186{,}324}$ seconds, or 498.5 seconds.

We have seen (1) that a star of parallax π is $\frac{206265}{\pi}$ astronomical units from us.

Light from this star would take $\frac{206265}{\pi} \times 498.5$ seconds to reach us.

Reducing this time to years, and writing Y for the number of years that the light is on its journey, we get

$$Y = \frac{3.258}{\pi} \qquad (2)$$

The distance which light travels in one year is called "one light year," and this unit is frequently used in comparing the distances of different stars of measured parallax. It is a far less cumbersome unit than the mile, the kilometer, or even the astronomical unit, for stating such tremendous distances.

Solving for Proxima Centauri:

$$Y = \frac{3.258}{0.784} \text{ light years,}$$
$$= 4.1 \text{ light years.}$$

Stellar Parallax converted into Parsecs.

For a long time the light year was the unit in which stellar distance was generally stated. But it has disadvantages, and lately has been replaced by the *parsec*.

A star with parallax $1''$ is said to be 1 parsec away from us; a star at double that distance ($\pi = 0''.5$) 2 parsecs, and so on. Generally, for a star with parallax π, we have (writing P for its distance):

$$P = \frac{1}{\pi} \text{ parsecs.} \qquad (3)$$

For Proxima Centauri:

$$P = \frac{1}{0.784} \text{ parsecs.}$$
$$= 1.2 \quad \text{parsecs.}$$

Given a star's distance in parsecs (P), it will be seen that its parallax (π) and distance in light years (Y) may be determined very easily. For any star

$$\pi = \frac{1}{P} \qquad (4)$$
$$Y = P \times 3.258 \qquad (5)$$

It is the ease of these conversions that partly constitutes the utility of the parsec. Arbitrary formulæ also allow of easy conversion of parsec distance into miles and kilometres:

$$\text{Distance} = 2P \times 10^{13} \text{ miles.} \qquad (6)$$
$$= 3P \times 10^{13} \text{ kilometers.} \qquad (7)$$

TABLE I.—DISTANCES OF NEAREST STARS.[3]
(Arranged in order of distance.)

Star.	Parallax.	Distance.		Spectroscopic Parallax.
		Light Years	Parsecs.	
Proxima Centauri	0″·79	4·1	1·2	
α Centauri *	0″·76	4·3	1·3	0″·79
Munich 15040	0″·53	6·2	1·9	
Lalande 21185	0″ 41	7·9	2·4	0″·43
Sirius *	0″·38	8·6	2·6	0″·38
Anon.	0″·34	9·6	2·9	
Cord V^h 243	0″·32	10·2	3·1	
τ Ceti	0″·32	10·2	3·1	0″·33
ϵ Eridani	0″ 31	10·5	3·2	0″·29
Procyon *	0″·30	10·9	3·3	0″·33
61 Cygni *	0″ 30	10·9	3·3	0″·29

* Denotes binary systems. The significance of the last column is explained in the text.

II.—The Brightness of a Star.

Apparent Magnitude.

The apparent magnitude of a star is the measure of its *apparent* brightness. Magnitude, then, is a standard of brightness and not of size. It is determined visually.

Sir John Herschel, in discussing his Cape observations, was the first to point out that the magnitudes of stars had been measured, all unconsciously, from the earliest times, along a logarithmic scale.[4] The scale along which magnitudes are grouped in the Harvard Revised Catalogue we owe to Podgson, and it also has a logarithmic basis. By it a star of a given magnitude appears $\sqrt[5]{100}$, or 2.512, times as bright as a star of magnitude next below it.

Knowing this, we can compare the apparent brightness of any two stars whose apparent magnitudes are known.

For let m_1 and m_2 be the magnitudes of two stars.

Then when the difference of their magnitudes $m_1 - m_2$ equals 1, the ratio of their brightness is as 1 to 2.512.

When $m_1 - m_2 = 2$, the ratio of their brightness is as 1 to 2.512×2.512, or 2.512^2.

And, generally, when $m_1 - m_2 = d$, the ratio of their brightness is as 1 to 2.512^d.

Writing the brightness of a star of magnitude m_1 as B_1 and that of a star of magnitude m_2 as B_2, we have

$$\frac{B_1}{B_2} = \frac{1}{2.512^d};$$

$$\text{Therefore } \log \frac{B_1}{B_2} = 0 - \log 2.512 \times (m_1 - m_2).$$

whence

$$\log \frac{B_1}{B_2} = -0.4\ (m_1 - m_2) \tag{8}$$

(since the log of 2.512 or $\sqrt[5]{100}$ is $\frac{2}{5}$ or, more conveniently, 0.4).

Comparison of Apparent Brightness of Stars.

By this means we may compare the relative apparent brightness of any two stars. Take Sirius and Proxima Centauri: the apparent magnitude of Sirius is -1.58, that of Proxima 11.0. The difference between their magnitudes is, therefore, 12.58. Hence, from (8), we have

$$\begin{aligned} \text{Difference in apparent brightness} &= 2.512^{12.58}. \\ \text{We have seen that } \log 2.512 &= 0.4. \\ \text{Therefore, } \log 2.512^{12.58} &= 12.58 \times 0.4. \\ &= 5.0. \end{aligned}$$

The antilog of 5.0 being 100,000, we find that Sirius is apparently 100,000 times as bright as Proxima.

Comparison of Apparent Brightness of Stars and the Sun.

The sun's apparent stellar magnitude has been determined as —26.57. Applying (8), we find that the sun gives us

(i) 10,000,000,000 times the light of Sirius.

(ii) 100,000,000,000 times the light of a star of magnitude 1.

(iii) 10,000,000,000,000 times the light of a star of magnitude 6.

(iv) 1,000,000,000,000,000 times the light of Proxima.

Luminosity.

But comparisons such as the above are at best poor, for they tell us nothing of the *actual* brightness of these stars.

The *apparent* brightness of a star as we see it depends upon two factors—its intrinsic brightness, or *luminosity*, and its distance from us. If all stars were of equal luminosity, we could determine their relative distances at once by measuring their apparent brightness. The quantity of the light which reaches us would then vary inversely as the square of the distance.

But stars are very unequal in their actual brightness, as will presently appear. The star with which we have the closest acquaintance is the sun, and a common method of examining the brightness of a star, *whose distance is known*, is to suppose the sun withdrawn to the same distance, and then contrast their respective luminosities.

First, let us attempt to determine the distance to which the sun would have to retreat to shine with a magnitude of 0.0.

We have seen that the sun's apparent magnitude is —26.57. Therefore, the sun is $2.512^{26.57}$ times brighter than a star of magnitude 0.0. And, as luminosity varies inversely as the square of the distance, the sun would have to be situated $\sqrt{2.512^{26.57}}$ times as far away as it is at present to shine with magnitude 0.0.

Call this distance D. Then

$$\log D = \frac{26.57 \times 0.4}{2}$$
$$= 5.314$$

and D = 206,000 times the sun's mean distance.

Now the parallax of a star distant 206,000 astronomical units is, from (1), equal to $\left(\frac{206265}{206000}\right)''$ or $1''.00$.

A star, then, having an apparent magnitude of 0.0 and a parallax of π'' is as bright as the sun would appear at π times that star's distance, and must, therefore, have a luminosity of $\frac{1}{\pi^2}$ times that of the sun.

If, however, its magnitude be not 0.0 but m, writing L for its luminosity, we have (the sun's luminosity being unity)—

$$\begin{aligned} L &= \frac{1}{\pi^2} \div 2.512^m. \\ &= \frac{1}{\pi^2 \times 2.512^m} \end{aligned} \qquad (9)$$

Alternative Formula for Luminosity.

Equation (9) may be rendered in a more convenient form thus:—

$$L = \frac{1}{\pi^2 \times 2.512^m}$$

$$\begin{aligned} \text{Therefore } \log L &= -2 \log \pi - m \log 2.512. \\ &= -2 \log \pi - 0.4m. \end{aligned} \qquad (10)$$

This ensures an easy computation of the luminosity of any star whose parallax and apparent magnitude are known. Sirius, we find, has 30.3 times the luminosity of the sun, Proxima Centauri only 0.00006 of it. Thus, while Sirius appears, as we have seen, to be 100,000 times as bright as Proxima, it is in reality 500,000 times as bright.

Absolute Magnitude.

There is, however, a more elegant method than this by which the actual brightness of the stars may be contrasted. Instead of moving the sun first to the distance of one star and then of another, let us suppose that the sun and all the stars under review be removed to a uniform distance, and their magnitudes gauged. Apparent magnitude now becomes *absolute magnitude.*

The trouble is that there is a difference of opinion regarding the distance at which absolute magnitude should be assessed. Kapteijn (at one time) and Plummer adopt a distance of 100 parsecs (325.8 light years), Heath, Russell, and most of his fellow Americans 10 parsecs (32.58 light years), Halm, Kapteijn (latterly) and Walkey 1 parsec (3.258 light years). There is great need for uniformity, and at present the balance seems to lie between 10 parsecs and 1 parsec.

Absolute Magnitude at 10 Parsec Distance.

The parallax of a star situated at a distance of 10 parsecs would be $0''.1$. Its apparent magnitude would also be its absolute magnitude.

Call this M_{10} and substitute for π and m in (10):

$$\log L = -2 \log 0.1 - 0.4M_{10}.$$

But from (10) $\log L = -2 \log \pi - 0.4m$.

Therefore, substituting for log L,

$$-2 \log \pi - 0.4m = 2 - 0.4M_{10}.$$
$$0.4M_{10} = 0.4m + 2 + 2 \log \pi.$$
$$\text{Whence } M_{10} = m + 5 + 5 \log \pi. \qquad (11)$$

This formula gives us the absolute magnitude (at 10 parsecs' distance) when the apparent magnitude (m) and the parallax (π) are known.

Solving for Proxima Centauri:

$$M_{10} = 11 + 5 + 5 \log 0.784.$$
$$= 15.5.$$

Absolute Magnitude at 1 Parsec Distance.

The parallax of a star situated at 1 parsec distance would be $1''$, and we would have in the foregoing working:

$$-2 \log \pi - 0.4m = -2 \log 1 - 0.4M_1.$$
$$= -0.4M_1.$$
$$\text{Whence } M_1 = m + 5 \log \pi. \qquad (12)$$

The conversion from one system to the other will be obvious:

$$M_{10} = M_1 + 5. \qquad (13)$$

In what follows the absolute magnitudes are assessed at 10 parsecs.

Some Comparisons of Absolute Magnitude.

The giant star Vega has a parallax of $0''.1$. That is to say, it is at 10 parsecs' distance, and its absolute magnitude and apparent magnitude correspond. If Sirius, the Sun and Proxima were placed at the same distance as Vega, their absolute magnitudes, deduced from (11), would denote the actual lustre with which they would then shine. The brightness of Vega will, of course, remain unchanged; Sirius will have a magnitude of 1.3, the sun will have dwindled to a fifth magnitude star, and Proxima Centauri, with as low a magnitude as 15.5, becomes the faintest of the stars whose actual brightness is known.

TABLE II.—ABSOLUTE MAGNITUDES AND LUMINOSITIES OF THE NEAREST STARS.[5]

(Arranged in order of actual brightness.)

Star.	Spectrum.	Absolute Mag.	Apparent Mag.	Luminosity.
Sirius A	A	1·30	—1·58	30·3
Procyon A	F5	2·90	0·48	6·95
α Centauri A	G	4·73	0·33	1·28
Sun	G	5·00	—26·57	1·00
α Centauri B	K5	6·10	1·70	·36
τ Ceti	K	6·17	3·65	·35
ϵ Eridani	K2	6·28	3·81	·31
61 Cygni A	K7	7·98	5·57	·064
61 Cygni B	K8	8·69	6·28	·034
Lal. 21185	Ma	10·69	7·60	·0054
Sirius B		11·32	8·44	·003
Cor V 243	K2	11·7	9·2	·0022
Munich 15040	Mb	13·3	9·7	·0005
Anon.		15·0	12·0	·0001
Procyon B		15·4	13·0	·00006
Proxima Cent.	Mb?	15·5	11·0	·00006

III.—THE DIMENSIONS OF A STAR.

If the angular diameter of a star of known parallax can be measured, we can at once obtain its actual dimensions.

For suppose that the angle subtended by its apparent diameter be a'' and its parallax π'', we get from a consideration of our definition of parallax:

$$\text{Diameter of star} = \frac{a}{\pi} \text{ astronomical units.} \tag{14}$$

About Nova Aquilæ III.

Prior to the erection of the Mount Wilson hundred-inch reflector the only stellar bodies presenting discs that allowed of direct measurement were one or two of the Novæ and the planetary nebulæ.

Nova Aquilæ III is an instance. Some two years after its outburst it presented a definite, greenish-coloured disc—easily visible in a small telescope*—which was measured by Moore and Aitken[6] at Lick Observatory and found to be 3″.8. Determinations of its parallax[7] give 0″.006.

* Mr. Wm. Reid observed the Nova on 1923, August 12, and found that colour and disc were still discernible in his 6-inch Cooke refractor. The observation was, however, no longer easy.

From (14) we find that this indicates a diameter of 59,000,000,000 miles. From (2) we learn that this stellar conflagration, first seen on earth in 1918, occurred about a century before the birth of Copernicus. The apparent magnitude of the Nova at the time of its greatest brilliance[8] was —1. This means —from (10)—that at that distant date it had blazed up to 70,000 times the luminosity of the sun.

Distances and Dimensions of the Planetary Nebulæ.

Adriaan van Maanen has made a special study of the parallaxes and angular diameters of the planetary nebulæ. Below will be found a reduction of his results thus far, reduced to distance in light years, and actual diameters in miles.[9]

N.G.C. No.	*Distance in Light Years.*	*Diameter in Miles.*
2392	148	200,000,000,000
6720	403	1,000,000,000,000
6804	148	100,000,000,000
6905	217	300,000,000,000
7008	204	500,000,000,000
7293	84	2,000,000,000,000
7662	142	100,000,000,000

The Diameter of Betelgeuse.

Recently, by a combination of the Michelson interferometer with the 100-inch reflector, the angular diameters of certain stars have been determined. The classic instance is Betelgeuse. The first determination[10] gave the diameter as $0''.047$. Betelgeuse has a parallax[11] of $0''.017$. Consequently (from (14))

$$\text{Diameter of Betelgeuse} = \frac{0.047}{0.017} \times 92{,}900{,}000 \text{ miles.}$$
$$= 257{,}000{,}000 \text{ miles.}$$

Subsequent observations[12] would seem to indicate that this diameter is variable, the whole star pulsating apparently in harmony with its variations in light magnitude and radial velocity. In November, 1921, it had attained a diameter of $0''.054$; by October, 1922, this had shrunk to $0''.034$. Applying (14), we find that during this period Betelgeuse had contracted in diameter by 110,000,000 miles.

Diameters of Antares and other Stars.

The angular diameter of Antares has also been well determined,[13] those of Aldebaran, Arcturus, and β Pegasi fairly, while the diameters of γ Andromedæ and α Arietis are suspicioned.[14] The results are reduced and tabulated below in order of angular diameters.

Star.	Apparent Magnitude.	Parallax.	Angular Diameter	Diameter in Miles.
α Orionis	0·92	0″·017	0″·047	257,000,000
α Scorpii	1·22	0″·009	0″·040	413,000,000
α Tauri	1·06	0″·062	0″·020	31,000,000
α Bootis	0·24	0″·095	0″·020	20,000,000
β Pegasi	2·6	0″·035	0″·020	55,000,000
γ Andromedæ	2·28	0″·004	0″·013±	300,000,000±
α Arietis	2.23	0″·037	0″·010±	25,000,000±

IV. The Intrinsic Surface Brilliancy of a Star.

Knowing the actual diameter and the luminosity of a star, it is possible to determine its intrinsic surface brilliancy (area for area).

For the purpose of this investigation we regard the sun and the stars as luminous discs. Their surface areas are then directly proportional to the squares of their diameters. The diameter of the sun is 864,000 miles; the diameter of Betelgeuse, we have seen, is 257,000,000 miles. Therefore, the area of the star's disc is $\left(\frac{257{,}000{,}000}{864{,}000}\right)^2$ times that of the sun. From (10) we find that the luminosity of Betelgeuse is 1,480 times that of the sun. It follows that the intrinsic surface brilliancy is

$$1{,}480 \div \left(\frac{257{,}000{,}000}{864{,}000}\right)^2, \text{ or } \frac{1}{60} \text{ that of the sun.}$$

Writing J for intrinsic surface brilliancy, and taking the sun's as unity, we have

$$J = \text{Luminosity of star} \div \left(\frac{\text{diameter of star}}{\text{diameter of sun}}\right)^2 \qquad (15)$$

Intrinsic Surface Brilliancy from Angular Diameter and Apparent Magnitude.

Solving for intrinsic surface brilliancy by the above method involves an accurate knowledge of the star's parallax. But, if the angular diameter and the apparent magnitude be known, J may be found without any reference to the star's distance.

The sun's angular diameter has been found to be 1919″.3. Suppose the diameter of a star disc measure α''. Then, if the intrinsic surface brilliancy of this star and of the sun be equal, the ratio of their apparent areas will be proportional to the ratio of their apparent brightness, since both apparent area and apparent brightness vary inversely as the square of the distance. And if the surface brilliancy of the sun and the star are in the ratio $\frac{1}{J}$ we get (writing α for angular diameter of the star and m for its apparent magnitude):

$$\left(\frac{1919.3}{\alpha}\right)^2 \frac{1}{J} = \text{ratio of apparent brightness of sun and}$$

star, or, from (8):

$$\left(\frac{1919.3}{\alpha}\right)^2 \frac{1}{J} = 2.512^{m+26.6} \tag{16}$$

By solving for J in the above, the intrinsic surface brilliancy of a star may be found.

V.—The Mass of a Star.

When we have a binary system, where one star revolves round another, we are able to obtain direct evidence of the joint mass of the two stars. By observing the motions of the two stars, the apparent orbit of the one star around the other is plotted, and from this the true orbit is computed.

If A be the semi-major axis of the true orbit of a binary system in terms of the sun's distance from the earth, and P its period in years, then, from an extension of Kepler's third law, we have (the mass of the earth being negligible):

$$\text{Mass of system} = \frac{A^3}{P^2} \text{ (times sun's mass).} \tag{17}$$

Let us take a specific instance. For α Centauri it has been found that the semi-major axis is 17″.7 and the period 81 years.[15] The parallax of the system is 0″.759.

First of all we must determine the length of the semi-major axis in astronomical units. It is indicated by (14) that

$$\text{Length of semi-major axis} = \frac{17.7}{0.759} = 23.3 \text{ astro. units.}$$

From (17) it now follows:

$$\frac{A^3}{P^2} = \frac{(23.3)^3}{(81)^2} = 1.9 \text{ times sun's mass.}$$

From this figure we can get the individual masses of the two components if we know their ratio, and this is obtained by observing the relative movements of the components in their orbit. In the case of the α Centauri system the two components are very nearly of equal mass. Each of them, then, is .95 times the mass of the sun.

The parallax and dimensions of this system as given above are susceptible to a very delicate test. From observation with the spectroscope the actual relative velocity of the stars in their orbit may be obtained in miles or kilometres per second. If this agree with the relative velocity as computed from the observed orbit and measured parallax, then these latter results must be entirely accurate. Such a test has been applied by Wright,[16] and it afforded a complete verification of the Cape heliometer parallax.

IV.—The Significance of Absolute Magnitude and Intrinsic Surface Brilliancy.

Absolute Magnitude.

Thus far we have dealt with measurements and determinations obtained from direct observations of the stars discussed. From a study of such results we are enabled to make certain definite assumptions. These assumptions form the basis of the Deductive Method to which reference was made at the start.

Study of the characteristics of the nearest stars shows a close correlation between absolute magnitude and spectral type. An examination of columns 2 and 3 of Table II will emphasize this. In Figure I this correlation is illustrated graphically, with spectral type as abscissa and absolute magnitude as ordinate.

Reference to formula (11) will show that absolute magnitude is correlated with distance through apparent magnitude. By examining a star's spectrum the star's absolute magnitude is deduced, and then by comparing this deduced magnitude with the apparent magnitude we can at once calculate the distance of the star. For, from (11)

$$-5 \log \pi = m + 5 - M. \qquad (18)$$

The last column of Table I shows spectroscopic parallaxes[17] (as they are called) derived by this method. The agreement with the measured parallaxes is extraordinary. Here, then, is a key to the distance of thousands of stars which are far beyond the reach of our instruments of survey, but whose spectra and apparent magnitudes it is possible to obtain.

Spectral Type.

Some explanation of the sequence of spectral types figuring on the diagrams would seem advisable. It forms part of a continuous linear sequence, successive classes of spectra being

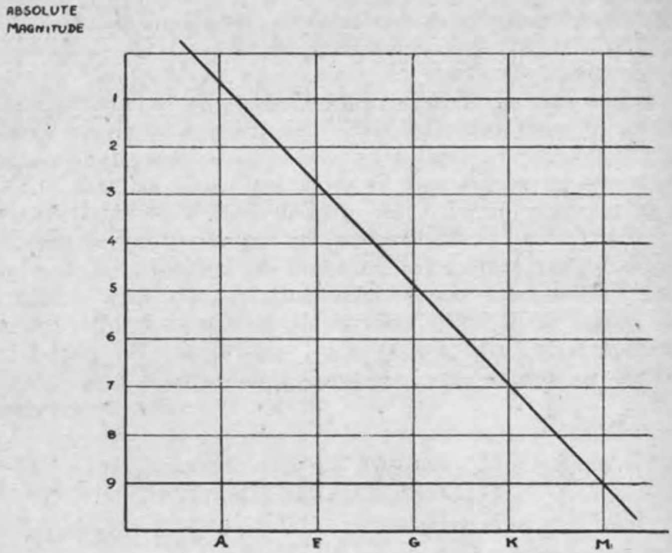

Fig I

Correlation between ABSOLUTE MAGNITUDE and SPECTRAL TYPE for the nearest stars.

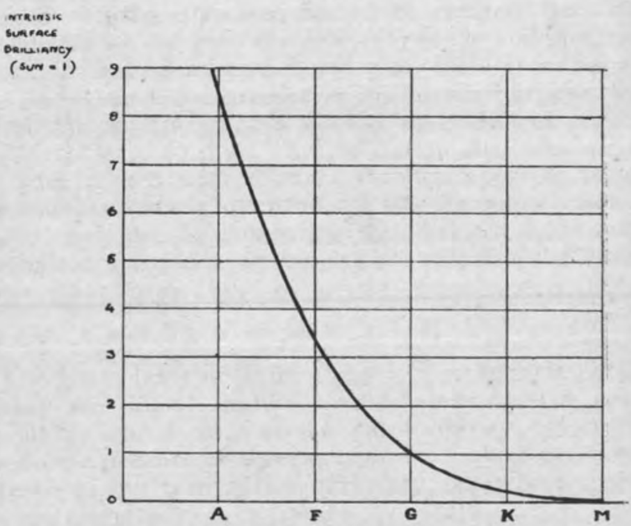

Fig II

Correlation between INTRINSIC SURFACE BRILLIANCY and SPECTRAL TYPE.

denoted by the letters A, F, G, K, M, the order in which the letters are given being connected with successive stages of the evolution, and, consequently, the physical properties of a star. Each class is further subdivided (i) by figures (representing decimal subdivisions) in the case of types A, F, G, K; and (ii) by letters in the case of M. Thus the detailed sequence would run A_0 A_1 A_2 . . . . A_9 B_0 B_1 etc. . . . . . K_9. M*a* Mb . . . On the diagrams the position of a spectral type intermediate between, say, F and G (*e.g.*, F_3) may be determined by interpolation.

Intrinsic Surface Brilliancy.

The study of intrinsic surface brilliancy is still in its infancy, but already there are indications that in a few years' time it will constitute the dominating feature in any dissertation on stellar astronomy. Recent astrophysic research tends to show that the amount of light radiated from unit area of a star (*i.e.*, its intrinsic surface brilliancy) is entirely a function of surface temperature, and that, once again, there is a close correlation between spectral type and intrinsic surface brilliancy. This correlation is illustrated in Figure II, with spectral type as abscissa and intrinsic surface brilliancy (in terms of that of the sun as unity) as ordinate. The estimates of intrinsic surface brilliancies employed in the construction of this graph are the work of Eddington,[18] and are based on theory. They allow the angular diameters of stars to be forecasted, and in his opening address to Section A of the British Association, Eddington, on August 24th, 1920, uttered the following remarkable prophecy[19]: "The star with the greatest apparent diameter is almost certainly Betelgeuse, diameter 0".051. Next comes Antares, 0".043. Other examples are Aldebaran, 0".022; Arcturus, 0".020." Compare these with the measures subsequently obtained and quoted in an earlier paragraph. Once again inductive and deductive methods are "miraculously in accord."

Hypothetical Dimensions of α Centauri A.

Let us illustrate the deductive method by continuing our investigation of the characteristics of the brighter component of the α Centauri binary system.

In what follows, all such quantities as mass, luminosity, surface brilliancy, diameter, etc., are referred to in terms of their ratio to that of the sun as unity.

α Centauri A is a star of spectral class G_0. From Figure II we see that its theoretical intrinsic surface brilliancy (J) is 1. In constructing Table II we found that its actual luminosity (L) was 1.28. From (15) it follows that

$$\text{Surface area of star} = \frac{L}{J} \text{ (times sun's surface area).} \quad (19)$$

Therefore, for α Centauri A,

$$\frac{L}{J} = \frac{1.28}{1} = 1.28 \text{ times sun's surface area.}$$

And the diameter of a star being proportional to the square root of this surface area (writing D for diameter),

$$D = \sqrt{1.28} = 1.13 \text{ times sun's diameter.}$$

Knowing the sun's diameter to be 864,000 miles, we find that α Centauri A is 977,000 miles in diameter.

Solving for α in (14), we find that this represents an apparent angular diameter of 0″.008.

Had we no knowledge of the distance and, consequently, of the hypothetical linear diameter of the star, we could still have found its hypothetical *angular* diameter by solving for α in (16):

$$\alpha = \frac{0.0093(0.631)^m}{\sqrt{J}} \text{ seconds of arc.} \qquad (20)$$

Hypothetical Density of α Centauri A.

Density varies directly as the mass and inversely as the volume. Hence we have

$$\text{Density} = \frac{\text{Mass}}{D^3} \text{ (times sun's density).} \qquad (21)$$

For α Centauri A this becomes

$$\text{Density} = \frac{.96}{(1.13)^3} = .6 \text{ times sun's density.}$$

The foregoing illustrates two of the many results which the application of the Deductive Method opens to us. It is hoped that in some future issue of the Journal a more competent pen will describe at length some of these results, and the vast conceptions of astronomical cosmography to which their accumulation is leading us.

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[6] *H. C. O. Bull.*, 721.

[7] Z. Daniel, *XXIV Meeting Am. Astro. Soc.*

[8] C. L. Brook, *B.A.A.J.*, XXVII, 8.

[9] van Maanen, *XXIX Meeting A.A. Soc.*, and *Communications to the Nat. Academy of Sc.*, 56.

[10] F. G. Pease, *XXV Meeting A.A. Soc.*

[11] van Maanen, *XXIX Meeting, A.A. Soc.*

[12] Pease, *Pub. Astro. Soc. of the Pacific*, Dec., 1922.

[13] Pease, *Pub. Astro. Soc. of the Pacific*, Aug., 1921.

[14] Michelson and Pease, *XXVIII Meeting A.A. Soc.* Parallaxes after Stetson, *Popular Astronomy*, XXXI, 4.

[15] Campbell, *Stellar Motions*, Table XXX.

[16] *Lick Obs. Bull.*, 3, 4, 1904.

[17] Adams, *Astrophysical Journal*, Vol. XLVI, and Lundmark and Luytens, *XXIX Meeting A.A. Soc.*

[18] Eddington, *Observatory*, XLIII, p. 350:—

	A.	F.	G.	K.	M
J in luminosities (Sun = 1) ..	8.3	3.3	1	$\frac{1}{5}$	$\frac{1}{77}$

[19] *Nature*, 106, 1920.

[Besides the above, the writer is greatly indebted to various papers and addresses by Major Hepburn.]

THE VALUE OF ASTRONOMY.

By H. E. Wood, M.Sc., F.R.A.S.

Astronomy is the very oldest of the sciences. The ancient ruins of the Earth—the Great Pyramids of Egypt, the Druid Circles in England and France, etc.—remain to us as evidences of the practical astronomical knowledge of early peoples. Important astronomical epochs were then celebrated by festivals, and many of these festival dates still survive, although the origin of them has almost been forgotten.

In the early days of civilization, when every man was an agriculturalist, it was also necessary for him to be a practical astronomer: the face of the sky was his only clock and almanac, and he relied on his own observations to determine the correct time of the year to begin his ploughing and sowing. In those days a working knowledge of simple practical astronomy was common to all. Our modern conditions of life, particularly town life, are not favourable to the general cultivation of practical astronomy. Clocks and watches render it unnecessary for us to observe the sun and the stars to know the time; newspapers and diaries keep us familiar with the changing of the time of year.

And so the study of practical astronomy is now mainly confined to a comparatively few persons. Each civilized country maintains an astronomical observatory, and one of the chief duties of the astronomer is to supply the correct time to the country. As our daily life becomes more complex, this duty becomes more and more important. The manager of a large industrial concern, employing thousands of people, is quite familiar with the cash value of a single minute of time, and would realize the serious loss which would result if each employee commenced work according to his own idea of the time obtained from an observation of the Sun.

Year by year, as our means of transit are accelerated, the world virtually becomes smaller, and our time system has to be modified to meet the change. Not so very many years ago each town had its own peculiar local time: but, with the introduction of railways, this was found to be so inconvenient that it became necessary to adopt a uniform time system to cover a whole country. Then, after the introduction of the electric telegraph and submarine cable, it became advisable to coordinate in a simple manner the times of different countries. It is on this basis that the time all over the Union of South Africa differs by the exact amount of two hours from the time of Great Britain. In the near future, following the development of the more rapid wireless method of communication, it may be found helpful to institute some system of time measurement which shall be common to the whole globe.

Astronomy plays as great a part as ever in our daily life, although this is not so apparent now as in the earlier days. The navigator of a vessel still depends upon the astronomical information contained in the Nautical Almanac to thread his way across the trackless ocean. When he arrives at a port, he again frequently has to rely upon an astronomical prediction as to the state of the tide to know whether he can safely enter the port.

We are not perhaps always fully aware of how much we owe to the beneficent radiation of the Sun, both past and present. Every form of energy with which we are acquainted originally came from the Sun. The burning of a piece of coal releases a supply of solar energy which reached the Earth from the Sun probably millions of years ago, and was stored up through the agency of vegetable life. When a factory is run by water-power, the real source of energy is again the Sun, for it is the sunbeam which lifts the water from the lower levels to the top of the waterfall. Every morsel of food we eat to maintain our vital energy is mainly stored-up sunshine.

In the crust of the Earth, in the form of coal and oil deposits, we have a large reserve supply of available preserved solar energy, and, generally speaking, that country is wealthiest which has the greatest reserve of ancient sunshine. It is not inconceivable, however, that a time may arrive in the history of the Earth when these reserve stocks may become exhausted. It will then be necessary, if civilized life is to continue on this globe, to make fuller use of the current supply of solar energy falling upon the Earth. Every square foot of the vast surface of the Sun is constantly emitting energy at the rate of ten thousand horse power. Of this truly gigantic output the Earth receives only a very minute fraction, but, even so, the amount of radiant energy falling upon a square mile of the Earth's surface near the tropics is equivalent to about half a million horse power. Not very much use is made as yet of this great supply, but the proper utilization of it will undoubtedly be a problem for the scientists of the future to deal with. The International Research Council at its meeting at Brussels in July, 1922, has already recommended as a promising field of research an investigation of the energy supply of the world (fuel, solar energy).

We all recognize to what a large extent the progress of civilization depends upon the advance of chemical knowledge, and this advance is intimately bound up with the study of astronomy. Many years ago (1868) the application of the spectroscope to the telescope indicated the existence of chemical elements in the heavenly bodies with which the chemist was not familiar. One of these elements—helium—which was discovered spectroscopically in the Sun, was found thirty years afterwards to be present on the Earth in a mineral found in Canada.

Later the chemist became aware that in the stars matter existed under conditions of temperature and pressure greatly exceeding any temperatures and pressures which could be produced in a chemical laboratory. The highest temperature which the chemist can actually produce is that of the crater of the electric arc, about 3,500 degrees Centigrade. The temperatures of the visible stars range from about 2,170 degrees to 28,000 degrees. The temperature of our Sun is about 5,320 degrees. These are minimum temperatures, and probably refer to layers near the surface: the temperatures of the interiors of the stars would be very much higher than these figures. The spectra of the stars thus afford the chemist evidence of the behaviour of matter over an enormous range of temperatures, and this information has had important bearings upon the development of theories of the ultimate nature of matter.

The study of the spectrum of the stars, combined with a mathematical investigation of the properties of gaseous masses, has led to the now generally accepted theory that the stars in their life-history pursue the following course—originally they are vast in size, but of very low density; up to a certain point their temperature rises, and also the density increases; the temperature reaches a maximum point, and then steadily falls, but the density goes on increasing. Thus there are "giant" and "dwarf" stars; the "giant" is the vast star of very low density at the beginning of its career; the "dwarf" is the compact star which has passed through its zenith and is now declining. Also the spectrum indicates that the chemical composition of the stars varies with the temperature. The hottest stars give evidence that they apparently consist almost entirely of helium, those next in the scale appear mainly to be formed of hydrogen, while the cooler stars show the presence of the more complex elements and even of compounds. The reasonable inference from this is that in the stars the process of "transmutation of the elements," so long sought for by the alchemists of old, takes place, and the chemist now accepts the belief that all the elements are actually different manifestations of some common prototype, and that the difference between one element and another is mainly a structural difference.

There are many other ways in which the work of the astronomer will ultimately lead to important material advances in our civilization, but probably the most important result of his efforts in attempting to discover the truth about the Universe is its lasting and progressive effect upon the modes of thought of the people of the world.

Correspondence.

OCCULTATION OF L20654 BY SATURN 1920 MARCH 14.

Professor W. H. Pickering has recently discussed his measurements of the thicknesses of Saturn's rings by his "direct vision" method, during the last passage of the earth through the plane of the ring system. His measurements of the thicknesses of rings A and B are well in accord with earlier determinations, and indicate that when L20654 was seen through the ring on 1920 March 14 by members of our Society, they were viewing it through about 330 miles of intervening ring matter.

Professor Barnard, however, from his observations of the rings, concludes: "Russell's estimate of their thickness, about 21 kilometers, seems reasonable." This would mean only about 115 miles of intervening ring matter. Dr. Louis Bell (*Astroph. J.*, 50, 10, 1919) inferred a thickness of 15 kilometers, equivalent to slightly over 80 miles of intervening matter, on the occasion of the South African observation.

Thus the difficulty found by certain authorities in crediting that a star could be viewed through the rings at such an oblique angle as was presented to us on 1920 March 14 seems to be reduced considerably by the revised measurements cited above, showing how much thinner than has been previously estimated the rings of Saturn may be.

STAMUS PRO VERITATE.

In answer to a correspondent, Dr. Halm recommends the following books as being suitable for the study of general and practical astronomy:—

Loomis, E.: "An Introduction to Practical Astronomy with a Collection of Astronomical Tables."

Young, C. A.: "A Text-Book of General Astronomy for Colleges and Scientific Schools."

Newcomb, S.: "Compendium of Spherical Astronomy."

Newcomb, S.: "Popular Astronomy."

Campbell, W. W.: "Handbook of Practical Astronomy."

Eddington, A. S.: "Stellar Movements and the Structure of the Universe."

Clerke, A. M.: "A Popular History of Astronomy in the 19th Century."

Scheiner, J.: "A Treatise on Astronomical Spectroscopy," being a translation of "Die Spectralanalyse der Gestirne." Translated, revised and enlarged with the co-operation of E. B. Frost.

Long, A. W.: "The Constellations as seen from South Africa."

Proctor, R. A.: "A New Star Atlas."

Review.

"The New Heavens," by George Ellery Hale, Director of the Mount Wilson Observatory. Published by Charles Scribner's Sons, New York, 1923. Price one dollar 50 cents. 88 pp.

This is quite a small book, and should be considered as a supplement to the same author's "The Study of Stellar Evolution," published in 1908. It deals mainly with the 100-inch reflecting telescope erected at the Mount Wilson Observatory, and the part this telescope is expected to play in the development of astronomical research. With this telescope it is possible to photograph stars as faint as the twenty-first magnitude, and to obtain spectra of the stars in globular clusters down to the fifteenth magnitude. The book describes in non-technical language the great achievement of the measurement, with the help of the interferometer, of the actual diameters of the "giant" stars Arcturus, Betelgeuze and Antares, and discusses the Russell-Hertzsprung theory of stellar evolution. The book is beautifully illustrated, many of the illustrations being reproductions of photographs obtained with the 100-inch telescope, and is valuable as giving a very concise account of the most recent astronomical advances.

The Editor acknowledges the receipt of a copy of the September, 1922, issue of *Die Himmelswelt,* the publication of Der Vereinigung von Freunden der Astronomie und Kosmischen Physik (E.V.); also of a cordial letter relative to the Journal from Dr. E. Opik, Astronomer of the Tartu (Dorpat) Observatory, Esthonia. The Editor, with the approval of the Council, has accepted the exchanges proposed in both cases.

The following have now been received from Tartu: *Publications de L'Observatoire Astronomique de L'Université de Tartu (Dorpat); Tome xxv, No.* 1, *A. Statistical Method of Counting Shooting Stars and its Application to the Perseid Shower of* 1920, *by E. Opik; No.* 2, *Notes on Stellar Statistics and Stellar Evolution, by E. Opik; No.* 3, *Photographic Observations of the Brightness of Neptune, Method and Preliminary Results, by E. Opik; No.* 4, *I., Results of Double-Count Observations of the Perseids in* 1921, *by E. Opik; II., Radiants of Meteors Observed in August,* 1920 *and* 1921, *at Tashkent, by E. Opik; III., Observations of Meteors in the Years* 1911-1920, *by K. Pokrovsky; No.* 5, *On the Luminosity-Curve of Components of Double Stars, by E. Opik.*

Reports

FOR THE YEAR ENDED 1923 JUNE 30.

COMET SECTION.

In presenting our report for the past year, we have much pleasure in recording the discovery of another new comet by our indefatigable worker, Mr. Skjellerup. Unfortunately Mr. Skjellerup has now left South Africa, but we are pleased to state he has not severed his connection with our Comet Section. We wish him every success in his new Australian home. Several new members are now taking an interest in comets, and we may fairly state that the Section is in a very healthy condition.

Comet 1922 b (Skjellerup) was well observed in the Northern Hemisphere, and is without doubt a periodic, belonging to the Jupiter family of comets. It is interesting to note that its period is the second shortest yet discovered. It may be expected to return to perihelion in 1927. Dr. Crommelin, in the *British Astronomical Association Journal*, gives many interesting details regarding this comet. His notes are full and exhaustive. Anyone interested may be referred to them.

The following elements are also by Dr. Crommelin, and are taken from the *B.A.A. Journal*:—

$$
\begin{aligned}
T &= 1922 \text{ May } 15.0325, \text{ G.M.T.} \\
\omega &= 354^\circ\ 47'.20 \\
\Omega &= 215\ \ \ 43.31 \\
i &= 17\ \ \ 23.36 \\
\phi &= 43\ 9.00 \\
\text{Log } q &= 9.94904 \\
\text{Log } a &= 0.44930 \\
\text{Period (years)} &= 4.7201
\end{aligned}
$$

The following new comets have been discovered since the date of our last report:—

Comet 1922 c. (Baade). A new comet was discovered by Dr. Baade at Bergedorf, Germany, on 1922 October 19th. It was observed for several months in the North, and though at all times a telescopic comet, it appears to have been a fairly bright object. Owing to its position, it was not seen in South Africa.

Comet 1922 d (Skjellerup). An unknown comet was discovered by Mr. Skjellerup at Rosebank, South Africa, on the morning of 1922 November 25th. When first seen it was a fairly bright nebulous patch with strong central condensation, about eighth magnitude, but it brightened up considerably later. On several occasions when observed by your Director a distinct nucleus could be detected.

Mr. H. E. Wood, of the Union Observatory, has forwarded the following interesting particulars:—

"Comet 1922 d (Skjellerup) was first observed photographically at the Union Observatory on 1922 November 27, and then visually with the 9-inch refractor on 18 occasions from 1922 November 28 to 1923 February 17, when it was noted as extremely faint and very difficult to observe. A preliminary orbit was computed from the Royal Observatory observation on November 26, and Union Observatory observations on November 27 and 28, and gave—

$$
\begin{aligned}
T &= 1923 \text{ Jan. } 1.145 \\
\omega &= 260^\circ\ 31'.3 \\
\Omega &= 261\quad 7.7 \\
i &= 23\quad 3.5 \\
q &= 0.9460
\end{aligned}
$$

"A further orbit has been computed from the Union Observatory observations of 1922 November 28, 1923 January 9, and February 17, giving the elements—

$$
\begin{aligned}
T &= 1923 \text{ Jan. } 3.7685 \\
\omega &= 264^\circ\ 36'\ 12'' \\
\Omega &= 262\quad 3\quad 6 \\
i &= 23\quad 22\quad 13 \\
q &= 0.92508
\end{aligned}
$$

"The comet was also observed at La Plata Observatory, Argentine, from 1922 December 8 to 1923 February 24.

"The orbit of Skjellerup's comet greatly resembles that of Comet 1892 VI., and the two comets probably belong to the same family."

Comet 1922 e (Nakamura). A very faint comet was discovered by Mr. Nakamura at Kyoto University Observatory, Japan, on 1922 November 29th, and was observed by him on the two following mornings. It is reported to have been exceedingly faint, and was not seen by any other observer. It is supposed to be Perrin's Comet of 1896 and 1909.

Since the date of our last report Donohoe Comet medals of the Astronomical Society of the Pacific have been awarded to the following members of the Section:—

Mr. Reid, for the discovery of Comet 1922 a.

Messrs. Skjellerup and Reid for the independent discovery of Comet 1922 b.

Mr. Skjellerup for the discovery of Comet 1922 d.

WILLIAM REID,
Director.

VARIABLE STAR SECTION.

The total number of observations received up till the end of June is 1,242, divided among three observers as follows:—Mr. H. E. Houghton, 381; Mr. A. W. Long, 185; Mr. W. H. Smith, 676. Some of the older observers, however, have long series of observations which will have to be dealt with one star at a time.

The following maxima have been deduced from the observations made by the section; the minima are generally too faint to be observed.

005475	U Tucanæ	1922, August 13, and 1923, May 10.
043738	R Cœli	1923, February 24.
051247	T Pictoris	1923, January 5.
051533	T Columbæ	1923, February 4.
074241	W Puppis	1922, December 11, and 1923, April 10.
082476	R Chameleontis	1922, September 2.
092962	R Carinæ	1923, March 6.
100661	S Carinæ	1922, December 31, and 1923, May 5. Minimum, 1923, March 16.
131283	U Octantis	1922, December 21.
133633	T Centauri	1923, March 30.
140528	RU Hydræ	1923, May 10.
140959	R Centauri	1923, April 10 (very flat).
155823	RZ Scorpii	1922, September 10.
193972	T Pavonis	1922, September 7, and 1923, May 20.
235265	R Tucanæ	1923, January 13.

The results will be published in the circulars of the Union Observatory.

W. M. WORSSELL,

Director.

METEOR SECTION.

Appeal for Observers.

The Council invites astronomers, throughout South Africa, to co-operate in the observation of meteors, with a view to accumulating material for the compilation of statistics and of obtaining well-determined radiants for Southern declinations.

The importance of such observations cannot be over-emphasized. In his inaugural address to the Society the late President remarked, when speaking of meteors: "I mention this in particular as a branch of astronomy which may be undertaken by anyone possessed of the true scientific instinct as to what is worthy of observation and record, and which does not require any elaborate instrumental aid.

Miss A. Grace Cook, Director of the B.A.A. Meteor Section, recently wrote: "The Southern radiants have received very little attention, so that *there is a rich harvest awaiting those who have the energy to gather it.*"

The apparatus required for this work is very simple:—

(i) A watch keeping S.A. standard time;

(ii) A thin, straight wand about a yard long;

(iii) Long's and Norton's Star Atlases for reference;

(iv) A shaded lantern and the necessary material for making notes.

Having furnished himself with the above necessaries, the observer cannot do better than proceed along the lines laid down by Miss Cook for the members of her section. These we shall proceed to quote at some length:

"Before he commences business the beginner must practise counting for duration of flight. Five counts to a second is suitable: 1, 2, 3, 4, 1; 1, 2, 3, 4, 2, and so on, for each second of duration. A stop-watch is a help in this, though it is seldom much used while observing. He must also as quickly as possible learn the principal stars for reference.

"Directly the meteor is seen the wand is projected along its path. Stars along the track beyond the meteor's path at beginning and end are noted for alignment (the alignment will generally be a few degrees away from these stars). Also stars are observed near the beginning and end of the meteor's path to obtain the length of the path. On first sight, the observer starts counting for duration of flight, and observes the brightness or magnitude as compared with moon, planets, or stellar magnitudes. He also obtains the general appearance; the colour and shape of the head, and if it has train or tail attached to it, or an after-streak (note the duration of this also), or any other details which may be seen.

"The observer next looks at his watch, notes the time to the nearest half-minute, records it in his notebook, together with magnitude, duration of flight, alignments for radiant and length of path, and general notes as to appearance. Each observer finds out for himself the quickest method of recording. After some practice it is possible to record a meteor in 30 seconds."

Will South African observers follow the procedure laid down by Miss Cook and mail their results to the Director of the Meteor Section, D. G. McIntyre, Ben Etive, Rondebosch? Will they also remember that one protracted watch on one evening is likely to produce far more valuable results than several short watches on consecutive evenings? Of course, a long watch every evening is what should ultimately be aimed at.

THE SKY IN OCTOBER.

By Arthur W. Long, F.R.A.S.

The Constellations.

The Southern Cross is now on the horizon a little to the west of south; the stars Delta and Gamma are already below the Johannesburg horizon, and two hours later the whole of the Cross will be invisible to observers north of latitude 26 degrees south. The Centaur is to the west of the Cross, and is partly set. Its bright forefeet, the Pointers, are still above the horizon, and to their west lies Lupus. Triangulum Australis is over the Pointers, with Ara to the west. The Peacock (Pavo) stands fairly erect above the Triangle and Ara, and over it is Indus.

The Scorpion stands on its head over the horizon a little to the south of west, looking like a great but reversed note of interrogation. Ophiuchus, with part of Serpens, is above the horizon due west, and filling the middle space between them and the zenith is Sagittarius.

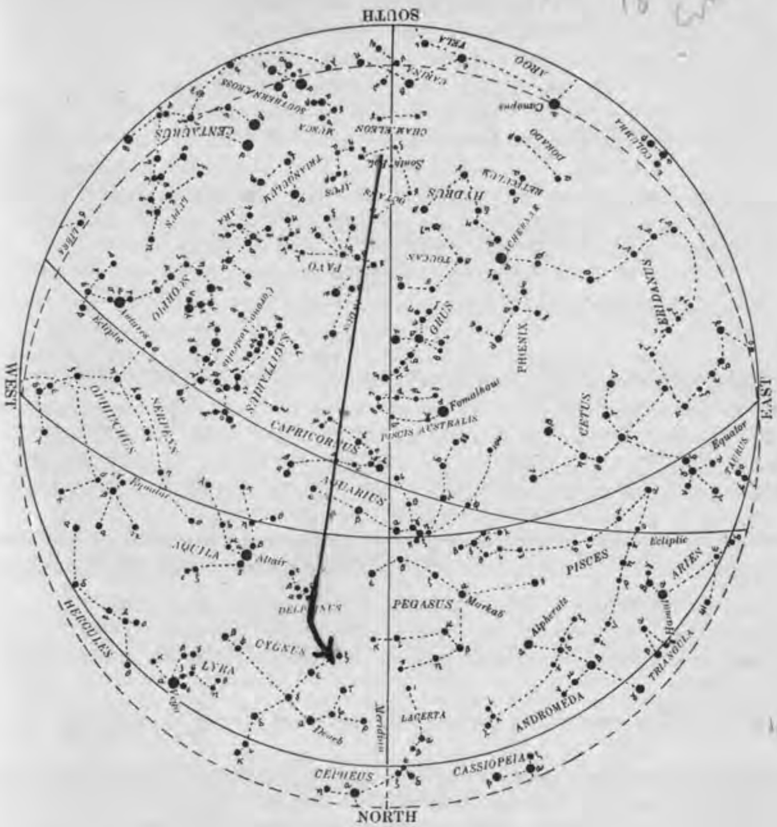
A few stars of Hercules are still above the north-western horizon, and beside them towards the north is Lyra. Midway to the zenith in the north-west is Aquila, and above is Capricornus reaching to the zenith. The Swan (Cygnus) is dipping to the horizon west of north. Some stars in Cepheus are on the Johannesburg horizon due north, and to the east of them Cassiopeia is rising. These stars are not seen from Cape Town.

Andromeda lies along the north-eastern horizon, one of the principal stars, Gamma, being invisible at this time from Cape Town. The Great Square of Pegasus is above Andromeda; the rest of the constellation extends to the meridian. Between Pegasus and the zenith is Aquarius.

To the east of Andromeda Aries is rising, and above it the two strings of small stars, one running into Andromeda and the other up towards Aquarius, form the constellation Pisces. In the east Cetus extends from the horizon two-thirds of the way to the zenith. The River Eridanus winds its way from the eastern horizon towards the south, ending in the bright star Achernar, which is more than half-way to the zenith. East of Achernar is Phœnix, and above it with its head in the zenith is the Crane (Grus). Piscis Australis droops from the zenith towards the east.

The greater part of the Ship (Argo) is below the southern horizon. The four stars in the shape of a cross which form the keel of the Ship (Carina) are just above the Johannesburg horizon directly below the Pole. Canopus, the second brightest star in the heavens, the Alpha of Argo, is seen well above the horizon at Cape Town to the east of south, but it has just risen to observers in Johannesburg. Above Canopus are the

(Continued on page 63).



This map indicates the appearance of the sky on October 1, at 10 p.m. in Cape Town, and at 9.22 p.m. in Johannesburg.

To find the time for which the map is correct on any later date, subtract from the figures given above four minutes for each day after October 1.

To find the time for which the map is correct on October 1 at any place in South Africa, subtract from 10 p.m. four minutes for every degree east of Cape Town, and add four minutes for every degree west.

The continuous circle represents the horizon at Cape Town, the broken circle the horizon at Johannesburg.

Only one-half of the map can be used at one time; the other half represents the sky behind the observer. The map is held correctly when the word which represents the horizon facing the observer is at the bottom. The centre of the map in all cases is the zenith.

minor constellations of Dorado and Reticulum. The larger Magellanic Cloud is in Dorado, and above it is Hydrus and the smaller Cloud. Toucan lies between Phœnix and Pavo.

There is no bright star to mark the position of the South Pole. The longer axis of the Southern Cross points nearly in its direction, the Pole being at a point about four and a half cross-lengths from the foot of the Cross. A line drawn from Beta Hydri, a fairly bright star situated close to the smaller Cloud, to Alpha Crucis, the most brilliant star in the Southern Cross, passes almost directly through the Pole, which is at a point in this line one-third of its length from Beta Hydri.

The Planets.

Venus may now be seen near the western horizon after sunset. It sets at 7.13 p.m. on the first of October, but will become more favourably placed as the month progresses. It will set at 7.43 p.m. on the 16th, and at 8.16 p.m. on the 31st. This planet, although now at about its minimum brightness, far outshines all stellar objects, being more than five times as bright as Sirius, the brightest star. It appears in the telescope as a bright little moon almost full.

Saturn is too close to the Sun to be of any interest at present. It is in conjunction with Venus on the 9th, passes behind the Sun on the 17th, and is in conjunction with Mercury on the 30th.

Jupiter is in the constellation Libra, and is now at its faintest, being brighter than Canopus but excelled by Sirius. This planet is now beyond the reach of northern observers, but it remains in our evening sky for several weeks. It is, however, too low in the sky when darkness sets in to be observed to advantage. It sets at 10.3 p.m. on the 1st, at 9.18 p.m. on the 16th, and at 8.35 p.m. on the 31st. Satellite I is occulted on the 3rd at 8.17 p.m., and Satellite III. is occulted on the 28th at 7.36 p.m. The reappearance after eclipse of Satellite I. occurs on the 12th at 7.40 p.m., and the reappearance of Satellite III. on the 21st at 7.24 p.m. These phenomena are observable in small telescopes.

Uranus is excellently placed for observation this month, being near the meridian at the time for which the map is set. This planet is just within the limit of naked eye vision. It may, however, be easily found and followed with field-glasses. It is almost directly in a line between the stars Phi and Lambda Aquarii, and about one and a quarter degrees from the latter.

Neptune is in the constellation Leo. A small telescope is needed for the observation of this, the most distant planet, as it is only of about the 8th stellar magnitude. Its meridian transit, when it is best placed for observation, takes place at present in daylight.

MARS moves from the constellation Leo into Virgo. It rises after dawn, and being very distant and faint, is invisible throughout the month.

MERCURY is in Virgo. This morning apparition is an unfavourable one for southern observers on account of the planet being considerably to the north of the Sun. When at greatest elongation on the 14th it rises only 42 minutes before the Sun. It may, however, on that date be glimpsed by keen sight as it is mag. —0.2, *i.e.*, three times as bright as Spica.

THE MOON.

Last Quarter on the 3rd at 7.29 a.m.
New Moon on the 10th at 8.6 a.m.
First Quarter on the 16th at 10.54 p.m.
Full Moon on the 24th at 8.26 p.m.

Day of Month.	Moon rises and sets at Cape Town.	Moon rises and sets at Johannesburg.	Moon rises and sets at Durban.
	Rises a.m.	Rises p.m.	Rises p.m.
	h. m.	h. m.	h. m.
1	—	11.37	11.31
2	0.31	a.m.	a.m.
3	1.21	0.26	0.21
4	2.10	1.15	1.10
5	2.57	2.3	1.57
6	3.41	2.49	2.43
7	4.24	3.35	3.27
8	5.6	4.19	4.10
9	Sets p.m.	Sets p.m.	Sets p.m.
10	7.17	6.33	6.23
11	8.27	7.40	7.31
12	9.36	8.46	8.38
13	10.44	9.50	9.44
14	11.47	10.51	10.47
15	a.m.	11.49	11.45
16	0.45	a.m.	a.m.
17	1.37	0.43	0.38
18	2.23	1.32	1.25
19	3.5	2.16	2.8
20	3.43	2.56	2.47
21	4.17	3.33	3.23
22	4.50	4.9	3.57
23	5.22	4.45	4.31
24	Rises p.m.	Rises p.m.	Rises p.m.
25	7.49	7.0	6.52
26	8.42	7.51	7.43
27	9.35	8.41	8.34
28	10.27	9.31	9.26
29	11.17	10.21	10.16
30	a.m.	11.10	11.4
31	0.6	11.57	11.52

ASTRONOMICAL SOCIETY OF SOUTH AFRICA.

REPORT OF COUNCIL FOR YEAR ENDED 25TH JULY, 1923.

In submitting their first Annual Report, the Council desire first of all to express their profound regret at the death of the distinguished President of the Society, which took place on the 8th July at Gerrard's Cross, England, after a long and painful illness. Mr. Hough took a keen interest in the welfare and the work of the Society, and the loss of his invaluable advice and kindly presence will be greatly felt.

The negotiations between the Cape Astronomical Association and the Johannesburg Astronomical Association mentioned in the last Annual Reports of those bodies resulted in the draft Constitution of the Astronomical Society of South Africa being adopted by both Associations, which thereupon became respectively the Cape and Johannesburg Centres of the Society.

As it was not possible to complete the necessary formalities previously to the 1st July, 1922, the date from which the Constitution has effect, the Society was not established on a working basis till the 23rd August, 1922.

Until the latter date, in accordance with the provisions of the Constitution, the Society was governed by the last Council of the late Cape Astronomical Association, which met twice under the Presidency of Mr. A. W. Long, F.R.A.S. The first elected Council of the Society has since met five times, when the four Johannesburg members of Council were represented by their alternates.

Of the elected Officers and Members of Council, whose names were recorded in the first issue of the Journal, Mr. J. F. Skjellerup, Treasurer, and Mr. Theodore MacKenzie, Secretary, resigned their offices on leaving for Australia and Grahamstown respectively. The Council appointed Mr. A. F. I. Forbes and Mr. C. L. O'Brien Dutton to fill their places. Mr. Skjellerup's valuable work as a variable star observer and as Director of that Section is well known, as also his success in discovering three new comets, in respect of each of which he was awarded the Donohoe Comet Medal by the Astronomical Society of the Pacific. Although Mr. Skjellerup remains a Member of the Society, and intends to work for it in Australia, his present help and advice will be greatly missed. No less may be said of Mr. MacKenzie, whose able and tactful treatment of the difficult task of launching the new Society was beyond praise, and whose services as Secretary can therefore be ill spared. His faculty for historical research may, however, we hope, long be available to the Society. The Council heartily wish both these gentlemen all success, astronomical and otherwise, in their new fields of labour.

The Bye-laws of the Society, as adopted with the Constitution, have remained unchanged, with the exception of a minor alteration in Bye-law 5, which is recommended for confirmation by the Annual Meeting.

Copies of the Journal were supplied free, not only to all Members of the Society as required by the Constitution, but also to nine South African newspapers, five publications dealing with astronomical subjects, and 24 public institutions, mostly astronomical.

The thanks of the Council have been accorded to the Union Observatory for a complete set of the Circulars issued by that Institution.

The purely scientific work of the Society is the main interest of the two Centres, the only part therein that is definitely assigned to the Council being the appointment of Directors of Observing Sections.

The functions of the Council are, in general, the government and advancement of the Society, and, in particular, the co-ordination and publication in the Journal of the results of the Society's work.

But it must also be the Council's peculiar care to see that all the objects of the Society, as set forth in Art. III. of the Constitution, are duly served.

The first of these objects is: The encouragement and stimulation of the study of astronomy throughout South Africa.

The second: The association of observers and their organization in the work of astronomical observation and research.

Every Member and Associate is enjoined to assist the Council in the attainment of these objects by selecting and assiduously following up, by observational work if possible, some particular branch of astronomical study, and, further, by interesting therein as many others as he can and persuading them to join the Society.

When, in a locality remote from either of the two Centres, Members and Associates become sufficiently numerous to organize themselves, the question of asking the Council to form a Branch of the Society might be considered.

Already, in Natal and at the Transvaal University College, amateur astronomers, some of whom are Members of the Society, have come together and have formed promising associations of their own. The Council have been in correspondence with these bodies, and, although no positive results can yet be recorded, they are hopeful that in time such keen astronomers may perceive the advantage of union with this Society.

A not unduly optimistic view held in an influential quarter is that before long the Society will make a great advance and become an institution of real importance and world-wide repute. The impending arrival in our midst of skilled American astronomers will no doubt afford a further stimulus to the study of astronomy in South Africa.

At the same time, it cannot be too fully realized that the future of the Society is intimately connected with the production and circulation of the Journal. The more frequently the Journal can be issued the greater will be the inducement to those interested in its contents to join the Society; and the better the quality of its contents, the wider will be its general circulation. There is, one may suppose, no wish to aim at making the Journal self-supporting. Even if such a result were attainable, which is perhaps unlikely, the policy of future Councils should be to secure the best all-round results with the funds at their disposal, and to make the Journal in every way worthy of the objects and aspirations which the Society has set before itself.

But the more favourable conditions as regards the Journal which the Council have in mind can only be reached by a strong initial effort to increase the membership of the Society, until sufficient funds are available to enable at least four Journals to be issued during the year. For this probably another fifty Members will be required. For the sake of the quality of the Journal, there should be no less an effort on the part of Members and Associates to increase their activities in study and observation.

Apart from the Journal, the Council have thought that a most suitable publication for the Society to undertake would be Dr. Halm's paper on the Sundial, in English and Dutch. This was written some years ago for use in schools, but it is now being adapted for general use, and the diagrams made detachable, so that by pasting them on a wooden framework of the simplest construction a portable sundial could be readily produced. It has been arranged that this publication shall involve no loss whatever to the Society's funds, but that the Society shall receive half of any profits.

AUDITED FINANCIAL STATEMENT FOR YEAR ENDED 30TH JUNE, 1923.

RECEIPTS.	£ s. d.	PAYMENTS.	£ s. d.
Contributions from Cape Centre to Society Headquarters, under Art IX (i) of Constitution	21 15 4	Balance of cost of printing Constitution	2 2 6*
Ditto from Johannesburg Centre	11 10 9	Printing Journal.. ...	12 0 0
Proceeds of Sale of Journal...	2 7 3	Other Printing and Stationery..	4 11 9
		Secretary's expenses...	2 15 11
		Treasurer's expenses..	0 2 5
		Balance in hand, 30th June, 1923	14 0 9
	£35 13 4		£35 13 4

Audited and found correct.

E. J. STEER.

* Note by Council.—The cost of printing the constitution was £10 2s. 6d., of which the late Cape Astronomical Association paid £8 as a donation to the Society's funds.

CAPE CENTRE.

Annual Report, Session 1922-3.

Your Committee, in presenting this, the Ninth Annual Report, have to make the following statement:—

In accordance with Article X. of the Constitution, a Special General Meeting of the Centre was held, on September 13th, 1922, at which your Committee was elected and a schedule of Rules and Bye-Laws for the management of the Centre was adopted. This has since received the approval of the Council of the Society.

Meetings.

Your Committee are pleased to record the unabated interest by the members in the affairs of the Centre. In addition to the afore-mentioned meeting, there have been nine ordinary meetings of the Centre, which have been fairly well attended. The Committee have met six times.

In February an observational meeting was held at the Royal Observatory, when the six-inch and seven-inch and astrographic telescopes were placed at the disposal of members. The thanks of the Centre are tendered to His Majesty's Astronomer and the Observatory Staff for this privilege. In May a Conversazione and Exhibition was held, at which a large number of interesting photographs and transparencies were exhibited.

The following lectures and papers were read and discussed at the ordinary meetings:

"Apparent Enlargement of the Moon when near the Horizon," Mr. T. MacKenzie; "Predicting Occultations," Mr. A. W. Long, F.R.A.S.; "The Moon through a Three-Inch Telescope," Mr. H. W. Schonegevel; "The Development of Astronomical Knowledge," Dr. J. K. E. Halm, F.R.A.S.; "The Sun," Mr. A. W. Long, F.R.A.S.; "Observations of the Moon," Prof. E. H. L. Schwarz; "The Planet Mercury," Mr. D. G. McIntyre; "The Planet Venus," Mr. H. W. Schonegevel; "The Earth as a Planet," Mr. H. E. Houghton; "Methods of Observation of Variable Stars," Senator the Hon. A. W. Roberts, D.Sc., F.R.S.E.

Library.

Owing to the generous bequest of the late Mr. Clement Jennings Taylor, F.R.A.S., a former President of the Cape Astronomical Association, a large number of volumes, including Memoirs and Monthly Notices of the Royal Astronomical Society, have been added to the library of the Centre. Mr. W. H. Cox has presented several Star Catalogues.

Lantern Slides.

The late Mr. Taylor has bequeathed to the Centre his fine collection of lantern slides, and a number has been presented by Mr. A. W. Long. Further additions have been made by purchase; so that the Committee is now in a position to make loans of slides to members for purposes of lectures, etc., in terms of Bye-Laws 8 to 15.

Practical Instruction.

Arrangements have been made to hold a class of instruction in Practical Astronomy during the ensuing session. Young's "General Astronomy" will be used as the Hand-book.

Astronomical Contributions to the Press.

The monthly notes with chart of the heavens have been published in the *Cape Times*, as in previous years, and frequent articles are now contributed to *De Burger* having reference to astronomical phenomena.

Audited Financial Statement for Year ended 30th June, 1923.

Receipts.	£	s.	d.	Payments.	£	s.	d.
Balance in hand, 1st July, 1922	6	1	2	Contribution towards Cost of printing Constitution	8	0	0
Subscriptions to late Cape Astronomical Association	9	12	0	Contributed to Society Headquarters under Art. IX (i) of Constitution	21	15	4
Subscriptions, 1922-23 ..	39	6	9	Rent of No. 35, Wale Street	10	0	0
Subscriptions, 1923-24 ..	4	4	0	Library and Lantern Slides	2	6	0
Profits from Sale of "The Constellations as seen from South Africa," by A. W. Long, F.R.A.S.	3	0	0	Secretary's expenses ...	10	10	7
				Treasurer's expenses ...	1	6	4
				Balance in hand, 30th June, 1923	8	5	8
	£62	3	11		£62	3	11

JOHANNESBURG CENTRE.

Report for Session 1922-1923.

The Session just concluded has been notable in that during its course the amalgamation of the Cape Astronomical Association and the Johannesburg Astronomical Association took place, the Astronomical Society of South Africa being thus formed.

The Johannesburg Centre was accorded a representation on the Council of four members, including Mr. W. B. Jackson, M.Sc., as Vice-President.

The Committee hopes this joining of hands will have the much-needed effect of increasing considerably the interest taken in astronomical matters in South Africa.

The following papers were read during the year:—

"The Calendar," T. Beamish; "Mars," James Moir, M.A., D.Sc., F.I.C.; "Venus," W. B. Jackson, M.Sc.; "Navigation," J. D. Stevens.

A question night was also held, and quarterly visits were made to the Union Observatory.

A gift of a copy of "The Constellations," by Mr. A. W. Long, F.R.A.S., was received from the Cape Centre of the Society.

The Committee wishes to record its congratulations to Dr. Innes, the first President of the Johannesburg Astronomical Association, on the degree of Doctor of Science conferred upon him by the University of Leyden.

The thanks of the Society are again due to Dr. Innes and the Union Observatory Staff for their kindness and untiring efforts in entertaining and instructing Members of the Society during their visits to the Observatory, and to Mr. Worssell for his monthly presentation of the Ephemerides of the planets.

AUDITED FINANCIAL STATEMENT FOR YEAR ENDED 30TH JUNE, 1923.

RECEIPTS.	£	s.	d.
Balance in hand, 21st October, 1921	17	3	6
Subscriptions to late Johannesburg Astronomical Association..	4	9	0
Subscriptions, 1922-23 ..	23	2	0*
Observatory Visitors ..	0	3	0
	£44	17	6

PAYMENTS.	£	s.	d.
Contributions to Society Headquarters under Art. IX (i) of Constitution	11	10	9
Rent of Rooms	1	5	0
Purchase of Publications	3	16	9
Printing and Advertisements	3	17	6
Secretary's and General Expenses	3	7	1
Subscription to British Astronomical Association	1	1	6
Balance in hand, 30th June, 1923	19	18	11
	£44	17	6

* Includes commission of 6d. tendered on cheque.

Astronomical Society of South Africa.

OFFICERS AND COUNCIL, 1923-24.

President: R. T. A. Innes, D.Sc., F.R.S.E., F.R.A.S., F.R.Met.A., Union Astronomer, Union Observatory, Johannesburg.

Vice-Presidents: J. K. E. Halm, Ph.D., F.R.A.S.; Senator the Hon. A. W. Roberts, D.Sc., F.R.S.E., F.R.A.S.; J. D. Stevens.

Hon. Secretary: C. L. O'Brien Dutton, P.O. Box 2061 (Tel. 2992 Central), Cape Town.

Hon. Treasurer: W. H. Smith, Arum Villa, Plumstead (Tel. 676 Claremont).

Members of Council: W. Eaton, W. B. Jackson, M.Sc., A. W. Long, F.R.A.S., D. G. McIntyre, W. Reid, H. W. Schonegevel.

Alternate Members of Council: W. H. Cox, A. F. I. Forbes, H. E. Houghton, B. Jeary.

Auditor: E. J. Steer.

DIRECTORS OF OBSERVING SECTIONS.

Comet: W. Reid, "Glen Logie," Camp Ground Road, Rondebosch (Tel. 597 Claremont).

Variable Stars: W. M. Worssell, F.R.A.S., Union Observatory, Johannesburg.

Meteor: D. G. McIntyre, "Ben Etive," Park Road, Rondebosch (Tel. 449 Claremont).

Mars: J. Moir, M.A., D.Sc., F.I.C., 54a, Esselen St., Hospital Hill, Johannesburg.

Editor of Journal: H. E. Wood, M.Sc., F.R.A.S., Union Observatory, Johannesburg.

Librarian: The Secretary.

COMMITTEE OF CAPE CENTRE, 1923-24.

Chairman: J. K. E. Halm, Ph.D., F.R.A.S., Royal Observatory, Cape (Tel. 567 Central).

Vice-Chairman: D. G. McIntyre.

Hon. Secretary: H. W. Schonegevel, P.O. Box 2061, Cape Town (Tel. 240 Central).

Hon. Treasurer: A. F. I. Forbes, "Craigie Brae," Liesbeek Road, Rosebank (Tel. 2713 Central).

Members of Committee: C. L. O'Brien Dutton, A. W. Long, F.R.A.S., the Rev. J. McAllister, W. Reid, W. H. Smith.

Librarian: W. Potts.

Auditor: E. J. Steer.

COMMITTEE OF JOHANNESBURG CENTRE, 1923-24.

Chairman: J. D. Stevens.

Hon. Secretary: W. Eaton, P.O. Box 2402, Johannesburg.

Hon. Treasurer: F. B. Hall, P.O. Box 470, Johannesburg.

Members of Committee: W. Geddes, W. B. Jackson, M.Sc., J. Moir, M.A., D.Sc., F.I.C., F. J. Nance, W. M. Worssell, F.R.A.S.