THE VARIABLE STARS AND NEBULAE NEAR R CORONA AUSTRALE.

THE early history of this region with a map is given in the *Cape Annals*, Vol. IX, p. 133B, and in *Bulletin* No. 16 of the Helwan Observatory. A photographic map of the region was published in *Circular* No. 5 of the Transvaal Observatory, and further references will be found in *Circulars* Nos. 20 and 33 of the Union Observatory and in two short papers by Mr. J. H. Reynolds and Mr. H. Knox Shaw in the *Monthly Notices* for 1916, June.

If we refer to the diagram, Plate VIII (1), we note that the largest star is lettered D, then follow in order of size A, B, R, and T. The positions of these objects are :—

Object.	C.P.D. No.	C.P.D. Mag.	1875. R.A.	1875. Dec.	Notes.
	°		h. m. s.	° ′	
D	— 37 8446	6·4	18 52 37·1	— 37 13·7	A wide double star.
A	— 37 8449	7·2	18 53 13·5	— 37 3·6	
B	— 37 8450	8·7	18 53 15·0	— 37 2·8	Variable.
R	— 37 8452	10·1	18 53 28·0	— 37 7·5	Variable.
T	...	...	18 53 33·0	— 37 8·3	

Another star S Cor. Aust. was considered to be variable by Schmidt, but it is now generally assumed to be invariable or nearly so; a similar remark also applies to the star T. The main interest centres around the stars marked B and R and their nebulous appendages. The star D is a 12″·5 double, showing no change in angle or distance in seventy years. As seen telescopically, the double star D is quite free from nebulosity, but photographically it is involved in convolutions of nebulosity which cover the whole region as is shown in the diagram. Visually, the only nebulous appendages, as seen in the 9-inch telescope, are the two circular atmospheres surrounding A and B and the patch between R and T.

Although much detail is lost in reproduction of the photograph, an enlargement, Plate VIII (2), made from Mr. Worssell's plate of 1914, July 16, exposure 120m in the Franklin-Adams Star Camera, is given. This is supplemented by the above diagram from a drawing made by the writer from the same plate. All our better photographs show the same structure, and on them A and B are just separated.

If we now refer to plate 13 of the *Monthly Notices* (1916, June), the diagrams show the stars A and B almost hidden in their nebulous envelopes and R Cor. Austr. with its attached nebula extending towards T.

In Union Observatory *Circular* No. 33 it was announced that the star B is variable. Its period is very closely 26 days. Usually it shines as a star of the 8·9 mag., but for a few hours it is faint, sinking to below the 12th mag., and variability of the Algol type is suggested—unfortunately that the type of variability is thus, was only noticed when it was too late to get observations extending over a whole minimum. So far the photographs give no information confirming the variability or otherwise and we have to rely on visual observations for the changes in B and its envelope. As already remarked, the envelopes to A and B are visually quite uniform, whilst the photographs reveal a very intricate structure. The net result of the visual observations made here is that A's envelope is generally the larger and brighter, but when B is faint, its envelope is the larger and brighter. The crucial observations are as follows:—

Date.	G.T.	Mag. of B.	Envelopes.
1915, Oct. 29	...	12·4	
,, ,, 31		9·0	Envelopes equal.
,, Nov. 24		11·5	Envelope around B quite bright whilst A's is nearly invisible, but twilight.
1916, Aug. 9		9·0	B's envelope the smaller and fainter.
,, ,, 10		12·1	Moon.
,, ,, 11		9·4	Moon. Colour of B = red 5.
,, Sept. 4		9·4	A's envelope the larger and brighter.
,, ,, 5	5h 30m	11·5	Looks like the nucleus of a nebula, this nebula being brighter and denser, but not larger than A's envelope.
,, ,, 5	6 30	9·9	But B's envelope still larger and brighter than A's.
,, ,, 6	5 0	9·0	A's envelope the larger and brighter.

Observations on the 7, 8, 9, 10, 11, 13, 15, 16, 17, 18, 20, 21, 22, 23, 25, 26, 27, 28, 29 September gave B's mag. from 8·9 to 9·2, with the envelopes about equal, but the preference ,if any, to B's as being slightly larger and brighter; then we continue—

Date.	G.T.	Mag. of B.	Envelopes.
1916, Sept. 30	$5^h\ 30^m$	9·0	and B's envelope is the larger and brighter.
,, ,, 30	8 15		
,, Oct. 1	5 3	11·5	B's envelope is very much the larger and brighter; star just like a fine stellar point in nucleus of a comet.
,, ,, 1	6 23	10·0	Decided brightening.
,, ,, 1	7 15	10·0	B's envelope the brighter.
,, ,, 3		8·9	B's envelope the brighter, but ☾ (or moon).

Then 5 to 13 October, 8·9 to 9·0, envelopes about equal, but B's generally considered a little larger and brighter.

Date.	G.T.	Mag. of B.	Envelopes.
1916, Oct. 26	$5^h\ 10^m$ to $5^h\ 16^m$	9·0	B's envelope a little larger and brighter. Twilight.
,, ,, 27	$7^h\ 6^m$	10·0	Very poor: between passing cloud.
,, ,, 27	7 16	9·5	Envelopes about equal.
,, ,, 31		9·0	
,, Nov. 2		8·9	

The minima indicate a period just under 26 days. When B is faint, it is observed that its envelope is larger and brighter than A's, but this may be due to the contrast effect; but if it is real, we have the interesting conclusion that when the star is faint, its envelope becomes bright as though there is an exchange of energy. As visually no detail can be seen in the envelope, the nature of the changes can only be investigated when large-scale photographs are available.

We now pass to a consideration of R Corona Austr. and the nebulous matter betwixt it and the star T. A careful examination of our photographs and the Helwan plate (especially diagram No. 2 of that plate) shows that between R and T there are three variable arcs of nebulous matter, but visually these cannot be separated; they blend into each other and look like a fan shape, apex at R and opening to T. The brightest arc is a the nearest to R, and generally the end a_1 is the brighter, sometimes the end b_2 of b is bright. The fan seems to shift in its direction according to the shifting of the bright portions of the arc. From 1915, June, to 1916, October, R has ranged from 9·5 to 14·7 mag., but there is no trace of regular periodicity. R becomes almost invisible when at its faintest, but the nebula never disappears; it brightens when R brightens. As with the previous star and its nebulous appendage, visual observations with so small a telescope as 9 inches cannot answer the questions which arise.

The photographs yield:—

	Mag.	Concentrations of Light in Nebulous Arcs.
1910, Aug. 5	9·0	b_2 c_2
,, Sept. 1	9·5	a b c_1 c_2
1912, June 21	12·0	a_1 b_1 b_2 c_1 c_2
,, July 13	10·7	
1913, ,, 28	12·4	a_1 only.
,, Aug. 27	12·0	
,, Oct. 2	12·2	a_1 b_1 c_1
1914, July 16	10·1	a_1 a_2 b c
,, ,, 23	10·4	c_1 c_2
,, ,, 25	10·4	a_1
1915, May 7	12·5	
,, ,, 9	13·0	
,, June 10	11·5	
,, Aug. 3	10·7	b c_1
,, ,, 6	10·7	b_2 c_2
,, Sept. 7	12·7	a ft. c_1 c_2:
1916, July 19	11·0	a_1 b c
,, ,, 21	10·7	
,, Sept. 15	9·5	
,, ,, 16	9·5	b_2

The visual observations of the magnitude of R are:—

1915,	July	29.....	13·7	1915,	Oct.	13.....	14·0	1916,	Aug.	21.....	13·5	1916,	Sept.	20.....	11·0
,,	,,	30.....	13·2	,,	,,	14.....	14·0	,,	,,	22.....	13·3	,,	,,	21.....	11·0
,,	,,	31.....	13·7	,,	,,	18.....	14·0	,,	,,	23.....	13·5	,,	,,	22.....	11·5
,,	Aug.	5.....	13·7	,,	,,	19.....	14·0	,,	,,	24.....	13·0	,,	,,	23.....	12·0
,,	,,	7.....	12·7	,,	,,	29.....	14·5	,,	,,	25.....	13·2	,,	,,	25.....	11·0
,,	,,	9.....	13·2	,,	,,	31.....	14·5	,,	,,	26.....	13·2	,,	,,	26.....	9·9
,,	,,	10.....	13·5	,,	Nov.	1.....	14·5	,,	,,	27.....	13·2	,,	,,	27.....	11·0
,,	,,	16.....	12·3	,,	,,	8.....	14·5	,,	,,	28.....	13·2	,,	,,	28.....	12·0
,,	,,	17.....	12·4	,,	,,	14.....	14·5	,,	,,	29.....	12·8	,,	,,	29.....	12·5
,,	,,	18.....	12·1	,,	,,	18.....	14·5	,,	,,	30.....	12·5	,,	,,	30.....	12·9
,,	,,	19.....	12·4	,,	,,	24.....	14·5	,,	,,	31.....	11·5			(5h. 30m.)	
,,	,,	21.....	12·4	,,	,,	26.....	14·5	,,	Sept.	1.....	11·0	,,	,,	30.....	13·5
,,	,,	26.....	12·4	1916,	June	23.....	13·5	,,	,,	2.....	11·0			(8h. 15m.)	
,,	,,	27.....	12·2	,,	,,	25.....	13·5	,,	,,	3.....	10·0	,,	Oct.	1.....	13·6
,,	,,	30.....	12·4	,,	,,	26.....	13·0	,,	,,	4.....	10·0	,,	,,	3.....	13·6
,,	,,	31.....	12·4	,,	,,	29.....	13·4	,,	,,	5.....	9·5	,,	,,	5.....	13·7
,,	Sept.	2.....	12·6	,,	,,	30.....	13·2	,,	,,	6.....	9·5	,,	,,	6.....	13·6
,,	,,	4.....	13·5	,,	July	1.....	13·0	,,	,,	7.....	9·7	,,	,,	10.....	11·5
,,	,,	5.....	13·5	,,	Aug.	3.....	13·0	,,	,,	8.....	10·5	,,	,,	12.....	11·5
,,	,,	9.....	13·5	,,	,,	4.....	13·0	,,	,,	9.....	10·7	,,	,,	13.....	11·5
,,	,,	20.....	14·0	,,	,,	5.....	13·5	,,	,,	10.....	10·2	,,	,,	26.....	12·0
,,	,,	23.....	13·5	,,	,,	9.....	13·0	,,	,,	11.....	10·0	,,	,,	27.....	12·0
,,	,,	25.....	13·7	,,	,,	15.....	13·3	,,	,,	13.....	10·0	,,	,,	31.....	9·5
,,	,,	28.....	14·2	,,	,,	16.....	12·5	,,	,,	15.....	9·7	,,	Nov.	2.....	10·5
,,	Oct.	3.....	14·5	,,	,,	17.....	13·0	,,	,,	16.....	10·0	,,	,,	11.....	9·2
,,	,,	4.....	14·7	,,	,,	18.....	13·0	,,	,,	17.....	10·5				
,,	,,	12.....	14·0	,,	,,	19.....	13·5	,,	,,	18.....	10·5				

These magnitudes are in the scale used at Helwan. It will be noticed that the light remains fairly constant for some time and then changes in sequences of 11 days. On each occasion, the position and brightness of the nebula near R was also recorded, but the results seem to be without any sequence and are probably valueless; the nebula was always seen unless the moon was near; the appearance was frequently as if R was the stellar nucleus of a comet with a tail whose S. boundary nearly reached to T and whose N. boundary made an angle of 40° with R....T. The nebula is visually as well as photographically variable, but its full investigation requires more optical power than is here at present.

Mr. Hubble's paper on the variable nebula N.G.C. 2261 in the *Astrophysical Journal* fo r1916, October, may be mentioned; there is a family likeness between N.G.C. 2261 and the nebula of R. Cor. Austr.

R. I.

PLACES OF MINOR PLANETS (324) AND (423).

PLATES, mainly to deal with R Corona Austrina itself, were secured by Mr. W. M. Worssell with the Franklin-Adams Star Camera on 1916, July 19 and 21.

Incidentally the planets *Bamberga* (324) and *Diotima* (423) were swept on and their places taken off with a millimetre scale, as follows:—

Date and Greenwich Time. 1916.	*Bamberga*, 9·0 m.		*Diotima*, 10·3 m.	
	R.A.	Dec.	R.A.	Dec.
	h. m. s.	° ′	h. m. s.	° ′
July 19·29372.....	19 24 19	— 34 24·3	19 5 26	— 33 16·1
,, 21·31319.....	19 21 49	— 34 20·8	19 3 41	— 33 21·7

These places are the Astrographic Positions for the equinox of 1875. If necessary the images could be measured with greater accuracy.

R. I.

ERRATUM.

Circular No. 35, last word on page 269:—For $= \sqrt{d}$ read $= \cdot 9\sqrt{d}$.