

HARVARD COLLEGE OBSERVATORY.

CIRCULAR No. 90.

105 NEW VARIABLE STARS IN SCORPIUS.

THE investigation of large nebulous regions, described in Circulars Nos. 78, 79, 82, and 86, has been continued by Miss Henrietta S. Leavitt, with the results given in this Circular.

In no respect has the results of photography been more striking than in the revelation of diffused nebulae of vast extent whose faintness renders them almost beyond the reach of visual observation. One of the most remarkable of these extends over many square degrees in the constellations of Scorpius and Ophiuchus. Like the Nebula of Orion, it attaches itself to individual stars, the principal condensation being about the quadruple star, ρ Ophiuchi. The region is marked by a noticeable absence of stars of the fainter magnitudes, and dark lanes can be traced in different directions for a considerable distance beyond the visible nebulosity. A cursory examination of a part of this region has led to the discovery of seventy-two new variable stars, besides the known variables, R, S, W, X, Y, RX and RZ Scorpil, and No. 1 in the cluster N.G.C. 6093. The position, R. A. = $16^h 23^m 39^s$, Dec. = $-19^\circ 7'.1$ (1900), does not differ greatly from R. A. = $16^h 23^m 49^s$, Dec. = $-19^\circ 13'.3$ (1900), which is that given for Y Scorpil by its discoverer, Dr. Peters. As Hartwig states that the position of Y Scorpil is uncertain, it is assumed that the two positions refer to the same object. Thirty-three plates were examined. Of these, twenty-six were taken with the 24-inch Bruce Telescope, with exposures of from 60 to 273 minutes, and seven were taken with the 8-inch Bache Telescope, with exposures of from 45 to 150 minutes. In the region extending in right ascension from about $16^h 0^m$ to $16^h 20^m$, and in declination from about -18° to -23° , it is improbable that any large number of variables, which at maximum are brighter than the fourteenth magnitude, have been overlooked. The region extending in right ascension from about $16^h 25^m$ to $16^h 45^m$, and in declination from about -25° to -30° , has also been fairly well covered, especially in the following portion. A few variables outside of the above limits are in regions for which there was but little material available for examination.

In Table I, the successive columns give a number for reference, the right ascension and declination for 1900, the brightest and faintest observed magnitudes, according to a provisional scale, and the range.

TABLE I.
VARIABLE STARS IN SCORPIUS.

No.	R. A. 1900.			Dec. 1900.	Br.	Ft.	R.	No.	R. A. 1900.			Dec. 1900.	Br.	Ft.	R.
	<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>°</i>					<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>°</i>			
1	15	57	34	-23 18.4	12.8	<15.0	2.2	37	16	25	28	-27 41.7	12.2	<13.6	1.4
2	16	1	6	-21 54.0	13.5	14.4	0.9	38	16	26	40	-26 10.4	11.8	<15.0	3.2
3	16	1	10	-23 24.0	12.9	14.0	1.1	39	16	27	13	-25 58.6	11.8	13.7	1.9
4	16	1	45	-23 2.6	11.3	14.5	3.2	40	16	27	38	-26 32.2	12.2	14.8	2.6
5	16	1	52	-23 47.6	12.3	13.9	1.6	41	16	28	2	-26 24.2	11.7	13.1	1.4
6	16	2	35	-21 49.1	12.4	14.2	1.8	42	16	29	4	-26 16.5	11.2	15.0	3.8
7	16	3	42	-21 37.9	13.0	13.6	0.6	43	16	30	41	-29 31.8	12.8	<15.0	2.2
8	16	4	18	-22 27.3	11.8	13.3	1.5	44	16	30	52	-27 6.5	12.2	<15.0	2.8
9	16	4	27	-23 50.4	11.2	13.1	1.9	45	16	31	12	-27 53.6	13.7	<15.0	1.3
10	16	4	52	-22 48.2	10.7	14.8	4.1	46	16	31	32	-29 6.9	13.2	14.2	1.0
11	16	6	7	-19 40.3	13.0	14.2	1.2	47	16	31	58	-28 22.0	10.5	<15.0	4.5
12	16	6	36	-20 40.4	11.4	12.2	0.8	48	16	32	37	-27 49.4	13.5	<15.0	1.5
13	16	8	46	-21 27.1	11.2	14.3	3.1	49	16	34	48	-27 15.9	10.9	<14.5	3.6
14	16	9	8	-21 30.6	11.1	12.1	1.0	50	16	36	37	-24 34.2	10.5	12.0	1.5
15	16	9	37	-24 46.0	12.3	15.5	3.2	51	16	38	16	-27 49.9	13.1	14.1	1.0
16	16	9	38	-22 28.1	11.2	12.8	1.6	52	16	38	42	-24 55.6	11.2	12.8	1.6
17	16	10	10	-23 21.3	12.3	13.7	1.4	53	16	38	46	-28 43.2	13.6	14.5	0.9
18	16	10	58	-21 24.3	12.9	13.6	0.7	54	16	39	1	-26 41.5	12.6	13.8	1.2
19	16	12	11	-21 34.6	13.4	<15.0	1.6	55	16	39	30	-28 1.7	10.9	13.0	2.1
20	16	12	22	-20 57.4	12.4	14.2	1.8	56	16	39	43	-29 31.9	13.6	14.9	1.3
21	16	13	28	-22 7.0	11.8	<15.0	3.2	57	16	40	23	-27 12.4	10.7	14.8	4.1
22	16	13	42	-23 10.0	10.8	12.3	1.5	58	16	40	25	-29 57.5	13.8	<14.8	1.0
23	16	14	36	-23 0.2	12.9	14.1	1.2	59	16	40	29	-27 56.8	13.6	<14.8	1.2
24	16	15	2	-21 17.4	11.7	12.4	0.7	60	16	41	6	-30 15.7	12.5	13.5	1.0
25	16	15	32	-21 53.1	11.6	12.3	0.7	61	16	41	8	-28 1.9	14.2	14.8	0.6
26	16	15	48	-22 39.1	13.6	14.7	1.1	62	16	41	15	-29 25.3	13.9	14.5	0.6
27	16	16	42	-20 44.3	13.3	14.7	1.4	63	16	42	12	-29 56.9	12.8	13.8	1.0
28	16	18	14	-22 16.0	12.3	12.8	0.5	64	16	43	5	-27 2.6	13.0	<15.0	2.0
29	16	19	21	-24 15.9	12.5	12.9	0.4	65	16	43	36	-27 16.2	13.7	14.9	1.2
30	16	20	43	-22 5.6	12.9	<15.5	2.6	66	16	43	36	-29 24.1	11.3	11.8	0.5
31	16	20	50	-22 0.3	13.0	13.8	0.8	67	16	43	56	-28 17.2	10.9	<14.7	3.8
32	16	21	1	-31 4.7	10.6	<14.7	4.1	68	16	44	4	-27 49.6	13.0	14.0	1.0
33	16	22	6	-21 22.1	12.1	13.0	0.9	69	16	44	9	-28 1.2	13.6	14.5	0.9
34	16	22	21	-21 32.8	12.0	12.9	0.9	70	16	44	17	-25 23.4	10.9	<15.0	4.1
35	16	23	8	-29 48.3	13.8	14.7	0.9	71	16	44	38	-27 47.6	13.8	14.8	1.0
36	16	23	13	-20 1.0	12.4	13.5	1.1	72	16	46	18	-28 22.8	12.2	<15.0	2.8

REMARKS.

No. 10. This star is C. DM. -22° 11391.	No. 39. The northern and preceding of two stars.
No. 29. In a strongly nebulous region. Variation well seen, though small.	No. 49. This star is C. DM. -27° 11069.
No. 36. The variation, although well seen, is less marked than the estimated magnitudes would indicate. The variable is near the edge of the plates, and difficult to observe.	No. 50. This star is C. DM. -24° 12774.
No. 38. A star of about the magnitude 14.5 precedes the variable about $1^{\circ}.5$, and is south of it about $0^{\circ}.8$.	No. 55. The following of two stars.
	No. 66. Variation well seen, though small.
	No. 69. The central star of a line of three having nearly the same declination.
	No. 72. A star of the fifteenth magnitude is about $2'$ following, and $0^{\circ}.7$ north.

Nos. 7, 11, 17, 18, 26, 27, and 62, are apparently variable stars of short period, but the majority of the others will perhaps be found to have long periods. These variables are, in general, brighter at maximum than those announced in Circulars Nos. 78, 79, and 82. The range of variation is greater, twenty-one showing changes of two magnitudes or more. It cannot be determined whether many of these variable stars are directly connected with the nebula, as only one of them, No. 29, is in a strongly nebulous region. Very few faint stars are seen in such regions, excepting on one plate, which was exposed for 273 minutes.

An open and rather irregular globular cluster, Messier 4 (N.G.C. 6121), is situated at the edge of the nebula, near α Scorpii. Two variable stars were discovered in it during the general examination of the region, and seven others were noticed while these were being observed. This led to a careful examination of the cluster, by Professor Bailey's method, as described in Volume XXXVIII of the Annals. Eight plates, four of which were taken with the 24-inch Bruce Telescope, and four with the 8-inch Bache Telescope, were used. Within a radius of fifteen minutes from the centre of the cluster, in an area of 706 square minutes, 334 stars were counted, and 32 variables found besides No. 33, which is seventeen minutes from the centre. Five other stars are suspected, and will probably be confirmed as variable when additional photographs can be examined. These variables and several catalogue stars are given in Table II. The first two columns give the designation and the number in the Cordoba Durchmusterung. In the third and fourth columns are given the coördinates referred to the assumed centre of the cluster, and expressed in seconds of arc. They depend upon eye estimates, but are probably correct within three seconds of arc. No correction has been made for the scale and orientation of the enlargement used. These, however, may be determined from the catalogue stars. The last three columns give the brightest and faintest observed magnitudes, and the range.

TABLE II.

VARIABLE STARS IN N.G.C. 6121.

Des.	Cat. No.	x	y	Br.	Ft.	R.	Des.	Cat. No.	x	y	Br.	Ft.	R.
A	-26° 11305	-379	-1053	..	..	..	15	.. ..	-32	+436	12.7	13.7	1.0
B	-26° 11310	-152	+564	..	..	..	16	.. ..	-29	+69	12.8	13.8	1.0
C	-26° 11316	+61	-204	..	..	..	17	.. ..	-8	+20	13.2	13.7	0.5
D	-25° 11495	+184	+924	..	..	..	18	.. ..	+4	+27	13.0	13.7	0.7
E	-26° 11329	+881	-1029	..	..	..	19	.. ..	+11	+358	12.6	13.6	1.0
1	.. ..	-281	+42	13.0	13.5	0.5	20	.. ..	+13	-63	13.0	13.4	0.4
2	.. ..	-248	-195	13.0	13.9	0.9	21	.. ..	+19	-4	13.0	13.7	0.7
3	.. ..	-208	-507	12.6	13.6	1.0	22	.. ..	+34	+80	13.1	13.7	0.6
4	-26° 11309	-185	-340	10.7	12.0	1.3	23	.. ..	+38	-26	12.9	13.4	0.5
5	.. ..	-185	-93	13.1	13.4	0.3	24	.. ..	+49	+48	12.4	13.9	1.5
6	.. ..	-115	+318	13.1	13.5	0.4	25	.. ..	+70	+70	12.9	13.6	0.7
7	.. ..	-113	+231	12.9	13.8	0.9	26	.. ..	+94	-72	12.1	13.7	1.6
8	.. ..	-110	+111	13.0	13.7	0.7	27	.. ..	+118	+255	12.7	13.7	1.0
9	.. ..	-104	+105	13.1	13.7	0.6	28	.. ..	+259	+84	12.9	13.5	0.6
10	.. ..	-68	+159	12.7	13.7	1.0	29	.. ..	+326	+598	12.4	13.7	1.3
11	.. ..	-64	-297	12.0	13.4	1.4	30	.. ..	+340	-69	13.0	13.5	0.5
12	.. ..	-53	-207	12.7	13.9	1.2	31	.. ..	+353	+45	11.9	13.5	1.6
13		-47	+270	12.0	12.6	0.6	32		+746	-40	12.6	13.5	0.9
14		-47	-244	13.1	14.2	1.1	33		+805	+630	12.5	13.2	0.7

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