

PHOTOGRAPHS OF NEBULAE WITH THE 60-INCH REFLECTOR 1911-1916¹

By FRANCIS G. PEASE

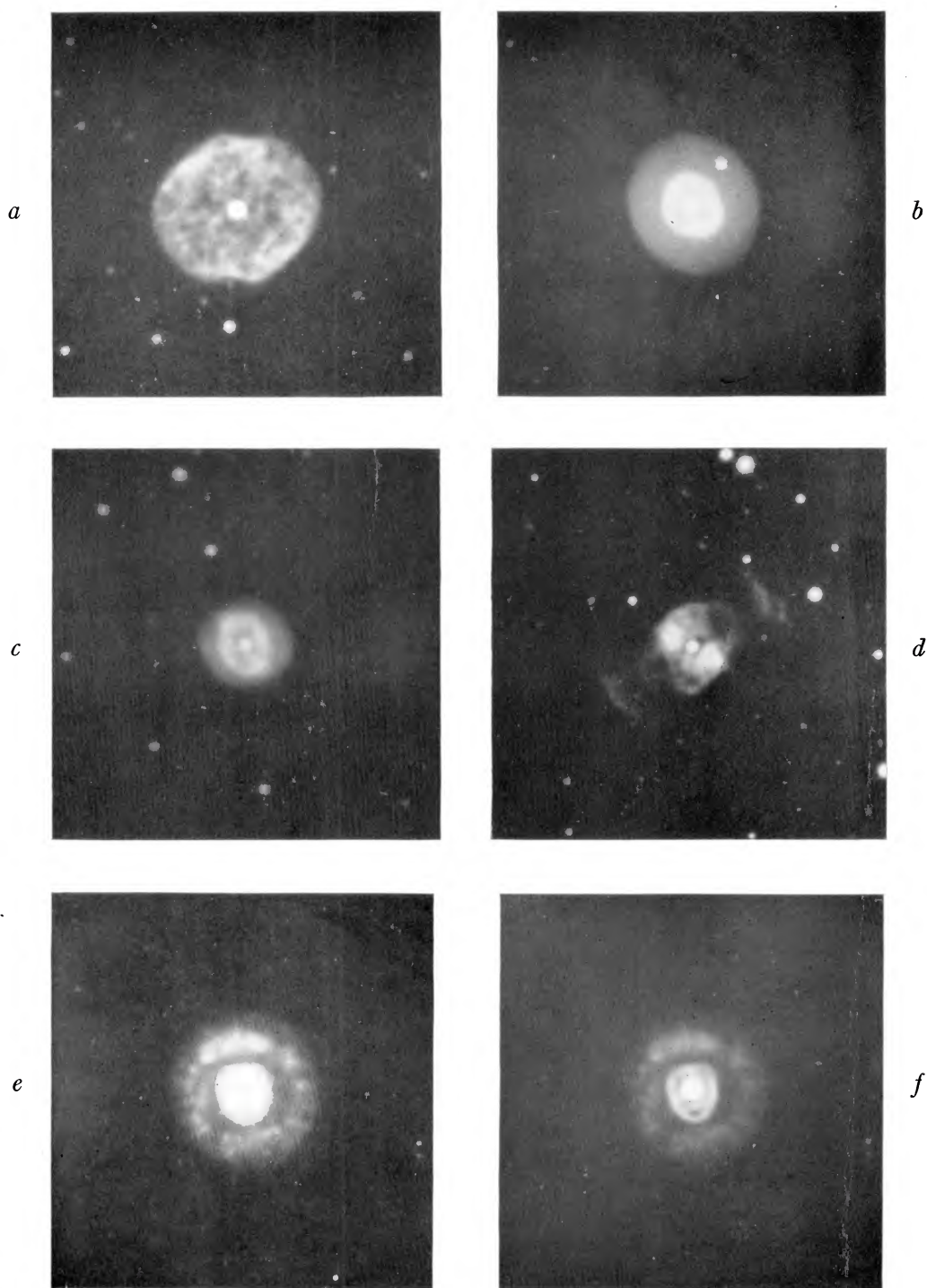
The 60-inch reflector with its aperture ratio of $F/5$ is well adapted for the photography of faint nebulae and all such objects as require great light-gathering power together with considerable scale in order to show their details. For the program of observations, of which some account is given in this paper, the objects selected were in general those whose real nature was unknown or those which possessed curious or questionable characteristics. Many photographs were made under very unfavorable observing conditions, and, in consequence, for these little more than the type is discernible. At times of good seeing, well-known objects were photographed for purposes of measurement. Exposures on several of the bright planetaries were made with the 80- and 100-foot focus, Cassegrain arrangements, with a corresponding increase in scale.

The double-slide plate-holder and its manipulation have been previously described,² and but few changes in the instrument or in its usage have been made since that time. Since the actual photographic image is many times the theoretical diameter of the diffraction image, small changes of focus are unimportant in their effect on the images, and intervals of an hour and more were permitted between refocusing. When the image of the guiding star vibrates rapidly, it is found advisable to neglect its excursions to and fro and to follow only the slow drift of its mean center. Both eyes were used alternately for guiding; and on long exposures two guiding stars were used, and correction was made for variation in size and rotation of the field produced by refraction and imperfect adjustment of the instrument. Changes in character of the guiding image during the exposure are responsible for as many plates with elongated images as are irregularities in the driving of the telescope.

¹ *Contributions from the Mount Wilson Solar Observatory*, No. 132.

² *Mt. Wilson Contr.*, No. 47; *Astrophysical Journal*, 32, 26, 1910.

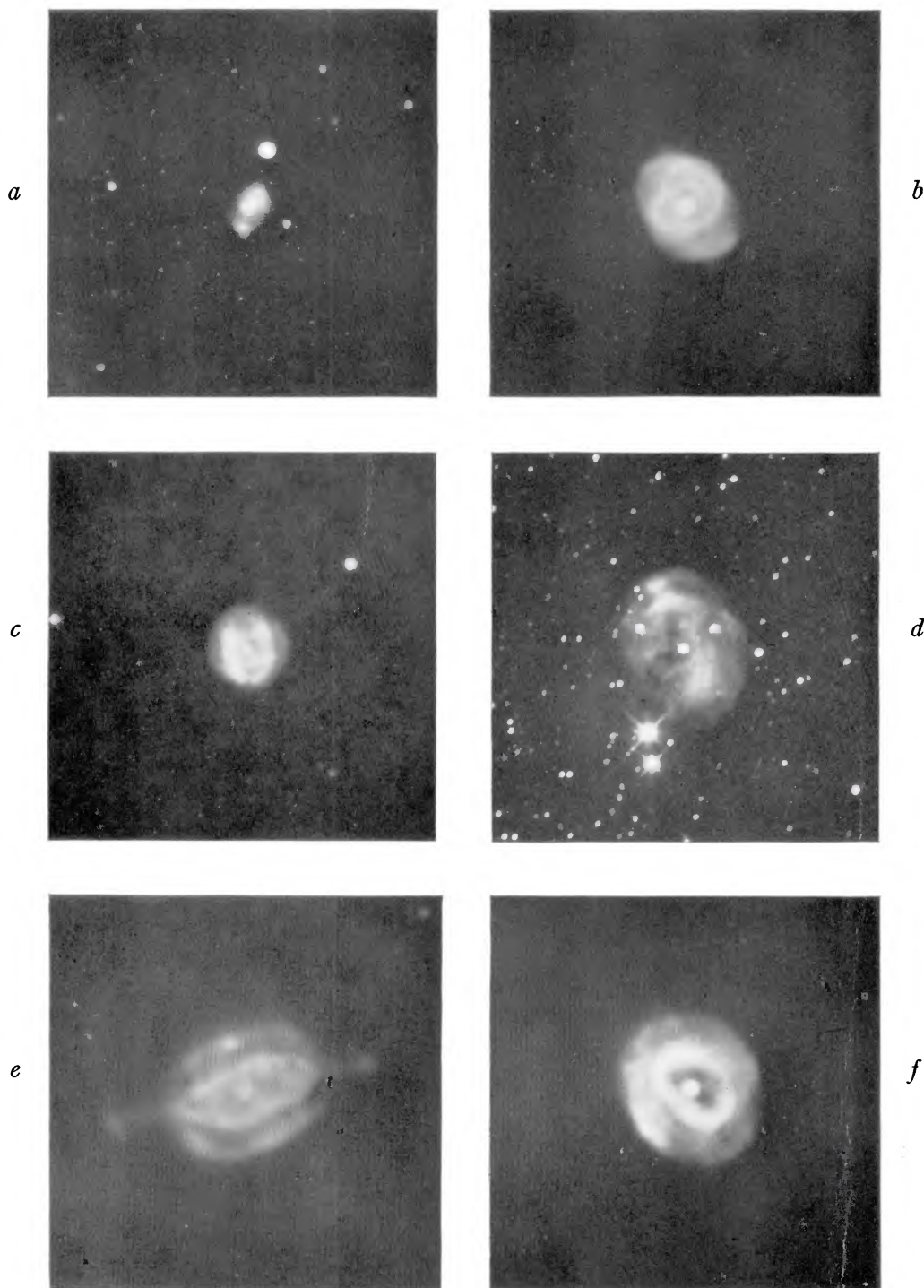
PLATE I



<i>a</i>	N.G.C. 1501	Exposure 120 ^m ,	Enlargement 10.0,	1 mm = 2".7	
<i>b</i>	1535	85	11.2	2.4	
<i>c</i>	2022	60	11.1	2.5	
<i>d</i>	2371-2	221	5.2	5.2	
<i>e</i> and <i>f</i>	2392	120	4.0	2.1	80-ft. focus

e and *f* are reproduced from the same negative with differences in exposure and development.

PLATE II



<i>a</i>	N.G.C. 6309	Exposure 90 ^m ,	Enlargement 9.6,	1 mm = 2".8	
<i>b</i>	6543	50	4.5	1.5	100-ft. focus
<i>c</i>	6818	75	2.8	2.4	100-ft. focus
<i>d</i>	7008	180	5.9	4.7	
<i>e</i>	7009	210	4.5	1.5	100-ft. focus
<i>f</i>	7662	90	4.5	1.5	100-ft. focus

PLATE III

a

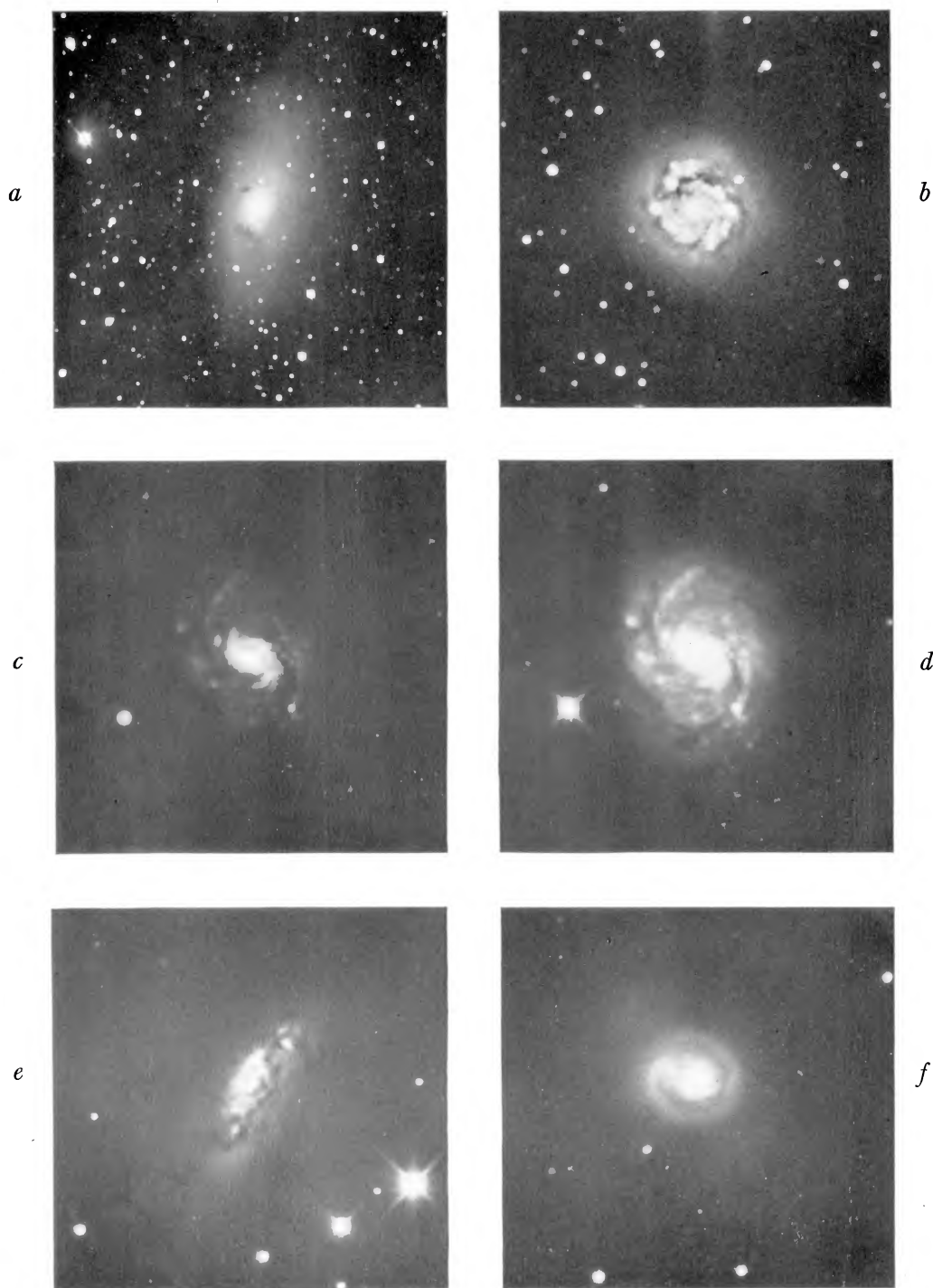


b



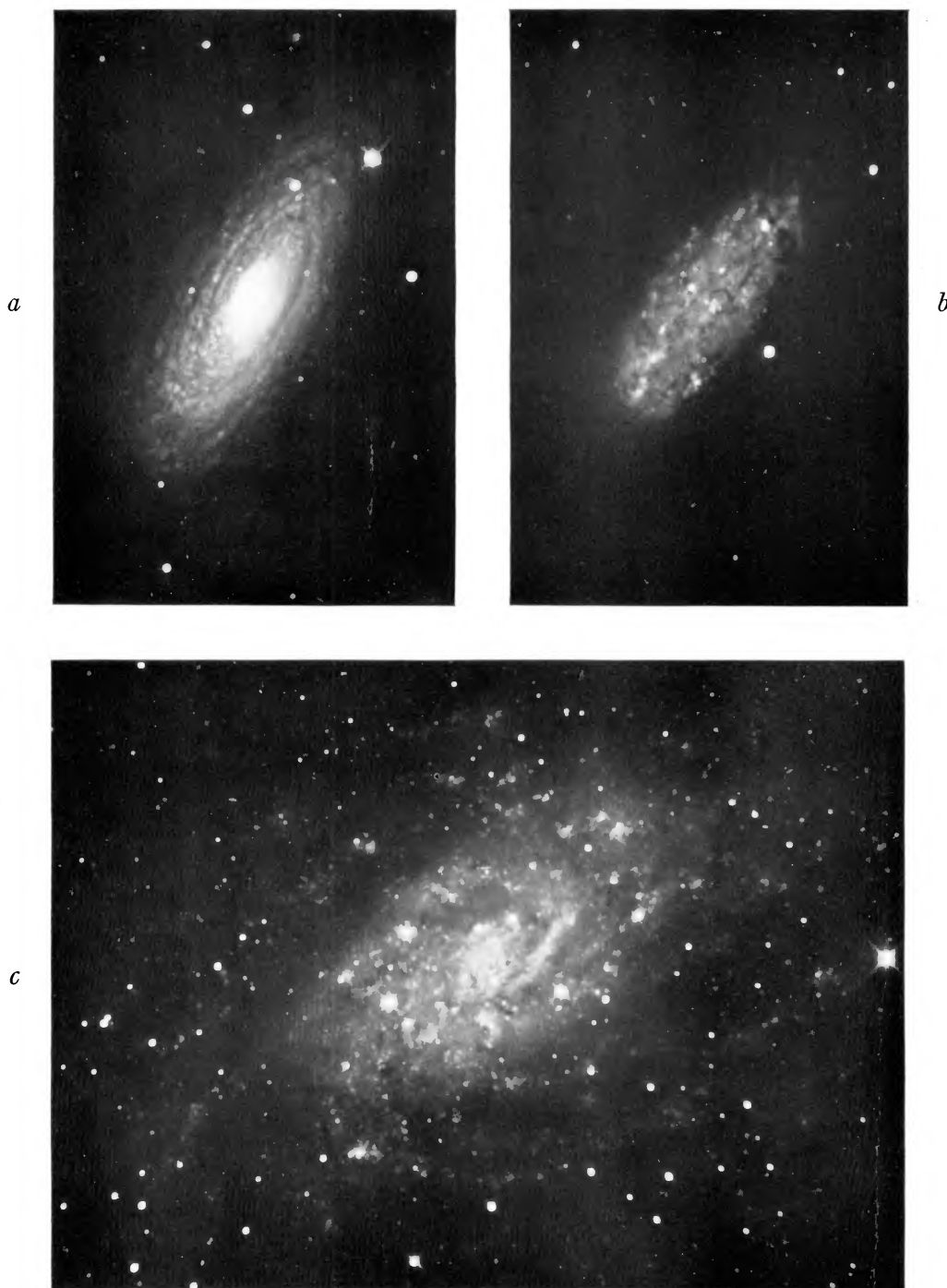
<i>a</i>	N.G.C. 1579	Exposure 420 ^m ,	Enlargement 3.0,	1 mm = 9".1
<i>b</i>	4449	300	5.8	4.7

PLATE IV



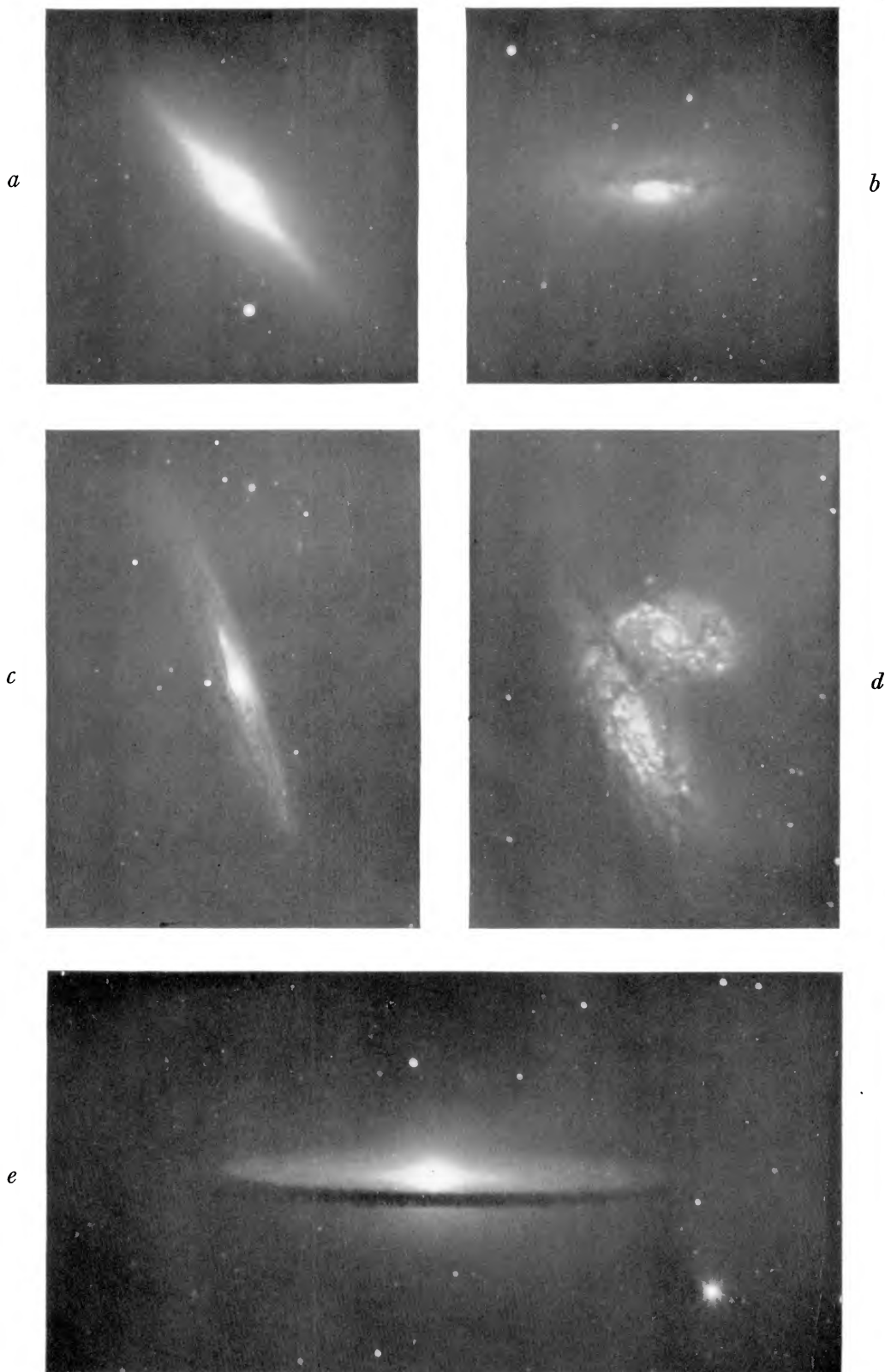
<i>a</i>	N.G.C. 205	Exposure 230 ^m ,	Enlargement 1.5,	1 mm = 19".4
<i>b</i>	278	240	5.8	4.7
<i>c</i>	1068	22	5.5	5.0
<i>d</i>	1068	120	5.5	5.0
<i>e</i>	972	195	6.9	3.9
<i>f</i>	2681	190	7.9	3.4

PLATE V



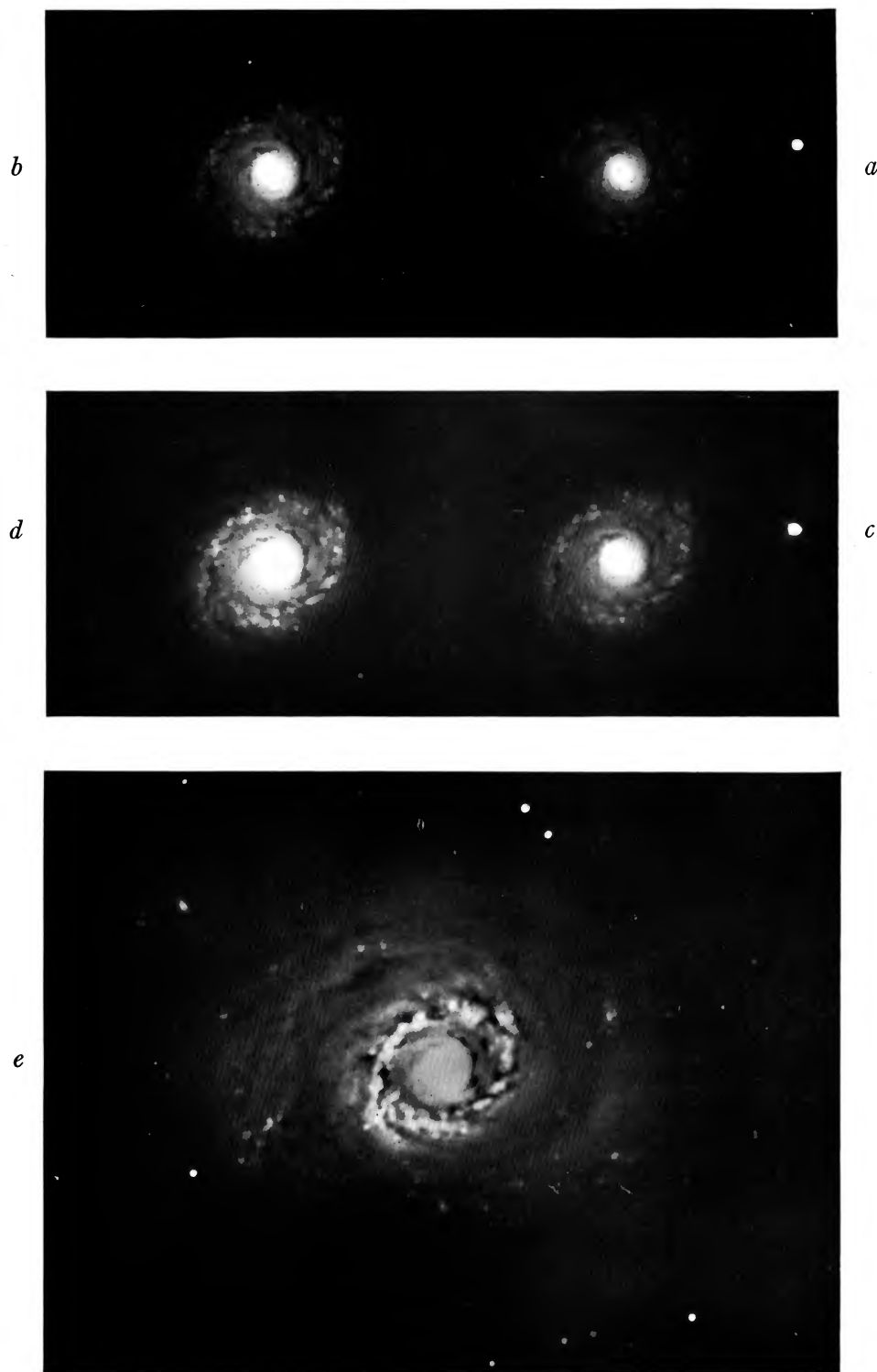
<i>a</i>	N.G.C. 2841	Exposure 120 ^m ,	Enlargement 3.8,	1 mm = 7".2
<i>b</i>	2976	180	4.7	5.7
<i>c</i>	2403	210	2.7	10.0

PLATE VI



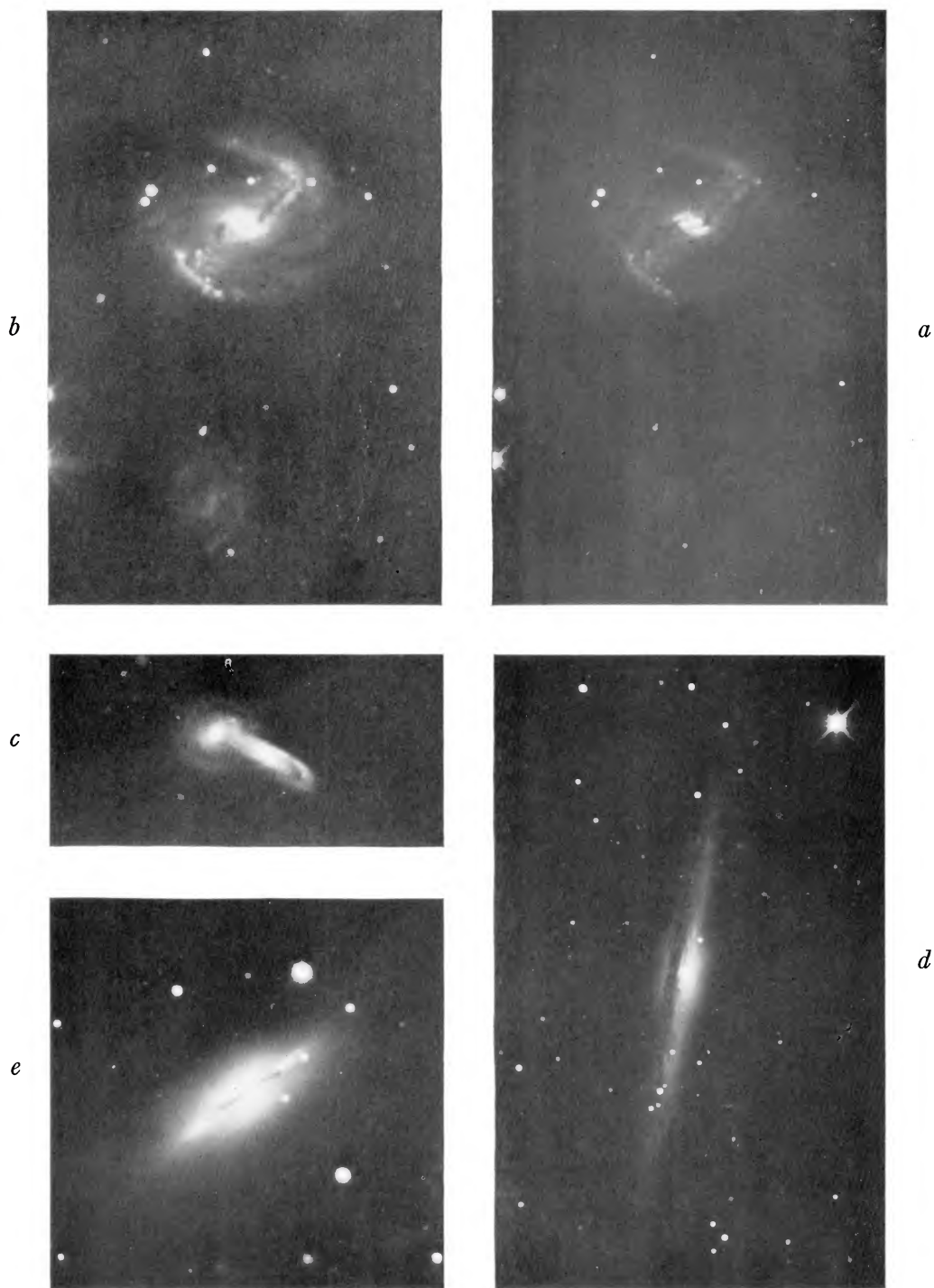
<i>a</i>	N.G.C. 3115	Exposure 100 ^m ,	Enlargement 5.5,	1 mm = 5".0
<i>b</i>	3593	210	5.5	5.0
<i>c</i>	4216	90	3.0	9.2
<i>d</i>	4567-8	360	4.9	5.6
<i>e</i>	4594	132	4.5	6.0

PLATE VII



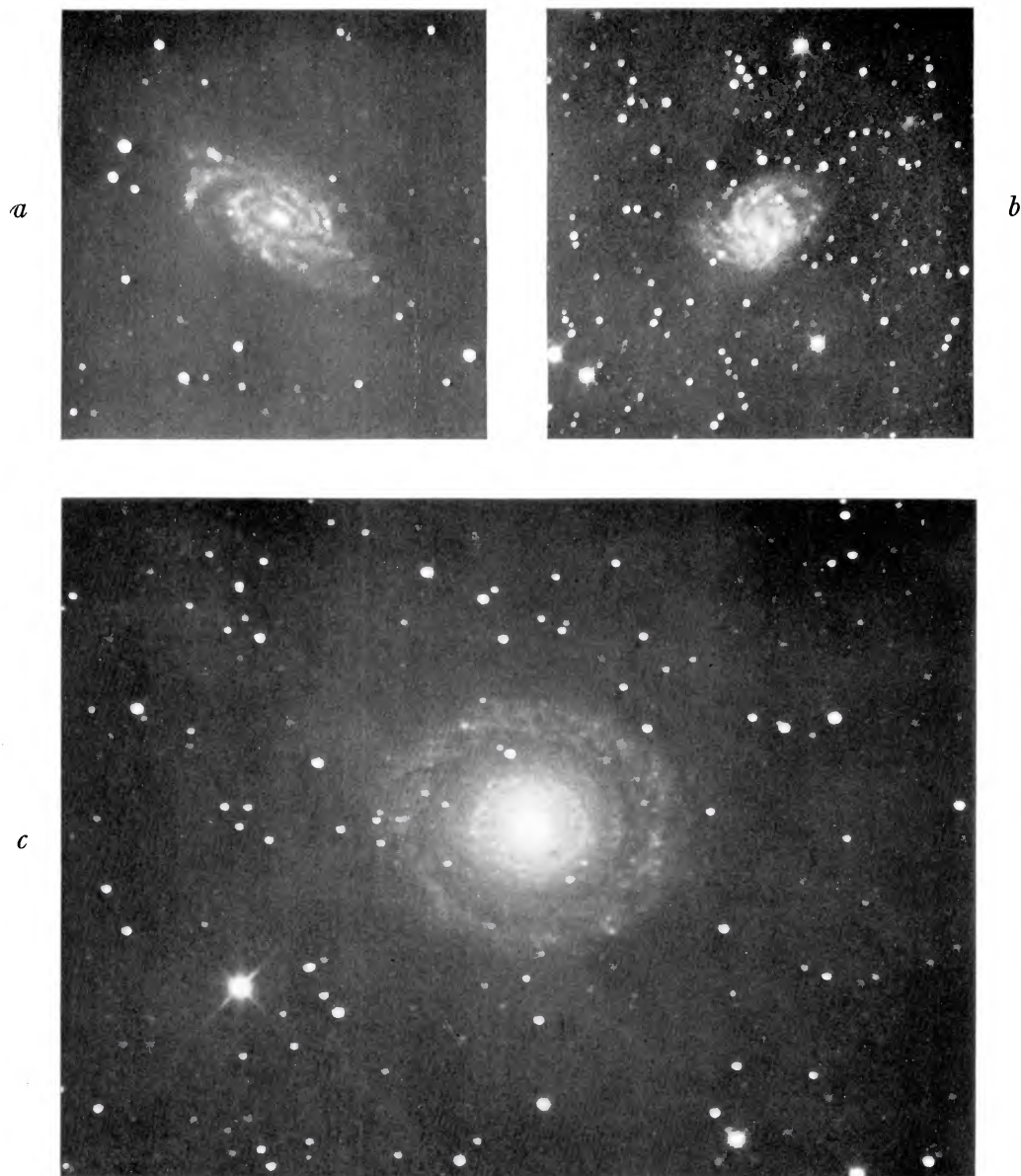
N.G.C. 4736 Exposure *a*, 5^m; *b*, 10^m; *c*, 20^m; *d*, 40^m; *e*, 225^m,
 Enlargement 5.1, 1 mm = 5".4

PLATE VIII



<i>a</i>	N.G.C. 5383	Exposure 180 ^m ,	Enlargement 5.0,	1 mm = 5".4
<i>b</i>	5383	360	4.9	5.5
<i>c</i>	5544-5	360	5.5	5.0
<i>d</i>	5746	360	3.4	7.9
<i>e</i>	5866	165	5.0	5.5

PLATE IX



<i>a</i>	N.G.C. 6070	Exposure 150 ^m ,	Enlargement 4.2,	1 mm = 6".5
<i>b</i>	6555	360	4.5	6.0
<i>c</i>	7217	330	5.5	5.0

Many objects are so situated as to place the observer in arduous positions for guiding, a difficulty now avoided by using a "goose-neck" microscope—a double-prism device which enables the guiding image to be viewed at a convenient angle.

All negatives were made on Seed 23 plates unless otherwise mentioned. For long exposures and for all those on fields containing bright stars the plates were backed. The usual development was with rodinal, of concentration $1/64$ for 30 minutes at 20° C., though in some cases $1/32$ for 15 minutes was used. All plates, except a few of early date and those otherwise noted, were taken with the full aperture of 60 inches, with a central stop of 23 inches diameter introduced to cut out the irregularly shaped cell of the Newtonian flat.

The appended list of the nebulae photographed gives (a) the approximate position for 1917 (the 1860 position of the *N.G.C.* corrected for precession); (b) the constellation; (c) the numbers assigned in various catalogues; (d) the type (El.=elliptical or elongated, Spl.=spiral, Plan.=planetary, Irr.=irregular, Spe.=spindle); (e) the 60-inch plate number, and (f), if illustrated, the number of the reproduction.

In the text following Table I is given the *N.G.C.* number of the nebula, its position for 1917, its galactic co-ordinates taken from a chart prepared by Professor Kapteyn, a list of the plates on which the object appears, and a brief description of its principal features. Much of the detail is faint and diffuse, unsuitable for comparator measures, so that the description is based on measures and estimates obtained with a magnifying glass of low power and a photographic reseau giving polar co-ordinates. The orientations have been derived from star trails, but as some of the plates are not provided with trails the results are approximate. Position angle (p) is measured from the north toward the east through 360° . The type of spectrum has been added wherever possible, a number of spectrograms, besides those by other observers, having been obtained with the focal-plane spectrograph of the 60-inch reflector.

A left-handed spiral has been defined as one in which an object traveling inward along one of the arms moves in a counter-clockwise direction. Many spirals which are inclined to the line of sight have

TABLE I
NEGATIVES WITH THE 60-INCH REFLECTOR

N.G.C.	α 1917	δ 1917	Constellation	G.C.	H and Others	h	Type	Plate Nos.	Illustrations
205.....	0 ^h 35 ^m 51 ^s	+41° 14.2	Andromeda	105	V	18	El.	152	IVa
278.....	0 47 23	+47 0.0	Cassiopeia	158	I	159	Spl.	108	IVb
650-1.....	1 37 4	+51 9.2	Perseus	385-6	I	193	Irr.	57, 150, 151, 170	.....
895.....	2 17 29	- 5 54.3	Cetus	529	II	438	Spl.	281	.....
955.....	2 26 20	- 1 28.6	Cetus	551	II	278	Spe.	220	.....
972.....	2 29 20	+28 56.9	Aries	560	II	211	El.	231	.....
1023.....	2 35 12	+38 42.5	Perseus	575	I	156	El.	171	IVe
1068.....	2 38 26	- 0 21.9	Cetus	600	M	77	Spl.	49, 51, 53	.....
1186.....	3 0 4	+42 30.2	Perseus	639	IV	43	Spl.	244, 245	IVc, d
1501.....	3 59 50	+60 41.9	Camelopardus	801	IV	53	Plan.	174, 178	la
1535.....	4 10 23	-12 50.9	Eridanus	826	IV	26	Plan.	163, 182	lb
1579.....	4 24 46	+35 6.0	Perseus	853	I	217	Irr.	227	IIIa
1931.....	5 25 55	+34 11.0	Auriga	1137	I	261	Irr.	277, 278	.....
2022.....	5 37 33	+ 0 2.7	Orion	1225	IV	34	Plan.	183	Lc
2366.....	7 20 7	+60 11.5	Camelopardus	1315	III	748	Irr.	279	.....
2371-2.....	7 20 20	+29 39.1	Gemini	1319-20	II	316-17	Irr.	257	Id
2392.....	7 24 10	+21 5.0	Gemini	1532	IV	45	Plan.	187, 189, 190, 191, 255	le, f
2483.....	7 28 49	+65 46.9	Camelopardus	1541	V	44	Spl.	169	Vc
2681.....	8 47 36	+51 37.7	Ursa Major	1711	I	242	Spl.	179	IVf
2825.....	9 14 21	+34 5.1	Lynx	1806	.....	.....	Spe.	246, 247	.....
2826.....	9 14 22	+33 58.0	Lynx	1807-1809	.....	.....	Spe.	246, 247	.....
2827.....	9 14 23	+34 16.7	Lynx	1808	.....	.....	El.	246, 247	.....
2828.....	9 14 33	+34 17.2	Lynx	1810	.....	.....	El.	246, 247	.....
2829.....	9 14 39	+34 0.8	Lynx	1864	.....	.....	Neb. star	246, 247	.....
2830.....	9 14 44	+34 6.0	Lynx	1811	.....	.....	Spe.	246, 247	.....
2831.....	9 14 45	+34 6.6	Lynx	1812	.....	.....	Neb. star	246, 247	.....
2832.....	9 14 46	+34 6.9	Lynx	1813	.....	.....	El.	246, 247	.....
2834.....	9 15 3	+34 3.3	Lynx	1815	.....	.....	Neb. star	246, 247	.....
2839.....	9 15 36	+33 50.2	Lynx	1821	.....	.....	Neb. star	246, 247	.....
2841.....	9 16 18	+31 19.7	Ursa Major	1823	I	255	Spl.	58	Va
2976.....	9 40 24	+68 17.9	Ursa Major	1905	I	285	Spl.	175	Vb
3115.....	10 1 6	- 7 18.9	Sextans	1905	I	163	Spe.	56	Vla
3593.....	11 10 17	+13 16.0	Leo	2008	I	29	Spl.	185	Vlb
3666.....	11 20 8	+11 47.9	Leo	2347	I	20	Spl.	248	.....
3938.....	11 48 31	+44 35.4	Ursa Major	2405	I	203	Spl.	249	.....
4206.....	12 11 6	+13 30.5	Virgo	2597	II	165	Spl.	192	.....
4216.....	12 11 40	+13 36.4	Virgo	2705	I	35	Spl.	192	.....
4222.....	12 12 10	+13 48.0	Virgo	2806	II	109	Spe.	192	Vlc
4230.....	12 12 48	+69 56.0	Draco	2841	V	51	Irr.	201	.....
4374.....	12 20 52	+13 20.8	Virgo	2825	M	84	Neb. spot	234	.....
4387.....	12 21 30	+13 16.0	Virgo	2930	II	167	El.	234	.....
				2955	.....	.....	.....	.....	.....

PHOTOGRAPHS OF NEBULAE

27

4388.....	12 21 35	+13 7.2	Virgo	2949-2956	II	168	1244	El.	234	.....
4402.....	12 21 55	+13 34.8	Virgo	2965	M	86	1253	El.	234	.....
4406.....	12 21 59	+13 44.3	Virgo	2961	.....	.....	1255	Neb. spot	234	.....
4407.....	12 22 4	+13 6.0	Virgo	2968	.....	.....	1267	El.	234	.....
4425.....	12 22 11	+13 11.7	Virgo	2963	II	170	1281	Spe.	198	.....
4449.....	12 24 11	+44 33.0	Canes Venatici	3002	II	213	1356	Irr.	235, 237	.....
4504.....	12 32 15	+11 53.6	Virgo	3105	II	68	1358-9	Spe.	235, 237	.....
4507-8.....	12 32 20	+11 42.0	Virgo	3108-9	IV	8-9	1376	Spl.	256, 262	.....
4594.....	12 35 40	-11 10.0	Virgo	3132	I	43	1456	Spl.	60, 3093P, 3094P	.....
4736.....	12 46 59	+41 34.3	Canes Venatici	3258	I	94	1509	Spl.?	188	.....
4900.....	12 46 58	+2 50.5	Virgo	3356	I	143	1547	Spl.	59	.....
4905.....	13 7 3	+37 30.2	Canes Venatici	3437	I	96	1674	Spe.	196	.....
5005.....	13 7 3	+61 23.5	Ursa	3362	I	255	1717	Spe.	195, 199	.....
5308.....	13 44 15	+42 14.0	Canes Venatici	3723	I	181	1771	Spl.	127, 261	.....
5383.....	13 53 41	+36 57.3	Boötes	3833-4	II	419	1778	Spl.	250	.....
5544-5.....	14 13 33	+4 22.3	Virgo	3845	II	579	1779	Spl.	250	.....
5560.....	14 15 54	+4 22.8	Virgo	3846	I	144	.....	Spl.	250	.....
5566.....	14 16 10	+4 19.8	Virgo	3848	.....	.....	.....	Spl.	250	.....
5569.....	14 16 22	+4 20.1	Virgo	3955	II	538	1872	Spl.	236	.....
5740.....	14 40 21	+2 2.0	Virgo	3937	I	126	1874	Spl.	236	.....
5746.....	14 40 43	+2 18.3	Virgo	4058	I	215	1909	Spe.	129	.....
5866.....	15 4 12	+56 5.0	Boötes	4087	II	759	1917	Spl.	197	.....
5907.....	15 13 44	+56 38.0	Serpens	4164	III	533	1947	Spl.	265, 267	.....
6070.....	16 5 45	+0 55.7	Hercules	4234	Σ	5	1970	Plan.	139	.....
6210.....	16 41 1	+23 57.2	Ursa Minor	4330	I	286	.....	Spl.	200	.....
6217.....	16 36 32	+78 22.0	Ophiuchus	4351	VI	41	.....	Plan.	252, 263	.....
6399.....	17 9 24	-12 48.9	Draco	4321	SW	III	.....	Spl.	128	.....
6412.....	17 32 4	+75 46.6	Draco	4373	IV	37	.....	Plan.	135	.....
6478.....	17 46 41	+51 11.6	Draco	4383	II	902	.....	Spl.	268	.....
6543.....	17 58 35	+66 38.2	Hercules	4383	.....	.....	.....	Neb. spot	269, 270	.....
6555.....	18 3 28	+17 35.3	Lyra	5931	.....	.....	.....	Plan.?	269, 270	.....
6702.....	18 44 33	+45 36.7	Lyra	5932	.....	.....	.....	Plan.	120	.....
6703.....	18 44 55	+45 27.5	Aquila	4499	VI	38	2043	Plan.	115, 116, 137	.....
6804.....	19 27 37	+9 2.9	Sagittarius	4510	VI	51	2047	Plan.	130, 131, 132	.....
6818.....	19 39 17	-14 21.1	Cygnus	4514	IV	73	2050	Plan.	4, 7	.....
6826.....	19 42 34	+50 19.4	Cygnus	4565	IV	13	2072	Plan.	145, 147, 149	.....
6840.....	20 13 3	+30 18.6	Delphinus	4572	IV	16	2075	Plan.	243	.....
6905.....	20 18 42	+19 59.3	Cepheus	4627	I	192	2090	Irr.	138, 140	.....
7008.....	20 58 8	+54 13.5	Aquarius	4628	IV	1	2098	Plan.	12	.....
7009.....	20 59 39	-11 41.6	Draco	4634	IV	74	.....	Irr.	156	.....
7023.....	21 0 35	+67 50.3	Cygnus	.....	Burnham	.....	.....	Plan.	142	.....
7026.....	21 3 30	+47 30.8	Cygnus	.....	Webb	.....	.....	Plan.	142	.....
7027.....	21 3 56	+41 54.0	Cygnus	.....	.....	.....	.....	Irr.	273, 274	.....
7120.....	21 41 4	+65 43.3	Cepheus	4702	IV	75	2131	Spl.	126	.....
7177.....	21 56 44	+17 20.4	Pegasus	4734	II	247	2130	Spl.	216	.....
7217.....	22 4 10	+30 57.2	Pegasus	4760	II	207	2149	Plan.	20, 148, 157, 172, 173, 177	.....
7602.....	23 21 54	+42 4.8	Andromeda	4904	IV	18	2241	Plan.	.....	.....

NOTES

N.G.C. 2825-2829, 2831, 2832, 2834, 2839, see text description of N.G.C. 2830.
 N.G.C. 4206, 4222, see text description of N.G.C. 4216.
 N.G.C. 4374, 4387, 4388, 4402, 4407, 4425, see text description of N.G.C. 4406.
 N.G.C. 4504, see text description of N.G.C. 4567-8.
 N.G.C. 5566, 5569, see text description of N.G.C. 5560.
 N.G.C. 5749, see text description of N.G.C. 5746.
 N.G.C. 6702, see text description of N.G.C. 6703.

a different shading on one side of the major axis from that on the other, one side being soft while the other is more knotted and of stronger contrast, the latter resembling the effect produced by the sun shining through an irregular bank of clouds. All illustrations are placed with north (N) at the top and west (W, preceding) at the right.

All catalogued nebulae showing on any of the photographs here discussed have been inserted in the list; but those which appear only incidentally are described in the text under the *N.G.C.* number of the object for which the plate was primarily taken (see notes to Table I). A number of uncatalogued nebulae and nebulous stars are also shown. Mention of such is made in the text description of *N.G.C.* 1186, 2681, 2830, 2841, 4406, 5308, 5383, 6555, and 6703.

I am indebted to Mr. Ellerman for the preparation of the positives for the half-tones.

N.G.C. 205 Andromeda

$$\alpha = 0^{\text{h}}35^{\text{m}}51^{\text{s}}, \delta = +41^{\circ}14'2'' (1917); \lambda = 89^{\circ}, \beta = -22^{\circ}$$

Plate No. 152, 1912, October 9, 230^m. Images large

Illustrated Plate IVa

This is the bright nebula lying on the Np side of the great nebula of Andromeda 36'.4 distant. On a diffuse ellipse 10'×4', $p = 172^{\circ}$, gradually fading away at the edge, lies centrally a brighter patch about 1'.5×1'. Besides the sharp nucleus there is detail in the bright central part, and dark patches of irregular shape, similar in character to that surrounding the nucleus of the great nebula, lie one on the S end and the other on the Nf end. The nebula is possibly spiral, but the exposure is not long enough to show detail in the outer nebulosity. Huggins¹ assigns it a continuous spectrum.

N.G.C. 278 Cassiopeia

$$\alpha = 0^{\text{h}}47^{\text{m}}23^{\text{s}}, \delta = +47^{\circ}6' (1917); \lambda = 92^{\circ}, \beta = -16^{\circ}$$

Plate No. 168, 1912, November 8, 240^m. Fine plate.

Illustrated Plate IVb

This fine left-handed spiral is seen in plan. Four or five whorls emanating from the nucleus make about a half-revolution before

¹ *Philosophical Transactions*, 156, 388, 1866.

fading suddenly to a very much less intensity, thus forming a bright center irregularly round, $50''$ in diameter. One arm, however, is interrupted, but again continues strong and forms a wing to the bright patch on the northern side. Along these arms lie many bright nebulous knots and condensations. Outside this the arms continue faint, and they fade out at $85''$ diameter. The nucleus is irregular and appears to be a number of knots bunched together, each forming the starting-point of an arm.

N.G.C. 650-651 Persei

$\alpha = 1^h 37^m 4^s$, $\delta = +51^\circ 9'$ (1917); $\lambda = 99^\circ$, $\beta = -11^\circ$

Plate No. 57, 1912, February 19, 105^m. Poor plate

Plate No. 150, 1912, October 7, 180^m. Poor plate

Plate No. 151, 1912, October 8, 360^m. Poor plate

Plate No. 170, 1912, December 6, 15^m. Poor plate

The shape of this gaseous nebula reminds one of a moth; a strong, irregular, elliptical mass with diaphanous extension on either side. The body is about $1.6 \times 1'$, $p = 41^\circ$, with wings extending about $1'$ either side. The whole forms the central zone of a circle of $3'$ diameter, the wing periphery being tangent to the circle. On the E side a faint wisp extends beyond this; at the center of the circle lies a faint star. The brightest spot in the nebula, forming the *Sp* portion, is N.G.C. 650; N.G.C. 651 is the *Nf* portion. The spectrum of the nebula shows bright lines.¹

N.G.C. 895 Cetus

$\alpha = 2^h 17^m 29^s$, $\delta = -5^\circ 54.3'$ (1917); $\lambda = 140^\circ$, $\beta = -58^\circ$

Plate No. 281, 1916, November 28, 75^m. Weak exposure

This is a right-handed spiral $3.5 \times 2'$, $p = 120^\circ$. Two prominent arms emerge from the faint nucleus, one of which, as is often the case, is interrupted only to fork out into two branches. This, however, may be merely an effect of contrast caused by an overlapping streamer. Quite away from the nucleus the arms are apparently strings of knotted nebulosity. N.G.C. 894 blends with the spiral.

¹ *Astrophysical Journal*, 33, 59, 1911.

N.G.C. 955 Cetus

$$\alpha = 2^{\text{h}}26^{\text{m}}20^{\text{s}}, \quad \delta = -1^{\circ}28'6'' (1917); \quad \lambda = 138^{\circ}, \quad \beta = -54^{\circ}$$

Plate No. 229, 1913, November 25, 90^m. Images elongated

This is a spindle nebula, almost certainly spiral, about $80'' \times 7''$, $p = 20^{\circ}$, with a stellar nucleus W of the center. At one time it was thought to be variable, but Dreyer has doubted this. The strong part of the nebula forms a rhombus $45'' \times 7''$.

N.G.C. 972 Aries

$$\alpha = 2^{\text{h}}29^{\text{m}}20^{\text{s}}, \quad \delta = +28^{\circ}56'9'' (1917); \quad \lambda = 116^{\circ}, \quad \beta = -28^{\circ}$$

Plate No. 231, 1913, November 26, 195^m. Good plate

Illustrated Plate IVe

This object has the shape of an irregular ellipse of greatly varying intensity, about $2' \times 1'.9$, $p = 152^{\circ}$, almost certainly a left-handed spiral. The strong region E of the major axis is somewhat elliptical in shape, $40'' \times 15''$, with its axis parallel to the general figure of the nebula. Its detail is knotted and full of contrast, with a very strong knot at the N end. W of the major axis, except for the knots described below, the nebulosity consists of large softer wisps mingled with dark lanes. At $28''$ Np the nucleus is a strong triple condensation and at $26''$ Sf the nucleus is a strong knot, both lying on the major axis. There are two more condensations beyond the N one, both surrounded by a dark ring except for a wisp on the rear side as met traveling along the arm from the center and a fine strong thread on the front side.

N.G.C. 1023 Perseus

$$\alpha = 2^{\text{h}}35^{\text{m}}12^{\text{s}}, \quad \delta = +38^{\circ}42'5'' (1917); \quad \lambda = 112^{\circ}, \quad \beta = -18^{\circ}$$

Plate No. 171, 1915, December 7, 240^m. Bad seeing

A bright nucleus $15''$ in diameter lies on an ellipse $90'' \times 45''$, $p = 70^{\circ}$. From this extend faint wings in either direction along the major axis, forming an ellipse $5' \times 1'$, $p = 85^{\circ}$.

Fath¹ found for the nebula a spectrum of the solar type, and Slipher's² value of radial velocity is roughly $+200$ km.

¹ *Astrophysical Journal*, 37, 199, 1913.

² *Popular Astronomy*, 23, 36, 1915.

N.G.C. 1068 Cetus

$$\alpha = 2^{\text{h}}38^{\text{m}}26^{\text{s}}, \quad \delta = -0^{\circ}21'9'' \text{ (1917)}; \quad \lambda = 141^{\circ}, \quad \beta = -51^{\circ}$$

Plate No. 49, 1911, December 22, 120^m. Illustrated Plate IVd

Plate No. 53, 1911, December 25, 22^m. Illustrated Plate IVc

Good plates

This left-handed spiral is viewed in plan, with three striking gradations of intensity centrally superimposed. Surrounding the bright central nucleus, elongated in $p=40^{\circ}$, is a strong, distinct spiral forming an ellipse $40'' \times 25''$, $p=50^{\circ}$, consisting mainly of two arms emanating from the ends of the nucleus, which extend a little more than a half-revolution. Distinct nebulous condensations lie along these arms. Outside this strong center is a fainter annulus $130'' \times 110''$, $p=10^{\circ}$, still holding the spiral form. Two of the arms are continuations of the central branches, but there are others besides, all softly mottled in appearance. Beyond this lie two immense and very faint arms, starting at about $p=30^{\circ}$, and extending to an ellipse $6' \times 5'$, $p=60^{\circ}$. These are so faint that it is difficult to say more than that they appear mottled. On the plate showing this external faint material the entire central spiral form is so overexposed that no detail shows. The spectrum¹ obtained with the focal-plane slit gives a value for the radial velocity of $+765$ km, while Slipher's² value is $+1100$ km. Fath³ found an absorption spectrum with bright lines.

N.G.C. 1186 Perseus

$$\alpha = 3^{\text{h}}0^{\text{m}}4^{\text{s}}, \quad \delta = +42^{\circ}30'2'' \text{ (1917)}; \quad \lambda = 115^{\circ}, \quad \beta = -13^{\circ}$$

Plate No. 244, 1914, November 13, 75^m. Good plate

Plate No. 245, 1914, November 14, 130^m. Good plate, grain a little coarse

This supposedly variable nebula lies 2° north of Algol. It is a faint left-handed spiral $2' \times 0'.5$, $p=120^{\circ}$, with faint stellar nucleus. A star several magnitudes brighter than the nucleus lies directly on one of the arms at $p=230^{\circ}$, $12''$. There is a knot N of the nucleus at $p=330^{\circ}$, $12''$. There are 15 faint nebulae lying within a radius of $15'$.

¹ *Publications of the Astronomical Society of the Pacific*, 27, 134 and 192, 1915.

² *Popular Astronomy*, 23, 36, 1915.

³ *Astrophysical Journal*, 33, 60, 1911.

N.G.C. 1501 Camelopardus

$$\alpha = 3^{\text{h}}59^{\text{m}}50^{\text{s}}, \quad \delta = +60^{\circ}41'.9 \text{ (1917)}; \quad \lambda = 112^{\circ}, \quad \beta = +7^{\circ}$$

Plate No. 174, 1912, December 10, 60^m

Plate No. 178, 1913, January 7, 120^m. Illustrated Plate Ia

Good plates

This is a fine planetary of regular elliptical shape, $60'' \times 45''$, $p = 120^{\circ}$, with protuberances at each end of the minor axis making the total breadth $53''$. The nebula is irregularly mottled, bearing a resemblance to the convolutions of the brain. Its periphery is in general denser than its center, and is twice as dense at the ends of the minor axis as at the extremities of the major axis. There is a bright central stellar nucleus. The spectrum shows bright lines.

N.G.C. 1535 Eridanus

$$\alpha = 4^{\text{h}}10^{\text{m}}23^{\text{s}}, \quad \delta = -12^{\circ}56'.9 \text{ (1917)}; \quad \lambda = 174^{\circ}, \quad \beta = -39^{\circ}$$

Plate No. 163, 1912, November 5, 60^m. 100-foot focus

Plate No. 182, 1913, February 4, 85^m. 25-foot focus. Illustrated Plate Ib

This is a planetary of almost uniform intensity $46'' \times 40''$, $p = 23^{\circ}$, on which lie a strong ring, a strong stellar nucleus, and a faint star. The ring is irregularly round, $18''$ in diameter, elongated in the same direction as the disk, quite sharp on the outer edge, but softer on the inner edge with branches running to the nucleus. The star is at $p = 320^{\circ}, 17''$. The spectrum shows bright lines; Keeler's¹ value of the radial velocity is -10.4 km.

N.G.C. 1579 Perseus

$$\alpha = 4^{\text{h}}24^{\text{m}}46^{\text{s}}, \quad \delta = +35^{\circ}6'.0 \text{ (1917)}; \quad \lambda = 133^{\circ}, \quad \beta = -8^{\circ}$$

Plate No. 227, 1913, October 29, 30, 31, 420^m. Illustrated Plate IIIa

This is an irregular nebula of the dispersive type; the dark lanes call to mind the Trifid nebula, and the outer faint nebulosity, that of the Orion nebula. The most prominent bit of nebulosity is a broad arrowhead adjoining the principal dark lane on the N and pointing due E; it is mottled in appearance and full of detail. Directly S of the arrowhead in the dark lane is a very faint star.

¹ W. W. Campbell, *Stellar Motions*, p. 210.

The principal part of the nebula lies within a circle of $5'$ diameter, while faint patches extend N

to a distance of $10'$ from the center. There are four stars which form nuclei for patches of nebulosity. Their positions with respect to the faint central star are as follows:

<i>a</i>	$35^{\circ}12'8$	10	mag. (very rough)
<i>b</i>	$213^{\circ}6.5$	11	mag.
<i>c</i>	$251^{\circ}10.0$	11	mag.
B.D.+34°883.....	$346^{\circ}3.1$	9.5	mag.

N.G.C. 1931 Auriga

$$\alpha = 5^{\text{h}}25^{\text{m}}55^{\text{s}}, \quad \delta = +34^{\circ}11'0 \text{ (1917)}; \quad \lambda = 143^{\circ}, \quad \beta = +1^{\circ}$$

Plate No. 277, 1916, October 27, 15^m

Plate No. 278, 1916, October 28, 60^m

This group of small stars, one of which is double, is here apparently superimposed upon an irregular, patchy, nebulous mass contained within a circle $1'5$ in diameter. Several loops appear in the nebulosity, and there are two prominent dark spots. At $3'7$ S of the nebula lies another star with a nebulous wing to the SW. The region is rich in stars, though the nebula lies in one of the so-called dark lanes, where the stars are much fewer than in the adjacent parts.

N.G.C. 2022 Orion

$$\alpha = 5^{\text{h}}37^{\text{m}}33^{\text{s}}, \quad \delta = +9^{\circ}2'7 \text{ (1917)}; \quad \lambda = 164^{\circ}, \quad \beta = -9^{\circ}$$

Plate No. 183, 1913, February 4, 60^m. Good plate. Illustrated Plate Ic

This is a fairly bright planetary with a disk of almost uniform intensity, on which lies a ring and nucleus. The nebula is sharply outlined, and may best be described as the central zone of a circle $30''$ in diameter; equator lies in $p = 115^{\circ}$, the distance between the sides being $27''$; the S side is a little convex outward. The ring is very much stronger in intensity than the disk. It is elliptical, $20'' \times 15''$, $p = 13^{\circ}$ (median line), and on the average about $4''$ wide. There is a condensation in the ring at each end of the axis in $p = 30^{\circ}$, making the axis $23''$ long. There is an interruption in the N side of the ring and a wisp running toward the nucleus from the S knot. The spectrum shows bright lines.

N.G.C. 2366 Camelopardus

$$\alpha = 7^{\text{h}}20^{\text{m}}7^{\text{s}}, \quad \delta = +69^{\circ}11'.5 \text{ (1917)}; \quad \lambda = 113^{\circ}, \quad \beta = +29^{\circ}$$

Plate No. 279, 1916, October 30, 60^m. Very weak

This is the same general character as N.G.C. 4449, composed of nebulous knots and soft nebulosity. Very irregular in shape, $3' \times 1'$, $p = 30^{\circ}$, with the brightest star or knot near the S end; $1'$ E of this star lies a group irregularly $30''$ in diameter.

N.G.C. 2371-2 Gemini

$$\alpha = 7^{\text{h}}20^{\text{m}}20^{\text{s}}, \quad \delta = +29^{\circ}39'.1 \text{ (1917)}; \quad \lambda = 157^{\circ}, \quad \beta = +21^{\circ}$$

Plate No. 257, 1916, March 6-7, 221^m. Bad seeing. Images large

Illustrated Plate Id

This gaseous nebula comprises an irregularly round, patchy mass of nebulosity lying within $33''$ radius of a stellar nucleus; two wisps on opposite ends of an axis in $p = 120^{\circ}$, each $1'$ distant from the nucleus. The striking parts of the nebula are two strong condensations in the central part, diametrically opposite each other on an axis in $p = 60^{\circ}$, each about $15''$ in size and $15''$ from the nucleus. In the f condensation is a faint star, and on the W edge of the p one a hazy nucleus. Faint wisps extend from the central mass to points halfway between the nucleus and the outer condensations, the W ones forming a loop, a feature seen also in N.G.C. 7026. Each of the outer wisps is $10'' \times 45''$ and lies perpendicular to the line joining them, being slightly convex outward with streamers turned inward.

N.G.C. 2392 Gemini

$$\alpha = 7^{\text{h}}24^{\text{m}}16^{\text{s}}, \quad \delta = +21^{\circ}5'.0 \text{ (1917)}; \quad \lambda = 165^{\circ}, \quad \beta = +19^{\circ}$$

Plate No. 187, 1913, March 6, 180^m. 25-foot focus

Plate No. 189, 1913, March 7, 10^m. 25-foot focus

Plate No. 190, 1913, March 7, 30^m. 25-foot focus

Plate No. 191, 1913, March 7, 60^m. 25-foot focus

Plate No. 255, 1915, December 8-9, 120^m. 80-foot focus

Illustrated Plate Ie, and If

Plate No. 258, 1916, April 1, 30^m. 25-foot focus

This bright planetary can best be described as the pupil of an eye with the surrounding iris. The iris varies only a few seconds from a mean outside diameter of $46''$ and consists of a uniform

annulus with about 20 bright knots non-uniformly distributed along its median line. The knots are sharply bounded on the side toward the pupil and stringy toward the outside. There are several interruptions in the string of knots, notably at $p=144^\circ$, where two lie diametrically opposite. The brighter knots are on the S side along $p=189^\circ$, where four or five of them form an almost continuous mass. Opposite these is another continuous set, but not so bright. Between the ends of these two series the knots stand more apart. W of the "pupil," between it and the ring of knots, is an elongated condensation lying in a NS position. A 3^h exposure does not extend the disk any, but 3 threads spring from as many knots of the iris on the E side and curve out over the edge of the disk a distance of 5". The pupil is stirrup-shaped, $19'' \times 17''$, with axis $p=5^\circ$, and has a strong central nucleus. The N periphery is bright; the E has two bright knots, the W two, and the S one that reaches almost to the nucleus, and half-way between the nucleus and the N side is another; between this latter and the N side is a vacant space. The nucleus is listed as B.D. $+21^\circ 16'09''$. A focal-plane spectrum shows a continuous band crossed by projecting bright lines. Campbell and Moore¹ found internal motion in the nebula. Both illustrations are from the same negative, the one to show central detail, the other the external ring.

N.G.C. 2403 Camelopardus

$$\alpha = 7^{\text{h}}28^{\text{m}}49^{\text{s}}, \quad \delta = +65^\circ46'9'' (1917); \quad \lambda = 118^\circ, \quad \beta = +30^\circ$$

Plate No. 169, 1912, November 8, 210^m. Good plate. Illustrated Plate Vc

This fine right-handed spiral nebula resembles M 33. The bright part is contained within an ellipse roughly $9' \times 5'$, $p=126^\circ$. Faint knots and arms extend as far as $10'$ from the center. It does not possess the wealth of detail of M 33, but it has the same sharp stellar images, the nebulous stars, the bunching of these into knots, and the dark streaks where one can imagine one looks completely through the nebula to the sky beyond. While M 33 has two strong arms running out from the center, this nebula has but one, which starts from the central mass at the Sp side, the opposite side being

¹ *Publications of the Astronomical Society of the Pacific*, 28, 119, 1916.

a continuous sheet of nebulosity, not separable into arms. There is no distinct central nucleus.

N.G.C. 2681 Ursa Major

$$\alpha = 8^{\text{h}}47^{\text{m}}36^{\text{s}}, \quad \delta = +51^{\circ}37'7'' \text{ (1917)}; \quad \lambda = 134^{\circ}, \quad \beta = +41^{\circ}$$

Plate No. 179, 1913, January 7, 190^m. Good plate. Illustrated Plate IVf

This right-handed spiral is seen in plan. There is a strong central nucleus out of which springs at $p = 35^{\circ}$ a single arm which wraps itself concentrically around the nucleus at a mean radius of $20''$ and stops in the NE quadrant. It is possible that this arm is really continued inward in the ring of nebulosity which entirely surrounds the nucleus at a mean radius of $8''$. In the SW quadrant of this ring, however, are two strong condensations, which appear as if they might be very short arms, and a third fine wisp that starts at $p = 185^{\circ}$ and runs into the outer arm. Traces of the W half of a ring of $40''$ radius appear with ends forming elongated knots at $p = 25^{\circ}$ and 205° , and at a mean radius of $1'.25$ is an almost continuous faint broad ring. A long exposure is necessary to determine whether the two outer rings really form part of the spiral arms. Five small faint nebulae appear on the plate.

N.G.C. 2830 Lynx

$$\alpha = 9^{\text{h}}14^{\text{m}}44^{\text{s}}, \quad \delta = +34^{\circ}6'0'' \text{ (1917)}; \quad \lambda = 158^{\circ}, \quad \beta = +46^{\circ}$$

Plate No. 246, 1914, November 15, 150^m

Plate No. 247, 1914, November 16, 60^m

This is a spindle nebula $50'' \times 6''$, $p = 106^{\circ}$, with faint stellar nucleus.

The ends of the nebula bend counter-clockwise, giving it a resemblance to the integral sign. The traces of detail show that it is almost certainly a spiral.

On this photograph $36' \times 36'$ are 28 nebulous spots or stars, 6 spindles with nucleus, and 3 without; among them are the following:

N.G.C. 2825—A spindle about $40'' \times 4''$, $p = 83^{\circ}$, of about the same intensity as N.G.C. 2830. It has a stronger nucleus than N.G.C. 2830 and a knot Nf the nucleus.

N.G.C. 2826—A rhombus about $1' \times 6''$, $p = 143^{\circ}$, with nucleus and nebulosity much stronger than N.G.C. 2830.

- N.G.C. 2827—Faint nucleus in elongated nebulosity in $p=8^\circ$.
 N.G.C. 2828—Nebulous star in very faint elongated nebulosity $p=45^\circ$.
 N.G.C. 2829—Nebulous star.
 N.G.C. 2831—Nebulous star.
 N.G.C. 2832—Strong nucleus surrounded by strong nebulosity that fades rapidly to about $14''$ diameter, then gradually to $30''$ diameter. The whole is elongated, $p=150^\circ$.
 N.G.C. 2834—Nebulous star.
 N.G.C. 2839—Nebulous star.

N.G.C. 2841 Ursa Major

$$\alpha=9^h16^m18^s, \delta=+51^\circ19'7'' (1917); \quad \lambda=135^\circ, \beta=+45^\circ$$

Plate No. 58, 1912, February 19, 120^m. Good plate. Illustrated Plate Va

This is a fine left-handed spiral nebula $6'.5 \times 2'.2$, $p=150^\circ$. The strong nucleus lies in an almost uniform glow of nebulosity, but the fine sweeping arms are streamers of nebulous knots. This nebula shows very nicely the difference in the nebulosity on the two sides of the major axis. The W side is softened and permeated with a glow, lacking in the E side, which is of marked contrast. In a field $36' \times 36'$, 16 faint nebulae appear.

N.G.C. 2976 Ursa Major

$$\alpha=9^h40^m24^s, \delta=+68^\circ17'9'' (1917); \quad \lambda=111^\circ, \beta=+42^\circ$$

Plate No. 175, 1912, December 10, 180^m. Good negative
 Illustrated Plate Vb

This bright elliptical nebula $3'.2 \times 1'$, $p=142^\circ$, is full of condensations and dark lanes, with faint extensions $25''$ – $30''$ at each end. The arrangement of some of the patches and dark lanes gives it somewhat the appearance of a spiral, but one cannot be certain. There is no nucleus, but at the center are three bright stellar knots and a fourth elongated knot. There are 11 more of these knots scattered about the nebula, together with many that range from small nebulous spots to areas barely distinguishable from the general nebulosity.

N.G.C. 3115 Sextans

$$\alpha=10^h1^m6^s, \delta=-7^\circ18'9'' (1917); \quad \lambda=216^\circ, \beta=+38^\circ$$

Plate No. 56, 1911, December 25, 100^m. Good plate. Illustrated Plate VIa

This is a bright spindle with an oblate center, which measures about $30'' \times 25''$. The disk lies in $p=45^\circ$, is about $6''$ wide, and

strong and continuous for about $45''$ either side of the nucleus; then come several interruptions and knots. The whole lies within an elliptical halo of nebulosity $3' \times 1'$. Slipher's[†] value for the radial velocity is roughly $+400$ km.

N.G.C. 3593 Leo

$$\alpha = 11^{\text{h}}10^{\text{m}}17^{\text{s}}, \quad \delta = +13^{\circ}16'.0 \text{ (1917)}; \quad \lambda = 210^{\circ}, \quad \beta = +64^{\circ}$$

Plate No. 185, 1913, March 5, 210^m. Good plate. Illustrated Plate VIb

This nebula has more or less of the spiral characteristics, but it cannot be said for certain that it is a spiral. On a faint patchy elliptical ground of nebulosity $4.5' \times 1'$, $p = 89^{\circ}$, lies centrally a bright patch $60'' \times 13''$. The E $15''$ of this ellipse is not much brighter than the fainter nebulosity; the W end is crossed by two straight dark lanes, the one nearest the center running in $p = 39^{\circ}$ to 219° , the other in $p = 178^{\circ}$ to 358° , thus forming two isolated bright spots. At the E end of the bright central part are two stellar condensations. At the E end of the faint nebulosity there are a number of dark wisps or tongues curved left-handed. An irregular dark lane runs N of the bright center almost the length of the major axis.

N.G.C. 3666 Leo

$$\alpha = 11^{\text{h}}20^{\text{m}}8^{\text{s}}, \quad \delta = +11^{\circ}47'.9 \text{ (1917)}; \quad \lambda = 215^{\circ}, \quad \beta = +66^{\circ}$$

Plate No. 248, 1915, February 12, 150^m. Weak plate

This is a faint left-handed spiral $3.5' \times 0.7'$, $p = 100^{\circ}$, the central part $80'' \times 20''$ being brighter, and having a number of nebulous knots scattered through it, the brightest of which is the nucleus. At one time it was suspected of variability, but Dreyer's conclusions are opposed to this.

N.G.C. 3938 Ursa Major

$$\alpha = 11^{\text{h}}48^{\text{m}}31^{\text{s}}, \quad \delta = +44^{\circ}35'.4 \text{ (1917)}; \quad \lambda = 118^{\circ}, \quad \beta = +70^{\circ}$$

Plate No. 249, 1915, March 12, 39^m. Poor plate

The photograph is a very weak exposure, but sufficient to show a right-handed open spiral $4'$ in diameter, having a small bright nucleus and resembling M 74 or M 101, with most of the material in the well-separated arms.

[†] *Popular Astronomy*, 23, 36, 1915.

N.G.C. 4216 Virgo

$$\alpha = 12^{\text{h}}11^{\text{m}}40^{\text{s}}, \quad \delta = +13^{\circ}36'.4 \text{ (1917)}; \quad \lambda = 243^{\circ}, \quad \beta = +73^{\circ}$$

Plate No. 192, 1913, March 7, 90^m. Illustrated Plate VIc

Good plate, but needs longer exposure

This is a left-handed spiral $6' \times 1'$, $p = 21^{\circ}$. The nucleus and the arm starting from it are bright; there is a condensation $1'$ N of the nucleus. The p side is soft, while the f side shows the marked contrast usual in inclined nebulae. There are many nebulous spots scattered over the plate and $10' p$, $2' N$ of the nucleus of 4216 lies a left-handed nebula about $30''$ diameter. The two following nebulae also appear on the plate:

N.G.C. 4206—Faint spiral, $4' \times 30''$, $p = 1^{\circ}$.

N.G.C. 4222—Faint spindle, $2'.5 \times 10''$, $p = 59^{\circ}$.

N.G.C. 4236 Draco

$$\alpha = 12^{\text{h}}12^{\text{m}}48^{\text{s}}, \quad \delta = +69^{\circ}56'.0 \text{ (1917)}; \quad \lambda = 95^{\circ}, \quad \beta = +47^{\circ}$$

Plate No. 201, 1913, May 7, 180^m. Poor plate

This nebulosity lies Sp the variable star SW Draconis. It is an irregular cloud of nebulous stars and nebulous haze roughly scattered about a region $15' \times 4'$, $p = 160^{\circ}$. The strongest parts are a mixed group in the Np corner and a wisp extending from the N end a little to the E of southward for about $7'$.

N.G.C. 4406 Virgo

$$\alpha = 12^{\text{h}}21^{\text{m}}59^{\text{s}}, \quad \delta = +13^{\circ}24'.3 \text{ (1917)}; \quad \lambda = 251^{\circ}, \quad \beta = +75^{\circ}$$

Plate No. 234, 1914, March 18, 90^m

The photograph shows a nebulous spot, having a bright nucleus, gradually decreasing in brightness until it fades away at a mean radius of $35''$. It is slightly elongated in $p = 130^{\circ}$. Besides a number of faint nebulae and spots the following nebulae appear:

N.G.C. 4374—Practically the same type and size as N.G.C. 4406. The nucleus is possibly a little larger, but the nebula lies near the edge of the plate.

N.G.C. 4387—Of the same type as N.G.C. 4406, $40'' \times 15''$. Elongated in $p = 140^{\circ}$.

N.G.C. 4388—An elliptical nebula $3'.5 \times 30''$, $p = 90^{\circ}$, lying near the S edge of the plate. A bright T-shaped knot, base to the N, cuts across

the center, with a dark spot on either side. A second bright elongated knot lies just W of the base of the τ . Probably spiral.

N.G.C. 4402—A faint elongated nebula $3' \times 35''$, $p = 89^\circ$, dark elongated central space, bright periphery, soft outside and indented inside; probably spiral.

N.G.C. 4407—An elongated nebulous spot lying near the S edge of the plate, $20'' \times 8''$, $p = 10^\circ$.

N.G.C. 4425—A spindle consisting of nucleus $8''$ diameter in uniform nebulosity about $90'' \times 22''$, $p = 30^\circ$.

N.G.C. 4449 Canes Venatici

$\alpha = 12^h 24^m 11^s$, $\delta = +44^\circ 33' 0''$ (1917); $\lambda = 96^\circ$, $\beta = +72^\circ$

Plate No. 198, 1913, April 7, 300^m. Illustrated Plate IIIb

This is an irregular nebulous mass in which many nebulous stars are distributed unevenly. The greater part of the nebula is roughly rectangular, about $4'.5 \times 2'.5$, $p = 40^\circ$, there being an assemblage of some dozen nebulous stars W of the SW corner. On the original negative there are 230 nebulous stars or patches, about 40 appearing bright and 190 faint, though the gradation is very uniform. Two-thirds of them are in the N half. The nebulosity proper is weak toward the edge, gradually increases inward, and culminates along a central ridge, where it is as strong as the stars themselves. A number of dark irregular rifts appear here and there in it. Wolf[†] found an absorption spectrum similar to that of the Andromeda nebula, with possible bright lines.

N.G.C. 4567-8 Virgo

$\alpha = 12^h 32^m 20^s$, $\delta = +11^\circ 42' 9''$ (1917); $\lambda = 264^\circ$, $\beta = +73^\circ$

Plate No. 235, 1914, March 19-20, 180^m

Plate No. 237, 1914, April 24, May 19, 360^m. Illustrated Plate VI d

The plate shows two fine overlapping spirals; one, N.G.C. 4567, seen more nearly in plan than N.G.C. 4568.

N.G.C. 4567 is a right-handed spiral $2' \times 1'.5$, $p = 75^\circ$, having a small bright nucleus and two arms consisting chiefly of nebulous stars. The nebulosity is weak and irregular in intensity with a number of dark lanes, notably one following the concave side of

[†] *Sitzungsberichte der Heidelberger Akad.*, August 26, 1912.

the p arm. There is evidence of much disturbance in the nebula, as the W arm is broken off and forked and the E arm offset.

N.G.C. 4568 is a right-handed spiral $4' \times 1'.5$, $p = 29^\circ$, having a small nucleus which is fainter than that of N.G.C. 4567. It is hard to trace the arms distinctly about the nucleus, as the nebulous knots are irregularly placed. At their extremities the arms are much broken, especially on the N side, which is crossed with several great rifts; there is no question, however, as to the general trend. The dark rift at the apparent contact line of the two nebulae may really belong to N.G.C. 4568, which apparently lies beyond N.G.C. 4567.

N.G.C. 4564 appears on the plate as a spindle $90'' \times 20''$, $p = 49^\circ$, with strong nebulous nucleus, $15''$ diameter. There are 6 or more very small faint nebulous spots or spindle nebulae on the plate.

N.G.C. 4594 Virgo

$$\alpha = 12^h 35^m 40^s, \quad \delta = -11^\circ 10' (1917); \quad \lambda = 269^\circ, \quad \beta = +52^\circ$$

Plate No. 256, 1916, February 12, 55^m

Plate No. 259, 1916, April 6, 120^m

Plate No. 262, 1916, May 3, 132^m. Illustrated Plate VIe

Plate No. 264, 1916, May 26, 90^m. Seed 27 bathed Wallace 3 dye. Red screen

This fine spiral nebula, $7' \times 1'$, $p = 89^\circ$ is seen almost edge-on, the convolutions being so nearly concentric that it is not possible to state whether it is right- or left-handed. It is crossed by a dark streak which lies at the periphery, being possibly an outer ring of cooler material, or perhaps the unilluminated edge of the thin disk of nebulous matter surrounding the brilliant nucleus. The streak is $9''$ wide except near the ends, where it gradually broadens to twice this width. A trace of nebulosity runs almost centrally along the dark streak. A strong halo $2'$ in diameter surrounds the nucleus, and the first ring is much stronger than the surrounding ones. A test for possible differences in temperature, by exposures made on a Seed 23 plate and on a red-sensitive plate with a screen transmitting λ 5650–7600, showed no certain difference.

An 80-hour exposure with the focal-plane spectrograph, the slit parallel to the major axis and across the nucleus, showed that: (a) the spectrum is F5; (b) the velocity-curve is sensibly linear, $V = -278x + 1180$, the radial velocity accordingly being 1180 km

and the rotation, at a distance of $2'$, 330 km, the W side approaching and the E side receding from the observer.

N.G.C. 4736 Canes Venatici

$$\alpha = 12^{\text{h}}46^{\text{m}}59^{\text{s}}, \quad \delta = +41^{\circ}34'.3 \text{ (1917)}; \quad \lambda = 85^{\circ}, \quad \beta = +76^{\circ}$$

Plate No. 60, 1912, February 20, 225^m. Illustrated Plate VIIe

Plate No. 3093P, 1916, May 8, 5^m. Illustrated Plate VIIb

Plate No. 3093P, 1916, May 8, 10^m. Illustrated Plate VIIa

Plate No. 3094P, 1916, May 8, 20^m. Illustrated Plate VIId

Plate No. 3094P, 1916, May 8, 40^m. Illustrated Plate VIIc

This fine right-handed spiral has three regions of very marked difference in brightness. From a very bright, sharp stellar nucleus spring branches of smooth nebulosity, which after a turn about the nucleus break into a series of nebulous knots forming the periphery of an ellipse $2' \times 1'.5$, $p = 126^{\circ}$. Here the intensity suddenly diminishes while the arms continue in fine sweeping curves of faint smooth nebulosity, devoid of knots save for two or three small patches, to such an extent as to fill an ellipse $5' \times 4'$, $p = 105^{\circ}$. The nebulosity for a distance of $30''$ diameter around the nucleus is very strong. Plates 3093-4 P, taken by Mr. Seares, show the central parts well. The nebula has a solar-type spectrum,¹ with possible Wolf-Rayet bands. Its radial velocity² is roughly $+200$ km.

N.G.C. 4900 Virgo

$$\alpha = 12^{\text{h}}50^{\text{m}}28^{\text{s}}, \quad \delta = +2^{\circ}56'.5 \text{ (1917)}; \quad \lambda = 280^{\circ}, \quad \beta = +66^{\circ}$$

Plate No. 188, 1915, March 5, 210^m. Elongated images

The type of this interesting nebula cannot definitely be stated, though the lines are such as are followed by a left-handed spiral. It is irregularly round, $1'.5$ in diameter, patchy in appearance, with a number of nebulous stars, a single row around the N rim and a double row on the S side. There is a faint central stellar nucleus crossed by a bright patch of nebulosity $15'' \times 6''$, $p = 145^{\circ}$. A star much brighter than the nucleus lies on the Sf point of the rim.

¹ *Astrophysical Journal*, 37, 199-200, 1913.

² *Popular Astronomy*, 23, 36, 1915.

N.G.C. 5005 Canes Venatici

$$\alpha = 13^{\text{h}} 7^{\text{m}} 3^{\text{s}}, \quad \delta = +37^{\circ} 30' 2'' (1917); \quad \lambda = 64^{\circ}, \quad \beta = +78^{\circ}$$

Plate No. 59, 1912, February 19, 50^m

This left-handed spiral $3'.5 \times 1'.3$, $p = 69^{\circ}$, has a stellar nucleus surrounded by strong nebulosity which gradually fades toward the edge. The N half shows contrast, and the S half is smooth.

N.G.C. 5308 Ursa Major

$$\alpha = 13^{\text{h}} 44^{\text{m}} 15^{\text{s}}, \quad \delta = +61^{\circ} 23' 5'' (1917); \quad \lambda = 76^{\circ}, \quad \beta = +55^{\circ}$$

Plate No. 196, 1913, April 4, 180^m. Good plate

This is a spindle with oblate center $2' \times 0'.25$, $p = 60^{\circ}$, having almost no detail. On either side of the bright nucleus the major axis appears as a bright line, gradually fading toward the rim and apparently interrupted at the nucleus on the p side. Several nebulous spots appear on the plate.

N.G.C. 5383 Canes Venatici

$$\alpha = 13^{\text{h}} 53^{\text{m}} 41^{\text{s}}, \quad \delta = +42^{\circ} 14' 9'' (1917); \quad \lambda = 48^{\circ}, \quad \beta = +69^{\circ}$$

Plate No. 195, 1913, April 3, 180^m. Images elongated. Illustrated Plate VIIIb

Plate No. 199, 1913, May 5, 6, 360^m. Good plate. Illustrated Plate VIIIa

This right-handed spiral resembles a pinwheel lying about a very bright multiple nucleus within a circle $2'.25$ diameter. Some disturbance has altered the regularity of distribution of the typical form. On the f side much of the nebulosity has been swept into a broad band running in a SE direction to a row of bright nebulous knots lying along the rim at right angles to it; enough nebulosity remains, however, to show the spiral form. In the p arm there are no traces of the spiral form, everything being swept into a broad band running in a NW direction from the nucleus for some distance, when it suddenly turns counter-clockwise in a bright ridge diametrically opposite and similar to that of the E arm. A dark streak runs from between the central and S parts of the nucleus and separates the p band into two arms; opposite this another dark interrupted streak emanating from between the central and the N members of the nucleus, runs E and S following the line of the spiral. The nucleus consists of 3 almost parallel bright condensations $15''$ to $20''$

long, elongated in $p=100^\circ$, their central lines separated about $6''.5$, the northernmost slightly f , and the southernmost p the central one. A dark streak cuts across the three members of the nucleus, running almost due NS.

S of N.G.C. 5383, $3'.25$, lies a faint S-shaped left-handed spiral about $1'$ in diameter.

N.G.C. 5544-5 Boötes

$$\alpha = 14^h 13^m 33^s, \quad \delta = +36^\circ 57'.3 \text{ (1917)}; \quad \lambda = 32^\circ, \quad \beta = +68^\circ$$

Plate No. 127, 1912, June 13, 180^m

Plate No. 261, 1916, May 1, 2, 3, 4, 5, 360^m. Illustrated Plate VIIIc
Good negatives

These are two overlapping spirals, the E one in plan, the W one very much inclined to the line of sight.

N.G.C. 5544 is a left-handed spiral $70'' \times 15''$, $p=60^\circ$, its f end just tangent to the NW point of the nucleus of N.G.C. 5545. The nucleus is faint and stellar. The arms are about equal in intensity where they start from the nucleus, but that on the E side continues bright for a much greater distance, being interrupted, however, at several points.

N.G.C. 5545 consists of a bright stellar nucleus, a nebulous ring $28''$ outside diameter, a fainter diametral streak crossing the nucleus in $p=130^\circ$, and another ring about the same intensity as the inner one, irregularly round, $45''$ outside diameter, both being slightly elongated $p=120^\circ$.

In N.G.C. 5545 the nebulosity is entirely soft; in N.G.C. 5544 several knots and condensations appear.

N.G.C. 5560 Virgo

$$\alpha = 14^h 15^m 54^s, \quad \delta = +4^\circ 22'.3 \text{ (1917)}; \quad \lambda = 318^\circ, \quad \beta = +57^\circ$$

Plate No. 250, 1915, April 11, 200^m

This right-handed spiral is very much inclined to the line of sight. It has a weak nucleus, several knots in nebulosity near the nucleus, and two arms that make a half-revolution, then sweep outward very rapidly and fade away. It is $3' \times 0'.3$, $p=105^\circ$.

N.G.C. 5566 is a right-handed spiral, with a bright nucleus, $18'' \times 8''$, $p=30^\circ$. Surrounding the nucleus is faint nebulosity from

which the arms emerge. More exposure is needed to bring out the arms well, but they sweep outward so as practically to fill an ellipse $6' \times 1'.5$, $p = 32^\circ$. An elliptical ring of nebulosity $90'' \times 45''$, $p = 20^\circ$, gives the appearance of overlapping arms.

N.G.C. 5569 is a faint right-handed spiral in plan.

N.G.C. 5746 Virgo

$\alpha = 14^h 40^m 43^s$, $\delta = +2^\circ 18'.3$ (1917); $\lambda = 323^\circ$, $\beta = +52^\circ$

Plate No. 236, 1914, March 20, 21, 22, 360^m. Good plate

Illustrated Plate VIII*d*

This fine right-handed spiral is seen almost edge-on, having the characteristic oblate center surrounding the bright nucleus. It is crossed by a dark streak parallel to the major axis; nebulosity full of contrast occurs on the W side, the E side being smooth. The spiral form measures $7'.5 \times 0'.75$, $p = 170^\circ$, and the oblate halo projects to a semi-minor axis of $30''$.

N.G.C. 5740 lies near the S edge of the plate. It is a left-handed spiral $3' \times 1'.25$, $p = 160^\circ$, with bright nucleus, and arms gradually weakening toward the edge. An asteroid trail appears (March 20) $p = 234^\circ$, 19', Sp the nucleus, the trail lying in $p = 158^\circ$. Through the kindness of Dr. Leuschner, Miss Levy identified this as (304) Olga.

N.G.C. 5866 Boötes

$\alpha = 15^h 4^m 12^s$, $\delta = +56^\circ 5'.0$ (1917); $\lambda = 58^\circ$, $\beta = +52^\circ$

Plate No. 129, 1912, June 14, 165^m. Illustrated Plate VIII*e*

This nebula is lenticular, $2'.5 \times 0'.75$, $p = 126^\circ$, with no apparent nucleus, but with a bright center gradually decreasing in intensity toward the edge. Lying across the center and making an angle of 3° with the major axis is a narrow dark streak, $p = 123^\circ$, about $1'$ long. Overlapping this at either end, and extending along the major axis to a distance of $45''$ in either direction from the center, lies a streak as bright as the central nebulosity, which gradually fades out toward the end. Slipher's¹ value for the radial velocity is $+600$ km.

¹ *Popular Astronomy*, 23, 36, 1915.

N.G.C. 5907 Draco

$$\alpha = 15^{\text{h}}13^{\text{m}}44^{\text{s}}, \quad \delta = +56^{\circ}38' (1917); \quad \lambda = 57^{\circ}, \quad \beta = +51^{\circ}$$

Plate No. 197, 1913, April 4, 90^m. Weak plate

This nebula is a spiral seen edge-on, similar to N.G.C. 5746 in having a longitudinal absorption streak lying just to one side of the nucleus. It measures $11' \times 0.7$, $p = 156^{\circ}$.

N.G.C. 6070 Serpens

$$\alpha = 16^{\text{h}}5^{\text{m}}45^{\text{s}}, \quad \delta = +0^{\circ}55.7' (1917); \quad \lambda = 340^{\circ}, \quad \beta = +35^{\circ}$$

Plate No. 265, 1916, May 26, 75^m

Plate No. 267, 1916, May 27, 150^m. Illustrated Plate IXd

This is a right-handed spiral $3' \times 1.3$, $p = 59^{\circ}$. Several arms dotted with nebulous stars make a full turn or more; those ending on the *f* side are well defined, those on the *Sp* side diffused and free of knots. Directly *f* the nucleus two arms of the same curvature appear to overlap. There is a small stellar nucleus in an elongated nebulous knot. In a line a little to E of N of the nucleus the arms are much reduced in intensity.

N.G.C. 6210 Hercules

$$\alpha = 16^{\text{h}}41^{\text{m}}1^{\text{s}}, \quad \delta = +23^{\circ}57.2' (1917); \quad \lambda = 11^{\circ}, \quad \beta = +36^{\circ}$$

Plate No. 139, 1912, July 13, 60^m. 100-foot focus

This is the well-known bright planetary nebula, Struve No. 5. The negative is overexposed, but one can see a bright central nucleus, bright nebulous streaks, fainter short curves bowed outward, some of them fading before returning, and several faint extensions, all of which give the nebula an angular appearance. The focal-plane slit spectrum is continuous for the star and crossed by bright lines projecting on either side. Keeler's¹ value of the radial velocity is -34.3 km and Campbell and Moore² have found internal motion.

¹ W. W. Campbell, *Stellar Motions*, p. 210.

² *Publications of the Astronomical Society of the Pacific*, 28, 120, 1916.

N.G.C. 6217 Ursa Minor

$$\alpha = 16^{\text{h}}36^{\text{m}}32^{\text{s}}, \quad \delta = +78^{\circ}22' \text{ (1917)}; \quad \lambda = 79^{\circ}, \quad \beta = +33^{\circ}$$

Plate No. 200, 1913, May 6, 60^m. Weak plate

This right-handed spiral has a stellar nucleus. Nebulosity is noticeably absent near nucleus. There are nebulous knots along the arms. It measures $1'.5 \times 1'$, $p = 160^{\circ}$.

N.G.C. 6309 Ophiuchus

$$\alpha = 17^{\text{h}}9^{\text{m}}24^{\text{s}}, \quad \delta = -12^{\circ}48'9'' \text{ (1917)}; \quad \lambda = 337^{\circ}, \quad \beta = +13^{\circ}$$

Plate No. 252, 1915, May 10, 90^m. Illustrated Plate IIa

Plate No. 263, 1916, May 5, 10^m

The plate shows a nebulous spot with a well-defined arrowhead at the S end, a blunt arrowhead at the N end, both pointing outward, the two connected by faint nebulosity. A faint stellar nucleus lies at the base of the N head a little N of the center of the nebula. It measures $22'' \times 12''$, $p = 162^{\circ}$. Keeler's¹ value of the radial velocity is -51.5 km.

N.G.C. 6412 Draco

$$\alpha = 17^{\text{h}}32^{\text{m}}4^{\text{s}}, \quad \delta = +75^{\circ}6'6'' \text{ (1917)}; \quad \lambda = 74^{\circ}, \quad \beta = +31^{\circ}$$

Plate No. 128, 1912, June 13, 80^m. Weak plate

This is a faint left-handed spiral $90'' \times 70''$, $p = 160^{\circ}$, having a faint stellar nucleus, with respect to which there is a knot of about the same brightness, $p = 350^{\circ}$, $36''$.

N.G.C. 6478 Draco

$$\alpha = 17^{\text{h}}32^{\text{m}}4^{\text{s}}, \quad \delta = +51^{\circ}11'6'' \text{ (1917)}; \quad \lambda = 46^{\circ}, \quad \beta = +29^{\circ}$$

Plate No. 135, 1912, July 11, 270^m

This is a right-handed spiral, $90'' \times 30''$, $p = 32^{\circ}$, having a stellar nucleus. A star a little brighter than the nucleus lies at $p = 10^{\circ}$, $14''$. It is surrounded by a dark space $5''$ to $6''$ in diameter, the arms being cut off sharply. Does the star have an absorbing atmosphere? The detail is stronger in contrast on the p side. There are over a dozen very small and faint nebulae on this plate.

¹ W. W. Campbell, *Stellar Motions*, p. 210.

N.G.C. 6543 Draco

$$\alpha = 17^{\text{h}}58^{\text{m}}35^{\text{s}}, \quad \delta = +66^{\circ}38'3 (1917); \quad \lambda = 63^{\circ}, \quad \beta = +9^{\circ}$$

Plate No.	9, 1911, July	23, 10 ^m .	25-foot focus
Plate No.	10, 1911, July	23, 20 ^m .	25-foot focus
Plate No.	11, 1911, July	23, 6 ^m .	25-foot focus
Plate No.	20, 1911, July	25, 90 ^s .	25-foot focus
Plate No.	34, 1911, October 18,	50 ^m .	100-foot focus

Illustrated Plate II*b*

Plate No.	238, 1914, May 17,	90 ^m .	80-foot focus
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This is the well-known planetary nebula in Draco. The long exposures show a sharply outlined ellipse $24'' \times 18''$, $p = 40^{\circ}$, without detail, beyond which project ansae $2''$ to $3''$ on an axis in $p = 20^{\circ}$. On the shorter exposures the brighter nebulosity has the appearance of a curved thread which crosses itself several times, the ansae forming the ends. Its continuity is more or less disturbed in several places. Overlapping points are of greater brightness. At two points the thread approaches the bright stellar nucleus, giving almost the appearance of arms starting therefrom, but in neither case do they connect directly with the nucleus. The focal-plane slit spectrum appears as a continuous band corresponding to the nucleus, crossed by bright lines which project on either side. Keeler's¹ value for the radial velocity is -64.7 km, and Campbell and Moore² have found internal motion.

N.G.C. 6555 Hercules

$$\alpha = 18^{\text{h}}3^{\text{m}}28^{\text{s}}, \quad \delta = +17^{\circ}35'3 (1917); \quad \lambda = 12^{\circ}, \quad \beta = +16^{\circ}$$

Plate No. 268, 1916, May 28-29, 360^m. Illustrated Plate IX*b*

This left-handed spiral $1'.5 \times 1'$, $p = 111^{\circ}$, is in a rich field of stars. There is a star which might be taken for the nucleus, but the real nucleus is a slightly elongated knot a few seconds N. The brightest part of the nebula is a double knot at $p = 240^{\circ}$, $13''$, with respect to star. A number of small faint nebulae appear on the plate.

¹ W. W. Campbell, *Stellar Motions*, p. 210.

² *Lick Observatory Bulletin*, No. 278, 1916.

N.G.C. 6703 Lyra

$$\alpha = 18^{\text{h}}44^{\text{m}}53^{\text{s}}, \quad \delta = +45^{\circ}27'.5 \text{ (1917)}; \quad \lambda = 42^{\circ}, \quad \beta = +18^{\circ}$$

Plate No. 269, 1916, July 1, 60^m

Plate No. 270, 1916, July 1, 180^m

A long exposure is necessary to show whether this is a ring nebula of a type very different from that usually met with, or whether a spiral, though indications point toward the former. The central nucleus lies in a bright nebulous spot which gradually fades out at 30'' diameter. The surrounding ring is very faint and narrow and about 80'' diameter.

N.G.C. 6702 appears as a nebulous spot very similar to, but fainter and smaller than, the central part of 6703. It is slightly elongated in $p=60^{\circ}$.

There are six additional small faint nebulae on the plate, three being nebulous spots and three spindles, the brightest two of the latter with respect to N.G.C. 6703 being at $p=177^{\circ}$, 8'.9, elongated in $p=120^{\circ}$, and $p=132^{\circ}$, 9'.8, elongated in 129° .

N.G.C. 6804 Aquila

$$\alpha = 19^{\text{h}}27^{\text{m}}37^{\text{s}}, \quad \delta = +9^{\circ}2'.9 \text{ (1917)}; \quad \lambda = 13^{\circ}, \quad \beta = -6^{\circ}$$

Plate No. 120, 1912, June 11, 60^m. Weak

The plate shows the nebula as a faint annulus with an irregularly shaped ring 5'' to 10'' in width and about 32'' \times 25'', $p=60^{\circ}$. It has the typical central star and another of about the same magnitude lying directly upon the ring at the W end of the major axis. As in many planetaries, the nebulosity is stronger near the ends of the minor axis than near the ends of the major axis. Huggins¹ found that it had a bright-line spectrum.

Plate 294, 1917, June 24-25, 5^h25^m exp., shows a planetary nebula with uniform disk 65'' \times 55'', $p=165^{\circ}$, on which lies the ring described above. The N p and S points of the rim are strengthened while the f side is missing.

¹ *Philosophical Transactions*, 166, 386, 1866.

N.G.C. 6818 Sagittarius

$$\alpha = 19^{\text{h}}39^{\text{m}}17^{\text{s}}, \quad \delta = -14^{\circ}21'.1 \text{ (1917)}; \quad \lambda = 353^{\circ}, \quad \beta = -19^{\circ}$$

Plate No. 115, 1912, June 10, 5^m. 25-foot focus

Plate No. 116, 1912, June 10, 2^m. 25-foot focus

Plate No. 137, 1912, July 12, 75^m. 100-foot focus. Illustrated Plate IIc

This bright planetary nebula is about 25'' in diameter and contains a small faint nucleus and much detail. Upon the faint uniform disk lies a moderately bright elliptical ring 25'' \times 16'', $p=9^{\circ}$, and varying in width and intensity, the N end almost fading into the disk and the other end crossed by a dark streak. From each of two strong knots, about 8'' apart and equidistant from the nucleus in the W limb of the ring, a wisp runs inward to the major axis, the two wisps being parallel. A thread runs from the nucleus NE to the E limb. The spectrum has bright lines; Keeler's¹ value for the radial velocity is -16.7 km.

N.G.C. 6826 Cygnus

$$\alpha = 19^{\text{h}}42^{\text{m}}34^{\text{s}}, \quad \delta = +50^{\circ}19'.4 \text{ (1917)}; \quad \lambda = 52^{\circ}, \quad \beta = +12^{\circ}$$

Plate No. 130, 1912, June 14, 10^m

Plate No. 131, 1912, June 14, 5^m

Plate No. 132, 1912, June 14, 25^m

Bathed-process plate and red screen; Pan-Iso developer

This is a bright planetary nebula 30'' \times 27'', $p=127^{\circ}$. The central nucleus is bright, sharply defined, and about 10'' in diameter. A knot appears at each end of the major axis, otherwise the disk is uniform. On the red-sensitive plate the nucleus is about 5'' in diameter and lies in a faint nebulous haze that fades out at about 18'' diameter. The Cassegrain short-focus camera gives a spectrum strongly continuous for the star, crossed by bright lines, some projecting but a slight distance beyond the nucleus, others clear across the disk. Values obtained for the radial velocity are -5.3^2 and -8^3 km.

¹ W. W. Campbell, *Stellar Motions*, p. 210.

² *Ibid.*

³ *Publications of the Astronomical Society of the Pacific*, 27, 239, 1915.

N.G.C. 6894, Cygnus

$$\alpha = 20^{\text{h}}13^{\text{m}}3^{\text{s}}, \quad \delta = +30^{\circ}18'6'' (1917); \quad \lambda = 37^{\circ}, \quad \beta = -3^{\circ}$$

Plate No. 4, 1911, July 2, 60^m

Plate No. 7, 1911, July 3, 14^m

This is a well-defined ring; on the outside there is a haze, particularly on E and W sides; and on the inside, many protrusions toward the center giving an internal-toothed appearance. The strongest thread of the ring measures $42'' \times 32''$, $p = 45^{\circ}$. The central nucleus is stellar and small. In the Np section of the ring is a star with a very faint companion partly surrounded by a dark ring. A. Searle¹ found the spectrum to show bright lines.

N.G.C. 6905 Delphinus

$$\alpha = 20^{\text{h}}18^{\text{m}}42^{\text{s}}, \quad \delta = +19^{\circ}15'3'' (1917); \quad \lambda = 29^{\circ}, \quad \beta = -11^{\circ}$$

Plate No. 145, 1912, August 16, 180^m. 100-foot focus

Plate No. 147, 1912, September 5, 175^m. 100-foot focus

Plate No. 149, 1912, September 6, 205^m. 100-foot focus

All plates weak

This is a planetary nebula $47'' \times 34''$, $p = 175^{\circ}$, containing much detail, strongest on E and W sides and weak along the NS line. Huggins² found it to have a bright-line spectrum.

N.G.C. 7008 Cepheus

$$\alpha = 20^{\text{h}}58^{\text{m}}8^{\text{s}}, \quad \delta = +54^{\circ}13'5'' (1917); \quad \lambda = 61^{\circ}, \quad \beta = +5^{\circ}$$

Plate No. 243, 1914, July 22, 180^m. Illustrated Plate II*d*

This planetary nebula is elliptical in shape, $95'' \times 75''$, $p = 5^{\circ}$, containing much detail. The strongest bits of nebulosity are two condensations just E of the N end of the major axis. On the S side the elliptical form seems eaten away, but traces of nebulosity may be seen connecting with a star which lies $p = 156^{\circ}$, $53''$. A number of stars a magnitude or two fainter than the nucleus appear in the nebula. Except for one, they are surrounded by a dark ring which in turn opens directly on a dark region. As the nucleus

¹ *Harvard Annals*, 33, 145.

² *Philosophical Transactions*, 156, 385, 1866.

itself presents this appearance, it is suggested that these stars lie within the nebula. One of these stars, $p=240^\circ$, $23''$, appears elongated; it may be a double star or a very bright bit of nebulosity. One star at $p=65^\circ$, $29''$, with respect to the nucleus, is but partly surrounded by the dark ring. Huggins¹ found the spectrum to be gaseous.

N.G.C. 7009 Aquarius

$$\alpha=20^h59^m39^s, \quad \delta=-11^\circ41'6'' (1917); \quad \lambda=5^\circ, \quad \beta=-36^\circ$$

Plate No. 138, 1912, July 12, 90^m. 100-foot focus

Plate No. 140, 1912, July 13, 210^m. 100-foot focus. Illustrated Plate IIe

This is a most striking planetary, owing to its resemblance to Saturn. The brightest nebulosity is in the form of an elliptical ring, outside diameter $30'' \times 13''$, $p=78^\circ$. A second ring, more or less complete in outline, lying across the nucleus and in $p=160^\circ$, almost at right angles to the first, shows as a condensed knot on the N side, broadening out as it approaches the S side. Another feature is the rhomboid-shaped uniform mass with the E and W edges, approximately $18''$ long lying parallel to a NS line, and with the N and S sides, $23''$ long, slightly convex outward and running parallel to the major axis of the bright ellipse. The faint ansae are about $51''$ apart and connect with the central parts of the nebula through a bar lying in $p=78^\circ$. Other knots and threads besides those described also show. The reproduction has been prepared with a view to detail rather than to relative intensities. The focal-plane slit spectrograph shows a bright-line spectrum. The radial velocity is $+10.1$ km,² and Campbell and Moore have found internal motion.³

N.G.C. 7023 Draco

$$\alpha=21^h0^m35^s, \quad \delta=+67^\circ50'3'' (1917); \quad \lambda=72^\circ, \quad \beta=+14^\circ$$

Plate No. 12, 1911, July 23, 149^m

This large nebula contains a great wealth of detail and is intimately connected with a star of the seventh magnitude lying in it.

¹ *Philosophical Transactions*, **156**, 387, 1866.

² W. W. Campbell, *Stellar Motions*, p. 210.

³ *Lick Observatory Bulletin*, No. 278.

It occupies one of those dark regions which appear devoid of stars and which have been explained in several ways: the stellar material is at present in the nebula, or the nebula, containing both dark and bright material, lies this side of the stars and cuts off their light. Traces of the nebula extend as far as $9'$ from it, but only in those regions that are starless. The nebulosity surrounding the star is strongest and projects on its Sp side. Several bright filaments run Sp from the star, and there are two more S of the star running in an EW direction. The spectra of both the star and the nebulosity $13''6$ N of the nucleus photographed with the focal-plane spectrograph are continuous with absorption lines. The velocity of the nucleus is $+0.7$ km.¹

N.G.C. 7026 Cygnus

$$\alpha = 21^h 3^m 30^s, \quad \delta = +47^\circ 30' 8'' (1917); \quad \lambda = 57^\circ, \quad \beta = 0^\circ$$

Plate No. 156, 1912, October 10, 120^m. 100-foot focus

This bi-nuclear planetary is formed by two nebulous knots of about the same intensity, elongated NS , one lying $6''$ almost due E of the other. They are connected by a bar but there is no central star. There are traces of two loops, one on the N and another on the S , so connecting the knots that the whole forms an ellipse, $27'' \times 11''$, $p = 10^\circ$. The spectrum shows bright lines and Campbell and Moore² have found internal motion.

N.G.C. 7027 Cygnus

$$\alpha = 21^h 3^m 56^s, \quad \delta = +41^\circ 54' 0'' (1917); \quad \lambda = 53^\circ, \quad \beta = -5^\circ$$

Plate No. 142, 1912, August 15, 30^m. 100-foot focus

This is Webb's bright planetary, a bright starlike patch with faint wings extending $3''$ to $4''$ to the N and E . A second condensation of about the same intensity as the wing, elongated in $p = 80^\circ$, and of about the same size as the star lies at $p = 130^\circ, 5''$. The focal-plane spectrum shows very strong bright lines with practically no continuous background. Internal motion has been detected³ by Campbell and Moore.

¹ *Publications of the Astronomical Society of the Pacific*, 27, 239, 1915.

² *Ibid.*, 29, 55, 1917.

³ *Ibid.*, 28, 119, 1916.

N.G.C. 7129 Cepheus

$$\alpha = 21^{\text{h}}41^{\text{m}}4^{\text{s}}, \quad \delta = +65^{\circ}43'.3 \text{ (1917)}; \quad \lambda = 73^{\circ}, \quad \beta = +9^{\circ}$$

Plate No. 273, 1916, August 31, 150^m

Plate No. 274, 1916, September 3, 25^m

This nebula lies in one of the vacant Milky Way regions in which one or more bright stars are involved in nebulosity, faint traces of which may be followed over a large part of the dark area. Seven stars are involved in nebulosity, their positions with respect to the brightest, *a*, being as follows:

<i>ab</i>	$p = 298^{\circ}, 58''$	<i>ac</i>	$p = 50^{\circ}, 62''$	<i>ad</i>	$p = 15^{\circ}, 60''$
<i>ae</i>	$p = 355^{\circ}, 4'.5$	<i>af</i>	$p = 346^{\circ}, 4'.9$	<i>ag</i>	$p = 63^{\circ}, 5'.9$

The nebulosity about *a* for a distance of 12'' is very strong, completely masking the star; beyond it is fainter and more or less interrupted by dark patches up to a distance of 30'', where the curve begins. From *a* the nebulosity sweeps Nf, just passes *c* and *d* on the N, and sweeps backward to the W underneath *b*. Fainter clouds appear Sp as far as 4'.5 from *a*. Not including *e*, *f*, and *g* the nebula lies within a circle 6' in diameter, the center of which is about 1'.5 Sp *a*. Two stars lie near this center, but do not seem involved in the nebula; *e*, *f*, and *g* are each centers of nebulosity of medium intensity and irregular form about 1'.5 to 2' in diameter. A long exposure will probably show all these stars connected by nebulosity.

N.G.C. 7177 Pegasus

$$\alpha = 21^{\text{h}}56^{\text{m}}44^{\text{s}}, \quad \delta = +17^{\circ}20'.4 \text{ (1917)}; \quad \lambda = 43^{\circ}, \quad \beta = -30^{\circ}$$

Plate No. 126, 1912, June 12, 75^m

This nebula is a right-handed spiral with moderately bright nucleus, arms fairly strong over roughly 30'' diameter. Outside of this are traces of arms filling an ellipse 2'.5 × 1'.5, $p = 75^{\circ}$. One arm starts from the nucleus and branches in two, the arm opposite being deformed or missing altogether.

N.G.C. 7217 Pegasus

$$\alpha = 22^{\text{h}}4^{\text{m}}10^{\text{s}}, \quad \delta = +30^{\circ}57'2'' (1917); \quad \lambda = 54^{\circ}, \quad \beta = -21^{\circ}$$

Plate No. 216, 1913, September 2, 330^m. Illustrated Plate IXc

This nebula is a fine right-handed spiral seen in plan. It measures $3' \times 2'.5$, $p = 80^{\circ}$. For one turn about the nucleus the nebulosity is quite bright; then it drops in intensity over a space $75'' \times 60''$ where it fades away, to increase again in brightness so as to form a ring, at the periphery $20''$ to $30''$ wide, almost as bright as the second stage. Instead of two separate arms there seem to be many small ones composed of fine, knotted, and stringy nebulosity lying closely parallel. It lies in a region rich in stars. Huggins¹ found the spectrum to be continuous.

N.G.C. 7662 Andromeda

$$\alpha = 23^{\text{h}}21^{\text{m}}54^{\text{s}}, \quad \delta = +42^{\circ}4'8'' (1917); \quad \lambda = 74^{\circ}, \quad \beta = -18^{\circ}$$

Plate No. 29, 1911, October 17, 90^m. 100-foot focus, 44-inch aperture
Illustrated Plate II f

Plate No. 148, 1912, September 5, 60^m. 100-foot focus

Plate No. 157, 1912, October 10, 60^m. 100-foot focus. Seed 27 plate

Plate No. 172, 1912, December 10, 1^m, 3^m, 6^m, 10^m

Plate No. 173, 1912, December 10, 7^m, 30^m

Plate No. 177, 1913, January 7, 4^m, 7^m

Plate No. 275, 1916, September 3, 1^m, 4^m, 10^m

This is the well-known planetary in Andromeda with sharp bright nucleus and a mottled disk $31'' \times 27''$, $p = 40^{\circ}$, on which lies a very bright elliptical ring, $2''$ to $3''$ wide, whose median line is $15'' \times 9''$, $p = 45^{\circ}$, weakened on the minor axis. The E edge is tipped with a bright line of nebulosity. The longer exposures show a considerable number of knots on the rim, and from two of these at opposite ends of a diagonal in $p = 200^{\circ}$ threads appear which project over the edges and form ansae. The spectrum with focal-plane slit has bright lines, with practically no continuous background. Keeler's² value of the radial velocity is -11.4 km.

MOUNT WILSON SOLAR OBSERVATORY

April 1917

¹ *Philosophical Transactions*, 156, 391, 1866.

² W. W. Campbell, *Stellar Motions*, p. 210.