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Light-curves of several recent Novae, and some notes on the general features thereof.

By

I. Yamamoto.

(Received March 24, 1919)

(I) Provisional light-curve of Nova Aquilae.

Since my undergraduate course, some seven years ago, the New Star problem has been one of my subjects of study. Beginning with Nova Geminorum No. 2, of 1912, for convenience, many light-curves of comparatively recent objects were obtained, the physical interpretations of which, in terms of spectroscopic data, being mainly attacked. Some results were read several times in public meetings, the following being some of the remarks among others:

1. " Studies on New Stars, with special references to Nova Geminorum No. 2," on Oct. 30., 1913, at Meeting Phys. Inst.

2. " On Nova Lacertae," on Feb. 21., 1914, at Meeting, Phys. Inst.

3. " Spectral transformations of Novae," on Nov. 25., 1916, at Meeting Phys. Inst.

4. " On New Stars," on Feb. 21., 1918, at Meeting Phys. Inst.

Most recently a remarkable member has been found in Nova Aquila No. 3, and the careful study of its nature has become one of my daily labours since then. A preliminary light-curve being my first necessity, I obtained one last December, which is here reproduced. As it is now too early for us to get observational data from foreign countries, however, I was obliged to content myself with those of my own country-men only. Provisionally I found five observers here, among whom Mr. Sekiguti has already published his own estimations of magnitudes in the " Temmon-Geppo," and Messrs. Ueta and Kudara have respectively added their valuable observations to my own, while Mr. Sasaki sent me in letters his elaborate data. To these gentlemen my sincere thanks are due for this work.

Being quite preliminary in nature, and also of provisional necessity, the curve was drawn by inspection through the most probable mean values of individual observations, plotted on paper. Although this was been smoothed out partially with too scanty materials, the general form can be rather well traced, which is sufficient for my hasty examinations. Let me give here a statistical table of the materials used :

Observers	Estimations	Mean. Magnitudes	Nights
Mr. K. Sekiguti	102	29	23
Mr. Y. Ueta	42	36	35
Mr. Kudara	250	103	94
Mr. T. Sasaki	53	32	28
Mr. K. Yamamoto	80	38	38

(II) Light-curves of 5 recent New Stars.

In this connection I here reproduce more or less definite light-curves of five Novae of comparatively recent discovery, all of which were obtained from as many available materials as possible.

My method of obtaining the light-curve is this : I prefer generally *continuous* observations to any isolated data, especially are those made during several consecutive days welcomed as most valuable. Data of this kind are collected as many as possible, and plotted frankly on a sheet of section paper, taking Greenwich Mean Time as abscissa and the observed stellar magnitude as ordinate. Then those observations, which were observed by the same observer, and probably by the same means, are connected in the successive pairs by straight lines—here the connections between two consecutive days (or shorter intervals) must be valued most highly, so that the longer intervals are usually conected by dotted lines, by which the former kinds should be distinguished. After all connections have been made, a mean curve is drawn following the observations, and utmost care is taken to get the curve, each part of which should be as *parallel* to straight-line connections as possible.

By this method the absolute magnitudes may not be freely followed at the cost of time variations which are the most important to me. The general accuracy in magnitude is accordingly lowered, which is in these cases an unavoidable sacrifice for my purpose. Indeed, gradually it has become very clear to me that very rapid and complex fluctuations of light-intensities reasonably exist in New Stars, and sometimes the spectroscopic evidences are connected with them. This consideration has made me take the above method. And also, the art of smooth curve to express the "light-curve" has been changed into that of straight-line connection (as seen in these diagrams) by which to avoid the preoccupied images induced by the artificial smoothness of the drawn figure, and to allow any one freely to imagine the most probabale form of curve by means of apparently unnatural point-connection. (The light-curve of Nova Aquila is here exceptionally smoothed out.)

The light-curves of the Novae are here given in the order of establishment:

1) Nova Geminorum No. 2, 1912.

All materials were obtained at the library of the Kyoto University, amounting to 774 observations, and read on Oct. 30., 1913.

Mean Magnitudes.

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Mag.
d	*M*	*d*	*M*	*d*	*M*
1912 Mar. 11.8	5.0	Mar. 22.3	5.0	Apr. 4.3	6.1
12.3	4.35	23.3	4.9	5.3	6 1
13.4	4.2	24.0	4.7	6.4	6.55
13.6	4.1	24.4	4.65	7.3	6.5
14.3	3.9	25.3	5 05	8.4	6.3
14.5	3.7	26.4	5.9	9.4	6.1
15 3	4.2	27.3	6.6	10.4	6.5
15.4	4.4	28.4	6.2	14.4	6.5
16.4	5.5	29.3	6.2	12 4	6.3
17.3	5.45	30.4	5.6	13 4	6.6
18.4	5.4	31.3	6.1	14.4	6.6
19.3	5.4	Apr. 1.4	6.36	15.3	6.7
20.3	5.6	2.4	6 o	16.4	6.6
21.3	5.7	3.4	5.85	17.3	6.8

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Mag.
d	M	d	M	d	M
1912 Apr. 18.4	6.7	Apr. 29.4	7.1	May 13.3	7.7
19.4	6.55	30.4	7.0	14.4	7.8
20.4	6.8	Mar. 1.4	6.9	18.4	7.6
21.3	6.9	2.3	7.1	19.4	7.4
22.4	7.0	3.4	7.25	20.4	7.6
32.4	7.05	4.3	7.4	23.6	7.7
24.4	7.1	5.4	7.35	25.0	7.5
25.4	7.15	6.3	7.4	26.0	7.5
26.4	7.2	8.3	7.4	30.4	7.6
27.4	7.4	10.4	7.7		
28.5	7.5	12.4	7.5		

(2) Nova Lacertae, 1910–1911.

All materials were obtained at the library of the Kyoto University, amounting to 236 observations, and a paper on this curve was read on Feb. 21., 1914, at a regular meeting of the Physical Institute.

Mean Magnitudes.

(i) First series.

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Mag.
d	M	d	M	d	M
1910 Dec. 30.7	7.3	Jan. 20.25	8.5	Feb. 14.2	9.1
1911 Jan. 1.3	7.7	21.3	8.5	15.2	9.25
2.6	7.4	23.3	8.6	16.3	9.1
3.7	6.9	24.4	8.5	17.4	9.4
4.7	7.55	25.3	8.54	18.3	9.4
5.6	7.55	26.2	8.62	20.3	9.3
6.3	7.6	27.3	8.57	21.2	9.4
7.4	7.6	28.2	8.58	22.3	9.5
8.6	7.6	29.5	8.8	24.2	9.27
9.5	7.8	30.3	8.7	25.7	9.27
10.2	7.9	31.3	8.95	26.3	9.4
11.2	8.0	Feb. 1.3	8.8	27.3	9.1
12.6	8.15	2.3	8.8	28.4	9.0
13.6	8.2	3.4	8.8	Mar. 1.4	9.2
14.2	8.15	4.3	8.8	2.3	9.2
15.3	8.2	5.3	8.89	5.4	9.35
16.2	8.45	6.3	8.9	6.2	9.24
17.3	8.55	8.4	9.05	7.3	9.28
17.8	8.6	9.3	9.2	9.3	9.26
18.3	8.5	10.3	9.16	11.3	9.25
19.3	8.47	13.2	9.2		

As the original materials of the above values are very scant in number, the determinations of magnitudes after March 12th. are practically impossible with published data, which show somewhat traceable continuations to the end of the year. These have been combined to get the usual mean magnitudes, and given below as another series, together with the results treated similarly for the preceding period.

(ii) Second series.

G. M. T.	Mag.	G.M.T.	Mag.	G.M.T.	Mag.
d	*M*	*d*	*M*	*d*	*M*
1911 Jan. 2.5	7.4	Feb. 27.5	9.1	June 9.0	10.40
6.5	7.7	Mar. 4.5	9.2	24.0	10.45
10.5	7.7	14.5	9.3	July 4.0	10.68
13.0	8.0	19.5	9.3	13.0	10.50
20.0	8.4	27.0	9.3	Aug. 3.0	10.90
22.0	8.4	Apr. 2.0	9.5	23.0	10.50
25.5	8.6	9.0	9.6	Sept. 7.0	10.74
30.0	8.7	17.0	9.8	Oct. 2.0	10.90
Feb. 2.0	8.9	24.0	9.9	Nov. 1.0	11.45
9.0	9.15	May 2.0	9.5	21.0	11.26
17.5	9.05	17.0	10.26	Dec. 16.0	11.10

3) Nova Persei No. 2, 1901.

All of the materials, in this case, were collected at the library of the Mizusawa International Latitude Observatory, to whose Director my hearty thanks are due. A paper on this was read at a regular meeting of our Institute on November 25th., 1916.

Mean Magnitudes.

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Mag.
d	*M*	*d*	*M*	*d*	*M*
1901 Feb. 21.6	2.7	Feb. 24.6	0.5	Feb. 27.6	1.8
22.2	0.8	25.3	0.9	28.3	17.5
22.5	0.4	25.7	1.1	28.6	1.7
23.3	0.2	26.3	1.3	Mar. 1.3	1.9
23.6	0.2	26.6	1.4	1.7	2.2
24.4	0.5	27.4	1.7	2.3	2.5

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Ma
d	M	d	M	d	M
Mar. 2.6	2.3	Mar. 33.3	3.9	Apr. 24.3	5.5
3.3	2.5	24.3	4.2	25.3	5.9
4.4	2.5	24.6	5.2	26.4	5.8
5.3	2.4	25.3	5.4	27.4	4.4
6.3	2.9	26.3	43.5	28.4	5.35
6.7	3.0	26.6	3.9	29.4	6.0
7.3	2.9	27.3	3.8	30.4	6.0
7.6	2.8	28.3	4.8	May 1.3	5.8
8.4	3.3	29.3	4.8	2.3	4.6
9.4	3.6	30.3	4.25	3.4	5.6
10.4	3.4	31.4	4.5	4.4	5.9
11.3	3.3	Apr. 1.3	4.4	5.4	5.9
12.3	3.3	2.4	5.4	6.4	6.0
12.6	3.3	3.4	5.5	7.4	4.7
13.3	3.7	4.3	4.3	8.4	4.6
14.3	3.6	5.3	4.5	9.3	5.9
14.6	3.5	6.4	5.6	10.4	5.9
15.3	3.5	7.4	5.7	11.4	6.0
16.3	4.0	8.3	4.4	12.4	5.5
16.6	4.0	9.3	4.5	13.3	4.6
17.3	3.8	10.4	5.6	14.4	5.7
17.6	3.8	11.4	5.7	15.4	6.3
18.3	3.5	12.3	4.9	16.4	6.3
18.6	3.8	13.4	4.5	18.4	5.0
19.3	5.0	14.3	5.7	19.4	6.2
19.4	5.1	15.3	5.6	20.3	6.0
19.6	5.0	16.4	5.7	21.4	6.2
20.2	5.9	17.4	5.2	22.3	5.0
20.3	3.5	18.4	4.3	23.3	5.9
21.3	3.8	19.4	5.5	24.4	6.2
21.6	4.4	20.3	5.8	25.4	6.3
22.3	5.2	21.3	6.0	26.4	5.4
22.4	5.3	22.3	5.7		
22.6	5.0	23.3	4.3		

4) Nova Aurigae, 1892.

All the materials were collected at the library of the Kyoto University, and a paper in connection therewith was read on February 21st, 1918.

Mean Magnitudes.

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Mag.
d	*M*	*d*	*M*	*d*	*M*
1892 Feb. 1.3	5.3	Feb. 23.5	5.85	Mar. 18.4	9.05
2.3	5.3	24.3	5.95	19.4	9.2
3.4	4.8	24.7	5.75	20.6	9.55
4.3	4.95	25.7	5.5	21.7	9.65
5.4	4.6	26.6	5.6	22.7	9.8
6.3	4.5	26.75	5.45	23.6	10.1
7.4	4.45	27.7	5.3	24.4	10.2
8.7	4.4	28.7	5.2	25.5	11.25
9.7	5.1	29.8	5.35	27.3	11.55
10.6	5.12	Mar. 2.7	5.4	28.4	11.9
11.3	5.15	3.7	5.6	29.3	12.0
11.7	4.8	4.6	6.0	30.4	13.0
12.7	5.05	5.6	5.9	31.4	13.3
13.5	5.2	6.6	6.2	Apr. 1.4	13.4
13.8	5.08	7.7	6.1	2.4	13.5
14.7	4.8	8.6	6.2	3.4	13.5
15.6	5.95	9.55	6.8	4.7	12.5
16.5	5.97	10.7	7.5	7.7	14.4
17.5	5.35	11.6	7.8	12.7	14.95
17.7	5.0	12.4	7.55	15.6	15.2
18.5	5.0	13.5	7.8	18.6	15.55
20.65	5.05	14.6	8.0	22.7	16.55
21.9	5.35	15.6	8.5	24.7	16.8
22.6	5.80	16.6	8.6	26.7	17.4
22.75	5.7	17.3	8.8		

It is to be regretted that in the latter part of this curve the observations are not rich so that the values above given are not fully relied upon: figures of the first decimals are uncertain.

5) Nova Geminorum No. 1, 1903.

Observational data were collected at the Kyoto University, and a paper on it was read on February 21st, 1918, in the same occasion as the preceding.

Mean Magnitudes.

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Mag.
d	M	d		d	M
1903 Mar. 6.6	5.1	Apr. 12.6	8.5	May 3.4	9.1
11.6	6.7	13.4	8.8	4.5	9.2
12.6	7.1	14.4	8.8	5.4	9.1
13.5	7.2	15.4	8.7	6.4	9.3
14.6	7.4	16.4	8.6	7.3	9.4
15.3	7.2	17.5	8.7	8.5	9.6
15.7	7.5	18.6	8.8	9.3	9.75
16.6	7.5	19.4	9.1	11.5	9.65
25.6	8.0	20.3	9.0	12.4	9.3
27.4	8.1	21.6	8.8	13.4	9.4
28.4	8.3	24.4	9.4	14.4	9.2
29.4	8.2	25.4	9.6	15.4	9.3
30.3	8.3	26.4	9.6	18.4	9.35
31.4	8.3	27.4	9.6	19.4	9.3
Apr. 1.6	8.4	28.4	9.5	20.4	9.2
3.4	8.6	29.4	9.3	21.4	9.4
4.6	8.7	30.4	9.5	22.4	9.5
10.6	8.8	May 1.6	9.45	23.4	9.5
11.6	8.8	2.3	9.15	24.4	9.5

(III) Notes on general features.

Let here be given briefly a summary of, and the present ideas about, the New Star Phenomena. Common features, which are clearly seen in the above mentioned stars and probably in all the rest of this kind are

1) Rapid decreasing of light intensity after the maximum phase;

2) More or less periodic fluctuations of light intensity during the decreasing stage;

3) Some regular spectroscopic transformations, i. e., in the order of B-type to F-type, Nova peculiar, Nebular, Planetary Nebular, and Wolf-Rayet type;

4) Peculiarities in the spectra, especially the curious juxtapositions of bright and dark lines of the same chemical origin, always in the same scheme, i. e., the bright components at the less refrangible side and the dark ones at the other side;

5) Great width in the spectral lines;

6) Prevailing behaviour of Hydrogen, Helium, and Calcium, as well as of the unknown Nebulium;

7) Large relative radial velocities shown in the Doppler interpretations of the juxtaposed components of the spectral lines;

8) Connections with suspected surrounding nebulosities. Of the above, the following physical meanings may be suggested: 1) shows that the material masses closely concerned in the phenomenon are very small, even compared with the tiniest members ever known in the solar system, or otherwise the cooling would take longer; this idea of small mass can also be applied to the explanation of 2); 6) makes us easily recall the similar facts in the solar prominences, close studies on which also throw some light on 7), and lead us a step farther that the whole phenomena may be imagined as extreme cases of solar prominences, of course eruptive in nature; from this idea and moreover from the probable fact that the spectral displacements of the dark components of 4) are possibly proportional to wave-lengths while it is not so in the bright ones, the most difficult problem of 4) can be solved if we suppose a tremendous gas-outburst on the stellar surface, in which the displacements of tho bright lines are due to the eccentric absorption by the dark components arising from high velocity eruptions of gases (amounting to about 1000 to 2000 killometers or over, which velocities can almost be paralleled by those of prominences), whose relatively low temperatures can be allowed by the consideration of their high altitudes reached above the surface. 5) shows very complex and extreme states of the gaseous field, and at the same time 3) and 8) suggest to us some conditions transcendental, to an extent, to our terrestrial experiences. These ideas were read at the last two meetings at Kyoto already mentioned. Recently, a paper by Mr. W. H. Pickering on quite similar problems was received by our library in Pop. Ast. Nov., 1918, in which a theory of planetesimal encounter was successfully treated, reaching almost to the similar gaseous behaviours as the above

mentioned ones but not apparently to a prominence. His paper, however, was very suggestive to me naturally, and immediately led me to the idea of connecting the New Star, the Meteoric actions, and indeed the interesting theory of Sun-Spots proposed some time ago by Prof. H. H. Turner (Monthly Notices R. A. S. Vol. 74, p. 82.)

The detailed studies of the problem will follow in another paper later.

Kyoto University Observatory,

January 24th., 1919.

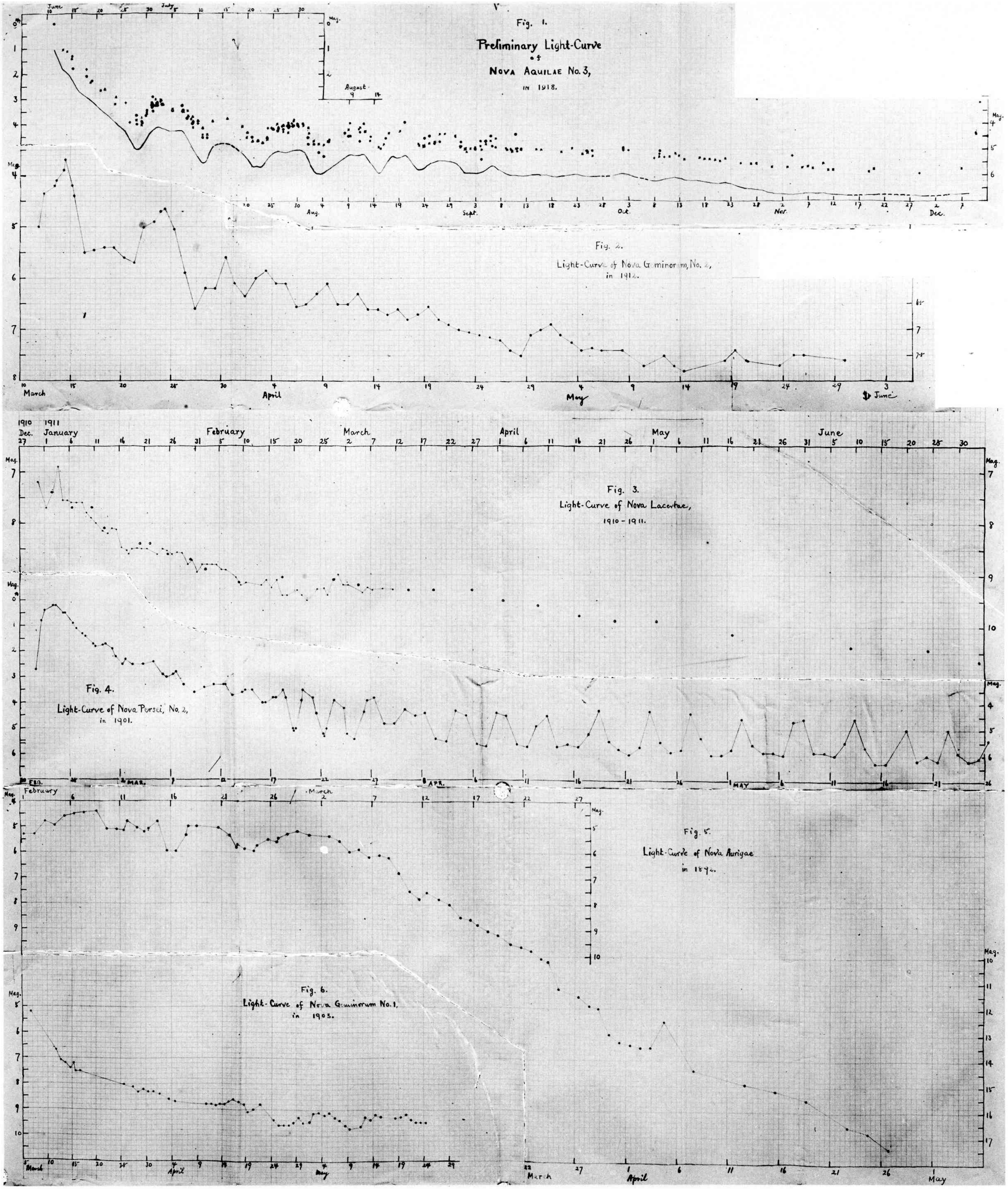

Fig. 1.
Preliminary Light-Curve of Nova Aquilae No. 3, in 1918.
Fig. 2.
Light-Curve of Nova Geminorum, No. 2, in 1912.
Fig. 3.
Light-Curve of Nova Lacertae, 1910-1911.
Fig. 4.
Light-Curve of Nova Persei, No. 2, in 1901.
Fig. 5.
Light-Curve of Nova Aurigae in 1892.
Fig. 6.
Light-Curve of Nova Geminorum No. 1, in 1903.