ART. XXXIV.—*Double Stars discovered by Mr. Alvan G. Clark;* by S. W. BURNHAM.

THE double stars discovered by Mr. Alvan G. Clark, of the well-known firm of Alvan Clark & Sons, telescope makers, Cambridgeport, Mass., are for the most part prominent and interesting objects, and, with the exception of Sirius, have not been published, or brought to the attention of astronomers generally. They are nearly all difficult pairs, and such as require for measurement a first-class, if not a large, instrument. All the recorded measures of each star in the following list are given, except of the first. Most of the micrometrical observations are by the Washington observers, and by Baron Dembowski and myself. All of the latter measures have been made at the Dearborn Observatory, Chicago.

The names and places of the stars are as follows:

No.	Star.	R. A. 1880.	Decl. 1880.	Magnitudes
1	Sirius.	$6^h\ 39^m\ 53^s$	$-16°\ 33'$	1 --10
2	W VII, 1131.	7 40 20	+28 59	8 --11
3	ρ Hydræ.	8 42 5	+ 6 17	5 --13
4	L 23271.	12 20 37	+ 0 29	7½--10
5	46 Virginis.	12 54 25	− 2 43	5–6--8–9
6	Arg. (30) 2534.	14 28 45	+30 21	9½--10
7	ε Coronæ.	15 52 37	+27 14	4 --13
8	102 Herculis.	18 3 38	+20 48	5 --12–13
9	γ Lyræ.	18 54 27	+32 31	3 --12
10	P XIX, 257.	19 39 15	+10 29	7½-- 7½
11	ζ Sagittæ.	19 43 39	+18 51	6 -- 6
12	a^2 Capricorni.	20 11 24	−12 55	3 --
13	τ Cygni.	21 10 0	+37 32	5½-- 8
14	78 Pegasi.	23 37 57	+28 42	5 -- 8

No. 1. *Sirius.*

The history of this interesting system is too well known to require more than a brief mention. From periodical irregularities in the observed proper motion of Sirius, Bessel, more than thirty years ago, suspected the existence of a satellite revolving with the large star around their common center of gravity. The theoretical orbit of the disturbing body was calculated by Peters, and a period of fifty years found to satisfy the meridian observations. The suspected companion was looked for by many observers without success. In January, 1862, Mr. Clark placed the 18½-inch object glass, now at the Dearborn Observatory, Chicago, then the largest object glass in the world, in a temporary stand, and turned it upon Sirius. A small star was at once detected almost exactly in the place assigned by theory. Once discovered, it was readily seen and measured with the same instruments with which it had been vainly looked for before. I have seen it repeatedly with my 6-inch Clark refractor; but a steady air is necessary with any moderate aperture, because of the great brilliancy of Sirius, which overpowers the light of the small star, and because of its low altitude in northern latitudes. Probably in the southern hemisphere a good 5-inch object glass would show it satisfactorily. Why it should have remained so long undiscovered, after attention had been called to it, cannot be easily explained. For this discovery, Mr. Clark was awarded the Lalande gold medal.

The companion has been measured every year since 1862, and during the latter portion of the time the observations are very numerous. The last orbit of the theoretical satellite, computed by Auwers, based upon all the available observations of proper motion, gives a period of 49·40 years. From these elements an ephemeris has been calculated for every second or

third year, which is given in the following table, together with some of the actual measures made near the corresponding times. It will be seen that the angular motion of the real star is more rapid than that of the theoretical star, and with a less change in distance, indicating a longer period than fifty years.

Calculated.			Observed.			
1862·0	85°·4	10″·10	1862·2	84°·6	10″·7	Bond.
			62·2	85·0	10·09	Rutherfurd.
			63·2	82·5	10·15	O. Struve.
1865·0	79·9	10·78	1865·2	77·2	10·60	O. Struve.
			65·2	76·8	10·77	Förster.
			65·2	75·0	10·07	Secchi.
1868·0	75·0	11·15	1868·2	70·2	11·25	Vogel.
			68·2	69·5	11·35	Bruhns.
			68·3	71·6	10·95	Engelmann.
			69·2	68·6	11·26	Dunér.
1871·0	70·3	11·20	1871·2	64·0	11·21	Dunér.
			72·2	59·8	11·14	Dunér.
			72·2	67·7	11·55	Newcomb.
1874·0	65·5	10·95	1873·2	65·8	11·12	Hall.
			73·2	60·9	10·65	Dunér.
			73·9	59·4	12·27	Hall.
			74·2	59·0	11·46	Newcomb.
			74·2	58·7	10·99	Holden.
			74·2	57·9	11·10	Hall.
			75·2	57·1	10·81	Dunér.
			75·2	56·6	11·41	Newcomb.
			75·2	56·3	11·08	Hall.
1876·0	62·1	10·59	1876·1	54·9	11·82	Holden.
			76·2	55·2	11·19	Hall.
			77·1	53·1	11·20	Stone.
			77·2	52·8	11·35	Holden.
			77·3	53·4	10·95	Hall.
1878·0	58·4	10·05	78·0	52·4	10·83	Burnham.
			78·1	50·5	11·07	Holden.
			78·2	51·7	10·76	Hall.
			79·1	50·7	10·44	Burnham.
1880·0	54·2	9·33				

The last observed position is the mean result of ten nights' measures made at the Dearborn Observatory in the past two months.

The existence of another satellite has been suggested as an explanation of the variation shown above, but all attempts to find any other body have thus far been unsuccessful.

No. 2.

Discovered in May, 1876, with the 12-inch object glass now at the Vienna Observatory. This very unequal pair is in the neighborhood of Pollux, about 40′ south, and a little following. The only measure is the following:

Burnham.....P=114°·9 D=0″·81 1879·0 1*n*

No. 3. *ρ Hydræ.*

The very minute attendant to this star was detected with the Washington 26-inch refractor. The only measures I am acquainted with are those made with the 18½-inch of the Dearborn Observatory. A mean of three observations is as follows:

Burnham	P=144°·9	D=12″·40	1878·0	3*n*

No. 4. L 23271.

A close and unequal pair discovered May 19, 1876, with the Vienna 12-inch object glass. The following are all the measures:

Hall	P=233°·6	D=0″·85	1876·4	3*n*
Dembowski ..	234·1	0·87	1877·4	2*n*

No. 5. 46 *Virginis.*

Discovered on the same evening as the preceding, and with the same glass. It is a fine pair, and just within the reach of a 6-inch aperture. It has been measured as follows:

Hall	P=158°·9	D=1″·32	1876·4	3*n*
Dembowski ..	148·5	1·21	1877·4	2*n*
Stone	145·7	1·15	1878·2	1*n*
Burnham	151·5	1·48	1878·3	2*n*

The magnitude of the small star is rated 8 by Dembowski, 9·5 by Stone, and 11 by Hall.

In measuring this pair, a very faint companion, about 13th magnitude, was detected.

P=116°·9 D=33″·86 1878·3

No. 6.

A difficult pair of small stars in a low-power field with *σ* Bootis, *np*. It has been measured by Dembowski only, and the following is a mean of two observations:

Dembowski ...	P=139°·8	D=0″·76	1877·0	2*n*

This was also found with the Vienna glass.

No. 7. *ε Coronæ.*

A very difficult and unequal pair discovered May, 1876, with the Washington 26-inch. The companion is an exceedingly minute point of light, even with a large aperture. Mr. Edgecomb, of Hartford, sees it with a 9·4-inch Clark refractor, but this must be regarded as a very remarkable test of acute vision. The following are all the measures:

Hall	P=351°·4	D=2″·17	1876·4	4*n*
Burnham	360·2	1·86	1878·3	2*n*

No. 8. 102 *Herculis.*

A faint companion detected with the 12-inch Clark object glass now in the possession of Dr. Draper. The only measure is:

Burnham	P=46°·9	D=23″·42	1878·4	1*n*

No. 9. *γ Lyræ.* (*OΣ* 544.)

This pair, discovered a number of years since with the 12-inch glass now at the Vienna Observatory, is one of the recently published additions to the Pulkowa Catalogue. It has been measured as follows:

Otto Struve	P=296°·9	D=13″·79	1868·6	3*n*
Newcomb	297·8	12·48	1874·5	1–4*n*
Burnham	301·1	12·76	1878·4	2*n*

No. 10. P XIX, 257. (AC=Σ2570=ℍI. 91=S 723.)

This has been known as a wide pair nearly a century. With the Draper 12-inch, the large star in August, 1875, was found to be an excessively close pair. I have measured this with Dearborn Observatory refractor on four nights, as follows:

P=126°·1	----	1877·68
147·4	----	1877·72
147·0	D=0″·26	1878·62
142·0	0·32	1878·70

There is no evidence of change in the 9·5 magnitude star, as will appear from the following observations:

Herschel I	P=278°·2	----	1783·6	1*n*
Struve	276·2	D=4″·08	1827·0	3*n*
Mitchel	275·7	3·95	1847·7	1*n*
Secchi	275·3	4·10	1857·6	1*n*
Wilson and Seabroke	279·9	3·87	1874·1	2*n*
Wilson and Seabroke	277·8	4·30	1876·7	1*n*
Burnham	276·6	4·16	1878·7	1*n*

No. 11. *ζ Sagittæ.* (AC=Σ2585=ℍII. 30=S*h* 307.)

Discovered as a wide pair in 1781 by Herschel I. It was measured by many observers down to 1875, when the duplicity of the principal star was detected with the same instrument with which the two preceding discoveries were made. My measures of this at the Dearborn Observatory indicate an increase in the distance. I found it obviously less difficult in 1878 than the previous year. The individual measures are as follows:

P=158°·3	D=0″·22	1877·72
157·6	0·24	1877·73
158·1	0·27	1877·77
158·7	0·35	1878·64
155·4	0·35	1878·70

Struve gives the magnitutes, 5·7 and 8·7, of the wide pair. These stars appear to be relatively fixed.

Struve	P=312°·8	D=8″·49	1831·1	7*n*
O. Struve	311·2	8·71	1846·9	7*n*
Wrottesley	311·8	8·77	1854·6	3*n*
Wilson and Seabroke	311·2	8·8	1873·6	1*n*

No. 12. α^2 *Capricorni.* (AB=H 608.)

Herschel II discovered a 16-magnitude companion to this star and entered it in his second catalogue of double stars. Since that time it has received but little attention from double-star observers. Under favorable conditions a 6-inch refractor will show it fairly. The following are all the measures:

Herschel II	P=141°·2	D=6″ ±	1830±	1*n*
Mitchel	144·1	6·36	1846·7	13*n*
Holden	146·2	....	1874·6	2*n*
Burnham	150·2	7·41	1878·5	3*n*

In November, 1862, with the 18½-inch object glass now at the Dearborn Observatory, Mr. Clark found that this minute companion was itself a close, equal pair. Professor Young was able to see it with the 9·4-inch refractor of the Dartmouth College Observatory when observing at Sherman, Colorado, from an altitude of more than 8,000 feet above the sea level. This, to anyone who has seen this minute pair, is a striking illustration of the importance of getting above the lower atmosphere. The following are all the measures:

Holden	P=57°·6	D=1″·72	1874·6	1*n*
Newcomb	58·6	1·24	1874·6	1*n*
Hall	65·2	1·14	1875·7	1*n*
Hall	63·2	....	1876·7	1*n*
Burnham	61·2	1·06	1878·5	2*n*

No. 13. τ *Cygni.*

This fine pair was discovered in October, 1874, with the 26-inch object glass manufactured for Mr. L. J. McCormick of Chicago. It has already shown rapid angular motion, and is undoubtedly a binary system. It has been carefully and regularly observed by Baron Dembowski. The individual measures are as follows:

P=174·8	D=1·06	1874·90
174·3	1·43	1875·33
171·0	1·33	1875·51
171·5	1·37	1875·67
168·9	1·26	1875·89
163·2	1·26	1876·76
159·8	1·23	1876·82
157·0	1·47	1877·39
157·7	1·25	1877·43
157·5	1·33	1877·59
155·8	1·37	1877·70
155·0	1·21	1877·79
152·5	1·15	1877·84
154·2	1·14	1877·92
152·9	1·17	1877·94

Other measures, with the mean results of Dembowski's observations, are:

Newcomb	P=162°·6	D=1″·10	1874·8	2*n*
Dembowski	174·5	1·24	1875·1	3*n*
Dembowski	170·5	1·32	1875·7	2*n*
Dembowski	161·5	1·24	1876·8	2*n*
Waldo	166·9	1·62	1876·9	2*n*
Hall	160·2	1·03	1776·9	2*n*
Dembowski	155·3	1·26	1877·7	8*n*
Burnham	150·0	1·06	1878·4	1*n*

There is a third extremely faint star:

Newcomb	P=261°·7	D=15″·10	1874·7	1*n*
Hall	260·3	15·68	1876·9	1*n*

No. 14. 78 *Pegasi.*

An unequal, but not very difficult pair, discovered in Nov., 1875, with the 12-inch glass now at the Morrison Observatory, Glasgow, Missouri. Dembowski gives its magnitudes: 5·0 yellow, 8·1 olive. The only measures are:

Dembowski	P=192°·0	D=1″·45	1876·6	4*n*
Burnham	190·8	1·54	1878·8	1*n*

Chicago, March 1, 1879.