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II.

Elements of the orbit of γ Virginis.

By *W. Doberck.*

After re-investigating the orbit of γ Virginis I have no longer any doubt that the differences between the observed and calculated places near the periastron passage are at least partly due to the perturbations to which I called attention in A. N. 4229. Changes in the shape of the stars and even explosive action are probably also not without influence on the orbit. The path observed after periastron also bears traces of perturbation. Double stars moving in such very eccentric orbits are worthy of the attention of spectroscopists while the companion is close to the main star. On the other hand the comparison between observed and calculated places shows clear cases of several different observers' measures deviating in the same direction from the most probable value, and indicates that the systematic errors are not always eliminated by taking the mean of many different observers' measures. I shall now re-investigate the orbits of γ Ophiuchi, λ Ophiuchi, ζ Aquarii etc. to ascertain whether they also furnish clear indications of perturbations. The anomalies are counted positive before, and negative after the periastron passage. The quantity λ given below should be written $260^{\circ}22'$ according to the American system. The hypothetical parallax is $0''.116$. The elements refer to the equinox 1900. The ephemeris has been corrected for precession.

Elements

$$\begin{aligned}\Omega &= 40^{\circ}26' & P &= 182\frac{1}{2}30 \\ \lambda &= 99\ 38 & T &= 1836.42 \\ \gamma &= 29\ 52 & a &= 3''.743 \\ e &= 0.88736\end{aligned}$$

Retrograde.

$$\begin{aligned}1^{\circ}9747(1836.42 - t) &= E - 50^{\circ}84 \sin E \\ \varrho \cos \theta &= +2''.2649 - 2''.7919 \sin(E + 66^{\circ}4') \\ \varrho \sin \theta &= -1.8020 - 2.4077 \sin(E - 57\ 29) \\ \pm z &= -1.6312 - 1.8433 \sin(E - 85\ 31)\end{aligned}$$

t	θ_c	ϱ_c	$\Delta\alpha$	$\Delta\delta$	$\pm z$
1909.0	327.0	6''.02	-0''.219	+5''.05	-3''.313
1911.0	326.3	6.05	-0.223	+5.04	-3.340
1913.0	325.8	6.08	-0.228	+5.02	-3.365
1915.0	325.2	6.10	-0.232	+5.01	-3.387
1917.0	324.6	6.11	-0.236	+4.99	-3.407
1919.0	324.0	6.13	-0.240	+4.96	-3.424
1921.0	323.4	6.14	-0.244	+4.94	-3.438
1923.0	322.8	6.15	-0.248	+4.91	-3.451
1925.0	322.3	6.15	-0.251	+4.87	-3.460
1927.0	321.7	6.16	-0.255	+4.83	-3.468
1929.0	321.3	6.16	-0.258	+4.79	-3.473

Observer	ρ	P. E. of Angle			Errors of Distance		
		Deg. at $4''.0$	arc	n	Constant	P. E.	n
J. Herschel	1''.3	$\pm 0^{\circ}59$	$\pm 0''.041$	11	$+0''.296$	$\pm 0''.312$	7
Encke	1.6	± 0.54	± 0.038	4	$+0.335$	± 0.137	4
W. Struve	1.6	± 0.57	± 0.040	13	$+0.112$	± 0.111	12
Challis	1.7	± 2.02	± 0.141	4	$+0.285$	± 0.181	4
Smyth	2.1	± 0.49	± 0.034	14	$+0.098$	± 0.080	14
Dawes	2.4	± 0.42	± 0.029	27	$+0.073$	± 0.075	24
Mitchell	2.4	± 0.45	± 0.032	3	$+0.140$	± 0.422	3
Mädler	2.5	± 0.61	± 0.043	25	$+0.175$	± 0.084	19
Miller	3.0	± 0.45	± 0.031	3	$+0.063$	± 0.065	3
O. Struve	3.1	± 0.65	± 0.045	28	-0.008	± 0.051	28
Fletcher	3.2	± 0.51	± 0.036	6	$+0.063$	± 0.067	6
Jacob	3.2	± 0.73	± 0.050	9	-0.084	± 0.303	9
Morton	3.5	± 1.06	± 0.074	5	$+0.092$	± 0.126	5
Secchi	3.7	± 0.52	± 0.036	7	$+0.106$	± 0.053	7
Main	3.7	± 0.89	± 0.062	28	$+0.122$	± 0.078	28
Powell	3.7	± 0.90	± 0.063	3	—	—	—
Dembowski	4.1	± 0.38	± 0.026	11	$+0.013$	± 0.066	11
Knott	4.4	± 0.65	± 0.047	6	$+0.065$	± 0.119	6

Observer	p	P. E. of Angle			Errors of Distance		
		Deg. at 4".0	arc	n	Constant	P. E.	n
Talmage	4.6	± 1.065	$\pm 0".114$	9	$+0".504$	$\pm 0".263$	7
Dunér	4.7	± 0.31	± 0.022	3	-0.120	± 0.041	3
Wilson	4.7	± 1.65	± 0.115	5	$+0.426$	± 0.299	5
W. Herschel	4.8	± 1.52	± 0.106	3	—	—	—
Engelmann	4.9	± 1.13	± 0.079	3	-0.070	± 0.076	3
O. Stone	5.0	± 0.56	± 0.039	4	$+0.195$	± 0.114	4
Seabroke	5.1	± 1.27	± 0.089	5	$+0.058$	± 0.157	5
Schiaparelli	5.2	± 0.26	± 0.018	10	-0.036	± 0.034	10
Gledhill	5.2	± 0.69	± 0.048	20	-0.029	± 0.100	19
Hall	5.3	± 0.81	± 0.057	12	$+0.127$	± 0.047	12
H. C. Wilson	5.3	± 1.29	± 0.090	4	$+0.132$	± 0.125	4
Doberck	5.4	± 1.31	± 0.092	10	$+0.061$	± 0.147	10
Hough	5.5	± 1.31	± 0.092	3	$+0.167$	± 0.044	3
Leavenworth	5.5	± 0.65	± 0.046	4	$+0.040$	± 0.059	4
Bigourdan	5.6	± 1.43	± 0.100	4	$+0.022$	± 0.022	4
Maw	5.6	± 1.24	± 0.087	3	-0.130	± 0.031	3
Glaserapp	5.6	± 0.71	± 0.050	8	-0.052	± 0.203	8
Tebbutt	5.6	± 1.21	± 0.085	5	$+0.172$	± 0.089	5
Scott	5.7	± 1.14	± 0.080	3	$+0.110$	± 0.090	3
Comstock	5.8	± 1.14	± 0.080	13	-0.071	± 0.066	13
Doolittle	5.8	± 0.53	± 0.037	5	$+0.088$	± 0.059	5
Bryant	5.8	± 1.83	± 0.110	3	$+0.100$	± 0.103	3
Bowyer	5.8	± 2.49	± 0.174	5	-0.072	± 0.138	5
Sternberg Phot.	5.9	± 0.76	± 0.053	3	-0.083	± 0.010	3

Observer	Epoch	θ_c	ϱ_c	$\theta_o - \theta_c$	$\varrho_o - \varrho_c$	Observer	Epoch	θ_c	ϱ_c	$\theta_o - \theta_c$	$\varrho_o - \varrho_c$
Bradley	1718.20	329.8	5.85	$+ 1.0$	—	Dawes	1832.30	251.9	1.24	$- 2.0$	$+0.09$
Cassini	20.31	329.1	5.90	$- 10.1$	$+1.59$	Cooper	32.33	251.7	"	—	$+0.70$
Tob. Mayer	56.20	318.4	6.08	$+ 6.0$	$+0.42$	Smyth	32.40	251.4	1.22	0.0	-0.02
Chr. Mayer	77±	311.6	5.62	$- 1.6$	$+4.18$	W. Struve	32.52	250.4	1.20	$+ 3.1$	$+0.06$
W. Herschel	80.18	310.6	5.52	—	-1.32	J. Herschel	33.20	244.5	1.06	$- 2.7$	$+0.35$
"	81.89	310.0	5.46	$+ 0.7$	—	Smyth	33.34	243.0	1.03	$+ 0.1$	$+0.27$
"	1802.08	300.9	4.44	$- 2.5$	—	Mädler	33.35	242.9	1.02	$- 6.5$	—
"	03.37	300.2	4.36	$+ 0.6$	—	Dawes	33.36	242.8	"	$- 2.7$	$+0.12$
W. Struve	19.40	287.0	3.01	—	$+0.55$	W. Struve	33.37	242.7	"	$+ 2.8$	$+0.03$
"	20.28	285.9	2.91	$- 1.0$	-0.15	Dawes	34.29	230.7	0.82	$- 3.4$	—
"	22.02	283.5	2.73	$- 0.7$	—	Smyth	34.30	230.4	0.81	$- 3.3$	$+0.09$
J. Herschel	22.25	283.2	2.69	$+ 0.2$	$+1.10$	Mädler	34.34	229.8	"	-15.0	—
Amici	23.19	281.7	2.59	—	$+0.71$	J. Herschel	34.37	229.2	0.80	$- 6.1$	-0.29
W. Struve	23.32	281.5	2.58	$+ 0.1$	$+0.37$	W. Struve	34.38	229.0	"	$+ 2.6$	$+0.11$
South	25.32	277.8	2.33	$- 0.9$	$+0.93$	J. Herschel	34.54	226.1	0.76	-11.2	—
W. Struve	25.32	"	"	$+ 0.1$	$+0.04$	W. Struve	34.84	219.8	0.69	$- 6.2$	—
J. Herschel	28.35	270.2	1.91	$+ 0.1$	—	J. Herschel	35.11	212.6	0.62	-11.2	—
W. Struve	28.38	"	1.90	$+ 1.3$	$+0.17$	W. Struve	35.38	204.0	0.55	$- 8.5$	-0.04
J. Herschel	29.22	267.5	1.77	$+ 0.2$	$+0.02$	Senff	35.39	203.4	0.54	$- 8.2$	$+0.03$
W. Struve	29.39	266.8	1.74	$+ 1.5$	$+0.04$	Smyth	35.40	203.0	"	$- 8.0$	-0.04
J. Herschel	30.24	263.4	1.60	$- 0.6$	$+0.62$	O. Struve	35.42	202.2	"	$- 5.1$	—
Dawes	30.39	262.7	1.58	$- 1.2$	—	Dawes	36.28	153.0	0.37	$+16.5$	—
Bessel	30.59	261.8	1.54	$+ 0.4$	$+0.05$	Smyth	36.35	147.1	"	$+22.6$	—
Dawes	31.30	258.3	1.42	0.0	$+0.57$	W. Struve	36.41	142.4	"	$+ 9.2$	-0.11
J. Herschel	31.32	258.2	"	$- 1.0$	$+0.32$	O. Struve	36.41	"	"	$+15.8$	—
W. Struve	31.36	257.9	1.41	$+ 3.0$	$+0.08$	Sabler	36.41	"	"	$+11.8$	—
Smyth	31.38	257.8	"	$- 2.9$	$+0.19$	Encke	36.59	127.4	"	-13.5	—
J. Herschel	32.27	252.3	1.24	$- 2.1$	-0.03	Mädler	36.59	"	"	$- 9.9$	—

Observer	Epoch	θ_c	ϱ_c	$\theta_o - \theta_c$	$\varrho_o - \varrho_c$	Observer	Epoch	θ_c	ϱ_c	$\theta_o - \theta_c$	$\varrho_o - \varrho_c$
Smyth	1837.21	86°0	0".47	— 0°6	+0".13	Jacob	1847.94	2°1	2".50	— 2°2	+0".38
Mädler	37.37	78.6	0.50	— 3.1	+0.31	Mädler	48.34	1.4	2.54	— 0.6	+0.17
O. Struve	37.41	77.1	0.52	+ 0.8	+0.06	Smyth	48.36	»	2.55	— 1.9	+0.25
Encke	37.46	75.0	0.53	+ 1.3	+0.14	Dawes	48.37	»	»	— 0.8	+0.07
J. Herschel	38.08	56.4	0.69	+ 1.0	—	O. Struve	48.43	1.3	»	— 0.8	0.00
Smyth	38.28	52.0	0.75	+ 3.7	+0.05	Bond	48.45	1.2	2.56	— 0.8	+0.04
Dawes	38.32	51.2	»	+ 2.2	—	Mitchell	48.45	»	»	— 0.6	+0.24
Lamont	38.36	50.5	0.76	—	+0.48	Main	48.48	»	»	— 0.7	+0.04
W. Struve	38.40	49.7	0.78	+ 2.2	+0.08	Dawes	49.37	359.8	2.68	— 0.8	+0.17
O. Struve	38.43	49.2	0.79	+ 1.9	+0.01	O. Struve	49.41	359.7	»	— 4.2	— 0.04
Mädler	38.44	»	»	— 2.0	+0.11	Bond	49.45	359.6	2.69	+0.2	+0.31
Galle	38.46	48.7	0.80	+ 0.3	— 0.10	Main	49.50	»	»	— 2.6	+0.23
Dawes	39.31	37.0	1.01	— 2.4	+0.25	Johnson	50.23	358.4	2.79	+1.3	+0.06
Galle	39.35	36.7	»	— 1.2	+0.29	Hartnup	50.30	»	»	— 0.9	+0.11
Smyth	39.40	36.1	1.02	+ 1.1	— 0.02	Fletcher	50.36	358.2	2.80	— 1.5	+0.15
Kaiser	40.26	28.4	1.21	— 0.5	+0.09	O. Struve	50.39	»	»	— 1.4	— 0.06
Dawes	40.38	27.5	1.24	— 1.8	0.00	Mädler	50.42	»	2.81	+0.9	—
O. Struve	40.45	27.1	1.26	— 1.7	+0.04	Main	50.48	358.1	2.82	+1.6	+0.12
Challis	41.19	22.6	1.41	— 1.7	+0.01	Philpott	51.17	357.2	2.89	— 0.4	+0.03
Dawes	41.34	21.7	1.44	— 1.7	+0.14	Mädler	51.28	357.0	2.90	+0.9	+0.09
Mädler	41.35	»	»	— 1.6	+0.29	Main	51.36	356.9	2.91	— 0.6	+0.13
O. Struve	41.41	21.4	1.45	— 4.7	+0.05	Fletcher	51.40	»	2.92	— 0.9	+0.13
Mädler	42.21	17.5	1.60	— 0.9	— 0.02	Dawes	51.40	»	»	— 0.4	+0.07
Main	42.34	17.0	1.63	+ 0.4	+0.04	O. Struve	51.42	356.8	»	— 0.9	— 0.04
Airy	42.35	»	»	+ 0.6	+0.20	Miller	51.47	»	2.93	— 0.9	+0.11
Challis	42.35	»	»	— 4.8	+0.22	Mädler	51.98	356.2	2.98	+0.4	+0.32
Dawes	42.38	16.9	»	— 2.0	+0.10	Jacob	52.24	355.8	3.01	— 0.4	+0.11
O. Struve	42.41	16.7	1.64	— 3.1	+0.09	Miller	52.26	»	»	— 0.3	+0.11
Kaiser	42.82	15.2	1.72	— 0.7	+0.04	Dawes	52.32	355.7	3.02	— 0.5	— 0.01
Mädler	42.88	15.0	1.73	— 0.3	+0.11	Fletcher	52.42	355.6	3.03	— 0.2	+0.11
Challis	43.30	13.4	1.80	— 12.7	+0.25	Smyth	52.42	»	»	— 0.1	+0.17
Mädler	43.35	13.2	1.81	— 1.1	—	Mädler	52.43	»	»	— 1.0	+0.14
Main	43.39	13.0	»	+ 0.6	+0.27	O. Struve	52.43	»	»	+0.4	— 0.03
Dawes	43.40	»	1.82	— 0.8	0.00	Main	52.47	355.4	3.05	+4.3	+0.15
Encke	43.48	12.8	1.83	— 1.4	+0.62	Jacob	53.24	354.7	3.12	— 1.5	0.00
Challis	44.33	10.2	1.97	— 1.2	+0.66	Powell	53.24	»	»	0.0	—
Richardson	44.34	10.1	1.98	— 7.2	+0.22	Miller	53.27	354.6	3.13	+0.3	— 0.03
Mädler	44.36	»	»	— 1.2	—	Fletcher	53.32	»	»	0.0	+0.05
Encke	44.38	10.0	»	— 1.4	+0.29	Smyth	53.35	354.5	3.14	— 0.6	+0.06
Kendall	44.55	9.6	2.01	+ 1.5	+0.28	Dawes	53.36	»	»	— 0.4	— 0.08
Encke	45.28	7.7	2.12	+ 1.2	+0.29	Main	53.38	»	»	+2.9	+0.16
Smyth	45.34	7.5	2.13	— 2.1	— 0.03	Mädler	53.39	»	»	— 0.3	+0.11
Mädler	45.37	7.4	2.14	— 0.4	—	O. Struve	53.40	»	»	+0.1	— 0.01
O. Struve	45.46	7.2	2.15	— 1.7	+0.08	Jacob	53.91	353.9	3.20	— 0.9	— 0.14
Hind	46.28	5.4	2.26	— 0.4	—	Mädler	54.39	353.4	3.25	— 1.4	+0.20
Jacob	46.32	5.3	2.27	— 3.1	+0.62	Dawes	54.39	»	»	— 0.7	— 0.04
Main	46.39	5.2	2.28	+ 1.1	— 0.03	Morton	54.40	»	»	— 1.3	+0.15
O. Struve	46.39	»	»	— 1.9	+0.07	Dembowski	54.47	353.3	3.26	+0.3	— 0.03
Mitchell	46.49	4.9	2.30	— 0.8	— 0.47	O. Struve	55.18	352.6	3.33	— 1.0	+0.03
Dawes	46.90	4.1	2.35	— 0.4	+0.10	Dembowski	55.19	»	»	— 1.3	+0.18
Hind	47.07	3.8	2.37	— 1.9	+0.25	Philpott	55.30	352.5	3.34	+0.9	—
Dawes	47.35	3.2	2.41	— 0.7	— 0.01	Main	55.39	352.4	3.35	+1.1	+0.10
Main	47.41	3.1	2.42	+ 9.9	— 0.05	Secchi	55.40	»	»	+0.2	+0.02
Smyth	47.42	3.0	»	— 1.1	+0.18	Smyth	55.40	»	»	— 0.8	+0.05
O. Struve	47.42	»	»	0.0	— 0.02	Mädler	55.45	352.3	3.36	+1.8	+0.06
Mitchell	47.56	2.8	2.44	— 0.3	+0.65	Dawes	55.46	»	»	— 1.1	— 0.05

Observer	Epoch	θ_c	ϱ_c	$\theta_o - \theta_c$	$\varrho_o - \varrho_c$	Observer	Epoch	θ_c	ϱ_c	$\theta_o - \theta_c$	$\varrho_o - \varrho_c$
Morton	1855.53	352.2	3.37	+1.1	+0.14	Engelmann	1865.14	344.7	4.19	+1.6	-0.18
Jacob	56.10	351.7	3.42	-1.2	+0.03	Main	65.36	344.6	4.20	+0.6	+0.08
Main	56.29	351.5	3.44	-2.5	+0.10	Dawes	65.42	"	"	-0.6	+0.17
Secchi	56.38	351.4	3.45	+0.2	+0.09	Knott	65.45	344.5	4.21	-0.2	+0.13
Mädler	56.39	"	"	+0.3	+0.14	Dembowski	65.74	344.4	4.23	-0.1	-0.05
Dembowski	56.39	"	"	-0.9	+0.11	Secchi	66.31	344.0	4.27	+0.3	+0.12
Carpenter	56.96	350.9	3.50	+2.1	+0.14	Winlock	66.37	"	4.28	-	+0.72
Morton	56.97	"	"	+0.4	+0.16	O. Struve	66.42	"	"	0.0	+0.01
Schmidt	57.07	350.8	3.51	-	+0.99	Main	66.45	"	"	+1.2	+0.07
Dawes	57.35	350.5	3.54	-0.4	+0.05	Kaiser	66.46	"	"	+1.9	-0.27
Secchi	57.39	"	"	+0.3	+0.20	Talmage	66.48	343.9	4.29	-0.5	+0.24
Baxendell	57.40	"	"	+2.4	+0.04	"	67.24	343.5	4.34	-0.6	+0.94
Smyth	57.41	"	"	+0.1	-0.04	Searle	67.27	"	"	+1.3	+0.17
Fletcher	57.41	"	"	+1.1	0.00	Winlock	67.30	"	"	+0.6	+0.15
Mädler	57.42	"	"	-0.3	+0.05	Main	67.38	"	4.35	-2.1	+0.05
Dawes	57.42	"	"	-0.6	-0.02	Dembowski	67.80	343.2	4.38	0.0	-0.08
O. Struve	57.44	"	"	-0.3	+0.09	Searle	68.16	343.0	4.41	+1.8	+0.18
Jacob	57.96	350.0	3.59	+0.6	-0.09	Talmage	68.26	342.9	"	-2.3	+0.65
Dembowski	58.34	349.7	3.63	-1.3	+0.13	Main	68.42	342.8	4.42	-1.8	+0.21
Mädler	58.37	"	"	+0.2	+0.38	O. Struve	68.45	"	4.43	+0.5	-0.13
Fletcher	58.39	"	"	+0.3	-0.06	Brünnow	69.22	342.4	4.48	+2.5	+0.29
Smyth	58.39	"	"	+0.2	+0.17	Talmage	69.25	342.3	"	-2.7	+0.86
Secchi	58.40	"	"	+2.3	-0.02	Main	69.49	342.2	4.50	-2.4	+0.24
O. Struve	58.44	"	"	-0.4	+0.04	Dunér	69.98	342.0	4.53	-0.2	-0.10
Dawes	58.45	"	"	-0.9	+0.05	Gledhill	70.33	341.8	4.56	+0.8	+0.09
Carpenter	58.47	349.6	3.64	-1.6	+0.21	Main	70.38	"	"	-1.2	+0.20
Morton	58.48	"	"	+1.1	-0.24	Talmage	70.39	"	"	-3.2	-
"	59.15	349.0	3.70	+1.7	+0.25	Dembowski	70.72	341.6	4.58	+0.5	+0.05
Mädler	59.37	348.8	3.72	+0.4	+0.16	O. Struve	70.77	341.5	4.59	+1.8	-0.15
O. Struve	59.38	"	"	-0.9	+0.04	Peirce	71.21	341.3	4.61	-1.5	+0.70
Wakelin	59.39	348.7	3.73	+1.3	+0.45	Main	71.35	341.2	4.62	-0.3	-0.08
Secchi	59.44	348.8	"	+0.7	+0.18	Talmage	71.38	"	"	+1.9	+0.14
Dawes	59.46	"	"	-0.6	+0.04	Knott	71.38	"	"	-1.4	-0.13
Jacob	60.30	348.1	3.81	-0.1	-0.91	Wilson	71.38	"	"	-1.7	+0.73
Mädler	60.35	"	"	-2.2	+0.09	Gledhill	71.53	341.1	4.63	+0.7	+0.14
Knott	60.44	348.0	3.82	+1.3	+0.23	Dunér	72.12	340.8	4.67	+0.3	-0.08
O. Struve	61.15	347.5	3.88	-0.6	+0.05	Gledhill	72.30	340.7	4.68	-1.0	-0.28
Jacob	61.19	347.4	"	+0.3	-0.76	Wilson	72.34	"	"	+1.5	+0.91
Main	61.28	"	3.89	+0.4	+0.10	Talmage	72.37	"	"	-2.1	+0.12
Powell	61.31	"	"	-1.3	+0.05	Knott	72.40	"	"	+0.8	+0.14
Auwers	61.36	"	"	+1.1	+0.23	O. Struve	72.41	"	"	-0.7	-0.04
Mädler	61.41	347.3	3.90	+0.5	+0.21	Main	72.41	"	"	-0.4	+0.10
Dawes	62.03	346.8	3.95	-0.3	0.00	Dembowski	72.86	340.4	4.71	+0.4	-0.12
Powell	62.32	346.6	3.97	-1.3	-0.07	Wilson	73.23	340.2	4.73	+1.7	+0.17
Mädler	62.38	346.5	3.98	-1.0	+0.41	Main	73.40	340.1	4.74	+0.1	+0.09
Main	62.38	"	"	+0.1	+0.02	Gledhill	73.41	"	"	-0.4	-0.09
O. Struve	62.41	"	"	-0.5	-0.01	O. Struve	73.43	"	"	+0.7	-0.20
Main	63.25	346.0	4.04	+0.7	+0.02	Lindstedt	73.46	"	4.75	+0.4	+0.21
Romberg	63.27	"	"	-0.9	+0.30	Gledhill	74.27	339.8	4.80	+0.7	+0.28
O. Struve	63.46	345.9	4.05	+1.4	-0.15	Wilson	74.31	339.7	4.81	+1.4	+0.20
Dembowski	63.63	345.8	4.07	-0.2	+0.01	Talmage	74.32	"	"	-0.4	+0.58
Main	64.40	345.2	4.13	+0.5	+0.14	Main	74.33	"	"	-1.2	+0.43
Secchi	64.41	"	"	+0.3	+0.15	O. Struve	74.41	"	"	+0.7	+0.06
O. Struve	64.42	"	"	-0.2	-0.07	Dunér	75.14	339.4	4.84	-0.3	-0.18
Dawes	64.44	"	"	+0.2	-0.03	Gledhill	75.22	339.3	4.85	-0.8	+0.01
Knott	64.44	"	"	+0.2	+0.14	Main	75.29	"	"	+0.5	+0.24

Observer	Epoch	θ_c	ϱ_c	$\theta_o - \theta_c$	$\varrho_o - \varrho_c$	Observer	Epoch	θ_c	ϱ_c	$\theta_o - \theta_c$	$\varrho_o - \varrho_c$
Wilson	1875.30	339°3	4"85	+1°2	+0"12	H. C. Wilson	1885.32	335°0	5"35	-1°3	+0"01
Dembowski	75.32	"	"	-0.1	-0.05	Baillaud	85.35	"	"	-0.2	+0.31
Schiaparelli	75.41	"	4.86	+0.3	0.00	Tarrant	85.38	334.9	"	+1.9	0.00
Doberck	76.24	338.9	4.90	-0.2	+0.44	Schiaparelli	85.44	"	"	+0.3	-0.05
Gledhill	76.27	"	"	-0.4	-0.12	Doberck	86.00	334.7	5.37	+2.6	+0.36
Talmage	76.36	338.8	4.91	+1.2	—	Glaserapp	86.28	334.6	5.38	+0.4	-0.30
O. Stone	76.38	"	"	+1.0	+0.39	H. C. Wilson	86.30	"	"	+1.9	0.00
Waldo	76.40	"	"	+0.9	-0.27	Hall	86.37	"	"	+0.3	+0.19
Hall	76.41	"	"	+1.4	+0.24	Glaserapp	87.26	334.3	5.42	+1.4	+0.21
Schiaparelli	76.45	"	"	+0.2	-0.07	Hall	87.35	"	"	+0.5	+0.16
Main	76.48	"	4.92	-0.6	+0.26	Tebbutt	87.39	334.2	5.43	+1.3	+0.22
Gledhill	77.07	338.5	4.95	0.0	—	Schiaparelli	87.41	"	"	0.0	0.00
Plummer	77.24	338.4	4.96	+1.6	-0.31	H. Struve	88.10	334.0	5.45	-1.3	-0.02
Doberck	77.28	"	"	-2.6	+0.08	Glaserapp	88.27	333.9	5.46	+0.6	+0.20
Knott	77.29	"	"	+0.1	-0.12	Hall	88.33	"	"	+0.7	+0.04
O. Stone	77.30	"	"	-0.3	+0.23	Leavenworth	88.36	"	"	+0.8	+0.01
Jedrzewicz	77.40	338.3	4.97	+1.2	-0.06	Maw	88.41	333.8	5.47	+1.3	-0.18
Schiaparelli	77.42	"	"	-0.4	-0.06	Tebbutt	88.48	"	"	+1.1	+0.30
Flammarion	77.43	"	"	+0.1	-0.01	Glaserapp	89.27	333.5	5.50	+0.1	+0.43
Dembowski	77.83	338.1	4.99	0.0	-0.01	Leavenworth	89.29	"	"	+0.4	-0.05
Seabroke	78.27	338.0	5.01	+2.1	+0.01	Burnham	89.31	"	"	-0.1	+0.22
Goldney	78.37	"	5.02	-0.9	+0.04	Hall	89.43	333.4	5.51	-0.4	+0.03
Pritchett	79.01	337.6	5.05	-1.3	+0.02	Gledhill	90.25	333.1	5.54	+0.3	-0.04
O. Stone	79.12	"	"	-0.3	+0.15	Cosserat	90.30	"	"	+2.9	-0.04
Schiaparelli	79.13	"	"	-0.1	-0.08	Glaserapp	90.37	"	"	+0.2	-0.44
Gledhill	79.35	337.5	5.07	+1.1	-0.07	Hall	90.43	"	"	-0.3	+0.05
Hall	79.37	"	"	+0.8	+0.13	Hayn	90.44	"	"	+2.9	+0.59
Seabroke	79.38	"	"	+0.8	-0.02	Gledhill	91.30	332.8	5.57	+0.3	+0.03
Burton	80.19	337.1	5.11	-0.4	+0.19	Leavenworth	91.34	"	"	+0.5	+0.14
Burnham	80.30	"	5.12	+0.4	+0.25	Hall	91.39	"	"	+0.3	+0.07
Hall	80.30	"	"	+1.1	+0.15	Bigourdan	91.44	"	"	-1.8	+0.07
O. Stone	80.32	"	"	-0.2	+0.01	Maw	91.46	332.7	5.58	+1.1	-0.10
Gledhill	80.32	"	"	+0.2	-0.22	Gledhill	92.34	332.4	5.61	-0.6	+0.19
Doberck	80.37	"	"	+1.0	-0.17	Searle	92.40	"	"	+0.2	+0.40
Tebbutt	80.39	337.0	"	+0.2	+0.62	Leavenworth	92.43	"	"	-0.2	+0.06
Seabroke	80.40	"	"	+0.5	-0.23	Comstock	92.49	"	"	+1.2	-0.06
Franz	80.66	336.9	5.13	+0.1	+0.09	Bigourdan	92.52	"	"	-0.6	0.00
Gledhill	81.24	336.7	5.16	-0.4	+0.24	Tebbutt	92.52	"	"	-0.1	-0.05
Doberck	81.24	"	"	+0.4	-0.14	Jones	92.96	332.2	5.63	-0.1	+0.20
Hall	81.35	336.6	5.17	+1.1	+0.16	Cohn	93.11	"	"	-1.0	+0.01
Schiaparelli	81.39	"	"	+0.2	+0.03	Hough	93.25	332.1	5.64	-0.6	+0.18
Hough	81.42	"	5.18	+2.1	+0.10	Glaserapp	93.28	"	"	+0.9	-0.15
H. C. Wilson	82.25	336.3	5.21	-1.3	+0.25	Scott	93.29	"	"	+0.5	+0.14
Doberck	82.28	336.2	5.22	+1.2	+0.14	Gledhill	93.29	"	"	-0.5	+0.06
Seabroke	82.34	"	"	-0.3	+0.30	Lewis	93.32	"	"	-0.4	+0.22
Schiaparelli	82.41	"	"	+0.5	+0.01	Coleman	93.35	"	"	-0.8	+0.10
Engelmann	83.07	335.9	5.25	-0.3	-0.03	Collins	93.42	"	"	-0.4	+0.10
Hall	83.36	335.8	5.26	+1.0	+0.19	Comstock	93.43	"	"	+1.0	+0.02
Küstner	83.41	"	"	+0.7	+0.07	Bigourdan	93.46	"	"	-0.4	+0.02
Schiaparelli	83.41	"	"	-0.2	-0.03	Gledhill	94.25	331.8	5.67	-0.5	-0.17
H. C. Wilson	84.32	335.4	5.30	-0.2	+0.27	Scott	94.32	331.7	"	-0.4	+0.21
Hall	84.37	"	"	+0.7	+0.12	Coleman	94.39	"	"	-0.3	-0.04
Perrotin	84.38	"	"	+0.3	+0.13	Comstock	94.40	"	"	+0.4	-0.17
Schiaparelli	84.40	"	"	+0.2	-0.11	Bigourdan	94.48	331.6	5.68	-1.3	0.00
Seabroke	84.40	"	"	+1.7	+0.23	Chofardet	94.48	"	"	-2.4	+0.25
Engelmann	84.89	335.2	5.32	+0.9	0.00	Gledhill	95.26	331.4	5.70	+0.4	-0.10

Observer	Epoch	θ_c	ϱ_c	$\theta_o - \theta_c$	$\varrho_o - \varrho_c$	Observer	Epoch	θ_c	ϱ_c	$\theta_o - \theta_c$	$\varrho_o - \varrho_c$
See	1895.30	331.4	5.70	-0.3	+0.10	Gledhill	1900.27	329.7	5.84	+1.4	-0.24
Hough	95.34	"	"	+0.2	+0.22	Tebbutt	00.41	"	"	+0.7	+0.16
Glaserapp	95.36	"	"	-0.1	-0.09	Bryant	00.45	"	"	-0.6	-0.06
Tebbutt	95.36	"	"	-1.5	+0.23	Doolittle	01.19	329.4	5.87	-0.6	+0.12
Comstock	95.43	331.3	5.71	+0.7	-0.06	Bowyer	01.37	"	"	-4.9	-0.01
Collins	95.44	"	"	-0.2	+0.10	Comstock	01.37	"	"	+0.9	0.00
Doberck	96.07	331.2	5.72	+1.8	-0.07	Doberck	02.20	329.1	5.89	+0.2	0.00
Gledhill	96.27	331.1	5.73	+1.2	-0.03	Copenhag. Phot.	02.30	"	"	-0.3	+0.24
Comstock	96.37	331.0	"	+0.7	-0.18	Thiele	02.30	"	"	-0.8	+0.45
Lewis	96.37	"	"	+2.2	+0.23	Sternberg	02.36	329.0	"	-0.6	-0.07
Hussey	96.49	"	5.74	-1.1	+0.18	Bowyer	02.40	"	"	-0.9	-0.14
Bowyer	97.32	330.7	5.76	-0.7	+0.23	Comstock	02.45	"	"	-0.2	-0.07
Gledhill	97.36	"	"	+0.7	-0.06	Doberck	03.22	328.8	5.91	-0.5	-0.02
Doolittle	97.43	"	"	+0.3	-0.03	Sternberg	03.28	"	"	-0.5	-0.09
See	97.46	"	"	+0.7	+0.07	Doolittle	03.29	"	"	-0.8	+0.14
Cogshall	97.46	"	"	+0.3	-0.10	Biesbroeck	03.34	"	"	-0.4	+0.01
Comstock	97.47	"	"	-1.7	-0.13	Comstock	03.36	"	"	+0.6	-0.04
Aitken	97.97	330.5	5.78	-0.8	-0.22	Greenwich	03.37	"	"	-1.8	-0.11
Doolittle	98.27	330.4	5.79	+0.2	+0.17	Scott	03.40	328.7	5.90	+1.3	-0.02
Bowyer	98.31	"	"	+0.3	-0.20	Biesbroeck	04.28	328.4	5.93	-0.3	+0.05
Maw	98.35	"	"	-0.2	-0.12	Sternberg	04.30	"	"	-0.5	-0.07
Bryant	98.36	"	"	-1.4	+0.20	Comstock	04.48	328.3	5.94	+1.8	-0.23
Comstock	98.36	"	"	+0.7	+0.13	Farman	05.21	328.1	5.95	-0.9	-0.60
Glaserapp	98.38	"	"	+0.9	-0.18	Doberck	05.46	328.0	5.96	+0.5	-0.01
Greenw. Phot.	99.32	330.0	5.82	-0.4	-0.09	Lau	06.22	327.8	5.97	-1.5	-0.06
Bowyer	99.36	"	"	-2.3	-0.24	Olivier	06.40	"	"	-0.7	-0.10
Doolittle	99.38	"	"	+0.1	+0.04	Comstock	06.49	"	"	+0.3	-0.13
Bryant	99.39	"	"	+1.7	+0.16	Janssen	07.14	327.6	5.99	-0.7	+0.18
Comstock	99.50	"	"	-1.4	0.00	Lau	07.16	"	"	-1.1	+0.14

Sutton, Surrey, 1908 Febr. 10.

W. Doberck.

On certain spectroscopic binaries.

By Edwin B. Frost.

Dr. Ludendorff's remarks (A.N. 4225) on the radial velocity of the fainter component of ζ Ursae majoris (Mizar) are of especial interest to the observers with the Bruce spectrograph, as we have been closely following the star during the present season, and I had entered it upon our list of established spectroscopic binaries only a short time before A. N. 4225 arrived here. Our observations, based upon 18 spectrograms, fully confirm the variation in velocity suggested by Dr. Ludendorff's measures, but give a larger range, from -17 km to $+10$ km. The spectrum which we obtain with a dispersion of one prism may be regarded as quite well measurable, and fifteen lines have generally been used. The first two plates obtained here, both in 1907, indicating a range of at least 10 km, led me to suspect the constancy of the star's velocity. The measures on this star have so far been made by Mr. O. J. Lee. The period of the star's variation cannot yet be stated. Our exposure time is generally between 20 and 30 minutes. The full particulars of our observations will be published in the *Astrophysical Journal*.

The star Alcor has also long been on our program of stars of type Ia₂, but we only began to observe it in this season, on the same nights as the star just mentioned. Twenty-five plates have thus far been obtained, with exposures averaging about 22 minutes. The comparison spectrum is in fairly good focus from $\lambda 4000$ to $\lambda 4900$, but the star lines in this region are all so diffuse and ill-defined as to make measurement almost impossible. A qualitative examination of the plates soon showed, however, that the spectrum varies very perceptibly, the *Mg* line at $\lambda 4481$ and the hydrogen lines being sometimes double and sometimes single. The displacement of $\lambda 4481$ with respect to the titanium line of almost the same wave-length also varies very obviously, leaving no doubt that Alcor is also a spectroscopic binary. The changes in the spectrum succeed each other so rapidly that I have found it necessary to have spectrograms of this star made in continuous succession for several hours. The impression given at present is that the period will be found to be exceedingly short, but a greater number of plates will be necessary for the establishment of the period.