ASTRONOMISCHE NACHRICHTEN.

Band 176. Nr. 4224. 24.

Changes in photographic films found by measurements of double star photos.

By *H. Thiele.*

For being able with the Copenhagen double-refractor to photograph measurable double stars with smaller distance than it was possible in the focus of the objectiv alone (v. Astr. Nachr. Nr. 3837), where, only under very favourable conditions, the lower limit 2".1 could be obtained, there was set a negative lens in a distance of 10 cm before the photographic plate, the focal distance of the lens is −5 cm and the enlargement therefore nearly 3 times.

With this system there were taken from 1903 September to 1904 April 180 plates of 140 double stars, and of these 125 plates were fitting for measurements; on the whole 443 images of 110 different Σ stars were measured.

The proportion between the successful plates and the exposed is better than with the exposures in 1902, and the 10 times longer exposure may partly be the cause of this, but certainly it is also the result of the better understanding of the most important influence of the air on the images, the »seeing«, although it was but later on, that I was able to give the numerical measurements of this influence and so the exact description of the air conditions and the different ways in which the normal quiet image of a star is changed. With this understanding the proportion between the successful and the exposed plates can be still better, and the agreement between the results of the measurements of the different plates of the same object be improved, in so far as no other disturbances take place, as mentioned later on. (The said method has made it possible to find out the characters of different places in Denmark for astronomical measurements with comparatively small means.)

The seeing not being sufficiently known and taken into consideration, the lower limit for the distance between the double star components obtained on these plates can not be considered final; notwithstanding that I have always noted the steadiness and the definition of the images in scales with 5 degrees.

About the condition of the instrument there is to be said, that the formerly mentioned periodical movement in 1^m of a star in equator, caused by the movement of the clock, in the beginning was determined to 2", but afterwards it was considerably reduced by turning the little cog wheel on the end of the clock-screw, which drives the instrument, 180°, the remaining periodical movement was at the utmost $^1/_2$". The movement has since become still better, as the cylindrical worm-screw, that goes in the said cog wheel, has been worn off to quite a conspicuous degree by the movement itself.

The correction of the refractor has a few times been determined by determinations of the direction of the daily motion of stars. The deviation from the apparent pole, the angle between the axes and the angle between the telescope and the declination axe are all within 1' of their theoretical value, but even when the flexures are taken into consideration, there still remains an uncertainty in the direction of the daily motion of about 1'. In the determinations of this direction in the same declination the readings change suddenly and not continuously, but for double stars the stability is quite sufficient in not too small distances from the pole.

The photographic system, which has a field of 15', gives round images in the middle where it is used, at the edges they get a little oblonged in radial direction. The system was carefully centred and kept clean, which in spite of a dewcap can be difficult enough in the spring. The focus was determined by trails of double stars and measurements of the extrafocal image of a star. In this way there was found a focus-difference for Vega and Capella of 0.5 mm. 1 mm on the plate was found to be 14".90 (focus 46.0 mm) according to several determinations by Atlas and Plejone and ν_1 ν_2 Draconis.

The manner of distribution of the exposures on the plate was the same as in 1902: as a rule 4 images on a line in position-angle 0° and one image used for orientation to the west of the four and on the same parallel as one of them.

On account of the long time of exposure only Lumière plates (etiquette blue, size 8 × 8 cm) are used. On the last half of the plates the group round 4 H Draconis was photographed with the same time of exposure as the double star, with the intention of determining the photographic magnitude of the latter. The connection between the star magnitude, image and time of exposure was determined by measurements of the diameters of the 4 H Draconis stars 78°412, 78°411, 78°410, 78°409, 78°408 (whose magnitudes are given in the Harvard Annals Vol. 24 as 5.04, 6.64, 8.34, 8.78, 9.38) exposed on the same plate, but with different times of exposure. The diameter was found proportional to the star magnitude and proportional to the fourth root of the time of exposure. The magnitude of those double stars on the plates on which the 4 H Draconis stars were exposed in the same length of time as the double star itself, were determined by the method of least squares, the photographic extinction taken into consideration. In this way it was found, that the photographic magnitudes of

78°412, 78°411, 78°410, 78°409 ought to be 5.12, 6.58, 8.43, 8.71. On the other hand the time of exposure and the magnitude are connected by the formula

$$\log t' = 2.26 + 0.35\,(m - 7.0)$$

for a diameter of 3", and as the diameter d is connected with the time of exposure t by

$$\frac{d}{3''} = \left(\frac{t}{t'}\right)^{1/4}$$

then $$m_1 - m_2 = -11.4\,(\log d_1 - \log d_2)\;.$$

If with this formula the diameters of the 4 H Draconis stars are reduced, there sometimes remain big systematical residuals even between exposures on the same plates from the same night. The transparency is of course quite different at different times, and the seeing ought to be taken into consideration. I think the greatest interest of the diameter measurements to be the possibility of finding the difference of magnitude between the components of the double stars, and therefore the diameters for all the measured plates are given. The star is considered beginning by the first trace of a continuous disk.

The measurements are made with the same microscope as in 1902. The unit was determined by measuring a millimeterscale on glass, which was put directly on the plate and remained there, also during the measurements of the double star. Each plate is measured twice, the enlargement of the microscope being resp. 15 and 43 times, $\Delta\delta$ and $\Delta\alpha\cos\delta$ are measured in the four directions N, E, S, W. The results are given in Table I. The first column is the Σ number, then follow the date of the exposure, the hour angle, the magnitude (if with two decimals then determined as formerly described), the position-angle (P), distance (s), number of images in the first and in the second measurement, the mean error of P and s (determined by the differences between the $\Delta\delta$ and $\Delta\alpha\cos\delta$ on the separate plates, all taken together and calculated back for the separate plates). At last the diameters of the components are given.

Table I.

Σ	Date	θ	Magnitudes		P_1	s_1	n_1	P_2	s_2	n_2	Mean errors		Diameters	
33	1903.846	$+2^h3$	8.32	8.40	208°3	2"74	4	208°0	2"73	4	±0°9	±0"05	2"71	2"62
55	3.728	+1.9	8.2	8.8	326.7	1.79	4	321.3	1.92	4	1.6	0.05	4.04	3.44
59	3.687	−1.9	7.0	7.7	146.9	1.90	4							
»	3.693	−0.3	»	»	141.4	1.77	4	140.7	2.26	4	1.3	0.05	4.28	2.99
»	4.126	+4.1	»	»	147.2	2.30	4	145.6	2.23	4			3.32	2.47
65	3.813	+0.2	8.03	8.09	217.2	3.06	4	217.2	3.15	4	0.8	0.05	2.73	2.68
74	3.682	+0.8	8.2	9.0	305.3	2.65	4	305.7	3.23	4	0.8	0.05	3.37	2.82
140	3.687	−1.4	8.5	9.2	173.9	3.28	3	173.2	3.36	3	0.8	0.06	2.67	2.02
158	3.715	−0.5	8.6	9.1	257.9	1.90	3	259.2	2.11	4	1.3	0.05	2.52	2.44
162	3.674	−0.3	6.5	7.2	213.5	1.87	4	209.9	2.16	4	1.4	0.05	3.33	2.50
174	3.789	+0.4	6.1	7.0	344.3	2.57	4	343.2	2.68	4	1.1	0.05	3.79	3.35
178	3.819	+1.0	8.85	8.82	15.6	3.05	4	16.8	3.26	4	0.7	0.05	2.34	2.29
179	3.758	−0.8	7.1	7.9	158.2	3.62	4	159.5	3.61	4	0.7	0.05	3.44	2.76
212	3.674	+0.2	8.0	8.3	165.6	1.86	4	165.9	2.07	4	1.5	0.05	2.60	2.28
213	3.868	+5.3	8.5	9.0	321.5	1.66	2	325.8	1.72	2	2.2	0.07	3.87	3.29
268	3.819	−1.4	6.89	8.49	127.9	2.68	4	128.6	2.81	4	0.9	0.05	3.98	2.20
269	3.717	+1.8	7.1	8.4	345.5	1.50	3	346.5	1.68	4	1.7	0.05	3.18	2.80
272	3.860	−0.9	7.99	8.27	39.1	1.87	1							
285	3.824	−0.5	6.9	7.7	171.1	1.64	4	168.9	1.72	4	1.6	0.05	2.12	2.00
300	3.860	+0.7	7.31	7.44	302.9	2.88	4	304.8	2.90	4	0.8	0.05	4.65	4.24
305	3.887	+0.1	8.18	8.51	316.7	2.99	4	317.7	2.99	4	0.9	0.05	3.93	3.47
311	3.682	+0.4	4.9	8.4	121.9	3.02	4							
314	3.819	+2.2	6.8	7.1	303.8	1.34	2	301.2	1.66	2	2.3	0.07	3.17	2.88
384	3.876	−3.0	8.98	9.20	90.9	2.08	4	91.2	2.09	4	1.4	0.05	2.24	1.98
388	3.895	−1.1	8.25	9.52	210.9	2.90	4	210.6	2.97	4	0.9	0.05	4.19	3.18
389	3.816	−1.6	6.4	7.6	70.8	2.55	3	64.6	2.36	3	1.2	0.06	3.72	2.48
414	3.884	+2.3	8.02	8.22	184.5	7.31	4	184.9	7.36	4	0.4	0.05	3.68	3.39
425	3.758	−0.9	7.0	7.1	93.2	2.32	4	92.7	2.71	4	1.0	0.05	3.18	2.87
»	3.786	+1.2	»	»	90.6	2.50	4	91.2	2.68	4	1.0	0.05	2.90	3.07
522	3.868	−2.2	8.5	8.6	31.8	1.30	2	33.7	1.41	2	2.7	0.07	2.83	2.71
553	3.805	−0.9	8.0	8.7	133.4	2.99	3	133.7	3.19	3	0.9	0.06	2.48	1.90
559	3.687	−1.6	7.0	7.1	98.8	2.85	3	97.1	3.14	4	0.7	0.05	3.51	3.27
622	3.786	+1.1	8.1	8.1	350.3	2.06	3	353.8	2.45	2	1.4	0.07	2.47	2.30
666	3.840	−0.9	7.2	7.5	75.5	3.23	2	77.3	3.05	2	1.2	0.07	3.85	3.66
677	4.000	+0.9	8.43	8.46	251.2	1.16	2	242.5	1.17	4	2.4	0.05	2.52	2.47

Σ	Date	θ	Magnitudes		P_1	s_1	n_1	P_2	s_2	n_2	Mean errors		Diameters	
712	1904.203	+1ʰ8	7.77	7.86	55°9	2″79	4	53°3	2″83	4	±0°9	±0″05	4″41	2″60
738	4.142	+0.3	4.0	6.0	42.5	4.40	4	42.5	4.48	4	0.6	0.05	5.13	2.83
795	3.876	+1.5	5.79	5.82	26.3	1.60	5	26.9	1.55	4	1.8	0.05	3.66	3.64
861	4.156	+1.8	8.0	8.3	321.0	1.38	3	315.3	1.50	4	1.9	0.05	2.42	2.27
867	4.181	+0.8	7.42	8.50	153.5	2.24	3	152.4	2.21	3	1.3	0.06	3.90	2.72
899	4.068	−1.6	7.0	7.5	19.8	2.33	4	19.4	2.32	4	1.2	0.05	2.56	2.15
932	4.142	+1.3	8.15	8.37	325.3	2.00	3	326.2	2.02	3	1.5	0.06	2.69	2.47
941	4.000	+1.3	6.98	8.07	85.2	2.21	4	82.3	2.04	4	1.4	0.05	3.68	2.64
948	3.876	+2.7	4.55	5.15	120.2	2.01	4	115.6	1.90	4	1.4		4.63	4.11
	3.876	+2.7	4.55	7.42	305.9	8.48	4	306.2	8.58	4		0.05	4.63	2.17
1009	3.986	+1.5	6.82	7.12	154.1	3.76	4	153.8	3.75	4	0.7	0.05	4.12	3.83
1033	4.205	+2.8	8.04	8.37	275.2	1.48	1	279.1	1.64	4	1.7	0.05	2.65	2.27
»	4.230	+5.8	»	»	282.4	1.20	1							
1137	4.233	+1.6	7.95	7.98	133.3	2.77	3	130.5	2.89	4	0.9	0.05	3.24	3.19
1187	3.986	+3.0	7.1	7.9	39.1	2.12	4	42.5	2.09	4	1.3	0.05	4.65	3.85
1273	4.000	+0.6	2.52	6.89	238.5	3.55	2	241.3	3.66	2	1.0	0.07	6.41	3.07
1282	4.214	0.0	8.20	8.39	277.6	3.66	4	277.2	3.77	4	0.7	0.05	2.20	2.06
1334	4.194	+0.8	4.2	6.3	234.7	3.08	3	233.8	2.97	4	0.8	0.05	4.93	2.50
»	4.203	+0.3	»	»	238.1	3.28	2	239.0	3.18	2	1.1	0.07	5.59	2.72
»	4.205	+3.4	2.62	6.65	236.0	3.15	3	238.6	3.27	4	0.8	0.05	5.25	2.36
1338	4.194	+1.9	7.36	8.02	167.6	1.59	3	168.5	1.36	3	1.9	0.06	2.85	2.31
»	4.238	−0.2	7.31	7.49	172.7	1.11	2	170.7	1.38	2	2.6	0.07	2.44	2.30
»	4.252	−0.2	7.45	7.65	172.2	1.59	2	169.6	1.48	2	2.5	0.07	1.83	1.71
1355	4.134	−0.3	7.90	7.99	332.6	2.35	3	331.1	2.28	3	1.2	0.06	3.04	2.92
»	4.238	+1.6	7.61	7.89	332.7	2.43	4	331.6	2.53	4	1.1	0.05	2.81	2.23
»	4.252	+1.3	8.21	8.56	336.2	2.56	2	331.5	2.23	4	1.1	0.05	2.59	2.23
1374	4.003	−0.3	7.91	8.90	287.3	3.30	4	287.1	3.33	4	0.8	0.05	3.35	2.29
1386	4.003	−4.3	9.40	9.61	113.5	1.98	4	112.8	2.07	4	1.3	0.05	2.15	1.90
1424	3.884	−2.7	2.2	3.4	114.8	3.64	4	115.3	3.79	4	0.7	0.05	4.87	3.59
1428	4.003	−2.5	8.52	8.81	86.3	3.34	4	86.9	3.48	4	0.7	0.05	2.52	2.20
1439	4.068	−3.2	7.9	8.4	110.5	1.58	2	115.0	1.88	1	2.9	0.10	2.35	2.11
1523	4.194	−2.2	4.0	4.4	139.7	2.61	3	138.2	2.67	4	1.1	0.05	3.28	2.89
»	4.236	+1.4	»	»	140.0	2.51	4	138.7	2.48	4	1.1	0.05	3.77	3.16
1527	3.884	−2.8	6.87	8.33	16.7	3.30	2	16.0	3.21	3	0.9	0.06	4.31	2.77
1626	4.120	−3.3	8.5	8.7	5.5	2.02	3	5.3	2.24	3	1.3	0.06	2.43	2.04
1643	4.142	−1.8	9.30	9.70	36.8	1.85	2	38.3	1.92	4	1.6	0.05	2.39	1.93
»	4.206	−1.0	9.37	9.79	35.8	1.92	4	37.0	1.99	4	1.4		1.76	1.35
1661	4.211	0.0	8.97	9.08	240.8	2.40	2	240.3	2.42	4	1.1		2.07	1.94
1722	4.211	+1.8	8.90	9.07	338.6	3.12	4	337.1	3.26	4	0.7		2.32	2.18
1757	4.238	+0.5	7.30	8.25	79.6	2.50	3							
1758	4.214	−4.0	8.60	8.89	305.1	3.82	3	304.8	3.98	4	0.6		2.43	2.11
1771	4.214	−2.0	8.39	9.03	79.2	1.64	2	74.1	1.76	4	1.6		2.77	2.04
»	4.224	−2.2	8.68	9.14	75.3	1.64	4	76.7	1.82	4	1.6		2.65	2.14
1777	4.230	+1.4	6.42	7.07	230.0	2.82	3	235.7	2.93	4	0.9		4.33	2.93
1820	4.214	+1.5	9.15	9.22	75.4	1.92	2	78.1	2.05	4	1.3		2.03	1.97
1825	4.231	+2.4	6.42	8.33	173.3	4.02	4	172.3	4.24	4	0.6		5.28	2.57
1842	4.271	−1.3	8.90	8.97	15.9	2.45	3	16.4	2.33	3	1.2	0.06	2.12	2.00
1877	4.211	+2.1	3.0	6.2	335.0	3.07	4	333.9	3.20	2	1.2	0.07	4.96	3.82
»	4.236	+2.0	»	»	333.2	3.11	3	331.0	3.05	4	0.8	0.05	4.40	3.39
1890	4.252	−2.5	5.5	6.2	46.1	3.40	4	44.6	3.22	4	0.8		2.78	2.59
1909	4.271	+5.2	5.2	6.1	243.4	4.37	4	243.4	4.35	4	0.6		2.67	1.90
1954	4.250	−1.9	3.9	5.5	186.0	3.61	4	186.3	3.64	4	0.7		3.32	2.64
1988	4.250	−1.4	7.65	8.01	260.7	2.69	4	261.2	2.72	4	1.0		2.19	1.93
2021	4.121	−2.6	7.1	7.2	335.2	3.92	3	335.6	3.97	3	0.7	0.06	2.83	2.81
2032	4.250	−0.4	5.8	6.7	212.8	4.53	4	213.9	4.62	4	0.6		2.77	1.98
2130	4.252	−1.9	5.0	5.0	140.1	2.30	3	138.0	2.41	4	1.2		2.36	2.28

Σ	Date	θ	Magnitudes		P_1	s_1	n_1	P_2	s_2	n_2	Mean errors		Diameters	
2161	1904.142	−1ʰ1	4.6	5.5	312°9	3″86	4	313°1	3″94	4	±0°7		4″11	3″39
2205	4.279	−2.9	9.26	9.44	307.5	1.99	2	305.3	2.13	3	1.4	±0″06	1.51	1.34
2271	4.279	−0.6	8.65	9.30	265.4	2.39	3	265.9	2.38	3	1.2	0.06	2.33	1.65
2375	4.277	−2.1	6.68	7.00	116.6	2.15	4	118.9	2.03	4	1.3	0.05	2.86	2.59
2382	3.671	+1.9	5.0	7.0	12.1	2.99	4	12.1	3.12	4	0.7			
2383	3.671	+1.9	5.1	5.2	126.7	2.30	4	126.8	2.38	4	1.2			
2415	4.293	−4.0	6.96	8.31	298.0	1.96	2	297.2	1.94	2	1.9	0.07	3.35	2.09
2576	4.277	−2.4	7.9	8.2	107.3	2.11	2	106.5	2.20	2	1.8	0.07	2.26	1.99
»	4.293	−3.6	»	»	112.2	2.06	3	114.0	2.01	3	1.5	0.06	2.26	2.19
2603	3.936	+5.6	3.95	5.89	5.1	3.06	4	3.8	3.30	4	0.8	0.05	5.71	3.61
2705	3.816	+1.2	7.52	8.16	262.7	2.88	4	262.0	3.03	4	0.9	0.05	3.54	2.64
2711	3.679	+0.7	7.9	9.0	224.1	2.37	2	221.2	2.46	2	1.4	0.07	2.96	2.26
2716	3.783	+0.7	6.0	8.2	45.3	3.05	4	45.0	2.99	4	0.9	0.05	5.35	3.69
2735	3.726	+2.7	6.2	7.9	287.9	1.68	2	285.2	1.90	4	1.4		3.84	3.67
2741	3.728	+2.4	6.0	7.3	28.1	1.94	4	26.5	2.00	4	1.4		4.81	3.89
2751	3.690	+0.1	6.4	6.8	348.6	1.66	4							
»	3.698	+0.4	»	»	349.0	1.42	4	348.7	1.79	3	1.6	0.06	3.11	2.77
2767	3.797	+0.1	7.9	8.2	34.0	2.16	3	31.2	2.30	3	1.3	0.06	3.01	2.58
2799	3.712	−0.8	7.1	7.4	116.9	1.19	4	111.8	1.53	4	1.8	0.05	2.89	2.60
2801	3.695	+0.8	7.1	7.8	269.0	1.73	3	274.4	1.74	4	1.6		3.15	2.49
2804	3.674	+0.3	7.7	7.7	333.1	2.80	4	333.3	2.92	4	0.9		2.95	2.78
2807	3.717	+1.2	8.1	8.1	311.8	1.74	4	310.1	2.10	4	1.3		3.18	2.77
»	3.723	+2.0	»	»	312.7	2.15	4	312.2	2.22	4	1.3		2.28	1.92
2837	3.698	+0.5	8.0	8.5	295.7	2.51	4	289.3	2.86	2	1.3	0.07	2.43	1.73
2843	3.723	+0.6	7.0	7.3	139.2	1.95	4	138.1	2.03	4	1.4	0.05	3.50	3.16
2845	3.857	+1.3	7.7	8.3	174.9	1.57	2	169.6	1.86	2	2.0	0.07	3.87	3.41
»	3.868	+6.0	»	»	170.8	1.70	3							
2854	3.816	+0.1	7.7	7.8	81.9	2.60	2	84.1	2.90	1	1.9	0.10	3.68	3.55
2881	3.674	+0.8	7.5	8.2	100.0	1.25	4	100.2	1.70	4	1.6	0.05	2.62	2.04
2940	3.690	−0.3	8.2	9.7	322.6	2.49	3	319.1	2.65	3	1.2	0.06	2.99	2.62
2948	3.726	+2.5	7.1	8.5	1.5	2.54	4	2.4	2.90	4	1.0	0.05	4.03	2.70
2950	3.715	−0.3	5.7	6.9	307.5	1.95	4	302.7	2.18	4	1.2		3.73	3.15
2961	3.698	+0.5	8.0	8.2	340.4	1.63	4	347.3	1.82	4	1.6		2.53	2.31
2963	3.717	+2.0	7.7	8.2	351.4	2.02	4	353.8	2.35	4	1.2		3.67	2.89
»	3.723	+2.0	»	»	354.8	2.14	4	352.7	2.36	4	1.1		2.71	2.08
2974	3.789	+1.2	7.9	8.3	161.4	2.71	4	161.9	2.75	4	1.0	0.05	3.52	3.06
2990	3.674	+1.1	8.2	8.2	242.2	1.67	4	243.5	1.91	2	2.1	0.07	2.42	2.20
»	3.824	+0.8	8.66	8.83	242.5	1.96	4	244.5	2.03	4	1.4	0.05	2.59	2.40
3001	3.695	+0.8	5.2	7.6	199.4	2.94	4	199.0	2.93	4	0.9		4.46	2.77
3037	3.712	+2.4	6.9	9.0	207.9	2.51	4	210.1	2.59	4	1.1		3.28	2.60
3049	3.723	+2.7	4.8	7.1	321.9	3.44	3	319.6	3.62	4	0.7		6.73	3.91
3050	3.687	−2.2	6.0	6.4	213.5	2.33	5	211.7	2.54	5	0.9	0.04	3.11	3.09

The following Table II gives after the plate number and Σ number the differences between the second and first measurement ($P_2 - P_1$, $s_2 - s_1$) in the order according to which the plates were measured in both measurements, and the number of images measured. The table contains furthermore the changes in the distances between the nearest exposure from the first to the second measurement in units of 0.001 mm, positive if the distance is found bigger by the second than by the first; and the mean of the changes.

Table II.

Plate Nr.	Σ	Differences P	Differences s	n	Changes of measured distances			Mean
14	2804	+0°2	+0″12	4	+2	0	+4	+2
15	2881	+0.2	+0.45	4	+30	−39	+3	−2
16	2990	+1.3	+0.24	4,2				
17	162	−3°6	+0″29	4	−8	+12	+8	+4
19	212	+0.3	+0.21	4	+2	+13	+12	+9
20	2711	−2.9	+0.09	2				−4

Plate Nr.	Σ	Differences P	s	n	Changes of measured distances	Mean
21	74	+0°.4	+0".58	4	+9 0 +15	+8
23	3050	−1.8	+0.21	5	−8 +5 +17 −2	+3
25	140	−0.7	+0.08	3		
26	559	−1.7	+0.29	3,4	+16 −23 +22	+5
28	2940	−3.5	+0.16	3	+1 +35	+18
29	59	−0.6	+0.49	4	−10 −12 +4	−6
31	2801	+5.4	+0.01	3,4	+13 +23 +10	+15
32	3001	−0.4	−0.01	4	+25 −1 +21	+15
34	2751	−0.3	+0.37	4,3	+18 +12 −6	+8
35	2837	−6.4	+0.35	4,2		+10
36	2961	+6.9	+0.19	4	+6 +7 +11	+8
37	2799	−5.1	+0.34	4	−6 −1 +34	+9
40	3037	+2.2	+0.08	4	−32 +2 0	−10
42	2950	−4.8	+0.23	4	+3 +6 −15	−2
43	158	+1.3	+0.21	3,4		−18
45	2807	−1.7	+0.36	4	+10 +14 −12	+4
46	2963	+2.4	+0.33	4	+6 +2 +7	+5
47	269	+1.0	+0.18	3,4	−6 +17 −14	−1
48	2843	−1.1	+0.08	4	+1 +7 −29	−7
49	2807	−0.5	+0.07	4	−8 +16 +1	+3
50	2963	−2.1	+0.22	4	+7 +13 +7	+9
51	3049	−2.3	+0.18	3,4	+3 −21 −6	−8
52	2735	−2.7	+0.22	2,1	−8 −6 −4	−6
53	2948	+0.9	+0.36	4	+17 +10 +3	+10
57	2741	−1.6	+0.06	4	−4 +18 −20	−2
59	55	−5.4	+0.13	4		−7
65	179	+1.3	−0.01	4	−14 +8 +9	+1
66	425	−0.5	+0.39	4	+23 +6 +7	+12
67	2716	−0.3	−0.06	4	+5 −20 +12	−1
68	425	+0.6	+0.18	4	+3 +5 +7	+5
69	622	+3.5	+0.39	3,2		−35
70	2974	+0.5	+0.04	4	−11 +11 +6	+2
71	174	−1.1	+0.11	4	+10 +13 +1	+8
73	2767	−2.8	+0.14	3	+12 −2	+5
75	553	+0.3	+0.20	3	+29 +7	+18
76	65	0.0	+0.09	4	+9 +8 −2	+5
77	2854	+2.2	+0.30	2,1		−3
78	2705	−0.7	+0.15	4	−5 +15 −10	0
79	389	−6.2	−0.19	2,3	−1 +3	+1
80	268	+0.7	+0.13	4	+2 +18 −5	+5
81	178	+1.2	+0.21	4	+5 +14 +3	+7
82	314	−2.6	+0.32	2		−2
83	2990	+2.0	+0.07	4	+2 −6 −5	−3
84	285	−2.2	+0.08	4		+5
87	666	+1.8	−0.18	2		−1
88	33	−0.3	−0.01	4	+17 +2 +17	+12
90	2845	−5.3	+0.29	2		−18
93	300	+1.9	+0.02	4	−5 −4 +9	0
94	522	+1.9	+0.11	2		+24
96	213	+4.3	+0.06	2		−2
97	384	+0.3	+0.01	4	−2 +3 +8	+3
98	795	+0.6	−0.05	4		0
99	948	−4.6	−0.11	4	+4 −2 +19	+7
100	414	+0.4	+0.05	4	+110 −16 −4	+30
101	1424	+0.5	+0.15	4	+18 −17 +5	+2
102	1527	−0.7	−0.09	2,3	+12 +8	+10
103	305	+1°.0	0".00	4	+1 +19 +13	+11
105	388	−0.3	+0.07	4	+8 +10 +18	+12
109	2603	−1.3	+0.24	4	+22 −13 +18	+9
111	1009	−0.3	−0.01	4	−5 −8 −5	−6
113	1187	+3.4	−0.03	4	+13 −1 0	+4
116	677	−8.7	+0.01	2,4		+10
117	941	−2.9	−0.17	4	+9 +15 −9	+5
118	1273	+2.8	+0.11	2		−18
120	1386	−0.7	+0.09	4	+8 +27 −17	+6
121	1428	+0.6	+0.14	4	+19 +12 +4	+12
122	1374	−0.2	+0.03	4	+1 +7 +3	+4
132	899	−0.4	−0.01	4	+13 +31 +4	+16
133	1439	+4.5	+0.30	2,1		+1
138	1626	−0.2	+0.22	2,3	−8 +12 +2	+2
140	2021	+0.4	+0.05	3	+12 −18	−3
141	59	−1.6	−0.07	4	−2 0 −4	−2
143	1348	−1.5	−0.07	3	−3 +5	+1
147	738	0.0	+0.08	4	−1 +18 +7	+8
149	932	+0.9	+0.02	3	−8 +6	−1
151	1643	+1.5	+0.07	2,4		−5
157	2161	+0.2	+0.08	4	−15 +18 +9	+4
158	861	−5.7	+0.12	3,4	+20 −2	+9
160	867	−1.1	−0.03	3	−14 +12	−1
161	1523	−1.5	+0.06	3,4	−22 +15 −14	−7
162	1334	−0.9	−0.11	3,4	−4 +4 0	0
163	1338	+0.9	−0.23	3	+20 −14	+3
164	712	−2.6	+0.04	4	+20 +16 +6	+14
165	1334	+0.9	−0.10	2		−10
167	1033	+3.9	+0.16	1,4	−11 −4 +45	+10
168	1643	+1.2	+0.07	4	+17 +7 +15	+13
169	1334	+2.6	+0.12	3,4	+8 0	+4
172	1661	−0.5	+0.02	2,4	+16 +24 +11	+17
173	1722	−1.5	+0.14	4	+10 −6 +2	+2
174	1877	−1.1	+0.13	4,2	−15 −8 −10	−11
175	1282	−0.4	+0.11	4	+14 +7 +12	+11
176	1758	−0.3	+0.16	3,4	−3 −1 +10	+2
177	1771	−5.1	+0.12	2,4	+16 −16 +6	+2
178	1820	+2.7	+0.13	2,4	+15 +2 +16	+11
180	1771	+1.4	+0.18	4	0 −3 +15	+4
182	1777	+5.7	+0.11	3,4	+16 +13 +22	+17
183	1825	−1.0	+0.22	4	+14 +29 −19	+8
184	1137	−2.8	+0.12	3,4	+10 −5 +7	+4
188	1523	−1.3	−0.03	4	−1 −12 −8	−7
190	1877	−2.2	−0.06	3,4	+20 +4 +27	+17
191	1338	−2.0	+0.27	2	+6 +4	+5
192	1355	−1.1	+0.10	4	+16 +5 +15	+12
197	1954	+0.3	+0.03	4	−1 +20 +11	+10
198	1988	+0.5	+0.03	4	+9 +8 +4	+7
199	2032	+1.1	+0.09	4	+8 +9 +4	+7
200	1338	−2.6	−0.11	2		+7
201	1355	−4.7	−0.33	2,4		+16
202	1890	−1.5	−0.18	4	−4 0 −8	−4
204	2130	−2.1	+0.11	3,4	+8 0	+4
205	1909	0.0	−0.02	4	+9 −14 +5	0
207	1842	+0.5	−0.12	3	−3 −3	−3
209	2375	+2.3	−0.12	4	+19 −14 +1	+2

Plate Nr.	Σ	Differences P	s	n	Changes of measured distances	Mean
210	2576	−0ʺ8	+0ʺ09	2		−19
211	2271	+0.5	−0.01	3	−6 +12 +24	+10
213	2205	−2.2	+0.14	2,3		+ 3
215	2415	−0ʺ8	−0ʺ02	2		− 1
217	2576	+1.8	−0.05	3	+7 +17	+12

The differences P_2-P_1 and s_2-s_1 are bigger than the agreement between the images on the same plate leads one to expect, and go systematically in that direction, that the s are bigger by the second than by the first measurement; but s_2-s_1 seems on the whole to diminish towards the end of the series of measurements.

For understanding this increase in the distances on the plate one could imagine a change of the unit, but during all the measurements the same scale is used in exactly the same manner. There was little change in the temperature, besides the scale being of the same material as the plates, and the distances between the exposures show that the unit has not altered enough for explaining a change in s proportional to the distance.

Further one could imagine a change of the perception by the measurements with 15 and 43 times enlargement, but it is to be remembred that the plates are measured in four directions, and the increase does not with surety alter with the distance between the components, if the plates with s from 1ʺ to 2ʺ, 2ʺ to 3ʺ, &c. are taken together, the increases are

1ʺ− 2ʺ	+0ʺ14 ± 0ʺ03
2 − 3	+0.10 ± 0.02
3 − 4	+0.08 ± 0.03
4 − 5	+0.09 ± 0.05

I have also made measurements of some plates in between the two series of measurements with 15 times enlargement and found the distances increased.

An augmentation of the distances on the plates can actually have taken place, and there are some experiences which show in that direction: the components often look better separated immediately after development and fixing, than after the washing, the dried plate looks better again. By the last measurement 20 images more are measured than by the first, though the greater enlargement makes the separation rather more difficult.

A direct proof of the increase of the distances was possible by the measurement of the distance between the (generally four) exposures, which was made for the sake of reduction, and therefore only once by each measurement. Table II gives the changes in these distances and their mean. The table shows an increase on the 1.63 mm (or 24ʺ3) of +0.004 mm ± 0.0008 mm (or +0ʺ06 ± 0ʺ01). Further there seems to be a connection between the great displacements of one image and negative or big positive values of s_2-s_1 and P_2-P_1. In general there has been an increase in the distances from the first to the second measurement, of which the first is made two months after the exposure and the second nine months after the first, although the change has been greatest on the first half of the plates, where the first measurement is made in winter, the second in summer. This increase is perhaps a consequence of the drying of the plate, which was not finished in two months in the winter, the drying begins always at the edges and goes from all sides towards the middle, and may in this way produce a strain in the film. In the image, where the silver is left, the constitution of the film is another one, or else the drying takes place in another way, so that in combination with the strain the increase in the short distances can be explained, but there are no data for carrying out this explanation. Whether the film is ever in the same condition as during the exposure and under what circumstances this becomes the case only further experiments can show.

Kopenhagen, Universitätssternwarte, 1907 Nov. 22.

H. Thiele.

Positions de petites planètes

observées à l'équatorial de 10 pouces de l'observatoire de Genève.

1907	T.m.Genève	$\Delta\alpha$	$\Delta\delta$	Cp.	α app.	Parall.	δ app.	Parall.	Red. ad l. app.	*
					(17) Thetis.					
Juill. 4	9ʰ 7ᵐ56ˢ	+0ᵐ44ˢ03	+4′ 0ʺ2	6,6	18ʰ13ᵐ41ˢ46	−0ˢ21	−18° 26′ 34ʺ1	+6ʺ7	+2ˢ12 + 5ʺ1	1
10	8 51 55	−0 48.98	−2 42.2	6,6	18 8 29.60	−0.19	−18 51 13.4	+6.6	+2.16 + 5.0	2
11	9 18 48	−0 45.14	+5 15.1	6,6	18 7 39.58	−0.15	−18 55 30.9	+6.7	+2.16 + 5.0	3
12	9 8 48	+1 23.88	−6 29.3	6,6	18 6 52.78	−0.16	−18 59 40.7	+6.7	+2.16 + 4.8	4
					(148) Gallia.					
Juill. 14	10 9 27	+0 47.94	+2 59.1	6,6	20 17 14.78	−0.15	− 1 52 24.6	+3.6	+2.05 + 9.1	5
17	9 1 27	+0 12.76	+7 1.8	6,6	20 14 54.43	−0.19	− 2 17 50.5	+3.7	+2.07 + 9.5	6
17	9 23 43	+2 16.71	+2 53.7	6,6	20 14 53.57	−0.17	− 2 17 58.9	+3.7	+2.07 + 9.4	7
18	9 2 15	+1 28.95	−6 0.4	6,6	20 14 5.82	−0.18	− 2 26 52.8	+3.7	+2.08 + 9.6	7
18	9 18 26	−0 36.15	−2 7.6	6,6	20 14 5.53	−0.17	− 2 26 59.8	+3.7	+2.08 + 9.6	6
19	9 12 29	−0 58.36	+0 19.1	7,7	20 13 16.64	−0.17	− 2 36 13.4	+3.7	+2.09 + 9.7	8