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ELEMENTS AND EPHEMERIS OF COMET *c* 1903 (BORRELLY)

The following system of elements is based on the observations of June 22, June 30 and July 10, by Dr. Aitken.

$$\begin{aligned} T &= 1903 \text{ August } 27.6056 \text{ Greenwich M.T.} \\ \omega &= 127^\circ 19' 25''.5 \\ \Omega &= 293 \ 32 \ 55.0 \\ i &= 84 \ 59 \ 45.3 \end{aligned} \left. \vphantom{\begin{aligned} T \\ \omega \\ \Omega \\ i \end{aligned}} \right\} 1903.0$$

$$\log q = 9.518126$$

$$\begin{aligned} \text{Residuals. (O-C)} \\ \Delta\lambda' \cos \beta' &= -1''.0 \\ \Delta\beta' &= +5.7 \end{aligned}$$

CONSTANTS FOR THE EQUATOR OF 1903.0.

$$\begin{aligned} x &= r [9.610075] \sin (206^\circ \ 0' \ 21''.2 + v) \\ y &= r [9.962172] \sin (13 \ 53 \ 30.3 + v) \\ z &= r [9.998662] \sin (105 \ 51 \ 25.5 + v) \end{aligned}$$

EPHEMERIS FOR GREENWICH MEAN MIDNIGHT.

1903	True α			True δ	$\log \Delta$	Br.
July 14.5	20 ^h	4 ^m	52 ^s	+48° 30' 3"	9.430	12.9
16.5	19	14	38	58 7.7	9.427	14.1
18.5	17	55	38	65 28.9	9.442	14.1
20.5	16	10	57	68 39.8	9.472	13.3
22.5	14	34	11	67 38.7	9.512	12.0
24.5	13	27	36	64 27.6	9.556	10.6
26.5	12	45	22	60 45.6	9.601	9.4
28.5	12	17	36	57 14.5	9.644	8.3
30.5	11	58	12	54 5.4	9.687	7.7

1903	True α			True δ	$\log \Delta$	Br.
Aug. 1.5	11	43	44	+51 18.8	9.726	7.1
3.5	11	32	21	48 51.6	9.764	6.7
5.5	11	22	50	46 40.4		
7.5	11	14	49	44 41.2	9.832	6.3
9.5	11	7	31	42 50.8		
11.5	11	0	49	41 6.3	9.893	6.3
13.5	10	54	23	39 24.1		
15.5	10	48	12	37 42.9	9.947	6.7
17.5	10	42	2	35 58.0		
19.5	10	35	58	34 7.2	9.996	7.4
21.5	10	29	54	32 7.0		
23.5	10	24	3	29 54.8	0.038	8.2
25.5	10	18	30	27 27.0		
27.5	10	13	31	24 47.3	0.074	7.9
29.5	10	9	20	21 54.6		
31.5	10	5	59	18 53.8	0.100	6.2
Sept. 2.5	10	3	36	15 49.9		
4.5	10	2	1	12° 45' 1"	0.118	4.3
6.5	10	1	8	9 43.1		
8.5	10	0	50	6 45.1	0.132	2.9
10.5	10	1	2	3 50.8		
12.5	10	1	37	1 2.4	0.142	2.0
14.5	10	2	27	— 1 42.8		
16.5	10	3	35	— 4 21.9	0.152	1.5
18.5	10	4	52	— 6 58.7		
20.5	10	6	19	— 9 29.5	0.161	1.1

The unit of brightness is that at the time of observation on June 22.

C. D. PERRINE.

July 14, 1903.

MERIDIAN CIRCLE OBSERVATIONS OF COMET *c* 1903 (BORRELLY)

1903	Mt. Hamilton M.T.			Comet's Apparent			Wt.	$\log p \Delta$
				α	δ			
June 27	15 ^h	24 ^m	27 ^s .9	21 ^h 46 ^m 0 ^s .78	—1° 36' 46".9	4	9.798	
29	15	13	13.7	21 42 37.82	+1 11 22.2	1	9.770	
30	15	7	16.2	21 40 35.89	+2 47 23.2	3	9.753	
July 3	14	47	37.2	21 32 43.29	+8 36 20.1	3	9.681	

The nucleus of the comet was of the brightness of a $9\frac{1}{2}$ magnitude star, during these observations.

R. H. TUCKER.

July 7, 1903.

OBSERVATIONS OF COMET *c* 1903 (BORRELLY)

The following observations of the comet discovered by M. Borrelly were secured with the 12-inch equatorial telescope. $\Delta\alpha$ was measured directly with the micrometer on all nights. At the time of the first observation the comet was estimated equal to an 8th

magnitude star in brightness, with a sharp nucleus of about $9\frac{1}{2}$ to 10th magnitude. A brushy tail could be traced about $\frac{1}{2}^\circ$ in the south preceding quadrant. The comet grew brighter very rapidly and could easily be seen with the unaided eye on June 30th.

1903.	Mt. Hamilton M.T.	Star	No. of Comparisons	Comet—Star		Comet's Apparent		$\log p \Delta$	
				$\Delta\alpha$	$\Delta\delta$	α	δ	α	δ
June	22 ^d 12 ^h 52 ^m 14 ^s	1	10, 6	+22.94	—6' 58.9	21 ^h 51 ^m 39.57	—7° 0' 48.2	<i>n</i> 9.518	0.769
	23 11 35 3	4	10, 6	—10.03	+7 12.1	21 50 52.45	—6 9 51.4	<i>n</i> 9.624	0.749
	23 11 45 30	3	10, 6	—15.97	—0 57.8	21 50 52.08	—6 9 26.0	<i>n</i> 9.610	0.752
	24 12 52 44	6	10, 6	+14.81	+5 16.5	21 49 52.66	—5 8 48.3	<i>n</i> 9.496	0.760
	26 15 33 2	7	8, 6	—1.14	+4 0.9	21 47 24.48	—2 50 29.3	<i>n</i> 7.276	0.752
	30 13 20 50	8	8, 6	+15.04	+1 37.8	21 40 45.87	+2 39 59.1	<i>n</i> 9.320	0.628
July	10 9 21 52	10	8, 6	+10.17	+5 45.9	20 55 46.32	+30 22 7.8	<i>n</i> 9.695	0.494
	12 9 11 36	12	8, 6	—3.14	+7 54.1	20 33 51.14	+39 36 8.0	<i>n</i> 9.723	0.279

MEAN PLACES FOR 1903.0 OF COMPARISON STARS

Star	α	Red. to app. place	δ	Red to app. place	Authority
1	21 ^h 51 ^m 14.19	+2.44	—6° 54' 5.9	+16.6	Micrometer comparison with (2).
2	21 48 50.98	+2.42	—6 58 19.4	+16.6	Vienna A.G. Zones. 2 obs.
3	21 51 5.62	+2.43	—6 8 44.7	+16.5	Vienna A.G. Zones. 2 obs.
4	21 51 0.05	+2.43	—6 17 20.1	+16.6	Vienna A.G. Zones. 2 obs.
5	21 51 16.51	+2.46	—5 13 0.1	+16.5	$\frac{1}{2}$ (Yarnall 9870 + Munich I. 29862).
6	21 49 35.39	+2.46	—5 14 4.8	+16.5	Micrometer comparison with (5).
7	21 47 23.06	+2.56	—2 54 46.5	+16.3	Munich II. 12069.
8	21 40 28.14	+2.69	+2 32 5.9	+15.4	Micrometer comparison with (9).
9	21 39 53.50	+2.69	+2 32 48.5	+15.4	A.G. Albany 7593.
10	20 55 32.98	+3.17	+30 16 9.1	+12.8	Micrometer comparison with (11).
11	20 54 22.80	+3.17	+30 14 54.2	+12.8	$\frac{1}{2}$ (A.G. Leiden 8607 + A.G. Cambridge 11970).
12	20 33 50.97	+3.31	+39 28 1.4	+12.5	A. G. Lund 9550.

R. G. AITKEN.

July 13, 1903.

THE SPECTRUM OF COMET BORRELLY OBTAINED WITH THE CROSSLEY REFLECTOR

A spectrogram of Comet Borrelly was obtained with the small slit spectrograph on July 15th, with an exposure of four hours. The five bands are shown which were photographed by Campbell in Comet *b* 1893 (Rordame)* and in Comet *b* 1894 (Gale.)†

The relative intensities of these bands in the spectrum of Comet Borrelly appear to be the same as in the two earlier comets, after making allowance for the

differences in dispersion and absorption of the two instruments, with the exception of the band at $\lambda 420$. Although this band is one of the strongest in both of the earlier comets it is extremely weak in Comet Borrelly.

The brighter of the bands show evidence of their composite character, although they are not resolved.

Very little continuous spectrum is shown by the photograph.

C. D. PERRINE.

July 16, 1903.

* Astronomy and Astro-Physics, Vol. XII, p. 652.

† Astronomical Journal, Vol. XIV, p. 111.

OBSERVATION OF THE SPECTRUM OF COMET BORRELLY MADE WITH THE THIRTY-SIX INCH REFRACTOR

The spectrum of the Comet Borrelly was observed on July 14 and 15 with Spectrograph I (cf. L. O. Bulletin, No. 8). Visually it showed a relatively strong continuous spectrum and the three characteristic bands. Of these that at $\lambda 4700$ seemed the brightest, while the other two were much fainter.

The attempt was made to secure a photograph of the spectrum with an exposure of six hours, using the same instrument, but the intrinsic brightness of the comet is quite small, and only the merest trace shows on the plate in the region near $\lambda 4700$.

H. D. CURTIS.

July 17, 1903.

PRELIMINARY NOTE ON PHOTOGRAPHIC OBSERVATIONS OF COMET *c*, 1903 (BORRELLY)

Photographic observations of Comet *c*, 1903 (Borrelly), were begun at the Lick Observatory on the night succeeding that of discovery, and are still in progress. Nine exposures ranging in length from thirty-eight minutes to four hours have been made with the Dallmeyer camera of 15 cm. aperture, 82.6 cm. equivalent focal length, and $14^\circ \times 16^\circ$ angular field. Three negatives with the same range of exposure have been obtained simultaneously with the Floyd camera of 13 cm. aperture and 178 cm. focal length.

Two tails, one of which is nearly straight, the other greatly curved, appear on all but the last plate. The curved tail is short and very bright while the straighter tail is relatively fainter and longer but develops some very interesting forms.

On a plate of four hours' exposure on June 23d, the tails are widely separated. The strait tail is narrow at the head, but broadens and extends $1\frac{1}{2}$ degrees. On the plate of June 29th the longer tail has split up into two distinct branches which emerge separately from the head and diverge slightly as they extend into space. With four hours exposure on June 30th the secondary tail appears very bright with a length of $1\frac{1}{2}$ degrees. The primary extends five degrees from the nucleus. The form is indistinct, but the division

of the previous night still persists. One branch remains straight while the other is broader and longer and follows a sinuous curve. On the following night the strait tail is sharp and single.

The plates of July 12th and 13th still show two tails. The primary tail is straight and narrow and the secondary tail still greatly curved. On the plate of July 12th, with 38 min. exposure, the primary tail is four degrees long; the secondary tail is 1.5 degrees in length. The plate of July 14th, 1 hr. 48 min. exposure, shows one straight narrow tail, $8\frac{1}{2}$ degrees in length, widening out slightly as it extends away from the head.

On all the plates the nucleus is sharp and approximately central with respect to the heavy coma.

During these exposures the earth has been approaching rapidly to the plane of the comet's orbit. At the same time the apparent angle between the tails has steadily diminished until, on the plate of July 14th, they are coincident. Measures of the position angles of the tails on two plates are given below. P_a , P_b and P_r represent respectively the position angles of the primary tail, secondary tail, and radius vector from the sun to the comet. The difference $P_a - P_r$ appears in the last column.

No. of plate	Date 1903	P.S.T. of mid-exposure	α	δ	P_a	P_b	P_r	$P_a - P_r$
5	June 30	13 ^h 33 ^m	21 ^h 41 ^m 5	+ 2° 48'	236°0	21°68	238°0	—2°0
7	July 12	8 52	20 34.2	+39 23	197.3	188.0	199.6	—2.3

R. H. CURTISS,
SEBASTIAN ALBRECHT.

July 15, 1903.