

The mean daily areas and numbers of hydrogen absorption markings on the disk as obtained from Kodaikanal records are given in the following table :

	Area in millionths of the Sun's visible hemisphere (uncorrected for foreshortening)					Number				
	North	South	East	West	Total	North	South	East	West	Total
1956										
Jan.-June	2744	1846	2355	2235	4590	17.67	11.56	14.96	14.27	29.23
July-Dec.	3046	2175	2544	2677	5221	17.82	13.49	15.63	15.68	31.31
Whole year (weighted mean)	2882	1997	2442	2437	4879	17.74	12.43	15.26	14.91	30.17

Compared with the previous year there was in 1956 a considerable increase in activity as judged from the areas as well as the numbers of hydrogen absorption markings, the increase in areas being 169 per cent and that in numbers 160 per cent. The noteworthy feature of the distribution of areas in latitude in the northern hemisphere was a pronounced peak of activity in the 25° - 30° zone with a clear secondary maximum at 60° - 65° . In the southern hemisphere too there were two peaks of activity, one in the latitude belt 30° - 35° and the other at 45° - 50° . The activity as judged from hydrogen absorption markings was however less in the southern than in the northern hemisphere, as was also indicated by the limb prominences.

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COMETS (1956)

In 1956 nineteen comets were under observation, including three new ones and five periodic comets, as well as the two annual comets and nine of those mentioned in previous reports.

Comet Schwassmann-Wachmann (1) continued to show large fluctuations in brightness and appearance. Although at a low altitude, it was recorded by Van Biesbroeck at Yerkes in May as a very faint nebulosity, which on July 14 had assumed a stellar appearance. On August 3 at Lick, Jeffers noted the appearance of a round coma 2' in diameter, in which the 17th magnitude nucleus was displaced from the centre. The coma was seen to be 5' in diameter on August 7 but the nucleus had again become prominent by September 3 (Van Biesbroeck) when the total magnitude was estimated at 15. By October the appearance of the comet had again returned to normal.

Comet Oterma was recorded by Jeffers at Lick in August and October and by Miss Roemer at Yerkes on October 3. The nearly stellar image had a magnitude around 18.

1954 e, periodic comet Faye, was last observed on March 16 at Lick, as recorded in the last report. (*Observations 1954 July 25 to 1956 March 16*)

1954 g, periodic comet Schwassmann-Wachmann (2), was observed by Miss Roemer with the Crossley reflector at Lick on May 16 and 29, a year after previous observations and nearly fifteen months after perihelion passage. The comet was exactly on the ephemeris position and showed a nearly stellar image of magnitude 19. (*Observations 1954 July 28 to 1956 May 29*)

1954 h, Baade, continued to show considerable activity in the early part of the year. On February 2, Miss Roemer at Lick reported a well-condensed nucleus in a faint coma ; on long exposures, the nucleus was stellar, of magnitude 16.5,

placed unsymmetrically in the coma, with a jet extending $0\cdot5$ in p.a. 170° and a broad tail $5'$ long at 20° . On March 12, in poor seeing, a similar appearance was still obtained, and was confirmed by van Biesbroeck on the following night. The total magnitude was given as 12.5 on January 3 (Reinmuth, Heidelberg) while Beyer's observations (Hamburg-Bergedorf) showed a decrease from 12.3 on January 2 to 13.4 on April 7.

After conjunction with the Sun, the comet was again observed in the autumn at Yerkes, Van Biesbroeck describing the coma as very diffuse on September 11, while Miss Roemer gives it as moderately condensed on October 5; in both cases the magnitude was estimated at 17. The comet was still under observation in the new year. (*Observations 1954 July 31 to 1956 December, continuing*)

1954 k, Haro-Chavira, was a circumpolar object in the spring months, and has been observed continuously during the year. At Lick in February and March the comet was estimated at magnitude 14 and had a sharply defined nucleus about two magnitudes fainter. On April 1, Van Biesbroeck reported a short tail, which was still apparent in August (Yerkes, Lick) although the comet had by then faded to magnitude 15.5. The tail was only suspected in September, although the well defined nucleus remained easy to measure. On October 24, Miss Roemer at Yerkes reported a short tail $3'$ long at 0° , but by December 30 Van Biesbroeck found only a round coma $25''$ diameter, centrally condensed. The comet continues under observation, but is now fading. (*Observations 1954 December 17 to 1956 December, continuing*)

1955 b, Abell, was observed at Lick during the early months of the year. On February 15 it appeared as a diffuse coma of magnitude 18 and diameter $0\cdot1$ with a faint tail in p.a. 80° . A similar but fainter image was obtained on March 20, while on April 30 a moderately sharp nucleus, magnitude 19.3, was observed, with a faint tail $0\cdot8$ long at 80° . The comet was not found on June 2, and must then have been much fainter than magnitude 19. (*Observations 1955 April 13 to 1956 April 30*)

1955 c, periodic comet Ashbrook-Jackson was again observed in the summer when it had moved out into the morning sky. All reports agree that the object was fainter than the ephemeris predictions and from August to December it remained at about magnitude 17. In October it showed a nearly stellar nucleus (Roemer, Jeffers) with a short faint tail extending south-west. On December 22 (Jeffers) it showed only a small round diffuse image of magnitude 17.5. (*Observations 1955 April 24 to 1956 December 22*)

1955 d, Whipple, was photographed in January (Lick) and February (Yerkes) as recorded in last year's report. (*Observations 1955 May 25 to 1956 February 6*)

1955 e, Mrkos, was photographed at Lick on April 17, the 30-min exposure showing a condensed image of magnitude 17.5. (*Observations 1955 June 12 to 1956 April 17*)

1955 i, periodic comet Perrine-Mrkos, was last photographed in the first week of February with the 20-inch at Lick, but the images could not be measured. (*Observations 1955 October 19 to 1956 February*)

1956 a was the periodic comet Olbers, whose return had been predicted by Rasmusen. It was recovered photographically on January 4 by Antonin Mrkos with the 50-cm reflector of his private observatory at Lomnický štít; the image was described as diffuse, without central condensation, magnitude 16. The comet was thus less bright than had been expected, and this accounts for the failure of previous searches to locate it. Rasmusen's work was based on a complete revision of the motion of the comet since its discovery in 1815, and it was found that a close approach to Jupiter in 1888-9 had reduced the period from 72 to 69 years. Comet Olbers was recovered within $\frac{3}{4}^\circ$ of the predicted position and subsequent observations indicated a correction of +5.5 days to the time of perihelion passage. Pre-recovery positions were subsequently found on a plate taken with the 82-inch at McDonald on November 12 and on a Tokyo plate of January 2.

Miss Roemer, at Lick, described the comet on February 4 as having a sharp nucleus of magnitude 16.3 with a fainter coma 0.4 in diameter. By the end of April the magnitude had reached 14.3 and the coma was somewhat larger. On March 31, Van Biesbroeck at Yerkes reported a condensed coma 4' diameter with an extension in p.a. 85° forming a coarse tail about 5' long, the total magnitude being 9.8. The tail is also reported in a long series of observations by Beyer covering the period March 28 to September 25, and it is clear that the comet became rapidly brighter in the summer. In June-July the total magnitude was less than 7, and during this period a coarse tail could be traced to 1° from the nucleus (Van Biesbroeck). The tail was still visible in early September, but was not mentioned in this observer's report on September 12 (magnitude 9.3) and was not seen by Beyer on September 25. Further observations should be possible in the morning sky in the spring of 1957. (*Observations January 4 to September 25*)

1956 b was the first new comet of the year, and was found visually on March 12 by Antonin Mrkos in the course of a routine search with 25 × 100 Somet-Binar binoculars. The comet moved rapidly north east and observers found it difficult to trace in the first few days after discovery. Van Biesbroeck found it the following day far from the centre of a plate taken with the Ross 3-inch lens, as a diffuse coma 3' diameter, magnitude 9. On March 21 its magnitude was 8.3, and a faint narrow tail 5' long was noted. Beyer made the magnitude somewhat brighter and also mentions the tail. By April 10 the magnitude (Yerkes) had dropped to 11, and this rapid decrease of brightness at the approach to perihelion is noted also in the report by Beyer, who gives a magnitude of 8.8 on March 28 (when $r = 0.892$) and of 10.4 on April 12 ($r = 0.842$).

The comet was last photographed on April 28 at Lick when the image was diffuse and difficult to measure, estimated magnitude about 17.5. A search with the 82-inch reflector at McDonald in early May failed to locate the comet. (*Observations March 12 to April 28*)

1956 c was discovered by C. A. Wirtanen on a plate taken on March 16 with the Lick 20-inch astrographic telescope and confirmed in the same way two days later. The comet was described as diffuse, with central condensation, magnitude 15.5, and a short faint tail was detected. Miss Roemer, using the Crossley reflector, obtained a number of photographs from March 20 to May 28.

Ref.	Comet	T(U.T.)	q	e
(1)	1925 III Reid	1925 July 29·8551	1·633208	0·995069
(2)	1939 III Jurlof-Ach.-Hassel	1939 April 10·1689E	0·528266	0·998482
(3)	1939 V P/Pons-Winnecke	1939 June 22·7216	1·101472	0·669682
(4)	1942 VII P/Oterma	1942 Aug. 21·6942	3·389728	0·144364
(5)	1948 IX P/Ashbrook-Jackson	1948 Oct. 4·7793E	2·311016	0·395537
(6)	1950 VII P/Arend-Rigaux	1950 Dec. 18·9235	1·386497	0·610388
(7)	1951 VI P/Pons-Winnecke	1951 Sept. 8·6114	1·160607	0·653246
(8)	1952 II P/Harrington	1952 Feb. 6·6825	1·599159	0·540813
(9)	1952 IV P/Grigg-Skjellerup	1952 Mar. 11·1414	0·855697	0·703573
(10)	1953 b P/Brooks (2)	1953 Aug. 7·3616	1·866111	0·486654
(11)	1953 f P/Encke	1954 July 2·5200	0·338403	0·847302
(12)	1955 e Mrkos	1955 June 4·1864	0·534786	0·990452
(13)	1954 k Haro Chavira	1956 Jan. 26·9612	4·07392	1·0
(14)	1956 b Mrkos	1956 April 13·6089	0·842360	1·0
(15)		1956 April 13·613	0·8422	1·0
(16)	1956 a P/Olbers	1956 June 15·867p	1·178530	0·930327
(17)	1956 f P/Johnson	1956 July 24·219p	2·25878	0·375060
(18)	1956 g P/Crommelin	1956 Oct. 19·369p	0·743220	0·919153
(19)	1956 i P/Grigg-Skjellerup	1957 Feb. 2·743p	0·855362	0·703635
(20)	1956 e P/Tempel (2)	1957 Feb. 4·949p	1·369473	0·547576
(21)	1956 h Arend-Roland	1957 April 8·1063E	0·316679	1·000178
(22)		1957 April 8·0462	0·316162	1·000204
(23)	1956 c Wirtanen	1957 Aug. 31·2855	4·450686	1·0

REFERENCES AND NOTES TO TABLE OF ELEMENTS

- (1) 1925 III Reid. Stefan Wierziński, *Ź. des Obs.*, **39**, No. 7, p. 124, 1956. This is a correction of the orbit given in *M.N.* **114**, and *UAIC* 1432.
- (2) 1939 IV Jurlof-Achmarov-Hassel. L. Belous, *Ast. Circ. U.S.S.R.* No. 168. Definitive, 358 observations in 12 normals covering a 39 day arc; perturbations Venus to Saturn.
- (3) 1939 V Pons-Winnecke. V. L. Ananjeva, *Pub. Ast. Obs. Kasan*, No. 32. From two apparitions 1933-1939 with perturbations by planets Venus to Saturn.
- (4) P/Oterma. A. Fokin, Unpublished dissertation. Elements from 7 apparitions 1943-1950 with Jupiter and Saturn perturbations; 100 observations in 7 normals.
- (5) 1948 IX P/Ashbrook-Jackson. M. Merslyakova, Unpublished dissertation. 92 observations, 14 months arc, with perturbations by planets Mercury to Saturn.
- (6) 1950 VII P/Arend Rigaux. I. Hasegawa, *UAIC* 1566. 39 observations, January 8 to April 5. Gives predicted orbit for 1957.
- (7) 1951 VI P/Pons-Winnecke. M. P. Candy and J. G. Porter, *B.A.A. Handbook* 1957. Elements of *M.N.* **112**, 342-3, 1952, corrected by 7 observations 1951 Feb.-Oct., with prediction for 1957.
- (8) 1952 II P/Harrington. K. Hurukawa, *N.A.Z.* **10**, 28, 1956. Corrected elements using observations 1951 Oct. 8 to 1952 Apr. 24. A prediction for 1958 is given.
- (9) 1952 IV P/Grigg-Skjellerup. C. Dinwoodie, *B.A.A. Handbook* 1957. Elements of *M.N.* **113**, 390-1, 1953 corrected by 5 observations in 1952.
- (10) 1953 b P/Brooks (2). A. Dubiago, *Ast. Circ. U.S.S.R.* 168. See also reference given below.
- (11) 1953 f P/Encke. G. Makower, *UAIC* 1595. From observations during 5 apparitions, 1937-1954, with perturbations by planets Mercury to Saturn.
- (12) 1955 e Mrkos. I. Hasegawa, *UAIC* 1551. 5 normals, 81 observations, covering a 44 day arc; residuals reach 11" in one case.

Cometary Orbits

Period (years)	ω	Ω	i	Equinox	Epoch of Osculation	Ref.
...	259°2719	5°9892	26°9724	1925°0	...	(1)
6490	89°2480	311°4312	138°1153	1939°0	1939 May 2°0 E.T.	(2)
6°09	169°3489	96°7978	20°1228	1950°0	1939 June 26°0 U.T.	(3)
7°89	354°7883	155°1680	3°9898	1950°0	1943 Oct. 3°0 U.T.	(4)
7°48	348°9042	2°3412	12°5132	1950°0	1948 Sept. 6°0 E.T.	(5)
6°71	326°2713	124°7280	17°1897	1951°0	...	(6)
6°12	170°2266	94°4012	21°6809	1950°0	1951 Aug. 22°0 U.T.	(7)
6°50	186°9033	254°2753	18°4945	1950°0	...	(8)
4°90	356°3294	215°4232	17°6349	1950°0	1952 Mar. 9°0 U.T.	(9)
6°92	195°6918	177°6806	5°5509	1950°0	1953 Aug. 11°0 U.T.	(10)
3°30	185°1991	334°7460	12°3740	1950°0	1954 May 18°0 U.T.	(11)
419°19	32°5590	48°3096	86°4828	1955°0	...	(12)
...	57°3332	72°2549	79°6251	1955°0	...	(13)
...	80°9111	226°0083	147°3481	1956°0	...	(14)
...	81°017	226°117	147°450	1956°0	...	(15)
69°569	64°6362	85°4153	44°6099	1950°0	1956 June 16°0 U.T.	(16)
6°87	205°8998	118°1735	13°8602	1950°0	...	(17)
27°87	196°0472	250°3651	28°8697	1950°0	1956 Oct. 14°0 U.T.	(18)
4°90	356°2974	215°4281	17°6431	1950°0	1957 Jan. 2°0 U.T.	(19)
5°27	191°0129	119°2780	12°4701	1950°0	1957 Feb. 11°0 U.T.	(20)
...	308°7430	215°1454	119°9884	1950°0	...	(21)
...	309°7760	215°1562	119°9615	1950°0	...	(22)
...	12°8833	233°2072	33°1036	1956°0	...	(23)

- (13) 1954 k Haro-Chavira. G. Merton, *UAIC* 1542. 4 pairs of observations Jan. to Sept. 1955. Residuals average 7" for 2 middle places.
- (14) 1956 b Mrkos. G. Schrutka-Rechtenstamm, *UAIC* 1549. No details.
- (15) E. Roemer and A. Mowbray—*ibid.* No details.
- (16) 1956 a P/Olbers. H. Q. Rasmusen, *Pub. Cop. Obs.* No. 147, 20. Predicted elements based on those of 1815 and 1887; 24 normals with perturbations by all planets. Observations indicate $\Delta T = +5.35$ days.
- (17) 1956 f P/Johnson. W. H. Julian and B. O. Wheel, *B.A.A. Handbook* 1956. Observations indicate $\Delta T = +2.4$ days.
- (18) 1956 g P/Crommelin. M. P. Candy and J. G. Porter, *B.A.A. Handbook* 1956. Predicted elements based on those of *M.N.* 116, 226–7, Ref. (1). Observations indicate $\Delta T = +5.86$ days.
- (19) 1956 i P/Grigg-Skjellerup. C. Dinwoodie, *UAIC* 1562 and *B.A.A. Handbook* 1957. Prediction derived from elements of Reference 9 above. Observations indicate $\Delta T = -0.15$ days.
- (20) 1956 e P/Tempel (2). R. Luss, *B.A.A. Handbook* 1956. Prediction based on the elements of *M.N.* 112, 243–3, 1953. These were corrected for observations before applying perturbations by Jupiter and Saturn. Observations indicate $\Delta T = +0.1$ day.
- (21) 1956 h Arend-Roland. M. P. Candy, *UAIC* 1585. 76 observations arranged in 6 normals covering 1956 Nov. 7–1957 Jan. 26.
- (22) 1956 h Arend-Roland. J. Kovalevsky, *UAIC* 1591. 48 observations, 1956 Nov. 18 to 1957 Jan 23. The discrepancy of 1° in ω between these two orbits needs investigation.
- (23) 1956 c Wirtanen. E. Roemer and A. G. Mowbray, *UAIC* 1555. Based on 3 observations March 20, April 2, April 30.

The appearance of the comet remained almost unchanged, with a nucleus of magnitude 16.5 surrounded by a slightly unsymmetrical coma about 20" diameter and with a faint persistent tail in p.a. 300°. A similar description is given from Yerkes by Van Biesbroeck who last saw the comet on June 2 before its conjunction with the Sun.

The comet was nearly 5 a.u. from the Earth at the time of discovery, and will not reach perihelion (with a large perihelion distance of 4.5) until August 1957. (*Observations March 16 to June 2*)

1956 d was reported by Martynov (Engelhardt) as having been discovered by Tcherepashtshuk, but this object has not been confirmed.

1956 e, periodic comet Tempel (2), was recovered by Van Biesbroeck using the 82-inch reflector at McDonald Observatory on May 5. The comet, of magnitude 19, was exactly in the place predicted by R. Luss in the *B.A.A. Handbook*, but it is badly placed for observation and no other reports have been received. (*Observed May 5*)

1956 f, was the second apparition of periodic comet Johnson 1949 II. It was recovered by J. A. Bruwer at Johannesburg, using the Franklin Adams astrographic telescope of the Union Observatory, on August 6. The magnitude of the comet was then 13.5, which is close to the limit for the F.A. camera, and the comet was followed at Johannesburg only until September 12. It was recorded at Yerkes by Van Biesbroeck on September 3 and 8 as a fairly well defined coma about 20" diameter; the magnitude was estimated at not brighter than magnitude 15, but the object was then at low altitude.

Miss Roemer photographed the comet at Yerkes on September 28 and October 1, and again on October 28, by which time the magnitude had become 17.8 and the image appeared as a weak diffuse spot about 0.4 diameter on 20-minute exposures. (*Observations August 6 to October 28*)

1956 g, periodic comet Crommelin, was recovered on September 29 by Mrs. Ludmilla Mrkosová-Pajdušáková at Skalnaté Pleso Observatory during a visual search with the 25 × 100 Somet-Binar binoculars. The comet was then of magnitude 10, and in view of the prolonged searches which had been made at many observatories, must be regarded as much fainter than was expected.

The early observations indicated a correction of +5½ days to the predicted time of perihelion. The prediction was based on a correction of the 1928 orbit using the few observations available. The comet has been a diffuse object at previous returns and accurate observations rare. On this occasion the nucleus appears well condensed, and it is to be hoped that the observations secured at this apparition may enable an improved orbit to be computed.

Miss Roemer found the comet conspicuous visually in the 24-inch reflector at Yerkes on October 3. Photographs showed a well condensed centre to a coma nearly 1.5 in diameter, with a suggestion of a very narrow tail extending about 3' in p.a. 300°. Similar appearances were given by plates taken on other nights during the month; in all cases the nucleus, of about magnitude 14, was surrounded by an unsymmetrical coma.

The comet was also photographed at Johannesburg on November 7, magnitude 7.3, and at Cordoba on November 10. The last observation reported comes from Bosque Alegre on November 29. (*Observations September 29 to November 29*)

1956 h, Arend-Roland, was found on two 30×30 cm Kodak 103 aO plates taken with the twin astrograph at Uccle on November 8 during routine observations of asteroids. The comet was then a tenth magnitude object, but the first reliable orbits showed promise of a considerable increase in brightness as the comet approached perihelion in 1957 April. Observations by Beyer at Hamburg-Bergedorf and by Jeffers at Lick showed a progressive brightening by 1^m by the end of 1956, while Van Biesbroeck at Yerkes on December 27 noted a short tail $8'$ long in p.a. 51° . The more accurate orbits computed from the many observations that became available showed that the motion is definitely hyperbolic. (*Observations November 8 to end of year, continuing*)

1956 i, periodic comet Grigg-Skjellerup, was recovered on December 29 by K. Tomita at Tokyo, estimated magnitude 14. It was observed by Van Biesbroeck at low altitude on December 30 and again in the early days of January by Tomita, but the object was diffuse and measurements uncertain. No other information is available. (*Observations December 29, continuing*)

Unsuccessful searches were made during the year at Yerkes, Lick and Johannesburg for periodic comet Schajn-Shaldach; negative reports were also received of periodic comets d'Arrest (Yerkes and Lick) and Taylor (Yerkes), and of comets 1955 f, 1955 g and 1955 i (Lick).

The numerical designation of comets (in order of perihelion passage) has been extended by the I.A.U. Bureau (*UAIC* 1580). The list that follows continues that given in *M.N.* **116**, 225, 1956. The perihelion dates (T) are from orbits noted in these annual reports.

Comet	T	Name	Year and letter
1953 I	Jan. 5.4	Harrington	1952 e
II	Jan. 24.9	Mrkos	1952 f
III	May 26.4	Mrkos-Honda	1953 a
IV	June 8.7	P/Borrelly	1954 b
V	Aug. 7.3	P/Brooks (2)	1953 b
VI	Sept. 22.4	P/Harrington	1953 e
VII	Dec. 25.9	P/Finlay	1953 i

The table giving the elements of cometary orbits is arranged as in last year's report. Comets are listed in order of perihelion date, which is normally given in U.T.; the symbol E indicates that the computer has used Ephemeris Time. A periodic comet is denoted by the symbol $P/$, and predicted elements by p after the perihelion date. Notes on each comet follow the table.

ADDITIONAL NOTES

Individual Comets

P/Halley. M. Kamienski, "Halley's Comet in 2320 B.C." *Acta Astr.*, **6**, (1) 3, 1956.

P/Wolf (1). M. Kamienski, *Acta Astr.* **6**, (2), 74 and **6**, (4), 153, 1956.

P/Encke. S. K. Vsessviatsky "On the change of brightness of Comet Encke-Backlund", *Pub. Kiev. Obs.* (7), 31, 1956. S. G. Makower, *Trans. Inst. Theor. Astr.* VI, 67, 1956. The mass of Mercury is found ($1/m = 628000 \pm 350000$) from observations of Encke's comet in 1937-1954.

1949 VI P/Schajn-Shaldach. A. Dubiago, *A. J. (U.S.S.R.)*, **33**, 382. Definitive elements (see *M.N.* **116**, 226, 1956) and prediction for 1957 using Ephemeris Time. A German abstract is given.