COMETS (1958)

Thirteen comets were under observation during 1958, but none of these was brighter than eighth magnitude. In addition to the two comets of small eccentricity which are observed annually, there were two new comets, three periodic comets whose return had been predicted, and six previous discoveries. Reports of observations have been unusually few during the year, the lion's share of the work being done by Dr Elizabeth Roemer, using the 40-inch reflector of the U.S. Naval Observatory at Flagstaff, Arizona. This instrument is very favourably placed for the observation of faint comets, and Miss Roemer's contributions to this work are of the very first importance. Extensive observations are also made by Van Biesbroeck at Yerkes and McDonald Observatories and by Jeffers at Lick, but otherwise comets are very much neglected. There is, however, considerable observational research on comets in the U.S.S.R., and in 1958 positions or physical measurements of seven comets are given for ten observatories in the Russian *Astronomical Circulars*.

Comet Schwassmann-Wachmann 1925 II was recorded at Flagstaff, Lick and McDonald, and has continued to show fluctuations of structure and brightness. On August 12 it had a sharp nucleus with only a faint coma, but on August 15 the nucleus appeared diffuse with a broad fan extending to 10″ from the nucleus, total magnitude 13·5. By September 12 the magnitude was near 18, and the coma diffuse, but on September 22 the image was nearly stellar, magnitude 15, with only the faintest trace of coma. There was another outburst at the end of November (Van Biesbroeck), confirmed by a series of photographs at Flagstaff, when the total magnitude reached 14·0, which is three magnitudes above normal brightness. At the beginning of December the coma was more than 1′ in diameter with a clearly defined nucleus, but by December 10 the comet had faded noticeably. On December 4 N. U. Mayall obtained a spectrogram of the comet using the Crossley reflector at Lick; the spectrum was of the solar type with no emission features.

Comet Oterma, 1942 VII, has remained as a faint object throughout the present period. It was photographed at McDonald and Flagstaff in January, when it had a short tail, and again in April when it had a well condensed nucleus of magnitude 18; this is confirmed by photographs at Lick in April and May. At the end of the year it was again photographed at Flagstaff and was then of magnitude 18·8 with a trace of a tail to the N.W. Several papers of outstanding interest on the subject of this comet have recently appeared. Dr Liisi Oterma of Turku, Finland, has computed a definitive orbit for this comet (which is the third of three comets which she herself discovered in 1942–1943) and has studied its past history and future behaviour. It appears that the present 8-year period resulted from a prolonged approach to Jupiter in the period 1936–1939, when the comet's distance from the planet decreased to 0·17 unit. The previous orbit had a period of 18 years, with a perihelion distance of 5·65 a.u. as compared with the present 3·40 a.u. The circumstances will repeat themselves in the years 1962–1964, and this time the closest approach to Jupiter will be 0·095 a.u. in 1963 April. As a result, the comet's orbit will be enlarged once more, with an increased eccentricity and a period of 19 years. A paper on the same subject by A. Fokin in *Bull. Inst. Theor. Astr.* (Leningrad) **7**, (2), also gives a definitive orbit and carries the perturbations back to 1936. The original orbit is stated to have had a period of 23 years.

Some idea of the changes in the orbital elements may be gained from the following approximate values, derived from Oterma's papers:

	a	e	π	Ω	i	Period
1934	6·86	0·18	283°	35°	3°	18·0 years
1950	3·97	0·14	150	155	4	7·9 ,,
1965	7·17	0·25	23	333	2	19·2 ,,

Since the perihelion distance in the future orbit will be as much as 5·35 a.u. it is certain that this faint comet will be lost to moderate instruments after 1962. It is to be hoped that the largest telescopes will be able to follow its departure from the present orbit.

1954k, Haro-Chavira, was under observation at Flagstaff from February to May. On May 15 the comet was near opposition, at a heliocentric distance of 7·7 a.u., and appeared on 90-min exposures as a weak nearly stellar nucleus of magnitude 20·9; there was a very faint nebulosity about 0′·5 diameter.
(*Observations* 1954 *December* 17 *to* 1958 *May* 15)

1956 c, Wirtanen, continued to show a double nucleus throughout the year. In January (McDonald) and February (Flagstaff) the nuclei were separated by about 20″ and were of magnitudes 16·5 and 18. At both stations and at Lick a faint tail was reported in April and this continued to be present until the end of July. In April and May there seems to have been an emission of material from the sunward side of the primary nucleus. By the end of the year the nuclei had separated to about 25″, and were last photographed at Flagstaff on December 11 at low altitude, magnitudes 18·5 and 19·0. The comet should be observable in the spring of 1959 after conjunction.
(*Observations* 1956 *March* 16 *to end of* 1958, *continuing*)

1956 h, Arend-Roland, was photographed on January 25 by Van Biesbroeck, using the 82-inch reflector at McDonald Observatory. The comet was estimated at magnitude 20 and showed a faint coma. Photographs at Flagstaff in January and March were made under conditions of poor seeing, but on April 11 exposures of 90-mins gave measurable images of magnitude 21·0.
(*Observations* 1956 *November* 8 *to* 1958 *April* 11)

1957 d, Mrkos, was well south of the equator, and observations in the northern hemisphere were difficult. In such circumstances reports from southern observatories are always welcome, and in this connection it is gratifying to be able to correct an error in last year's report on this comet. Observations were made at the Perth Observatory from 1957 August 30 to October 21, and the positions obtained appear in *UAIC* 1629. These accurate positions will be most valuable, and it is to be hoped that the observers at Perth will be able to continue with such work.

Comet Mrkos was observed at Johannesburg on 1958 February 21 and March 2, but all other reports come from Van Biesbroeck (McDonald, January 27), Jeffers (Lick, April 26), or Miss Roemer (Flagstaff, February 17–July 19). The comet faded from about magnitude 16 at the beginning of the year. In April and May it had a well-condensed nucleus (magnitude 18) with an unsymmetrical coma of about 0′·2 diameter. Conditions for observation, with the comet in declination −31°, were far from ideal; the last photographs were taken on July 9, when the magnitude on 60-min exposures was estimated at 19·0.
(*Observations* 1957 *July* 29 *to* 1958 *July* 9)

1957 e, P/Reinmuth (1), was photographed at Flagstaff and McDonald in January; it then appeared as a somewhat diffuse coma about 0′·1 diameter, magnitude 18. In April (Lick) the appearance was that of a diffuse spot of magnitude 18·5; there was still a faint trace of coma surrounding a nearly stellar nucleus, magnitude 18·8, on May 15 (Flagstaff).
(*Observations* 1957 *September* 20 *to* 1958 *May* 15)

1957 g, P/Harrington (1), was again observed after perihelion passage in August. At McDonald the comet had a faint narrow tail 1′ long on the west side of a diffuse nucleus. At Flagstaff the nucleus appeared more strongly condensed, but the tail was also reported and the same general appearance continued during succeeding months, as the comet faded from magnitude 16·5 to about 18·6.
(*Observations* 1957 *November* 18 *to end of* 1958, *continuing*)

1958 a was discovered by Robert Burnham Jr., an amateur of Prescott, Arizona, on February 21–22, as mentioned in last year's report. Burnham was using a new 8-inch reflector at his home, and at once notified the Lowell Observatory, whose co-operation enabled Miss Roemer to photograph the comet within two hours of the discovery.

The visual magnitude of the comet at the time of discovery was about 9, but it was much fainter than this photographically. Observations were widely made in Europe and the U.S.A. At Heidelberg, Richter gave the total brightness as magnitude 9·1 in March, 8·5 to 8·8 in April, and this agrees with the customary careful observations of Max Beyer at Hamburg–Bergedorf. Using a law of the type $m=H_0+2{\cdot}5n \log r+5 \log \Delta$, Beyer finds from 25 observations over the period April 6 to June 18 that $H_0=6{\cdot}72\pm0{\cdot}27$ and $n=7{\cdot}36\pm0{\cdot}74$. Thus even a sixth-power law would be inadequate to represent the changing brightness of this comet. We seem to be as far as ever from a solution of the problem of the luminosity of comets, and this is undoubtedly due to a lack of observational material.

The comet was followed at Flagstaff until September. In its early stages (March 10) it had a centrally condensed coma about 2′·5 diameter with a narrow straight tail 12′ long directed eastwards. The tail was still visible in mid-May, when the total brightness reached magnitude 8·2 and the well-defined nucleus was surrounded by a coma of 4′ diameter (Van Biesbroeck). The comet faded rapidly after this and had reached magnitude 17 on August 20 (McDonald) and 19 on September 15 (Flagstaff).

A Sonneberg Sky Patrol plate taken on February 10 was found to contain a pre-discovery image.
(*Observations February* 10 *to September* 15)

1958 b, periodic comet Arend–Rigaux, was recovered by Dr Roemer on January 29 on the second of a series of search plates centred at $\Delta T = +2^{d}$ and $+5^{d}$ from Candy's ephemeris in the *B.A.A. Handbook*. The stellar image was confirmed on later plates, and the faint comet (magnitude 19 at recovery) was followed until June 7. The magnitude was then 20·5, and the comet was not found on a 90-min exposure on July 8. The comet at the time of recovery was well past perihelion, and observations indicate that Haségawa's predicted orbit in *UAIC* 1566 was in error by only $\Delta T = -1 \cdot 5$ days.
(*Observations January* 29 *to June* 7)

1958 c, periodic comet Wolf (1), is the object of continuous research by Kamienski, and its recovery on June 13 is particularly gratifying. Exposures of 90 mins at Flagstaff during May had failed to locate the comet, but at the suggestion of Dr Roemer, a pair of plates was taken by W. A. Baum with the 200-inch telescope at Palomar, centred on positions computed by Roemer. Both plates showed the stellar image of the comet, magnitude 20·4, and subsequent plates at Flagstaff confirmed the recovery. In September the comet was in a rich star-field, but plates taken in October show probable images of the comet. Two good exposures of 90-mins on November 9, using 103a-D plates developed in metol sulphite showed no trace of the comet, which was then moving clear of the Milky Way. Kamienski's ephemeris of P/Wolf (1) was in error by only $0^{s} \cdot 3$ and $1''$, and it is hoped to locate it again in the autumn of 1959.
(*Observations June* 13 *to October* 14 (?))

1958 d, periodic comet Kopff, was recovered on the nights of June 25–26 by Dr Roemer at Flagstaff. The comet, photographed at low altitude through the branches of a tree, showed a diffuse image not fainter than apparent magnitude 18·8. It was photographed in July (Flagstaff), August (McDonald and Lick) and September (Lick), and displayed a round coma $0' \cdot 3$ in diameter, magnitude 18·5. By October it had faded below 20th magnitude and the images on plates taken in November and December at Flagstaff were very diffuse and nearly at the plate limit; the estimated magnitude was 21·6.

The recovery of this comet is a matter of some importance. The close approach to Jupiter in 1954 caused serious changes in the orbit, the line of nodes being moved through 130°, so that the orientation of the plane of the orbit is completely altered. Although the orbit remains of the same size and shape, and the longitude of perihelion is little changed, the new orbit is inclined at nearly 11° to the old one. Kepinski's careful work on this comet has been rewarding, and emphasises once again the necessity of using accurate initial elements in such cases of close approach to Jupiter. It is also clear that a suitable perturbation method must be used; Kepinski's prediction was within 10^{s} and $1'$ of the observed position of the comet, and this can only be due to the particular care with which he computed the perturbations. He writes that he proposes to recompute them,

using intervals decreasing to 1·25 days in a Jovicentric system, in order to link the three apparitions of 1945, 1951 and 1958.
(*Observations June* 25 *to December* 4)

1958 e was the second new comet of the year, and was discovered by Robert Burnham Jr. and Charles D. Slaughter on a plate taken on September 7 with the 13-inch telescope at Lowell Observatory in the course of a systematic survey of proper motions in the northern hemisphere. The first plates of this survey were made in the autumn of 1929, forming part of the programme for the discovery of Pluto in 1930, and continuing so as to cover the entire sky with this instrument. It is to be noted that the first cometary discovery of 1959 was also due to these two young astronomers working on the same proper-motion survey.

Comet 1958 e was a diffuse object of magnitude 14 at the time of discovery; it had a well condensed nucleus with a coma 0′·7 diameter and a short tail pointing south of east. The tail was also visible in October, but by November 10 the comet had merely a strong nuclear condensation set off-centre in a round coma. The comet was brighter in December, with a nucleus of magnitude 15·8 (Roemer) and total brightness (Van Biesbroeck) 13·5, the observations being made at low altitude. Systematic observations of position were also made during this period by observers at Skalnaté Pleso.
(*Observations September* 7 *to end of year, continuing*)

Unsuccessful searches were made during 1958 for the following comets :

P/du Toit-Neujmin-Delporte. Skalnaté Pleso (July 11, 12 to magnitude 17); McDonald (10-inch Cooke lens, August, to magnitude 16); Palomar (48-inch Schmidt, April 13); Lowell (13-inch, July, September to magnitude 16); Johannesburg (May, June, July, October).

1957 f, Latyshev-Wild-Burnham. Flagstaff (January, February to magnitude 19); McDonald (January, February); Johannesburg (February).

P/Harrington-Wilson. Flagstaff (February to magnitude 19); Palomar (48-inch Schmidt, April 12–13 to magnitude 20).

P/Ashbrook-Jackson. Flagstaff (February 11 to magnitude 20–21).

P/du Toit (1). Flagstaff (December and in 1959, continuing).

The numerical designation of comets (in order of perihelion passage) has been extended by the I.A.U. Bureau (*UAIC* 1662). The list that follows continues that given in *M.N.* **118,** 399, 1958. The perihelion dates (T) are from orbits noted in these annual reports.

Comet	T	Name	Year and letter
1955 I	Feb. 27·1	P/Schwassmann-Wachmann (2)	1954 g
II	Mar. 4·6	P/Faye	1954 e
III	June 4·2	Mrkos	1955 e
IV	July 11·5	Bakharev-Macfarlane-Krienke	1955 f
V	Aug. 4·1	Honda	1955 g
VI	Aug. 13·2	Baade	1954 h
VII	Sept. 27·4	P/Perrine-Mrkos	1955 i
VIII	Nov. 29·8	P/Whipple	1955 d

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Elements of

Ref.	Comet	T (U.T.)	q	e
(1)	1931 II P/Encke	1931 June 3·1136*E*	0·331867	0·849786
(1)	1934 III P/Encke	1934 Sept. 15·2816*E*	0·331861	0·849806
(1)	1937 VI P/Encke	1937 Dec. 27·7538*E*	0·332391	0·849604
(1)	1941 V P/Encke	1941 Apr. 17·1513*E*	0·341369	0·846175
(2)	1941 VII P/du Toit-Neujmin-Delporte	1941 July 21·2208*E*	1·305008	0·582987
(3)	1942 VII P/Oterma	1942 Aug. 22·1947	3·389461	0·144431
(4)	1945 V P/Kopff	1945 Aug. 11·2676	1·495674	0·556076
(1)	1947 XI P/Encke	1947 Nov. 26·3263*E*	0·341026	0·846290
(5)	1948 VIII P/Forbes	1948 Sept. 16·1212*E*	1·545253	0·552716
(6)	1948 XII P/Honda-Mrkos-Pajdušáková	1948 Nov. 17·7086*E*	0·559024	0·814293
(7)	1949 V P/Väisälä	1949 Nov. 11·2782	1·752058	0·635232
(8)	1953 I Harrington	1953 Jan. 5·4170	1·664975	0·995947
(9)	1953 VI P/Harrington (2)	1953 Sept. 22·1628	1·694081	0·536031
(6)	1954 III P/Honda-Mrkos-Pajdušáková	1954 Feb. 5·1067*E*	0·555646	0·815126
(10)	1954 IV P/Van Biesbroeck	1954 Feb. 20·8099*E*	2·414935	0·550031
(11)	1955 VIII P/Whipple	1955 Nov. 29·6926	2·449952	0·355800
(12)	1956 b Mrkos	1956 Apr. 13·6092*E*	0·842240	1
(13)	1956 c Wirtanen	1957 Sept. 2·338	4·44611	1·00086
(14)	1958 b P/Arend-Rigaux	1957 Sept. 8·29*p*	1·38539	0·61070
(15)	1958 d P/Kopff	1958 Jan. 20·077*p*	1·516199	0·556223
(16)	1958 a Burnham	1958 Apr. 16·3041*E*	1·322625	1
(17)	1957 g P/Harrington (1)	1958 Aug. 11·830*p*	1·604438	0·539881
(18)	1958 e Burnham-Slaughter	1959 Mar. 11·527*E*	1·628380	1
(19)	1958 c P/Wolf (1)	1959 Mar. 21·824*p*	2·506895	0·394754
	Predicted orbit			
(20)	P/Encke	1961 Feb. 5·583*p*	0·339017	0·847056

References and Notes to Table of Elements

(1) P/Encke. S. Y. Luchich, *Bull. Inst. Theor. Astr.* (Leningrad), **7**, (2), 1958. Definitive elements.

(2) P/du Toit-Neujmin-Delporte. B. G. Marsden, *UAIC* 1652. From 24 Uccle observations 1941 August 19–October 12, confirming the definitive elements of N. F. Boeva (*M.N.*, **111**, 242, 1951)

(3) P/Oterma. A. V. Fokin, *A.J.* (*U.S.S.R.*), **35**, 675, 1958. From 127 observations 1943–1950 at 7 oppositions, Jupiter and Saturn perturbations included. See also *Bull. Inst. Theor. Astr.* (Leningrad), **7**, (2), 1958.

(4) P/Kopff. F. Kepinski, *Acta Astr.*, **7**, (2), 1957. Definitive.

(5) P/Forbes. B. G. Marsden, *MS*. From 13 observations 1948 May 4 to October 2 in 5 normals, assuming the period given by Cripps; Jupiter perturbations included.

(6) P/Honda-Mrkos-Pajdušáková. B. G. Marsden, *MS*. From 19 observations 1948 December 7 to 1949 January 10 and 28 observations 1954 January 28 to April 1.

(7) P/Väisälä. L. Oterma, *MS*.

(8) 1953 I, Harrington. J. E. Forbes, H. Spinrad and D. B. Wood, *A.J.*, **63**, 510, 1958. Improved orbit from 3 observations, comparison with 15 others; arc of 292 days, Jupiter perturbations.

(9) P/Harrington (2). C. Dinwoodie, *MS*. Improved orbit, using 5 observations 1953 August 15 to December 10,

Cometary Orbits

Period (years)	ω	☊	*i*	Equinox	Epoch	Ref.
3·28	184°·9133	334°·8974	12°·5633	1950·0	1931 June 28·0 E.T.	(1)
3·28	184·9452	334·8823	12·5604	1950·0	1934 July 22·0 E.T.	(1)
3·29	184·9393	334·8810	12·5488	1950·0	1937 Nov. 30·0 E.T.	(1)
3·31	185·1599	334·7634	12·3505	1950·0	1941 Feb. 15·0 E.T.	(1)
5·54	69·3394	229·6123	3·2604	1950·0	...	(2)
7·89	354·7883	155·1679	3·9898	1950·0	1943 Oct. 3·0 U.T.	(3)
6·18	31·5393	253·1185	7·2228	1950·0	1945 July 4·0 U.T.	(4)
3·30	185·1820	334·7502	12·3524	1950·0	1947 Oct. 22·0 E.T.	(1)
6·42	259·7387	25·4443	4·6207	1950·0	1948 Sept. 6·0 E.T.	(5)
5·22	184·1047	233·0918	13·1632	1950·0	1948 Nov. 25·0 E.T.	(6)
10·53	44·3340	135·4651	11·2804	1950·0	1949 Feb. 13·0 U.T.	(7)
8326·5	191·6307	220·7322	59·1201	1953·0	1953 Jan. 23·0 U.T.	(8)
6·98	219·3820	136·6205	11·6009	1950·0	...	(9)
5·21	184·1410	233·0836	13·1950	1950·0	1954 Jan. 18·0 E.T.	(6)
12·43	134·3373	148·9757	6·5905	1950·0	1954 Sept. 25·0 E.T.	(10)
7·42	190·4345	188·5091	10·2507	1950·0	as *T*	(11)
...	81·0098	226·1081	147·4555	1956·0	...	(12)
...	13·263	232·944	33·200	1950·0	...	(13)
6·71	326·405	124·648	17·200	1950·0	1957 June 15·0 U.T.	(14)
6·32	161·7203	120·9975	4·7078	1950·0	1957 Jan. 2·0 U.T.	(15)
...	16·4596	150·6178	15·7920	1958·0	...	(16)
6·51	187·0288	254·2266	18·4790	1950·0	1958 Sept. 24·0 U.T.	(17)
...	100·7334	323·2066	61·2598	1959·0	...	(18)
8·43	161·0780	203·9045	27·2975	1950·0	1959 Mar. 13·0 U.T.	(19)
3·30	185·2271	334·7214	12·3597	1950·0	1960 Dec. 12·0 U.T.	(20)

(10) P/Van Biesbroeck. G. Van Biesbroeck, *A.J.*, **63,** 500, 1958. Definitive, with predicted elements for 1966.

(11) P/Whipple. C. Dinwoodie, *MS*. Improved orbit, using 6 observations, 1955, comparison with 22 others.

(12) 1956 b, Mrkos, B. G. Marsden, *B.A.A.J.*, **68,** 124, 1958. From 32 observations 1956 March 13 to May 5 in 4 normals.

(13) 1956 c, Wirtanen. I. Haségawa, *UAIC* 1665. Observations 1956 March to 1958 November; no perturbations.

(14) P/Arend-Rigaux. I. Haségawa, *UAIC* 1566. Observations suggest $\Delta T = -1{\cdot}5$ days.

(15) P/Kopff. F. Kepinski, *Acta Astr.*, **8,** (4), 1958. Predicted elements derived from the 1951 orbit with perturbations by six planets.

(16) 1958 a, Burnham. B. G. Marsden, *UAIC* 1651. From 3 observations, arc of 31 days.

(17) P/Harrington (1). J. Kordylewski, *Acta Astr.*, **8,** (2), 1958; perturbations by Jupiter and Saturn.

(18) 1958 e, Burnham-Slaughter. M. P. Candy, *UAIC* 1661. From 3 observations September 7, October 4, November 4.

(19) P/Wolf (1). M. Kamienski, *Acta Astr.*, **7,** (1), 1957.

(20) P/Encke. S. G. Makower, *MS*. Based on the elements of *B.A.A. Handbook* 1957 with perturbations Mercury to Saturn.

The elements of cometary orbits recently computed are tabulated on pp. 442/443 in order of perihelion passage *T*. Ephemeris Time has been used in those cases marked *E*; all other times are in U.T. The symbol *p* indicates predicted elements only.

Additional Notes

Individual Comets

P/Halley. M. Kamienski, *Acta Astr.* Vol. 8. The past history of the comet is considered in relation to historical references.

P/Wolf (1). M. Kamienski, *Ibid.*

P/Oterma, 1942 VII. A. V. Fokin, *Bull. Inst. Theor. Astr.* (Leningrad), **7,** (2), and *A. J.* (*U.S.S.R.*), **35,** (4). The references to the papers of L. Oterma were given in last year's report.

P/Schwassmann-Wachmann (1). E. Roemer, *P.A.S.P.*, **70,** 272, 1958. An account of the outbursts of this comet.

P/Encke. S. Y. Luchich, *Bull. Inst. Theor. Astr.* (Leningrad), **7,** (2). The author shows that the secular acceleration of Comet Encke cannot be explained on Mokhach's hypothesis that it may be due to systematic errors of observation.

P/du Toit-Neujmin-Delporte. A. S. Sochilina, *Bull. Inst. Theor. Astr.* (Leningrad), **6,** (9). See *M.N.*, **118,** 397, 1958, reference (16).

1956 h, Arend-Roland. G. Larssen–Leander, *Ark. für Astr.* Bd 2, (23), 259, 1958. (*Stockholm Medd.* 111). Physical observations of the comet with some excellent photographs and bibliography.

General

Computers of the Warsaw and Cracow observatories, under the direction of Kamienski, are investigating the orbits of periodic comets Perrine-Mrkos, Harrington (1) 1952 II, Grigg-Skjellerup and Giacobini-Zinner. In the U.S.S.R., Galibina has investigated the original and future orbits of some long-period comets: *Bull. Inst. Theor. Astr.* (Leningrad) **6,** (9). Both Vsessviatsky and Orlov have published books on comets (in Russian) during the year. Vsessviatsky, Babuch and Kazutinsky discuss the capture theory of the origin of short-period comets in *A. J.* (*U.S.S.R.*) **35,** (3); they conclude that the hypothesis is inconsistent with the observed distribution of orbits. Steins has derived criteria governing the capture of comets from a parabolic orbit, assuming plane motion: *A. J.* (*U.S.S.R.*), **35,** (1)

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