

Doppler displacements of the $H\alpha$ line in prominences were observed on 148 occasions with the prominence spectroscop. In 38 cases the shifts were towards the red side, in 67 cases towards the violet side, while the rest showed displacements in both directions. The following table gives particulars of prominences which showed the largest displacements:—

Date	Coordinates of prominence	Doppler displacement observed
1947 May 13	W. Limb— $16^{\circ}5$ N.	6.0 A. towards red.
1947 May 16	E. Limb— $22^{\circ}5$ N.	6.0 A. towards red.
1947 Aug. 8	W. Limb— 43° S.	6.0 A. towards violet.

Observations with the spectrohelioscope in $H\alpha$ line showed Doppler displacements in prominences in 35 cases, 10 of which were towards the red, 11 towards the violet and the remaining in both directions.

The mean daily area of hydrogen absorption markings (without applying fore-shortening correction) computed from $H\alpha$ spectroheliograms is 7357 millionths of the Sun's visible hemisphere, representing an increase of 50 per cent over the previous year's mean value. The latitudinal distribution shows a principal maximum in the zone 25° – 30° in both the hemispheres, with secondary maxima between 55° – 60° N. and 65° – 75° S.

A. K. DAS.

COMETS

The year 1947 was a record one for comets, and ended with a brilliant though brief display—but only for those in the south—by the brightest comet since 1910, the year of Halley's comet and the great daylight comet 1910 I. No less than twenty-one comets were under observation during the year under review, including eight new ones but excluding one reported but not confirmed.* Three of the new ones were discovered by Michiel Johan Bester at the Boyden Station of the Harvard College Observatory, at Bloemfontein, in the course of his daily inspections of all plates after development; and Hamilton M. Jeffers at the Lick Observatory was first in detecting three of the five periodic comets whose return to perihelion had been predicted.

Observations of six of the previous year's comets were continued in 1947. Timmer's comet 1946 a was recovered by Jeffers on June 24 (19^m) and followed by him till August 9 (19^m). The periodic comets Giacobini-Zinner 1946 c and Brooks (2) 1946 e, were recorded (18^m) by him on January 24, and Tempel (2) 1946 b by G. van Biesbroeck at the Yerkes Observatory on January 15, while both Jones's comet 1946 h and Bester's 1946 k, though very faint, were still being followed at the end of 1947.

In addition to these, the two "annual" period comets, Schwassmann-Wachmann (1) and Oterma, were again recorded at around opposition. As they are being followed year by year round their orbits, they are not now included in the annual letter designations for comets. Schwassmann-Wachmann (1), = 1925 II, photographed (19^m) by Van Biesbroeck and Jeffers early in the year, was recovered by Van Biesbroeck with the 24-inch reflector ($f/4$) at the Yerkes Observatory on October 21 (18^m); and Oterma, 1943 a = 1942 VII, was detected by

* *Added in press*: The numbers of discovered and observed should be increased by one, since the comet designated 1948 a was actually first found by Antonín Mrkos in 1947 on December 20 but, owing to twilight and then a spell of bad weather, was not confirmed and announced till January 18 when he himself recovered it.

Jeffers at the Lick Observatory on July 24 (18^m). The former was active again in November, being found some five magnitudes above its normal brightness, namely 12^m.5, on November 12 and 22 (Jeffers); but it had faded again to 18^m by December 19. Regarding its outburst in January 1946, noted in our last report, Seth B. Nicholson has drawn attention (*P.A.S.P.*, 59, 30, 1947) to the fact that the giant spot, then present on the Sun, was on the hemisphere toward the comet at the time.

1947 a was the periodic comet Grigg-Skjellerup. It was detected on March 11.1 by H. L. Giclas with the 13-inch (*f*/5) photographic telescope at the Lowell Observatory, and independently later on the same day by E. L. Johnson with the Franklin-Adams camera at the Union Observatory at Johannesburg. It was about two degrees away from the predicted position and this probably accounts for its not having been found sooner, for it was relatively bright (11^m). It brightened to about ninth magnitude at perihelion in April, a very diffuse object of about 2½' diameter and only slightly condensed. Thereafter it faded rapidly, being only about fifteenth magnitude on June 25 when last photographed with certainty by Van Biesbroeck—a later record by him, on July 14, is at present unconfirmed.

1947 b, a new comet, was found first by Esteban Rondanina, an Argentinian astronomer on the staff of the Montevideo Observatory, Uruguay, on a plate of the κ Crucis region taken with the 16 cm. (*f*/4.5) Zeiss astrographic camera on March 24.0; and independently by M. J. Bester, at the Boyden Station of the Harvard College Observatory, on a patrol plate taken with the 1.5-inch Cooke lens camera on the night of the same day. At discovery its brightness was around 9^m (estimates varied ± 2), and it brightened rapidly to 6^m early in April and reached 4½^m in May, when it was at perihelion, showing a bright diffuse central condensation and a slender tail several degrees long. It was seen with the naked eye in Brazil during the solar eclipse on May 20 (Van Biesbroeck). It then soon started to fade and by the latter half of June had dropped to eighth magnitude.

H. M. Jeffers, on a photograph of it taken on June 23, found two distinct tails, each ¼° long, one sharp, narrow and straight extending westward and away from the Sun, the other broader and more diffuse, pointed south-west. At the end of June Harold L. Johnson, with the photoelectric photometer of the Lick Observatory, obtained measures of the brightness which gave magnitudes from 8.3 on June 25.4 to 10.1 on July 13. The comet was followed till September 21 when it was 18^m. (Jeffers).

1947 c, a new comet, was discovered in Draco by Antonín Bečvář at the Skalná Pleso Observatory (Czechoslovakia), which he directs, on March 27.9, 9^m. It was found visually during a routine search for comets, which is part of the regular programme of the observatory, using one of the six 100-mm. Somet "Binar" binocular comet seekers ($\times 25$) with which the observatory is equipped, and was confirmed the same night by a photograph with the 600-mm. (*f*/5.5) Zeiss reflector. The comet, a diffuse object about 4' in diameter and showing but little condensation, moved rapidly northward, passed very near the Pole, and then continued southwards through Auriga and Orion and, fading, was lost in the evening twilight early in May. When last recorded, by H. L. Giclas at the Lowell Observatory on May 8, it was 11^m.7.

1947 d, a further discovery by M. J. Bester at the Boyden Station, was found by him on May 19 on a plate taken on May 18 with the 8-inch Bache telescope engaged on variable star work. The comet was in Lupus, within half a unit of the Earth, a diffuse object of eleventh magnitude without appreciable condensation.

In June it was described by W. H. Steavenson (30-in. refl.) as unusually diffuse in appearance, fading into the sky without any marked boundary; it was about 4' in diameter (Merton). On June 14 he noted it as having a sensibly stellar nucleus of about fourteenth magnitude. It faded very rapidly as the distance from the Earth increased, being fifteenth magnitude in mid-July. It was last recorded with certainty on August 7, by Jeffers, 17^m.3, but an unconfirmed image on a plate taken by him on November 25 may also belong to it.

1947 e referred to the reported discovery of an eleventh magnitude comet on June 15 by Jakovkin Jr. at Kiev in the U.S.S.R. Numerous searches however, including that of a large plate of the area, taken by H. L. Giclas at the Lowell Observatory about the time of the supposed discovery, failed to disclose any new object.

1947 f was the periodic comet Faye, which was detected by Jeffers, near the predicted place, as a small nearly stellar coma of about seventeenth magnitude on a plate taken with the 20-inch astrograph at the Lick Observatory on June 19.4. On a photograph of it on July 25, when it was about 14^m.5 with coma 10" in diameter, he found a narrow tail 4' long. The comet reached its greatest brightness in November, after perihelion (Sept. 28). It was then about 12^m.5, a circular diffuse object about $\frac{3}{4}$ ' in diameter with a central condensation of about 5" (Steavenson). It was still under observation after the end of the year.

1947 g, the periodic comet Whipple, was also found by H. M. Jeffers at the Lick Observatory, on a plate taken with the 36-inch Crossley reflector ($f/5.8$) on June 21.4, 18^m; and independently by Van Biesbroeck with the 24-inch reflector ($f/4$) at the Yerkes Observatory on June 26, a small fuzzy spot on the plates, about 17^m or 18^m, in the position predicted. The comet will not reach perihelion till 1948 June 25.7 but its orbit, lying between those of Mars and Jupiter, is of such moderate eccentricity (0.36) that it is within reach of observation at opposition for some time before and after perihelion. In fact, L. E. Cunningham has suggested it may be possible to record it at opposition each year.

1947 h, a new comet, was discovered by Carl A. Wirtanen at the Lick Observatory, as a trail on a plate taken for the special proper motion programme with the Carnegie 20-inch ($f/7.4$) astrographic camera on July 18.4, a small diffuse object in Aquarius of magnitude 12 $\frac{1}{2}$ with an almost stellar condensation and a tail 3' in length. W. H. Steavenson, observing it on August 6 at Cambridge, with his 30-inch reflector ($\times 150$), described it as one of the smallest comets he had ever seen: diameter 10" with a central condensation of 3". It was at perihelion when discovered and faded with unexpected rapidity, being recorded by Jeffers on November 7 as only 17^m.5, about two magnitudes fainter than had been anticipated.

1947 i, the periodic comet Encke, was detected near its predicted position by H. M. Jeffers at the Lick Observatory, on a plate taken with the Crossley reflector on August 14.4. He described it as diffuse and very faint, with a fan-shaped and not quite stellar coma of the eighteenth magnitude. It brightened slowly at first, Van Biesbroeck reporting it as fifteenth magnitude in mid-September, and then more rapidly, reaching eighth magnitude in mid-October, when it showed a fan-shaped coma, about 4' across, moderately condensed and with a well-defined nucleus, the coma extending some 7' towards the Sun. It was then on the average 1^m.3 brighter than predicted by Van Biesbroeck's formula (*A. J.*, 36, 43, 1924) but came into accord with it at the beginning of November. When last seen in the morning twilight, at the Tokyo Observatory on November 22.9, three days

before perihelion passage, it had reached $5^m.5$. A study of the visual estimates of brightness has been undertaken at the Warsaw Observatory and Dr J. Gadoski has requested observations to be sent to him. He has remarked that the development in appearance was different from other comets: at the start a diffuse spot, then it condensed gradually, and later became star-shaped (M. Mazur).

1947j, a new comet, was discovered in Pegasus by Karl Reinmuth on two routine minor planet plates taken with the 40-cm. Bruce photographic telescope at the Königstuhl Observatory at Heidelberg on September 10–11: a small diffuse object, $12^m.7$, with a fourteenth magnitude nucleus. Its orbit was found to be one of short period, Reinmuth's second discovery of this nature. It had passed perihelion when discovered and was fading, but it was followed into the next year.

Tracing the path back it was found that the comet's motion must have experienced heavy perturbations between the middle of 1943 and the end of 1945, while it was within about one astronomical unit of Jupiter, and the suggestion was made that it might be identical with Tuttle (1858 III)–Giacobini (1907 III). However, the result of a preliminary investigation, by E. Rabe at Heidelberg, has shown this to be impossible. Rabe has undertaken the definitive investigation of the orbit.

1947k, another new comet, was discovered by M. J. Bester at the Boyden Station at Bloemfontein, on a plate taken for the routine patrol with the 3-inch Ross lens camera, on September 24–25. It was in Eridanus, a small, diffuse, centrally condensed object of the eleventh magnitude. It brightened to 9^m by November and showed a twelfth magnitude nucleus and a faint tail some minutes of arc long. By the end of the year it had reached the eighth magnitude and a photograph taken at the Boyden Station showed a tail 3° long. It was followed into the next year, still increasing in brightness as it approached perihelion in 1948 February.

1947l, the periodic comet Schwassmann-Wachmann (2), originally discovered in 1929, was detected on this its third observed return by Van Biesbroeck, on a plate taken with the 24-inch reflector at the Yerkes Observatory on October 20.2, in the position predicted by H. Q. Rasmusen. It showed a round diffuse coma, $12''$ in diameter, 16^m . Like Whipple's, this comet has a moderate eccentricity (0.38) which keeps it within range of observation for some time before and after perihelion passage—at this return, 1948 August.

1947m, another new comet, as the result of systematic searching with a 15 inch-reflector ($\times 23$), was discovered in Corvus by Minoru Honda, an amateur astronomer at Kurashiki (Okayama Prefecture) in Japan on November 13.8, just prior to its perihelion passage. It was a slightly condensed diffuse object of the eighth or ninth magnitude. Its motion carried it rapidly into high south declination, so that it could not be followed by northern observatories. By December 19, when Johnson last recorded it with certainty at the Union Observatory, Johannesburg, it had faded to the tenth magnitude, and an unsuccessful search by Albert Jones (8-inch reflector, $\times 36$) early in the following January indicated it was then fainter than the twelfth magnitude.

1947n, the last comet of the year, appeared unexpectedly, a fine spectacle in the evening skies of the southern hemisphere, on December 8. The first news of it came from the Cape but numerous reports from places on land, and from ships at sea, followed, two of these claiming to have seen the comet the previous night, December 7. Its brightness on December 8 appears to have been about -1^m ; by December 13 it had faded to 3^m . The head was described as of an orange colour

and a tail stretched vertically upwards in the sky for 20° to 30° curving towards the south; in appearance it was very like Comet 1910 I.

Accurate observations of position proved difficult to obtain in the twilight but Jorge Bobone, on December 10.0, at the Cordoba Observatory in the Argentine, was successful in obtaining the first. Later, on the same day, Van den Bos, at the Union Observatory in Johannesburg, was able to observe the comet telescopically and immediately detected that the nucleus was double, the components being $6''$ apart. He obtained a series of measures covering almost every night to the 20th when bad weather intervened, but by then observations of the components were being obtained at observatories in the U.S.A. There was a gradual increase in the separation (to $21''$ on January 10) and change in position angle, but the remarkable feature was the variation of the relative brightness of the components: the one which was the fainter by four magnitudes on December 10 was slightly the brighter on the 15th and 16th, then faded again relative to the other. On December 16 and 17 long exposure photographs were obtained, at the Boyden Station at Bloemfontein, which showed two tails 20° long and no less than three others shorter and fainter.

Table of the Elements

Comet		T (U.T.)	q	e
1930 IV	Beyer	1930 Apr. 18.1212	2.078673	1.000379
1946 b	P/Tempel (2)	1946 July 2.3436	1.393315	0.542233
1947 a	P/Grigg-Skjellerup	1947 Apr. 20.435 <i>p</i>	0.853190	0.704486
		1947 Apr. 18.1370	0.853130	0.704259
1947 c	Bečvár	1947 May 3.9198	0.961836	1.0
1947 b	Rondanina-Bester	1947 May 20.9669	0.559816	0.997503
1947 d	Bester	1947 May 31.1155	1.402874	1.0
1947 h	Wirtanen	1947 July 18.937	2.8283	1.0
1947 j	P/Reinmuth (2)	1947 Aug. 18.5789	1.863161	0.469017
		1947 Aug. 19.5650	1.866728	0.468958
1947 f	P/Faye	1947 Sept. 28.4001	1.663269	0.563602
1947 m	Honda	1947 Nov. 12.013	0.7177	1.0
		1947 Nov. 19.445	0.7435	1.0
1947 i	P/Encke	1947 Nov. 26.591 <i>p</i>	0.340337	0.846566
		1947 Nov. 26.3295	0.341130	0.846197
1947 n	Southern Comet	1947 Dec. 2.5811	0.109857	1.0
		1947 Dec. 2.5869	0.110050	1.0
1947 k	Bester	1948 Feb. 16.4330	0.747809	1.0
1947 g	P/Whipple	1948 June 25.846 <i>p</i>	2.448768	0.355630
1947 l	P/Schw.-Wach. (2)	1948 Aug. 24.242 <i>p</i>	2.15241	0.38370
		1948 Aug. 23.632 <i>p</i>	2.152282	0.383830

REFERENCES AND NOTES TO TABLE OF ELEMENTS

- 1930 IV Beyer. (1) G. Pels, *B.A.N.*, 10, 237, 1947. Definitive, from 249 observations covering 673^d . Osc. epoch 1930 September 24.
- 1946 b P/Tempel (2). (2) L. E. Cunningham, *HAC*, No. 842. From observations covering 210^d , with first-order Jupiter perturbations taken into account. Osc. epoch 1946 June 29.0.
- 1947 a P/Grigg-Skjellerup. (3) F. R. Cripps, *B.A.A. Handbook*, 1947. Prediction based on his elements in *Handbook*, 1942. (4) L. E. Cunningham, *HAC*, No. 821. From observations covering 49^d , assuming corrected period deduced from Cripps's prediction, namely $P=4.899533$.

From December 15 to 23 the McDonald Observatory was able to obtain spectrograms which included records of the infra-red region. On these were found a band with a sharp maximum at $\lambda 7908 \text{ \AA}$., and probably a secondary maximum at 7869 \AA ., which it was suggested were due to a rotation-vibration band of ammonia but which were later identified as belonging to the Cyanogen red system.

This was not a great comet. Although for a day or two its brightness was seen to exceed that of any other comet since 1910—the effect of its small perihelion distance (0.11)—it faded very rapidly and by the end of the month was no brighter than eighth magnitude. Early in 1948 January the Sun started to gain on the comet in the evening sky, the last known observation being that by Van Biesbroeck on January 20 ($10^m.5$), after which the comet was lost in the evening twilight.

The table of the elements of cometary orbits which follows is arranged as in the last report: the comets are listed in order of perihelion date; the symbol P/ indicates a periodic comet, and p after the perihelion date that the elements were predicted ones.

of Cometary Orbits

Period (years)	ω	Ω	i	Equinox	Computer	Ref.	Comet
...	$24^{\circ}6213$	$116^{\circ}3925$	$71^{\circ}9751$	1930.0	Pels	1	1930 IV
5.31	$190^{\circ}8549$	$119^{\circ}4163$	$12^{\circ}4310$	1950.0	Cunningham	2	1946 b
4.91	$356^{\circ}3915$	$215^{\circ}3712$	$17^{\circ}6466$	1950.0	Cripps	3	1947 a
4.90	$356^{\circ}4011$	$215^{\circ}3747$	$17^{\circ}6456$	1950.0	Cunningham	4	1947 a
...	$182^{\circ}1407$	$322^{\circ}3300$	$129^{\circ}1579$	1947.0	Cunningham	5	1947 c
3356	$303^{\circ}7646$	$353^{\circ}1630$	$39^{\circ}2913$	1947.0	Cunningham	6	1947 b
...	$357^{\circ}3973$	$232^{\circ}3245$	$111^{\circ}4117$	1947.0	Cunningham	7	1947 d
...	$9^{\circ}55$	$311^{\circ}07$	$97^{\circ}37$	1947.0	Cunningham	8	1947 h
6.57	$43^{\circ}3434$	$297^{\circ}4469$	$7^{\circ}1262$	1947.0	Rabe	9	1947 j
6.59	$43^{\circ}9653$	$297^{\circ}3611$	$7^{\circ}1257$	1950.0	Cunningham	10	1947 j
7.44	$200^{\circ}5230$	$206^{\circ}3072$	$10^{\circ}5333$	1947.0	Cunningham	11	1947 f
...	$205^{\circ}27$	$295^{\circ}97$	$95^{\circ}63$	1947.0	Cunningham	12	1947 m
...	$225^{\circ}67$	$314^{\circ}57$	$111^{\circ}42$	1947.0	Hirose	13	1947 m
3.30	$185^{\circ}1991$	$334^{\circ}6798$	$12^{\circ}3501$	1947.0	Matkiewicz	14	1947 i
3.30	$185^{\circ}1985$	$334^{\circ}7223$	$12^{\circ}3505$	1950.0	Merton	15	1947 i
...	$196^{\circ}1953$	$336^{\circ}6422$	$138^{\circ}4339$	1950.0	Schmitt	16	1947 n
...	$196^{\circ}2018$	$336^{\circ}5654$	$138^{\circ}5071$	1947.0	Hirst	17	1947 n
...	$350^{\circ}2410$	$270^{\circ}6914$	$140^{\circ}5633$	1947.0	Cunningham	18	1947 k
7.41	$190^{\circ}1196$	$188^{\circ}5963$	$10^{\circ}2468$	1950.0	Dinwoodie	19	1947 g
6.53	$358^{\circ}1204$	$126^{\circ}0229$	$3^{\circ}7237$	1950.0	Beart, Henderson	20	1947 l
6.53	$358^{\circ}1213$	$126^{\circ}0213$	$3^{\circ}7236$	1950.0	Rasmusen	21	1947 l

1947 c Bečvář. (5) L. E. Cunningham, *HAC*, No. 807. From observations covering 14^d .

The angular elements were deduced from his constants.

1947 b Rondanina-Bester. (6) L. E. Cunningham, *HAC*, No. 857. From observations covering 146^d . Two observations 32 days later showed a residual of $4\frac{1}{2}''$ only. He states that a parabolic orbit would leave a residual (elsewhere) of about $0^{\circ}.1$.

1947 d Bester. (7) L. E. Cunningham, *HAC*, No. 838. From observations covering 49^d .

1947 h Wirtanen. (8) L. E. Cunningham, *HAC*, No. 839. From observations covering 6^d .

1947 j P/Reinmuth (2). (9) E. Rabe, *N.A.Z. Vorl. Mitt.*, No. 19 and *UAIC*, No. 1114.

From observations covering 27^d . Rabe has undertaken the definitive investigation of the orbit. (10) L. E. Cunningham, *HAC*, No. 888. From observations covering 96^d .

- 1947 f P/Faye. (11) L. E. Cunningham, *HAC*, No. 853. From observations covering 65^d, assuming $a=3.8113557$.
- 1947 m Honda. (12) L. E. Cunningham, *HAC*, No. 862. Cabled observations discordant; elements uncertain. (13) H. Hirose, *UAIC*, No. 1122. From rough observations.
- 1947 i P/Encke. (14) L. Matkiewicz, *UAIC*, Nos. 1090, 1106. Predicted elements (converted to ecliptic) which, after altering T to 1947 November 26.318 U.T. to obtain best fit for observations of August 14.4 and October 26.1, left residuals of about 5', apparently mainly due to error in the value of the eccentricity. (15) G. Merton, MS. Preliminary correction of Matkiewicz's orbit, which reduced these residuals to a few seconds of arc. Corrected value of period = 3.303196 assumed; elements ω , Ω and i unchanged but given for equinox 1950.0.
- 1947 n, the Southern Comet. (16) A. Schmitt, *UAIC*, No. 1139. From 9 observations at Algiers covering 22^d. (17) W. P. Hirst, *UAIC*, No. 1144. From 18 observations covering 25^d.
- 1947 k Bester. (18) L. E. Cunningham, *HAC*, No. 855. From observations covering 9½^d — an unusually successful preliminary determination.
- 1947 g P/Whipple. (19) Cameron Dinwoodie, *B.A.A. Handbook*, 1948. Prediction based on the elements by D. H. Sadler and Miss F. M. McBain for 1940 quoted in last report (*M.N.*, 107, 110; ref. No. 33). The recovery observation of 1947 June 21 indicated T 1948 June 25.770.
- 1947 l P/Schwassmann-Wachmann (2). (20) W. E. Beart and W. P. Henderson, *B.A.A. Handbook*, 1948. Prediction based on the elements by W. P. Henderson and H. Whichello in *Handbook*, 1941. (21) H. Q. Rasmusen, MS. Based on his previous investigation of the orbit, *Pub. Copenhagen Obs.*, No. 106, 1935. The recovery observation of 1947 October 20 indicated T 1948 August 23.5.

ADDITIONAL NOTES

- 1941 VI P/Schwassmann-Wachmann (1) = 1925 II. An investigation of the orbit 1934-44, by Paul Herget, has been published in *A.ŷ.*, 53 (No. 1165), 16, and predicted ephemerides to 1951 July are given. His basic osculating elements, for 1941 January, were included in our last report (*M.N.*, 107, 110; ref. No. 35).
- 1942 VII P/Oterma = 1943 a. An investigation of the orbit 1943-44, also by Paul Herget, has been published in *A.ŷ.*, 53 (No. 1165), 18, and predicted ephemerides to 1951 August are given. His basic osculating elements, for 1943 October, were included in our last report (*M.N.*, 107, 110; ref. No. 41). Herget remarks that as there was a very close approach of the comet at aphelion to Jupiter at perihelion in 1937, and another will take place in 1961, many well-spaced accurate observations (not only at opposition) must be obtained during the next few years to determine the orbit with sufficient exactitude for the investigation of the very large alterations to the orbit during these approaches.

CORRIGENDUM

- 107, 111; note on 1910 III Metcalf, at foot of page, line 5. For "Yamarnato" read "Yamamoto".

G. MERTON.