

The two bright comets of 1957

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A report of the Comet Section (Director: Jonathan D. Shanklin)

Introduction

In 1957 two bright comets were visible from northern latitudes within a few months of each other: C/1956 R1 (Arend–Roland) in April and May, and C/1957 P1 (Mrkos) in August. It was fortunate that they arrived in that order as Arend–Roland was found while quite faint and several months before perihelion, and the orbit soon showed very favourable prospects for northern observers especially. This early warning allowed astronomers, both amateur and professional, to prepare observing programmes and equipment for the forthcoming apparition, which in the event, came up to expectation and was widely observed. The unexpected appearance of another comet, Mrkos, already at perihelion, allowed little time for preparation but the experience gained observing the earlier comet was put to good use and again important results were obtained.

The appearance of these bright and well-observed comets was timely, as an increased interest in comets had led to several important new theories, in particular Whipple's icy conglomerate model of the comet nucleus, Biermann's proposals on the interaction between the solar wind and ion tails, and Oort's comet cloud model. Some useful spectra of comets such as C/1940 R2 (Cunningham) had been obtained but some bright comets were needed to extend this work to higher dispersion and to study a full range of cometary phenomena. There had been no really conspicuous comet in the northern hemisphere since the Great January or Daylight Comet of 1910 (C/1910 A1) which was brighter than Halley's seen later the same year. Only comets C/1927 X1 (Skjellerup–Maristany), the Southern Comet C/1947 X1 and the Eclipse Comet C/1948 V1 seem to have reached first magnitude or brighter during this period and they were all best seen from low northern or southern latitudes.

Most bright comets remain really bright for only a matter of days or a week or two at the most, are often in twilight, and are difficult to observe in moonlight and poor weather conditions. Favourable opportunities for their study are few. One would be very lucky to see a first magnitude comet once in ten years on average, and to see two in four months was good fortune indeed.

The forecast that comet Arend–Roland would be easily visible to the general public made it newsworthy in a way not seen again until Halley's Comet in 1985–1986. Photographs taken by Dr R. L. Waterfield appeared on the front page of the London evening newspaper *The Star* and in the weekly periodical *Illustrated London News*. Star photographers set up a mobile darkroom outside Waterfield's observatory at Ascot in order to get prints quickly for the

next afternoon's edition. A live BBC outside radio broadcast was made from Waterfield's observatory in late April, though clouds frustrated attempts to give a first hand account of how the comet looked that evening. The first 'Sky at Night' presented by Patrick Moore appeared on BBC Television in 1957 April and photographs of the comet were shown. Comet Mrkos also made the daily Press and was widely observed and reported, though it lacked some of the novelty of the earlier object.

Visual photometry

In 1957 there was a serious lack of reliable star atlases and catalogues. A few members had old copies of Webb's *Star Atlas*, and even fewer the *Bonner Durchmusterung* charts. For catalogues, only the BD showed most stars (to -23° declination) of about 9.5 magnitude or brighter with some additional fainter stars. The BD magnitudes were generally of a rather low accuracy and a few observers consulted the *Harvard Revised Photometry*, *Yale Bright Star* and other specialist catalogues. In re-examining all the observations for this Report, use has been made of the more recent *Smithsonian Astrophysical Star Atlas and Catalogue* and the *Atlas Coeli Katalog II* (as well as the BD) where it was possible to identify the comparison stars, but in many cases the original reported magnitudes had to be accepted. While the methods of determining comet magnitudes may not have been formalised then, most observers used what is now called the 'Sidgwick' method of defocusing the comparison stars, and chose small instruments and low magnifications for this work. The light curves are believed to give a good indication of the changes in brightness of the two comets. However, there is considerable uncertainty as to how bright comet Arend–Roland was at maximum, though this is not uncommon with comets seen near the horizon in a bright sky. Often no comparison stars at a similar altitude were visible and it is not possible to say by how much more a hazy comet is affected in these conditions compared with a star.

Photography

Photography amongst amateur astronomers in 1957 was rather different in scope from that of today. Most photographs of stars and comets were taken with either old portrait lenses of 50mm to 150mm aperture at f/2 to f/4, or with ex-military aerial photography lenses of similar aperture at f/2.5 to f/6.3. The portrait lenses were very fast and

Table 1. Comet C/1956 R1 (Arend–Roland) 1957 III

Epoch 1957 March 23.0

T	1957 Apr. 8.0324 TDT	ω	308.7852	
q	0.316035 AU	Ω	215.1596	1950.0
e	1.000168	i	119.9493	

Oh UT	RA h	(1950.0) m	Dec. °	Δ AU	r AU	Rv °	Elong. °	Mag
1956								
Nov 8	2	3.3	+29 41	1.88	2.84	38	163	+10.4
28	1	15.4	21 55	1.74	2.56	80	138	9.8
Dec 18	0	39.9	13 16	1.76	2.27	83	108	9.3
1957								
Jan 7	0	21.3	6 09	1.86	1.96	79	81	8.8
27	0	16.1	+0 55	1.93	1.63	76	57	8.1
Feb 16	0	19.7	-3 13	1.92	1.27	78	37	7.0
Mar 8	0	28.4	7 21	1.76	0.88	98	19	5.2
28	0	37.6	12 26	1.33	0.45	169	16	+1.7
Apr 7	0	43.1	-11 16	0.94	0.32	195	19	-0.6
17	1	19.2	+12 52	0.60	0.41	299	5	-0.5
27	2	59.9	49 05	0.65	0.62	12	37	+1.5
May 7	5	8.3	62 00	0.92	0.84	19	51	3.5
17	6	40.2	63 40	1.23	1.04	23	54	5.1
27	7	36.6	62 51	1.52	1.23	26	54	6.3
Jun 6	8	14.6	61 38	1.80	1.42	28	52	7.3
16	8	43.4	60 28	2.06	1.59	28	49	8.1
26	9	7.3	59 28	2.30	1.76	28	47	8.8
Jul 6	9	28.3	58 38	2.51	1.93	27	45	9.3
26	10	5.8	57 27	2.88	2.24	21	43	10.3
Aug 15	10	40.0	56 56	3.15	2.53	12	44	11.0
Sep 4	11	12.7	57 10	3.35	2.81	4	50	11.6
24	11	44.7	58 16	3.48	3.08	357	59	12.1
Oct 14	12	16.7	+60 22	3.56	3.34	352	69	12.5

Predicted magnitudes from $m = 4.5 + 5 \log \Delta + 10 \log r$
(Elements from *Catalogue of Cometary Orbits*, 1986 edition; magnitude formula from BAA Circular 381, 1956 Dec 19)

often had very sharp central definition, but good star images over a field of only 5 degrees or so, though comet tails looked better. The aeroplane lenses had more elements but central definition was sometimes compromised by the need to obtain a wide field of acceptable definition combined with short exposure: stopping down the faster lenses (e.g. the f/2.5 Aero Ektars) usually helped here.

Waterfield used a 150mm aperture f/4.5 Cooke triplet specially designed for photographing stars and comets, but such equipment was unusual in amateur hands. Today's wide range of 35mm cameras, extension tubes, adapters and fittings did not exist and controllers on electric telescope drives were rudimentary, making fine guiding with long focal lengths very difficult. There were no off-the-shelf Schmidt cameras and Schmidt–Cassegrains in members' hands and the photography of comets with focal lengths of more than about 500mm was largely in the hands of a few professional astronomers. Few if any members took photographs of objects requiring long exposures through their telescopes: they used them to guide smaller cameras.

Most photographs were taken on glass plates such as Ilford Zenith (blue-sensitive) or HP3 (panchromatic)

which were readily available. The special made-to-order scientific emulsions were faster for long exposures but rather grainy. Kodak Oa-0 (blue-sensitive) and Oa-E (panchromatic), and the corresponding Ilford Zenith Astro-nomical and Ilford Astra III plates were widely used. The Kodak T-Max and Technical Pan emulsions, which have done so much to improve the results of photography with small instruments, were decades away.

Comet C/1956 R1 (Arend–Roland)

Circumstances of the apparition

Comet Arend–Roland was discovered on 1956 November 8 at the Uccle Observatory (Brussels) on photographs taken with the double astrograph by S. Arend and G. Roland during routine work on asteroids. Towards the end of November the comet was 10th magnitude, strongly condensed and already showed a short tail.

At the 1956 November 28 meeting of the Association Dr Steavenson (in the absence of Dr G. Merton, then Director of the Comet Section) reported on the discovery of the comet, his observations at Cambridge with his 760mm reflector, and the elements and ephemeris computed by M. P. Candy which predicted perihelion passage on 1957 April 8. He concluded that the comet was already unusually well developed for its distance from the Sun and we could anticipate a good display during the coming April. (However, he warned about communicating too optimistic a prophecy to the daily press: some things do not change!)

Figure 1 shows the orbit diagram and Table 1 the elements of the orbit and ephemeris. At discovery the comet was near opposition in Triangulum and moving south-westwards through the evening sky, turning south through Pisces during December and crossing the equator on 1957 February 2. The last pre-perihelion observation from the British Isles was on February 25. The comet was a southern hemisphere morning object though near the Sun

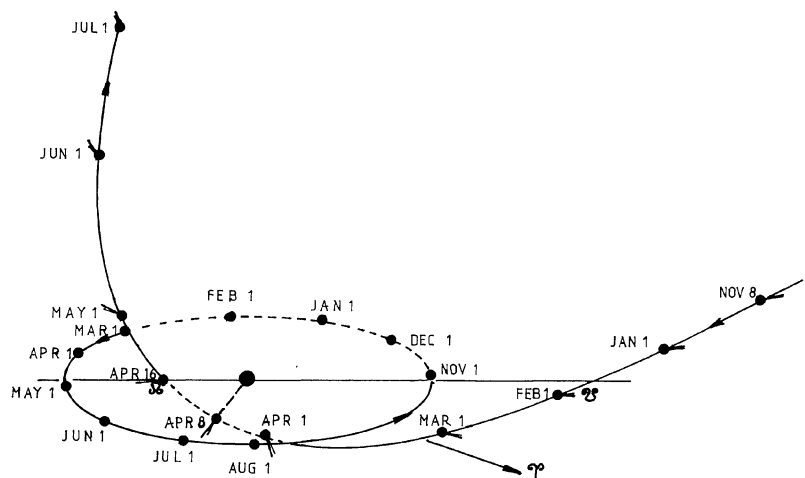


Figure 1. Orbit diagram for Comet Arend–Roland. The Earth passed through the plane of the comet's orbit on 1957 April 25.

during March and early April, having reached its most southerly point (in Cetus) of -13° declination at the end of March.

Moving north at up to four degrees per day, the comet was back in Triangulum when the first reported post-perihelion observation from the British Isles was made on the evening of April 20. By midnight on the night of April 23–24 its declination had increased by another ten degrees and it was being widely observed throughout the night.

Comet Arend–Roland moved quickly through Andromeda and Perseus, in Camelopardalis in early May and Ursa Major by the beginning of June. Thus the comet was cir-

Table 2. List of observers

Observer	Location	Instrument	56 R1	57 P1
Alcock G. E. D.	Peterborough, Cambs	100R	×	×
Barrett M. J.	Mediterranean (at sea)	B	×	×
Candy M. P.	Herstmonceux, Sussex	100R	×	×
Clark W. A.	Keyingham, Hull	B	×	×
Collinson E. H.	Ipswich, Suffolk	E	×	
Dale C. F.	Teignmouth, Devon	B	×	
Darvill P. G.	Aylesbury, Bucks	100A		×
Davies–Scourfield M.	Steyning, Sussex	B	×	
Dinwoodie C.	Langholm, Scotland	80R	×	
Garstang R. H.	Mill Hill Obsy, London	610A	×	
Glynn R. T.	Florida, USA	B	×	
Gow J. G.	Tapui, New Zealand	E	×	
Granger W. A. & E. M.	Peterborough, Cambs	150R, A	×	×
Hamilton A. R.	Oxford	50R	×	
Hare C.	Tamworth, Staffs	60R	×	×
Harlick M. A.	Fareham, Hants	A	×	
Haughton J. L.	Winchester, Hants	A	×	
Hayward H.G.	Durban, Natal, S. Africa	B	×	
Hendrie M. J.	Westcliff-on-Sea, Essex	60A, 150L	×	×
Holborn F. M.	Peaslake, Surrey	300L	×	×
Hole G.	Brighton, Sussex	B	×	
Hougenhaut N. M.	Jeffrey's Bay, S. Africa	100R	×	
Hunt H. C. C.	Aylesbury, Bucks	100A		×
James J. F.	Lymington, Hants	B	×	
Jones A. F. A. L.	Timaru, New Zealand	320L, 70R	×	×
Jones D.	England	E	×	
Kemp P.	Baldock, Herts	B	×	
Lester K. M.	Wembley, Middx	E	×	
McClure A.	Los Angeles, USA	100A	×	
Manning B. G.	Stourbridge, Worcs	50A	×	
Marsden B. G.	Oxford & Cambridge	60R	×	×
Martin H.	Barnard Castle, Durham	80R	×	×
Meisel D.	Fairmont, Virginia, USA	200L	×	
Merton G.	University Obsy, Oxford	B	×	×
Murray J.	Hawick, Scotland	50R, B	×	
New Zealand				
Antarctic Expedition	Scott Base	E	×	
Panther R. W.	Moulton, Northants	200L, 40R	×	×
Ranck O. C.	Milton, Penn., USA	100R		×
Ridley H. B.	Barnes, West London	50R	×	×
Ryan M.	Christmas Island	E	×	
Scrafield W. J.	Salvador, Brazil	E	×	
Soper A.	Godalming, Surrey	90R	×	×
Steavenson W. H.	Cambridge	760L	×	×
Stone G. E.	Dorking, Surrey	70R	×	×
Taylor G. E.	Horsebridge, Sussex	100R	×	×
Thomas W.	Birkenhead, Merseyside	60R	×	×
Thomsen I. L.	Carter Obsy., New Zealand	E	×	
Vince A. W. & P. H.	Amersham, Bucks	160R	×	×
Waterfield R. L.	Ascot, Berks	150A, 150R	×	×
Welsh H.	Port Elizabeth, S. Africa	200R	×	
Whitaker E. A.	Herstmonceux, Sussex	100R		×
Wieth–Knudsen N.	Copenhagen, Denmark	B	×	

Principle instruments used (apertures in mm): R = refractor, L = reflector, B = binoculars only, E = naked eye only, A = astrograph or camera. Many observers also used binoculars and the naked eye for the brighter phases.

Comet Arend–Roland 1956 h

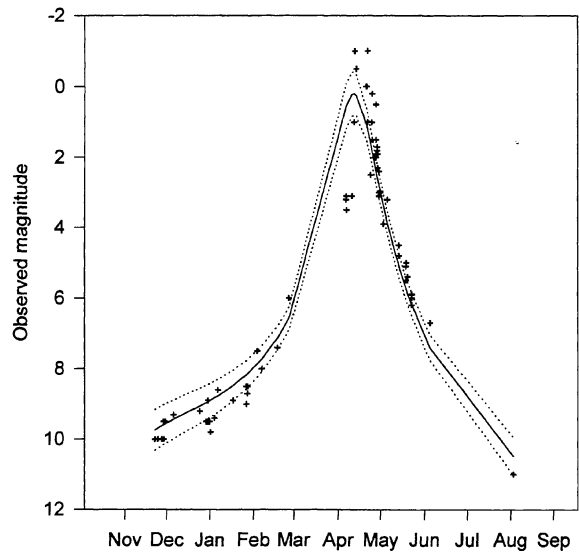


Figure 2. Comet Arend–Roland observed magnitudes. The curve is the best fit over the apparition, with no corrections applied. The tick marks indicate the first of each month from 1956 November 1.

cumpolar from the British Isles from about April 24 until it faded from view in September.

Observations by members were presented and discussed at the monthly meetings of the Association: comprehensive reports of these meetings can be found in the *Journal*.

Visual observations

Visual observations were received from most of the 37 observers listed in Table 2. While the observed magnitudes showed the usual scatter of a magnitude or so when the comet was seen in a dark sky, there was a wide scatter around the time of perihelion in early April when the comet was in twilight.

The plot of the observed visual magnitudes is shown in Figure 2 and reduced visual magnitudes in Figure 3. A least squares analysis of the visual observations leads to the formula: $m = 5.0 \pm 1.0 + 5 \log \Delta + 7.9 \pm 0.5 \log r$.

Descriptive notes on comet Arend–Roland

1956 November

The first reported observation by a BAA member was by Steavenson on 1956 Nov. 22.76 with his 760mm reflector $\times 140$ and $\times 300$ at Cambridge. He described the comet as about 10th magnitude with a strongly condensed coma about $40''$ across, with a sensibly stellar nucleus and a short tail about $2'$ long in p.a. 060° . The comet was photographed on Nov. 24.83 and 26.91 by M. J. Hendrie with an 85mm $f/2.5$ portrait lens at Westcliff-on-Sea, Essex and by R. L. Waterfield on Nov. 25.95 with his 150mm $f/4.5$ astrograph at Ascot, confirming the small, strongly condensed head and

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Comet Arend-Roland 1956 h

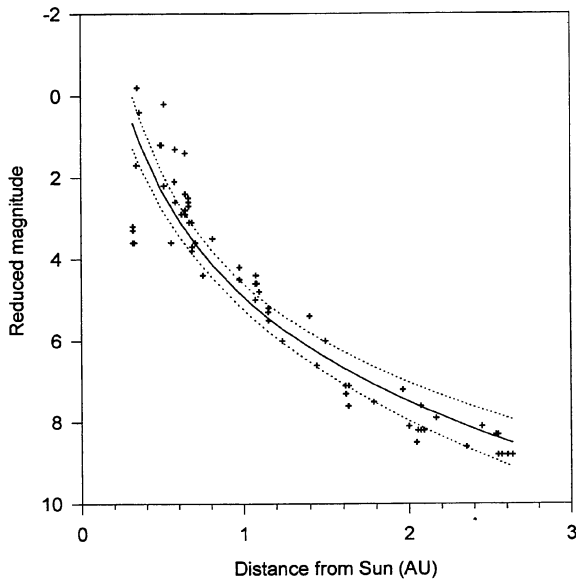


Figure 3. Comet Arend-Roland magnitudes corrected for aperture and reduced to a distance of 1 AU from the Earth, plotted against the distance from the Sun.

straight tail 2–3' long in p.a. 060°. The comet was observed visually on Nov. 27.45 by A. F. Jones at Timaru, New Zealand and on the night of Nov. 28–29 by M. P. Candy and G. E. Taylor at Herstmonceux, all of whom confirmed the general appearance and magnitude. On Nov. 29.90 A. W. and P. H. Vince at Amersham made the comet 9.5 magnitude with their 160mm refractor $\times 50$ and $\times 180$, noting a small coma less than 1' across, centrally condensed and with a short, bushy tail 2' long towards the east.

December

Comet Arend-Roland was in Pisces until the end of February. On Dec. 2.9 F. M. Holborn using his 300mm reflector $\times 150$ at Peaslake noted the bright, almost stellar nucleus and bright spine down the short fanned tail. On the same evening a 60 minute exposure by Waterfield showed a bright central condensation 30" across within a 60" bullet-shaped head merging into a straight tail 8' long in p.a. 060°. The comet was not visible in the 60mm finder, but in the 150mm Cooke refractor $\times 130$ Waterfield and Hendrie noted the comet's well-developed appearance (Figure 4). On Dec. 5.82 R. W. Panther used his 200mm reflector $\times 36$ to estimate the comet at 9.3 mag, with a pear-shaped coma 1' across with an almost stellar centre. There was a short 2' tail visible in p.a. 056°.

By early December the comet was still 2.5 AU from the Sun and it was 1.7 AU from the Earth, but this distance was increasing until early February when the Earth-comet distance reached 1.95 AU, helping to account for the slow rate of brightening as it approached the Sun.

Full Moon was on Dec. 17 so no further observations were reported until Panther's on Dec. 24.75 when he made the comet 9.2 magnitude. An observation by A. Jones on the 29th made it 9.5 magnitude. Waterfield obtained a short

15 minute exposure on Dec. 30.76 with some passing cloud which showed a very strong central condensation 30" across with very little faint extension beyond this. The tail was strong and straight for 7' in p.a. 060°. He estimated the brightness at 9.5 mag in the 150mm refractor and could just discern the comet in the 60mm finder. A photograph was obtained by Hendrie on this night and visual observations by Panther and W. A. and E. M. Granger at Peterborough confirmed the general appearance though putting the brightness close to 9.0 magnitude.

1957 January

During early January several observers noted the coma as diffuse with a moderate condensation and a short broad tail in p.a. 060°. An almost stellar nucleus was reported by A. Jones, D. Meisel in the USA and A. W. Vince, while Panther described the condensation as slight with a coma 4.5' in diameter and an 11' long fan tail with faint central spine in p.a. 045°. He made the comet 8.6 mag but his next observation on Jan. 17.76 made it slightly fainter at 8.9 mag, diffuse, slightly condensed and with a faint fan tail 7' long in p.a. 053°.

Waterfield obtained a 10 minute exposure on Jan. 26.82 and one of 30 minutes the next night. These continued to show the head smaller than recorded visually, as is often the case. The tail was at least 30' long in p.a. 050°, slightly fan-shaped and straight. Visual observations on Jan. 26–27 by Panther, Stone and Waterfield made the comet diffuse or very diffuse with only a weak condensation, wide diffuse tail and of 8.5–9.0 magnitude.

February

During the first week of February Panther, Meisel, Waterfield and Stone reported the comet visually to be 7.5–8.0 magnitude and about 3' in diameter, Mrs Stone at Dorking seeing it quite easily on Feb. 6.8 in a 70mm refractor $\times 30$ despite a first quarter Moon. After the full Moon on the 14th there were few observations but Waterfield and Stone made it 7.0 and 7.4 magnitude on the 17th. It was seen by H. Walsh with the 200mm Cooke refractor and also with binoculars at Port Elizabeth, South Africa on Feb. 23 but under extremely poor conditions and in a light sky, so no detailed observations were possible.



Figure 4. Comet Arend-Roland, 1956 Dec. 2.85, 150mm refractor $\times 130$ at Ascot. M. J. Hendrie.

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The last pre-perihelion observation from the British Isles was by Stone on Feb. 25.8 who made it 6.0 mag with a 60mm refractor $\times 30$ in a very clear but bright sky: the comet was 4' in diameter but no tail could be seen. Comet Arend-Roland was then 1.1 AU from the Sun (elongation 27°) but had increased its distance from the Earth to 1.9 AU.

March

Due to the comet's proximity to the Sun, no observations were reported in 1957 March.

April 1 to 19

Comet Arend-Roland was seen again on Apr. 2.7 by Dr J. G. Gow in New Zealand in slight haze, a fairly bright sky and at low altitude, using a small refractor from a hilltop to get a better view. He described the comet as a little brighter than β Ceti or about 2.0 magnitude. The tail pointed towards this star or almost due south (p.a. 180°).

H. Walsh saw it on April 4, 5 and 6 with the 200mm Cooke refractor at Port Elizabeth, South Africa, describing a blunt head with bright nucleus and a streaky tail, but poor conditions frustrated more detailed observations. He could not see it without optical aid. H. G. Hayward observing from Durban also saw it on the 6th but did not see any tail in passing clouds. A. F. Jones saw the comet on Apr. 6.7 as a naked eye morning object, 3.1 magnitude and with a tail 4° long in p.a. 180° . With a 200mm reflector $\times 96$ the nucleus was not stellar, appeared orange in colour and was at the tip of the coma which was shaped like the bow of a boat: this merged with the parallel-sided tail. Members of the New Zealand Antarctic Expedition at Scott Base made it a little fainter at 3.5 mag on this same date, but it was only 18° from the Sun and must have been in a bright sky, so probably these estimates related more to the central condensation within the coma. They reported a tail up to 5° in length towards p.a. 185° .

A. F. Jones observed again on Apr. 8.74 and 10.75 in hazy skies, in twilight and with the comet at low altitude. He again reported the boat-shaped coma-tail with the 3.1 mag, sharp condensation diameter 1' at the tip. There was a tail in p.a. 190° . N. M. Hougenhout observed from Jeffrey's Bay near Port Elizabeth on the morning of April 12, seeing the comet above a low bank of cloud with the naked eye. He described it as 'by no means a spectacular object' but guessed that it must be brighter than 1st magnitude having regard to the difficult conditions of very low altitude and bright sky. He had failed to find it on earlier mornings or on the following morning. I. L. Thomsen of the Carter Observatory, New Zealand reported observations by several naked-eye observers over the period April 8–13 which suggested it might have been as bright as -1 magnitude by the last date. There were no further observations until the comet reappeared for northern observers on April 20.

April 20 to 30

Several observers in the British Isles searched for comet Arend-Roland on mornings in mid-April hoping to see the

comet's tail if not the head. Candy made unsuccessful searches on every morning from Apr. 16–20. On Apr. 20.83 however, Candy saw the comet about 3° above the north-western horizon using a 40mm refractor and estimated the brightness to be 0^m with an uncertainty of a magnitude either way. It was suspected with the naked eye but not certain. Dr N. Wieth-

Knudsen also reported observing it from the Urania Observatory in Copenhagen on the same evening.

A search from Westcliff-on-Sea by H. B. Ridley and Hendrie that evening failed to find the comet but the next morning, Apr. 21.17, Hendrie found it in a bright sky and followed it with a 150mm reflector until clouds intervened 30 minutes before sunrise. The central condensation was about 2' across and as the sky brightened only an almost stellar nucleus remained. With no stars with which to make a comparison, the brightness of the head was estimated to be about 0 magnitude. Candy saw it again on this morning but not with the naked eye.

The same evening, Apr. 21.83, E. H. Collinson saw it with the naked eye ($+1$ mag) and so did Waterfield (-1 mag). Hendrie also saw it with the naked eye and noted that in a small refractor the head was shaped like a 'U' with a sharp, bright condensation at the bottom on the 'U': this sharpened to an almost stellar point at moments of good seeing (Figure 5). No distinct tail had been reported up to this time, only an extension of the head towards the north. On Apr. 22.85 both Candy and Hendrie found the comet an easy naked eye object despite poor conditions and very low altitude. About half a degree of tail was reported by Hendrie and G. A. Hole.

By April 23 the comet was being observed at greater altitude and in darker evening skies. Light pollution even in towns was much less of a problem than it is now. Indeed the younger astronomer of today may find it hard to believe that the Milky Way and comet tails could be well seen and photographed from suburban gardens in comparatively recent times. Haze and thin cloud and obscuration by trees and houses were more of a problem for observations near the horizon. For example, on Apr. 23.8 Hendrie with a very poor sky reported a tail length of about 1° while others reported a much longer tail: Candy (15° possibly 20°), Panther (14° in p.a. 012°), G. E. Taylor (more than 10°) and by A. W. and P. H. Vince (15° in p.a. 000°). The first visual reports of the anti-tail or 'beard' were on this night, by Panther (2° long in p.a. 202°), Taylor and Vince (2 – 3° long).

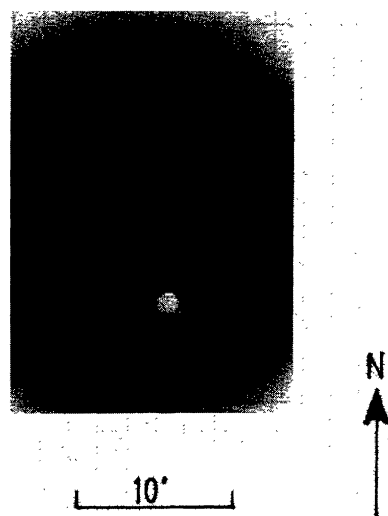


Figure 5. Comet Arend-Roland, 1957 Apr. 21.83, 50mm refractor $\times 25$ at Westcliff-on-Sea. M. J. Hendrie.

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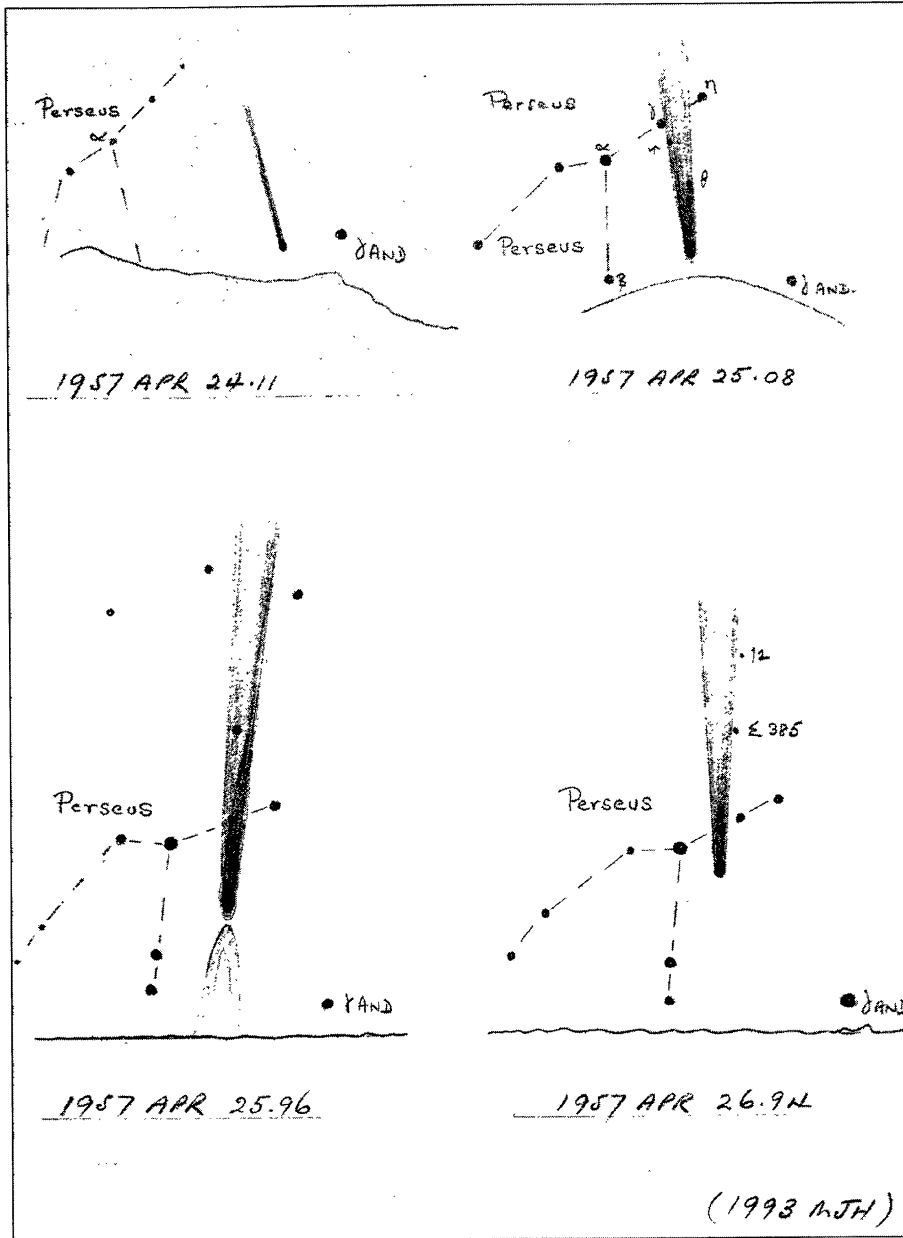


Figure 6. Comet Arend-Roland, 1957 April 24.1–26.9, seen by C. Dinwoodie from Langholm, Dumfriesshire. (Redrawn by M. J. Hendrie from original sketches).

From April 24 comet Arend-Roland became circumpolar from the British Isles and C. Dinwoodie made the first of a series of sketches of the comet from Langholm, Scotland (Figures 6 and 7). On April 24.37 M. Davies-Scourfield reported a strong central condensation and a 15° tail with a 3° anti-tail. That evening A. Soper at Godalming described a stellar nucleus with a dome-shaped coma $8'$ in diameter, extending into a fan-shaped tail 14° long in p.a. 020° with a fainter shaft of light of equal width towards p.a. 200° . C. Hare saw 11° of tail and Merton at Oxford 20° , estimating the brightness of the head at about 1st magnitude.

With a spell of generally quite good weather across the country and the absence of moonlight (new Moon on April

29), the comet was observed on every night through to the end of April. It was a beautiful sight seen in a dark sky with the broad tail pointing vertically upwards from the horizon. Hendrie noted that in small wide-field binoculars, comet Arend-Roland appeared to float in the foreground with the stars as a distant background. The longest tail length (30°) was reported by H. Martin at Barnard Castle on April 26. Observers still found it difficult to estimate the brightness of the head: observing conditions were certainly a factor and also no doubt because it merged imperceptibly with the tail. On April 27.9 B. G. Marsden made it 1.4 mag, Stone 2.0 mag, Merton 1.5 mag, Taylor 1.5 mag and Martin 1.9 magnitude. Figures 8–13 show a selection of photographs taken about this time.

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Panther described the comet on April 27.92 as seen in 8×40 binoculars as having a coma diameter of 11' with little condensation but a white star-like nucleus. The primary tail was 10° long in p.a. 026° with the anti-tail 2.5° long in p.a. 190°. The primary tail was fan-shaped, the edges diverging at 40°, with the tail brighter and the sky darker on the preceding side. The last visual observations of the anti-tail may have been on April 28.93 by A. R. Hamilton at Oxford who reported a thin very faint spike about 3° long in p.a. 165°: the main tail stretched 16°. By April 30 the brightness had fallen to about 3rd magnitude and tail lengths to about 8–10 degrees.

May to June

On May 1.96 Dinwoodie reported the tail at 7° long, in agreement with observations by Vince on the 2nd and Panther on the 3rd. On May 5.91 Panther saw the comet

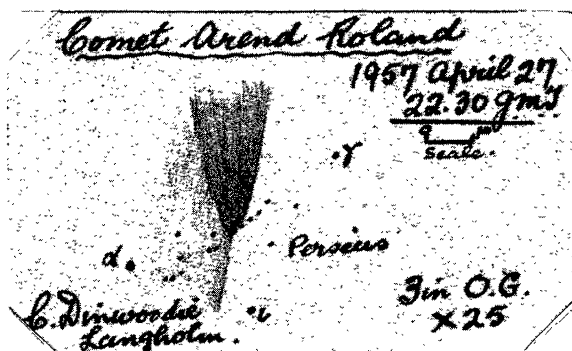
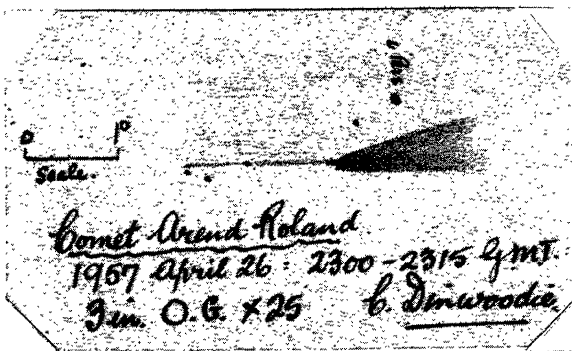
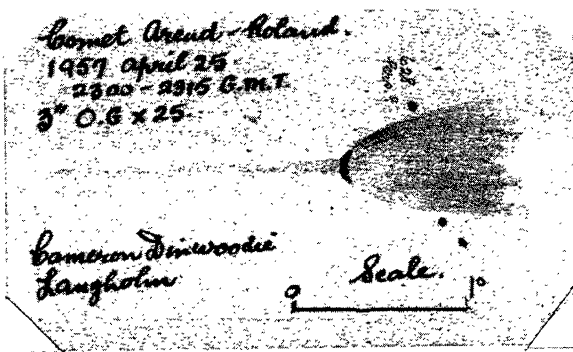


Figure 7. Comet Arend-Roland, 1957 Apr. 25.9–27.9, original sketches by C. Dinwoodie using a 70mm refractor ×25.

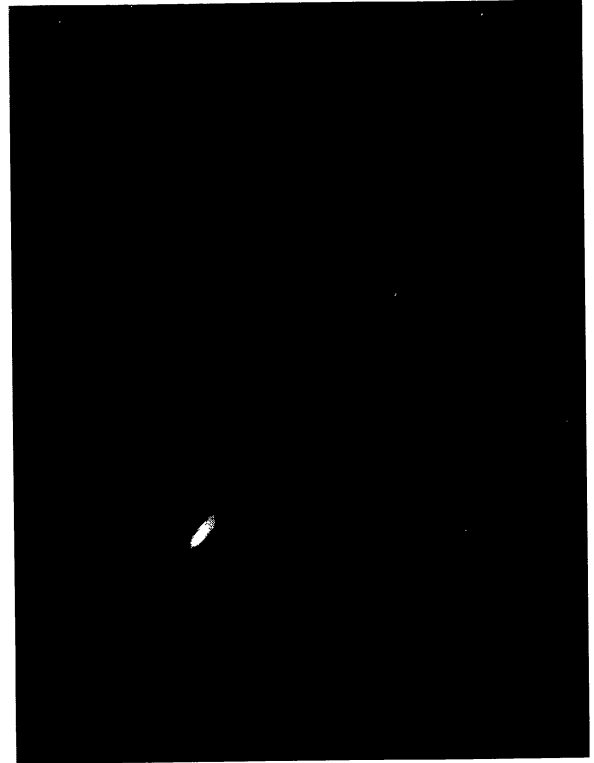


Figure 8. Comet Arend-Roland, 1957 Apr. 24.9, 36 minutes on a Kodak Oa-0 plate with an Ilford Aviol 2 yellow filter using the 150mm f/4.5 Cooke triplet at Ascot. R. L. Waterfield.

easily with the unaided eye despite a 5 day old Moon. In 8×40 binoculars the coma was moderately condensed, diameter 7' and the fan tail 4.5° long in p.a. 051°. That evening Stone saw 4° of tail with a condensation 2' in

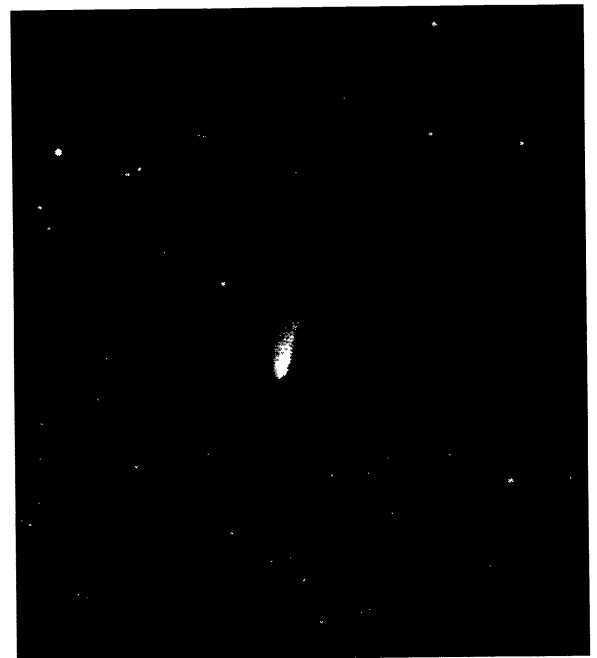


Figure 9. Comet Arend-Roland, 1957 Apr. 26.9, 1 minute exposure, instrument and observer unknown.

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Figure 10. Comet Arend-Roland, 1957 April 28.8, 30 minute exposure on a Kodak Oa-E plate with an Ilford Micro 5 orange filter using a 60mm f/3.5 Aldis lens. *R. L. Waterfield.*

diameter using a 70mm refractor×30: it was 3.2 magnitude. By May 11.93 comet Arend-Roland was only just visible to the unaided eye in bright moonlight but 4° of tail could still be seen in 8×40 binoculars. Full Moon was on the 13th but there was a total eclipse which enabled Hare, Hendrie, Soper, Stone, Waterfield and others to observe the comet. It was still faintly visible to the naked eye to Stone, estimated 4.5 magnitude, with a 5' coma and 2' condensation.

By May 18–20 G. E. D. Alcock, Hare and Marsden agreed on 5.1 magnitude while Stone made it 5.4 mag on May 20 and 5.9 mag on the 23rd. The coma continued to be moderately condensed and there was a short tail noted. Panther estimated the comet to be 6.7 mag on June 5.01 using 8×40 binoculars and in a 125mm reflector ×35 he recorded a coma 4' across with a moderate condensation and a faint fan tail 15' long in p.a. 092°.

The last reported visual observations were made by A. W. and P. H. Vince at Amersham using their 160mm



Figure 11. Comet Arend-Roland, 1957 Apr. 28.9, 36 minutes on an Ilford HP3 plate with a 80mm f/6.3 aerial survey lens of 510mm focal length. *W. A. Granger.*



Figure 12. Comet Arend-Roland, 1957 Apr. 28.9, 60 minute exposure with the 610mm refractor at the University of London Observatory at Mill Hill. *R. H. Garstang.*

refractor $\times 50$. Full Moon was on June 12 but they managed to make a very useful series of observations on June 11, 14–17, 22 and 27, though they did not record any estimates of its brightness. On all except the last night the short tail towards p.a. 070° was visible despite the bright summer twilight, and the head remained condensed. On June 27.9 the tail was only suspected.

Comet Arend–Roland was unusual in that for more than 7 months from our first visual observations at 10 mag, through 0 magnitude to the last visual observations at around 9 mag, it always showed a well-defined tail.

The tails of comet Arend–Roland

Most recent books on comets mention the anomalous tail and after the apparition hundreds of papers and articles appeared. Most agree that the maximum length of the main tail occurred during April 23–26 at about 30° , agreeing with the BAA observations and corresponding to a real length of 45 million km.

The reasons for the appearance and direction of the anti-tail were also discussed at length. A comet's tail has greatest extension in the plane of the comet's orbit. The tail points away from the Sun with the ion tail often lagging by a few degrees, but the dust tail may lag much further behind and be noticeably curved. In the case of comet Arend–Roland the appearance of the



Figure 13. Comet Arend–Roland, 1957 May 2.9, 15 minute exposure on an HP3 plate with a 60mm f/3.5 portrait lens. *M. J. Hendrie.*

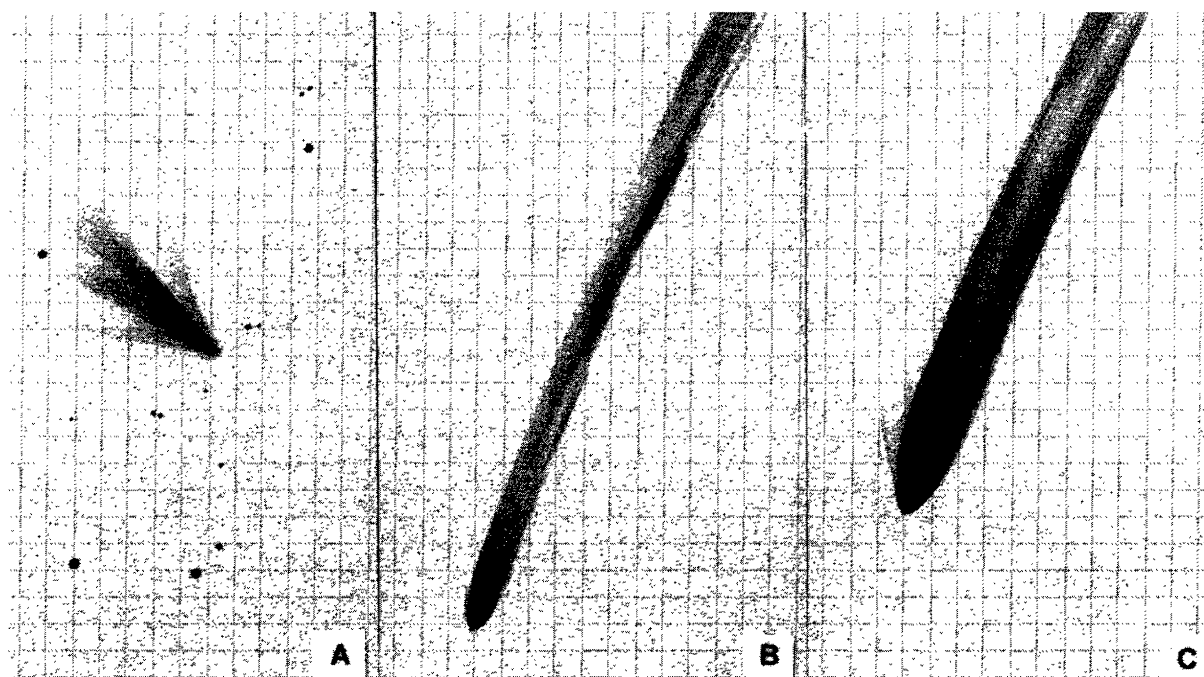


Figure 14. Comet Arend–Roland drawn by G. E. D. Alcock.

A. 1957 Jan 17.8, 100mm refractor $\times 30$; B. Apr 23.9, 12 $\times$ 45 bin.; C. Apr 23.9, 100mm R $\times 30$; (*continued overleaf*)

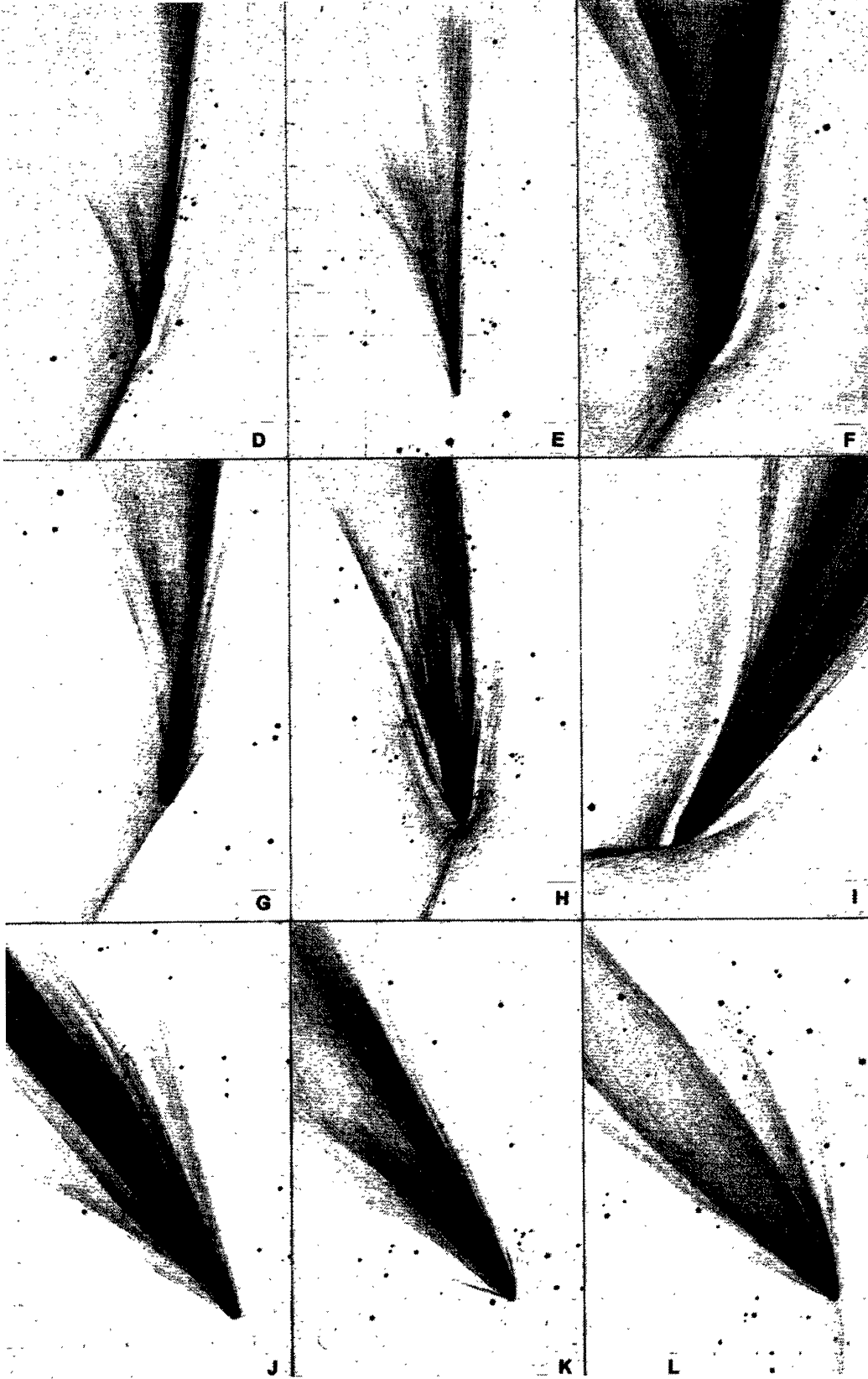
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Figure 14. Comet Arend-Roland drawn by G. E. D. Alcock (*continued*).

D. Apr 27.9, 12×45 B; **E.** Apr 28.9, naked eye; **F.** Apr 28.9, 100mm R×30, 12×45 B; **G.** Apr 29.9, 100mm R, 12×45 B; **H.** May 2.9, 100mm R, 12×45 B; **I.** May 6.1, 100mm R×30, 12×45 B; **J.** May 19.9, 100mm R×30, 12×45 B; **K.** May 20.9, 100mm R, 12×45 B; **L.** May 26.0, 100mm R×30, 12×45 B.

anti-tail has been explained by a thin sheet of larger dust particles, outside the comet's orbit and trailing farther behind the head than the main dust tail. There must have been little extension of this dust sheet above and below the plane of the comet's orbit.

The Earth passed through the comet's orbital plane about April 25.8. Before that date the anti-tail was seen as a faint fan directed towards the right or preceding side of the main tail. Over the next few nights the anti-tail moved clockwise or towards the left becoming brighter and narrower until on April 25–26 it was seen as a very narrow bright 'spike', parallel-sided and pointing in the opposite direction to the main tail. The true thickness was less than 20,000km. Reliable observations put the greatest length of this 'spike' at 15°, which would have given it a true length of 56 million km, or greater than the length of the main tail. On subsequent nights the clockwise motion continued as the anti-tail again became fan-shaped and broader, becoming undetectable after a few days.

The apparent pointing of the anti-tail towards the Sun was an effect of perspective as both tails were in fact farther from the Sun than the head of the comet. While sunward pointing tails are not exactly rare, they are usually short, faint and difficult to observe and comet Arend–Roland's was the finest example of recent times as Waterfield's photographs show well.

Comet C/1957 P1 (Mrkos)

Circumstances of the apparition and discovery

As often happens with the discovery of a bright nova or comet, reports received at the IAU Central Bureau for Astronomical Telegrams (then in Copenhagen) are not always in the order of the priority of discovery. In the case of a comet discovery not more than three names are in any case attached to a single comet.

The first notification received was from the Czech astronomer and comet discoverer A. Mrkos, reporting his discovery on the morning of August 2. However, amongst others who saw the comet prior to this date reports were received from S. Kuragano in Japan (July 29) and airline pilot Peter Cherbak over Colorado (July 31 and August 1). In view of the diverse claims to discovery it was decided to name the comet just Mrkos.

Unlike comet Arend–Roland, comet Mrkos was discovered when already a naked eye object. It had moved up from the southern hemisphere behind the Sun and hidden in its glare (Figure 15) and when it became observable in morning twilight at the beginning of August, it was already at perihelion (0.35 AU) and at its brightest, about 1st magnitude. The elements and ephemeris are shown in Table 3.

Comet Mrkos was 1.2 AU from the Earth on August 1

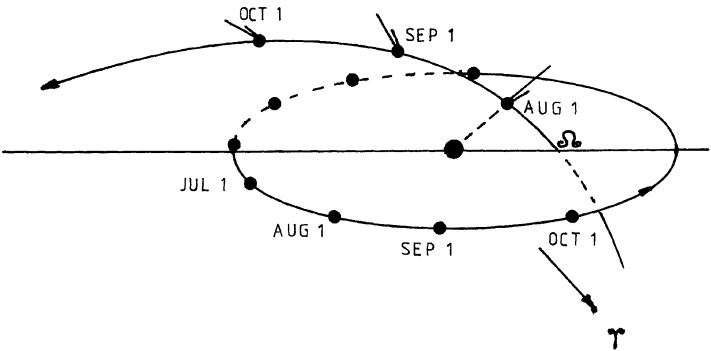


Figure 15. Orbit diagram for Comet Mrkos, showing the comet's approach from behind the Sun.

closing to 1.1 AU by the 10th and then increasing steadily to 2.0 AU by the end of September when it was 1.4 AU from the Sun.

Though comet Mrkos was best seen for the first few days in the morning sky, its increasing right ascension and declination carried it quickly north of the Sun to become an evening object by about August 8. In Gemini at discovery, the comet passed through Lynx and into Leo Minor by August 8 where it reached its greatest northern declination of +38°, so that it was never really an all-night object from most of the British Isles as comet Arend–Roland had been.

Passing through Ursa Major during August 14–20, its declination had decreased to +31° as it entered Coma Berenices on the 21st reaching +15° declination in the same constellation by the beginning of September. It then passed into Boötes but became a difficult object in evening twilight. During the whole apparition the elongation from the Sun had never exceeded 43°. Poor weather and a full Moon on August 10 hindered observations.

Table 3. Comet C/1957 P1 (Mrkos) 1957 V

Epoch 1957 July 21.0									
T	1957 Aug. 1.4373 TDT	ω	40.3135						
q	0.354933 AU	Ω	67.6252	1950.0					
e	0.999365	i	93.9392						
Oh UT	RA (1950.0)	Dec.	Δ	r	Rv	Elong.	Mag		
	h m	° ′	AU	AU	°	°			
1957									
Jul 31	7 51.5	+29 52	1.20	0.36	319	16	+1.9		
Aug 5	8 43.1	35 46	1.13	0.37	350	19	1.9		
10	9 49.8	38 10	1.08	0.43	16	24	2.5		
15	10 58.1	36 25	1.07	0.52	36	29	3.3		
20	11 55.8	31 45	1.10	0.62	50	34	4.1		
25	12 40.3	25 56	1.17	0.72	61	38	4.9		
30	13 13.8	20 10	1.26	0.82	70	41	5.6		
Sep 4	13 39.6	14 56	1.37	0.92	76	42	6.3		
9	14 0.1	10 23	1.49	1.02	81	43	6.9		
14	14 16.9	6 28	1.62	1.11	84	43	7.5		
19	14 31.2	3 08	1.76	1.21	87	42	8.0		
24	14 43.7	+0 15	1.89	1.30	89	40	8.5		
29	14 54.7	-2 15	2.02	1.39	91	39	9.0		
Oct 4	15 4.8	4 26	2.16	1.48	92	37	9.4		
9	15 14.0	-6 22	2.29	1.56	92	34	9.7		

Predicted magnitudes from $m = 6.0 + 5 \log \Delta + 10 \log r$
(Elements from *Catalogue of Cometary Orbits*, 1986 edition; magnitude formula from BAA Circular 388, 1957 Aug 23)

Comet Mrkos 1957 d

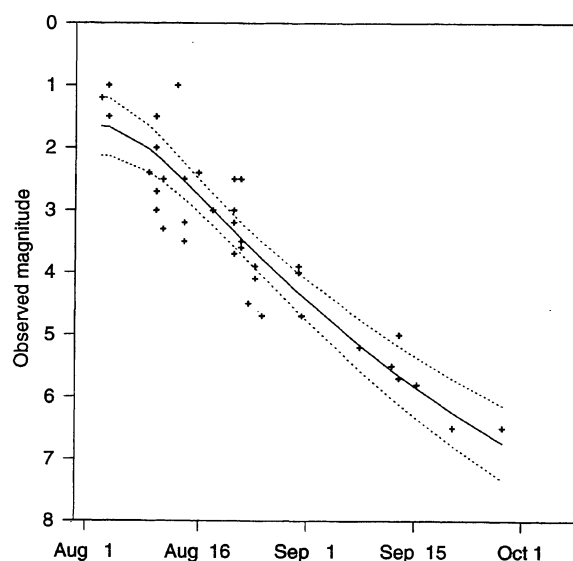


Figure 16. Comet Mrkos observed magnitudes. The curve is the best fit over the apparition, with no corrections applied.

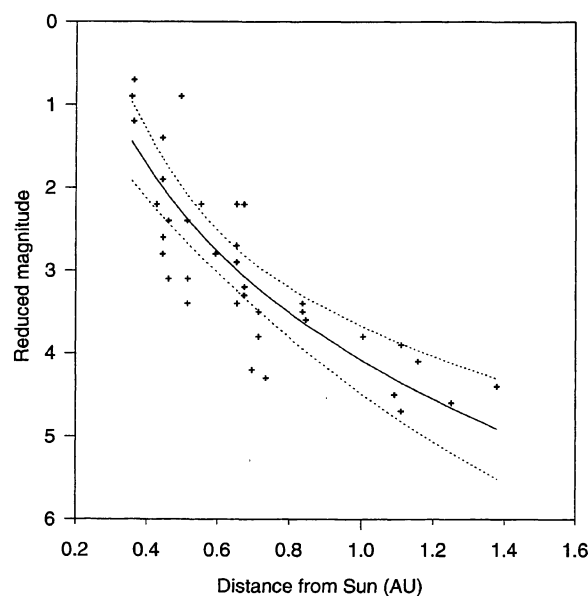


Figure 17. Comet Mrkos magnitudes corrected for aperture and reduced to a distance of 1 AU from the Earth, plotted against the distance from the Sun.

Visual photometry

Visual observations were received from most of the 33 observers listed in Table 2. The plot of observed visual magnitudes is shown in Figure 16 and reduced magnitudes in Figure 17. The rather wide scatter is likely to be at least partly due to the presence of moonlight and twilight and the relatively low altitude of the comet when seen in a darker sky. A least squares analysis of the visual observations, corrected for aperture, leads to the formula:

$$m = 4.2 \pm 0.1 + 5 \log \Delta + 6.3 \pm 0.6 \log r + 0.033 \text{ ap}$$

Photography

General aspects of photography have been covered under comet Arend-Roland, most observers using the same equipment and methods. We were fortunate to receive a splendid series of observations from Alan McClure who observed with a battery of transportable instruments from the Californian mountains. Our records do not show what camera he used for the photographs reproduced here but for photographs of comet Mrkos published in *Sky and Telescope* he is reported to have used a 100mm f/4 Goto lens. It seems likely our prints were made from the same series of negatives.

Conditions for photography in this country were more difficult than for comet Arend-Roland due to summer twilight, moonlight, poor weather and the low altitude of the comet when seen in a dark sky, but a number of useful photographs were obtained by several members.

Descriptive notes on comet Mrkos

Before a BAA *Circular* could be prepared the comet had been discovered independently by BAA member Clive Hare, then still at school, from near Tamworth on the morning of August 3.12. He made it equal to Pollux (β Geminorum) in brightness or about 1.5 magnitude, with a small bright head and a 2° long tail diverging by about 10° . W. A. Clark from near Hull, also a BAA member, reported seeing it (again without prior knowledge of its discovery) on August 4.1.

Dr Merton alerted some members of the Comet Section on August 3, suggesting a magnitude of 2 to 3 but a search by Hendrie on August 3.9 in good conditions but with a first quarter Moon failed to show the comet. However, later that night on August 4.15 Hendrie saw the comet's tail rising in the north-east over rooftops. The head was strongly condensed about $5'$ across, of about 1.5 magnitude with a bright straight tail 4° long diverging by about 20° towards



Figure 18. Comet Mrkos, 1957 Aug. 10.4, 10 minute exposure in twilight. Alan McClure, California.

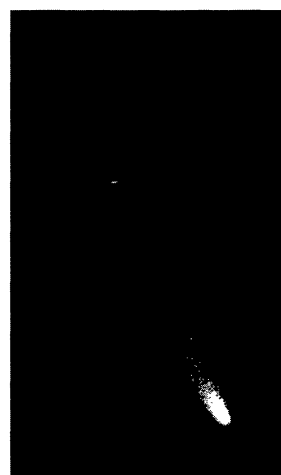


Figure 19. Comet Mrkos, 1957 Aug. 13.9, 15 minute exposure, HP3 plate, 80mm f/5.6 Aldis aerial survey lens. P. G. Darvill.

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Figure 20. Comet Mrkos, 1957 Aug. 21.9 and 24.9: two sketches prepared from an examination of 6 photographs taken on each night by M. J. Hendrie.

p.a. 320° . The sky was clear but there was bright twilight and only Castor and Pollux were visible, just to the east of the comet. It was followed until 0330 UT with the naked eye and 0345 UT in binoculars, sunrise being at 0430 UT. It was a splendid sight as the tail, though not very long, was bright along its full length.

Waterfield obtained a photographic position on August 4.9 and observed it visually through gaps in the clouds on August 6.9, but owing to bad weather conditions there were no further reports from BAA members until August 9.9 when Dinwoodie reported a 1° tail in p.a. 000° with the comet 2.4 magnitude, as seen against a bright sky back-



Figure 21. Comet Mrkos, 1957 Aug. 24.9, complex structure in the ion and dust tails seen with a 100mm refractor $\times 30$ and 100mm binoculars $\times 25$. G. E. D. Alcock.



Figure 22. Comet Mrkos, 1957 Aug. 17.8, 29 minute exposure, Oa-0 plate and Ilford Avirol 2 filter, 150mm f/4.5 Cooke triplet. R. L. Waterfield.

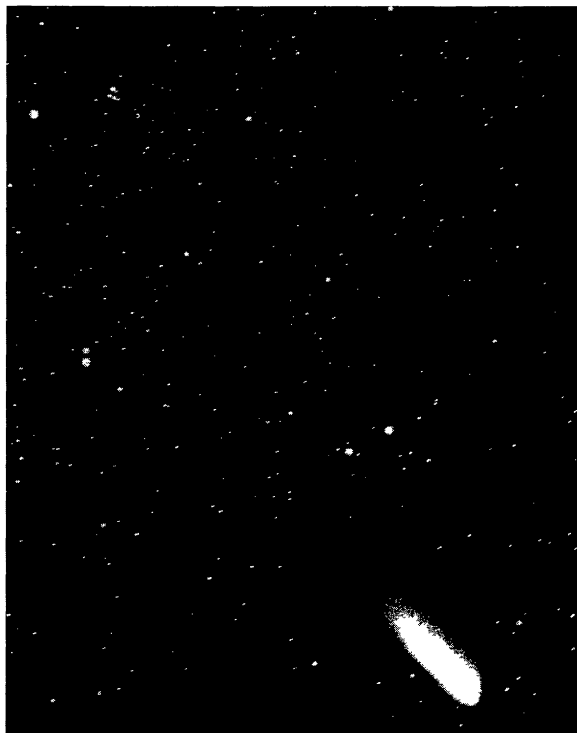
The bright comets of 1957

Figure 23. Comet Mrkos, 1957 Aug. 20.2, 9 minute exposure. *A. McClure, California.*

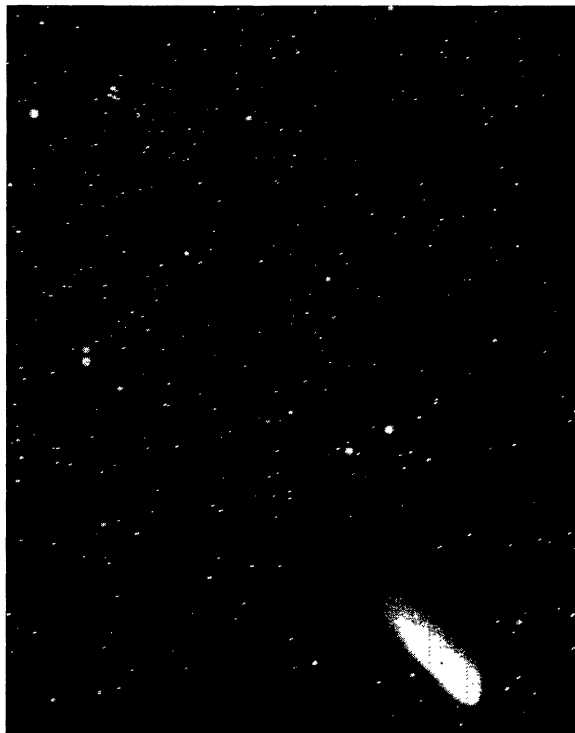


Figure 24. Comet Mrkos, 1957 Aug. 20.2, 25 minute exposure showing banded structure in the dust tail. *A. McClure.*



Figure 25. Comet Mrkos, 1957 Aug. 21.8, 150mm f/4.5 Cooke triplet, showing structure in the ion tail. *R. L. Waterfield.*



Figure 26. Comet Mrkos, 1957 Aug. 22.9, 40 minute exposure, Ilford Zenith astronomical plate with an 100mm f/4 portrait lens, showing further structure in the ion tail. *E. A. Whitaker.*



Figure 27. Comet Mrkos, 1957 Aug. 25.2, 29 minute exposure. A. McClure.

ground. However several observers including Granger, Hare, Hendrie, Merton, Panther, Steavenson and Waterfield observed the comet on August 10.9, most estimating its brightness as between 1.5 and 2.0 with a large, diffuse coma about 4' in diameter with strong condensation and a bright, slightly curved tail some 3° long. The coma was described as orange-yellow and the tail yellowish. Granger remarked that it was a splendid object and, though smaller in extent, much easier to see than comet Arend-Roland had been (Figures 18, 19).

G. E. Taylor reported 2° of tail with naked eye on August 13.9 and Candy, P. Kemp, Merton and Soper estimated its brightness as 2.5 to 3 magnitude with a fan-shaped tail 2–3° long towards p.a. 040°. The head was still strongly condensed. The Moon was at last quarter on the 18th. The comet was observed visually by H. Martin on August 18 in poor conditions and on Aug. 21.9 by Candy at Herstmonceux in a good sky, showing a 3° tail and well condensed head of 3.2 magnitude. It was easily seen with the naked eye. Visual observations were made the same night (with tail lengths) by Hare (3–4°), Hendrie (3–4°), Panther (3.8° p.a. 060°), and Taylor (2°).

With no interference from moonlight and better weather than earlier in the month the comet showed a great deal of detail photographically that was not recorded visually (Figures 20 and 22–30) except by Alcock (Figure 21). On August 24.9 the comet was still easily visible to the naked eye by Hendrie, Marsden and Panther who reported up to 3° of tail and on the following day to M. Ryan and Hare who drew a slightly diverging tail streaming away from a well condensed head with a sharp condensation. Candy and Taylor made the comet 4.0 magnitude on the 30th with a 2.5° length of tail, and still visible to the naked eye.

A. F. Jones of Timaru, New Zealand made his first obser-

vation of Comet Mrkos on 1957 August 31.3 reporting a bright condensation within a diffuse coma with a narrow tail 30' long and a total brightness of 4.7 magnitude falling to 5.2 mag by the 8th. Taylor observed on September 12.8 and 13.8 describing it as a fuzzy object low in the western sky and 5.7 magnitude: Candy made the comet 5.7 magnitude with a tail 1° long in p.a. 070°.

A. F. Jones observed again on September 16.3 with a 50mm finder giving 5.8 magnitude, diffuse coma with strong condensation and a faint tail while on the 21st it had faded to 6.5 mag. with a diffuse coma 4' across with a strong oval condensation of 9.0 magnitude. The broad tail pointed towards p.a. 085°. There was little change in the brightness or appearance of comet Mrkos when Jones observed it again on September 28th, though he glimpsed a faint nucleus on the later date.

Conclusion

Although there have been a few comets as bright or brighter than those of 1957 since that time, only comet C/1969 Y1 (Bennett) in the spring of 1970 and C/1996 B2 (Hyakutake) in the spring of 1996 were as readily accessible to observers in the British Isles. Comet



Figure 28. Comet Mrkos, 1957 Aug. 26.9, 25 minute exposure on an Ilford Zenith plate with an f/3.8 lens of 200mm focal length. B. G. Manning.

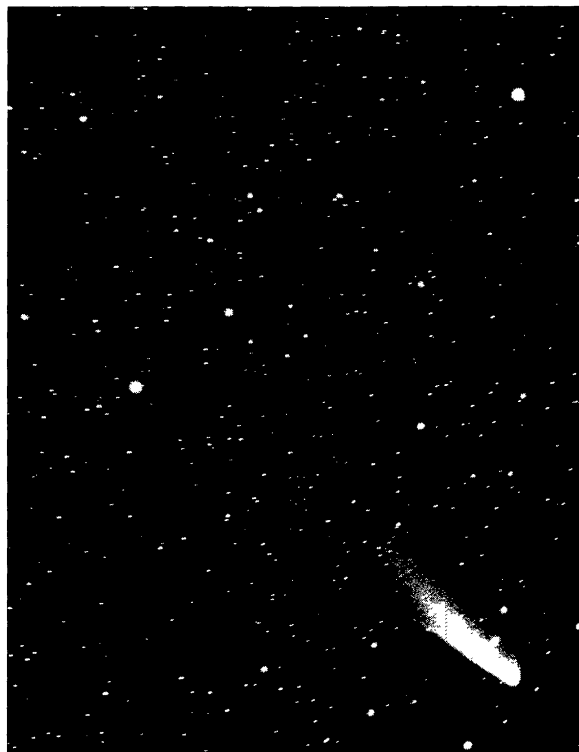


Figure 29. Comet Mrkos, 1957 Aug. 28.2, 30 minute exposure. *A. McClure.*

C/1975 V1 (West) was low in morning twilight when at its brightest in early 1976 March and the weather was generally troublesome.

I should like to thank J. D. Shanklin for using his photometric program to analyse the magnitude observations and for preparing the magnitude diagrams and for his general encouragement during the preparation of this report. Articles and papers on these two comets are too numerous to list but the general report by J. G. Porter is a very useful summary. The two comets were discussed at the Association's meetings and quite fully reported in the *Journals* at the time.

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- 2 Shanklin J. D., 'Comet Analyses', *J. Brit. Astron. Assoc.*, **105**(6), 291 (1995)



Figure 30. Comet Mrkos, 1957 Aug. 30.9, 24 minute exposure with 100mm f/4 portrait lens, showing the dust tail noticeably weaker. *E. A. Whitaker.*

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