2024 December
Vol. 134 No. 6

Journal of the British Astronomical Association

C/2023 A3 (Tsuchinshan–ATLAS)

Journal of the British Astronomical Association

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The *Journal* is published six times per year, in February, April, June, August, October & December.

Library subscription (UK and surface mail overseas): £83.00. To purchase single copies of specific issues please see **britastro.org/shop**.

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Issue	*Date*
2024 February	2024 Dec 12
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Published by:
The British Astronomical Association,
PO Box 702, Tonbridge TN9 9TX
Tel: 020-7734 4145
BAA: **britastro.org/** *Journal:* **britastro.org/journal/**

ISSN 0007–0297

The Magazine Printing Co., Hoddesdon, EN11 0FJ

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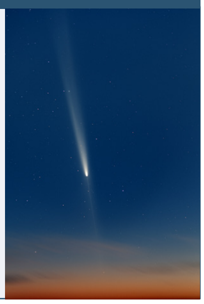
On the cover

C/2023 A3 (Tsuchinshan–ATLAS) — *Nick James*

Much anticipated, the comet C/2023 A3 put on a good show in mid-October. Earth crossed its orbital plane on Oct 14, resulting in a bright anti-tail in the opposite direction to the main dust tail of the comet. The anti-tail is well seen in this beautiful photograph by Comet Section Director Nick James, whose report on members' observations is on p. 392.

2024 Oct 14, 19:56 UTC. 100-mm focal-length, *f*/2, Sony A7s III. 20 × 8 s, ISO 1600. 13 × 21°. Taken on the island of La Palma at an elevation of 2,100 m.



Comet Section

Comet C/2023 A3 (Tsuchinshan–ATLAS) at its best

The Director of the Comet Section reports on observations of the much-anticipated comet.

Nick James
Director

► **Figure 1.** 2024 Oct 13, 19:45 UTC. 250-mm FL, *f*/4.9, ASI 2600MC. 30 s. 3.6×5.4°. Nick James, 2100 m, La Palma.

Circumstances & predictions

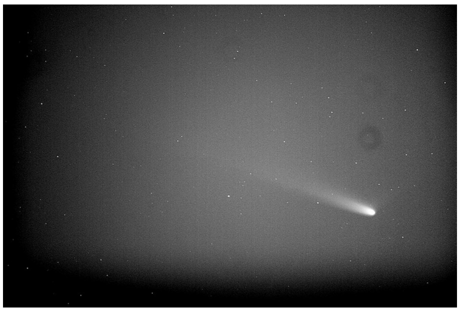
Comet C/2023 A3 (Tsuchinshan–ATLAS) was discovered in 2023 Jan and, as soon as the first accurate orbit was computed, there was speculation that it would be an impressive naked-eye object around the time of perihelion.[1,2] It is always wise to be sceptical of comet magnitude predictions based on limited observations, particularly if the comet is far from the Sun. However, in this case, the comet was well behaved and it went on to follow the predictions closely.

When it was discovered, the comet was an 18th-magnitude object, 7 astronomical units (au) from the Sun. It would come to perihelion on 2024 Sept 27 at a solar distance of only 0.39 au (about the mean distance of Mercury). The inbound barycentric orbital eccentricity was very close to 1, suggesting that this comet likely fell from the Oort Cloud and thus has an indeterminate period. The outbound eccentricity is actually significantly greater than one, indicating that the comet will likely be ejected from the Solar System. The orbital period of 80,000 yr widely quoted in the media is wrong. It is likely this is the one and only time that this comet has visited the inner Solar System. We were very lucky to be here when it did!

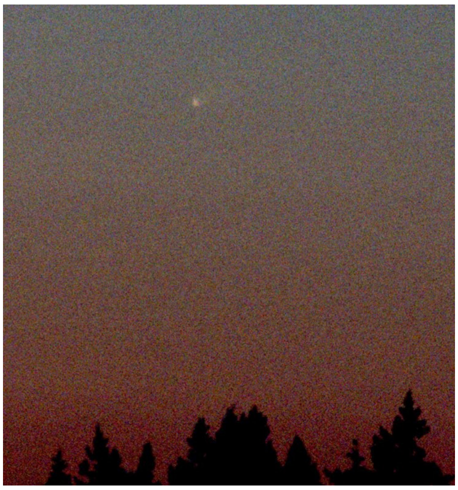
The orbit geometry was particularly good as seen from the Earth. The comet would spend 2023 and much of 2024 around a declination of zero, so was visible from both hemispheres. During this period, it brightened gradually until 2024 Apr, when it had a temporary fade before starting to brighten again.[3] The dip caused some consternation, but it was mainly a phase-angle effect. It was used as evidence that the comet was fragmenting,[4] but observations did not support that hypothesis and, as we have seen, the comet was actually very healthy.

As the elongation reduced, the comet was lost in the evening twilight around the end of 2024 Jul for northern-hemisphere observers, and a little later for those in the southern hemisphere. By that time, the comet had reached 9th magnitude and was faithfully following the predicted light curve. It would reappear in the morning sky for southern observers in mid-September as the elongation increased, reaching around 23° towards the start of October before diving down to conjunction on Oct 9 at an elongation of only 4°. Thereafter, the comet would appear in the evening sky at a rapidly increasing elongation. The southern hemisphere was favoured before conjunction, although there was a possibility of seeing the comet very low in the morning sky from UK latitudes around the end of September, and the northern hemisphere was favoured after conjunction. The comet would make its closest approach to Earth on Oct 12 when it would be 0.47 au away.

There were two particular aspects to the post-perihelion geometry that were expected to have a significant effect on our view of the comet. ►



Above: **Figure 2.** 2024 Sept 21, 17:02 UTC. 0.18-m, *f*/2.8, Canon 550D. 10 × 10 s, ISO 1600. 4.1 × 2.7°. John Drummond, Gisborne, New Zealand.



Right: **Figure 3.** 2024 Sept 28, 05:07 UTC. Seestar S50 (250-mm FL, *f*/5, IMX462). 10 s. 0.7° width. Mark Hardaker, Knowlton, Dorset.

Figure 4. 2024 Sept 29, 06:35 UTC. 200-mm FL, *f*/2.8. Nikon D7500. 3 s. 6.8 × 4.7°. Mazin Younis, Morocco.

► The first was that the viewing geometry post-perihelion was expected to lead to a significant brightening due to forward scattering from dust particles in the coma. The scattering angle reached a minimum of 7 degrees on Oct 9 and Joe Marcus predicted that this could increase the comet's brightness by 7 magnitudes over the basic light curve.[5] This implied that the comet could reach magnitude –4 on Oct 9, but at this time the solar elongation was only 4°. The elongation would increase rapidly after this date, but the effect of forward scattering would quickly reduce, although the comet could still be very bright on the evenings of Oct 11 & 12 when it was possible that it would be visible just after sunset if the sky was clear.

The second effect would be seen around Oct 14. On this day, Earth was to pass through the comet's orbital plane, so the dust tail would be seen edge-on and its brightness would be significantly enhanced. Such a situation shortly after perihelion is likely to lead to a significant anti-tail. The most famous example of this effect was in C/1956 R1 (Arend–Roland) after its perihelion in 1957.

After the plane crossing, the comet will fade as it heads back to the Oort cloud, although it should be visible in amateur telescopes for several years.

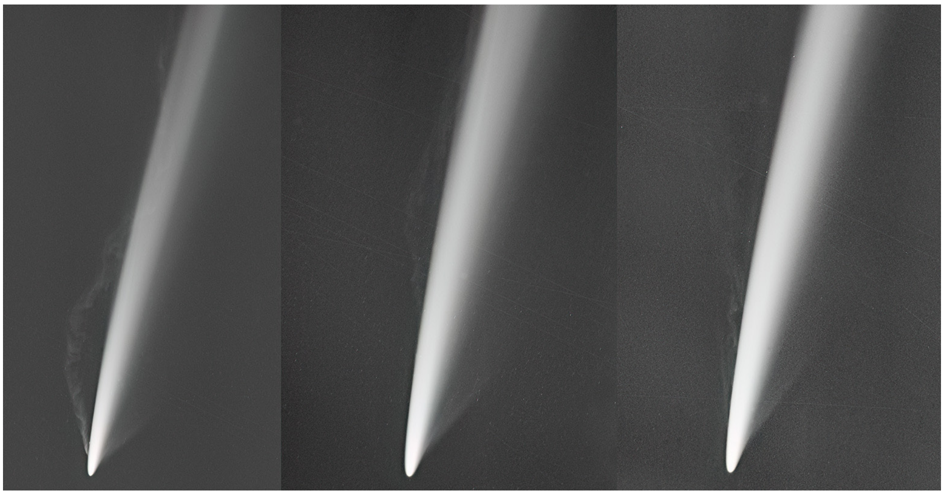
Pre-conjunction observations

The first morning-sky observation from the southern hemisphere was by Terry Lovejoy (Queensland, Australia) in bright twilight on Sept 11.794. He estimated a total visual magnitude m_1 of 5.5. The next day, Mike Mattiazzo (Victoria, Australia) imaged the comet and reported that the magnitude was similar to that of delta Sextans (magnitude 5.2). Both estimates were in line with the predicted light curve, so were very encouraging.

Subsequent images over the next few days by Lovejoy, Mattiazzo, and Rob Kaufman (New South Wales, Australia) showed the comet to be brightening rapidly as it moved into darker skies. On Sept 21, John Drummond (New Zealand) imaged the comet using a Takahashi Epsilon, revealing a tail approximately 1.2 degrees in length (Figure 2). By Sept 22, the comet was higher in a darker sky, but the Moon was still a problem.

On Sept 22.78, Rob McNaught (Coonabarabran, Australia) reported that the comet was just visible with the naked eye and he estimated m_1 to be approximately 4.1. From the northern hemisphere, Mazin Younis (remote observatory in Morocco) imaged the comet as it rose over the Atlas Mountains over several mornings between Sept 25 and Oct 3. By Sept 28, Lovejoy's deep image showed that the dust tail length was more than 11 degrees and that the comet also had ion and sodium tails. The magnitude had already increased to around 2.5 and the predicted forward scattering was starting to have an effect.

Two pre-conjunction observations from the UK were reported to the BAA, both from the morning of Sept 28. The first, at 04:58 UTC, was from Jim Burchell (Dartford). His Seestar image shows an object which is probably the comet, but this is difficult to confirm. At the time, the comet would have been less than 2° above the horizon. The second observation, at 05:07 UTC, is more secure. This is from Mark Hardaker (Dorset) who managed to find and image the comet using a Seestar S50 (Figure 3). He reports that the sky had been very transparent, but that haze built up along the eastern horizon as dawn approached. Despite knowing where to look, he could not find the comet in 10 × 70 binoculars. His images show a tail, and this is definitely the comet. ►



Above: **Figure 5**. 2024 Sept 30, Oct 1, and Oct 2; approx. 03:10 UTC. 300-mm FL, *f*/5, ASI 6200MM, L-filter. 2 × 120 s. 3 × 7° each panel. Michael Buechner, Tivoli Farm, Namibia.

Right: **Figure 6**. 2024 Oct 2, 18:31 UTC. 85-mm FL, *f*/2, Canon 6D Mk III. 2.5 s, ISO 2000. 16 × 24°. Rob McNaught, Coonabarabran, NSW, Australia.

► On Oct 1, Mark Radice (Sossusvlei, Namibia) reported that the comet was a 'very pleasant' view in 8 × 56 binoculars. His wide-angle image shows a tail 3 degrees long. The elongation was now decreasing rapidly, and the comet was becoming more of a challenge in the morning sky. Despite this, Michael Buechner (Tivoli Farm, Namibia) was still imaging it, and his compilation (Figure 5) shows the rapid development of the tail from Sept 30 to Oct 2.

The comet was lost to Earthbound observers after Oct 6, but its evolution could be followed using the *Solar Terrestrial Relations Observatory Ahead* (STEREO-A) Heliospheric Imager, and *Solar and Heliospheric Observatory* (SOHO) Large-Angle and Spectrometric Coronagraph (LASCO) instruments. SOHO, positioned at the L1 Lagrange point, has a view similar to that of Earth. In contrast, STEREO-A is currently about 26 degrees ahead of Earth in its orbit, resulting in a different viewing geometry. This difference caused the comet's dust tail to appear far broader in the STEREO-A images (Figure 7, below).

Post-conjunction observations

The first reports of the comet in the evening sky post-conjunction were received on Oct 10. Alexei Pace (Malta) imaged the comet in a bright sky only 3° above the horizon. The magnitude was around $m_1 \cong -2.5$ on that date.

At this time, the comet's dust tail was still visible from the southern hemisphere in the morning sky. Both McNaught and Mattiazzo submitted images showing this ghostly tail, with the comet's head well ►

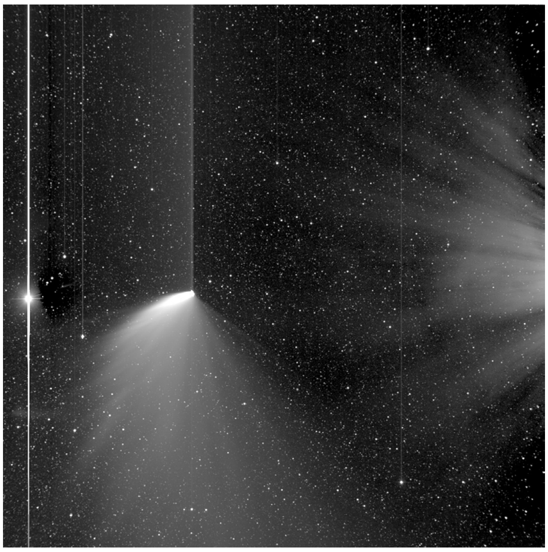
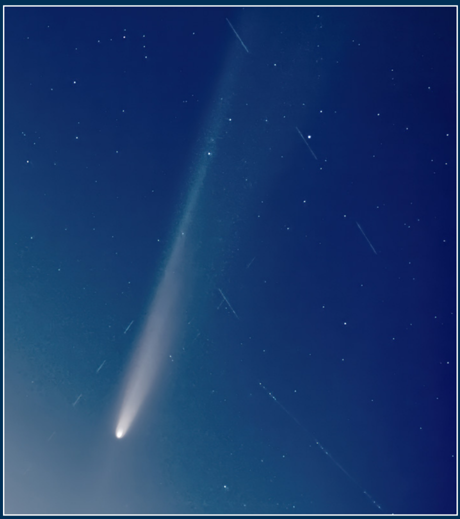
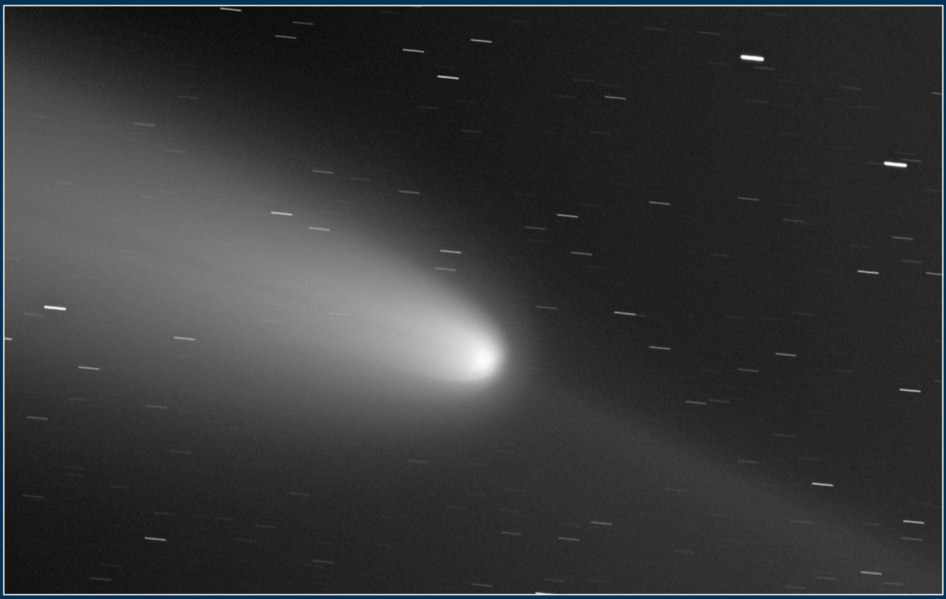


Figure 7. 2024 Oct 7, 23:28 UTC, 78-mm FL, *f*/4.9, E2V CCD42-40, 30 × 40 s. 20.4 × 20.4°. STEREO-A HI-1, 26° ahead of Earth along the ecliptic.

Figure 8. 2024 Oct 12, 18:30 UTC. 105-mm *f*/3.5, Canon 7D, 2 s, ISO 1200. 13 × 9°. Paul Whitmarsh, Ashdown Forest, East Sussex.





Clockwise from top left

Figure 9. 2024 Oct 13, 18:25 UTC. 135-mm FL, *f*/4, Canon 450D. 6 × 2 s, ISO 1600. 5 × 6°. Mike Greenhill-Hooper, Miradoux, France.

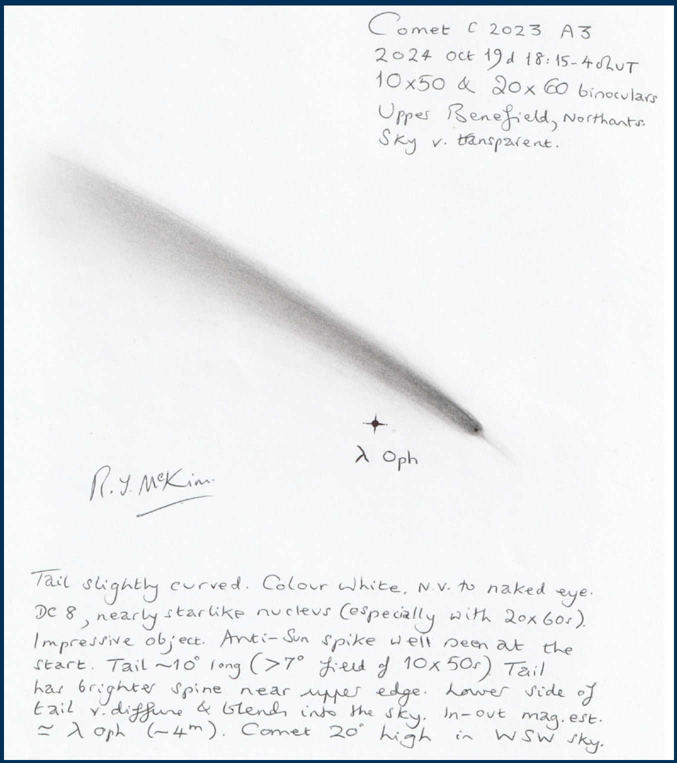
Figure 10. 2024 Oct 14, 19:29 UTC. Seestar S50 (250-mm FL, *f*/5, IMX462). 80 × 10s. 0.5 × 1.1°. Steve Knight, 2100 m, La Palma.

Figure 11. 2024 Oct 17, 19:10 UTC. 0.32 m, *f*/8, QHY600. 20 × 7s. 0.8 × 0.5°. Peter Carson, Fregenal de la Sierra, Spain.

Below

Left: **Figure 12.** 2024 Oct 17, approx. 19:00 UTC. 50-mm FL, *f*/1.2, ASI 1600MM. 40 min total, 2 s per frame. Field of view 6° in height. Nick Haig, Southampton.

Right: **Figure 13.** 2024 Oct 19, 18:30 UTC. 10 × 50 & 20 × 60 binoculars. Richard McKim, Upper Benefield, Northants.



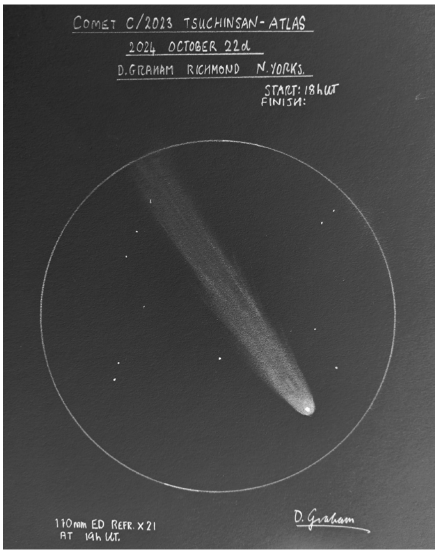


Figure 14. 2024 Oct 22, 19:00 UTC. 0.11-m refr., ×21. David Graham, Richmond, N. Yorks.

Figure 15. 2024 Oct 26, 19:45 UTC. 0.16-m, *f*/3.3, Sony A7s. 100 × 30s, ISO 6400. 2.5 × 1.7°. Denis Buczynski, Tarbatness, Highland.

► below the horizon, on the other side of the Sun.

On Oct 11, Jason Hatton (Noordwijk, Netherlands) managed to see the comet in 11 × 50 binoculars at 17:41 UTC. Steve Knight (La Palma) also obtained a fleeting view on that evening using a Seestar, but clouds low in the west prevented detailed observations.

A number of UK observers managed to pick up the comet in the bright evening twilight on Oct 12. These included Honor Wheeler (Kent), James Dawson (Nottingham), Peter Carson (Essex), Nick Quinn (Sussex), Philip Jennings (North Yorks.), Paul Whitmarsh (Sussex) and Shaun Taylor (West London). On this night, Jonathan Shanklin (Cambridge) estimated $m_1 \cong 0.3$ using 8 × 40 binoculars.

By Oct 13, McNaught was reporting that the tail was still visible in the morning sky. In the evening sky, the anti-tail was growing in prominence and was visible in images from Mark Greenhill-Hooper (Miradoux, France) and Nick James (La Palma). From La Palma, the comet was a wonderful naked-eye object low in the twilight between Venus and Arcturus, with a tail of at least 13 degrees visible on images despite the persistent cloud to the west.

Oct 14 was the day of the orbit plane crossing. Andrew Robertson (Norfolk) had a good view and reported an 8-degree tail with the naked eye. Robin Leadbeater (Cumbria), Steve Brown (North Yorks.) and David Swan (Newcastle) also had clear skies. Brown estimated the tail length to be 15 degrees. Despite the nearly full Moon, the view from La Palma was stunning, featuring a 12-degree, naked-eye tail pointing upward from the horizon. A sharp anti-tail was also visible through binoculars and, particularly in images, stretching all the way down to the horizon. On images, the dust tail measured over 20° in length, ►

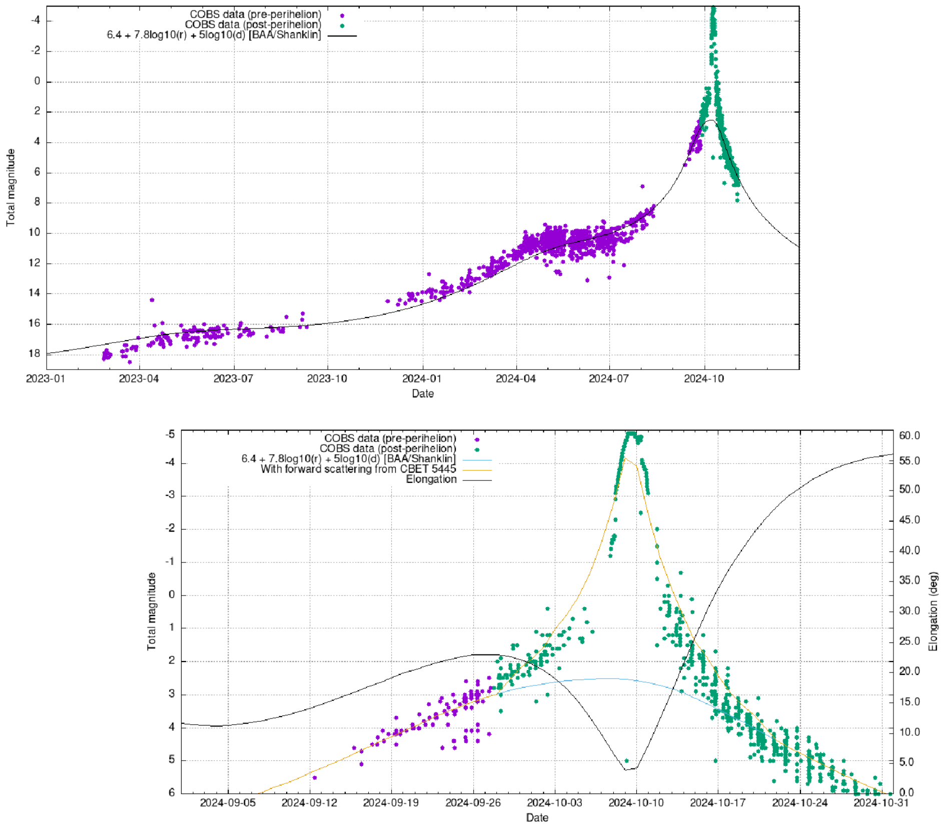


Figure 16. The top light curve shows estimates of the comet's total magnitude (m_1) taken from the COBS database. Purple points are pre-perihelion and green are post-perihelion. The comet was very well behaved and it followed a simple magnitude law very well, except around conjunction, where the magnitude was significantly enhanced by forward scattering. This effect is shown in more detail in the second plot. This shows the basic light curve in blue, the total predicted magnitude including forward scattering in orange, and the comet's elongation as the black curve. The estimates around the time of conjunction are taken from SOHO coronagraph images.