Blouberg. The sighting occurred at about 18h15, as I was driving North on Marine Drive. Shortly before passing Dolphin Beach, I noticed a very bright fireball streaking across the sky from East to West. The fireball had a bright head and visible flames for a tail. I perceived it as being at a relatively low altitude and it seemed to pass through some clouds before burning out over the ocean'.

Event 243 – 2012 December 9 – Cederberg, W Cape

Observed by Cliff Turk at 00h53 during a watch on the Velid meteor shower. m_v = -3. Colour white, medium speed, duration 0.5 seconds. Based on its observed path Cliff identified the fireball himself as a Geminid. ☆

The Daytime Bolide of 12 March 2013

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In the early afternoon of 12 May 2013, a meteoroid, probably weighing several hundred kilograms, entered the Earth's atmosphere over the Western Cape. The resulting fireball was widely seen despite its passage in broad daylight. Based on a few eye witness accounts, Tim Cooper attempted to reconstruct the event.

Following on from other recent bright meteor events, such as the daytime Chelyabinsk bolide and consequent meteorite over Russia on 15 February 2013, South Africa witnessed its own very bright bolide (the correct term for a very bright meteor seen to explode) just after mid-day on 12 March 2013. This too was a daytime event, and was widely observed from the Cape Town metropole, and the western Cape as far north as Lutzville. This latest event was the brightest since the very bright bolide which crossed the country around 23h00 on 21 November 2009 (see *MNASSA* Vol. 70, June 2011 pp 109-110). There are also similarities between this event and that of 21 July 2002 (see *MNASSA* Vol. 62, August 2003, pp 156-157), which was also seen during daylight, including by an experienced amateur astronomer who estimated the brightness as magnitude -10, and by two airline pilots. That bolide resulted in a meteorite fall near the village of Thuathe in Lesotho, with over one thousand fragments being found with a combined mass of over 30 kg, the largest weighing 2.4 kg.

The 12 March 2013 event was widely observed over the Western Cape, reported on Facebook, Twitter, and various Internet sites, and reported by at least two radio stations. The best set of reports, enabling the author to reproduce at least a probable path, were those reported to the SAAO website, and provided to the author courtesy of Nicola Lauring. These consisted of nine

reporters, each of which was sent a report form requesting as much detail of the sighting as possible, and which were used in the preparation of this article. With these reports to hand, a check was made to see if any decays of space debris occurred at about this time over the area of visibility. There were none recorded, and based on this fact, and the short duration of the path as reported by eight of the nine reporters, I concluded the event was meteoric in nature.

Eye-witness locations and accounts

The locations of the nine reporters are shown in Figures 1 and 2. The most southerly report was from Anwar Sasman in Retreat, Cape Town. The most northerly report was from Rena Rall, near to the town of Lutzville on the Cape west coast. Seven of the nine reports were from the City environs of Cape Town, and only two from outside. The eye-witness reports are summarised as follows, from the most southerly to the most northerly:

1. Anwar Sasman saw the bolide from 10th Avenue, Retreat. He saw the object move above, and on the ocean side of Table Mountain, descending left to right, roughly from the direction of Hout Bay to Camps Bay, that is in a northerly direction and in the general direction of Melkbosstrand. Duration was given as 15-20 seconds, and colours were white and then orange.

2. Alison Sussex was driving towards Cape Town on the N2 freeway and was just approaching the airport off-ramp at the time. She reported the fireball seen directly in front of her, and slightly to her right, in the direction of Signal Hill. Duration was about 4 seconds, left a 4 seconds persistent train, and disappeared in a small cloud of smoke which persisted for more than 15 minutes. The colour of the fireball was given as orange.

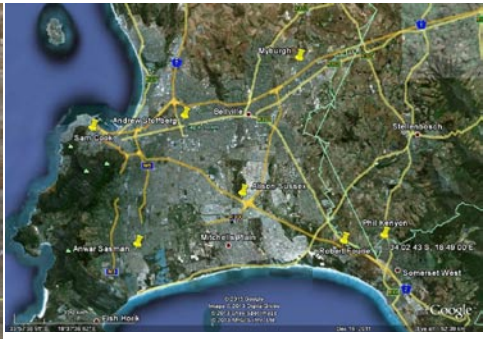

Figure 1 (left) Map showing general visibility of bolide from Cape Town to Lutzville.
Figure 2 (above) Map showing location of reports from Cape Town environs.

3. Phil Kenyon saw the object at descending at an angle of about 20° from vertical, slightly left to right towards azimuth 293°, where it exploded at an altitude of about 19°. Duration was about 3 seconds, colour was silver and after the object exploded, it left a cloud which was still visible an hour later.

4. Robert Fourie was about ten minutes out of Somerset West, also on the N2 towards Cape Town when he saw the object, initially in the one o'clock position from his vantage point, and descending at a steep, near vertical angle, before bursting into a cloud of smoke and several bright fragments, which burned out almost immediately. The colour was bright green, then turned orange.

5. Samantha Cook was in Wale Street in the city centre. She reported 'I was stationary at the robot [traffic light] in Wale Street, facing Signal Hill. All off a sudden I saw a bright fluorescent ball with a tail behind it heading towards the Waterfront'. The start point was above Signal Hill, heading northwards. The colour was given as white, duration 1 second, and left a 1 second persistent train.

6. Andrew Stoffberg observed the object from Kimberley Street in Goodwood, noting it moved from a high altitude in the south towards the north, descending all the while until it disappeared. Colour was given as bright sharp white and had the appearance of a bright twinkling star or a small sun. No disintegration was noted.

7. Myburgh (sic) was located in Kraaifontein and reported the bolide moved from the south-east above him towards the north west. Duration was 2-3 seconds, and disappeared leaving a smoke cloud which lasted 10 minutes. Colour was given as very bright green. No disintegration was noted.

8. Christene Labuschagne observed the bolide from near Theronsberg, and was the eastern-most reporter. She estimated the altitude as about 20-30° above the horizon and moving very roughly towards the north while facing west.

9. Rena Rall observed the bolide from Uitsig Farm between Lutzville and Strandfontein on the West Coast. Duration was about 2 seconds. It exploded, leaving a round cloud which turned into four downward-pointing lines, all of which disappeared after 30 seconds. The direction it exploded was over the mouth of the Olifants River near Strandfontein, towards the south-west of her. Colours appeared as gold, silver, blue and red. The event was also seen by two farm workers, who saw the fireball moving from left to right with a curved angle.

Time and Duration

The times of appearance and durations of the bolide are given in Table 1.

Note the times given appear to be accurate to about 5 minutes, but the overall consensus seems to be that the time of

appearance was around 12h35-12h40 SAST. There is a greater variation in the travel time of the bolide, from as little as one second, to as high as 7 minutes. The latter duration of passage is physically impossible for a meteor, and thus the spread can be taken as 1-20 seconds. This wide spread is probably due to the fact that not all observers witnessed the entire duration of passage, and some included the visibility of the persistent train. The true duration is probably in between the two limits, and is likely a few seconds.

Brightness and colours

The brightness of the event is indeterminate, seeing that it occurred during broad daylight with no useful objects with which to compare, apart from the sun, and the fact that most observers are not versed in brightness estimation. Clearly the object was bright enough to be noticed by whomsoever was looking in the right direction at the time, and so was very much brighter than m_v = -4 to -5, which is about the brightness of Venus, and which is already difficult to see during broad daylight. The bolide was probably also brighter than the aforementioned Thuathe event, estimated as m_v = -10, and which was seen by fewer observers in broad daylight, despite having passed over the densely populated Gauteng area. In the absence of any more clear evidence, the only assumption I can make is that the object was brighter than magnitude -10, consistent with a pre-atmospheric mass of several hundred kilograms or more.

Colours seen in meteors are influenced by the composition of the meteor and its effects on atmospheric gases, with the overriding colour determined by whether the compositional spectrum or atmospheric plasma emission predominates. The range of colours reported are shown in Table 2. The perception of colours in meteors is somewhat observer-dependent, and also depends on the air-mass through which the light has passed as seen by the observer (for the same reasons the Sun and Moon appear red when low above the horizon). However, most reported the passage started at high elevation above the horizon, such that the effects of air-mass can be ne-

Table 1 Time of appearance and duration reported by each site.

Site	Time SAST	Duration, seconds
1	12h40	15-20
2	12h40	4
3	12h35	3
4	12h30	1
5	12h40	--
6	12h20	5-10
7	12h35	2-3
8	12h35	7 minutes ?
9	12h40	2

Table 2 Colours reported from each site.

Site	Colours reported
1	White, becoming orange
2	Orange
3	Silver
4	Bright green, becoming orange
5	White
6	Bright white
7	Bright green
8	
9	Gold, silver, blue, red

Figure 3 Rena Rall's sketch of smoke trails left after explosion.

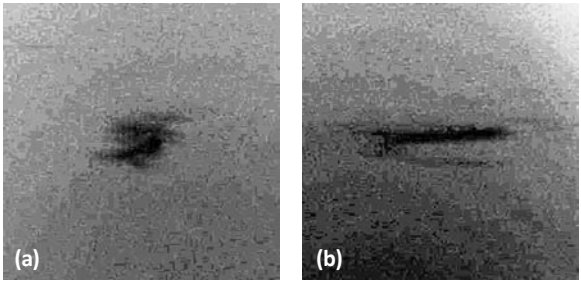

Figure 4 Phil Kenyon's images of smoke trail after explosion.

glected. The perception of colour will also have been affected by contrast effects, having been seen against a bright daytime sky background. However, the general trends from bright white and green to orange and red is consistent with the object rapidly losing energy in the few seconds it descended in the atmosphere. The two reports of bright green in the case of Robert Fourie (site 4) and Myburgh (site 7) may indicate they witnessed the event early in its passage, as this colour in bright meteors is normally associated with the energetic excitation and recombination of atmospheric oxygen, with attendant fluorescence at 557.7 nm in the green region of the spectrum.

Sounds heard

Despite the reports of audible sounds posted by a number of individuals on certain Internet sites, none of the nine respondents included in this article reported any sounds heard. In the absence of information to the contrary, I assume that any reports of sounds reported on the aforementioned sites are unverified, and may have been from entirely coincidental terrestrial sources.

Photos of the smoke cloud

Several reporters observed the object to explode, leaving a persistent cloud which was visible up to one hour after the passage of the bolide. The most detailed reports came from Phil Kenyon and Rena Rall. From Lutzville, near the West Coast, Rena reported seeing the object explode, following which the resultant circular cloud split into four lines, pointing in a downward direction, and one of which was swirled. These distinct lines lasted for about 30 seconds. Her original sketch is reproduced as Figure 3. Phil provided several images of the resultant cloud, which I have image processed to enhance the detail and reproduced as Figure 4. The two images were taken at 12h43 and 13h00 SAST, or approximately eight and twenty five minutes after the explosion, which Phil noted as 12h35. Figure 4a was taken shortly after the explosion, as seen from Phil's location at Site 3. He commented it appeared to disperse into an S-shape from the train.

Some minutes later, the cloud had been considerably dispersed as shown by Figure 4b.

Probable trajectory

It is not possible to give an exact description of the path of the bolide, since the event occurred during broad daylight, so that no celestial reference points were visible to enable an exact determination of the co-ordinates of start and end points. Also, no CCTV images of the bolide were submitted and the trajectory could only be based on visual descriptions. However, at least a tentative path can be inferred, albeit with a wide margin of error, from the reports already given in this article, and is shown in Figure 5.

The most southerly point of entry into the atmosphere can be estimated from the reports of Anwar Sasman, Alison Sussex, Phil Kenyon and Robert Fourie, who all gave a direction of the start point consistent with direction A. This point must also have been to the west of Cape Town, as indicated by the reports from the City area that the object was first seen at high altitude over Table Mountain or Signal Hill. Most reports indicate the object was at high altitude, and descending steeply, probably indicating the bolide entered the atmosphere at an oblique angle. Phil Kenyon indicated the object was descending left to right at an angle of about 20° to the vertical to altitude 19°, azimuth 293° as seen from his location at Site 3. Rena Rall gave the direction of movement as left to right, before exploding in direction B. She was sure the bolide did not pass her location and that it probably fell into the ocean after exploding. Based on these reports the possible path is shown as a white arrow in Figure 5, and probably falls somewhere within the confines of the red triangle.

Figure 5 Possible trajectory of the fireball.

Conclusions

A very bright bolide entered the atmosphere on Tuesday 12 March 2013, at about 12h35-12h40 South African Standard Time, that is during broad daylight. Nine eye-witness reports were collected, which would seem to indicate the bolide entered the atmosphere at an oblique angle, and after a passage of perhaps a few seconds, exploded leaving a persistent cloud visible up to one hour after the explosion. The possible path constructed from the accounts indicates the object most likely exploded offshore and any debris probably fell into the Atlantic Ocean, off the west coast. ☆