Meteor Section

Brilliant Earth-grazing fireball of 2012 September 21

At about 21:55 UTC (22:55 BST; 23:55 CEST) on Friday 2012 September 21, a remarkably slow-moving, brilliant fragmenting fireball was seen by hundreds of eyewitnesses across northern Europe, with a high concentration of the observations coming from northern England, Scotland, Wales and Northern Ireland.

From an early stage it became clear that this was one of the most dramatic events to be reported to the BAA Meteor Section in recent years.

That Friday evening, there was scattered and more continuous cloud cover over much of southeast England, but the rest of the UK and Ireland were largely very clear, with transparent starry skies. This, coupled with the fact that many people were out on a Friday evening and the truly spectacular nature of the fireball itself, were clearly the main factors in its being seen by so many thousands of people over such a very wide area.

Several hundred eyewitnesses sent reports of the event to the BAA Meteor Section, many of them encouraged to do so by local Society secretaries and BAA members. These extracts from two of the more detailed accounts (which have, of necessity, been shortened here) give a very good general idea of the nature of this most unusual fireball event.

From David Stewart, Observing Coordinator of the Irish Astronomical Association (IAA), observing from Delamont Country Park, one mile south of Killyleagh in County Down:

'At 22:54 BST, a group of twelve IAA members spotted an amazing group of fireballs rising from trees at the eastern horizon to the right of Jupiter as seen from the main car park. It was immediately thought they might be fireworks but they continued to rise at a steady pace and fan out slightly as they approached us from distance with their numbers increasing and their brilliant intensity remaining unchanged.

We estimated approximately 20–30 fireballs were seen following the same east to west trajectory, each with an estimated brightness between mag –5 to –7, and each left a medium trail as they travelled almost directly overhead. No noise was heard except for that from the excited astronomers. A larger group of 4 or 5 fireballs was at the front of the group and differences in size were apparent, but each burned with a similar brightness and a distinct orange hue.

We were able to observe the fireballs for 2 mins from the trees in the east to the trees on the western horizon and we had particularly good views in that direction. As the fireballs approached the western horizon their numbers dwindled, possibly due to burning up and atmospheric extinction, but at least 2 or 3 were seen disappearing behind the trees. They were travelling at a speed somewhat faster than the ISS but not as fast as a typical meteor on entry into the Earth's atmosphere.'

From Paul Buglass, reporting on behalf of 10+ members of the York Astronomical Society (YAS) who were observing at the YAS Observatory, 4 miles west of York. Conditions were totally clear, with a very transparent night:

'At approximately 10:56-ish (BST), a group of us were talking outside and I noticed a very bright light low down over York (due East)... very bright with a slight green tint... It seemed to be moving very slowly, flickering slightly, and at first I thought it was a low flying aircraft... then I thought perhaps it was a helicopter. It still hadn't moved much, but as the seconds ticked by it slowly started to show more movement to the left and slightly gain elevation... As its angular velocity increased, the bright green light started to show a slight tail as it passed through the bottom of Auriga, and then as its apparent angular speed increased more, a longer trail of darker red/orange formed, with bits coming off, as it approached the Plough. It then started to lose more distinct fragments downstream, with an orange almost ember like appearance, then the main bright white/green head puffed explosively and lost many more orange fragments which trailed off downstream as it passed through the Plough... It continued West in a very flat trajectory, gradually losing the bright head as it moved to the West, and... faded to about 6 or 7 glowing orange points... The direction it was finally lost from view was directly under Hercules... Total observation time was possibly 60+ seconds from first sighting low in the East to fading from view in the West.'

When first seen the fireball appeared as a single very brilliant object, but it then fragmented into a large number of bright secondary fireballs, all travelling along roughly parallel paths across the sky. One highly unusual feature of these was the length of time for which they were visible due to their apparent very slow speed of movement across the sky. This led some people to speculate that the fireball was due to the re-entry of a large fragment of space debris and indeed there were several BBC and other news reports to this effect, but given the east-to-west trajectory of the fireball at a latitude of about 54.5° North, this interpretation seemed most unlikely from the outset.

The majority of the visual reports received by the Meteor Section were either quite brief or contained a lot of descriptive information about the fireball's changing visual appearance, but there was a need for more detailed positional information relating to the fireball's trajectory across the sky. Consequently, an appeal went out for photographs or video clips which showed the fireball's path against the background stars, and a wealth of such data was subsequently received which has proved invaluable in refining the trajectory and velocity of the fireball.

We must emphasise that our analysis of the fireball is continuing, but in the light of the very considerable speculation that has appeared about this event, we provide the following information based on our results to date.

Using the large number of visual reports received and still images of the fireball's path

Map showing the ground track of the 2012 September 21 fireball *(Google Earth)*.

against the background stars, it has been possible to derive an accurate ground track for the main body of the fireball and this is shown above. Most useful in this regard have been the photographic images provided by Truls Gabrielsen, Thomas Heaton (see cover image), Craig Usher, Drew Buckley, Robert Cobain (video), Colin Campbell, Matthew Johnston, Paul Messitt, Damien Stenson and Conor Ledwith.

Currently, our most easterly pair of images of the object are by Truls Gabrielsen observing from near Mandal, Vest–Agder in southern Norway, when the fireball was high over the North Sea. We have used an accurately timed 2.25-second shutter gap to determine that the velocity at this point was 12.0 km/s and the height was around 60km descending. This velocity is in excess of Earth's escape velocity and so this rules out a man-made satellite re-entry. Therefore, it is most probable that this object was natural and that atmospheric entry was well to the east of our first images. Video meteor cameras in northern Poland were operating at the time but did not record the event, so it seems probable that the fireball would first have become visible over the north-eastern coast of Germany or southern Denmark before tracking out over the North Sea.

We have used the known exposure duration of an image from the west coast of Ireland to estimate the velocity of the two brightest components as they moved out over the Atlantic. We obtain velocities of 7.8 and 8.5 km/s and a height of 62km ascending. These velocities and the track orientation and position are not at all consistent with the suggestion that there is a connection between the fireball being considered here and a fireball seen in south-eastern Canada/north-eastern USA 155 minutes later. Indeed, we find no compelling evidence for a connection between the two events.

Our analysis of this remarkable fireball continues, but the work summarised here would not have been possible without the large number of observers who sent in their observations of the event and the assistance of those who helped collect the observations and encouraged people to submit them for analysis. In this regard we offer our especial thanks to William Stewart, Robert Cobain, Andy McCrea and Terry Moseley.

John W. Mason *(Director)* **& Nick James**