RE-ENTRY OF 'COSMOS 749' ROCKET ON 1980 DECEMBER 25

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The fireball seen on 1980 December 25 at 2107 approximately has been identified as being due to the re-entry of *Cosmos 749* Rocket. The report outlines the results of the observations made from Morocco, France and England.

On 1980 December 25 at 2107 hours a group of very bright objects were seen to cross the sky by many observers in the southern half of England, Holland and Germany. Subsequent analysis has shown that the fireballs seen from England were due to the re-entry of 1965–52B, *Cosmos 749* Rocket, but the phenomena reported from Belgium, The Netherlands and Germany had other origins and were not connected in any way with the re-entry.

The reasons for separating the Dutch and German reports are quite strong. Data from the *Tables of Earth Satellites*[1] gave December 25 for the most likely date for the re-entry of three objects. Subsequent data has shown that only one of these, *i.e. Cosmos 749* Rocket, had orbital elements which gave an orbital plane anywhere near north-west Europe at the appropriate time. The predicted orbital plane coincided with that obtained from observations of the fireball[2]. In addition, it is now known that the other objects re-entered the atmosphere at different times. The approximate angle to the meridian, θ, at which a satellite will cross a given parallel of latitude can be computed using the simple formula:

$$\sin \theta = \frac{\cos i}{\cos \phi}$$

where i = orbital inclination of the satellite and ϕ = required latitude.

Because the orbital inclination of *Cosmos 749* Rocket was 74°, its orbital plane would cross the 51° latitude at an angle of 26°. This means that the object would at that time be travelling on a bearing of approximately 26° east of north. In no way could the object have passed over the south coast of England in the vicinity of Beachy Head and then pass over and deposit fragments in Belgium.

The very slow speed of transit across the sky was such that any possibility of the fireball being caused by a natural body entering the atmosphere could be discounted completely. The possibility of it being due to the

re-entry of some unlisted component was then considered, with such a body having an orbital inclination of about 52° to 55°. This is now thought to be highly remote because observations from France do not support such an orbit. Observations from Morocco[3], Portugal[4] and eight from France, from both sides of the track[5], as well as some from south-west England are all consistent with a 74° orbit and a track crossing southern England in roughly a NNE direction.

The Dutch and German reports will be reported elsewhere[6] and, therefore, only those thought to be related to the re-entry of *Cosmos 749* Rocket will be discussed in this report.

As has been mentioned on many occasions, if the maximum amount of information is to be gained from a study of major fireballs, it is essential to collect information and interview observers as quickly as possible after the event. On this occasion, some difficulties arose due to the event occurring on the evening of Christmas Day. Nevertheless, one of us (J.M.) spent many hours interviewing observers living in the Hampshire, Sussex and Kent regions. Appeals in the Press and BAA *Circulars* provided further reports from the West Country and South Midlands. Overall about 100 reports were received, a high percentage of which provided very useful information. Most of the observers in Sussex were located to the west of the track but, fortunately, those on the eastern side were very close to the track itself.

The star background reports were more helpful than is often the case because the observed track passed through or close to the constellation of Orion, a well-known star group. The usefulness of these reports were in some cases reduced on two counts. Statements that the fireball passed just below, say, the star Rigel can be misleading because of the interpretation of the word 'below'. In addition, the angular size of a group of fireballs produced by a decaying rocket requires an assessment of the path of the central region of the group.

Some problems arose in the analysis because of the shortness of that part of the track that was well observed. Meteorological conditions were such that over the English Channel and Sussex the sky was fairly clear. Over Kent, however, there was a fairly extensive bank of cloud, which made it difficult to give a detailed account of the object's behaviour in that region.

The start of the luminous part of the re-entry was observed by J. P. Kloster from Tineghir, South Morocco (31·50°N, 5·50°W), using 8×50 binoculars[3]. He first observed the satellite as a -1 magnitude object in the west travelling northwards. By the time it reached the north-west it was strongly orange in colour and had reached a brightness of magnitude -4. From this point a trail appeared which persisted for over 5 minutes.

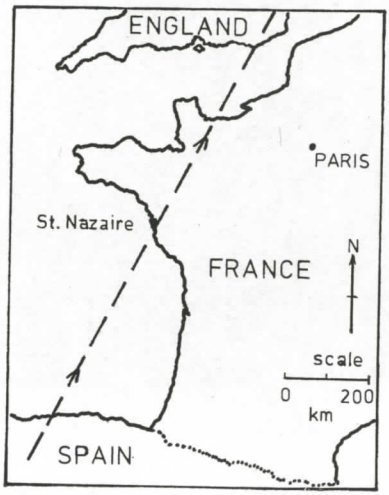

FIGURE 1. The dotted line shows the track of the re-entry of *Cosmos 749* Rocket over north-west Europe.

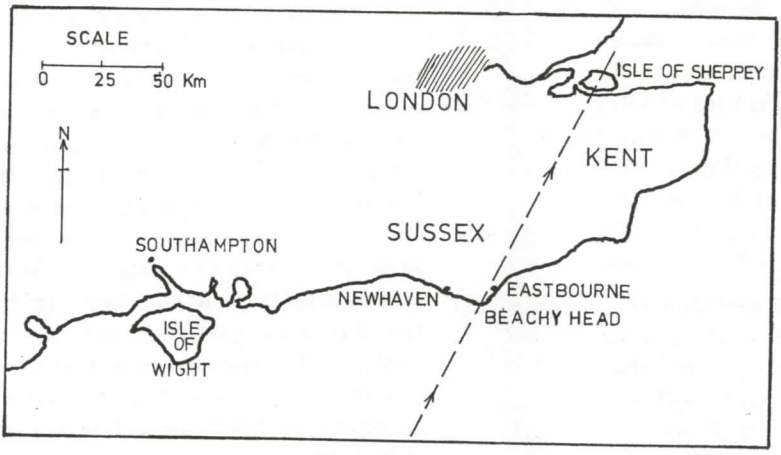

FIGURE 2. The dotted line shows a more detailed line of the track over south-east England.

Fragments were breaking from the main body and, in addition, an element of magnitude +3 to +4 was seen to follow a parallel trajectory about 2° below the main body. This was seen for about 10 seconds. The main object then disappeared behind the Atlas mountains in the north.

As shown in figures 1 and 2, the track of the re-entry took it across Spain, the Bay of Biscay, St Nazaire, North-West France, crossing the

coast at a point just north-west of Bayeux. It crossed the English coast at Beachy Head and went up to the Thames estuary in the region of the Isle of Sheppey. The point of crossing of the English coast was very well defined. Several observers from the area of Newhaven reported overhead passes but slightly to the east. Observers from the Bexhill–Eastbourne area similarly reported overhead passages but slightly to the west. This gave a maximum bandwidth of 17 km from these observers but, when other reports are considered, the most likely track is thought to be within 2 km of Beachy Head itself. Because of the extensive cloud over Kent, the loss of sighting of the fireball did not necessarily coincide with an extinction point. It is thought that there was no general extinction point as the many fragments were burning out or becoming non-luminous over quite a large range of the track. It is known that at least four fragments were still luminous as it crossed over the Thames estuary, but two of them faded quite quickly. By the time the object was about 12 km east of Southend only one fragment was still luminous. The end point of the final fragment could not be defined accurately but it is thought to have been in the region of Clacton. This is supported by the fact that nothing was recorded on an all-sky camera situated at Ipswich and which was operating at the time[7]. No British or French reports were received which conflicted considerably with the track although, as expected, some variations in detail were present.

Star-background reports and some altitude-azimuth estimates enabled fairly accurate values for the height and angle of descent to be determined. Over the English Channel and Sussex the angle of descent was found to be $9° \pm 1°$ with a height at Beachy Head of 46 km $\pm$ 3 km.

With the exception of the three reports received from Kent, none reported any sonic effects. However, the Kent observers all gave accounts of rumbles and sonic booms. The time delay after the visual passage was given by one observer as about half a minute.

The possibility of the sightings from near Brugge, Belgium, of the re-entry of the rocket cannot be dismissed without comment. It is considered unlikely to be the case because the maximum altitude would have been in the region of 10°, whereas the report from that area referred to the object being high in the sky. The report that part of the rocket had been recovered from this area has now been found to be false. The suspected object has been analyzed and found to be a lump of PVC plastic. The Dutch and German reports of the sightings of a fireball at the time of the re-entry of *Cosmos 749* Rocket have not been examined but they are reported to be of insufficient positional accuracy to weaken the results as given in this report[8].

Observations showed that the break-up of the rocket was a continual process, with many observers actually recording the break-up of an

individual piece into several fragments. As it started its track across the Bay of Biscay, it consisted of five objects, all orange yellow in colour with the leading one much brighter than the others. All were enveloped in a greenish halo. As it travelled towards northern France, one gained the impression from the observations that the rocket, or remnants thereof, was still rotating because reports from some areas recorded luminous fragments ahead of the main component, whereas reports from other regions mentioned only fragments behind the brightest component. On the other hand, this observed feature may have been due to the continual and irregular break-up. The brightening of individual components was reported from observers in England.

As it crossed the English Channel, some observers recorded witnessing the disintegration of individual fragments. Several observers reported short-lived components ahead of the main object. There was fairly general agreement that the fragmentation consisted of three groups, a leading, and by far the brightest, component, followed by a group of 3 to 5 fairly bright fragments and, farther behind still, another group of about 6 components fainter than the others. Each fragment had a reddish coloured tail and at times emitted numerous sparks. Several members commented on the spreading out of the components as it travelled across the sky and some mentioned a bluish colour around the yellow orange fragments. The process of breaking up with fainter components fading completely continued all the way up to the Thames estuary. This general description is very similar to that reported[9] on the re-entry of *Cosmos 253* Rocket on 1968 November 20.

Cosmos 749 was launched from the launching site at Plesetsk in the Soviet Union on 1975 July 4. It was reported as being launched for studies into scientific and telemetric problems. The rocket was thought to weigh 2200 kg and have a cylindrical shape, 7·4 m long and 2·4 m diameter. It went into an initial orbit ranging from 298 to 550 km above the Earth's surface.

Acknowledgements

The analysis of events such as re-entries depends very much on the willingness of members of the public to send in their observations to the collecting agency and quite often to be subjected to a close scrutiny of their statements. We should like to express our thanks to all these persons for their help. To reach these people it is often necessary to request the co-operation of the local Press and radio. This was certainly the case on this occasion and therefore we would like to give our grateful thanks to these organizations. We also wish to thank Pierre Neirincke for making available the reports from France, and Hans Betlem for his comments on the reports from Holland and Germany.

References

1 *Tables of Earth Satellites*, Royal Aircraft Establishment, Farnborough, Hants, undated.
2 Russell Eberst, Assistant Director, Artificial Satellite Section, BAA.
3 *Satellite Orbits Notes* (SON 818/81, 1981 March 27), SRC Rutherford and Appleton Laboratories.
4 Verbal communication from D. J. King-Hele, Royal Aircraft Establishment, Farnborough.
5 Telex messages containing French Gendarmarie reports, sent to Pierre Nierincke, Satellite Orbits Group, SRC Rutherford and Appleton Laboratories, Slough, England.
6 Dutch Meteor Society, under the direction of Hans Betlem; to be published later.
7 Written communication from Robert Mackenzie, British Meteor Society.
8 Written communication from Hans Betlem, Dutch Meteor Society.
9 Re-entry of *Cosmos 253* Rocket over the British Isles on 1968 November 20, *J. Brit. astron. Assoc.*, **79**, 156 (1969).