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RESEARCH

Unusual Atmospheric Phenomena Observed Near Channel Islands, UK, 23 April 2007

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Abstract—Unusual atmospheric phenomena (UAPs) were observed in daylight by multiple observers on board two civil aircraft in widely separated locations. We summarise results of an investigation based on radio communications reporting events in real time to Air Traffic Control (ATC), ATC radar and weather radar recordings, Civil Aviation Authority (CAA) documents, witness interviews and statements, and other sources. We describe attempts to explain the phenomena with the help of expert specialist advisers and professional resources in the fields of meteorology, atmospheric optics, oceanography and geophysics.

We are able to show that widespread media stories describing enormous phenomena up to a mile wide and detected by radar were based on speculation and misunderstandings. Many news reports were grossly exaggerated and inaccurate. However, we are unable to conclusively identify the UAPs observed. It proves possible to eliminate a number of theories with a fairly high level of confidence, leaving us with two types of phenomena—a rare atmospheric-optical effect or an earthquake precursor—both of which have the potential to explain at least some, although not all, features of the reports. We highlight certain features that appear to leave open the possibility of unusual physical processes.

Keywords: UAP—atmospheric optics—anomaly—mirage—earthquake lights—EQL

Summary of Visual Observations

The first observation was made by the sole pilot of a BN2a Mk3 Trislander (Aurigny Airline 544, G-XTOR) inbound to Alderney from Southampton (Figure 1) on a heading of 207° on airway R41. Capt. Raymond Anthony Bowyer, a professional airline pilot with 18 years experience, had flown this

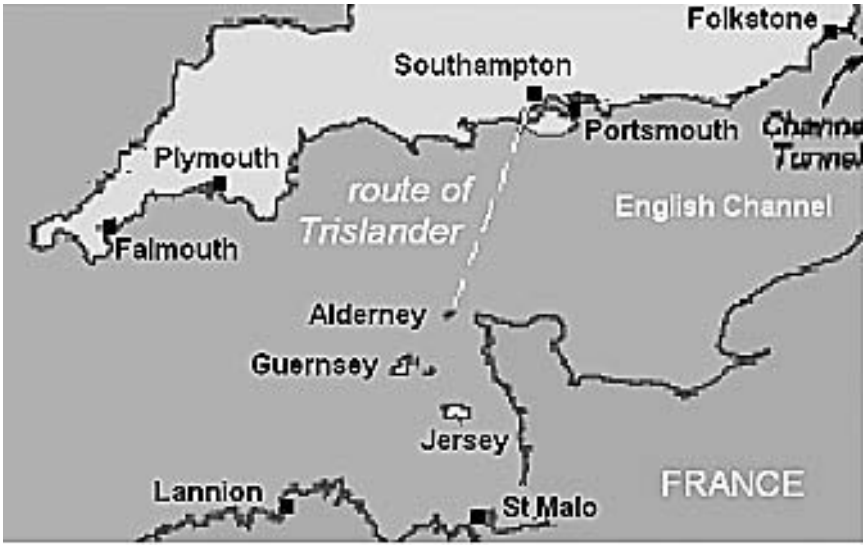

Fig. 1. Location of the Channel Islands, showing the Trislander's route from Southampton to Alderney.

particular aircraft on this route for 8½ years, amounting to between 500 and 600 round trips.

The Trislander was in cruise at 130 knots (IAS) at FL40 (~4200 ft).[1] It was a bright, dry afternoon with patchy medium-level altocumulus and high-level cirrus shading the direct sun (~45° elevation in the SW, ~17° to the right of the flight path). The E and W horizons were cloudy, and there was a layer of thin haze below the aircraft at approximately 2000 ft. But the horizon ahead was free of cloud, and visibility was estimated to be 100 miles at the flight altitude. The islands of Alderney and Guernsey were also visible.

Analysis of the Jersey radar and voice recordings[2] established that the time was about 1406UTC when, at a position some 13 nautical miles (nmi) NNE of the ORTAC reporting point (approx. N50°W02°), Capt. Bowyer noticed a bright light close to the horizon almost directly ahead of the aircraft. His initial impression was that he could be seeing sunlight reflected from large vinery glasshouses on the Island of Guernsey, tens of miles away. He had often seen such an effect before, which would vanish in moments as the aircraft moved through the critical angle for reflection. But this light did not disappear, and looking closer he realised that it was something unusual apparently in the sky at or near to his own altitude (we will refer to this as unusual atmospheric phenomenon [UAP] #1). The flight controls were set to 'autopilot', leaving Capt. Bowyer free to observe the UAP with the naked eye and with 10× magnification binoculars. He observed what appeared to be a ''sparkling yellow'' object (also described as ''bright orange-yellow'', ''golden yellow'' and ''sunlight yellow''),

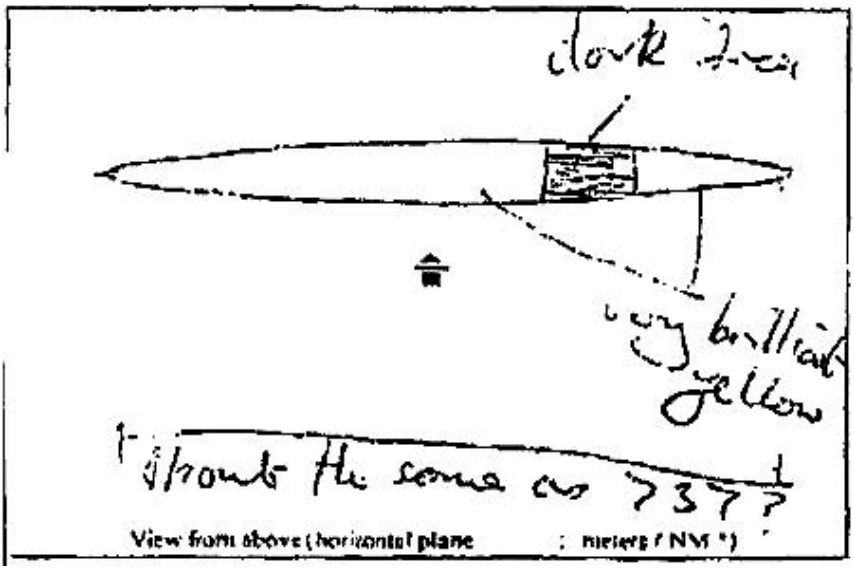

Fig. 2. Capt. Bowyer's original drawing for the CAA Air Safety Report, 23 April 2007.

the profile of which was like that of a thin cigar suspended horizontally above the horizon (Figure 2). It appeared to be self-luminous rather than reflective and was ''brilliant'' but not dazzling or tiring to the eye. It had ''very sharply defined'' edges and pointed ends. Approximately two thirds of the way from the left-hand end, like a narrow band around a cigar (about one tenth of the length of the object), was a ''dark graphite grey'' patch. The edges of the band where it met the bright yellow were not sharp but ''hazy'' and the dark colour had a ''shaky'' or ''glittering'' quality that he found hard to describe, but which he felt was an objective property of the object and not an optical illusion.

The naked eye angular subtense of UAP #1 when first seen was estimated later as equivalent to 6–7 mm at arm's length, or approximately 0.5° of arc. Capt. Bowyer's initial impression was that it was a 737-sized object, or bigger, at about 4000 ft altitude somewhere near ORTAC, not more than about 15 nmi away.

At 14:09:32UTC, after about 3 minutes of observation with binoculars, the object was still ahead of the aircraft, just a few degrees to the right of the nose, and Capt. Bowyer now radioed Jersey Control Zone on 125.2 MHz. He asked the controller, Paul Kelly, ''Do you have any traffic, can't really say how far, about my 12 o'clock, level?''

Kelly replied, ''No, no known traffic at all in your 12 o'clock''.

''Roger'', replied Bowyer, ''I've got a very bright object ... extremely bright yellow, orange object, straight ahead, very flat platform, looking at it through binoculars as we speak''.

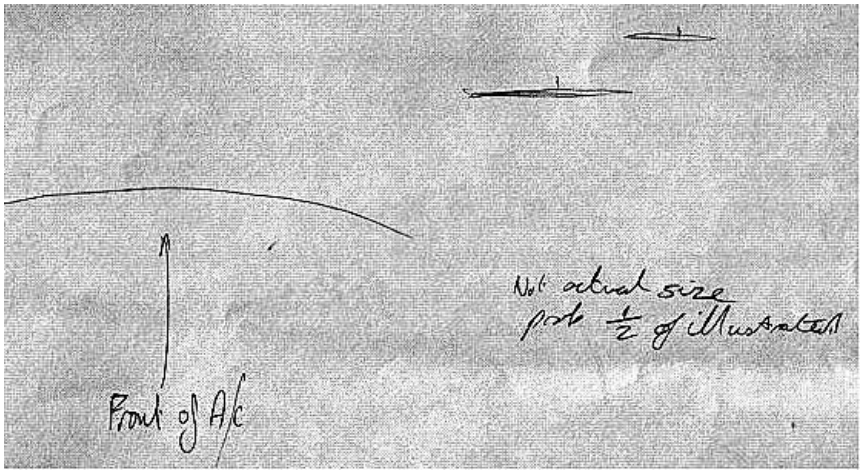

Fig. 3. Drawing by Capt. Bowyer, 8 July 2007, indicating size and position of UAP #2 (right) when first seen, relative to UAP #1 (left) and the nose of the Trislander.

Immediately Kelly responded that he did now have ''a very faint primary contact'', 11 o'clock at 4 miles from the aircraft. Bowyer acknowledged.

After half a minute Bowyer again asked Kelly, ''any more information on that aircraft please?''

There was still a primary contact on the left of the Trislander, said Kelly, now 10 o'clock at a range of 3 miles, but nothing that appeared to correspond to the visual UAP. Kelly thought the contacts might be false echoes caused by anomalous propagation.[3]

At about 1412:30UTC Capt. Bowyer crossed the 50° parallel of latitude and passed left abeam the ORTAC reporting point. At about this time he noticed a second object (UAP #2) a little to the right of the first, and at slightly higher elevation, as shown in Figure 3. This one was identical in appearance, including the golden yellow colour and asymmetrical graphite-grey band, except that #2 looked smaller, was a little less bright and seemed further away. Both objects were seen to the west of Alderney and to the right of the aircraft flight track, but to the left of the Casquets lighthouse (a small islet at 49°43′42″N 02°22′42″W), which at this time was visible about 12° to the right of the flight line. They were both visible simultaneously in the same binocular field of view, laterally separated by only a degree or so. ''As the flight continued'', emphasised Capt. Bowyer, ''the second appeared above the first, whereupon finally the second appeared to the *left* of the first [UAP] at last sighting''.

He reported the appearance of this second object to Jersey Air Traffic Control (ATC) at 1414:04 and observed that they both appeared to be somewhere west of Alderney. Seconds later at 1414:23 the Controller replied that a primary radar contact was now showing in the area of the Casquets. Capt. Bowyer replied that this possibly corresponded with the position of one of the UAPs.[4]

As the Trislander continued in flight towards Alderney three changes happened: The UAPs changed their bearings relative to one another; they changed their elevation relative to the horizon; and their angular sizes increased.

By approximately 1416UTC, as the plane was about to begin its turn towards Alderney, the two UAPs had closed their lateral separation and appeared ''lined up'', one directly above the other. Also at this time the line of sight to the UAPs had fallen slightly below the horizontal, so that just before beginning the descent from FL40 Capt. Bowyer estimated that they appeared at a shallow depression angle of about –2°, and appeared against the sea.

As the plane descended and turned to the left, further away from the line of sight, the elevation angle rose back towards the horizontal and UAP #2 continued its relative drift to the left of #1, i.e., reversing their original relative bearings. When the plane reached the haze layer at about 2000 ft the UAPs appeared at 0° relative elevation, their angular sizes had increased by almost a factor 3 (so that #1 was now 15–18 mm at arm's length, or ~1.25°), and UAP #2 had moved across so that it lay perhaps 2° to the left of #1.

The time now was approximately 1418 as the plane descended into the haze layer, where visibility dropped to a few miles and both UAPs were lost from sight.

One or both UAPs were seen by several (at least five, possibly as many as nine) passengers on board the Trislander. The flight deck area is not enclosed, but forward visibility from passenger seats further back is limited by other passengers, the high instrument fascia, windscreen frames and the pilot himself.

A single male passenger seated immediately behind Capt. Bowyer was able to see both objects, with the naked eye and with the use of Capt. Bowyer's binoculars, and a couple seated in the next row also witnessed all or part of the event. But these witnesses have so far declined to be identified.

Another couple was seated three rows back, John and Kate Russell from Alderney. John Russell's view was the more restricted but by leaning across his wife's seat he could see one of the objects through the cockpit windscreen, describing it as ''an elongated oval'' or ''lozenge-shaped'' and ''brilliant orange'' brighter than any reflection of the sun could be. He stated that he thought this object moved a little to the west (right) during the time it was visible.

Kate Russell had the better view. She was diverted from her book by noticing that the pilot had turned to talk with the passenger immediately behind him—something she had never seen happen before—and both appeared to be looking at something. This went on for a while and more passengers began to react,[5] but still nothing was visible from her position until the pilot dropped the nose of the plane at the start of the descent. The radio transcript and Jersey radar plot indicate that this was at very shortly after 1415:30UTC. Soon after this time she was able to see two very bright ''cigar''-shaped lights ahead of the plane, one larger than the other but both ''sunlight coloured''.

They were below the horizon (Capt. Bowyer's report mentions that the UAPs had reached a maximum depression angle of –2° just before this point in the flight). She thought initially that one object (the small one) was above Alderney,[6] the other over the sea, seeming larger and nearer. After a short while she lost sight of them as the plane's nose came up briefly. Then as the nose dipped again in the continued descent towards Alderney they reappeared. This time the yellow hue of the lights was more distinct, but she disputed her husband's description of an ''orange'' colour (claiming that John was colour-blind!), although the word ''orange'' was also used by Capt. Bowyer.

Both witnesses disputed Capt. Bowyer's later public opinion (based on a revised impression of range) that the objects might have been thousands of feet across. Kate had no definite impression of size, but felt that they were ''nothing like as large'', the nearest seeming to be perhaps 10 miles away, between the plane and Alderney. John had the impression that the object he saw might have been smaller than the Channel merchant vessels they saw during the flight. In other words, their visual judgments at the time were not dissimilar to Capt. Bowyer's.

At approximately 1412UTC Capt. Bowyer asked Jersey Zone controller Paul Kelly if anyone else was seeing the object (at this time only UAP #1 was visible). Kelly replied that he had ''nothing really in the area'', but called a BAe Jetstream 32 turboprop passenger aircraft of Blue Islands airways (BCI832, Sqk. 7770) cruising at about 250 knots SE-bound past Guernsey *en route* to Jersey from the Isle of Man. In charge of this aircraft was Capt. Patrick Patterson, a pilot with several thousand hours of experience (in excess of 2500 hours in the command seat) who had been flying routes in the Channel Islands area for approximately 1 year.

Kelly asked ''... in your left, just behind 9 o'clock, can you see anything in that direction?'' Capt. Patterson, who had overheard the previous exchanges, replied, ''I'm having a look, stand by''. A minute later the pilot replied that he could see nothing at all in that position, and at 1413:24 Kelly handed off Blue Island 832 to Jersey Approach.

However, very soon after this, at 1414:43, the pilot radioed Jersey Approach, explained the situation and stated that ''I've got something about 8 o'clock resembling the description''.

From a point close to the island of Sark (E of Guernsey) the Jetstream pilot looked back over his left shoulder towards Alderney and now saw in his 8 o'clock position what he described in a written report the following day as an object ''fitting [Capt. Bowyer's] description'' and having a ''yellow/beige'' colour, apparently 2000 ft below him at about 1500-ft altitude a little to the W or NW of Alderney about 20 nmi away.

Subsequent questioning established that this object appeared ''oval'' or ''oblong'' and its outline was very hazy, just a patch of yellow coloration comparable to the paint colour of an Aurigny Trislander fuselage (a bright chrome yellow), as seen in hazy conditions at distance. But he knew there were no other

aircraft in that area west of Alderney (visible in outline through haze together with nearby Burhou) and his minimum estimate of size was 4 or 5 times the size of a Trislander. By comparison with the island he judged later that it would have had a *maximum* horizontal dimension of about 0.5 nmi (900 m, indicating a maximum angular width of about 1.3° for the object, or more than twice the apparent diameter of the moon). It was in the air but did not appear to move. It was not like anything he had ever seen before. He speculated about a tethered airship or similar object, perhaps connected with a military exercise,[7] but it was not well-defined and he thought it was most likely to be an atmospheric phenomenon of some sort.

Visibility was ''fairly poor'' due to the haze layer below his altitude but the pilot saw this object several times in between brief interruptions due to flight deck duties. After approximately 1 minute he looked back and had lost visual contact.

Investigation of Radar Evidence

There is no UK air defence radar coverage of the Channel Islands area at relevant altitude, and MoD say they have no information on any possible radar contacts. The Channel Islands Air Traffic Control Zone lies within the French air defence zone. A French long-range *Centaure* air defence radar with coverage of the area is located close by at Maupertus near La Hague on the Cotentin peninsula. An early inquiry to the French authorities eventually produced a negative response. Centre de Conduite des Opérations Aériennes (CCOA) informed us that a reconstruction of all aerial movements in the region from the radar network log revealed no unidentified phenomenon or aircraft in the time frame studied (1409-1418UTC).

The Jersey ATC radar recordings accessible to us showed no clear evidence of anomalous primary echoes; however, we are conscious that this result has limited value owing to *a*) the fact that we elected not to duplicate a rigorous analysis of all primary plots being undertaken in parallel by the French official group GEIPAN,[8] and *b*) the use of signal processing such as Moving Target Indicator (MTI), designed to suppress stationary or near-stationary targets.

We also obtained Jersey C-band weather radar images for the sighting period. Unlike the ATC radar data, which is specially processed to remove non-aircraft targets, weather radars collect essentially unprocessed raw radar echo, which might enhance the possibility of finding echo correlating with any radar-reflective UAPs. We found nothing clearly anomalous. But in weighing this result we should bear in mind that the resolution of the video product is poor, and that due to a ponderous scan algorithm the radar has the opportunity of only one very brief sampling at relevant altitude during the sighting period. At 50-km range a 2-km resolution cell corresponds to $\sim 2.5^\circ = 1/(360/2.5\ ) = 1/144$ of the 60-second antenna rotation, or about 0.4 seconds, and the total dwell-time of a point target in the 1° beam width would be only ~1.7 seconds.

In summary, the radar evidence examined is not helpful in establishing the presence of unusual phenomena. An ATC radar echo reported below the approximate visually-estimated position of one UAP may have been associated with an identifiable moving surface vessel, which may also have been picked up on the low beam of the weather radar. At the same time there are factors—use of MTI and poor sample rate—which limit the usefulness of this negative result, and pending the results of the GEIPAN study the ATC data files have not yet been examined to a level of detail that would completely rule out the presence of interesting primary echoes.

Discussion

Our method[9] was first to identify the significant constraints on bearings and elevation angles imposed by radar plots of the aircraft, voice recordings and narrative testimonies, and to reconstruct (initially by trial and error) a best-fit sighting geometry that would respect these. We found that this process drove us (against early expectation) towards a map of triangulated apparent UAP positions (Figure 4) which was notably similar to that indicated by Capt. Bowyer in a TV interview 2 days after the event. We then proceeded to plot by computer the changing angular relationships between lines of sight (LOSs) in three dimensions and to explore in detail the self-consistency of observer-estimated quantities inside this best-fit model.

Almost all values investigated turned out to be rather unusually self-consistent if interpreted as observations of some large near-static objects or features at 1500–2000 ft altitude at the locations triangulated (in the case of UAP #1) by independent LOSs 140° apart. These values included: Ratio of initial and terminal estimated angular size of UAP #1 and ratio of corresponding distances; ratio of angular sizes of UAP #1 and UAP #2 and ratio of distances of the two UAPs; rate and magnitude of changes in relative bearing; and changes in estimated elevation angle. We were able to prove from the ATC voice recordings that Capt. Patterson's and Capt. Bowyer's similar estimates of the altitude of UAP #1 were independent of one another. Also, the mean of Capt. Patterson's divergent estimates of size (~485 m) compares well with the mean of the much narrower range of values derived from Capt. Bowyer's sighting geometry (~510 m).

But we also noted the coincidence that the average LOS from the Trislander to the lights was not far from the sun azimuth, inviting a reflection theory. Some witness descriptions used phrases like ''sunshine yellow'' and ''sunlight coloured'', which were also suggestive. And if Patterson could not see anything at 1413UTC from above FL65 and reciprocal to the Trislander's LOS, why not? A FlyBe 146 in a similar position a little later also reported no visual contact. An optical theory might explain these anomalies. An optical theory would also be consistent with the absence of unambiguous radar evidence.

Next we wished to investigate the physical and optical properties of the atmosphere along the lines of sight, for which purpose we consulted professional

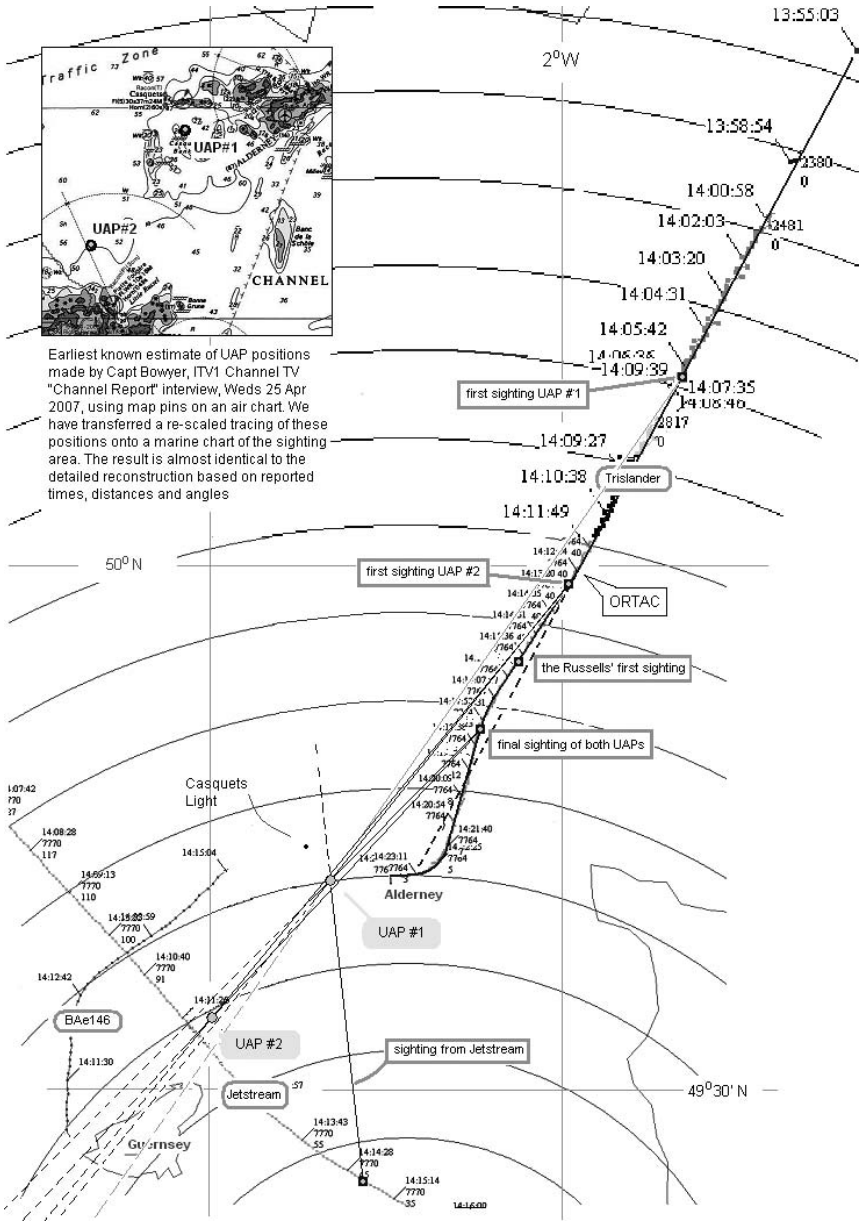

Fig. 4. Best-fit triangulation of possible UAP positions based on ATC radar plots and sightlines.

TABLE 1
Ranking of 16 hypotheses

Rating	Hypothesis
0 very implausible	sundog, subsun, 3rd/4th order rainbows, windscreen reflections, earthquake clouds
1 somewhat implausible	sun ray patches on the sea, sun-glitter reflections from lakes in Brittany, aircraft contrails, ship tracks, military exercise, lighter-than air vehicles
2 barely plausible	sun-glitter reflections from the sea off Brittany, direct specular reflections from Guernsey glasshouses, lenticular clouds
3 somewhat plausible	specular glasshouse reflections scattered from a haze layer, earthquake lights
4 very plausible	none
5 definite identification	none

meteorologists, several with expertise in the Channel Islands; Guernsey Airport and Alderney Airport half-hourly surface weather reports covering the period of 1150–1550UTC; daily climate records for the month of April from Jersey Met Office; upper air radiosonde balloon measurements of pressure, temperature, dewpoint and winds from the four nearest French and English release sites[10]; satellite images[11]; miscellaneous other UK Met Office weather products; Jersey Met Office C-band weather radar images; and a Meteo-France ALADIN 4-hourly computer numerical simulation of temperature, dewpoint and winds over coastal waters near Brittany. The detailed meteorological model developed was then applied to interpretations of the evidence in terms of 16 distinct hypotheses in an attempt to explain the observations.

Most of the 16 hypotheses (Table 1) could be effectively ruled out, some almost immediately, others after more careful investigation (space precludes detailed discussion here). It was not completely surprising that Rating Level 5 (definite identification) remained empty, but we might reasonably have hoped to have something in Rating Level 4 (very plausible) which we should have regarded as a satisfactory explanation for practical purposes.

We found some evidence suggestive of an atmospheric-optical explanation, meaning in general some effects on the propagation of light either by airborne particles (haze, mist or ice crystals) or by refractive index anomalies (unusual temperature gradients, causing mirage).

Ice-halo effects (sundogs, subsun) are ruled out by the required reflection geometry and fundamentally by the absence of ice crystals in the line of sight (the freezing level was some 6000 ft above the flight altitude). But there was a haze layer below the aircraft, probably associated with a weak temperature inversion in the Channel Islands area. That inversion would be the remnant of a much stronger advection inversion near the Breton coast, beyond the normal horizon, which we found was probably strong enough to form a localised optical duct through the first $\sim$200 m of the atmosphere off shore.

Given the finding of a possibly mirage-producing duct near the French coast

one might feel that this cannot reasonably be a coincidence, and that mirage of sun-glitter on the sea near Brittany really ought to be a clear favourite. Such a duct could trap light rays (i.e., refract rays with a curvature approaching the Earth curvature of 33 arcseconds/km) and release them upwards at the point where the advection inversion breaks down, over the sea south of the Channel Islands. For an observer above the top of the duct, the result could be a ''mock mirage'' of the sun-glitter pattern on the sea near the Breton coast, which would disappear as the aircraft descended towards the duct (Cowley, 2007). But we have placed this theory in Rating Level 2 (barely plausible). Why?

- Capillary wave orientation and capillary wave slope distribution are crucial factors in formation of a sun-glitter pattern. Meteorological evidence suggests some likelihood of a sea breeze development that may have generated near-shore surface winds parallel to the LOS from the Trislander by about 1400UTC (favourable orientation); but wind speeds of ~2 m/second would suggest only a small tail of the favourable ~20° slopes (45–43° solar elevation) in the wave slope distribution.[12]

So although the evidence is inconclusive we cannot rule out a bright sun-glitter pattern. However, we find it unsatisfactory that

- the theory offers no interpretation of Capt. Patterson's sighting; and
- the sharp-edged outlines and ''dark bands'' of two identical reflection patterns several km apart (1° at ~150 km = 2.6 km) are not easy to understand.

But these are perhaps not fatal, and it might seem justifiable to set them on one side for the sake of promoting the theory at least to Rating Level 3 (somewhat plausible). The most serious problem is

- that during the course of 6 minutes Capt. Bowyer observed the two UAPs steadily cross each other from left to right, horizontally, over an arc of a few degrees.

Stable refractive index gradients in nature occur vertically, not horizontally. We are satisfied that there is no mechanism in the literature—even a very speculative one—that would begin to explain a mobile lateral mirage of this type and that this lateral mobility is a significant feature of the report which we have no good reason to dismiss.

This presents us with the classic dilemma of eyewitness evidence: What is its weight, balanced against conventional scientific models of the world? In this case we can get rid of a major problem, and have an interesting but unchallenging mirage, if only we disregard the description of the two identical images crossing laterally. Do we have a good reason to disregard it? Our position is that *ad hoc* trimming for the express purpose of ''saving the phenomena'' is not a good enough reason unless alternative explana-

tions that do not require trimming can be ruled out as unacceptable on other grounds.

In judging whether it is good method to scrap significant features of the observation other factors come into play, such as the internal consistency of the *prima facie* sighting geometry, whereby respecting the reported lateral motions we find

- a consistent set of sightlines from the Trislander to a pair of locations in the Alderney-Guernsey area, including the correct parallax due to the aircraft motion,
- relative angular sizes of the two UAPs consistent with the distances to these locations,
- the correct ratio of changing angular sizes, and
- a UAP #1 location consistent with an independent sightline from an observer on a near-reciprocal bearing (obviously neither the localised Breton inversion to the south nor sun-glitter reflection are relevant to a sightline looking north from near Sark).

A mirage—even a scientifically unknown ''lateral mirage in the free atmosphere''—doesn't explain these things in a natural way. On the other hand, something like reflections on local haze, or lenticular clouds, or earthquake lights (EQL) in that area could do so. Lenticular clouds were relegated to Rating Level 2 (barely plausible) for a variety of meteorological and observational reasons. This left us with two somewhat plausible hypotheses in Rating Level 3:

1. Sunlight reflected specularly at a shallow angle from the glass roof panes ($\sim 23^\circ$ pitch) of large commercial glasshouses on Guernsey could intercept the underside of a haze layer at a shallow angle. If the layer is thin and elevated, the scattering volume could appear localised north of Guernsey, over the sea. Peak brightness would occur in the 0° forward-scattering direction, but efficiency at a slightly off-axis angle for moving observers close to that direction (Bowyer) might be enhanced by coronal diffraction. A secondary back-scattering peak at about 140° from the same scattering volume could explain a fainter patch of light observed from the south by Capt. Patterson (UAP #2 being some miles further SW and out of his field of view). An elevated haze layer was present, associated with a humidity and optical thickness jump at the top of a weak local temperature inversion (remnant of the strong coastal duct a few tens of miles further to the south, so that this feature turns out to be indirectly causal even if no raypath from the UAPs to the observer's eye passed through this region of the atmosphere). From Centre Nationale de la Recherche Scientifique (CNRS) we obtained 15-minute integrated satellite measurements of solar irradiance at two specimen locations on Guernsey, and Guernsey Met Office provided the 24-hour Campbell-Stokes sunshine recorder card,

which confirmed that bright sunlight was shining at the time of the incident in both areas of the island containing dense concentrations of large glasshouses (total glass area 1.54 km^2).

2. EQL are poorly understood luminous phenomena sometimes reported prior to or during earth tremors and are believed to be associated with tectonic strain. No tremors are known to have occurred in the immediate area at the sighting time, but a magnitude 5.2 earthquake occurred below Folkstone on the Kent coast 4 days later. This was the strongest UK quake for 100 years. We considered that a related EQL 4 days earlier might be possible, even at 330 km from the shallow hypcentre. We looked at the geology and seismicity of the Channel Islands area. We found from Jersey Meteorological Dept/British Geological Survey records for the years 1996–2006 that the area is subject to a few earthquakes every year, mostly minor tremors of around magnitude 1.0 or less, and mostly with epicentres near Jersey. The geological feature of most interest was the Alderney-Ushant fault system, passing down the Channel a few miles N of Alderney (where the fault boundaries enclose the deepest seafloor structure in the Channel, the Hurd Deep) and extending in a NE-SW direction to the island of Ushant. Mechanisms proposed for EQL include piezoelectricity, heat of friction, sonoluminescence, phosphine gas emissions and more. Problems with the favoured electrical charge migration theories have centred around getting a sufficient negative electron density to the surface through the rocks. A recent promising theory developed by Friedemann Freund of the National Aeronautics and Space Administration (NASA) suggests that EQLs are instead caused by positive hole charge carriers (p-holes) that turn rocks momentarily into p-type semiconductors (Freund, 2003; St-Laurent & Freund, 2005). Freund's experiments ''suggest that the wavefunction associated with positive hole charge carriers is not localized on any one oxygen anion but spreads out over many oxygen anion positions, maybe as many as several hundred. If the number density of p-holes reaches a threshold ... the wavefunctions will begin to overlap and the system will undergo a transition from a weakly doped semiconductor state to a highly doped (quasi-metallic) plasma state''.[13] The result of this transition could be that a wavefront of p-type plasmons propagates rapidly through the rock and ''bursts out'' in the form of a luminous corona discharge. We further learned from Freund that the plasma might conceivably be channelled and focused by certain carbonate rocks whose crystal structure is known to prevent the propagation of the p-hole defect, in particular magnesite associated with lamprophyres. In this case the plasma might conceivably arrive at the rock-air interface as a ''bubble'' able to penetrate an overlying sheet of water and give rise to a relatively discrete luminous body. We discovered that lamprophyres are indeed present throughout the geologically-connected area (northern edge of the Massif Armoricain) containing north Brittany, Contentin, and the Channel

> Islands. All of the islands (with the exception of little Sark) contain lamprophyres (Adams, 1976). These are relatively young rocks dating to the period of ''Variscan plutonism'' about 280–345 million years ago and presumably overlay many of the older igneous and ancient basement rocks, but we have not found a precise map of the distributions.

Certain features of the haze-scattering theory are attractive. Given narrow sunbeams from two similar, slightly displaced sources of specular reflection on Guernsey we can in principle locate two separate luminous phenomena (two scattering regions of the haze layer) at altitude over the sea in approximately the areas apparently triangulated by observation and explain the relative horizontal angular motions of the UAPs in a natural way in terms of parallax. But the brilliance/persistence of the images proves difficult to explain, as does the occurrence (*ex hypothesi*) in two locations miles apart of duplicate images, their similarity extending to the ''very sharp'' definition of their shapes and the detail of ''graphite grey'' bands.[14] We also take note of the fact that no phenomenon even similar to this has been seen before by Capt. Bowyer in 8½ years and hundreds of flights on this same airway in all conditions.

The EQL theory also has clear difficulties: The persistence and stability of UAP #1 for at least 12 minutes; the ''very sharply defined'' binocular outline; extreme brightness in strong daylight (typical EQLs are not perceived as brilliant even at night, but as aurora-like glows); anisotropic luminous output (''very brilliant'' from the north; pale ''yellow/beige'' from the south; nothing detected on overhead satellite images at km resolution); yellow/orange colour (blue or purplish colours—the colours of corona discharge—seem statistically favoured); apparent immobility for the whole observation period; all of the above duplicated in an identical (apart from angular size) UAP #2 for at least 6 minutes; the ''graphite grey'' bands at the same position on each object; distance from dry land (in at least one case) by several nautical miles and 1500–2000 ft of altitude.

We are aware of no well-authenticated observation of EQL that reproduces even a few of these features together. But given that the nature and mechanism of EQL is at best obscure it does not seem possible to do more than define the class of EQL phenomenologically, rather than physically. One does not know *a priori* whether a given observation should be excluded from the class or included to redefine the class. So with a view to the striking coincidence of the Kent earthquake as well as the local geology, we cannot rule out novel EQL-related effects.

Conclusion

An unusual mock-mirage of brilliant sun-glitter reflections from the sea near the French coast was given careful thought. We were not able to rule out conditions favourable for a bright sun-glitter pattern, and the theory might even have been worth the cost of discounting Capt. Patterson's sighting were it not for Capt. Bowyer's explicit description of lateral image motions. This feature is

effectively impossible for mirage; even so, we put the theory in the category of ''barely plausible'' to acknowledge its other attractions.

We think it would be exciting to be able to claim evidence of a completely new type of refractive index phenomenon. But, before adopting such an extraordinary lateral mirage as a favourite, one would like to have thoroughly ruled out the haze-scattering theory, the EQL theory, the theory that observers were mistaken, *and* all other possible theories—including those that we have not yet thought of.

We are not convinced that the observations were mistaken, although we accept that this can never be ruled out by any objective test short of conclusively proving the presence of some phenomenon that explains them. During our investigation the overall cohesion and reliability of Capt. Bowyer's account (in particular) has been tested in various small ways and it appears to us to have been careful and reliable. We think it possible that the UAPs did behave as described. This being so, we believe that the haze-scattering theory and the EQL theory are interesting alternative possibilities which could repay further study by experts, although we acknowledge that these also have shortcomings.

An alternative would be to propose an entirely ''new'' phenomenon tailored to preserve all significant features of the sightings, possibly having no direct physical connection to atmospheric optics or EQL. Although we think this is much less likely, and is arguably less economical, we cannot rule it out.

Finally, we note that either of the theories placed in Rating Level 3 could be consistent with the absence of unambiguous ATC or weather radar detection, although as mentioned the raw ATC radar data has not yet been thoroughly investigated to the point of ruling out all possibility of significant echoes.[15] Moreover, the complexity of the radar and software environment does mean that, in this case, absence of evidence would not necessarily be sufficient evidence of absence, so it may not be straightforward to exclude other theories solely on this basis.

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References

Adams, C. J. D. (1976). Geochronology of the Channel Islands and adjacent French mainland. *Journal of the Geological Society, 132,* 233–250; esp. table 1, p. 235.

Cowley, L. (2007). *Channel Islands Sightings: An Investigation into Possible Role of Atmospheric Optical Phenomena*. Privately produced.

Freund, Friedemann T. (2003). Rocks that crackle and sparkle and glow: Strange pre-earthquake phenomena. *Journal of Scientific Exploration, 17,* 37–71.

St-Laurent, France, & Freund, Friedemann T. (2005). *Earthquake lights and the stress activation of positive hole charge carriers in rocks.* International Workshop on Seismo Electromagnetics (IWSE), 2005.

Notes

[1] Altitudes are based on SSR transponder reports of the plane's pressure altimeter reading displayed on the Jersey Air Traffic Control (ATC) radar. These are not true altitudes above sea level (ASL) and require adjusting according to the difference between the standard flight level pressure calibration (QNE) and the local pressure (QNH). This leads to a true cruise altitude at FL40 of approximately 4216 ft ASL and all subsequent radar altitudes must be adjusted by the same 216 ($\pm$50) ft.

[2] Thanks to the Jersey States Airport Director and ATC engineers we obtained all Channel Islands Control Zone ATC radio recordings for the period and composite screenshots of the ATC radar picture produced by ELVIRA software (*E*nregistrement, *L*ecture et *V*isualisation d'*I*nformation Radar) from radar files in ASTERIX format (a European standard format for radar data management). We were also provided by Jersey ATC with a complete 24-hour ELVIRA radar playback and original data files in RDIF format for a period of several hours

containing the sighting period. For various reasons the present discussion is limited to radar information contained in composite screenshot format. We discuss later the extent to which this limitation may affect our conclusions.

[3] These plots are visible in the radar recording, intermittently, appearing to be left behind by the Trislander. We could confirm that there appeared to be no relationship to the visual UAPs.

[4] This echo was still there at 1415 when Kelly asked a nearby FlyBe 146 to look for a visual on a primary target, below them about 1 mile on their right, again ''in the vicinity of the Casquets''. FlyBe was unable to see anything. In his CAA report, Channel Zone controller Paul Kelly described this echo as ''anaprop possibly associated with one of the objects''. He confirmed to us later, and independently to Capt. Bowyer, that it was unstable or ''ragged'' and that in his opinion it was probably not a solid target. We were able to show the likelihood of slightly super-refractive radar propagation conditions which could have caused echoes from rocks or disturbed water in the vicinity of the Casquets reef (a possibility suggested by Kelly). However, we also noted that this echo position—about 1 mile on the right of FlyBe at about 1415—was close to the 1415 position of one quite prominent slow target plotted moving north of Guernsey. It was suspected early on that this could be a surface ship on a route between the Channel Islands and the south coast ports of England, and our inquiries identified a northbound Brittany Ferries vessel, MV Bretagne, scheduled to leave St Malo at 09:45UTC and arriving in Portsmouth at 19:30UTC, reaching the vicinity of Alderney just after the sighting time.

[5] Capt. Bowyer did not himself draw his passengers' attention to the objects. They spotted them independently.

[6] Alderney was at this time to the left of the flight track. Capt. Bowyer's sight-lines to both objects were to the right of the flight track and UAP #1 appeared to him to be aligned with Guernsey. A detailed reconstruction of times and sighting angles confirms that ''Alderney'' was almost certainly Guernsey.

[7] We obtained a statement from MoD that they were aware of no military activities of any kind in the area. Channel Islands ATC Zone were aware of no Notices to Airmen or Airspace Co-ordination Notices.

[8] GEIPAN (groupe d'études et d'informations sur les phénomènes aérospatiaux non identifiés) is the UAP investigation group of CNES (France's National Centre for Space Studies). http://www.cnes.fr/web/5038-geipan.php).

[9] A detailed 180-page report is to be made available elsewhere.

[10] Courtesy of the Dept of Atmospheric Science, University of Wyoming College of Engineering.

[11] Courtesy of Dundee University Satellite Receiving Station.

[12] Wavebuoy data from PreviMer (IFREMER Operational Coastal Oceanographic Centre) and surface wind data from Meteo-France, Toulouse.

[13] Personal e-mail to Martin Shough from Friedemann Freund, 25 May 2007.

[14] It is natural to wonder if such a band could be explained as a null in a diffraction annulus, despite the low probability that this happenstance occurs

twice with two quite separate coronae produced by two separate patches of haze. A sharp and thin null (the angular width of the UAP images was generally smaller than about 1° with the dark bands in the order 0.1°) requires a large droplet size of about 70 μm or more. But a large droplet size is in tension with the requirement for a broad scattering angle in order to preserve diffraction brightness through a LOS rotation of perhaps 10° due to the aircraft motion, which implies a small droplet size (~5 μm or less) more consistent with the type of haze reported. Dry haze nuclei (salts, dust, pollen, etc.) are typically <1 μm. In conditions of high relative humidity they expand by deliquescence and the optical thickness rises appreciably. The resulting droplets can be of arbitrary size, becoming mist, fog, cloud or precipitation. The reports in this case indicate a southerly ''dry air intrusion'' at the haze level, with the haze caused by (in Capt. Bowyer's words) ''bad air from the continent'', indicating perhaps a mix of petrochemical (ozone, nitrous oxides and hydrocarbon) smog, dusts and pollens, which swell less than salt nuclei. The air at the haze level appears very dry (relative humidity 10%) on the Brest balloon sounding. A small droplet size is suggested, which could fit a scattering theory by removing the blue wavelengths and yellowing transmitted sunlight to the ''yellow'' and even ''orange'' hues reported. However, a fine droplet size would produce a corona far too large to explain the ''dark bands'', and in any case the brightness ratio between peak lobe and first sidelobe approaches 100:1, and it is not clear that this would answer the witness description.

[15] We anticipate that this issue will be clarified in a forthcoming report by the French government agency GEIPAN. It is our informal understanding, as of the time of writing, that GEIPAN's analysis has found no significant echoes in the area.

The authors' complete 180 pp report is available online at http://www.guernsey.uk-ufo.org.