- Exploded (after which they disappear either with a pop, a mild bang or a significant explosion)
- Possibly imploded
- Buzzed or 'fluttered'
- Sparked (when colliding with foliage, objects)
- Crackled.

These sounds occur quite separately from thunder or precipitation - in fact there may be no storm present. Termination often occurs after a colour change (see para. 15 below). Sometimes a residue is left after an explosion (no further information).

## DURATION

13. The duration of ball lightening varies from a few seconds to several minutes. However, most seem to last for up to five seconds, with the longest on record as 15 minutes.

## RADIATION - HEAT AND LIGHT

14. Almost all ball lightning reports are visual in the first instance. After they have disappeared (either peacefully or explosively), the observers recall the added features of sound (paragraph 12, above) and any damage caused, which is dealt with below at paras 20 to 22.

15. **Light** Attention is drawn to the phenomena visually, and although there are variations, most sightings fall into the categories of:

- Blue or blue/green
- Red (or pink/rose-pink)
- Red changing to white
- Violet changing to white
- Yellow
- Yellow changing to white
- White to red (observation on one occasion for 65 seconds)

Most sightings fall in the red or red/yellow category. They often disappear noisily after a colour change. Some structures seem to favour certain colours. The main attributes are:

- Rod structures are often purple/violet
- Solid types (see para. 9) often appear as green/violet
- Rotating types can have a combination of colours
- Burning types are mostly red or red/yellow in appearance
- Colours described and classed as atmospheric luminescence
- Hovering or horizontal motion types are often red or red/yellow
- Predominantly red if 'floating'
- Blue or blue/white occurs on only 5% of reports
- Red or yellow types occur on 60% of reports, sometimes reported as being in a bluish envelope
- Less than 1% change colour
- Can emit sparks, fireworks-like
- Can leave behind smoke-colour trial
- Emit, on occasions, bright flashes
- Reported blue or white 'hollow'
- Leave behind a mist (seen as direct light) or blue or white (in reflected light) in moist air
- Smelly types leave behind a brown mist
- Colours may be pulsating.

16. **Heat** Reports both of intense heat and of no apparent heat can be found. The attributes reported are:

- Apparent colour on the surface and a hot core
- "Ball fell into water tank and boiled the water"
- Absence of heat, despite intense light
- ~1% (of those closer than 15m) were reported to emit heat

- Temperature emitted burns humans (see paragraph 20, below).

17. **EM Radiation** An intense E field, set up during storm conditions can charge sharp protrusions. This is thought to account for the attraction (often erratic darting movements) of globes/balls to sharp edges, pylons, fence etc. The presence of these fields causes sparking, incandescent traces (and radio interference/static). The electrical potential is quoted as 3-400kVm$^{-1}$. Pyrotechnic 'streamers', like a fireworks 'burst', accompany the high potentials. EM radiation (E plus H fields) are present, but little magnetic (H field) measurement has been made. Radiation (measured as RF) in storms can be at 6kHz to 450MHz. When lightning is present the radiation is very wideband 100Hz-4000MHz, vertically polarised. The power present is reported to fall off as $1/f^2$. The logic for the radiation is considered at paragraph 23, below.

18. There is no indication of gamma radiation from either ball or bead lightning.

## ODOURS

19. Odours are frequently present. Most are reported as:

- Sharp
- Repugnant
- Ozone-like
- Sulphurous
- Nitric oxide/dioxide
- Methane
- Burning.

It is known that an increased nitrogen level persists for long periods after passage of a lightning ball.

## EFFECT ON HUMANS

20. Serious burns and other effects are reported. [It is of particular interest that many of these are similar to those reported by UAP observers]:

- Humans burned on hands, feet and arms etc. (This seems to be unpredictable/inconsistent as sometimes **no heat** is reported).
- Startling and fright (specially with noisy/explosive types of ball-lightning). Some effects of fright are reported in animals. Hairs bristle, dogs/cats cower, farm animals stampede in fields.
- Humans knocked over.

Potential electromagnetic mental effects on humans, separate from these other, more tangible physical effects, are considered at Working Paper No. 1 Annex F.

## EFFECTS ON ENVIRONMENT

21 The following effects have been reported:

- Holes in the ground (reportedly up to 1m in diameter and over 1m deep)
- Furrows in the earth
- Trees uprooted
- Granite boulders broken/cracked
- Water boiled (see 'heat' above (para. 16) and discussion at para. 26 below)
- Electrically-excited atomic/molecular species, causing single and multiple atmospheric discharges and micro-discharges
- Charging of atmospheric dust particles
- Luminosity from water droplets
- Bio-luminescence and chemical luminescence/due to chemical reactions (not due to thermal sources)
- Production of visible light at room temperatures (and at other temperatures)
- Atmospheric trails/traces (usually terminating at the ball, or persisting afterwards). Pyrotechnic in appearance.

## EFFECTS ON EQUIPMENTS

22 Apart from the reported 'static' on receiving equipment (see also EM Radiation (para. 17 above), example effects are:

- Attachment to power lines/electrical wires/pylons (but no effect on the system reported)
- Entry of 'balls' of various diameters into aircraft cabins
- Stopped (Russian) aircraft engine (1956)
- Military fighter destroyed (1948)
- Moved ahead of aircraft (Russian 1956)
- Russia (1959) caused 100° compass error.

The aircraft incidents above were at altitudes from 2500m to 3400m. Some general EM effects on equipment (not necessarily ball lightning) are also discussed at Working Paper No. 1 Annex D.

## SUPPORTING THEORIES

23. No single theory seems to support all the criteria. The phenomena appears to be sighted only when one or more of the following are present:

- Charged particles or droplets
- High electrical charges in the atmosphere (not necessarily caused by lightning)
- When dust particles are generated (e.g. during volcanic activity)
- When high concentrations of nitrogen and ozone are created
- When marsh gas (methane) is given off
- Vortices (incandescent gas vortices).

24. Luminosity is observed from water droplets of opposite charges. The plasma (plasmoid) appears to be a mass of charged luminous material with sizes, structures and shapes as described, (at para. 27-30 below).

25. It is known that ball lightning is a natural electromagnetic radiation formation. However, it has been impossible to produce in the laboratory, unless the object has some sort of containment and, once formed, does not rely on external field(s) to maintain equilibrium.

26. There are several unusual features and questions:

- If the body is hot, why does it not rise?
- What constraints could be keeping it at level altitude (floating type)
- Is the plasma rotating? If so is this the means of storing it's energy?
- Is the spiral action (seen in vortices) due to the Earth's E and H fields.

27. The energy stored (E) must be proportional to volume, and E must be proportional to the cube of the cloud dimension. Similarly the light emitted is proportional to the surface area. Hence, the light is proportional to the square of a dimension. Plasma theory shows that a 10cm diameter ball could glow for 0.01 sec. The maximum energy which, in theory, could be stored in a ball appears to be less than could sustain it. In theory if the ball is lighter or heavier than air, then it should, respectively rise or fall. For equilibrium (hover or 'float') the ball density must be $1.29 \times 10^{-3}$ gm. $cm.^{-3}$.

28 To achieve colours, one associates this with temperatures:

| | | |
|---|---|---|
| Yellow | $\lambda$ =5800 Å = | 5000°K |
| Red | $\lambda$ =6300 Å = | 4600°K |
| Blue | $\lambda$ =4700 Å = | 6200°K |
| White | - | 10,000°K to 14000°K |

This, of course, does not accord with the perception of colours reported when no heat is reported. It may be, of course, that, although present, no heat was felt/sensed for various reasons (e.g. long range, cooling wind, etc.)

29. The logic is that to glow for longer than the 0.01sec (at para. 27 above) energy must be received from somewhere.

30. The diameter of a spherical ionic plasma is determined by the resonance of the ball with the EM oscillations of the external wave at which energy absorption is most efficient. Resonance occurs when (for a sphere), the $\lambda$ of the external radiation is 3.65 times the sphere diameter. To get typical ball

sizes reported, λ would have to be 35-100cm. Hence, the upper limit would be $3x10^8/1=300MHz$ (whereas 30 and 50MHz are reported from microcharges). It should be noted that rarely are there any measurements from real ball lightning; any measurements quoted are from experiments attempting to simulate the phenomenon.

## LABORATORY-PRODUCED BALL LIGHTNING

31. Many attempts have been made to produce ball lightning under laboratory conditions and it is reported[1] that (in the USA) it is routinely possible to produce a specific type of this phenomenon. Golka also claims that plasmoids can be produced by combustion inside a 'microwave oven'. However, it is not proposed that the ball lightning generated accounts for all types. In the experiments the fireballs lasted from two to five seconds but with only diameters of ~1cm. This has been achieved by short-circuiting 60Hz currents as low as 1200A across copper and aluminium electrodes under ~2cm of water. Another researcher (Silberg, unreferenced) describes how this phenomenon, produced green fireballs in a submarine engine room, using 260 Volts and 156,000 Amperes. Ball diameter was 6 to 10cm. For a 10cm diameter ball (volume $515cm^3$) there are $1.4 \times 10^{23}$ molecules. When the medium (used in the switching contacts) is nitrogen and an ionisation energy of 15eV per ion pair for the single ionisation, it can be calculated that there must be $3.4 \times 10^4$ Joules contained in the ball. The ball quickly disperses unless a source of replenishment energy is present.

32. The fireballs produced rise to the surface and remain until exhausted, 1-2KJ of energy having been deposited. The type of lightning balls produced are reported to be similar to those observed in aircraft during flight and, strangely, in submarines during WWII. With higher power the 'ball' can be made to travel higher from the surface and 'bounce' and 'dance'. It is postulated that the more power applied, the larger the diameter which may be produced. Hence, the phenomenon might be scaleable.

33. Other characteristics clearly depend on the materials and size of the electrodes and their burning temperature when a tremendous energy level is applied to a very small surface area. For aluminium this is of the order 4400°F. As might be expected, as the fireballs surface they sizzle and hiss, some leave the surface and produce spiralling smoke trails, leading to the supposition that the fireballs are spinning (see below). Different electrode types produce more or less smoke. Those remaining on the water exhibit random motion until they decay.

34. Experiments were only made with the electrodes under water because this method enabled measurements to be made before the fireballs darted off in all directions, making measurements difficult. Whereas previous researchers had expected high voltages to be a prime requirement, these experiments were made at 40-50 volts. Even so, enough energy overall was deposited on occasions to make the balls leave the surface of the experimental tank and leap onto the floor.

35. Aluminium electrodes produce white fireballs, while iron-to-iron electrodes produce yellow. Either the outer surface or the kernel appears to be spinning. As soon as the ball stops emitting light, it shrinks to sugar-grain size. If over water these particles sink.

36. It is postulated that if the sphere is spinning a boundary layer phenomena will be set up, retarding thermal radiation in the same way that the filament of an incandescent lamp forms sheath layers which keep the filament at a higher temperature.

37. As a result of these experiments the author suggests that, as ball lightning has only very rarely been reported inside pressurised aircraft, that the product of the balls was due to natural lightning attachment to the aircraft skin forming a small hole (at 4400°F) with consequent formation of a plasma ball on the **inside** of the aircraft.

[1] "Laboratory-Produced Ball Lightning" R.K.Golka, Journal of Geophysical Research Vol. 99 No. D5 May 20 1994.

## PLASMOID

38. A plasmoid is postulated as formed by a small volume of plasma (small as compared with $\frac{\pi d^2}{6}$), where d is the diameter of the final ball. The energy is formed by RF at $\lambda/3.65d$, and ionisation grows - but eventually becomes stabilised and expands but eventually deviates from resonance and cools and returns to $d=\lambda/3.65$. A weak shock is formed on collapse when the RF energy is cut off suddenly - but if the RF field reduces gradually the extinction progress becomes smooth and noiseless. It is reported that spherical plasmoid shapes can be sustained by RF energy at low pressure, and the concept of a phase-locked loop of EM radiation at a wavelength stable to the circumstances previously has also been suggested. It is suggested, in this instance, that the stable standing wave excites the ambient gases to glow and that the colour is dependent on the constituents, such as dust etc. in suspension. In some cases it is claimed that ball lightning has the ability to absorb light, hence it can be grey or black in appearance.

Ball Lightning
- sometimes has glowing tentacles
- rapid rotation of sphere despite slow linear path motion
- light given off can which is ascribed to electronic excitation

It is theorised (Ashby and Whitehead, Aldermaston 1971), following the collection of remotely sensed signals during thunderstorms, that because gamma-ray levels soared dramatically (X50), on several occasions (for several seconds) that more complex explanations than hitherto might be responsible for the plasma production - perhaps involving minute particles of anti-matter (micrometeorites). However, it is not clear how the plasmas remain in suspension or even enter aircraft on occasions - a well documented occurrence by multiple witnesses.

## AURORAL LOOPS

39. **Ball Light Ozone Spheres** The gravitational force on a sphere of ozone a metre in diameter is 430g and it would descend. A 0.5m diameter sphere would experience a force of 54g. If the sphere was visible ozone, on sudden expansion when conversion occurs to oxygen (20 litres for a 50cm sphere of ozone), it produces explosive energy. Ozone is the only gas denser than air produced in quantity under stress in air, as distinct from production from a streaming spark discharge. The earth's surface and ozone spheres are both generally negatively charged. Although blue in colour, if nitrogen is present the explosion colour is yellow.

40. **Power Intensive Plasma Formations (PPFs)** In the search for the key characteristics of ball (and bead) lightning PPFs, a related phenomenon appeared to show some further similarities to UAP reports; of which the most relevant are:

- PPF dimensions extend to tens of cm.
- They can disappear in one point of space and simultaneously appear in another.
- Sound propagation speeds in PPF are much higher than the speed of sound in gas and may reach 1600 $ms^{-1}$.
- The plasma temperature inside is <1000°K.
- PPFs can burn metals leaving holes (but not affect dielectric material).
- PPFs do not disturb the gases they pass through in movement.

Large PPFs (e.g. 1m diameter) are known as METEOXTRONES. Working papers 19, 21 and 24 describe other types of atmospheric plasmas.

## BALL LIGHTNING AND AIRCRAFT

41. The reported incidences of ball lightning 'flying' ahead or behind aircraft have brought about some investigations into the expected characteristics of ball in the aircraft airstream. It seems likely that the incidence of sightings of 'foo fighters' (as they became known in World War 2) would increase, purely

because of the huge numbers of aircraft flying - certainly much more night flying than had been carried out in the short history of manned flight.

42. It is stated that large radius ball lightning (similar plasma bodies) can 'chase' aircraft while maintaining shape and more or less constant distance from the aircraft. The 'ball' is able to do so because it is not solid (otherwise a thrust force of thousands of Kg would be needed )! It is postulated that the layer of air adjacent to the surface of the ball loses its viscous properties. The ball follows the aircraft even in manoeuvres. Observations of ball lightning show that its characteristics do not change appreciably during its lifetime. When it is in the airstream of an aircraft it is postulated that it behaves as a non-deformable solid sphere in the airflow which holds its position due to the electrical/magnetic charges, described elsewhere in this Working Paper. The main reason for interest in close encounters of aircraft with ball lightning is one of flight safety. It is reported that large balls can be comparable with body diameter of large aircraft and can be 'captured' by the exhaust from engines and 'chase' the aircraft at a velocity of 150-200m.s$^{-1}$ (278-370kts), maintaining an apparent constant range from the tail assembly.

43. One (TU134) pilot reported that at an altitude of 10,000ft and flying at a velocity of 800km hr$^{-1}$ (~220ms$^{-1}$), the ball (in this case green) "appeared as though tethered behind the aircraft". Another (Russian) crew report, when flying at 7500ft altitude were 'followed' by a huge ball which was still in 'pursuit' after a fast descent to 4500ft. It refused to leave despite manoeuvre - which was limited for an airliner.

44. If the moving object were solid it would take the force of many Newtons to make it follow an aircraft. Clearly the ball is sensibly weightless (apart from the mass of the gases it contains). It is believed that the electrical charge of the ball diminishes as ionisation of the air-layer in contact with its surface occurs. The USSR treated the ball lightning phenomenon as very important and Gaidukov [3] reported after modelling the interaction that:

- All efforts should be made to avoid lightning seen ahead (before a ball is formed).
- To avoid the chance of an encounter with a ball, pilots should 'encircle around a vertical line passing through the centre of the lightning'.
- Pendulum-like undulations in altitude may be seen (by balls ahead), and every effort should be made to place the ball astern, where it will assume a stable position.
- The balls cannot 'catch up' the aircraft once the pilot has ensured that the ball is astern.
- The ball will dissipate. Reports of 10km (tail chase!) are not unusual.

45. Several comments can be made:

(a) The instances of phenomena of ball lightning ahead of, or behind, aircraft is relatively rare, but the Russian research suggests, apart from initial lightning avoidance, that the aircraft would be safe with the ball astern.

(b) Reports of balls above aircraft 'pushing or forcing' an aircraft to descend are of concern, even if the ball does not cause physical damage its presence is clearly menacing to the uninitiated - especially as it occurs suddenly.

(c) A 'collision' from astern is not considered likely.

(d) A 'collision' head-on is possible and its imminence might cause violent pilot (control) reaction even though the contact may not (at the last moment) have actually occurred.

The 'stand off' of the ball lightning from an aircraft seems to be very much like the situation encountered in several scenarios where pilots have been scrambled to investigate 'UFO' sightings. A scenario where this occurs not only involves the 'stand-off' described here

but also the 'black' centre described, below, at para. 48

## PLASMA SHAPE CHANGES AND SIZE

46 It can be argued that the buoyancy of the plasma is balanced by charged ion droplet mass, with the actual shape make-up dependent on the distribution of forces within the ball. Although some have suggested that the oval shapes occasionally reported are due, not to the mass of the droplets/particles (which gravity may pull into a pear shape, individually), but to the presence of a strong D.C. field, elongating the ball in the field direction. It is believed that the production of nitric acid (note the section on nitrous smells) leads to an inflow of air which aids ball stability. The size of the ball seems to be determined at its creation[4] and it is believed the cycle of change in electric field, of ion production, of water demand, and then evaporation might change the temperature gradient in the ball but not its size. In the many attempts to develop a theory to explain ball lightning (and by so doing possibly understanding the 'earthlights' phenomenon), it is always postulated that a source of energy is essential within the phenomenon for it to exist and be sustained. It has been difficult to apply recognised theory, although at the turn of the century it was recognised that Maxwell's equations could be generalised to include magnetic charge and current as the mirror-partners to electric charge and electric current. Since then 'new physics', has postulated the 'magnetic photon' as a corollary to the more widely known conventional optical photon. Hence, some theories concerning the ball lightning phenomenon have developed using the 'magnetic photon' and 'magnetic charge'. 'Vortons', in turn, are postulated to occur in pairs and create a rotating magnetic field. [Comment: This is of particular significance when related to the discovery that humans exposed to rotating magnetic fields can produce responses strikingly similar to those reported from close encounters with a UAP].

## SURVEY OF COLOURS

47. Smirnov[2] analysed over 4100 ball/bead reports (indicating that the Former Soviet Union must have a considerable database on UAP-type topics). The total power radiated by a black body obeys the Stephen-Boltzmann Law of proportionality to the fourth power of temperature and in 4112 samples the temperatures produced the following statistical colour distribution:

| | |
|---|---|
| White | 20.4% |
| Red/Pink | 17.7% |
| Orange | 23.1% |
| Yellow | 20.2% |
| Green | 1.4% |
| Blue/Violet | 11.4% |
| Mixed Colours | 5.3% |

From this it can be seen that for the atmospheric luminous phenomenon seen as a ball, there is around an 80% likelihood of the ball (or bead) colour being either white, Red/Pink, Orange or Yellow and around a 20% chance of it being one of these four options, rather than green, blue or mixed.

An apparent paradox in the understanding of the intensity (and hence colours) has been that the calculated radiant power (using colour temperature to determine intensity) has resulted in intensities that seem to be far too large to be in agreement with actual observations of heat and light. One of the later theories resolves this by suggesting that the vortons (see para. 46 above), moving as a gas, exhibit positive Doppler shifts of the radiant black-body energy to a higher colour temperature (moving towards the observer) and to a lower colour temperature for movement away. Variable cloud shapes other than balls can occur, it is claimed, if a ferromagnetic-like interaction of the dipole forces of the individual vortons occurs.

[2] Smirnov B.M. Sov. Phys. USP 35 650 (1992) and Phys Rep No. 224 151 (1993)

## OPTICAL 'THICKNESS' OF BLACK BODY RADIATORS

48. A supportable theory suggests that some balls have a coherent core which is too cool to radiate in the optical visible spectrum - hence such a volume would appear totally black. The visible appearance of the phenomenon depends on optical 'thickness', where:

- If the body (of gases/particles??) is hot enough to radiate, then its intensity is uniform over the surface; independent of the angle the surface makes with the sightline of the observer.
- When the radiator is too cold to radiate a significant amount of energy in the optical region, it will completely absorb any optical radiation which falls on it and hence would be 'seen' as a totally black object.

**NOTE: This later statement would seem to have a significant read-across to frequent UAP sightings where a black shape (often rectangular or triangular) is seen between visible lights at the extremities**. Although, Black and grey-body radiators are, respectively, 'thick' and 'thin' optical sources.

## THERMO-CHEMICAL REFRIGERATION

49. Considerable evidence exists to show that the incidence of ball lightning, especially with a longer lifetime, is higher when conditions of high humidity are present. Further, because of rapid ion motion and a higher temperature than the surrounding air, ions escaping from the plasma become hydrated and this action adds heat to the system; keeping the hydration zone (boundary) fairly hot. However, if the ions survive long enough to become hydrated by ~5 water molecules it is postulated that cooling occurs. To this thermochemical action is attributed the characteristics of the reported harmlessness of occasional human brushing contact with a ball and the reason for the cloudiness/indistinct appearance of the edges of the ball.

## SUMMARY OF BALL LIGHTNING CHARACTERISTICS

50. A survey of literature on ball and bead lightning and its relevance to UAP reports, has shown that:

- There is a near constant brightness, size and shape, which can exist from a few seconds to minutes.
- The balls/beads have considerable mobility.
- It is possible for an electronically-charged body (possibly including ball lightning) to 'attach itself' to an aircraft in flight; where, apparently due to a balance of fields (electrostatic/magnetic or EM), it can remain in close proximity (formation abreast or astern).
- Ball lightning can enter houses and structures including aircraft and can actually exist within closed metal structures
- Sounds and smells are present on rare occasions. These are both often described, respectively, as 'electrical' (e.g. buzzing sounds, or explosions) and smells witnesses associate with electrical equipment, such as insulators overheating or rotten eggs.

51. **Near Terrestrial Events** There is a tendency for ball lightning not to rise - most sightings remain at low level near the earth in a near horizontal path. This is explained, in theory, in the reasonable expectation that the balance of charges between the ball in its environment (either indoors or outdoors) is such that the postulated radially-moving negative ions form a static charge on nearby surfaces which tend to repel the negative body of the ball; keeping it at a distance. This, it is argued, is the most likely reason for the balls to reportedly try to pass through any aperture (i.e. window, door, chimney). In short, as it moves it creates a field which tends to hold the ball in position (e.g. at constant altitude outdoors, or across the centre of a room. Further, since no charge builds on the aperture, the ball can proceed - presumably sending a positive charge somewhere ahead. This may also account for

the propensity of balls to 'dart' towards power cables or any object where the radial does not exceed the local positive value.

52. **In-Structure Phenomena** The fact that the plasma phenomena can reportedly exist in closed metal structures suggests that, contrary to expectations, the existence of the ball is apparently not dependent on an external source but must retain it's own electric or magnetic field in order to exist and, once formed, is self-sustaining until its demise. Within the past year some researchers have suggested that atmospheric plasmas may owe their duration to a combination of both vertical and horizontal (i.e. orthogonal) magnetic looped fields which contain and sustain the phenomena. If this is the case the process may be applicable to any atmospheric plasma - however formed, if the field are strong enough. It has been proposed [6] that the stability of a volume (ball) of air at 16,000 to 30,000 degrees Kelvin might be contained within linked magnetic lines. Discharge arcs (e.g.lightning) advance along narrow tracks 50-100μm in diameter in air. These streamers would only occupay a small volume of the ball. It is postulated that some of these form short circuits, resulting in circulating currents, each loop acting as a coil. the physical appearance of the charge-contgined ball would be shining and diffused. It can be shown by Maxwell's equations that a 'magnetic knot' is feasible and this has now been observed under laboratory conditions. The conducted energy cannot be stationary and is postulated to produce a slowly-varying magnetic field. The magnetic energy is a function of the ball radius, the vacuum magnetic permeability, the number of magnetic lines which are linked and a field normalising function. It is not within the scope of this study to pursue this important phenomenon further, other than to emphasise the likely connection between this, the formation of plasmas by meteors and the effects of varying magnetic fields on humans (Working Paper No 25), in the UAP context.

53. **Demise** For those balls/beads visible to humans it is reported that the silent demise is normally a simple fade in brightness and diameter, while the explosive demise is sometimes preceded by an increase in brightness and a colour change. Similarly, plasmas of other origins than ball or bead lightning may also decay in the same way. Hence, in the UAP sighting reports it is almost impossible to determine the origin of a particular UAP because, it is believed, the behaviour is very similar. Further, if the premise that meteors (see Working Papers and statistical results at Volume 1) also cause the formation of UAP, then a UAP could be formed during a thunderstorm (as well as from ball or bead lightning) and similarly persist afterwards.

## SUMMARY - RELEVANCE TO UAP

54. An examination of a wide range of research into ball and bead lightning has shown that it is certainly connected with a proportion of the UAP reports received from within the UK airspace. Descriptions of these particular forms of lightning correlate in time, colour and motion with qualitative description often given by reliable UAP witnesses. Because those UAP which are formed and then reported as a result of lightning are, of course, transitory in nature and their form is apparently changing as they head towards demise, it is reasonable that the colour descriptions vary, that they exhibit strongly influential electrical field characteristics, exceptional motion and pyrotechnic displays. All of which are unfamiliar to the majority of the population.

## REFERENCES:

1. "Ball and Bead Lightning" J.D. Barry Plenum 1980.
2. "The Nature of Ball Lightning" S.Singer Plenum 1971.
3. "Hydrodynamic Model of the Interaction of Ball Lightning with the Airstream of an Aircraft in Flight" N.I. Gaidukov. Technical Physics 38(9) Sep 1993.
4. Turner D.J. "Ball Lightning" Phil Trans. Royal Society, London 1994.
5. Fryberger D. "A Model for Ball Lightning" Ostfold College Norway Report No. 1997:5 Part 1 (1994) Proc.

First International Workshop on ULAP, Hessdalen.

6. "A Model of Ball Lightning as a Magnetic Knot with Linked Streamers" A F Ranada, M Soler & J L Trueba. Journal of Geophysical Research, Vol 103 Sep.1998.

WORKING PAPER NO. 3

# POTENTIAL REASONS FOR HIGHER DENSITIES OF UAP SIGHTINGS

# POTENTIAL REASONS FOR HIGHER DENSITIES OF UAP SIGHTINGS

## INTRODUCTION

1. In the current database analysis it has been important not to misinterpret the reasons for UAP occurrences, by drawing the wrong inferences from a statistical analysis. One of the first analyses was to ascertain the density of UAP sightings across UK aerospace to look for high incidence areas - in the hope/possibility that this may shed some light on the nature of the phenomena, lead to more focused scientific work and possibly to obtain more data when sightings occur (e.g. correlation of visual sightings with coincident radar coverage). As the unknown is being investigated, preconceptions are no part of initial assumptions.

2. Taking the extreme case - that UAP are more than natural occurrences - it cannot be assumed that locations where the objects occur will necessarily be of obvious importance to humans. Further, it cannot be ruled out that these appearances may only take place at certain intervals and be entirely unrelated to our concept of time. They may even be related to the relative disposition of the gravitational fields of various bodies in space, or even of other fields of which we may have scant or even no knowledge at present.

3. On the initial assumption that the phenomena of a UAP sighting can occur anywhere, then the presence of larger numbers of sightings in a particular part of UK will be dependent, at first sight, upon:

(a) The population density

(b) The weather/visibility

(c) The time of year

(d) The time of day

(e) The location

(f) Availability and competence of witnesses.

## POPULATION DENSITY

4. It would seem logical that if there are a greater number of potential observers, and on the assumption of an equal probability (i.e. equal distribution of UAPs in the UK air space), then sighting clusters could be expected to occur in more highly populated areas. However, in areas of greater population there is also a much higher night-time background lighting level, making observation of flying objects much less likely to be seen (as evidenced by astronomical observatories, which have been forced to move away from lit-up areas). The contrary situation is that more sparsely populated areas have fewer potential observers, but little or no interference from ambient surface lighting. It is thus difficult to immediately connect the number of potential observers available in a geographical area against the likelihood of expectation of UAP sightings, since other factors are present. As an initial guide Table 1 shows the population distribution for the UKADR[1].

## WEATHER/VISIBILITY

5. A brief analysis to determine the relative prevalence of sightings in cyclonic and anti-cyclonic conditions has been made. There was no clear evidence of correlation with temperature, dew point, wind, etc. However, the continued prevalence of UAP reports whether thunder (i.e. Lightning, as a pre-requisite - see Working Paper No 2) was present or not on the same day in the same area was of particular importance in an attempt to discover whether atmospheric conditions are key to the formation of UAP. However, adequately clear visibility for viewing low and

[1] Oceania World Index Johan van der Heijden 1996

medium altitude UAPs can exist in both weather patterns; although the high pressure clear conditions, rather than the misty conditions in high pressure are likely to provide the best viewing conditions. There is, nevertheless, a possibility that UAP sightings might be connected to weather patterns.

## TIME OF YEAR

6. It is instinctive to imagine a larger number of reported sightings during dusk and darkness - simply because the greatest number of reports are ones where 'lights' are seen - and this is rarely the case reported in daylight. Of course, this does not necessarily mean that there are fewer UAPs present during daylight (assuming that their occurrence is indifferent to the presence or absence of light). [Since we do not know what they are we cannot assume any attributes]. In addition to weather, it may be shown that the electrostatic and electromagnetic nature of the atmosphere correlates with sightings ( see Working Papers No. 1, 2 and 10). It is known that sightings occur in the vicinity of volcanic activity - possibly connected with the presence of electrical charges caused by particle friction in the dust which is present and its velocity. The potential connection between UAP and ball lightning are summarised at Working Paper No 2.

## TIME OF DAY

7. Although a time-of-day connection with **UAP reports** is inevitable because of the relative daylight and darkness viewing conditions for 'lights' in the sky, the actual occurrence of the total of these phenomena, within the atmosphere at any given time may not be time-dependent. One must not fall into the trap of assuming that the presence of unexplained objects in the atmosphere (or in near space) is necessarily connected to our world measurement cycle of time or that the rate of occurrence is somehow connected to the routine of life. As this study only involves sightings within the UK's airspace, this investigation will not be in a position to correlate UK sightings with successive sightings (if they were reported or even if they were present) in Europe or over Ireland, in the Atlantic, North Sea or Bay of Biscay. However, if there is shown to be a cycle of sightings, we shall have no other option than to measure it in terms of time as we know it. If, for example, this (to our eyes) appears to recur at regular intervals, the problem will then be to fit this time period to a meaningful pattern, perhaps sidereal. It may, of course, be shown not to fit any known pattern (e.g. celestial, seasonal, etc).

## LOCATION

8. It is sometimes claimed that UAP sightings are more likely to occur in some locations than others. Apart from the volcanic connection, claimed by some observers (clearly not applicable to UKADGE), it has been suggested that the location list at the database (Table UAP-2, Volume 1) may be connected with sightings. Before useful statistical work can be done on locations, the following must be considered for a rigorous analysis to be made:

(a) The location of a sighting is often given crudely. A 'place name', 'near a place', 'between two places', 'out to sea off xxxx', 'on holiday near xxxx'. The address of the witness may not be the location of the sighting.

(b) Lat/Long co-ordinates and Grid References are rare (but could be generated approximately from most of the witness reports).

(c) Post codes might be a good method.

(d) Plots (maps) of the following are required in electronic form:

- National Grid/Local Power lines down to main sub-station level
- Airfields - Civil
- Airfields - Military/Experimental Establishments
- Air corridors

- Low Flying Routes for Military Aircraft
- National strategic sites
- Power Stations (including nuclear)
- Locations of ancient monuments/ fault lines (to investigate the claim of heightened probability of UAP sightings electromagnetic/gravity/ earth's field changes claimed at these sites).

## AVAILABILITY AND COMPETENCY OF WITNESSES

9. Clearly only a proportion of UAP phenomena is reported. There is no way of ascertaining what proportion this may be. It can only happen where people are present, therefore there may be large areas of the UK, with high UAP activity, but never seen or reported. The phenomenon of the lack of radar correlations is considered at Working Paper No. 10 and at Volume 3 for specific in-service systems.

10. The decision to report activity depends on the witness. The more 'responsible' are likely to do so because the UAP sighting is a unique event in most cases: it has caused fright or concern and there is a 'need' to tell someone in authority. Because the sighting is 'airborne' the preferred reporting option is the nearest RAF Station, followed by the coastguard or the police. Dating of reports compared with sighting dates clearly indicates that some witnesses often wait a day before making a report. [As for all delayed reports there is always the possibility of forgetfulness on detail or embellishment!]. Many witnesses delay because of concern about their credibility. A comprehensive report is not usually obtained from the very basic UAP (UFO) reporting form - and the accuracy and detail obtained from a witness depend significantly on the attitude and care taken by the police or other reporting authority. Hence, there is no reliable consistency of reporting - even from the ATC/CAA sources.

11. It is wrong to separate so-called competent/reliable witnesses from others because every scrap of evidence has the potential of being important. For example several single-witness crude sightings can complement a 'reliable' sighting, since these extra sightings:

- Allow multiple angle/aspects to be registered
- Allow object velocities, colours, altitudes and sizes to be established independently
- Allow geometry to be used to eliminate heavenly bodies (i.e. planet sightings)
- Allow both silhouette as well as reflected-light viewing
- Allow multi-aspect viewing to ascertain shape, colour and flight profile
- Eliminate the retained after-image sighting of single witnesses - so establishing true sighting times
- Confirmed UAP geometries and spacings independently.
- Eliminate single-human events (e.g. occult, drugs, psychological etc.)
- Usually eliminate the hoax option
- Reinforce credibility of each others reports from a group of independent witnesses
- Allows multiple photography/video to be taken.

## HIGH INCIDENCE LOCATIONS

12. Within the UKADR it is reported by researchers that the greatest incidence of UAP events are centred on:

- Lothian (Scotland)
- Luce Bay (Scotland)
- South Wales
- Warminster (S. England)
- Pennine Hills

13. Elsewhere in the world concentrations of events occur at 20 prime general locations. These, include France, Belgium and Scandinavia - all which have airspace adjacent to the UKADR

14. Hence, reports are sometimes received of UAPs entering from, or leaving towards, these nations. Only NE Italy and Spain are among the other NATO nations reporting large numbers of sightings (although these are not shared or reported through official channels to UK MOD).

## AIR CONTAMINATION

15. It is postulated by some plasma and other atmospheric researchers that the presence of

particles (from whatever sources), as well as the introduction of various industrial gases, will affect the conditions for the formation of atmospheric plasmas. This is considered further in the relevant Working Papers, principally Number 19. It is noted, in passing, that those nations with higher atmospheric dust-producing conditions(e.g. Volcanic and Earthquake Regions), reportedly have a high incidence of UAP reports. Further, if this theory is true, one would expect to find more UK reports at, or close to, centres of the older smoke or gas producing industries and possibly nearer to areas such as airports where exhaust particles of various types are likely to be in higher concentration.