The Orb Phenomenon by Dr. Bruce Maccabee

INTRODUCTION

In recent years a number of people have reported finding anomalous circular images, often called "orbs," in photos taken at night with a flash, under seemingly ordinary conditions. The photos have been taken both outdoors and indoors. These photos were not taken under "conventional UFO," conditions, i.e., there were no strange lights or objects visible to the photographer. These images first turned up in photos taken for various reasons other than to photograph "orbs," i.e., photos of home scenes, outdoor scenery at night, etc. Subsequently numerous photographers have simply taken pictures "into the dark," even though they didn't see anything that could make orb images, in order to find out if "orbs" would appear in the photos. (Note: I should point out that there have been numerous photos of unusual lights at night which were seen at the time of the photos and which have also been called orbs. Photos such as these are not the subject of this discussion. The subject of this discussion is orb images which appear in photos taken when there was no observed cause for them.)

The images discussed here are rather diffuse or "transparent" areas of the film that are generally slightly brighter, but sometimes much brighter, than the (generally dark) background. For many cameras the orb images are round, but for at least one type (Polaroid Model 600) the shape is nearly rectangular. Figure 1 shows an example of such images in a flash photograph of an outdoor nighttime scene. If one examines the dim circular images carefully one sees that they have a bluish tint. Images such as these appear at random locations in photos. Similar images obtained by other investigators can be found at www.orbsite.com. Photos have been taken at many different geographic locations. Some outdoor locations produce more, perhaps many more, of these images than other locations. Therefore the occurrence of these images raise the following questions: (a) what are they or what causes these images, (b) why do they occur in some locations and not (or rarely) in others, and (c) why are they (apparently) a recent photographic phenomenon? The investigation reported here has provided answers to these questions.

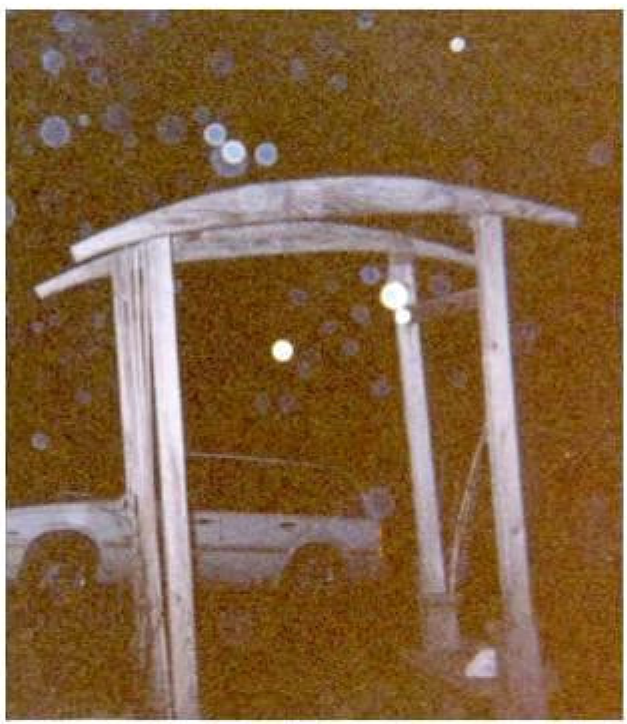


FIGURE 1
ANOMALOUS IMAGES IN FRONT YARD

This investigation was prompted by several correspondents who reported to me that they had found these round images in their own digital photos. They had not seen anything when the photos were taken, yet here were the distinct, reasonably bright round images. They asked for my comments on their photos and photos of others.

My first impression upon seeing images such as these (see Figure 1 for example) was that they were unfocused images of small, bright reflectors of light. However, I could not prove that there were such reflectors present at the times of the photos. The photographers didn't see anything. At the same time, an alternative hypothesis presented itself. So far as I knew, the first photos in which these images appeared, or at least the first in which they were noticed, were flash photos that had been taken with consumer-grade digital cameras. This raised the question of whether or not these images were some sort of strange artifact of the digital camera like some unexpected light leak. (More recently similar images have turned up in flash photos taken with recyclable cameras, such as the one used to take Figure 1. Other photographers have found similar images in photos taken with 35 mm cameras.) On the other hand, if the cause did not lie with the camera, then it must be something outside the camera. Perhaps the flash had illuminated something very small that was close to the lens. Perhaps a few small flying insects happened to be close to the camera lens when the flash went off. This hypothesis (tiny insects very close to the camera and lit by the flash) seemed acceptable for photos taken when such insects would be present (outdoors in the spring, summer, fall) but not when such insects would unlikely be present (very cold weather,e.g., winter, or inside buildings).

Since I did not have a digital camera (they have been quite expensive until recently) I was not able to do any experiments myself to determine whether or not these anomalous images could be an artifact of the camera and so there the matter rested until recently when a correspondent reported finding some images in digital photos he had taken inside his house using a new Olympus camera. He was worried that his new camera had some sort of strange defect. He wrote, "The (anomalous images) look like lens flares, but there appear to be too many of them, and they don't seem to be in the right position for lens flares." He offered to send me some of his pictures and wanted to ask my advise as to whether or not he should return the camera.

He emailed the pictures to me and I, too, was puzzled. They showed scenes in a house where insects would not likely be flying around close to the camera lens. About the only thing I could do was suggest some experiments to determine whether or not these images were caused by something outside the camera or inside the camera. One of the experiments was to take flash pictures with his hand over the lens to block light. This would test whether or not the images were coming from inside the camera, as, for example if there were some bizarre hole in the camera structure that would allow light to leak directly from the flash to the film. For comparison I asked him to take pictures in some area where there were no surfaces to reflect light, for example, outdoors where the nearest object was far away. I pointed out that if he got anomalous images when his hand was not on the lens and got no such images when his hand was on the lens then the anomalous images were coming from light reflectors outside the camera. The correspondent noted that there was a bright metal ring around the lens aperture and thought that perhaps that might cause some unexpected images. I suggested that he cover it with black tape. To my suggestion that there might have been tiny reflective particles in front of the camera he replied,

The tiny, shining objects idea is an interesting one. Most Christmases, my kids make various things with glitter, which they bring home. This stuff sheds into the carpet and can be quite difficult to get out. I believe this could be the explanation for the (anomalous images which appear to be silhouetted against) the carpet. I'll take some repeated shots from the same position and see if they move--if not, then we've got the explanation for those, at least. As for the 'floating' (images), perhaps some minute particles of glitter can float on air currents--but would they stay around for a year? Again, some sequence shots might help here, too.

It is clear from what he wrote that he thought the anomalous images that appeared silhouetted against the rug might have been caused by bright reflections from tiny pieces of reflective material - glitter - on the rug. He also wondered whether or not floating glitter could explain the images which appeared to be above the rug, e.g., silhouetted against the walls or ceiling. I did not believe that "Christmas glitter" in the rug or floating in the air would explain the images, but I didn't know what would.

About a month and a half later he wrote again and this time supplied the first good suggestion as to the source of the anomalous round images:

I have followed the experiments you suggested, as well as done a few of my own. I can definitely state that the (images) are the result of the illumination of dust particles in the air by camera flash. I was able to produce a (picture) image with hundreds of (round images) by having the kids run around for several minutes on an un-vacuumed carpet! Most of the dust particles seem to be intrafocal, although even those at greater distances can produce quite a convincing small (image). I borrowed a professional flash, which fires several times a second, and was amazed at just how much 'junk' is stirred up in the home environment by ordinary activity. I could see hundreds of quite brilliantly-illuminated particles with my eyes.

When I read the above I knew that what the correspondent said was perfectly logical. I already knew that reflective particles so tiny that they could not normally be seen by the naked eye could make circular, defocused images if they were close enough to the lens. What I didn't know was the nature of these particles. The correspondent supplied that answer.

By extension, one can infer that pollen grains and aerosol particles can also cause such images. These types of particulate matter are also floating in the atmosphere at various concentrations that depend upon the geographic location, whether inside or outside a building, the time of year, the temperature, wind, etc. For example, near a wooded area small particles from plants and trees could float in the air at higher concentrations than in areas where there are no trees or plants. Fine dirt particles, such as from a road or dry, sandy area, can be stirred up by wind or human activities (automobiles) and could be suspended in the air for considerable amounts of time and be transported over considerable distances. This could explain the geographic dependence of the phenomenon. Of course the photographer would not normally notice these particles during the time of the flash because the photographer would be looking through the viewfinder. Even with a single lens reflex camera (that allows the photographer to look through the lens) the photographer would not see the particles during the time of the flash because the "reflex mirror" within the camera moves to a location that blocks the view through the camera while the photo is being taken.

After reading what my correspondent wrote I decided to carry out my own experiments. Figure 1 shows the result of one particular experiment. Figure 2 shows how one can be fooled into thinking that an "anomalous source" of the anomalous image is far from the camera lens. The arrow points toward a small, bluish disk that appears to be partially occulted (blocked) by the archway structure. If one were to assume that the image was actually caused by an object on the far side of the structure, about 20 feet away, then one could calculate that the object was several inches in diameter. However, the object which caused that image was actually only a dust grain close to the camera and the apparent blockage of the image by the structure is an illusion. The faint bluish image can be seen at the right side of the vertical support of the arch because it is silhouetted against perfect blackness. The portion of the circular image that overlaps the structural member cannot be detected because its low brightness was overwhelmed by that of the structure.

FIGURE 2
ANOMALOUS IMAGE
PARTIALLY HIDDEN
BY STRUCTURE

Figure 1 shows only a portion of the complete outdoor photo of anomalous images. Figure 3 shows the complete photo. Very obvious in the upper left corner is a whitish cloud or "jumble" of circular images, some resembling soap bubbles, some resembling white discs and others being the circular, diffuse or transparent "anomalous images" of varying sizes and brightness. This cloud is actually a large "puff" of spackle dust (dust from dry spackling compound that I had sanded off a wall I was repairing) that I blew into the air a few inches in front of the camera just before taking the flash picture with a Kodak "throw away" camera. By the time of the flash some of the particles had drifted to the right and appear silhouetted against the archway, automobile, ground and (dark) sky. The date of the photo was January 13, 2000, and the location was in Maryland, so there was no pollen or dust in the atmosphere other than the spackle dust.

FIGURE 3
FULL FRAME VIEW
OF OUTDOOR SCENE

In examining this picture one finds many of the characteristics of typical "anomalous circular images." Most are faint and bluish in color but some are bright white. The diameters range from very small up to some maximum size.

Figure 4 shows an indoor picture with lots of anomalous images, including some elongated images that seem to indicate downward motion of the reflective particles during the duration of the flash. This was taken with a Model 600 Polaroid so the elongation is a result of the shape of the aperture and does not indicate motion during the short time of the flash. The astute observer will be able to find several dozen anomalous images in this photo which was created by holding the camera about one inch above the floor, by hitting the rug with one hand and then quickly taking the flash picture with the other hand. The presence of dust in the atmosphere near the floor after the rug had been hit was verified by using the very bright beam from a slide projector to provide constant illumination of the atmosphere just above the rug. This illumination is sufficiently bright to make visible tiny dust particles in the air. (Evidently one could test for the presence of dust and pollen at any geographical location by shining a powerful beam of light through the atmosphere.)

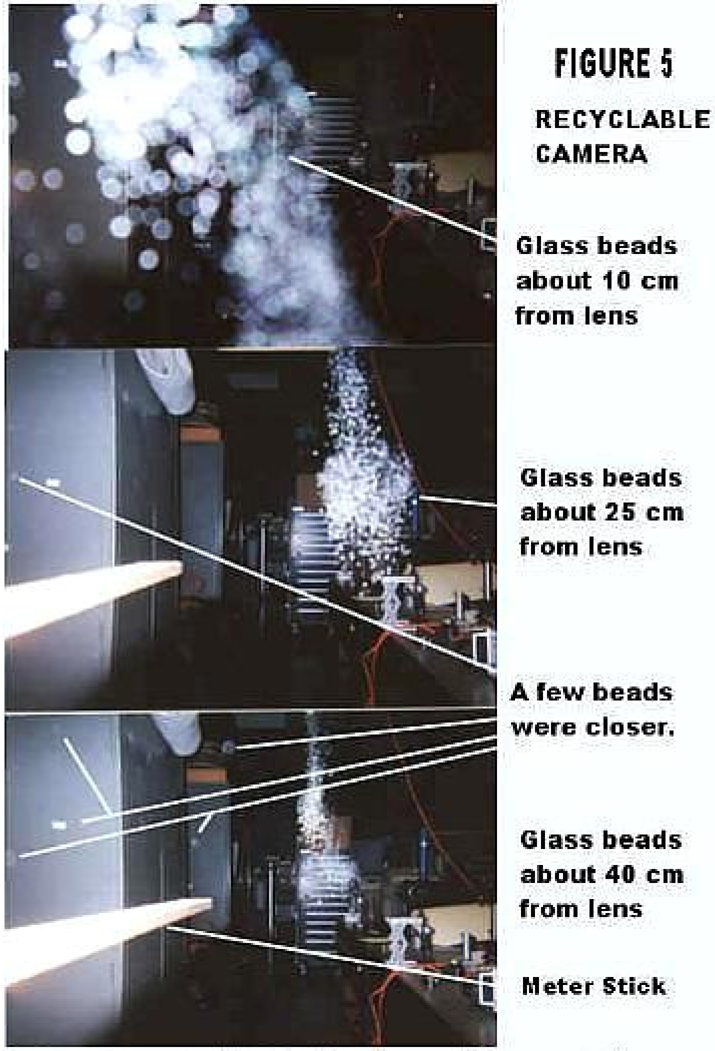
FIGURE 4
ANOMALOUS IMAGES IN PHOTO OF LIVING ROOM

One may conclude from these experiments that at least some and perhaps many (all?) of the anomalous circular (and other shaped) images which have been reported in to appear only in flash pictures recent years are, in fact, images caused by tiny reflective particles which float in the air (or perhaps insects flying past the lens). But this raises the above-mentioned question, why haven't they been noticed before, i. e. in previous decades? My answer, which must be considered as conjecture, divides into two parts. The first part is that there probably have been anomalous images of this sort in pictures before, but they were few and far between and considered to be merely occasional film flaws. The second part of my answer is that the newer photographic equipment is somewhat different from that available in previous decades in (at least) two ways. The first is the proximity of the flash unit to the lens, on the small cameras especially, being only 2 -3 inches away, whereas in decades past the flash units were typically 5 or more inches from the lens. The second is the greater distance over which flash pictures can be taken, a result of increased film sensitivity or "speed" (ISO 400 or 800 film in recyclable cameras, for example) or use of a "focal plane detector array" (the charge coupled device - CCD - which, in a digital camera or videocamera, plays the role of film) and a result of increased brightness of the flash itself. The overall increase in sensitivity and flash brightness results in images of objects up to 30 ft from the camera, whereas in the past one was lucky to get a good flash picture at 20 ft (or even as low as 10 ft). The decreased distance between the flash and the lens means that the edge of the illuminated volume of space in front of the camera (or the edge of the "beam" from the flash) passes very close to the lens. Experiments with a recyclable camera showed that there was useable flash illumination at a distance of only 2 cm from the lens. Hence any particulate matter that happens to be within a few cm of the lens will be more brightly lit nowadays than it would have been in decades past. It is my conjecture that this combination of the particular matter close to the lens being more brightly lit and the film (or CCD) being more sensitive in the present decade than it was in past decades accounts for the "newness" of this phenomenon.

ORB EXPERIMENTS

(A) IMAGE SIZE AND BRIGHTNESS

The four illustrations already discussed show orb images created by photographing dust in the air. In order to get an idea of what the object (dust particle) size and distance has to do with the sizes of the orb images, experiments were conducted using tiny glass spheres with a size distribution ranging from about 30 to about 150 microns (0.003 to .015 cm), with the peak of the distribution at about 100 microns. These tiny hollow spheres were dense enough to fall downward but slowly. Using a recyclable camera (approximately a 3 mm diameter lens aperture, 31mm focal length, hence an f/10 system) and a meter stick to determine the distance from the lens, a large number of spheres was dropped above the camera field of view and then flash photographed as they fell. Figure 5 shows the results of three such experiments. The top picture was taken with the spheres in the distance range 8 - 10 cm from the lens, the middle picture with the spheres about 25 cm from the lens and the bottom picture with the spheres about 40 cm from the lens. In the middle and bottom pictures a few stray sphere images that were closer can be seen at the left (indicated by lines). The diameters of the circular images in the top picture are roughly 1-1.3mm, in the middle picture roughly 0.25 mm and in the bottom picture roughly 0.15 mm. These sizes are roughly independent of the sizes of the spheres themselves (this is not geometric imaging; see below).



Experiment with 30-150micron diameter hollow glass beads dropped close to the lens.

Generally one can say that the closer the spheres, the larger and brighter are the images. This is to be expected although I have not been able to determine a quantitative relationship. Qualitatively one knows that the reflected light that reaches the film plane and makes an image is proportional to the illumination reaching the object (which depends upon the optical power output of the flash multiplied by the "radiation pattern" factor), to the reflectivity of the object, to area of the lens aperture and to the inverse fourth power of the distance (just as with radar - inverse square out t the target and inverse square back to the receiver). The inverse fourth power with distance means that the image brightness (actually the image exposure, which is the product of the optical power per unit area within the image multiplied by the exposure time) changes rapidly with distance of the reflective object. On the other hand, the image size also decreases with increasing distance, almost in the inverse proportional to distance (even though the object is too close for to be focused) so the image area is approximately proportional to the inverse square of the distance. Therefore the combination of the inverse fourth power decrease of illumination on the image with the inverse square shrinkage of the image area means that the exposure (proportional to the power per unit area) decreases only as the inverse square of the distance. Both the overall decrease in image size and brightness with increasing distance is evident in Figure 5. However, distance alone does not explain the brightness variation. The image brightness is also affected by the object size and this means that a collection of different sized objects all at the same distance will make images approximately the same size but differing considerably in brightness. The size dependence of the brightness occurs because the amount of light reflected by one of these tiny objects is proportional to its "cross-sectional area," that is, to its diameter squared. In the case of these glass spheres there was a wide range in diameters and hence a wide range in image brightness even for spheres at nominally the same distance.

(B) FLASH DURATION

The shape of an image of a moving object is determined by the object shape itself as modified by motion during the exposure time. Hence, if a perfectly circular light or steady intensity moved in a straight line a distance 3 times its own diameter during the exposure time the resulting image would be elongated, 4 times as long as it is wide, with rounded ends.(Why not 3 times its own width? Draw a circle on a piece of paper. It has some diameter, d. Now imagine sliding the circle to the right by the distance d, and then another distance d and then once more. Now measure the distance from the far left to the far right boundary. It is d + md, where m is the number of displacements.) In the case of a constantly moving object with a constant velocity v perpendicular to the line of sight the length of the image is d + vt. (In the previous example vt was 3 times the diameter, 3d, so we had d+3d = 4d.) (In the more general case the length of the image is the integral of the component of velocity perpendicular to the sighting line over the time of the exposure.) Clearly the shorter the exposure time the smaller the motion "smear." In order to determine how much of the image shape might be due to motion it is necessary to know the exposure duration. This duration is determined by the shutter during ordinary non-flash photography and by the flash duration when a flash is used.

I set up an experiment to measure the shutter time (time during which the shutter is open), the flash duration and the synchronization between the shutter and flash of a recyclable camera. This experiment used a steady light illuminating the lens and a photodiode to measure the light transmitted. (Note: this experiment required partial destruction of the camera since I wanted to place the light source just behind the lens/aperture/shutter combination.) I operated the shutter several times without the flash and I also operated the shutter with flash. Figure 6 shows the results. The near-trapezoidal shape of the two "shutter graphs" at the left side is expected from the mechanics of the shutter: it opened quickly but not instantaneously, remained fully open for a period of time and then quickly closed. (The downward slope of the "top" of the shutter curve is not a result of the shutter starting to close slowly but rather an artifact - a capacitive effect - of the electronic circuitry.) According to the measurements the shutter was fully open for about 8 ms (1/125 of a second, which is a standard camera shutter time for general use). The illustration at the right side of the figure shows the shutter-time curve with the much shorter flash "spike" superimposed. (This was obtained by letting light from the flash reach the photodiode.) Notice that the flash began about 3.5 milliseconds after the shutter started to open and hence about 1.7 ms after the shutter was completely open.

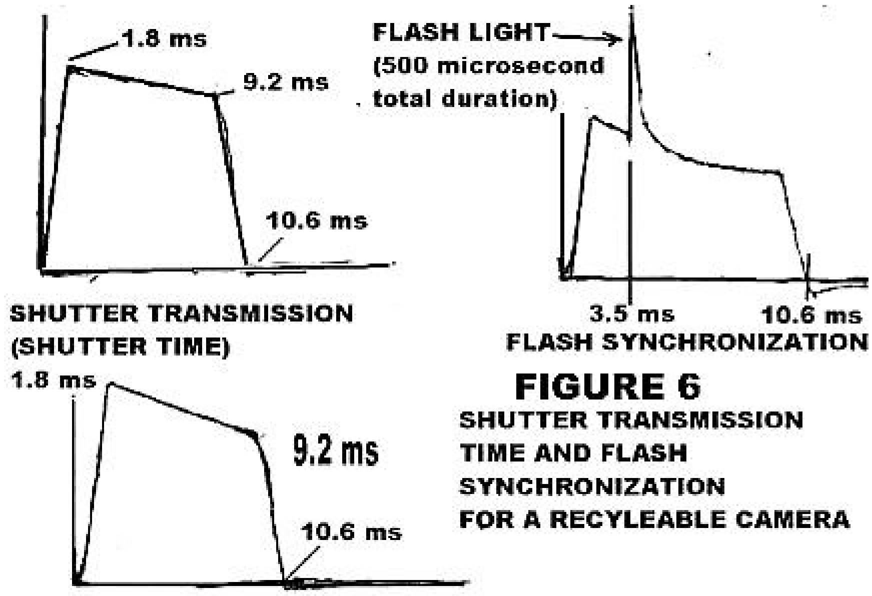


FIGURE 6
SHUTTER TRANSMISSION TIME AND FLASH SYNCHRONIZATION FOR A RECYLEABLE CAMERA

Figure 7 illustrates the time dependence of the flash intensity for the recyclable camera and also for the Polaroid Model 600. The amplitudes of the two flash intensities were about the same, but obviously the Polaroid flash was shorter.

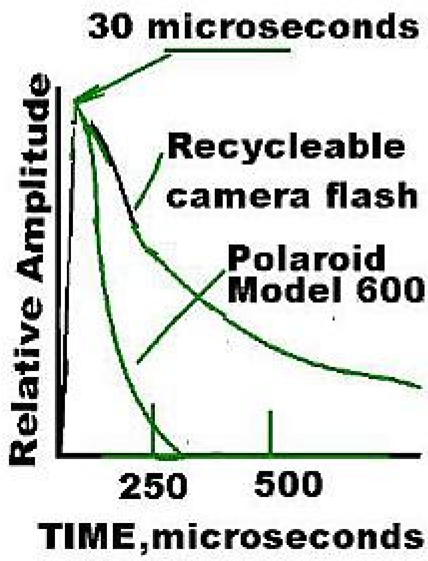


FIGURE 7
TIME VARIATION OF FLASH ILLUMINATION

For the recyclable camera the flash intensity reached its peak very, very quickly (about 30 microseconds) and then the flash brightness decayed (approximately exponentially) over the next millisecond. The effective duration of the flash was about 300-500 microseconds (depending upon how one wants to quantitatively define "effective duration"). When photos are taken in the dark the only source of light is the flash and hence the flash duration determines the exposure time. (In normal non-flash daylight shots the shutter determines the exposure time.) This is an "effective shutter time" of 1/2000 to 1/3000 of a second. An object moving several meters per second or millimeters per millisecond will be quite effectively "stopped" in its motion by such a short shutter. By "stopping the motion" is meant having such a short exposure that the image hardly moves during the exposure. For example, if a tiny object were to move perpendicular to the line of sight at 1 meter per second at a distance of 10 cm from the camera lens its angular rate would be (100 cm/sec)/(10 cm) = 10 rad/sec. For a 3 cm focal length this transfers to an image velocity of 30 cm/sec. In 1/3000 of a second the image would move 30 x (1/3000) = 0.01 cm = 0.1 mm. At the same time, these experiments suggest that the image diameter for a tiny object 10 cm from the lens (of the recyclable type of camera) would be a bit over 1 mm (see above). Hence the motion smear would be a small fraction of the image size and the image would be nearly circular. Objects moving more slowly than 1 m sec or objects at greater distance would create even less smear. (However, objects at greater distance also make smaller images so for constant sized objects at the same velocity but at varying distances the percentage of the image which is smear could be constant.) In the case of the glass spheres used in these experiments the velocities were in the range of several to ten centimeters per second rather than a meter per second so the motion smear is not detectable.

(C) ORBTUBES

Besides the individual circular (or other shaped, depending upon the aperture shape) "orb's" discussed above there have also been photographic recordings of "orbtubes" or "light tubes" such as illustrated in Figure 8 (see also the "orbsite" for further examples).

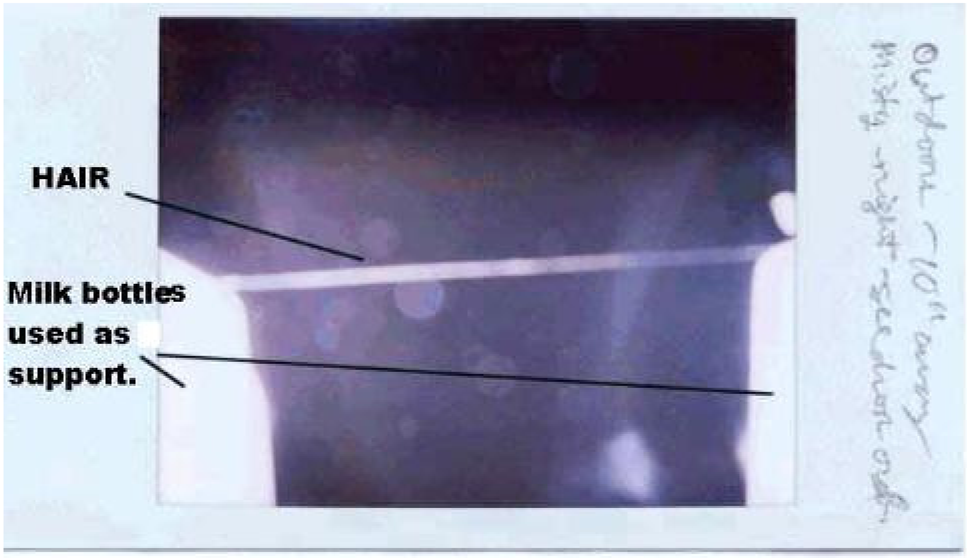
FIGURE 8
STRANGE MANIFESTATION
OUTSIDE MY HOUSE
The thickness of the image is about 1.4 mm.

These orbtubes are generally curved, generally have brightness variations along the image and generally shrink in width from one end of the image to the other, such as illustrated in Figure 9 where the image width shrinks from about 4 mm to about 2 mm. The appearance of images such as these naturally led to the speculation that they were evidence of rapid motion of the "orb" or reflector during the time of the flash. However, as the above discussion shows, at speeds typically expected of insects or particulate matter in the air there would not be enough time during the flash for the object to create a long exposure track on the film.

FIGURE 9 HAIR EXTENDING AWAY FROM THE LENS

The thickness decreases from about 4 mm at my fingertip to about 2.5 mm at right hand side of the picture.

If the length of an orbtube could not be reasonably explained as due to rapid motion of a tiny "point" reflector, then it must be a result of reflection from an elongated reflector. Again the reflector had to be very tiny and close to the lens. To test this hypothesis I purchased a Polaroid "Joycam" which uses type 500 film. The flash is 2.5 inches from the lens and the effective focal length is about 105 mm. The images in photos 8, 9 and 10 are of hairs which were about 4.5/1000 of an inch or about 115 microns (0.115 mm) thick, by measurement with a micrometer. I also sacrificed several of my remaining hairs (sniff) to provide thin elongated objects. Figure 8 shows a hair about a foot from the lens. Figure 9 shows a hair that was held by my fingers while I blew on it to force the free end to be farther from the lens than the near end. The width of the hair image shrinks from about 4 mm to about 2 mm and the brightness is much lower at the far end, except for a small "dot" image just at the end, suggesting that there was a tiny piece of dust that increased the reflectivity at that point on the hair. Figure 10 shows a hair suspended between two milk bottles (!) at 30 cm = 300 mm from the lens. The thickness of the hair image is about 1.9 mm. Other photos taken at shorter distances confirm the approximate relation that the image width is inversely proportional to the distance (3.7 mm at about 150 mm, 5 mm at about 75 mm and 10-12 mm wide at 50 mm). This leads to the following approximate quantitative relation: w = 550 mm^2/D for this 105 mm focal length camera, which can be compared with the previous equation (see above) for the image width using the 31 mm focal length camera, w = 70 mm^2/D.



BLONDE HAIR WITH MILK BOTTLES
The hair was 25 cm from the lens. The thickness of the image of the hair is about 2 mm. This was taken outside in a mist. The circular images are defocused water droplets.

Figure 10 was taken outdoors at night in a mist. In the photo are lots "orb" images caused by reflections from tiny water droplets. There is also a "haze" or glare over the photo which is probably a result of the very bright reflection from the white plastic milk bottles that supported the hair (which was glued at each end to a bottle).

The hairy experiments show that a very thin, elongated reflector close to the lens can create a wide elongated image of varying brightness and width. There are similarly shaped airborne objects in nature: animal hair, plant seeds borne by thin "hair" and spider web strands, for example. Thus, outdoors one might have plant or animal (spider) generated "hairs" that could blow past the camera, and indoors one could have tiny cloth strands or animal "hairs" that would be temporarily suspended by the atmosphere. Of particular interest are the spider web strands since they can be quite long.

For comparison see an orb tube photograph taken by Bryan Williams (Sargel 18) at.

http://sarge18.iwarp.com/42298-1.JPG

[Might be a picture of a human hair or spider web strand drifting in front of the camera lens. Note how the lower right portion is more out of focus, being closer to the lens. Also note the similarity to the images taken by Maccabee. It is necessary to rule out a mundane cause such as a hair from the photographer's head being blown by wind in front of the camera before any "intelligence" or paranormal significance can be suspected, let alone attached to such images. That's the scientific method!]

CONCLUSION: ORBS OR DUST

"Orb Lore" has developed over the last few years about the nature of these strange orb images, with some people attributing them to "creatures" or intelligent entities from some other reality that are penetrating our reality.This interpretation has resulted from the failure of the initial "orbists" to find reasonable explanations for the images. Of course, I cannot state positively that every anomalous image of the orb type considered here (non-self-luminous so that nothing was seen before or after the flash photo was taken and the image is a small, "transparent" circle or disc or an elongated "tube") was caused by a reflection of light from a tiny object close to the camera. However, it seems to be a "good guess" that many or most of them are. (Note: the above discussion does not apply to self-luminous orbs seen without the aid of a flash, light beam or any source of light. There are such orbs... example: see the Oregon Red Ball report.)