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Anomalous Orbic "Spirit" Photographs? A Conventional Optical Explanation

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Abstract—With the development of reliable and inexpensive digital cameras, numerous individuals have reported capturing anomalous round-shaped (orbic) objects in photographs. These seemingly anomalous orbic images (AOIs) have sometimes been interpreted as reflecting "spirits," "angels," "light beings," "aliens," and/or "UFOs." We decided to determine whether we could (1) replicate capturing AOIs, and (2) investigate their possible mechanism(s). Approximately one thousand photographs were taken with five different digital cameras over multiple sessions under conditions that would purportedly increase the chance of observing AOIs. This included two "spiritual energy healers" performing various diagnostic and treatment procedures in a semi-dark room. More than two hundred photographs contained AOIs. Careful examination of the photographs revealed a plausible conventional optical mechanism that could explain most of the AOIs observed. The most common mechanisms involved are (1) stray reflections (often from the flash) from various shiny objects in the environment (mirrors, glass windows, doorknobs, furniture, metal art work) that are then doubly re-reflected off of lens surfaces and (2) diffraction from the flash reflecting off of dust and dirt particles near but not on the lens. Spiritual or other-worldly interpretations of "orbs" in photographs should only be considered under conditions in which all sources of stray reflection and diffraction have been eliminated from the environment.

Keywords: anomalous orbic images—digital cameras—spirit photography—parapsychology—stray reflections—ghost images

Introduction

With the advent of digital photography aided by high-speed gigahertz personal computers with gigabyte hard drives, it now possible for scientists as well as laymen to readily collect photographic information. Sometimes optical anomalies are observed; typically they are spherically shaped. These seeming anomalies are

often described as "orbs." Sizes may range (in apparent perceived physical scale) from ping-pong balls to basketballs. The most frequent sizes appear to be hardballs and softballs. We term these phenomena "anomalous orbic images" (AOIs).

In the fields of science encompassed by the disciplines of the present authors (psychology, psychophysiology, integrative medicine, optical sciences, digital music analysis), it is not surprising that there is virtually no published literature on AOIs. However, there is a vast amount of information on the Internet under the general rubric of "spirit photography" that examines AOIs and presents controversial interpretations ranging from "spirit" and "light beings" to "angels," "aliens," and "UFOs." Representative web sites are http://ghosthunter.com and http://orbsite.com.

The "spirit" interpretation was of potential interest to the first author in the context of research on the possibility of survival of consciousness after physical death (reviewed in Schwartz, 2002). However, given the controversial nature of AOI phenomena, and the need to collaborate with scientists skilled in optical sciences and digital imaging, G.E.S. did not consider researching AOIs.

It was fortuitous that the second author, a senior optical scientist whose personal interests extend from musical theory to biofield therapy, began to collaborate with G.E.S. on the possible effects of music and biofields on cellular growth (Creath & Schwartz, 2004). When G.E.S. recently met two people who claimed to be able to reliably capture AOIs using Sony Mavica digital cameras, he invited K.C. to collaborate with him to investigate these claims.

This paper presents multiple AOIs captured by G.E.S. and K.C., plus AOIs captured by individuals in the presence of G.E.S. and K.C. (or of those personally known by the authors). It then presents a conventional optical explanation that accounts for virtually all of the AOIs observed.

Method

Digital Cameras

Photos with 640 by 480 resolution were taken with two Sony MVC FD100 Mavica 1.3-megapixel cameras. Photos with 1,600 by 1,200 resolution were taken with two Canon Digital Elph Powershot 2.1-megapixel cameras (models S100 and S300). Photos with 2,240 by 1,680 resolution were taken with an Olympus E10 4-megapixel single lens reflex camera. One picture with 2,128 by 2,832 resolution was taken with a Fuji FinePix 6800 3.3-megapixel camera in high-resolution mode obtaining a 6-megapixel image.

Environment

The primary photos presented in this paper were taken in the living room of a private home in Tucson, Arizona. The décor is southwest and includes Native-American artwork.

The photos were taken at night. Recessed light fixtures set at a moderate

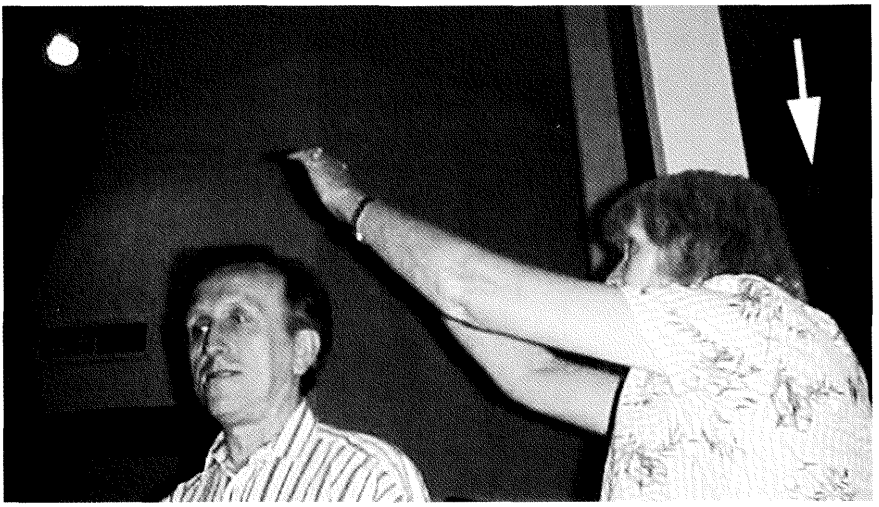

Fig. 1. AOI observed behind a healer's head while she was purportedly sensing energy around a male. Note the glare from the light in the upper left hand corner of the photo.

intensity provided background light. There were various reflective surfaces in the environment, including large windows, doorknobs, and metallic objects of art. Nighttime indoor photographs were taken with flash.

Secondary photos were taken in a room used for plant research (K.C.) (Creath & Schwartr, 2004); the windows were covered to keep out outside light. The photos were taken during the day and required use of a flash. There were some reflective surfaces in the environment, including furniture and a small mirror.

The color images were converted to black and white images. Arrows have been inserted to highlight specific AOIs.

Results

Figure 1 displays a typical AOI observed when a female spiritual energy healer was purportedly "sensing energy." A small, dim AOI is visible to the right of the woman's head. The bright light in the upper left corner is the recessed lighting. The photo was taken by G E S. using a Sony camera

Figure 2 displays an AOI when a male spiritual energy healer was purportedly "calling spirits" to come in. The A01 is on the upper right side, observed in a window (which appears black because it was night). The photo was taken by G.E.S. using a Canon camera.

Figure 3 displays an AOI photographed on a black stand supporting a Native-American kachina doll (right side of picture). The bright light on the left is the reflection of the flash. The photo was taken by K.C. using a Canon camera.

Figure 4 displays an AOI photographed on a window to the right of the kachina doll. The bright light on the left is the reflection of the flash. The photo

Fig. 2. AOI on the right side of photo observed while a male healer was purportedly "calling spirits" to come in. Note the retlections on various surfaces in the photo.

in Figure 4 was taken shortly after the photo displayed in Figure 3. The photo was taken by K.C. using a Canon camera.

Figure 5 displays a similar-shaped AOI captured by K.C. in the process of photographing seed germination chambers (Creath & Schwartz, 2004) using a Canon camera. The A01 is seen in the bottom right corner. The reflection of the flash is visible on the slats of the wooden chair.

Often more than one AOI was observed in the photographs. Figure 6 shows two AOIs captured in a single photograph. One AOI is the size of a golf ball on the bottom right side (on a black couch); the other is the size of a baseball above the couch on the wall. The reflection of the flash is seen on a black and white framed picture (with glass) on the top left side located in an adjacent room behind the couch. The photo was taken by G.E.S. using a Canon camera.

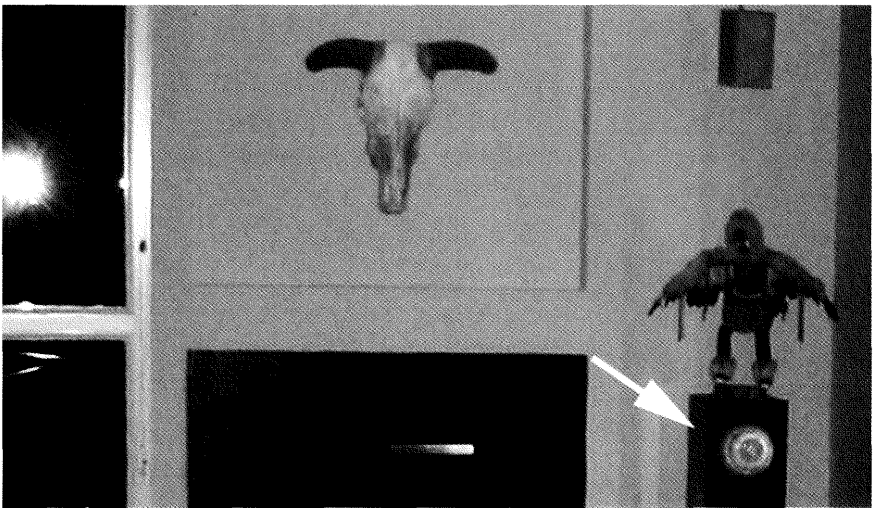

Fig. 3. AOI on the bottom right of the photo; reflection observed on the left side of the photo

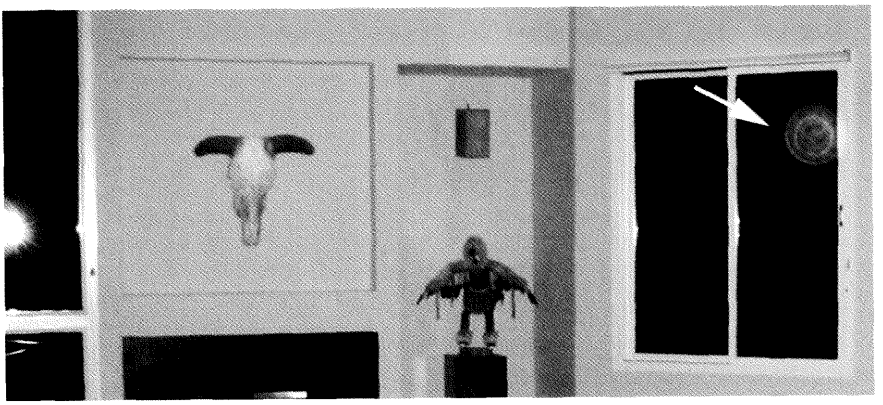

Fig. 4. Especially large AOI on the right side of the photo; reflection of flash observed on the left side of the photo.

Figure 7 is an enlargement of the smaller AOI on the couch displayed in Figure 6. This AOI can be described as looking like a face, say, maybe, a likeness of Albert Einstein. AOI images that have apparent facial features are often interpreted as "spirit" pictures.

The photo we obtained with the greatest number of AOIs is displayed in Figure 8. Note the multiple sources of reflection (from the fireplace on the lower left, the window on the right, and the pyramid-shaped sculpture on the table in the lower right). This particular piece of sculpture contains multiple pieces of glass that reflect light. This photo was taken with a Sony camera and the contrast

Fig. 5. AOI in the lower left at the photo; reflections observed on the chair in the middle of the photo.

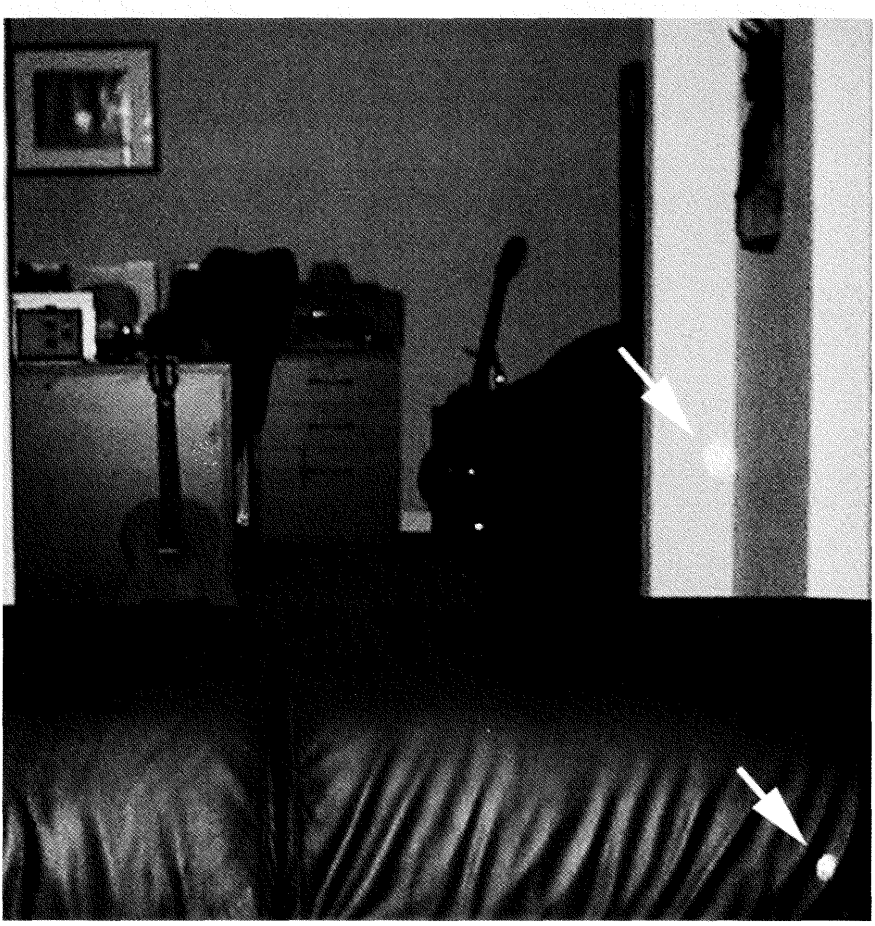

Fig 6. Two AOIs observed on the right of the photo Reflections observed in the upper left of the photo off of glass in picture.

has been enhanced to highlight the orbic imager. More than 21 AOIs can be seen in this photo.

AOIs also have been captured without the use of a flash. The photo displayed in Figure 9 was taken with a high-resolution 6-megapixel camera. The AOI was captured outdoors by Christopher Robinson. The high-resolution AOI appears to be over the face of a little girl. However, there is evidence of reflection of the sun on the pole held by the larger girl.

Optical Analysis of the AOIs

In the process of reviewing the more than 200 photos (more than 20% of the total) that contained AOIs, we noticed that virtually all of them had clear evidence of reflection (on glass, metal, or other shiny surfaces) in the photos.

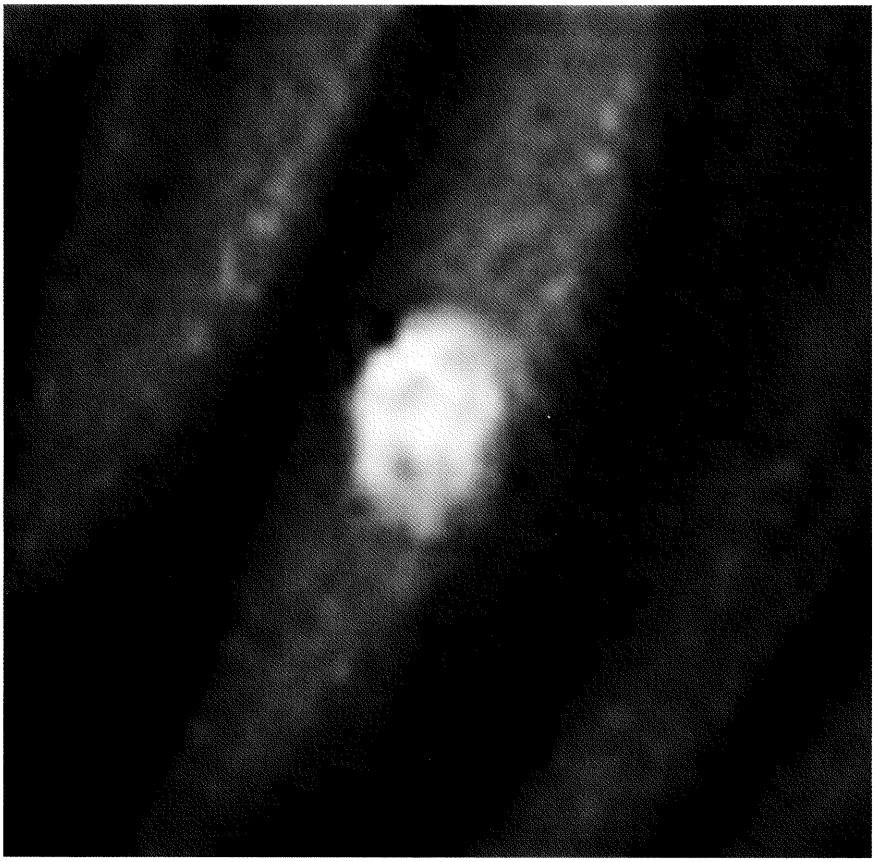

Fig. 7. Enlargement of the lower AOI from Figure 6. Note the structure in the AOI.

These surface reflections were created typically, but not exclusively, with the flash. We also noticed that the more expensive Olympus E10 camera did not capture a single A01 (out of more that *50* photos taken), whereas the less expensive Sony and Canon cameras regularly captured AOIs (typically 10 or more out of 50 photos taken).

Specifications for the Olympus camera lens point out that it was intentionally designed to minimize effects of "stray reflections" due to the flash. (It is a much more expensive camera than the Sony and Canon cameras we used.) In our view, stray reflections are the first arid most obvious source of artifacts responsible for orbic images in photographs.

A conventional optical explanation of some of the orbic images is described in Figure 10 (after Kingslake, 1992). Light from a stray reflection of the camera flash off of a shiny surface (or some other light source in the field of view, such as a lam]:, or the sun) is reflected into the camera lens. Every optical surface inside the camera lens, which typically has 6 to 20 optical surfaces (depending upon the quality of the

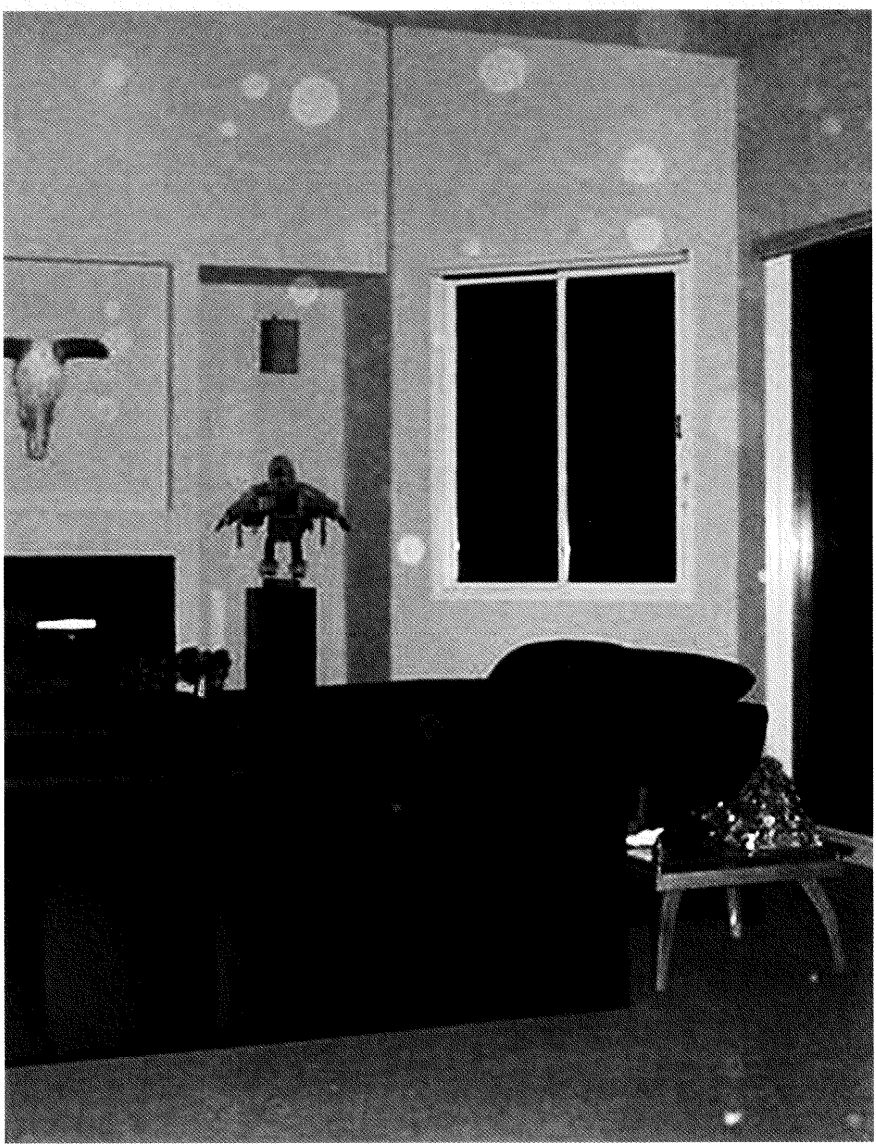

Fig. 8. The photo with the greatest number of AOIs; note the multiple reflective surfaces in the photo.

lens), has the potential to then reflect part of the light that is incident (Kingslake, 1992). Uncoated glass and plastic lenses reflect approximately 4% of the light impinging on each surface while passing 96% of the light.

For light from a stray reflection to get to the image plane it must reflect off of two (or any even number of) internal surfaces within the lens. In optics terminology, these unwanted, often translucent images that get to the focal plane

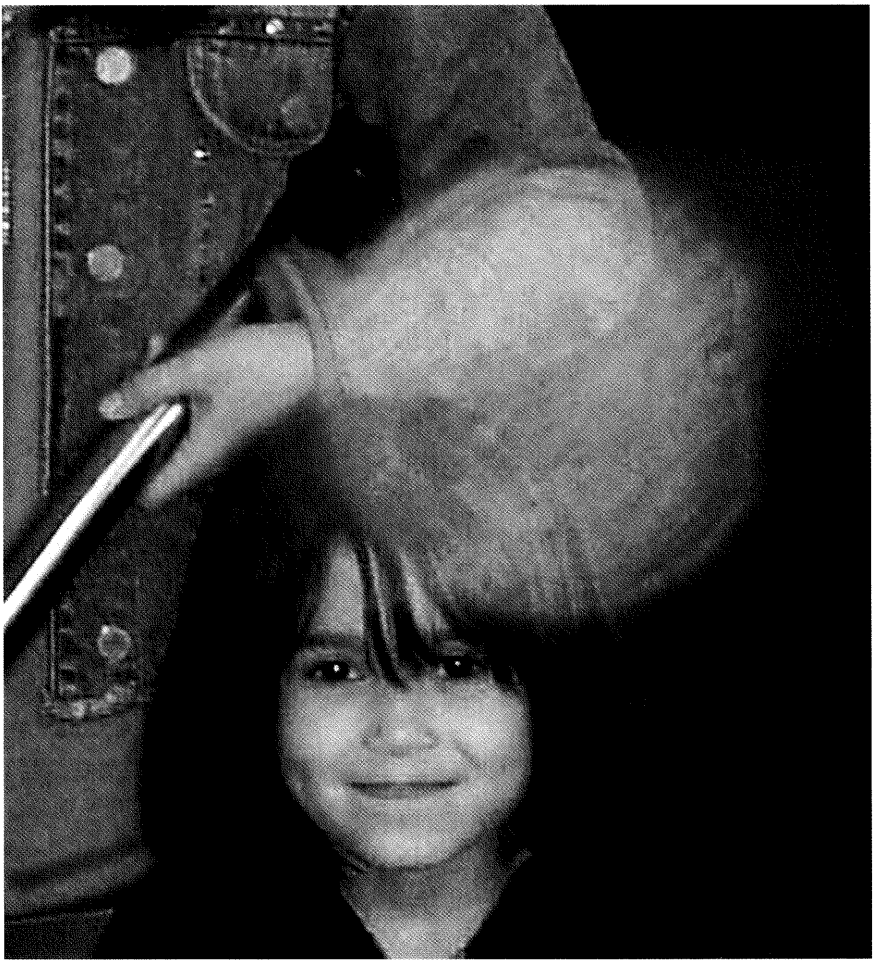

Fig. 9. Large AOI captured without a flash; however, note the reflection of light (probably from the sun) off the pole.

are traditionally called "lens flares" or "ghost images." These "ghost images" take on the shape of the aperture stop of the lens. A round aperture stop typical in digital cameras will lead to round or elliptical artifacts. Elliptical orbic images are caused by reflections that enter the lens at steep angles, causing a foreshortening of the aperture image in one direction. This effect is often used artistically by photographers and cinematographers as they catch flares around the sun coming through trees or from streetlights (see Kingslake, 1992).

Because almost every image we have studied contains a bright reflection or light source that produced stray reflections and could produce "ghost images," the simplest and most parsimonious explanation for most AOIs is stray reflections. If, however, stray reflections are not evident in the image, the next

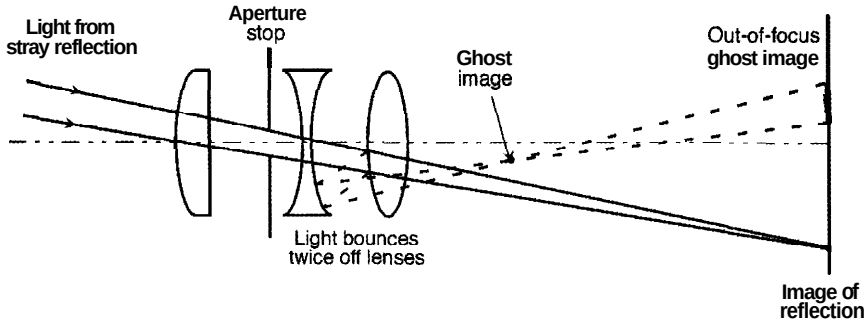

Fig. 10. Diagram displaying how "ghost images" can be formed. See text for explanation (after Kingslake, 1992).

obvious source of artifacts is reflections of the camera flash off of small particles in the air, such as dust. Figure 11 illustrates how optical artifacts can be created by the reflection from small particles in front of the lens. Because these small particles reflect light into the camera lens and are often not near the object being focused on, they can create out-of-focus orbic shapes in the image.

Figure 12 shows an example of anomalous images not all caused by internal reflections within the lens. This image, taken with the Sony camera, shows images of small particles where the camera flash apparently reflected directly off of dust particles in the air. In this figure the camera lens focused on the dust (as indicated by the arrows with dashed lines) rather than the window because the reflections from the dust were brighter than the scene. This image also shows

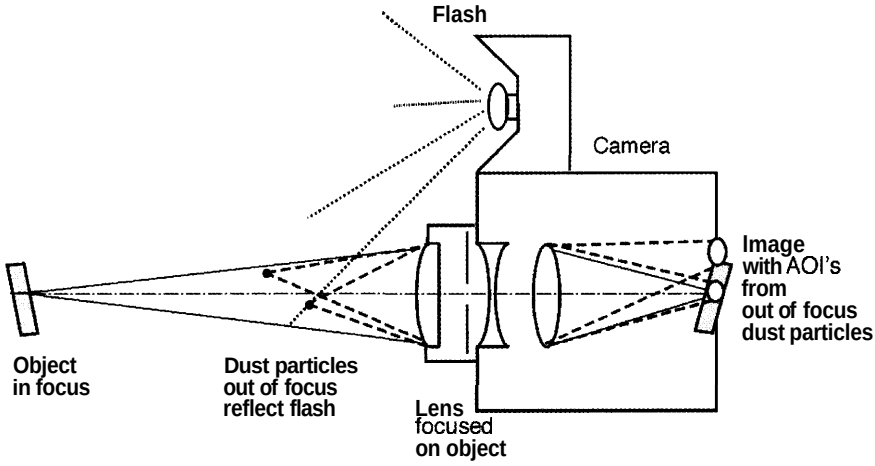

Fig. 11. Diagram showing how light reflected from dust particles can cause out-of-focus artifacts in the image.

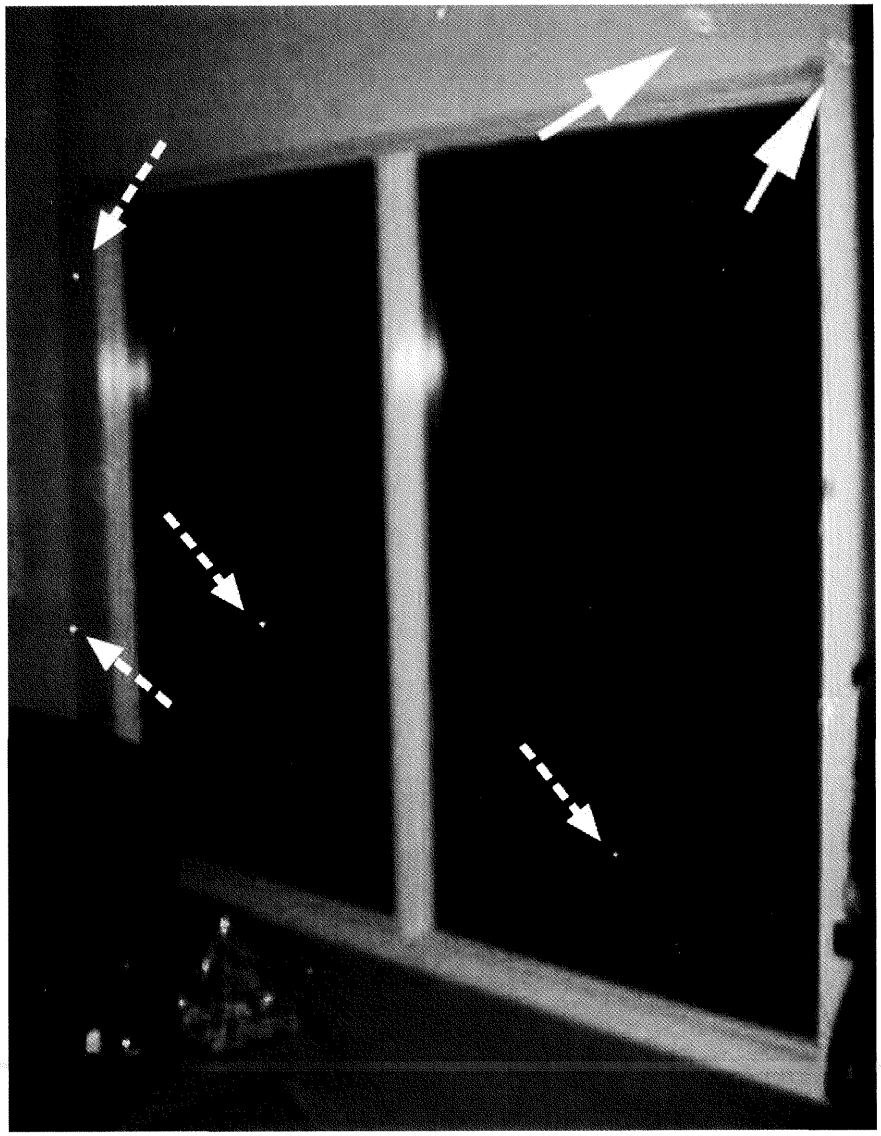

Fig. 12 Out-of-focus image owing to camera focusing on small dust particles, indicated by arrows with dashed lines. The two AOIs in the upper right ot the photo are due to reflections off the metal window frame

a couple of orbic images rclatcd to reflections off of the metal surfaces surrounding the window, as indicated with solid arrows.

As another example, it is also possible that in addition to the large number of possible sources of stray reflection, some of the AOIs in Figure 8 could be due to dust particles in the air. A way to differentiate between the two possible sources

of artifacts is to place the camera on a tripod and take multiple exposures. Artifacts owing to stray reflections will be consistent from image to image, while those due to dust in the air would be assumed to move with the air currents between exposures.

A camera design feature of small cameras that can cause artifacts due to stray reflection or dust is the way the flash is incorporated into the camera. By having the flash close to the lens, it is much more likely that stray reflections can enter the lens than if the flash was physically separated further from the lens, as in higher end and professional cameras. The larger the angle between the flash and the lens, the fewer stray reflections get into the lens. Having a small angle between flash and lens also makes it easier to focus on dust particles illuminated by the flash. With the flash farther from the lens, reflections from dust particles are not likely to be seen by the lens.

It important to stress that AOIs can be captured without a flash (as shown in Figure 9). All that is necessary is a light source, such as the sun, or a shiny object that reflects bright light into the camera lens. These types of reflections are everywhere. A technique used by professional photographers, especially in outdoor situations, is to use a lens hood to block flare and stray reflections from entering the lens.

The reason many of the orbic images are so bright is because the specular reflections from the flash are much brighter than the surrounding scene. The light metering system in the camera that determines the exposure time senses the light level with the use of a preflash. The preflash will pick up the brightest object in the field of view, focus on that and set the exposure values for that brightest object. When the main flash is triggered the reflections can be quite bright in comparison to the rest of the scene, so that 4% of a stray reflection can still be brighter than the rest of the image. This can lead to artifacts that can be brighter and in clearer focus than other parts of the image.

As pointed out by a reviewer of this manuscript, there are at least four distinct properties of AOIs created from particles at different distances from a camera. (1) The closer the particles are, the larger the images and vice versa. (2) "Orb images which overlap images of brighter reflective objects appear to be 'behind' the object (hence the claim by some that orbs are behind tree branches, etc., and so must be many feet from the camera and therefore large)." (3) Larger particles appear to create brighter images than smaller particles. And (4) elongated "orb tubes" "can be images of strands of hair or sections of spider web very close to the camera" (see also http://brumac.8k.com/orb– 1.html).

The similarity in the shapes of the AOIs obtained by K.C. in Figures 3 through 5 is informative. Figure 13 displays the AOI from Figure 5 (captured over a porous, rounded, foam black surface) and the AOI from Figure 4 (captured over a solid, flat, glass and wood surface) side by side (resized to be similar). A similar concentric ring pattern is evident. This concentric pattern is related to the shape of an aspheric (non-spherical) lens surface inside the Canon camera lens. Because the lens surface is not spherical, it reflects the light unevenly. An AOI

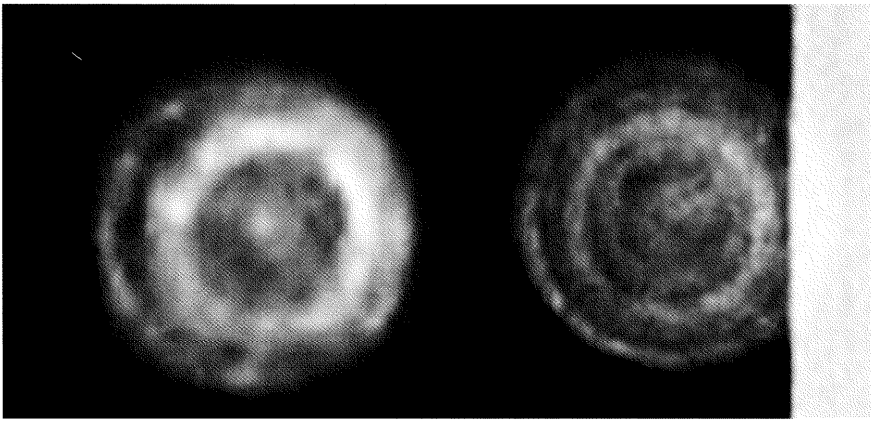

Fig. 13. Comparison of the structure of AOIs from Figures 4 and 5

due to an out-of-focus dust particle that does not reflect off of internal lens surfaces will look differently and usually has a more uniform structure. Thus, structure within an AOI is another clue as to its origin.

The apparent "face" observed in Figure 7 is also evidence of stray reflection, in this case modified by the source of the reflection (the glass-faced, black and white picture show in Figure 7). Figure 14 shows how the pattern reflected from the picture could modulate the light pattern that was subsequently reflected within the lens of the camera and projected onto the image plane in a portion of the image containing the couch. The structure in the orbic stray reflection is related to the shape of the surface that reflected the light.

High-end professional cameras have antireflective coatings to reduce these ghost reflections (Macleod, 1986) as well as baffles to trap stray reflections within the lens (Breault, 1995). Low-end camera\ tend not to include these features as a means of reducing production costs. This is the main reason why these phenomena are seen more in low-end cameras and why there has been such a huge proliferation in the number of orbic and anomalous photograph\ being circulated.

Discussion

The ability of relatively inexpensive models of digital cameras to capture AOIs is clearly evident. The most parsimonious explanation for the AOIs we observed is stray reflection\. Assuming our analysis of the stray reflection mechanism is correct, the less expensive the digital camera used, the more likely it will be to observe AOIs. The use of expensive cameras that specifically minimize the effects of stray reflections should dramatically reduce the likelihood of observing AOIs. Professional photographers are very careful to avoid sources of possible stray reflection and use more expensive cameras. Most

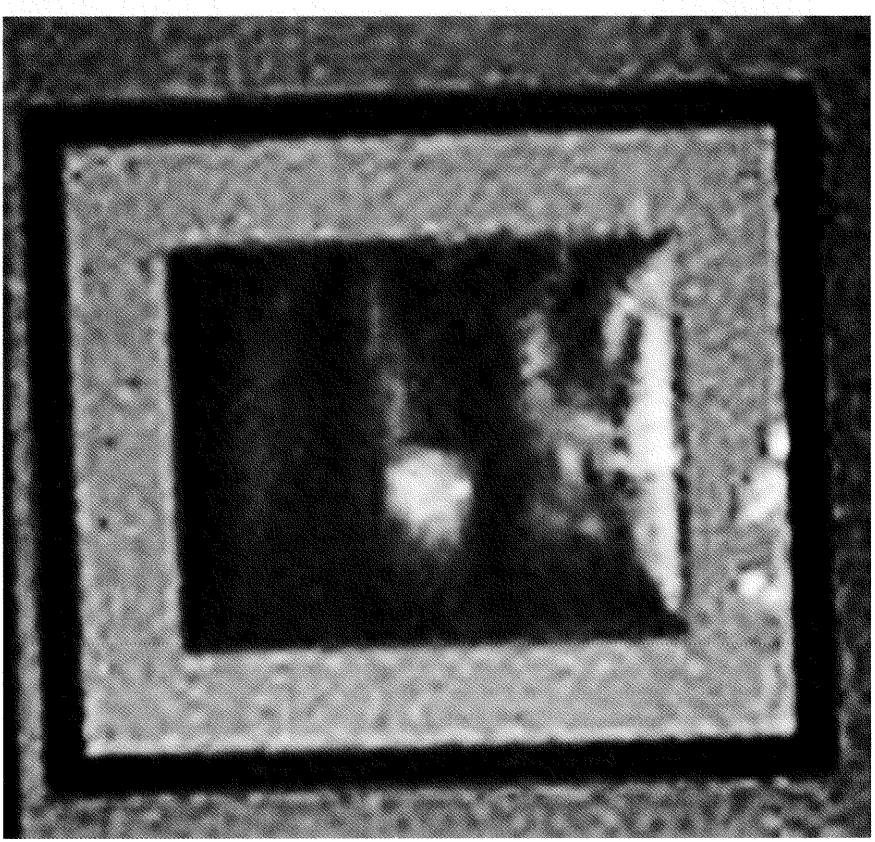

Fig. 14. Pattern of reflective surface that could have created the apparent "face" in Figure 7

camera manufacturers market expensive professional cameras as well as inexpensive cameras.

One experimental approach to demonstrate which AOIs are based upon stray reflect mechanisms would be to quickly take several pictures from a tripod. Internal lens reflections would remain the same, while out of focus images due to small particles in the air would change as the particles moved.

If photos are taken in controlled environments where highly reflective surfaces and small particles in the air are absent, and if stray reflection is the primary cause of AOIs, then it is predicted that AOIs will not be observed.

However, if other mechanisms can create AOIs (such as purported "spirits" or "other-worldly beings"), it should be possible to capture AOIs in appropriately controlled environments using multiple cameras simultaneously. Moreover, it should be possible to determine whether AOIs are representations of cooperating "spirits" (termed "departed hypothesized co-investigators" in research reported by Schwartz, 2002). This would involve research mediums reporting the

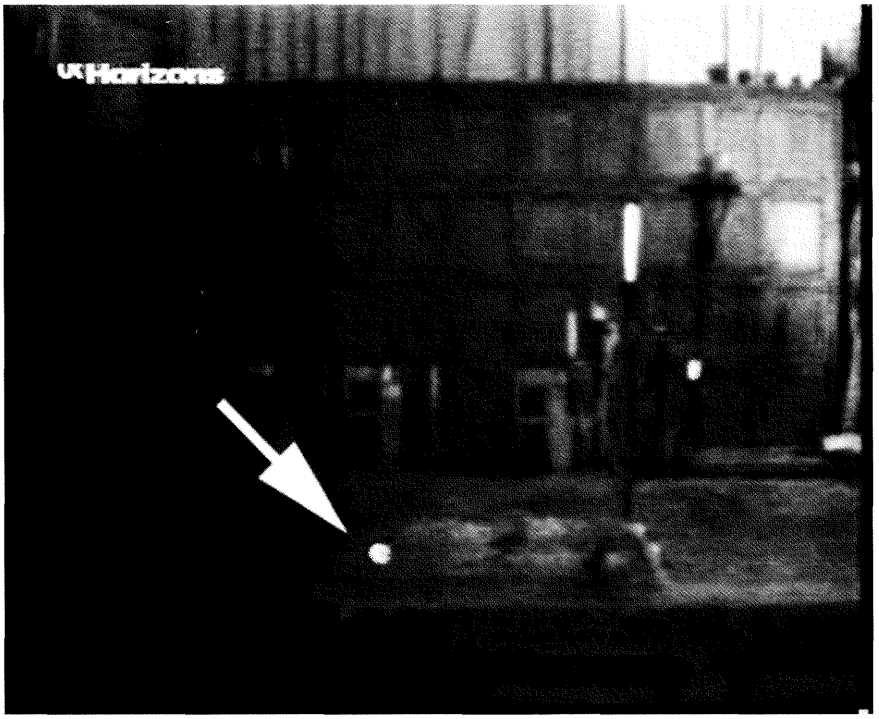

Fig. 15. Single frame taken from a BBC documentary AOI was observed to move across the room. The camera was an expensive thermal, infrared system that did not emit light. This moving AOI can not be explained as a "ghost image" that is an artifact of reflected light

presence and absence of specific spirits invited to stand in front of a white wall while photographs were taken with a camera mounted on a tripod.

An anonymous reviewer raised the question "if you can take a picture of it why can't you see it?" Given that "consumer cameras, and the radiation range they record, are designed to match what people see," how can a camera capture what the eye can not see'! While photographic film is designed to match what people see in terms of spectral range, digital cameras contain sensors that can record light further into the red and near infrared than our eyes can see. It is possible that this energy beyond our visual senses contains things we cannot see with our naked eyes. It may also be possible that the events recorded by a digital camera occur faster than the eye can perceive.

It should be recognized that there are available examples of AOIs that appear to deserve the term "anomalous." Figure 15 presents a single frame from a UK Horizon documentary produced by the BBC and shown on television. The movie footage was purportedly taken with an expensive passive infrared (i.e. thermal) video camera system without applied artificial lighting or flash. It was not taken with an inexpensive active infrared system, such as the Sony "Nightshot" system, which would create stray reflections. The passive infrared video camera

was mounted on a tripod. An AOI can be seen above the left comer of the table. In the video footage, the AOI is observed to appear, move slowly across the table, and disappear.

It is not possible to explain orbic objects such as these that move in dynamic and unpredictable paths as being caused by stray reflections. It is also not possible to explain many of them as being caused by dust particles in the air. It is neither logical nor responsible at this point to conclude that every AOI observed worldwide can be explained by a conventional optical science mechanism such as stray reflection. Nonetheless, it is prudent to rule out plausible and well-known conventional mechanisms before invoking other explanations for seemingly anomalous digital visual images (be they "spirits" or "UFOs").

As the late Carl Sagan was fond of saying, "Extraordinary claims require extraordinary evidence." This paper suggests that the majority of the orbic images observed in the photographs obtained by the authors are probably not "anomalous." It is important that the public be educated about the apparent ease with which seemingly "anomalous" orbic images can be inadvertently created by stray reflections in uncontrolled environments with inexpensive digital cameras.

Acknowledgments

We thank Gerhard Klugl, Doris Schmaz, and Christopher Robinson for encouraging us to replicate and investigate anomalous orbic images as well as assisting us in obtaining photographs. We also thank Robinson for the passive infrared images reported in the discussion. We thank two anonymous reviewers of the manuscript for their valuable suggestions. This paper is dedicated to Rudolf Kingslake, the first and founding professor of the Institute of Optics at the University of Rochester, Rochester, NY, where he taught for more than 50 years. A noted lens designer and teacher, he was the father of lens design in the US (and the mentor of the second author of this paper).

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