# Science of Orb Photos

by Mark Kimura, Ph.D.
Research Coordinator, Paranormal Research Investigations
Chief Scientist, HCRL
E-Mail: mk77@cornell.edu
(Edited by: Justine Singer)

Paranormal Research Investigations (PRI) had an experimental session to photograph "orbs". Members of the group suspected that the paranormal anomalies often called orbs, which many people see in photographs, are, in fact, optical phenomena; that is, reflections from airborne particles. Group members attempted to validate this assumption by replicating orbs in photographs using materials prepared by the group.

An orb is considered “typical” when it is round, white and concentric circles are visible on the inside. Below are three photos in which "typical" orbs are pictured.

Photo 1a 1b 1c

Photos 1a and 1b were taken at two Learning Light Foundation major events in 2005. Photo 1c was taken some time in 2005, at night, outside of the Learning Light Foundation building. PRI investigators noticed that the spatial pattern of some orbs is similar to "interference fringe" formed by a small particle when it is illuminated by a laser.

Researching further, PRI investigators found a few web sites on orbs that point out:

1. Camera flash units are almost always used when orbs are seen in photographs.
2. More orbs have been seen in photos since digital cameras have become popular.

Furthermore, it should be noted that PRI investigators have not discovered in their photos any orb that is partially hidden behind an object.

The PRI investigators assumption was that if orbs are indeed interference fringes, it should be possible to replicate them by taking pictures of small particles such as water spray or powder.

**The Experiment**

PRI had an ad hoc meeting on August 13, 2006. The meeting and experimental photo session took place in the kitchen at the Learning Light Foundation. Additionally, photos were taken in the Betty Easily Hall. The equipment for the experiment was two plastic, hand-spray bottles filled with tap water and three compact digital cameras.

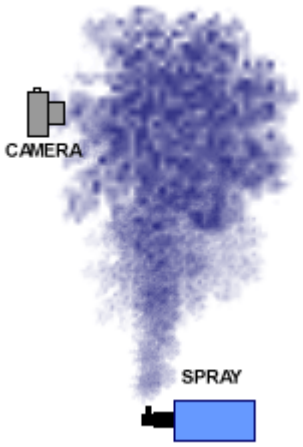

Figure 1

The setting for the experiment is shown in Figure 1. First, the camera was turned on and held still. Then water was sprayed into the air directly in front of the camera to ensure that there would be water droplets very close to the camera. Photos were taken while the water spray was still in the air.

Approximately 30 photos were taken. Photo 2 is one the photos.


Photo 2

It is difficult to see if the white "dots" in Photo 2 are analogous to the orbs in Photos 1a, 1b and 1c. The following photo 3a is an enhanced image of Photo 2. Photos 3b and 3c are enhanced images from the set of photos taken during the experiment.


Photo 3a 3b 3c

These optical entities share the same qualitative attributes with the orbs in Photos 1a, 1b and 1c--circular shape with multiple concentric circles inside. This provides some strong evidence that the orbs with similar attributes are also optical products from small particles.

**The Theory**

It is known that the CCD or CMOS sensors in digital cameras are more sensitive to infrared than human eyes. In fact, human eyes cannot see infrared lights but digital cameras can. CCD or CMOS sensors are the elements in digital cameras that are equivalent to film in traditional cameras. In Photo 4, the emitter of a remote control is photographed while pushing a button on it. This picture proves the above statement. It also shows that digital cameras register infrared lights as white light.

Photo 4

PRI investigators performed their experiment to answer the following question. Is it a realistic assumption that digital cameras can photograph fringe patterns from airborne particles that exist in nature that cannot be seen by the human eye?
Researchers in the field of the holography of small particles use an index called "Far-Field Number" defined as follows:

$$N = \frac{\lambda \times z}{d^2}$$

*N* is the Far-Field Number, *Lambda* is wavelength of light; *z* is the distance between particle and camera (*1); and d is the diameter of the particle.

It is known that when *N* is in the range between 2 and 8, we observe clear fringe patterns.

It is also known that:

(1) The wavelength of infrared ranges from 1 um (micron) to 1000 um (=1mm).
(2) The sizes of airborne particles, especially windblown dusts, range from approximately 2 um to 20 um.

Assuming that the wavelength of the infrared that digital cameras capture is 1 um since it is the closest to visible light. We also use *N*=5, which would yield very clear and "typical" concentric circles.

Given the conditions above, we can estimate the distance between the camera and the particle. Table 1 shows the relationship between the particle size and the distance from the camera.

Table 1: Particle size (*d*) and distance from the camera (*z*) under *N*=5 and *Lambda* =1um

| *d* (um) | *z* (mm) |
|---|---|
| 2 | 0.02 |
| 20 | 2 |
| 100 | 50 |

This result indicates that in order for airborne particles to yield fringe patterns caused by infrared light, the particles must be very close to the camera. However, fine water droplets can yield fringe patterns caused by infrared light when they are a few inches away from the camera. This explains why orbs are never hidden behind other objects--except other orbs: it is because the particles are so close to the camera that there cannot be any object between the particles and the camera. It also explains why photographers do not see particles when taking photos: it is because the particles are too small for the human eye to see.

*1) The distance between particle and camera should actually be optical path length due to the presence of the lenses.

**Conclusion**

This experiment suggests that orbs that have circular patterns are likely to be interference fringes caused by reflected infrared from the camera's flash unit. Approximately 90% of the orbs seen in photos taken during past PRI investigations are of this type.

Another orb phenomenon is daylight color orbs: that is, photos taken during the day in which colored orbs can be seen. As for daylight color orbs, they could be lens flares. PRI has not successfully replicated daylight color orbs in their photography experiments.

In conclusion, PRI considers orb photos as paranormal if they are taken under the following conditions:

1) A film SLR camera with a lens hood is used
2) No flash is used
3) There are no circular patterns inside the orb
4) The orb has color