

Great Balls of Fire

R. James Vavrek
Science Teacher
Henry F. Eggers School
Hammond, Indiana 46320

Ronald L. Holle
Research Meteorologist
Oro Valley, Arizona 85737

Dr. Mary Ann Cooper, MD, Associate Professor
Departments of Emergency Medicine and Bioengineering
Director, Lightning Injury Research Program
University of Illinois at Chicago 60612

Jim Allsopp
Warning Coordination Meteorologist
NOAA, National Weather Service
Romeoville, Illinois 60446

Kentucky, early 1980's: A quick and violent thunderstorm arose in Kentucky, causing the skies to darken. Several farmers were gathered at an informal cattle show in an open field surrounded by trees. One man was standing near a tree by the rear of a cow. Lightning appeared to hit a tree and observers reported an orange ball about the size of a soft ball came down the tree and hit the first man. Different observers report that the ball of light either came out of this man's mouth or chest, rolled onto the cows back and forward to her head where another man was holding the cow's halter. Both the men and cow had cardiac arrests. Resuscitation was unsuccessful with the first man. Although the second man who had been holding the cow's halter regained a pulse, he was pronounced dead two days later after he failed to have an adequate blood pressure or resume spontaneous breathing. Two other people survived but suffered confusion and short-term amnesia afterwards. One of the two survivors said they saw 'a ball of white fire on the first man's chest, reached over to slap it out but it was not hot.' The dead man's clothes showed a distinct circle of color about 6-8 inches (15-20 cm) in diameter on his under-shirt. Tiny pieces of skin were also found stuck to the inside of the under-shirt. The metal zipper and other articles of the man's clothing showed typical lightning arcing marks.

Introduction

Lightning has probably existed since early in the earth's formation. Throughout human history, it has influenced cultures, religions, and myths. The term "bolt" has occasionally been used in reference to describe lightning, but is an undefined term. The words flash, stroke, or channel, are better suited to its description.

In the United States there are about 120 million flashes of lightning annually with over 20 million cloud-to-ground (CG) lightning strikes.

In contrast, ball lightning is in a category by itself because it does not look or act, like any other form of lightning. Instead, it appears as a mysterious mobile, glowing or sparkling, sphere. There have been numerous reports of ball lightning dating as far back as the Middle Ages. Sightings are often accompanied by sound, odor, and sometimes, permanent material damage. However, despite many theories, there is no satisfactory explanation for these ghostly glowing apparitions nor have they been reproduced under scientific laboratory conditions. Many controversies abound about

this phenomenon, making it the most puzzling, unusual, and unpredictable form of lightning in existence.

This paper will provide information about this controversial phenomenon. It will describe ball lightning's known characteristics, sightings, occurrence, origin, appearance, life span, motion, decay, presents theories about its existence, and probable causes. It will also act as a resource for science teachers, students, and other interested individuals.

Occurrence

Although the majority of reports about ball lightning occur during thunderstorms, other electrical discharges have been implicated. Ball lightning typically occurs at or near a lightning strike point immediately after a cloud-to-ground (CG) lightning flash. It may hang in mid-air, rotate or fall from the base of clouds toward the ground. It may appear as a sphere and show motion. Seldom has ball lightning been described as rising.

Ball lightning has often been confused with St. Elmo's fire. The latter is a faint bluish or greenish glow (corona-like light) observed around objects protruding from the surface of the earth. It can appear around trees, power or communication lines, ship masts, on the leading edge of an aircraft's front cockpit windows, and on the leading edge of wings on an airplane.

There are accounts of ball lightning occurring within enclosed metal objects such as airplanes in flight and in submarines. One of the discriminating differences between ball lightning and St Elmo's fire is the mobility and duration of the event. St. Elmo's fire remains attached to the conductor and have a longer duration whereas ball lightning tends to travel, bounce around and often, end with an explosion or 'pop'.

- 1963: Ball lightning is reported to have entered an Eastern Airlines flight enroute from New York City to Washington, D.C., during an intense electrical thunderstorm. It traveled down and along the center aisle the entire length of the airplane, appeared blue-white, then disappearing silently at the rear of the plane. It did not radiate any sensation of heat, or noticeable hissing sound.

Origin

Ball lightning frequently has its origin next to, attached to, or protruding from objects that have been struck. These can be trees, poles, or metallic objects such as wire fences, telephone lines, or moving along those objects. There are eyewitness claims of ball lightning entering homes via the telephone or electrical outlets, passing through window screens, windows, and even down chimneys.

- 1918: In Black Top, Ohio, lightning struck a tree during a thunderstorm, and ball lightning was seen bouncing onto the ground and exploding soon after.

Appearance and Duration

Ball lightning typically assumes a spherical shape and lasts 10 seconds or less, but a small percentage of incidents lasts over one minute. The diameter ranges from one half inch (1.3 cm) to many feet/meters. The average size is 4 to 8 inches (10-20 cm), the size of an orange or grapefruit. It has also been seen as small as the size of a pea to as large as a bus. Descriptions indicate ball lightning maintains a constant brightness and size after formation. Not exceptionally bright, it can be clearly seen in daylight. The most common colors are red, orange, and yellow, but other colors occur.

- 1977: In Wales, England, a brilliant yellow-green transparent ball bounced down a hillside. It lasted for about 3 seconds and was the size of a bus.

There is speculation that ball lightning may happen more often than previously thought. A brilliant cloud-to-ground (CG) lightning flash may temporarily affect a person's vision consequently blinding the witness to the appearance of a short-lived ball lightning event. An estimated 5-10% of the population is said to have seen ball lightning and those who have seen it say they will never forget it.

Motion

Ball lightning is usually reported to move horizontally at a speed of a few yards or meters per second. Other descriptions state that it remains motionless in mid-air or descends from the base of clouds towards the ground. Rarely does ball lightning rise, so the idea that ball

lightning is a sphere of hot rising air is dismissed. Many reports have included seeing rotation or spinning and sometimes bouncing on or along the ground.

Heat-Sound-Odor

Although there have been accounts of structures burned and wires melting, ball lightning is rarely reported to produce the sensation of heat to the human skin. There are also reports of a 'hissing' sound coming from ball lightning. A large number of reports indicate there is distinct foul, repugnant odor resembling burning sulfur or the smell of rotten eggs associated with its appearance.

- 1996: During a thunderstorm a large, red-hot ball of fire fell from the sky striking a house, cutting the telephone wire, burning the window frame, and then burying itself in a tub of water. The water boiled for several minutes, then cooled enough for searching but nothing was found.

Decay

Ball lightning can decay either loudly or silently. The majority of the time it decays rapidly by exploding and producing a loud noise. Silent decay can be either rapid or slow. Whichever mode occurs, it is often reported that a mist or residue remains for a short period of time. Occasionally, ball lightning has been seen to break into two or more smaller balls before decaying.

Theories

At present, no theory adequately explains ball lightning. It cannot be tested or reproduced under controlled laboratory conditions and does not follow the known laws of physics. Purported photographs of ball lightning are predominantly time-exposed snapshots lasting seconds and appearing as a meandering ribbon of light. This makes the photograph questionable at best because of the lack of clarity and detail. This meandering light could easily be confused with automobile headlight movement, other moving lights, or moving the camera.

Some of the finest minds in physics and related fields have attempted to explain it without success. No theory can completely explain the

high degree of mobility, consistency of light output, or lack of rising motion. The majority of theories have regarded ball lightning as some kind of hot plasma gas of electrons or positively charged atomic or molecular ions in an electrical discharge. This is understandable because ball lightning has predominantly been associated with thunderstorms whose lightning ionizes the air, creating columns of plasma along their path. One scientist suggested it was a kind of microwave laser where a wave-like excitation of air keeps its shape like a tidal bore in a river. Another recent theory explains ball lightning as an aerosol-related phenomenon.

All theories presented to date fall into two categories: those in which the energy source comes from within the ball (internal) and sustains the globe and those with the energy source from outside the ball (external). Theories for internal powered ball lightning include these six subclasses:

- It is a ball of gas or air burning slowly,
- The sphere contains heated air or various impurities,
- It is a very high density ionized gas (plasma),
- The ball is a closed-loop current flow in its own magnetic field.
- It is an air vortex containing luminous gases, forming the sphere.
- It is a high frequency electromagnetic field in a thin spherical sheet of ionized air.

One of the latest speculations advanced suggested that ball lightning might be nothing more than a burning orb of silicon, generated by lightning striking the ground and vaporizing minerals. This theory hypothesized that ball lightning may involve more chemistry than physics. When lightning strikes the ground, the mineral grains in the soil are changed into tiny particles of silicon and compounds with oxygen and carbon. These tiny particles were predicted to link into chains forming filamentary networks, like sugar strands of candyfloss. The filaments could then form a light, fluffy ball-shape, which could be borne aloft by air currents. These tiny particles would be very reactive and slowly burn

up in the air, emitting light in the process. Calculations for duration, brightness and color of the glow could match those for ball lightning. When this theory was tested, it failed and was unable to generate ball lightning. This theory was also flawed because it did not address ball lightning falling from the base of clouds, inside airplanes and submarines where there is no ground/silicon. While most scientists agree that ball lightning exists, the cause remains highly controversial. The mystery continues and is as elusive as ever.

Conclusion

Some people firmly believe that ball lightning does not exist and is caused by an overactive imagination or optical illusion. As proof they claim that there has not been a photograph, movie or video taken of the phenomena. Photographs that purportedly show ball lightning are questionable. Yet it would be very difficult to deny the existence of ball lightning. Too many reliable people have documented it over

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the centuries.

One of the difficulties in finding solutions to ball lightning formation is its inconsistency. It has occurred in many settings and displayed a wide range of characteristics. Ball lightning has been seen falling from clouds, in submarines, in flying aircraft, bouncing along the ground, floating in mid-air, appearing small or large, passing through solid objects, splitting into two, having different colors, and lasting a few seconds to over a minute. Another problem is that scientists are not able to reproduce it in laboratory.

Presently, it appears these orbs will remain a mystery. Some of the most creative minds in physics and chemistry have attempted to explain ball lightning. Nature seldom gives up its secrets easily and ball lightning continues to generate attention, curiosity, and controversy. A complete explanation and understanding about ball lightning continues to elude scientists and may do so for decades.

