

# Ball Lightning

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## Introduction

Of all the forms of lightning, ball lightning is, beyond any doubt, the most rare and mysterious. Even though it was discussed by Aristotle in the 4<sup>th</sup> century B.C. in his work on meteorology,<sup>1</sup> and has, in the intervening years been reported by thousands of reliable observers, it has only recently gained acceptance as a real phenomenon by the majority of scientific authorities. A survey conducted at the Oak Ridge National Laboratory in 1960 by J. Rand McNally, Jr. asked 15,923 employees if they had witnessed ball lightning, resulting in 515 positive replies.<sup>2</sup> Sufficient evidence has now been accumulated to form a fairly compelling case for the existence of ball lightning, although its characteristics are such that no theory thus far submitted provides a satisfactory explanation.

## General Characteristics

One of the likely reasons that theories devised to account for the existence of ball lightning have met with little success is perhaps because of the many and varied ways it manifests itself. It can range in size from a few centimeters to well over one meter, but is most commonly seen in the 20-30 cm range. It takes on a broad spectrum of colors including red, orange, greenish blue, and even white. It has been seen to be nearly spherical in shape but is more often oblate, with boundaries that may be either sharply defined or hazy and indistinct. Sometimes ball lightning is seen to have protrusions issuing from the main mass and/or sparks flying away from it. It often makes a hissing or crackling sound but many times has been reported to be completely silent.

It can be seen to move through the air, seemingly at will, without regard to direction, yet sometimes seems to be constrained to move along a conductor such as a rain gutter or an electric wire. In addition, it can hang motionless, even in the presence of winds. In most cases ball lightning does not seem to radiate heat yet can explode or scorch walls or floors, indicating the presence of substantial internal energy, and has, on occasion, resulted in injury and loss of life. The death of Prof. G. W. Richmann in 1753 has been attributed to a contact with ball lightning.<sup>3</sup> It has been seen descending at varying rates of speed from storm clouds but is most often noticed near the ground in the vicinity of an atmospheric electrical discharge.

## Eyewitness Reports

Perhaps the best way to gain some familiarity with the behavior of ball lightning is to study a number of eyewitness accounts. Only a few representative cases are given here; the interested reader should refer to Singer for additional information. The most common type of ball lightning observations are those wherein the phenomenon is first seen shortly after its formation. This usually occurs in conjunction with an electrical storm, although this is by no means always the rule, as is shown by the

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1 Stanley Singer, *The Nature of Ball Lightning*, Plenum Press, New York, 1971, p. 5.

2 Harold W. Lewis. "Ball Lightning," *Scientific American*, March, 1963, p. 107.

3 Stanley Singer, *The Nature of Ball Lightning*, Plenum Press, New York, 1971, p. 9.

fourth example.

“In the summer of 1943 in the United States an engineer finished taking a shower on the second story of a wooden house during a short rainstorm. He heard thunder and saw a 30 to 45 cm diameter ball, bluish in color, float through a window screen at the end of the hall. It passed through the 9 meter long hall in 3 to 4 seconds and then went out a screened window at the other end of the hall. As it floated by him at waist height he felt no heat but smelled the odor of ozone.”<sup>4</sup>

“During a short violent storm in Germany in 1905 a bright ball lightning approximately 20 cm in diameter formed. After a moment in which it remained stationary, it moved in a straight line downward, accompanied by a faint noise like that of an electrical discharge. On its left side were small protrusions from which shadows moved over the surface, indicating a rotational motion. After 5 or 6 sec. it exploded illuminating the nearby region with a red light.”<sup>5</sup>

“A dull red, pear-shaped fireball floated slowly from an enclosed room with 2 ft. thick walls used as a drying oven. Short streamers of red flame flared out from it in all directions. It passed across a wooden landing, over the top of a truck, and exploded 1 meter from the ground. There was no sign that anything had penetrated the wall at that point into the room where the fireball started.”<sup>6</sup>

“Four men had resumed their work in construction of a wall following a rainstorm in Germany in 1868. The sun was shining, and in the blue skies there were only a few almost transparent clouds. The men were about to lift a stone approximately 80 cm square to the wall. They were standing around the stone when suddenly there was a flash of lightning; in the middle, approximately 90 cm above the stone, a round, yellow, transparent ball of about 20 cm diameter appeared, steadily moving up and down for a distance of 4 cm. In the center of the ball was a bluish flame which was pear-shaped with the point downward and 4 cm in length. The flame revolved in a vertical circle of 7 cm diameter inside the large ball. A sharp crack was heard after a few seconds, and the ball lightning disappeared...”<sup>7</sup>

In a few rare cases observers have actually witnessed the formation of ball lightning. Singer reports such an instance in which ball lightning seemingly originated in a sharp bend in a zigzag lightning flash.<sup>8</sup> In another case:

“...the witness noted a snake-like discharge descending extremely slowly to a telegraph pole during a heavy rain. It came to a halt approximately one meter above the pole and formed a ball one-third meter in diameter which exploded with such a crash that several people rushed out of doors to see what had happened.”<sup>9</sup>

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4 *Ibid.* p. 29.

5 *Ibid.* p. 35.

6 *Ibid.* p. 37.

7 *Ibid.* p. 34.

8 *Ibid.* p. 95.

9 *Ibid.* p. 27.

## Artificial Generation of Ball Lightning

From a consideration of cases of the type discussed above it would seem that ball lightning is generated only in conjunction with electrical disturbances of great magnitude. A number of instances have been reported, however, wherein a seemingly genuine ball lightning has been generated by artificial means and in the presence of much lower energy levels. The earliest such case concerns the generation of ball lightning in a Leyden jar sometime in the eighteenth century.

“A ball of fire like a red-hot iron ball approximately 2 cm in diameter and rotating rapidly was seen in a Leyden jar as it was being charged. Suddenly there was a loud explosion accompanied by a bright flash, and the glass of the bottle was pierced by a circular hole.”<sup>10</sup>

In 1889, in his Colorado Springs laboratory, Nikola Tesla, to whom we are all indebted for the development of the Tesla high frequency induction coil, claimed that he was able to develop balls of electrical energy some two and one-half inches in diameter. The December 1919 issue of radio amateur magazine, QST, contained a letter to the editor by two ham radio operators in Chattanooga, Tennessee, which claimed that they accidentally generated a ball of lightning with their radio apparatus. More recently, such a manifestation is seen approximately once a year at the Hill Air Force Base Missile Radiographic facility in Utah. Volleyball size fireballs are seen to drop out of the air from the vicinity of a high voltage supply for the 25 MeV linear accelerator. Unfortunately, no one has as of yet been able to design a repeatable experiment which gives rise to a ball lightning manifestation under controlled conditions. It seems that in each of the above cases there existed some unknown or hidden variables which by chance had obtained the correct value, in conjunction with the conditions that were known, to generate the phenomenon.

## Theories

There has been no shortage of theories put forth in an attempt to render understandable the complex phenomenon of ball lightning. These theories include chemical reactions, nuclear reactions, molecular ion interactions, vortices, electrical discharges, and, more recently, plasmas. A summary and discussion of these theories and more is given in Singer.

## Discussion

Ball lightning has inspired considerable surges of theoretical activity throughout its history. The apparent lack of any successful explanation may be due to one or more of the following causes:

1. Ball lightning is not a genuine physical phenomenon.
2. The theorists have not worked hard enough and need more time.
3. The manifestation is a consequence of factors that are not embraced in the structure of contemporary physical theory.

If the latter possibility (number 3) should be applicable in this case, it would seem that the development of a theory elaborating the characteristics of ball lightning would be a suitable undertaking for those interested in expanding the scope of the Reciprocal System. Such a theory could be easily tested through its ability to identify the hidden variables that have prevented repetition of the accidental instances of artificial generation of ball lightning.

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<sup>10</sup> *Ibid.* p. 79.

On the experimental front, an industrious electrical engineer, Robert Golka, has secured a grant from the U.S. Air Force and is currently working at the Wendover Air Force Base in Utah toward the artificial production of ball lightning. He is attempting to reproduce the Tesla technique using a 25 million volt coil of his own construction. It is his belief that a thorough understanding of the nature of ball lightning may stimulate a significant advance toward the use of atomic fusion as a practical energy source.

Given below is a rather general flow chart of a possible mechanism for ball lightning. Anyone with an interest and a background in a related area should be encouraged to give this matter some thought.

