Optik 127 (2016) 6155–6161

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.de/ijleo

How Ball Lightning penetrates in room through small holes and splits

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ARTICLE INFO

Article history:
Received 17 February 2016
Accepted 13 April 2016

Keywords:
Ball lightning
Fire ball
Nonlinear optical medium

ABSTRACT

We show in a frame of optical model of Ball Lightning how it finds out holes and splits to penetrate through them and analyze forces responsible for deformation of Ball Lightning. There is no plasma responsible for the natural Ball Lightning existence.

1. Introduction

There are numerous evidence that natural Ball Lightnings (BL) penetrate indoor through various small holes slots, splits, and keyholes as well as through chimneys [1–4]. BLs change their cross-section if it is required in this time. Even living creatures do not have similar properties. None of the known theories does not even try to explain these properties. Of course, BL has no sight, touch and other senses to find the hole. Of course, BL has no means to assess the size of the hole and change its shape so as to freely penetrate through the opening. If the theory could explain these features in a natural way, with a high degree of confidence it can be argued that this theory correctly describes the BL physical nature.

Below we will show that the self-confined light (SCL) has all necessary properties to satisfy the presented requirements. Unfortunately, nobody investigated the SCL till 2002 when we put forward a hypothesis that the SCL exists in the nature and BLs are a confirmation of its existence. The SCL can be imagined as a thin spherical layer of strongly compressed air where the intensive white light is circulating in all possible directions. The refractive index of the layer of the compressed air is greater than that of the surrounding space and the layer is a planar waveguide, the curvature of which is different from zero. Similar planar waveguides are a basis of the contemporary integrated optics where the optical processes take place in a transparent film, refractive index of which is greater than that of the surrounding space. The planar waveguide, the curvature of which is different from zero is also possible. Thus, the layer of the compressed air prevents radiation of light in free space.

In turn, the circulating light compresses the air due to the electrostriction pressure in the regions where it is circulating. The combination of the layer with the increasing refractive index due to compressed air and the intense light that provides the compression is called by the optical incoherent space soliton. Typically, such solitons are studied in the situation where their curvature is equal to zero because it is unknown how the spherical soliton can be formed. The fact that the BL is a rare natural phenomenon testifies that the production of the spherical solitons is not trivial problem. We can conclude that at present the scientific knowledge is sufficient to study the SCL. No new terms and notions are required for this purpose.

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http://dx.doi.org/10.1016/j.ijleo.2016.04.055
0030-4026/

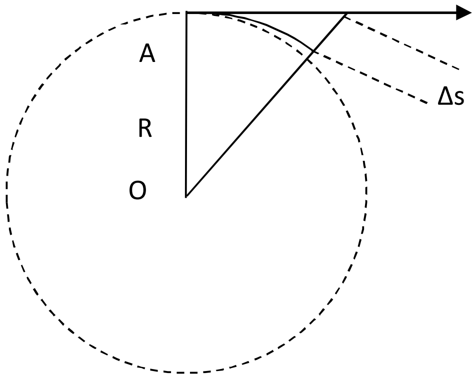

Fig. 1. Propagation of a light beam in the optical medium, where grad(n) depends on R and is directed to the center O. Dotted lines are perpendicular to the surfaces. They show directions of the gradient of the refractive index.

The energy of light in the SCL is significantly greater than the energy of the compressed air. That is why the behavior of the SCL is determined mainly by laws of optics rather than laws of mechanics. Optically induced forces (OIF) arising at an interaction between the light and matter (surrounding air in our case) were known since time of Maxwell. Having taken into account this kind of force, we have explained numerous puzzles and intriguing BL behavior [5–15] as well have presented a theory of the SCL [16–19].

Unfortunately, the contemporary notions about OIF are erroneous. The Lorentz force is taken as a foundation of OIF in last 40 years. We have shown that this approach gives incorrect results in the simplest situations [20]. It is not surprising that our SCL theory is not met in a proper understanding of the scientific community. In last five years we have developed on the basis of the unambiguous thought experiments the theory of OIF and have shown that notions of Maxwell and Helmholtz remains in force at the present time [21–38]. In particular, the century-old dilemma of the theoretical physics about a magnitude of the momentum in matter has been resolved.

The most essential property of the SCL for considered situation is its great deformability. Unlike a child balloon where the pressures inside and outside the balloon are different and the air cannot penetrate through the shell of the balloon, the pressures inside and outside the SCL are identical and the air can penetrate through the shell of the compressed air.

OIF applied to the SCL surface is proportional to the gradient of the refractive index of the surrounding air. If the surrounding air is homogeneous, then the gradient is equal to zero and the SCL is motionless. If the surrounding air is inhomogeneous (for example, different air pressure due to wind or flying aircraft, different temperature, different proportion of various gas components) the SCL is moving in the direction of the gradient of the refractive index (along the gradient of the pressure at the homogeneous temperature, against the gradient of the temperature at the homogeneous pressure). Thus, if the gradient of the refractive index is homogeneous in the space where the SCL is located, it moves along the gradient without deformation of its shape. If the gradient is inhomogeneous in the space where the SCL is located, its shape is deformed.

These information is sufficient to explain a majority of BL puzzles.

2. BL motion in a terrestrial atmosphere

SCL is an extremely sensitive device to the inhomogeneity of the refractive index of the surrounding air. SCL can react on the smallest changes in the refractive index. Let us consider a motion of light in an inhomogeneous optical medium, the refractive index of which is changed in space. A trajectory of the light beam is determined by the following eikonal equation

$$grad(n) = \frac{d}{dl}(n\boldsymbol{e}_S) \tag{1}$$

where n is the refractive index that is changed in space, l is the distance along the light beam, $\boldsymbol{e}_s$ is the unit vector directed along the propagation of the beam. Let grad(n) be dependent on R only where R is the distance between center O and the beam. Let the beam propagate along the tangent to circumference of R as is shown in Fig. 1. At this case, $dn/dl = 0$ and $d\boldsymbol{e}_s/dl$ determines the curvature of the trajectory at point A. Then the radius of the curvature R_0 at point A in accordance with Eq. (1) is equal to n/grad(n). Let us calculate a displacement of SCL of 0.1 m diameter at the time of one rotation of light within SCL when the light propagates at distance about s = 0.3 m. Let us assume that the same displacement by order of magnitude has the beam propagating from point A at distance 0.3m. The displacement of the beam from a straight line Δs in Fig. 1 is equal to $\Delta s = R_0/Cos(\frac{s}{2\pi R_0}) - R_0 = R_0(\frac{s}{2\pi R_0})^2/2 = \frac{s^2}{(2\pi)^2 R_0}/2 = \frac{s^2 grad(n)}{(2\pi)^2 n}/2.$

For example, if grad(n) = 10^{-6} m^{-1}, we have $\Delta s = 10^{-9}$ m. However, the light makes $N = c/s$ rps in the SCL. Since $s = 0.3$ m, we have $N = 10^9$ and SCL is displaced by 1 m per second.