

Small-sized and Composite Ball Lightning

Anatoly I. Nikitin

Institute for Energy Problems of Chemical Physics, Russian Academy of Sciences, 117344 Leninsky Prospekt, 38, Build 2, Moscow, Russia

According to observations, ball lightning consists of a shell, inside which elements of 1-3 mm size are placed. These elements are described as randomly moving shining balls, avoiding collisions with each other [1]. In some cases in experiments with electric discharges in water on plates, placed near discharge zone, tracks of objects with diameter about 0.1 mm were registered [2]. All this attracts attention to investigations of possibility for existing of miniature ball lightning. On the base of developed electrodynamic model of ball lightning [3] it is shown that energy of ball lightning (basically defined as kinetic energy of protons W_p , rotating in orbits of radius R around the central negative charge Q_e) may be expressed by formula:

$$W_p = 5.32 \cdot 10^9 Q_e^{3/2} / R^{1/2} \text{ J.}$$

Energy density of the ball lightning power core is

$$\rho_w = 1.27 \cdot 10^9 Q_e^{3/2} / R^{7/2} \text{ J/m}^3.$$

According to these formulae proton's kinetic energy and energy density abruptly increase at reducing of the core radius R . For preventing of expansion the ball lightning power core must be placed inside a reasonably strong container. A role of this container is played by a shell of water molecules. This shell tends to shrink in radial direction due to existence of unipolar electric charge inside it. An account of real potentialities of this shell restricts allowable limiting energy density in ball lightning power core by values $1\text{-}5 \cdot 10^{10} \text{ J/m}^3$. Minimum size of this ball lightning with total proton's charges from 10^{-7} to $4 \cdot 10^{-5} \text{ C}$ is about 0.2-3 mm. Because all miniature ball lightning have like electric charge they must repel

each other. However they may be gathered inside a common shell of some dielectric. This configuration was named as a “composite ball lightning”. In this system a force, shrinking the shell, appears because of unipolar overall charge of great quantity of miniature ball lightning, placed inside the shell. Estimates show that inside the shell of volume 1 liter and wall thickness 1-3 cm some hundreds or thousands of miniature ball lightning with total energy 1-16 MJ may be confined. In this case maximum values of energy are obtained at sizes of miniature ball lightning from 3 to 10 mm. With charges values 10^{-14} - 10^{-13} C minimum size of the miniature ball lightning may be about 10 nm. This small ball lightning, obviously, can pass through intact glass. An alternative system of moving charges – an activated hydrate cluster – is considered. In this cluster a central charge is a negative ion. Some number of protons rotates around this ion. The Coulomb repelling of these protons is compensated by the shrinking shell of water molecules. It is shown that in such cluster total kinetic energy of protons does not exceed 20 eV, and this cluster cannot emit visible light.

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