

# BALL LIGHTNING IN SMETHWICK

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## Abstract

The incident took place in 1975 and remained unexplained, since then. The provided description<sup>1</sup> refers to a woman, living at that time in Smethwick, a territory in Birmingham, West Midlands, (U.K). The woman had been attacked in the kitchen of her house by a sudden appearance of a ball lightning. In this study, I put forward to explain the phenomenon, by using methods of High Energy Physics and High Energy Astrophysics, together with those of Heat. The most acceptable hypothesis, after analyzing all properties of that occurrence, is a conversion of a minute fragment meteoroid of antimatter into a ball lightning. This conclusion supports further my previous studies for the hypothesis of antimatter meteors that fully explains the mechanisms of the origin and formation of the ball lightning phenomenon. It also supports the existence of antimatter in our solar system, possibly in structures of antimatter comets. Consequently, it suggests existence of larger stellar objects made of antimatter in the entire Universe.

## Introduction

Cosmological studies suggest that antimatter does not exist in the Universe. These studies are based mainly on Steigman's<sup>2</sup> hypotheses and became popular among the various even to non scientific magazines. Steigman discussed some features, such as cosmic rays, solar wind and gamma rays but disregarded to look into material objects such as antimatter meteors that may enter into the Earth's atmosphere from the outer space. However, the greater part of scientists who had studied the particular case of antimatter meteors are insisting that such a kind of meteors does actually exist as clearly can be seen in the following,

Between 1898 and 2006, twenty six (26) studies were published. The following list shows their results.

Cowan<sup>3</sup>, Konstantinov<sup>4</sup>, Bullough<sup>5</sup>, and Ashby<sup>6</sup> have published experimental results which support the existence of antimatter meteors. Crawford<sup>7</sup> rejects the results of Ashby considering that gamma radiation can be produced from positrons in cosmic rays. M. Beech<sup>8</sup> refers to the well known arguments of G. Steigman<sup>2</sup>.

Schuster<sup>9</sup>, Wyatt<sup>10</sup>, Sofia and Van Horn<sup>11</sup> are supporting studies about the existence of antimatter meteors, by using results based on theoretical and observational data. Stecker<sup>12</sup> also supports the existence of antimatter in the Universe.

Nauenberg and Ruderman<sup>13</sup> are expressing skepticism about the survival possibility of antimatter meteors below the height of 300 km. It was proven by Ph. M. Papaelias<sup>14</sup> that this is not correct and that the annihilation cross section is smaller than the elastic cross section, so that an antimatter meteor can penetrate deeper the atmosphere than the height of 300 km. Finally, Philip M. Papaelias<sup>15</sup> developed the mathematical relationships that govern the behavior of antimatter meteors in the Earth's atmosphere and gave a solution for the induced phenomena. It has to be noted that similar factors are affecting ordinary matter meteors, making them able to reach the ground though they are carrying enough kinetic energy to become evaporated at heights far above the ground.

Summarizing all the above we see that from 26 papers which were published between 1898 and 2006, more than twenty three (23+) are supporting existence of antimatter meteors. One (1) does not support existence of antimatter meteors and two (2) are expressing skepticism. Of the eighteen (18) researchers that had been involved in antimatter meteors research, fifteen (15) of them are supporting

existence of antimatter meteors. Two (2) are expressing skepticism, but they do not reject the possibility of such an existence and only one (1) does not support existence of antimatter meteors.

Contrary to cosmological theories and experimental results, these new studies seen from another point of view have confirmed that the majority of the researchers, who studied the particular case of antimatter meteors, have found evidence of existence of antimatter meteors on Earth. At extension, there may be evidence of existence of compact antimatter bodies in our solar system. Antimatter fragments may leave from such comets, when the tail of the comet is crossing the Earth's orbit. Finally, the annihilation processes are completing the phenomenon as a ball lightning, by exciting antiatoms and atmospheric molecules, producing in such a way the glowing phenomena.

The Physics that governs an antimatter meteor fall was published by Philip M. Pappalardo who derived a set of formulae that explains how its cosmic velocity<sup>16</sup> and original mass<sup>14</sup> are decreasing and for how long its remaining mass may survive, depending in case of evaporation absence<sup>17</sup> or in case of simultaneous production of vapours<sup>18</sup>. More important, a full explanation for the puzzling property of antimatter meteor motion is given<sup>19</sup>, since a long time. Another useful study derives the energy that can be stored inside an antimatter meteor by the penetrating particles. These particles can turn the antimatter meteor into a ball lightning, by excitation of the surrounding air molecules as well of its own antiatoms<sup>20</sup>. This framework of Physics helped Ken Bullough<sup>5</sup> from Sheffield (UK), to identify that a small group of comets he was studying were in fact made of antimatter, since they were showing unusual characteristics that can distinguish them from the majority of comets. This study was radar observations at 73 MHz made in June 1953 at Jodrell Bank, as part of the meteor/radio-aurora observational programme. Publication of these data was suppressed because, at that time, no interpretation was possible within the then existing framework of physics and, in addition, the radar echoes were not detected on nominally similar equipment operating at 72MHz. Decades later, when he was aware about the physics of antimatter meteors and comets, he returned at the Jodrell Bank Observatory (Manchester) to search for the list of those comets. Forty two years after the first observation, his study was published by the editors of the Journal with permission of his relatives, since at the time of completing the paper, Bullough had suddenly passed away. These results include the short period (6.37 year) 7P/Pons–Winnecke comet and the 29P/Schwassmann-Wachmann 1925 II in a group of few dozens of antimatter comets. Fragments from those comets are entering in the atmosphere when Earth is crossing their tails. When these fragments are reaching at lower atmospheric heights they become visible as glowing spheres, which last until the mass of the antimatter meteors are completely annihilated. In addition of this study, Bullough analyzed extensively the Tunguska event and concluded that the explosion was generated by the annihilation of an antimatter meteor in the atmosphere. Pappalardo<sup>21,22,23,24</sup> explained the conditions of slowly annihilated small antimatter meteoroids that can produce glowing phenomena, which are known as ball lightning.

Under the hypothesis of antimatter meteoroids, several mechanisms had been proposed which can produce the phenomenon of ball lightning. Including to those phenomena are a) the Tungus event<sup>15</sup> in 1908, b) the Star of Bethlehem<sup>21</sup> c) the ball lightning that occurred in 2006, over Alexander Platz of Berlin<sup>24</sup> and d) possibly the Dyatlov Pass incident the Ural mountains occurred in 1959. The phenomena may include a variety of characteristics, some of which can exhibit violent and catastrophic events, depending on the mass of the antimatter meteor. The higher the mass of the antimatter meteor, the more serious are expected for the accompanied phenomena, though other factors are also playing significant role in the behavior of the ball lightning. Among them, there are the weather condition, the electrical activity of the atmosphere, the humidity, the chemical composition of the antimatter meteoroid and the value of a possible existence of a repulsive potential between antiatoms interacting with atmospheric atoms<sup>13</sup>.

### **The ball lightning event in Smethwick**

Stenhoff<sup>1</sup> reported in the *Nature* scientific Journal the case of a ball lightning of ~10 cm in diameter surrounded by a flame-colored halo, which was hovering about 95 cm above the ground. Its color was bright blue to purple, which is a common feature to that kind of atmospheric phenomena. The ball lightning appeared during a thunderstorm on the 8<sup>th</sup> of August 1975 over the cooker and injured a lady who was at that time in the kitchen, causing redness on her skin and holes on her clothes. The woman, herself who had never before heard of ball lightning reported that, "The ball seemed to hit me below the belt, as it were, and I automatically brushed it from me and it just disappeared. Where I brushed it away there appeared redness and swelling on my left hand. It seemed as if my gold

wedding ring was burning into my finger.” As she touched the ball lightning, she felt that the fiery ball exploded. Belts do have metals to adjust the waist and it is well established since a long time that one of the clearest property of a ball lightning is the attraction by metals which are close, according to many studies (e.g. Kapitza<sup>25</sup>, Singer<sup>26</sup> and Barry<sup>27</sup>).

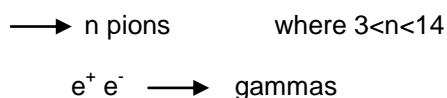
### Antiatoms annihilated by atoms

On air, an antimatter meteor is coming into contact with a number of atmospheric molecules producing particles enough to make it hovering and glowing, raising at the same time its temperature. When the woman in Smethwick touched with her hand the ball lightning, the antimatter meteor came into contact with a denser object, (the ring and the skin of the finger) which resulted in the production of much higher number of particles. Fermi and Teller<sup>28</sup> had calculated the cross sections  $\sigma_{\text{air}}$  and  $\sigma_{\text{solid}}$  for air and solids respectively and found the  $\sigma_{\text{solid}}$  to be larger than  $\sigma_{\text{air}}$  by a factor of 4 times of magnitude. The high number of these particles passing through the ring had caused ionization and excitation of atoms and antiatoms and left energy which was changed into heat, increasing in that way the temperature of the ring. The metals of the ring can, obviously, increase the temperature of the ring, faster than the skin itself. This explains why it seemed as if the gold wedding ring was burning into the woman’s finger and caused swelling on her left hand. Obviously, the high temperature of the golden wedding ring left redness on her left hand.

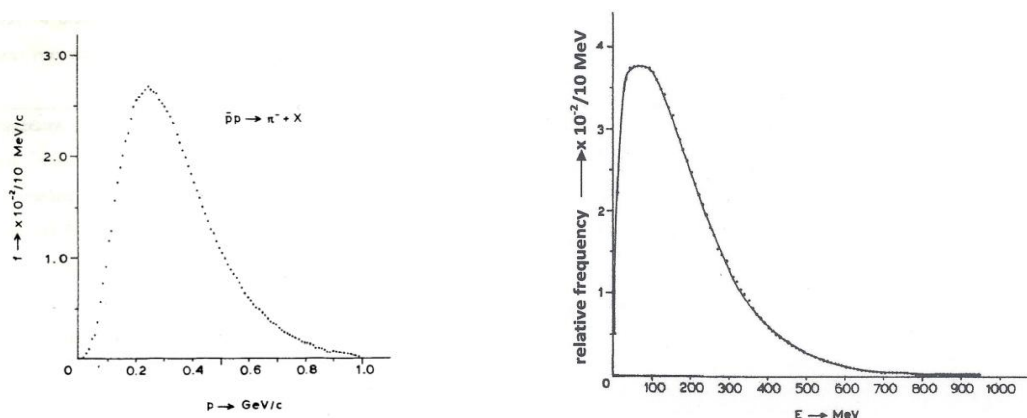
The woman, who had never before heard of ball lightning, felt that the ball exploded just as she touched it and this can be explained by the large amount of particles produced which evaporated the antimatter meteor by absorption of energy of the passing particles through the antimatter meteoroid. The high temperature explains further why her legs became red and numb a typical characteristic for human beings who had been exposed to radiation, in this case the flux of pions.

### The annihilation process

When ordinary matter meets antimatter, the baryons (B) of the ordinary matter atoms are being annihilated by the same number of antibaryons ( $\bar{B}$ ) of the antimatter object. Electrons ( $e^-$ ) are being annihilated with same number of positrons ( $e^+$ ). The processes are



The combinations of  $\bar{B}$  are  $p\bar{p}$ ,  $p\bar{n}$ ,  $\bar{p}n$  and  $n\bar{n}$ .



Left. Spectrum of negative pions produced by a proton-antiproton inclusive reaction. Right. Spectrum of gammas produced by the decay of  $\pi^0$

Experiments at CERN have revealed the multiplicities of the pions produced by baryon-antibaryon interactions. The mean multiplicity  $n$  of pions produced when the annihilation takes place at rest is  $n = 5.1$  as had been derived by Papadopoulou<sup>29</sup>. One third of the short living pions are positive charged and after  $10^{-8}$  s the pions decay into positive  $\mu$  mesons and neutrinos. Positive muons decay after  $10^{-6}$  s into positrons, neutrinos and antineutrinos. Another one third of the  $\pi$  mesons is negative and

decays in the same way with their mirror matter products. The remaining one third of pions is neutral  $\pi^0$ s. Within  $10^{-16}$  s, these particles are decaying mostly into a pair of gammas (98.93%) and a few of them (1.17%) in the decay process  $\pi^0 \rightarrow \gamma e^+ e^-$ . Spectra of those products are given above.

The above interactions with multiplicities and spectra are expected to take place during the annihilation process of antimatter atoms of the meteoroid with atmospheric atoms or molecules. That is, one particle can be annihilated with its counterpart antiparticle ( $e^+ e^-$  or  $B\bar{B}$ ). The spectrum of any type of charged pions produced from  $B\bar{B}$  combination is expected to be more or less similar to the above which can be described by a Maxwellian curve.

### Calculations

The mixtures of Alloys mixed with Gold are variable, depending on the number of karats of the ring. It depends whether the color of the gold is white, yellow or red. In order to produce heating effects on skin of the finger, an increasing of the temperature of about 50 degrees higher than the environment should be accepted. It is therefore, easy to identify how the ring became so hot and caused redness on the woman's hand. A wedding ring weighs between 2 and 9 gram, for a typical wedding ring on a woman's finger we use a mass of 6 gram and 14 karats, which are the most frequent kind of wedding rings

The energy absorbed by the ring is  $\Delta E = \sum w_i \Delta E_i$ , where  $\Delta E_i$  is the energy absorbed in each element of the ring and  $w_i$  the percentage for each element. This amount of energy can be deposited according to the fraction of metals, by the charged and the products of the neutral pions. In order for the ring to cause redness on the woman's finger, some difference of the temperature around 50 °C is necessary. In our calculations, precise details are not important. The results are given in the following table,

**Energy deposited in a 14 kt ring heated by 50 °C**

Element	Percentage of mass (%)	Density (gr/cm <sup>3</sup> )	Contribution of Mass (gr)	Specific heat (J/g°C)	$\Delta\theta$ (°C)	$\Delta Q$ (J)
Gold	58.3	19.32	3.5	<b>0.129</b>	50	22.575
Silver	30	10.5	1.8	<b>0.240</b>		21.6
Copper	11.7	8.96	0.7	<b>0.385</b>		13.475
Total	100		<b>6</b>			<b>57.65</b>

The energy  $\Delta Q$  is produced by the annihilation of the antimatter meteor when the lady brushed away the ball lightning. In the words of Einstein  $\Delta Q = \Delta E = 2 \Delta m c^2$ , where  $\Delta m$  is the equivalent mass that could be annihilated off the antimatter meteoroid to heat the ring. From this, we find,

$$\Delta m = 57.65 \cdot 10^7 \text{ J erg} / [J \cdot 2 (3 \cdot 10^5 \cdot 10^5 \text{ cm/s}^2)] = 57.65 \cdot 10^7 \text{ erg} / 2 \cdot 9 \cdot 10^{20} \text{ cm}^2 \text{ s}^{-2} =$$

$$57.65 \cdot 10^7 \text{ erg} / 18 \cdot 10^{20} \text{ cm}^2 \text{ s}^{-2} = 3.2 \cdot 10^{-13} \text{ gr}$$

However, this is a small fraction of the total mass of the antimatter meteor, since the particles produced are not moving towards the finger of the lady only, but they are spreading towards any direction in a volume surrounding the meteor. Excitation of the atoms and antiatoms can produce light emission, making the fragment a source of light, which appears, in most cases, as a glowing sphere of radius far exceeding the size of the fragment. In addition, pions and gamma rays, which are passing through the ring and the finger, are not spending their total energy, but they penetrate ring and finger, escaping at a distance, with a lot of their energy reserved.

With the above assumptions, I estimate the residual mass of the antimatter meteoroid to be between the value of  $3.2 \cdot 10^{-13}$  gr and  $10^{-11}$  gr.

This result shows the value of the mass of the ball lightning at the time of the incident and does not include the mass annihilated during descent from the outer space to the ground and/or possibly during the time of exhausting on the ground, before the incident to take place. Its original mass, therefore, could be much higher. The small quantity of mass explains why the ball lightning exploded and ceased, without any further catastrophic phenomena. Nevertheless, this result is consistent to the size of micrometeors, corresponding to the 99% of all types of meteors that may enter in the Earth's

atmosphere. If the glowing sphere, instead of exploding instantly, was gradually seizing, then the power output for a typical 10 s duration of the ball lightning would be ~180 W, well within the range of 100-300 W that most studies confirm (Shmatov<sup>30</sup>, Stephan<sup>31</sup>).

### Absorption of Energy

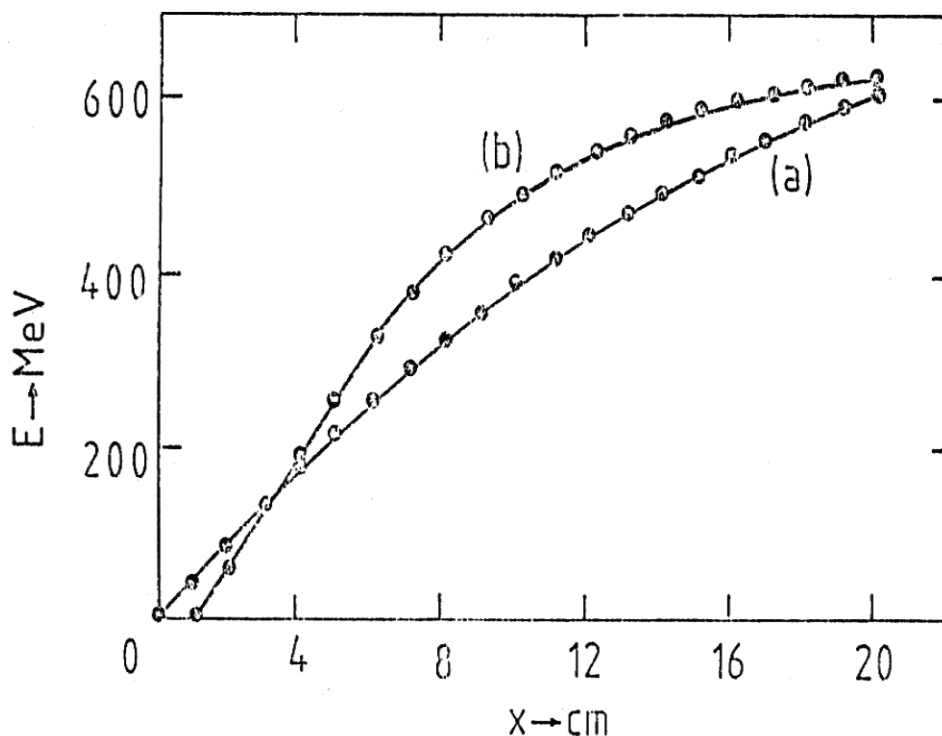
It is not possible to have any information about the composition of an antimatter meteor, unless we have the spectrum of its elements. Assuming that these objects are similar to the ordinary ones, we accept that iron, nickel-iron or chondrites e.t.c. made of antimatter are the most likely for their structure.

The energy loss which can be caused by charged particles penetrating an object can be described by the Bethe Bloch formula. In its simplified form, it can be given by the following relation

$$S = -\frac{1}{\rho} \frac{dE}{dx} = \frac{A}{\beta^2} \left[ B + 0.69 + 2 \ln \frac{p}{mc} + \ln T - 2\beta^2 - \delta - u \right]$$

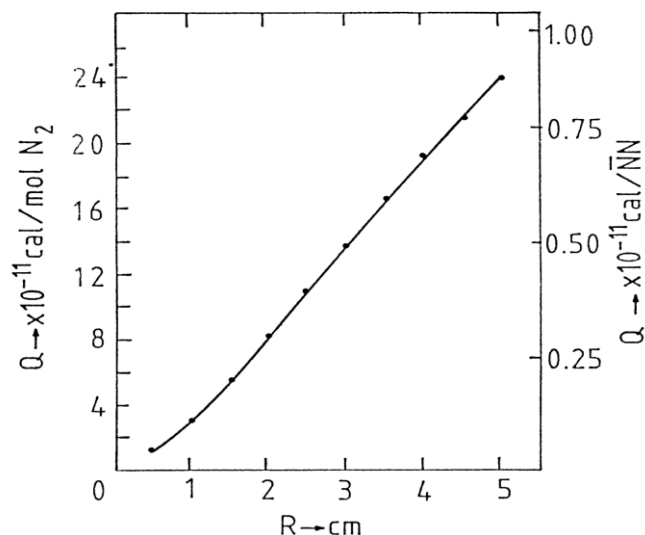
where S is the stopping power and  $\rho$  is the density of the absorber  $\beta=v/c$ .

In the above formula the velocity of the particle is denoted by the letter v, c is the speed of light, A and B constants, dE/dx the energy loss of the particle when is passing through the depth dx, p the momentum of the particle and T is the maximum energy transfer of the collision. The factor  $\delta$  is the density effect correction, while u represents shell corrections to the energy loss rate. Penetration of the iron antimatter meteor by the gamma rays can also deposit energy, which can be calculated by using Monte Carlo methods.



**Absorption of Energy per NN, as a function of the distance traveled by a) charged and b) the neutral  $\pi$  mesons (and their decay products), through the antimatter meteor (iron case)**

A Monte Carlo program named "EGS code" can perfectly do such statistics for a large number of materials and I used it at CERN for similar calculations in the case of an iron antimatter meteor. By using both the above equation and the spectrum of the  $\pi$  mesons taken from bubble chamber experiments, we get the above plot for the energy deposition of the charged pions and neutral pions as a function of the radius for an antimatter spherical iron meteor.

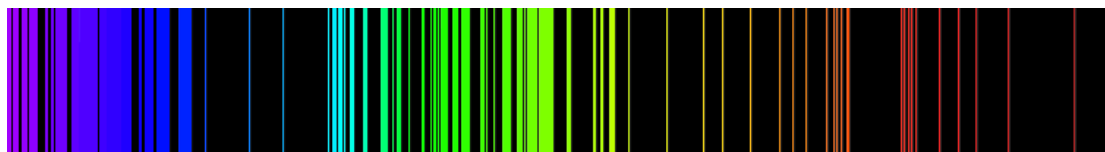


**The heat Q stored in a spherical antimatter meteor by the annihilation interactions (iron case), as a function of its radius**

The figure above shows the small amount of energy that can be stored inside a fragment of iron with minute dimension, compared to the high amount of energy carried by the produced elementary particles.

### The color of the ball lightning

The woman said that the color of the ball lightning was bright blue to purple, which is a common feature of that kind of atmospheric phenomena. Iron spectrum has a wide purple-blue spectrum band as shown below.



**The above spectrum of iron shows intensive lines of blue purple color, as described by the woman. There are also fewer but intensive green lines. Few weak red-pink lines do not significantly contribute to the visible color output**

The description of the woman, combined with the spectrum shown above, may be an evidence of an iron type antimatter meteor, the vapors of which had been excited by the pions produced, when the annihilation of antimatter atoms with atmospheric atoms took place. Another evidence is the strong attraction of the ball lightning by objects made of iron. In one incident, a ball lightning destroyed instantly a heavy metal stove, showing a force that in nature can be exhibited only by few natural phenomena, including antimatter objects annihilated by ordinary matter at thermal energies.

### Associated phenomena

The ball moved straight towards the witness at an estimated height of 95 cm from the ground. Burning heat was felt, and there was a singeing smell. A sound something like a "rattle was heard" and this can be explained by the instant explosion and the rapid evaporation which destroyed the molecular bonds of the antimatter body. Heating effects by the penetration of the particles to all objects around the explosion could also cause a singeing smell.

In the iron case, the total energy needed for an atom to leave the object as a vapor from initial temperature of 0 °C is  $\sim 10 \text{ eV/atom} = 10 \text{ eV} \cdot 1.6 \cdot 10^{-19} \text{ J/eV/atom} = 1.6 \cdot 10^{-18} \text{ J/atom}$ . This value should be compared with the energy released in the form of energetic particles by only one pair of proton-antiproton annihilation interaction, which is  $\sim 2 \text{ GeV}$ . A small quantity of iron mass equivalent to  $10^{-11} \text{ gr}$  consists of  $\sim 6 \cdot 10^{12}$  baryons or  $6 \cdot 10^{12} / 56 = 11 \cdot 10^{10}$  atoms. The energy needed to evaporate this small quantity is  $1.6 \cdot 10^{-18} \text{ J} \times 11 \cdot 10^{10} = 1.8 \cdot 10^{-7} \text{ J}$ . Once all these atoms change phase, and become vapors, they can instantly be annihilated by the atmospheric atoms, since the collision rate at the ground level

is close to the frequency of the electromagnetic spectrum ( $\sim 10^9$  collisions/s). Possibly, the ball lightning was already quite hot and the touch of both the hand and the ring with the ball lightning had only accelerated the process towards the explosion, instead of gradually increasing its temperature. Collisions between the metallic fragments at the time of the rapid evaporation/explosion may account for the "rattle" heard.

The energetic charged particles produced by annihilation of baryons with antibaryons not only are causing excitation but they can also ionize the air molecules. It is not surprising therefore, why electrical devices are automatically starting working, in the presence of a ball lightning. Ionization of air molecules between the terminals of a switch can close its circuit and turn on any connected to the switch electrical and/or electronic device. For the same reason, it is not strange for lamps to turn into lit, while their connection switch is turned off.

## Discussion

The above study, not only explains the ball lightning phenomenon of Smethwick, under the antimatter hypothesis, but also it is establishing the existence of antimatter in our vicinity and consequently in the entire Universe. These major problems of Cosmology, together with the most mysterious atmospheric phenomenon of ball lightning, are therefore solved with the help of a wedding ring on a woman's finger, who happened to be in the wrong place at the wrong time.

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