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Research Article

Tracks of Ball Lightning in Apparatus?

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Abstract

Researchers of electrical discharge and electrolysis experiments have been finding microscopic markings that are unusual and anomalous. It is possible that these markings are made by microscopic objects that are in the size range of 400–0.1 Åm. These objects may be a type of microscopic ball lightning. They may share the anomalous characteristics of natural ball lightning. They are also finding highly anomalous material activity and emissions. Pictures of the markings and anomalous effects that were taken by six groups of researchers are shown and interpreted in this article.

Keywords: Ball lightning, Plasmoids, Transmutation experiments, Microscopic ball lightning

1. Introduction

It is possible that microscopic ball lightning may leave microscopic markings and residual effects similar to those caused by natural ball lightning, tornadoes and experimentally produced plasmoids. Since 1992, Matsumoto, Dash et al., Shoulders, Lewis, Savvatimova, Urutskoev et al., Ivoilov and other groups have published pictures of microscopic ball lightning markings and effects, and the photographs show patterns of behavior that are identified and interpreted in this article. These effects can be classified as (1) the effect of ball lightning motion by moving or changing material: bore holes, scratches and trenches, and pits, (2) ball lightning radiation and emission effects, (3) residual markings such as trails and rings and residues, (4) areas of atomic motion such as heatless motion, sloshing, change of crystalline structure, phase transitions, the disappearance of atoms, crystals, dendrites and filaments, and (5) possible transmutation and isotopic residues.

It is possible that microscopic ball lightning exists. There is no reason, a priori, why this should not be so. First of all—the structure and composition of reported ball lighting in nature is not well understood. There seem to be various kinds. In prior articles, I have described how *macroscopic* ball lightning in nature vary greatly in size from centimeter to kilometer size (i.e. [1]). There is no reason why they might not also be micrometer size or smaller. The behavior of these objects, as evidenced by their tracks and effects, is like that of ball lightning, as explained in other articles [2–4], especially in how they bore and pass through materials like water, air, electrolysis cell walls, and paper (as Urutskoev

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reports [5]), and travel comparatively long distances in air before leaving interesting tracks in emulsions. Some ball lightning have been reported to pass through glass by making a hole in it, and some to pass though glass without making a hole in it. I have written about microscopic ball lightning now for 15 years [3, 4], and have been suggesting that people put detectors such as emulsions and CR-39 inside and outside their experiments. Urutskoev's report and some other evidence suggest that the "strange" objects are emitted even after the reactor parts are taken out and put in a Petri dish [5].

Also, there is some evidence of very unusual deposits left by BL. These deposits were possibly due to transmutation. Savvatimova has written that there is a correlation between number of markings found and the extent of transmutation in a given experiment. Matsumoto, Shoulders and Savvatimova have all written that the strange markings—the pits, tunnels, trenches and tracks—are locations of transmutation products.

Experimental researchers have produced interesting and beautiful pictures of microscopic ball lightning (MBL) and their effects that require explanation. People have experienced the anomalous behavior of natural BL and experimentally produced plasmoids, but a theory was lacking. One of the basic ideas presented in this article is that atoms may enter a state in which they behave anomalously. In 1991, Matsumoto published an article on elemental transmutation in which he showed microscopic voids with transmuted elements [6]. He published pictures of the anomalous microscopic markings left on electrodes and witness sheets (nuclear emulsions used for particle detection) during his electrolysis and discharge experiments. I hypothesized that microscopic BL were being formed at the site of the voids or that BL were causing the voids [3, 4]. After he received my correspondence, he started investigating microscopic ball lightning and published pictures of tracks of what I suspect are MBL. The many kinds of markings he and others have found are evidence the hypothesis is a valid one, since the markings show that the microscopic objects behave like natural ball lightning.

There is a state of existence of substance and space like that of natural BL. Objects in this state behave in ways that are anomalous to generally accepted theory. These objects may travel through materials, move anomalously such as in sharp angles without acceleration, move at low energies or low heat, transmute, combine to form bigger plasmoids, divide, emit plasmoids and beams, convert to energy, exhibit superconductivity and form interesting structures. These behaviors can be classified in the five categories of possible BL behavior explained in this article. Many of these behaviors are evidenced in the photographs shown here by the various researchers. These objects have been researched for decades, but only recently have the more anomalous BL-like behaviors been clear and a full theory is still lacking. These objects have been called by various names including EVs and charged clusters by Shoulders, EB filaments and plasmoids by Bostick and other researchers, ectons by Mesyats and other researchers, micro-ball lightning by Matsumoto, and microscopic ball lightning or tiny ball lightning by me.

The evidence is that these MBLs behave like the larger natural ones. Maybe BL smaller than a millimeter were not reported because they are difficult to see and people mistake the objects for something else. When I was a small kid, I may have seen BLs about 1 mm in size that I made by breaking a rock with a hammer, but I called them sparks. If I remember correctly, they changed colors, gave off a high-pitched sound, and one of them circled me and hit me on the wrist causing pain for a second, but left no mark. About 12 years ago, Matsumoto reported the microscopic markings left by natural MBL generated during the Matsumae earthquake in Hokkaido where he lives [7]. He was using special Acrylite plastic sheets called nuclear emulsions for artificial MBL experiments. One of the microscopic markings that he found on these sheets after the earthquake remind me of a hole left by a whirlwind type effect because there was a cone of material left intact inside a ring shaped pit and there was evidence of whirling behavior in the mark.

2. Five Classifications for Traces of BL

2.1. Class 1. The Effect of BL Motion by Removing Material: Bore Holes, Trenches and Scratches and Pits

BLs move though materials either by boring or without boring. One of the anomalous behaviors of natural BL is making holes in glass windows and in walls [8]. BL, tornadoes [1], and whirlwinds may move loose materials and pick up leaves, dirt, rocks and other objects. They sometimes leave trenches or grooves in the ground or on materials. The transported

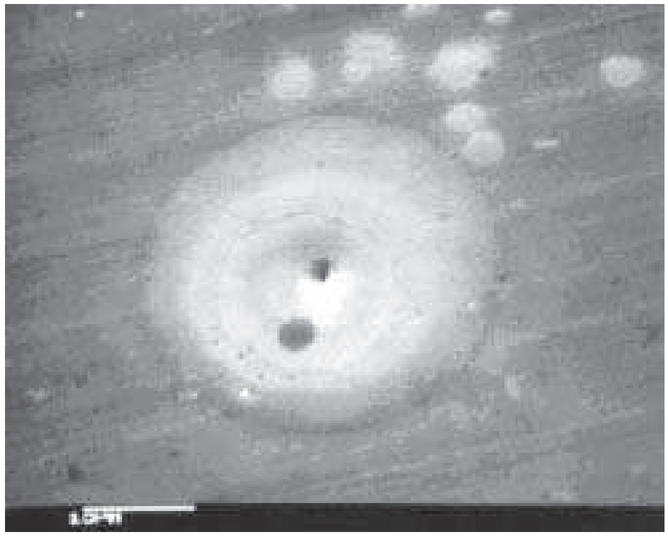

Figure 1. Entry pit of EV into aluminum sheet.

materials may revolve around these objects or may simply be moved by them. These behaviors are discussed in prior articles. Sometimes, BLs pass through glass windows without visible effect to the glass. The manner of passage of BL through material may depend on the properties of the material. For example, some windows were made with lead [9].

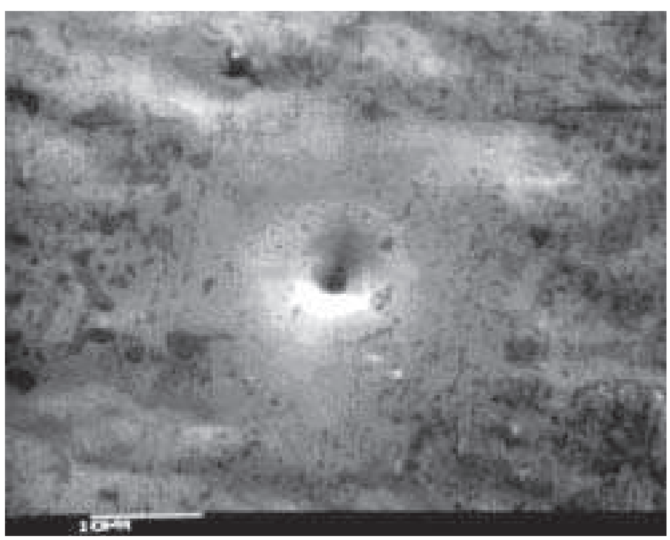

Figure 2. Opposite exit pit of EV from the sheet.

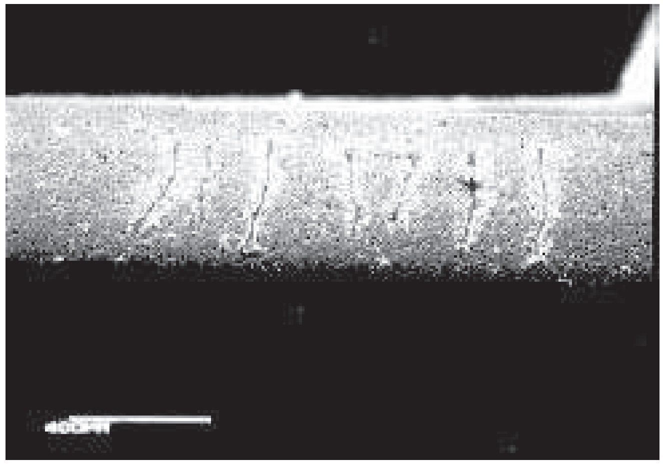

Figure 3. The scale is 400 μm.

Some of the microscopic objects Matsumoto produced experimentally may have passed though glass and plastic sheets without leaving an apparent hole before they left markings on his acrylite plastic nuclear emulsions.

Figures 1–3 show typical tunnel-like borings [10]. In Figs 1 and 2, the holes are in aluminum foil that is 6 μm thick, and are the entry and exit holes of a BL-like object. The pit in Fig. 1 is about 2 μm wide, and the one in Fig. 2 is about 3 μm wide. Perhaps the object grew as it passed through, which is a typical BL behavior. Figure 3 shows a cross section that shows EV boreholes through a 0.5 mm thick aluminum oxide plate. The aluminum oxide has a melting point of 2050°C. This shows some of the power of these little objects to make holes.

Natural BL is often seen paired or in chains or rings of individual BLs. For example, someone reported a train of 25–30 blue globes the size of bowling balls roll rapidly down a mountain path during a thunderstorm [11]. This alignment is evident in Fig. 3. Roberto Giudici [12] took a picture of a four waterspouts that were in aligned in a straight row and look to be equally spaced on August 1999 near Albania in the Adriatic Sea. Prior articles will explain that I identify BL and tornadoes as types of the same general kind of plasmoid [1, 13]. BL often forms geometrical figures, and there are many reports of BL type objects moving in formation, splitting off or separating, and coming back

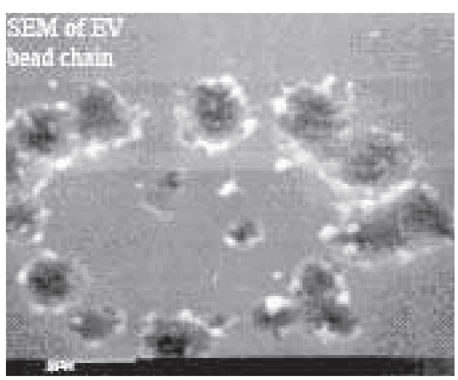

Figure 4. The scale is 25 μm.

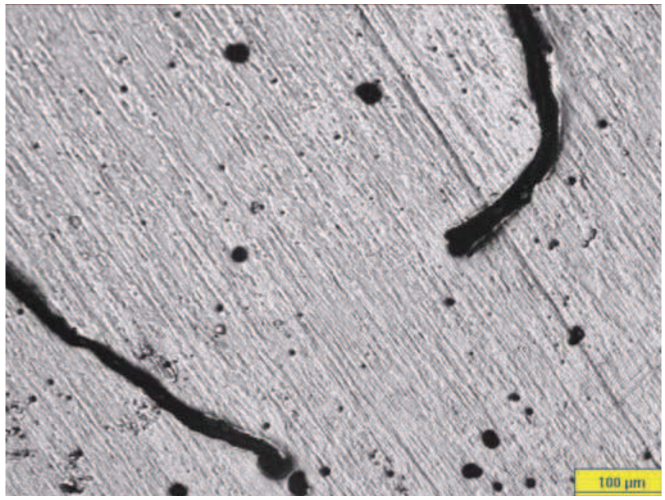

Figure 5. Scale here is 100 μm. Trenches in Palladium. About 50 μm Wide. Many Pits Also.

together again. BL acting in this way have been called UFOs. They exhibit spatial organization [14], and often mimic each other over long distances. Possibly this is why some tracks shown by researchers like Matsumoto and Ivoilov show mimicing motion of MBL. Perhaps atoms in a BL state would also exhibit such behavior, forming geometrical structures and showing organization and mimicing behavior. More about this is described later in the Class 4 section of this article.

Figure 4 [15] is a typical BL ring mark of pits arranged in a circle. Ball lightning often travel in ring formations,

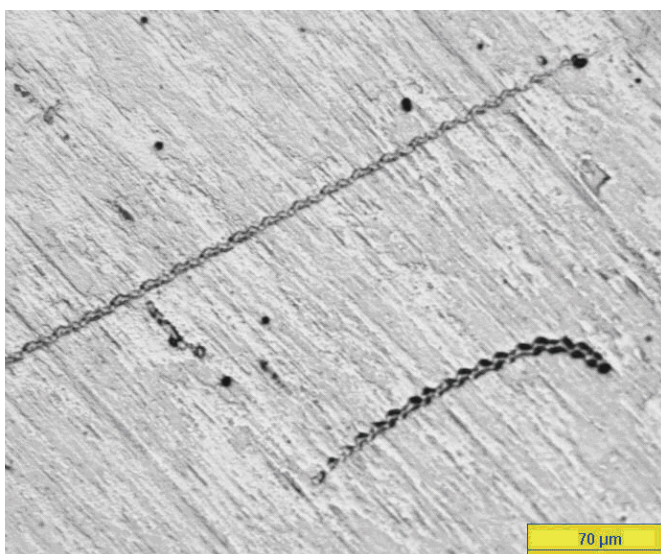

Figure 6. Scale here is 70 μm.

and when they contact material they may leave pits. Sometimes BL and tornadoes will leave a trench in the ground as they move. Here is one example. I have read several reports similar to this:

"A tornado or an accompanying fireball dug a trench in a hard-packed clay tennis court at Curepipe, Maritius, in the Indian Ocean, on May 24, 1948: A trench running in a north-south direction, 60 feet long and 1–2.5 feet wide, was cut in the bare surface of the court to a depth varying from 1 to 4 in. The material lifted from the trench was all thrown to the west to a distance of 50 feet; pieces weighing about one pound were thrown as far as 30 feet. The surface material was slightly blackened as if by heating, and a crackling that of a sugar-cane fire was heard for 2 or 3 min. One claims to have seen a ball of fire about two feet in diameter which crossed from a football pitch to the tennis court through a wire-netting fence without leaving any evidence of it passage [16]".

Maybe the trench-like markings in the next several pictures were caused by a similar effect. People may find ball lightning deposits like that described in the quotation just above. In Fig. 5, Savvatimova found these trench-like marks and pits in the surface of palladium used in a glow-discharge experiment [17] that are due to the movement of BL over the surface. Some tornadoes and BL were reported to hop up and down making holes, and as was explained previously [18] some of the markings shown by Matsumoto show the same effect of hopping. See for example, the picture by Matsumoto in this article.

Figure 6 was also taken by Savvatimova and shows two BL trail-like markings in palladium [17]. The top linear mark may show that a BL entered the pit or made the pit, since the track ends at the pit. Notice the short, thin, shallow trench mark below the long one that crosses the picture. Tracks like that one remind me of marks in the 1993 article by Silver et al. [19] and in components of one of Miley's experiments [20,21]. There was a pit in a titanium electrode in that experiment with marks that appeared sort of like rings and shallow grooves in the picture I took (see Fig. 4 of ref. [18]; the picture did not print as clear as the original). Many of the pictures taken during this decade by Urutskoev and Savvatimova show a pattern of repeating patterns in a line, like these long ones and like others discussed below. In this article and in other articles, I speculate about the cause for the various markings. But the idea of revolving MBL as an explanation for spiral marks such as those in Figs. 11 and 14 in this article might be a good idea.

Figure 7 taken by Savvatimova may show that a BL made pits in palladium [17] as it traveled in a fairly straight line. The pits may be connected by a shallow and narrow trench mark. There are other such marks. It seems less likely to me that a string of MBL left the string of pits. Brush discharge markings connected plasmoid pits and rings in a picture shown by Nardi et al. [22] that are similar to some of the others shown in this article, but the thin lines between the pits in the above figure do not look like brush discharges.

Figures 8 and 9 show ring marks on the microspheres from an experiment by Miley et al. [20] taken by me [21]. As explained previously [18], this cell registered the highest recorded energy output of various microsphere runs. Compare these three rings to the one by Shoulders in Fig. 4. Figure 8 shows two rings of pits in the metal coating of the microsphere [20, 21]. Also Fig. 9 shows a faint white ring in the plastic substrate of a microsphere [20, 21]. This copy of the photograph is not as clear as the original.

Figure 10 was an optical photograph taken by Shoulders [15] of a revolving pair of EVs loosening up. In nature, two or more BLs and tornadoes often revolve. Shoulders used a special form of particle sensitive camera. The photograph is included to compare it with the marking on the electrode shown in Fig. 11 and the trace on X-ray film shown in Fig. 14a. The evidence is that the plasmoids he has researched are individual objects that form larger structures such as pairs, rings and strings.

Figure 11 was taken by Savvatimova and shows the mark of a BL or maybe a pair of them [17] which left a dark mark on the surface of the palladium used by Savvatimova. I am speculating that the mark was made by a revolving MBL or a couple of MBLs that were revolving.

Could the trenches, tunnels, ring marks, pits and other markings be made by a beam of some type and not by individual objects? People have reported that beams are associated with low energy transmutation, but the evidence is that the markings discussed in these pictures were not made by beams, but by individual objects. Ken Shoulders

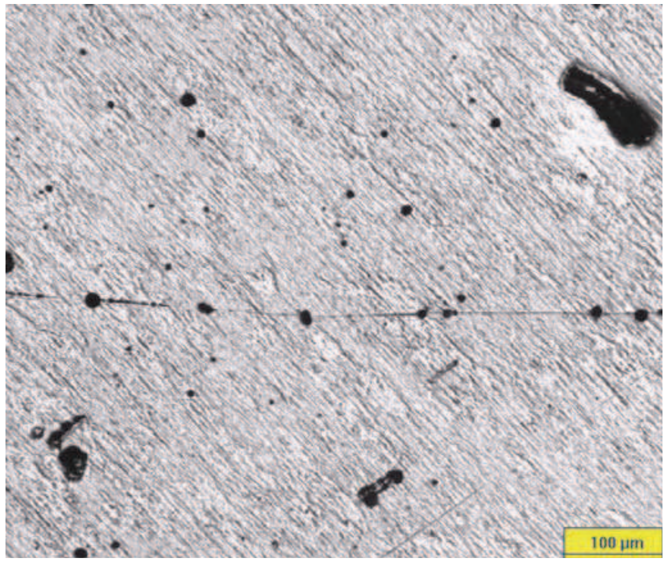

Figure 7. Scale is 100 μm. Maybe an MBL hopped or skimmed along and made this line of pits. Perhaps this was caused by a chain of MBLs.

told me that EB-filaments studied by Bostick, Nardi, and other researchers were found later to be individual objects traveling very fast when a very fast camera was used [23]. K. Shoulders has recently written that Winston Bostick came to recognize that the plasmoids he studied, also called EB-filaments, were composed of the EVs. For example, Shoulders wrote: "…Winston did his work, he did not know that EVs were the main component of his plasmoids. Years later, when I employed him as a consultant on EV technology, he came to see the effect and love it. [24]".

Figure 8. Two rings of pits in thin film of Ni on a plastic microsphere. The microsphere was in Miley's Ni on plastic run No. 8 experiment.

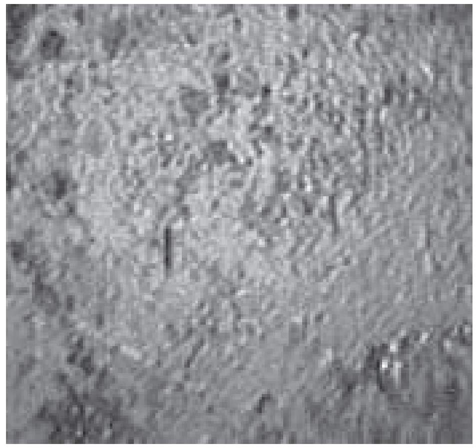

Figure 9. Faint ring in plastic microsphere. There are light colored pits in a ring just above the black line I drew.

Maybe the pictures here show two ways that MBL leave holes. One way is by boring, and the other is by drilling without passing through, like a tornado. As an example of the second way a BL makes holes, Egon Bach reported that two large BL-like objects drilled holes in the ground in the Soviet Union [25]. A slightly flattened glowing ball about 400 m in diameter hung for an hour low over the ground over the same spot—only 1 km from seven observers. Afterward, they found a huge hole that they thought the object had probably dug. No trace of the excavated material could be found. Another group of seven men saw a similar, smaller red object about 3 km away from the first. Professor Zolotov was asked to study the holes. One of the strange holes was three to 4 feet wide but 30–40 feet deep. It widened to 8 feet in diameter at the bottom. The walls were covered with a layer of carbon dust about 0.2 mm thick. The carbon fiber had a radiation three times above normal [25].

Figure 10. Optical picture of revolving EVs. Taken with a special camera. From Shoulder's article. See how similar this looks to Figs. 11 and 14.

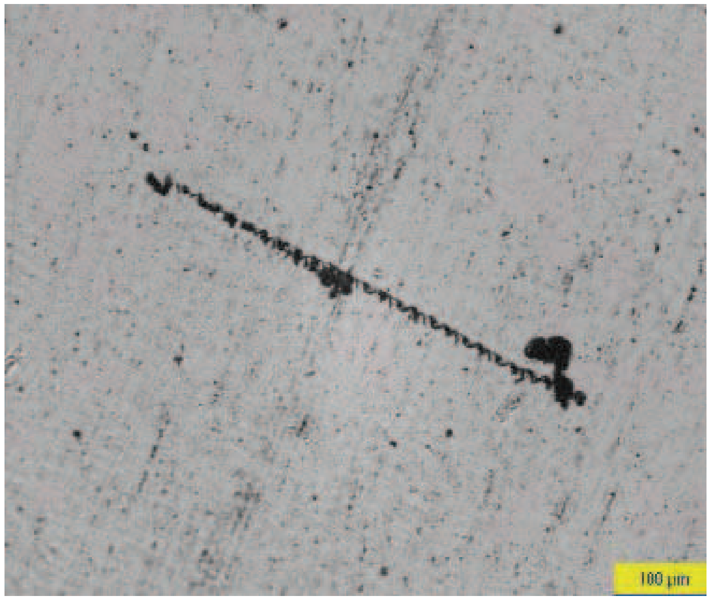

Figure 11. Marking in Palladium by Savvatimova.

The carbon dust is an example of residues left by BL as discussed in the section for Classification 3. Carbon residues have been reported by Matsumoto and Savvatimova and some other CF researchers.

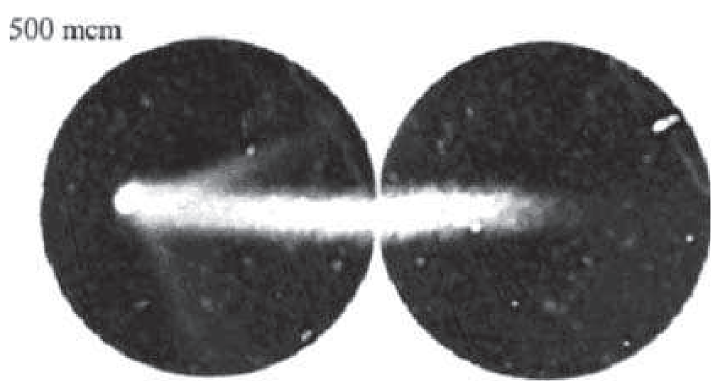

Figure 12. Comet-like marking with rays. Photograph by Urutskoev et al.

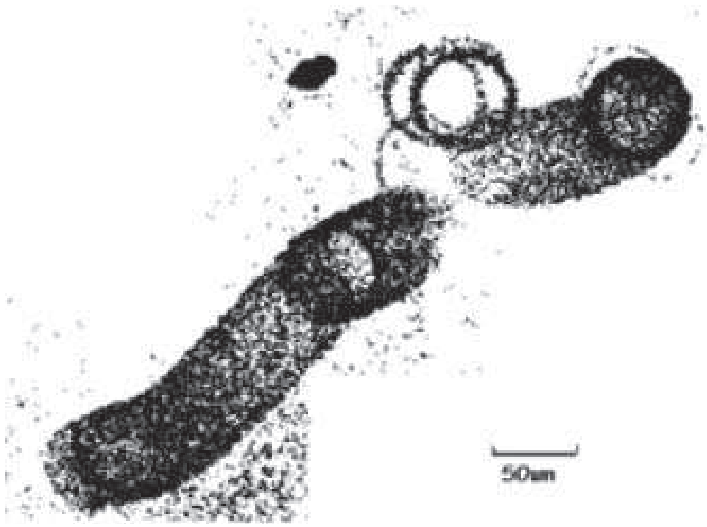

Figure 13. Ring marks + trail marks on nuclear emulsion.

2.2. Class 2. Ball Lightning Radiation and Emission Effects

These objects emit particles, beams, sound, light, electrical discharges, and plasmoids of various kinds. Most BL photographs are not actually a photograph of the object itself, but of the streak of light caught by the camera as it

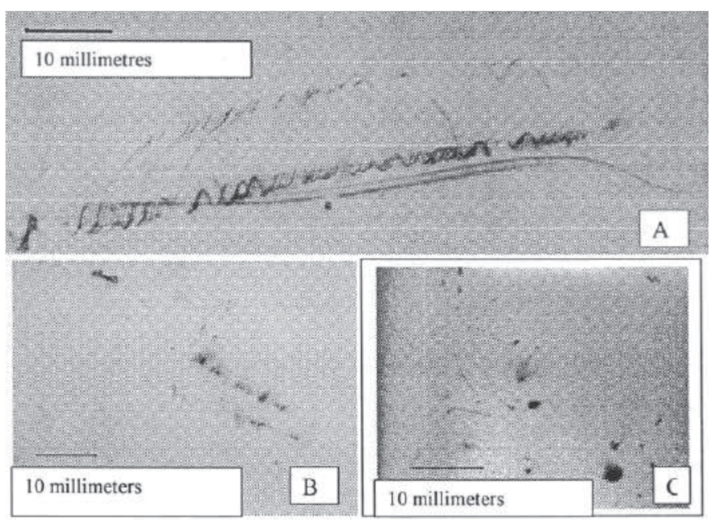

Figure 14. Markings on X-ray films set outside (A,B) and inside (C) vacuum chamber. Deuterium irradiation in glow discharge. The mark in A may record a spiral motion of an MBL or a revolution of two MBLs. The ones in B look like the ones Matsumoto called interference patterns. The ones in C look like ones Matsumoto photographed as well.

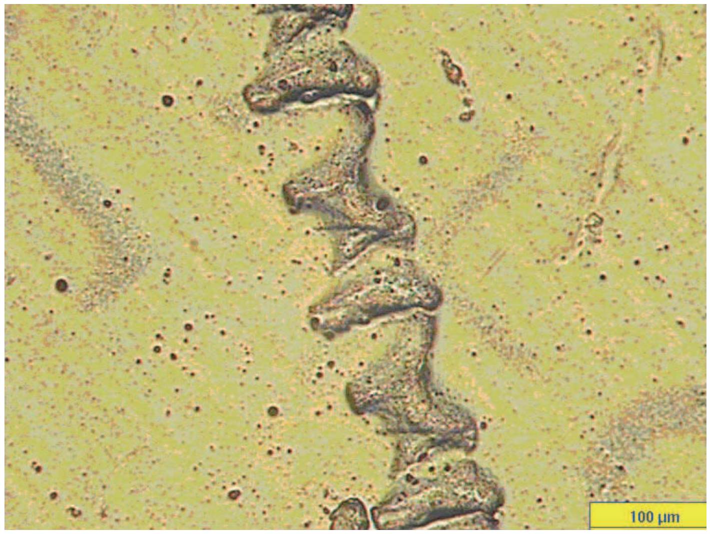

Figure 15. Residual trail mark on emulsion. It is about 100 μm wide. Urutskoev and Savvatimova have called patterns like these "tire-track" markings. At lower magnifications, they look like dark lines The scale is about 100 μm.

moved, like the optical photograph by Shoulders shown in this article. According to Feugeas, the EB-filaments that he studied with Nardi and Bostick traveled at a speed of .76 of the speed of light [26]. People photographing fast moving plasmoids may have thought that they photographed a beam or a current. I suspect that the dark path in Fig. 11 is a streak of the light emitted from the plasmoid moving over the surface.

These objects emit neutrons and other particles. Nardi et al. [22] reported that their plasma focus discharge device containing deuterium oxide produced neutrons. Lightning is known to produce neutrons [27], and Dijkhuis and Pijpelink [28] reported neutrons during their experimental study. One trace shown by Matsumoto in his articles which he called a "superstar trace" (Fig. 8 in [29]) showed some types of particles or small plasmoid emission from a larger BL-like object that moved on the plastic sheet. A similar track without marks of emissions is shown in Fig. 3e of Ref. [30]. BL and MBL discharge electricity. Some of Matsumoto's and Urutskoev's markings show the emission of beams or rays of some type. For example, Fig. 2b of Matsumoto's article [30] shows a mark like a discharge from the object. The emission of beams, rays or sparks of some type are commonly reported about BL [11].

Figure 12 taken by Urutskoev shows emission from the MBL that made the trace registered on a nuclear photoemulsion [31]. I am assuming that the long streak is a MBL track made by the light emitted from MBL. One can see that there was emission of rays or flares from the MBL. He wrote: "Six such 'comets' were detected inside the area 4 cm^2. Their sizes varied from 300 to 1300 mcm" [31]. They look like markings Matsumoto called traces of "white holes" in his article in *Fusion Technology* [30]. Urutskoev wrote that these markings evidence very high energy. However, they also traveled a long distance through air, and through black paper and the container of this experiment. Ball lightning acts like this.

2.3. Class 3. Residual Markings Such as Trails and Rings and Residues

Unlike a trench or pit marking due to the removal of material, this type of marking may be the deposition of a residue of some type or a chemical change that colors materials.

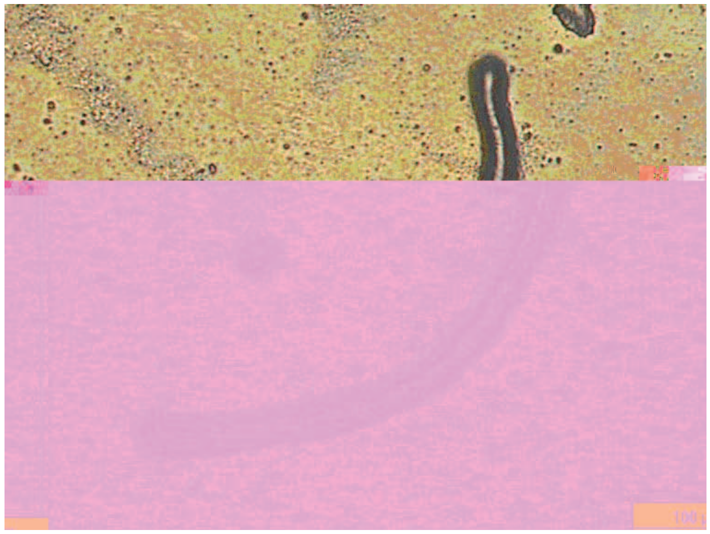

Figure 16. A trail marking on nuclear emulsion. From deuterium glow discharge experiment with W–W cathodes. The scale is 100 μm.

Figure 13 [32] is like another Matsumoto has shown on acrylite plastic nuclear emulsions showing both ring and trail marks as if MBL translated and hopped on a nuclear emulsion in a tornado-like manner. In this picture, one MBL may have been responsible for all the marks [1, 13].

Figure 14 shows markings on X-ray film outside (A, B) and inside the vacuum chamber after deuteron irradiation in glow discharge [33]. Figure 14a may show the trace of a MBL moving in a spiral motion or of two MBLs revolving. The blots in Fig. 14c look like the round dark spots on emulsions shown by Matsumoto [30] and may be like the round spots shown by Urutskoev in Fig. 16c of his article [31]. The spiral in Fig. 14a opens from right to left, and looks similar to Shoulder's photograph in Fig. 10.

Figure 15 is by Savvatimova of a marking on nuclear emulsion placed around a glow discharge chamber [17]. She found many such markings on emulsion set both inside and outside the chamber. It is about 100 μm wide. The fainter light colored marking to the right which is about 15 μm wide, seems more similar to the clear long track markings on nuclear emulsions which Matsumoto called "loop-like [29]" traces (group 6 of Ref. [29]), which I thought were due to either some type of sloshing or shallow indentation of MBLs moving in contact with the emulsions. Urutskoev [31], Ivoilov [34], and Savvatimova have published these kinds of patterned tracks. This one looks like deposits or segmented areas of a change of the chemical composition of the emulsions. One MBL may leave different kinds of markings as it travels along. For example, one may make a continual line track and then make this kind of track. See for example, Fig. 18.

Figure 16 is a marking on nuclear emulsion [17]. This may be a record of the radiation that the MBL was emitting. It looks like a marking shown by Matsumoto in Fig. 3c,d of Ref. [30] that seems to show two objects that mimicked each other moving in opposite directions on an emulsion. Figure 3c has a light colored boundary and Fig. 3d has a dark boundary. These two figures are simply different focusing of the microscope on the same track. But the track in Fig. 3d of that article by Matsumoto looks much like this Fig. 16. I am wondering if this may be the reason for the thick, dark border in Fig. 16.

One of the anomalous behaviors reported about some BL and UFO objects is sharp angled turns without any

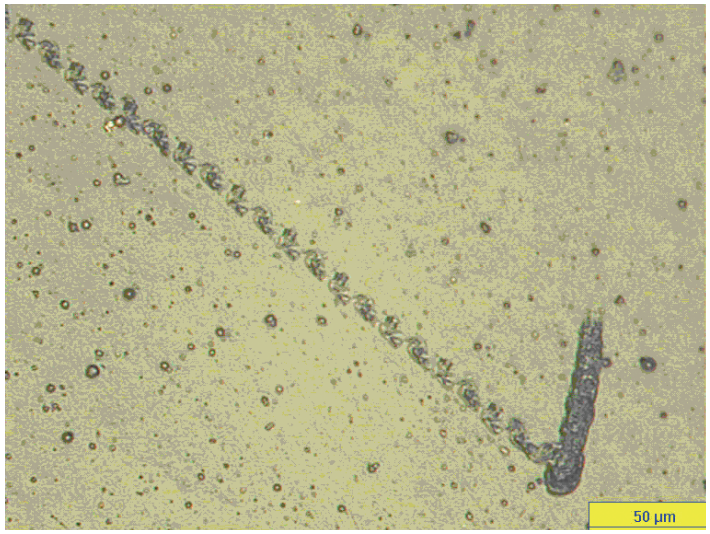

Figure 17. Sharp angle turn track on X-ray film.

deceleration. This unusual movement probably attracts the attention of observers, and is why people called them UFOs. Planes do not move in this way. Another anomalous behavior of MBL is that groups of them may mimic each other's motions, and they may divide, move in patterns, and come back together again. Sometimes they are

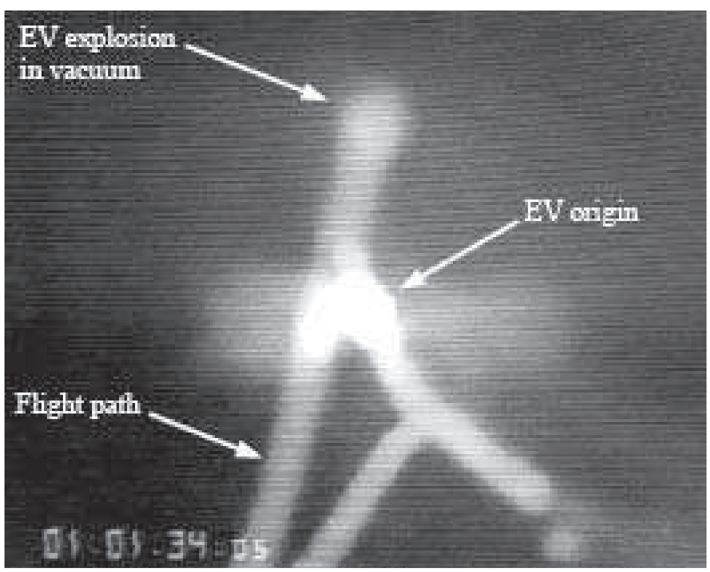

Figure 18. EV picture showing sharp angle turn. The sharp turns are on the right side of the picture.

reported to repeat a pattern of motion several times. Ivoilov has photographed tracks showing mimicing, sharp angled movement of microscopic objects [34]. The tracks may evidence angular motion without acceleration or curvature. This is characteristic of MBL (see Figs. 17 and 18).

In Fig. 17, a sharp angle of turn of MBL may be recorded in emulsion [17]. The track appears to be a chemical change or a deposit on the emulsion. From the looks of it, a MBL moved downwards leaving the thick stroke, backtracked slightly and then made the segmented track. The last position of the object on the thicker streak was at the intersection with the segmented track. I am speculating that some type of revolving or rotating motion may be involved. The object might have been round because a round mark is evident at the point of intersection.

Figure 18 is a photograph showing a sharp angle turn by Shoulders [15]. As he explained, it is evident that there was no acceleration at the turns because the path shows the same brightness throughout. It is interesting that this photograph may also show that the object backtracked, as an MBL may have done on the emulsion shown in Fig. 17.

2.4. Class 4. Areas of Atomic Motion such as Heatless Motion, Sloshing, Change of Crystalline Structure, Phase Transitions, the Disappearance of Atoms, Crystals, Dendrites and Filaments

Two ways atoms may move anomalously are as the result of BL contact or influence and due to stresses. Atoms may move and reorganize in the presence of BL leaving crystals or changing the crystalline structure or phase structure of material. Stressing materials or substances may cause the formation of BL or the emission of plasmoids of various kinds, or cause atoms be in the anomalous state [2, 4, 18] to exhibit qualities such as superconductivity [4, 35], anomalous motion at temperatures below their melting point [4], and change crystalline structure or phase transition [4, 35]. For example, Lipson's early experiments on superconductivity and cold fusion effects showed that when a sample of HTSC $YBaCu_3O_{7-x}$ was heated [4, 36], starting from 77^o, there was definite neutron emission accompanying the loss of superconductivity and the phase transition to a non-superconducting state. Zhukov and Egorov have written that researchers who study the behavior of electrodes during electrical discharge know that "intense electric fields acting on the emitting surface cause a thin layer with liquid-like properties to form at temperatures below the melting point" [37]. The rings in the layer they photographed reminded me of sunspots.

Figure 19 was taken by Dash and shows pictures of a Ti cathode before and after electrolysis and of a magnified scratch mark showing some sloshing on the side [38]. As another example of anomalous "melting" behavior, atomic motion without heat, Benjamin Franklin researched the phenomenon of lightning striking metals inside insulating material such as clothing and seemingly merging together as if by melting without scorching the material [4, 18]. He called this strange effect "cold fusion." I think that this anomalous state of atoms exemplified by behavior like this is part of the key to understanding cold fusion. CF phenomena, and I suspect superconductivity [4] and many other anomalous behaviors, occur when atoms are in this state. Researchers such as Dash have noted the anomalous appearance of crystals, areas of apparent melting, and metal deformation during electrolysis. Based on the observations of researchers, it is known that even after an experiment is finished, there is continued transmutation, change of metal morphology, growth of filaments and strange structures [38], radiation, and emission of microscopic objects that act like ball lightning [5]. This is evidence of a previously unknown state of substance [4, 18].

Figures 20 and 21 show filaments that grew on electrodes used by Dash [38]. According to Dash [39], Mizuno found similar growths. In Fig. 21, if you look closely, you will see that the particular fiber they analyzed looked different over time. The fibers in Fig. 21 are particularly anomalous because they grew and changed after the experiment was long over.

As explained previously, it is hypothesized that there exists a state of substance which exhibits anomalous properties [2, 4, 18, 35]. Atoms in this state may tend to organize in geometric patterns. As shown by the mimicing tracks in Iviolov's ICCF11 presentation [34], Fig. 3c,d of Ref. [30] by Matsumoto, and Shoulders' research, plasmoids have a tendency to mimic each other even over relatively long distances when they are in a group. BL mimic each other in

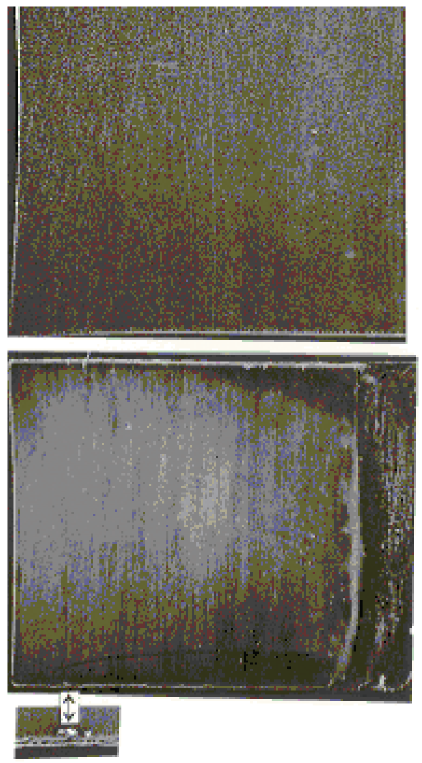

Figure 19. Trench on Ti cathode with sloshing on the sides.

this way in a group. This is how they form groups.

2.5. Class 5. Possible Transmutation and Isotopic Residues

The various researchers report a relationship between the emission of anomalous microscopic objects and transmutation and isotopic changes. These microscopic objects may possibly be microscopic ball lightning. Matsumoto's transmutation experiments show this correlation, and Savvatimova wrote, "There are more tracks for experiments with increasing new elements on the cathode surface [33]." In Ref. [10], Shoulders wrote that the only places on their deuterium loaded Pd that exhibited elemental changes were those places struck by the EVs [10]. There have been reports of residues left by UFOs that were highly unusual in that there were radioactive isotopes and rare and very heavy elements and other unusual materials. I speculate that these were simply large BLs. More evidence of this possible connection between MBL and transmutation is that the microsphere cell Run No. 8 in Miley's lab has many markings [18, 21].

3. Conclusion

It is possible that microscopic sized ball lightning exists, because there is not reason, a priori, that they should not. Anecdotal reports of things that may be called ball lightning in nature describe effects and behavior that are highly unusual, but similar to that of cold fusion. These reported behaviors including luminosity, explosions, emissions of

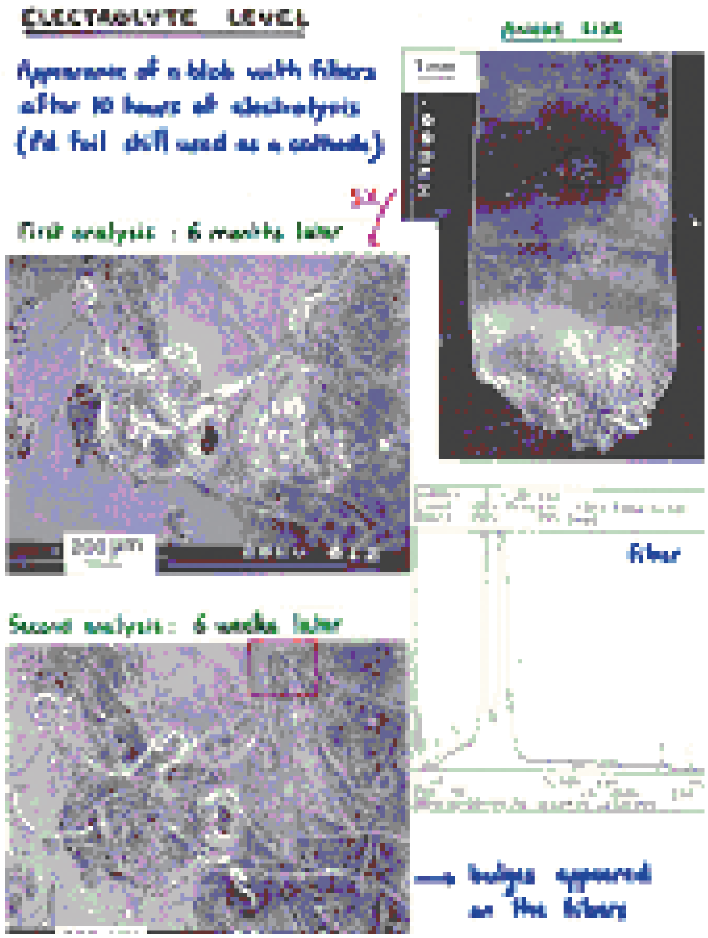

Figure 20. Fibers that grew during electrolysis.

beams and sparks, high radiation, leaving strange residues, leaving heavy or rare elements, passing through glass without leaving holes, passing through materials by boring holes, leaving pits and trenches, moving material, moving in geometrical patterns, dividing and coming together again, and forming groups of rings, lines, or equilateral figures like triangles or parallelograms [14] are all exhibited by the microscopic objects emitted from transmutation experiments. This is evidence for the possible existence of ball lighting that are extremely small and of their possible role in transmutation experiments. Ivoilov showed tracks that evidence complicated mimicing motion of these objects over long distances and of sharp angled turns without acceleration. Perhaps this kind of motion is analogous to known natural BL behavior. Shoulders showed that experimental plasmoids evidence sharp turns without acceleration. Similar tracks have now been observed by about seven groups of researchers.

Based on the report by Pryakhin et al. [40] and other reasons, I would like to warn people investigating transmutation and MBLs that the microscopic emissions may be hazardous. They ran a preliminary study on mice next to Urutskoev's

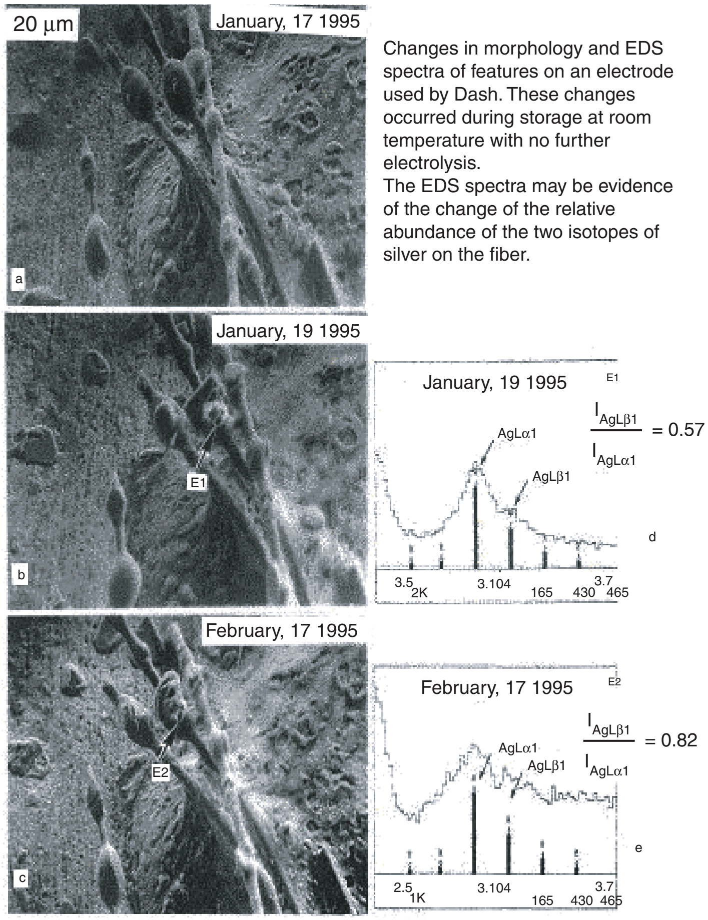

Figure 21. Fibers that grew on the electrode after an electrolysis experiment during 1 month with EDS charts.

experiments producing the "strange radiation" as they call it, and found that the mice were affected after only a few days. Ball lightnings have killed and injured people.

It is hypothesized that atoms enter an anomalous state in contact with MBL [4, 18] or when subjected to stresses. Atoms may remain in this state long after the cause is gone. It is this state that may explain the reports of anomalous behavior of atoms after the end of experiments, and during experiments. This article was written to summarize some evidence for microscopic BL, to explain evidence relating MBL to plasmoids produced experimentally by researchers like Shoulders and Bostick, to summarize the recent (post 2000) experimental evidence and relate the work to earlier results, and to attempt to explain the kinds of MBL effects people have been discovering experimentally.

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I would like to thank Savvatimova, Shoulders, Matsumoto, Dash, and Urutskoev for permission to use the pictures. Two photographs were taken by E. Lewis of various components of Ni-Plastic Run No. 8 in the laboratory of Professor Miley at the University of Illinois in 1996. His cooperation in allowing this work is gratefully acknowledged. This is a very modified version of a paper that was published previously: Lewis, Traces of ball lightnings in apparatus, in: *Proceedings Second International Symposium on Unconventional Plasmas, ISUP-06, Eindhoven, The Netherland, August 14–16, 2006.* Editors D.K. Callebaut, G. C. Dijkhuis and H. Kikuchi [2].

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Research Article

Dynamic Mechanism of TSC Condensation Motion

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Abstract

This paper discusses and explains the time-dependent quantum-mechanical behavior of electron-clouds in 4D/TSC (tetrahedral symmetric condensate) condensation motion by the Langevin equation, in comparison with steady ground state electron orbits and their de Broglie wave lengths for the D-atom and D_2 molecule. An electron orbit in a "d–e–d–e" quasi-molecular system of a face of 4D/TSC under time-dependent condensation makes a spiral track, finally reaching the center-of-mass point of the TSC, with a tail of time-varying effective wave length. The role and merit of the heavy mass electronic quasi-particle expansion theory (HMEQPET) method for approximating time-dependent TSC trapping potential and relating it to the estimation of time-dependent Coulomb barrier penetration probabilities of a 4D cluster is explained.

Keywords: Tetrahedral symmetric condensate, 4D cluster, condensation motion, Langevin equation, Time-dependent trapping potential, Barrier penetration, Fusion rate

1. Introduction

The formation of 4D/TSC (tetrahedral symmetric condensate) at or around a T-site of a regular PdD lattice under D-phonon excitation; or on the topological (fractal) nano-scale surface of PdD*x*; and/or along the interface of metal–oxide–metal nano-composite, has been proposed as the seed of deuteron-cluster fusion, which produces heat with helium-4 as 4D fusion ash [1]. The dynamic motion of TSC condensation was quantitatively studied by the quantum-mechanical stochastic differential equation (Langevin equation) for many-body cluster systems of deuterons and electrons under Platonic symmetry [2–6].

By the ensemble averaging of the Langevin equation with the weight of quantum mechanical wave-functions for electrons and deuterons, we could further derive a time-dependent one-dimensional Langevin equation for expectation value $\langle R_{dd} \rangle$, which is nonlinear, but could be solved by the Verlet's time-step method [2,3]. We showed in our previous work [4] that only 4D(or H)/TSC, among D_2, D_2^+, D_3^+, 4D/TSC and $6D^{2-}$/OSC clusters, can condense ultimately to form a very small charge-neutral entity, with a radius of about 10–20 fm. At the final stage of 4D/TSC condensation in about 2×10^{-20} s, 4D fusion with two ^{4}He products takes place with almost 100% probability, according to our heavy

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mass electronic quasi-particle expansion theory (HMEQPET) calculation [3,4] for barrier factors and the fusion rate formula by Fermi's first golden rule.

This paper presents further discussions and explanations of the time-dependent quantum-mechanical behavior of electron clouds in 4D/TSC condensation motion, in comparison with steady ground state electron orbits and their de Broglie wave lengths for the D-atom and D_2 molecule. An electron orbit in a "d–e–d–e" quasi-molecular system of a face of 4D/TSC under time-dependent condensation makes a spiral track, finally reaching the center-of-mass point of the TSC, with a tail of time-varying effective wave length. Electron kinetic energy at $t = 0$ is 19 eV, and it continuously increases during the condensation time (1.4007 fs) reaching finally 57.6 keV at $R_{dd} = 25$ fm. The trapping potential depth of TSC was estimated to be -130.4 keV at $R_{dd} = 25$ fm.

The role and merit of the HMEQPET method for approximating time-dependent TSC trapping potential and relating to the estimation of time-dependent Coulomb barrier penetration probabilities of 4D cluster is explained. HMEQPET provides a practical method for calculating time-dependent (hence time-averaged) fusion rate under TSC condensation, based on Fermi's first golden rule.

2. Condensation motion of 4D/TSC by Langevin equation

The basics of methods with Langevin equations for D-cluster dynamics, especially for D-atom, D_2 molecule, D_2^+ ion, D_3^+ ion, in a 4D/TSC (tetrahedral symmetric condensate) and $6D^{2-}$/OSC (octahedral symmetric condensate) are described in our latest paper [4].

First, one-dimensional Langevin equations for D-clusters with the R_{dd} (d–d distance) are formulated under the Platonic symmetry [2] of multi-particle D-cluster systems with deuterons and quantum-mechanical electron centers. Under the orthogonally coupled Platonic symmetry for a Platonic deuteron system and a Platonic electron system, dynamic equations for so-many-body system of deuterons and electrons with metal atoms, a simple one-dimensional Langevin equation for the inter-nuclear d–d distance R_{dd} can be formulated, as we showed in the previous paper [4]. The Langevin equation of electron-cloud-averaged expectation value of d–d distance R_{dd} for D-cluster is given by

$$N_e m_d \frac{d^2 R}{dt^2} = -\frac{k}{R^2} - N_f \frac{\partial V_s}{\partial R} + f(t). \tag{1}$$

This is the basic Langevin equation for a Platonic symmetric D-cluster having N_e d–d edges and N_f faces of "d–d–e" (D_2^+) or "d–e–d–e" (D_2) type. Here, R is the d–d distance and m_d is the deuteron mass, V_s is the d–d pair trapping potential of either "d–e–d–e"-type ($i = 2$) or "d–d–e"-type ($i = 1$) molecule. The first term on the right side in Eq. (1) is the total Coulomb force (converted to one-dimensional variable R) of the D-cluster system, and $f(t)$ is the fluctuation of force for which we introduce a quantum mechanical fluctuation of deuteron positions under condensation motion. The quantum mechanical effect of electron clouds is incorporated with the second term on the right-hand side as "friction" in Langevin equation. Parameters for different D-clusters are given in Table 1.

Table 1. Parameters of D-cluster Langevin equation.

Cluster	N_e (number of d–d edges)	K (total Coulomb force parameter, keV pm)	Type of electron trapping potential on a surface	N_f (number of faces)
D_2	1	0	$i = 2$	1
D_2^+	1	0	$I = 1$	1
D_3^+	3	6.13	$i = 1$	6
4D/TSC	6	11.85	$i = 2$	6
$6D^{2-}$/OSC	12	29.3	$i = 1$	24