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Tracks of strange radiation. Their properties. An attempt at explanation

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Abstract: **A brief description of the detected properties of tracks that occur near installations in which LENR processes occur is given. A hypothesis is presented explaining where the particles that "draw" tracks come from, why the drawings of tracks are unique, why the intensity of the appearance of tracks is not constant. Experiments confirming this hypothesis are described.**

Keywords: **LENR, strange radiation, tracks, drip tracks, microcraters, dust, electric charge, X-ray radiation, AUGER electrons, piezoelectrics**

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CONTENTS

1. INTRODUCTION

The phenomenon called "strange radiation tracks" (SRT) was first described in detail in an article on the effects detected during electric foil explosions [1], although LENR researchers (Low Energy Nuclear Reactions - nuclear reactions at low energies) had observed similar tracks before [2,3,4]. In the study [1], photoemulsions were used as detectors. The traces found were not similar to tracks formed by charged particles of high energy, since, first of all, they were very long (up to several millimeters). The shape of the detected tracks is different: continuous straight or curved tracks, tracks with kinks, tracks with a complex periodically repeating pattern. All tracks are located strictly along the surface. An estimate of the energy release in the tracks gave a value of ~1000 MeV (particles arising in nuclear reactions have an energy of ~ 1 MeV). Note that the effects of strange radiation are not only extended tracks, but also microcraters [5].

LENR reactors of various types (nickel-hydrogen, with incandescent lamps, with electrolysis and plasma electrolysis) were created in the KIT experimental design laboratory in 2015-2022 [6-13]. Some of them worked continuously for a long time (up to 7 months). The duration and stability of the operation of the reactors made it possible to conduct systematic studies of SRT, examining not only the type of specific tracks, but also the speed of their appearance on the surface of the detectors, dependence on distance and dynamics over time.

Initially, detectors used in nuclear physics experiments to register high-energy charged particles were used for the study of SRT: photographic films, X-ray films and nuclear photoemulsions. But it was soon discovered that SRT also appear on smooth surfaces of almost any substance. In addition to photoemulsion detectors, glass, mica, metals, plastics and a number of other materials were tested at KIT research laboratory. Most of the experiments were done using CD and DVD discs (polycarbonate) as detectors. Fresh discs have a very smooth surface without scratches and are easily accessible in large quantities, which makes it possible to increase the statistical reliability of the results obtained. Optical, scanning electron (SEM) and atomic force (AFM) microscopy methods were used to study the shape of the tracks.

This article does not aim at a detailed description of the research methodology and the array of data obtained, as they are set out in publications [14-19]. Here are only the most important results and the main conclusions arising from the various studies conducted. We will systematize the types of tracks, give an analysis of the results obtained, and on the basis of the revealed patterns we will formulate a hypothesis explaining the main experimentally discovered properties of SRT.

2. TACKS TYPES

2.1. Smooth tracks

Smooth tracks (**Fig. 1**) predominate in plastic fusible materials (plastics, gelatin in photoemulsion). Such tracks have the form of grooves with a depth of about 0.1 microns and a width of several microns. On the sides, protrusions are visible with a height approximately equal to the depth of the groove (probably squeezed out material).

2.2. Tracks with a periodically repeating complex pattern

Tracks with a period from 44 to 200 microns were detected. In each track of this type, the pattern is unique (**Fig. 2**). Occur both in plastic materials and moderately hard and heat-resistant (glass, metals). The cross-sectional profile of such tracks has a complex character (**Fig. 3**). Sometimes it is possible to observe the transition of a smooth track into a periodic one (**Fig. 4**).

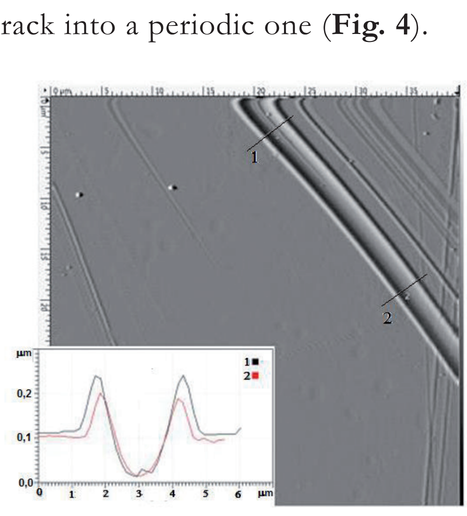


Fig. 1. *"Smooth" tracks on polycarbonate. The image obtained by atomic force (AFM) microscopy* [18,19].

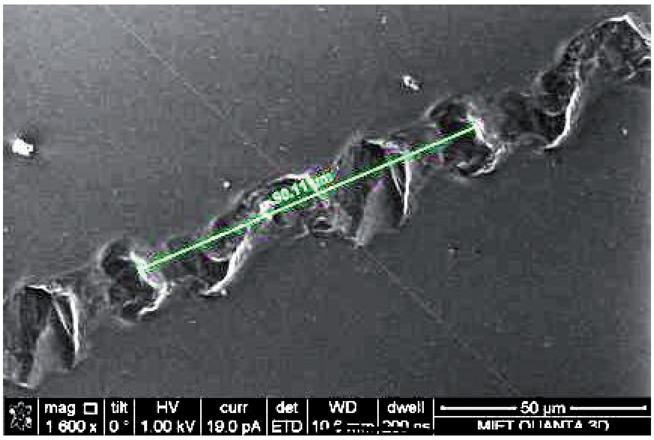


Fig. 2. *Fragment of a typical track with a periodic pattern on the surface of polycarbonate (SEM). The period is about 90 microns* [18,19].

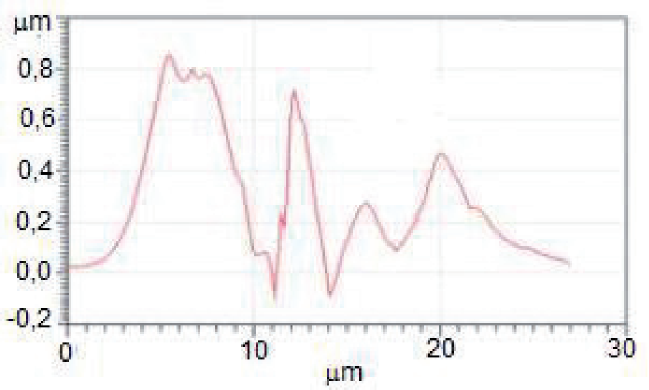


Fig. 3. *Example of AFM profilogram cross-sectional of one of the sections of a periodic track on polycarbonate* [18,19]

Fig. 4. *Transition of a periodic track (period 45 microns) to a smooth one (or vice versa). Polycarbonate. Optical microscope* [15]

Fig. 5. *Fragment of the track on the glass. Optical microscope. The track pattern repeats with a period of about 70 microns. Bright areas, possibly cracks in the glass* [22].

2.3. TRACKS ALONG WHICH CRACKING AND SCATTERING OCCURS

Occur in brittle heat-resistant materials (mica, glass, ceramics, etc.)

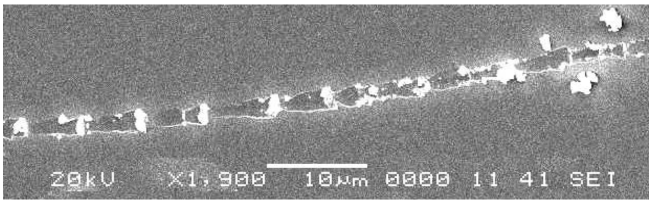


Fig. 6. *Example of a mica track (SEM) [15,17].Tracks on mica represent extended traces of surface destruction, as if the captured material is raked and then periodically left on the further path. Next to the tracks, small mica particles are visible on the mica surface, possibly ejected from the track.*

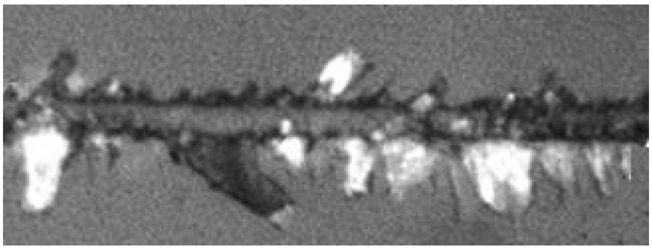


Fig. 7. *Tracks on the surface of lithium niobate* $LiNbO_3$ *are accompanied by numerous cracks. Optical microscope* [22].

2.4. TRACKS IN THE FORM OF CHAINS OF ROUND SPOTS ("DRIP TRACKS")

Found near electrolysis cells.

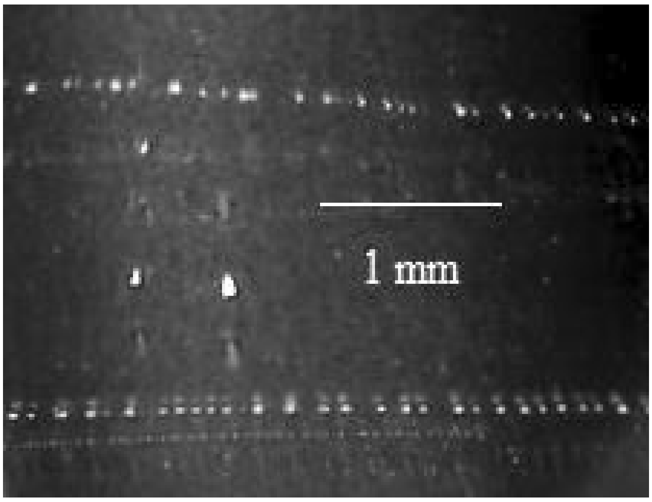


Fig. 8. *"Drip" tracks on DVDs near an* H_2SO_4 *electrolytic cell with nickel electrodes* [12].

2.5. Microcraters

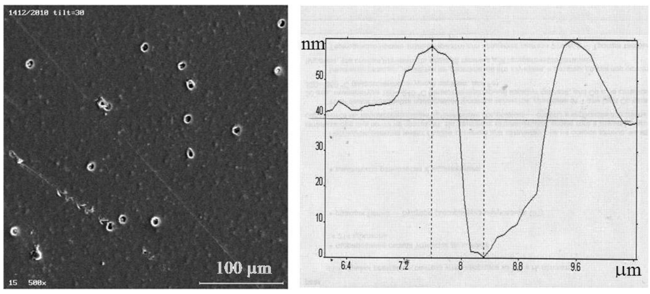


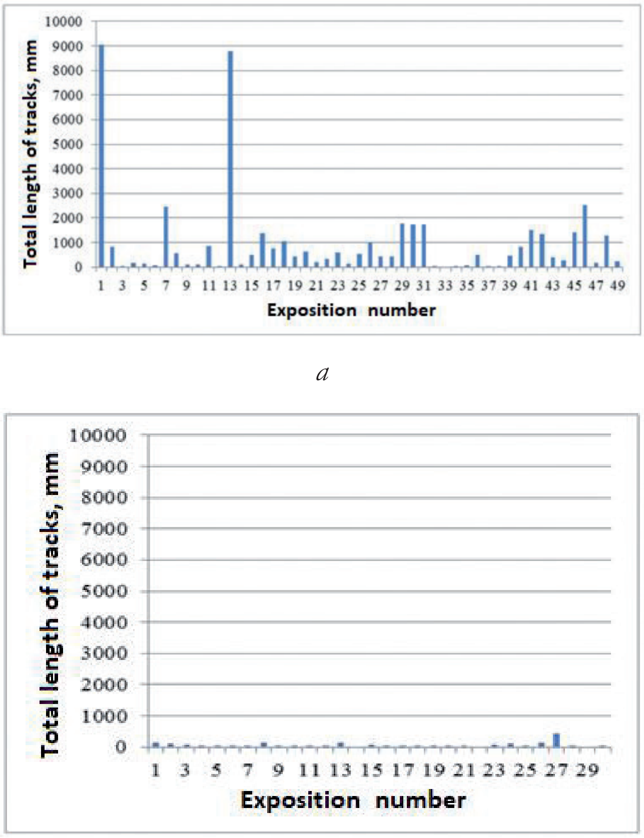
Fig. 9. *On the left: microcraters and tracks detected on the X-ray film located near the cavitation unit. On the right: AFM profilogram of one of the microcraters. This microcrater has a diameter of about 1.1 microns and a depth measured from the film plane of 38 nm* [5].

3. GENERAL PROPERTIES OF STRANGE RADIATION TRACKS

3.1. Intensity of the appearance of tracks depending on the distance to the LENR reactors. Variability

To numerically estimate the intensity of the appearance of tracks, the method of calculating the total length of tracks and comparing the obtained values of the experimental samples with the control was used [14-16]. The usual duration of each exposure is 1 week. Due to the fact that the size of the detectors is comparable to the size of the area in which the appearance of a sufficiently large number of tracks is observed, and, in addition, the intensity of the appearance of tracks is extremely unstable over time, the determination of the dependence on distance can only be estimated. Despite this, numerous long-term measurements allow us to draw an important conclusion about a sharp decrease in the intensity of the appearance of tracks at a distance of more than 20 cm from the reactors. Thus, the average for 5 exposures, the total length of tracks on mica for distances of 5 cm from the reactors (948 mm per sample) exceeds by more than an order of magnitude the average for 10 exposures, length of tracks for long distances (37 mm per sample). A large variation in the values of individual measurements is characteristic for this phenomena.

The results on the DVD are similar to those obtained for mica: on average, 980 mm per sample for a zone closer than 20 cm from the reactors (49 exposures) and 54 mm per sample for a zone further than 20 cm (30 exposures). There is also a large spread of values obtained both in the near and far zone (see **Fig. 10**).



a

b

Fig. 10. *Total lengths of tracks on DVD by exposure: (a) for the near zone, (b) for the far zone* [14,15].

Note that the appearance of tracks is a rather rare phenomenon. According to [14,15], the average rate of accumulation of tracks at a distance of 5-13 cm from the nickel-hydrogen reactor [7] is 0.027 mm per cm^2 per hour, i.e. the appearance of tracks with a total length of 1 mm on a square centimeter of the detector can be expected for a time of about 37 hours.

3.2. Intensity of the appearance of tracks depending on the shielding and orientation of the detectors

In the course of various experiments, the following was found out [16]. Discs tightly arranged in a stack protect each other (tracks appear mainly on the first disc). There are few tracks on discs located in a plastic box closed from all sides.

In part of the exposures from the nickel-hydrogen reactor, an aluminum foil curtain covered DVDs from thermal radiation. This curtain did not form a solid shell around the disc, and was separated from the disc by a distance of several cm. At the same time, the discs gained a significant number of tracks, unlike the control discs located at a distance from the reactor. Protection against the appearance of tracks seems to work only in the case of a screen tightly covering the detector from all sides.

No regularity in the accumulation of tracks by discs depending on their orientation were observed in our experiments.

3.3. Investigation of the substance elemental composition in the tracks

One of the methods used to study the shape of tracks was scanning electron microscopy (SEM). This method, along with obtaining high-resolution images, makes it possible to analyze the elemental composition of a substance at specified points on the surface under study. Analyses made in the area of tracks and at a distance from them did not reveal significant differences.

4. HYPOTHESIZING THE NATURE OF STRANGE RADIATION TRACKS (SRT)

An overview of approaches to the explanation of SRT (the hypothesis of magnetic monopoles, the hypothesis of tachyons, the hypothesis of magneto-toro-electron radiation, the hypothesis of "dark" hydrogen, the hypothesis of multicharged clusters, etc.) can be found in the article [23]. None of these hypotheses can explain the complex of properties inherent in this amazing phenomenon. In particular, two important properties are ignored, without which it is impossible to do without an explanation: a very complex, diverse, non-repeating pattern of periodic tracks, and a strong unpredictable variability in the intensity of the appearance of tracks. The hypothesis outlined below makes it possible to approach the explanation of not only one side of this phenomenon, but the whole set of experimentally discovered properties.

4.1. Tracks with a periodically repeating complex pattern can be formed as a result of rolling objects ranging in size from 14 to 64 microns [18,19]. The irregularities of these objects are imprinted on the surface of the detector, which ensures the repeatability of the pattern with detected periods from 44 to 200 microns.

4.2. It is reasonable to assume that these objects are dust particles suspended in the air. The variety of dust motes shapes explains the uniqueness of the drawings in various tracks (**Fig. 11**). The dustiness of the air, and, consequently, the intensity of the appearance of tracks, depends on many difficult-to-control circumstances. Dust particles driven by air currents can penetrate into any places that do not have reliable protection against air penetration.

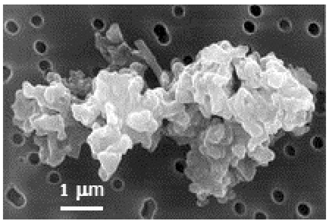


Fig. 11. *A dust particle under a microscope* [20].

4.3. In order for a dust particle to leave an imprint, it must be harder than the detector material and pressed hard enough against the detector surface. If we count the area of contact of a dust particle with the detector surface of 1 μm^2 and the tensile strength of 50 MPa (polycarbonate), a force of $f \sim 5 \cdot 10^{-5}$ N is needed for irreversible deformation.

4.4. Let's assume that the force is related to the electric charge of a dust particle. Suppose that a dust particle has the shape of a sphere with a diameter of d = 20 microns. To attract to a flat electrically conductive surface with a force of $f = 5 \cdot 10^{-5}$ N, a sphere with a diameter of 20 microns must have a charge $q = 2d(\pi\varepsilon_0 f)^{1/2} = 1.5 \cdot 10^{-12}$ C ($9.3 \cdot 10^6$ electron charges). The force of attraction to the dielectric surface has the same order of magnitude (depends on the permittivity). Electric capacity of a sphere with a diameter of 20 microns $C = 2\pi\varepsilon_0 d = 1.1 \cdot 10^{-15}$ F, potential $\varphi = q/C = 1350$ V, electric field energy $W = C\varphi^2/2 = 1.0 \cdot 10^{-9}$ J = 6300 MeV, the electric field strength on the surface of the sphere $E = q/\pi\varepsilon_0 d^2 = 1.3 \cdot 10^8$ V/m.

4.5. Such a charge may appear in a dust particle when it is located near the LENR reactor. Experiments show that the agent causing nuclear transmutations acts not only inside, but also outside the reactor [9-11]. Discussion of the nature of this agent is beyond the scope of this article. It is this agent, which has a high penetrating power, that is "strange radiation".

4.6. The electron shells of atoms resulting from nuclear transmutations are in a highly excited state (this is evidenced by soft X-ray radiation near LENR reactors) [21]. The excitation of electron shells is removed not only by *X*-ray radiation, but also by the emission of Auger electrons with an energy of up to tens of keV. They are usually absorbed in close areas of the surrounding matter. But in the case of a small dust particle, they can come out. For example, the path length of an electron with an energy of 10 keV in a substance with a density of $2 \cdot 10^3$ kg/m^3 (silicon dioxide) is about 5 microns [24]. As a result, a dust particle acquires a positive charge. Assuming that each act of nuclear transmutation is accompanied by the loss of one electron, $9.3 \cdot 10^6$ transmutations (approximately one transmutation per 10^8 atoms of the dust particle substance) are required to acquire a charge of $1.5 \cdot 10^{-12}$ C.

4.7. The high intensity of the electric field near the charged dust particle (~10^8 V/m), it would seem, should lead to the ignition of the corona discharge and the rapid draining of the electric charge. However, the occurrence of electronic avalanches requires not only a high field strength, but also a sufficiently high potential difference [25]. A potential difference of about 1000 V is not enough for this. In addition, dielectric particles as a result of nuclear transmutations are charged volumetrically, which makes it difficult for charges to drain from the surface.

4.8. A dust particle attracted to the detector surface can either release the energy of an electric charge, forming a microcrater (6300 MeV energy is quite enough for this), or move if there is an electric field along the surface or the detector material is inhomogeneous (the relative permittivity is unstable). There may also be reasons unrelated to the electric field, for example, the movement of air along the surface of the detector. Moreover, the particle will predominantly not slide, but roll, since the coefficient of rolling friction is 2-4 orders of magnitude less than the coefficient of sliding friction.

4.9. "Smooth" tracks are formed by particles up to 10 microns in size [18,19]. During the movement, heat is released as a result of deformation and destruction of the detector material and dust particles. This can lead to melting of the material on which the tracks are formed, and to smoothing out possible irregularities [18,19]. It is clear why there are especially many "smooth" tracks on fusible materials (plastics).

4.10. Brittle materials with a high melting point (for example, mica, glass) are destroyed by a moving particle not only by pressure, but also by a sharp temperature drop. Particularly severe damage occurs in materials with piezoelectric properties (for example, lithium niobate) as a result of the action of a strong electric field. Approaching the surface of the dielectric detector of a positively charged body causes polarization of the dielectric, equivalent to the action of a negative charge of the same magnitude (in our example, $q = 1.5 \cdot 10^{-12}$ C). If a substance has piezoelectric properties with a typical piezo module $d \sim 10^{-11}$ C/N, it will contract with a force $f = q/d \sim 0.1$ N. This force acts on an area of about 10 μ^2 (10^{-11} m^2), causing a pressure of 10^{10} Pa, which significantly exceeds the strength limits of conventional materials.

4.11. "Drip" tracks. In the process of electrolysis, many droplets of electrolyte are formed in the form of an aerosol. Some of them, being in the field of action of the agent causing nuclear transmutation, acquire a positive electric charge. The properties of such droplets ("charged clusters") are studied in detail in [23]. They move, periodically approaching and moving away from the detector surface, dropping a cluster much smaller than the main one at the moment of approach. Chains of circular traces appear on the detector.

4.12. A sharp decrease in the probability of tracks appearing at a distance of 20-30 cm from LENR reactors is probably due not only to a geometric weakening of the intensity of the agent activating the dust particles, but also to the limited retention time of electric charges on the dust particles.

5. EXPERIMENTAL JUSTIFICATIONS

5.1. Modeling of the process of track formation as a result of dust particles rolling on the detector surface [22]

5.1.1. Tracks on DVD

a) For two days, a clean DVD disc without scratches lay on the windowsill near the open window with the working surface up, accumulating dust. Then the working surface of the dusty disc was rubbed against another disc with a very light pressure.

Tracks with periodic patterns appeared on the disc, as well as smooth single and double tracks, very similar to tracks of strange radiation (**Fig. 12**).

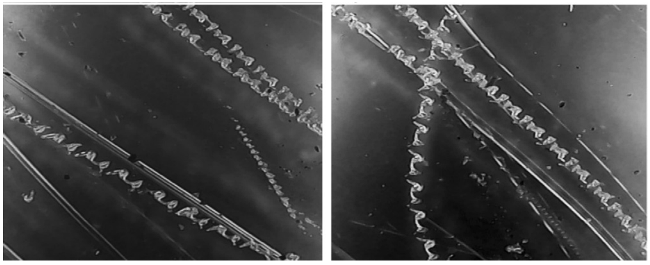


Fig. 12. *Tracks that appeared on the surface of a DVD disc when rolling dust particles (optical microscope).*

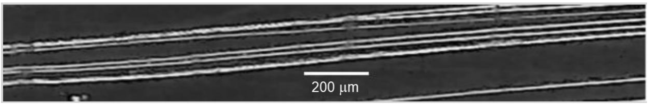


Fig. 13. *Tracks that appeared on the surface of a DVD disc during rolling of carbonyl nickel particles (optical microscope).*

b) Several carbonyl nickel particles with a shape close to spherical and a size from 5 to 20 microns were applied to a fragment of a clean DVD, covered with another fragment of a clean DVD and moved the upper disc by about 1 cm. Several parallel tracks with a width of ~ 10 microns appeared on the discs (**Fig. 13**).

5.1.2. Tracks on glass

Grains of quartz sand, corundum, and carbonyl nickel were placed between the microscope slides (**Fig. 14**). The compression force of the plates is ~ 1 *N* (light finger pressure), the movement of the upper glass relative to the lower one is about 1 cm.

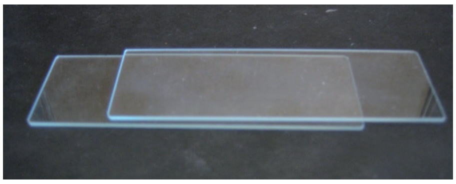


Fig. 14. *Location of the microscope slides.*

Fig. 15 shows one of the tracks that occurred when using corundum grains of ~ 50 microns in size. The randomness of the track pattern may be related to the randomness of the process of crack formation in the glass, as well as the gradual destruction of a grain of corundum.

When using grains of quartz sand and carbonyl nickel, tracks on the glass did not occur (the hardness of these substances is lower than the hardness of glass).

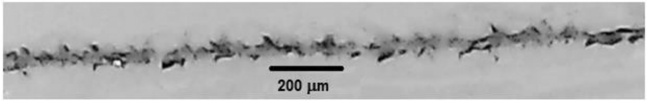


Fig. 15. *Slide glasses, corundum grains ~ 50 microns in size (optical microscope).*

Fig. 16. *Track on an X-ray film from a grain of quartz sand (optical microscope).*

5.1.3. Tracks on photoemulsions

Several grains of quartz sand 100-200 microns in size were applied to the RM-1 X-ray film with a size of 2x5 cm^2, covered with the same film and moved the upper film by about 1 cm with light pressure. Tracks with a distinct pattern periodicity appeared on the films (**Fig. 16**).

These experiments confirm the possibility of the appearance of traces similar to the tracks of strange radiation when rolling various particles on the surface of various materials.

5.2. High intensity of track formation at high concentration of dust-like particles

A halogen incandescent lamp with a rated power of 300 W at an increased supply voltage from 220 to 320 V is suspended inside a ceramic pipe. Experiments show that incandescent lamps operating in forced mode are sources of an agent that causes nuclear transmutations [9-12]. When turned on, the lamp and ceramic tube are heated to a high temperature, which contributes to the convection movement of air from the bottom up. If a powder, such as corundum, is poured at the bottom, rather small particles are carried away by the ascending air flow and pass near the lamp (**Fig. 17**). A detector (for example, a glass plate) is located on top of the pipe. The air coming out of the pipe with trapped particles washes the detector.

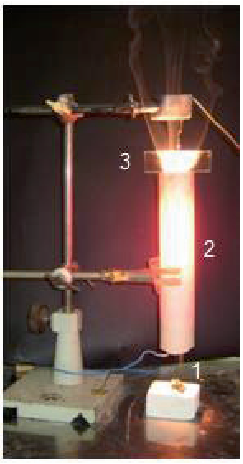


Fig. 17. *"Generator" of tracks. 1 – aerosol source, 2 – ceramic tube with an incandescent halogen lamp located inside, 3 – detector.*

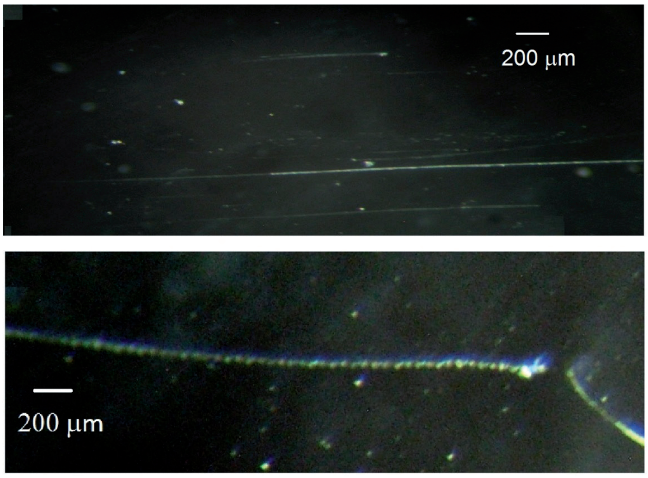


Fig. 18. *Some of the tracks that appeared on the slides during 1 minute of operation of the "track generator" (optical microscope).*

In order to avoid overheating, the installation can be turned on only for 1 minute. But even this time is enough for tracks to appear on the detectors (examples in **Fig. 18**). This is a very high intensity. Recall that under normal conditions, the appearance of tracks with a total length of 1 mm on a square centimeter detector can be expected in about 37 hours (see section 3.1)

6. CONCLUSION

The assumption that tracks of strange radiation form dust particles or liquid droplets suspended in the air, which have acquired an electric charge as a result of nuclear transmutations, allows us to explain many features of the phenomenon of tracks of strange radiation, indicated at the beginning of the article. The proposed hypothesis answers the questions:

- why tracks only appear on the surface;
- where do the particles forming the tracks come from;
- why does an electric charge appear in them and what does LENR have to do with it;
- how tracks with unique periodic patterns, smooth tracks, tracks with cracks and "drip" tracks arise;
- why the intensity of the appearance of tracks is unstable under seemingly identical conditions.

The possibility of the appearance of tracks similar to SRT when dust and dust-like particles are pressed against the surface of various detectors has been confirmed experimentally. Based on the hypothesis put forward, an experimental setup has been created in which the intensity of the appearance of tracks is significantly increased compared to the natural process.

Thus, the proposed hypothesis allows us to explain a number of characteristic features of the phenomenon of strange radiation tracks, which seemed mysterious. At the same time, there are still questions that require reflection and further research.

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