Review of experimental results on low-energy transformation of nucleus

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1 Introduction.

I am faced with a difficult problem — to cover during 40 minutes the experimental results that have been mined during 5 years by efforts of about 30 specialists, to say nothing about the technical staff. Detailed description of the results, the procedures, and the equipment we used and detailed analysis of the possible experimental errors would require five or six reports. Since only one type of measurement could be described comprehensively within the given time limit, I have chosen a different option. I will give a brief account of all the results to represent the scope of our research. One of the measurements based on the Mössbauer effect will be described in detail in the report of doctor Ivoilov. Theoretical considerations and the results of numerical computations will be reported by doctor Filippov. In my report I will present only general physical interpretations and simple estimates.

2 Historical background.

The historical development of the problem of low-energy transformation of chemical elements is a spacious topic that could serve as the subject of a separate report. We are certainly *not the first group* to be engaged in this problem; this was done by A. Smits and A. Karssen [1], H. Nagaoka [2], A.Miethe and H.Stammreich [3], A.Gaschler [4], F.Soddy [5] — and this list is far from being full. A common feature of all the experiments performed was transmission of a high-power electric discharge through a substance melt, solution, or vapor. However, as the quantum-mechanical paradigm has been established and the energy scale of the nuclear forces has been realized, such studies and publications ceased.

We are not the *only research group in Russia* who report "highly unscientific" data on low-energy transmutation. There are at least three or four groups that report similar results (M.Solin, I.Savatimova, A.Karabut, V.Krivitskii) [6,7,8].

However, our group was lucky in two aspects.

1. By chance, the effect we immediately came across was very pronounced (~10%). A smaller effect would be most likely missed and regarded as an error of measurements.
2. You all are aware of the fact that scientists working at large and well-known scientific centers (such as the Kurchatov Institute) are always very busy. They have research plans, contracts, obligations and so on. Hence, they have not enough time to study things that cannot exist — they have to study things that must exist. Therefore, such "impossible" things are often investigated by single persons in much less prestigious laboratories. Of course, the experimental facilities and, generally, the grade of research are less advanced in these cases. However, due to the demolition of science in our country, we had no longer any research plans in 1998, but still had the research potential. So we enthusiastically started this work.

Now, we finally pass to the main body of the report.

3 Transformation.

Some of the experimental results were included in my report delivered last year at the colloquium organized by the Foundation Louis de Broglie and published in [9]. Therefore I will only briefly outline the design of the setup and the experimental procedure.

A typical experimental scheme is shown in Fig. 1. A capacitor bank with the stored energy W~50 kJ and the charge voltage U ~ 5 kV is discharged during the period τ~120 μs to a foil load (for example, Ti foil). The load is located in a blasting chamber, which is represented by a sealed thick metallic container whose inner structure is made of high-density polyethylene. The design of the blasting chamber provides for gas inlet and outlet and means for taking gas samples into cylinders. The electrodes were produced from high-purity titanium. The working fluid used was either bidistilled water with an impurity content of 10^{-6} g/L or solutions of various metal salts in bidistilled water.

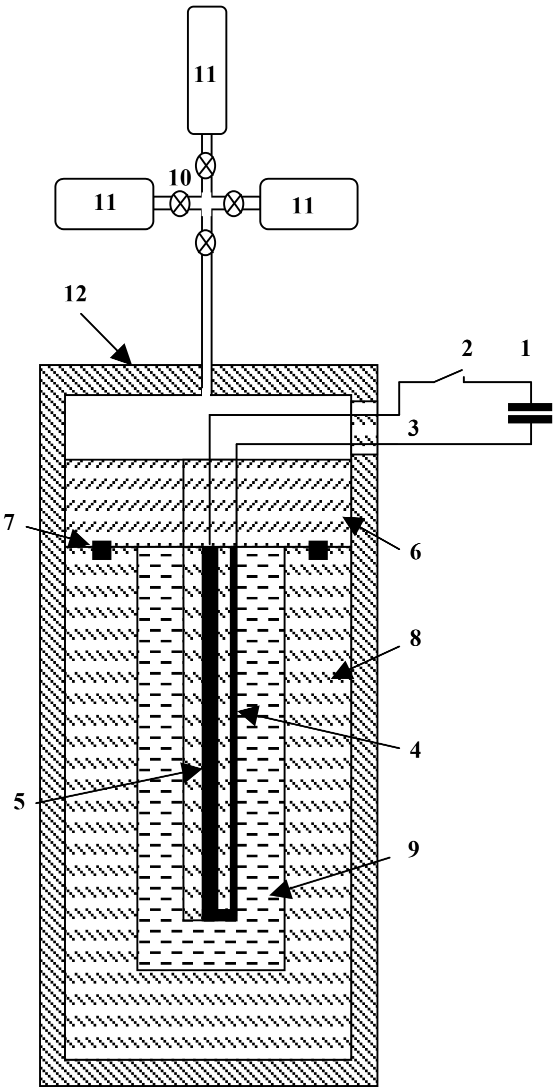
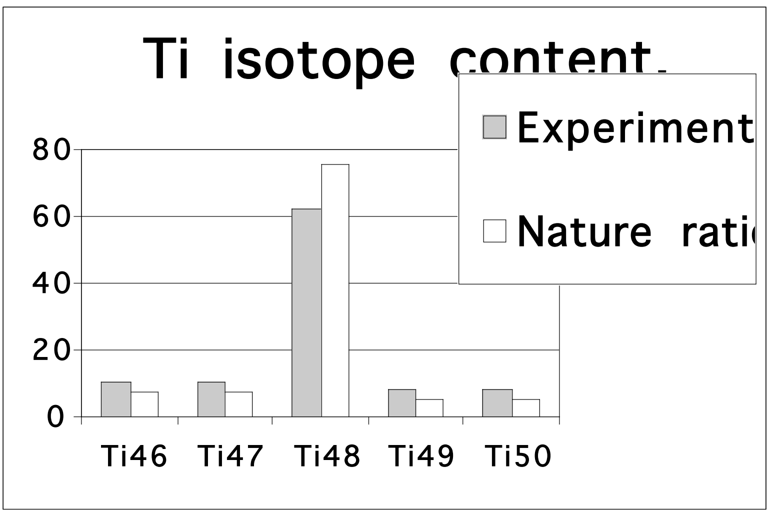


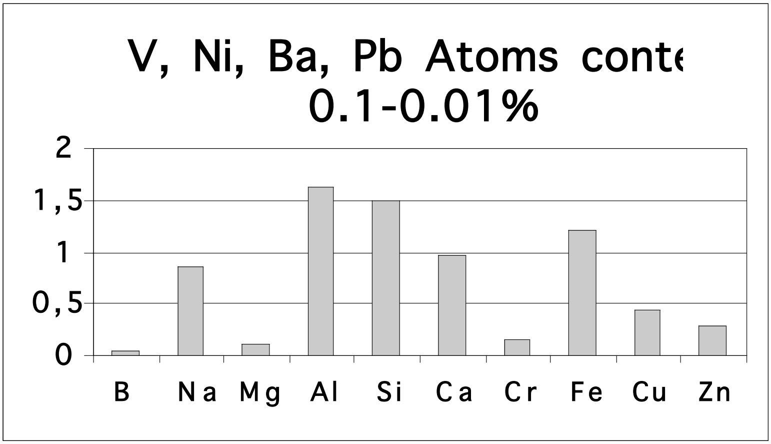
Figure 1

1 : capacitor bank – 2 : discharger – 3 : cable – 4 : foil – 5 : electrode – 6 : polyethylene – 7 : compression – 8 : blasting – 9 : liquid – 10 : valves – 11 : containers – 12 stainless steel body

The main outcome is as follows. Analysis of the titanium foil remainder reveals a distorted isotopic ratio of titanium (Fig. 2a). The natural titanium has the following composition: Ti^{46}, 8%; Ti^{47}, 7.3%; Ti^{48}, 73.8%; Ti^{49}, 5.5%; and Ti^{50}, 5.4%. As can be seen from the Figure, the situation looks as if Ti^{48} disappeared at the instant of the pulse. Please, pay attention to the fact that Ti^{48} has not been transformed into another titanium isotope but has disappeared (indeed, the Ti^{46}, Ti^{47}, Ti^{49}, and Ti^{50} contents have remained in approximately the same ratio, of course, with allowance made for the experimental error). The deficiency of Ti^{48} in some experiments amounts to ~10%, while the accuracy of measurements is for $Ti^{46,47,50}$ - ±0.2%; for Ti^{48} - ±0.4% and for Ti^{49} - ±0.13%. Simultaneously with disappearance of Ti^{48}, a sharp (10-fold) increase in the contents of impurities in the sample was detected by mass spectrometry, X-ray fluorescence analysis, and other methods. The percentage of the newly appeared impurities was proportional to that of the lost Ti^{48} [9]. The chemical composition of the impurities formed is shown in Fig. 2b. Bar chart presents only those chemical elements the specific concentration of which overcomes 30 times the detection limit of mass-spectrometer. It should be mentioned that the data presented don't include impurities being a part of initial Ti foil and the possible impurities of the samples tested coming from polyethylene parts of the device and from electrodes.



a) standard deviation value can't be shown due to scale of the bar chart.



b) Bar chart of newly formed elements. The rest is Ti.
Fig. 2

I will not dwell on analysis of the experimental regularities observed, as they were reported in [9]. It should be mentioned that in case we use 40% solution of glycerin in bidistilled water instead of pure bidistilled water as a result we have the percentage of Ti^{48} distortion 1.5-2 times higher. The results were highly unexpected, hence, they required an independent verification, which was performed by our colleagues from the Joint Institute of Nuclear Research from Dubna town (Kuznetsov's group). They planned to report the results at our colloquium but, unfortunately, our colleagues had no opportunity to come to Paris. I will not retell the contents of this rather voluminous report (about 40 pages), as it has been published [10]. It should only be mentioned that they confirmed all our most important results and conclusions, moreover, owing to the use of a more sensitive neutron activation analysis (detection limit of about 10^{14} atoms), they were able to observe more subtle features.

One more fact observed in both our experiments and Kuznetsov's verification experiments is very important. None of us found any significant residual γ-activity in the samples. The absence of excited nuclei in the samples is important, because any hypotheses that propose acceleration mechanisms for the transmutation can be immediately refuted. Indeed, overcoming of the Coulomb barrier through an acceleration mechanism is impossible without exciting the nucleus. Just in the same way, one cannot occupy a fortress by forward storm without destroying the walls or gates. Nevertheless, the fortress has been occupied, as follows from the experiments, so we should look for traces of undermining the wall.

Yet another important result is that, unlike Fleishman and Pons, we did not find neutrons in experiments with a limitation on the neutron flux of $I<10^3$ per pulse. This is an additional argument supporting the statement that strong interactions are not involved in the "magical" nuclear transformations we observed.

The proportionality between the Ti^{48} isotopic shift and the percentage of "alien" chemical elements prompts the necessity of writing balance equations. We composed balance equations for the binding energy and baryon, electric, and lepton charges.

4 Model.

This aspect is comprehensively covered in doctor Filippov's report, therefore, here I present only one partial result and brief conclusions.

$$11\cdot{}^{48}_{22}\mathrm{Ti}+2\cdot{}^{16}_{8}\mathrm{O}+4\cdot e\rightarrow{}^{4}_{2}\mathrm{He}+{}^{12}_{6}\mathrm{C}+{}^{37}_{17}\mathrm{Cl}+7\cdot{}^{49}_{22}\mathrm{Ti}+{}^{53}_{24}\mathrm{Cr}+{}^{55}_{25}\mathrm{Mn}+{}^{56}_{26}\mathrm{Fe}-o(1\mathrm{kev})$$

$$2\cdot{}^{49}_{22}\mathrm{Ti}+4\cdot{}^{1}_{1}\mathrm{H}\rightarrow 4\cdot{}^{4}_{2}\mathrm{He}+{}^{40}_{19}\mathrm{K}+{}^{46}_{22}\mathrm{Ti}+e+o(1\mathrm{kev}) \qquad (1)$$

This equation cannot be considered as describing many-particle collisions but rather a cluster with proton and neutron exchange taking place inside.

Thus, this example demonstrates that the reaction products are selected from the Mendeleev Table in a purely combinatorial way and in such a way that the difference between the binding energies of the initial and final nuclei is $|\ddot{A}E| \sim 100\mathrm{ev}$. It is clear that the $|\ddot{A}E|$ value is much smaller than the accuracy of measurement of the nuclear binding energies. According to experimental data, the number of transformed atoms is $\sim 10^{19}$ to 10^{20} per pulse. It also follows from the experiment that neither substantial energy evolution nor substantial absorption of the supplied energy is involved. However, against the background of 50 kJ of supplied energy, a value of about 1-5 kJ could be either evolved or absorbed without attracting particular attention. Thus,

$$\frac{\ddot{A}E}{N}=\frac{2\cdot 10^3 G}{10^{19}\grave{a}t}\sim 1\mathrm{Kev} \qquad (2)$$

This value represents the energy unbalance per cluster (1) that can be afforded by the phenomenological model.

The following conclusions were drawn from the numerical experiment:

1. If one or two Ti^{48} atoms are taken as the initial nuclei, as in the conventional nuclear physics, no plausible combinations that meet condition (2) can be selected.
2. All combinations that meet condition (2) are selected only for an ensemble of nuclei, that is, if this process takes place, it should be collective.
3. In view of the extremely high nuclear binding energy, E~10 MeV, the finite character of the Mendeleev Table (~450 isotopes), and the obligatory fulfillment of all the conservation laws, it is surprising that some combinations differing by $|\Delta E|$~100 eV can still be selected. In any case, this is an arithmetic result that can be readily verified.
4. For Ti atoms, no combinations with allowance for condition (2) can be found with Z values greater than $Z = 30$ $({}_{30}Zn)$, which is in line with the experimental diagram shown in Fig. 2b.
5. All combinations are selected without resorting to strong interactions, that is, β^- decay, β^+ positron decay, and K-capture are considered. This result was also obtained by our colleagues from Dubna Institute (Kuznetsov, Pen'kov). It follows from the phenomenological model that, if vanadium V is present as a parent nucleus, the transformation should give Fe^{57}:

$$ {}^{51}_{23}V + {}^{48}_{22}Ti + {}^{18}_{8}O \rightarrow {}^{57}_{26}Fe + {}^{23}_{11}Na + {}^{37}_{17}Cl + e + o(1kev) $$

Since the natural abundance of this isotope is rather low (Fe^{57}, 2.2%), its appearance can be easily detected. We carried out two series of experiments. In one series, a combined Ti–V load was used and bidistilled water was employed as the working liquid, while in the other series of experiments, a titanium load was blasted in a solution of the vanadium salt VCl. Both series showed an increase in the proportion of Fe^{57} up to 3.7%±0,5%. This cannot prove the model but strongly indicates that we are on the right track.

5 Beads.

Now we should divert from this interesting subject and consider the question of where the transformation takes place. Does it occur locally or throughout the whole bulk of the chamber? This question can partly be answered by considering the results of examination performed by an electron microscope. Figure 3 shows a typical micrograph of an arbitrary section of the sample of the titanium foil remainder after electric blasting. The characteristic scale is indicated in the right corner. It can be seen from the Figure that the sample is composed of a gray spongy material and beads of different diameter, d ~0.01 to 100 μm, having regular or irregular shape.

Such beads can be easily obtained by dropping hot lead into water. Therefore, initially, we believed that they have been formed exactly in this way and that they were solid. Figure 4 shows the back-scattered electron micrograph of a giant bead that we have carefully broken. It can be seen that the bead is empty and resembles a ball used to decorate the Christmas tree. This result, although qualitative, is obviously unexpected and elegant. In all probability, the bead was blown from the inside by high gas pressure. Those who doubt such interpretation can look at Fig. 5 where one can clearly see the holes that have let out the gas. By measuring the wall thickness and the radius of the beads, it is easy to estimate pressure in two limiting cases. The first is the soap-bubble approximation, that is, hot blowing. The second case is cold blowing. I will not cite these simple calculations, but present only the result: the number of gas atoms is $N \sim 10^{17-19}$, which is quite a measurable value. These measurements have been really performed but this will be discussed below.

Since an electron microscope not only gives the elemental composition but can also provide an image in the rays of one or another chemical element, of course, we made use of this opportunity. It was found that the spongy component is almost uniform in elemental composition and mainly contains, in addition to Ti, light impurities, namely, Si, Na, K, and Ca and the highest amounts of Fe, Cu, and Zn. Meanwhile, bead-like particles contain a minor amount of Fe impurity and no Ni, Zn, or Cu but, instead, they contain Pb and Au impurities. The highest contents of Pb and Au reach fractions of percent and are found in regularly shaped beads. The reason for these phenomena remains obscure. Neither Pb nor Au is detected in the initial foil by the instrument used. I could speak more and more about these interesting results but the key conclusions can already be drawn: 1. The transformation does not occur uniformly throughout the bulk of the chamber. 2. Several transformation channels appear to exist. Note that these studies are in progress; hence, new results will be obtained.

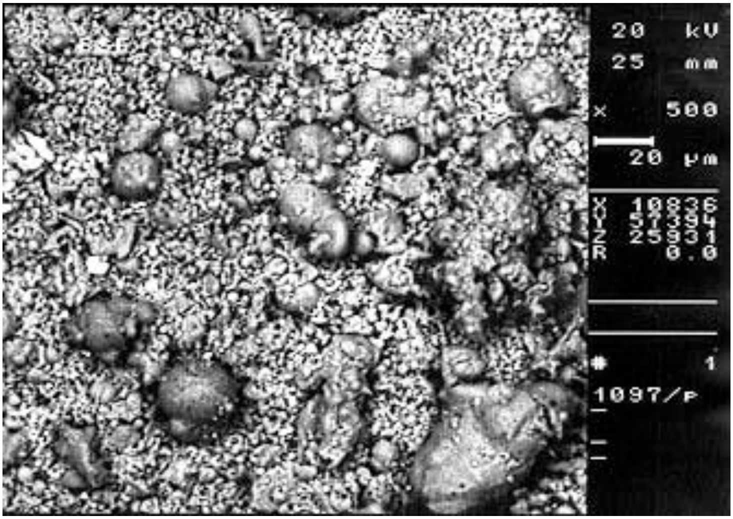

20 kV
25 mm
x 500
20 µm
X 10836
Y 57394
Z 25931
R 0.0
1
1097/P

Fig. 3.

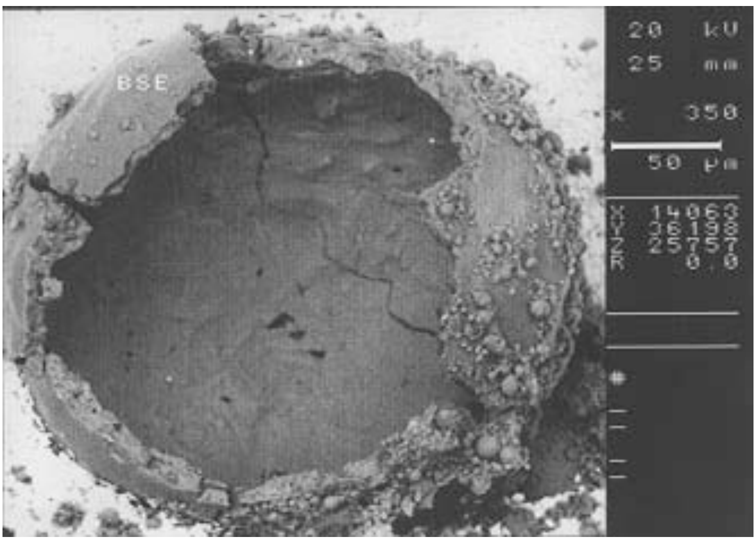

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Fig. 4.

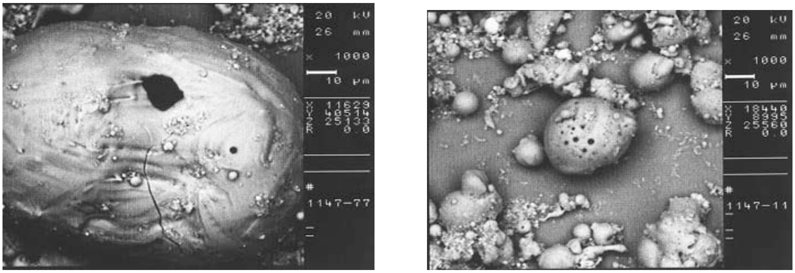

Fig. 5.

6 Gas measurements.

Gas measurements were carried out in the following way. Prior to the shot, the pre-chamber was evacuated and filled with a ballast gas (N_2 or Ar). After the electric blasting, a gas sample was taken into pre-evacuated cylinders. The mass spectrum was recorded on a gas mass spectrometer and then the same sample was identified using optical lines in a glow discharge. The results were as follows. We have detected $\sim 10^{22}$ H_2 atoms but almost no oxygen O_2. If water has decomposed under the action of electric current, where is oxygen then? The amount of Ti in the load is $1.1 \cdot 10^{21}$ atoms, and the oxidation state of titanium is known from the sample mass spectrometry; it varies from TiO to TiO_2. Thus, the expected number of H_2 atoms is $\sim 2.2 \cdot 10^{21}$, but the actual number is ten times greater than the expected one. The reason for this result is still to be elucidated. The assumption that H_2 could have been dissolved in Ti or in the chamber bulk can be ruled out. This can be demonstrated by performing a simple blank experiment with a liquid containing no H_2, for example, CCl_4. No hydrogen is found in such experiments. These investigations proceed currently at full pelt.

7 Other foils and U.

Is titanium the only element able to undergo low-energy transformation? Of course, the answer is no. This is indirectly supported by experiments with vanadium. In addition, we carried out experiments with Zr, C, Pb, U, Ta, Ni, and Fe. In the case of Ni and Fe foils, we observed no transformation. The transformation in Zr foil occurred as easily as with titanium. Transformation also takes place in C, Pb, and U. However, each element is responsible for a specific "spectrum" of the elements formed. For example, lead is converted into Sb, Ba, Hg, and Au. Our colleague from Georgia, doctor Kortkhonjia informed us that upon electric explosion of a Pb wire, he was able to obtain gold in an amount sufficient for chemical isolation. If this information represents the fact, then the centuries-old dream of mankind has come true. Speaking seriously, it should be noted that an even-even isotope mainly "disappears" from all elements. For lead, this isotope is Pb^{208}. Now it is difficult to decide unambiguously whether this is a regular feature or a measurement-related effect.

Of interest are the results of our experiments with uranium salts. In this series of experiments, we exploded a titanium foil in a solution of the salt $(UO_2)SO_4$. The results obtained were published in detail in [11]. The key conclusions are as follows. The electric blasting induces a substantial (up to several percent) enrichment in U^{235}. In all probability, the enrichment is due to the transformation of U^{238} (which is an even-even isotope). Since the ratio of uranium isotopes can be measured by both mass spectrometry and α-, β-, and γ-spectrometry, these results are quite reliable from the measurement standpoint. Thus, in my opinion, mankind has got a rather "unpleasant" surprise, because, probably, within several years, when the low-temperature transmutation will have been well studied, it would be rather easy to devise a facile and inexpensive process for uranium enrichment. In view of the growth of terrorism all over the world, this outlook seems mournful.

In addition to transformation, these experiments displayed other, equally interesting phenomena related to deterioration of the Th secular equilibrium and the change in the β-decay probability of the protactinium Pr^m isotope. This aspect is covered in the report by doctor Filippov.

8 «Strange» radiation.

Turning back to the phenomenological model, we can state that this model advanced the problem of low-energy transformation of chemical elements from the condition "this is impossible" to the condition "this is possible but highly improbable". Thus, the transformation is not forbidden and can occur under the barrier, that is, with low probability. However, as long as the experiment shows a high efficiency of this process, we should look for a catalyst. The search for such catalyst acting as the philosophers' stone started in the first experiments in 1998-1999. To my deep regret, the last year has not brought a breakthrough in this line of research; however, I will briefly formulate the key results obtained previously:

1 Using photonuclear detectors (X-ray films and nuclear emulsions) located at distances of up to 2 m from the setup, we detected traces of a "strange" radiation. The peculiarities of these traces included the following. The traces were

(a) discontinuous and shaped like dumb-bells (a typical trace is shown in Fig. 6);
(b) accompanied by a second, less pronounced parallel trace;
(c) arranged usually on the detector surface whose normal vector $\vec{n}$ is collinear to the radius-vector $\vec{r}_0$.
(d) unusually broad, Δ~10-15 μm, and long, l ~μm.

2 The traces were clearly not of the acceleration origin, because they could be detected over a period of 24 h using a detector placed near the foil remainder. However, the last-mentioned fact apparently has an interpretation, as will be clear from the report by doctor Ivolilov.

3 If the blasting chamber is placed in a rather low magnetic field H_z ~20 Gs, the traces start to resemble comets (Fig. 7). Thus, it can be seen qualitatively that the "strange" radiation interacts with the magnetic field.

4 Rather surprising is the mere fact of recording radiation at the distance of l ~2 m from the setup. Indeed, the radiation had to emerge from the setup, pass through the air and penetrate two layers of black paper wrapped around the detectors. It is clear that a charged particle would not travel this distance. The other remarkable fact is that the particle energy estimated from the blackening area under the assumption of Coulomb interaction equals E ~700 MeV. However, in this case, δ-electrons, or a "hairy leg," as nuclear physicists would say, should be observed. However, it can be seen from the Figures that the "leg" is "shaven", that is, no δ-electrons are involved.

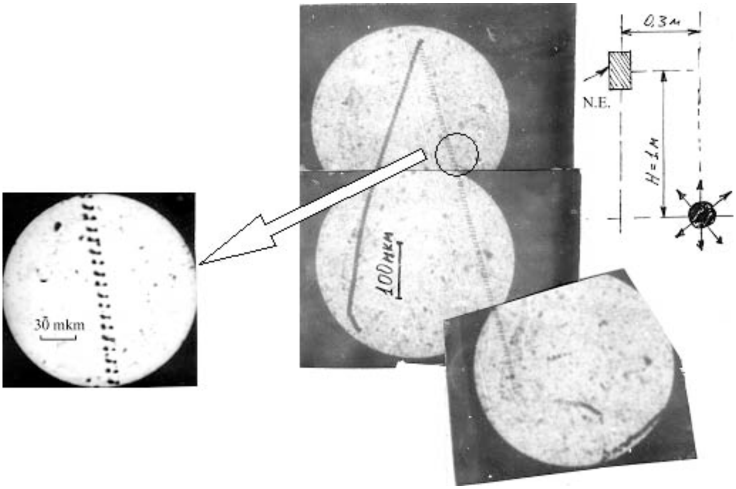

Fig. 6 : Tracks on nuclear emulsions

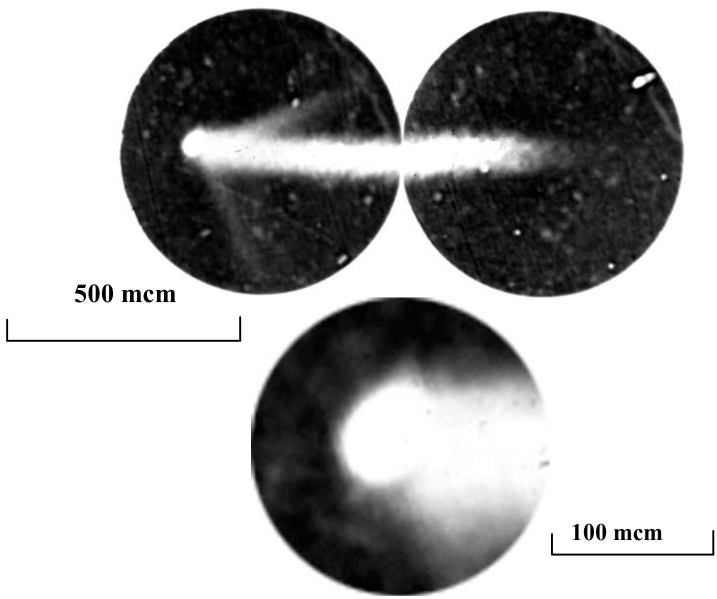

Fig 7 : Tracks in magnetic field Hz

All the above facts made us to suggest that we have come across an absolutely new phenomenon. The hypothesis of magnetic charges represented a "forced move." The next step was to attempt detecting the magnetic charges using the Mössbauer effect. These measurements will be described by doctor Ivoilov.

Since a negative result is still a result, it is worth mentioning that an attempt to record the "strange" radiation using conventional tracking detectors (kindly provided by German colleagues from Julich) completely failed. However, we fortunately managed to obtain the first results using detectors based on superheated liquids. This technique relies on the same principle as the use of a bubble chamber, but the dimensions (and, hence, the price) are much smaller. However, these studies are in progress and the results cannot yet be taken for granted.

Recently, we have found one more fact, not very important from the theoretical standpoint, but very significant for our research group from the financial standpoint. We were able to detect the "strange" radiation on industrial electrical equipment at emergency situation. The traces detected were identical to those obtained in the laboratory. Power engineers believe that these results would be helpful in elucidating the reason for failure of commercial facilities. However, currently the conclusion is that we detect something but there are still more questions than answers.

9 Discussion.

I hope that the foregoing made clear the reasons why we invoked the magnetic monopole hypothesis as the base for interpretation of the unusual experimental results. Some additional, fairly weighty reasons will be presented in the report by doctor Filippov.

Now I would like to explain briefly why we have chosen the G. Lochak's monopole. Of course, Mr. Lochak is a first-class physicist and a charming person and I am proud that I can call him my friend. However, our choice of his theory was dictated by the mathematical harmony and elegance of his lepton monopole theory rather than by his personal features. It would be improper to oppose Lochak's theory to the Dirac theory but I rather sympathize with the former. If you ask why, I will be happy to answer. First, Lochak's theory is logically simple, relies on the Dirac equation, and does not use any additional assumptions except for the symmetry principles and the continuity condition for the wave function relative to a rotation group. Conversely, the Dirac theory resorts to somewhat artificial (at least, from experimenter's standpoint) assumptions concerning the thread unobservability. Evidently, this is due to Dirac's predilection for the projective geometry, the thread unobservability being an analog of the view of improper point in the projective geometry. Certainly, this is my personal point of view and I am not going to thrust it on anybody. Moreover, in my opinion, Dirac's conclusion is mathematically strict and aesthetically beautiful.

However, the main reason for choosing the lepton monopole is not the elegance of derivation but rather its "energetic lightness"; its formation does not require much energy, which is consistent with our experimental conditions. It is fair to say that the mass equal to m_g ~1–3 GeV is obtained for the Dirac monopole provided that the monopole radius is equal to the classical electron radius. Strictly speaking, this assumption is not substantiated and, in my opinion, it is rather arbitrary.

There is yet another important fact which was not first adequately appreciated by the author (i.e., Lochak), as he himself admitted. The Lochak monopole is a lepton and, hence, it is involved in electroweak interactions. Thus, it is pertinent to look for its influence on the $\beta^{\pm}$-decay, K-capture, and the $\hat{a}_b^-$-decay to the bound state. Such experiments have been conducted in my laboratory during this year. It is too early to draw final conclusions but it can be stated with a high degree of confidence that we register a decrease in the specific β-activity of tritium H^3, which amounts to ~1% per pulse. Changes for other β-decaying nuclei are also noted but it is too early to discuss this topic. These facts are very important, and everybody knows how harmful for science were the premature declarations of Fleishman and Pons.

10 Dreams.

Usually, theoretical discussions start with the words: "let us consider a point magnetic charge in the field of an electric charge or vice versa." However, while examining the wide traces in nuclear emulsions, one can feel a doubt in the validity of the term "point magnetic charge."

Let us assume, for example, that basically, a magnetic monopole is not a point particle but is something like a cloud. The greater the monopole charge, the denser the cloud; then, collision of two clouds gives a denser cloud with dimensions of the larger cloud. These objects are properly described in terms of P–Adic Quantum Mechanics based on P-adic analysis. The body of mathematics needed to describe such objects has been developed in detail. With introducing these particles into physics, the "chronic disease" of classical electrodynamics – Coulomb divergence – could be overcome quite naturally. However, these are only dreams.

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