



Research Article

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Spin Supercurrent Against Gamma-Radiation



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Abstract

The aim of this work is to show that spin supercurrent (process emerging between precessing spins of quantum objects and transferring angular momentum) may determine the action of gamma (γ)-radiation on a biological system in two directions. First, the spin supercurrent emerges between spins of photons constituting gamma (γ)-radiation and spins of virtual photons created (according to Feynman's hypothesis) by quantum objects of biological system influenced by gamma (γ)-radiation. The effectivity of action of this spin supercurrent, in other words, the effectivity of action of gamma (γ)-radiation can be varied by preliminary change in spins' characteristics of virtual photons created by quantum objects of biological system.

Secondly, the spin supercurrent can be used for the preliminary change in spins' characteristics of virtual photons created by quantum objects of biological system. An additional substance can be used in this case. The spin supercurrent emerging between spins of virtual photons created by quantum objects of an additional substance, on the one hand, and spins of virtual photons produced by quantum objects of biological system, on the other hand, changes the characteristics of the spins connected with biological system and influences in such a way the effectivity of follow up action of gamma (γ)-radiation on the biological system.

It is proven experimentally that so-called "strange" radiation accompanying low-energy nuclear reactions, the radiation of operator and at some condition the gamma (γ)-radiation itself can be such additional "substances".

Keywords: Gamma-radiation; Spin supercurrent; Therapy; Virtual photon; Quantum mechanics; Vector magnetic potential

Introduction

The gamma (γ)-radiation (or γ -radiation or γ -rays) is a rigid electromagnetic radiation at the short-wave edge of the electromagnetic wave spectrum consisting of photons with frequencies $3 \cdot 10^{19}$ - $3 \cdot 10^{21}$ Hz [1]. The effective protection from γ -radiation is possible only by using of a very thick substance containing lead, tungsten, depleted uranium and other substances with heavy nuclei. On the Earth, the magneto - sphere protects biological systems from most types of lethal cosmic radiation but other than γ -rays.

The action of gamma-radiation on a biological system depending on its dose and duration can cause chronic and acute radiation sickness. The consequences of irradiation that has not exact dose threshold and manifests through many years after radiation are called stochastic. The stochastic effects include various types of oncological diseases (in particular, leukemia, myeloid leukemia,

non-melanoma skin cancer). For example, after atomic bombing of Nagasaki and Hiroshima in 1945 oncological diseases are registered during many decades. Totally after those explosions 2000 people died from oncological diseases only. At present, as a result of technogenic catastrophes (natural phenomena, accidents on atomic stations, security breaches) the people continue to get cancer as a result of gamma radiation [2]. Therefore, it is very important to investigate methods decreasing negative action of gamma radiation on a human organism. It should be noted that at some small doses the gamma radiation can have a therapeutic effect. This case will be considered in this work.

Only the process having high penetrating ability and able to accomplish interaction between identical components of photons and of quantum objects constituting a biological system can perform the action of γ -rays on biological systems. In this work

using theoretical and experimental data it is shown that spin supercurrent can be such a process: it is not shielded by molecular and electromagnetic screens and can emerge between spins of photons constituting γ -rays and spins of virtual photons created by quantum objects constituting the biological system.

The spin supercurrent is a process transferring angular momentum, in particular, transferring angles of precession and deflection between objects having precessing spins. The first works introducing the process of transfer of angular momentum in descriptions of physical phenomena were works by J. C. Maxwell describing a model of luminiferous ether in 1861-1873 [3,4]. In hundred years, the investigation of the process of transfer of angular momentum was continued (with taking into account the quantum object characteristic discovered in the 20th century spin) by M. Vuorio [5], in his experiments this process was called "long transport of spin polarization". In the following years the process was studied in experiments with superfluid $^3\text{He-B}$ by A. Borovic-Romanov, Yu. Bunkov, V. Dmitriev, I. Fomin et al [6,7,8]; in the latter investigations the process of transfer of angular momentum is called "spin supercurrent".

It should be noted that Bunkov, Dmitriev, and Fomin were awarded the Fritz London Memorial Prize in 2008 for the studies of spin supercurrents in superfluid $^3\text{He-B}$.

The influence of spin supercurrent on a biological system is accomplished by the action of spin supercurrent on spins of virtual photons created by quantum objects constituting the biological system.

In 1949, R. Feynman for the denotation of force fields in his diagrams introduced virtual particles created by quantum objects [9]. The properties of the virtual particles depended on the interaction in which they were involved. For example, electric and magnetic interactions are accomplished by so-called virtual photons whose characteristics are analogous to photon's characteristics transferring electromagnetic oscillation as well. That is, they have precessing spin and the characteristics associated with it: the frequency of precession, the angle of precession, angle of deflection [10].

There are exist many examples of effective therapeutic action of spin supercurrent on biological systems: in homeopathy [11-15], in treatment with using of nanoparticles [16], in treatment with using of cavity structures [17]; in struggle with viruses [18], in ecology [19], in distant transmission of disease [20] and in combined action of low-intensity physical factors (including biologically active substances in ultra-low doses) and intensive physical and chemical factors in medicine [21].

The action of gamma-radiation on a biological system may be accomplished by spin supercurrent emerging between spins of photons constituting the gamma-radiation and spins of virtual particles created by quantum objects constituting the biological system. The value of spin supercurrent I_{ph-v} between photon and virtual photon in the direction of orientation of their spins' precession frequencies ω_{ph} and ω_v can be described by the expression:

$$I_{ph-v} = -b_1(\alpha_v - \alpha_{ph}) - b_2(\beta_v - \beta_{ph}), \quad (1)$$

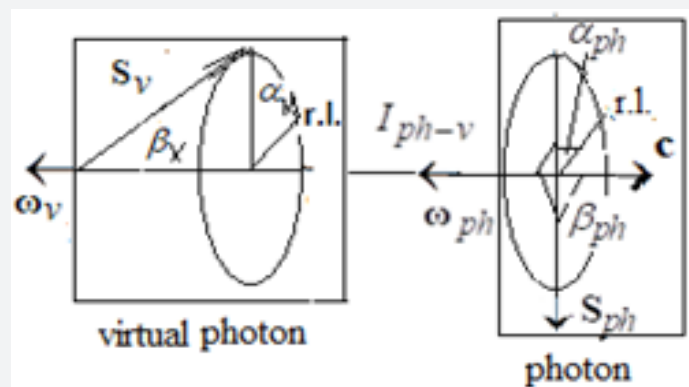


Figure 1: Schematic diagram of characteristics determining spin supercurrent I_{ph-v} . The characteristics of virtual photon: S_v is spin, ω_v is the frequency of precession, α_v is the precession angle measured from the reference line (r.l.), β_v is the angle of deflection. The characteristics of left-circular photon: S_{ph} is spin, ω_{ph} is the frequency of precession, α_{ph} is the precession angle measured from the reference line (r.l.), β_{ph} is the angle of deflection, c is the velocity. I_{ph-v} is spin supercurrent.

where coefficients $b_1 > 0$ and $b_2 > 0$ are dependent on the properties of the virtual photons. The photon's precession angles α_{ph} and virtual photon's precession angle α_v are determined from reference line (r.l.). The angle of deflection β_{ph} for photon is the angle between photon's spin S_{ph} and its precession frequency, ω_{ph} ; according to experiments of Weber and Kelvin [22] it equals $\pi/2$. The angle of deflection β_v for virtual photon is the angle between spin S_v and the direction opposite to precession frequency, $-\omega_v$. Schematic diagram of characteristics of spin supercurrent I_{ph-v} is given in Figure 1.

As follows from Eq. (1), the value of spin supercurrent I_{ph-v} and, consequently, the effectivity of action of gamma (γ) radiation on a biological system depends on the characteristics (precession angles α_v and deflection angles β_v) of spins of virtual photons created by quantum objects constituting the biological system. Changes in these characteristics are possible by using an

additional substance. Then, spin supercurrent I_{va-v} emerging between virtual photons created by quantum objects constituting the additional substance and virtual photons created by quantum objects constituting the biological system changes precession angles α_v and deflection angles β_v .

Schematic diagram of characteristics of spin supercurrent I_{va-v} is given in Figure 2. The virtual photon created by quantum object constituting an additional substance has the following characteristics: S_{va} is spin, ω_{va} is the frequency of precession, α_{va} is the precession angle determined from the reference line (r.l.), β_{va} is the angle of deflection.

The spin supercurrent I_{va-v} is determined by expression:

$$I_{va-v} = -b_1(\alpha_v - \alpha_{va}) - b_2(\beta_v - \beta_{va}). \quad (2)$$

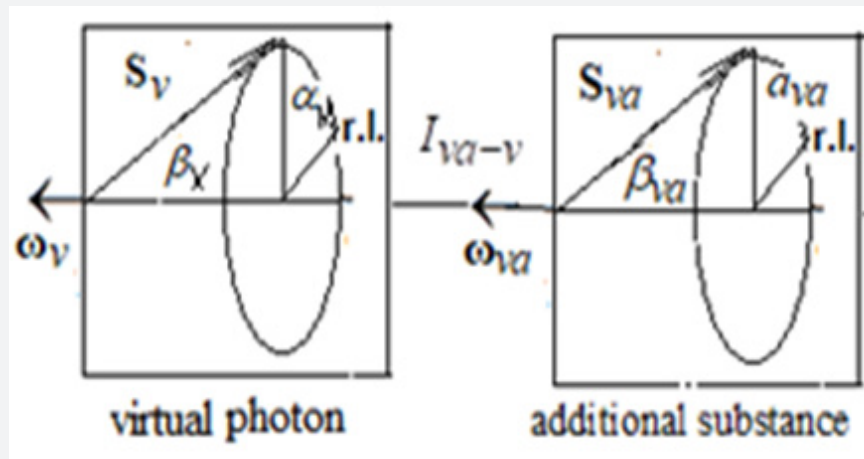


Figure 2: Schematic diagram of characteristics determining spin supercurrent I_{va-v} . The characteristics of virtual photon created by quantum object of the biological system: S_v is spin, ω_v is the frequency of precession, α_v is the precession angle measured from the reference line (r.l.), β_v is the angle of deflection. The characteristics of virtual photon created by quantum objects of the additional substance: S_{va} is spin, ω_{va} is the frequency of precession, α_{va} is the precession angle measured from the reference line (r.l.), β_{va} is the angle of deflection.

Spin supercurrent tends to equalize the respective characteristics of the spins of interacting virtual photons, that is, the following inequalities take place:

$$|\alpha_v - \alpha_{va}| \geq |\alpha'_v - \alpha'_{va}| \quad (3)$$

$$|\beta_v - \beta_{va}| \geq |\beta'_v - \beta'_{va}|, \quad (4)$$

where α'_v and β'_v are, respectively, the angle of precession and angle of deflection of virtual photon created by a quantum object of biological system after the action of spin supercurrent I_{va-v} ; α'_{va} and β'_{va} are, respectively, the angle of precession and angle of deflection of virtual photon created by a quantum object of additional substance after the action of spin supercurrent I_{va-v} . Thus, the action of spin supercurrent I_{va-v}

can change the characteristics of biological system and, consequently, influence on the characteristics determining supercurrent I_{ph-v} (Eq. (1)). Thus, using an additional substance before the action of gamma (γ)-radiation on the biological system, the effectivity of action of the γ -radiation can be changed.

In this work there are considered experiments indicating a possibility of using as “additional substances”, capable to decrease the effectivity of follow up influence of γ -radiation on biological systems, of the following physical phenomena: so-called “strange” radiation accompanying low-energy nuclear reactions [23,24], the radiation of operator [10,25], preliminary γ -radiation [26]. The possibility of therapeutic action of γ -radiation on a biological system [27] is considered as well. In Conclusion to this work it is considered a possibility of therapeutic action of field-free magnetic vector potential on the biological system irradiated preliminarily by γ -radiation [28,29]

The Experimental Data

The action of γ -radiation on a biological system activated by “strange” radiation

The results of the studies of electrical explosions of foils made from super-pure materials in water pointed to the emergence of new chemical elements, that is, to the emergence of low-energy nuclear reaction [30,31]. An additional finding was the emission of a so-called “strange” radiation accompanying transformation of chemical elements. It is shown in [24] that this radiation accompanying the nuclear reaction has all the properties of spin supercurrent.

The experiments were conducted demonstrating that the irradiation of animals by “strange” radiation changed the reaction

of these animals to subsequent irradiation of them by gamma (γ)-radiation. The studies were performed in the Russia in 2004 [23]. The “strange” radiation discharged during explosions of Ti foils in water and aqueous solutions. The dependence of characteristics (for example, the rate of micronuclei in the bone marrow erythrocytes) of animals on the total number of explosions of Ti foils in water and aqueous solutions was studied.

The animals used in the experiment were female mice of C57Bl/6 line aged 80 days with body weight 16–18 g. The cages with animals were placed at 1m from the explosion epicenter. Every cage was occupied by 20 mice of the control group or 17–20 mice of one of the three experimental groups.

The investigations were conducted in the following directions:

-the first experimental group was exposed to 3 explosions within the 1st day.

-the second experimental group was exposed to 3 explosions within the 1st day and 4 explosions within the 2nd day.

-the third experimental group was exposed to 3 explosions within the 1st day, 4 explosions within the 2nd day and 3 explosions within the 3d day.

The combined exposure to “strange” radiation and subsequent γ -irradiation at a dose of 600 rad are used in the experiment. To evaluate the genotoxic effect of “strange” radiation, the rate of micronuclei in the bone marrow erythrocytes was analyzed. The following factor was used: normalized number n_r of micronuclei in the bone marrow erythrocytes of mice. The value of n_r is determined as follows: $n_r = n / n_c$, where n is number of micronuclei in the bone marrow erythrocytes at arbitrary total number of explosions, n_c is number of those micronuclei at zero total number of explosions. The observed value n_r of micronuclei in the bone marrow erythrocytes in experimental groups of mice is shown in Figure 3.

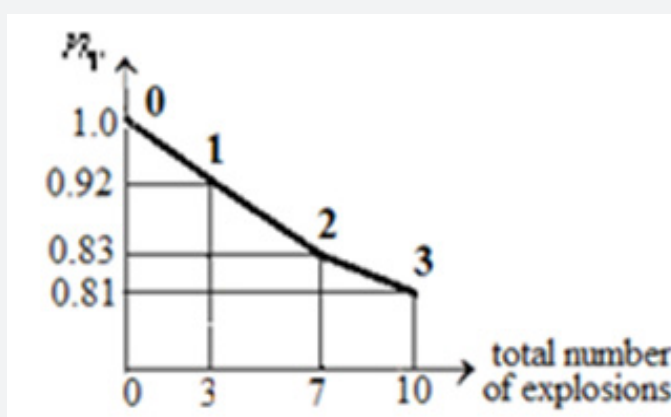


Figure 3: It is shown the normalized (related to rate of control group) rate n_r of micronuclei in the bone marrow erythrocytes in experimental groups of mice after the combined exposure to “strange” radiation and subsequent γ -irradiation at a dose of 600 rad.

Thus, the “strange” radiation induces changes in a biological system resulting in the increased resistance of the system to genotoxic exposures (the lethal doses of γ -radiation of 600 rad are used).

The action of γ -radiation on a biological system activated by operator’s influence

The experiments were conducted by researchers headed by V.I. Kartsev at an institute of the Russian Academy of Science (RAS) in 1991-1992 [25]. The researchers had the aim to analyze a capability of a human (operator M.V. Fatkin) to influence the vital functions of mammals for minimization of subsequent action on them of a lethal dose of γ -radiation (up to 900 rad). It is shown in [10] that the action of operator on a biological system is performed by spin supercurrent.

The experiments were conducted on adult hybrid mice of the first generation, the gray color line (CBA**C57B1/6*)F1; the females had the mass of approximately 25 g. All groups of animals of the same experimental series were exposed uniformly and

simultaneously to radiation of γ -source Cs-137. The control group of exposed animals was not subjected to the mental action of the operator. The irradiation of mice was conducted in five acrylic plastic pencil-cases placed horizontally above each other. In the course of the experiment, the irradiation field from the isotopic source Cs-137 was controlled by a reference dosimeter “Vacutronics” whose accuracy was 7 percent in the given region of γ -radiation spectrum. Measurements showed that the exposure doses in all pencil-cases were the same to within the measurement error. The electric, magnetic and thermal influences on mice after their irradiation with Cs-137 were excluded.

The number of exposed animals was 9 in the test group subjected to the influence of the operator; 10 in the control group which the operator did not act upon. The time of the operator’s influence was 15-20 min before the exposure (900 rad). The distance between the location of the animals and location of operator was about 1000 km.

Figure 4 shows the average (taking into account all tests) number of survived mice as a function of time (days) after the γ -exposure.

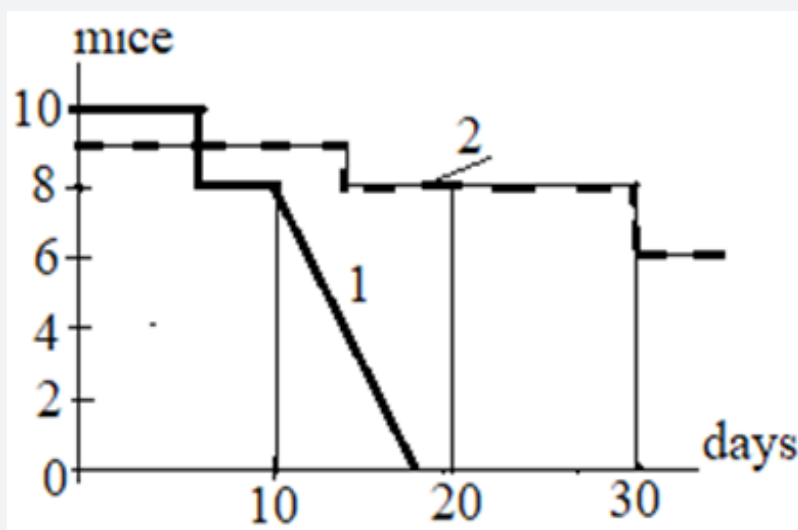


Figure 4: It is shown the number of mice which survived after γ -exposure (900 rad). Curve 1 refers to the control group; curve 2 refers to the test group subjected to the preventive influence of the operator.

Six mice from the test group have lived for no less than 1.5 years. The hair of all mice turned gray. The overall appearance and behavior of the animals were quite satisfactory. All animals in the control group that were exposed to γ -radiation but were not subjected to the mental action of the operator lived less than 20 days.

Thus, the obtained data suggest that the remote influence

of the operator has resulted in an increase in the resistance to radiation in laboratory animals (mice) which were exposed to lethal doses of γ -radiation: 900 rad.

Note. The period of time of operator’s habituation to test animals preceded the period of the registered influence of operator on animals [10].

The action of γ -radiation on a biological system “activated by the same γ -radiation”

There exist regions of the Earth in which the absorbed dose rate by a person is 1000 times greater than the average the permissible radiation rate - $0.35 \mu Sv$ /hour; for example, areas with a high concentration of minerals containing phosphates with an admixture of uranium and thorium – in India (Keral state), in Brazil (Espirito Santo State). However, the population survey did not reveal shifts in the data of morbidity and mortality [26].

As in those regions the population not only live but born as well, the spin supercurrent emerges between photons constituting γ -radiation and a subject when the latter is in embryonal state. The characteristics of subject in this case can significantly change and in accordance with the properties of spin supercurrent (see Eqs (2)-(4)) the emergence of equalities $\alpha_{ph} \approx \alpha_v$ and $\beta_{ph} \approx \beta_v$ is possible, where α_v and β_v are, respectively, the angle of precession and angle of deflection of virtual photon created by quantum object constituting the subject in embryonic state. Due to appearance of these equalities the spin supercurrent emerging over time between the photons constituting γ -radiation and virtual photon created by quantum object constituting the affected subject, according to Eq. (1), becomes negligible. Thus, γ -radiation cannot affect those who were born in the above considered regions.

The Possibility of Therapeutic Action of γ -Radiation on a Biological System

The possibility of therapeutic action of γ -radiation on a biological system can be connected with the following property of spin supercurrent: at a definite difference $\Delta\alpha_c$ in the precession angles (phases) of the spins of a photon of γ -radiation and a virtual photon created by quantum object of the biological system a precession phase slippage (drop) takes place [8,10]. The critical spin supercurrent $(I_{ph-v})_c$ between a photon of γ -radiation and a virtual photon created by quantum object of the biological system corresponds to value $\Delta\alpha_c$. The two cases of change in spin supercurrent during the precession phase slippage: with a change in the sign and without a change in the sign are shown respectively in Figure 5 (variants (a) and (b)). (As spin supercurrent transfers energy [32], the change in the sign of spin supercurrent's direction means the change in the direction of energy flow between interacting photon and virtual photon). The line a-b corresponds to the change in the supercurrent I_{ph-v} depending on the hypothetical difference in precession angles $\Delta\alpha = \Delta\omega \cdot t$, where $\Delta\omega$ is difference between precession frequencies of spins of virtual photons constituting the interacting objects, t is time. $(I_{ph-v})_{ps}$ is the residual current emerging after the phase slippage.

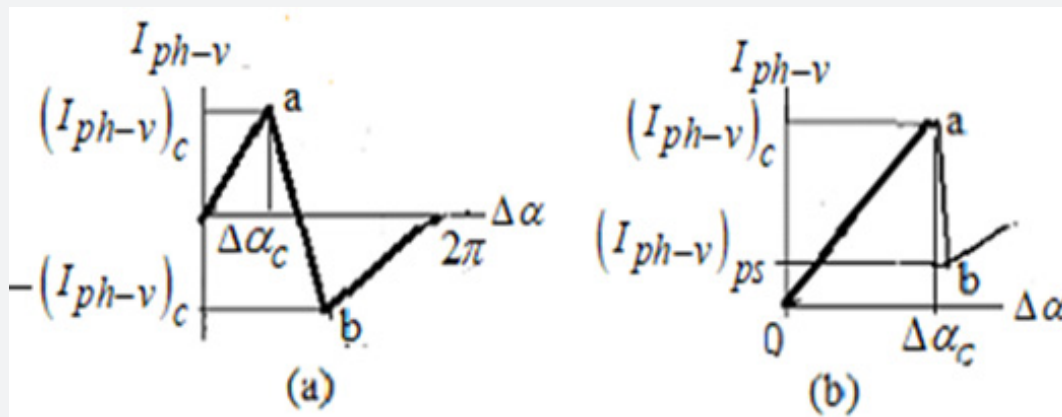


Figure 5: The variants of the dependence of spin supercurrent I_{ph-v} between interacting photon and virtual photon on the hypothetical difference in their precession angles $\Delta\alpha$. $(I_{ph-v})_c$ is the critical spin supercurrent. The line a-b corresponds to the phase slippage; $(I_{ph-v})_{ps}$ is the residual current; and $\Delta\alpha_c$ is the phase difference at which the phase slippage takes place.

In experiments investigating the influence of spin supercurrent on biological systems the cases of non-monotonous character of the influence occur very frequently [10].

In particular, the effect of precession phase slippage (drop) presents in experimentally obtained dependence (Figure 6) of hu-

man mortality (caused by leukemia) on the value of the equivalent dose d of ionizing radiation. The curve is based on the data collected under E. Burlakova's guidance in an RAS institute of the Russian Federation [10,27]. With regard to the death rate K , the ratio of the number of deaths per 100000 person-years to the number

of deaths caused by the equivalent dose d of about 23 mSv (2.3 rad) is used (the equivalent dose is a dose of radiation that takes into account the specificity of the action of any type of ionizing

radiation on a human biological tissue on the basis of weighted radiation factors).

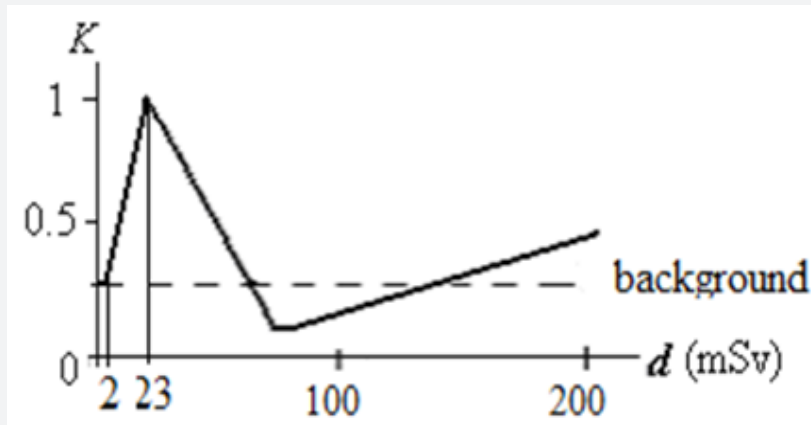


Figure 6: The type of dependence of human mortality (caused by leukemia) on the equivalent dose d . K is the ratio of the number of deaths per 100000 person-years caused by arbitrary value of d to the number of deaths at $d \sim 23$ mSv.

It is noteworthy that there is a range of values of d (at about 75 mSv), where the magnitude of K is less than that for the background value of d (about 2 mSv). It can be said that ultra-low doses of ionizing radiation in this range have a therapeutic effect [11-15].

Discussion. The Effect of Field-Free Magnetic Vector Potential on BS Preliminary Irradiated by γ -Radiation

In classical electrodynamics, the induction $\mathbf{B}$ of the magnetic field is determined [33] by equation $\mathbf{B} = \text{curl} \mathbf{A}$. If the magnetic field is shielded, that is $\mathbf{B} = 0$, it is possible that $\mathbf{A} \neq 0$ which is referred to as the field-free magnetic vector potential. In 1959, the possibility of influence by $\mathbf{A}$ on the characteristics of quantum objects, even though there is no electromagnetic field at the location of the objects was considered by Aharonov and Bohm [34]. It is shown in [10] that the action of field-free magnetic vector potential on quantum objects may be accomplished by spin supercurrent.

There exist experiments pointed on the possibility of therapeutic action of field-free magnetic vector potential $\mathbf{A}$ on a biological system irradiated preliminary by γ -radiation [28]. The device consists of permanent magnets of 150 mT magnetic induction and arranged in a form of torus. The field-free magnetic vector potential with the maximum value $\mathbf{A} = 3.5 \cdot 10^{-4} \text{ T} \cdot \text{m}$ while magnet-

ic field $\mathbf{B} = 0$, is created inside the torus.

The action of field-free magnetic vector potential on the characteristics of a biological system can be performed in two ways: the "direct" action and the "indirect" action with the use of an intermediate medium water. The schemes of devices for those ways of investigation are shown in Figures 7a ("direct" action) and 7b ("indirect" action). The experiments described below use the "indirect" action.

It follows from the experiments that water activated by field-free magnetic vector potential can accomplish a therapeutic action on a human exposed to ionizing radiation. Let us consider experiment in which γ -irradiation by ^{137}Cs source in dose of 100 rad of healthy donor's blood takes place. As a result, there was observed the appearance in lymphocytes of chromosome aberrations with rate δ_i considerably exceeding the background value δ_0 . However, the holding of irradiated blood of donor for an hour in water activated by field-free magnetic vector potential resulted in a decrease in the overall rate of the said aberrations by 20 percent. In absence of field-free magnetic vector potential the values of δ remains equal to δ_i (dashed dotted line in Figure 8).

Note. The experiments indicate that "indirect" action of field-free magnetic vector potential is stronger than "direct" [10,29,35]

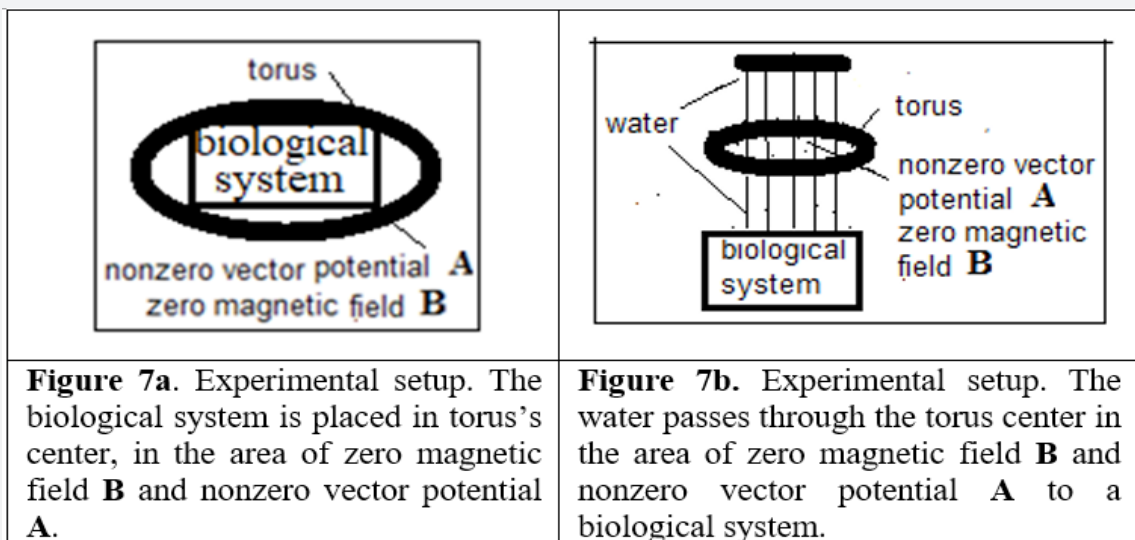


Figure 7: Figure 7a, Experimental setup. The biological system is placed in torus's center, in the area of zero magnetic field **B** and nonzero vector potential **A**. Figure 7b, Experimental setup. The water passes through the torus center in the area of zero magnetic field **B** and nonzero vector potential **A** to a biological system.

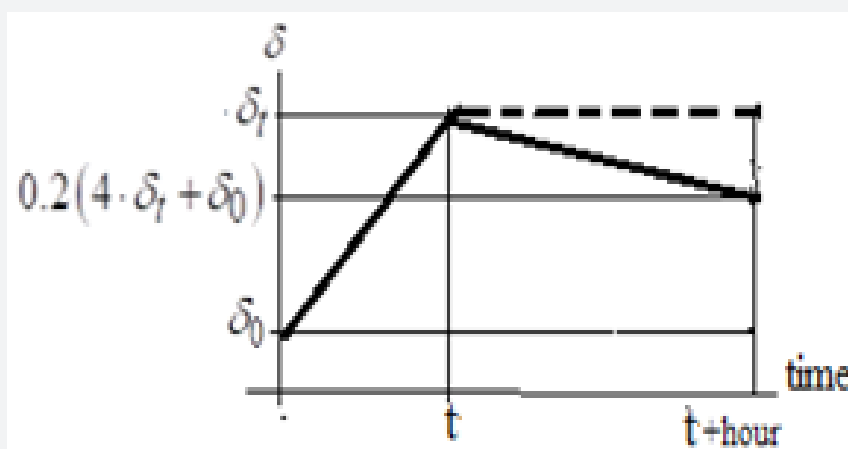


Figure 8: The rate δ in lymphocytes of chromosome aberrations. δ_0 is the background value. δ_t is the overall rate in lymphocytes of chromosome aberrations at time t at γ -irradiation by ^{137}Cs source. The time interval t ($t+\text{hour}$) is the time interval of action of water activated by field-free magnetic vector potential. The dashed dotted line response to the magnitudes of δ_t obtained without use of field-free magnetic vector potential.

Conclusion

The spin supercurrent accomplishes the influence of gamma (γ)-radiation on a biological system.

It has been proven experimentally that the following physical phenomena decrease the effectivity of influence of γ -radiation

on biological systems: the so-called “strange” radiation accompanying low-energy nuclear reactions, the radiation of a human operator, the field-free magnetic vector potential.

The possibility of therapeutic action of γ -radiation on a biological system was considered as well.

Conflict of Interest

No conflict of interest for this study.

Acknowledgement

None.

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