Application of Appratus for Magnetotherapy together with Amplipuls in Medicine

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Abstract – **"The healing effect of separate application of low frequency magnetic field generated by apparatus for magneto-therapy is well known in medicine. The healing effect of separate application of middle frequency electrical signals with amplitude modulation generated by apparatus, called amplipuls is also well known. But a simultaneously application of low frequency magnetic field generated by apparatus for magneto-therapy and middle frequency electrical signals with amplitude modulation generated by amplipuls is a new method in physiotherapy. The mathematical description and computer simulation of movement of ions in alive tissue in the case of simultaneously application of apparatus for magneto-therapy and amplipuls is the goal of present paper. These mathematical description and computer simulation are important not only for medical education , but for engineering education, also.**

Keywords - **low frequency, middle frequency, amplipuls, magnetotherapy, education.**

I. Introduction

The separate influence of apparatus for low frequency magnetic field for therapy of hand (for instance) can be seen on Fig.1

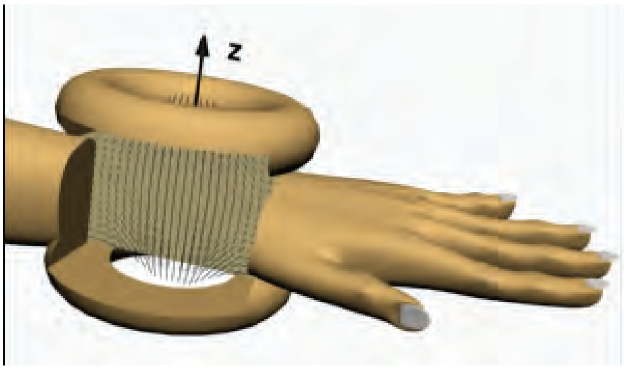

Fig1.Separate application of low frequency magnetic field for therapy of hand

On the Fig.2 can be seen different electrical signals generated by amplipuls. The influence of electrical field is on alive tissues is only on the base these 1D-signals in the case of separate application of amplipuls.

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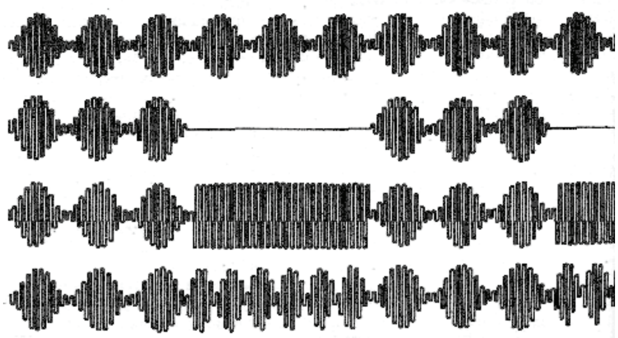

Fig.2.Otput signals of amplipuls

There are influence of two fields on the ions in alive tissues: electrical with intensity $\vec{E}(t)$ and magnetic with magnetic induction $\vec{B}(t)$ in the case of simultaneously application of apparatus for magneto-therapy and apparatus for middle frequency electrical signals with amplitude modulation called amplipuls(Fig.3).

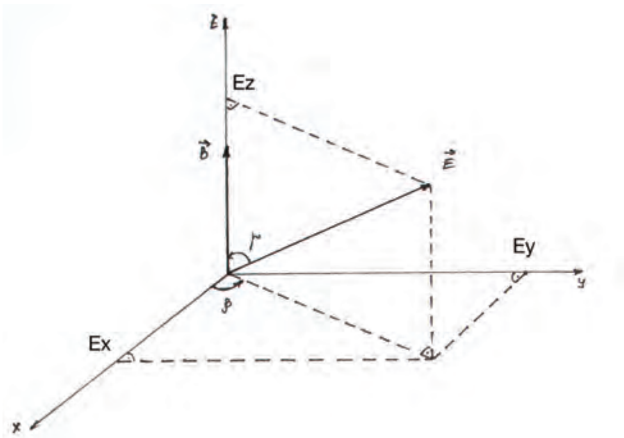

Fig.3 Influence of electrical and magnetic signals on the ion, which in the centre of coordinate systems X,Y,Z

II. Mathematical Description and Computer Visualization of Movement of Ions

A. Mathematical description

According to the Fig.3, in the case of simultaneously application of apparatus for magneto-therapy and amplipuls (simultaneously influence of two fields on the ions in alive tissues: electrical with intensity $\vec{E}(t)$ and magnetic with magnetic induction $\vec{B}(t)$), the movement of ions can be described using the differential equations:

$$
\begin{aligned}
&m_i \frac{d^2x(t)}{dt^2} = q[E(x,y,z,t)\sin\gamma\cos\beta + \\
&+ B(x,y,z,t)\frac{dy(t)}{dt}] \\
&m_i \frac{d^2y(t)}{dt^2} = q[E(x,y,z,t)\sin\gamma\sin\beta + \\
&+ B(x,y,z,t)\frac{dx(t)}{dt}] \\
&m_i \frac{d^2z(t)}{dt^2} = qE(x,y,z,t)\cos\gamma
\end{aligned}
\qquad (1)
$$

where:

$\vec{E}(x,y,z,t)$ is the intensity of electrical field;

$\vec{B}(x,y,z,t)$ is the magnetic induction;

m_i is the mass of ion;

β is the angle between axis X and projection of the vector of intensity of electrical field $\vec{E}(x,y,z,t)$ on the plane XOY;

γ is the angle between axis Z and vector of intensity of electrical field $\vec{E}(x,y,z,t)$;

If:

$$
\begin{aligned}
&\vec{E}(t) = \vec{E}_m(1 + m\cos\omega_1 t)\cos\omega_2 t \wedge \\
&\wedge \vec{E}_m(x,y,z) = const \wedge \vec{B}(x,y,z) = const \wedge \\
&\vec{B}(t) = \vec{B}_m \cos\omega_3 t \wedge m = const \wedge \omega_1 = const \wedge \\
&\wedge \omega_2 = const \wedge \omega_3 = const, \beta = \gamma = 45^\circ
\end{aligned}
\qquad (2)
$$

the equations (1) can be written as equations (2):

$$
\begin{aligned}
&m_i \frac{d^2x(t)}{dt^2} = q[E_m \sin\gamma\cos\beta(1 + \\
&+ m\cos\omega_1 t)\cos\omega_2 t + \frac{dy(t)}{dt}B_m\cos\omega_3 t] \\
&m_i \frac{d^2y(t)}{dt^2} = q[E_m \sin\gamma\sin\beta(1 + \\
&+ m\cos\omega_1 t)\cos\omega_2 t + \frac{dx(t)}{dt}B_m\cos\omega_3 t] \\
&m_i \frac{d^2z(t)}{dt^2} = qE_m\cos\gamma(1 + m\cos\omega_1 t)\cos\omega_2 t
\end{aligned}
\qquad (2)
$$

where:

m is the coefficient of amplitude modulation of electrical signals;

ω_1 is the frequency of low frequency electrical signal for amplitude modulation;

ω_2 is the frequency of carried electrical signal;

ω_3 is the low frequency of magnetic signal;

$\vec{E}_m$ is the amplitude of electrical intensity;

$\vec{B}_m$ is the amplitude of magnetic induction.

B. Computer visualization of movement of ions in alive tissues

The equations (2) can be solved by MATLAB. Their solutions can be investigated for different values of parameters. The solutions of equations (2) can be seen on Fig.4 in the case of movement of ions of Na^+ for the following values of parameters:

$$
\begin{aligned}
&\left|\vec{E}_m\right| = 200[V/m], \omega_1 = 2\pi 100[1/s], \\
&\omega_2 = 2\pi 4000[1/s], m = 1, \left|\vec{B}_m\right| = 30[mT], \\
&\omega_3 = 2\pi 50[1/s]
\end{aligned}
$$

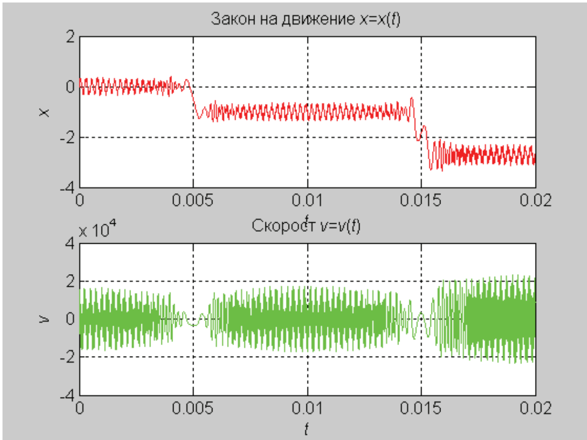

Fig.4a Movement and velocity of Na^+ ions on the axis X

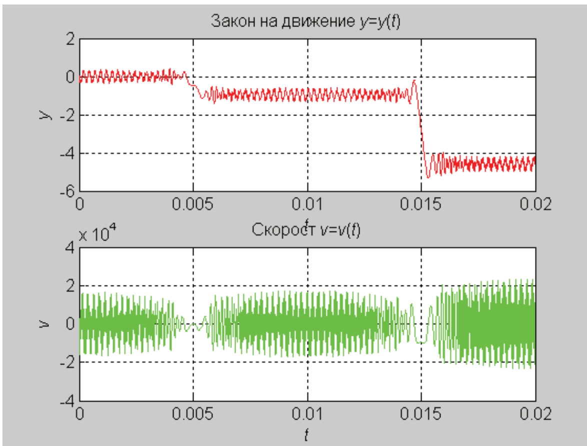

Fig.4b Movement and velocity of Na^+ ions on the axis Y

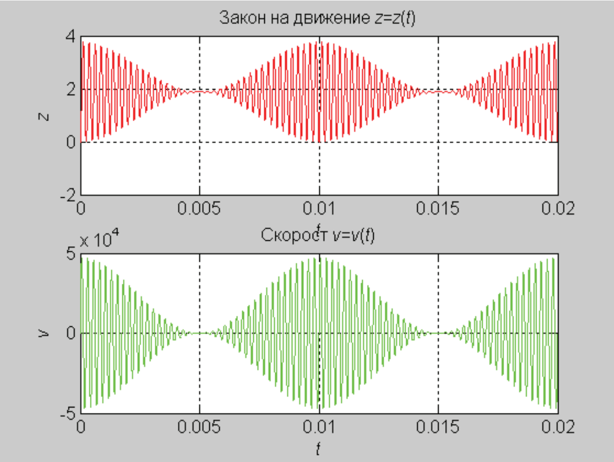

Fig.4c Movement and velocity of Na^+ ions on the axis Z

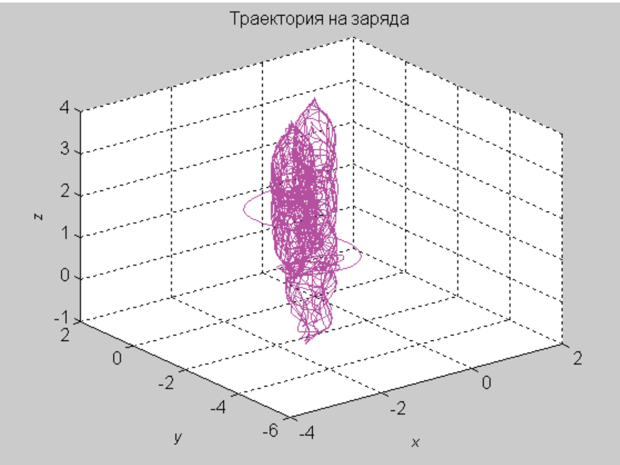

Fig.4d 3D -trajectory of movement of Na^+ ions

Separately on the axis X,Y and Z (Fig. 4a, Fig.4b and Fig.4c), the movements and velocities of ions are periodical because of the periodical “external” electrical and magnetic signals.The trajectory of movement of ions are 3D (Fig.4d). This is the main result of simultaneously application of apparatus for magneto-therapy and amplipuls. This is the main reason for obtaining of more fast healing effect.

The trajectory of movement of ions depends to the value of amplitude of carried electrical signals in the process of amplitude modulation in the apparatus amplipuls. The results of investigation of trajectory and velocity of ions in the case when

$$\left|\vec{E}_m\right| = 1[V/m], \omega_1 = 2\pi 50[1/s], \omega_2 = 2\pi 4000[1/s],$$

$$m = 1, \left|\vec{B}_m\right| = 30[mT], \omega_3 = 2\pi 50[1/s]$$

can be seen on the Fig.5.

The trajectories and velocities on the axis X,Y and Z are again periodical because of influence of periodical external electrical and magnetic signals , but there is lessening of values of amplitudes of functions of movements and velocities on the axis X,Y and Z. This effect is only because of decrease of the value of amplitude of carried electrical signals of amplipuls. The trajectory of movement of ions is again 2D. It’s clear that changes are only quantitative.

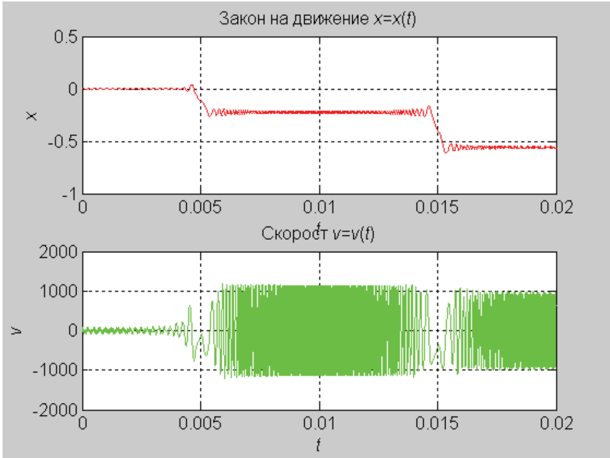

Fig. 5a Movement and velocity of Na^+ ions on the axis X

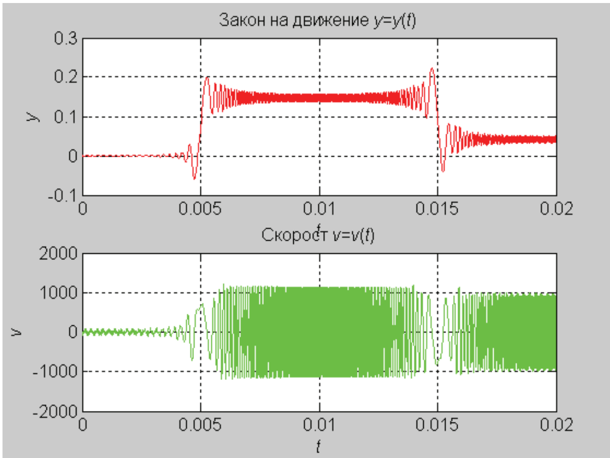

Fig.5b Movement and velocity of Na^+ ions on the axis Y

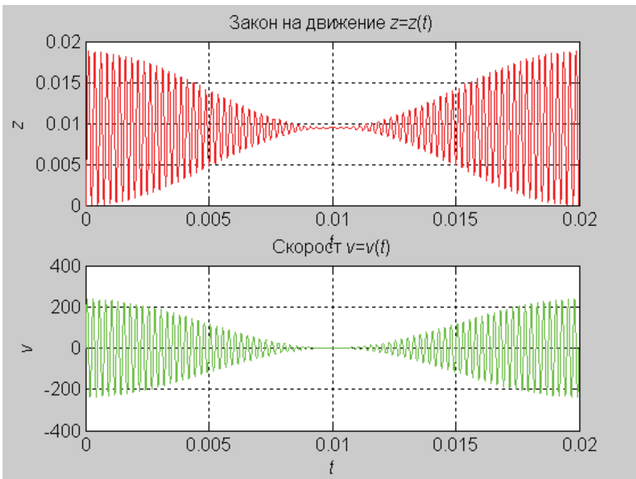

Fig.5c Movement and velocity of Na^+ ions on the axis Z

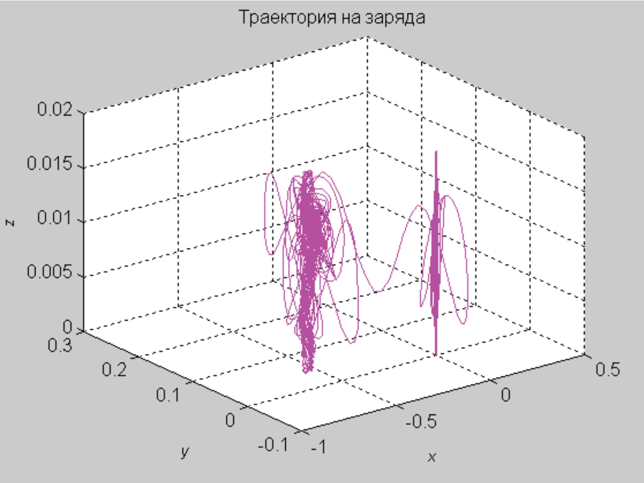

Fig.5d 3D -trajectory of movement of Na^+ ions

The trajectory of movement of ions depends to the values of angles β and γ (Fig.3). The results of investigations which can be seen on the Fig.4 anf Fig.5 are for the values of these angles $\beta = \gamma = 45^\circ$. The 3D trajectyory of movement of ions when

$$\left|\vec{E}_m\right| = 1[V/m], \omega_1 = 2\pi 50[1/s],$$
$$\omega_2 = 2\pi 4000[1/s],$$
$$m = 1, \left|\vec{B}_m\right| = 30[mT], \omega_3 = 2\pi 50[1/s],$$
$$\beta = 85^\circ, \gamma = 30^\circ$$

can be seen on Fig.6

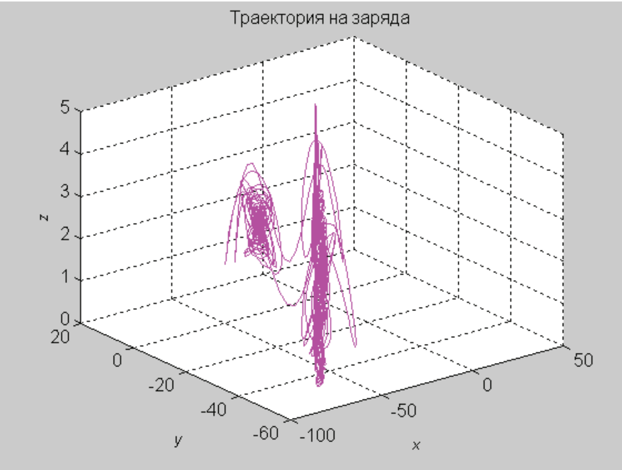

Fig.6 3D -trajectory of movement of Na^+ ions

It's clear that there is a rotation of 3D trajectory of movement of ions if the Fig.5d and Fig.6 would be compared. Of course the trajectory is periodical because the external electrical and magnetic signals are periodical.

III. Conclusion

1.A mathematical descriptions and computer simulation of movements of ions in alive tissues in the case of simultaneously application of apparatus for magneto-therapy and amplipuls is described in the paper.

2.An investigation of influence of different parameters of external electrical and magnetic signals on the movement of ions in alive tissues has been done in the paper.

3.It's clear that the trajectory of movement of ions is 3dD in the case of simultaneously application of apparatus for magneto-therapy and amplipuls.

4.The trajectories and velocities of movement of ions in alive tissues are periodical if the external electrical and magnetic signals are periodical.

5.The obtained results , described in the paper can be used not only as scientific and one base for development of medical therapy , using new more effective methods, but for presentation in the process of education, also.

References

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