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ELECTROAURAGRAMS OF MAN AND ANIMALS,(U)

SEP 77 P I GULYAYEV, V I ZABOTIN

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# FOREIGN TECHNOLOGY DIVISION



AIR FORCE SYSTEMS COMMAND

## ELECTROAURAGRAMS OF MAN AND ANIMALS

by

P. I. Gulyayev, V. I. Zabotin,
N. Ya. Shlippenbakh

FOREIGN TECHNOLOGY DIVISION





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# U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

| Block | Italic | Transliteration | Block | Italic | Transliteration |
|---|---|---|---|---|---|
| А а | *А а* | A, a | Р р | *Р р* | R, r |
| Б б | *Б б* | B, b | С с | *С с* | S, s |
| В в | *В в* | V, v | Т т | *Т т* | T, t |
| Г г | *Г г* | G, g | У у | *У у* | U, u |
| Д д | *Д д* | D, d | Ф ф | *Ф ф* | F, f |
| Е е | *Е е* | Ye, ye; E, e* | Х х | *Х х* | Kh, kh |
| Ж ж | *Ж ж* | Zh, zh | Ц ц | *Ц ц* | Ts, ts |
| З з | *З з* | Z, z | Ч ч | *Ч ч* | Ch, ch |
| И и | *И и* | I, i | Ш ш | *Ш ш* | Sh, sh |
| Й й | *Й й* | Y, y | Щ щ | *Щ щ* | Shch, shch |
| К к | *К к* | K, k | Ъ ъ | *Ъ ъ* | " |
| Л л | *Л л* | L, l | Ы ы | *Ы ы* | Y, y |
| М м | *М м* | M, m | Ь ь | *Ь ь* | ' |
| Н н | *Н н* | N, n | Э э | *Э э* | E, e |
| О о | *О о* | O, o | Ю ю | *Ю ю* | Yu, yu |
| П п | *П п* | P, p | Я я | *Я я* | Ya, ya |

*ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ë in Russian, transliterate as yë or ë. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

## GREEK ALPHABET

| | | | | | |
|---|---|---|---|---|---|
| Alpha | Α | α | Nu | Ν | ν |
| Beta | Β | β | Xi | Ξ | ξ |
| Gamma | Γ | γ | Omicron | Ο | ο |
| Delta | Δ | δ | Pi | Π | π |
| Epsilon | Ε | ε ϵ | Rho | Ρ | ρ ϱ |
| Zeta | Ζ | ζ | Sigma | Σ | σ ς |
| Eta | Η | η | Tau | Τ | τ |
| Theta | Θ | θ ϑ | Upsilon | Υ | υ |
| Iota | Ι | ι | Phi | Φ | φ ϕ |
| Kappa | Κ | ϰ κ | Chi | Χ | χ |
| Lambda | Λ | λ | Psi | Ψ | ψ |
| Mu | Μ | μ | Omega | Ω | ω |

## RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

| Russian | English |
|---|---|
| sin | sin |
| cos | cos |
| tg | tan |
| ctg | cot |
| sec | sec |
| cosec | csc |
| sh | sinh |
| ch | cosh |
| th | tanh |
| cth | coth |
| sch | sech |
| csch | csch |
| arc sin | $\sin^{-1}$ |
| arc cos | $\cos^{-1}$ |
| arc tg | $\tan^{-1}$ |
| arc ctg | $\cot^{-1}$ |
| arc sec | $\sec^{-1}$ |
| arc cosec | $\csc^{-1}$ |
| arc sh | $\sinh^{-1}$ |
| arc ch | $\cosh^{-1}$ |
| arc th | $\tanh^{-1}$ |
| arc cth | $\coth^{-1}$ |
| arc sch | $\mathrm{sech}^{-1}$ |
| arc csch | $\mathrm{csch}^{-1}$ |

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| Russian | English |
|---|---|
| rot | curl |
| lg | log |

## GRAPHICS DISCLAIMER

**All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.**

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# MACHINE TRANSLATION

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In the interest of economy and timeliness, the original graphics have been merged with the computer output and editing has been limited to that necessary for comprehension. No further processing is anticipated.

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# ELECTROAURAGRAMS OF MAN AND ANIMALS.

P. I. Gulyayev, V. I. Zabotin, N. Ya. Shlippenbakh.

Laboratory of physiological cybernetics.

Hypotheses about the existence of electromagnetic field in space (in air) around nerve, muscle, the heart, the brain, which generate during its activity alternating electric currents, were presented repeatedly already more than 100 years ago. Thereby to less reliably measured this field for long could not be due to the absence of the corresponding equipment. According to the spectral characteristics of bioelectric momentum/impulse/pulses, frequency of these fields they correspond to the range of very long and long waves (from 3 km and more).

On this theme there is a comparatively small number of scientific works, whereupon contradictory according to its results also in majority not confirmed.

The electric field component of the action potentials of the isolated/insulated nerve of frog was reliably recorded for the first time in 1949 by the Americans Burr and Mauro (Burr, Mauro, 1949). Sensor was the extension unit of input amplifier stage with the fastened to its entrance metallic electrode in the form of disk. The input impedance of amplifier was on the order of $10^9$ ohm; however, in the article it is not shown, on which frequency it was measured, and other data relative to the construction of sensor given. The maximum distance, at which Burr and Mauro was possible to record the field of nerve, was 12 mm.

At Leningrad university we carried out several public demonstrations of the electric fields, appearing in space (air) around living objects. Under term "field" in this case we understand the external electric field, which is generated in space (air) around object (nerve, muscle, heart) because of a potential difference between excited and unexcited by sections on the surface of this object. Demonstrations were conducted in the society of the specialists - the biologists, the physicists, the physicians, the engineers and the mathematicians. The first demonstration took place on 13 February 1967 and convinced the most distrustful specialists in the possibility of successful recording these fields at close (to 25 cm.) distances from biological object. Recordings were conducted by the measurement of the variable component of the electric potential of near field, under conditions of the screening of biological object from external electric (in essence electrostatic) interferences, in the frequency band from 10 Hz to 10 kHz. The notation of recording electric field we call electroauragram (EAG).

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This term must mean that is measured the electric (but not magnetic) field in air (aura = air, airspace, glow), and not in the tissues of body or the liquid media of organism. The totality of the methods of recording electric the components of these fields we call electroauragraphy or simply - auragraphy (Gulyayev, etc., 1967). Respectively, the removal/diversion of the potential of field in air we call aural removal/diversion.

The sensor of field (aura-sensor), designed by aspirant V. I. Zabotin, is the highly sensitive amplifier, to entrance of which is connected metal electrode - probe. The amplifier of the aura-sensor, in turn, is the high-speed electrometric repeater with low inherent noise level and high input impedance. It is constructed according to the ~~schematic~~ of complex cathode follower according to parallel ~~schematic~~ (Gribanov, 1961; Brewer, 1953; Krakauer, 1953). The calculation of these ~~schematics~~ is given in the book of K. E. Erglis and I. P. Stepanenko (1964). The aura-sensor is constructed on Soviet tubes EM-4 and Zh-18B and is structurally designed in the form of extension unit with ~~size/~~dimensions of 150 × 70 × 40 mm. As probes are used interchangeable metallic disks ~~from~~ 0.2 to 10 cm. in diameter, connected ~~up~~ the ~~entrance~~ of the amplifier of the aura-sensor. The input capacitance of amplifier was 0.05 pF during resistance $10^{12}$ ohm. The ~~actual stress~~ of the inherent noise, converted ~~for~~ the ~~entrance~~ of amplifier in the frequency band ~~from~~ 10 to 500 Hz, comprised: ~~upon~~ the short-circuited ~~entrance~~ - less than 7 μV, with diameter of probe 6 and 0.2 cm. ~~are~~ 0.1 and 0.5 mV respectively. Signal from the output~~/yield~~ of sensor entered the asymmetric ~~entrance~~ of two-beam oscillograph with the maximum sensitivity of 60 μV/mm. To the second ~~ray/~~beam could simultaneously be ~~supplied~~ any other signal. The gain control and band produced in the amplifier of oscillograph. In parallel to the output~~/yield~~ of the aura-sensor ~~they~~ connected electron-tube millivoltmeter with ~~arrow~~ reading for recorling super-slow fluctuations of field (0.1-1 Hz). To the output~~/yield~~ of oscillograph could be connected the sound producing ~~setting up~~ for recording "on the audition" of the signals, entering from the output~~/yield~~ of sensor. Investigations were conducted within the shielded grounded chamber ~~by size/~~dimensions of

2150 X 660 X 650 mm, ~~by the~~ made from sheet iron with thickness of 0.8 mm: one side of the chamber was curtained by iron grid - blind. Within the chamber was ~~arrange~~/located the aura-sensor and the investigated object, ~~entire~~/all remaining equipment was placed outside the chamber.

INVESTIGATIONS ON FROG.

Investigations on the isolated/~~insulated~~ nerve. One of the installations for the removal/~~diversion~~ of the EAG of the nerve of frog (n ischiadicus, R temporaria) is similar to that, which ~~that~~ was described in the work of the American researchers (Burr, Mauro, 1949). Nerve was ~~arrange~~/located horizontally, at a distance of approximately 5 cm from the grounded surface (Fig. 1). Essential supplement was the shielding of the stimulated ~~irritated~~ section of nerve, than was possible to completely remove the field of the artifact of stimulation and ~~to~~ record the only field of nerve. Figure 2 depicts those (obtained by us) EAG of nerve.

Is determined the experimental dependence of the intensity of field from distance to nerve (Fig. 3), expressed directly in ~~the~~ values of the fundamental characteristics of field (potential, intensity/~~strength~~). It is similar to the dependence, obtained by Burr and Mauro, where the function of distance was the voltage/~~stress,~~ directed at the ~~entrance~~ input of their amplifier of sensor.

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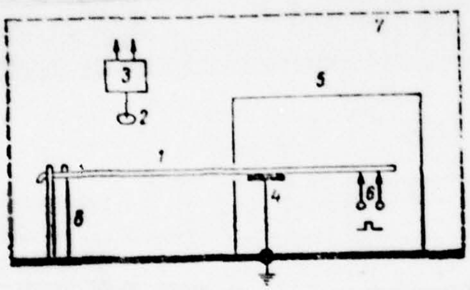


Fig. 1. Measuring circuit of the electropotential of the field of the sciatic nerve of grass frog in air. 1 - the sciatic nerve of frog; 2 - the discharge probe; 3 - the preamplifier: 4. silver plate; 5 - metal screen; 6 - ~~the~~ stimulating electrodes; 7 - working chamber; 8 - support/~~socket~~ made of ~~organic~~ glass-like plastic

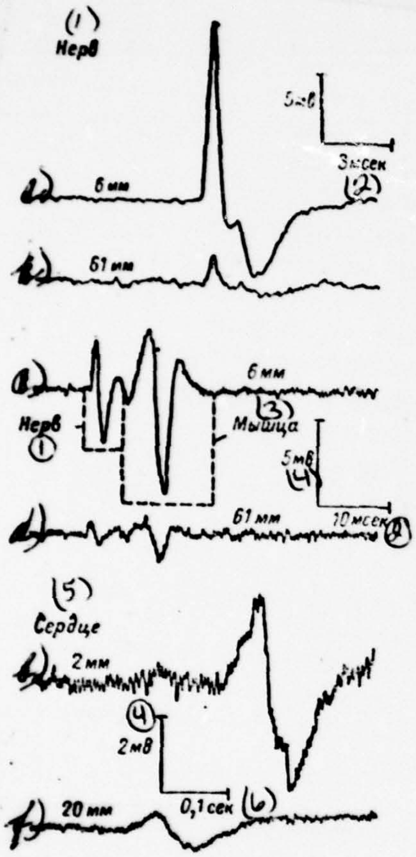
(1) Нерв
5мв
3мсек (2)
6 мм
61 мм
6 мм
(3) Мышца
Нерв (1)
5мв (4)
10мсек (2)
61 мм
(5) Сердце
2 мм
(4) 2мв
0,1 сек (6)
20 мм

Fig. 2.

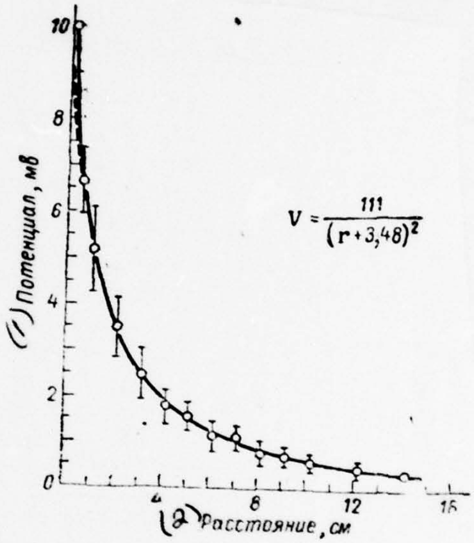
(1) Потенциал, мв
(2) Расстояние, см
V = 111 / (r+3,48)²

Fig. 3.

Fig. 2. Electroauragrams (EAG) and electroauracardiograms (EAKG) of frog. a) is the isolated/~~insulated~~ sciatic nerve, recording from distance of 6 mm, probe is a disk Ø 1.2 cm., the band of frequencies Δf = 10-500 Hz, input ~~entrance~~ (+) (beam deflection upward corresponds to the development of the electrical positiveness of the potential of the field of nerve); b) the same, recording from distance of 61 mm (on ~~to~~ EAG are noticeable the inherent noise of aura-sensor); c) the neuromuscular preparation of frog (sciatic nerve - calf muscle), recording from distance of 6 mm above muscle, the filter of passband is ~~establish~~/installed at ~~to~~ the maximum of amplification at frequency of 500 Hz, probe - disk Ø 1.2 cm., input ~~entrance~~ (+); d) is the same, recording from distance of 61 mm; e) ~~is a~~ heart, recording from distance of 2 mm in the air above the head of ventricle, Δf = 5-50 Hz, probe ~~is a~~ disk Ø 0.5 cm., input ~~entrance~~ (+); f) the same from distance of 20 mm, probe ~~is a~~ disk Ø 6.5 cm. from current-conducting paper.

Key: (1). Nerve. (2). ms. (3). Muscle. (4). mV. (5). Heart. (6). s.

Fig. 3. Graph/~~diagram~~ of the experimental dependence of the amplitude of the potential of the field (V) of the sciatic nerve of frog on distance (r). Probe ~~is a~~ disk Ø 1.2 cm. Vertical lines - the boundaries of the scatter of experimental points for six preparations (with r = 14.1 cm. is made only one measurement); dashed ~~dotted~~ line is a section of curve, calculated from the approximating equation and

diverging with experimental curve (solid line).

Key: (1). Potential, mV. (2). Distance, sec

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We have found the formulas, which approximate this dependence and the numerical coefficients with them:

$$V = \frac{K_1}{(r + K_2)^2}; \quad E = \frac{2K_1}{(r + K_2)^3},$$

where V is amplitude of the potential of the field of nerve (mV); E - the amplitude of the strength of the field of nerve (mV/cm); r - distance upward from the middle of nerve (cm.); $K_1$ = 111 (mV • cm²); $K_2$ = 3.48 (cm) - constant values.

The more detailed measurements of field in the different points of the which surrounds nerve space were conducted with the aid of the stimulating device (Fig. 4) of the special construction, where the nerve was suspended vertically approximately in the center of the volume of the chamber, i.e., at the maximum removal/distance from metallic walls. In this case was provided power feed to the nerve of the wetting physiological solution. It is reveal/detected that in this position the rotation of nerve around its longitudinal axis had no effect on amplitude and form of FAG; consequently, the field of nerve is axisymmetric. Are experimentally acquired data on the dependence of the decrease of the intensity of the field of nerve on distance along horizontal on its middle and on vertical line on free end. Is given electrotechnical analysis and explanation of forms and differences in the form of the FAG, removed at the different points of space around nerve (Zabotin, 1968). Experimentally the obtained dependences of the amplitude of field on distance are in good agreement with those, which we have obtained theoretically, on the basis of methods of the solution of problems in electrostatics.

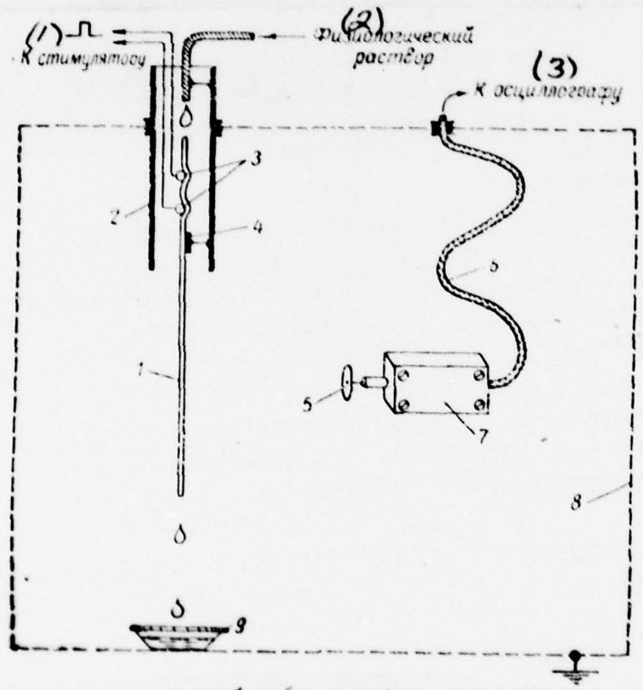


Fig. 4.

Fig. 4. Installation diagram for the removal/~~diversion~~ of electroauragram with the vertical suspension of nerve. 1 - nerve; 2 - cylindrical screen; 3 - the stimulating electrodes; 4 - the grounding plate; 5 - probe; 6 - the shielded cable; 7 - aura-sensor; 8 - the shielding chamber; 9 - vessel for the collection of the wetting solution.

Key: (1). To stimulator. (2). Physiological solution. (3). To oscillograph.

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~~The~~ significant (in volume) part of our investigations was allotted to the question: are not the obtained recordings the result of action on the aura-sensor of the disregarded factors? The application/~~use~~ of usual physiological methods of investigation ~~for~~ the artifacts: the cutting of nerve, the wetting of it with ammonia, the replacement by ~~the~~ f~~ilament~~, moistened with physiological solution, ~~it~~ led to the disappearance of field. At the same time ~~for~~ the EAG of undamaged/~~uninjured~~ nerve distinctly observed such phenomena as refractoriness, the thresholds of amplitude - duration and others, ~~the~~ well-known (to electrophysiologists) laws. The latter indicates that the electric field is the data carrier about the physiological state of nerve. Was investigated also the effect of the mechanical vibrations of the nerve: rapping by solid object/subject against the support/socket, on which was fix/recorded the nerve, the reproduction of loud sounds near nerve and aura-sensor. Finally, was conducted the replacement of nerve by the bare metallic wire, to which was supplied the voltage 30 mV, 300 Hz frequency; in this case the amplitude of field and the character/nature of its dependence on distance remained the same as and during the passage of nerve impulse along nerve. It is calculated, that the amplitude of the mechanical vibrations of nerve, capable of causing the recorded changes in the field, must be order 1 cm, and is easy to observe by rule of thumb. The corresponding calculations showed also that the effect of the intrinsic conduction of air under any conditions remained negligible. From foregoing is made the final conclusion: recorded EAG are nothing else but changes of the potential of the field, created in space (in air) because of electric processes in nerve during the passage along it of nerve impulse.

From the analysis of a series of the works, which relate to recording the magnetic field component of the action current of nerve (Krayukhin, 1938, 1948; Khvedelidze, et al., 1965; Gengerelli, 1942, 1943; Gengerelli et al., 1961, 1964; Seipel, Morrow, 1960; Stratbücker, Hyde, Wixson, 1963), it follows that the positive results, described in these works, could be the consequence of the action of electric field component on the winding of the induction sensors, electrostatic screening of which was not provided for. In favor of this confirmation speaks the ~~discrepancy~~ contradictoriness of the obtained (by them) results. Our tentative calculations show that at the existing values of the achieved/~~reached~~ sensitivity of magnetic sensors (for example, $10^{-6}$-$10^{-7}$ A/m, per Valeyev, 1967) similar measurements are impossible. In all probability, by this are explained clearly the negative results, obtained by Khvedelidze with co-authors (1965) during their attempt to record the field of nerve by induction magnetic sensors.

The total analysis of the different works, which relate to the question of ~~auto/~~self-generation by ~~the~~ biological objects of electromagnetic low-frequency fields, makes it possible to make the conclusion that the selected (by us) method of recording these fields precisely on electric component is, on the basis of the contemporary level of the development of metrology, most successful.

Investigations on muscle and heart. The muscle of the isolated/~~insulated~~ neuromuscular preparation (n. ischiadicus, m. gastrocnemius) ~~they~~ were ~~dilate/~~extended between two ~~stops~~ supports from fiberglass so that muscle could not change its length during excitation. ~~They~~ From above was fed ~~on top~~ the sounding electrode of aura-sensor. Nerve ~~they/~~ was ~~irritated~~ stimulated by single stimuli. From the obtained EAG (Fig.

2c, d) it is evident that initially appears the field of nerve, and then - the field of muscle. Electroauramyogram (EAMG) have recorded we at distances up to 25 cm.

Auragraphic investigations on heart are interesting in that relation, that the heart is hunting system, and no artificial stimulators for its excitation are required.

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Electroauracardiogram (EAKG) above the opened thoracic cavity of frog (R. temporaria) is recorded at a distance to 20 mm in air from the surface of the exposed heart (Fig. 2e, f). Comparison of EAKG with EKG (electrocardiogram), obtained by the direct imposition of probe on the surface of the heart of the same frog, it showed isomorphism and the identical time characteristics (distance between the apex/vertexes of peaks) of both removal/diversions. The obtained results attest to the fact that was recorded precisely the bioelectric field, but not the artifacts, connected with the mechanical pulsations of heart. This was confirmed in the investigations, carried out with the aid of the electron analogue of heart, which is mechanically motionless voltage generator EKG.

Electric fields, which appear around man as a result of the activity of his heart and muscles.

The convincing results, obtained in experiments on the isolated/~~insulated~~ organ/~~controls~~, made it possible to approach toward investigations on intact, ~~undamaged/~~uninjured organisms. The test experiments are, carried out on frog, not ~~the distance of~~ distinct results. Further investigations were conducted on man. In this case it was assumed that the body of man, taking into account his geometric dimensions, is more powerful emitter, than, for example, frog. The most intense electric generator of our body is the heart. The amplitude of ~~stress~~ EKG with direct ~~removal/diversion~~, for example leg - head, can reach 5 mV.

Recording the EAKG of man produced in the same shielded chamber. The tested was ~~arrange/located~~ lying, on soft ~~littering~~, head ~~it~~ rested upon cushion. The experiment showed that most favorable for the removal/~~diversion~~ of EAKG is the space overhead of tested. This unexpected fact finds its explanation in ~~particular~~ the structure of the field of the heart of man; the approximate ~~picture~~ of this field ~~have~~ obtained ~~we~~ by the method of modelling on electro-conductive paper (Fig. 5). Usual clothing on the body of tested virtually does not impede the removal/~~diversion~~ of EAKG. Therefore the majority of experiments was conducted on tested in their daily clothing. Recording of EAKG is possible both in the absence and when the grounding of the body of tested is present. In the latter case was observed a change of amplitude and form of EAKG up to reverse, depending on the place of application of grounding electrode. Detailed investigations were conducted under conditions, close to natural, i.e., with the grounding of legs. The grounding of immediately both legs or only one did not introduce noticeable changes in the form and amplitude EKG from head and EAKG near the head. Usually was grounded the left strut, and to right was fastened electrode for simultaneous recording EKG from legs. By this was eliminated the distortion of field in the field of head. Actually, the recorded overhead EAKG (Fig. 6a) underwent no noticeable changes depending on whether was conducted simultaneous removal/diversion from legs or not. If both removal/diversions would be conducted from one place (for example, head), then three-dimensional/space configuration is unavoidably distorted by the presence of the conductor, connected with the superimposed in this place electrode. The notation of simultaneous recording of EKG from legs and EAKG near head showed the synchronism of repetition periods and coincidence in time of tooth points R of both removal/diversions.

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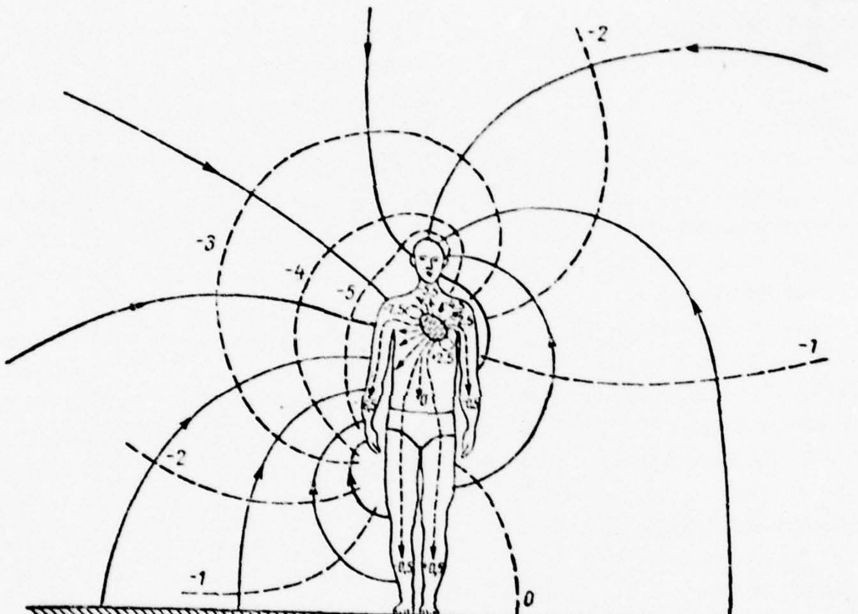


Fig. 5.

Fig. 5. Frontal sketch of the aural field of the heart of man ~~into~~ at one of the ~~torque~~/moments of his activity (maximum of tooth R). Num~~erals~~ bers ~~are a~~ value of potential in mV; arrow~~/pointer~~s - the direction of field lines. Man stands on the conducting surface (earth~~/ground~~).

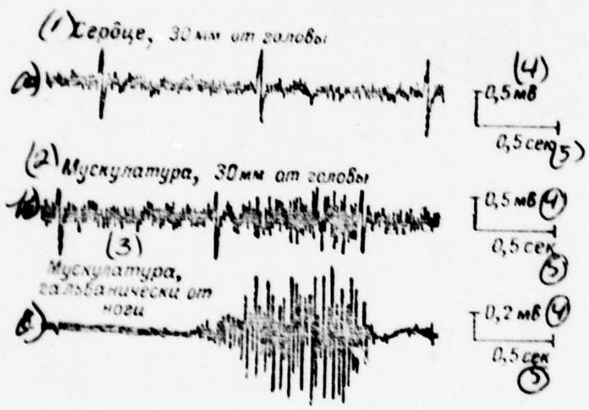


Fig. 6. Electroauracardiograms (EAKG) and electromyogram (EMG) of ~~removal/diversion~~ lead from the right ~~digit~~ leg of man. a) electroauragram,

recorded from distance from the surface of ~~front~~ forehead 30 mm $\Delta f$ = 25-50 Hz, probe ~~is a~~ disk Ø 6 cm., entrance (-), the position of one tested lying, in clothing, the left ~~strut~~ leg is grounded; b) the same, $\Delta f$ = 50-250 Hz, probe ~~is a~~ disk Ø 6 cm., ~~entrance~~ input (-), the position of one tested lying, in clothing, the left ~~strut~~ leg is grounded. Are noticeable: EAMG and EAKG; c) the electrogram of galvanic removal/~~diversion~~ from the right ~~strut~~ leg, made simultaneously with recording of b, $\Delta f$ = 10-10000 Hz, ~~entrance~~ input (+). Are noticeable: EMG and EKG.

Key: (1). Heart, 30 mm from head. (2). Musculature, 30 mm from head. (3). Musculature, galvanically from leg. (4). mV. (5). s.

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A similar picture was observed when probe came into contact with the surface of ~~front~~ forehead, i.e., during simultaneous recording of two removal of/~~diversions~~ EKG: leg ~~are a~~ leg and leg ~~is a~~ head. It was established that the EAKG is always isomorphous with EKG, ~~abstract~~/removed from nearest to the probe ~~of~~ the point of body, if only distance from probe to the surface of the body is short (several cm). These results sufficiently convincingly ~~they~~ speak about the fact that obtained recordings of EAKG are ~~notation~~ recording of ~~the~~ precisely bioelectric field of heart.

In order that it is final to be convinced of the fact that the obtained notations are not recordings of the mechanical pulsations of the body surface of tested, was placed the series of scale-model experiments. As the source of voltage/stress EKG, free from mechanical vibrations, applied the developed in us construction of the electron analogue of heart, which is the analog of the electric and functional processes of heart muscle as a whole. The spherical glass bulb, which imitates head, was filled with the salt (physiological) solution, in which was immersed the iron core. From the output/yield of the electron analogue of heart was supplied to rod the voltage/stress, which was establish/installed by the approximately equal in amplitude to voltage/stress EKG leg - the head of man (several millivolt). The electroauragrams which were observed at different distances from bulb/flask, in their form and amplitude seemed not distinguished at first glance from the electroauragram usually observed in man. The analysis of the obtained photographs showed that the level of low-frequency fluctuations in scale-model experiments was considerably below. Consequently, the EAG of man contains the supplementary, besides EAKG, information about mechanical pulsations and the motions of his body, random and involuntary. At the same time the imposition of the electric fields, caused by mechanical pulsations, is not the factor, which blocks recording of EAKG. The greatest distance, at which it was possible (under our conditions) to obtain recordings of the EAKG of man, is 25 cm.

Recording of field in immediate proximity of the contracting ~~being reduced~~ muscles of man under our conditions did not give convincing results. Reason for this - intense low-frequency fluctuations because of the mechanical vibrations of the surface of the skin near the con- ~~being~~ tracting ~~reduced~~ (or strained) muscles. Nevertheless the electric field (in air) of the of action potentials of musculature - electroauramyogram (EAMG) of man ~~it~~ was reliably recorded by us under appropriate conditions of the setting of experiment. In one of such procedures, repeatedly applied in public demonstrations, was utilized the remarkable physiological special feature/~~peculiarity~~ of our hearing ~~audition~~ to effectively distinguish signals against the background of intense fluctuation noises. In this case there was utilized the connected to ~~for~~ the output/~~yield~~ of oscillograph sound producing apparatus ~~setting up~~.

The experiment, in which it was possible to documentally record the EAMG of man, consisted of the following. The tested one was ~~arrange~~/located within the shielded chamber, precisely ~~it is accurate~~ under the same conditions as during recording of EAKG. The probe of aura-sensor was ~~arrange~~/located ~~into~~ 3 cm above the surface of forehead ~~of front~~. The left leg ~~strut~~ was ~~they~~ grounded, and the fastened on ~~with~~ the right leg ~~strut~~ electrode was ~~they~~

connected with the ~~entrance~~ input of the preamplifier of the second light beam of oscillograph. To tested they proposed to rapidly strain and ~~to~~ weaken the musculature of legs, remaining as far as possible motionless. On the obtained electroauragrams (Fig. 6b) ~~are~~ there simultaneously are visible; the EAKG of heart and EAMG of the strained muscles of legs, which coincides in time with that which is ~~abstract~~/removed simultaneously from the right ~~strip~~ leg electromyograms (electromyogram of ~~usual~~ standard removal/~~diversion~~) (Fig. 6c) both on an interval of duration and on separate peaks.

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Consequently, the electric field, which appears because of the biopotentials of the ~~being reduced~~ contracting musculature of legs, radiates simultaneously by an entire body surface and can be recorded in the ~~field~~ region of head. The distinctive special feature/~~peculiarity~~ of the field of musculature consists in the fact that it, apparently ~~seizes~~ covers the range of comparatively high frequencies (to 150 kHz), discovered with usual contact removal/~~diversion~~ (Volkers, Candib, 1960).

Low-frequency electric fields, which appear ~~during~~ with the motion of insects, birds and wild animals.

Our assumption about the fact that wings of insects, plumage of birds and hair of animals, being charged with their motion and friction against each other by electrostatic charge, must radiate electromagnetic waves, was completely confirmed experimentally. Recordings of electroauragrams were conducted on oscilloscope ~~face~~ screen, in parallel with audition at the sound producing ~~setting up~~ apparatus. One of the first subjects of our investigation was bumblebee (Bombus hortorum L.), which was placed inside the shielded chamber with ~~that which was establish~~/installed in it aura-sensor. It is revealed ~~detected~~ that the bumblebee in free-air conditions is a comparatively powerful radiation source of ~~ac~~/variable electrical fields in the range of sonic and subsonic frequencies. The electroauragrams (EAG) of bumblebee were recorded ~~with~~ at distances from it up to 1 m.

The experiment convincingly showed that these recordings were not connected with the sound vibrations of air. So, the ~~e~~inclusion of bumblebee under cap/~~hood~~ from the metallic grounded grid completely removed effect, while ~~bell jar~~ glass cap not at all did ~~not~~ a~~ttenuate~~/weaken it. But as soon as above ~~bell jar~~ glass cap again ~~were~~ was put on metallic cap/~~hood~~ (from grid), field ~~it~~ disappeared. Analysis of the EAG of bumblebee (Fig. 7b), ~~written~~ recorded simultaneously with its sound track (Fig. 7a) (by means of the ~~established~~/installed in the chamber microphone), ~~it~~

showed that the fundamental frequencies of the vibrations of field and of the issued by wings sound coincide. At the same time there are considerable differences in the form, which one must explain. The flight of bumblebee simultaneously was accompanied by the intense fluctuations of field in the range of ultralow frequencies (0.1-1 Hz), which were recorded with dial instrument. It was established that the bumblebee is the secluded driving, always positive charge, which creates on the surface of its body potential by value more than +10 sd. Simultaneously the bumblebee is the dipole, which radiates with the frequency of the stroke of wings. The galvanic contact of the pedicles of insect with the grounded metallic surface does not remove "dipole" effect, therefore, it is connected with the electrostatic charges of wings. Are made the experiments, in which bumblebee initially wholly they wetted by water (wetting with water completely eliminates all electric effects). After drying and the short-time flight of insect the picture of emission/radiation gradually was reduced to the usual. Are obtained the notations of EAG under the different flight conditions of bumblebee. Their analysis shows that the EAG of insect contains the detailed information about the state of its flight, aerodynamic properties, the direction of course, the distribution of electric charges on body, etc. However, this information still one must learn to decipher.

Analogous results are obtained on some other winged insects: on wasps - Pseudovespa vulgaris L, flies - Calliphora erytrocephala Mg. and Petina Mg, dixa/midges - Aedes communis De Geer (determination of form/species is carried out A. Kh. Saulich). Among investigated by us insects it was not met such, whose emission/radiation is absent.

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Animals are not only active emitters, but also passive, that radiate under the action of the falling/incident (on them) sound, in other words, they are electrostatic microphones. These our assumptions also were confirmed experimentally. It turned out that the body of living and dead insects, plumage of birds and rind behave like a beast really/actually they radiate ac fields with the frequency of the falling/incident (on them) sound, reproducing, for example, the word of man. We investigated to microphonic the wings of jay - Larrulus glandarius L, the tail of leg bolt is Tetrao urogallus L, tail proteins usual - Sciurus vulgaris L, the tail of hare white hare is Lepus timidus L.

The body of man completely is not exception/elimination in the relation to similar phenomena. For example, the wrist, presented to the probe of aura-sensor, reveal/detects the difference in its back and volar surface. The back side, on which there is a hair integument, during the puff of air generates the ac fields, audible through the loudspeaker as "rattle" ~~"grating/crash"~~, palm ~~polar~~ surface "keeps silent". The aura-sensor ~~establish~~/installed outside the shielded chamber, reacted to the most insignificant motion of the ~~locating indoor~~ visitor found in the room, which was recorded with dial instrument. Under some conditions was recorded the presence of man in adjacent room with enclosed door.

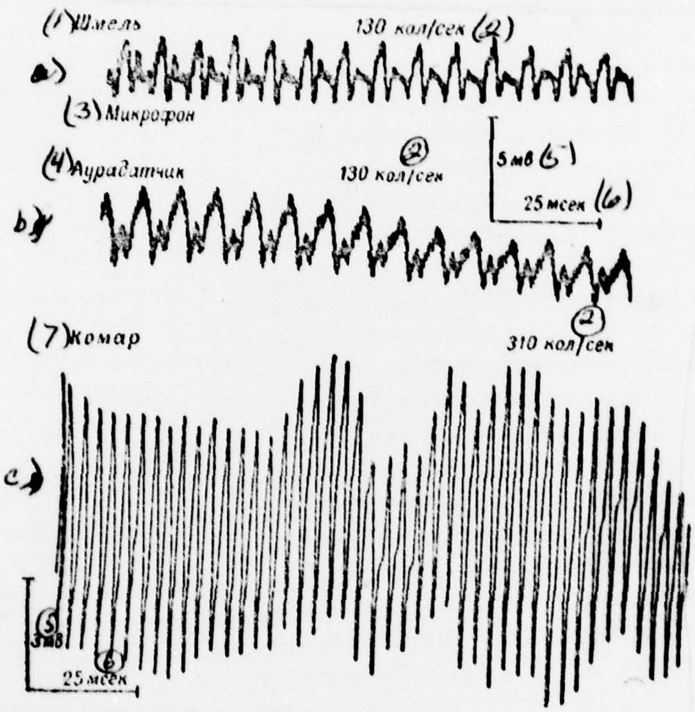


Fig. 7.

Fig. 7. Simultaneous ~~notation~~ recording of electroauragram and sound ~~track~~ record of bumblebee in free-air conditions, and also the ~~notation~~ recording of the electromagnetic radiation of ~~dixa midge~~ mosquitoes. a) ~~is a~~ — sound ~~track~~ recording (~~notation~~ recording from microphone) of bumblebee in flight from distance of approximately 5-10 cm.; b) the electroauragram written simultaneously ~~with~~ from a (bumblebee was located approximately in 30 cm from the probe of aura-sensor), Δf = 100-1000 Hz; ~~entrance~~ input (+). Microphone and aura-sensor are ~~spread to~~ spaced at distance of 35 cm, probe - dowel 9 cm long Ø 1 mm, for a microphonic ~~entrance~~ input Δf = 10-10000 Hz, without taking into account ~~of~~ the frequency characteristics of the ~~very~~ microphone itself (of type MD-47). The calibration of amplitude is shown only for b; the calibration of time for a and b is identical; c — electromagnetic radiation of ~~dixa midge~~.

Key: (1). Bumblebee. (2). osc./s. (3). Microphone. (4). Aura-sensor. (5). mV. (6). ms. (7). ~~Dixa midge~~ Mosquito.

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The mechanical vibrations of the charged parts of the body of animals can appear not only from the ~~falling~~ incident on them sound or active motion, but also from the action of electromagnetic waves. In this case there can appear the secondary electromagnetic radiation.

Generalizing these experimental results on all animals, we assert that there is still not an investigated in detail class of signals of living nature - the electromagnetic radiations of the charged parts of their body during motion. The informational value of these signals still not is opened. We assume that appears the new possibility of the explanation of the value of some forms of plumage of birds, hair of animals and form of the body of insects. These are not only the visually visible form, but also the electric form, which creates electric aura, possibly, informational signals.

A series of the experiments, placed for the purpose of the detection of the electric field of the biopotentials of the brain of man, on yielded positive results. Supposedly the intensity of this field to two orders lower than threshold sensitivity of our equipment. Searches in this direction are continued.

The conclusion

The comparison of the technical parameters of the amplifier of aura-sensor attests to the fact that some of the already described

~~constructions~~ designs of similar type of amplifiers completely could be used for recording of the electric fields, appearing in space (in air) around biological objects. Meanwhile there is only ~~only~~ single work of 1949, which ~~relates~~ refers to recording the electric field component of nerve (Burr, Mauro, 1949). Apparently, this position of ~~businesses~~ the matter ~~one~~ should be explained by the fact that the concrete formulation of this problem, until now, was absent and systematic studies in this direction initiated were not.

The results of our own experiments speak first of all about the fact that the bioelectric field is the carrier of ~~the~~ diverse data about the functional state of biological object, and the reception and processing of this information are completely possible ~~during~~ with the utilization of contemporary techniques.

Bioelectric field makes it possible to control at a distance physical instruments. For example, the electron beam of the cathode-ray oscillograph of our ~~setting up~~ apparatus was controlled at a distance by the means of the field of heart and musculature of man. It is possible to present the construction (in the future) of the machines, controlled at a distance by the bioelectric field not only of heart and musculature, but also brain.

Even now auragraphy can find some practical applications ~~uses~~.

for example aural removal/~~diversion~~ EKG of heart for diagnostic ~~target~~/purposes. In this case the procedures of the removal of clothing and imposition of electrodes on body are absent, removal/~~diversion~~ can generally be realized without ~~is driven/~~known patient. By this are eliminated the mental factors, which exert ~~the~~ sometimes traumatizing influence on patient. Aural removal/~~diversion~~ can find use for recording electrocardiogram ~~at the scald~~/burns of the body, when the imposition of electrodes on the body of casualty is impossible, and least touch to body sometimes causes shock. Definite interest is ~~of~~ the systematic side of the aural removal/~~diversion~~, when recording biopotentials at a distance, without direct contact with the object being investigated, creates ~~the determined~~ advantages when conducting electrophysiological investigations, especially on single structural ~~cell~~/elements.

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Are tempting the prospects for recording biocurrents of such objects, the direct removal/~~diversion~~ of electrogram of which ~~hinder~~/hampered or is impossible, for example, in insects and birds in flight, ~~of~~ those which were surrounded by the solid shell of the egg of embryos, etc. For the flying animal and insects the electromagnetic field can serve as the substance of information with attack and protection. It is possible that bat besides ultrasonic location manage electrolocation, but their victims ~~sacrifices~~ (insects) can be informed about the approach/~~approximation~~ of plunderer by the electric charges, which appear on the body either of plunderer or victim.

Upon meeting during the flight of insects the charges of their body interact according to the law of Coulomb, being repelled ~~pushed back~~ or being attract/~~tightened~~ to each other. In air this force of reaction can have ~~a~~ value. Insects and birds can perceive it in the form of mechanical ~~jerk/~~impulse, pressure, acceleration. Electric field does not depend on air flow direction, and ~~of~~ its propagation velocity is equal to the speed of light. It can serve for the correct grouping of birds in the flocks, animal in the herds, insects in swarms ~~synhesmas~~ or as the electrostatic trap of insects. It is completely possible to allow existence in the body of some animal special receptors of electric aural field.

The charged hair of head and skin, beard, whiskers, the eyelashes and ~~the~~ eyebrows of man not only radiate electromagnetic and acoustic waves, but also they receive them. These signals are related to the region ~~range~~ of super-weak irritants, and we ~~them~~ do not perceive them consciously. But unconscious perception cannot be excluded, and it can play a ~~the~~ leading role in our life.

The generalization of the results of the conducted investigations leads to the conclusion about the fact that the electromagnetic low-frequency ~~emission/~~radiation represent an extensive class of phenomena in living nature. Therefore for the expansion/~~disclosure~~ of all possibilities of auragraphy is necessary general biological approach to research on the examined phenomena.

Conclusions

1. Finally it is experimentally establish~~/installed~~ that the electromagnetic low-frequency field of living objects ~~really/~~actually exists.

2. Recording and ~~the~~ measurement ~~the~~ weak low-frequency electromagnetic fields, which appear in space around active living objects, are possible by the measurement of the electric component of near field in air, by applying the contemporary high-impedance high-speed electrometric amplifiers.

3. The reasons for the formation of electric field around biological object are different: ~~them~~ they can appear as physiological, ~~so~~ also physical factors. The respectively recorded fields can be divided ~~to~~ two groups: the fields, which are generated because of the bioelectric activity of living tissues; the fields,

which are generated because of the mechanical vibrations of the charged parts of the body.

4. The value of the electric potential of field in space around biological objects (in air) in the general ~~case~~ decreases in proportion~~al~~ to square, and intensity/~~strength~~ - to the cube of distance.

5. It is experimentally proved that the vital activity of living beings is exhibited also in the form of the generatable or electromagnetic fields, which are ~~spread~~ propagated in space far beyond the geometric limits of their body.

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