 5/3/92

[redacted]

In case you haven't gotten this. The technical discussion concerning vector/scalar ($\underset{\sim}{A}$, φ) potentials is both sophisticated and correct. With regard to Avramenko's claimed biocomm potential, it begs to have an experiment done, e.g., detecting random binary sequence of signals from an EM-suppressed, ($\underset{\sim}{A}$, φ) generator - just my cup of tea, as it turns out!
Best, Hal Puthoff

Informational Interaction of Isolated Systems Without Energy Transfer

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[Text]

I. Problem of the information component of biofield interactions.

A special feature of biofield interactions is the transfer of information from one biofield structure to another. Two types of relationship can be articulated for structures of that kind that effect the process of information transfer. One type of structure is associated with interactions within a system, such as the brain. An example of such a biofield interaction could be instantaneous -- in the terminology of psychology, simultaneous -- recognition. That recognition of very familiar objects suggests the interaction of a biofield model of an impression that comes from without and structures that were previously formed and are models of already perceived objects. Resonant contact of that sort produces the effect of virtually instantaneous drawing on past experience of a needed reference and can be considered the mechanism underlying simultaneous recognition.

Processes associated with thinking and with problem solving can be placed in that category of informational interactions between systems that are spatially isolated from each other. In the course of mental activity, the individual is known to create for himself something new, and that new semantic system usually enables the individual to solve a complex problem facing him. As numerous psychological studies show, the principal language the individual uses in his thinking is the language of systems of relationships between objects. If one approaches that psychological reality from the standpoint of the formation and work of biofield structures, then two components can be articulated in a system of relationships -- certain biofield equivalents of objects, and the stable field interactions of those equivalents, interactions that are the equivalents of the interactions between the objects.

In analyzing a given problem situation, the individual constructs a model of that situation that consists of, once again, the equivalents of the elements that make up the problem, plus the interactions between those equivalents. A good example of how the model of the situation is constructed is the process that takes place in the head of a chess player when he is analyzing his position on the chessboard. When he considers his position, the chess player perceives the pieces as functional points of sorts that have given properties of movement. In comprehending those properties of movement, he constructs a system of relationships among the pieces that become the basis of the functioning of his game strategy.

It's not difficult to see that that process -- just like the process of instantaneous, simultaneous recognition that we alluded to -- presumes, of necessity, the existence of biofield interactions: the relationships constructed in the analysis of the situation absolutely must interact with the relationships that constitute the content of the chess player's experience. Only on the basis of the realization of past relationships can the semantic system of a new situation develop.

Thus, analysis shows that the resonance between biofield structures is also a very important aspect in an individual's thinking. But in that context, it is not a resonance of representations of a single specific object that takes place, but a resonance of systems that include certain field equivalents of objects and of the relationships among them.

The exchange of information between completely isolated biological objects can be considered another type of informational biofield interaction. An example of that sort of interaction is telepathy, when information that is not encoded in known languages specially designed for the transfer of information is transmitted from one individual to another.

As a great deal of the literature shows, those sorts of bioinformational interactions can involve the transfer of the most varied of types of psychological manifestations. With telepathy it is possible to convey an action, the image of an object, a meaningful symbolic structure, or an emotional state. That means that in that kind of bioinformational contact, there is an interaction of biofield systems of various levels and modalities of the brains of two individuals who are separated from each other.

scalar waves!

All those types of biofield interactions, in which information is transferred from one system to another, are characterized first and foremost by the fact that the transfer of information involves no direct energy expense. Of course, each of the biofield systems that are associating with each other needs some amount of energy for its very existence. It's also probable that the features of the information exchange between the systems -- the clarity, the efficiency, and the so-called capacity of the exchange -- are associated with the energy characteristics of those systems. The process itself of informational interaction, unlike known hardware systems, does not require energy.

In that context, the problem arises of identifying the physical laws that would enable one to undertake the analysis of the informational interaction between spatially separate systems that does not require any expenditure of energy for its existence. Later, it will be shown that there already exists in modern physics the theoretical and experimental data that enable us to take up an examination of just such an energy-free transfer of information.

Here we should pause on certain aspects of biofield structures. That's all the more a good idea because the concept itself of biological field remains essentially undefined and is far from being completely analyzed in theoretical terms. The concept comes to biology from physics and is a unique analogy of the remote interactions between objects that are traditionally called fields in physics.

It is unquestionable, however, that the reality that got the name of biological field from A. G. Gurvich has, from the very outset, certain properties that indicate that the remote interactions between biological systems are substantially different from the physical interactions to which the concept of field has been affixed.

The most striking property of the biofield -- one that is specific and fundamentally unique -- is its dynamic systematism complicated by the property of selectivity. The cells of the cortex of the major hemispheres, for example, which make up a certain functional system of the brain, can detect field interactions between themselves, although they may be separated by rather considerable amounts of space. Those cells cannot, however, have any kind of field interactions with cells that are situated right next to them. Moreover, it is obvious that functional structures are constantly changing as a function of the tasks of human activity. That is why any given biofield interaction of any element of the brain may be replaced after a given period of time by an interaction with totally different elements. Physical fields, as a rule, are not acquainted with such selective systematism or such dynamism among elements.

The informativeness of biofield structures must also be considered a unique quality. Analysis shows that biofields always come about and function only in the context of the processes of generation and transfer of biological information. That link between biological fields and bioinformational processes is a property intrinsic to those unique fields. Unlike biofields, known physical fields can perform the function of information carrier only if some outside influence is applied to them. It is significant that the informativeness of a physical field, which comes about as the result of the exertion of a systematic outside influence -- the modulation of an electromagnetic field, for example -- has no significance whatsoever for the existence and functioning of the physical system that generates or receives such modulation. The whole of the informativeness of the dynamics of physical fields has meaning only for the individual who created the physical systems in question -- radio receivers and transmitters, for example.

But with biological fields, their informativeness is directly linked to the existence, the life process of the biological systems in which the fields function.

All those unique features of biological field interactions make them so different from the field interactions of objects known to physics that they make the term "field" itself, as applied to the processes of living systems, extremely arbitrary and, to a large extent, metaphorical. Perhaps, in the future we will think about creating a new concept, one that more adequately reflects the properties of those specific *[illegible]* interactions.

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For all their fundamental uniqueness, however, what we are now calling interactions between biofield structures are interactions that are either physical or biophysical. And the fact that those complex interactions are beyond the pale not only of physics, but also of all of natural science indicates that in our picture of the world, something fundamental was left out when the principles of natural-science inquiry were being formed.

There is reason to believe that that omission was associated with the fact that the object of most of the study of natural sciences was matter and the processes taking place in it. Of course, one cannot help but note that, in addition to matter, the objects filling the world also have form. But in the system of the world, the form of an object has not been given the significance of a fundamental factor. The category of form was made chiefly the object of philosophical analysis. However, the actual existence of form in objects as some always specific material structure poses the challenge of revealing its wave and field properties.

At present, the reality of the physical properties -- especially field properties -- of the form in objects can be proven by many groups of facts. Among such facts are the data that point to the existence of a charged layer around the human body. Those data also include data indicating the effectiveness of manipulating biologically active points of the skin. As ancient theoreticians of acupuncture assert, life-giving energy is concentrated around the human body in the space near the skin.

Constituting another group of facts pointing to the existence of forms as wave (or field) structures are those of (?lozokhodstva?), which was named too broadly and not entirely adequately by the term "biophysical effect." Analysis shows that the basis of that effect may be the interaction of the structural features of the external field (aura) of an operator and the external fields (form) of the sought-for object.

?! is this same as A-field as physical reality?

There is reason to believe that the properties of biofield structures that are responsible for the informational interaction of those structures are linked to specific features of the form in objects existing as a physical reality. Discovering those features could be of interest to a whole array of branches of knowledge; it presumes a special theoretical and experimental analysis of fundamental problems. Such analysis will probably be performed in the near future.

In the context of all these remarks, of special interest are the physical data that are already enabling the analysis of the possibilities of informational interactions. In particular, of great importance are the physical tenets that demonstrate how information exchange can take place, with no expenditure of energy, between spatially separate systems.

II. A possible physical interpretation of the informational interaction between isolated systems, without the transfer of energy.

The experimental data accumulated to date on informational interaction of biological systems[1] that is not an exchange of information via electromagnetic signals or particles force us to

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analyze more carefully the alternative possibilities of communication between isolated systems and, above all, possibilities that are feasible in the context of the existing fundamental physical concepts.

4field

Avramenko *et al.*[2] have shown that there exists a consistent possibility for the exchange of information between systems without the involvement of any kind of energy carrier, with the possibility based on the existence of a 4-x [4th dimension?] field potential distinct from zero with the *[illegible]* components of that field $\overline{E}$ and $\overline{B}$ absolutely equal to zero.

The formal body of mathematics for modern electrodynamics, constructed with sequential use of the principles of the theory of relativity,[3] shows that an electromagnetic field is most adequately described by a 4x field potential $\overline{A}_\mu = (\overline{A}, \varphi)$, whereas $\overline{E}$ and $\overline{B}$ represent only a few combinations of derivatives of its components $E = -\bar{\nabla}\varphi - \frac{\partial A}{\partial t}$ and $B = \bar{\nabla} \times \bar{A}$.[4]

Today's engineering, however, often uses field potentials superficially, for simplifying mathematical computations in the calculation in practical problems of the components $\overline{E}$ and $\overline{B}$, and those very components are felt to provide a complete description of an electromagnetic field in its interaction with matter $F = q(E + V \times B)$

The interpretation of fields $\overline{A}$ and φ as "real physical fields" is hindered, to some extent, by their mathematical ambiguity and the confusion in the literature about choice of ~~gage~~. At the same time, it known that only a Lorentz gage $\bar{\nabla}\cdot\bar{A} = -\frac{1}{c^2}\frac{\partial\varphi}{\partial t}$ is relativistically invariant, whereas, for example, the oft-used gage $\bar{\nabla}\cdot\bar{A} = 0$ is relativistically not invariant and indicates the existence of purely transverse -- i.e., plane -- waves of potential, something that electromagnetic waves with infinitely large energies would conform to.

In theoretical physics, it is the potentials of $\overline{A}$ and *[illegible]* that naturally go into the expressions for the action integral and the Hamiltonian function. In quantum electrodynamics, variation in the quantum mechanical phase of a particle of an electromagnetic field is determined by the well-known Feynman integral $\delta\Phi = \frac{q}{\hbar}\int \bar{A}\cdot d\bar{s} - \frac{q}{\hbar}\int \varphi\, dt$, i.e., it is a function of the field potential itself.

In the 1960s, Jaklevic, Lambe, Mercereau, and Silver[6,7] and Bohm [*sic*], Aronov, and Chambers[8] conducted a number of experiments that were specially set up for detecting the manifestation of field potential in regions of space in which $\overline{E} = \overline{B} = 0$ (with the use of the Josephson effect [by Jaklevic] and electron diffraction [by Chambers]). The work by those individuals demonstrated experimentally the possibility of detecting field potential when $\overline{E} = \overline{B} = 0$ and thereby showed the limitedness of the "engineering" description of an electromagnetic field with E and B. The results of those experiments enabled R. Feynman to again announce the "physical reality" of field potentials.[5]

The successful experiments of Jaklevic and Chambers legitimize the issue of the "reality" of the existence of electromagnetic field potential longitudinal waves propagating, for example, along the axis of an oscillating electrical dipole (or along the plane of a magnetic dipole). As we know, the solution of an electrodynamic problem involving the determination of the radiation field of an electrical dipole is based on the existence in the entire space of a spherical wave $\overline{A}$ propagating at the speed of light and with an amplitude that diminishes in a manner inversely proportional to distance, with the vector A parallel to the axis of the dipole at each point in space.[9,10] Detecting those waves at a distance would open the way to the realization of a new type of information transfer. The information would be transferred without any transfer of energy, because longitudinal waves of potential do not carry energy (the Umov-Poynting vector is equal to zero). Energy, however, must be expended at the point of transmission and at the point of reception. (We note that in the well-known experiments for the detection of A when $\overline{E}=\overline{B}=0$, energy from an outside source is expended in the detector.) The need to expend energy in the receiver and in the transmitter removes the apparent contradiction in the concept in question with the law of conservation of energy.[11]

We know that the problem of the physical reality of field potentials and of the possibility of their detection is closely related to the problem of gage invariance of equations of quantum physics, inasmuch as the assignment of field potential determines the quantum mechanical phase of a wave adequate for a given object. Gage invariance is usually understood to mean that assignment of given field potentials (but not their derivatives) has no effect on system energy. However, if in experiment, the possibility is realized for measuring and comparing phases of ψ-waves that correspond to certain elements A, B... of the system $M=A+B+\ldots$, then, after expending in the manner indicated above some amount of energy on the process of that measurement, it is possible to obtain information on the values of the components of 4x field potentials at the location of system M.

It should be noted that the phase relationships associated with de Broglie waves are the primary experimental data that have shown the wave nature of matter.

For example, the classic experiments of Davisson and Germer were the first to observe diffraction of electron ψ-waves reflected off single-crystal structures.[16] Thomson's experiments were the first to detect interference rings formed by electron waves on a photographic plate (as well as light and x-ray rings).[17]

The interference of electron waves was the principal effect observed in later experiments geared to corroborating wave mechanics and in experiments conducted by Tartakovskiy[18] and Fabrikant *et al.*[19]

The phase relationships of wave processes are used more widely in holographic technology than in engineering applications.

At present, that process has begun to be used in electron microscopy for producing holograms based on electron ψ-waves.[13,14,15]

A coherent electron ψ-wave source, as we know, can be any device that is capable of emitting electrons into a vacuum with little velocity (or impulse) straggling and that has small

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physical dimensions (a point source).

In well-known early experiments, various crystal structures were usually used as the object of which a hologram had to be recorded.[16,18] That was because the length of the electron wave is determined by the de Broglie relation

$$\lambda = h/mv,$$

where $\hbar = \frac{h}{2\pi} \sim 10^{-27}$ is Planck's constant, m is the electron mass, and v is the electron velocity.

With an electron energy of 1-100 eV, wavelength is $\lambda = (1.5\text{-}0.015)\ 10^{-8}$ cm, so that for observation of interference phenomena, the use of crystals with a lattice element spacing of approximately 10^{-8} cm is effective.

At the same time, methods developed in recent years for "cooling" particle beams, thereby enabling the achievement of extremely low values for particle velocity straggling, make it technically possible to produce beams with low total energy. For example, electrons have been slowed to an energy of 10^{-5} eV, with the wavelength of approximately 0.05 μm approaching the wavelengths of the visible range.

The small absolute length of ψ-waves for electrons with energies of 1-100 eV, most easily detected directly via photoemulsion exposure, makes the technical realization of the holographic process more difficult than if light waves were used.

For observing and recording the interference pattern produced by macro bodies even the size of 10-100 μm, one must use either larger distances from the object to the photographic plate or electron optics that result in the period of the spatial pulsations being larger than the resolution element of the emulsion.[22]

The use of "cold" particle beams with large wavelength and low energy for ψ-holography raises the issue of what method is to be used to record the amplitude distribution of the wave in the detection plane -- direct exposure of photoemulsion at a particle energy of <0.1 eV, for example, could be virtually absent. Certain difficulties can also arise in the successive recording of the hologram with scanning by an electron beam detector.

To record ψ-holograms based on cold electrons, it could turn out that it is best to use various methods of intermediate, simultaneous conversion of the interference pattern -- electron-microscopy methods of image transformation and enhancement and use of enhancement of the "ψ-image" via direct acceleration of the "cold" electrons between the plane for recording the ψ-hologram and the photodetector, and methods of enhancement that attach electrons to electronegative molecules with subsequent acceleration of those molecules in an electrical field, etc.

As with the visible and radio ranges of electromagnetic waves, methods of basic intensity

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holography, in which only the square of the amplitude of the interference pattern is recorded, are entirely applicable to ψ-holography, as are methods of holography that use a reference beam, thereby enabling the detection of the amplitude-phase distribution of the ψ-field.

Controlling the phase front of the ψ-wave with electrical and magnetic fields -- something that has been perfected in electron microscopy -- makes it possible to implement various hologram-recording systems that are well-known today for the optical range (for example, forming reference beams that have a plane or spherical phase front and fall on the hologram recording plane at a given angle).

The essential difference between ψ-holography and standard holography based on electromagnetic waves stems from the dispersion of the ψ-wave propagating in free space. That difference shows up in pulse methods of recording and playing back ψ-holograms, when the radiation used cannot be considered monochromatic. "Diffusion" of the wave packets (pulses) in free space (or in a vacuum) does not take place for electromagnetic waves and is peculiar only to the ψ-wave.

III. Features of the playback of holograms and the uncertainty principle.

As with standard optical holography, irradiating a ψ-hologram with a coherent ψ-wave (a single-energy flux of wave-particles) makes it possible to produce a three-dimensional image.

Of greatest interest as regards the ψ-wave (unlike with the optical hologram) is, apparently, the virtual image, which has a number of features of the actual object recorded in the hologram.

The greatest ψ-wave concentration is observed in the region of space in which the virtual image is formed, and location of the individual elements of the image is determined, naturally, only by the nature of the spatial distribution of the wave emanating from the plane of the ψ-hologram.

We should note, however, a number of fundamental questions that arise in connection with the possibility of synthesizing an image with a ψ-hologram.

First, there is the possibility of self-stress in the virtual image that is obtained and in its elements -- in general, ψ-waves interact nonlinearly. For example, electrons are pushed apart by electrical forces and are scattered on other electrons (unlike electromagnetic waves, which obey linear equations with great precision).

Next, a virtual ψ-image can obviously interact directly with an external electromagnetic field, since, generally speaking, that image constitutes a material medium with a given distribution of density and other parameters.

Finally, the possibility of a given placement of the "quantum mechanical" object in space in

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the playback of the hologram, in large measure independent of the pulse (de Broglie wavelength) magnitude, evokes the natural question of whether such a possibility contradicts the known Heisenberg uncertainty relation (see Vikhman[21] and Davydov,[29] among others).

Let us pause in more detail on that question.

In recent decades, in connection with the rapid progress in the theory and technology of radar measurements, a number of works that have become classics have examined the overall statistical theory, principles, and limitations associated with measurements that use wave processes. It has become clear that in actual situations, when wave processes (an electromagnetic field, for example) can have a certain, rather complex space-time modulation, the potential capabilities of measurements of target coordinates (range, speed, angle, etc.) are determined by so-called general uncertainty principles (see, for example, Shirman[23] and Urkovitts[24], as well as Bakut *et al.*[25] and Middleton,[26] among others).

In the 1950s, in particular, the development of the theory of wideband radar signals demonstrated the unsoundness of the Heisenberg uncertainty principle with regard to joint measurement of target range and speed (i.e., temporary position and *[illegible]* of a wave packet).

It turned out that, as correctly pointed by Vakman,[20] that principle reflects not the potential capabilities of measurements of actual physical magnitudes, but just some trivial *[illegible]* typical of the most basic type of oscillation *[illegible]* of a sine curve with a square, Gaussian envelope or one similar to it. In other words, the Heisenberg principle *[illegible]* that if an oscillation could have a duration of $\tau \sim T$, then its Fourier *[illegible]* could not be narrower than $\delta f \sim \frac{1}{T}$ such that $\tau \cdot \delta f \geq 1$.

Before the early 1950s, wideband signals were not known in radar, and it was mistakenly believed that the potential capabilities of joint measurement of target range and speed (not a single probing signal) were limited by a given "relation of durations," i.e., the longer the probing signal, the more accurately the Doppler frequency shift (speed) is measured, but the less accurately the delay of the *[illegible]* signal (range) is measured.

In 1953, the pioneering work of Woodward[27] came out, *[illegible]* for the first time was revealed *[illegible]* of such notions. It became clear that spectral width of the signal W, and not signal duration T, was the parameter that determines the potential accuracy of measurement of the range coordinate (delay), while, independent of the magnitude of W, the accuracy of the measurement of Doppler frequency is determined by signal duration T.

Modern detection equipment (radars, sonar, etc.) would be unthinkable without the use of wideband signals with $TW \gg 1$, frequency modulation, and phase manipulation.[23,28]

Woodward's general uncertainty principle holds true for such signals, saying that the potential capabilities of measurements are determined by a type of autocorrelation function $\xi\ (\tau, w)$

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[*sic*] of the "wave packet" of the probing signal s(t)

$$\xi(\tau,\omega)=\frac{1}{E}\int s\left(t-\frac{\tau}{2}\right)s'\left(t-\frac{\tau}{2}\right)e^{i\omega t}\,dt$$

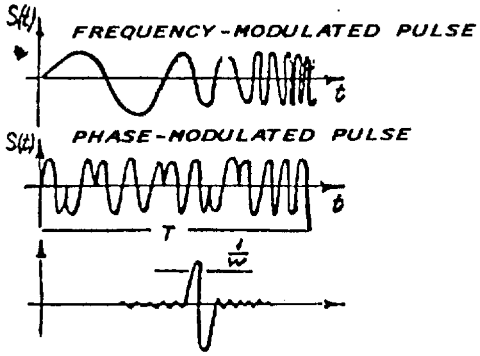
where E is the total energy of the signal.

The function $\xi(\tau, \omega)$ generally has its greatest value (peak) at the origin of the coordinates $\tau=0$, $\omega=0$, and the width of the peak is ~1/w in terms of the τ axis and ~$2\pi/T$ in terms of the ω axis. Those intervals also determine the potential accuracies of measurements in sequential statistical theory. But the Woodward uncertainty principle itself asserts that a volume bounded by $(\xi)^2$ and the plane (τ, ω) is finite and is equal to a constant, regardless of the type of wave packet,

$$V=\frac{1}{2\pi}\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}|\xi(\tau,\omega)|^2\,d\tau\,d\omega=1$$

Figures 1a and 1b depict the image of a typical autocorrelation function of a wideband (phase-modulated) signal and, for comparison, the topographic image of that function for an unmodulated radio pulse of the same duration T.

Signal at the filter output



Autocorrelation function of the signal TW>1

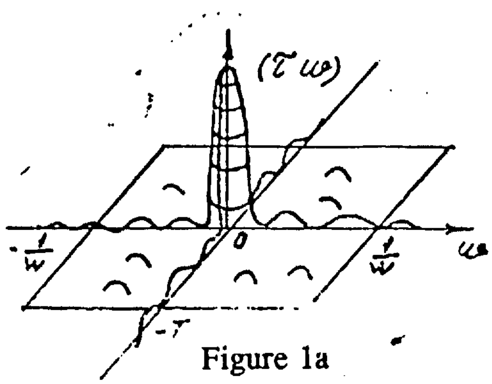


Figure 1a

Signals (wave packets) and uncertainty functions

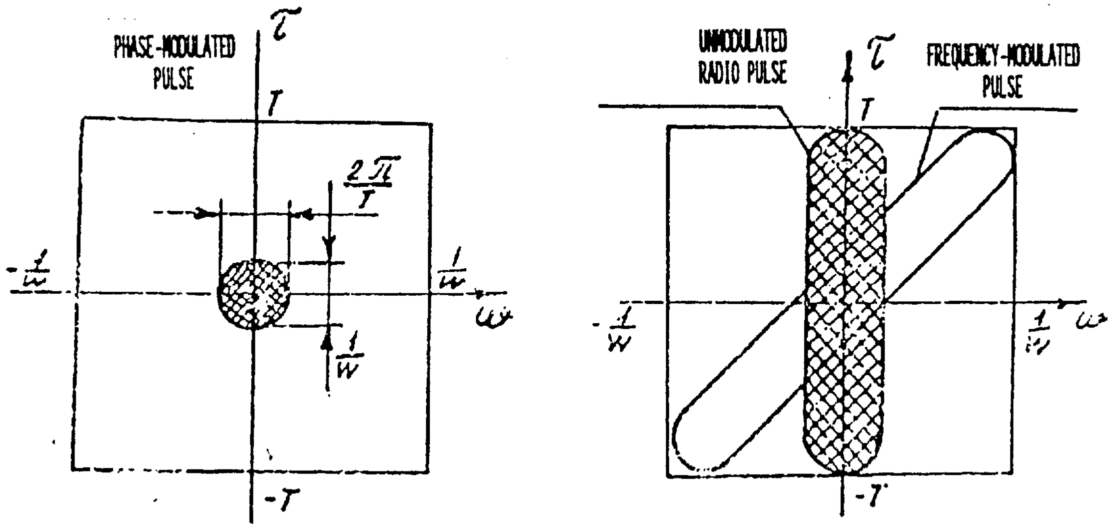


Figure 1b

Thus, we see that if the position of the wave packet in terms of the τ axis were determined only by its envelope curve, then the "relation of durations" would hold true -- increasing the duration of the *[illegible]* of oscillations would lead to a worsening of the accuracy of measurement of that position. (We are, of course, speaking of the statistical approach generally used both in wave (quantum) mechanics and in modern radar.) That's not so in an actual case of optimal processing of a wideband signal. The measuring device (filter or correlator), using *a priori* information on the type of interpulse modulation of the wave packet, makes independent measurements of position with an accuracy of 1/W and of Doppler frequency with an accuracy of 1/T; expansion of the signal spectrum W does not worsen the accuracy of measurement of speed of ~1/T.

The modern statistical theory for the measurement of parameters of wave processes is fully applicable to wave (quantum) mechanics.

In making that application, we must, of course, move from the primitive understanding of the essence of measurements in the context of Heisenberg ("relation of durations") to the modern concept of the limitations on those measurements, which has come about as a result of the development of the theory of statistical radio physics.

We cannot fail to note that in the modern literature on quantum mechanics, the use of the Heisenberg principle and the explanation of it as a fundamental relationship (!) is often somewhat peculiar. In the well-known Berkeley Course, for example, for purposes of illustration, there are figures of wave packets with intrapulse modulation "for which the accuracy of measurement of frequency is low," although a figure depicts what is essentially a

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wideband signal for which that assertion does not hold true.[21]

Why, in fact, has quantum theory lagged behind modern radio physics on the concept of statistical limitations on the accuracy of joint measurements of a number of parameters?

As we can see, the possibility of achieving the potential accuracy of measurements is governed by two factors:

- the formation of a wave packet with a given type of modulation

- the use of a measurement device the performs the procedure of optimal processing (in the statistical theory of radio physics, that is a procedure for constructing an *a posteriori* distribution of the probability of the presence of a target with given parameters of range and speed)

Both those factors have simply been outside the circle of questions studied in quantum theory. For example, the examination of the property of wave packets (de Broglie waves) is usually limited to the so-called quasiclassical approximation

[illegible]

where P is the pulse and v is the Hamiltonian operator. In other words, it is limited to cases in which phase modulation *[illegible]* at a distance commensurate with wavelength $\lambda = h/mV$ *[illegible]* that constraint is essentially equivalent to the exclusion *[illegible]* -ment of wideband ψ-waves with a marked frequency modulation (to say nothing of phase-modulated signals).

On the other hand, the measuring device is usually spoken of as a primitive device that records the intensity of a wave in a given region of space, but the obvious possibility of recording intrapulse phase relationships is completely ignored (and that in spite of the fact that phase relationships, as already noted above, lie at the basis of many modern macroscopic quantum instruments!).

In summing up what has been said, one can assert that no fundamental physical laws are known that would prompt attaching to the Heisenberg relation the sense of a "relation of uncertainties" that determines the potential capabilities of measurements. Quantum theory should use, as does modern statistical radio physics, the general uncertainty principle -- in particular, the Woodward principle, which adequately reflects the true limitations on the process of measuring "additional" magnitudes.

NOTE: Pa [illegible] design detection device

Achieving accuracy in the measurement of the position and pulse of a quantum mechanical object in conformity with the Woodward principle requires, of course, the use in physical experiment of a competently designed recording instrument that must respond not to ψ-wave intensity, but also to phase relations in wave packet being "received." An examination of

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specific methods for designing such instruments, however, is beyond the scope of this paper.

Returning to the question of playing back an ψ-wave image, we see that there is no contradiction between the possibility of a stipulated location of that image and any fundamental, verified physical law.

The analysis that has been made demonstrates that the use of modern mathematics (for example, the Woodward uncertainty principle) in quantum mechanics opens the possibility of recording phase relations between various parts of an isolated system M=A+B+... Those parts can be segments of a wave packet with a complex law of phase modulation. Phase modulation of those separate segments of the packet, in conformity with the Feynman integral, can be assigned external conditions created by another isolated system -- values of the components of 4x potential at the location of system M.

We note once again that we are looking at phase modulation of a ψ-wave in a space only, with the energy of system M remaining constant. According to the Woodward uncertainty principle, detecting such a phase modulation requires using measuring devices that perform optimal processing of the ψ-wave like the optimal processing of electromagnetic signals in the statistical theory of radar. Such devices, as far as we know, have not been developed for quantum processes.

At the same time, one can presume that the capacity for such information exchange is built into, and used in, biological systems.

Biological objects satisfy the main requirements of energy-free transfer of information, and it is not only the transmitting system, but also the receiving system that must be active (that is, energy must be expended for the reception of information).

The transfer of information between biological systems is closely linked to brain function and thought, in relation to which the quantum mechanical and holographic approach is developing rapidly.[30,31]

NOTE: check references

If one accepts that energy-free longitudinal waves of a 4x field potential are the carrier of information in remote communications between biological objects, then one begins to understand many experimental data thus far accumulated in bioenergetics and bioelectronics that are not contained in the classical theory for the transfer of communications via modulation of an electromagnetic wave or particle fluxes.

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