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Shift Phase as a Result of Formal Interaction

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ABSTRACT

The shift phase, defined as the shift of two series of observations relative to each other .and defined via the stiltjes integral, has a different physical interpretation. On the one hand, the shift phase up to a dimensional constant is equal to the work of generalized forces on generalized displacements of the object. In this sense, the shift phase shows the result of interaction. At the same time, the shift phase calls for a shift in the number of objects in a period of time or space. On the other hand, the shift phase is an "ideal" algorithm for comparing objects (a measure of similarity) that meets the minimum entropy production during the comparison operation. This fact allows us to believe that in the non-material world, comparison by the method of shifting phase is also the result of interaction between the transmitter and receiver of information. Therefore, the shift phase can be considered as a result and as an indicator of formal interaction simultaneously in the physical and informational world. The article discusses the consequences of this statement. In modern physics, there is no definition of information, and this article also attempts to define it using representations of formal interaction

Keywords:*Shift phase, the work of forces on displacements, the principle of minimum entropy production, information, formal interaction*

INTRODUCTION

The concept of "shift phase" was previously proposed by the authors as a tool for phase analysis of two identical-length series of observations. Each such series, as well as any function bounded on the segment, has an infinite number of phases, so a pair comparison of the phase shift between such functions (series) is not possible. To avoid an infinite number of comparisons in this case, a "shift phase" was proposed, which as a single number was associated with the shift between two objects as a whole (series of observations, functions. [1,2].

THE SHIFT PHASE

The shift, (physical) phase (φ) between two functions f_1 and f_2 we will call the Stiltjes integral of the form - $\varphi = C\int_{\Omega} f_1 df_2$ (1)

Where C = Const is the dimensional and normalizing constant, and (Ω) is the domain of phase determination. Based on (1) the spatial phase shift between f_1 and f_2 is equal to:

$$\varphi = C\int_{\Omega} f_1 \nabla f_2 d\vec{\sigma} \quad (2)$$

Where ddσ - is the element of the polar area $\Omega = \Omega(x)$, and the phase sign corresponds to the sign of the scalar product . Accordingly, the time-shifted shift phase is:

$$\varphi = C\int_{T} f_1 \frac{\partial_2}{\partial t} dt \quad (3)$$

Where T is the time period for setting functions.

This definition of phase coincides with the classical one, if the functions f_1 and f_2 are harmonic functions. The constant (C) is chosen as the product of the modules of the maximum values of two functions on the domain, i.e.

C = $1/|f_1|*|f_2|$,, or as the product of amplitudes in the compared harmonic functions.

SHIFT PHASE AND ENERGY

The Stiltjes integral (1) is the work of generalized forces on generalized displacements on a segment (time, physical or generalized coordinates). This fact has been used in numerous works to determine energy flows in geophysical media based on the ratio W = Const*φ, where W energy flow, φ, is the shift phase between the parameters that determine the energy flow according to the formula (1). Using the concept of shear phase, the energy of mechanical thermal interaction between the ocean and the atmosphere was found [3,], zones of climatic heating in the Earth's atmosphere were found [4], as the economic efficiency of business [5]. The shift phase is not only a qualitative indicator of the presence of interaction in the material world, but also a quantitative indicator of the result of interaction.

THE SHIFT PHASE AS AN ELEMENTARY "IDEAL" ALGORITHM FOR COMPARING PHENOMENA

Further, for the sake of brevity, we will denote a series of observations of the object under study as a continuous function f_1,, and the known object of comparison as f_2 . It is important that the segments for setting these functions f_1, f_2 are equal (the same number of identical comparison parameters). The result of comparing functions will be the Stiltjes integral on the function assignment area. Of the form (I)= (I) = $\int f_2 d f_1$, where ((1) is a number, as the result of comparing two sequences of data (numbers).

From the definition (1-3) follow the consequences:

- Restrictions on functions f_1, f_2 are minimal - they can be discontinuous at each point as a series of observations, but they are limited on a segment.

-The shift phase between functions f_1, f_2 that have the same symmetry on the segment is zero.

-Any function (f) on a segment can be represented as the sum of a constant and an "oscillatory" component $f = \bar{f} + \tilde{f}$:

$$\bar{f} = const, \oint \tilde{f}_{1,2} dt \equiv 0. \text{ Тогда } \varphi = C\int_T f_1 \frac{\partial_2}{\partial t} dt$$

$$\equiv C\int_T \tilde{f}_1 \frac{\partial \tilde{f}_2}{\partial t} dt \qquad (4)$$

Also note that any function on a segment (a sequence of observations) can be represented by the sum of two functions-linear and finite, i.e. f = (ax +б) + φ(x), where the finite function φ (x) at the ends of the observation segment turns to zero. It makes sense to compare linear functions (as an integral lianerized parameter of unidirectional change of an object on a segment), which can be compared arithmetically using linear dependence coefficients, and finite functions, which are compared using the Stiltjes integral. These comparisons carry different comparative information. For example, describing a unidirectional increase in the number of objects is the prerogative of a linear function. And the fact of recognizing an object as such in comparison with an image by analogy with a photo, i.e. by the totality of all data, is through the Stiltjes integrals.

Comparison of finite functions as a result of "deformation" or change

One object relative to the other has a visual geometric interpretation, Fig.1 On the plane of functions f_1, f_2, the integral (I) = $\int f_2 d f_1$.. Numerically equal to the area of the hysteresis loop (S). If f_1 =const f_2 the integral degenerates into a straight line (dotted line) with zero area.

If =const, the integral also degenerates into an oblique line with zero area. The zero area of the histeneresis loop degenerated into a straight line means that there are no fundamental differences between objects as a measure of differences.

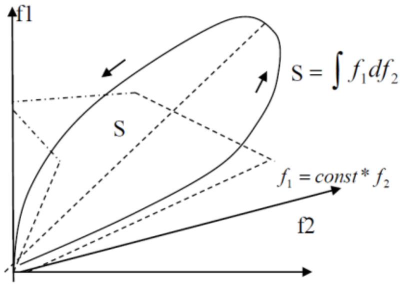

Fig1. *Geometric illustration of the algorithm for comparing functions in the stiltjes integral (S)*

Only "comparable" objects can be compared. It may happen that the areas (S) for two analogs are equal in comparison with the object under study (Fig.1), but one shape has the form of a smooth curve without self-intersections , stretched along the axis of the "correlation" of objects, and the other shape has the form of a complex polyline shape (dotted line in Fig. 1). In this case, visualization of the integral on the plane of parameters of the compared objects in the form of a loop form provides additional information about the possibility of similarity and comparison of objects and the applicability of the comparative approach to evaluation. The comparability criterion and similarity measure is the similarity of images of hysteresis curves representing an integral of the form, $\int f_2 d f_1$, and the approximation of the hysteresis loop to an ellipsoid elongated along the axis or degenerated into a straight line when comparing the object and the analog (these criteria are obvious).

Minimum Entropy Production when Comparing Objects Using the Shift Phase Method

Let the Functions (f_1 , f_2) as the dimensions of two physical objects being compared be defined on the same interval (time or state space). Compare f_1 и f_2 with the integral S , is numerically equal to the square shapes in the coordinate plane (f_1 , f_2), i.e., S = $\oint f_1 df_2$. This figure with area S written in a rectangle area ($|f_1||f_2|$), where the function modules ((f_1 , f_2) in this case denote the difference between the maximum and minimum values of the function on the chosen interval. Mark this area of the rectangle with the – ( ) icon. Put the values of function modules (f_1, f_2) as constants on the segment of parameter changes that define functions (,) as arguments. The relative entropy that occurred during the transition of the system from one state (f_1) to (f_2) we denote as f =ln (1+φ). If φ=0, then the state f_2 fully corresponds to the known initial state f_1. And The change in entropy F, which occurred when the system transitions from one state to another, can be represented as the relative area of the paving of the figure S in the area of the figure: (S = $\oint f_1 df_2$), i.e. as F = ln(1+ S /) = ln (1+φ) ≈ ,φ , $S \to \varphi, \varphi \to 0$.. — the area of the rectangle in which the loop (S) is inscribed, see expression (4). the Value () can also be interpreted as "energy" entropy, i.e. as the ratio of the actual work of "generalized forces on "generalized displacements" to its theoretically maximum possible value. We prove the identical fulfillment of the integral principle for the production of phase-type entropy F in time coordinates. From the substance of the proof will follow its execution in the General case of arbitrary defining (internal) coordinates.

The entropy production functional F = F (f_1, f_2) for time (τ) is equal to: F ≈φ, F (f_1, f_2) =

$$\int_0^\tau f_1 df_2 \Big/ |f_1||f_2| = \int_0^\tau Pdt \Big/ |f_1||f_2| \qquad (5)$$

where P = const* $f_1(\partial f_2/\partial t)$. Up to a constant is the rate of entropy production. The variation of the functional F are the functions f_2 in (5) is a sufficient condition for Euler:

$$\frac{dP}{df_2} - \frac{d}{dt}\left(\frac{dP}{d(\partial f_2/dt)}\right) = 0 \qquad (6)$$

It is easy to see that the sufficient Euler condition (6) is identically satisfied for the value P in the form P =$\psi * (\partial f_2/\partial t)$, (7)

where ψ is an arbitrary function of the message (received by the information receiver), i.e. ψ = ψ (f_1 , f_2). Comparing the value of P, whose structure is given in (4), with the value of P, whose structure is given in (7), we see the coincidence of these values when choosing an arbitrary function () in the form $\psi = f_1 / |f_1||f_2|$.

It follows that the amount of entropy (chaos or information generated during the comparison operation as in the "interaction of receiver and transmitter" according to definition (1-4), identically satisfies the fundamental principle of minimum entropy production in the system "object-sample" or " receiver-transmitter

Universalism of the Shift Phase as a Comparison Algorithm

Expression (1) in the non-material information world is a comparison algorithm that results in a shift that determines dissimilarity. On the other hand, expression (1) in the material world is the physical work of forces acting on an object when it is moved. Such an integral in mechanics is the work of generalized forces on generalized, displacements, the result of which is energy, while the normalizing constant (C) before the integral has the corresponding dimension. This circumstance by analogy gives the interpretation of the shift phase as a comparison algorithm, in which some information forces perform "work" on moving (deforming) an information object to match the image, and the result of this movement and information work is the generation of new information about the degree of similarity of objects.

The Shift Phase as a Result of Formal Interaction

Formal interaction is meaningless between arbitrary objects, functions (f_1, f_2) on a segment. In the non-material world, it occurs if objects (f_1,

f_2) can be compared. In the material world, this principle of comparability passes into the principle of causality, one of the functions is the cause, the other with a time shift-the effect. Then the shift phase makes sense as the result of some formal interaction, and it is a generator of new information.

Possible view of "Information

The definition of information given in the publication "Mathematical theory of communication" by Weaver and Shannon in 1948 is the definition of the volume (quantity) of the message", but not information as such. The message may be long, but it does not carry information.

Russian Academician N. N. Moiseev believed that information is only related to systems where there is goal-setting (in society, in the biosphere, in astrophysical sitnals), and therefore information is historical – information is a physical and historical concept.

We follow the principle that information is not only a function of the transmitter (not only a function of the message), but also a function of the receiver, and is the result of the interaction of the transmitter and receiver.

Discussion definition of "information"

Let the function f_1 be a message in the sense of a Weaver-Shannon (transmitter message). The function f_1 can be arbitrary. For certainty, we assume that it is a series of numbers consisting of zeros and units of length (dimension) n> 0, or a series of arbitrary numbers.

Let the function f_2 be the "thesaurus" of the message receiver, having the same dimension as.

Then the amount of information **(I)** received by the receiver is equal to

$$\textbf{(I)} = \text{Const}\ \{\int f_1 d(f_2)\},\ \text{Const} = 1/|f_1||f_2| \quad (8)$$

Where $|f_1|$, $|f_2|$ is the modulus of the difference between the maximum and minimum values of the corresponding function on the segment.

The discussion of this definition is that both the area of the hysteresis loop and the shape of the loop itself as the degree of similarity of objects, both of these values are information, and it is impossible to give information quality and quantity for these two parameters. Definition (8) is valid only in the fact that the obtained parameters are news (information), which according to (8) is normalized on the segment [0, 1].

Comment on the Definition of Information

The amount of information as a value (8) in paraphrasing is the result of the interaction of two objects – the receiver and the transmitter of information, and the result of the interaction is the appearance of a new information. However, you can't separate information by the quality-quantity type. Perhaps in this term, quality and quantity are not separate for the quantity (8). Then (8) mlzhno consider the amount of information. We assume that the state of the receiver-transmitter system before interaction differs from the state after interaction (which resulted in a change in the amount of information) by an amount that corresponds to the minimum change in entropy in the system. in Other words, we assume that the process of information interaction, defined by the integral (8), must meet the fundamental principle of minimum entropy production in the system (receiver-transmitter). This statement makes sense because the proposed definition of the amount of generated information of type (8) will be justified as a sufficient condition for fulfilling the fundamental integral principle of minimum entropy production in the system.

Divertissement/ Features of Formal Interaction and Paraphrasing of Results

From the point of view of kinematics of forms, an integral (1) of the Stiltjes type is ashift between phenomena f_1, f_2 in the space of certain parameters.

- From the point of view of mechanical analogy, the integral (1) is the normalized (specific) work of forces f_1 to move (and, or strain) the phenomenon over a distance f_2.
- From the point of view of information physics, integral (1) is the work of information forces f_1 to move an information phenomenon along generalized parameters f_2.
- From the point of view of thermodynamic analogy, the integral (1) as the amount of information is the result of the interaction of the "forces" of the transmitter with the

receiver surface, acting as normal stresses on the deformable surface (information form) of the receiver. Here the "shell" model of the "mechanical" interaction of the transmitter with the receiver shell is acceptable.

- From the point of view of physics, the integral (1) as a measure of information is acceptable, since it satisfies the fundamental physical principle of minimum entropy production in the transmitter-receiver system (this justification is reflected below).
- Note that here in the definition there is a principle of "historicity" of information on N. N. Moiseev in the sense that since it is possible to compare not any phenomena, but only comparable ones (which makes sense to compare), the thesaurus of the receiver is not arbitrary, but is selected as a function so that the phenomena are comparable, "the same in the sense of comparison in the present definition", but differ only by a shift. This selection process for a message, like the recognition process for a message, is not reflected in this definition, but is implicitly implied.
- Also note that from the definition of information quality, the definition of information quality as an entity that appears only with a non-zero amount of information (with a non-zero area of the shape as a hysteresis loop in the Stiltjes and nntegral).

  The quality of information (J) is the shape of a curve (shape of a figure), which on the coordinate plane $X = f_1$, $Y = f_2$ has an area equal to the integral (I). Fig.1.

  Information is also the shape of a shape whose area is equal to the amount of information). The quality measure is not defined here, because the definition is always a restriction, and therefore the quality measure of information for its definition requires additional goal setting (restrictions).
- It is Important that the information, or more strictly - " the amount of information in the form of (1), is a new quality, a new substance, "perpendicular" to the message and thesaurus of the receiver, i.e. the information, as a result of the interaction of the receiver and the transmitter, does not lie in the plane of information interacting functions f_1, f_2.
- Note that the amount of information (1) does not depend on transmitter power $|f_1|$, which is proportional to any power of the amplifier (gain) of the receiver, proportional f_2, ie does not depend on power "factor of understanding" of the receiver.
- Also note that the amount of information (1) can be positive or negative, like the polar area of a flat figure on the plane (,). TheNegative value of information (1) corresponds to the advance of the message relative to the receiver's thesaurus (forces are ahead of the offset), i.e. it is news, and carries meaning (physical and informational). A positive value (1) indicates that the message is "lagging" behind the receiver. Such information as the state of the transmitter lagging in time coordinates from the state of the receiver is not necessary in the material world, because the cause precedes the consequence.
- From the integral (1) and the observations implies that information is the product of the interaction between the receiver and transmitter, so we can talk not only about the impact of the transmitter on the successor by a message, but about the feedback effect of the receiver to the transmitter, which, in the framework of informational interaction of the form (1) is not dependent on the power of the transmitter of the message and power of the receiver amplifier. There is a principle here: if you study something, something will study you.
- If we accept the experimental fact that infinite displacements and velocities are not observable, then the phenomenon and the message about the phenomenon can be defined without limitation of generality in (1) as the SMM of a denite function and a finite one that turns to zero at the ends of the definition segment. a finite function, therefore by definition also finite.

$$S_1 = \int_T f \frac{\partial f_1}{\partial t} dt \equiv 0 \quad , \quad S_2 = \int_T f_2 \frac{\partial f_2}{\partial t} dt \equiv 0 \quad .$$

Paraphrasing – if the thesaurus (information state) if the receiver matches the message, then the transmitted information is zero.

The finite functions ((f_1 , f_2) on the parameter plane (f_1 , f_2)) form a closed loop type figure whose area is numerically equal to the Stiltjes integral of the form (1)

- Any function on a segment is represented as the sum of two functions - symmetric and anti-symmetric functions. Therefore, the finite functions on the segment, which can for example represent elementary particles, are represented as the sum of two functions -

symmetric and anti-symmetric. Therefore, the amount of information other than zero, in the sense of the proposed definition, occurs only when the" information interaction" of the symmetric and anti-symmetric components of the message and receiver functions. The same (identical) symmetry components of the message and receiver do not" act "on each other, do not "feel" each other, and do not "generate" information (are not news). The same (eponymous) components "feel" only a function of the type "correlation function", but not a function of information interaction I (t) of the type **I (t),**

I (t) = $\int_0^t f_1 d(f_2)$, A function of the form I (t),

which is an integral of the upper variable limit, is a "filter" of components of the same symmetry type in functions

(f_1 , f_2), i.e. it filters out components with the same symmetry and in this sense is an anti-correlation function.

- Based on the definition, it can be argued that the amount of information as an integral (8) occurs when interacting functions (f_1, f_2) components of different names by type of symmetry appear as "news".
- The definition of the amount of information (8) is given in the framework of the kinematic shell model of "information interaction" , in which the field of forces f_1 affects the shell f_2,, and the result of interaction depends only on the forms of mutual symmetry of these parameters, (the distribution of forces on the surface of the shell) but does not depend on the physical nature and essence of the forces f_1 and the shell f_2 .
- Determining the amount of information in the form of (8) there is also a restriction on the concept of "information". This definition does not apply outside the framework of representations of the "shell" model of information interaction. At the same time, the kinematic model of interaction is quite "extensive", since it does not impose restrictions on the physical type of interaction, on the physical type of "forces" of interaction.

Conclusions: The Shift Phase as a Result of Formal Interaction

Formal interaction is apparently meaningless between arbitrary objects, functions (,) on the observation segment.

In the non-material world, it occurs if objects (,) can be compared. In the material world, this principle of necessary comparability passes into the principle of causality, one of the functions is the cause, the other with a time shift-the effect. Then the shift phase makes sense as the result of some formal interaction, objects (phenomena), and the algorithm for obtaining it is a generator of new information. in this sense, the shift phase, like entropy, is a "bridge" between the material and non-material world in modern physics.

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