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Physical" Phase as a Relative Dimensionless Shift and an Algorithm for Comparing Measurements and Phenomena

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Abstract: *Mathematic (harmonic) phase concerns argument in functions (sin), (cos) with the same frequency. For common description any differences between physics phenomenon are suggested the Shift phase ore Physics phase. Shift phase is non size energy due common forces with common displacements.*

Keywords: *«Mathematic» (ore harmonic) phase, «Shift» phase ore «Physics» phase, common forces and common displacements.*

1. Introduction

The definition of "shear phases", the need for which arose on the basis of physical and geophysical applications. The form of this phase -"integral", in essence -"shift", reflects the "otherness" of objects modified or deformed by sliding relative to each other. In this sense, the shift phase is the phase of the phase "physical", because the offset can be determined without loss of generality, as normalized work of generalized forces on generalized displacements. Any finite function (as a function restricted on the interval (i.e., any number of observations) has an unlimited range and therefore an infinite number of phases leaving the harmonics. A comparison of the two rows had the same number of members gives also an infinite number of phases of the corresponding harmonics. Therefore, to compare finite functions (series of observations) phase of the classical way is impossible. But with the help of the concept of phase shift such a comparison is possible, here the shift between finite functions is determined by one number –one phase.

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Shear or "physical" phase reflects the essence of the title, so the form of the mentioned "physical" phase similar to a "shift" of the object as a whole, and is reduced to a harmonic of (mathematical) phase, if you compare features (phenomena) of the harmonic. Shear or "physical" phase reflects the essence of the title, so the form of the mentioned "physical" phase similar to a "shift" of the object as a whole, and is reduced to a harmonic of (mathematical) phase, if you compare features (phenomena) of the harmonic. Essentially, that shift, the "physical" phase with a precision of dimensional constants is responsible for the processes of transformation and transmission of energy, because these processes can be expressed in the form of "phase shift", which identically satisfies the principle of minimum entropy production in the studied system (the Euler condition as a necessary condition), and up to dimensional constants quantitatively determines the physical transport processes, shifts, changes of the density of sources in the compared fields.

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The "shear phase method" quantifies the differences between the actual mathematical objects and the physical processes and phenomena (the position or position of the object, the "recognition of the object, the finding of energy flows, mass, momentum in the material medium). The shift phase method is also designed to calculate (find) the phase of an arbitrary object (or its position), phenomenon, signal, without using harmonic (Fourier) analysis. The shear phase gives the magnitude of a time or spatial shift, as well as quantitative characteristics in the form of energy flows, momentum masses for "distributed objects", such as distributed media and large systems.

On the one hand, the "phase" in our definition is the kinematic concept, the shift or (or integral) phase as a parameter of the difference between shapes, shapes, surfaces (functions). On the other hand, the expression for the shear phase is proportional to the transport processes (mass, energy, momentum) in a material continuous medium or in a large system. The practical consequences of this coincidence of the forms are discussed below.

2. PHASE – A COMPARATIVE SETTING "LARGE SYSTEM»

Note that "phase" as a parameter and then the number applicable for comparative descriptions of a variety of points systems, or for describing the motion of a single point as a combination of its provisions (of the path). Thus, a single number (phase)describes the features of the system as a whole (the distribution of properties, the position of the points), or even a "large" system, where the number of elements is large, and describes the shift or shift. Displacement is the concept of relative (comparative). Phase also has a "comparison parameter" that has a positive or negative sign depending on the direction of shift in the selected coordinates

Definition [1]

Physical (shift , integral, activation) phase between two functions f1 and f2 we will call the integral of the form

$$\varphi = C \int_{\Omega} f1 d(f2), \qquad (1)$$

where C = Const is a dimensional and normalizing constant, is the domain of phase determination. On the basis of (1) the spatial phase shift between f1 and f2 is equal

$$\varphi = C \int_{\Omega} f1 \nabla f2 d\sigma \ , \qquad (2)$$

where $d\sigma$ - is the square element in the region $\Omega = \Omega(\ X\ )$, and the phase sign corresponds to the sign of the scalar product . Accordingly, the time phase is equal

$$\varphi = C \int_{T} f1(\partial\ f2 / \partial\ t)\, dt \qquad (3)$$

where T is the time interval.

This phase definition coincides with the classical one if the f1, f2 functions are harmonic functions. Letf1 = A1 Sin (ωx) , f2 = A2 Sin (ωx+ω), T-period Substituting the values f1, f2 in the integral (2) we have

$$\varphi = C\ 1\ A2 \int_{T} Sin(\omega x + \tau)\,[\ \partial / \partial\ x\,(Sin(\ \omega x\ )\,]\,dx = CA1\ A2\,(\omega/2) \int_{T} (\ Sin\,(\tau) + Sin\,(2x + \tau\ )\,dx = C\ A1\ A2\ T\,(\omega/2)\ Sin\,\tau\ .$$

Select constant as C = (2 /Tω A1 A2), from where we get –

$\tau = \sin\varphi$, where at $\tau \to 0$ $\tau = \varphi$

We see that the chosen definition of the shear phase coincides with the classical definition for harmonic functions. The proposed definition gives another interesting characteristic-a quantitative parameter of the difference between the functions, which can be briefly called -"shift". The connection of the "shift" with the mathematical phase is trivial – for harmonic functions, the shift and harmonic (mathematical) phases are the same. For arbitrary functions, there is no such connection (as well as the concept of the mathematical phase). Consider the relationship between the shift and the physical phase in the following paragraph.

3. SHIFT (PHYSICAL) PHASE AND KINEMATIC SHIFT [1]

The determination of the physical phase allows us to give a kinematic interpretation as a quantitative parameter of the difference between objects or finite functions in the form of a "shift". Let's assume that one finite function differs from another by a shift i.e. f 2 (x) = f1 (x+τ) see Fig. 1. Without loss of generality, let us assume that function f1 is finite and outside the region [A, B1] is equal to zero.

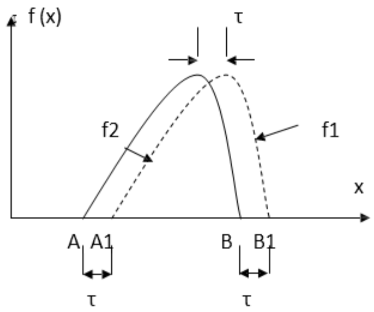

FIG1.

We compute the shear (physical) phase between the "congruent" finite functions f1, f2 according to the definition

$$\varphi = C\int f_1 df_2 = \int f_1 df_1(t+\tau)$$

(3)

The function f2 is representable as a power series in powers of (τ)

$$f_2(x) = f_1(x+\tau) = f_1 + \sum_n \frac{\tau^n}{n!}\frac{d^n f_1}{dx^n} + (\tau^n) \tag{4}$$

Substituting the value of f2 in the form of a series (4) into the integral of the form (3), we have under the small (τ)

$$\varphi \approx (C/2) f_1^2 + C\tau\int f_1 \frac{d^2}{dx^2} f_1 dx \tag{5}$$

Note that the first member in (5) equals zero. from where with small shifts we have

$$\boldsymbol{\varphi \approx \text{Const} * (\tau).} \tag{6}$$

The shift phase of the species (6) was used in [2] in the study of the large ocean- atmosphere geophysical system with the discovery of new natural phenomena, energy flows. An integral of type (1-3) in this example gives a phase as a "pure shift" between arbitrary finite functions with a sufficiently small value of this shift.

Returning to the example in Fig. 1, and consider the finite function f1, which is symmetric on the segment a, B, and the phase between f1 and the shifted function f2, see Fig. 2.

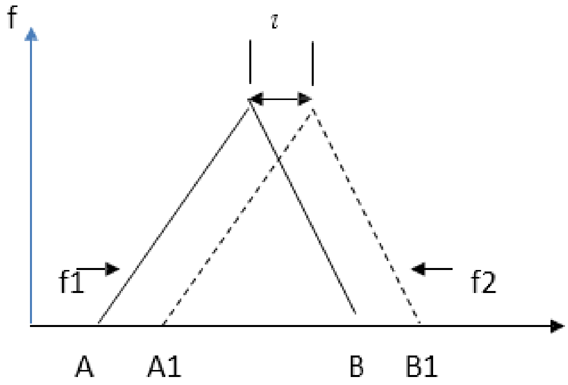

Fig2.

In the case of the symmetric on the interval A,B of the function (f1) the expression for the phase of the form (5) takes the form:

$$\varphi \approx (C/2)\, f_1^2 \Big|_{A}^{B+\tau} + C\int_A^{B+\tau} f_1 \frac{d^2}{dx^2} f_1 + \tau^2 \frac{1}{2} f_1 \frac{d^3}{dx^3} f_1 + \dots \frac{\tau^n}{n!} f_1 \frac{d^n}{dx^n} f_1)dx \qquad (7)$$

In this series, the first term is identical to zero for any finite function $f_1(A) \equiv f_1(B+\tau)$, because In the decomposition of the form (7) all the members of a series with even exponents also go to zero in the integration as the integrals of an odd function on the interval. For even (symmetric on a segment (A,B)) functions we have from (7):

$$\varphi = \mathrm{C}\sum_0^{\infty} \tau^{2m+1} \int_A^{B+\tau} (f_1 f_1^{2n+1} / n!)dx \qquad (8)$$

Thus, in our definition the phase, according to (8), always has a shift sign (τ), i.e.always shows the direction of the shift.

If we repeat the argument about the shift and phase on the shift segment for the asymmetric function on the segment, i.e. if b (5) is asymmetric on (A,B), then in the series of type (5,7) all integrals of the form

$$\mathrm{I} = \int_A^B f_1 f_1^{2n+1} dx \equiv 0$$

as integrals of the the antisymmetric function on the segment. Any function on the segment can be represented as a sum of symmetric and asymmetric functions. Therefore, for an arbitrary finite function, the phase shift between f(x) and f(x +τ) will always have the form of a series (7,8) at odd degrees and at small ones we obtain $\varphi \approx \tau$.

Thus, the phase shift between the finite functions in the sense of the introduced definition, in extreme cases, has the form and "pure phase" (harmonic functions), equal to "pure shift" (small shifts).

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The only constraint that was used above to display the equality (6), was to compare the function at the endpoints of the interval for calculation of the phase shift was equal to the same value, i.e. finite with accuracy up to constants. In the practice of calculating phase shifts for different physical processes, these values (the values of the function at the ends of the segment , as a series of observations) can have different arbitrary values, for example A) = (B) + C. Then in the same assumptions

f 1 (x) = f 2 (x + τ) 1 (x) = 2 (x +) we will have –

$$\varphi \approx \text{Const}\int_A^B f_1 df_2 \approx \boldsymbol{(}\tau\boldsymbol{)+}\textbf{Const(}\frac{f(B)-f(A)}{B-A}\textbf{)} \tag{9}$$

The first member in (9) represents a "pure" shift, and the second represents a "pure"

slope – the tangent of the slope angle on the segment. We see that the physical phase is a directed parameter of difference between forms, figures, surfaces(functions), which coincides in limit cases with the notion of kinematic shift and (or) with the notion of mathematical phase with small difference f1, f2 under condition F (B) = F (A) in (9).

4. Shift (Physical) Phase and Correlation Coefficient. [1]

At first glance, the integral in the definition of the shift (physical) phase between two functions (i.e. integral of the form $\varphi = \int f_1 df_2$) is similar to the integral for determining the correlation coefficient between them. Let us c that the similarity is remote - the phase has a sign; the correlation coefficient has no sign.

Let us compare the concept of physical phase between functions with the concept of correlation coefficient between them on the same segment under the condition of "pure shift", i.e. under the condition. We will stipulate that we do not consider the accepted concepts of correlation and functional relations. There is an infinite number of mathematical expressions for various correlation coefficients – depending on the task. Let us clarify that here, the correlation coefficient we will understand an expression of type

R = $\int f_1(x) * f_2(x)dx$.

The correlation coefficient between the function f_1, $_2$ on the segment (A, B+τ) accepted notations is equal (see Fig. 1,2)in the received symbols is equal (see Fig. 1.2)

$$\text{R=} \int_{Aa}^{B+\tau} f_1(x) f_1(x+\tau)dx = \int_A^{B+\tau} f_1[f_1 + f_1\tau + f_1'' \frac{\tau^2}{2} + ...]dx \tag{10}$$

In the expression (10) all members with odd powers will be equal to zero , as integrals of the form R = R ( ) from antisymmetric functions on the segment. As a result, we obtain that for functions that differ in the segment only by the shift, the correlation coefficient is represented by a number of even degrees of shift, and the phase shift in the sense of the accepted definition is represented by a number of odd degrees of shift, i.e.- R = $\sum_0^\infty K_n \tau^{2n}$, R = Const τ 0, (11)

$$\varphi = \sum_0^\infty Cn\,\tau^{2n+1} , \quad \varphi = \tau \quad \text{under } (\tau) \to 0.$$

For small shifts, the phase shiftbetween the finite functions is equal to the value of the shift , and the correlationcoefficient does not "feel" small shifts, and the direction of the shift correlation coefficient does not "notice". From (11) follows the approximate expression at small (τ)

$$\textbf{-R} \approx \textbf{1 - (Const)}\ \varphi^{\mathbf{2}} \tag{12}$$

In the kinematic shift of forms (functions), the correlation coefficient gives the degree of "similarity",

"similarity" of forms , and the physical phase is the degree of their "dissimilarity". Since the correlation coefficient is independent of the direction of shift (from sign ( ), so the dependence R( ) is quadratic in (12)

Shear phase" and minimum entropy production in measured value comparison operations [2]

Let Functions (, (f_1 , f_2)) as measurements of two compared physical objects be defined on the same interval (time or space of States).

We also compare with the integral S , numerically equal to the area of the figure in the coordinates on the plane (, (f_1 , f_2),), i.e. S = $\oint f_1 df_2$

This figure with area S is written in a rectangle with area (($|f_1||f_2|$),), where modules functions (, (f_1 , f_2) in this case indicate the difference between the maximum and minimum values of the function on the selected segment. Denote this area of the rectangle with the icon – ( ). The values of the function modules (f_1 , f_2), are constants on the interval of parameter changes that define the function , (f_1 , f_2), as arguments. The relative entropy that occurs during the transition of the system from one state (f_1) to (f_2) is denoted as FA =Ln(1+ φ) If φ =0, then the state completely corresponds to the known initial state, and the change of entropy F=0. The change of entropy in this can be represented as the relative area of tiling 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 φ 0.

It makes sense to interpret the value of F v as 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 performance of the integral principle for the production of type f entropy in the beginning in time coordinates. From the substance of the proof will follow its implementation in the General case of arbitrary defining (internal) coordinates.

The entropy production functiona F= F(, (f_1 , f_2)) in time (τ) is equal to (meaning that F ≈ φ , but this condition is not essential, and affects only the constant in (13,14,15).

The functionality of the entropy production F= F (, (f_1 , f_2)) for the fixed time (τ) is equal to

$$F=F(f_1, f_2)=\int_0^{\tau} f_1 df_2 \Big/ |f_1||f_2| = \int_0^{\tau} P dt \Big/ |f_1||f_2| \qquad (13)$$

where P = P = $f_1(\partial f_2 / \partial t)$.

The minimum of the functional of entropy production F, i.e. the minimum value the rate of generation (production) of entropy. within the limits of the definitions (restrictions), it is achieved when a sufficient condition for the existence of the extremum of the functional f is satisfied with the variation of the function f_2 in the form (Euler's sufficient condition) -

$$\frac{dP}{df_2} - \frac{d}{dt}\left(\frac{dP}{d(\partial f_2 / dt)}\right) = 0 \qquad (14)$$

It is easy to see that the sufficient Euler condition (2) is identically satisfied when p is in the form of P = , P = $\psi(\partial f_2) / \partial t)$, where there ψ is an arbitrary message and receiver function, i.e. ψ = ψ (f_1 ,

f_2). Comparing the value of P , the structure of which is given in (2), with the value ofP, the structure of which is given in (1), we see the coincidence of these values when choosing an arbitrary function in the form $-\ \psi\ =\ f1 \Big/ |f_1||f_2|$

It follows that the amount of entropy (chaos or information generated by the interaction of the receiver and transmitter according to definition (S), identically satisfies the fundamental principle of minimum entropy production in the receiver-transmitter system. The principle of minimum entropy production in the system can be illustrated in other coordinates defining functions f_1 , f_2,, for example, as the dependence of the number of series members on the number (n). Repeating the reasoning about the achievement of the extremum of the functional of entropy production in the coordinates (n), similarly we get that the condition is Euler's identity is performed when the value of the rate of entropy production P in the form

$$\mathbf{P}= \frac{f_1 (\partial f_2 / \partial n)}{|f_1||f_2|} \qquad (15)$$

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$$P = \mathbf{P}\ =\ \frac{f_1 (\partial f_2 / \partial n)}{|f_1||f_2|}$$

their "dissimilarity". Since the correlation coefficient does not depend on the direction of shift (on the sign (φ), so the dependence R(φ) is quadratic in (12).

Some Examples of the application of the shear phase for the calculation of heat, mass, moisture flows in Nature .[3,4]

The shear phase in the fields of water and air temperatures of the oceans $T_{,w}, T_a$ is responsible up to the dimensional constant is responsible for the non-zero heat flow between the ocean and the atmosphere in the annual cycle Q = const $\oint T_w dT_a$

Shear stage between the atmospheric pressure and temperature of the air P_a, T_a in a closed circuit with a precision of dimensional constants gives the heat flow through the selected loop in astrofizicheskoi approximation, Q = const $\oint T_a dP_a$ The shear phase between the atmospheric pressure field and the level of the world ocean up P_a, η to the dimensional constant gives the value of the mechanical energy exchange between the media for the selected period A = const $\int_T P_a d\eta$

The shear phase on the unsteady interface of the medium inside the Sun and gas planets between the pressure field on the surface $P\ ,\eta$ under gravity conditions and its level , up to the dimensional constant, gives the value of the mechanical energy of the exchange between the media for the selected period A = const $\int_T P\, d\eta$ The shear phase between the neutron flux and the cooling water temperature in the nuclear reactor N, T_a gives an accuracy to the dimensional constant of the time shift cycle as an important parameter of reactor control for its safety T = const $\oint NdT_w$

The shear phase in the fields of observed and absolute humidity at the surface temperature of the ocean in the earth's atmosphere in the drive layer up E_0, E_z to the dimensional constant is responsible for a non-zero flow of buried heat between the ocean and the atmosphere W= const $\oint E_0 dE_z$

SUMMARY

The shift phase is essentially informative for determining the "phase" shift of a large system as an entire object relative to a previous or other position in time or space. The concept of the shear (physical) phase allows to estimate changes in large systems in terms of their displacements and deformations (shapes, coordinates, time) according to experimental data. This concept was used in experimental physics [1], including in the climate system to find large-scale heat flows [3,4] . Also, the method of shift phase is the single one for tended comparison of finite functions in any applications (datum, technic, economy, physics, and so on….

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ANNOTATION

In the mathematical definition, the phase is defined as part (displacement) of the argument between functions of the form sin, cos, having the same frequency. For brevity, we call this phase "harmonic". In nature, the shifts between phenomena that have small differences are mathematically characterized by a big (infinite) set of harmonic phase shifts, each of which corresponds to its fixed harmonic in the representation of the phenomenon by the Fourier series. It is shown that the shift (displacement) of a large system can be described by one number as a "shift phase" within the framework of the physical representation of the work of generalized forces on generalized displacements. The shear phase in experimental and theoretical physics is simultaneously the normalized energy of the work of generalized forces by generalized displacements.

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