Calculation of the Intensity of Physical Time Fluctuations Using the Standard Solar Model and its Comparison with the Results of Experimental Measurements

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Abstract. The article reviews the possibility of describing physical time as a random Poisson process. An equation allowing the intensity of physical time fluctuations to be calculated depending on the entropy production density within irreversible natural processes has been proposed. Based on the standard solar model the work calculates the entropy production density inside the Sun and the dependence of the intensity of physical time fluctuations on the distance to the centre of the Sun. A free model parameter has been established, and the method of its evaluation has been suggested. The calculations of the entropy production density inside the Sun showed that it differs by 2-3 orders of magnitude in different parts of the Sun. The intensity of physical time fluctuations on the Earth's surface depending on the entropy production density during the sunlight-to-Earth's thermal radiation conversion has been theoretically predicted. A method of evaluation of the Kullback's measure of voltage fluctuations in small amounts of electrolyte has been proposed. Using a simple model of the Earth's surface heat transfer to the upper atmosphere, the effective Earth's thermal radiation temperature has been determined. A comparison between the theoretical values of the Kullback's measure derived from the fluctuating physical time model and the experimentally measured values of this measure for two independent electrolytic cells showed a good qualitative and quantitative concurrence of predictions of both theoretical model and experimental data.

Key words: standard solar model, irreversible processes, entropy production, physical time fluctuations, Kullback's measure.

1. Introduction

An actively discussed and developed hypothesis as to the existence of nonlocal communication of quantum macroscopic processes [1-4] and the related experiments [5-7] led to a strong conviction about the existence of mutual influence of dissipative processes in nature. The experimental verification of the hypothesis presented is carried out at the level of establishing mutual influence of electroencephalographic (EEG) brain activity from pairs of people [8], as well as in physical experiments [9, 10].

The theory of non-Markovian processes is developed at the same time, which allows the irreversible processes in a variety of systems to be described, with due regard for fluctuations in dissipation factors [11-13]. The application of a physical time model to describe the impact of dissipative processes on measuring systems was first proposed in the works [14, 15].

The fluctuating physical time model [16], which was used in the work [17] to describe the propagation of light in the Universe to estimate the possibility of recording relic gravitational waves, as well as in the work [18] to explain the causality inversion, may be considered as a hypothesis helping to explain mutual influence of irreversible macroscopic processes.
The work theoretically predicts the intensity of physical time fluctuations using the standard solar model [19] and compares the results of long-term records of the Kullback’s measure of voltage fluctuations on electrolytic cells with the predictions of the fluctuating time model [20, 21].

2. Fluctuating physical time model

Let us review the fluctuating physical time model [16], based on the assumption that the physical time under review is a random Poisson process \( t \) with fluctuations, equal to \( \tau_0 = 1/\nu_\tau \), where \( \nu_\tau \) - the intensity of physical time fluctuations. The process is graphically displayed in Fig. 1.

\[
g_\tau(\mu_\tau; t) = \exp((\exp(it\tau_0\mu_\tau) - 1)\nu_\tau t), \tag{1}
\]

and its \( n \)-dimensional characteristic function at \( t_n \geq \ldots \geq t_2 \geq t_1 \) accordingly takes the form

\[
g_{nt}(\mu_\tau_1, \ldots, \mu_\tau_n; t_1, \ldots, t_n) = \exp\left( \nu_\tau \sum_{j=1}^{n} t_j \left( \exp\left( it\tau_0 \sum_{k=j}^{n} \mu_k \right) - 1 \right) \right). \tag{2}
\]

The characteristic functions (1) and (2) make it possible to write the expectation function \( \langle \tau(t) \rangle \) and correlation function \( \langle \tau(t_1)\tau(t_2) \rangle \) for arbitrary time points \( t_1 \) and \( t_2 \) as follows:

\[
\langle \tau(t) \rangle = t, \tag{3}
\]

\[
\langle \tau(t_1)\tau(t_2) \rangle = t_1t_2 + \tau_0 \min(t_1, t_2). \tag{4}
\]

For the application of the proposed fluctuating time model, we need to develop a method of calculating the intensity \( \nu_\tau \) of physical time fluctuations.
3. Calculation of the intensity of physical time fluctuations during the production of entropy by irreversible processes

To calculate the intensity $\nu_\tau$ of physical time fluctuations during the production of entropy by irreversible processes for a quasi-stationary case, we use the following equation

$$\nu_\tau \left( \frac{\partial^2 \nu_\tau}{\partial x^2} + \frac{\partial^2 \nu_\tau}{\partial y^2} + \frac{\partial^2 \nu_\tau}{\partial z^2} \right) = -\frac{c}{k} \rho_S(x, y, z),$$

(5)

where: $c$ - speed of light, $k$ - Boltzmann's constant, $\rho_S(x, y, z)$ - volumetric density of the production of entropy by irreversible processes.

For a spherically symmetric case, the equation (5) takes the form

$$\nu_\tau \left( \frac{d^2 \nu_\tau}{dr^2} + \frac{2}{r} \frac{d \nu_\tau}{dr} \right) = -\frac{c}{k} \rho_S(r).$$

(6)

If we assume that irreversible processes do not occur in space and $\rho_S(r) = 0$, the equation (6) takes the form

$$\nu_\tau \left( \frac{d^2 \nu_\tau}{dr^2} + \frac{2}{r} \frac{d \nu_\tau}{dr} \right) = 0.$$

(7)

Its two solutions can be presented as follows

$$\nu_\tau(r) = 0$$

(8)

and

$$\nu_\tau(r) = C_1 + \frac{C_2}{r},$$

(9)

where $C_1$ and $C_2$ - arbitrary constants.

Let us review the case where the production of entropy occurs only at the surface of a sphere of radius $R$. Such a case in the first approximation corresponds to the production of entropy during solar radiation and the Earth’s thermal radiation. At the same time, it is also assumed that all other irreversible processes occurring inside the Sun and Earth make a small contribution to the development of physical time fluctuations.

Let us introduce the equation (6) for this case in the form of

$$\nu_\tau \left( \frac{d^2 \nu_\tau}{dr^2} + \frac{2}{r} \frac{d \nu_\tau}{dr} \right) = -\frac{c}{k} \sigma_S \delta(r - R),$$

(10)

where $\sigma_S$ - surface density of the production of entropy, $\delta(r - R)$ - delta function.

Then, within the sphere, we may assume that $\rho_S(r) = 0$ and solution (9) is valid (solution (8) is trivial and has no physical meaning). However, to fulfill the condition of finiteness of the intensity $\nu_\tau$ of physical time fluctuations at any point in space (particularly, in the centre of the sphere), the constant $C_2$ needs to be taken equal to zero: $C_2 = 0$. Consequently, at $r < R$ we obtain

$$\nu_\tau(r) = C_1.$$

(11)

Outside the sphere, at $r > R$, the solution (9) still remain valid. Based on the vanishing condition of the function $\nu_\tau(r)$ at an infinite distance from the sphere $\nu_\tau(r)|_{r \to \infty} = 0$, the constant $C_1$ needs to be taken equal to zero: $C_1 = 0$. Then the solution outside the sphere at $r > R$ takes the form
\[ v_z(r) = \frac{C_2}{r}. \]  

(12)

Based on the continuity condition of the function \( v_z(r) \) at \( r = R \), we may state the following:

\[ C_1 = \frac{C_2}{R}. \]  

(13)

Substitution of solutions (11) and (12) into equation (10) based on formula (13) allows us to determine the constants \( C_1 \) and \( C_2 \):

\[ C_1 = \sqrt{\frac{c}{R}} \sigma_S, \]  

(14)

\[ C_2 = \sqrt{\frac{c}{k}} R^3 \sigma_S. \]  

(15)

The resulting expressions allow us to estimate in the first approximation the surface density of production of entropy during the thermal radiation using the formula given in the work [23]:

\[ \sigma_S = \frac{4 W_c}{3 T_c} \frac{1}{4 \pi R_c^2} = \frac{W_c}{3 \pi T_c R_c^2}, \]  

(16)

where: \( W_c = 3.85 \cdot 10^{26} \) W – the power of solar radiation, \( T_c = 5830 \) K – temperature of the Sun, \( R_c = 6.96 \cdot 10^8 \) m – radius of the Sun. Then, the intensity \( v_z(r) \) of physical time fluctuations on the Sun’s surface will be equal to: \( v_{zC} = 1.48 \cdot 10^{22} \) s\(^{-1}\), and at a distance from the Sun to the Earth - \( v_{z0} = 6.87 \cdot 10^{19} \) s\(^{-1}\), respectively.

4. Calculation of the production of entropy using the standard solar model

The work [19] described the standard model of the internal structure of the Sun, which allowed us to calculate the temperature \( T_i \) inside the Sun in relation to the radius \( r_i \) and the power of energy \( W_i \) production due to the thermonuclear reactions inside the \( i \)-th spherical layer, where \( i \) is the number of the spherical layer inside the Sun. The data presented here allow us to calculate the density \( \rho_S(r_i) \) of production of entropy inside the Sun in relation to the radius \( r_i \). For this purpose, we use the formula similar to the expression (16):

\[ \rho_S(r_i) = \frac{4}{3} \left( \frac{\sum_{k=i} W_k}{T_{i+1}^2} - \frac{\sum_{k=1}^i W_k}{T_i^2} \right) \frac{1}{(V_{i+1} - V_i)}, \]  

(17)

where the sphere volume \( V_i \) of the radius \( r_i \) equals to: \( V_i = \frac{4}{3} \pi r_i^3 \).

Fig. 2 shows the diagram of the dependence of the production of entropy \( \rho_S(r) \) calculated by formula (17) with the use of the standard solar model parameters presented in the work [19]. The values of entropy production density \( \rho_S(r) \) in Fig. 2 are given in W/K·m\(^3\).
As may be inferred from the diagram, the entropy production density $\rho_S(r)$ inside the Sun first decreases with the increase of the radius $r$, and then starts to increase sharply within the near-surface layer and reaches its maximum value at the surface of the Sun. The sharp increase in the entropy production density within the near-surface layer of the Sun is associated with a sharp temperature drop within the same layer. However, it should be noted that, according to Fig. 2, the entropy production density differs by 2-3 orders of magnitude in different parts of the Sun.

5. Calculation of the intensity of physical time fluctuations

To calculate the intensity $v_\tau(r)$ of physical time fluctuations inside the Sun, we may use the formula (6) presented in the form of the system of equations

$$v_\tau \left( \frac{dk_\tau}{dr} + \frac{2}{r} \kappa_\tau \right) = -\frac{c}{k} \rho_S(r), \quad (18)$$

$$\frac{dv_\tau}{dr} = \kappa_\tau. \quad (19)$$

Outside the Sun, at $r > R_C$, the calculation of the intensity $v_\tau(r)$ of physical time fluctuations can be made using the formula similar to (12):

$$v_\tau(r) = \frac{v_\tau c R_C}{r}, \quad (20)$$

where $v_\tau c = v_\tau(R_C)$ - the intensity of physical time fluctuations on the Sun's surface.

The system of equations (18) and (19) was solved by the Euler numerical method with an allowance for correction [24]. At $r = 0$, the value $\kappa_\tau$ was assumed to be equal to zero:
\(\kappa_t(r)|_{r=0} = 0\), and the value of the intensity \(v_t(0)\) of physical time fluctuations varied.

To evaluate the intensity \(v_t(0)\), we need to use \textit{a priori} information that can not be derived from the model proposed. One of the possible options of evaluating the intensity \(v_t(0)\) is the assumption that the value is determined by the most probable thermonuclear reactions inside the Sun associated with the fusion of helium nuclei from hydrogen nuclei within the hydrogen-helium cycle. The energy of major reactions within the specified cycle has the following range of values: \(E = 5.5...17.3\ \text{MeV}\). Then, the intensity \(v_t(0)\) in the centre of the Sun may be estimated by the formula:

\[
v_t(0) = \frac{E}{\hbar}, \tag{21}
\]

where \(\hbar\) - Plank's constant. The calculation gives us the following: \(v_t(0) = (0.9...2.7) \cdot 10^{22}\ \text{s}^{-1}\). If we take into consideration the whole cycle of hydrogen-to-helium transformation, the energy of which is: \(E = 26.7\ \text{MeV}\), then the value of the intensity \(v_t(0)\) in the centre of the Sun results in: \(v_t(0) = 4.1 \cdot 10^{22}\ \text{s}^{-1}\). It is obvious that the values obtained are approximate.

Fig. 3 shows the diagrams for multiple values of the intensity \(v_t(0)\) of physical time fluctuations in the centre of the Sun: \(v_t(0) = (2;3;4) \cdot 10^{22}\ \text{s}^{-1}\).

\[
\begin{align*}
v_t, \ 10^{22}\ \text{s}^{-1} \\
1 & - v_t(0) = 2 \cdot 10^{22}\ \text{s}^{-1}; \\
2 & - v_t(0) = 3 \cdot 10^{22}\ \text{s}^{-1}; \\
3 & - v_t(0) = 4 \cdot 10^{22}\ \text{s}^{-1}
\end{align*}
\]

Fig. 3. Dependence of the intensity \(v_t(r)\) of physical time fluctuations at various values of intensity \(v_t(0)\) in the centre of the Sun:

1 - \(v_t(0) = 2 \cdot 10^{22}\ \text{s}^{-1}\); 2 - \(v_t(0) = 3 \cdot 10^{22}\ \text{s}^{-1}\); 3 - \(v_t(0) = 4 \cdot 10^{22}\ \text{s}^{-1}\)

As can be seen from the data obtained, the intensity \(v_tC\) of physical time fluctuations on the Sun's surface and, consequently, the intensity \(v_t0\) of physical time fluctuations created by the Sun on the Earth's orbit, depend on the adopted value of the intensity \(v_t(0)\) of the physical time fluctuations in the centre of the Sun. The latter may be calculated using formula
(20) with the insertion of distance $r$ equal to the distance from the Sun to the Earth: $r = 1.5 \times 10^{11}$ m.

Table 1 includes the calculated values of the intensity of physical time fluctuations on the Sun's $\nu_{tC}$ and the Earth's $\nu_{t0}$ surfaces in relation to the adopted value of the intensity in the centre of the Sun $\nu_t(0)$.

| $\nu_t(0)$, $10^{22}$ s$^{-1}$ | $\nu_{tC}$, $10^{22}$ s$^{-1}$ | $\nu_{t0}$, $10^{19}$ s$^{-1}$ |
|-------------------------------|-------------------------------|-------------------------------|
| 2.0                          | 0.67                          | 3.1                           |
| 3.0                          | 2.27                          | 10.5                          |
| 4.0                          | 3.47                          | 16.1                          |

As follows from the calculations performed, the value of the intensity of physical time fluctuations on the Sun's and Earth's surfaces heavily depends on the intensity $\nu_t(0)$ of physical time fluctuations in the centre of the Sun, the value of which is an arbitrary parameter within the model considered.

### 6. Calculation of the intensity of physical time fluctuations due to the Earth's thermal radiation

Let us calculate the intensity of physical time fluctuations for the case where the heat radiating sphere is located in a space with a certain value of the intensity $\nu_{t0}$ of physical time fluctuations, generated by external processes. Such a case is observed when calculating the intensity $\nu_t(r)$ of physical time fluctuations generated by the thermal radiation of the Earth under the Sun's external influence characterized by the intensity $\nu_{t0}$.

Then, the solution of the equation (10) inside the sphere can be presented as follows

$$\nu_t(r) = C_1 + \nu_{t0},$$  \hspace{1cm} (22)

and outside the sphere

$$\nu_t(r) = \frac{C_2}{r} + \nu_{t0},$$  \hspace{1cm} (23)

yet the formula between the constants $C_1$ and $C_2$ retains its form (13).

Substitution of solutions (22) and (23) in equation (10) allows us to obtain the following expression

$$(C_1 + \nu_{t0}) \left( - \frac{C_2}{R^2} \right) = - \frac{c}{k} \sigma_S ,$$  \hspace{1cm} (24)

which can be represented as an algebraic equation

$$C_1^2 + \nu_{t0}C_1 - \frac{c}{k} R \sigma_S = 0.$$  \hspace{1cm} (25)

Solution of equation (25) takes the form

$$C_1 = - \frac{\nu_{t0}}{2} \pm \sqrt{\frac{\nu_{t0}^2}{4} + \frac{c}{k} R \sigma_S},$$  \hspace{1cm} (26)

noting that the physical meaning pertains only to the solution with a plus sign in front of the root in (26).
Then, finally, in accordance with formula (22), the value of the intensity $v_\tau$ of physical time fluctuations on the Earth's surface will look as follows [25]

$$v_\tau = \frac{v_{\tau 0}}{2} + \sqrt{\frac{v_{\tau 0}^2}{4} + \frac{c}{k} R_3 \sigma_S},$$

(27)

where $R_3 = 6.4 \cdot 10^6$ m – radius of the Earth. The entropy production surface density due to the Earth's re-radiation of sunlight may be calculated by the following formula [23]

$$\sigma_S = \frac{4}{3} \left( \frac{w_3}{T_3} - \frac{w_C}{T_C} \cos \gamma \right),$$

(28)

where:

$w_3 = \sigma T_3^4$ - power of thermal radiation of the Earth from one square metre,

$\sigma = 5.67 \cdot 10^{-8}$ W/(K^4 m^2) - Stefan-Boltzmann constant,

$T_3 = 254$ K - the average radiation temperature of the Earth,

$w_C = 1368$ W/m^2 - the intensity of solar radiation falling on the Earth,

$T_C = 5778$ K - solar radiation temperature in the vicinity of the Earth,

$\gamma$ - the angle of sunlight incidence on the Earth's surface, which depends on the time of year and the day.

Substitution of formula (28) in equation (27) allows us to calculate the average intensity $v_\tau$ of physical time fluctuations on the surface of the Earth at $v_{\tau 0} = 3.1 \cdot 10^{19}$ s^{-1} (see Table 1): $v_\tau = 3.5 \cdot 10^{19}$ s^{-1}.

7. Calculation of the Kullback's measure of voltage fluctuations on electrolytic cells in relation to the intensity of physical time fluctuations

Let us make a thermodynamic calculation of variations of the Kullback's measure of voltage fluctuations on an electrolytic cell [21]. For this purpose, we use the following equation

$$dH = -v_\tau H dt + dW_\tau(t),$$

(29)

where the characteristic function of a Poisson process $W_\tau(t)$ may be presented as follows

$$g_\tau(\mu_\tau, t) = \exp[(\exp(iD_\tau \mu_\tau)) - 1)v_\tau t],$$

(30)

Here we have the symbol introduced

$$D_\tau = \frac{mc^2}{hN},$$

(31)

where: $m$ - ionic mass, $N$ - number of ions in a small amount of the electrolyte.

The characteristic function of the Kullback's measure based on equation (29) is given by [21]

$$g(\lambda_H; t) = \exp\left\{v_\tau \int_{-\infty}^{t} [\exp(\exp(iD_\tau G(t, \tau) \lambda_H)) - 1] d\tau \right\},$$

(32)

where

$$G(t, \tau) = \exp[-v_\tau(t - \tau)].$$

(33)

Substitution of formula (33) in equation (32) allows us to determine the first moment of the Kullback's measure:

$$\langle H \rangle = \frac{\partial g(\lambda_H)}{\partial \lambda_H} \bigg|_{\lambda_H = 0} = \frac{D_\tau}{v_\tau},$$

(34)
Calculation of the coefficient $D_z$ using formula (31) at a characteristic ionic mass in a distilled water $m = 3.2 \cdot 10^{-26} \text{ kg}$ and the number of ions $N = 10^{10}$ gives the following value of coefficient $D_z$:

$$D_z = 2.7 \cdot 10^{15} \text{ s}^{-1}.$$  \hspace{1cm} (35)

Substitution of the value in formula (34) taking into account the evaluation of the intensity of physical time fluctuations on the Earth's surface $v_z = 3.5 \cdot 10^{19} \text{ s}^{-1}$ allows us to calculate the approximate value of the Kullback's measure: $\langle H \rangle = 7.7 \cdot 10^{-5}$.

8. Calculation of the Earth's effective thermal radiation temperature

Later, we will proceed from the model assuming that the solar radiation heats the Earth's surface, and furthermore, due to the heat transfer process, the heat is transferred to the upper atmosphere with subsequent thermal radiation into space. Then the simplest model of the process described above may be represented by the following differential equation

$$\frac{dT_3}{dt} + \alpha T_3 = \alpha (T - \eta w_3),$$  \hspace{1cm} (36)

where $T_3$ - Earth's thermal radiation temperature, $\alpha$ - coefficient characterizing the process of heat transfer from the Earth's surface to the upper atmosphere, $T$ - the Earth's surface temperature, which in the first approximation can be considered equal to the air temperature at the Earth's surface, and the coefficient $\eta$ can be determined by the heat equilibrium condition: the average density of the radiation falling from the Sun onto the surface of the Earth $\langle w_C \cos \gamma \rangle$ is equal to the average density of the Earth's thermal radiation $\langle w_3 \rangle$:

$$\langle w_C \cos \gamma \rangle \equiv \langle w_3 \rangle.$$ \hspace{1cm} (37)

The following values of the coefficients were used in the calculations:

$$\alpha = 1.17 \cdot 10^{-5} \text{ s}^{-1},$$  \hspace{1cm} (38)

$$\eta = 7.9 \cdot 10^{-2} \text{ K/W}.$$ \hspace{1cm} (39)

In this case, the entropy production density will be calculated according to formula (28), in which the value of the Earth's thermal radiation temperature $T_3$ is substituted by the expression obtained in the solution of equation (36).

9. Results of modeling of variations of the Kullback's measure and comparison with experimental diagrams

When calculating the theoretical value of the Kullback’s measure $\langle H \rangle$, we shall use the expressions derived above: (27), (28), (34) and (36). For the evaluation the intensity was considered as $v_{t0} = 3.1 \cdot 10^{19} \text{ s}^{-1}$. The atmospheric temperature $T$ data within the near-surface layer of the Earth were taken from the web site "Pogoda i Klimat" (www.pogodaiklimat.ru) for the Moscow meteorological station located at the National Economy Achievement Exhibition (WMO index: 27612).

The works [20, 21] present the results of measurements of the Kullback’s measure of voltage fluctuations on two separate electrolytic cells. These papers also provide a detailed description of the electrolytic cells used and their characteristics.
Also presented are the experimental data that have been obtained over the past five years, from March 20, 2011 to June 19, 2016. The overall duration of the experiments was 1,919 days.

The time series obtained experimentally and taken from the web-site "Pogoda i Klimat" were subjected to two types of filtering: band-pass and low-pass [10]. In the case of band-pass filtering, the processes with the periods of less than 24 hours (1 day) and more than 600 hours (25 days) were discarded, and in case of low-pass filtering - the ones with periods of less than 240 hours (10 days) were discarded.

Fig. 4 shows the diagram of the correlation coefficient $K(H_1, H_2)$ of the Kullback's measures $H_1$ and $H_2$ for two independent experimental units under band-pass filtering. The maximum correlation coefficient value calculated by the method described in the work [26] is as follows: $K(H_1, H_2) = 0.252 \pm 0.099$, with a virtually zero shift of the given time series. The probability as to the presence of the specified value of the correlation coefficient is equal to: $p = 0.989$ [27].

$$K(H_1, H_2)$$

-3000 -2000 -1000 0 1000 2000 3000
-0.1 0 0.1 0.2 0.3

Fig. 4. Correlation coefficient of values of the Kullback's measures $H_1$ and $H_2$ for two independent units under band-pass filtering.

In case of low-pass filtering, the correlation coefficient of the Kullback's measures $H_1$ and $H_2$ for two independent units takes the following form: $K(H_1, H_2) = 0.377 \pm 0.094$; probability $p = 0.9999$.

Table 2 presents the values of correlation coefficients of experimentally obtained variations of the Kullback's measures $H_1$ and $H_2$ for two independent units and the theoretically calculated value of the Kullback's measure $\langle H \rangle$ based on formula (34). Please note that the time shift between the calculated values of variations of the Kullback's measure $\langle H \rangle$ and the experimental values $H_1$ and $H_2$ virtually equals to zero, which indicates a direct impact on the experimental units to change the entropy production density during the sunlight-to-Earth's
thermal radiation conversion. The table below presents correlation coefficients for two units, the top cells containing the coefficients calculated under band-pass filtering, the bottom cells - the ones calculated under low-pass filtering.

Table 2

| Correlation coefficients | Unit no. 1                  | Unit no. 2                  |
|--------------------------|-----------------------------|-----------------------------|
| \( K(\langle H \rangle) \) | \( 0.285 \pm 0.098 \) | \( 0.505 \pm 0.088 \) |
| \( K(\langle H \rangle) \) | \( 0.242 \pm 0.099 \) | \( 0.838 \pm 0.057 \) |

The correlation coefficient of the average value of the Kullback's measure \( H_{1,2} \) calculated by the formula

\[
H_{1,2} = (H_1 + H_2)/2,
\]

and its theoretical value \( \langle H \rangle \) under band-pass filtering has the value of

\[
K(H_{1,2}, \langle H \rangle) = 0.485 \pm 0.089; \quad p = 0.9999999,
\]

and under low-pass filtering equals to

\[
K(H_{1,2}, \langle H \rangle) = 0.630 \pm 0.079; \quad p > 0.9999999.
\]

The diagram shown in Fig. 5 illustrates the correlation function of the average value of the Kullback's measure \( H_{1,2} \) and the theoretically calculated value of the Kullback’s measures \( \langle H \rangle \) under band-pass filtering. As may be seen from the figure, the specified values are correlated with a virtually zero time shift.

\[
K(H_{1,2}, \langle H \rangle)
\]

Fig. 5. Correlation coefficient of the average value of the Kullback's measure \( H_{1,2} \) and the estimated value of this measure \( \langle H \rangle \) under band-pass filtering
Fig. 6 shows the comparison of the experimental time dependence diagram of the Kullback's measure $H_2$ for the second unit, and the same diagram for the estimated values of this measure $\langle H \rangle$. The diagrams shown are typical for the case of low-pass filtering.

The diagrams shown in Fig. 6 illustrate a clear correlation of the Kullback's measure $H_2$ and the estimated values of this measure $\langle H \rangle$ within the model of the entropy production during the sunlight-to-Earth's thermal radiation conversion.

10. Conclusion
The application of the standard solar model allowed us to calculate the intensity of physical time fluctuations based on equation (5) describing the dependence of the reported intensity on the production of entropy naturally occurring in irreversible processes. The theoretically calculated values of variations of the Kullback's measure $\langle H \rangle$ agree with the experimentally measured values of the Kullback's measures $H_1$ and $H_2$ of voltage fluctuations on two separate electrolytic cells, both qualitatively and quantitatively. To confirm the results obtained, four new installations aimed at exploring the voltage fluctuations in small volumes of electrolyte are being created.

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