Dependence of Changes of Histogram Shapes from Time and Space Direction is the Same when Fluctuation Intensities of Both Light-Diode Light Flow and ^{239}Pu Alpha-Activity are Measured

I. A. Rubinshtein*, S. E. Shnoll†§¶, A. V. Kaminsky‖, V. A. Kolombet†, M. E. Astashev†, S. N. Shapovalov‡, B. I. Bokalenko‡, A. A. Andreeva†, D. P. Kharakoz†

*Skobeltsyn Institute of Nuclear Physics, Moscow State University
E-mail: iarubinst@mail.ru
†Institute of Theoretical and Experimental Biophysics, Russ. Acad. Sciences
E-mail: shnoll@mail.ru
‡Arctic and Antarctic Research Institute
§Physics Faculty, Moscow State University
¶Puschino Institute for Natural Sciences
‖Elfi-tech Ltd., Rekhovot, Israel

The paper tells that spectra of fluctuation amplitudes, that is, shapes of corresponding histograms, resulting measurements of intensity of light fluxes issued by a light-diode and measurements of intensity of ^{239}Pu alpha-particles issues change synchronously. Experiments with light beams show the same diurnal periodicity and space direction dependencies as experiments with radioactivity. Thus new possibilities for investigation of "macroscopic fluctuations" come.

1 Introduction

Previous papers [1] have shown that shapes of fluctuation amplitudes spectra, i.e. shapes of corresponding histograms, constructed by results of measurements of various nature processes — from electronic device noises, rates of chemical and biochemical reactions, and Brownian movement to radioactive decay of various types — are determined by cosmophysical factors: diurnal and circumsolar rotations of the Earth. A histogram shape depends on geographical coordinates and space direction. Shapes of histograms of different nature processes taking place in different geographical locations but at the same local times are the same.

A histogram shape depends on a direction which alpha-particles issued at radioactive decay follow; this was shown in measurements of ^{239}Pu alpha-radioactivity fluctuations. Study of dependence between fluctuations and angle orientation of their source benefits a lot from focusing a source. When diameter of net collimator holes decreases, registered activity of particles flow falls crucially, preventing statistical reliability of results. This adverse effect complicates construction and use of a focused collimator-equipped ^{239}Pu source. For that matter, we have examined similar time and space direction dependencies at measurements of fluctuations of light beams intensity. Regularities of histogram shape changes at measurements of light flux intensity fluctuations were shown to be absolutely the same as those at measurements of radioactive alpha-decay. Use of this fact makes it possible to increase substantially accuracy of spatial resolution at increase of a light beam and to set out a lot of other experiment versions.

2 Devices and methods

2.1 Measurements of variously directed light flows. Sources and detectors of light flows

We measured fluctuations of intensity of light beams provided by a light diode and measured with a photo diode. Values to register were numbers of events, i.e. exceedings of a set threshold of light intensity per a time unit.

AL 307D light diode with ~630 nm wave length and 8 mA direct current was used as source of light. A224 photo diode by FGUP "PULSAR" Federal State Unitary Enterprise was used as a detector. Light and photo diodes were fastened in a tube with light channel; diameter of the tube was 3 mm, and space between diodes was 35 mm (Fig. 1).

The collimator with light and photodiodes can be oriented in a desired direction. Alternate component of the photo diode current comes through the low-noise amplifier to the input of the comparator registering signals that exceed a preset threshold value. The value should provide 200-500 exceeding

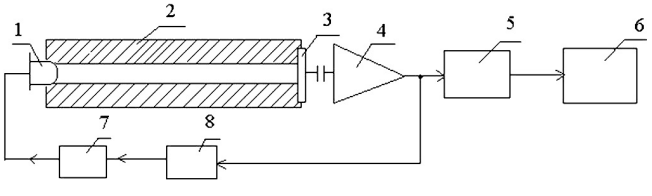

Fig. 1: Functional diagram of device measuring light beam fluctuations 1 — light diode 2 — collimator 3 — photo diode 4 — low-noise amplifier 5 — comparator 6 — impulse counter 7 — stabilizer of mean-square voltage value at amplifier (4) output 8 — light diode current generator

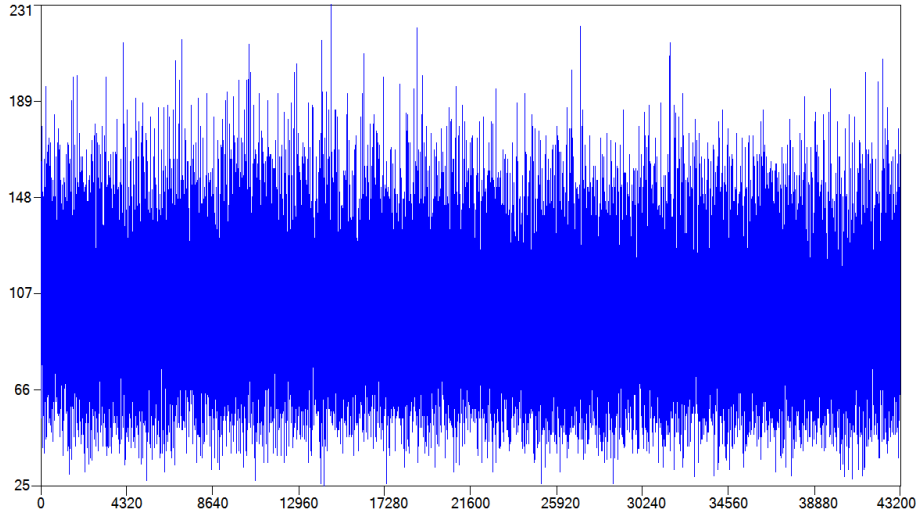

Fig. 2: Illustration of a time series image at measurements of fluctuations of light flow intensity. X-axis is time in seconds. Y-axis is numbers of light flow fluctuations with heights exceeding the device noise.

signals per a second. Besides counting impulses, the device can examine fluctuations of distribution of an amplifier signal heights by digitizing signals with a preset frequency, for example, 300 Hz. Nature of amplifier signal height distribution is electric noise. Its fluctuations can be examined by AD of noise signal followed with histograming of equal time periods.

Impacts of photons falling to photodiode were determined with measurements of mean-square values of amplifier signals, the amplifier being connected to source of current equal to photo diode CD without lighting (1.4 mcA). It equals to 5.6 mV, whereas mean-square value of signals at photons falling is 36 mV. If an electronic device noise consists of two components, its value can be determined by the following expression:

$$U_n = \sqrt{U_{n_1}^2 + U_{n_2}^2} \, .$$

In our case: U_{n_1} is photon noise signal, U_{n_2} is noise signal of current equal to photo diode one, and U_n is total noise signal. From here: U_{n_1} = 32.2 mV, that is ≅6 folds higher than current noise.

2.2 Results of measurements of numbers of discriminator threshold exceedings per a second

They were saved in a computer archive. Histograms were constructed, usually, by 60 results of measurements during one minute total time.

2.3 Computing histograms and analysis of their shapes

They have been multiply described earlier [1]. Shapes of histograms were compared by Edwin Pozharsky auxiliary computer program requiring further expert-made "similar-nonsimilar" diagnosis and by completely automated computer program by Vadim Gruzdev [2].

3 Results

Most of measurements were made at the Institute of Theoretical and Experimental Biophysics of Russian Academy of Sciences (ITEB RAS) in Puschino and in AARI Novolazarevskaya station in Antarctic. In Puschino we used a device with three light beam collimators directed towards West, East, and Polar Star and devices with alpha-activity measuring collimators directed the same towards West, East, and Polar Star. In Novolazarevskaya station we measured alpha-activity with

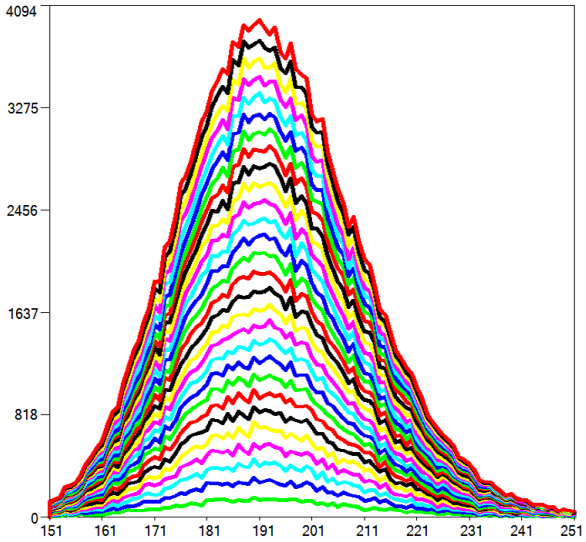

Fig. 3: Change of shapes of non-smoothed summed distributions according to stepwise increase of amount of light flow intensity measurements. 172,800 one-second measurements during two days: May 4 and 5, 2011. The collimator is East-directed. Layer lines mark each 6,000 measurements. X-axis is intensity (amounts of events per a second); Y-axis is amounts of measurements corresponding to the fluctuations intensity.

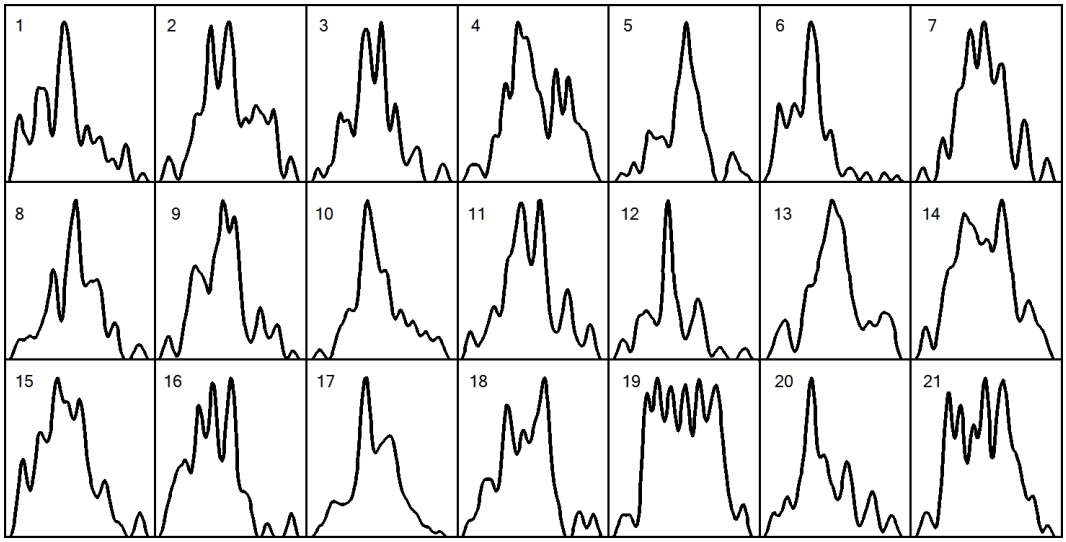

Fig. 4: Fragment of a computer log. Histograms constructed by sixty results of one-second measurements of East-directed light flow fluctuations on May 4, 2011. The histograms are seven times smoothed.

a collimator-free device.

Fig. 2 presents a section of a time series — results of registration of fluctuations of light flows from a West-directed beam. This is a typical stochastic process — white noise.

At this figure a regular fine structure, the same as in investigation of any other process, can be seen. The structure, different in different time periods, does not disappear but becomes more distinct when amount of measurements increase. The nature of this fine structure should become a subject of some special investigations (see in [1]).

The main material of this work is shape of sample distributions, histograms constructed by small (30–60) amount of measurements. The general shape of such histograms was at examination of light flux fluctuations the same as at examination of radioactivity and other processes. This can be seen from Fig. 4.

Similarity of shapes of histograms resulting measurements during other processes is conditioned by a reason shared by all of them. This follows from high probability of histogram shapes similarity at synchronous independent measurements of processes with different nature.

3.1 High probability of similarity of histograms computed by results of simultaneous measurements of light and alpha-decay intensities

Fig. 5 shows high probability of histograms similarity at synchronous measurements of light and alpha-decay intensities.

Comparing series of 360 (1) and 720 (2) histogram pairs we found that shapes of histograms resulting two different processes are high probably similar; this is shown at Fig. 6. Considering the “mirrorness” effect, that is coincidence of shapes of histograms that become similar after mirror overlapping (line 3 at Fig. 5), one can see the same similarity. This

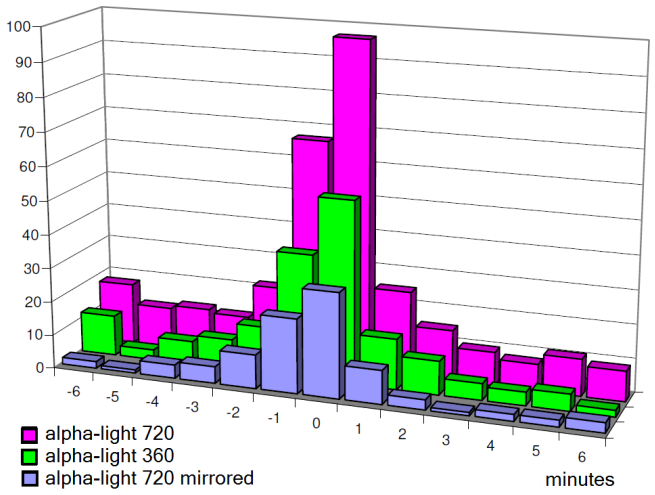

Fig. 5: High probable similarities of shapes of histograms constructed by sixty results of synchronous measurements of alpha-decay fluctuations, and light-beam intensity fluctuations. The measurements were made at West-directions of both 239Pu alpha-particles and light beams. X-axis is values of interval (minutes) between similar histograms. Y-axis is numbers of similar pairs of histograms corresponding to the values. Measurements dated April 4–5, 2011.

and similar experiments confirm the conclusion on the independence of a histogram shape from nature of a process under examination (^{239}Pu alpha-decay and flow of photons from a light diode).

Fig. 6 presents pairs of histograms, comprising the peak corresponding to the maximal probability of histograms similarity at measurements of light and alpha-activity. Shapes of all kinds can be found here. No shapes typical just for synchronism phenomenon are available.

Fig. 7 presents a larger scale of a Fig. 6 part to illustrate

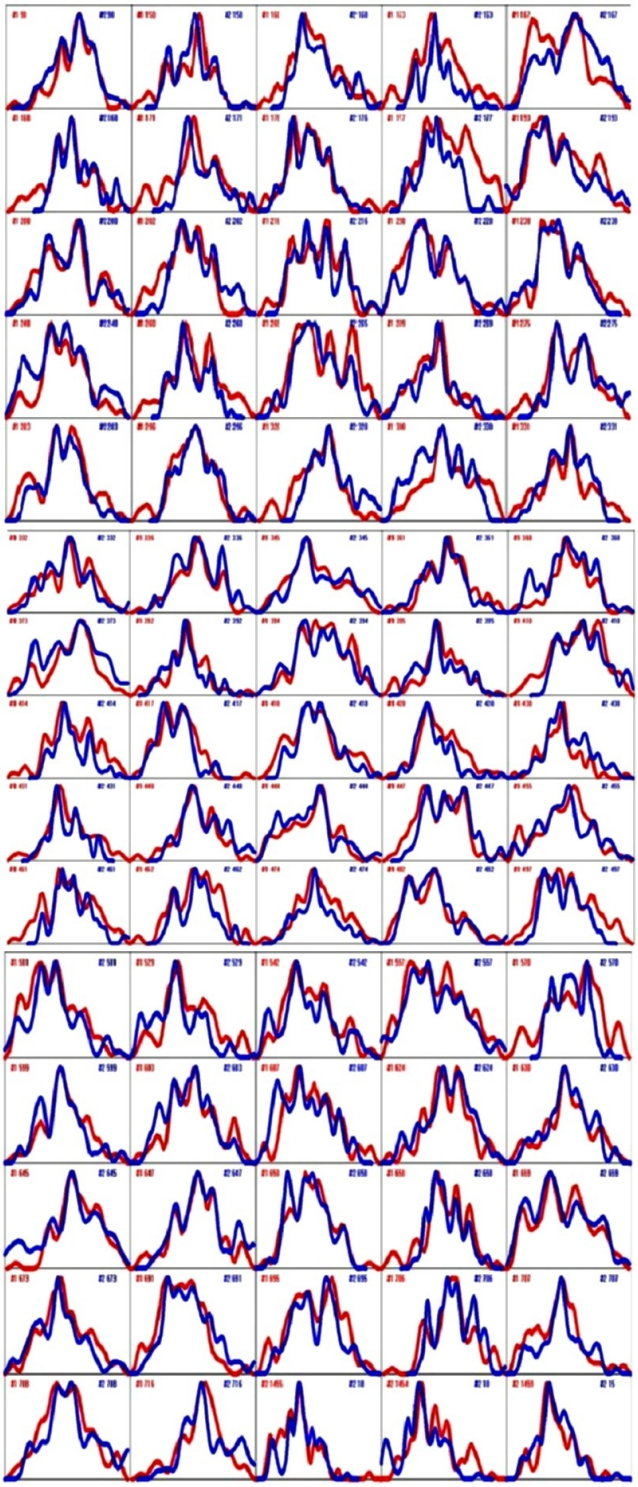

Fig. 6: Fragment of a computer log. Pairs of synchronous histograms from the central peak of Fig. 4. Indicated are numbers of histograms in series.

more visually similarity of shapes of histograms constructed by results of synchronous measurements of α-radioactivity and light intensity fluctuations.

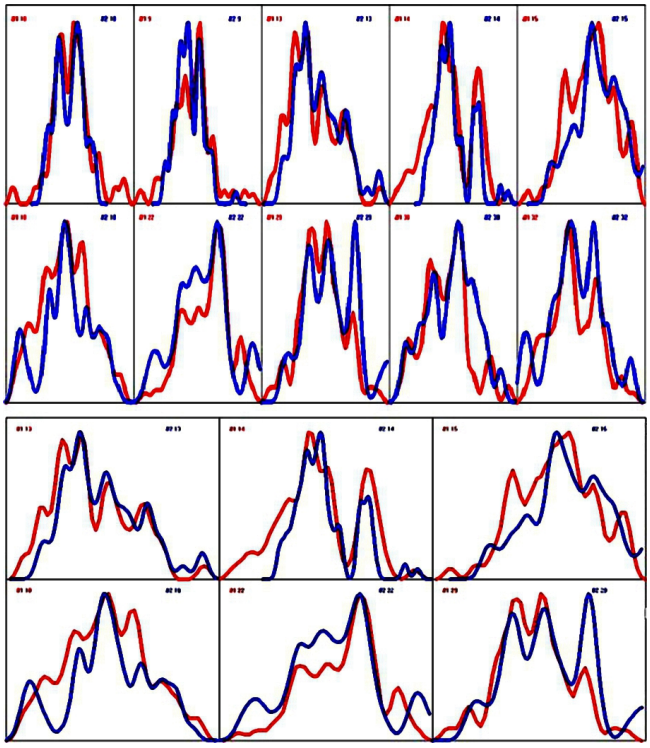

Fig. 7: Enlarged part of Fig. 6.

3.2 Near-a-day periods of similar shape histograms realization at measurements of light intensity fluctuations and their dependence from space direction of a light beam

Fig. 9 presents dependence between a period of similar histograms occurrence and a light beam direction. One can see that star and Sun periods appear equally both at West and East directions of a beam, and disappear completely when a beam is directed towards the Polar Star.

Therefore, changes of histogram shapes at measurements of light flow fluctuation are again related with axial rotation of the Earth. Distinct separation of near-a-day periods into "star" and "Sun" ones, the same as in other cases, means high degree of space anisotropy of observed effects. Difference between star and Sun days is only four minutes, corresponding to 1° in angular measure. These near-a-day periods from Fig. 10 are solved with approximately 20 angular minutes accuracy. Discrimination power of our method may, probably be determined by a collimator aperture, that is narrowness of a light beam.

The absolute lack of near-a-day periods when a light beam is directed towards the Polar Star is the same rather corresponds to ideas on relation of histogram shapes with diurnal Earth rotation. Moreover, the phenomenon means, as was earlier mentioned, that a histogram shape is provided not by some "effects" on a process under examination but only by space anisotropy.

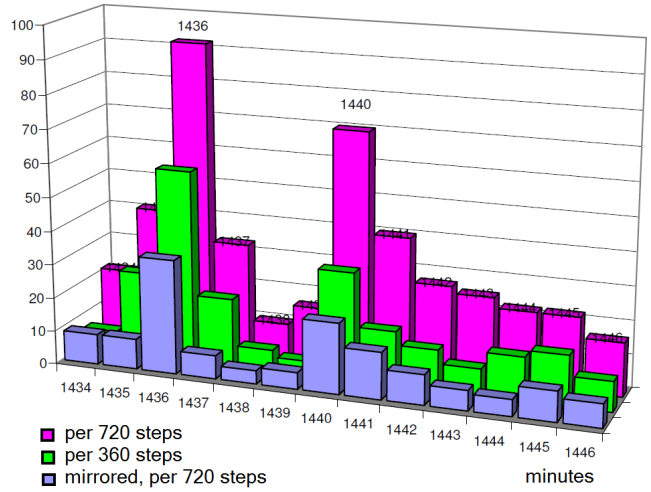

Fig. 8: Shapes of histograms resulting measurements of light intensity, the same as measurements of other nature processes, change with distinct day periods: star (1,436 minutes) and Sun (1,440 minutes) ones. A light beam is directed towards the West. Measurements were made on May 4–5, 2011. Distributions at comparison of lines from 1) 360, 2) 720, and 3) mirror similar pairs only at 760 histograms per a line. X-axis is periods (minutes); Y-axis is numbers of similar pairs after the correspondent time interval.

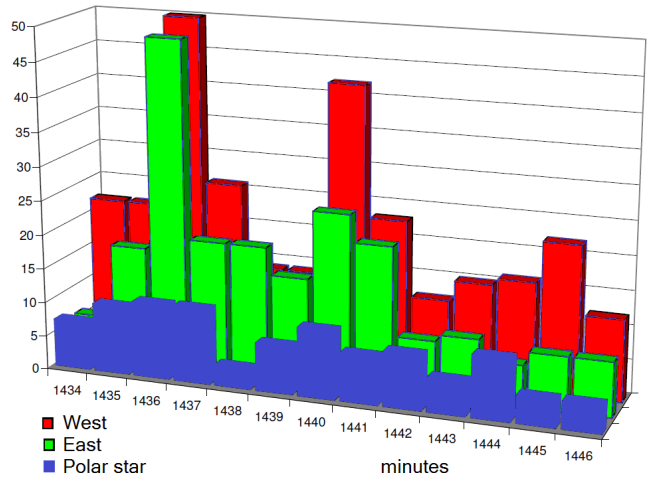

Fig. 9: It can be seen that when a light beam is directed towards the Polar Star no day period presents, and when it is West- or East-directed day periods ("star days" — 1,436 minutes and "Sun Days" — 1,440 minutes) are expressed very distinctly. X-axis is periods (minutes); Y-axis is numbers of similar histogram pairs correspondent to the period value.

3.3 Palindrome effect

A palindrome effect has been presented in [3, 4] when changes of histograms in different days periods were examined. The effect is that succession of histogram shapes since 6 am till 6 pm of accurate local time is like a reverse (inverse) histograms succession since 6 pm till 6 am of a following day. The effect was explained as follows: these are the moments when Earth axial rotation changes its sign relatively its circumsolar rotation: since 6 am till 6 pm ("the day time") these rotations have opposite directions, and 6 pm till 6 am they are co-directed. This implies that a histogram shape is determined by a direction of laboratory rotation corresponding to that of Earth at its diurnal rotation.

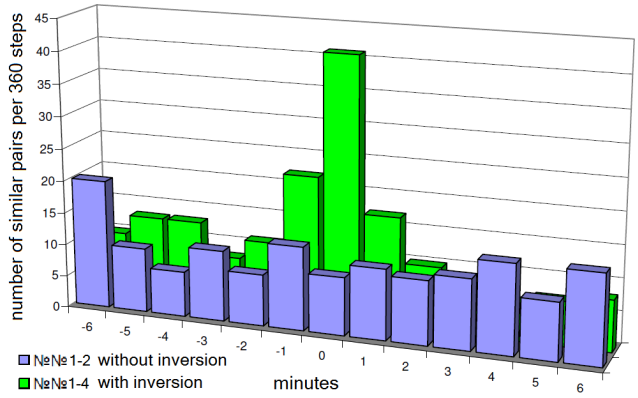

Fig. 10: A palindrome effect in an experiment with light beams. Presence of high similarity of synchronous one-minute histograms at comparison of "daytime" ones with those "nighttime" with inversion of one series and absence of the similarity without inversion. The measurements were made on March 27–28, 2011.

As can be seen from Fig. 10, at examination of histogram shapes in experiments with light beams rather distinct palindrome effect can be seen. When 6 am to 6 pm series of histograms ("day-time histograms") are compared with direct succession of "night-time" histograms their similarity is low probable (a number of similar pairs is little). And when daytime histograms are compared with inverse histogram series probability of synchronous histograms similarity is high.

The palindrome effect seems quite convincing evidence for dependence of a histogram shape from space direction. For this matter, we repeatedly tested its reproducibility at comparison of one-minute histograms with our routine expert method using GM and with just developed by V. A. Gruzdev HC computer program. With the HC program, the palindrome effect was obtained at comparison of ten-minute histograms. 72 "daytime" ten-minute histograms were compared with 72 histograms of direct and inverse series of "nighttime" histograms on "all with all" basis. As one can see from Fig. 11, application of completely automated comparison of histogram shapes with the help of HC program finds the same highly distinct palindrome effect.

3.4 When a light beam is West- or East-directed, similar western histograms are realized 720 minutes later than eastern ones

One of the evidences for relation of a histogram shape with diurnal Earth rotation was results of experiments with alpha-activity measurements with West- and East-directed collimators [5]. No *synchronous* similarity of the histograms could be found in the experiments. When two series — western and eastern ones — are compared, similar histograms occur in

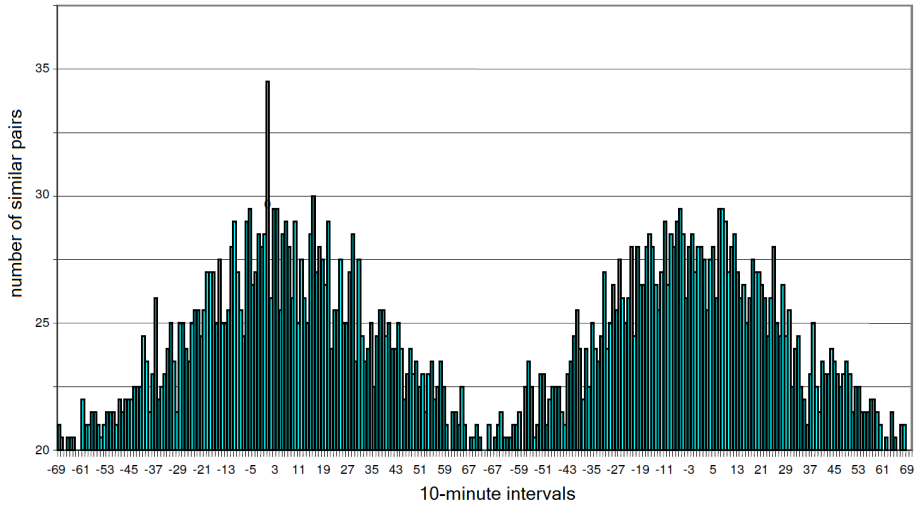

Fig. 11: The palindrome effect in experiments with light. A beam is directed towards West at comparison of ten-minutes histograms with the help of HC computer program. Left: distribution of number of similar histogram pairs at comparison of "daytime" (since 6 am till 6 pm March 27, 2011) histogram series with inverse "nighttime" (since 6 pm March 27 till 6 am March 28, 2011) histogram series; right: the same at comparison of inversion-free series.

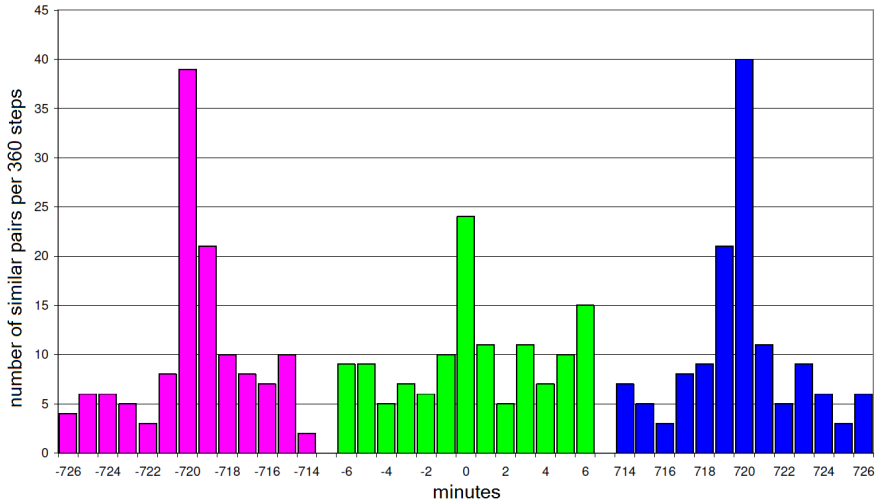

Fig. 12: When a light beam is West- or East-directed, probability of synchronous occurrence of similar histograms is low (intervals are near zero) and that with 720 minutes is high. Measurements from May 4–5, 2011.

720 minutes, that is, in half a day. More detailed investigation allowed us to find a "time arrow" [6]: histograms registered at measurements with eastern collimator were more similar with western in 720 minutes of the following day. In experiments with West- and East-directed light beams, occurrence of similar histograms in 720 minutes and absence of similarity at simultaneous (synchronous) measurements was observed the same rather distinctly. This is illustrated by Figs. 11 and 12.

3.5 Histograms obtained when a light beam is directed towards the Polar Star in Puschino are high probably similar by absolute time with those obtained at measurements of alpha-activity in Antarctic

We observed the same phenomenon earlier at synchronous measurements of alpha-activity in Puschino and in Novolazarevskaya (Antarctic). Histograms resulting measurements of ^{239}Pu alpha-activity in Puschino with a Polar Star directed collimator or with a Sun-directed collimator were high probably similar at one the same time with histograms resulting alpha-activity measurements in Novolazarevskaya with a collimator-free counter. When collimators were West and East directed no synchronism by absolute time between Puschino and Novolazarevskaya was noticed. Expression of synchronism by absolute and local times and its dependence from a space direction are extremely significant phenomena. Appropriate studies we began long ago [7] and continued them in the previous work at simultaneous measurements of alpha-activity in Puschino, Antarctic, and North Pole [8]. In this study we just got added evidence that light beam fluctuations along with alpha-activity measurements could be a quite ap-

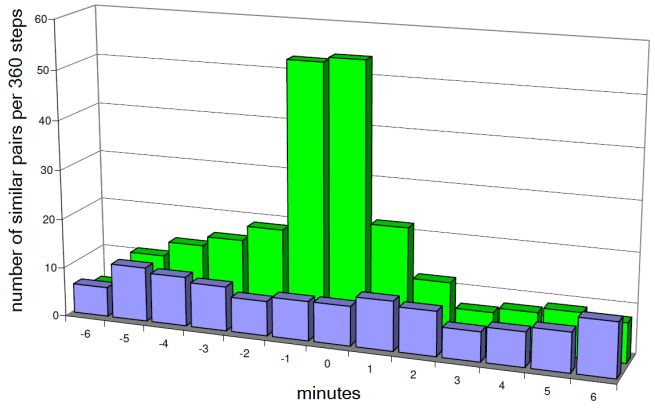

Fig. 13: At 720 minutes shift of eastern histograms measured since 6 am till 6 pm of exact local time to western histograms 6 pm — 6 am of the following day high probable similarity is observed. Without the shift eastern and western histograms are not similar.

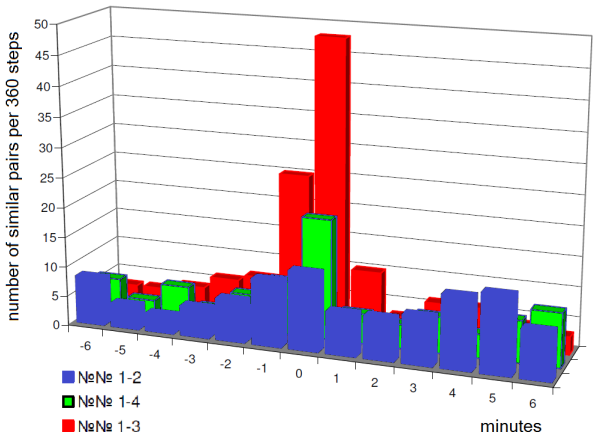

Fig. 14: Time-dependence of numbers of similar pairs of histograms resulting measurements of light beam fluctuations in Puschino and of alpha-activity in Novolazarevskay (1) when a light beam is directed towards Polar Star (3), West (2), and East (4). The origin of X-axis is the moment of absolute time synchronism. Measurements done in May 6, 2011.

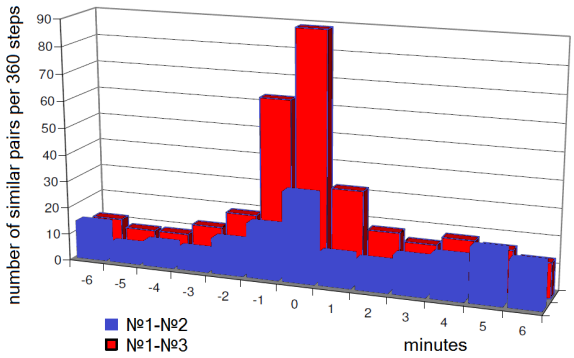

Fig. 15: High probability of absolute time synchronous changes of similarity of shapes of histograms resulting measurements of fluctuations of Polar Star directed light beam in Puschino and fluctuations of alpha-decay in Antarctic. No synchronous similarity can be seen when a light beam is West or East directed. Measurements from May 6, 2011.

propriate object for similar studies. This can be seen from the results of the experiment presented at Figs. 14 and 15.

In this experiment we compared histograms resulting measurements of intensity fluctuations of three light beams: 1) Polar Star, 2) West, and 3) East directed, made in Puschino, with those resulting measurements of alpha-activity with a collimator-free counter, made in Novolazarevskaya. From Figs. 13 and 14 it can be seen that when a light beam is directed highly probable absolute time synchronism of histogram shapes changes in Puschino and in Novolazarevskaya is observed. No synchronism is observed when light beams are West and East directed. The result obtained earlier with collimators and alpha-activity is repeated.

More detailed examinations of these phenomena should become an object for special study.

4 Discussion

Evidence of identical regularities observed at comparison of histogram shapes — spectra of fluctuation amplitudes — of alpha-decay and light diode generated light flow intensities, proves previous conclusion on universality of the phenomenon under examination [1, 9]. This result is not more surprising than identity of regularities at measurements of Brownian movement and radioactivity; or radioactivity and noises in semiconductor schemes [10, 11]. The most significant is an arising possibility to make, with the help of the developed method, more accurate and various examinations of dependence between observed effects and space directions.

As the paper shows, at use of a Polar Star directed light beam absolute (not local) time synchronism in different geographical points — Puschino (54° NL) and Novolazarevskaya (Antarctic, 70° SL) is the same observed. It means that at measurements in such directions factors determining shapes of histograms are expressed, being the same all over the Earth. These regularities, seeming us rather significant, along with others obtained earlier should make body of some special publication.

In conclusion, it should be once more mentioned that to our opinion experiments with light — near-a-day periods, palindrome effects, dependence from a beam direction — also cannot be explained with somewhat universal “effects”. Some “external power” equally affecting alpha-activity, Brownian movement, and fluctuations of photons flow seems unbelievable. The same as earlier, we suppose unevenness and anisotropy of different areas of space-time continuum where examined processes (“laboratories”) get in the result of Earth movement at its diurnal and circumsolar rotations, to be the only general factor determining shapes of histograms of so different processes [1].

Acknowledgements

This study was possible due to the financial support and interest to this line of investigations of the founder of "Dynasty Foundation", Professor D. B. Zimin.

S. E. Shnoll was supported by persistent interest and understanding of M. N. Kondrashova.

We thank V. A. Schlektarev for vivid interest to the study and manufacture of important devices. We are thankful to Olga Seraya for translation of the manuscript.

The continuous support and discussion on the essence of the work with D. Rabounski is of a great importance for S. E. Shnoll.

We are grateful to the colleagues for the discussion, at all stages of the study, at the laboratory seminar. We also thank V. A. Gruzdev for discussion and Fig. 11.

Submitted on March 11, 2012 / March 16, 2012

References

1. Shnoll S. E. Cosmic Physical Factors in Random Processes. Svenska Fisikarkivet, Stockholm, 2009, (*in Russian*)
2. Gruzdev V. A. Algorithmization of histogram comparing process. Calculation of correlations after deduction of normal distribution curves. *Progress in Physics*, 2012, v. 3, 25–28 (this issue).
3. Shnoll S. E., Panchelyuga V. A. and Shnoll A. E. The Palindrome Effect. *Progress in Physics*, 2009, v. 1 3–7.
4. Shnoll S. E. The "Scattering of the Results of Measurements" of Processes of Diverse Nature is Determined by the Earth's Motion in the Inhomogeneous Space-Time Continuum. The Effect of "Half-Year Palindromes". *Progress in Physics*, 2012, v. 1, 3–7.
5. Shnoll S. E., and Rubinstein I. A. Regular Changes in the Fine Structure of Histograms Revealed in the Experiments with Collimators which Isolate Beams of Alpha-Particles Flying at Certain Directions. *Progress in Physics*, 2009, v. 2, 83–95.
6. Shnoll S. E., Rubinstein I. A. and Vedenkin N. N. The "arrow of time" in the experiments in which alpha-activity was measured using collimators directed East and West. *Progress in Physics*, 2010, v. 1, 26–29.
7. Shnoll S. E., Rubinstein I. A., Zenchenko K. I., Zenchenko T. A., Udaltsova N. V., Konradov A. A., Shapovalov S. N., Makarevich A. V., Gorshkov E. S., and Troshichev O. A. Relationship between macroscopic fluctuations and geographical coordinates as inferred from the Data of the 2000 Arctic and 2001 Antarctic expeditions. *Biophysics*, 2003, v. 48 (6), 1039–1047.
8. Shnoll S. E., Astashev M. A., Rubinshtein I. A., Kolombet V. A., Shapovalov S. N., Bokalenko B. I., Andreeva A. A., Kharakoz D. P., and Melnikov I. A. Synchronous measurements of alpha-decay of ^{239}Pu carried out at North Pole, Antarctic, and in Puschino confirm that the shapes of the respective histograms depend on the diurnal rotation of the Earth and on the direction of the alpha-particle beam. *Progress in Physics*, 2012, v. 3, 11–16 (this issue).
9. Shnoll S. E., and Kaminsky A. V. Cosmophysical factors in the fluctuation amplitude spectrum of Brownian motion. *Progress in Physics*, 2010, v. 3, 25–30.
10. Shnoll S. E. and Kaminsky A. V. The study of synchronous (by local time) changes of the statistical properties of thermal noise and alpha-activity fluctuations of a ^{239}Pu sample. arXiv: physics/0605056.