Fine Structure of Distributions in Measurements of Different Processes as Affected by Geophysical and Cosmophysical Factors

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Abstract. The description of procedure of analyzing of similarity of histograms obtained from experimental time series is described. The biochemical and chemical kinetics, the electrophoretic mobility of cells and particles, water protons cross-relaxation time, neon lamp discharge time, earth crust vibrations, gravitational field gradient and the intensity of radioactive decay of different isotopes were measured by suitable methods. As a result of long-term measurements (during 1955-1997) of fluctuation distributions the existence of universal cosmophysical "force" was proved. This force determines at each time moment the current spectrum of discrete characteristics of different nature processes (the form of appropriate histograms). Performing measurements at different locations (in Pushchino, Moscow, Leningrad, Tomsk, on the coast of White Sea, aboard in Pacific and Indian oceans) it was shown that the form of appropriate histograms changes there simultaneously. The "lifetime" and the periodicity of the given form appearance exist – in the series of subsequent histograms the given histogram is the most probably similar to the nearest neighbors and repeats after 24 hours, 27 days and about 365 days. The changes of histogram forms in time and their similarity in the measurements of different nature processes and at different geographical locations are the evidence of the existence of common cosmophysical (cosmogonic) source of the discussed phenomena.

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1. Introduction

The effect described in this paper consists in the fact that fine structure of probability density distributions of experimental data is not completely random. We will precede results by detailed description of what is this fine structure and how we analyze it.

2. Methods

Investigation is started by obtaining long enough time series. At this point there is no difference what is the nature of measured signal, although in the majority of cases it is some kinetic process: chemical or biochemical reaction, radioactivity.

Procedure of analysis of time series can be divided onto four steps.

1) Break data onto portions of equal length (Fig.1, panel a) and calculate histogram for each of them (Fig.1, panel b). Number of points we use to calculate particular histogram is usually equal to 10^2 by the order of magnitude.

2) Smooth each histogram (Fig.1, panel c). Because of relatively small number of points used to calculate histogram in comparison with number of bins (not more than 1-2 counts in each bin) this smoothing is needful to obtain better approximation of instant distribution density. We generally use the following procedure of smoothing: value of histogram ordinate at each point is substituted by mean value of point itself and two adjacent points. This procedure is repeated as many times as it needs to obtain smooth histograms with clear fine structure.

3) Compare histograms and find pairs of similar (Fig.1, panel d). All possible pairs of histograms (when alone signal is investigated, the full number of pairs is N(N-1)/2, N – number of histograms. In the case when comparison is made for two signals, there are N_1N_2 of possible pairs) are treated to be similar or not. Comparison is made visually, it is allowed to shift and linearly stretch histograms to equalize proper mean values and dispersions of

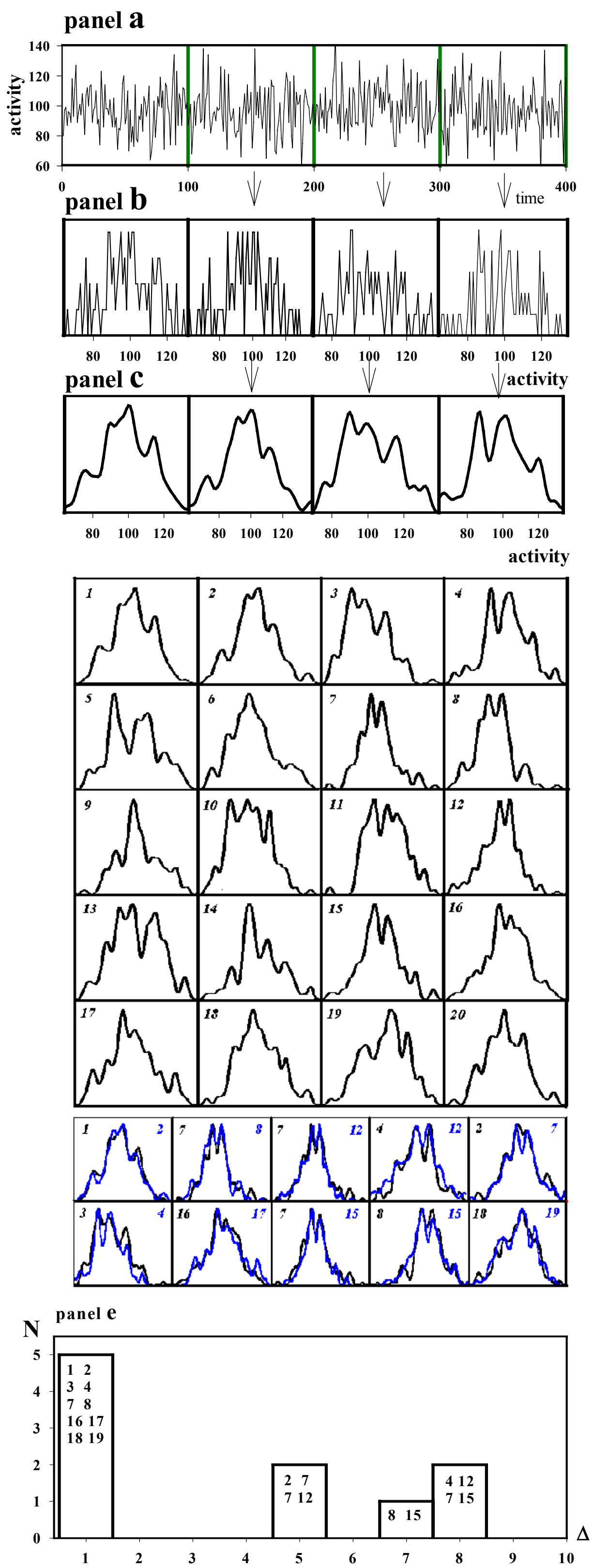

Fig. 1 Illustration of our approach to data analysis. Subsequent stages from time series to histogram distribution are shown: See text for details.

distributions. Histograms are mixed and their numbers are coded during comparison to avoid possible artifacts.

4) Draw "distribution of intervals" (Fig.1, panel e). It means that we calculate how many pairs are similar for each possible time interval between them. This distribution of intervals is the main goal of this procedure of analysis.

3. Results and Discussion

Usual way to analyze time series is to calculate mean value and dispersion, detect trends, and find auto- and cross-correlations. All these approaches are based on the idea that it is possible to describe signal by two quantities – mean value and standard deviation (dispersion), implied that we know empirical distribution density. According to conventional wisdom, in the majority of cases experimental data follow Gauss distribution (in the case of radioactivity it is Poisson distribution, but it can be shown that when number of detected events is large enough, Gauss distribution is a good approximation) which can be described in terms of these two characteristics.

We need to emphasize that our results don't contradict with classical approach of mathematical statistics. Histograms we obtain generally follow Gauss distribution with high level of significance. Fine structure you can see on Fig.1 (panels c and d), is in a good agreement with empirical hypotheses of Gauss distribution (remember that number of points is not large). We investigate this fine structure, and last two paragraphs are written in order to point out that classical approaches to analyze time series are not sensitive to it. We have studied different objects and physical parameters (the biochemical and chemical kinetics, the electrophoretic mobility of cells and particles, water protons cross-relaxation time, neon lamp discharge time, earth crust vibrations, gravitational field gradient and the intensity of radioactive decay of different isotopes were measured by suitable methods). We suggest radioactive decay to be one of the best objects to analyze peculiarities of histograms fine structure for the following reasons. It is easy to measure radioactivity during long time periods and it is rather stationary system (for example we were used α-decay of ^{239}Pu – mean lifetime of nuclei is 24000 years. It means that mean activity changes are negligible for years of measurements). On the other hand it is convenient to think that radioactivity is completely insensitive to external gravitational and electromagnetic field variations.

The probability to obtain similar histograms is expected to be independent upon time interval between appropriate measurements. But we have found that, as it can be clearly seen from Fig.2, it is more probable to obtain similar histograms for neighboring time moments («nearest zone») and after 24 hours (see legend for more detailed description). We have also found 27 days and 365 days increase of probability to obtain similar histograms.

It was found that the probability to obtain similar histograms is relatively higher in simultaneous

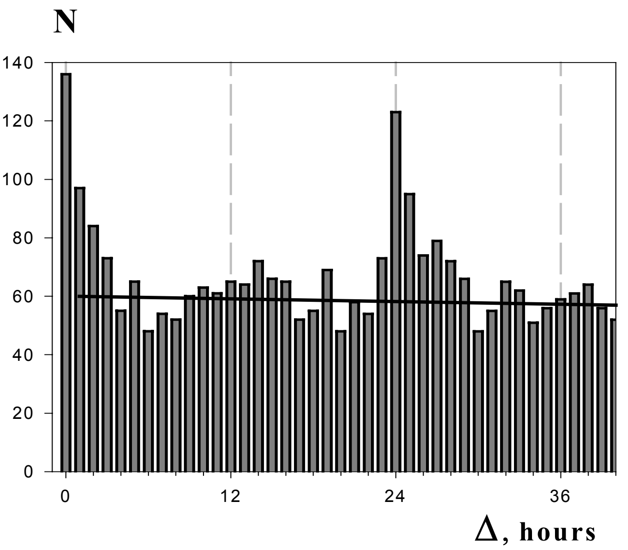

Fig. 2 The distribution of intervals between similar histograms within one set is shown. 60 measurements (each 6 seconds long) of ^{239}Pu sample α-activity are used to construct each histogram.

measurements both in the same process as well as in the case of different processes. This effect is shown in Fig.3, where distribution of intervals between similar histograms is presented for measurements of α-activity of ^{226}Ra family isotopes. The measurements have been performed using semiconductor detector connected with an amplitude analyzer capable of simultaneous measurements of isotope activities differing in energies of irradiated α-particles.

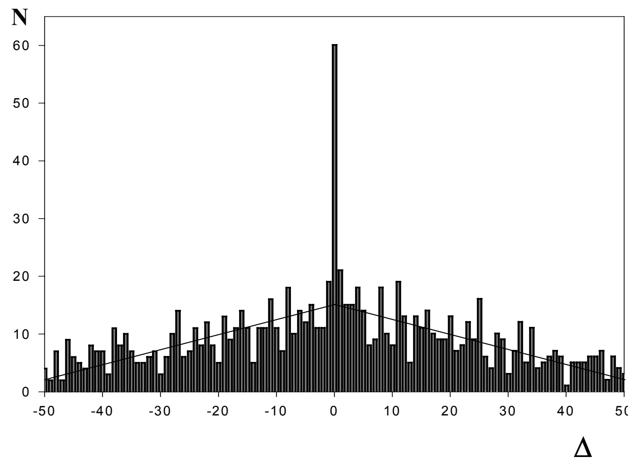

Fig. 3 The distribution of intervals between similar histograms constructed by simultaneous measurements of ^{226}Ra, ^{218}Po and ^{214}Po α-activity measured by the same semiconductor detector.

Similar behavior has been observed in measurements of very different processes, including cases when experiments have been performed in different locations with a large distance between. This is illustrated in Fig.4 where histogram forms obtained in measurements of amplitude of earth crust vertical vibrations near Tbilisi and in those of α-

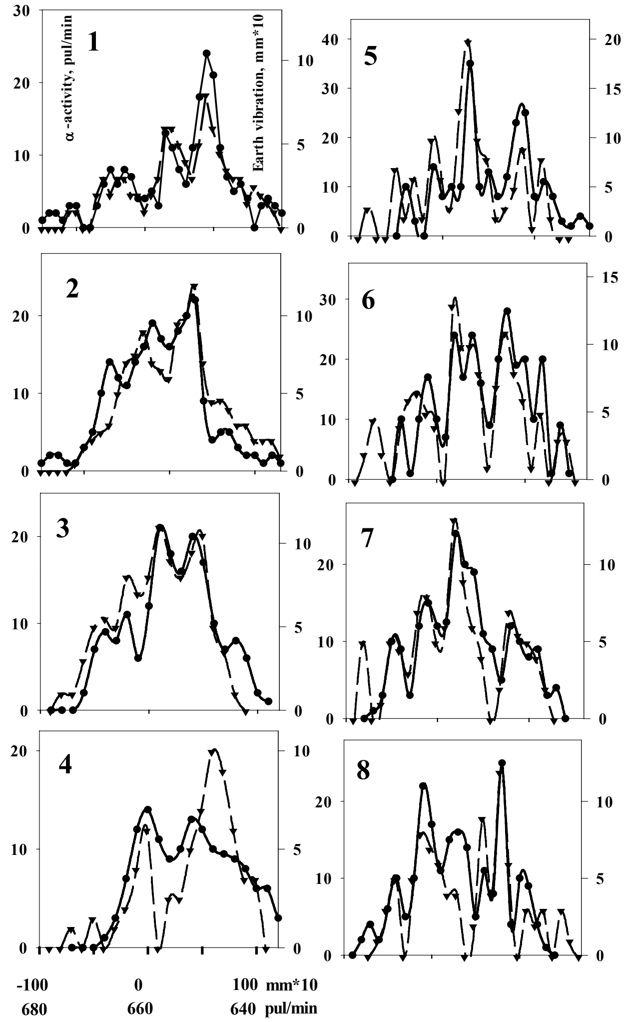

Fig. 4 Histograms for ^{239}Pu α-activity (registered in Pushchino) and for measurements of earth crust vertical vibrations amplitude (registered near Tbilisi, data are kindly provided by Dr. L.N.Petrova) at the same moment of time are plotted. The similarity of proper histograms is shown.

activity of ^{239}Pu in Pushchino are compared. It should be noted that 3000 km divide the two laboratories in this case.

Similar data were obtained in comparison of histogram forms in case of chemical reaction kinetics, rate of radioactive decay and kinetics of other processes when studied objects were separated by hundreds and thousands kilometers. It was shown that better similarity seems to be obtained when local time is used. For example, this effect was shown for α-activity of ^{239}Pu measured in Pushchino and on board of a ship in Indian Ocean (see Fig. 5).

Another example of geophysical data we have examined is time series of gravitational field gradient, measured as described in (Gusev et al, 1997). In addition to effect of "nearest zone" it is clearly seen in Fig.6 that probability to obtain similar histograms increases for 27 days time interval. It is also shown that histograms obtained from these experimental data are similar with higher probability

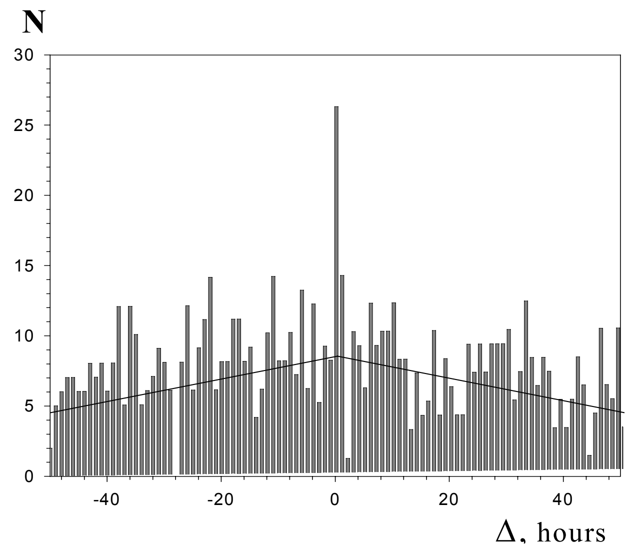

Fig. 5 The distribution of intervals between similar histograms constructed by simultaneous measurements of ^{239}Pu sample α-activity on the board in Indian ocean and in laboratory in Pushchino.

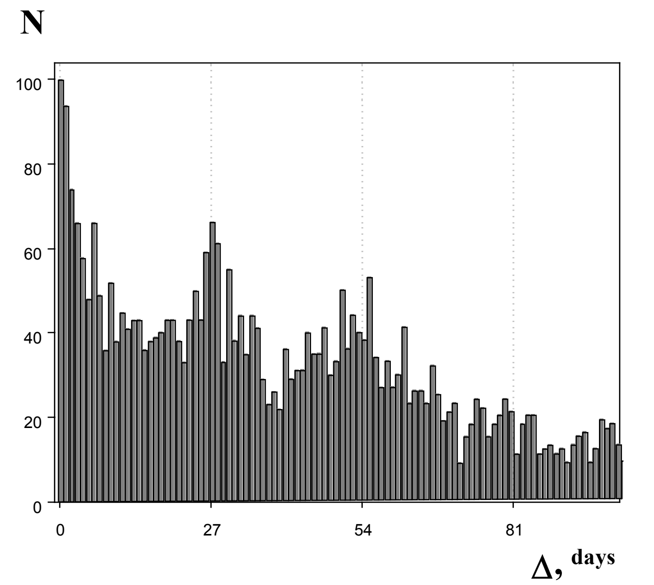

Fig. 6. The distribution of intervals between similar histograms within one set constructed by measurements of gravitational field gradient.

to the synchronous histograms, obtained in measurements of radioactivity (Fig. 7).

4. Summary.

Extraordinary character of the discussed phenomena is obvious. The proof of its reliability took many years of research. In the course of these studies a number of different hypotheses concerning the nature of fine structure of histograms, its synchronous changes in processes of different nature and correlation with cosmogeophysical

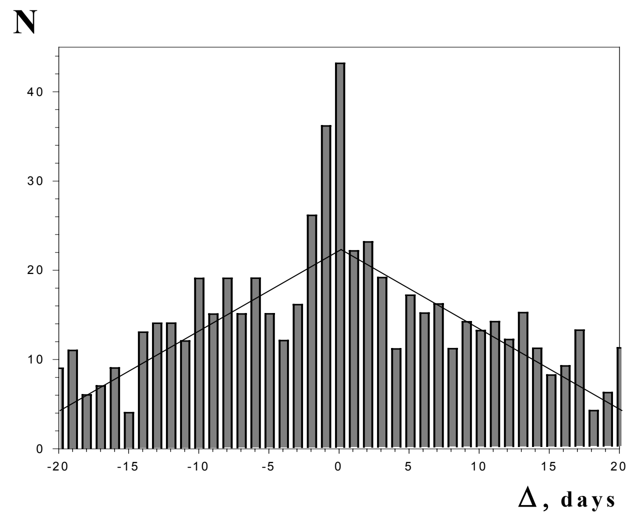

Fig. 7. The distribution of intervals between similar histograms obtained from simultaneous measurements of α-activity of ^{239}Pu sample (Pushchino) and gravitational field gradient (Moscow).

factors has been formulated (see references in (Shnoll et al, 1998). However, their discussion is beyond the scope of the paper entirely devoted to the description of the phenomenon.

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