The analysis of CMB anisotropy to temporary domain according to WMAP and Planck probes databases

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Abstract. The temporal changes in the anisotropy of CMB performed in more than 12 million directions of the celestial sphere using probes “WMAP” and “Planck” with a total duration of 13 years have been studied from the unified positions. Temporary temperature anisotropy jumps occurred between pairs of adjacent integral measuring time intervals were detected. Such jumps are present in the tails of statistical distributions of temperature anisotropy on pairs of various frequencies of measurement. It has been shown that the number of such surges is systematically greater than the number due to their statistically accidental occurrence.

1. Introduction
The purpose of this work is to compare in temporarily domain of the frequency-independent jumps of temperature anisotropy of CMB detected from satellite measurements of the probes “WMAP” (US) and “Planck” (EU).

Measurements of temperature anisotropy by the “WMAP” probe were performed [1] at five frequencies of 23 GHz (13.0 mm); 33 GHz (9.09 mm); 41 GHz (7.32 mm); 61 GHz (4.92 mm) and 94 GHz (3.19 mm). 23 GHz (K) and 33 GHz (Ka) frequency a channel was used to correct the results obtained from measurements on other channels. These amendments reduce the effect on CMB of the three main factors that occur in the path of CMB from the surface of the last scattering of the early Universe to the point of direct observation. The first is free radiation, i.e. thermal radiation, which is emitted by free electrons interacting with ionized gas ions. The second such factor is synchrotron, or magneto-braking, radiation that is emitted by charged particles moving at relativistic speeds along paths curved by the magnetic field. A third factor is the emission of mobile particles of charged dust.

At the same time, the published results of temperature anisotropy measurements are integral data, which are obtained in cumulative time intervals, lasting one year each at frequencies of 41 GHz (two channels, $Q_1$ and $Q_2$); 61 GHz (two channels, $V_1$ and $V_2$) and 94 GHz (four channels, $W_1$; $W_2$; $W_3$ and $W_4$). The research mission of the “WMAP” probe lasted from October 2001 through 2009. With the help of $Q$ channels; $V$ and $W$ were able to obtain data relating to nine cumulative annual cycles.

Measurements of temperature anisotropy by the “Planck” probe were performed [2] in two frequency bands, low frequency, with frequencies of 30 GHz (10.0 mm); 44 GHz (6.82 mm); 70
GHz (4.30 mm) and high frequency, with frequencies of 70 GHz (4.30 mm); 100 GHz (3.00 m); 143 GHz (2.10 mm); 217 GHz (1.38 mm); 353 GHz (0.850 mm); 545 GHz (0.550 mm); 857 GHz (0.350 mm). At the same time published results of measurements of temperature anisotropy are integral data, which were obtained in cumulative time intervals of six months duration. The research mission of the Planck probe continued from September 2009 to October 2013. At the same time, data related to eight accumulation cycles were obtained in the low frequency range.

The results of measurement of temperature anisotropy by both probes are distributed along $N_0 = 12.582.912$ equal body angles, uniformly covering the celestial sphere.

Thus, the results of the measurements made by the two probes should be considered as a set of seventeen consecutive integrated accumulation time intervals, with a total duration from 2001 to 2013. The first nine of these, lasting one year each, are obtained using the “WMAP” probe. The following eight time intervals of six months each, are obtained using the “Planck” probe.

The available sequences make it possible to estimate the nature of the change in the spatial anisotropy of CMB, i.e. the temporal anisotropy of this radiation over 13 years.

2. About gravitational microlensing as a possible cause of temporal changes in CMB

The work [3] described frequency independent jumps of CMB. These surges can be seen as a consequence of the gravitational microlensing of CMB by gravitational fields of non-uniform masses located on the surface of the last scattering of the early Universe, or between the surface of the last scattering and the ground observer. In the latter case, it can be the heterogeneities of the masses of the void filamentous structure.

In the process of gravitational lensing with point mass, gravity creates pairs of images of lensed rays. In the case of gravitational lensing, direct observations allow the resulting pairs of images to be resolved. In the process of gravitational microlensing, similar pairs of images cannot be selected because they merge into one common image. Microlensing phenomenon is determined by image luminosity enhancement due to contribution of each of pair images to total luminosity.

Gravitational microlensing differs [4] from other forms of development of radiation gloss variables in that microlensing forms two branches of its temporarily curve, ascending and descending. In the case of point mass microlensing, these branches are strictly symmetrical about an axis passing through the point of maximum luminosity. In the case of a point or distributed lensing mass, the observed luminosity curve must also conform to the standard theoretical curve. In addition, gravitational microlensing is frequency independent because the appearance of the luminosity curve is independent of the frequency of the received radiation.

It should be noted that a substantial non-uniformly distributed mass in space, such as a single point lens galaxy, which is located away from other masses, may not necessarily be required to increase the luminosity of the radiation, when it is a consequence of gravitational microlensing. Microlensing can also be created by relatively low mass formations, provided that one of such formations, the ground observer and the source of CMB are practically located on the same direct line. Such formations include dim red stars (M-dwarfs, or Jupiter’s).

If the source of the study, deflector, and observation point are on the same line, the lensed image is formed as a ring. Its apparent diameter is referred to as the Chwolson-Einstein diameter. The time of intersection of the Chwolson’s-Einstein’s diameter in the observed phenomena of gravitational microlensing of quasars by lensing galaxies ranged from several hours to several weeks. It can be assumed that when CMB is microlensed, its duration, which could be realized during satellite experiments “WMAP” and “Planck”, could also be characterized by similar orders of time. Then, it is not possible to identify the luminosity curve and to determine its degree of compliance with the shape of the standard curve, as well as the degree of axisymmetric
of the descending and ascending branches of this curve, because the duration of the integrated accumulation time intervals $\Delta t$, which reached a half year and a year, is substantially superior to the duration of the intersection of the Chwolson’s-Einstein’s diameter.

At the same time implementation of luminosity multiplication should influence measured values of temperature anisotropy in integral form. As in general, this influence should be realized at any frequency of the received radiation. Since, however, the instrumental integration of short-term luminosity jumps at a significant radiation time depends on the mode of operation of each radiation receiver, the specific measurement results can vary significantly from the frequency of the received radiation.

Therefore, in order to search for gravitational microlensing events, the frequency independence of changes in the anisotropy of CMB with relatively large amplitude, i.e., those contained in the tails of statistical distributions of changes in anisotropy, should be examined.

3. Method of detecting frequency-independent time surges of CMB

The methodic for detecting frequency independent jumps $\Delta T$ of CMB temperature $T$ anisotropy may be as follows.

A) In the first step, the radiation frequencies at which frequency-independent jumps are detected should be determined. Let, for example, such frequencies - two, $f_1$ and $f_2$.

B) In the second step, for each of the frequencies, $f_1$ and $f_2$, it is necessary to calculate changes $\Delta T$ in the anisotropy $T$ of microwave relict radiation for each of the directions on the celestial sphere within adjacent pairs of time intervals $\Delta t$, as differences of anisotropy values in the same directions of the celestial sphere.

C) In the third step, the resulting differences $\Delta T$. in temperature anisotropy values $T$ should be ordered in ascending order for each adjacent pair of time intervals $\Delta t$ as well as for each of the received radiation frequencies.

D) In the fourth step, the tails of the obtained distributions should be analyzed. Selected any adjacent pair of time intervals $\Delta t$. For this pair, let the change $\Delta T_1$ of the temperature anisotropy $T_1$ in any direction of the celestial sphere, when ordered in ascending order at frequency $f_1$, take the position numbered $n_1$. Consider the tail of a statistical distribution containing $n_1$ values of the change $\Delta T_1$ in anisotropy $T_1$. This tail contains negative change values $\Delta T_1$ most significant in absolute value.

The probability $p_1$ of detecting the value $\Delta T_1$ change in anisotropy $T_1$ in this tail is

$$p_1 = \frac{n_1}{N_0},$$

where $N_0$ is the total number of measurements in the distribution under consideration, i.e. the total number of directions in the celestial sphere for which temperature anisotropy $T$ are measured.

Further, let the change $\Delta T_2$ of the temperature anisotropy $T_2$ in the same direction of the celestial sphere when ordered in ascending order at frequency $f_2$ take the position with number $n_2$. Consider the tail of a statistical distribution containing $n_2$ values of anisotropy changes $\Delta T_2$. This tail also contains negative values of $\Delta T_2$ changes, most significant in absolute value.

The probability $p_1$ of detecting the value $\Delta T_2$ change in anisotropy $T_2$ in this tail is:

$$p_2 = \frac{n_2}{N_0}.$$  

At that probability of $P_0$ detection of $\Delta T_1$ and $\Delta T_2$ values of changes $\Delta T$ of anisotropy $T$ in considered tails on each of two frequencies, $f_1$ and $f_2$, is equal to:

$$P_0 = p_1 p_2 = \frac{n_1 n_2}{N_0^2}. $$

(3)
If the probability value of \( P_0 (3) \) is greater than the value, inversely proportional to the volume \( N_0 \) of the total set of temperature anisotropy \( T \) measurements:

\[
P_0 < \frac{1}{N_0},
\]

it means that the probability \( P_0 (3) \) of a random presence of significant in absolute values \( \Delta T_1 \) and \( \Delta T_2 \) negative values of changing anisotropy \( T_1 \) and \( T_2 \) in each of the distributions tails, both for frequency \( f_1 \) and frequency \( f_2 \), is less than one. If such hits are still detected, they should be considered as nonaccidental and physically conditioned by, for example, gravitational microlensing phenomena.

E) Further, in the distributions constructed according to position B), it is necessary to identify the whole set of directions in the celestial sphere satisfying (4), both for the tails of the distributions with significant negative values of \( \Delta T_1 \) and \( \Delta T_2 \) and for the tails of the distributions with significant positive values of \( \Delta T_1 \) and \( \Delta T_2 \), i.e. the whole set of candidates in the phenomenon of gravitational microlensing of CMB.

F) At the last stage, from the results of the performed statistical calculations, it is necessary to clarify the fuzzy equation (4) for all candidates for events of gravitational microlensing from manifestations of random variability of temperature anisotropy caused, in particular, by errors of satellite measurements.

We will proceed to the analysis of available satellite databases.

4. Analysis of temporal changes in CMB anisotropy

For analysis of time changes \( \Delta T \) of temperature anisotropy \( T \) for compliance with formula (4) among all data of satellite measurements by probes “WMAP” and “Planck”, taking into account above, results obtained at pairs of frequencies satisfying the following features were selected. These two frequencies with the best degree of proximity are present in the databases of each of the two probes. Total duration of measurements by both two probes for these two frequencies is the same and maximum.

These two frequencies \( f_1 \) and \( f_2 \) were 41 GHz (channel Q1) and 61 GHz (channel V1) for the “WMAP” probe [1], as well as the similar frequencies 44 GHz and 70 GHz for the “Planck” probe [2] (in the low frequency band). The results of temperature anisotropy measurements for these frequencies uniformly cover the celestial sphere with spherical sections in the number of \( N_0 \) resting on the mean plane angle 0.0573°, or 3′ 26,28″. As shown above, the time series of measurements in each direction of the celestial sphere is represented by integral results in the number of nine cumulative annual cycles for the “WMAP” probe, as well as in the number of eight cumulative semi annual cycles for the “Planck” probe. Thus, the series of temporal changes in temperature anisotropy are represented by fifteen points in each direction of the celestial sphere.

It should be noted that the \( N_0 \) of directions uniformly filling the celestial sphere form on it a coordinate grid HEALPix pixel coordinates [5] characterized by resolution index \( Res = 10 \). This index is equal to the measure of the degree to which the number 2 must be raised in order to obtain the number of the \( (1/12)N_0 \).

For further calculations for comparative analysis, the celestial sphere was divided into four equal quadrants with the pixel numbers of the HEALPix grid from 1 to 3.145.728 (No. 1), from 3.145.729 to 6.291.456 (No. 2), from 6.291.457 to 9.437.184 (No. 3), and from 9.437.185 to 12.582.912 (No. 4), respectively. The results of the analysis of experimental data are presented in four tables corresponding to the number of quadrants of the celestial sphere.

The first columns of these tables contain timestamps \( t \) from the start of the first “WMAP” probe to the end of the Planck probe. The second columns contain numbers of two integrated accumulation periods \( \Delta t \) of satellite measurements, from differences of values of temperature
anisotropy $T$ of which its time changes $\Delta T$ were calculated in order to find frequency independent jumps. The other columns contain the amounts of $N$ changes $\Delta T$ of the CMB anisotropy $T$ detected at both frequency $f_1$ and frequency $f_2$, i.e. the number of detected frequency-independent jumps $\Delta T$ of anisotropy $T$. Columns three to five correspond to negative tails of temperature anisotropy change distributions. Columns six to eight correspond to the positive tails of its distributions. The ninth to eleventh columns contain the total negative and positive tail data.

At the same time in the course of calculations the boundary of tails was considered floating depending on the indicator $n$. This indicator was taken to be equal to the number of frequency-independent changes in temperature anisotropy that can randomly enter a particular tail of the distribution, both at frequency $f_1$ and frequency $f_2$, i.e.:

\[ n = P_0 N_{01}, \tag{5} \]

where the $P_0$ value satisfies (3). Columns (5); (6) and (9) of Tables 1 to 4 corresponds to the expected number $n$ equal to one. Columns (4), (7) and (10) are obtained at $n = 10$ and columns (3), (8) and (11) are obtained at $n = 100$.

All the table functions listed here of the detected values of $N$ from time $t$ for the different values of parameter $n$ for satellite measurements, both using the “WMAP” probe and the “Planck” probe, are illustrated by the diagrams shown in Figure 1 (a) to (e), respectively. At the same time graphs 1 (e) are built according to data characterizing both tails of statistical distributions of changes $\Delta T$ of temperature anisotropy $T$. Corresponding to them amounts of $N$ frequency independent surges of temperature anisotropy are in columns from ninth to el eventh of Tables 1-4.

As shown above, the frequency-independent jumps in the temperature anisotropy of CMB differs from its frequency-independent changes in that for the jump, unlike the change, the

| Time $t$, years | Periods $\Delta t$ numbers | Number $N$ at calculated index $n$: |
|-----------------|---------------------------|-------------------------------------|
|                 |                           | $n = 100$ | $n = 10$ | $n = 1$ | $n = 1$ | $n = 10$ | $n = 100$ |
|                 |                           | In a negative tail | In a positive tail | Total in a two tails |
| 1.0             | 2-1                       | 473      | 63       | 10      | 11      | 58       | 410       | 21       | 121      | 883      |
| 2.0             | 3-2                       | 424      | 58       | 9       | 8       | 69       | 462       | 17       | 127      | 886      |
| 3.0             | 4-3                       | 417      | 63       | 10      | 10      | 71       | 450       | 20       | 134      | 867      |
| 4.0             | 5-4                       | 402      | 52       | 10      | 14      | 80       | 434       | 24       | 132      | 836      |
| 5.0             | 6-5                       | 494      | 71       | 14      | 12      | 71       | 449       | 26       | 142      | 943      |
| 6.0             | 7-6                       | 431      | 55       | 11      | 9       | 66       | 415       | 20       | 121      | 846      |
| 7.0             | 8-7                       | 398      | 49       | 12      | 12      | 64       | 419       | 24       | 113      | 817      |
| 8.0             | 9-8                       | 422      | 60       | 11      | 11      | 61       | 391       | 22       | 121      | 813      |

“WMAP” probe, 41 GHz and 61 GHz frequencies

| Time $t$, years | Periods $\Delta t$ numbers | Number $N$ at calculated index $n$: |
|-----------------|---------------------------|-------------------------------------|
| 9.0             | 2-1                       | 2483      | 311       | 74       | 62      | 416       | 2986      | 136      | 727      | 5469      |
| 9.5             | 3-2                       | 1700      | 233       | 31       | 36      | 302       | 2117      | 67       | 535      | 3907      |
| 10.0            | 4-3                       | 1313      | 181       | 23       | 65      | 288       | 2605      | 88       | 469      | 3918      |
| 10.1            | 5-4                       | 1109      | 151       | 13       | 35      | 283       | 1349      | 48       | 434      | 2458      |
| 11.0            | 6-5                       | 107       | 15       | 0        | 0       | 15        | 998       | 0        | 30       | 1105      |
| 11.5            | 7-6                       | 271       | 38       | 3        | 26      | 149       | 1174      | 29       | 187      | 1445      |
| 12.0            | 8-7                       | 808       | 90       | 15       | 84      | 654       | 1295      | 99       | 744      | 2103      |

“Planck” probe, 44 GHz and 70 GHz frequencies
Table 2. Dependences of number $N$ of detected frequency-independent jumps $\Delta T$ of temperature anisotropy $T$ from $t$ at calculated index $n$ for quadrant No. 2 in HEALPix system.

| Time $t$, years | Periods $\Delta t$ numbers | $n = 100$ | $n = 10$ | $n = 1$ | $n = 10$ | $n = 100$ |
|-----------------|-------------------------------|----------|----------|----------|----------|----------|
|                 |                               | In a negative tail | In a positive tail | Total in a two tails |
| 1,0             | 2-1                           | 389      | 66       | 18       | 5        | 40       | 352      | 23       | 106      | 741      |
| 2,0             | 3-2                           | 347      | 55       | 12       | 8        | 44       | 331      | 20       | 99       | 678      |
| 3,0             | 4-3                           | 381      | 56       | 8        | 6        | 45       | 363      | 14       | 101      | 744      |
| 4,0             | 5-4                           | 352      | 51       | 8        | 13       | 64       | 413      | 21       | 115      | 765      |
| 5,0             | 6-5                           | 328      | 43       | 7        | 6        | 51       | 341      | 13       | 94       | 669      |
| 6,0             | 7-6                           | 431      | 55       | 11       | 9        | 67       | 415      | 20       | 122      | 846      |
| 7,0             | 8-7                           | 397      | 49       | 12       | 12       | 64       | 419      | 24       | 113      | 816      |
| 8,0             | 9-8                           | 421      | 60       | 11       | 11       | 61       | 391      | 22       | 121      | 812      |

"WMAP" probe, 41 GHz and 61 GHz frequencies

| Time $t$, years | Periods $\Delta t$ numbers | $n = 100$ | $n = 10$ | $n = 1$ | $n = 10$ | $n = 100$ |
|-----------------|-------------------------------|----------|----------|----------|----------|----------|
|                 |                               | In a negative tail | In a positive tail | Total in a two tails |
| 9,0             | 2-1                           | 2483     | 311      | 47       | 62       | 416      | 2986     | 109      | 727      | 5469     |
| 9,5             | 3-2                           | 1717     | 222      | 24       | 150      | 1112     | 3431     | 174      | 1334     | 5148     |
| 10,0            | 4-3                           | 1353     | 175      | 23       | 42       | 231      | 1836     | 186      | 624      | 2227     |
| 10,1            | 5-4                           | 652      | 87       | 10       | 476      | 1063     | 2492     | 486      | 1150     | 3144     |
| 11,0            | 6-5                           | 391      | 52       | 6        | 180      | 572      | 1836     | 186      | 624      | 2227     |
| 11,5            | 7-6                           | 464      | 57       | 5        | 0        | 7        | 99       | 5        | 64       | 563      |
| 12,0            | 8-7                           | 620      | 93       | 10       | 1        | 7        | 298      | 11       | 100      | 978      |

"Planck" probe, 44 GHz and 70 GHz frequencies

Table 3. Dependences of number $N$ of detected frequency-independent jumps $\Delta T$ of temperature anisotropy $T$ from $t$ at calculated index $n$ for quadrant No. 3 in HEALPix system.

| Time $t$, years | Periods $\Delta t$ numbers | $n = 100$ | $n = 10$ | $n = 1$ | $n = 10$ | $n = 100$ |
|-----------------|-------------------------------|----------|----------|----------|----------|----------|
|                 |                               | In a negative tail | In a positive tail | Total in a two tails |
| 1,0             | 2-1                           | 350      | 45       | 9        | 12       | 64       | 368      | 21       | 109      | 718      |
| 2,0             | 3-2                           | 333      | 38       | 5        | 7        | 51       | 362      | 12       | 89       | 695      |
| 3,0             | 4-3                           | 367      | 64       | 11       | 7        | 41       | 365      | 18       | 105      | 732      |
| 4,0             | 5-4                           | 351      | 54       | 12       | 3        | 55       | 386      | 15       | 109      | 737      |
| 5,0             | 6-5                           | 337      | 39       | 6        | 6        | 54       | 386      | 12       | 93       | 723      |
| 6,0             | 7-6                           | 370      | 58       | 7        | 7        | 59       | 408      | 14       | 117      | 778      |
| 7,0             | 8-7                           | 370      | 48       | 8        | 7        | 54       | 380      | 15       | 102      | 750      |
| 8,0             | 9-8                           | 368      | 55       | 5        | 26       | 73       | 414      | 31       | 128      | 782      |

"WMAP" probe, 41 GHz and 61 GHz frequencies

| Time $t$, years | Periods $\Delta t$ numbers | $n = 100$ | $n = 10$ | $n = 1$ | $n = 10$ | $n = 100$ |
|-----------------|-------------------------------|----------|----------|----------|----------|----------|
|                 |                               | In a negative tail | In a positive tail | Total in a two tails |
| 9,0             | 2-1                           | 195      | 41       | 7        | 50       | 204      | 320      | 57       | 245      | 515      |
| 9,5             | 3-2                           | 378      | 139      | 23       | 1        | 48       | 208      | 24       | 187      | 586      |
| 10,0            | 4-3                           | 1152     | 172      | 20       | 52       | 194      | 316      | 72       | 366      | 1468     |
| 10,1            | 5-4                           | 879      | 126      | 12       | 595      | 2126     | 2843     | 607      | 2252     | 3722     |
| 11,0            | 6-5                           | 126      | 13       | 1        | 0        | 32       | 144      | 1        | 45       | 270      |
| 11,5            | 7-6                           | 242      | 20       | 2        | 50       | 165      | 338      | 52       | 185      | 580      |
| 12,0            | 8-7                           | 539      | 72       | 6        | 0        | 11       | 134      | 6        | 83       | 673      |

"Planck" probe, 44 GHz and 70 GHz frequencies
Table 4. Dependences of number $N$ of detected frequency-independent jumps $\Delta T$ of temperature anisotropy $T$ from $t$ at calculated index $n$ for quadrant No. 4 in $HEALPix$ system.

| Time $t$, years | Periods $\Delta t$, numbers | Number $N$ at calculated index $n$: |  |
|----------------|-----------------------------|----------------------------------|--|
|                | $n = 100$ | $n = 10$ | $n = 1$ | $n = 10$ | $n = 100$ | $n = 1$ | $n = 10$ | $n = 100$ |
| In a negative tail | In a positive tail | Total in a two tails |
| 1.0 | 2-1 | 350 | 45 | 6 | 8 | 58 | 431 | 14 | 118 | 781 |
| 2.0 | 3-2 | 333 | 38 | 7 | 7 | 59 | 427 | 14 | 127 | 760 |
| 3.0 | 4-3 | 367 | 54 | 9 | 9 | 64 | 402 | 16 | 128 | 753 |
| 4.0 | 5-4 | 351 | 54 | 7 | 9 | 64 | 402 | 16 | 128 | 753 |
| 5.0 | 6-5 | 337 | 39 | 10 | 6 | 44 | 408 | 16 | 110 | 745 |
| 6.0 | 7-6 | 370 | 58 | 7 | 4 | 59 | 430 | 11 | 110 | 800 |
| 7.0 | 8-7 | 370 | 48 | 11 | 6 | 61 | 400 | 17 | 109 | 770 |
| 8.0 | 9-8 | 368 | 55 | 6 | 12 | 77 | 398 | 18 | 132 | 766 |

“WMAP” probe, 41 GHz and 61 GHz frequencies

| 9.0 | 2-1 | 195 | 41 | 29 | 0 | 36 | 226 | 29 | 227 | 421 |
| 9.5 | 3-2 | 378 | 139 | 0 | 148 | 381 | 975 | 148 | 406 | 1353 |
| 10.0 | 4-3 | 1152 | 172 | 19 | 0 | 11 | 91 | 19 | 173 | 1243 |
| 10.1 | 5-4 | 879 | 126 | 0 | 1082 | 3463 | 11158 | 1082 | 3471 | 12037 |
| 11.0 | 6-5 | 126 | 13 | 0 | 1 | 10 | 542 | 1 | 55 | 668 |
| 11.5 | 7-6 | 242 | 20 | 13 | 5 | 62 | 640 | 18 | 205 | 882 |
| 12.0 | 8-7 | 539 | 72 | 46 | 41 | 45 | 909 | 87 | 149 | 1448 |

“Planck” probe, 44 GHz and 70 GHz frequencies

Figure 1. Dependences of number $N$ of detected frequency-independent jumps $\Delta T$ of temperature anisotropy $T$ from $t$ at calculated index $n$ for quadrant No. 1 on celestial sphere (2), No. 2 (b), No. 3 (c), No. 4 (d) and a for all sphere (e).
Figure 2. Dependences of $\delta$-factor of detected frequency-independent jumps $\Delta T$ of temperature anisotropy $T$ from $t$ at calculated index $n$ for quadrant No. 1 on celestial sphere (2), No. 2 (b), No. 3 (c), No. 4 (d) and a for all sphere (e).

probability of $P_0$ (3) its accidental occurrence is considered negligible. Figure 2, similar in construction to Figure 1, shows temporally diagrams of the ratio $\delta$ of theoretically set number $n$ of random changes ($n = 1$; $n = 10$ or $n = 100$) anisotropy of temperature to their number $N$ found in experimental data. The degree of small factor $\delta$ indicates a small probability of hit of accidental change of anisotropy in the number of physically conditioned frequency independent jumps.

Tables 5 to 6 contain data on the obtained values of mathematical expectation and mean quadratic deviation of factor $\delta$, respectively. Calculations were carried out separately for each of the two probes with averaging of operation time of each of them depending on directions in the celestial sphere selected in the HEALPix system, in which observations were carried out.

The first column of Tables 5 to 6 contains the number of the quadrant in which observations were made. The lines showing the four quadrants correspond to the totality of available satellite observations. Columns from the two to the seven contain information about factor $\delta$. Negative tails of statistical distributions of changes $\Delta T$ of temperature anisotropy $T$ correspond to columns from the second to the fourth, and positive - from the fifth to the seventh. Columns 2 and 7 are obtained with n-factor equal to one, columns 3 and 6 equal to ten, and columns 4 and 5 equal to one hundred.

The resulting numerical and graphical results provide the following conclusions.
Table 5. Dependence of estimate of factor $\delta$ mathematical expectation of frequency-independent jumps $\Delta T$ of temperature anisotropy $T$ from index $n$ in different directions and throughout the celestial sphere.

| Numbers of quadrants of the celestial sphere | Estimate of factor $\delta$ mathematical expectation in a negative tail | Estimate of factor $\delta$ mathematical expectation in a positive tail |
|---------------------------------------------|-------------------------------------------------|-------------------------------------------------|
|                                             | $n = 100$ | $n = 10$ | $n = 1$ | $n = 10$ | $n = 100$ |
| “WMAP” probe, 41 GHz and 61 GHz frequencies |                        |                        |          |          |          |
| 1                                           | 0.232      | 0.172      | 0.0935   | 0.0945   | 0.149    | 0.234   |
| 2                                           | 0.265      | 0.187      | 0.0935   | 0.128    | 0.190    | 0.267   |
| 3                                           | 0.282      | 0.206      | 0.140    | 0.149    | 0.182    | 0.261   |
| 4                                           | 0.282      | 0.206      | 0.140    | 0.149    | 0.182    | 0.240   |
| 1...4                                       | 0.263      | 0.181      | 0.108    | 0.115    | 0.170    | 0.321   |
| “Planck” probe, 44 GHz and 70 GHz frequencies |                        |                        |          |          |          |
| 1                                           | 0.241      | 0.177      | 0.0809   | 0.0197   | 0.125    | 0.0651  |
| 2                                           | 0.135      | 0.104      | 0.0841   | 0.151    | 0.423    | 0.221   |
| 3                                           | 0.339      | 0.266      | 0.248    | 0.152    | 0.228    | 0.412   |
| 4                                           | 0.339      | 0.266      | 0.248    | 0.152    | 0.228    | 0.301   |
| 1...4                                       | 0.197      | 0.123      | 0.148    | 0.0236   | 0.0491   | 0.120   |

Table 6. Dependence of estimate of factor $\delta$ mathematical expectation of frequency-independent jumps $\Delta T$ of temperature anisotropy $T$ from index $n$ in different directions and throughout the celestial sphere.

| Numbers of quadrants of the celestial sphere | Estimate of factor $\delta$ mathematical expectation in a negative tail | Estimate of factor $\delta$ mathematical expectation in a positive tail |
|---------------------------------------------|-------------------------------------------------|-------------------------------------------------|
|                                             | $n = 100$ | $n = 10$ | $n = 1$ | $n = 10$ | $n = 100$ |
| “WMAP” probe, 41 GHz and 61 GHz frequencies |                        |                        |          |          |          |
| 1                                           | 0.0171     | 0.0203    | 0.0122   | 0.0171   | 0.0149    | 0.0132  |
| 2                                           | 0.0256     | 0.0246    | 0.0295   | 0.0454   | 0.0391    | 0.0254  |
| 3                                           | 0.0122     | 0.0391    | 0.0457   | 0.0853   | 0.0314    | 0.0129  |
| 4                                           | 0.0122     | 0.0391    | 0.0457   | 0.0853   | 0.0314    | 0.00949 |
| 1...4                                       | 0.0101     | 0.0113    | 0.0108   | 0.0237   | 0.0159    | 0.00915 |
| “Planck” probe, 44 GHz and 70 GHz frequencies |                        |                        |          |          |          |
| 1                                           | 0.325      | 0.23      | 0.115    | 0.0128   | 0.239     | 0.0255  |
| 2                                           | 0.0818     | 0.0631    | 0.0685   | 0.375    | 0.687     | 0.365   |
| 3                                           | 0.254      | 0.271     | 0.355    | 0.374    | 0.319     | 0.249   |
| 4                                           | 0.254      | 0.271     | 0.355    | 0.374    | 0.319     | 0.377   |
| 1...4                                       | 0.172      | 0.0946    | 0.194    | 0.015    | 0.0319    | 0.0745  |

5. Conclusions
Frequency independent changes $\Delta T$ in the $\Delta T$ temperature anisotropy $T$ of CMB, as shown in Tables 1 to 4 and Figure 1, are present in both the “WMAP” and “Planck” probe databases. They are present in each of the four allocated quadrants of the celestial sphere during the entire time of active probe operation, which for the “WMAP” probe was nine years and for the “Planck” probe was four years.
The number of these changes during each of the integral accumulation time intervals $\Delta t$ varied in each of the quadrants of the celestial sphere in the range of several units to several thousand, taking into account the assigned values of the $n$-factor. This factor serves to estimate the probability that among the selected changes of $\Delta T$ there are those that result from unspecified random processes, i.e. it serves to estimate the $\delta$-factor. As shown in Figure 2, by varying the $n$-factor, it is possible to ensure that the $\delta$-factor does not exceed 0.01... 0.20, and then also to exclude the directions of the celestial sphere and the time intervals $\Delta t$, which may account for a significant number of changes in temperature anisotropy due to random processes.

The smallness of the $\delta$-factor provides the basis for the assertion that the detected frequency-independent changes in the temperature anisotropy of CMB are jumps caused by some physical process. It has been suggested that these surges may result from the microlensing of CMB of the large-scale structure of the Universe.

Tables 5 and 6 show that among the selected quadrants of the celestial sphere it is possible to select those which at some values of the $n$-factor are characterized by small estimates of the mathematical expectation of the $\delta$-factor and its mean quadratic deviation for the whole set of accumulative time intervals $\Delta t$. This may allow the pattern of change in frequency-independent surges in the celestial sphere to be monitored over time.

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