SIDEREAL ANISOTROPY OF COSMIC RAYS

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ABSTRACT

The data of the ionization chamber in Yakutsk for 1954-1984 are analyzed. A false sidereal variation caused by the second spherical harmonic in cosmic ray distribution was found and it has the amplitude 0.020±0.002%. The sidereal anisotropy with a very small amplitude (not more than 0.005%) was observed to exist.

In Table 1 the characteristics of the first harmonic of the solar-diurnal, sidereal and anti-sidereal variations of cosmic rays on data of the ionization chamber in Yakutsk from 1954 to 1984 are given. The data are pressure corrected.

From Table 1 it is evident that all the three variations significantly change from year to year. The solar-diurnal variation phase in 1954 and 1955 shifted to very early time as compared with other years. This tendency manifested in 1976 which evidences the 22-year recurrence of this variation.

The sidereal variation is ~ 3 times less than the solar-diurnal one. Its maximum time, on average, is 21 hr of the sidereal time varying 2-3 hours from it at various years. Sidereal variation in 1958 was somewhat anomalous with a very small amplitude (0.009%) and early maximum time (14.7 hr).

The anti-sidereal variation suffers the stronger changes from year to year either on amplitude or on phase. Its amplitude is ~ 2.5 times less and the maximum time is at earlier hours (13.8 hr) in comparison with the sidereal variation.

In Table 1 data separately for two periods 1958-1968 and 1972-1981 being characterized by various polarity of the general magnetic field of the Sun are also shown. It is evident that phases of sidereal and anti-sidereal variations at these periods are almost invariable. And the phase of the solar-diurnal variation in the second period 2,4 hr to the earlier time is shifted. The amplitudes of all the variations in 1972-1981 increased by 15-30%.

In Table 2 the characteristics of all the three variations corrected to pressure, influence of atmospheric temperature and the Earth's magnetic field (J_{hTM}) are presented. Contribution of the temperature (T) was determined by the

method described in [1] . Vectors T were substracted from the average observed vectors of the intensity anisotropy of of corresponding variations presented by the last three lines in Table 1. Then using receiving vectors [2] for the ionization chamber the correction to the influence of the geomagnetic field was introduced.

Table 2

Characteristics of solar, sidereal and anti-sidereal vectors of diurnal variation of ground temperature (t), of the contribution of the whole atmosphere (T) and of cosmic ray intensity corrected to atmospheric effects and to geomagnetic field (J_{hTM})

Vector	Period	Solar-diurnal		Sidereal		Anti-sidereal	
		Amp.	φ,h	Amp.	φ,h	Amp.	φ,h
t, °C	I*	3.9±0.1	15.2	1.4±0.1	8.1	1.1±0.1	21.5
T, %·10⁻³	II	40 ±3	4.7	14 ±1	21.9	11 ±1	10.2
J_{hTM}, %·10⁻³	I	244 ±8	16.8	24 ±2	21.7	20 ±2	20.3
t, °C	III	3.8±0.1	15.1	1.4±0.1	8.1	1.1±0.1	21.3
T, %·10⁻³	III	60 ±4	4.8	22 ±1.5	21.8	17 ±1.1	11.0
J_{hTM}, %·10⁻³	III	265 ±8	17.4	15 ±3	15.9	20 ±2.2	21.4
t, °C	IV	3.9±0.1	15.4	1.3±0.1	8.1	1.1±0.1	21.8
T, %·10⁻³	IV	24 ±4	4.7	8 ±1.3	21.4	7 ±1.1	11.3
J_{hTM}, %·10⁻³	IV	239 ±8	15.9	33 ±3	23.0	19 ±2.3	18.0

* I - 1954-1983, II - 1958-1979, III - 1958-1968, IV - 1972-1981

From Table 1,2 it is evident that after the corrections J_{hTM} were made the solar diurnal variation amplitude at all the observation periods increased by ~3 times and the phase had shifted 4 hr to later time. As for above two periods the amplitude of solar diurnal variation at the first period (1958-1968) in comparison with the second period became larger and the phase difference remained almost invariable. The phases of the solar-diurnal variation vectors of ground temperature (t) and of vectors T do not change on time. However, the T vector amplitude in the second period is more than twice larger than in the first one.

The J_{hTM} vectors of sidereal and anti-sidereal variations for 30-year period are equal on the value and differ significantly on the phase. Such a behaviour of the variation can be explained as it was shown in [3] by antisymmetric diurnal variation caused by the second spherical harmonic of the cosmic ray distribution in the interplanetary magnetic field. Due to this reason a false sidereal variation with the amplitude 0.020±0.002% and phase 21.7 hr occurs. After substraction of anti-sidereal variation from

Table 1

Amplitudes and phases of solar-diurnal, sidereal and anti-sidereal variations on data of ASK-1 ionization chamber in Yakutsk

Years	Solar-diurnal		Sidereal		Anti-sidereal	
	$A \cdot 10^{-3}$,%	φ,h	$A \cdot 10^{-3}$,%	φ,h	$A \cdot 10^{-3}$,%	φ,h
1954	55±2	5.8	70±2	22.0	29±2	4.1
1955	71	8.9	48	21.7	10	5.6
1956	107	12.2	34	20.8	16	14.3
1957	95	13.6	34	18.0	34	13.3
1958	90	13.6	9	14.7	15	14.2
1959	93	14.7	31	19.3	29	13.3
1960	95	14.9	37	19.7	14	15.3
1961	55	14.8	33	18.9	19	22.9
1962	96	14.8	27	19.4	8	13.3
1963	80	13.8	21	22.3	22	12.3
1964	72	13.3	15	21.9	9	13.8
1965	58	12.2	17	19.5	14	17.3
1966	89	13.7	15	20.5	7	15.8
1967	83	13.3	35	23.8	14	10.3
1968	87	14.3	23	23.9	3	18.2
1969	89	14.3	12	23.0	10	8.4
1970	87	13.5	15	01.4	5	9.8
1971	109	12.3	19	23.2	3	22.8
1972	91	11.4	35	22.2	6	13.0
1973	98	11.3	20	23.7	11	13.1
1974	95	12.6	24	18.5	18	17.6
1975	96	10.4	34	20.7	18	11.1
1976	84	9.9	21	23.0	10	13.2
1977	108	11.0	25	17.5	39	14.1
1978	117	11.0	18	21.7	15	18.1
1979	106	12.9	29	21.2	23	11.4
1980	91	13.1	24	22.6	22	18.2
1981	89	12.7	26	22.3	18	12.0
1982	87	14.7	26	19.4	3	13.9
1983	84	13.7	42	19.0	24	15.8
1984	105	14.7	35	21.7	15	12.5
1954-1983	78±0.3	12.8	24±0.3	21.0	9±0.3	13.8
1958-1968	80±0.5	14.0	20±0.5	20.6	10±0.5	14.3
1972-1981	93±0.5	11.6	23±0.5	21.3	13±0.5	14.2

sidereal one by means of mirrow reflection of anti-sidereal variation relative to the 21 hr direction (as in [4]) the galactic sidereal variation within the errors is not found.

Anti-sidereal variation on amplitude and phase does not change. This feature can be interpreted by the influence of the second harmonic in the cosmic ray distribution.

The sidereal variation suffers significant changes either on amplitude or on phase. Substracting anti-sidereal variation from sidereal one by the above method we obtain the galactic sidereal variation for 1958-1968 with an amplitude 0.018±0.002% and a phase 11.0±0.4 hr and for 1972-1981 - 0.015±0.002% and 22.0±0.4 hr. The vectors are equal on the value but their phases are almost opposite. It indicates the significant influence of sign change of the solar magnetic field upon galactic sidereal variation.

In conclusion it should be noted that on data of the ionization chamber in Yakutsk it was found: 1) the existence of false sidereal variation with an amplitude 0.020±0.002% and a phase 21.0±0.4 hr from contribution of the second spherical harmonic. 2) at periods of various polarities of the solar magnetic field the similar on the amplitude (0.005%) sidereal variation but with opposite phase was observed to exist.

References

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