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ZENITH ANGLE DISTRIBUTION OF THE COSMIC RAY MUON COMPONENT[1])

S. KAVLAKOV[2]), P. STAVREV[2]), Sofia

The cosmic ray muon component is measured simultaneously under three different zenith angles by means of a multichannel telescope. The "light power" of every channel is computed.

After corrections the muon data and the light powers are elaborated together.

The muon zenith angle distributions are obtained during periods with different solar activities.

ЗЕНИТНОЕ УГЛОВОЕ РАСПРЕДЕЛЕНИЕ МЮОННОЙ СОСТАВЛЯЮЩЕЙ КОСМИЧЕСКИХ ЛУЧЕЙ

В работе приведены результаты изменений мюонной составляющей космических лучей, полученные одновременно под тремя разными зенитными углами при помощи многоканального телескопа. Рассчитана «светосила» каждого отдельного канала. После коррекций проведена совместная обработка мюонных данных и «светосил». Зенитные угловые распределения мюонов получены в течение периодов различной солнечной активности.

I. INTRODUCTION

In a previous work [1] we measured the zenith angle distribution of the cosmic ray muon component using the expression:

$$I(\Theta) = I_0 \cos^{\gamma}\Theta \tag{1}$$

where Θ is the zenith angle of the muon trajectory, $I(\Theta)$ is the muon intensity measured under the zenith angle Θ and I_0 is the muon intensity in the vertical direction.

We obtained for γ:

$$\gamma = 2.12 \pm 0.08.$$

[1]) Contribution presented at the International Symposium on Acceleration and Propagation of Energetic Particles in the Heliosphere in Smolenice, September 27 — October 1, 1982.

[2]) Institute for Nuclear Research and Nuclear Energy, blvd. Lenin 72, 1184 SOFIA, Bulgaria.

It was during a period (the beginning of 1964) characterized with very low sun activity. Recently we have chosen another period (1981) characterized by a high sun activity, to estimate the same constant.

II. METHOD

Measurements were carried out in the same place — Musala Cosmic Ray Station ($\lambda = 23°35'$ E; $\varphi = 42°11'$ N; $H = 2925$ m a.s.l.). The same multichannel muon telescope with two perpendicular sections was used. A special arrangement of counters and appropriate electronics enable simultaneous measurements towards four different zenith angles (vertical, 40°, 60° and 70°) in each of the four principal cardinal points (E, W, N, S). Their zenith angle sensitivities are plotted in Fig. 1 and their azimuthal angle sensitivities are presented in the polar coordinates in Fig. 2.

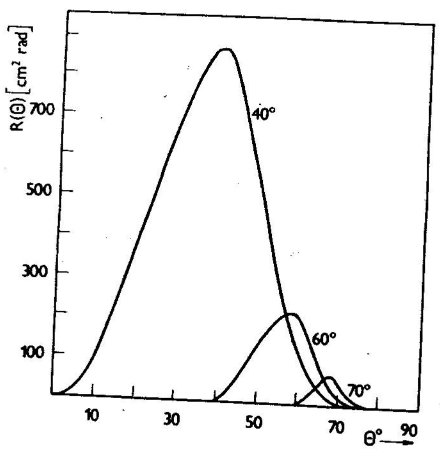

Fig. 1. Zenith angle sensitivities of the inclined telescopes.

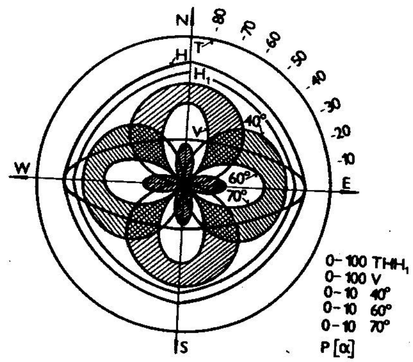

Fig. 2. Azimuth angle sensitivities of the telescopes.

We expressed the measured muon intensity value N [sec^{-1}] by means of

$$N = I_0 S \tag{2}$$

where I_0 is the vertical muon intensity in [sec^{-1}sterad^{-1}cm^{-2}] and S is the "light power" of the measuring telescope [2]. S could be obtained in [sterad cm^2] from

$$S = \frac{4a^2b^2}{h^2} \int_0^1 \int_0^1 \frac{(1-x)(1-y)\,dx\,dy}{(1+\alpha^2x^2+\beta^2y^2)^{2+\gamma/2}} \tag{3}$$

where a, b and h are the corresponding geometrical dimensions of the telescope in [cm] and

$$\alpha = a/h \qquad \beta = b/h. \tag{4}$$

We computed $S = S(\gamma)$ for each of our telescopes for $\gamma = 0; 0.25; 0.50; 0.75; \ldots 4.00$. Following [3] we calculated the logarithms of the ratios

$$S_v/S_{40°};\quad S_v/S_{60°};\quad S_v/S_{70°};$$
$$S_{40°}/S_{60°};\quad S_{40°}/S_{70°};\quad S_{60°}/S_{70°} \tag{5}$$

as functions of γ. Practically all these functions are close to the linear ones. They are plotted in Fig. 3.

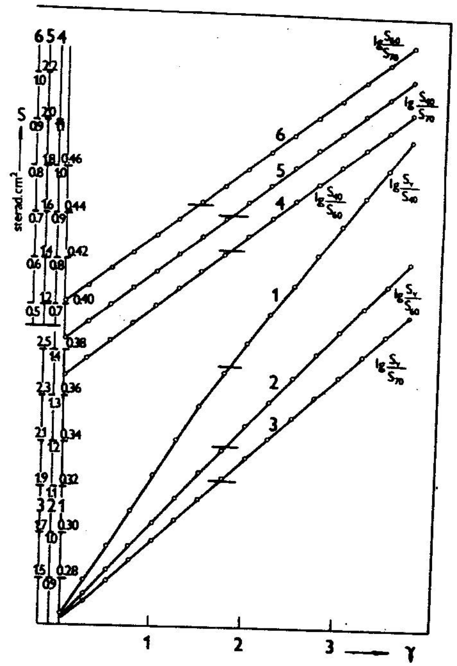

Fig. 3. The logarithmes of the ratios: S_v/S_{40}; S_v/S_{60}; S_v/S_{70}; S_{40}/S_{60}; S_{40}/S_{70}; S_{60}/S_{70}.

If now on the basis of measured and properly corrected values N_v, $N_{40°}$, $N_{60°}$, $N_{70°}$ we calculate the logarithms of

$$N_v/N_{40°};\quad N_v/N_{60°};\quad N_v/N_{70°};$$
$$N_{40°}/N_{60°};\quad N_{40°}/N_{70°};\quad N_{60°}/N_{70°} \tag{6}$$

and plot them on the corresponding graphs we obtain several cross points.

III. RESULTS

We took the average coordinate of these cross points as the experimental value of γ. The values of γ obtained now and earlier and the corresponding average Wolf numbers for the periods of measurements are shown in Table 1.

Table 1

γ	W
1.71 ± 0.15	158
2.12 ± 0.08	14

IV. DISCUSSION

There are indications for an anticorrelation between the Wolf sunspot numbers and γ. This means that during low sun activity periods the muon zenith angle distribution is steeper. One could suppose that it is due to some filtration of the low energy cosmic ray spectra part.

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