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III-4-13. Number Spectrum of Extensive Air Showers at Sea Lvel

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1. The data of simultaneous observations of extensive air showers (EAS) of various mean sizes were obtained during 1958–1960 with G-M counter arrangement. Three different areas of counter trays were used: 0.17, 0.5 and 1.0 m². The distances between counter trays were: 3.8, 40, 57 and 80 m. The arrangement consists of 45 counter trays with total area of 15 m². The EAS are selected by coincidences and anticoincidences method. The amount of light matter above G-M counter was equal to 3 g/cm². The insignificant effect of this matter was shown by our special experiment: shower frequency increases by 1% for counter separation distance $D=3.8$ m and it decreases by 3% for $D=57$ m.

2. In calculations the function of lateral distribution of charged particles in shower was taken in following form irrespectively of EAS size:

$$\varphi(r)=\begin{cases} 1.84\times10^{-3}\times r^{-1}, & r<10\text{ m} \\ 2.21\times10^{-3}\times r^{-1}\exp(-r/55), & 10<r<100\text{ m} \\ 0.57\times r^{-2.6}, & r>100\text{ m} \end{cases}$$

That is in agreement with Greisen's approximation[1] of Nishimura-Kamata function $\varphi(r)$ for age parameter $s=1.25$.

Also used was the well-known relationship between shower attenuation length Λ, absorption length of shower particles λ and exponent of shower number spectrum γ:

$$\lambda = \gamma\Lambda .$$

Shower arrival angular distribution is formed by shower attenuation in atmosphere (2 and others) it can be approximated by cosine power low $\cos^{\nu}\theta$, where $\nu=x/\Lambda$, x: depth of atmosphere, θ: zenith angle. The values of ν estimated assuming either constancy of Λ or constancy of λ for EAS of any size have been usually used. But the assumption of constancy is undoubtedly incorrect and the assumption of λ constancy is questionable[3]. Therefore we used the values of Λ corresponding to our measurements of barometric coefficients of EAS frequencies.

Fig. 1 shows the adopted by us (see below) integral number spectrum for the vertical intensity of sea level EAS (dashed line) and the corresponding spectra for EAS omnidirectional intensity calculated on various assumptions about ν (solid lines).

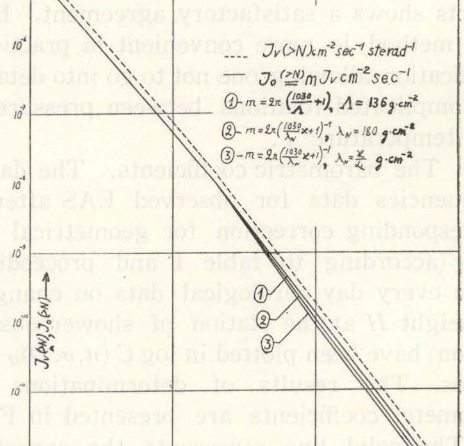

Fig. 1. EAS angular distribution dependence on the integral number spectrum for omnidirectional intensity of EAS at sea level.

3. The various forms of sea level number spectrum[5),6)] were tested. The results are presented in Fig. 2.

The spectrum[4)] corresponding to solid line gives a better agreement with our observation data. We conclude that the integral number spectrum for the vertical intensity of EAS at sea level can be presented by

* This paper was combined with III-4-12 and presented by D. D. Krasilnikov.

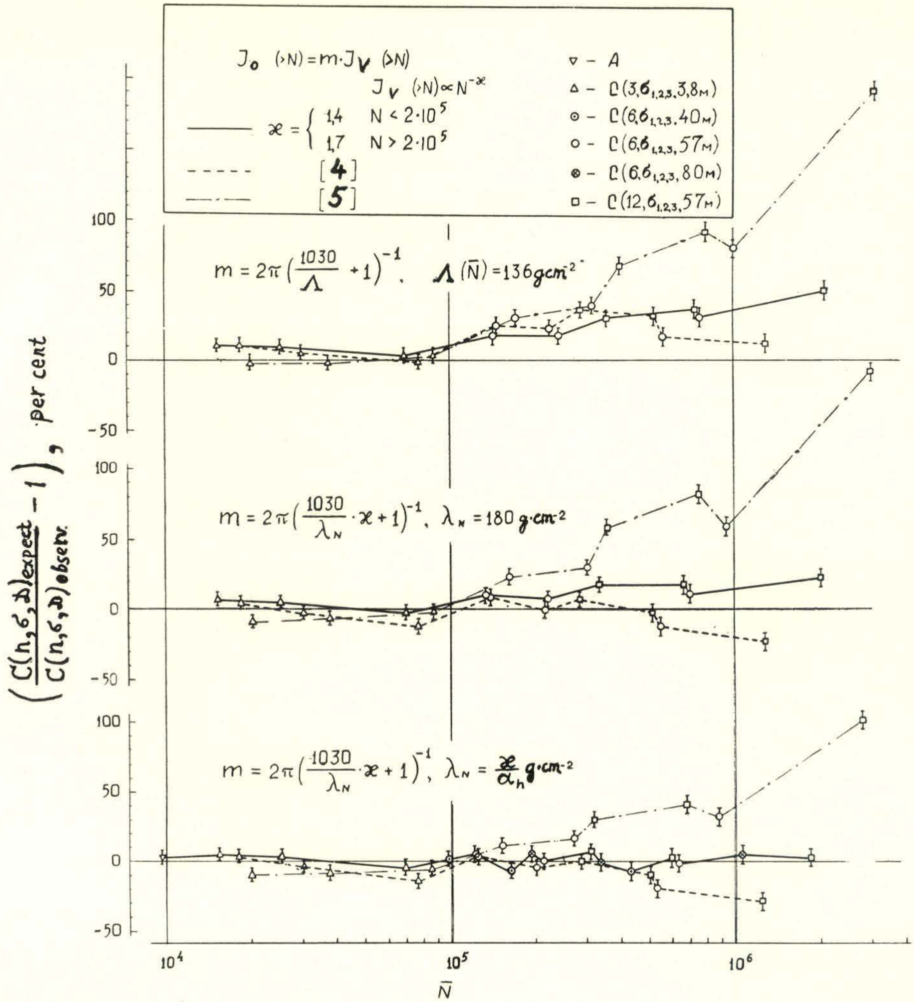

Fig. 2. A comparison of observed frequencies of EAS of various mean sizes with those expected at different assumptions on the number spectrum and the angular distribution of EAS at sea level.

$$J_V(>N)=\begin{cases} 7.50\times10^4\times N^{-1.4}\ \mathrm{m^{-2}\,h^{-1}\,sterad^{-1}} & \text{for } N<2\times10^5 \\ 2.85\times10^6\times N^{-1.7}\ \mathrm{m^{-2}\,h^{-1}\,sterad^{-1}} & \text{for } 2\times10^5<N<10^7 \end{cases}$$

This EAS number spectrum has somewhat less steep slope in large EAS region than the one obtained by authors of hodoscopical measurements. This tendency is probably explained partially by greater sensitivity of hodoscopical measurements to local fluctuation effect of lateral distribution function $\varphi(r)$ and, partially, by errors of assumptions on shower angular distribution.

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