Comparison of the Cosmic-Ray Intensity Variations Observed at Different Altitudes (*).

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1. - Introduction.

Continuous observations of the cosmic-ray meson component have been made by means of a Nishina type ionization chamber during these ten years at the Scientific Research Institute, Tokyo (Geomagn. Lat. +25° 40' N, Long. 206° 32' E, sea level) [1].

Since August, 1955, measurements of the meson component have also been made continuously at Mt. Norikura (Geomagn Lat. +25° 49' N, Long. 204° 31' E, Alt. 2840 m above sea level) by means of a ionization chamber identical with the one used at sea level.

Simultaneous registration of cosmic-ray intensity at different altitudes have already been performed by several workers using an identical equipment, however, the comparison of the intensity obtained by these kinds of observations has not yet been tried up to now.

The aim of this study is to find out the time variations of comparatively low energy primary cosmic rays by the comparison of the results obtained at different latitudes but at almost the same geomagnetic longitude and latitude.

2. - Comparison of the meson component observed at different altitudes.

Since the over-all multiplicity of $\mu$-mesons observed at mountain and at sea level is different, especially in the low energy regions, then the $\mu$-mesons observed at mountain and at sea level correspond to the primary cosmic rays

(*): This work was supported by the Ministry of Education and the Japanese National Committee for the IGY.
of different energy. Obviously the difference of the meson intensity observed at different altitudes reflects the intensity variation of the low energy primary particles.

It is well known that the meson intensity is affected not only by the time variation of primary particles but also by the temperature variation of the atmosphere above the stations. These features can be expressed by equations taking into account the partial temperature effect [2],

\[
\frac{\Delta M_s}{M_s} = \eta_2 + \varepsilon \Delta T_1 + \alpha \Delta T_2,
\]

\[
\varepsilon \frac{\Delta M_m}{M_m} = (\varepsilon - 1)\eta_1 + \eta_2 + (\varepsilon - 1)\alpha_1 \Delta T_1 + \alpha \Delta T_2,
\]

where \(\Delta M_s/M_s, \Delta M_m/M_m\) mean the variational fraction of mesons observed at sea and at mountain level, respectively, \(\eta_2\) means the variational fraction of primary cosmic rays corresponding to the meson component which can reach sea level, \(\eta_1\) the variational fraction of primary cosmic rays corresponding to the meson component which can be observed only at mountain level, \(\varepsilon \Delta T_1\) the variation caused by the temperature change above the mountain, \(\alpha \Delta T_2\) the variation caused by the temperature change below the mountain, \((\varepsilon - 1)\alpha_1 \Delta T_1\) the variation of the meson component which cannot reach sea level by the temperature change above the mountain, \(\varepsilon = M_m/M_s\).

From (1) and (2), we get

\[
\frac{\Delta M_\Delta}{M_s} = \varepsilon \frac{\Delta M_m}{M_m} - \frac{\Delta M_s}{M_s} = (\varepsilon - 1)\eta_1 + (\varepsilon - 1)\alpha_1 \Delta T_1 - \alpha \Delta T_2.
\]

Since the momentum of \(\mu\)-mesons observed only at mountain level is very low, the effective depth of the mean temperature \(T_1\) is situated only little above the mountain. Further, the variation of temperature above and below the mountain is approximately the same. Thus we may put \(\Delta T_1 = \Delta T_2\). Then we get

\[
\eta_1 = \frac{1}{\varepsilon - 1} \left( \frac{\Delta M_\Delta}{M_s} - \alpha \Delta T_2 \right).
\]

In order to check the equation (4), the relation between

Fig. 1. - The correlation between the difference of the meson intensities observed at Mt. Norikura and at sea level corrected for the barometer effect \(\Delta\) and the mean atmospheric temperature between mountain and sea level \(T_2\).