Transition Effect of Air Shower Particles in Plastic Scintillators

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ABSTRACT

Transition effect of air shower particles in the plastic scintillators near the core was measured by scintillators of various thickness. The air showers selected for the measurement were of size $\geq 10^5$. Results obtained are as follows:

i) The multiplication of shower particles in the scintillators is less than 20% for that of 50mm thickness.

ii) Dependence of the transition effect on age parameter is not recognized within the experimental errors.

1. Introduction In order to obtain an accurate density of air shower partiles, it is essential to know the distortion caused by the materials which compose the detector and the surrounding container.

The transition effect of the shower particles due to plastic scintillators and iron plate of the container was investigated in detail (1), and multiplication of 10% was recognized near the core of air showers for the plastic scintillators of 50mm thickness.

However, some group reports that multiplication of $> 50\%$ for the scintillator of 50mm thickness exists near the core compared to that of 3mm thickness, and that the transition depends remarkably upon the age parameter (2).

To reveal the contradiction, transition effect in the scintillators was studied by comparison of the response of each scintillator of different thickness which piled up in layer above and bellow.

2. Experiment and Results. Four sets of detectors composed of two plastic scintillators of different thickness piled up above and bellow, were placed in the air shower array of Kobe University. All scintillators are of $0.25m^2$ area. The thickness of the plastic scintillators of each set is listed in Table 1. Measurement was carried out during the period from December 1983 to June 1984 and about 6000 showers which

had size of $\geq 10^5$ and zenith angle less than 30° were selected. Using these showers, the transition effect of the shower particles near the core (within 30m from the core) was studied.

Table 1 Combination of Thickness of scintillators (mm)

upper scintillator	30	10	3	3
lower scintillator	50	20	50	50

A multiplication (or absorption) factor was obtained by dividing particles of lower scintillator by those of upper one. Fig. 1 shows mean values of the multiplication factors as a function of distance from the core of the showers, having size $\geq 10^5$ and age parameter $0.5 \leq s < 1.5$ In every case, mean value of multiplication factors exceeds one near the core, and decreases gradually as the distance increases, and becomes less than one at distance farther than 10m. None of the cases shows a multiplication factor exceeding by 20% near the core. Rate of multiplication (or absorption) is largest for the combination (30mm,50mm), and combinations (3mm,50mm) and (10mm, 20mm) are in order of decrease. These trends are well explained considering the cascade of electron components in the showers.

To study a dependence of shower age on the transition effect, showers were divided into 3 groups showers of age parameter $0.8 \leq s < 1.0$, $1.0 \leq s < 1.2$, and $1.2 \leq s < 1.4$, and for each group multiplication factor on the distance from the core were obtained.

Fig.2 represents the results, and the figure shows that any obvious dependence does not exist within the experimental errors

3.Discussion Four sets of detectors give us consistent values of multiplication factors each other, and we can safely say that the results mentioned above are in accordance with those obtained previously for scintillators of thickness 50mm does not exceed by 20%.

Our results are in disagreement with those of Akeno group. Disagreement may be caused by the different arrangement of detectors. We used the scintillators piled up directly,and they placed the thin scintillators independently among the array. Accordingly, their results reflect sharply the accuracy of location of the cores, compared to our cases.

Applying the results obtained by us and approximating the lateral distribution to NKG function, use of the plastic scintillators of thickness 50mm give us smaller value of age parameter by 0.03 independent of the values of age parameter, and it gives little effect on the shower size.

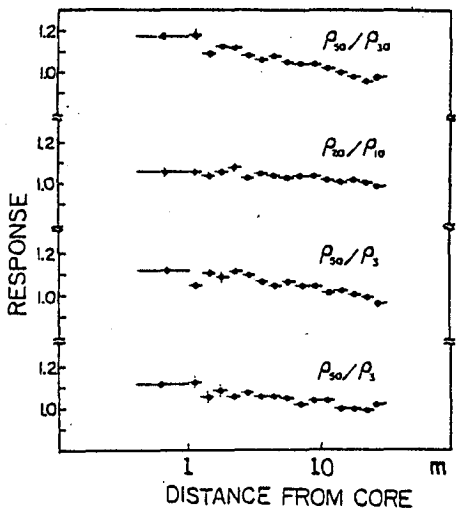
RESPONSE
1.2
1.0
ρ_{50}/ρ_{30}
ρ_{50}/ρ_{10}
ρ_{50}/ρ_{3}
ρ_{50}/ρ_{1}
1
10
m
DISTANCE FROM CORE

Fig.1

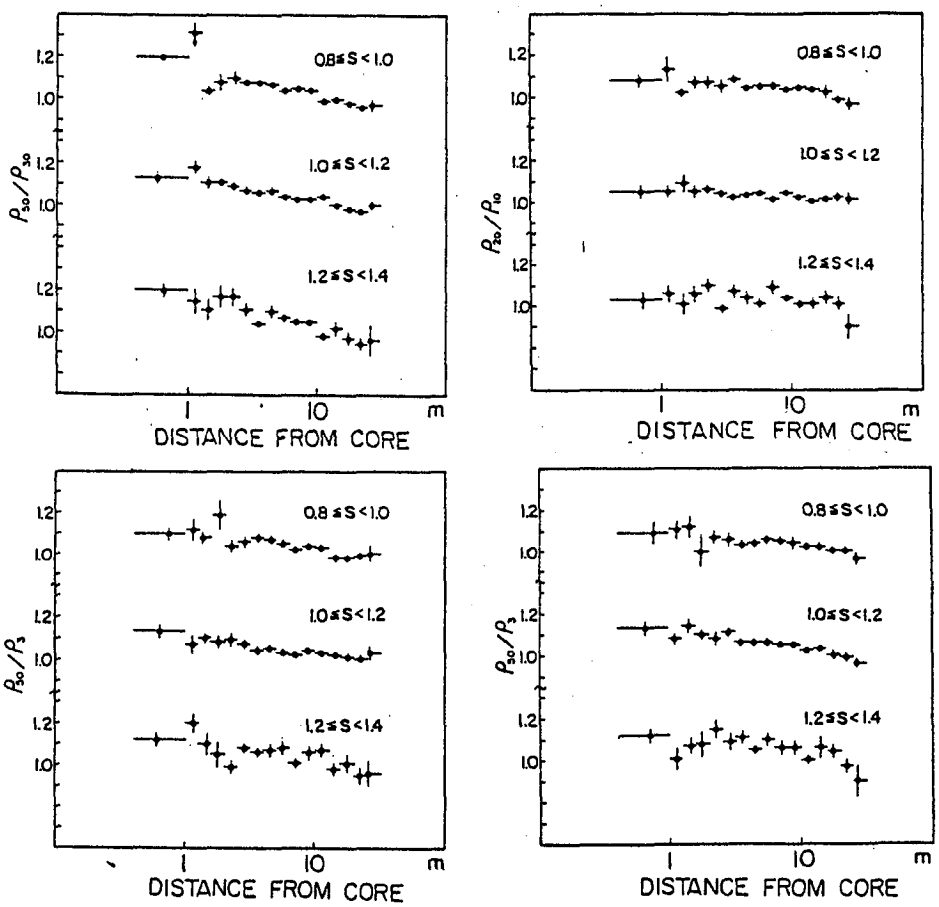
ρ_{50}/ρ_{30}
ρ_{50}/ρ_{10}
ρ_{50}/ρ_{3}
0.8≤S<1.0
1.0≤S<1.2
1.2≤S<1.4
1
10
m
DISTANCE FROM CORE

Fig.2

Reference

(1) K.Asakimori et al.: Proc. 16th Int. Conf. on Cosmic Rays, Kyoto 8 (1979) 252
(2) M.Nagano et al.: J.Phys. Soc. Jpn. 53 (1984) 1667