HE 3.4-3

OBSERVATION OF SUPER HIGH ENERGY BIG FAMILY WITH LARGE SCALE Fe EMULSION CHAMBERS

China-Japan Emulsion Chamber Collaboration*

I. Introduction. In order to get higher efficiencies for detecting hadrons and to make technical improvements in the chamber structure, the Mt. Kambala Emulsion Chamber Collaboration constructed 57 m^2 of Fe chamber, with thickness 29 c.u.(1c.u.=17.6 mm Fe), using 300 tons of Fe plates and made the first exposure from Sept., 1982 to May, 1984. The photosensitive layers consist of x-ray films of Sakura N type, Fuji No. 100 type and Tianjin III type, some of them contain also emulsion plates of Fuji ET7B type. They are inserted between the Fe plates at every 2 c.u., beginning at 5 c.u. from the chamber top. In a number of blocks, 3 mm spacings are provided at every 2 c.u. of Fe plates to facilitate the replacement of photosensitive layers, without disassembling the chamber. On the bottom of the chamber Fe plates of thickness 9 mm are placed in order to shield the chamber from the radioactivities of the ground. An event, numbered K2 58 of visible energy ΣE_γ = 7345 TeV was found in this exposure. It is the event with the highest energy obtained in Mt. Kambala emulsion chambers up to now. No obvious halo is seen in the event and all the showers are clearly separated and easy to measure. A brief report of the preliminary results is given here.

II. General characteristics of the event. There are 566 showers with visible energies greater than 3 TeV, distributed as shown in Fig.1. It is evident that the event is a single core family. On the map of the event, 161 high energy showers of total visible energy ΣE_γ = 4228 Tev are concentrated within a circle of radius 8 mm, therefore it is not necessary to carry out clusterization of the showers. Fig.2 is the optical density distribution contours of K2 58, obtained by the automatic photometer NGD-17×17, with optical aperture 300×300 m^2.

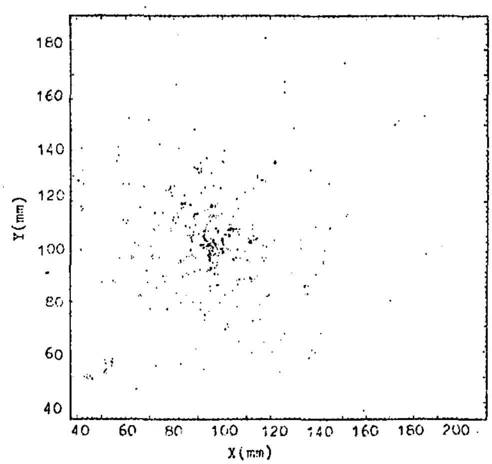

Fig. 1

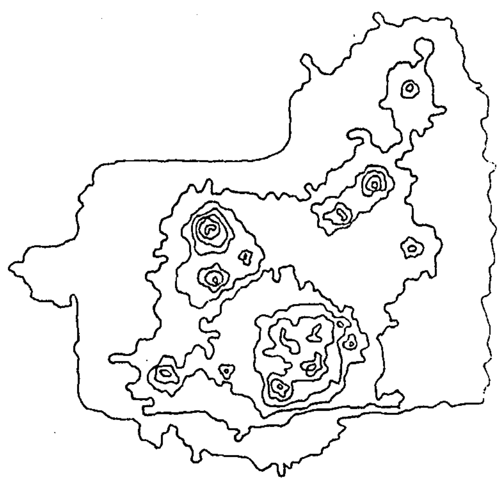
Fig. 2

Various statistical averages are given in the table I, where Δt is the depth of the starting point of a shower. The various averages remain unchanged when Δt is taken either as $\leq$ 4 c.u. or as $\leq$ 6 c.u.. The data in the last row of the table I are the corresponding quantities

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for events with visible energies $\Sigma E_\gamma \geq 1000$ TeV obtained in earlier exposures at Mt. Kambala (2). Both results agree well.

Table I. Statistical Averages for Big Families (E_{min} = 4 TeV)

Event	t (c.u.)	N	R (cm)	ER (TeV.cm)	E (TeV)	E (TeV)
K2 58	4	417	2.02	19.9	15.1	6300
	6	455	2.04	19.9	14.9	6800
Mean for 5 Events	6	134	1.94	16.3	11.7	1530

III. Energy spectrum and ER distribution. Shower energy spectra and ER distributions taken with different values of Δt are shown in Fig.3. The shape of the energy spectrum remains almost unchanged as the value of Δt is varied. It is nearly of the form $N(>E) \propto E^{-\beta}$, where β=1.2. All the energy spectra of showers in circles with different radii R and centered

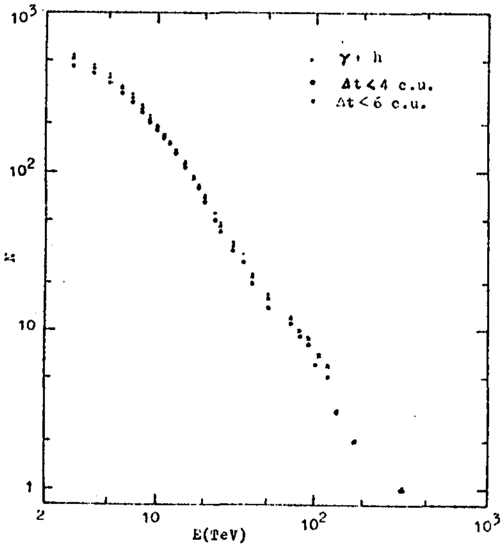

Fig. 3a

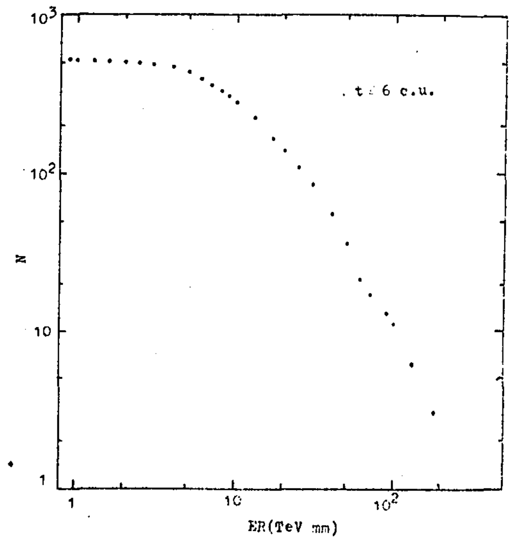

Fig. 3b

at the center of energy of the event are in power form (Fig.4). Furthe-

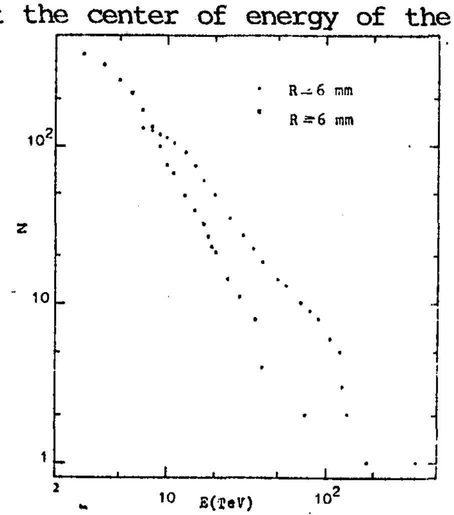

Fig. 4

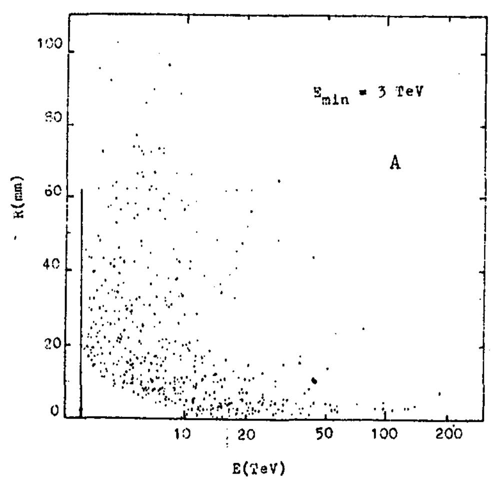

Fig. 5

more, the energy spectrum of showers with $E_\gamma \geq 10$ TeV remains almost the same when R has increased to 8 mm. These indicate that the production height of the event is so high that both the central and the peripheral parts of the event have already undergone sufficient electromagnetic processes. In the $R < 12$ mm region, are concentrated a large number of showers of energies in the interval 3-10 TeV, making the optical densities in their neighborhood greatly exceeding those of the background and rendering the showers with lower energies obscure (see the triangular blank region A in Fig.5). From the energy spectrum $N(>E) \propto E^{-\beta}$ at $E_\gamma \geq 10$ TeV, it is estimated that there should be about 180 showers with $E_\gamma \geq 3$ TeV in the blank region A, with a corresponding total energy $\Sigma E_{\gamma A} = 808$ TeV.

Fig.6 gives the energy spectrum for showers with $\Delta t = 6$ c.u., corresponding to the energy spectrum of a part of the Pb-jets in Pb chambers. The result is the same as that in Fig.3.

Thick Fe chambers are more effective than Pb chambers in the detection of hadrons, but the method for disciminating Fe-jets and γ-rays (electrons) remains to be further explored. Criteria based on the difference in Δt are unfavorable but considerations about the consecutive interactions of hadrons in Fe may be more adequate. Fig.7 gives an example of the transition curve in Fe of a high energy shower, with $\Delta t \sim 0$. It is seen that the trend of the shower development distinctly deviates from the transition curve of the showers produced by γ-rays (electrons), corrected for the L-M effect (3). However, this is applicable only to high energy showers but is difficult for low energy ones.

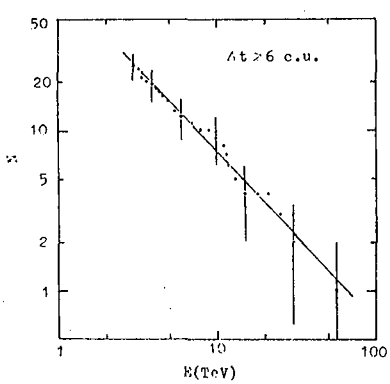

Fig. 6

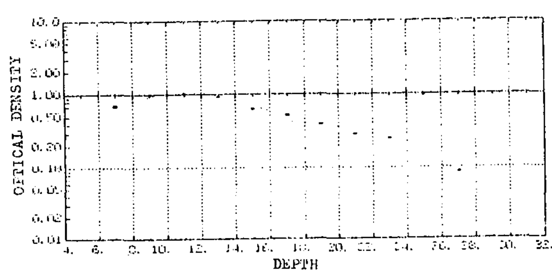

Fig.7

References

(1) I.Onta, Uchusen Kenkyu (in Japanese), 24(1980)147.

(2) J.R.Ren et al., Physica Energiae Fortis et Physica Nuclearis (in Chinese), to be published.

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