Search for Anomalous C-jets in Chacaltaya Emulsion Chamber Experiment

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Abstract

A search for anomalous C-jets is made in Chacaltaya emulsion chamber No.17 exposed by Brasil-Japan collaboration. Up to date, measurement of 150 C-jets (nuclear interactions occured in the target layer in the chamber itself) with total visible energy greater than 5 TeV was completed. They are recorded in area of 11 m^2, corresponding to 17.1 m^2·year exposure.

Among them, 7events has no pinaught and two events are peculiar in that 3 showers out of 4 show abnormal cascade development. Especially, two of them show remarkable characters indicating that they are coming from exotic interactions in the target layer. We present here some illustrations of these events and short discussions on the threshold of this type of events.

1. Introduction.

After the discovery of exotic interactions such as Chiron, Centauro and so on, among cosmic-ray induced nuclear interactions by Brasil-Japan collaboration of Chacaltaya emulsion chamber experiment, there has been studied extensively about the detailed structure of these events through the observation of atmospheric interactions. /1/ But there are no reports so far that these types of events are found in CERN SPS experiment at energy region around 200 TeV in lab. system nearly equal to C-jet energy region. As to the multi-pion production phenomena, we can see good agreement between the two. /2/ It is therefore urgent question what is the threshold energy of these events. Recently, the systematic survey of C-jets is carried out on chamber No.19 (abbreviated as CH19 hereafter) partly to answer this question. And it is found that there exist some exotic events with $\Sigma E^{(\gamma)}$ (sum of all visible energies) greater than 5 TeV. Present work is made to improve the statistics of exotic events in target interactions to give better understandings of the problem of exotic events.

2. Experimental Procedure.

C-jets recorded in the two-storeyed emulsion chamber No.17 exposed on the top of Mt.Chacaltaya are measured and partly reanalysed. Detailed description of the structure of the emulsion chamber and the method of observation is found elsewhere./2/,/3/

3 Result.

Up to date, 150 C-jets are accumlated from 55 blocks in CH17 corresponding 17.1 m^2·year of exposure. In Fig.1 we present $\Sigma E\gamma$ spectrum with the straight line power of which is -1.7. Fig.2 is the distribution of invariant masses of every possible pair of gamma rays from 78 newly measured events. The peak of pinaught is clearly seen which assures the accuracy of energy measurement. Fig.3 is the scattered diagram of observed showers of 120 events with multiplicity greater than 4. These figures show that the present measurement of C-jets is carried out without severe systematic errors.

Among 150 events, there are 7 pinaught-less events, i.e., there is no pair of showers whose invariant mass falls into pinaught region (100 - 170 MeV). In addition, two events show peculiar behavior indicating that constituent showers of these events are not simple gamma-ray originated showers. In table 1 these 9 events are summarized.

Among them, two-prong events with invariant mass about 4 or 5 hudreds of MeV can be interpreted as the result of fluctuation of normal multiple meson production. The remaining events are highly probable candidtes of non-pion interactions. Two events are illustrated here in detail. One is the event 17-151-3, which consists of 4 showers with energy 2.6, 1.3, 1.5 and 1.3 TeV, respectively. Careful search for another lower energy showers were in vain. Invariant masses are shown in Fig.4 with target map of the event. Numerical values in blackets are energies of showers. The constituent showers in this event have no partner to make up pinaught. Further, shower No.1 and 2 are not observed in 3 c.u. layer and shower No.2 shows abnormal development of track numbers in transition as well as shower No.4. Therefore, only No.3 can be considered as gamma-ray shower. In addition, transverse momenta of these showers are very large compared with the average ones $\sim$ 200 MeV. Sum of transverse momenta, $p_T(\gamma)$, of the four is 2.0 GeV/c which gives 500 MeV/c as the average.

The other event 17-135-A is also shown in Fig.5, as in the same way in the former event. Shower No.1 has multi-core structure from 4 c.u. layer down to the last layer 12 c.u. peculiar to Pb-jet in the lower chamber (local nuclear interaction in the lower chamber). No.2 has two maxima in transition of track numbers. No.4 has only 12 tracks within the circle with radius 25 μm at 5c.u. and then develops and attenuate abruptly. No.3 has also double maxima in transistin, but rather smooth fitting to the calculated curve can be made. Consequently only No.3 can be interpreted as gamma ray originated shower as in the former event. As well as the event 17-151-3, transverse momentum of showers in this event as as large as 0.38 GeV/c on the average which value of transverse momentum is close to that of Mini-Centauro event observed by atmospheric interactions.

4. Discussions.

Preliminary comparison with Momte-Carlo simulation tells us that above two events can not be seen in the artificial events so far which reproduce well the over-all feature of multiple meson production phenomena observed in C-jets. It is highly probable that several events found by the present analysis are coming from the same origin as the exotic events found in the atmospheric interactions. Frequency of these anomalous events is the same as in the result of the analysis of CH19 as a first approximation, several percent of the whole events.

If we assume that gamma-ray inelasticity of these showers are usual one (average is about 1/4 $\sim$ 1/3) and all showers are from the local nuclear interactions in the lower chamber itself, average energy of parent partiles producing these events is estimated as about 100 TeV which is within the limit of accelerator experiment. This seems to be a contradiction, which might be a fringe of the secrets of the nature.

Acknowledgement

The author expresses the sincere gratitude to all the members of Brasil-Japan collaboration of Chacaltaya emulsion chamber experiment for encouragement and offering him the data.

References

1. Brasil-Japan collaboration; Proc. of Workshop on Cosmic Ray Interactions High Energy Results, La Pas Rio de Janeiro (1982) 319.
2. Brasil-Japan collaboration; Supplement of Progress of Theoretical Physics, 1, and H. Kumano; ibid, 51.
3. Brasil-Japan collaboration; this issue, HE 3.2-6.

Table 1. List of Events

Event name	No. of showers	$\Sigma E^{(\gamma)}$ (TeV)	Remarks
17-89-2	5	8.00	Non pinaught
17-93-2	3	7.32	Non pinaught
17-116-3	2	6.90	Non pinaught, 560 MeV
17-122-14	2	5.55	Non pinaught, 519 MeV
17-140-C	2	5.60	Non pinaught, 559 MeV
17-144-24	2	> 6.9	Non pinaught, > 484 MeV One shower is pb-jet lower (Δt=8.3)
17-151-3	4	6.70	Non pinaught, See text
17-135-A	4	5.65	See text, at most one gamma ray
17-135-B	4	7.26	At most one gamma ray

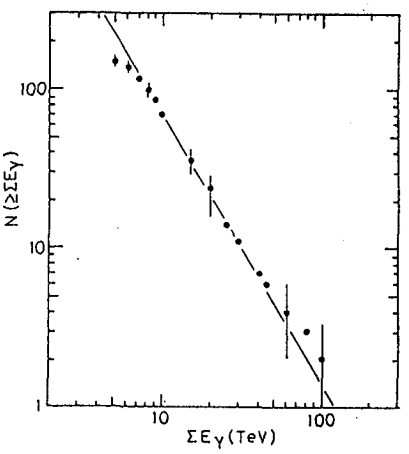


Fig.1 $\Sigma E^{(\gamma)}$ Spectrum

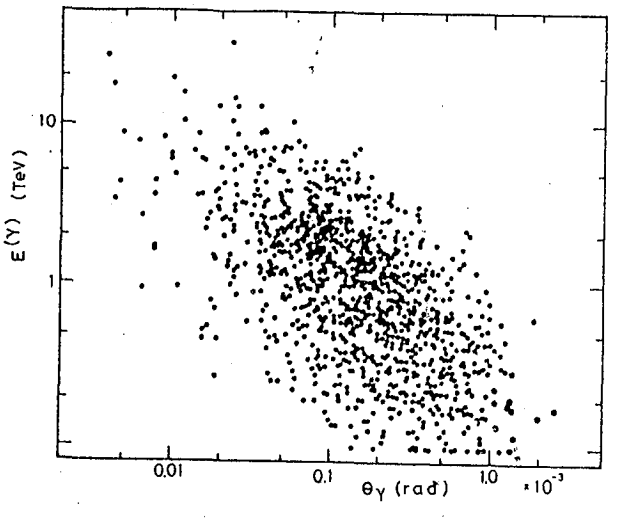


Fig.3 $\Sigma E^{(\gamma)}$ $-\theta_\gamma$ correlatuion

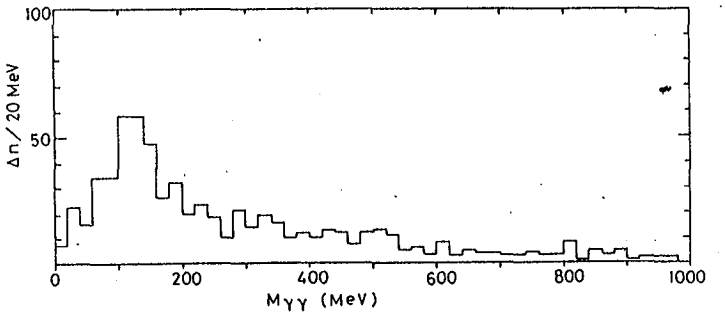
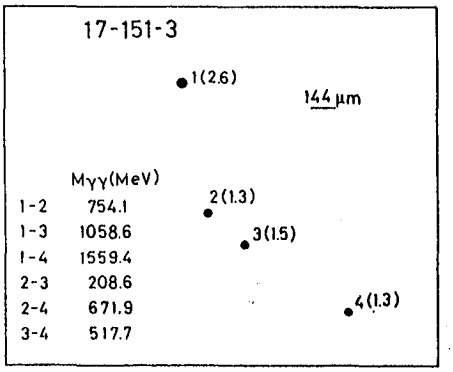


Fig.2 Invariant mass spectrum



Fi.4 Target map

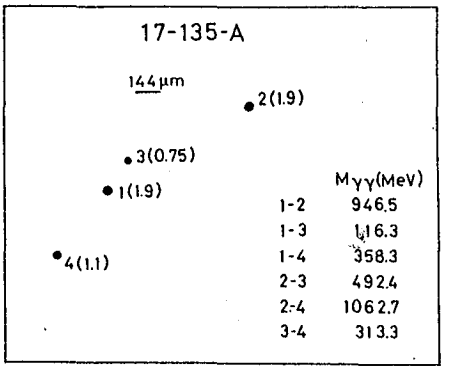


Fig.5 Target map