On An Intermittent Component of Hadron-less Air Showers Observed at Mt. Chacaltaya

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Absttract

Observation of UHE gamma-rays has been carried out at the hiest altitude with SYS air shower array from Feb. 1986. We study the time interval distribution of any successive air showers arriving from the same direction to find an excess on the celestial coordinate. The preliminary results from hadron-less air showers are shown in this paper.

§1. Introduction

We have been observing air showers with above size 10^4 at Mt.Chacaltaya(5200m) in the Southern Hemisphere. In order to search the existence of UHE gamma-rays in the primary cosmic rays and sources, we analyzes these air showers from points of view as follows :

a) The number of the hadronic component of gamma initiated air showers is smaller than that of ordinary nucleon initiated air showers. Consequently, we may distinguish gamma initiated air showers from ordinary air showers comparing an amount of hadronic component each other or at least we can reduce background events due top normal air showers with picking up hadron-less air showers as candidates of gamma initiated air showers.

b) Charge particles coming from galactic sources are scattered by magnetic field and undergo sufficient randomization. On the contrary, gamma rays emitted from a source come to observation retaining a original source direction. If UHE gamma-rays are emitted as short term out burst, the distribution of the time interval of air showers may be different from that of the background by normal air showers coming at random.

We study, accordingly, the number distribution of consecutive hadron-less air showers arriving from the same direction in a particular time interval to find an excess above the random distribution. We report in this paper results of analysis on about $1x10^6$ air showers with size above $4.0x10^4$ observed on the same condition about one year from March 1989 to May 1990.

§2.Experimental method

Air showers have been observed with the SYS air shower array at Mt. Chacaltaya (5200m a.s.l., S 16°21' and W 68°08') from Feb. 1986 in order to study UHE

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cosmic gamma rays. The arrangement of detectors of the array is shown Fig.1. The array consists of 31 scintillation detectors each of area 0.25m^2 and four similar ones each area 1m^2, spread up to 50m from the center of the array. We determine the total number of air shower particles(Size,Ne), the age parameter(s) and the core position of individual air showers.

Eight fast timing detectors each of area 0.25m^2 are located in the central area of the array to determine the incident angle of air showers. The resolution of the incident angle is ±4° for air showers with Ne $10^{4.9}$ and ±2° for Ne $10^{6.0}$.

In the center of the array, burst detectors of 32 unit each of area 0.25m^2 covered with 15cm pb (total area 8m^2) are installed. Hadrons in air shower cores are observed as bursts with these signal layer burst detectors. Air showers are observed with a trigger rate about 120 events per one hour in the period of the present analysis.[1]

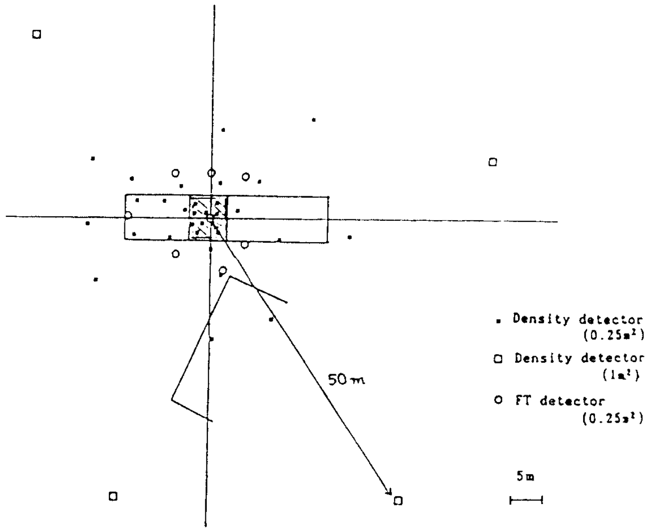

Fig.1 The arrangement of our experiment.

§3.Analysis and Discussion

We analyzed air showers with size between 6x10^4 and 6x10^5, incident angle less than 35° and core position within 10m from the center of the air shower array, in the present studies. However, we did not use any selection on the age parameters between 0.7 and 1.5. Moreover, we selected air showers according to the total number of hadrons. As above mentioned, we assume that the number of hadrons in gamma initiated air shower is smaller than that in normal air showers. Such an assumption is natural, if the cross section of nuclear interaction of gamma rays does not increase drastically in higher energy regions. The number of hadrons at a particular core distance in each air shower is determined statistically as a most probable density calculated from a ratio of a number of burst detectors hit with bursts to that with no burst in the same core distance region. The average lateral distributions of hadrons are determined in the same way for different regions of the shower size and the age parameter.

The ratios of hadron density to the average lateral distribution of hadrons are determined at various core distances in each air shower. The average of such ratios of an air shower is used as a parameter to select hadron less air showers. The hadron less air shower parameter 100% means that the total number of hadrons is similar to the average one.

In the present paper, we picked up air showers with the hadron less parameter less than 30%. In order to search an intermittent component coming from sources on the celestial coordinate, we analyzed the time interval of successive showers coming from each 10°x10° window on the celestial coordinate. The area of this window is reasonable view angle considering our angular resolution of the fast timing system. We have no knowledges about the number and the time interval of successive showers in our observations. Then, as the first step, the number of selected events in one day are determined for various declination and right ascension bands. As an example, we show event numbers per day for the declination band from -20° to -10° in Fig. 2(a) summed for all right ascension and in Fig. 2(b) limited for one right ascension band from 170° to 180°. Thus we can know the stability of our observation, event

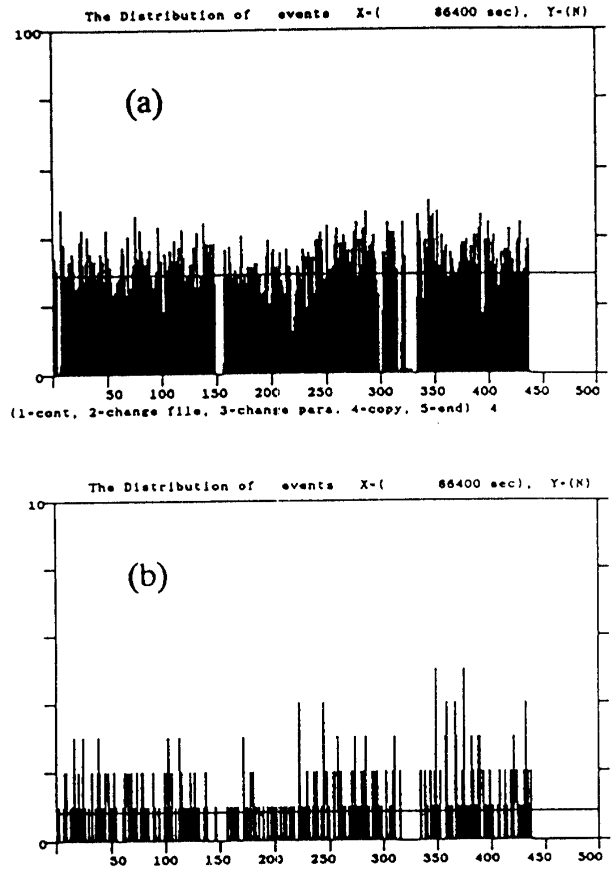

Fig.2 The observation counting rate per day.
(a) for all right ascension of declination band from -20° to -10°. (b) for 10°x10° window; right ascension(170°- 180°), declination(-20°- -10°)

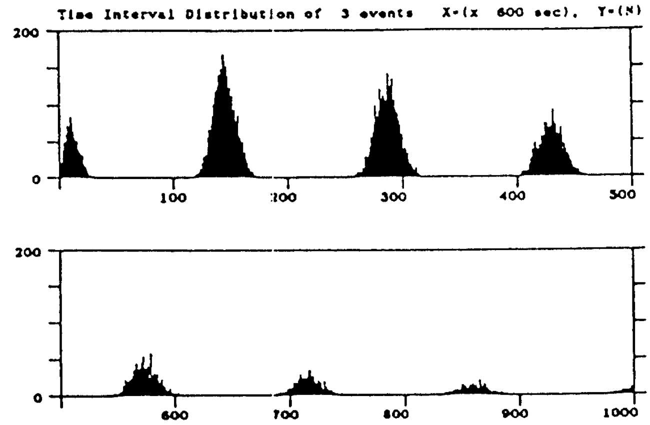

Fig.3 The time interval distribution of 3 successive event for all right ascension of declination band from -20° to -10°. The number on the horizontal axis is divided by 600 of the time interval(sec).

numbers and that fluctuation from a window 10°x10°.

We, next, analyzed the time interval distributions of any successive events of given number. Fig. 3 shows an example of such distribution of any three successive showers event for the declination band from -20° to -10° in spite of the right ascension. Since the scale unit of the horizontal coordinate is 600 sec, the first peak shows the distribution of the time interval within one day and the second peak corresponds to that for two days. Fig.4 (a)(b)(c) and (d) show the first peak with expanded scale (unit 60 sec) for successive events with various number. From these figures we could estimate number of air shower in successive events for limited time intervals. Thus, we analyzed number distributions of successive events in time interval 21000 sec(about one day) and 3600 sec(one hour) for various declination-right ascension bands.

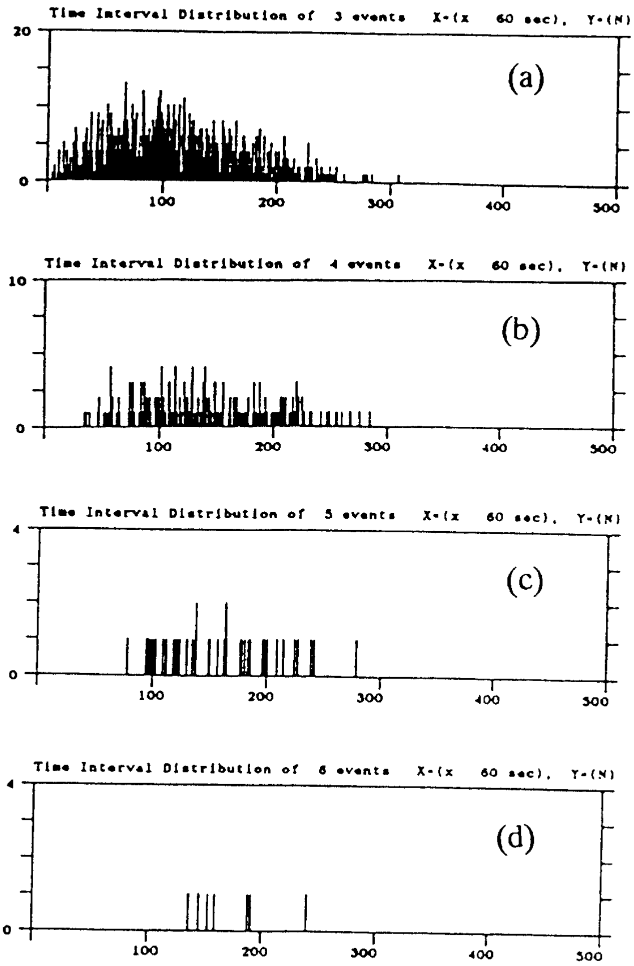

Fig.4 The time distribution of different number of successive event for all right ascension of declination band from -20° to -10°. The number on the horizontal axis is divided by 60 of the time interval(sec).
(a) is for 3 successive event, (b) is for successive event, (c) is for 5 successive event and (d) is for 6 successive event.

Results on the right ascension distribution of successive events in the time interval 21000 sec for the declination band from -20° to 10° are shown in Fig.5(c) for any three successive events, (b) for four events and (a) four 5 events. For different declination bands, similar results are shown in Fig.6(a) and (b). Results for the different time interval 3600 sec are shown in Fig.7(a) and (b) for four successive events and three, respectively in the declination band from -20° to -10° which corresponds to the top of the sky at our observation point.

When air shower number in a successive event is small, we could not find any concentration of events in an right ascension band, however the results shown in Fig.5(a) seems to show some peak around the right ascension from 190° to 200° and from 270° to 280°. When we limit the time interval to one hour, the second peak at 270°

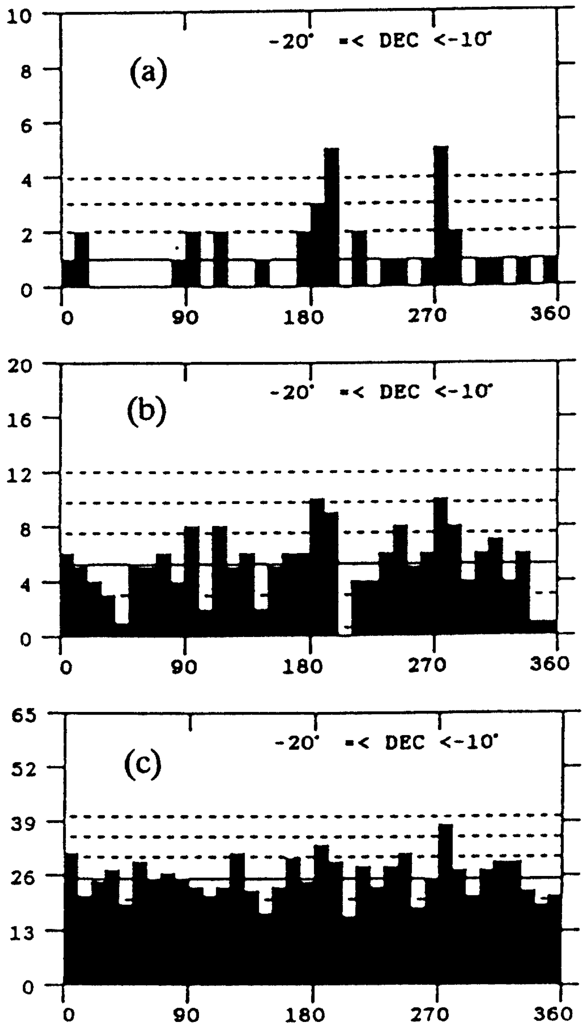

Fig.5 The right ascension distributions of different number of the successive event less than about one day of the time interval. declination band from -20° to -10°.
(a) 5 successive event, (b) 4 successive event and (c) 3 successive event.

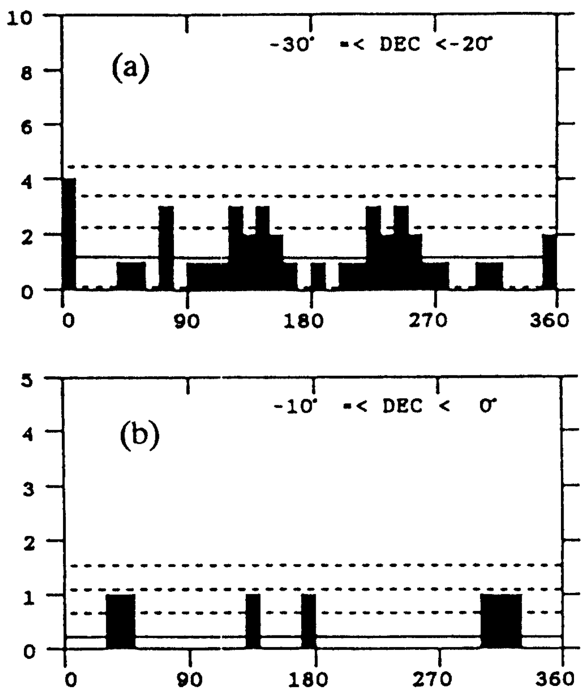

Fig.6 The right ascension distributions of different declination band less than about one day of the time interval. (a) declination band from -30° to -20°. (b) declination band from -10° to 0°.

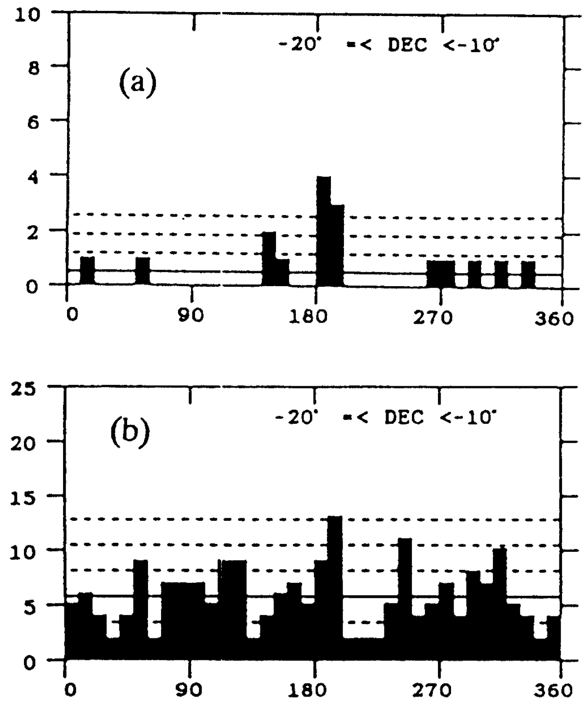

Fig.7 The right ascension distributions of different number of the successive event less than one hour of the time interval. declination band from -20° to -10°.
(a) 4 successive event and (b) 3 successive event.

is not find, however, the first peak at 190° is still found as shown in Fig. 7(a). However, we can not find any object for this direction in the celestial coordinate.

Acknowledgment

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Reference

[1] Matano et. al. ; 21st Int, Cosmic Ray Conf. 8 (1990), 226

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