BURST SIZE DISTRIBUTIONS IN THE DIGITIZED DATA OF THE ION CHAMBERS AT MT.NORIKURA AND SEA LEVEL STATIONS

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ABSTRACT

A practical and simple method for burst rejection was applied to the digitized data of cosmic ray ion chambers at Mt. Norikura, Tokyo and Kochi. As a result of burst rejection, the burst size-frequency distributions in the digitized data at mountain altitude and sea-level ion chambers were obtained. The results show that there are no significant differences between the digital and analog data processing in the burst rejection.

1. Introduction

Cosmic ray ion chambers have been used for the continuous observation since the early days of cosmic ray studies. Five sets of Nishina-type ion chambers were built during the period from 1935 to 1941.[1,2] Continuous recording by those Nishina-type ion chambers had been started at Tokyo in 1948, Mt. Norikura in 1955, Hong Kong in 1970 and Kochi in 1979. At present, the digital recording systems for cosmic ray ion chambers[3,4] are in operation (see Table 1).

The burst distribution in ion chamber records is recognized from an abrupt change in charge up voltage. It is generated from a bremsstrahlung of muon or some nuclear interaction in lead absorber which covers the chamber to avoid undesirable radiation around the apparatus. Since the size of a burst sometimes exceeds total voltage variation in an hour, it should be rejected to reduce fluctuations. In this paper, we discuss on the burst rejection and the burst size distribution in the digitized data at Mt. Norikura, Tokyo and Kochi.

Table 1. List of Nishina type ion chambers in Japan

Station	Mt. Norikura	Tokyo	Kochi
Cutoff rigidity (GV)	11.36	11.50	12.88
Altitude (m)	2770	20	30
Atmospheric depth (g/cm^2)	740	1030	1030
Nishina type ion chamber	No.1	No.5	No.4
Argon gas pressure (kg/cm^2)	39	30	39
Electrometer output range (V)	30	10	10
Thickness of roof (g/cm^2)	20	10	120
Thickness of lead shield (cm)	10	10	10

2. Method of burst rejection

There is no *a priori* way of rejecting the burst data, since smaller bursts can not be distinguished from ordinary statistical fluctuations. As a method of burst rejection, Wada *et al.*[4] proposed to chose the threshold from the distribution, so that the average is not change.

Kusunose *et al.*[5] presented a practical method to separate bursts from the ordinary cosmic ray data on the assumption that the frequency of burst number per hour follows the Poisson distribution. We reduced the procedure of burst rejection, where the principle is the same as the previous method. The threshold of burst rejection is taken as $k_n\sigma_n$ (n=1,2,...), where σ_n are standard deviations and k_n are constants, which are determined so that the frequency of burst obeys the Poisson distribution. In the previous report, n was taken up to 10, now we reduce it to 3.

χ^2-test of the Poisson distribution was applied to the distribution of the burst frequency per hour. The results show fairly good fitness to the Poisson distribution except for a few cases. The distributions of one minute values as differences from averages of respective hours are shown in Fig.1. Curves A's are the distribution of one minute values due to ionization current of cosmic rays detected in the chamber, and B's are the distribution of the rejected burst values. As shown in the figures, both curves are separated each other reasonably.

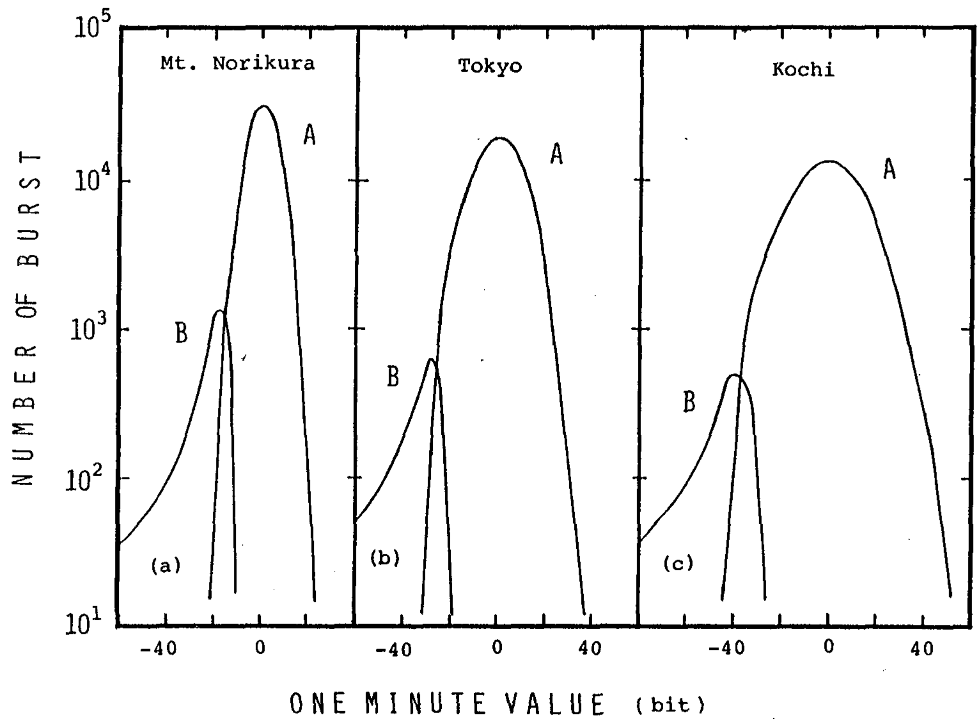

Fig. 1. Distribution of one minute values as deviation from the averages of respective hours at the period from May 24, 1980 to May 9, 1981.

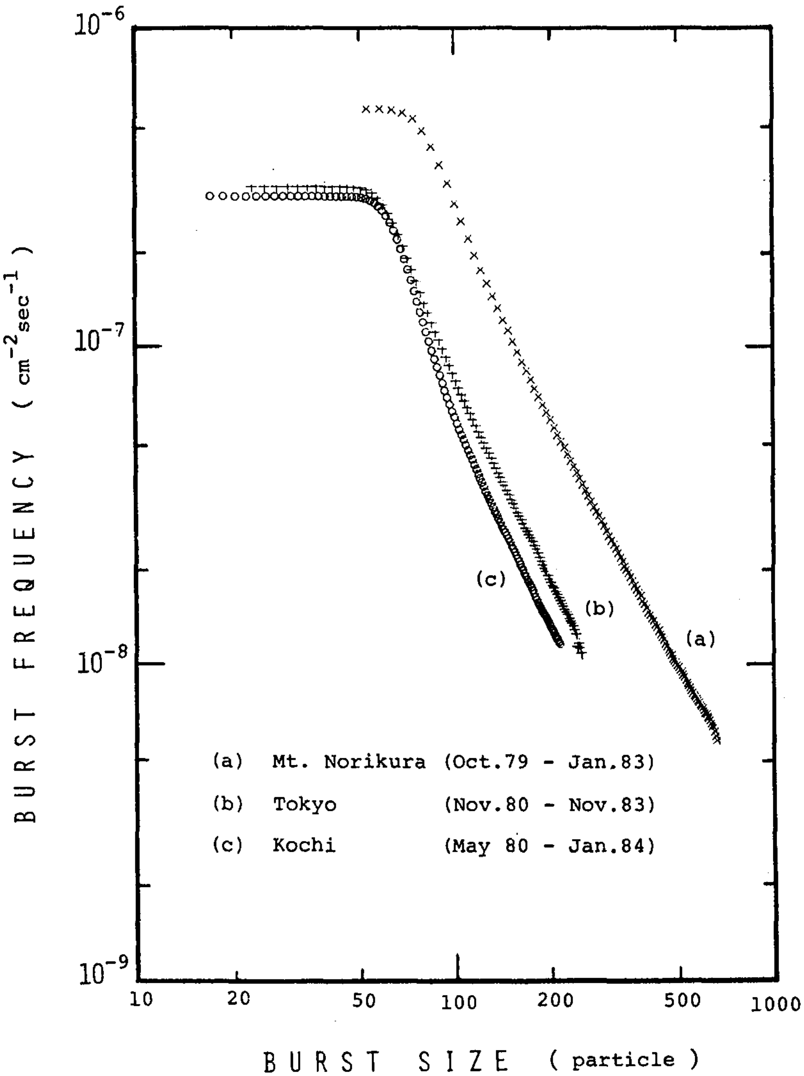

Fig. 2. Burst size-frequency distribution.

3. Burst size distribution

The integral size-frequency distributions of bursts thus obtained are shown in Fig. 2, where (a), (b) and (c) are those of Mt. Norikura, Tokyo and Kochi ion chamber respectively. In the figure, the burst size is represented in unit of particle that means the number of incident charged particles in a ion chamber. The frequencies of the bursts are indicated in the number of bursts divided by the time of total duration and by the horizontal cross-sectional area of the chamber.

The frequencies of the bursts at a point where the burst size is 200 particles, are shown as, 6.0×10^{-8} $cm^{-2}sec^{-1}$ at Mt. Norikura, 1.83×10^{-8} at Tokyo, and 1.35×10^{-8} at Kochi. The burst frequency at Mt. Norikura is 3.3 times that of Tokyo. According to Kameda and Wada[6], it means that considerable parts of the total bursts at sea level are those induced by N-components. The ratio of Tokyo to Kochi is found as 1.3. It will be explained by the difference in the cutoff rigidities and the thickness of roof materials.

The burst frequency spectrum can be expressed partly by the form of power function as $S^{-\gamma}$, where S is the burst size in unit of particle. We calculated the power γ in the range of burst size from 150 to 220 particles by the least square method. The results are $\gamma=2.07\pm0.01$ at Mt. Norikura, $\gamma=2.09\pm0.01$ at Tokyo, and $\gamma=2.09\pm0.01$ at Kochi. There is no significant difference among them.

4. Summary

In summary, we separated one minute data of cosmic ray ion chamber into the ordinary cosmic ray data and the burst data by the statistical way under the assumption that the number of bursts in one hour follow the Poisson distribution. The merit of this method is capable of testing the appropriateness of burst rejection by application of χ^2-test on the Poisson distribution.

As a result of the burst rejection, the distributions of burst size-frequencies were obtained. The differences of burst size spectrum bwteen Mt. Norikura and sea level ion chambers are generally in coincidence with the results of Kameda and Wada.

5. Acknowledgments

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