Analysis of the Arrival Time of Successive Air Showers by using Erlang Distribution

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Abstract: We analyze arrival time of air shower using Hirosaki AS Arrays. This array consists of 5 scintillation detectors with GPS antenna for arrival times. We use Erlang Distribution and High Order Correlation Method. The number of air showers observed within short time windows is analized by using arrival time difference of k-events serial air showers. We report the results of the analysis.

Introduction

We analyze arrival time of air shower using Hirosaki AS Array II which consists of 5 scintillation detectors and GPS(Location:40'35' N, 140'28' E, 63m from sea level) [4]. By using the GPS, we can record arrival times of air showers with an accuracy of 1 micro second. Any 3 folds coincidence within 100 nano seconds is used on the trigger condition for air shower events. The event rate is 3600 / day. Some special successive air shower events are recorded in short term among observation data which we will be explained later. Recently, N.Och et al. group [2] and T.Konishi et al. [1] reported that the arrival direction of such the successive air showers tends to concentrate to the Galactic plane. Relating to their reports we analyzed similar problems by two algorithm. One is with Erlang distribution and the other is with High order correlation method. The period from October 5, 2006 to January 8, 2007 were selected for the analysis.

Analysis by using High Order Correlation Method

In order to seek out a series of successive air shower events, first we set the time interval and the number of air shower events and we calculate the arrival directions of the air shower events in equatorial coordinates(the right ascension and the declination). When the events are included in the time interval, those are extracted as successive air shower events.

Analysis by using Erlang Distribution

Let us explain, how to utilize the Erlang distribution [3] for extracting the peculiar feature of successive air shower events. Here we sample successive air shower events, for example, six events. We take the time difference of No.1 event to No.6 event as first sample, that of No.2 to No.7 as the second, that of No.3 to No.8 as the third and so on. From these samples, we obtain frequency distributons of successive air shower events. In Fig.2, we compare observation with Erlang distribution and found significant difference between observation and the expected from Erlang distribution. We found significant discrepancy in smaller time difference, as shower in Fig.2.

References

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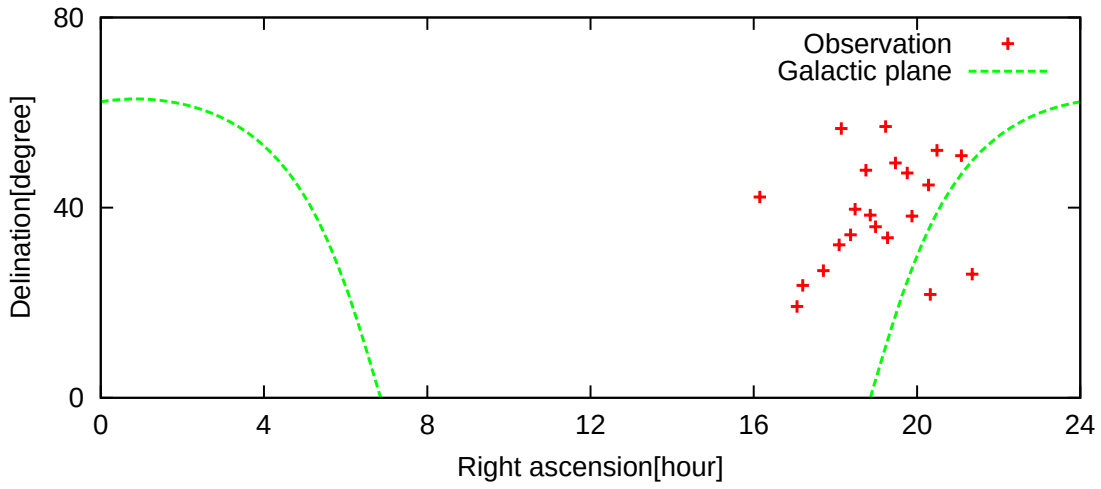

Figure 1:

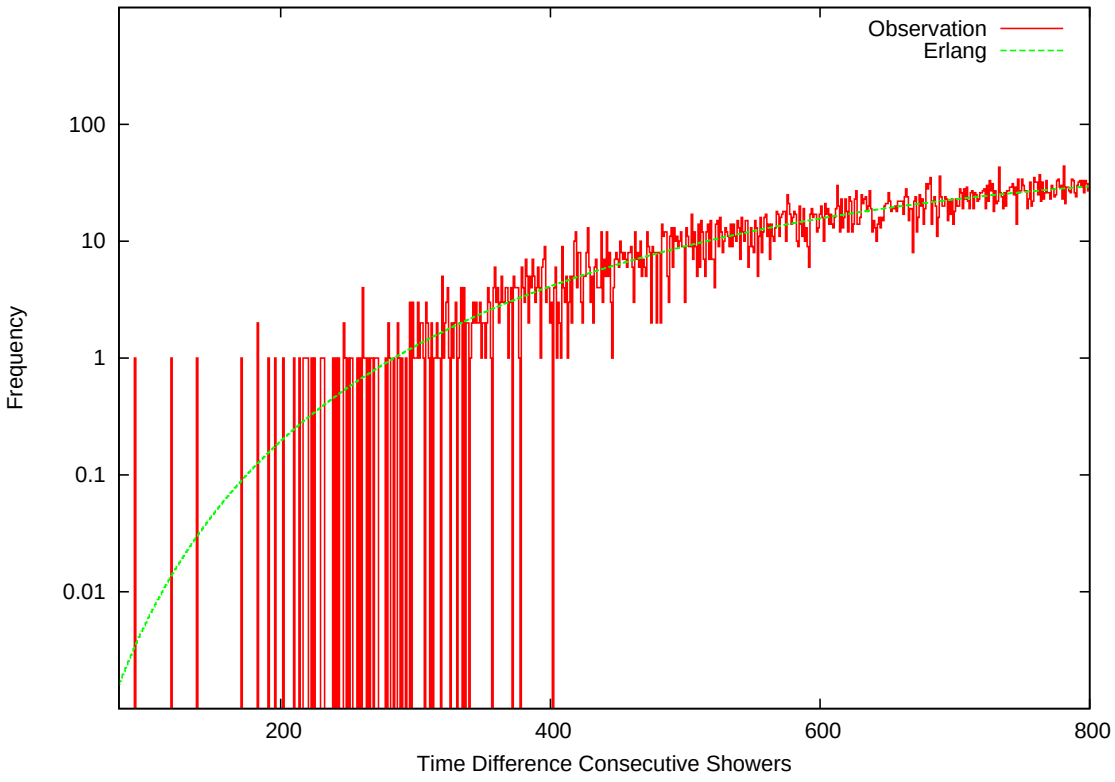

Figure 2: