論文の内容の要旨

論文題目　Observation of gamma ray storms at the earth's surface related to the thunderclouds and a study of their properties
(雷雲に関連した地表におけるγ線増大現象の観測と
その特性の研究)

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We observed three γ-ray bursts related to thunder clouds using the prototype of anti-neutrino detector PANDA deployed outside at Ohi Power Station. The maximum rate of the events which deposited the energy higher than 3 MeV on the detector was $(5.5 \pm 0.1) \times 10^2$ /sec.

To investigate the mechanism of the bursts, we made Monte Carlo simulations. We calculated bremsstrahlung γ-ray spectra from mono-energetic electrons projected vertically downward from the sky and investigated the detector response.

The result of the simulation showed that the spectra of bremsstrahlung γ-rays by 16 MeV electrons from 1100 m altitude and 400 m altitude well describe the observed energy spectrum of the bursts.

The arrival direction of the γ-rays were also investigated by the position information of each energy deposit and Compton scattering-angle calculation. We found that γ-rays of the bursts entered into the detector from the sky and from the direction close to the zenith. The arrival direction stayed constant during the burst.

We compared the observation results of γ-ray bursts with model calculation about the increase of electron flux in the strong electric field of thunder clouds with tripole charge structure made by Torii et al. and found that the increase of electron flux is less than the electron flux estimated from observed event by a factor of 28 even at low altitude.

In addition, taking advantage of the ability to detect the neutron of the prototype detector, we searched for the neutron bursts corresponding to the γ-ray bursts. Although we could

not definitively confirm the increase was due to neutrons, we found the increase of the flux of neutron-like events with maximum event rate of ~ 13 /sec.