【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Mathematical and Physical Sciences)

Title of Project : Cosmic gamma-ray observation by balloon borne emulsion telescope to study unsolved issues

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Research Project Number : 17H06132 Researcher Number : 80211689
Research Area : Particle, Nuclear, Cosmic ray, Astro physics
Keyword : Gamma-ray, Nuclear Emulsion

【Purpose and Background of the Research】

Gamma-ray is the most energetic light which gives us direct information from high energy phenomena in the Universe. Gamma-ray astronomy has remarkably developed through the use of the Large Area Telescope (LAT) of NASA's Fermi Gamma-ray Space Telescope launched in 2008. Fermi-LAT reconstructs the incident angle of the gamma-ray detecting tracks of electron positron pair converted by the gamma-ray with semi-conductor detectors. On the other hand, the angular resolution is inadequate to compare the spatial information with the result observed in other wavelength bands. And it is hard to detect polarization which is informative to discuss its production mechanism.

In this project, we shall realize a gamma-ray telescope using nuclear emulsion films whose principle is the same as that of silver halide photograph. The emulsion telescope can improve angular resolution of a gamma-ray with much finer tracking of the electron and the positron. Moreover, it is sensitive to polarization of the gamma-ray.

【Research Methods】

The emulsion film can record the tracks of electron and positron converted from the gamma-ray as shown in figure 1. The emulsion telescope consists of a converter to tell the gamma-ray angle, a time-stamper to tell the timing of the gamma-ray incident and an attitude monitor to tell the orientation of the telescope relative to the celestial sphere.

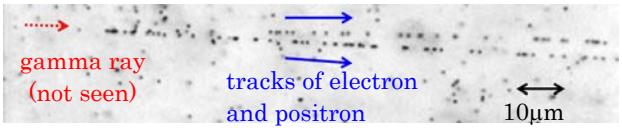

Figure 1 electron positron pair in emulsion film

The converter is made of a stack of emulsion films which is a tracking detector of the electron and the positron as well as a medium for gamma-ray conversion. All the tracks are read out by the fully automated scanning microscope system named Hyper Track Selector (HTS) shown in figure 2 (left).

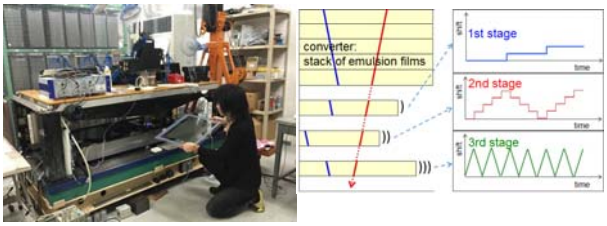

Figure 2 (left) Hyper Track Selector (0.5 m²/h)
(right) multi stage shifter for time-stamper

Tracks recorded in the emulsion film basically have time ambiguity during the period from its production to its development process. The time information of each gamma-ray is necessary since the celestial sphere rotates and the orientation of the telescope changes due to the rotation and swing of the gondola of the telescope. Several films located under the converter are intentionally shifted back and forth in the individual period. The combination of each shift enables us to get the time information. (figure 2 (right))

【Expected Research Achievements and Scientific Significance】

We shall start scientific observation realizing a gamma-ray telescope with 10m² aperture area (the world's largest) in this project in order to study unsolved issues of the cosmic gamma-ray.

【Publications Relevant to the Project】

"GRAINE 2015, a balloon-borne emulsion γ–ray telescope experiment in Australia", S. Takahashi et al., PTEP, Vol.2016, 073F01
"GRAINE project: The first balloon-borne, emulsion gamma-ray telescope experiment", S. Takahashi et al., PTEP, Vol.2015, 043H01

【Term of Project】 FY2017-2021

【Budget Allocation】 153,900 Thousand Yen

【Homepage Address and Other Contact Information】

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