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

Science and Engineering (Mathematical and physical sciences)

Title of Project : Observation of Galactic Gamma-ray Sources using Electron Tracking Compton Camera with Balloon borne Experiment

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Research Area : Cosmic-ray Physics

Keyword : MeV Gamma-ray Astronomy, Compton Camera, Micro-pattern gas detector, TPC

【Purpose and Background of the Research】

In the MeV region, there still remain many unobserved celestial objects, and MeV gamma-ray astronomy is expected to reveal the new universe, although the progress is slow. Its delay is due to the nonexistence of a reliable imaging method. We have developed the Electron Tracking Compton Camera (ETCC) which realizes a full reconstruction of the gamma-ray direction and a background rejection by utilizing the direction of the recoil electron. A micro pattern gas tracking device (μPIC in Fig.1) is good to measure low energy tracks. By measuring both the directions and energies of the scattered gamma ray and the recoil electron in Fig.1a, the direction of the gamma ray is determined for each photon. Also, an angle α in Fig.1 is used for the kinematical background rejection. We launched a 10cm cube ETCC by a balloon from JAXA balloon experiment base in 2006, and carried out 3 hours observation. 400 gamma rays from cosmic diffuse and air gamma rays were detected between 0.1-1 MeV, of which spectra were consistent with the previous results. In this project, based on the previous balloon results, we will develop the 40cm-cube ETCC which is expected to detect sub-MeV gamma rays from the Crab with > 5σ during 3 hours. During 2 years, we will develop the 40cm ETCC and peripherals for balloon experiment, and launch it from JAXA balloon base to observe the Crab or CygX-1.

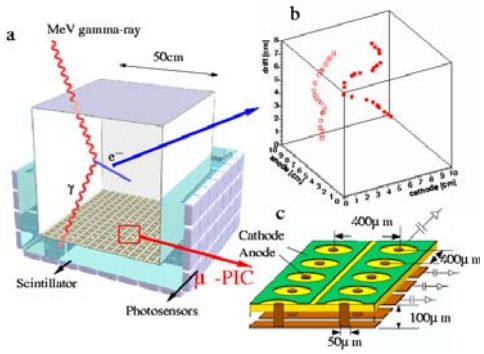

Fig.1. (a) Structure of ETCC (b) Measured tracks of electrons (c) Structure of the μ-PIC.

【Research Methods】

Based on the previous balloon results, we performed simulation study carefully taking account of the measured background, which shows that a 40cm-cube ETCC will detect gamma rays from celestial objects of Crab with >5σ in 3 hours balloon flight time. Also we have operated a 30cm-cube ETCC on the ground. The preparation of the development of a 40cm ETCC has been completed. Thus, 40cm ETCC and peripherals for balloon experiment will be developed with the first two years. To save the electrical power, we are developing a low power CMOS amplifier with KEK circuit group.

【Expected Research Achievements and Scientific Significance】

This project is a unique challenge in several plans about advanced Compton Cameras to measure celestial objects, since only ETCC can provide the kinematical background rejection for continuum emission. The detection of spectrum of Crab or CygX-1 by ETCC will surely indicate the ability of this kinematical background rejection using the scattered electron tracking. ETCC is a gas-based C.C. and a simple structure (also not so expensive). Therefore, ETCC looks quite fit to balloon-borne experiment, in particular long duration flight. Thus, the success of this project will surely ensure that the long duration flight observation with a 40cm-ETCC will advance a MEV gamma-ray astronomy.

【Publications Relevant to the Project】

・"MeV Gamma-Ray Imaging Detector with micro-TPC" T.Tanimori et al., New Astronomy Reviews 48 (2004) 263-268

・"The Observation of Diffuse Cosmic and Atmospheric Gamma Rays with an Electron-Tracking Compton Camera Loaded on a Balloon" A.Takada, et al., J. Phys. Soc. Jpn. 78 (2009) Supplement A pp. 161-164

【Term of Project】 FY2009-2013

【Budget Allocation】 161,500 Thousand Yen

【Homepage Address and Other Contact Information】

http://www-cr.scphys.kyoto-u.ac.jp/research/MeV-gamma/index.html