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Balloon-Borne Experiment for Deep Sky Survey of MeV Gamma Rays using an Electron-Tracking Compton Camera

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The observation of MeV celestial gamma rays provide us much information about various high energy phenomena. However, the sufficient observation has not yet been achieved due to the large radiation backgrounds and unclearness of Compton gamma-ray image.

To advance the MeV gamma-ray astronomy, we have developed an Electron-Tracking Compton Camera (ETCC) which consists of a gaseous Time Projection Chamber and pixel scintillator arrays. By measuring a three dimensional track of Compton recoil electron, we restrict the arrival direction of each incident photon to an arc segment. In addition, the energy loss rate of each track enables us to separate the Compton recoil electrons from background particles including neutrons efficiently. By these features, our ETCC has attained the higher-quality imaging and quite stronger background rejection than conventional MeV gamma-ray telescopes. Especially, the SPD angle, which is measured only from the direction of recoil electrons, reveals an excellent improvement of the contrast of image by a factor of >5. Thus, ETCC has resolved the above two obstacles for MeV astronomy.

To certificate the performance of an ETCC, we have carried out the balloon-borne experiments, "Sub-MeV gamma-ray Imaging Loaded-on-balloon Experiment" (SMILE) since 2006, and plan to observe the Crab and CygX-1 in 2016. The flight model of 30 cm-cubic ETCC was already completed, and several tests including the operation under the intense radiation condition by accelerator beams have been done. With the obtained results, the ETCC is expected to detect Crab Nebula with a significance of ~8 sigma level in several hours. By using the pressured CF4 based gas (3 atm), its detection efficiency will be increased one order, and we consider the long duration observation at the polar region for deep sky survey with a several times better sensitivity than COMPTEL.

Collaboration

– not specified –

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