

SMILE-2+: Balloon observation of electron-positron annihilation line gamma-ray in the galactic center region

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The observation of MeV gamma-ray is an important probe for searching the origin of matter because gamma-rays are emitted from the radioisotopes or the excited nuclei produced by nucleosynthesis in supernova or NS-NS merger. Recently there are not almost progress from COMPTEL launched in 1991. This reasons are the huge background and the difficulties of imaging of MeV gamma-ray. We are developing a new MeV gamma-ray telescope, a gaseous electron-tracking Compton camera (ETCC) which has the strong capabilities of the background rejection and an unambiguous imaging with the well-defined point spread function [1]. We are developing sub-MeV gamma-ray imaging loaded-on-balloon experiment 2+ (SMILE-2+) (Fig. 1) for the certification of the imaging spectroscopy in MeV region through the detection of bright sources by our telescope, an ETCC. The targets are Crab nebula and the electron-positron annihilation line from Galactic Center region. We launched SMILE-2+ balloon from Alice Springs, Australia on April 7, 2018. The flight duration time was 29 hours and we observed Crab nebula and Galactic Center for 5 hours and 8 hours, respectively. As the first result, we detect Crab nebula with a significance of 3σ via simple ON-OFF subtraction. Our result is consistent with an expectation from the ground calibration of SMILE-2+ ETCC. Additionally, we detect the annihilation line and the continuum component from the direction of the Galactic Center region with the significances of 5σ and 10σ , respectively (Fig. 2). In the future, we plan the observation with an improved ETCC loaded on a super pressure balloon or a satellite. The observation will enable us to detect and image MeV gamma-ray, e.g., the line gamma-ray emission from the radioactive decay of $^{56}\text{Ni}/^{56}\text{Co}$ produced by supernovae Ia. We could obtain the light curve for MeV gamma-rays for ~ 20 supernovae every year by the satellite ETCC [2].

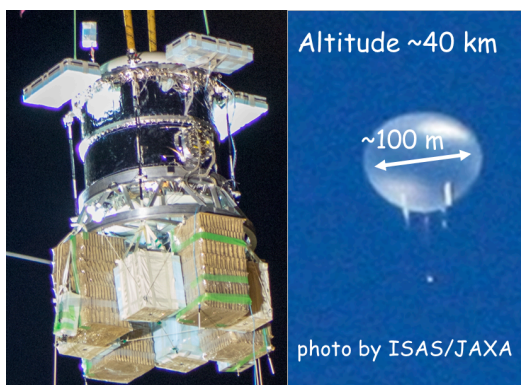


Figure 1. Pictures of a SMILE-2+ ETCC in flight configuration (left) and a balloon loading the ETCC (right)

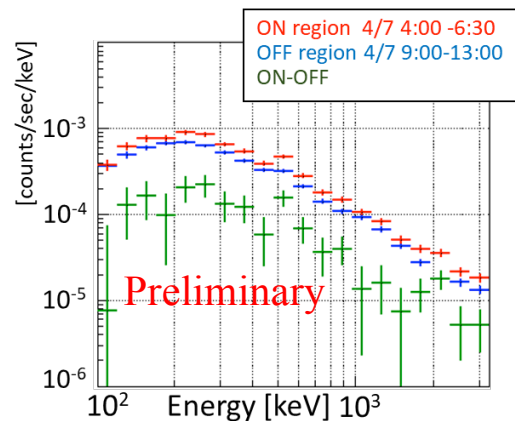


Figure 2. Energy spectra of SMILE-2+ observation of the Galactic Center region

- [1] T. Tanimori et al., The Astrophysical Journal, 810, 28, 2015.
[2] Y. Mizumura et al., arXiv:1805.07939