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East-West Effect of Cosmic Ray at 35 km Altitude in the GRAINE 2023 Balloon Experiment

GRAINE (Gamma-Ray Astro Imager with Nuclear Emulsion) is large-aperture-area observation project of cosmic gamma rays in the GeV/sub-GeV for precise by long balloon flights of the nuclear emulsion telescope. Nuclear emulsion is a charged particle detector with the highest spatial resolution based on the principle of silver halide photography. Due to the high spatial resolution (submicron) of the three-dimensional trajectory, the angular resolution of nuclear emulsion is close to the principle kinematical limit (0.1° for 1 GeV gamma rays, 1.0° for 100 MeV) and polarization information can also be provided as well. We have conducted the balloon experiments (2011, 2015, 2018) and succeeded in imaging the highest resolution of Vela Pulsar during the 2018 Australian balloon experiment. As a next step, we developed a telescope with a larger aperture area (6.5 times larger than in 2018) to 2.5 m^2 and performed a balloon experiment in Australia in April 2023. Furthermore, the altitude of the flight was 35-37 km, the flight time was 23.5 hours, 1.6 times longer than in 2018, and it succeeded in covered only the Vela Pulsar but also the galactic center.

The GRAINE telescope consists of three major parts: a converter, which detects γ -ray pair creation reactions by stacking 90 nuclear emulsion films; a timestamp, which adds time information to the tracks by moving the nuclear emulsion films at a time-specific period; and an attitude monitor, which determines the telescope's direction by taking star images. The arrival direction of a track on the celestial sphere can be determined by adding time information by timestamp and attitude information by attitude monitor to the track.

Since Nuclear emulsion records the tracks of all charged particles, many cosmic rays, not only those generated by γ -rays, are recorded in the flight data. We have attempted to directly measure the east-west effect at high flight altitude by analyzing mainly the minimum ionizing particles.

In this presentation, I report the current analysis of the GRAINE 2023 timestamp and attitude monitor, and the east-west effect observed in the flight data at an altitude of around 35 km.

Collaboration(s)

GRAINE

Author: Dr NAGAHARA, Shogo (Nagoya University, Institute of Materials and Systems for Sustainability)

Co-authors: Prof. IYONO, Atsushi (Okayama University of Science); GRAINE COLLABORATION (Kobe University, Nagoya University, Okayama University of Science, Gifu University, Aichi University of Education); Dr ROKUJO, Hiroki (Nagoya University); Mr YASUDA, Ibuki (Nagoya University); Mr USUDA, Ikuya (Nagoya University); Mr YAMASHITA, Jun (Kobe University); Prof. NAKAZAWA, Kazuma (Gifu University); Ms YAMASHITA, Mayu (Kobe University); Dr ODA, Miyuki (Kobe University); Dr TAKAHASHI, Satoru (Kobe University); Dr YAMAMOTO, Saya (Nagoya University); Prof. AOKI, Shigeki (Kobe University); Mr KATO, Takumi (Kobe University); Prof. NAKANO, Toshiyuki (Nagoya University); Mr ISAYAMA, Yudai (Nagoya University); Mr SUGI, Yuki (Okayama University of Science); Dr NAKAMURA, Yuya (Nagoya University)

Presenter: Dr NAGAHARA, Shogo (Nagoya University, Institute of Materials and Systems for Sustainability)

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