

Research Result Report

ICRR Inter-University Research Program 2025

Research Subject: Study of high-energy cosmic-ray at a high altitude in Tibet, China

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Summary of Research Result :

1. The Tibet AS+MD Array

- Gamma-ray halos above 100 TeV around Geminga were observed [1], and the properties of the surrounding magnetohydrodynamic (MHD) turbulence were investigated through the spatial extension of the emission. The results indicate that the diffusion coefficient of cosmic-ray electrons and positrons around Geminga is significantly smaller than the Galactic average, suggesting the presence of strong turbulent magnetic fields in the vicinity of the source. Furthermore, this turbulent environment suppresses the transport of high-energy electrons and plays an important role in the formation of the gamma-ray halo.

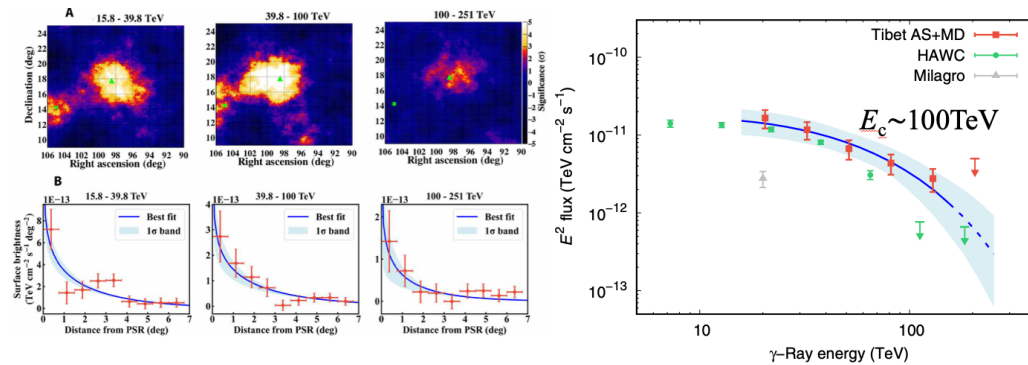


Figure 1. Energy dependence of the gamma-ray distribution around Geminga (left) and the energy spectrum (right).

- A convolutional neural network (CNN)-based method for gamma-ray and cosmic-ray event classification was experimentally verified using real observational data [2]. High-precision gamma/hadron separation was achieved using only air-shower array information, demonstrating an improvement in TeV gamma-ray observation sensitivity compared with conventional methods. The effectiveness of the method was confirmed using observational data from the direction of the Crab Nebula.
 - Based on the observation of sub-PeV diffuse gamma rays reported by the Tibet ASy experiment in 2021, the origin of Galactic gamma-ray emission was investigated [3]. In addition to PeVatron candidates such as supernova remnants and star-forming regions, the study evaluated contributions from Galactic diffuse emission by considering cosmic-ray propagation and interactions with molecular clouds.
2. The Tibet AS + YAC experiment
- The Tibet AS+YAC experiment aims to measure the energy spectra of cosmic-ray components in the knee region. The YAC-II array, consisting of 124 air-shower core (burst) detectors, is installed near the center of the Tibet Air Shower Observatory. In FY2014, the electronics and data acquisition system were completed, and YAC-II began observations focused on proton identification in knee-region cosmic rays. In FY2025, analysis software tools were further developed using Monte Carlo simulations.
3. International Conferences
- AIAC2025 (4/6 - 4/11 Santiago de Compostela, Spain) , ASTRONUM 2025(7/13-7/18,Madison, Wisconsin, USA), ICRC2025 (7/15– 7/24, Geneva, Switzerland), XVIII TAUP 2025 (8/24-8/30, Xichang, China), Total 8 presentations
4. Publications
- [1] M. Amenomori, et al., (Tibet ASy Collaboration), Constraining the magnetohydrodynamic turbulence around Geminga by observing the γ -ray halo beyond 100 TeV, Science Advances, 12, adv8173 (Mar. 2026)
- [2] M. Amenomori, et al., (Tibet ASy Collaboration), Experimental Verification of a Convolutional Neural Network Separation Method in TeV Gamma-Ray Observations by the Tibet ASy Experiment, Progress of Theoretical and Experimental Physics, 2025, id.103F01 (Oct. 2025)
- [3] Kato et al., A Discussion on the Origin of the Sub-PeV Galactic Gamma-Ray Emission, The Astrophysical Journal, Volume 984, id.98 (May 2025)