Research Report
ICRR Inter-University Research Program 2020

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

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Summary of Research Result :

1. Tibet AS + MD experiment

The Tibet-AS+MD experiment (Tibet Air shower array + Muon Detector array experiment), which aims to develop gamma-ray astronomy in the 100 TeV region (10-1000 TeV), has been actively done. In FY2020, we continued to develop a new software tool for data analysis. For the first time in the world, we succeeded in observing gamma-rays above 100 TeV from the region where the supernova remnant (G106.3+2.7) and the molecular cloud overlap (see Figures 1 and 2). The results are available in Nature Astronomy (2021), https://doi.org/10.1038/s41550-020-01294-9. Unfortunately, it is not possible to distinguish whether the gamma-rays are of electron or proton origin from the information in the energy spectrum alone. In addition, this result was press-released by IHEP, China and other institues. The HAWC experiment detected gamma rays up to 100 TeV a while ago, but it has not been able to distinguish whether the gamma rays are coming from the pulsar or the supernova remnant. The maximum acceleration energy of the proton is about 500 TeV, and the supernova remnant G106.3+2.7 is not powerful enough to be called a PeVatron today, but it is suggested to have been a PeVatron just after its birth, and is the most promising candidate for a PeVatron among the supernova remnants existing today.

2. Tibet AS + YAC experiment

The Tibet AS + YAC (Tibet air shower core detector array) experiment, which aims to

observe the energy spectrum of each particle component in the knee region cosmic rays, is being promoted. The Tibet air shower core detector array (YAC-II), which consists of 124 air shower core detectors [burst detectors], is installed near the center of the Tibet Air Shower Observatory. In FY2013, electronics and data acquisition software were implemented, and YAC-II, which focuses on proton discrimination in cosmic rays in the Knee energy region, started data acquisition. In FY2020, software tools for analysis were actively developed using Monte Carlo simulations.

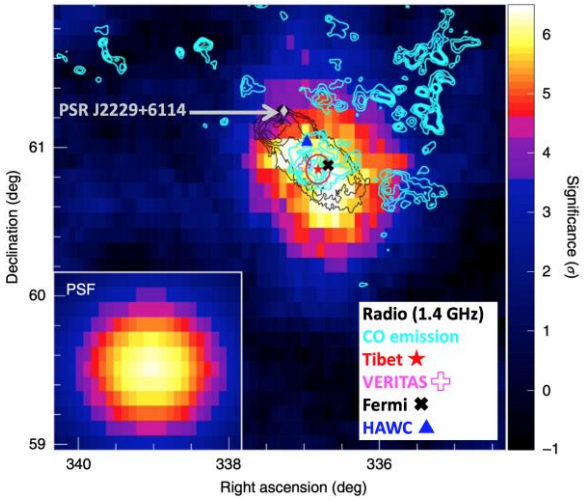

Fig. 1 Directional distribution (equatorial coordinates) of incoming gamma-rays above 10 TeV from the direction of G106.3+2.7 observed by the hybrid experiment of the Tibet air shower array and the underground muon detectors.

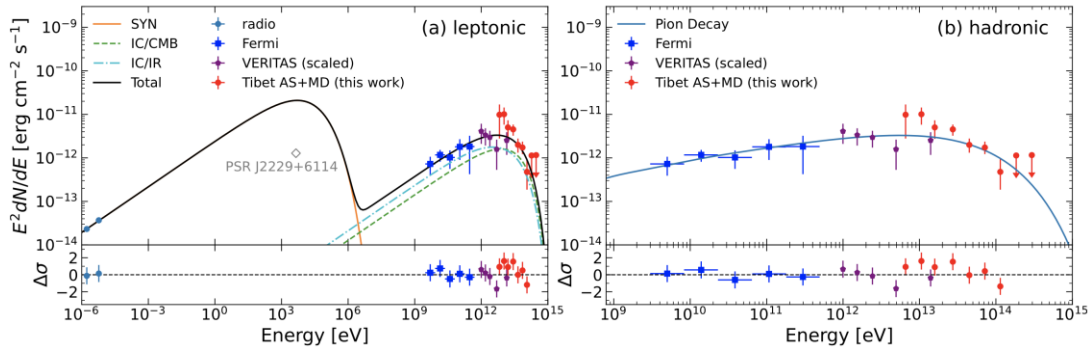

Fig. 2 Energy distribution of gamma rays from the direction G106.3+2.7 observed by the hybrid experiment of the Tibet air shower array and the underground muon detectors for (a): electron origin and for (b): proton origin, respectively.

3. International Conferences

1 presentation at “Connecting high-energy astroparticle physics for origins of cosmic rays and future perspectives”.

No.	