Observatory reveals key evidence of cosmic ray acceleration limit in W51 for first time

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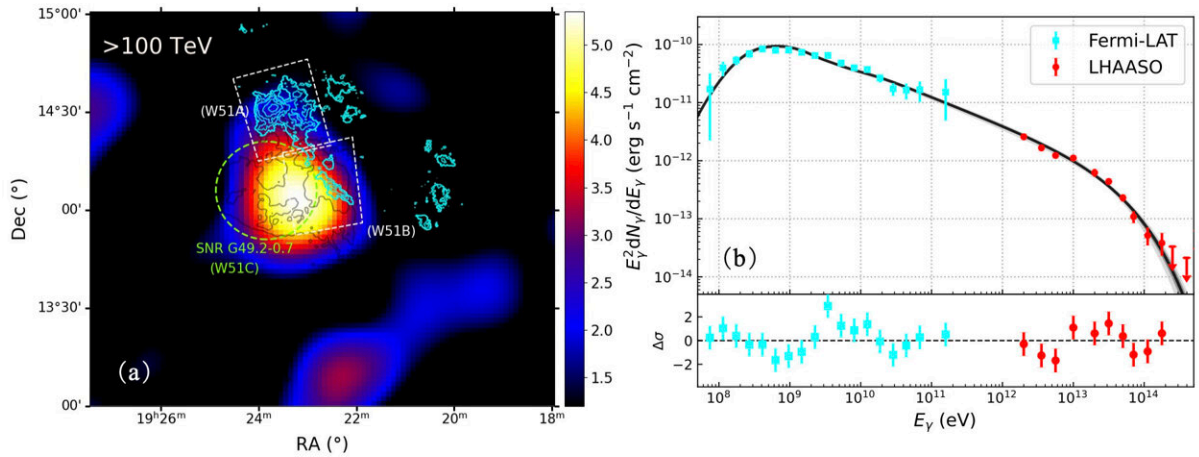

(a)The UHE gamma-ray emission is clearly observed from the W51 complex, which hosts the supernova remnant W51C and star forming region W51B. (b) The "bending" feature around tens TeV indicates the cosmic-ray acceleration limit in the W51 complex at around 400TeV. Credit: Science China Press

The Large High Altitude Air Shower Observatory (LHAASO) officially released the precise measurements of high-energy gamma radiation from the W51 complex, confirming it as a cosmic-ray accelerator boosting

particles up to so-called ultra-high energies (UHE, above 10^{14} electronvolts). The results also provide key evidence about the cosmic-ray acceleration limit in this complex.

The findings, titled "Evidence for particle acceleration approaching PeV energies in the W51 complex," were recently published online in *Science Bulletin*. The research was conducted by the LHAASO International Collaboration, led by the Institute of High Energy Physics, Chinese Academy of Sciences.

The W51 complex is one of the largest and the most active stellar factories in the Milky Way and one of the few regions confirmed to host GeV energy cosmic-ray accelerators. It plays a crucial role in unraveling the century-old mystery of the origin of cosmic rays.

Researchers utilized data from the LHAASO experiment to, for the first time, extend the measurements of the energy spectrum of gamma-rays from this region to the UHE range. They clearly observed a bending structure in the gamma-ray spectrum at tens of TeV, indicating the acceleration limit of cosmic rays in this region.

The energy spectrum measured by LHAASO can be smoothly connected with that which was measured by the Fermi-LAT collaboration at lower energies. Spanning six orders of magnitude of gamma-ray energy, the spectrum provides important evidence that the radiation originates from collisions between cosmic rays and molecular clouds. It also indicates that the W51 complex has a cosmic-ray acceleration limit of around 400 TeV.

"The supernova remnant W51C, located in the W51 complex, is the most plausible cosmic-ray accelerator responsible for the wideband gamma-ray emission," Prof. Li Zhe said, one of the co-corresponding authors.

LHAASO is a national major science and technology infrastructure located on Haizi Mountain at an altitude of 4,410 meters in Daocheng, Sichuan province, China. It consists of an array of 5,216 electromagnetic particle detectors and 1,188 muon detectors distributed over 1 km^2, a water Cherenkov detector array covering 78,000 m^2 and an array of 18 wide-field-of-view Cherenkov telescopes.

LHAASO was completed and began high-quality stable operation in July 2021. It is the most sensitive UHE gamma-ray detection device in the world, characterized by the large field of view and all-weather capability.

More information: Zhen Cao et al, Evidence for particle acceleration approaching PeV energies in the W51 complex, *Science Bulletin* (2024). DOI: 10.1016/j.scib.2024.07.017

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