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High-Energy Gamma-Ray Astronomy: Breakthroughs and Future Prospects from Space- and Ground-Based Observations

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Over the past two decades, high-energy gamma-ray astronomy has witnessed revolutionary progress driven by both space- and ground-based observations. Space-borne detectors, epitomized by the Fermi Large Area Telescope (Fermi-LAT), and ground-based facilities, including Imaging Atmospheric Cherenkov Telescopes (IACTs: H.E.S.S., MAGIC, VERITAS) and Extensive Air Shower (EAS) arrays (Tibet ASγ, HAWC), particularly the groundbreaking LHAASO, have dramatically expanded our observational window. This now encompasses the high-energy (HE), very-high-energy (VHE), and ultra-high-energy (UHE) gamma-ray regimes. These observatories have yielded a series of landmark achievements, profoundly transforming our understanding of non-thermal high-energy processes in the Universe and significantly advancing frontiers in particle astrophysics (such as dark matter, cosmic-ray origins, and extreme physics). This talk will systematically review the key technical characteristics and operational status of these major facilities. It will highlight their recent pivotal discoveries (e.g., the confirmation of Galactic PeVatrons), elaborate on their contributions to addressing core scientific questions in particle astrophysics, and conclude with an outlook on future directions in detection technology and scientific research.

Collaboration you are representing

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