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Unlocking the Non-Thermal Universe: Future Gamma-Ray Discoveries with CTAO

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The Cherenkov Telescope Array Observatory (CTAO) will be the world's first open, ground-based gamma-ray observatory, offering full-sky coverage through two sites —the Northern site at the Observatorio Roque de los Muchachos (La Palma, Spain), and the Southern site at the ESO Observatorio Paranal (Chile). Designed for a 30-year operation, CTAO will deliver groundbreaking insights across a wide range of topics —from cosmic rays acceleration process, to the nature of extreme astrophysical environments, and probes of fundamental physics. CTAO will significantly surpass the sensitivity, angular resolution, and energy coverage of current imaging Cherenkov telescope arrays. The Large-Sized Telescope 1 (LST-1), operational since 2018, is hinting full CTAO array capabilities through early results on gamma-ray bursts (GRBs), active galactic nuclei (AGNs), pulsars, and novae. Once the full array is operational, CTAO will cover an energy range from 20 GeV to 300 TeV with unprecedented precision.

This contribution presents an update on the status of the CTAO project and outlines its broad scientific capabilities. Special attention will be given to its performance in the time multi-messenger domain. CTAO's design enables rapid slewing, a large effective collecting area, and high temporal resolution, uniquely positioning the observatory to capture fast transients and respond in real time to multi-messenger events. Its role in time-domain, multi-wavelength, and multi-messenger astrophysics will be crucial to unlocking the dynamic, non-thermal universe.

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