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Bridging Gravitational Waves and High-Energy Gamma Rays: Searching for sGRB Afterglows from Compact Binary Coalescences with CTAO

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A complete understanding of compact binary coalescences requires combining gravitational wave (GW) observations with broadband electromagnetic data. The detection of GeV-TeV gamma rays will be crucial for probing the acceleration processes and environments near compact object mergers. The binary neutron star (BNS) merger GW170817 provided the first direct evidence that BNS mergers are progenitors of short gamma-ray bursts (sGRBs) with the detection of its electromagnetic counterpart. We present our approach to establish the prospects on binary neutron star (BNS) mergers that emit GeV-TeV gamma rays and are detectable by the Cherenkov Telescope Array Observatory (CTAO). With its unparalleled sensitivity, broad energy coverage (20 GeV - 300 TeV), and rapid slewing capabilities, CTAO is uniquely positioned to play a key role in these searches. Using simulations of CTAO's response to phenomenological models describing sGRB afterglows associated with GW events, we address the challenge of large source localization uncertainties through a real-time strategy designed to coordinate searches over vast sky regions. We optimize potential multi-site follow-up strategies and provide an estimate of the number of joint sGRB-GW events from BNS mergers that CTAO could detect during future LIGO-Virgo-KAGRA (LVK) observing run O5. In addition, our study aims to maximize the scientific return of CTAO observations by examining how key physical parameters—such as jet opening angle, luminosity, distance, and off-axis viewing angle—change the gamma-ray emission and the detection prospects.

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