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Pre-merger alert to detect the very-high-energy prompt emission from binary neutron-star mergers: Einstein Telescope and Cherenkov Telescope Array synergy

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The Einstein Telescope (ET), the third generation of gravitational wave detector is aimed at advancing multi-messenger astrophysics with strong synergy between current and future generation electromagnetic follow-up facilities, focusing mainly on the transients. Typically, the prompt emission from Gamma-ray bursts (GRBs) is observed within the 10 keV-10 MeV spectrum. However, detection at higher energies remains challenging. Although current very-high-energy (VHE; E > 30 GeV) gamma-ray detectors, such as MAGIC and H.E.S.S., have successfully detected GRB afterglows, the prompt detection phase has yet to be explored. This study explores the potential of multi-messenger observations to capture the prompt emission of short GRBs at TeV energies. Assuming binary neutron star mergers as progenitors of short GRBs, we assess the combined detection efficiency of the Cherenkov Telescope Array Observatory (CTAO) in conjunction with third-generation gravitational wave detectors. Our evaluation considers the capabilities of these facilities to detect and localize gravitational wave events already during the inspiral phase and issue early alerts to discover the prompt VHE emission. We show that the sensitivity of CTAO will make the detection of VHE emission feasible even if the emission is significantly fainter than that observed in the 10 keV–10 MeV range with telescopes such as Fermi/GBM. We discuss the implications within potential scenarios for prompt VHE counterparts of binary neutron star mergers, such as synchrotron self-Compton components within the leptonic framework, high-energy extensions of the hadronic GRB model, and external inverse Compton emission.

Collaboration(s)

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