W41a Very-high-energy gamma-rays from binary neutron star mergers

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The joint detection of GW170817 and a short GRB has provided the first direct evidence that at least some binary neutron star (BNS) mergers produce short GRBs. Recently, very-high-energy (VHE, > 0.1 TeV) photons are detected from several GRBs for the first time (e.g. GRB 190114C) and suggest synchrotron self-Compton (SSC) process as distinct emission mechanism. The VHE detection prospects of BNS mergers in the future gravitational-wave (GW) follow-up observations is encouraged by the upcoming operation of the Cherenkov Telescope Array (CTA) owing to its unprecedented sensitivity and rapid response.

In this study, we systematically develop a framework to evaluate GW, VHE and joint detectability of multi-messenger objects based on population models. We model detectability of BNS mergers via modeling SSC process in a relativistic structured jet, in contrast to previous predictions that are solely based on phenomenological extension of high energy spectra of observed short GRBs. We report the expected distributions and Malmquist bias of observables (distance, orientation, burst energies and ambient densities) for future events, and evaluate CTA' s capability of detecting BNS mergers in various observational scenarios.