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Multi-messenger observations in the Einstein Telescope era: binary neutron star and black hole - neutron star mergers

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The Einstein Telescope (ET) will extend the reach of gravitational wave (GW) astronomy for stellar-mass compact binaries to unprecedented distances, significantly enhancing opportunities for multi-messenger discovery. Building on the landmark observations of GW170817 and informed by our recent population modeling studies (Colombo et al. 2022, 2024), we investigate the prospects for detecting and characterizing electromagnetic (EM) counterparts to binary neutron star (BNS) and black hole–neutron star (BHNS) mergers with ET. Using a synthetic cosmological population of BNS and BHNS systems, we simulate GW signal-to-noise ratios, sky localization uncertainties, and multi-wavelength EM signatures—including kilonovae, short gamma-ray bursts prompt and afterglows spanning radio to very high-energy bands. We evaluate the multi-messenger yield of ET under various detector configurations, both standalone and within a global network, and quantify the impact of key astrophysical uncertainties, such as the neutron star equation of state and compact object mass distributions. This talk will present our latest projections for the ET era, outlining the transformative scientific potential and the strategic challenges facing multi-messenger astronomy in the next decade.

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