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BNS mergers as multi-messenger sources: end-to-end numerical modeling in preparation for the ET era

The advent of the Einstein Telescope (ET) will revolutionize our understanding of binary neutron star (BNS) mergers, with a huge number of gravitational wave (GW) detections expected every year, spanning about 10 billion years of cosmic history. As demonstrated by the GW170817 event, the greatest scientific potential is held by multi-messenger observations combining the GW signal with the prompt and afterglow emission from a gamma-ray burst (GRB) jet, and, for nearby events (within redshift 0.5), the radioactively-powered kilonova (KN).
Current understanding of an event like GW170817 is however limited by the lack of a unified theoretical framework directly connecting a specific BNS merger and corresponding GW emission with the emerging relativistic jet piercing through the post-merger environment and ultimately powering the GRB. As a consequence, also the KN is typically modeled without taking into account the strong constraints coming from the GRB-related signals. To fully leverage the opportunities offered by ET in this context, it is necessary to build such a unified theoretical framework.
In this talk, I will discuss recent progress in developing a consistent end-to-end description by combining numerical simulations that encompass very different scales, from the merger process itself to the production of an incipient jet piercing through the post-merger environment and its propagation up to the scales relevant for shaping the associated electromagnetic emission.

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