

Multi-Messenger Astrophysics and Cosmology with next-generation GRB missions

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The huge luminosity, the redshift distribution extending at least up to $z \sim 10$ and the association with the explosive death of very massive stars make long GRBs extremely powerful probes for investigating the early Universe (pop-III stars, cosmic re-ionization, SFR and metallicity evolution up to the “cosmic dawn”) and measuring cosmological parameters. At the same time, as demonstrated by the GW170817 event, short GRBs are the most prominent electromagnetic counterpart of gravitational-wave sources like NS-NS and NS-BH merging events, and both long and short GRBs are expected to be associated with neutrino emission. Moreover, the combination of extreme distances, huge number of photons emitted over wide photon energy range and the variability down to few ms makes these phenomena a promising tool for performing tests of fundamental physics like Lorentz Invariance Violation (LIV). My review will include the status, concepts and expected performances of space mission projects (e.g. THESEUS) aiming at fully exploiting these unique potentialities of the GRB phenomenon, thus providing an ideal synergy with the large e.m. facilities of the future like LSST, ELT, TMT, SKA, CTA, ATHENA in the e.m. domain, advanced second generation (2G++) and third generation (3G) GW detectors and future large neutrino detectors (e.g., Km3NET)

Primary author: AMATI, Lorenzo (INAF - OAS Bologna)

Presenter: AMATI, Lorenzo (INAF - OAS Bologna)

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