Multi-messenger detection prospects and follow-up strategies for binary compact object mergers

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Abstract

The binary neutron star merger GW170817 inaugurated the era of multi-messenger gravitational-wave astronomy. The follow-up of this inspiral signal revealed a rich set of electromagnetic counterparts: a short-hard gamma-ray burst, a kilonova optical transient, and a long-lived multi-wavelength afterglow. The significant progress in many fields of astrophysics and cosmology that this single event enabled proved the strong scientific potential of multi-messenger datasets. However, notwithstanding the intense effort in following-up other neutron-star merger gravitational-wave signals, the lucky GW170817 remains the only event with an astrophysically relevant multi-messenger dataset. Indeed, the subsequent gravitational-wave triggers revealed the severe challenges facing their electromagnetic follow-up: the large skymaps to cover in search for the astronomical transients, the rapid fading and dimness of these transients as the interferometers trigger on sources at larger distances, and the many unrelated transients that pollute the searches. These challenges motivate a three-fold effort: first, to accurately model the electromagnetic signals; second, to make realistic predictions of the signals to expect in observing campaigns by carrying out population studies of the sources that factor in the actual capabilities of the electromagnetic and gravitational-wave instruments; third, to tailor the stategies deployed during follow-up in light of these predictions to optimise the outcome of upcoming campaigns. I will review the recent developments in multi-messenger population studies of neutron-star mergers and in follow-up strategies targetting the second- (current) and third-generation gravitational-wave interferometers.