



Canadian Association
of Physicists

Association canadienne
des physiciens et physiciennes

Contribution ID: 124

Type: **Invited Speaker** / **Conférencier(ère) invité(e)**

Multi-messenger modeling of isolated neutron star binary mergers in the era of third generation gravitational-wave detectors

Wednesday 11 June 2025 11:15 (30 minutes)

Multi-messenger astronomy was revolutionized by the detections of gravitational waves (GW) from the binary neutron star (BNS) merger GW170817 and electromagnetic (EM) waves from the resultant kilonova explosion and short gamma ray burst. This single event confirmed the association of the latter two EM signals with BNS mergers, and the possibility of a kilonova remnant, analogous to a supernova remnant, has motivated studies of the late-stage evolution of the system. Together, these processes and phenomena form a multi-messenger nexus which places independent but astrophysically relatable constraints on the progenitors and products of BNS mergers. Simultaneously, GW170817 helped initiate new observational and theoretical strategies in anticipation of future GW and EM detectors, whose unprecedented sensitivities will illuminate the uncertain physics of BNS mergers and their progenitors. This implies a great demand for the development of comprehensive modeling frameworks that account for multiple scales and processes relevant for many multi-messenger observables. We demonstrate how combining currently available models of different aspects of the BNS progenitor-merger-product system reveals insights and modeling challenges that will need to be addressed in the coming decade of multi-messenger astronomy. Motivated by GW170817, this combined model relates the progenitor astrophysics of a BNS population with their (i) GW observability and localizability, (ii) kilonovae and GRB afterglows, and (iii) kilonovae remnants. We find that a network composed of at least three 40km gravitational wave detectors will be needed for optimal multi-messenger constraints; and that joint correlations between the GW and EM observables depend on a complicated interplay between modeling assumptions. We conclude with discussion on key astrophysical modeling systematics that will be crucial in the analysis of future datasets.

Keyword-1

Multi-messenger astronomy

Keyword-2

Black holes

Keyword-3

Gravitational waves

Author: Dr STEINLE, Nathan (University of Manitoba)

Co-authors: Prof. SAFI-HARB, Samar (University of Manitoba); Prof. NICHOLL, Matt (Queen's University)

Belfast); WORSSAM, Isabelle (University of Birmingham); Prof. GOMPERTZ, Benjamin (University of Birmingham)

Presenter: Dr STEINLE, Nathan (University of Manitoba)

Session Classification: (DTP) W1-5 Hot Topics in Theoretical Physics | Sujets d'actualité en physique théorique (DPT)

Track Classification: Symposia Day (Wed June 11) / Journée de symposiums (Mercredi 11 juin): Symposia Day (DTP - DPT) - Hot Topics in Theoretical Physics / Sujets d'actualité en physique théorique