



Canadian Association
of Physicists

Association canadienne
des physiciens et physiciennes

Contribution ID: 3887 Type: Oral Competition (Graduate Student) / Compétition orale (Étudiant(e) du 2e ou 3e cycle)

(G*) A Complex Window-Based Joint-Chirp-Rate-Time-Frequency Transform for BBH Merger Gravitational Wave Signal Detection

Wednesday 21 June 2023 15:00 (15 minutes)

Low-latency detection of Binary Black Hole (BBH) and Binary Neutron Star (BNS) merger Gravitational Wave (GW) signals is essential for enabling multi-messenger observations of such systems. The merger GW signals have changing frequencies and are contaminated by non-stationary noises. Earlier studies of non-templated merger signal detection techniques used traditional Fourier transform-based time-frequency decomposition methods for spectrogram generation, which have had difficulties identifying rapid frequency changes in merger signals with heavy background noise. To address the problem, we introduce the Joint-Chirp-rate-Time-Frequency Transform (JCTFT), in which complex-valued window functions are used to modulate the amplitude, frequency, and phase of the input signal. In addition, we outline the techniques for generating chirp-rate-enhanced time-frequency spectrograms from the results of a JCTFT. We demonstrate an average of 14% improved merger detectability among simulated detector signals with Signal-to-Noise Ratios between 6 and 10 using the InceptionV3 image classification neural network when compared to the same network trained with Q-transform spectrograms. The JCTFT is a general transformation technique that can be applied to existing and third-generation GW detector signals. We aim to analyze the characteristics of the complex window functions through the study of the Wigner distribution and the Fresnel functions.

Keyword-1

Gravitational Waves

Keyword-2

Fourier Transform

Keyword-3

Binary Black Hole Merger

Authors: LI, Xiyuan (Department of Physics and Astronomy, University of Western Ontario); Prof. HOUDE, Martin (Department of Physics and Astronomy, University of Western Ontario); Mr MOHANTY, Jignesh (Department of Physics, Indian Institute of Technology Kanpur); Prof. VALLURI, Sree Ram (Department of Physics and Astronomy, University of Western Ontario)

Presenter: LI, Xiyuan (Department of Physics and Astronomy, University of Western Ontario)

Session Classification: (DTP/DNP/PPD) W2-4 Advances in Nuclear and Particle Theory | Progrès dans la théorie nucléaire et la théorie des particules (DPT/DPN/PPD)

Track Classification: Technical Sessions / Sessions techniques: Theoretical Physics / Physique théorique (DTP-DPT)