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QUANTUM COMPUTING AND LIGO

Abstract

The Laser Interferometer Gravitational-Wave Observatory (LIGO) is a set of global observatories that were developed to detect the presence of gravitational waves predicted by Einstein's General Theory of Relativity. Gravitational waves are the ripples in the space-time fabric which are generated by any accelerating mass, but the ripples from smaller mass objects fade away due to very low frequency and the energy loss in propagation. The first gravitational waves - GW150914; were detected by the LIGO because the waves generated were the result of ripples set up by the merger of two massive black holes. These gravitational waves had sufficient energy to propagate to the detectors. The gravitational waves generated contain very crucial information regarding their source. The paper proposes an effective use of quantum computational methods to optimize the data acquired by the LIGO detectors across the globe. The development of Noisy Intermediate-Scale Quantum (NISQ) devices is a great opportunity to apply Quantum Technologies (QT) in the LIGO detectors as it will help to effectively analyze the obtained data and distinguish between the different sources for generation of gravitational waves. The proposed method aims towards distinguishing between various types of gravitational wave sources like a Binary Black Hole (BBH), a Binary Neutron Star or a pair of a neutron star and a black hole. The paper elegantly introduces the idea of integration of Quantum Computing techniques and LIGO detectors for efficient gravitational wave detection. The idea can further be extended to future projects under LIGO, like the Laser Interferometer Space Antenna (LISA) which can detect very faint gravitational waves from many smaller sources like supernovae, giant stars or a binary star system. The concept may bring one closer to detect the gravitational waves generated from the Big Bang and their correlation with the Cosmic Microwave Background (CMB).