DESCRIPTION FOR THE GENERAL PUBLIC

This project is proposed to explore the new physics beyond Einstein's general relativity and the new physics beyond standard model in particle physics through the new window of gravitational waves astronomy.

The first detection of gravitational waves from the merger of a pair of black holes by the aLIGO/Virgo collaboration on September 2015, one century after the fundamental predictions of Einstein, is a milestone event in the gravitational waves astronomy, and a breakthrough in the field of compact star astrophysics study. Several more observations were made in the next two years after the first gravitational waves detection, including the one from binary neutron star merger. This signal was observed by the LIGO and Virgo detectors on August 2017, of which electromagnetic waves counterpart was also detected by more than 70 observatories on seven continents and in space, across the electromagnetic spectrum, marking a significant breakthrough for multi-messenger astronomy. These observations have opened up a new window towards our universe. The potential of gravitational waves detection to improve our understanding on the fundamental physics of our universe, is comparable to the one of the CMB at its dawn, which marked the beginning of modern cosmology.

One thing we can do with gravitational wave astronomy is to test gravity theories. Gravity still remains the most mysterious among the four fundamental forces. Experimentally, we do not know gravity's properties and behaviors at the microscopic scale and cosmological scale. Theoretically, a consistent quantum gravity theory has never been achieved. Many attempts have been made to go beyond Einstein’s general relativity. Thanks to the gravitational wave as well as the electromagnetic counterpart observations, we are able to discriminate, constrain and even rule out many theoretical candidates at the level of very high accuracy.

On the other hand, the gravitational waves from the merger of a pair of black holes provide unique access to the properties of space-time at extreme curvatures: the strong-field and high-velocity regime. It may provide us some important evidences of quantum gravity. One of possible evidences of quantum gravity is the echo of gravitational waves from the black hole. We aim to analyze the gravitational wave signals, try to find the evidences of the gravitational wave echoes.

Last but not least, the gravitational wave observations also allow us to test the standard model of big bang cosmology, including its current expansion rate, the properties of dark energy, and even the fundamental physics that governed the very early stage of our universe. These studies will greatly improve our understanding of our universe, and thus profound impacts are well expected.