Talk-13

A method to measure a relative transverse velocity of a source-lens-observer system using gravitational lensing of gravitational waves

Yousuke Itoh
Tohoku University

Abstract

The gravitational wave (GW) detectors such as LIGO in U.S. have attained its pre designed sensitivity recently. The next generation detectors such as advanced LIGO are expected to detect several relativistic compact stars binary merger events out to ~ 200 Mpc. Furthermore, planned space-borne gravitational wave antennas such as LISA, BBO, DECIGO would see ringing-down super-massive black holes sitting at AGN centers for example, extragalactic relativistic compact stars binaries out to the redshift z ~ 1-3, and Galactic white dwarf binaries, etc. We will see gravitational wave astronomy near future.

The technological achievements mentioned above must go with theoretical development with which we learn physics from observation. In this work we study gravitational lens of gravitational waves.

Gravitational waves propagate along null geodesics like light rays in the geometrical optics approximation, and they may have a chance to suffer from gravitational lensing by intervening objects, as is the case for electromagnetic waves. Long wavelengths of gravitational waves and compactness of possible sources may enable us to extract information in interference pattern. We point out that the interference term contains information of relative transverse velocity of the source-lens-observer system at a cosmological distance, which may be obtained by possible future space-borne gravitational wave detectors such as BBO/DECIGO. The distribution of transverse velocities of relativistic compact binaries is highly unknown observationally. Such a distribution, when available, would tell us how relativistic compact binaries are born, namely we could study kick velocities in binaries and asymmetric nature of super-nova explosions from it.