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Generation, propagation and detection of gravitational waves in inhomogeneous universe

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In this talk, we shall present our recent studies on gravitational waves (GWs) produced by remote compact astrophysical sources. To describe such GWs properly, we introduce three scales, the typical wavelength of GWs, the scale of the cosmological perturbations, and the size of the observable universe. For GWs to be detected by the current and foreseeable detectors, we show that such GWs can be well approximated as high-frequency GWs. To simplify the field equations, we show that the spatial, traceless, and Lorentz gauge conditions can be imposed simultaneously, even when the background is not vacuum, as long as the high-frequency GW approximation is valid. Applying the general formulas we develop together with the geometrical optics approximation to such GWs, among several other things, we calculate the gravitational integrated Sachs-Wolfe effects due to the presence of the cosmological scalar and tensor perturbations, whereby the dependences of the amplitude, phase and luminosity distance of the GWs on these two kinds of perturbations are read out explicitly.

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