U06a Extracting parity-violating gravitational waves from projected tidal force tensor

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Gravitational waves (GWs) may be produced by various mechanisms in the early universe. In particular, if parity is violated, it may lead to the production of parity-violating GWs. In this talk, we focus on GWs on the scale of the large-scale structure. Since GWs induce tidal deformations of the shape of galaxies, one can extract such GW signals by observing images of galaxies in galaxy surveys. Conventionally the detection of such signals is discussed by considering the three-dimensional power spectra of the E/B-modes. Here, we develop a complementary new technique to estimate the contribution of GWs to the tidal force tensor field projected on the celestial sphere, which is a directly observable quantity. We introduce two two-dimensional vector fields constructed by taking the divergence and curl of the projected tidal field in three dimensions. Their auto-correlation functions naturally contain contributions of the scalar-type tidal field. However, we find that the divergence of the curl of the projected tidal field, which is a pseudo-scalar quantity, is free from the scalar contribution and thus enables us to extract GW signals. We also find that we can detect parity-violating signals in the GWs by observing the nonzero cross-correlation between the divergence of the projected tidal field and the curl of it. It roughly corresponds to measuring the cross-power spectrum of E and B-modes, but these are complementary to each other in the sense that our estimator can be naturally defined locally in position space. Finally, we present expressions of the correlation functions in the form of Fourier integrals and discuss the properties of the kernels specific to the GW case, namely the overlap reduction function.