論文の内容の要旨

Super-sample tidal effect on cosmological distortions

(超長波長スケールの潮汐力場が宇宙論的歪みに与える影響)

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Although large-scale perturbations beyond a finite-volume survey region, called “super-sample modes”, are not direct observables, these affect measurements of clustering statistics of small-scale (sub-survey) perturbations in the large-scale structure, compared with the ensemble average, via the mode-coupling effect. In this thesis we show that large-scale tides (super-sample tidal modes) induced by scalar perturbations cause apparent anisotropic distortions in the observed power spectrum of galaxies. Using the perturbation theory of structure formation, we derive a response function of the power spectrum to large-scale tides. In particular, we find that large-scale tides violates the statistical isotropy in the observed power spectrum and in the redshift-space power spectrum of galaxies this anisotropy depends on an alignment between the tide, wavevector of small-scale modes, and line-of-sight direction. We then quantify the impact of large-scale tides on estimation of cosmological distances (Alcock-Paczyński test) and the redshift-space distortion (RSD) parameter via the measured redshift-space power spectrum for a hypothetical large-volume survey, based on the Fisher information matrix formalism. We show that a degradation in the parameter estimation of cosmological distortions is restored if we employ the prior on the rms amplitude expected for the standard ΛCDM model. We also discuss whether the super-sample tidal modes can be constrained and find that the super-sample tides are detectable with an accuracy better than the ΛCDM prediction without impairing the accuracy of measurements of other cosmological distortions by using bipolar spherical harmonic (BipoSH) decomposition formalism to characterize statistically anisotropic power spectra. In addition, we develop the cosmological N-body simulation with the super-sample tidal modes to study effects of the large-scale tides on nonlinear structure formation in deeply nonlinear regime where the perturbation theory breaks down.