これまでの研究成果（英訳）

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Cosmological Principle which states "*our universe is spatially isotropic and homogeneous on large scales*" is the most fundamental working hypothesis in modern cosmology. As long as we assume a homogeneous and isotropic universe model, recent observations indicate an acceleration of the cosmic volume expansion. This implies the existence of Dark Energy that acts as a source of a repulsive gravitational force. However, there seems to be no satisfactory theory that can naturally explain the existence or the abundance of dark energy. By contrast, the inhomogeneous universe model that relinquishes homogeneity of the universe at cosmological scales may explain the observations without introducing dark energy, and have gathered much attention in recent years. In order to develop observational tests of the inhomogeneous universe model, we have studied cosmic structure formation in the model as follows.

1. Analysis of perturbations in the inhomogeneous universe model

We studied growth of density perturbations in the inhomogeneous universe model based on relativistic perturbation theory. It is known that perturbation equations in the inhomogeneous universe model are hard to solve analytically, since the background spacetime has less isometries. To avoid the difficulty, we focused on an inhomogeneous universe model of which radial inhomogeneity is small, and treated it as an isotropic linear perturbation around a homogeneous and isotropic universe. In this case, linear perturbation equations in an inhomogeneous model can be reduced to nonlinear perturbation equations in a homogeneous and isotropic universe. We solved the reduced equations order by order, and obtained density perturbations up to the second order around a homogeneous and isotropic universe. Then we showed that effects of the large scale inhomogeneity of the background to the density perturbations significantly appear at the second order of the expansion.

2. Two-point correlation functions of density perturbations in the inhomogeneous universe model

In order to clarify a stochastic property of perturbations, we derived two-point correlation functions of density perturbations in the inhomogeneous universe model. By computing the derived two-point correlation function, we showed that it has a distortion (local anisotropy) due to the existence of tidal fields in the inhomogeneous universe model. Since no tidal force exists in the standard homogeneous and isotropic universe models, our result suggests that we can test the inhomogeneous universe model by observing a statistical distortion of the galaxy distribution.

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