平成 29 年度大阪市立大学数学研究所 専任研究所員 ：申請書

研究計画の要旨（英訳）

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研究課題名	Ultra large scale structure of the Universe

The standard model of the modern cosmology can explain all current observational result, but the assumption of the modern cosmology that the universe is homogeneous and isotropic on large scales is not observationally confirmed yet. The isotropy of the universe is confirmed from the observation of the cosmic microwave background radiation(CMBR). However, the homogeneity of the universe is not confirmed. This is because, the observable domain is restricted mainly to the null hypersurface generated by past directed null geodesics emanated from the observer. Thus, there is a possibility that there are non-negligible large-scale inhomogeneities in our universe. Observational verification of the homogeneity of the universe is becoming possible with the development of observation technology in recent years, and it is important to study the inhomogeneous isotropic universe model. Until now, observables which do not require analysis of perturbation theory have been studied in the study of the inhomogeneous isotropic universe model, for example the distance-redshift relation and the peak position and height of the angular power spectrum of CMBR. This is because the perturbation theory in the inhomogeneous isotropic universe model is more difficult than the FLRW universe model, since the symmetry of the inhomogeneous isotropic universe model is lower than that of the FLRW universe model. However, the perturbation theory is important to calculate various observables. In recent years, the method of the perturbation calculation in the inhomogeneous isotropic universe model have been established by Nishikawa et al.(PhysRevD.85:103511), Meyer et al.(JCAP 1503 (2015) 03, 053) and so on. Nishikawa et al. and Meert et al. have studied the effect of the ultra large scale structure on the inhomogeneous anisotropic density fluctuation, I have studied that the gravitational wave produced from the density fluctuation in the inhomogeneous isotropic universe model. In order to restrict the amplitude of the ultra large scale structure, it is important to develop the perturbation theory in the inhomogeneous isotropic universe model, calculate observables and compare it with observational data.

In this study, we use the method of calculating perturbations in the inhomogeneous isotropic universe model proposed by Nishikawa et al., i.e., the inhomogeneous isotropic universe model is described as the FLRW universe model with isotropic perturbations, and we add inhomogeneous anisotropic perturbations to this universe model. This method is valid, if the amplitude of the ultra large scale structure is small.

I have studied the power spectrum and the energy density of the gravitational wave produced from the inhomogeneous anisotropic density fluctuation, but it is important to observe this gravitational wave to restrict the amplitude of the ultra large scale structure. In this study, we investigate observables that can capture this gravitational wave. If we observe this gravitational wave, we can restrict the amplitude of the ultra large scale structure.

It is known that a current due to the Compton scattering of photons and electrons creates the magnetic field by considering effects of second order perturbations in the FLRW universe model. It is expected that the Compton scattering of inhomogeneous isotropic photons (or electrons) fluctuation and inhomogeneous anisotropic electrons (or photons) fluctuation creates the magnetic field, if there is the ultra large scale structure in our universe. In other words, it is expected that a current due to the Compton scattering of photons and electrons creates the magnetic field by considering effects of linear perturbations in the inhomogeneous isotropic universe model. In this study, we calculate movements of electrons in the inhomogeneous isotropic universe model, and we investigate the magnetic field created by the Compton scattering. Since it is expected that this magnetic field exists in the universe on large scales, observing the magnetic field in a place where the astronomical activity is inactive tell us the amplitude of this magnetic field, and we may restrict the amplitude of the ultra large scale structure.