U08b 非一様宇宙における光度距離と赤方偏移の関係

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For a long time, we have regarded that a FRW model as a large-scale "average" of a locally inhomogeneous universe. Even though the observational data are consistent with the picture that our universe is described well by a FRW metric with small inhomogeneities of gravitational potential on it, we are not sure how to derive a background FRW model from the inhomogeneous universe by any "averaging" procedure. This remains a non-trivial question to which we have to give a clear answer.

Many approaches have been made to study how small-scale inhomogeneities affect the global behavior when averaged on larger scales, but none of previous works have treated the observable quantities directly. For examples, none of previous authors has shown how to relate the observed quantities such as redshifts for galaxies in our inhomogeneous universe with the averaged "Hubble constant" defined differently by each author. Thus, to understand clearly what effect inhomogeneities produce, it is necessary to relate them with physical quantities which we can observe.

In this study, we investigate the observable quantities in isotropic and inhomogeneous universes.

We solve the Raychaudhuri equation on a spherically symmetric "dustshell universe" where large inhomogeneities of density distribution exist. Then we obtain the luminosity distance–redshift relation, with which we can determine the cosmological parameters of a FRW model. It enables us to discuss what an inhomogeneous universe looks like when we "observe" it and interpret it using a FRW model.

We obtain a surprising result that the relation is fitted well by that of a FRW model if we set an appropriate initial condition. This supports the "averaging hypothesis" that a universe looks like a FRW model if the universe is homogeneous when averaged on large scales. Difference with FRW models and its implications are also discussed.