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Testing the cosmological principle with the CMASS galaxy sample

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The cosmological principle that the universe is homogeneous and isotropic at large scales is a fundamental assumption of modern cosmology. Recent observations of the galaxy redshift survey provide relevant data to confront the cosmic homogeneity with observation. Several previous studies claim that the homogeneity scale is reached at a radius around 70 Mpc/h. Here we present a homogeneity test for the matter distribution using the Baryon Oscillation Spectroscopic Survey CMASS galaxy sample. As a homogeneity criterion, we compared the observed data with similarly constructed random distributions by counting the number of galaxies in the truncated cones. Comparisons are also made with three theoretical results using the same method: (i) the dark matter halo mock catalogs from the N-body simulation, (ii) the log-normal distributions derived from the theoretical matter power spectrum, and (iii) the direct estimation from the theoretical power spectrum. We show that the observed distribution is statistically impossible as a random distribution up to 300 Mpc/h in radius, whereas it is consistent with three theoretically derived results based on the cosmological principle. The observed galaxy distribution (light) and the simulated dark matter distribution (matter) are quite inhomogeneous even on a large scale. We discuss the ontological status of the cosmological principle. Based on Y. Kim, C.-G. Park, H. Noh & J. Hwang, CMASS galaxy sample and the ontological status of the cosmological principle, A&A 660, A139 (2022).

Primary author: Prof. PARK, Chan-Gyung (Division of Science Education, Jeonbuk National University)

Co-authors: Mr KIM, Yigon (Department of Astronomy and Atmospheric Sciences, Kyungpook National University); Dr NOH, Hyerim (Theoretical Astrophysics Group, Korea Astronomy and Space Science Institute); Prof. HWANG, Jai-chan (Center for Theoretical Physics of the Universe, Institute for Basic Science (IBS))

Presenter: Prof. PARK, Chan-Gyung (Division of Science Education, Jeonbuk National University)

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