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Plenary — Atsushi Naruko: Understanding Cosmological Perturbations through the Separate-Universe Approach

Thursday, 19 November 2026 13:00 (1 hour)

How much can we learn about an inhomogeneous universe from homogeneous background solutions? The separate-universe approach offers a remarkably simple way to address this question: on sufficiently large scales, different regions of the universe can be treated approximately as homogeneous universes, allowing us to follow the nonlinear evolution of cosmological perturbations without solving the full inhomogeneous equations.

In this talk, I will introduce the basic physical picture of the separate-universe approach and its formulation in terms of the spatial gradient expansion. I will then explain how this leads to the δN formalism, which relates large-scale curvature perturbations to differences in the local expansion history. I will also discuss the assumptions underlying this description, why it works, and where its limitations become important. Finally, I will briefly touch upon extensions of the standard framework and recent developments in the study of nonlinear cosmological perturbations. The aim is to provide an accessible overview of the subject, emphasizing physical intuition and its usefulness for understanding the early universe.