



The evolution of cosmic web: A symphony of gravity and dark energy

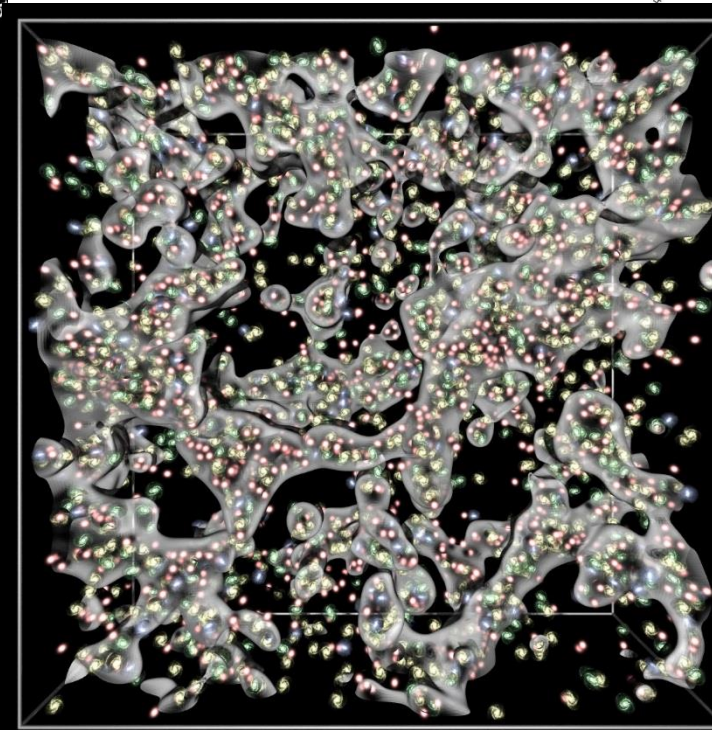
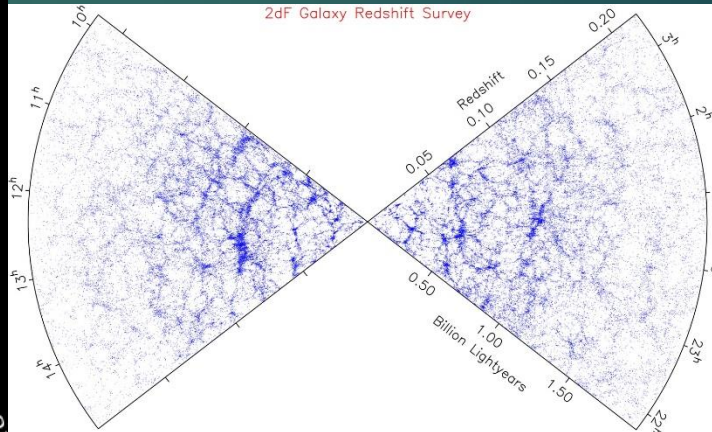
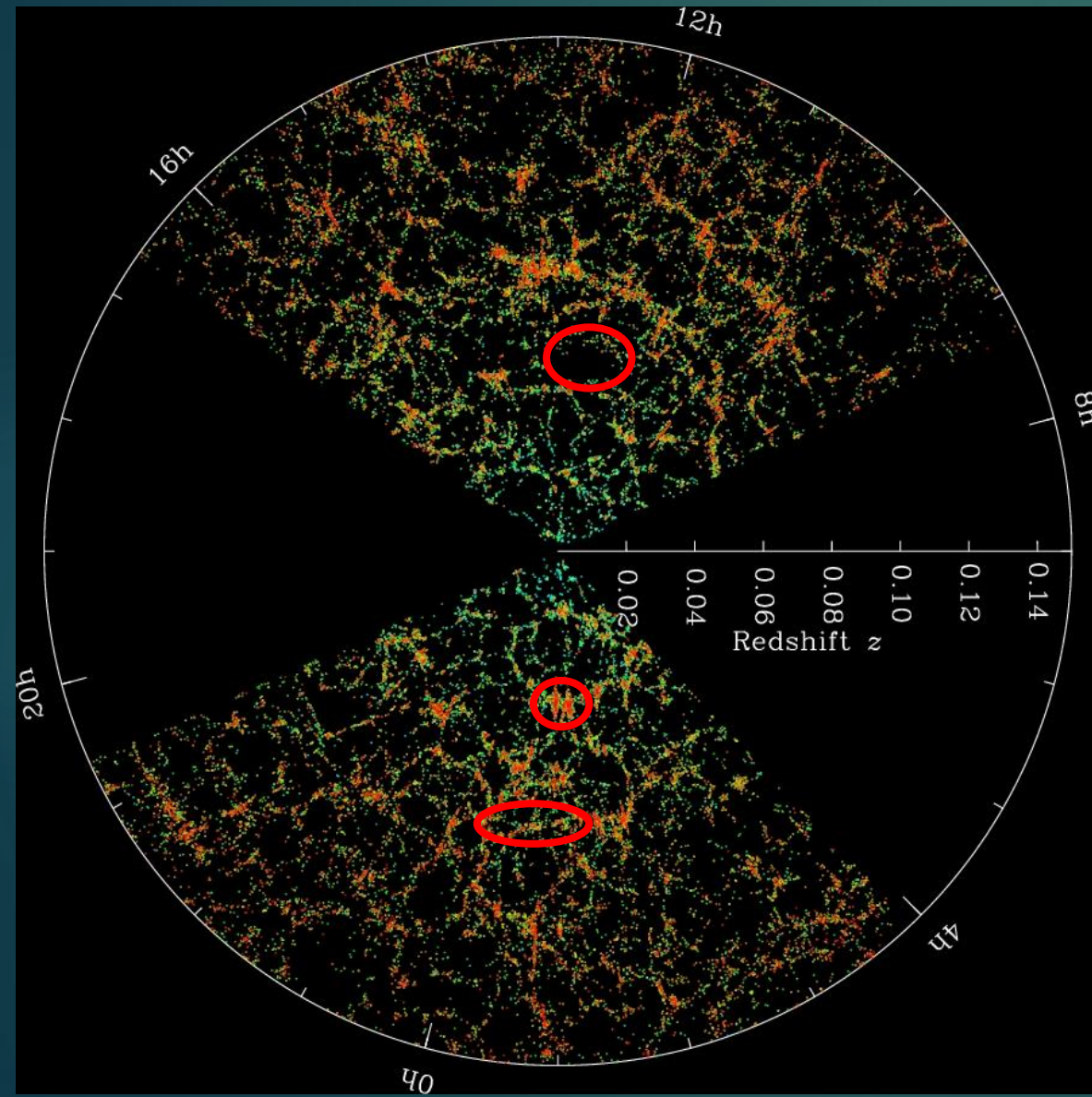
ZHANG JIAJUN

DEPARTMENT OF PHYSICS, CUHK

Outline

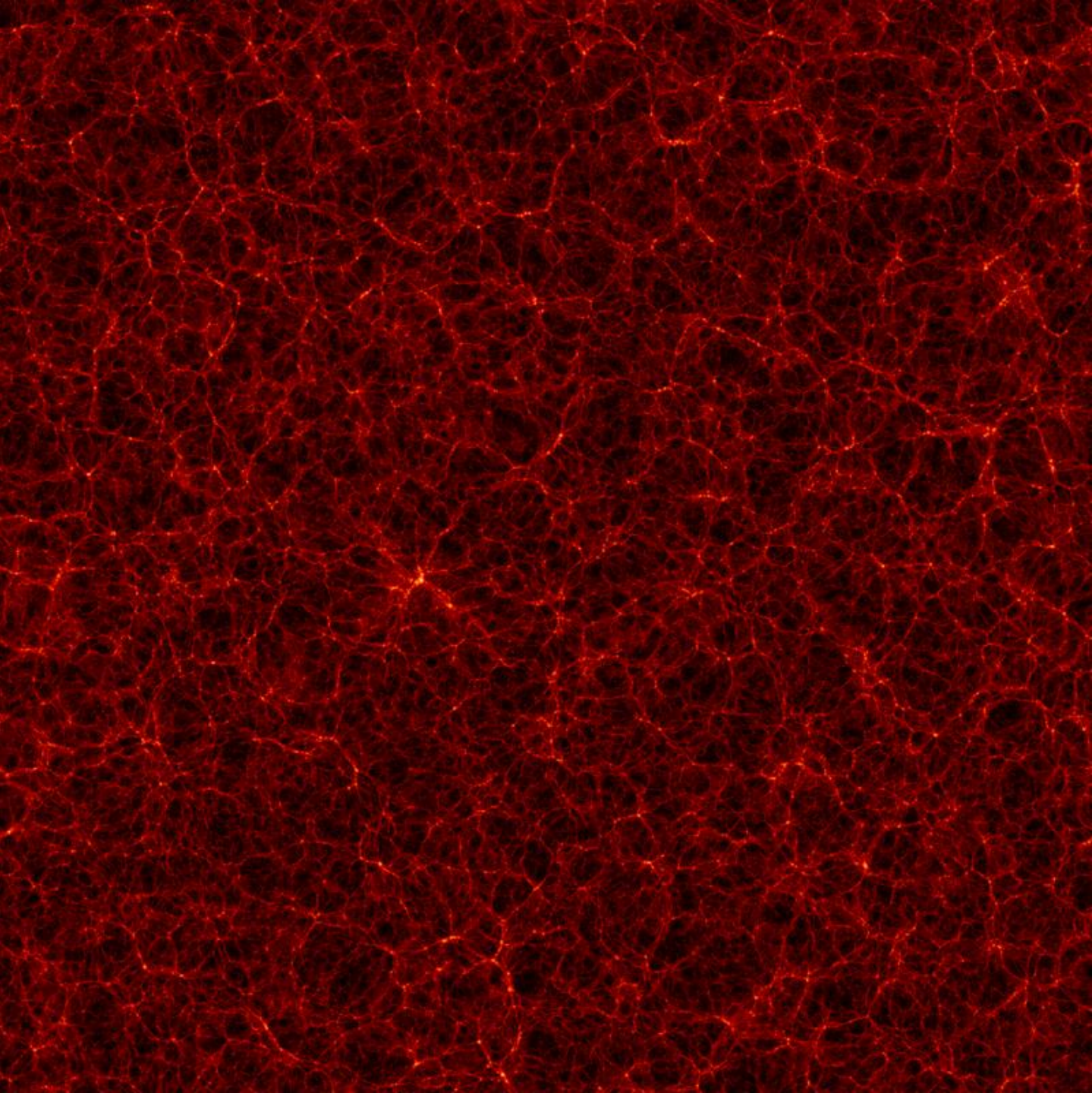
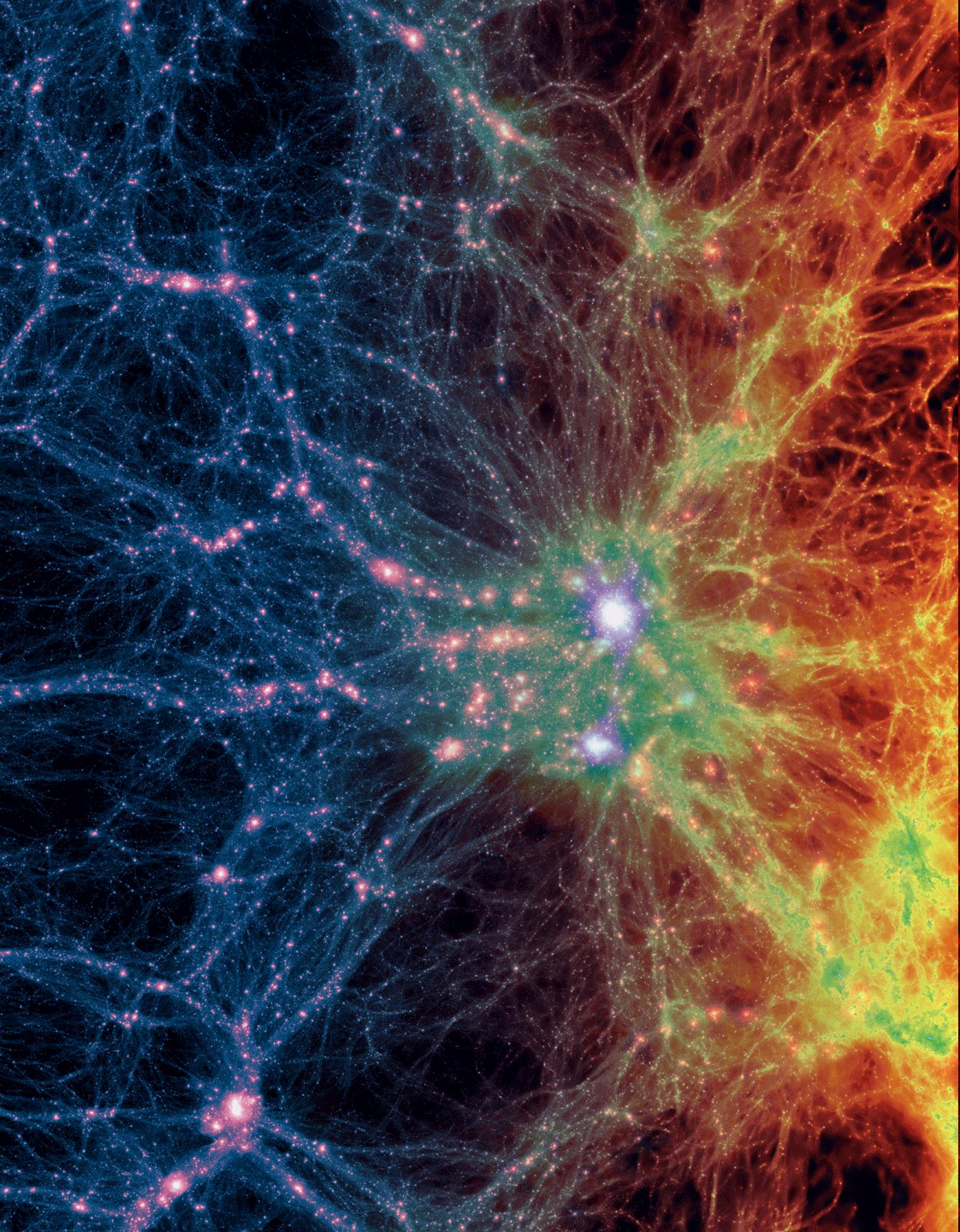
- ▶ What is cosmic web?
 - ▶ Large scale sky survey
 - ▶ N-body simulation
- ▶ Where does cosmic web come from?
 - ▶ Movement I: Initial perturbation and power spectrum
 - ▶ Movement II: Gravitational instability and cosmic expansion
- ▶ Where will cosmic web go?
 - ▶ Movement III: Competition between gravity and dark energy
 - ▶ Movement IV: Everything freeze, the victory of dark energy
- ▶ We are witnessing the climax of the symphony

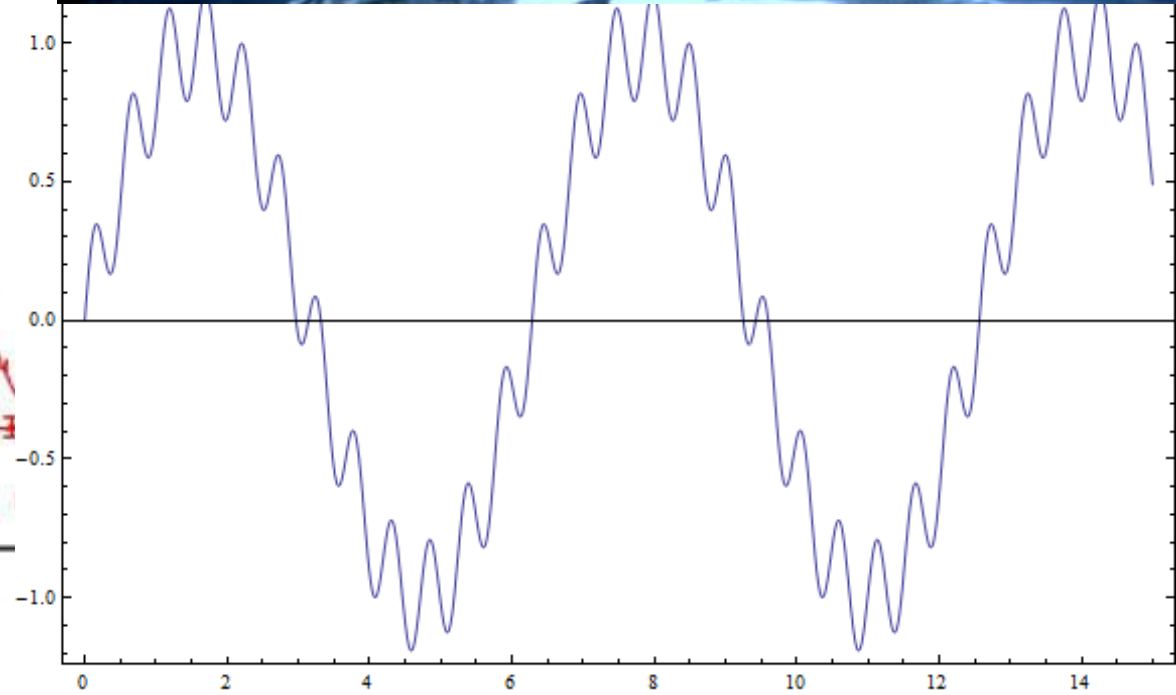
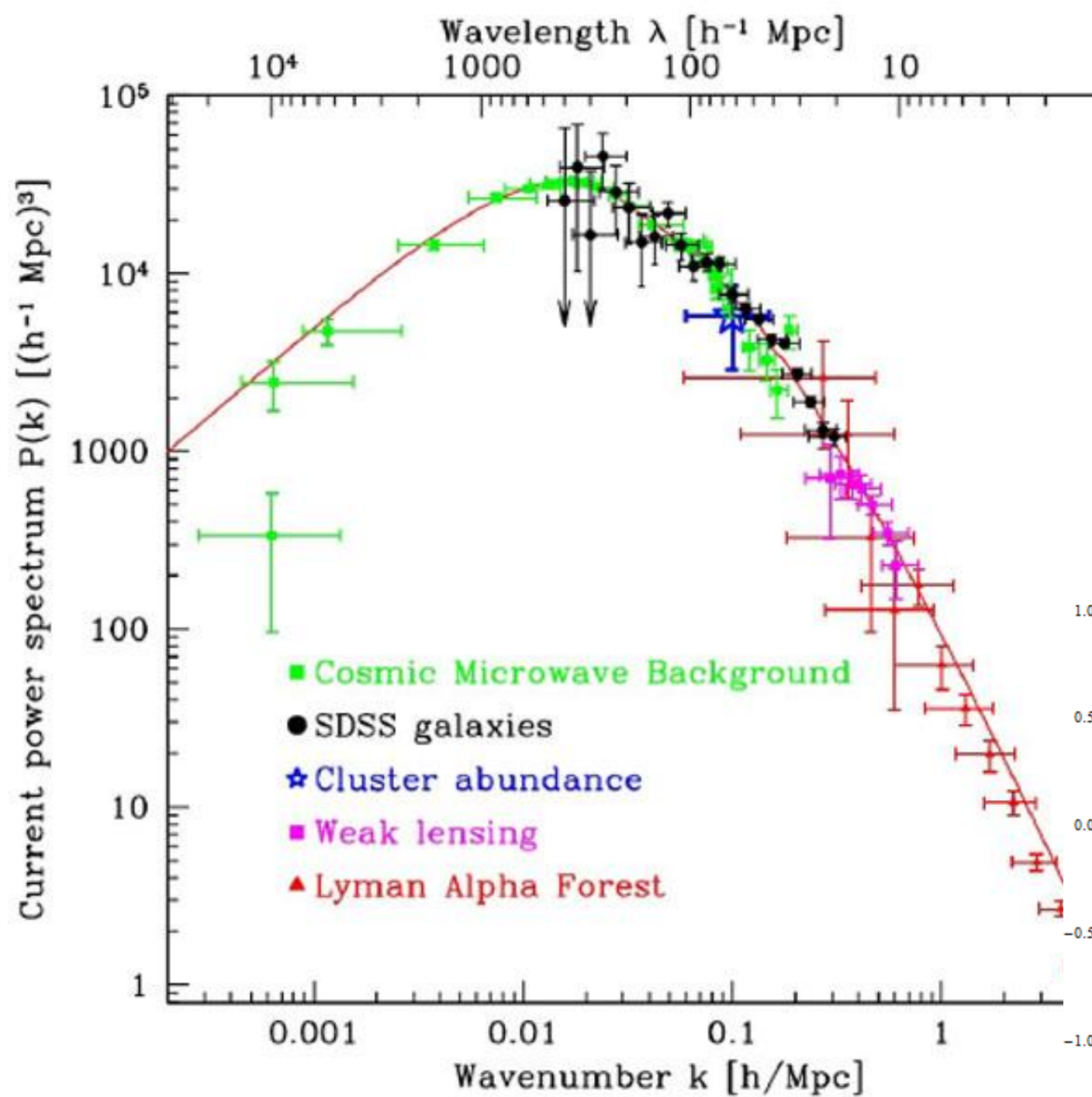
Large scale sky survey



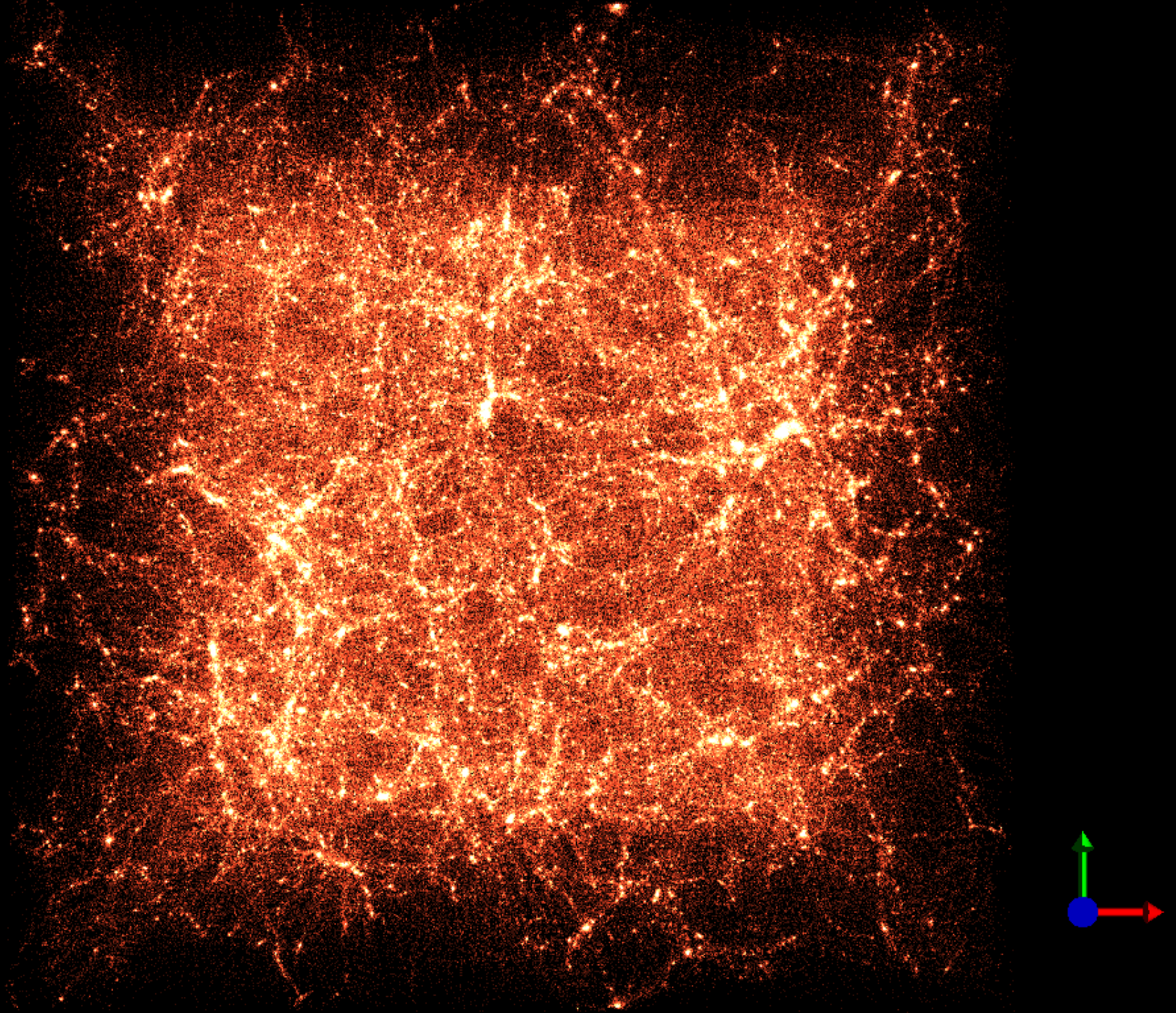
- ▶ SDSS and 2dF
- ▶ Nodes
 - Clusters
- ▶ Links
 - Filaments

A web-like galaxy distribution





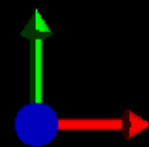
time : 1.0000

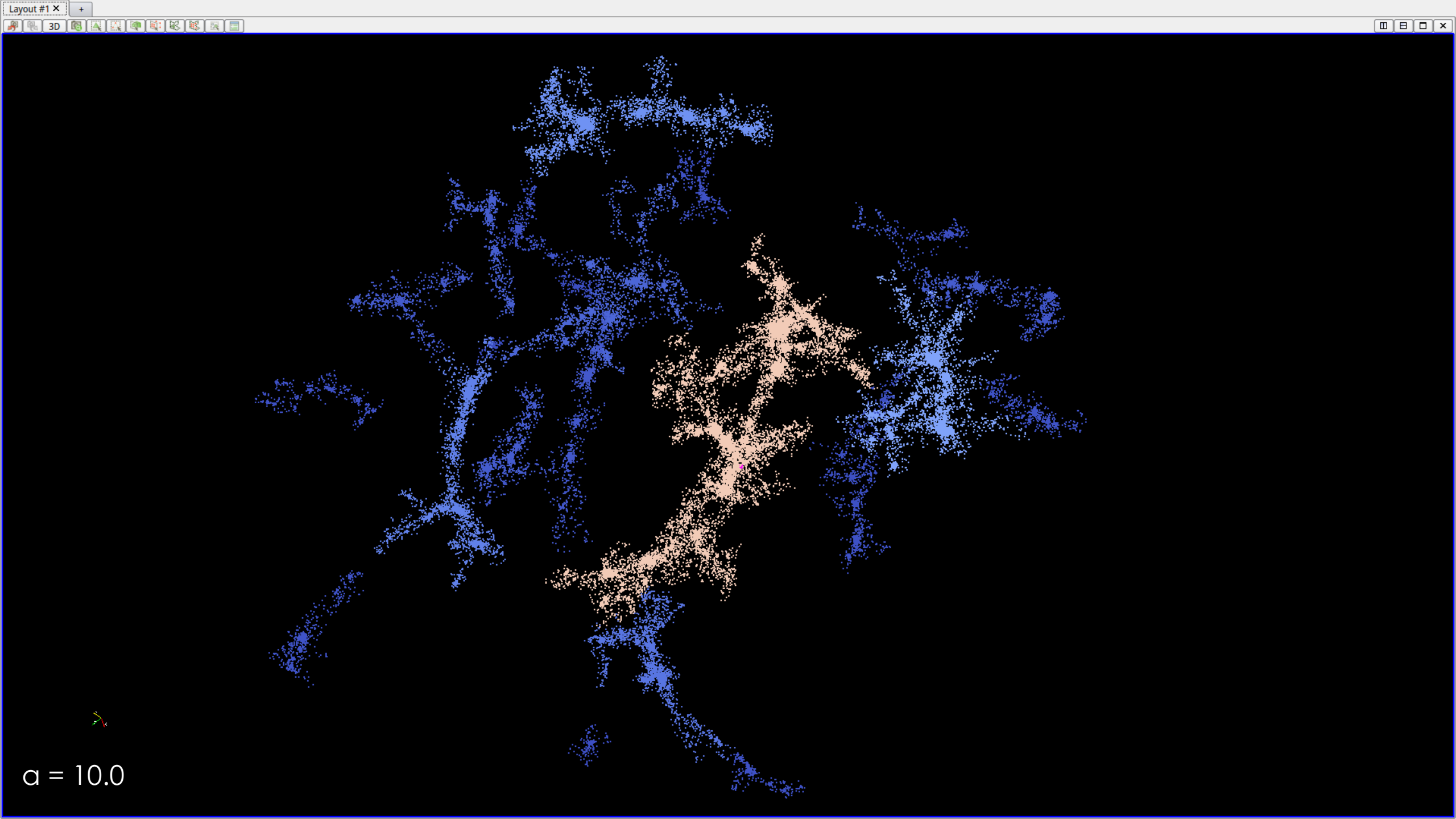


Gravity →
Collapse

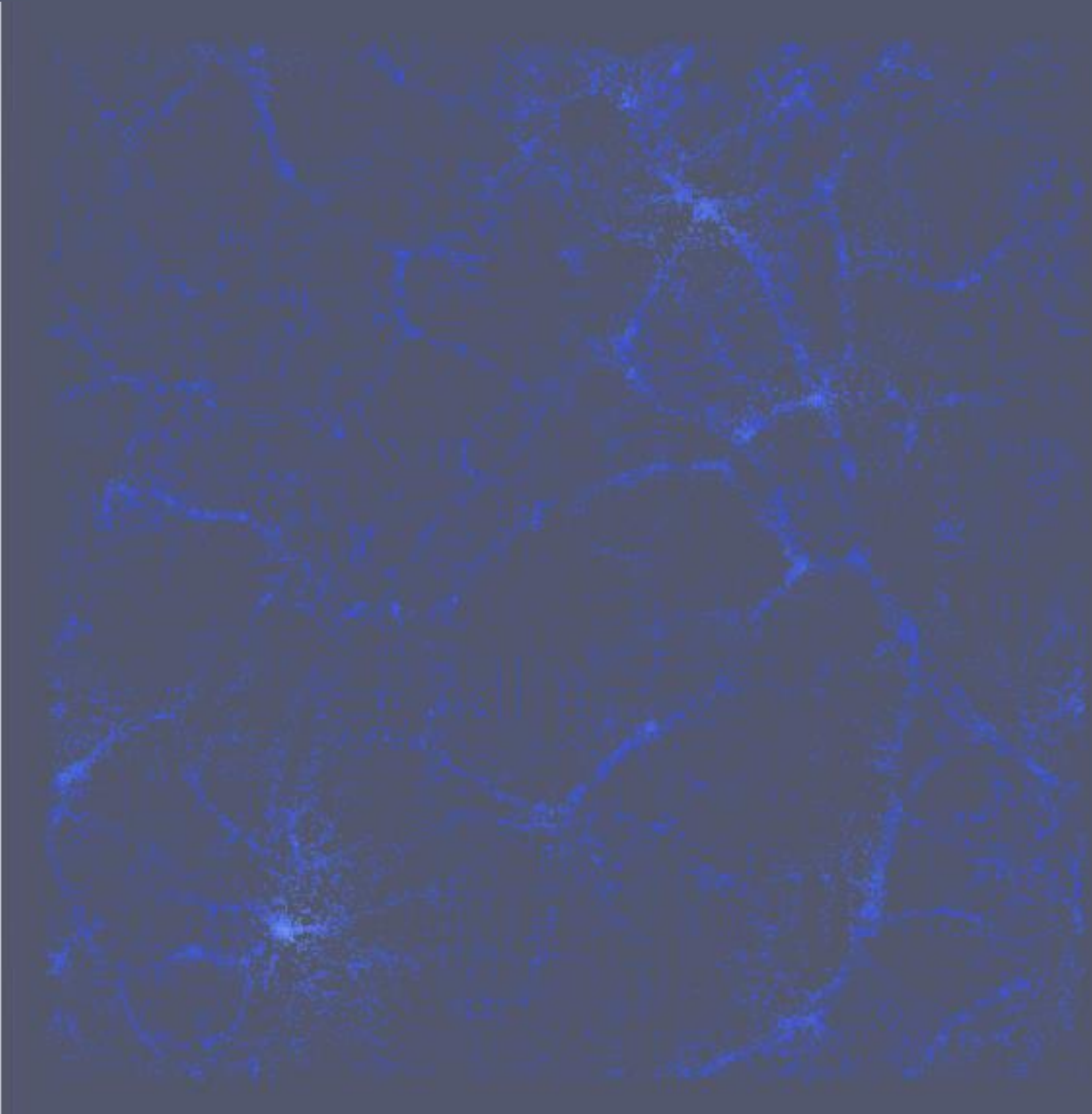
Density
contrast →
Enhanced

Higher
density →
More
galaxies

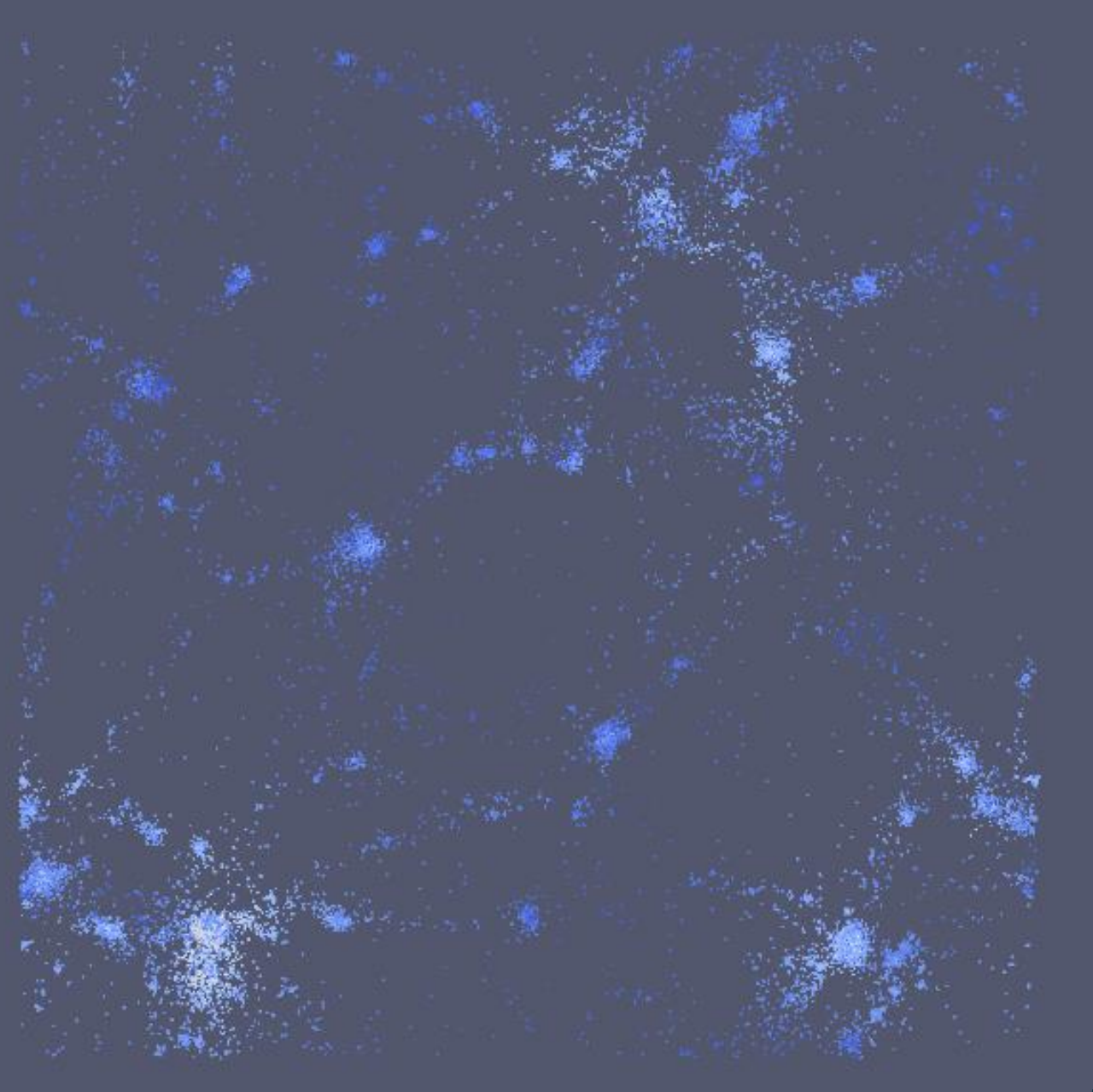




$\alpha = 10.0$



LCDM(with dark energy)
 $\alpha=1,2,4,6$



SCDM(without dark energy)
 $\alpha=1,2,4,6$

Summary

- ▶ Movement I
 - ▶ Density perturbation in the initial condition is the seed.
 - ▶ Large scale power is the main contribution for cosmic web.
- ▶ Movement II
 - ▶ Gravitational instability grew.
 - ▶ Cosmic web was seen.
- ▶ Movement III
 - ▶ Gravity → get matter back; Dark Energy → separate matter apart
 - ▶ Gravity → destroy → cosmic web ← protect ← Dark Energy
- ▶ Movement IV
 - ▶ Large Scale → dark energy; Small scale → gravity
 - ▶ Cosmic web is the large scale structure, will be frozen.