Structures et leur évolution

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Cours 1 : Introduction

Questions

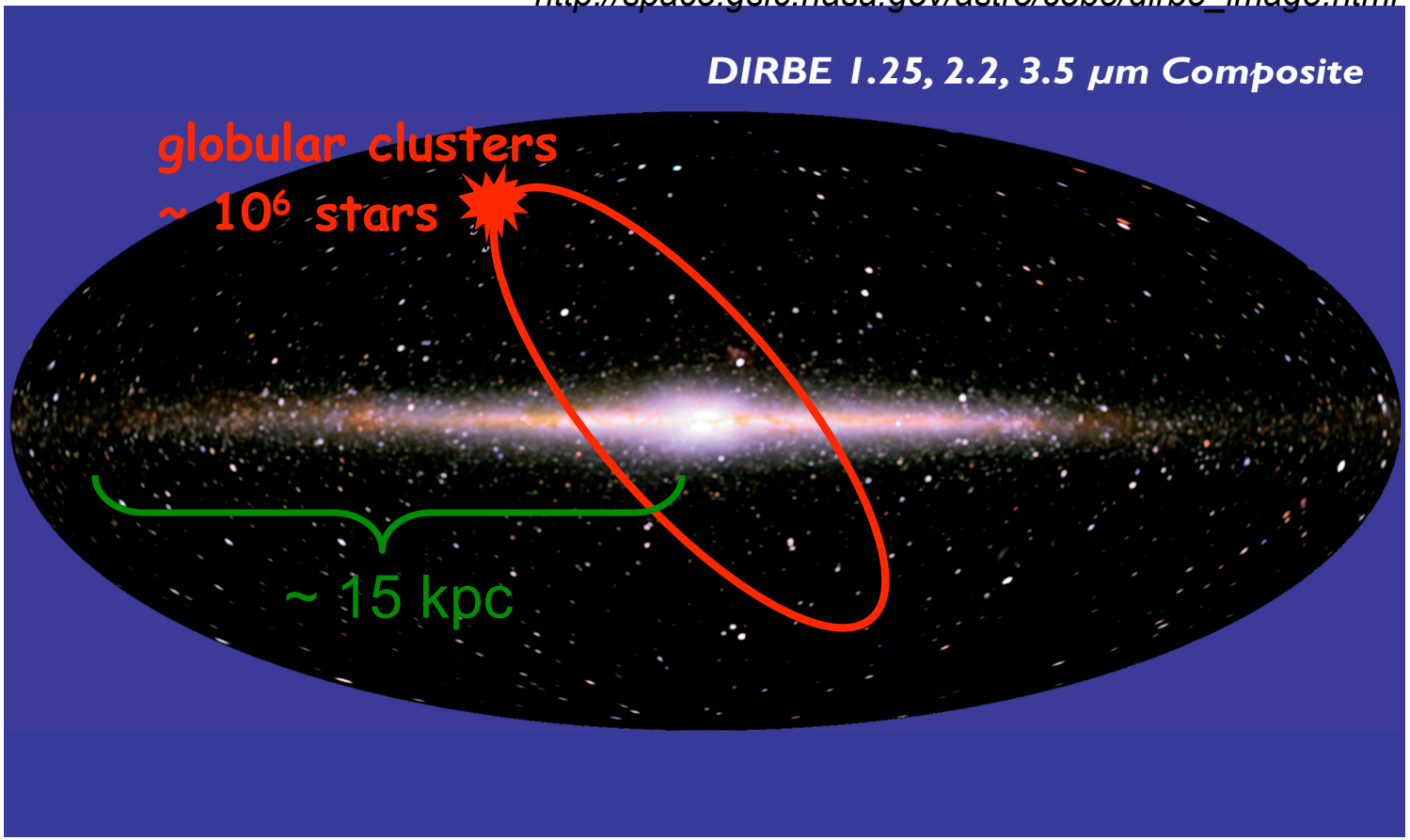
- Spectre de puissance
- Structures en tant qu'avant-plan CMB
- Matière noire
- Structures elles-mêmes
- Contraintes sur l'inflation
- Fonctionnement de la gravité
- Topologie
- Energie noire

Questions You Should Want To Know The Answer To

- *What* are these structures?
- *How* do we to study them?
- *Why* study them?

Our Galaxy

http://space.gsfc.nasa.gov/astro/cobe/dirbe_image.html



Sun at ~8 kpc from center

Our Galaxy -2MASS View

2MASS = 2 Micron All Sky Survey; 3 bands J(1.25 microns) H (1.65) K_s (2.17)

http://www.ipac.caltech.edu/2mass/gallery/showcase/

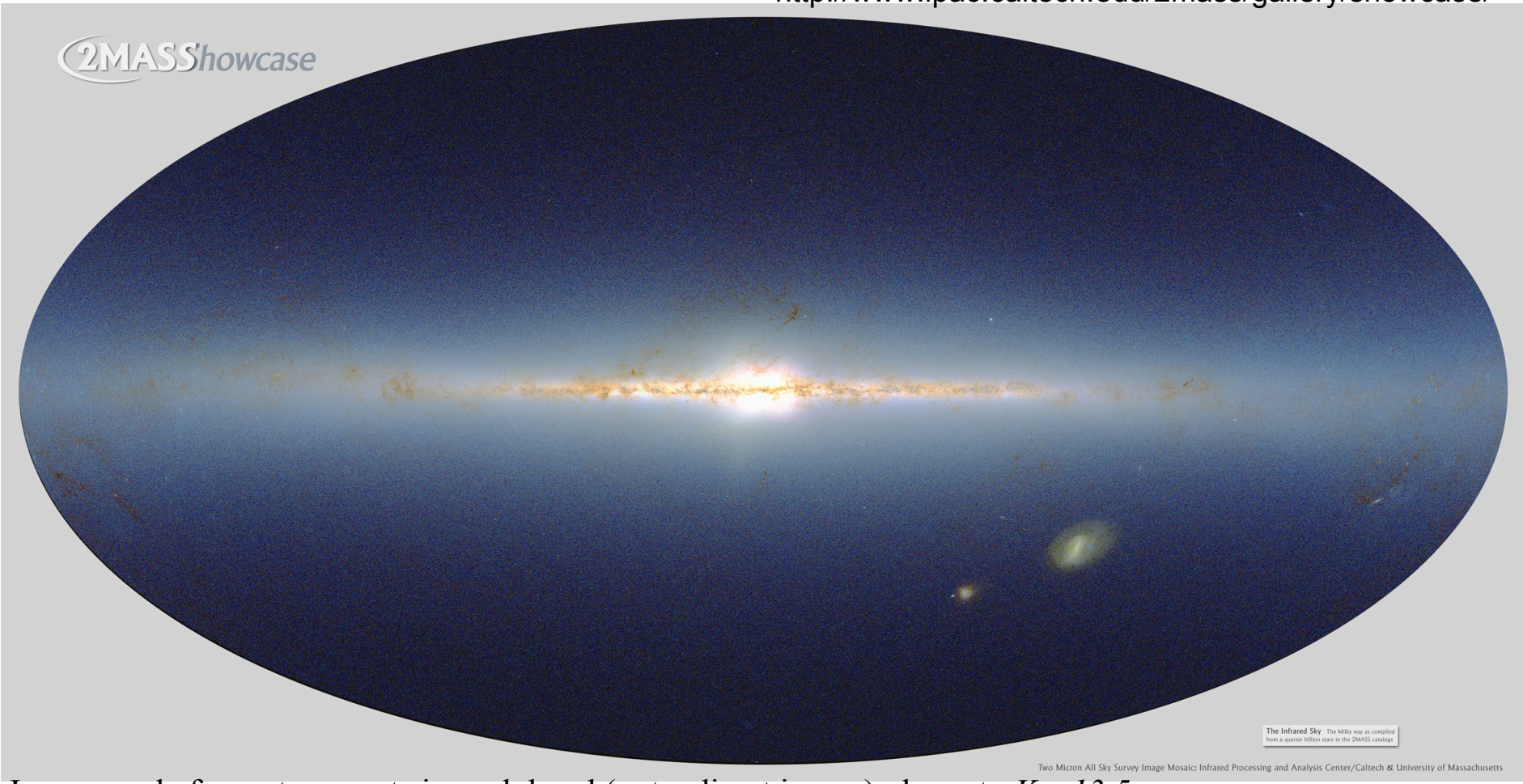
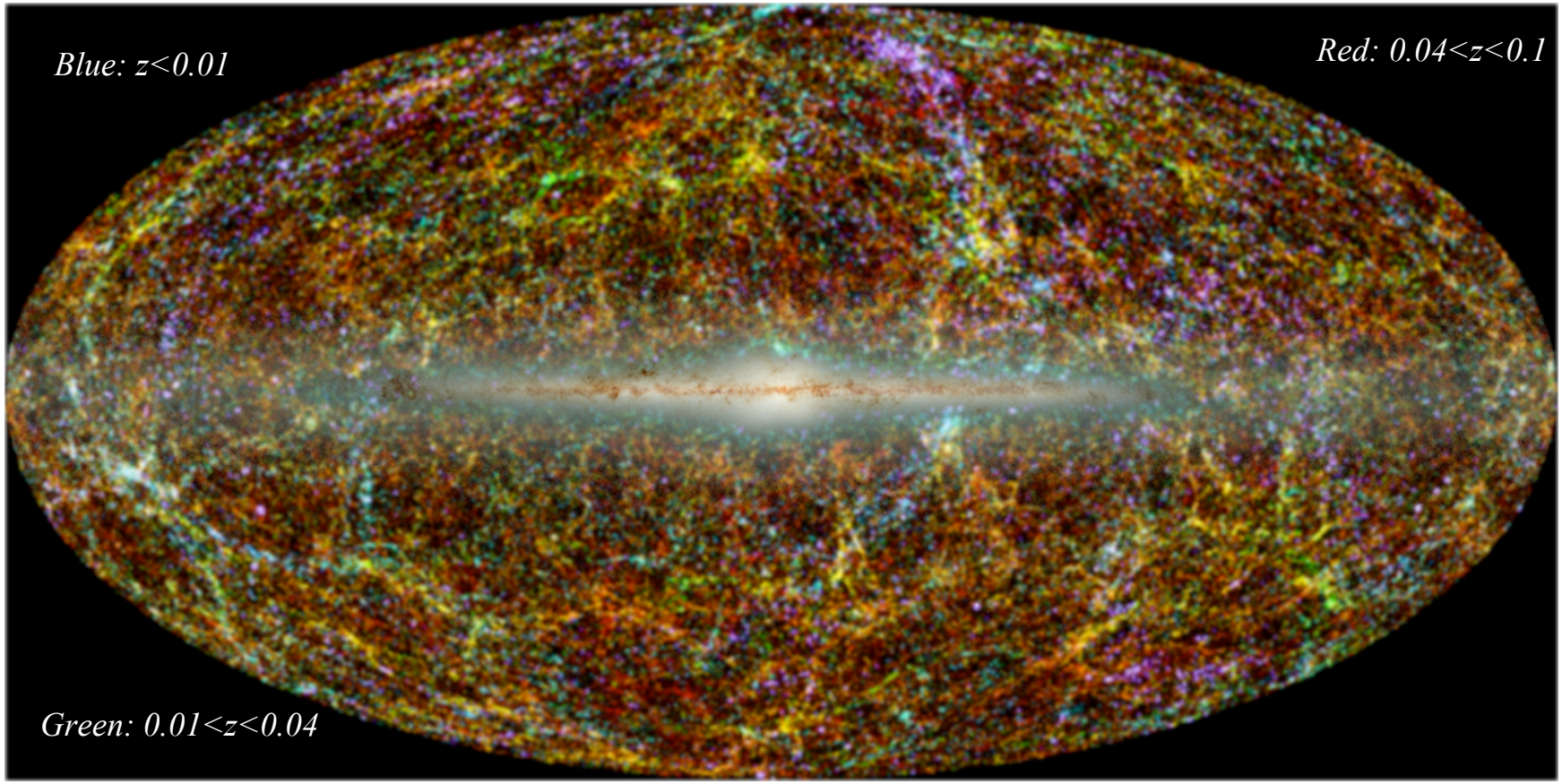


Image made from star counts in each band (not a direct image), down to $K_s=13.5$

A Universe of Galaxies

2MASS = 2 Micron All Sky Survey; 3 bands J(1.25 microns) H (1.65) K_s (2.17)



Jarrett, T.H. 2004, PASA, 21, 396 http://spider.ipac.caltech.edu/staff/jarrett/papers/LSS/

2MASS Redshift Movie

http://spider.ipac.caltech.edu/staff/jarrett/2mass/LSS/2mass_xscz.mov

Galaxy Characteristics

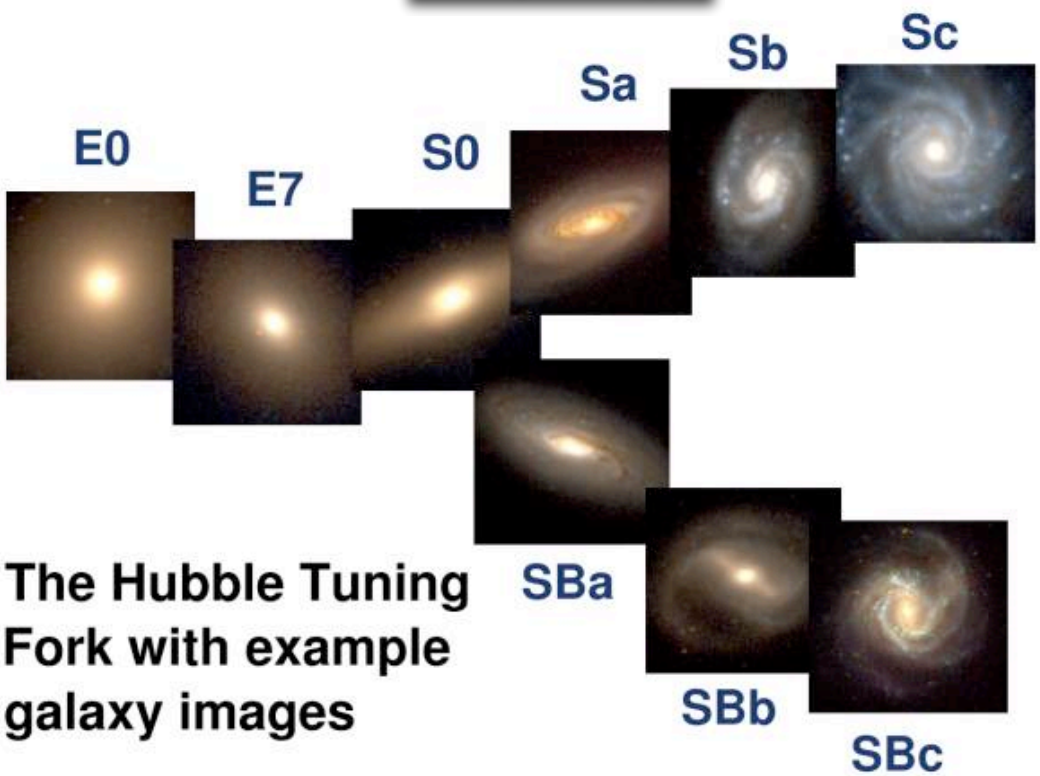
$R_{vis} \sim (10-20)h^{-1}kpc$

$M \sim 10^{12} h^{-1} M_{\odot}$

$L_{b_J} \sim 10^{10} h^{-2} L_{\odot}$

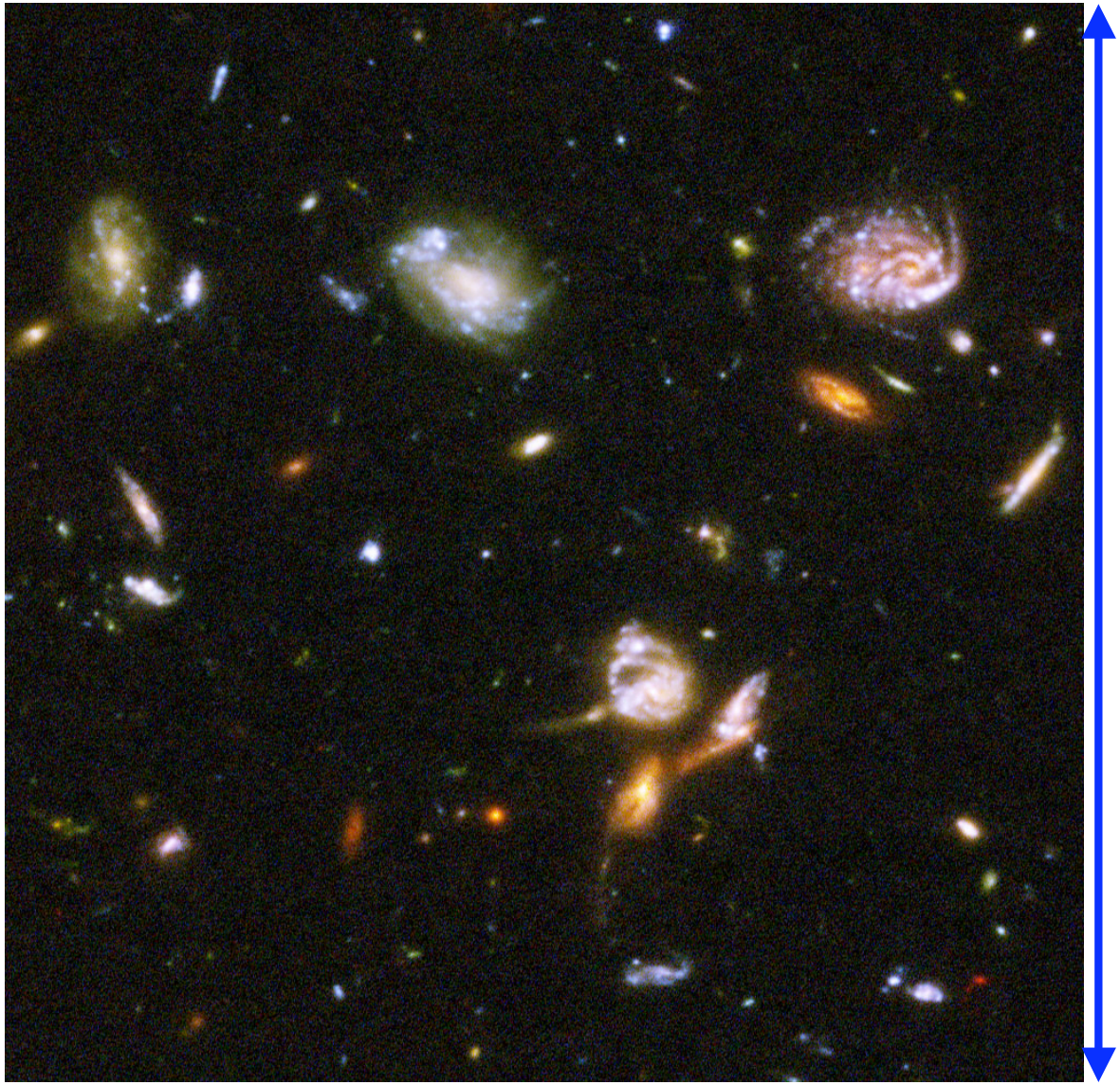
$n \sim 0.01 h^{3} Mpc^{-3}$

Morphology

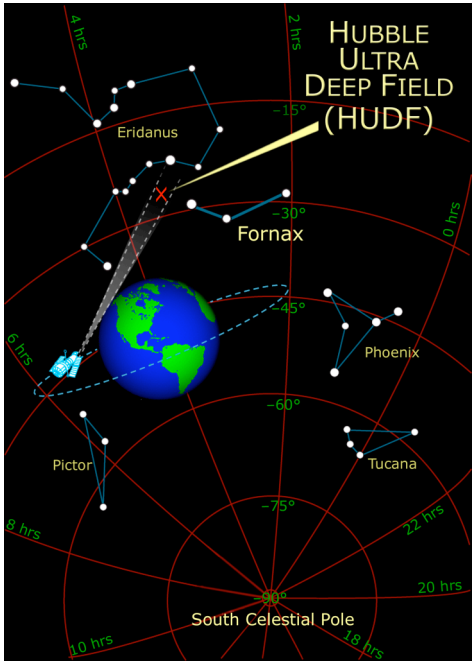


The Hubble Tuning Fork with example galaxy images

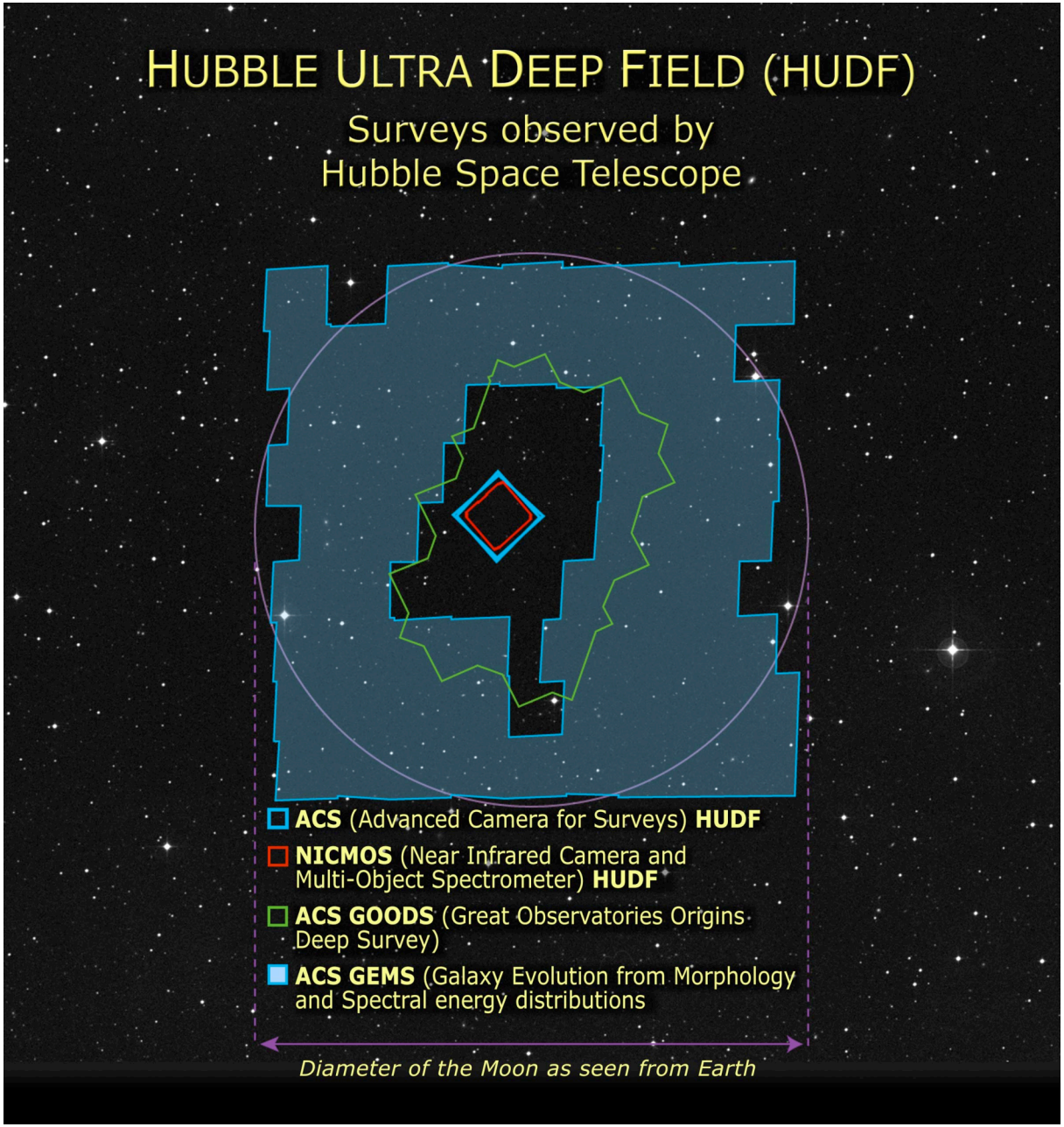
Hubble Ultra-Deep Field (UDF)



3 arcmins



11.3 day exposure!

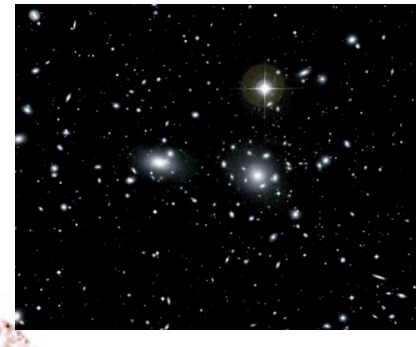


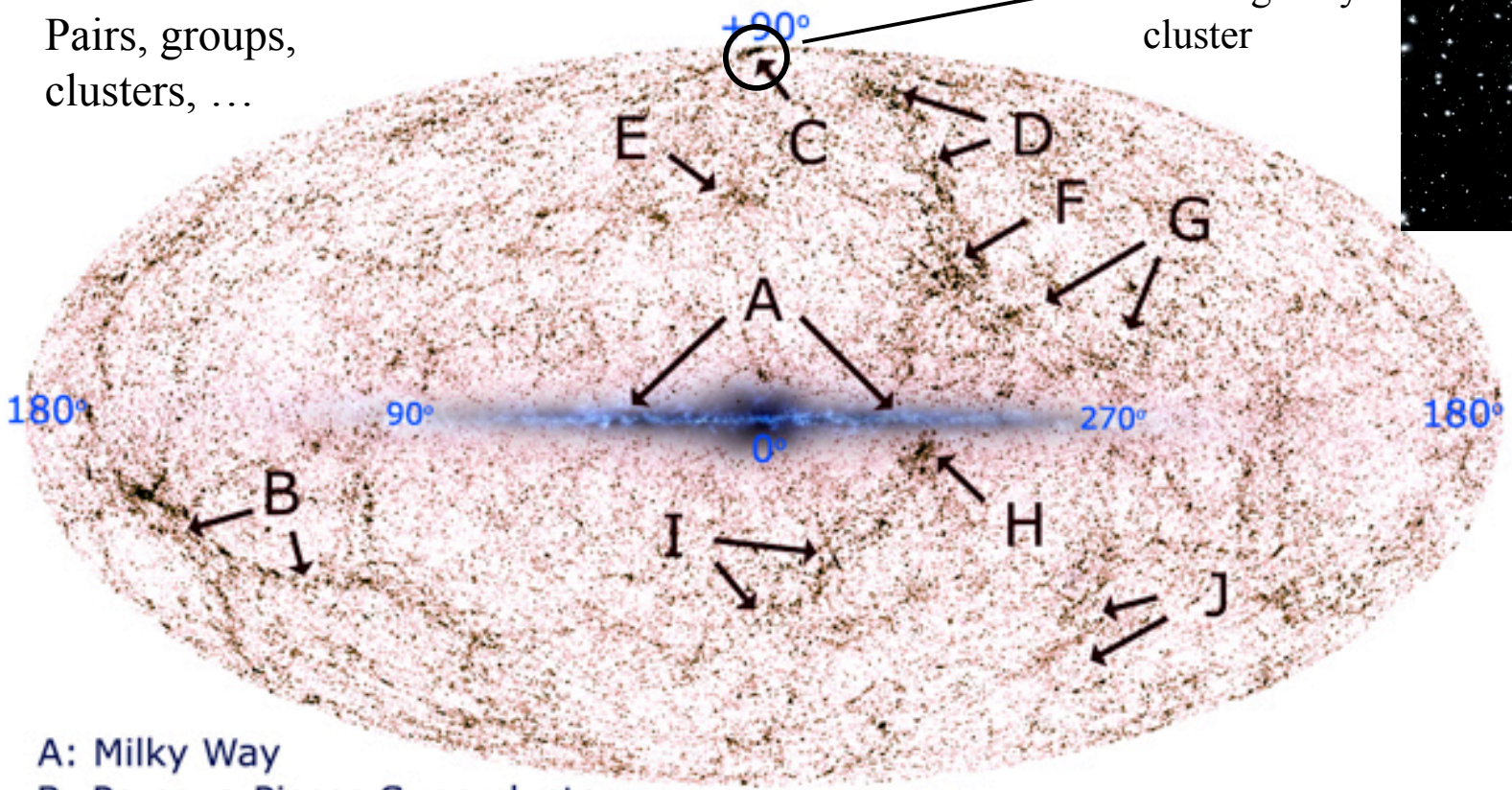
Tremendous number of galaxies in the universe!!

A Hierarchy of Structure

Pairs, groups, clusters, …

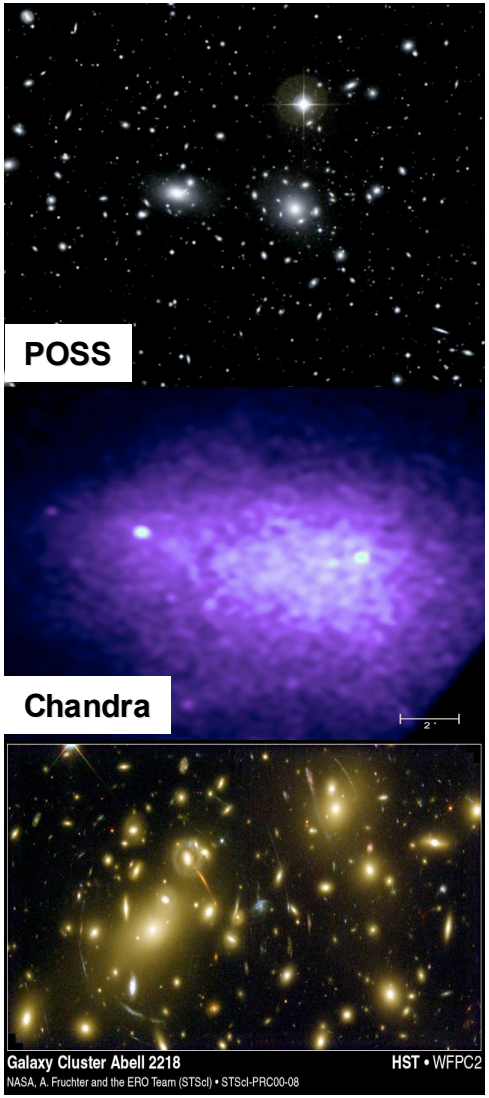
Coma galaxy cluster





A: Milky Way
B: Perseus-Pisces Supercluster
C: Coma Cluster
D: Virgo Cluster/Local Supercluster
E: Hercules Supercluster
F: Shapley Concentration/Abell 3558
G: Hydra-Centaurus Supercluster
H: "Great Attractor"/Abell 3627
I: Pavo-Indus Supercluster
J: Horologium-Reticulum Supercluster

Galaxy Clusters



Galaxies: $M_{gal} \approx 0.02 M_{tot}$ Early types

10 - 1000

poor groups - rich clusters

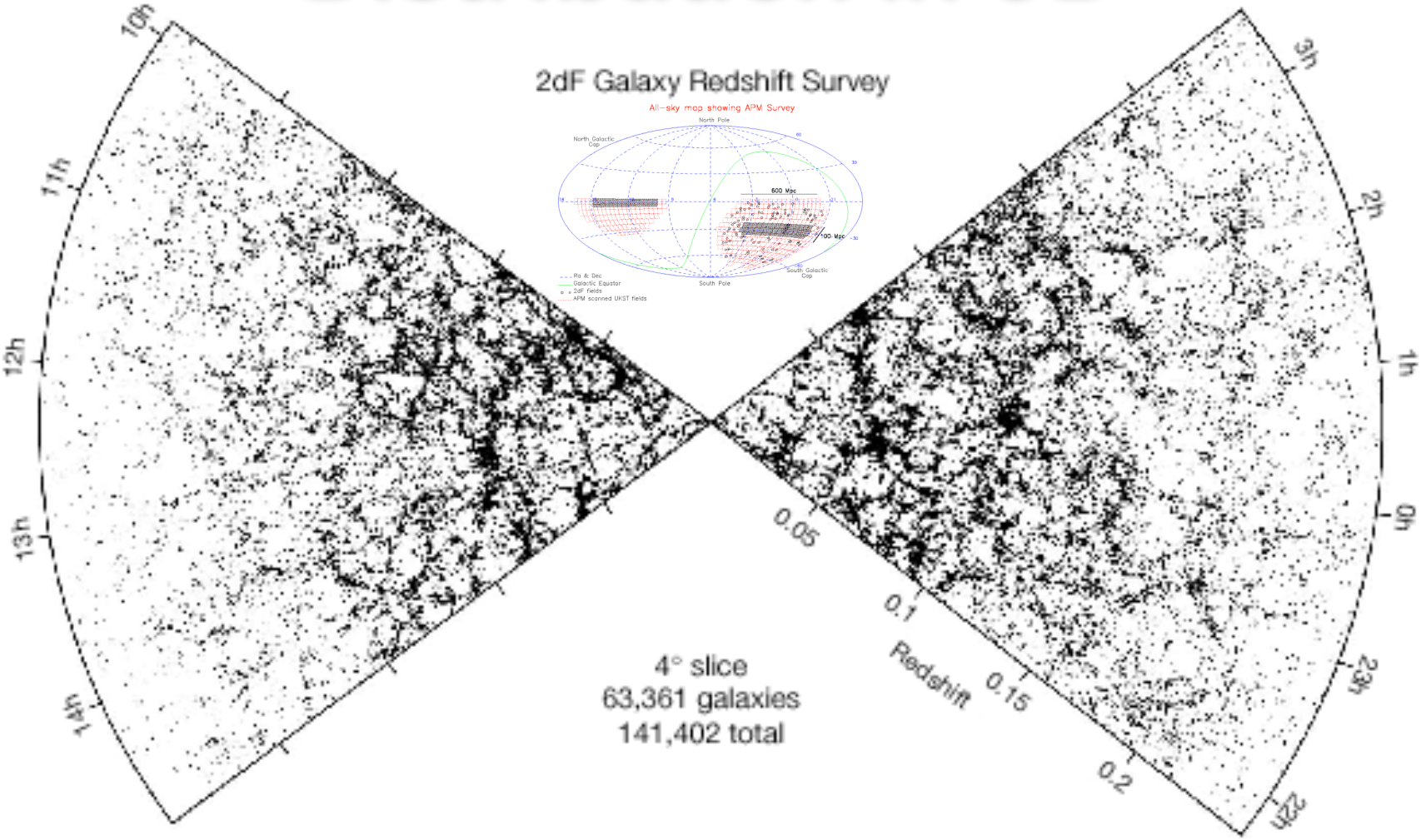
Gas: $M_{gas} \approx 0.1 M_{tot}$

$T_{gas} \approx (1-15)\ keV$ Heated by infall

Dark Matter: $M_{tot} \approx 10^{14} - 10^{15}$ Solar Masses

$R \approx 1\ Mpc$

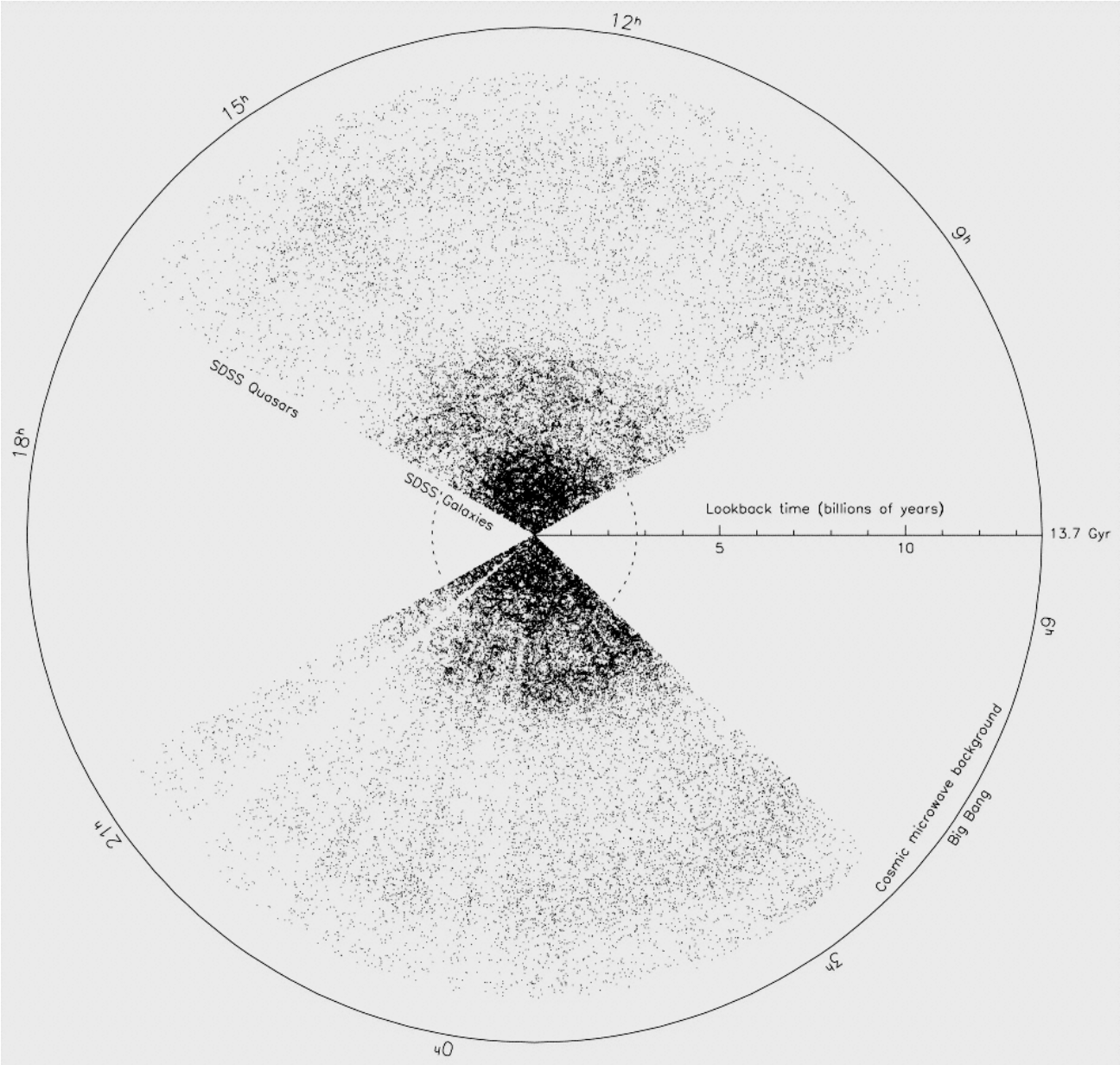
Distribution in 3D



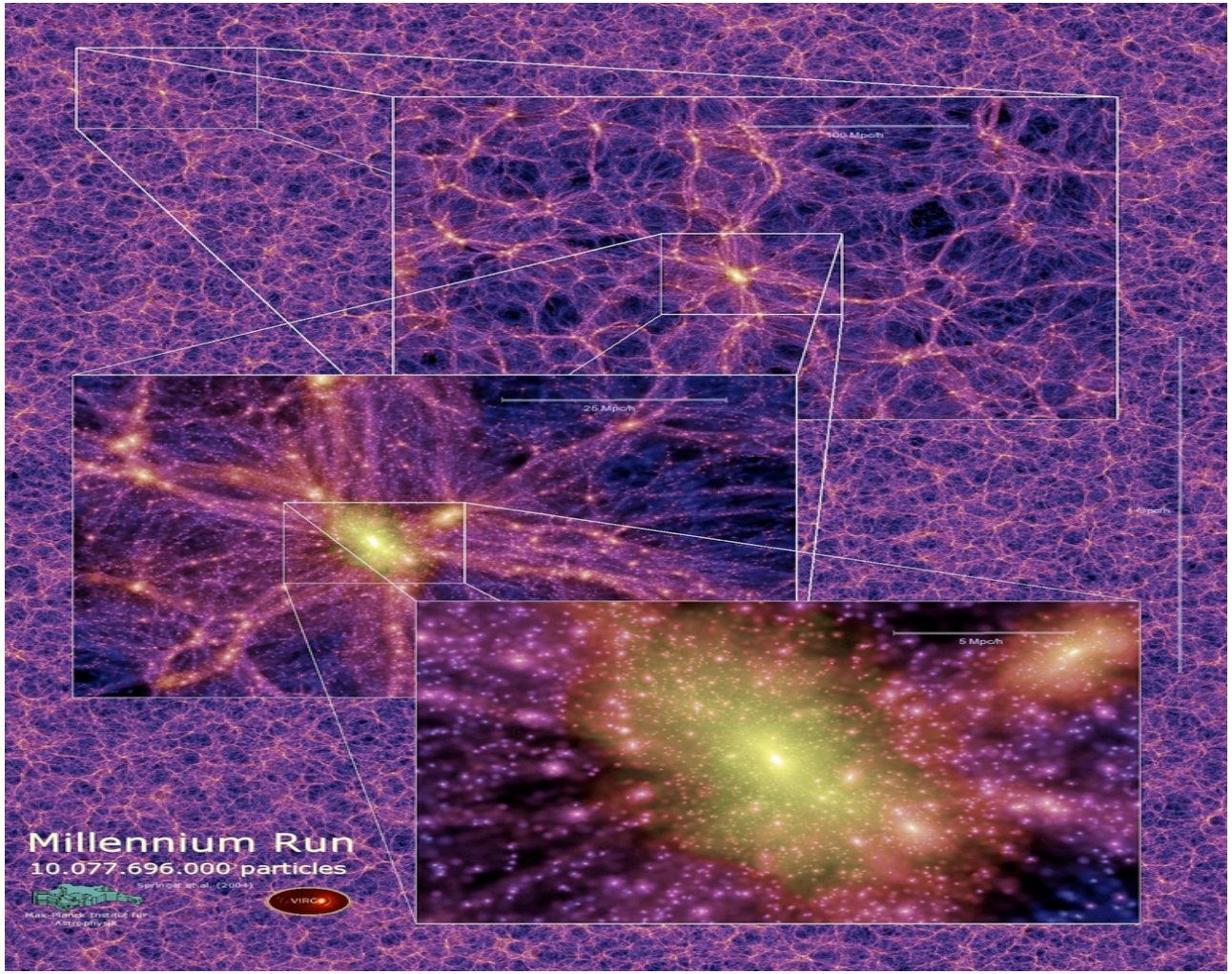
redshift space diagram ≠ real space … more later…

SDSS =
Sloan Digital
Sky Survey

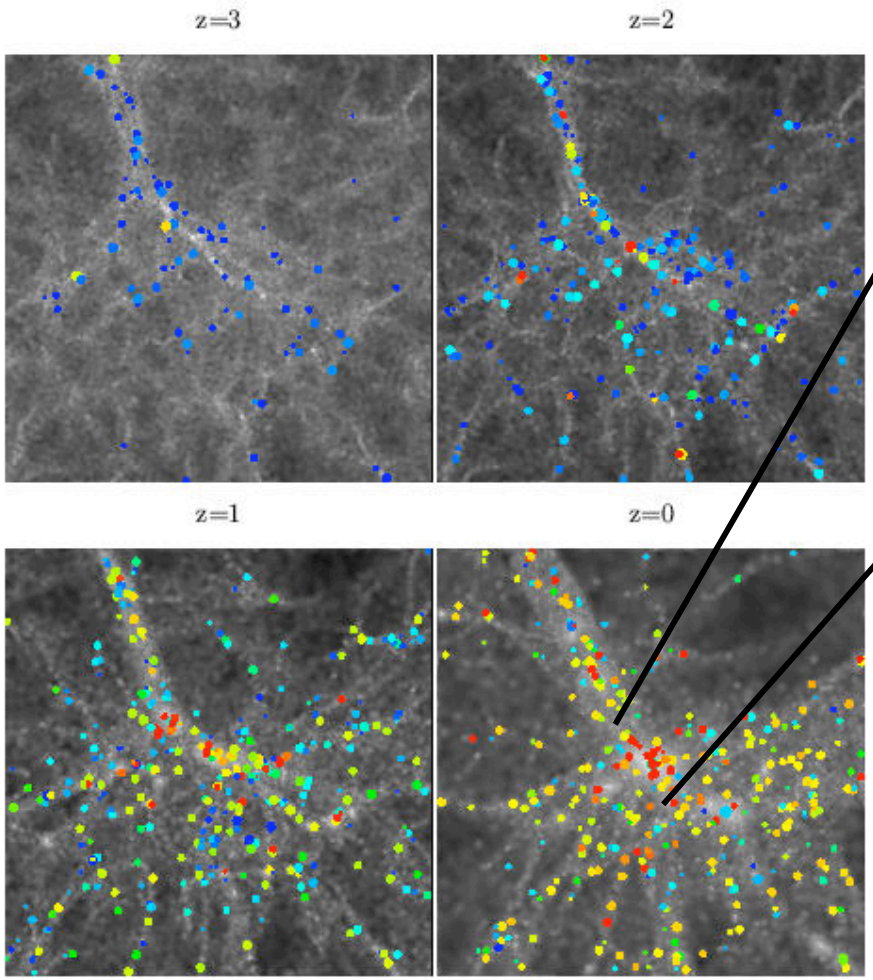
Gott et al. 2005,
ApJ 624, 463



Objects: knots in the fabric

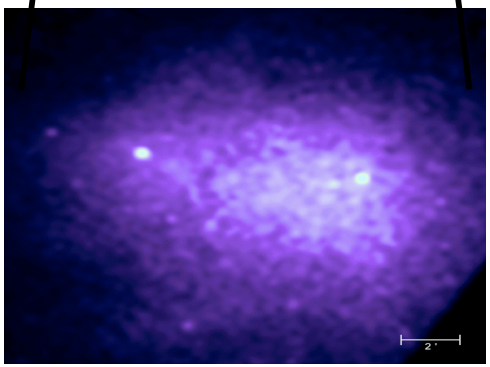


Halos Host What We See



Colberg & Diaferio (GIF, MPA)

Galaxies (POSS)



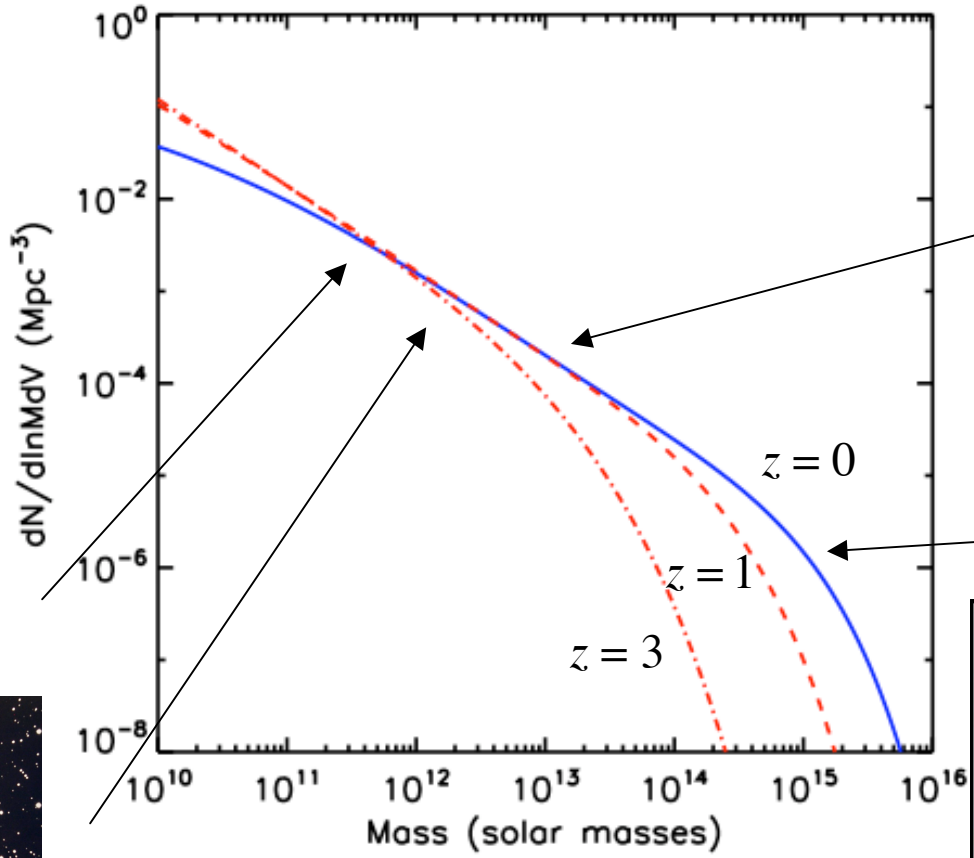
Intergalactic gas (Chandra: x-rays)

Need Halo Mass Measurements to test theory

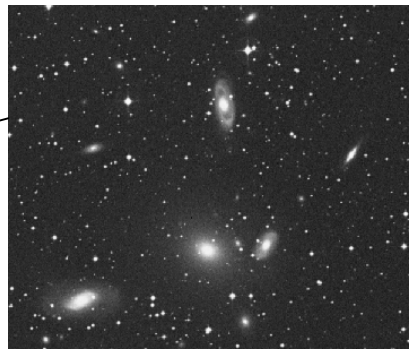
Halo Mass Spectrum

Mass Function

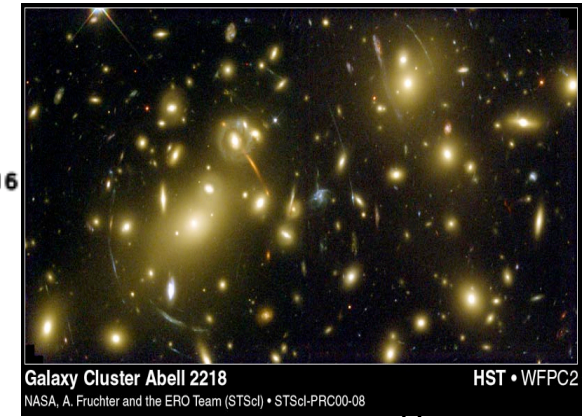
Galaxies: 10^{10}-10^{12}



Groups: >10^{12}-10^{14}



Clusters: >10^{14}



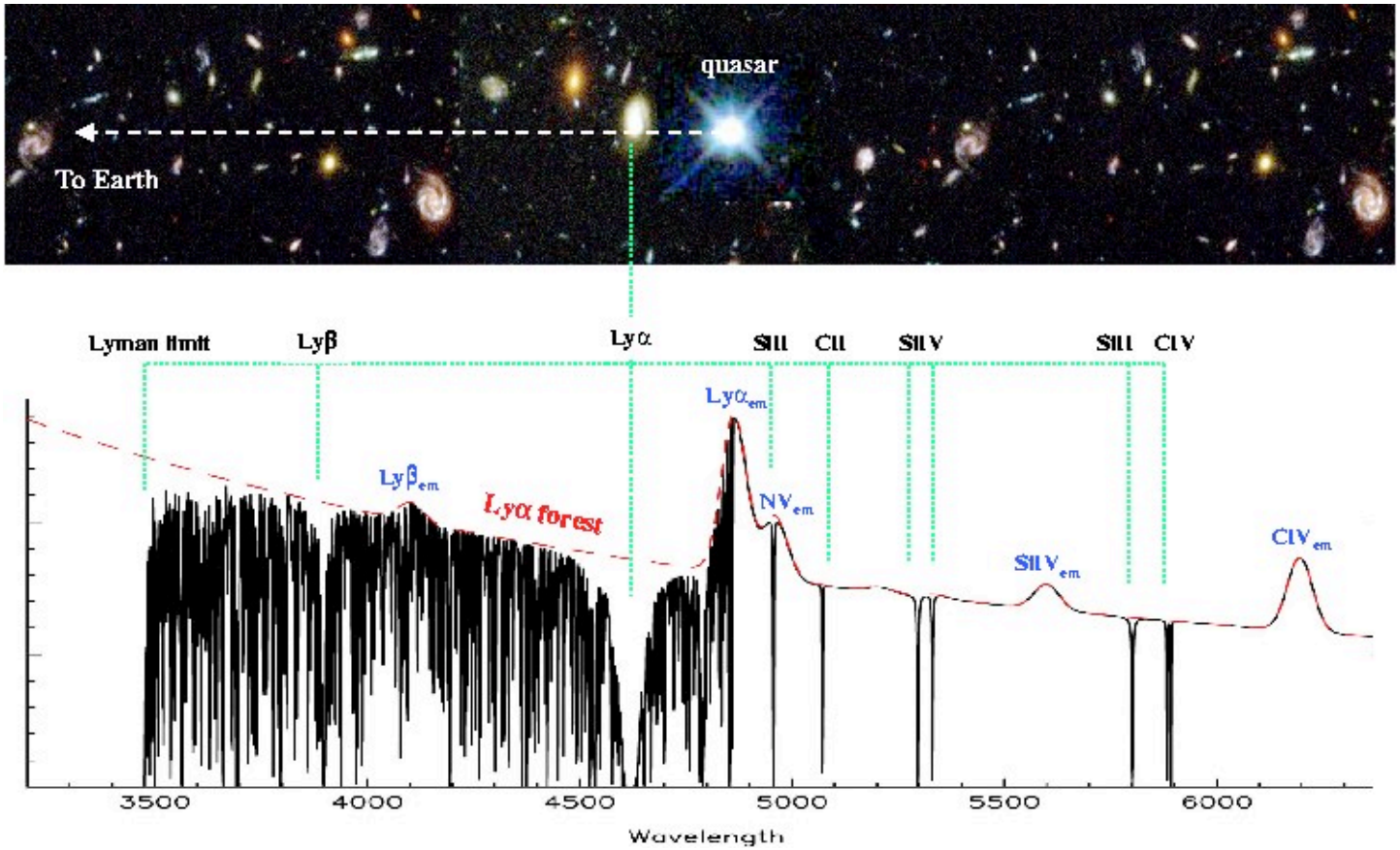
SDSS Movie

http://video.google.com/videoplay?docid=-8252705102362324792

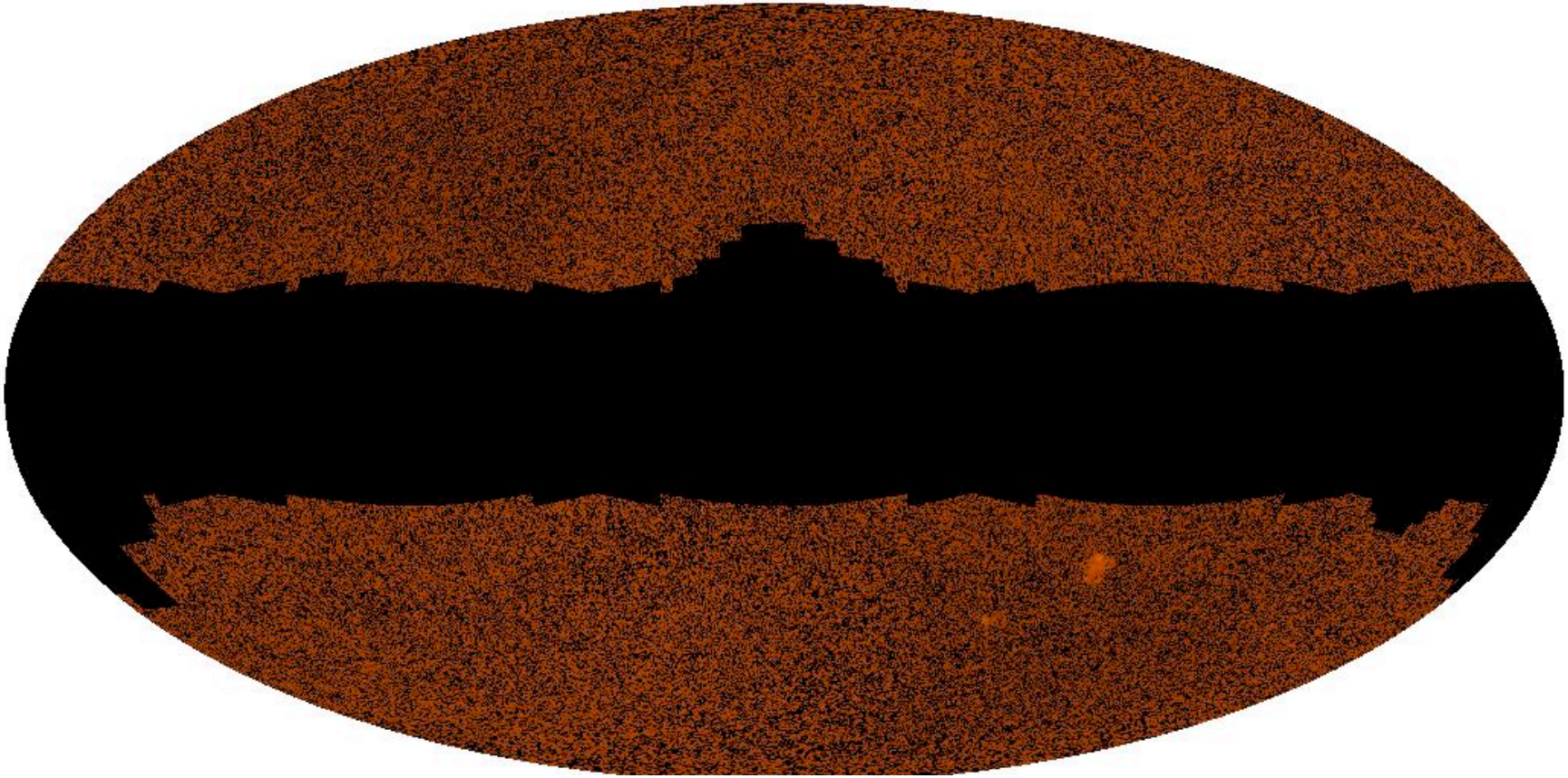
Discussion

- How do we want to describe these structures?
  - What are they/what do they mean?
- What other ways do we have to search for structures?

Absorption Systems



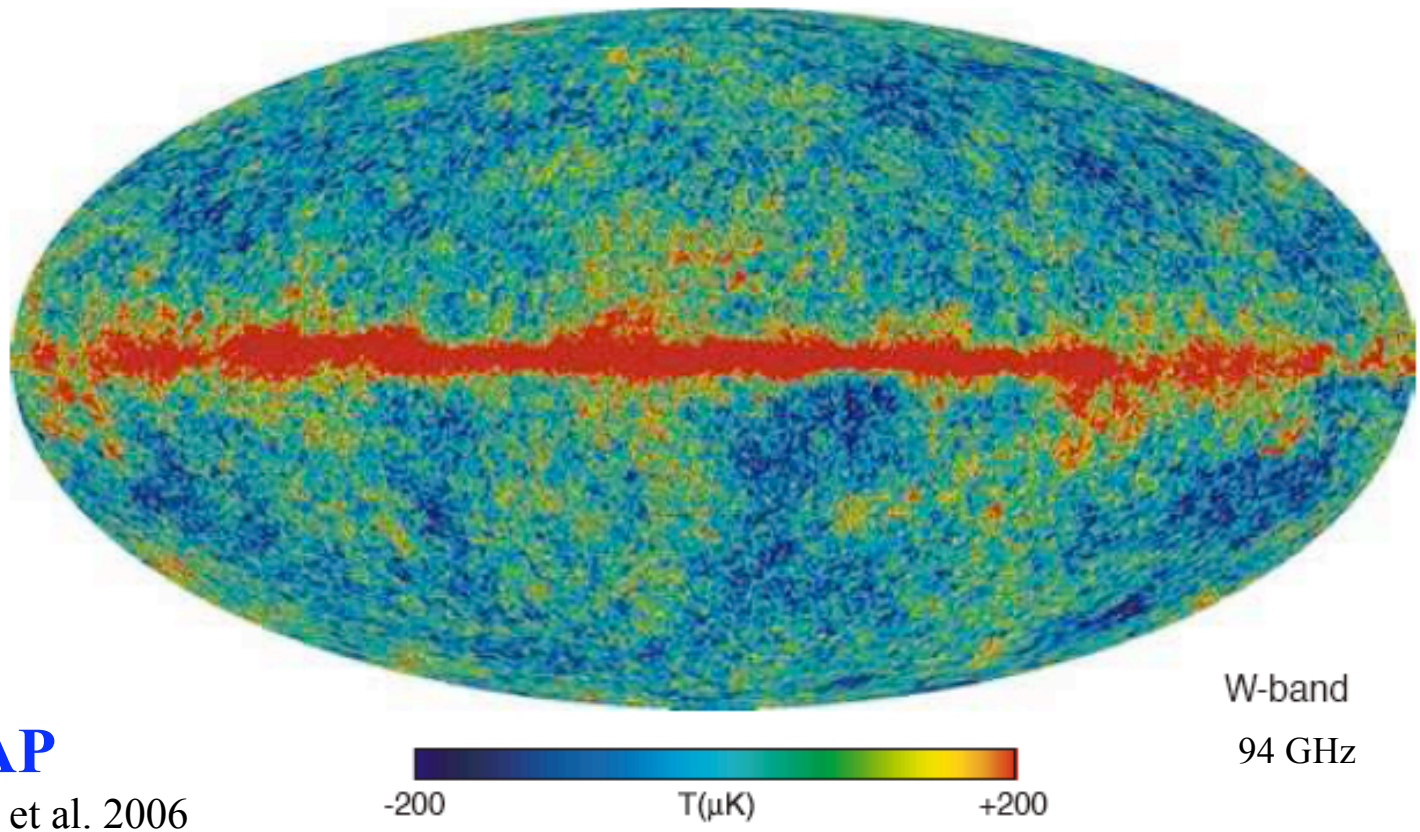
Far-Infrared Background



240 microns (red), 100 microns (green), 60 microns (blue)

Ned Wright
http://www.astro.ucla.edu/~wright/CIBR/images.html

Cosmic Microwave Background (CMB)



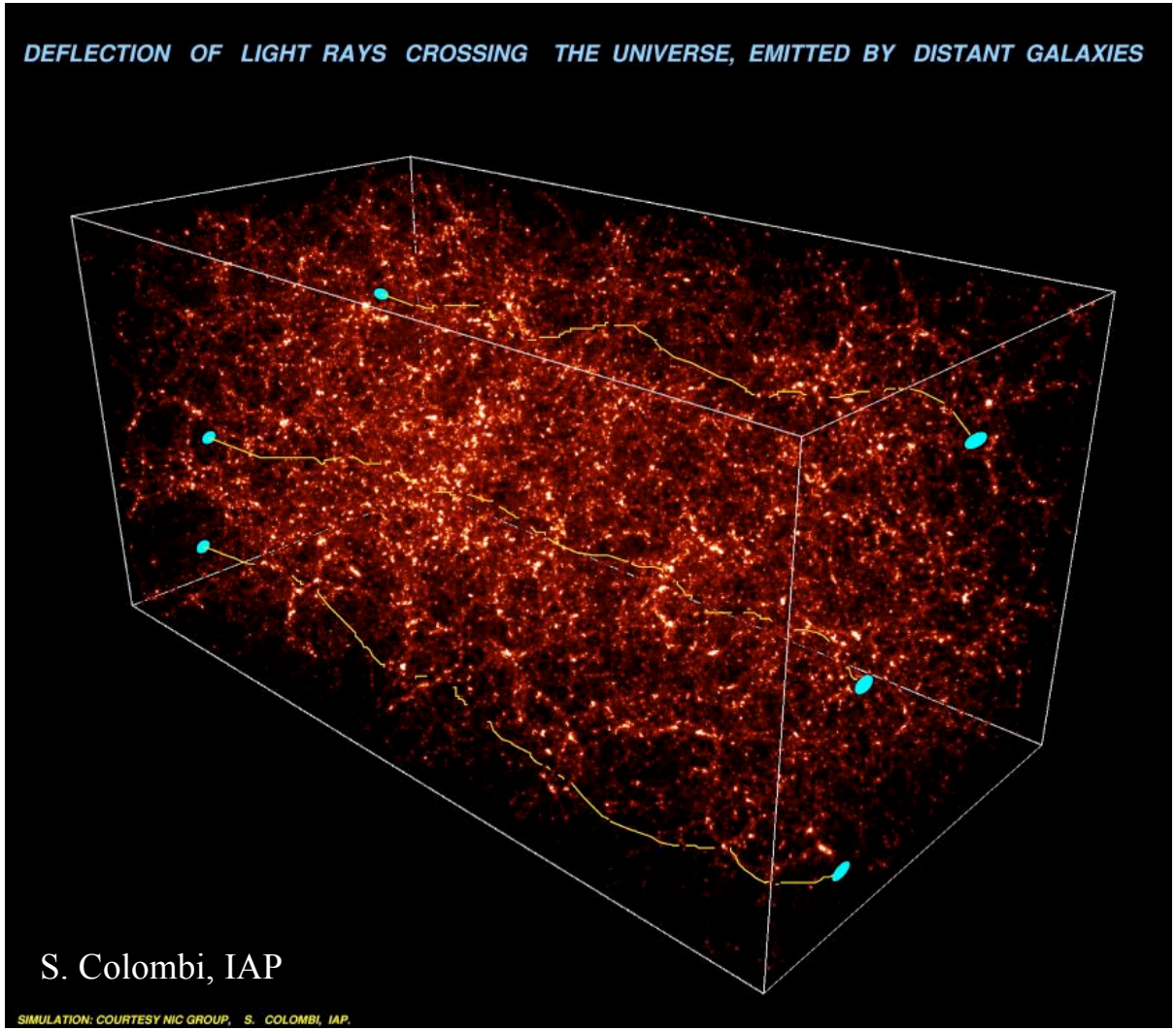
WMAP

Hinshaw et al. 2006

Cosmic Shear

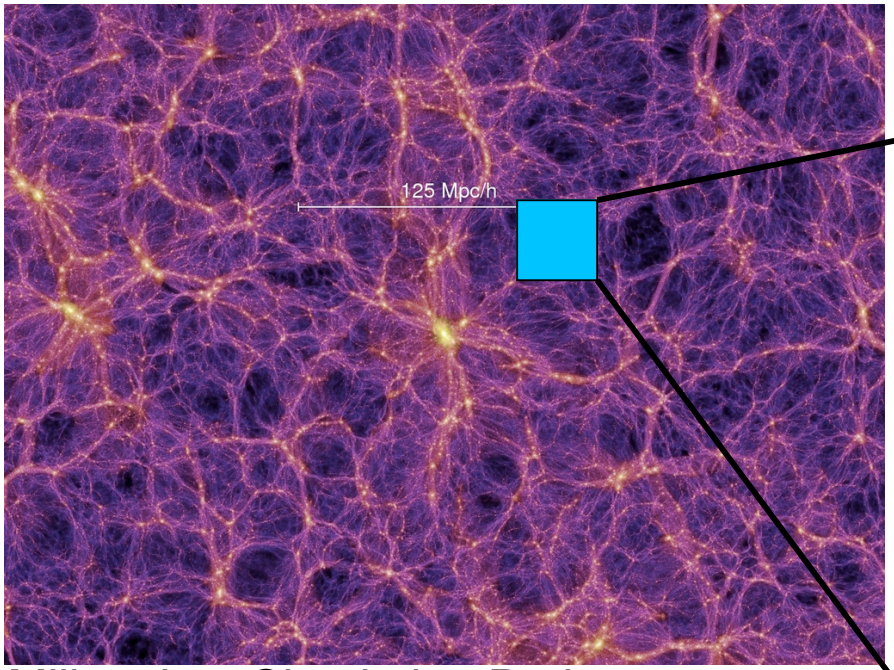
Gravitational deflection of light rays by general matter distribution

Distorts the shapes of background galaxies



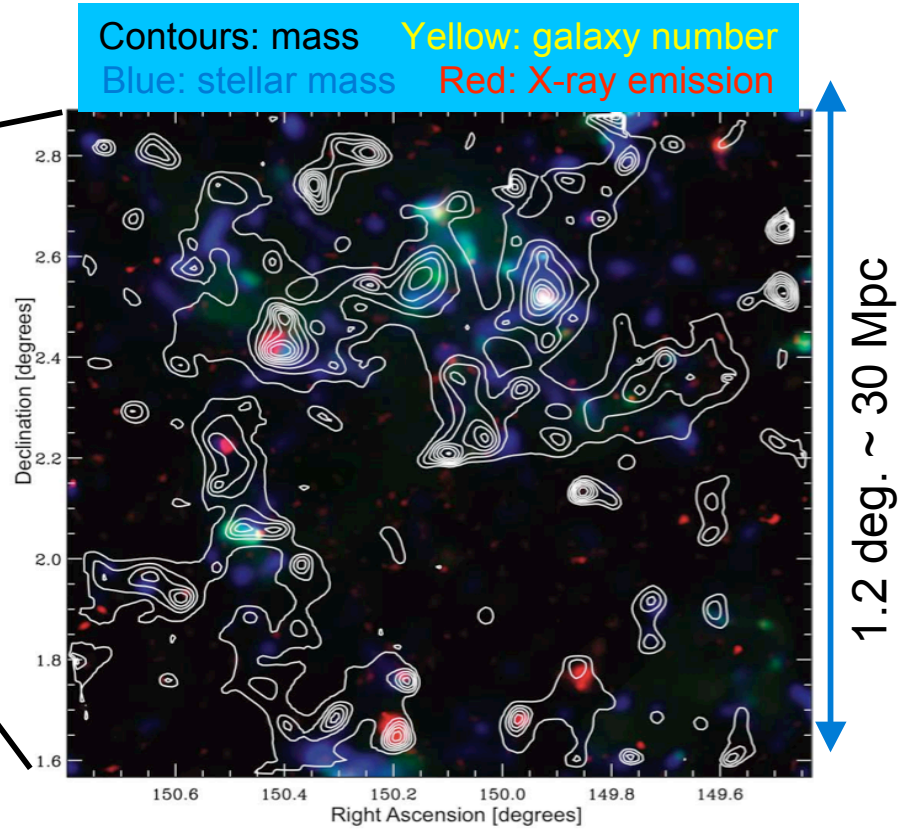
Dark Matter Fabric

Theory



Millennium Simulation Project (10^{10} particles)
Dark Matter Distribution

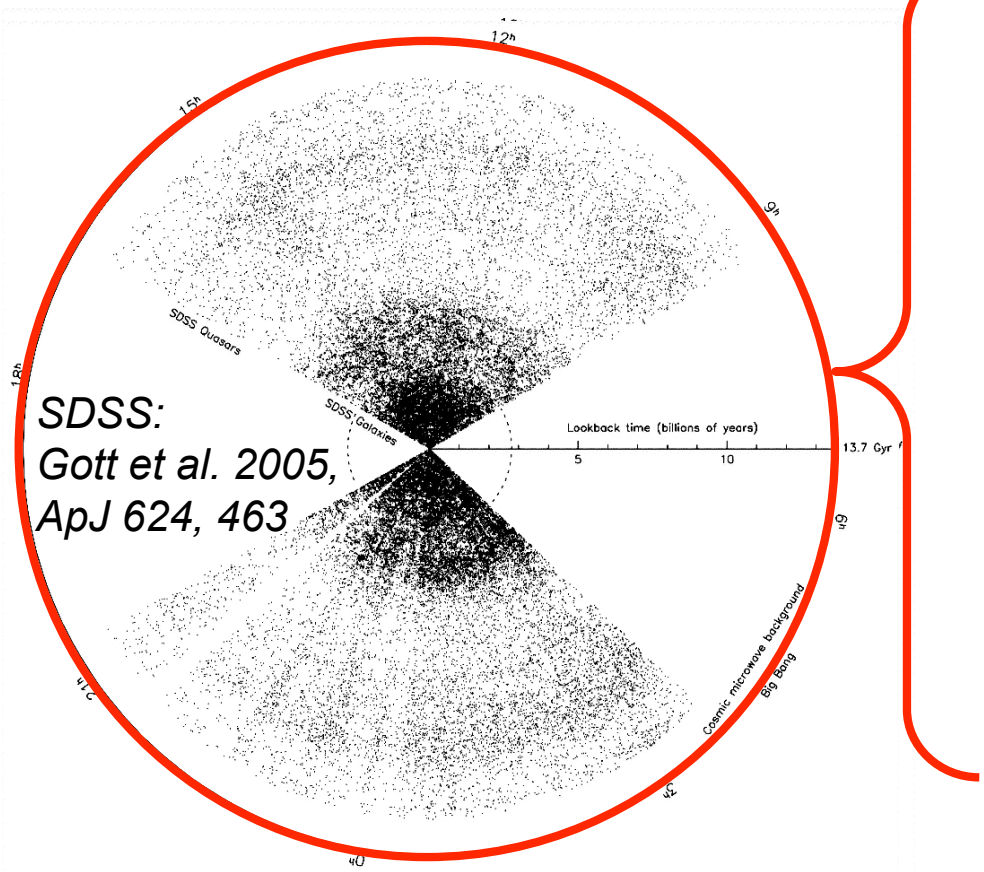
Observations



COSMOS *projected* mass distributions
(Massey et al., 2007)

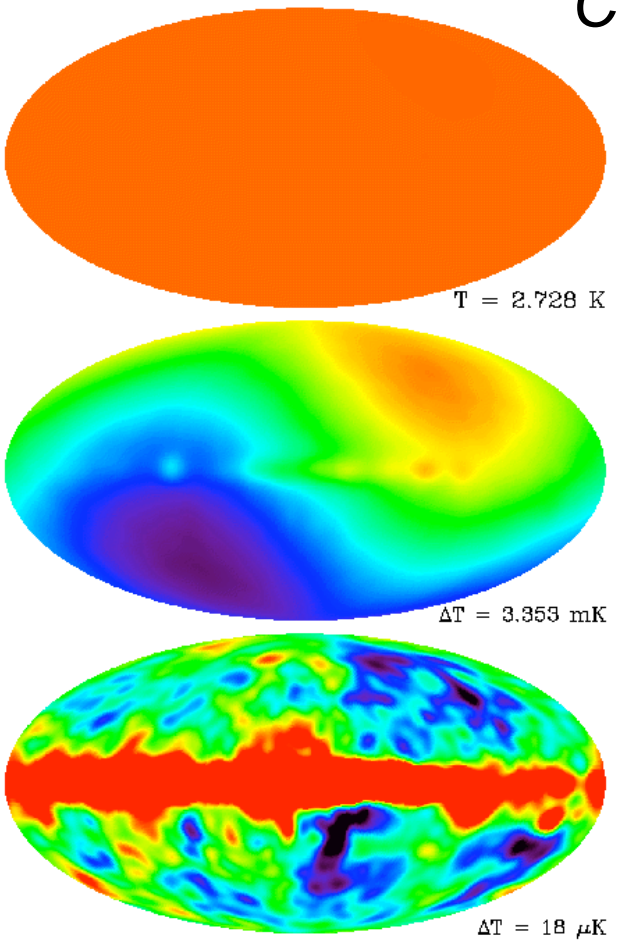
The Big Picture

Observational basis:



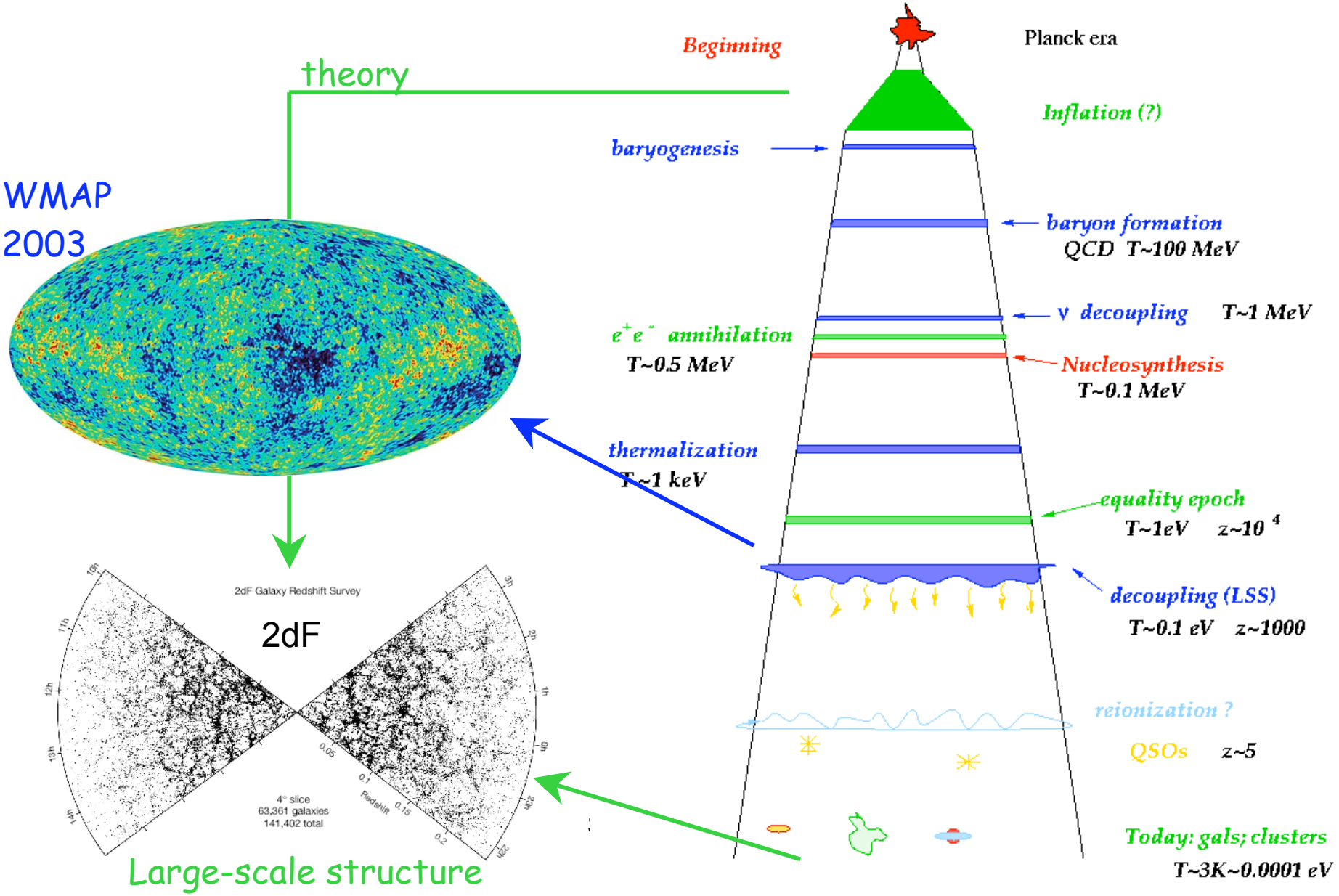
SDSS:
Gott et al. 2005,
ApJ 624, 463

CMB



COBE DMR

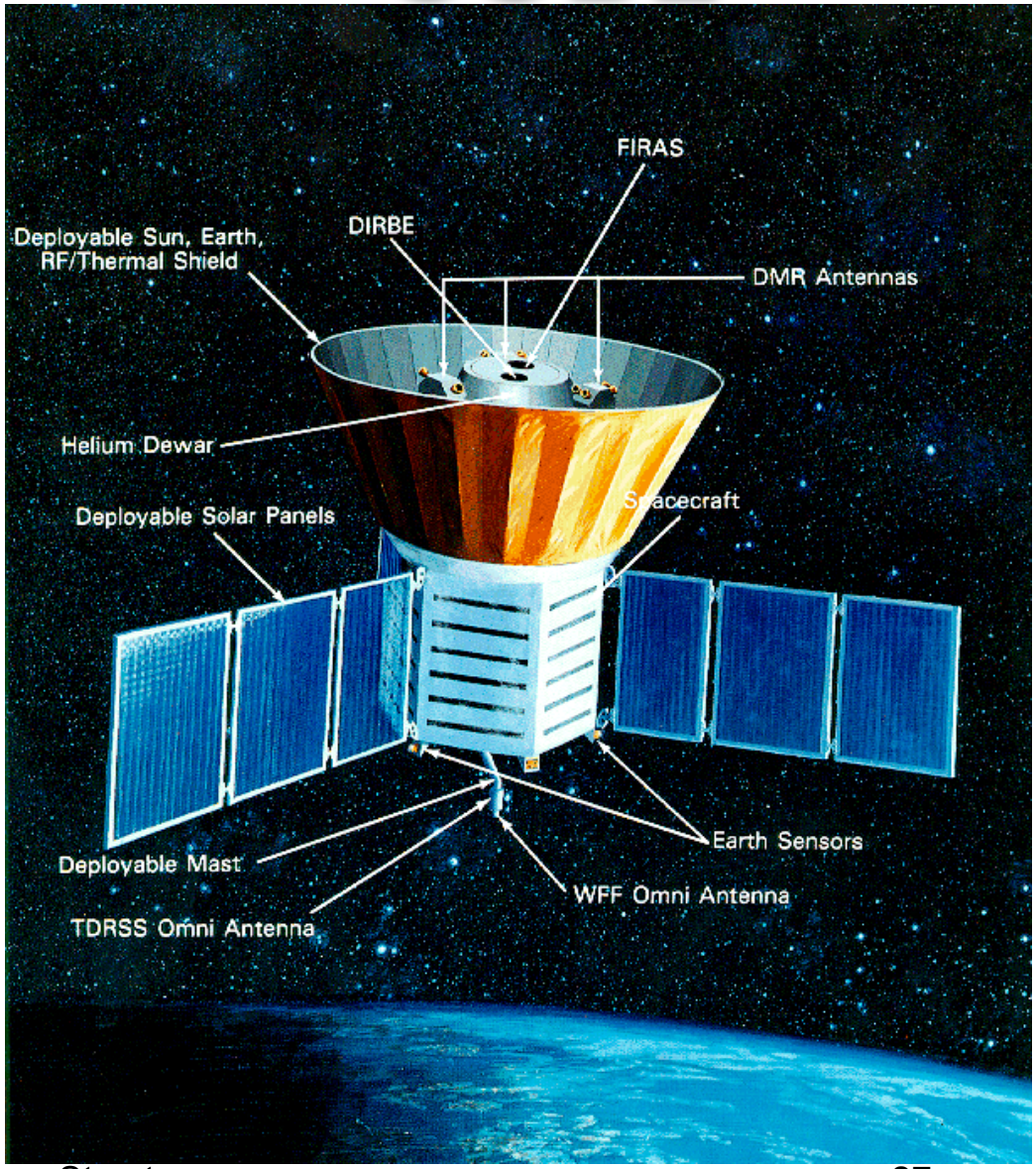
The Big Picture



COBE

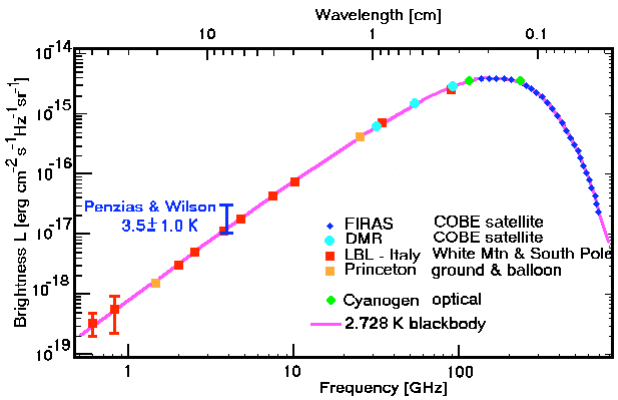
Physics 2006
Nobel Prize

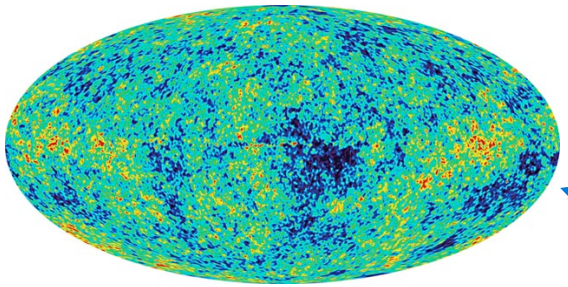
- John Mather
- George Smoot

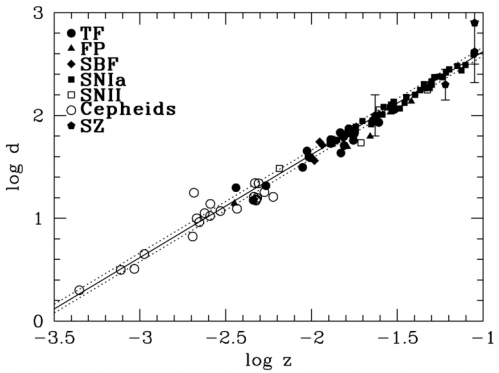


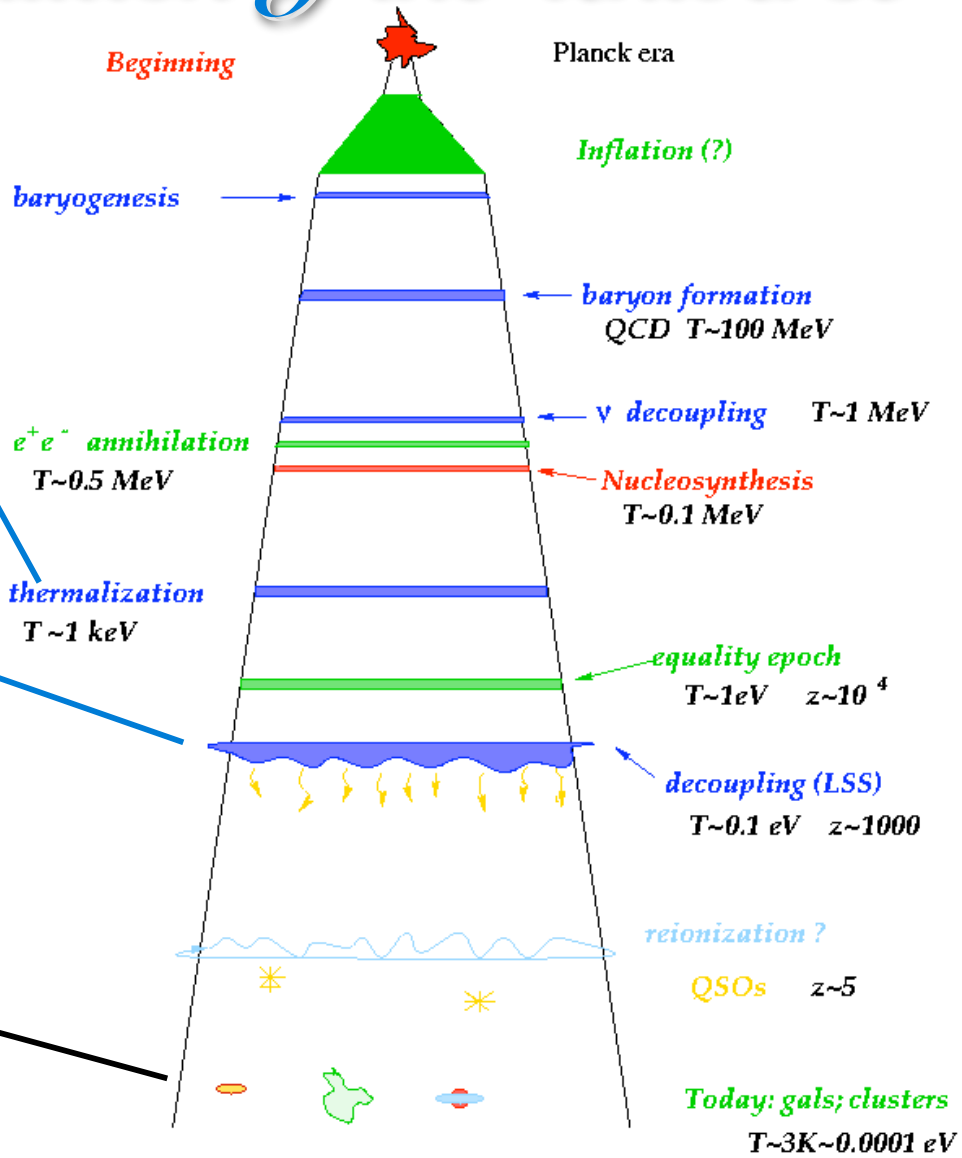
Overview

Contents & Evolution of the Universe









Why Study Them?

- To explain their origin and evolution; it's part of cosmology
- Use them to understand cosmology
  - Nature of Dark Energy
  - Nature of Dark Matter
  - Parameters
  - Neutrino Mass
  - Fundamental Physics