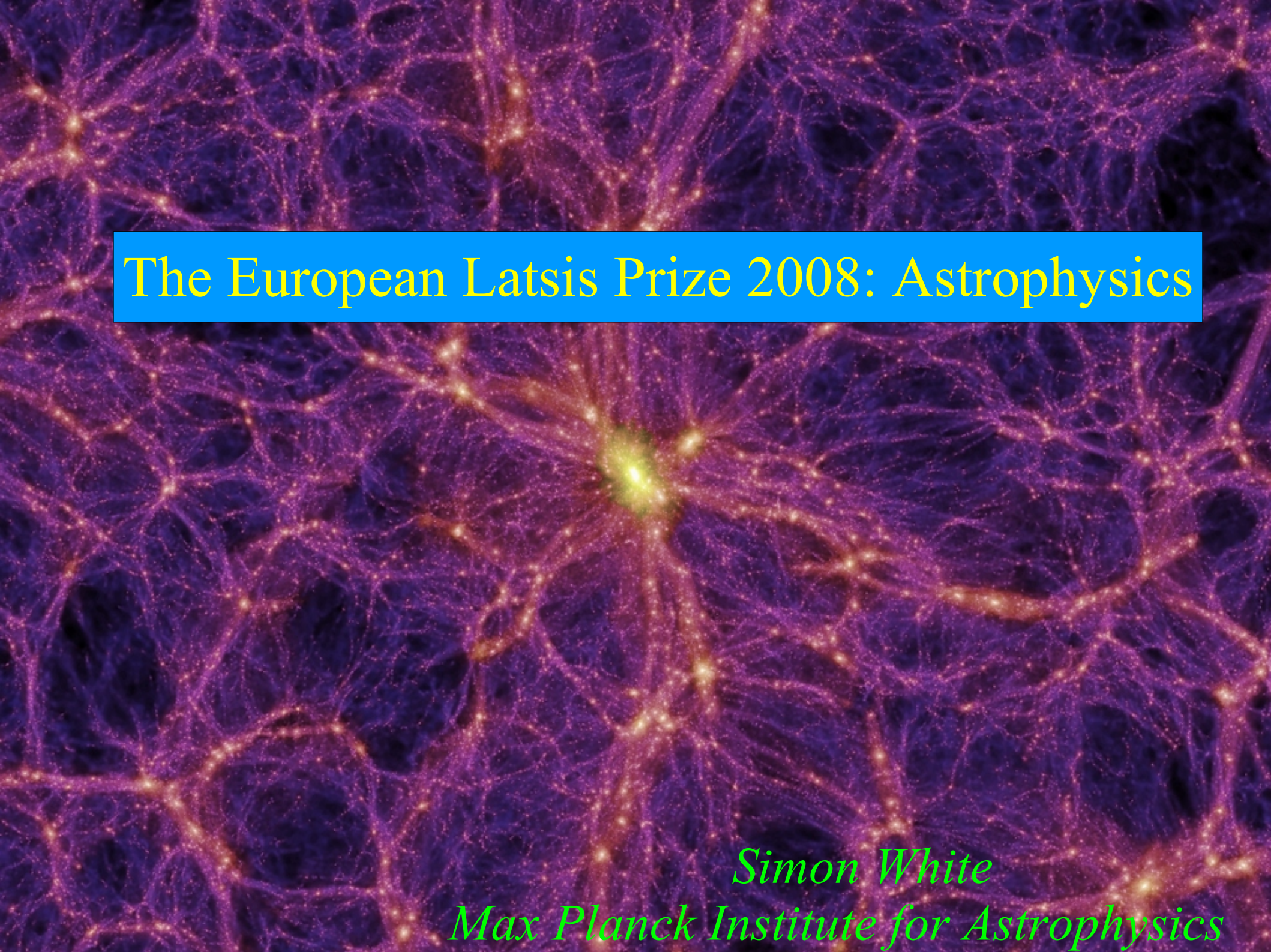
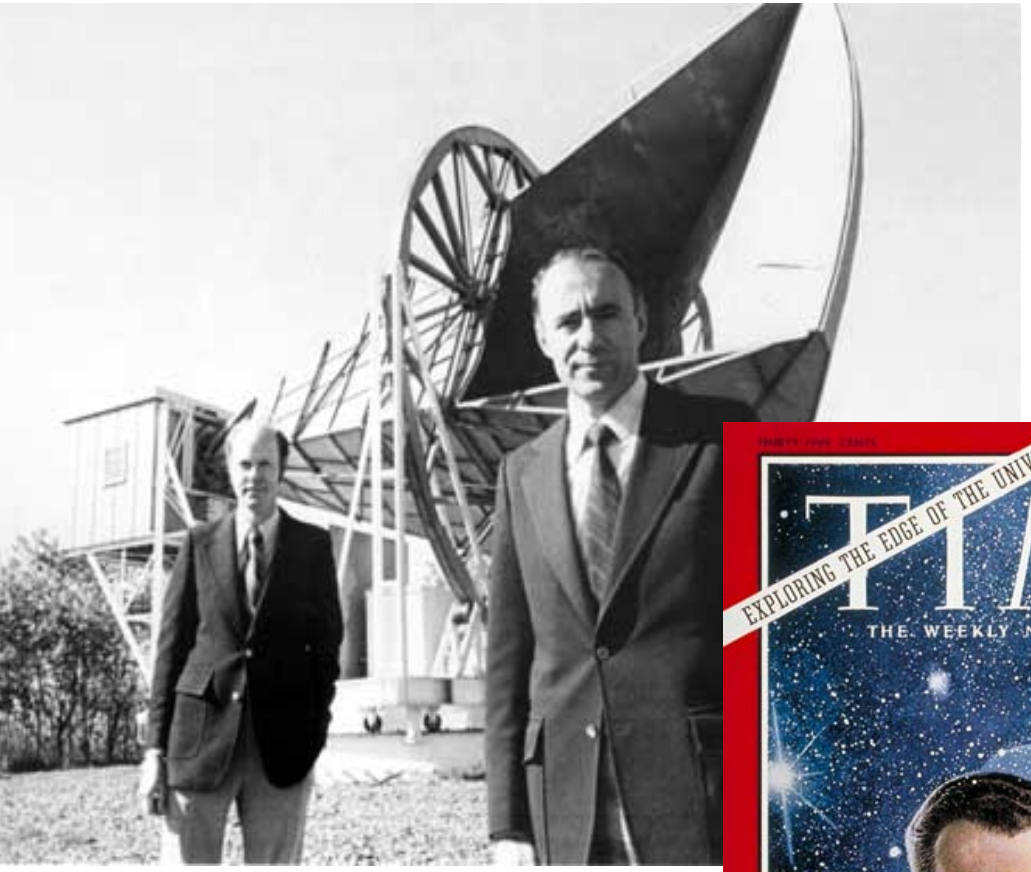


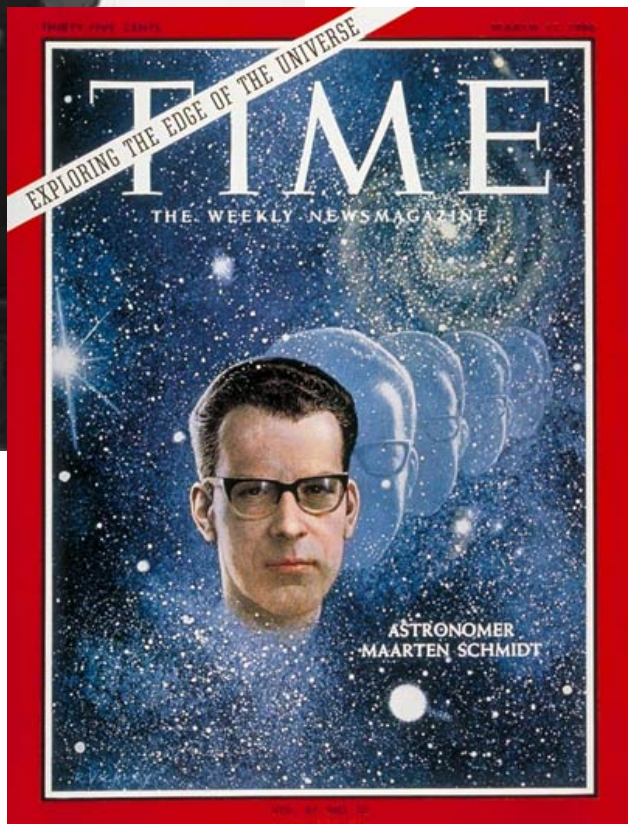
The European Latsis Prize 2008: Astrophysics

Simon White
Max Planck Institute for Astrophysics

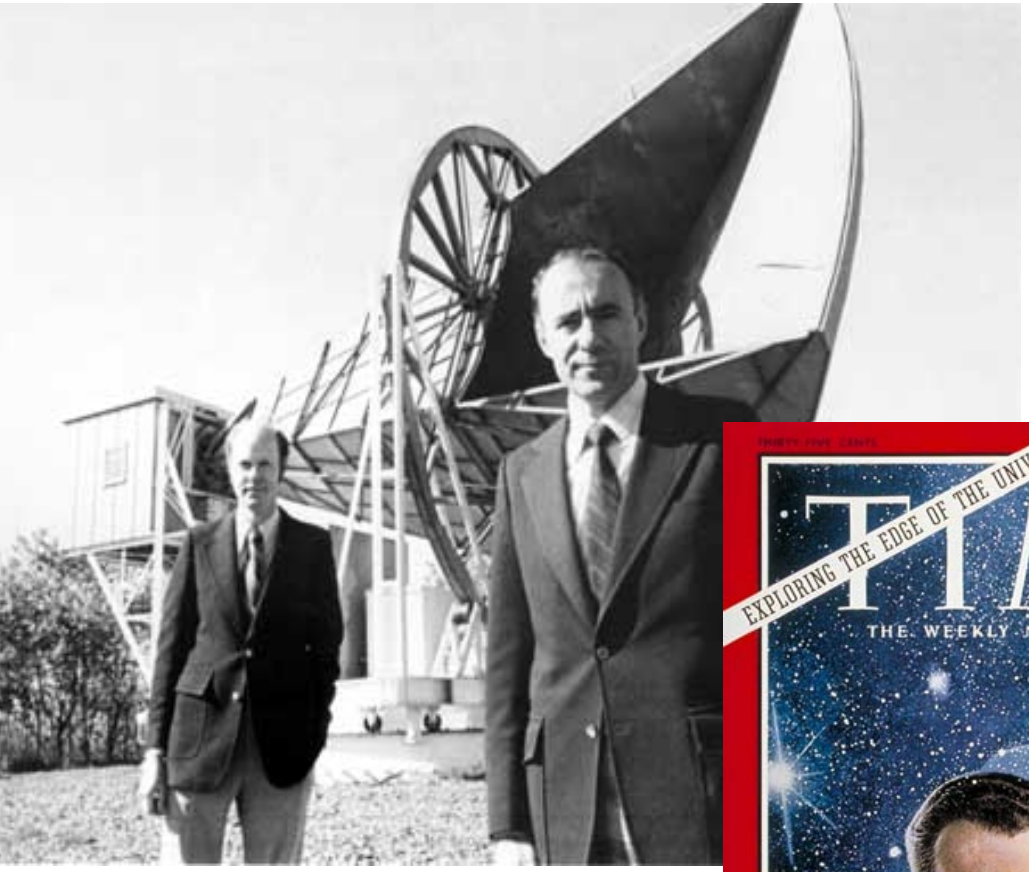
Cosmic Microwave Background



Cosmic Microwave Background



Quasars



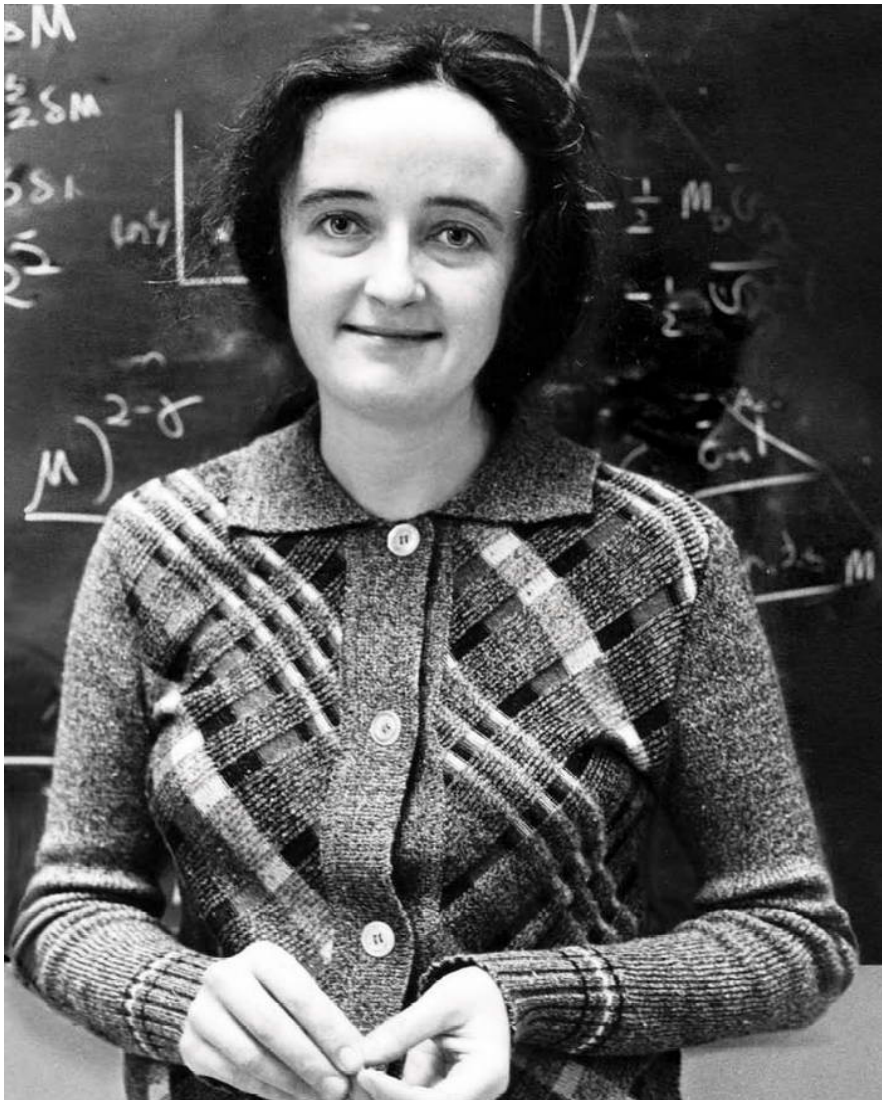
Cosmic Microwave Background

Quasars

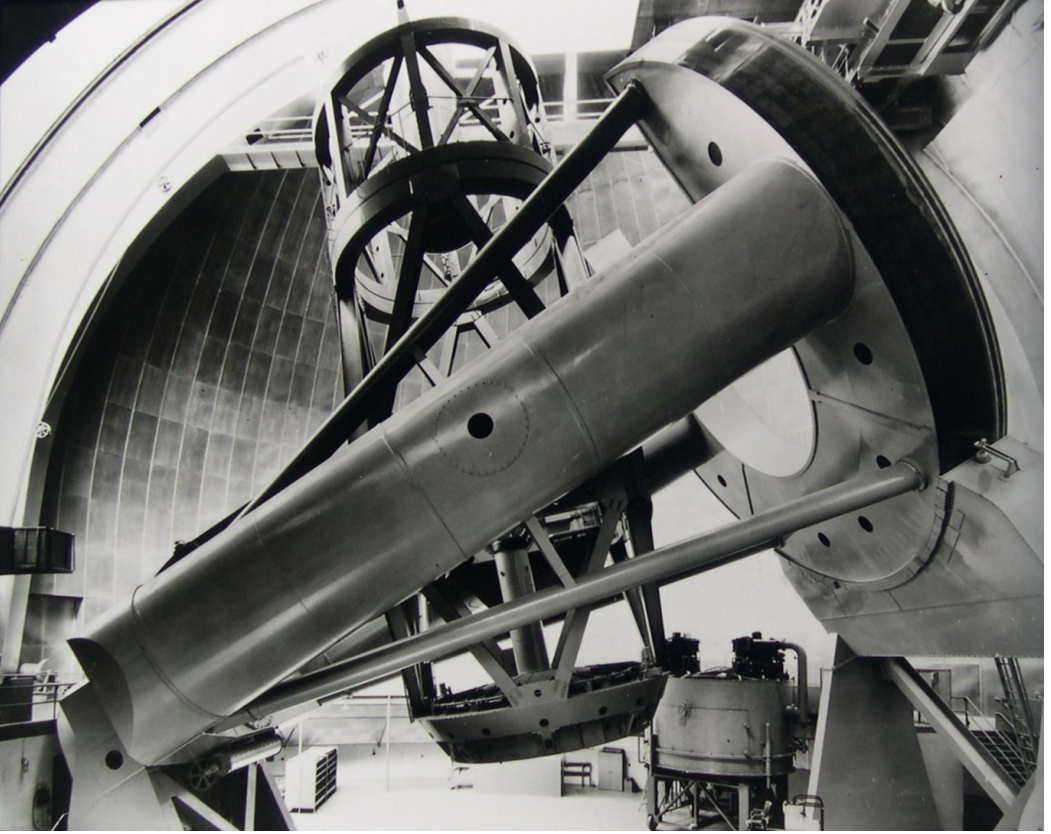
Pulsars

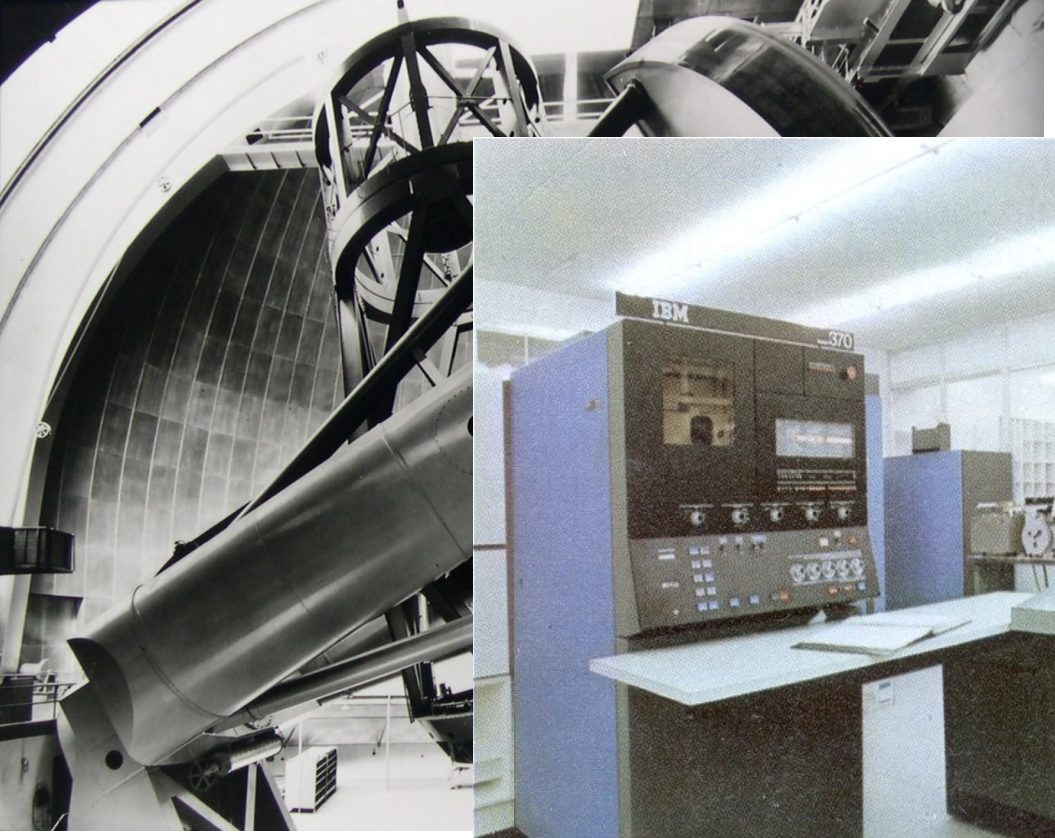
Fritz Zwicky
Unseen (“dark”) matter (1933)

Fritz Zwicky
Unseen (“dark”) matter (1933)

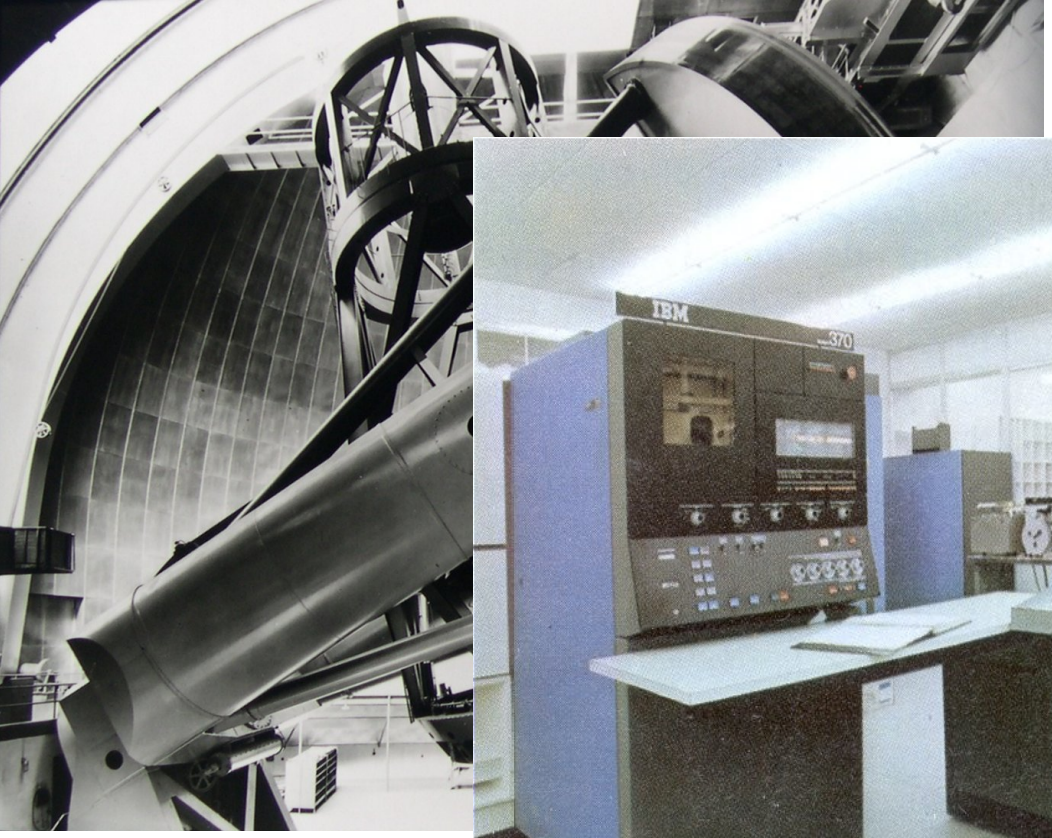


Beatrice Tinsley
Galaxy evolution (1970's)





IBM
370
http://compuclasico.homelinux.net



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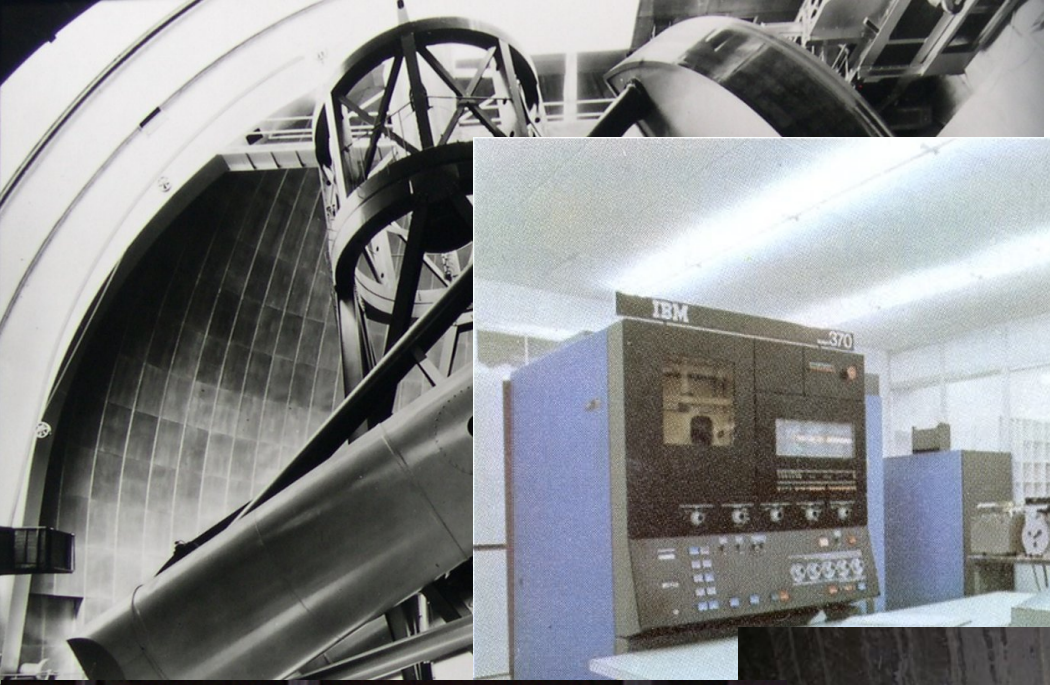
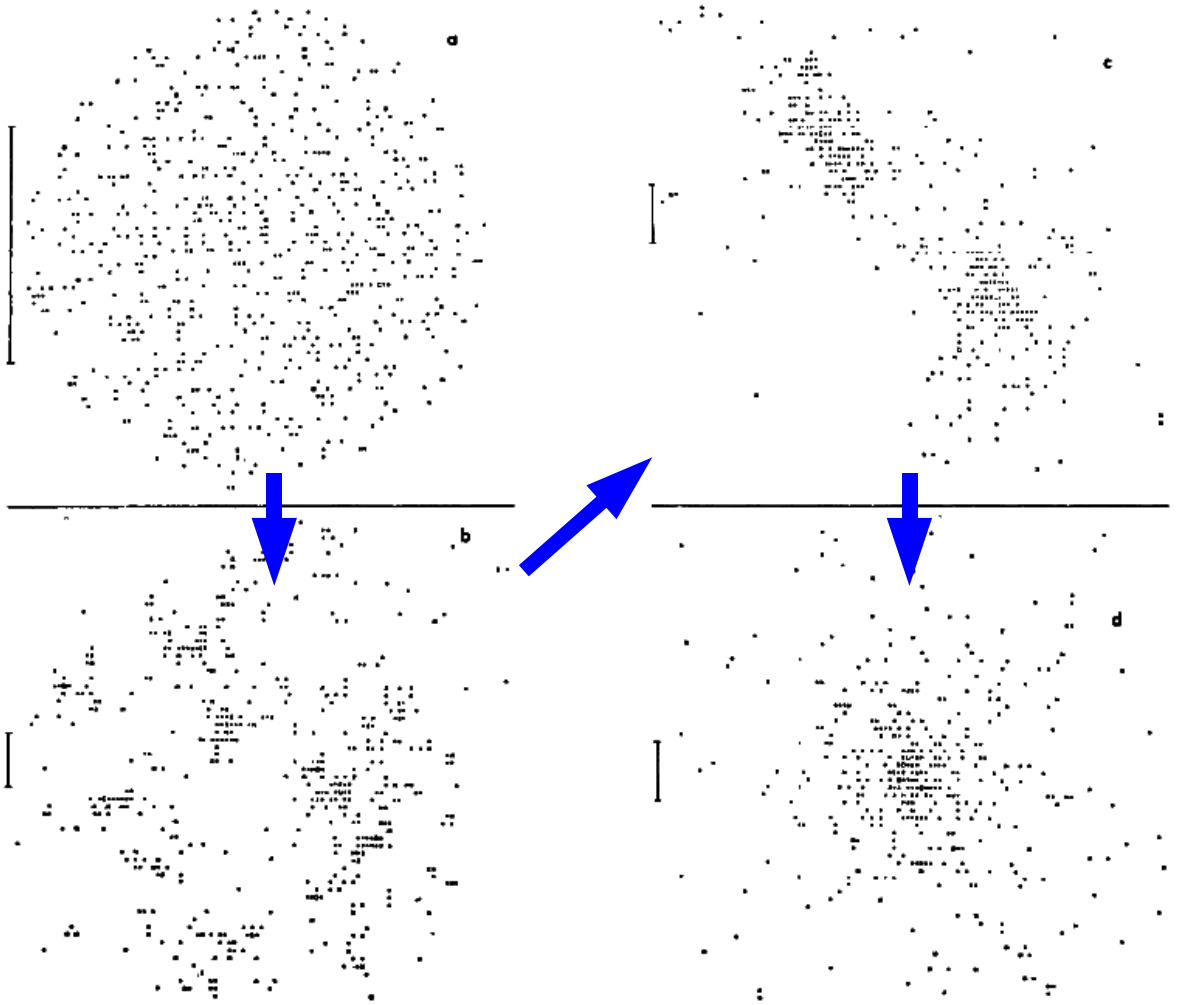
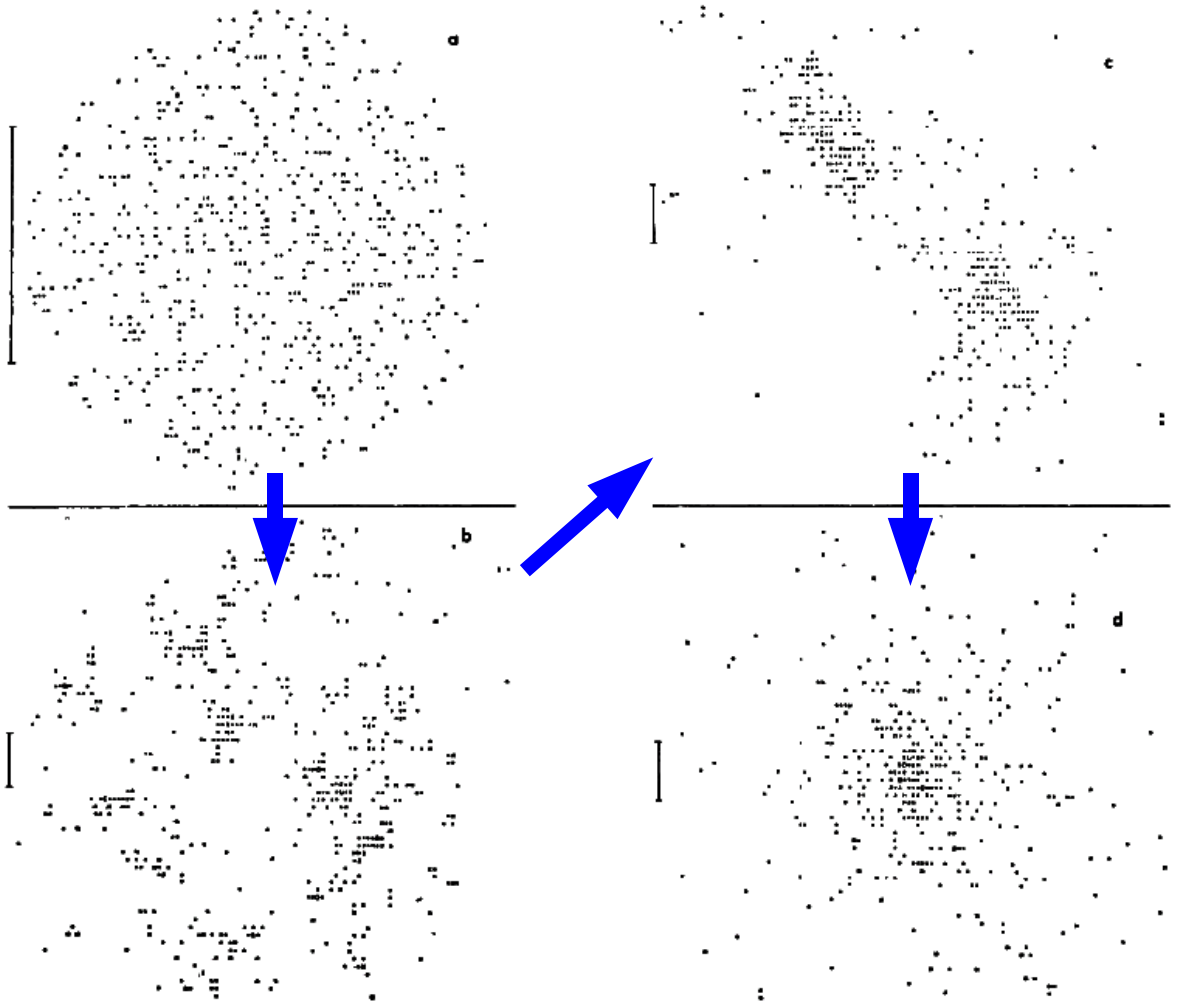


IBM
370

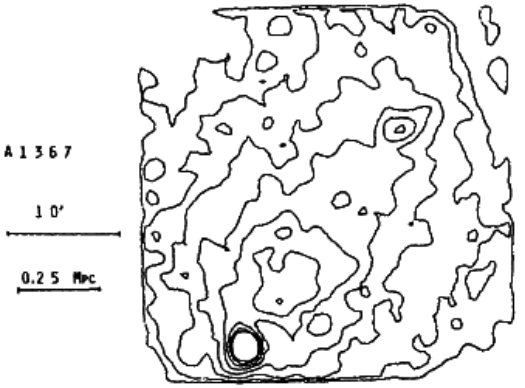
HYDROSTATICS
(METRIC)
INPUT
CREDIBILITY
(METRIC)
BONJEANS
STATICAL
STABILITY

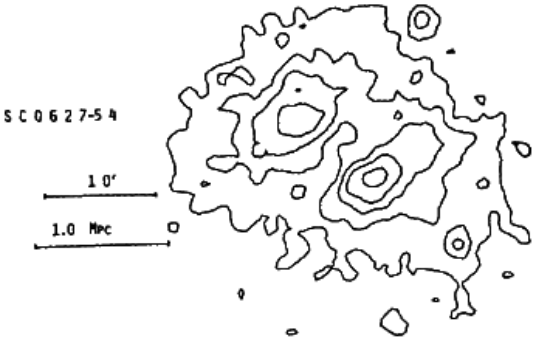


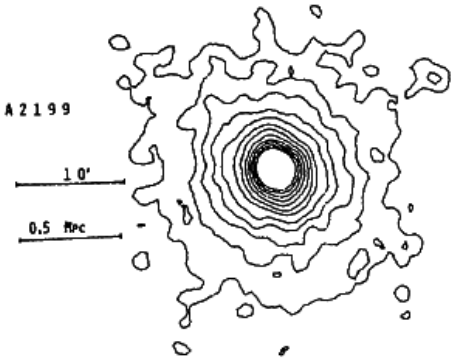
cluster simulation 1977



cluster simulation 1977



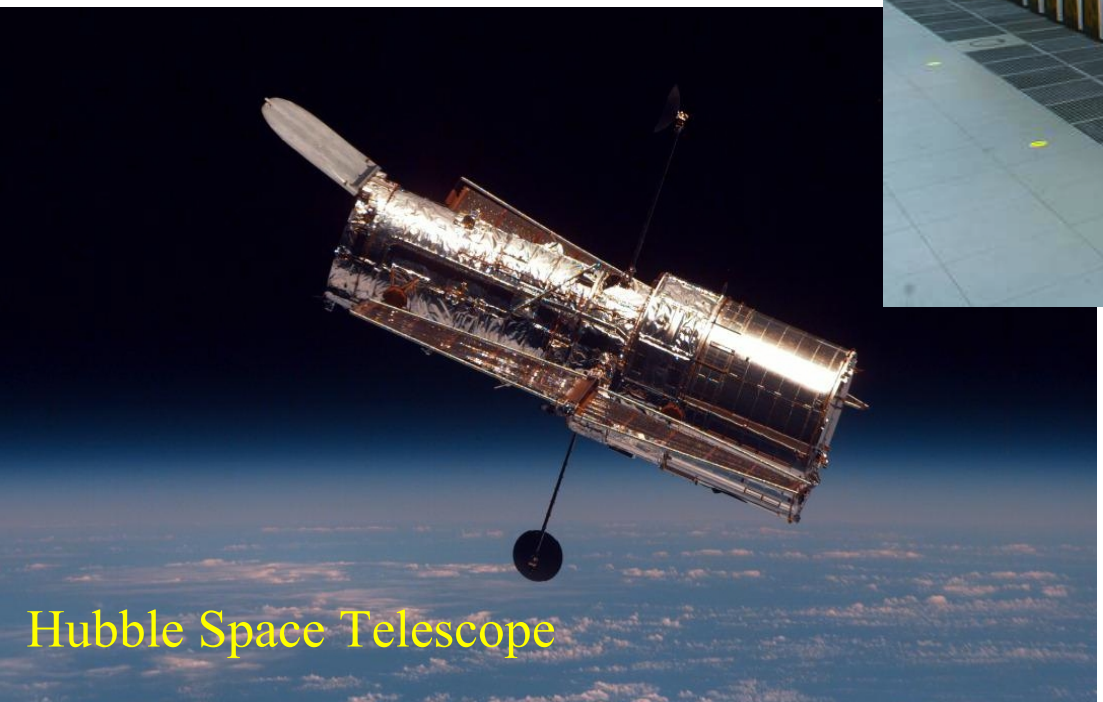




cluster images 1980

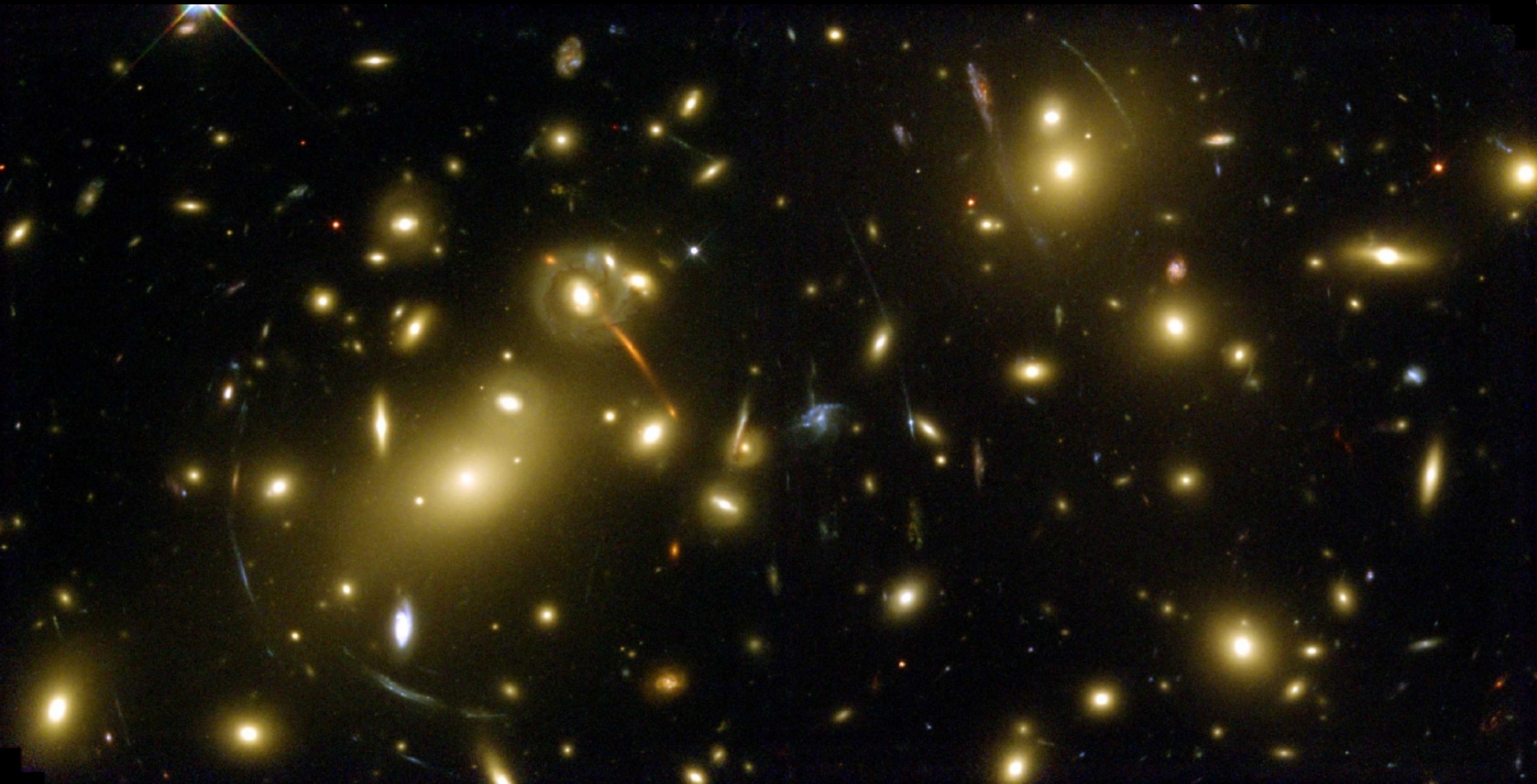

Very Large Telescope


Leibniz Computing Centre

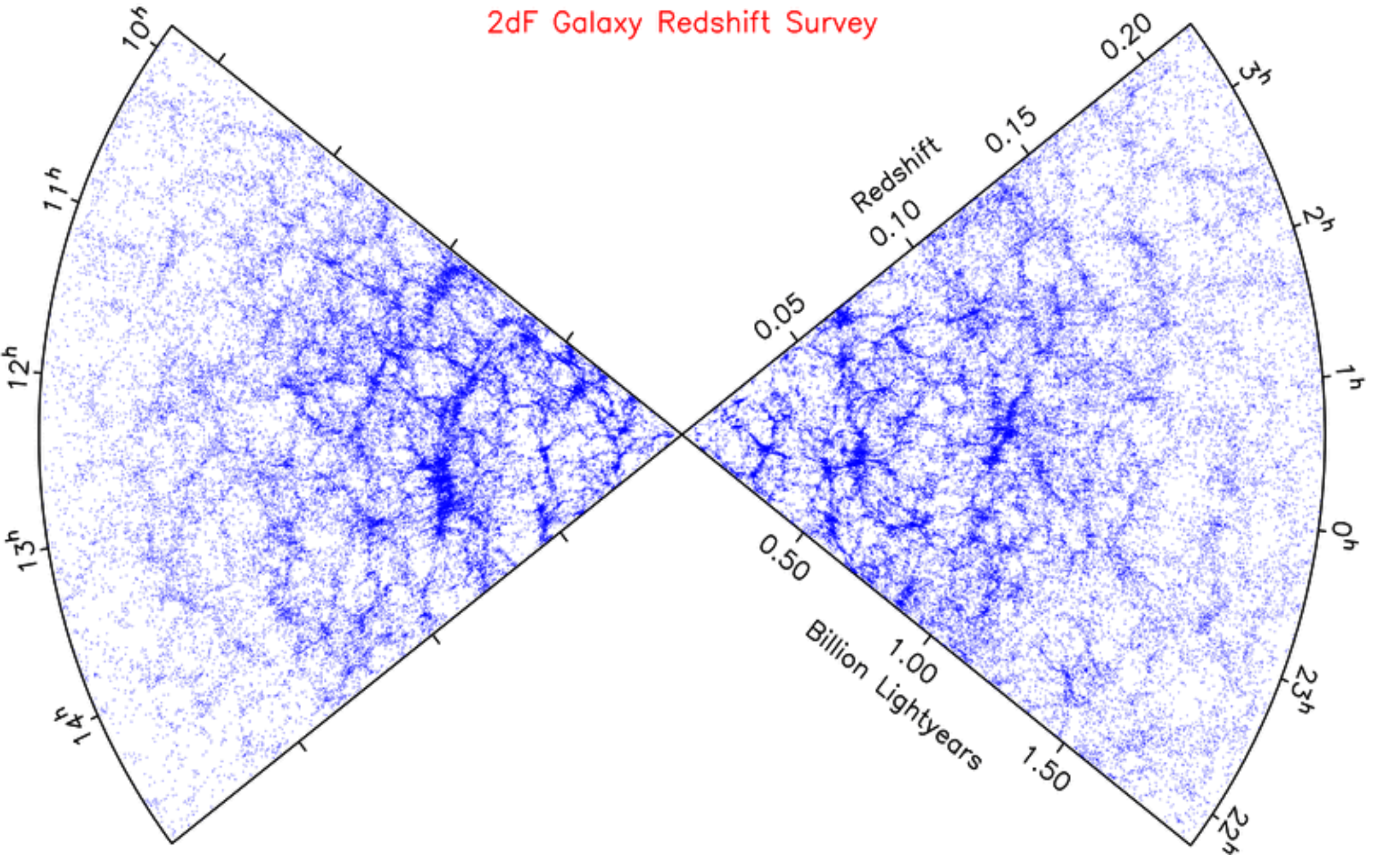

Hubble Space Telescope

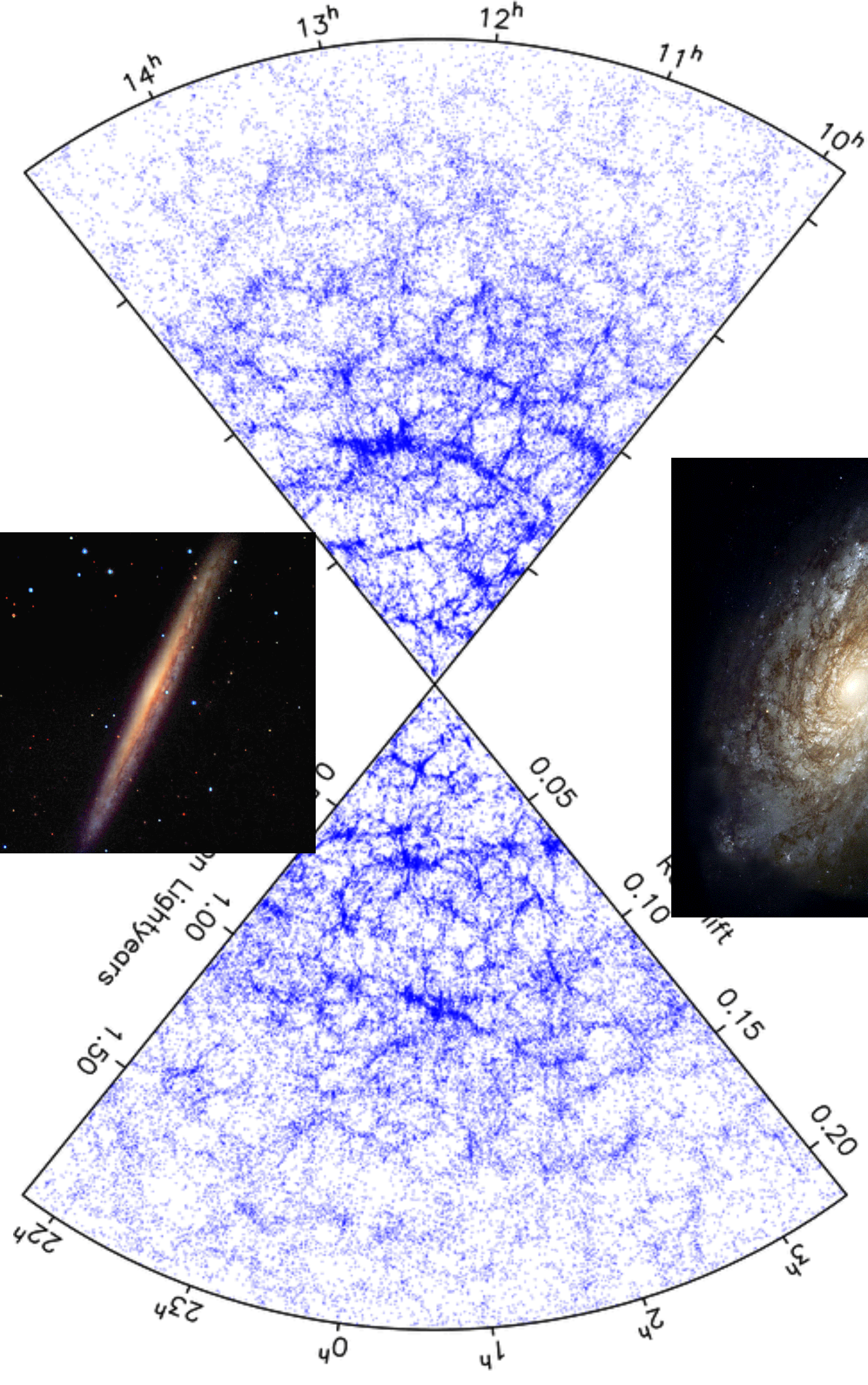
Gravitational lensing: “seeing” the dark matter

Abell 2218 z=0.17



“Nearby” large-scale structure




13h
12h
14h
11h
10h
0.05
0.10
0.15
0.20
1.00
1.50
22h
23h
0h
1h
2h
3h

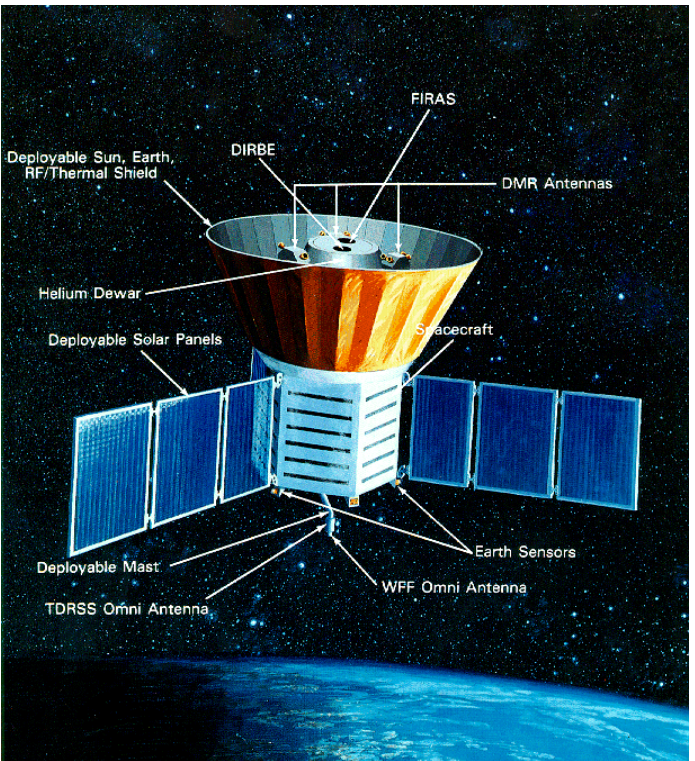
The deepest photo ever made

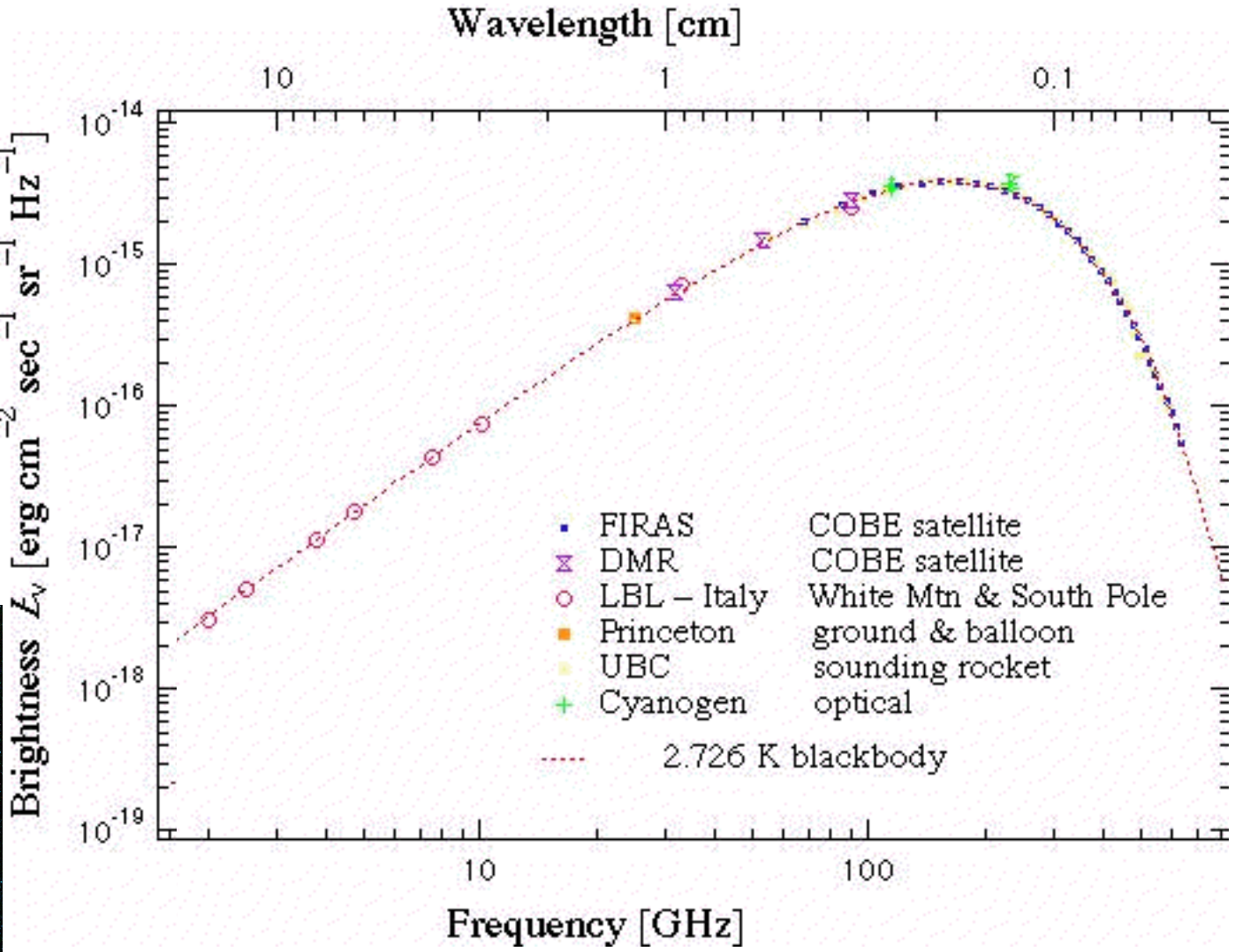
A 300 hour exposure with the Hubble Space Telescope

Galaxies seen when Universe was a tenth its present age!

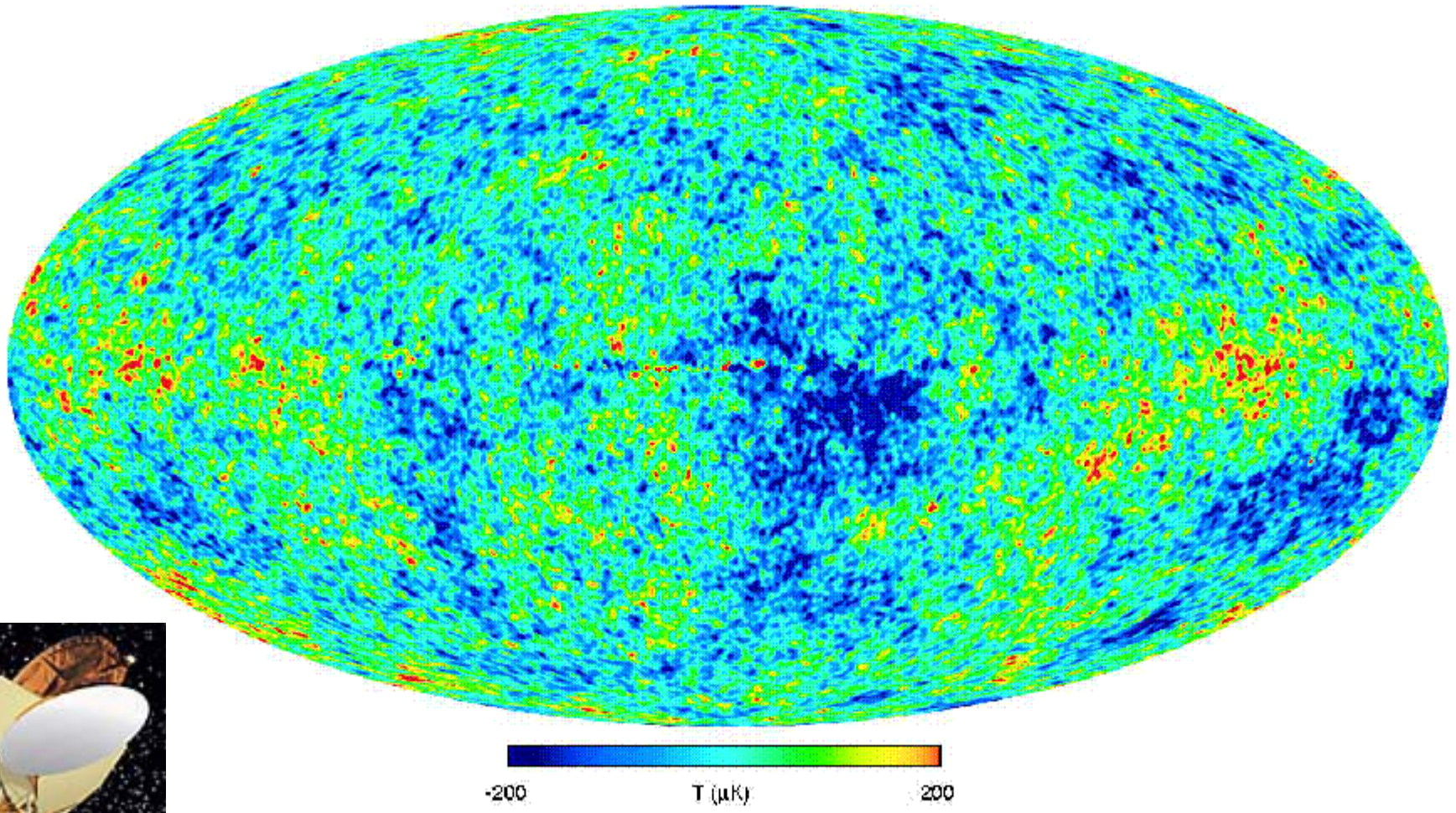
Today they are 30,000,000,000 light-yrs away!

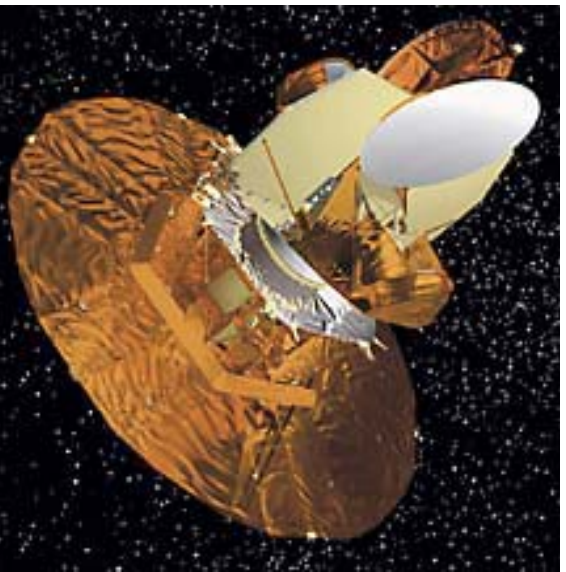
A Proof of the Hot Big Bang: the COBE satellite (1990)



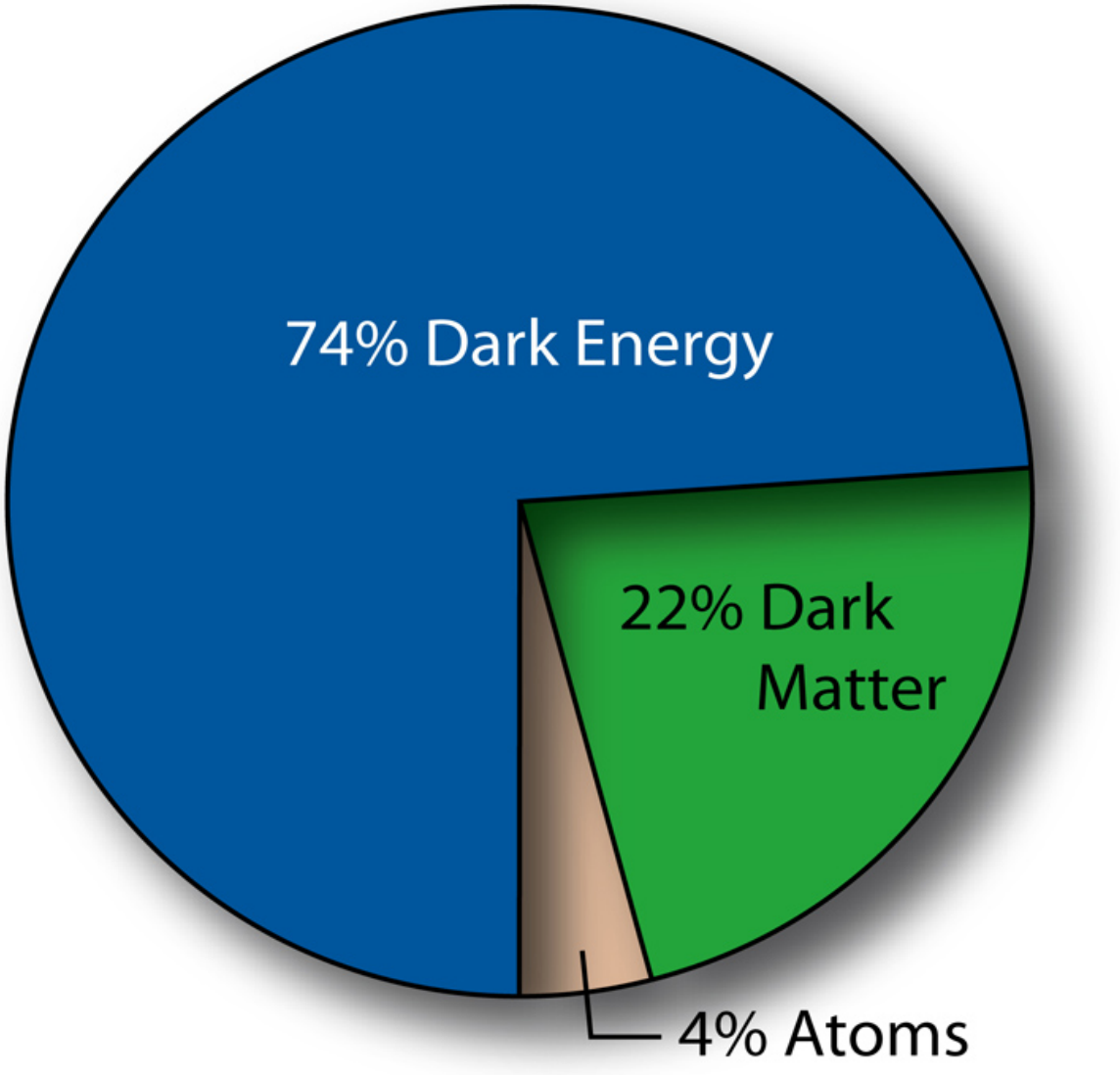


The *WMAP* of the whole CMB sky (2003)

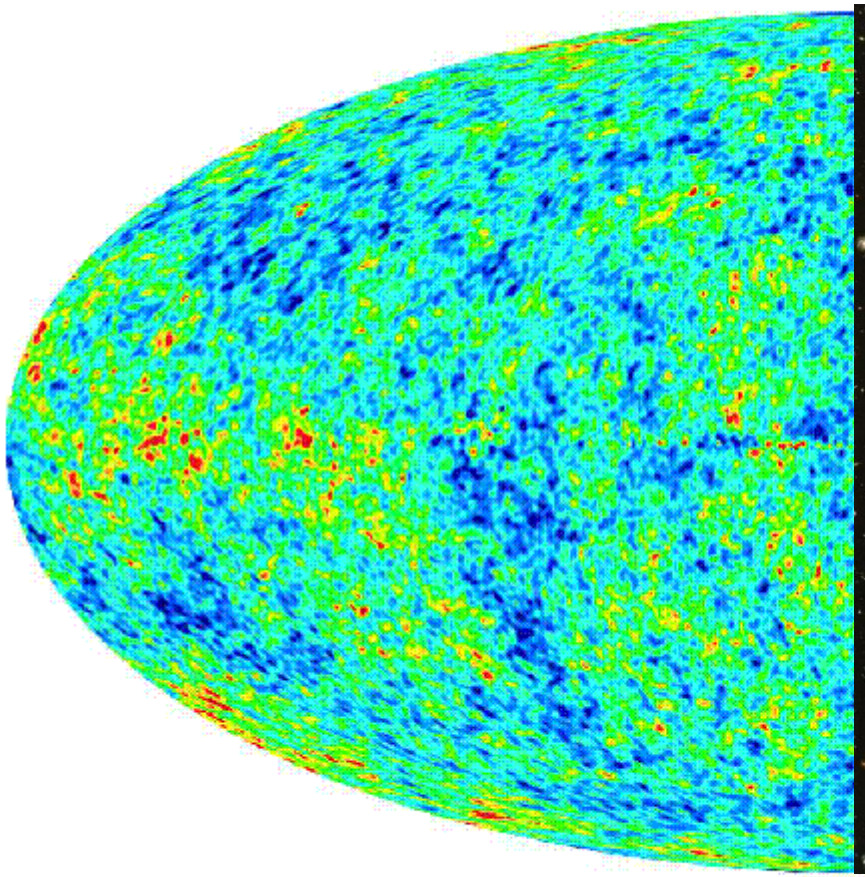




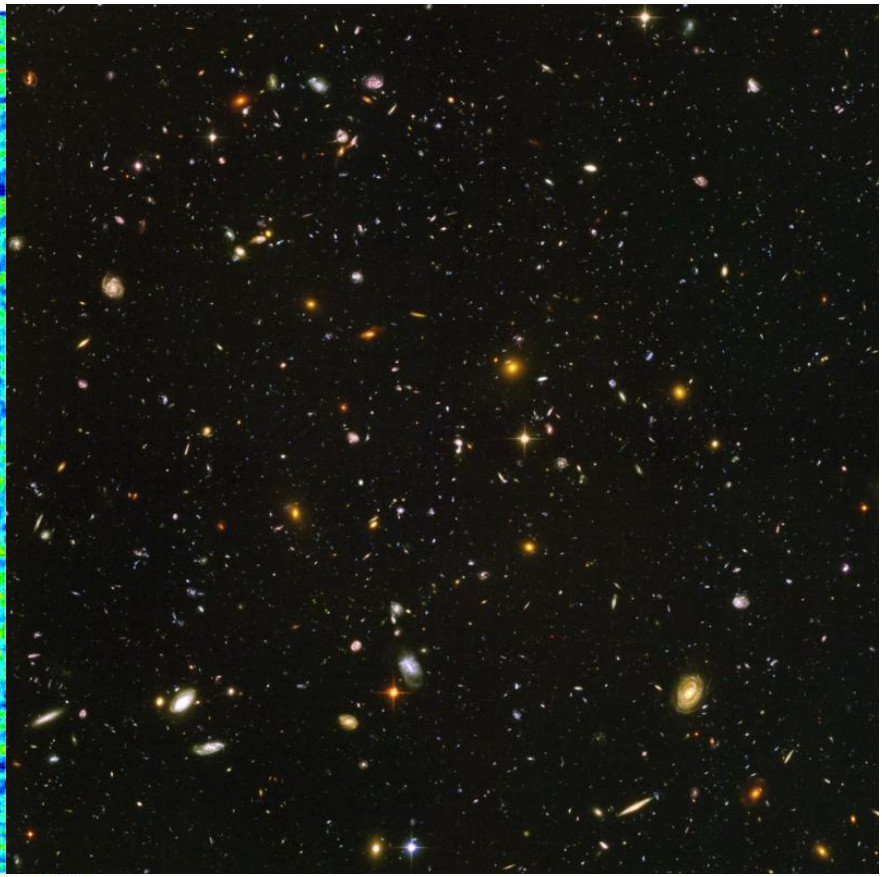
Ordinary matter is a small fraction of today's Universe



Our universe changes with time

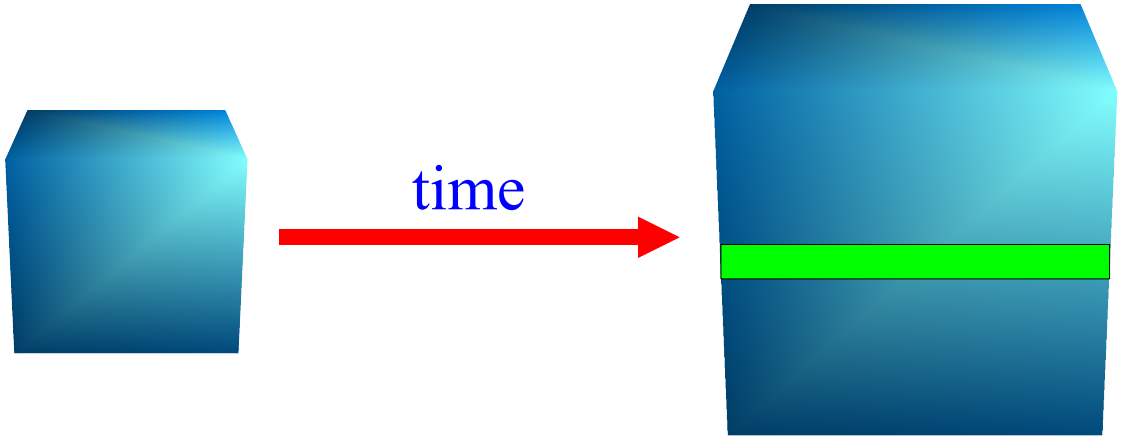


WMAP 2003

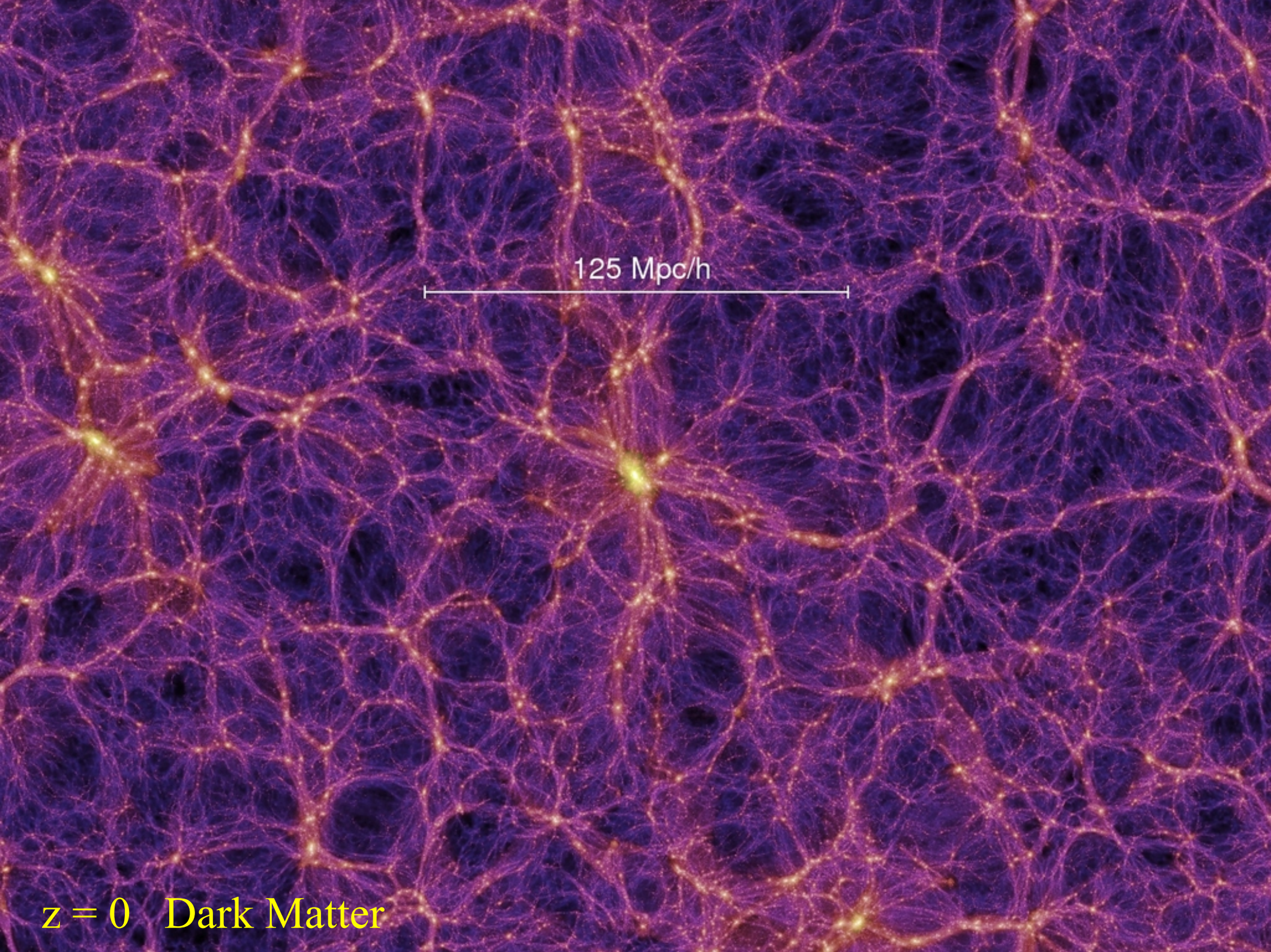


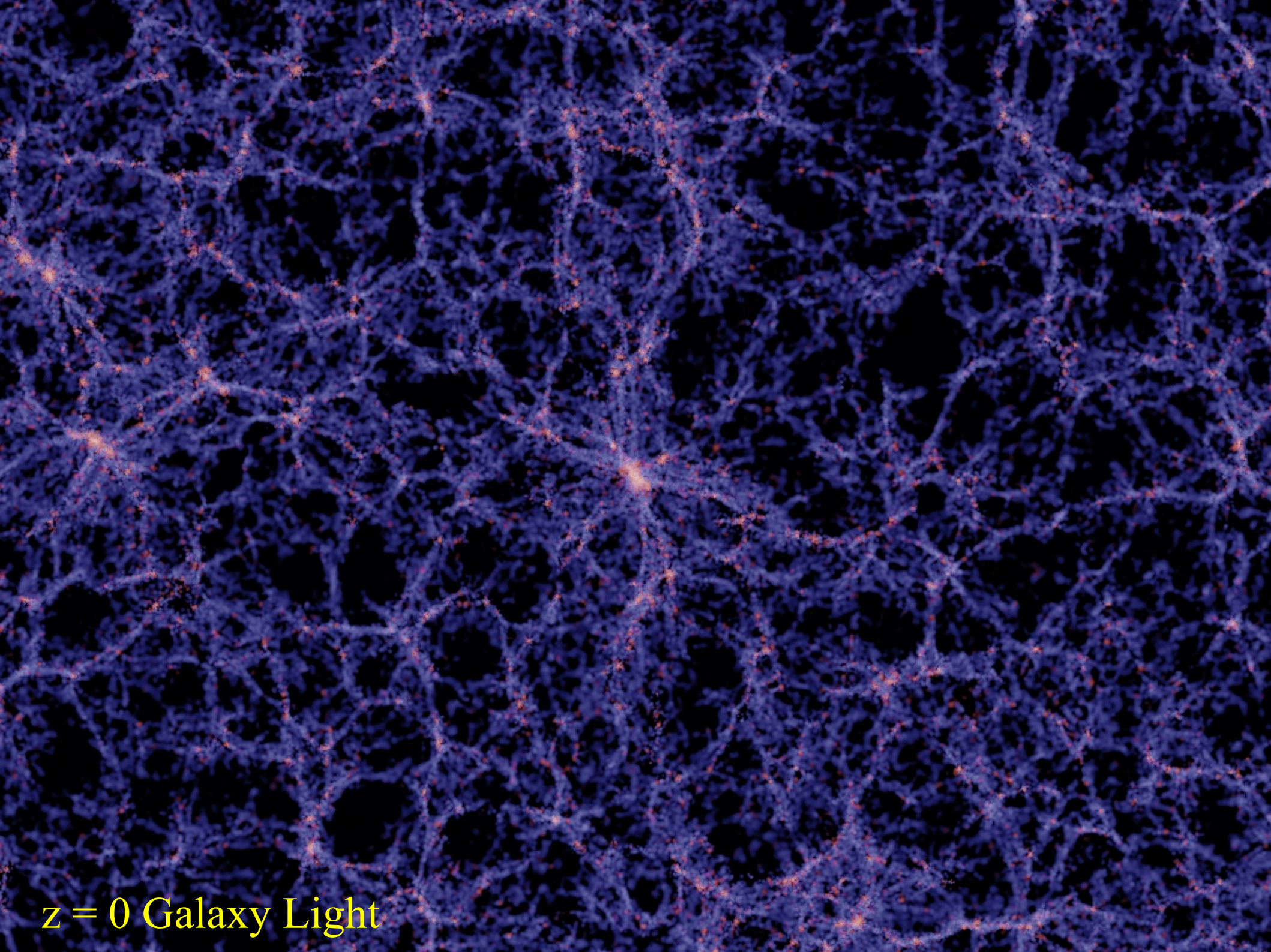
The Hubble Ultradeep Field

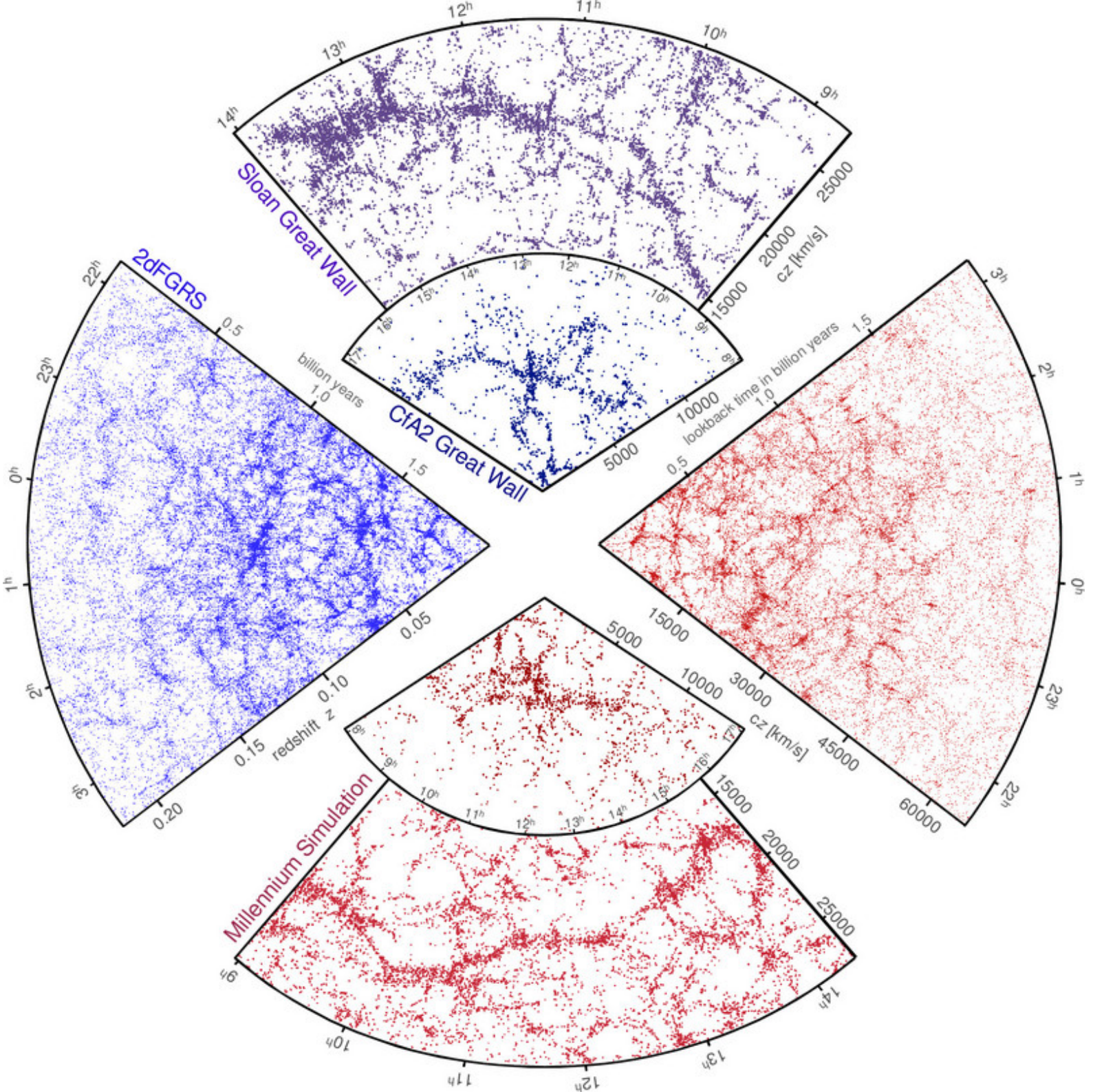
How structure emerges from the Big Bang

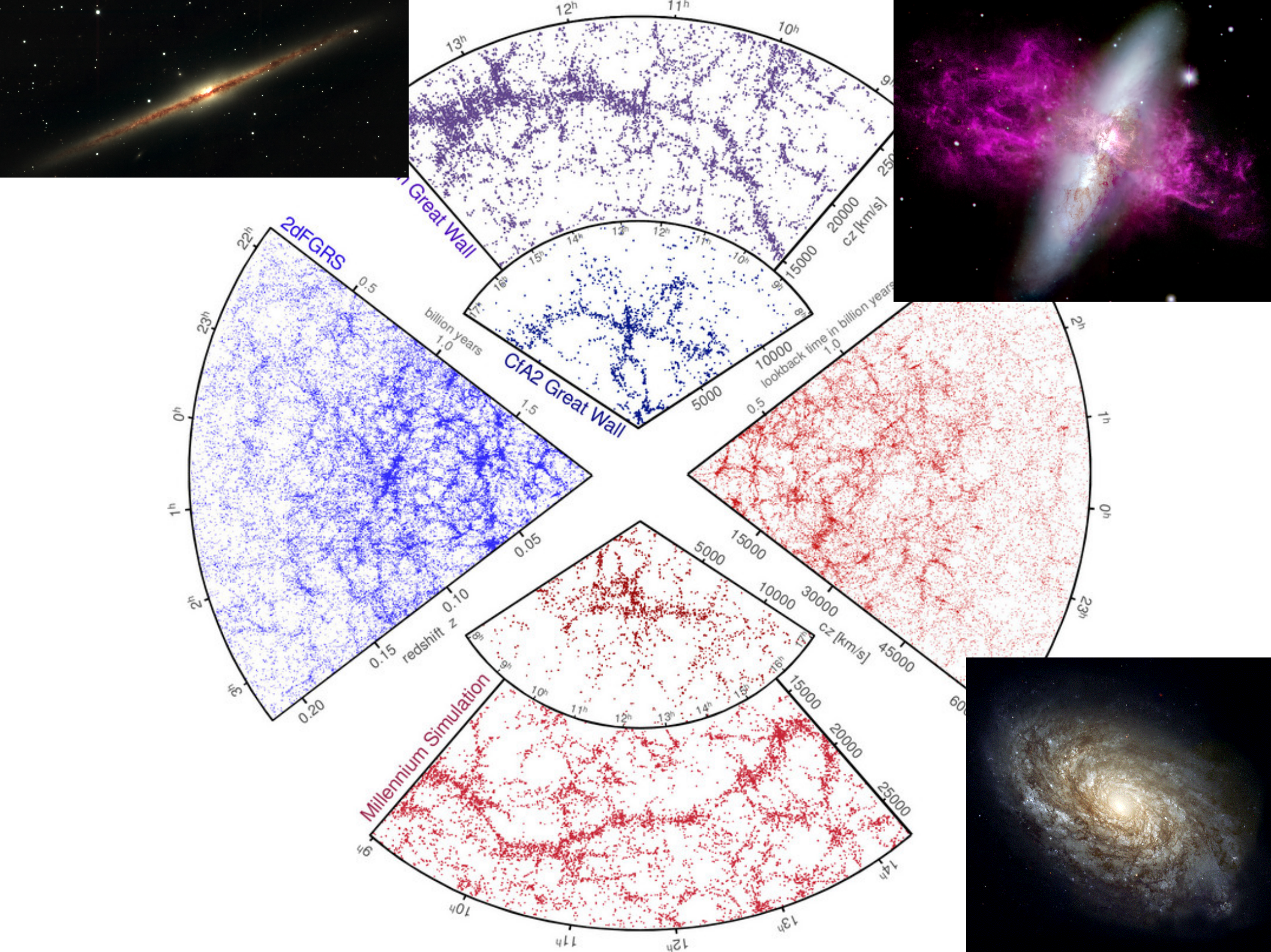


- Start 400,000 years after the Big Bang from the initial conditions seen in the microwave background
- Integrate the equations of motion forwards to the present day in a supercomputer
- The growth of dark matter structures in a thin slice
- A flight through the dark matter distribution

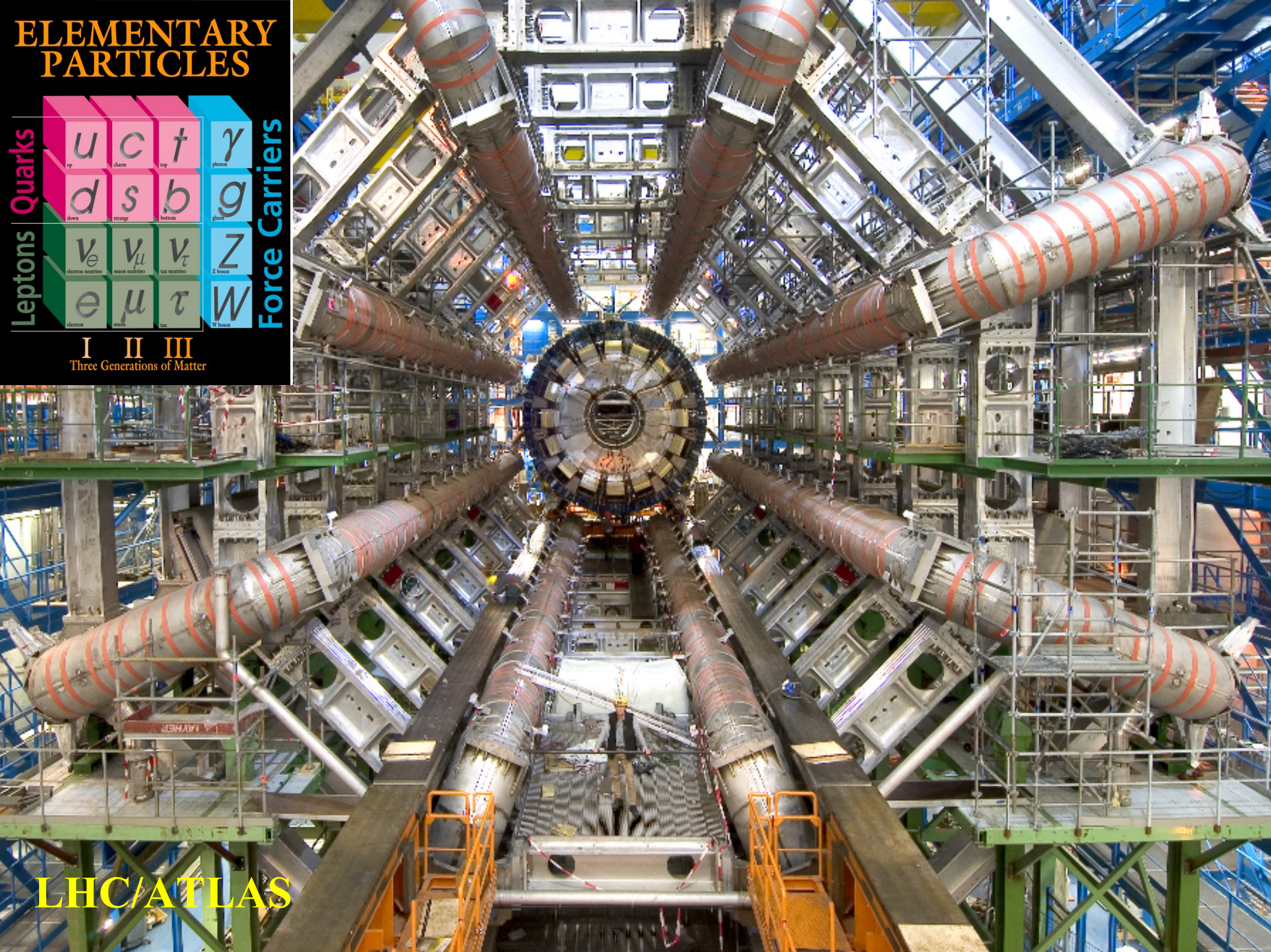

125 Mpc/h
z = 0 Dark Matter

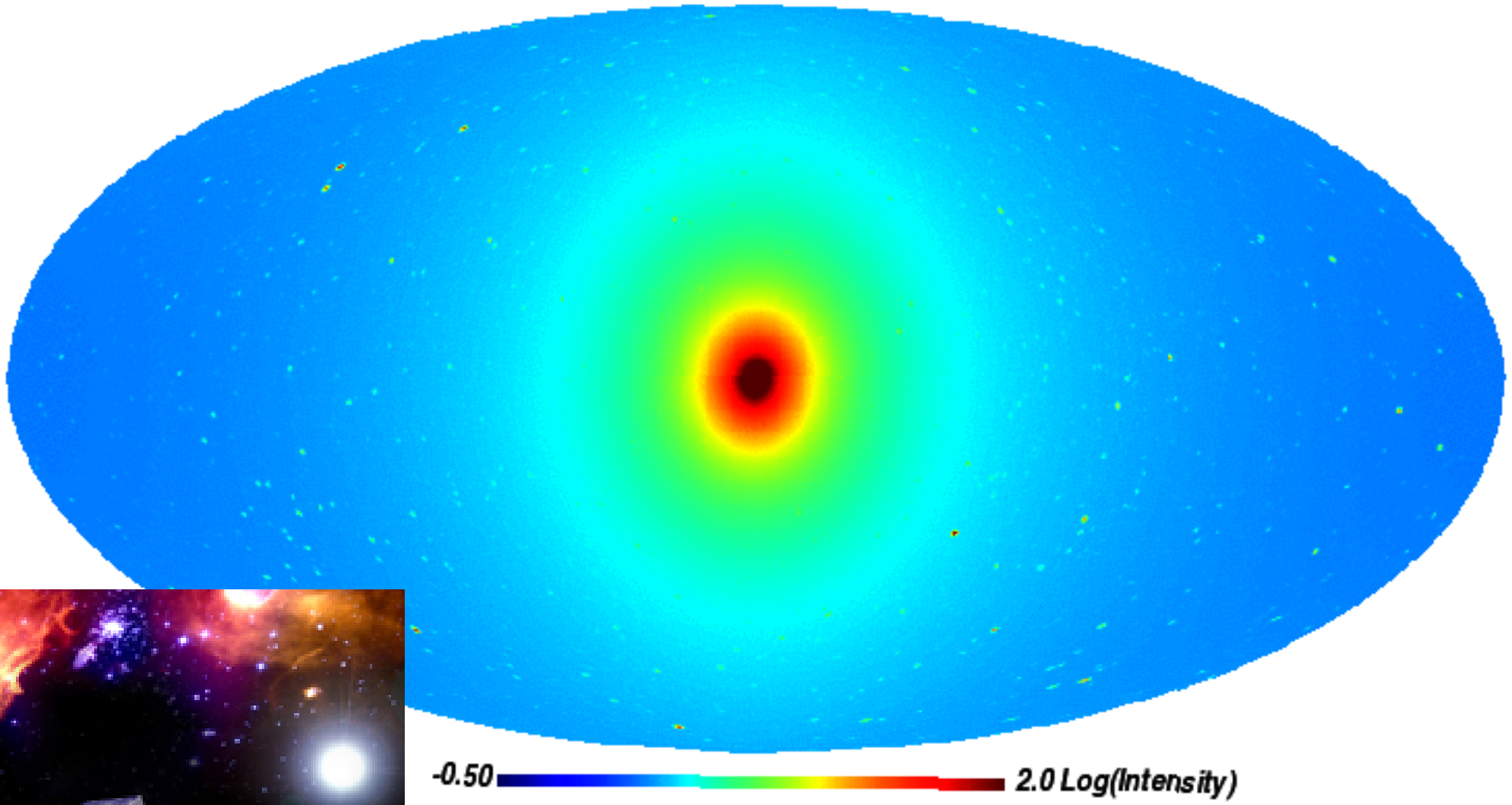

z = 0 Galaxy Light


Sloan Great Wall
2dFGRS
CfA2 Great Wall
Millennium Simulation
billion years
lookback time in billion years
redshift z
cz [km/s]


2dFGRS
CfA2 Great Wall
Millennium Simulation
billion years
lookback time in billion years
redshift z
cz [km/s]


Dark Matter around the Milky Way?


ELEMENTARY PARTICLES
Quarks
Leptons
Force Carriers
u c t γ
up charm top photon
d s b g
down strange bottom gluon
νe νμ ντ Z
electron neutrino muon neutrino tau neutrino Z boson
e μ τ W
electron muon tau W boson
I II III
Three Generations of Matter
LHC/ATLAS



Dark Matter as seen by Fermi?

What's next in astrophysics?

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We have been surprised by

- The cosmic expansion
- Dark Matter
- Cosmic evolution
- The microwave background
- Dark Energy
- ..also white dwarfs, pulsars, quasars, γ-ray bursts, neutrino masses, extrasolar planetary systems...

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→ We must remain opportunistic and open-minded, both scientifically and technically, if we are to continue to find surprises