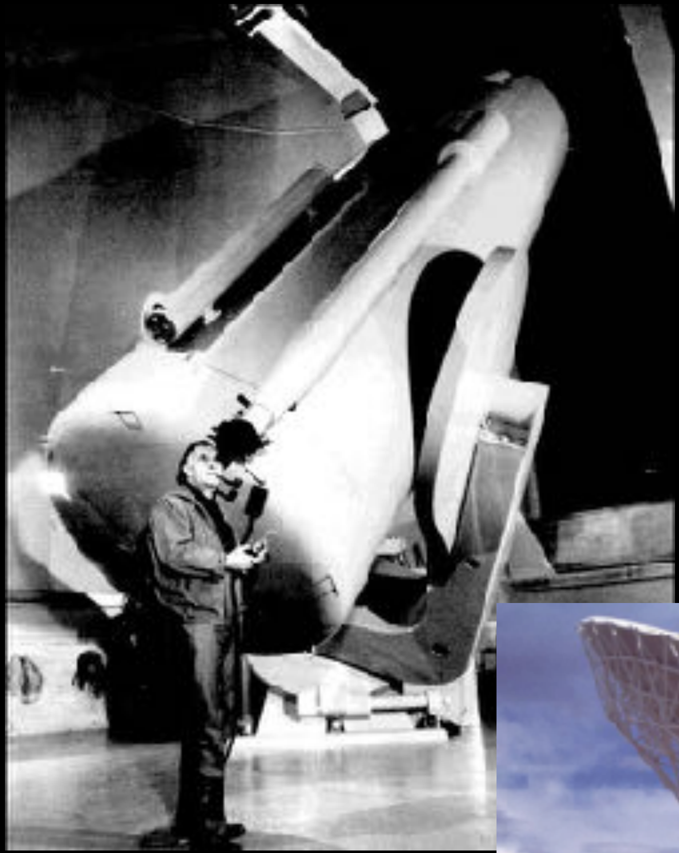
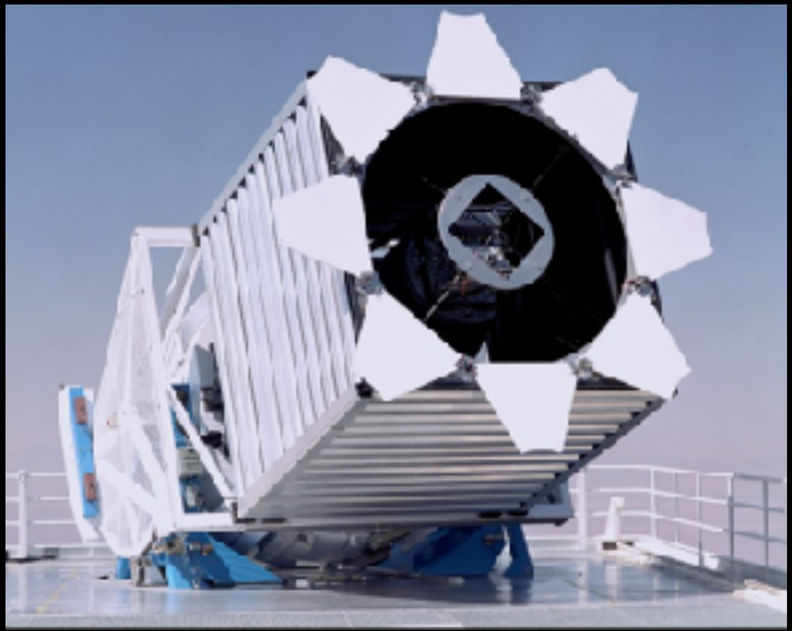
Galaxies Through Many Different Eyes





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But first, open up your computers!

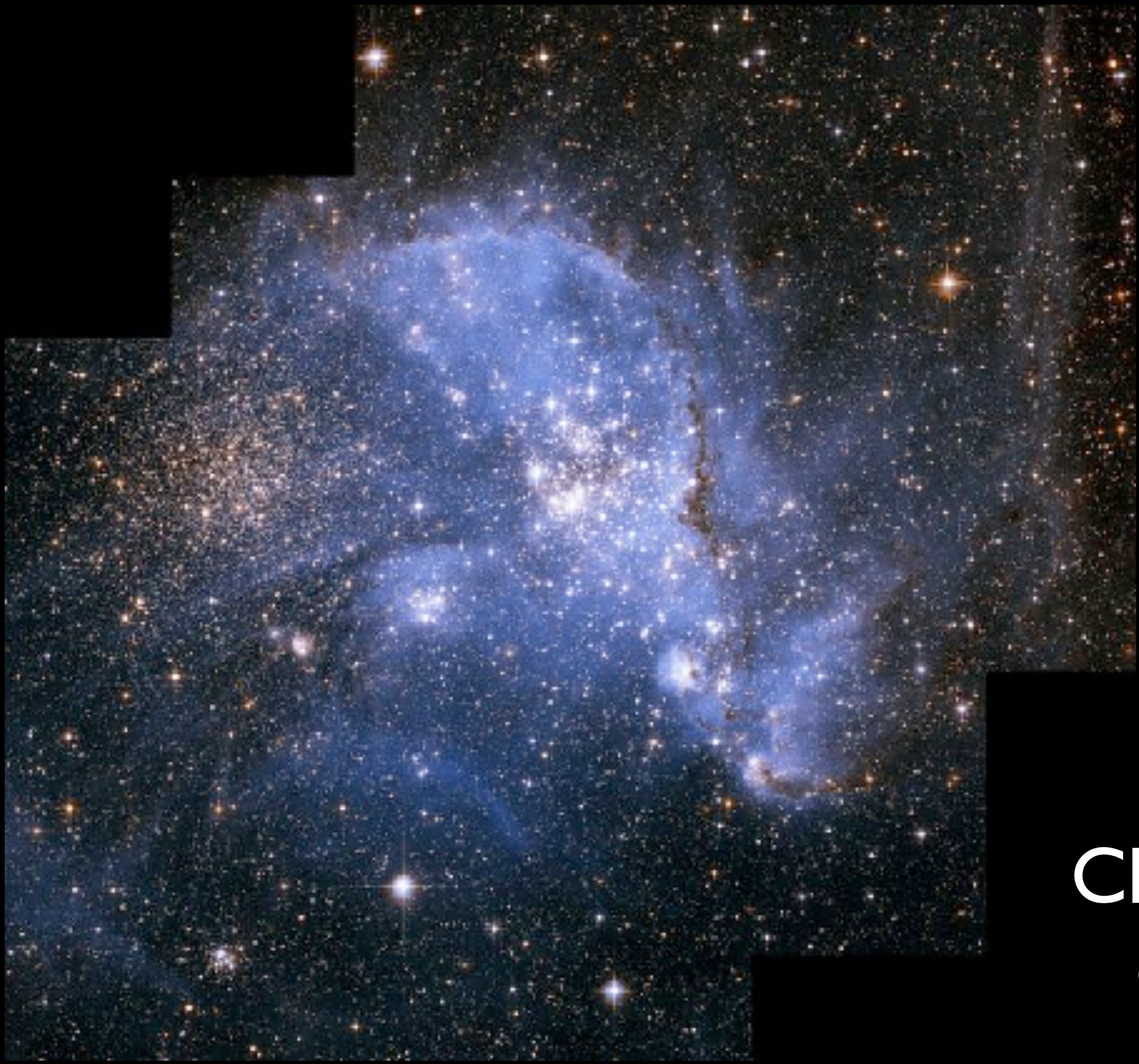
(activity time!)

http://tinyurl.com/ybnvhxdk

How is this galaxy...

M87, 10x the mass of the Milky Way

...related to this galaxy?



Small Magellenic Cloud, 1/100 the size of the Milky Way

And how do you use telescopes to figure it out?

A menagerie of galaxies

Disc and Spiral Galaxies


Andromeda galaxy
© Philip Perkins 1999

Elliptical galaxies

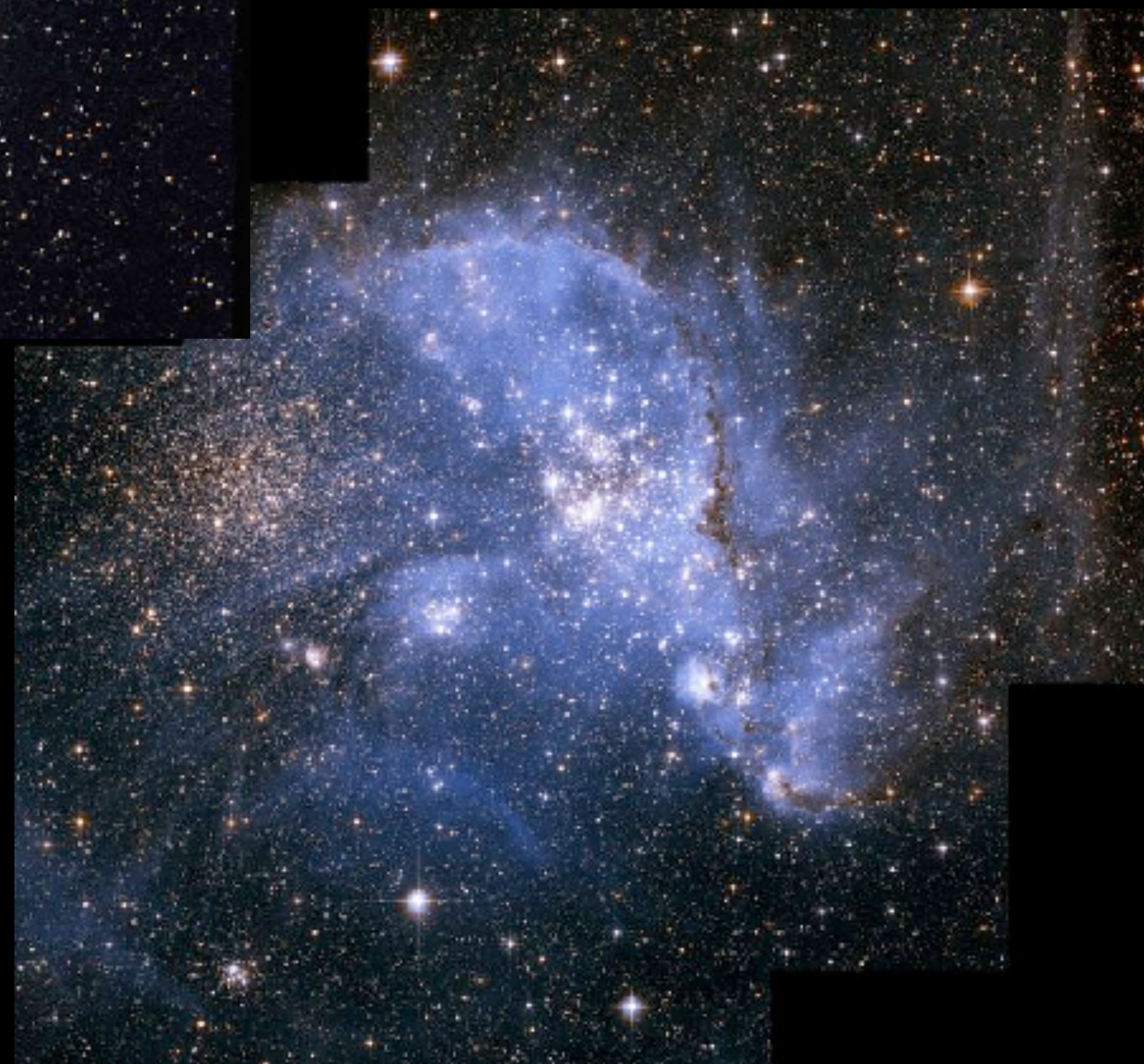
M87
(NGC 4486)


Coelum
Astronomia
The Giant Elliptical Galaxy Messier 87 by
CFH

Dwarf galaxies

Large Magellenic
Cloud (LMC)

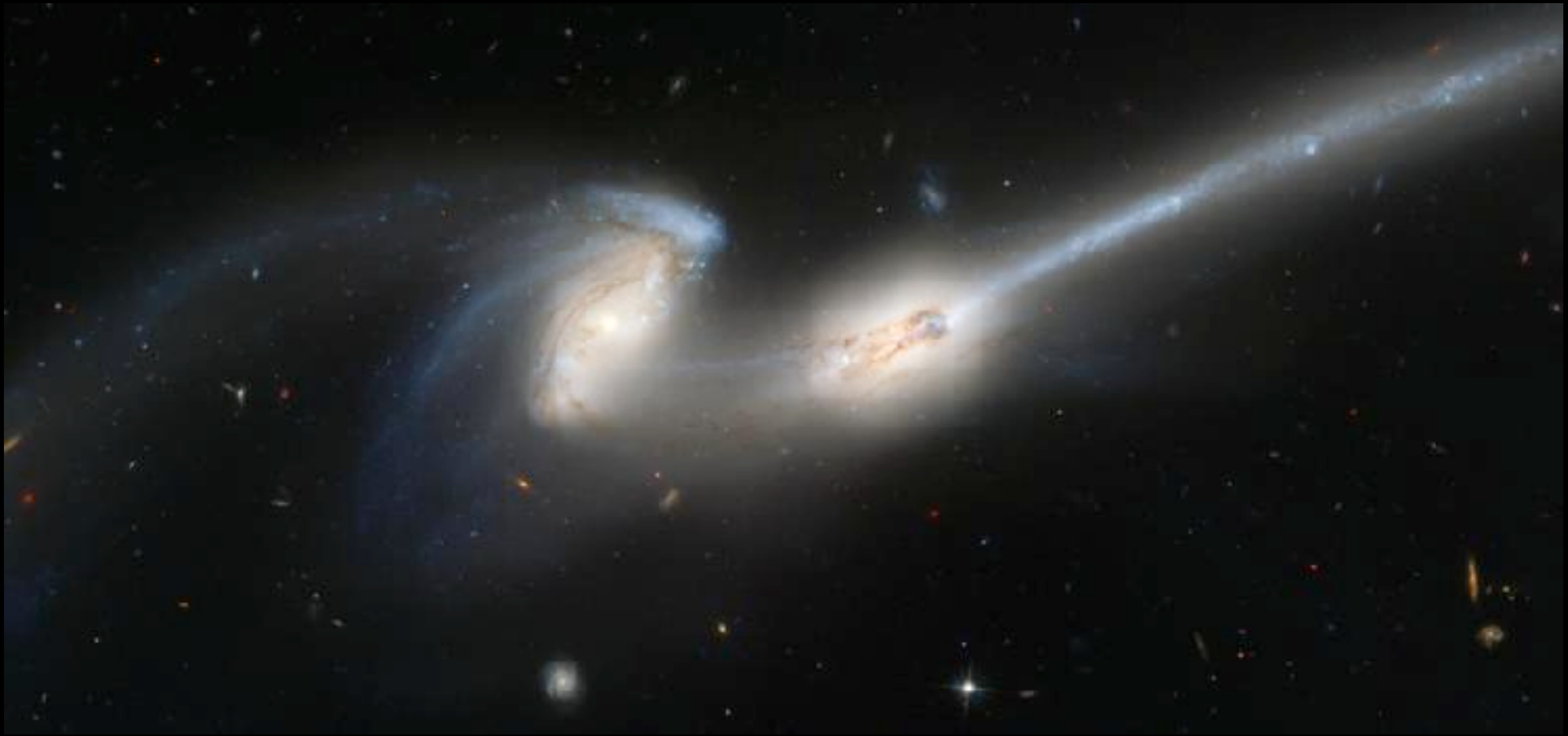
Small Magellenic
Cloud (SMC)



NGC 147

Merging galaxies

“The Mice” (NGC 4676)



Galaxy evolution over cosmic time

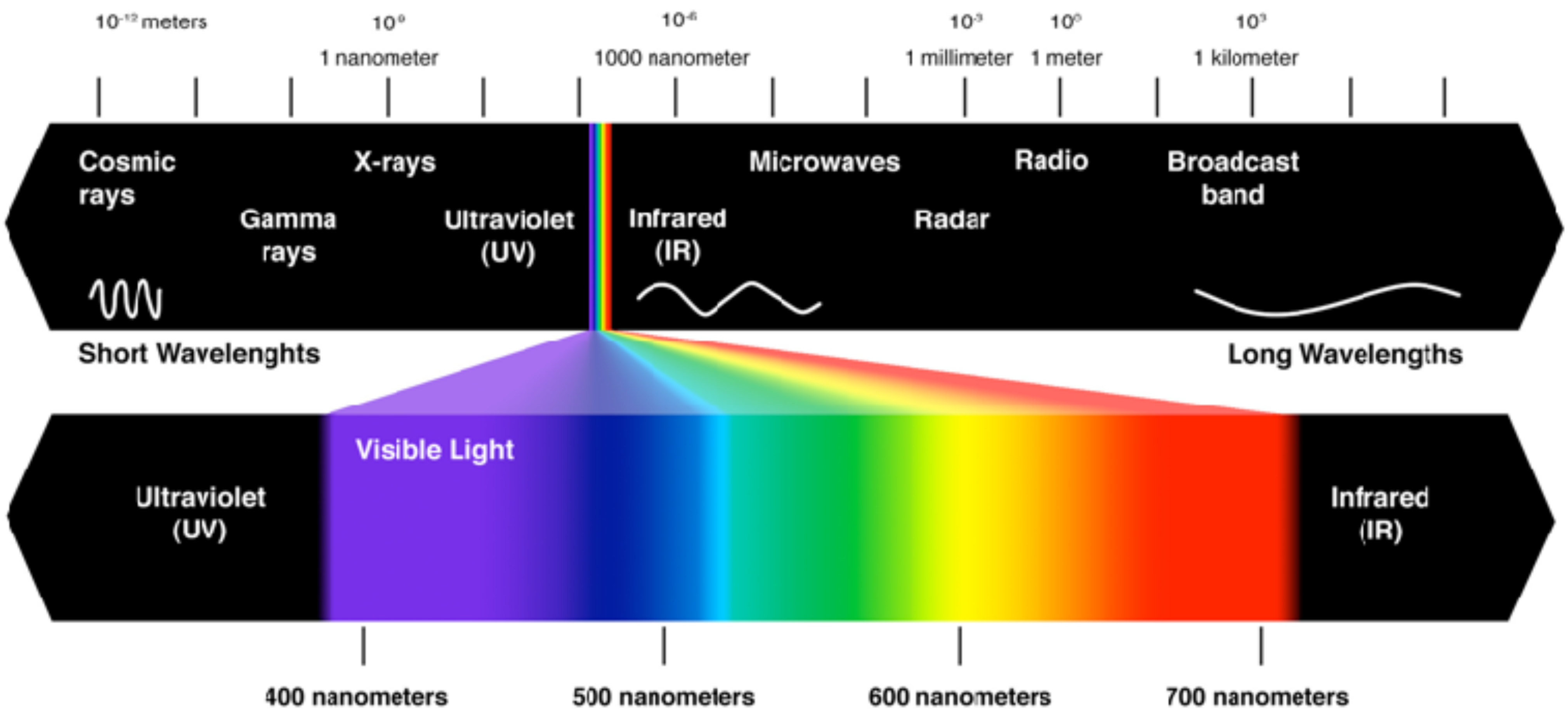

Hubble Ultra Deep Field

Questions (the big list)

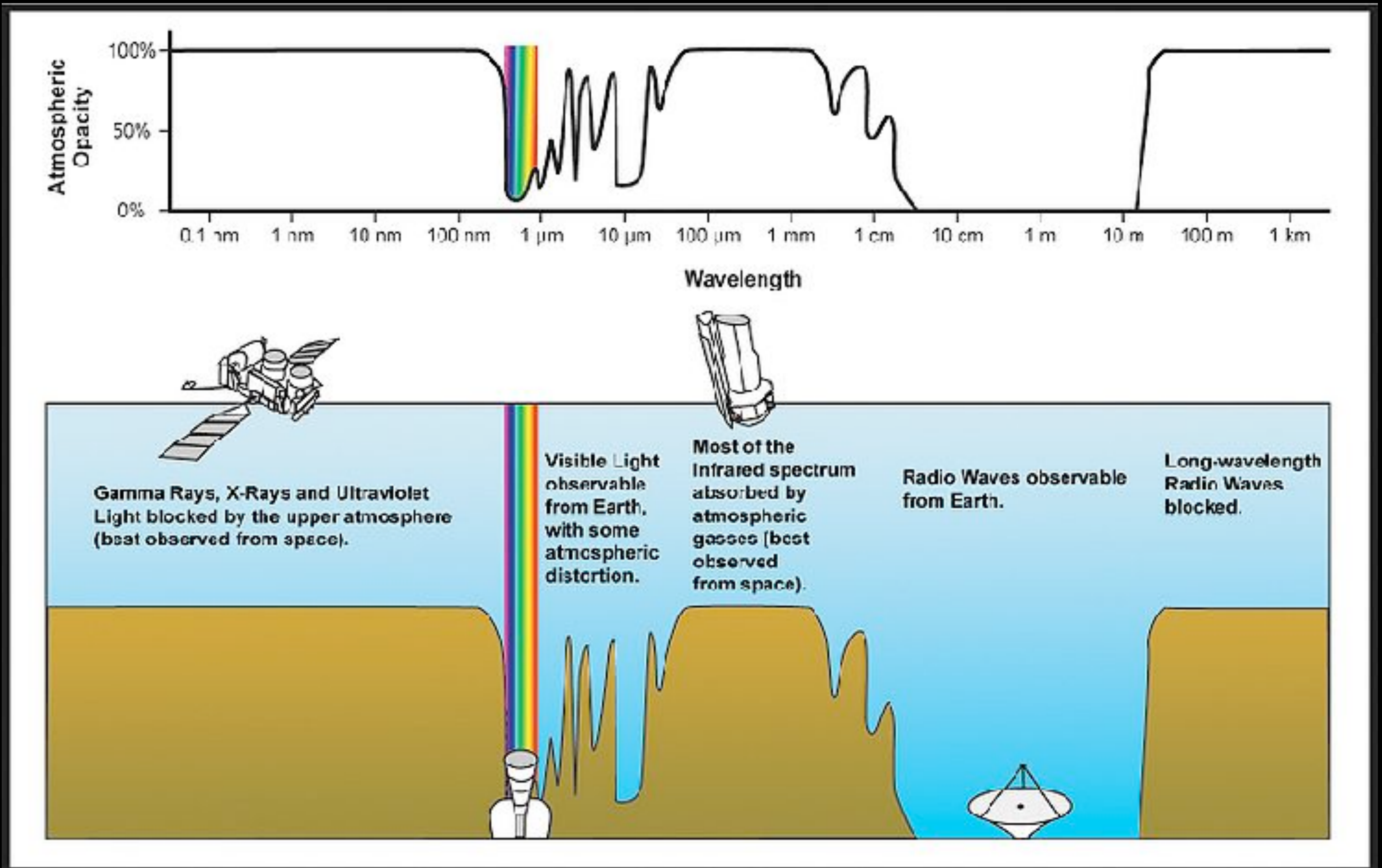
- Why are there so many types of galaxies?
- Why do they have such different properties and sizes?
- Why do the populations change over time?
- Can galaxies change from one type to another?
- How do we figure this out?

Electromagnetic Spectrum

Electromagnetic spectrum

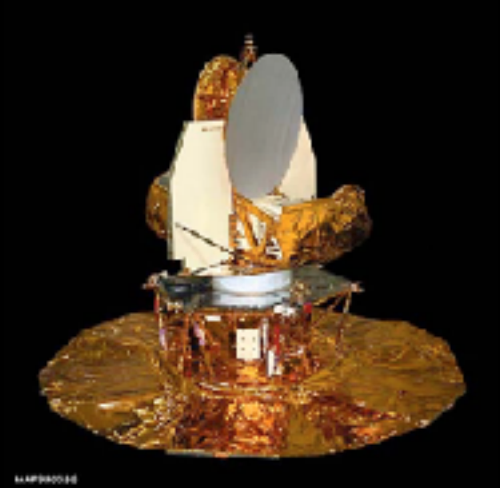


The "atmospheric window"



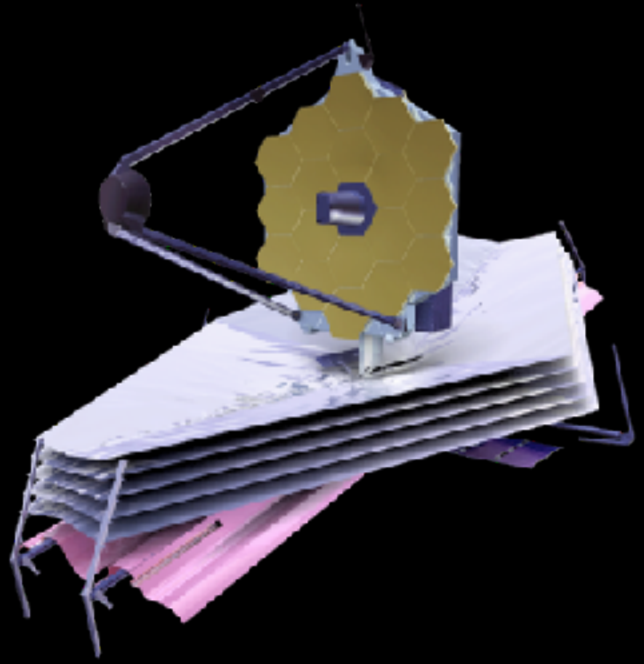
A multitude of telescopes

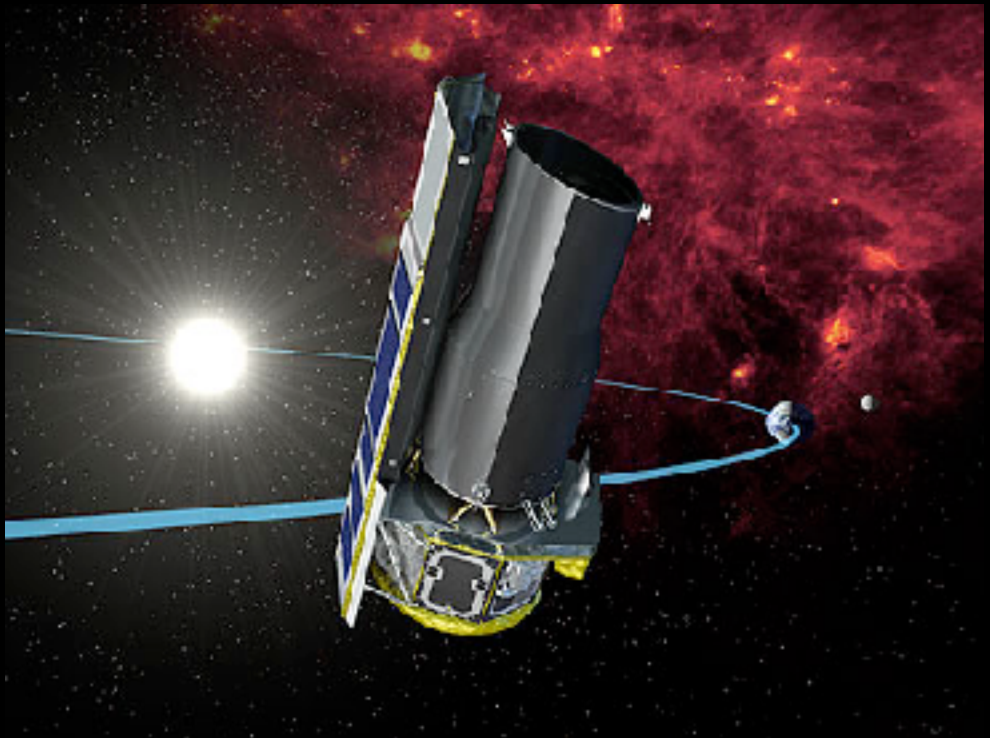
Radio: > mm wavelengths (roughly)



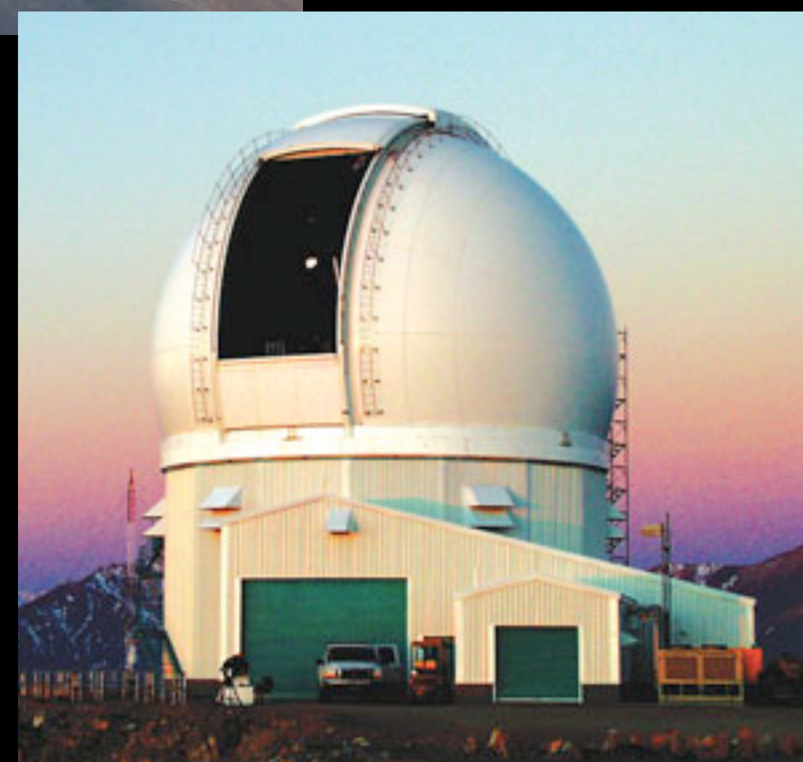
Microwave
1 mm - 1 m

Infrared light
800 nm - 300 μm
(1-400 Thz)

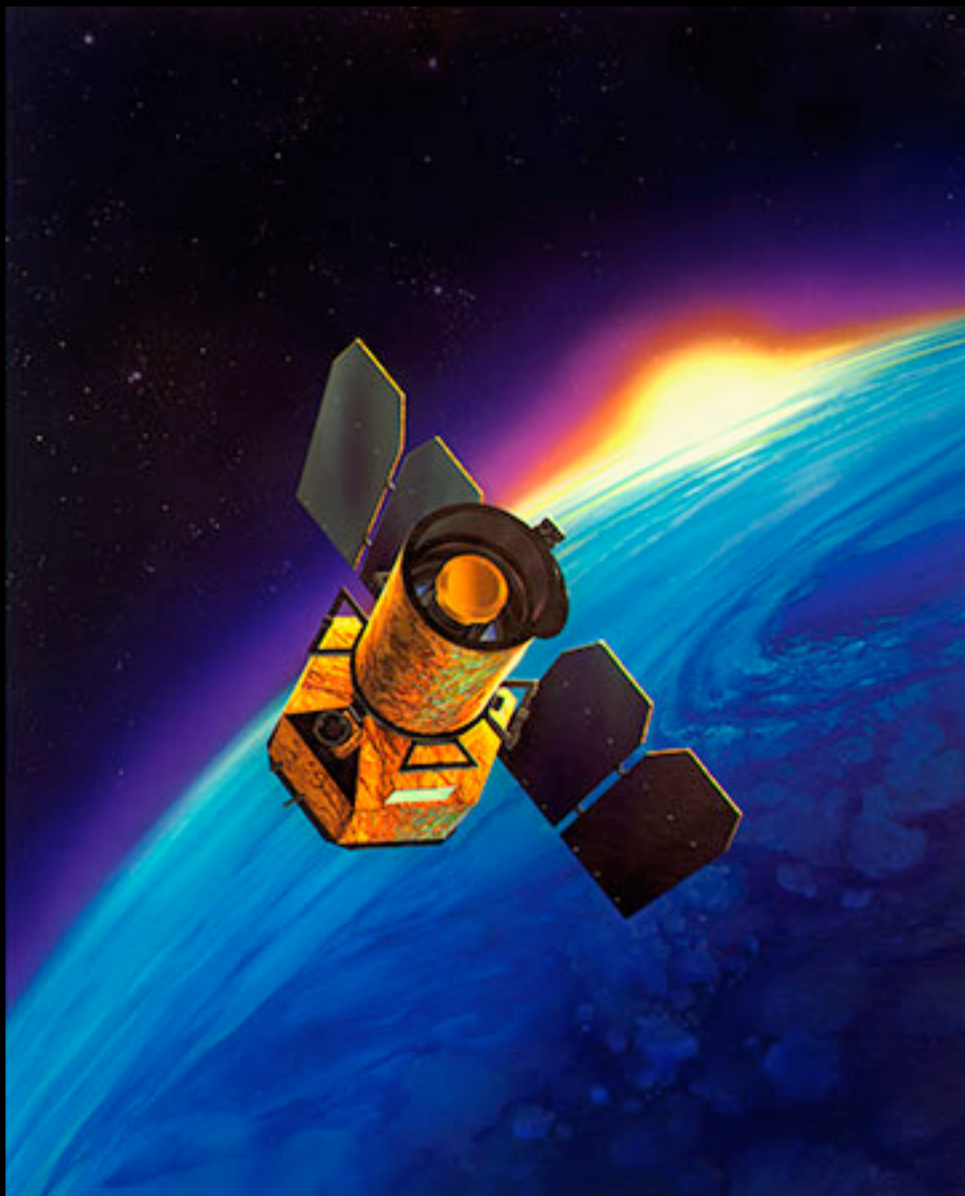


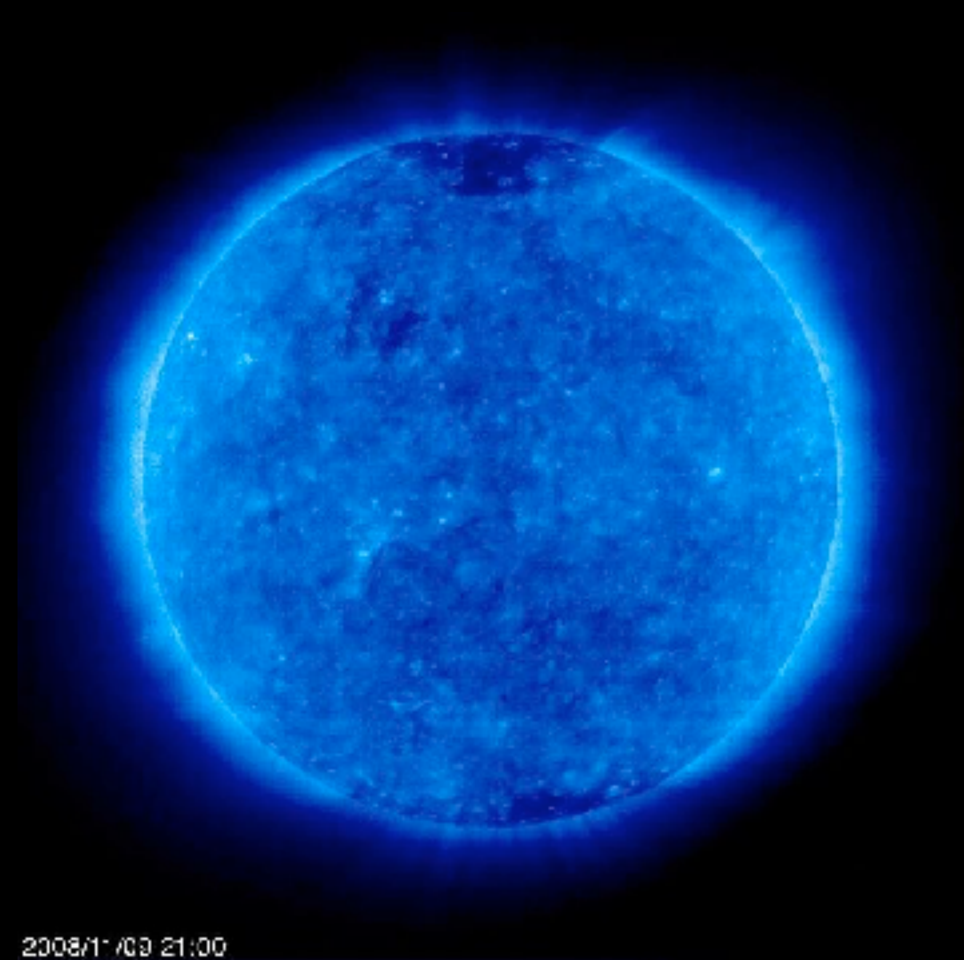


Optical light
~400-800 nm
(800-400 Thz)

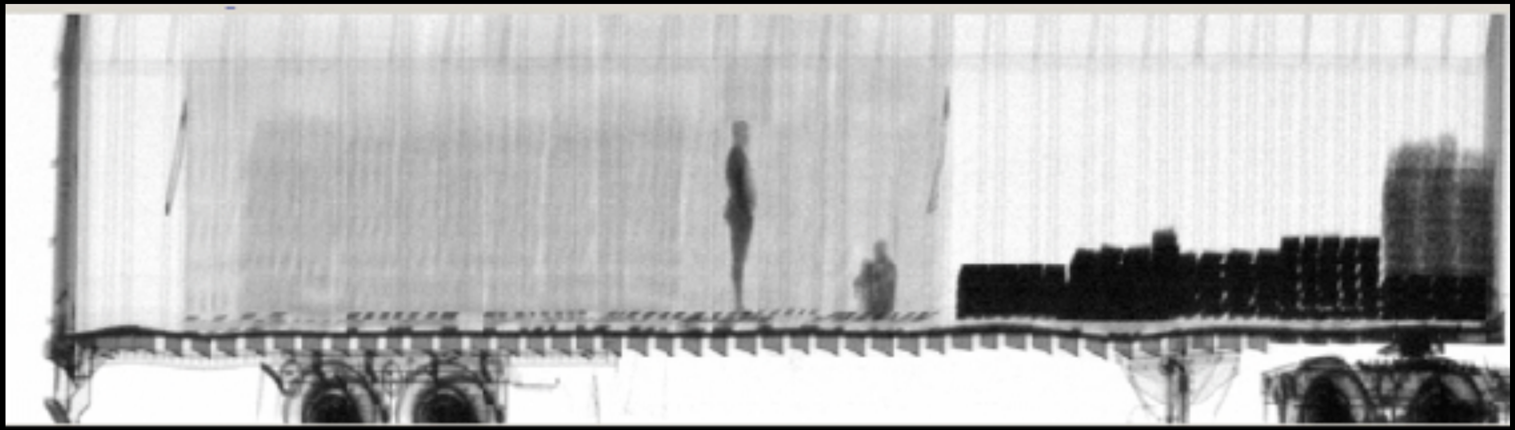


Ultraviolet
10 nm - 400 nm





X-ray: 0.1-10 nm
Gamma ray: < 0.1 nm



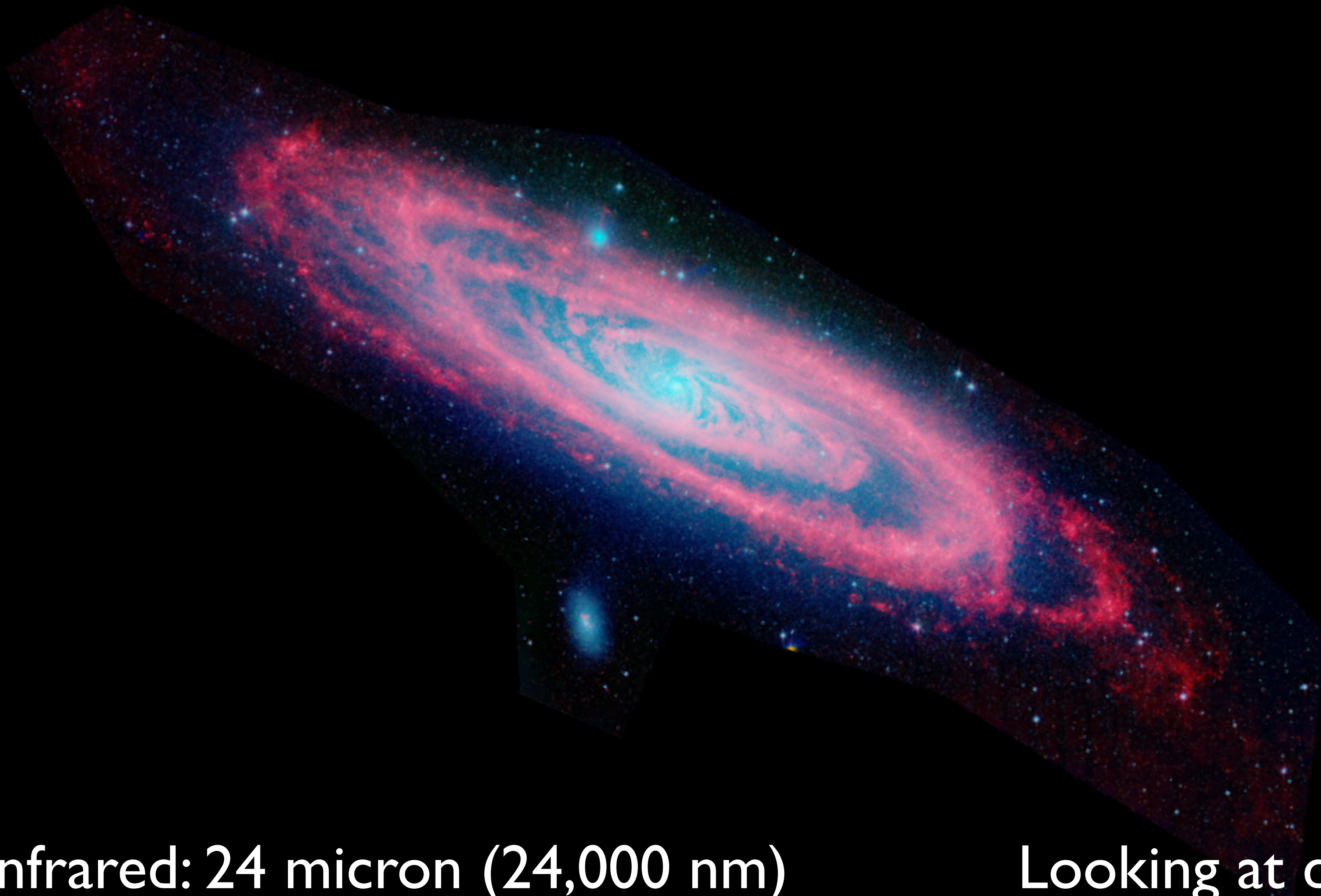
And now for some examples!

The Andromeda Galaxy

Optical (400-800 nm)

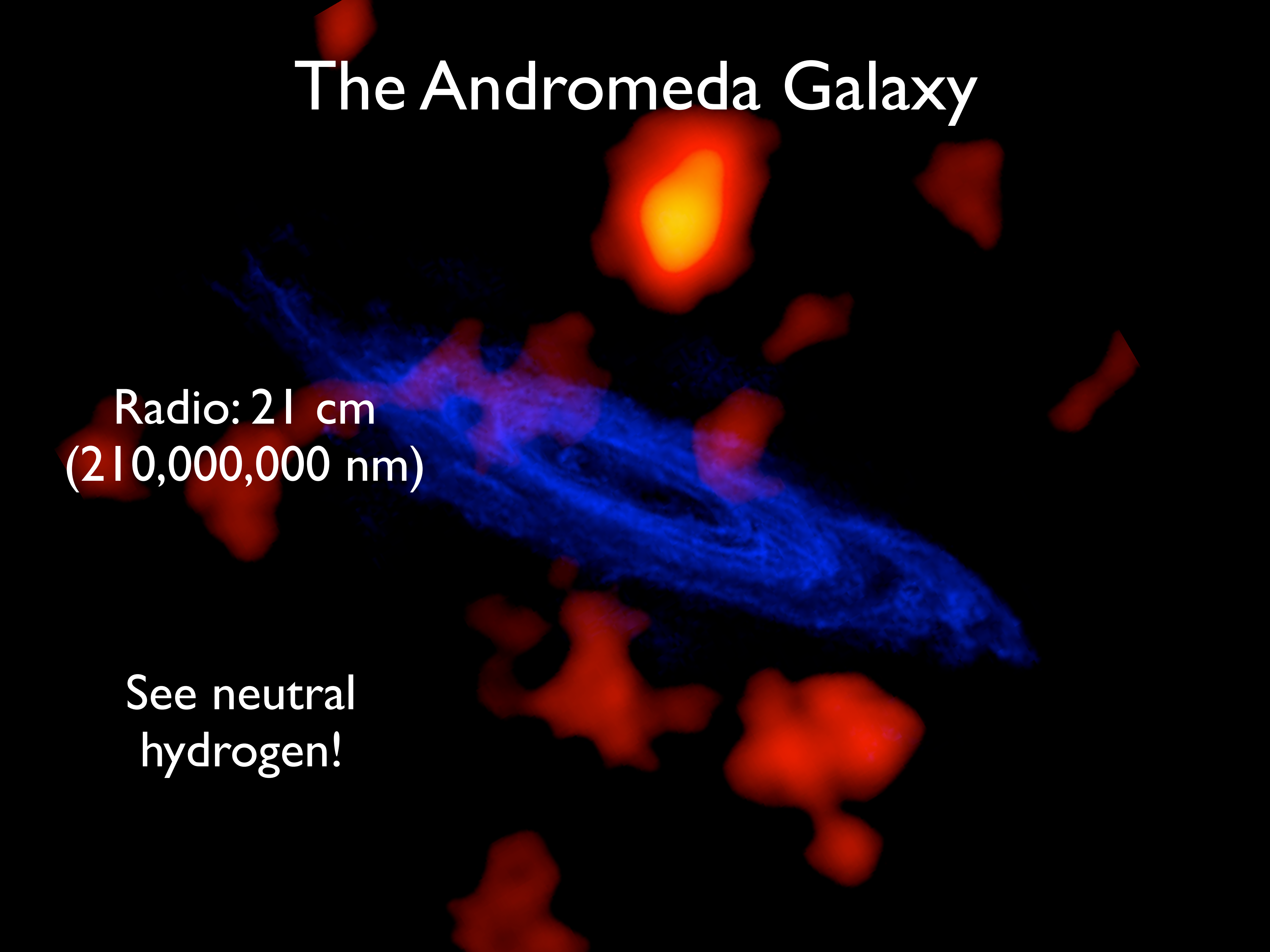
Sees starlight!

The Andromeda Galaxy

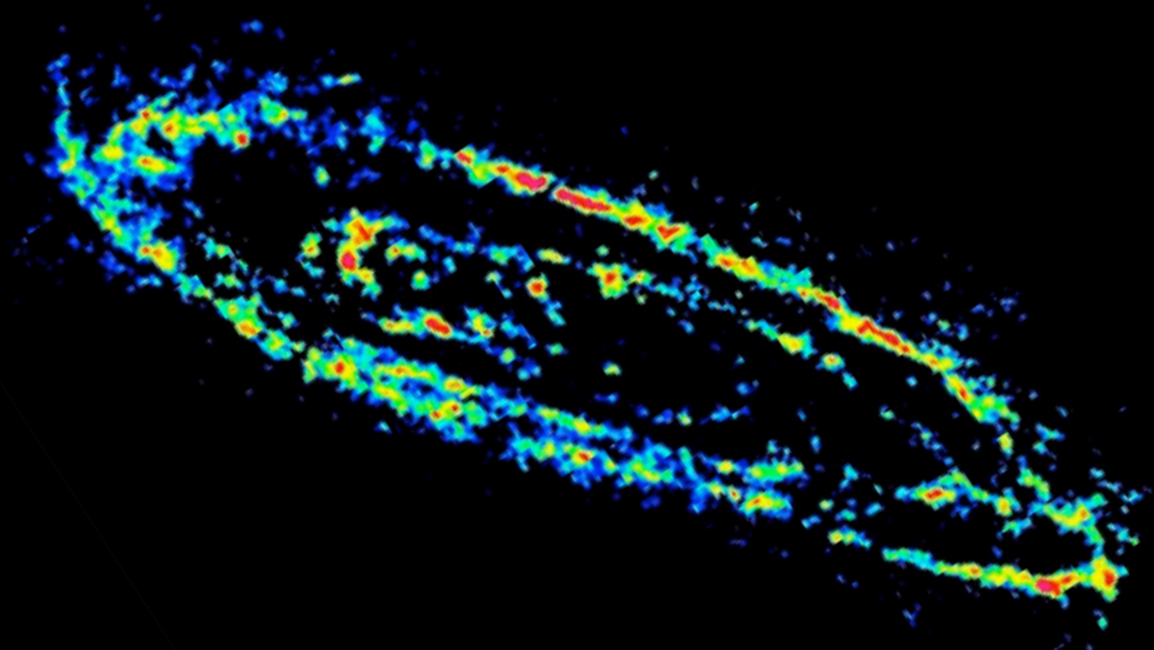


Infrared: 24 micron (24,000 nm)

Looking at dust!


The Andromeda Galaxy
Radio: 21 cm
(210,000,000 nm)
See neutral
hydrogen!

The Andromeda Galaxy

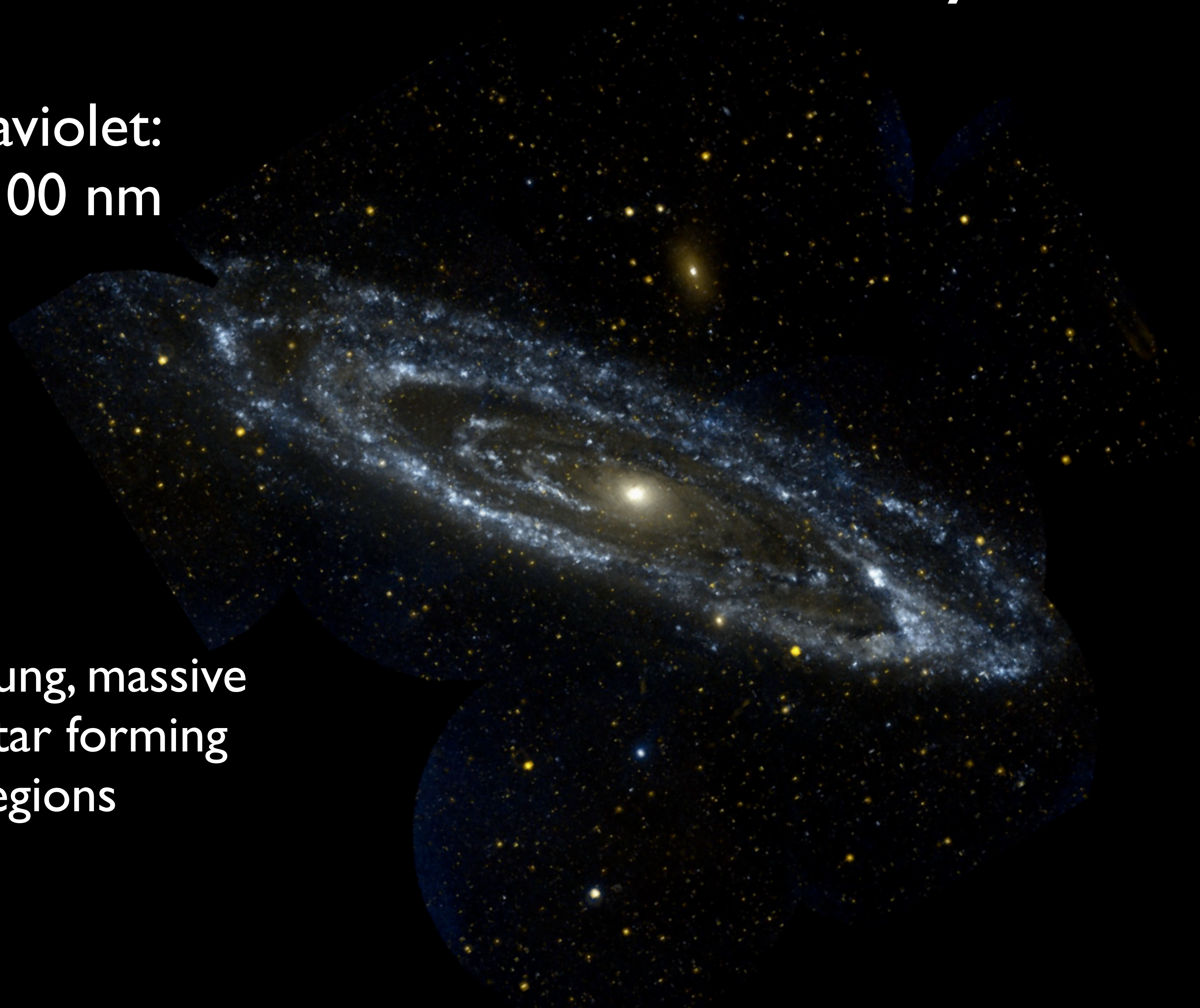


Radio: 2.6 mm
(2,600,000 nm)

Sees CO/cold gas

The Andromeda Galaxy

Ultraviolet:
~ 100 nm



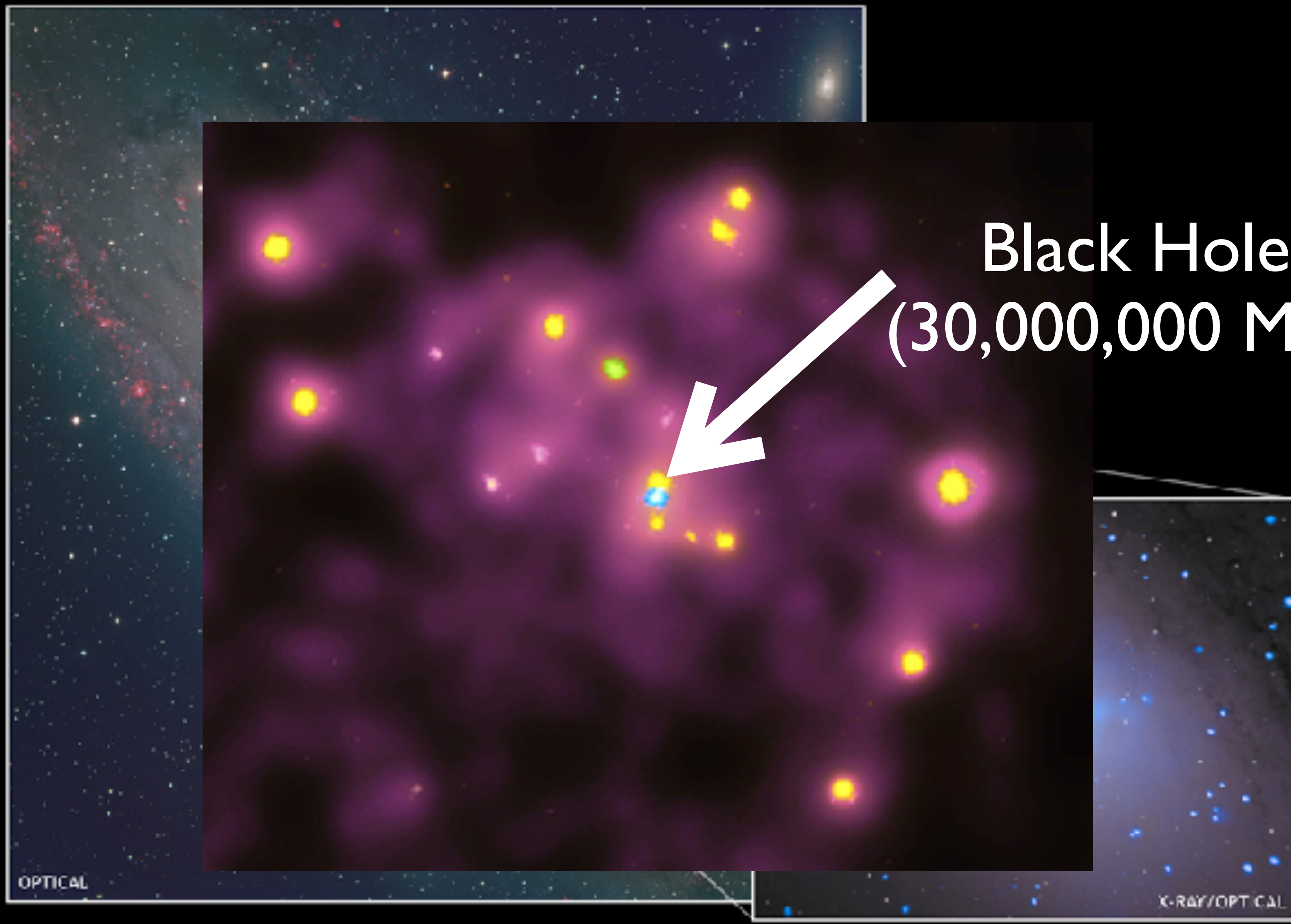
Sees young, massive stars, star forming regions

The Andromeda Galaxy

X-ray: approx. 1 nm

Sees: very hot gas (>10^6 K)

The Andromeda Galaxy

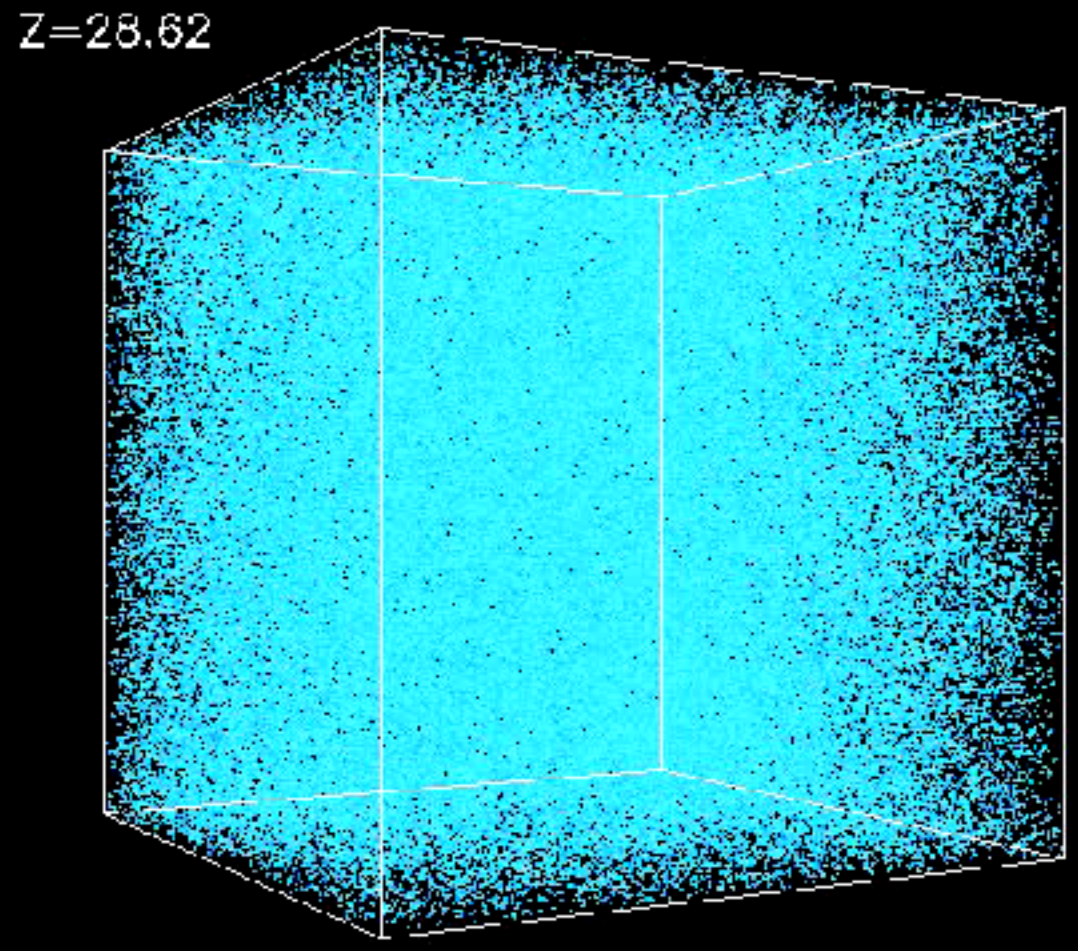


X-ray: approx. 1 nm

Sees: very hot gas (>10^6 K)

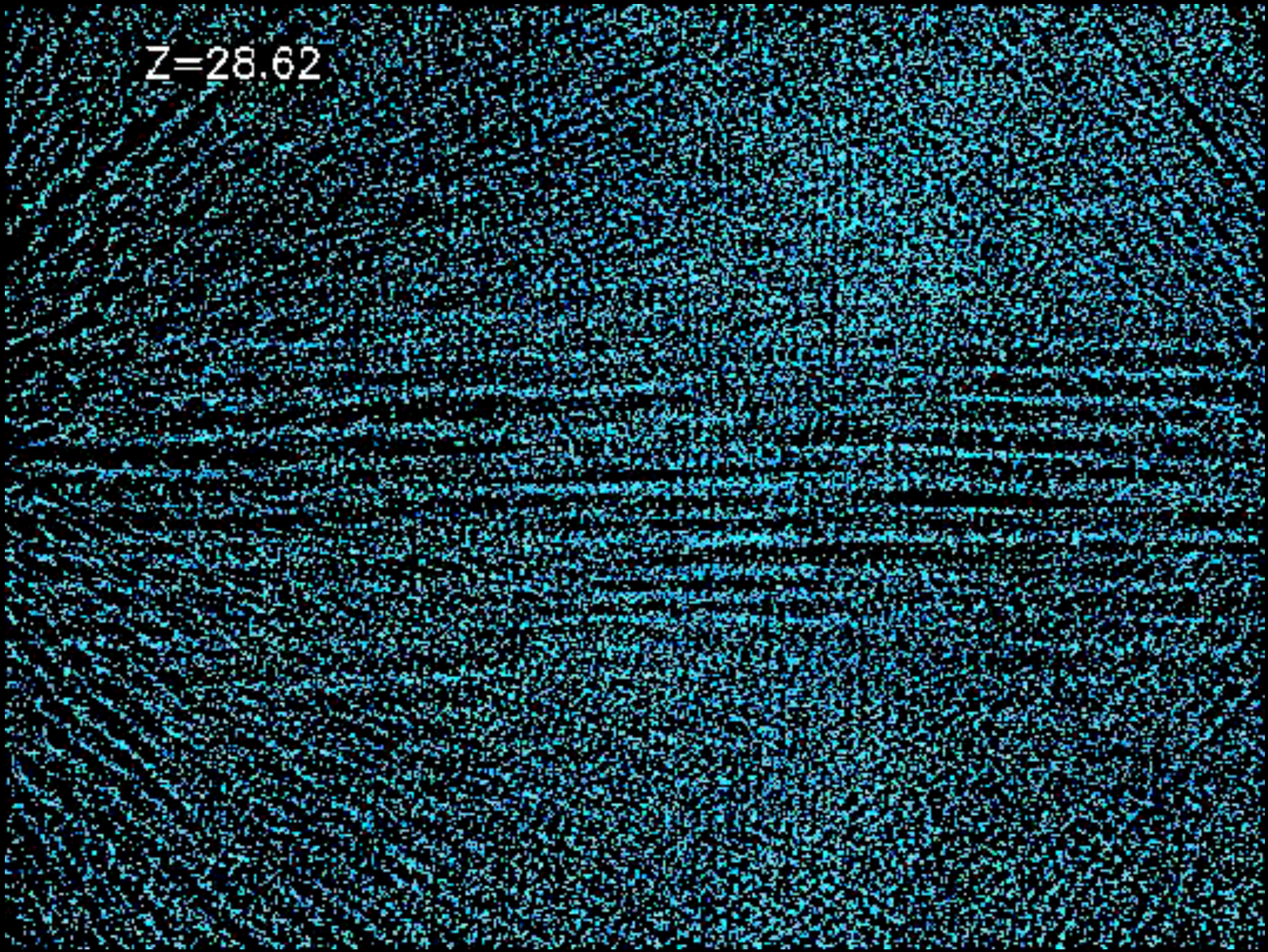
Supercomputers: telescopes for theoretical astrophysicicists

Formation of cosmological structure

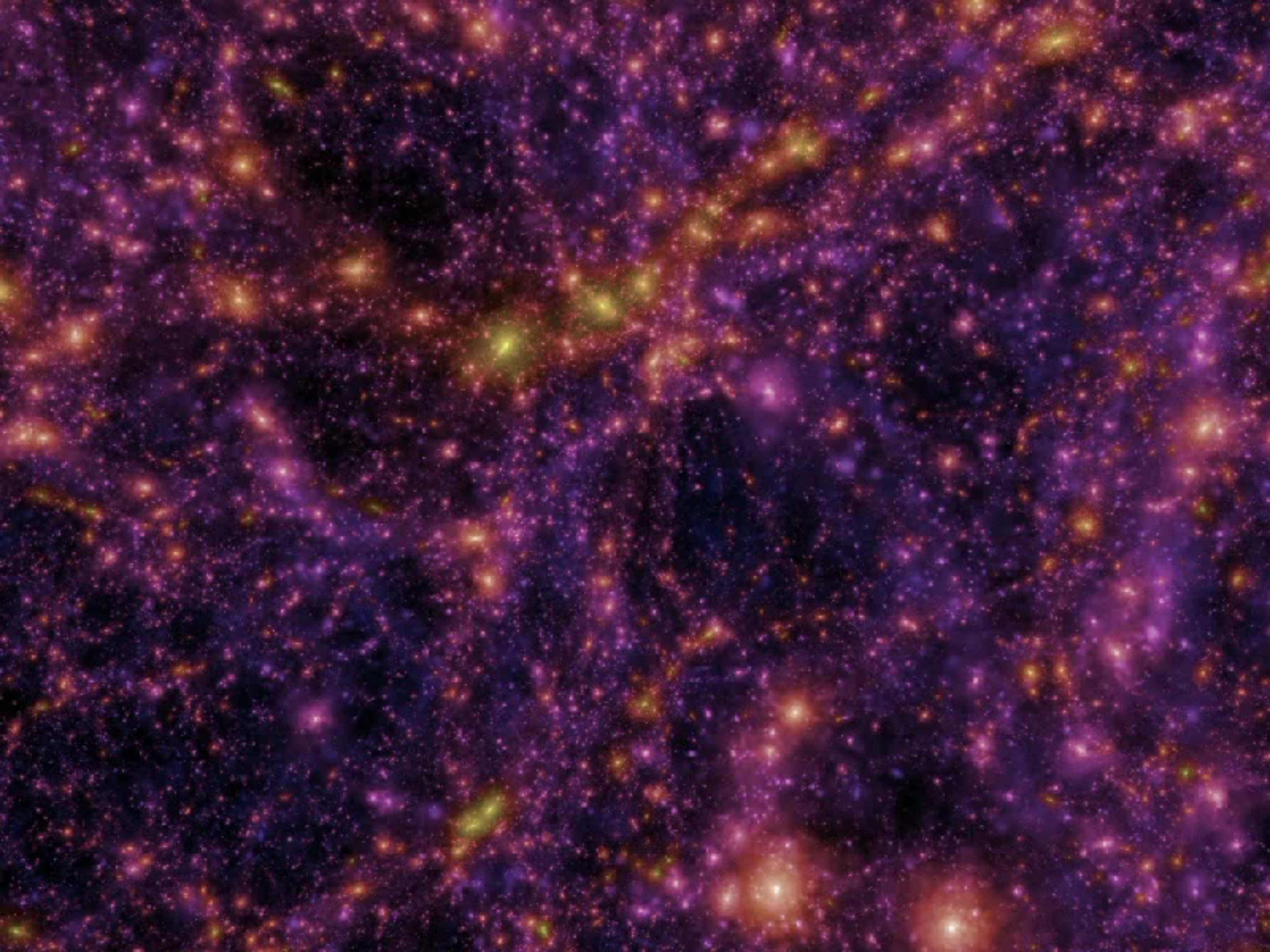


box size = 140 million light years across
start at t ~ 1 million years ABB, end at present day

Formation of a group of galaxies



Field of view = 14 million LY across
Final object = the Local Group (roughly)



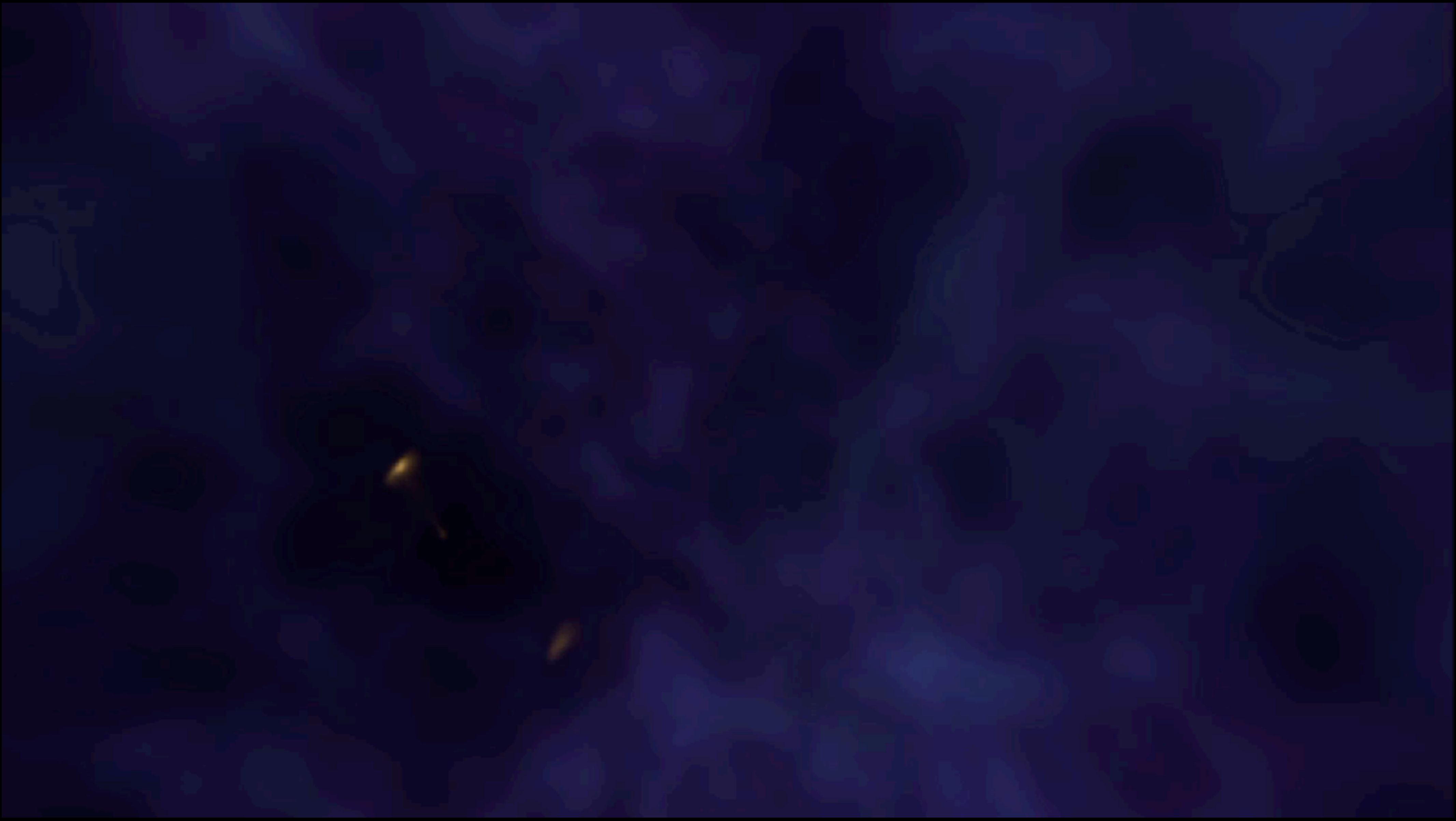
0.0 Gyr

Stars

10 kpc

Movie c/o
Phil Hopkins,
CalTech

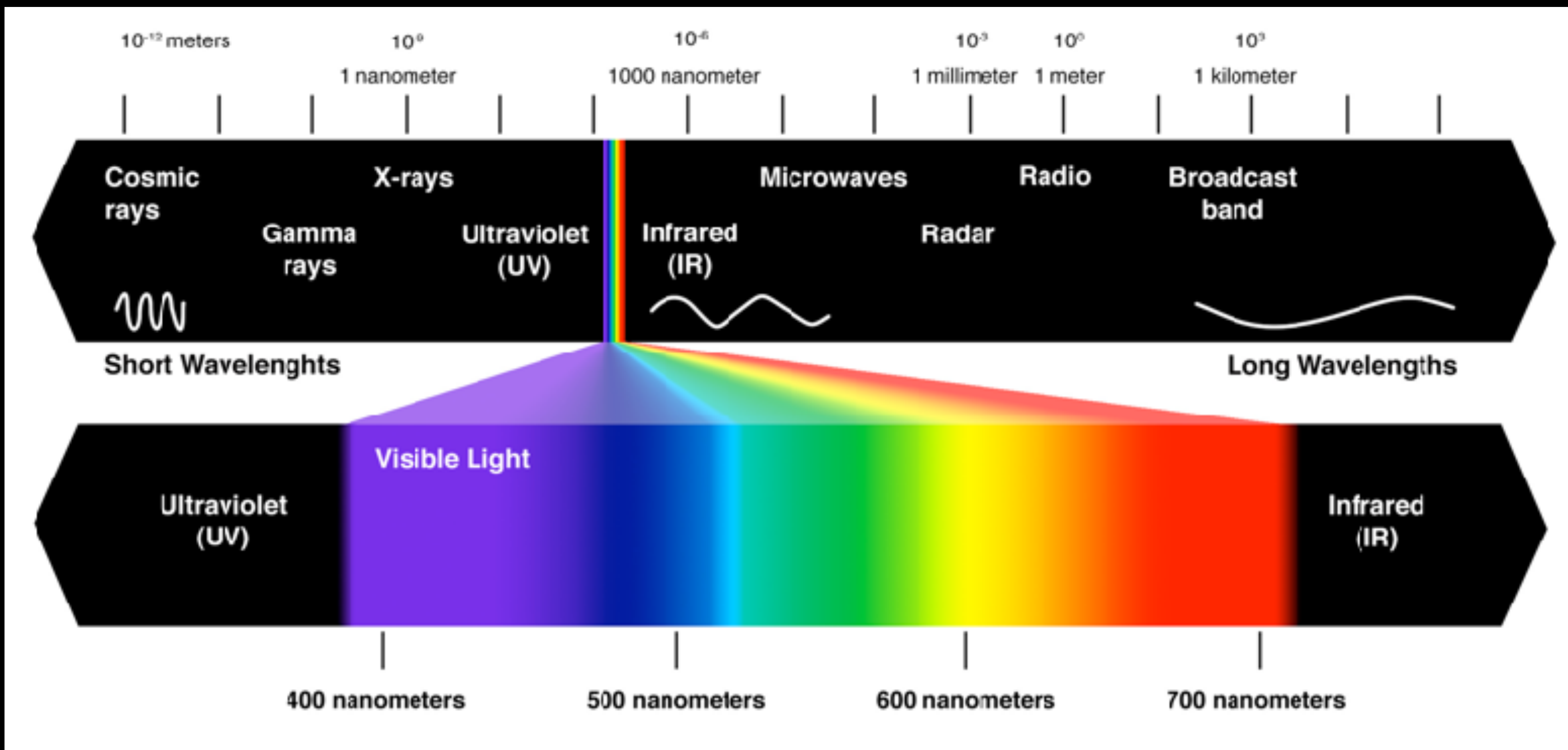
Galaxy formation - closeup



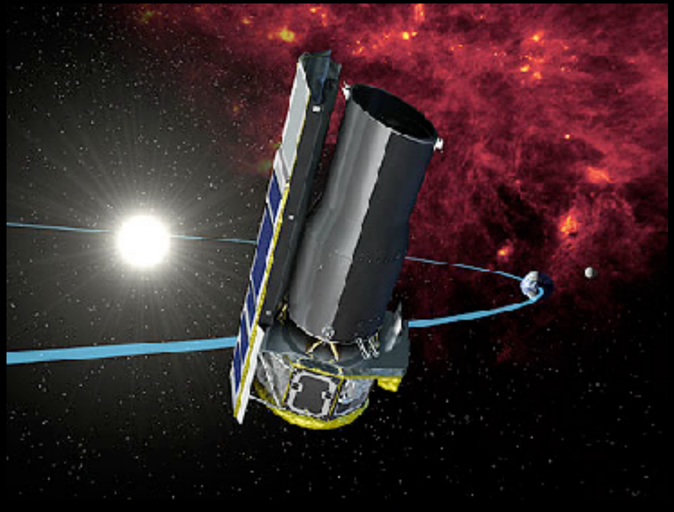
So, what did we learn?

- Galaxies come in many shapes and sizes, and have wildly different properties

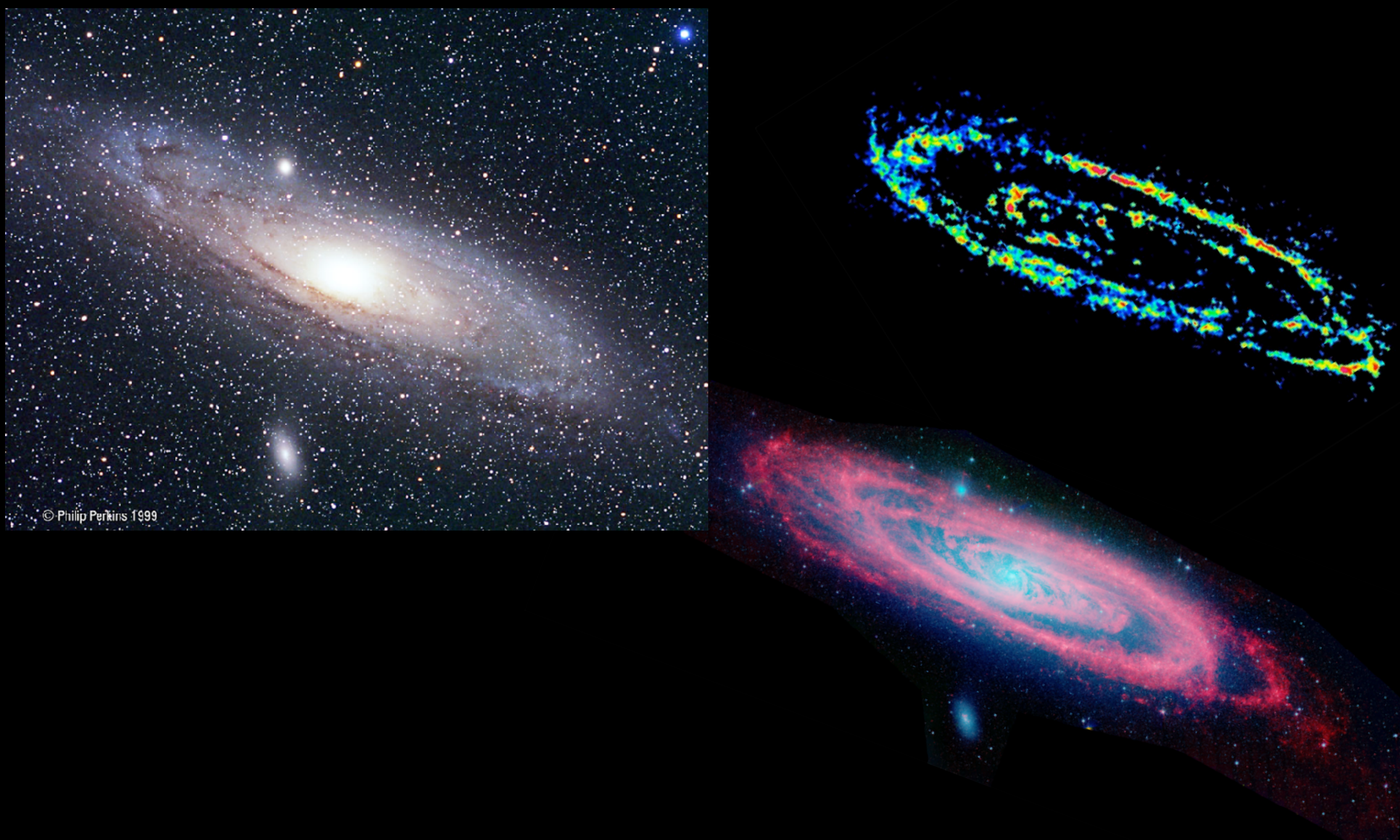
- The light that we can see with our eyes is only a small part of the electromagnetic spectrum...



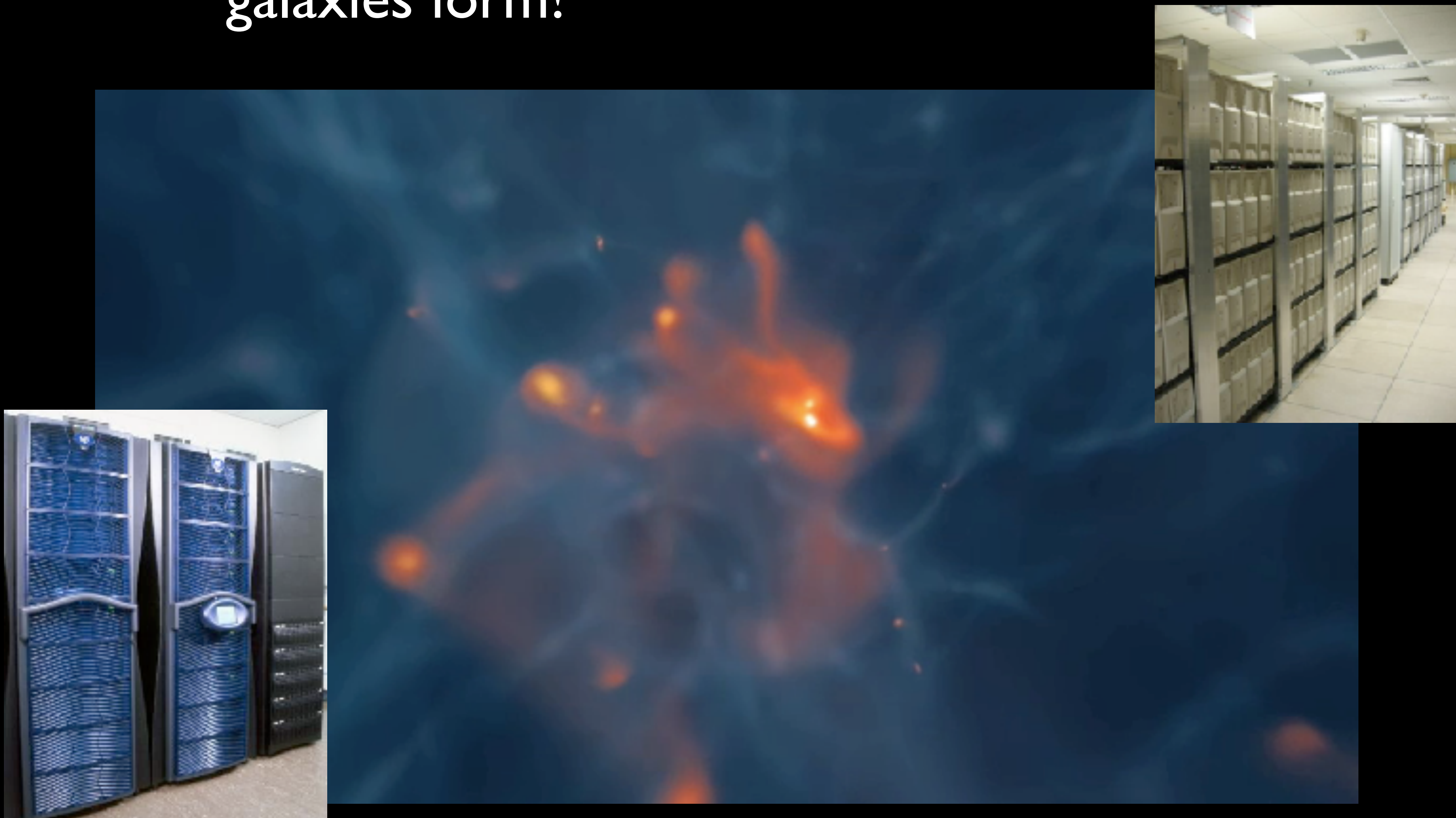
- Astronomers have constructed telescopes that can see at many different wavelengths, from radio through gamma ray



- and looking at a galaxy over the whole spectrum of light teaches us important things about how galaxies form and what they're made out of!



- We can also use supercomputers as 'theoretical telescopes' to probe how galaxies form!



- Using these tools, we have discovered that the different types of galaxies - disc, spiral, dwarf, elliptical - are phases in the evolution of a galaxy!

Questions?