9.7 Gyr

What in the world are galaxies and why are they out there?

Thales Gutcke

AstroTechTalk, June 3rd

500 000 light years

How on Earth do these form?

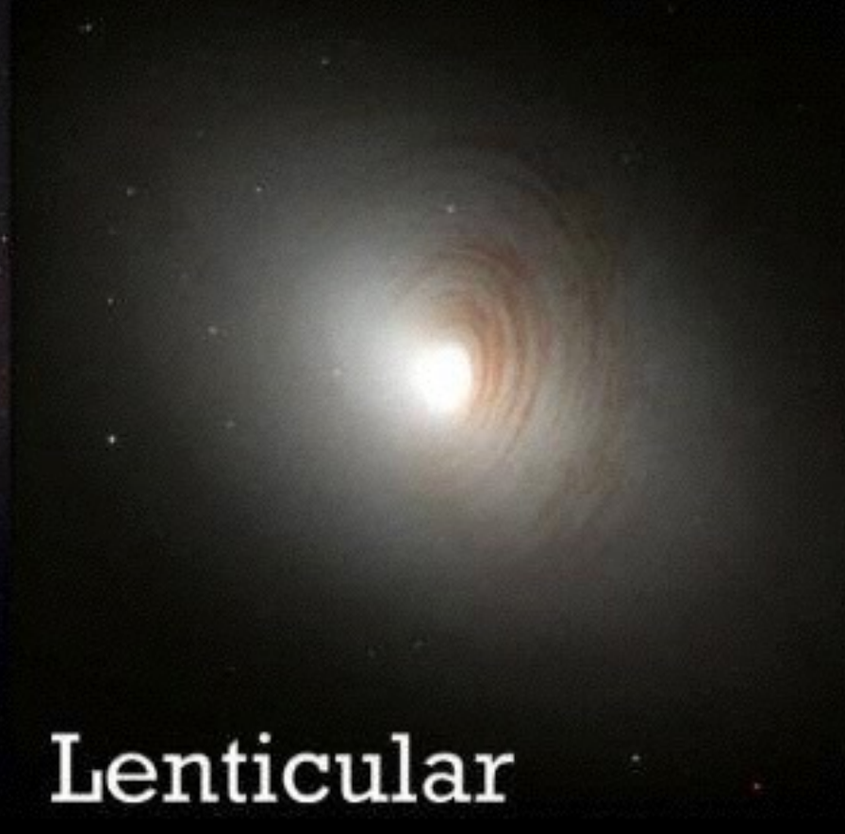


Image Credit: ESA & NASA

How can we know about the past?

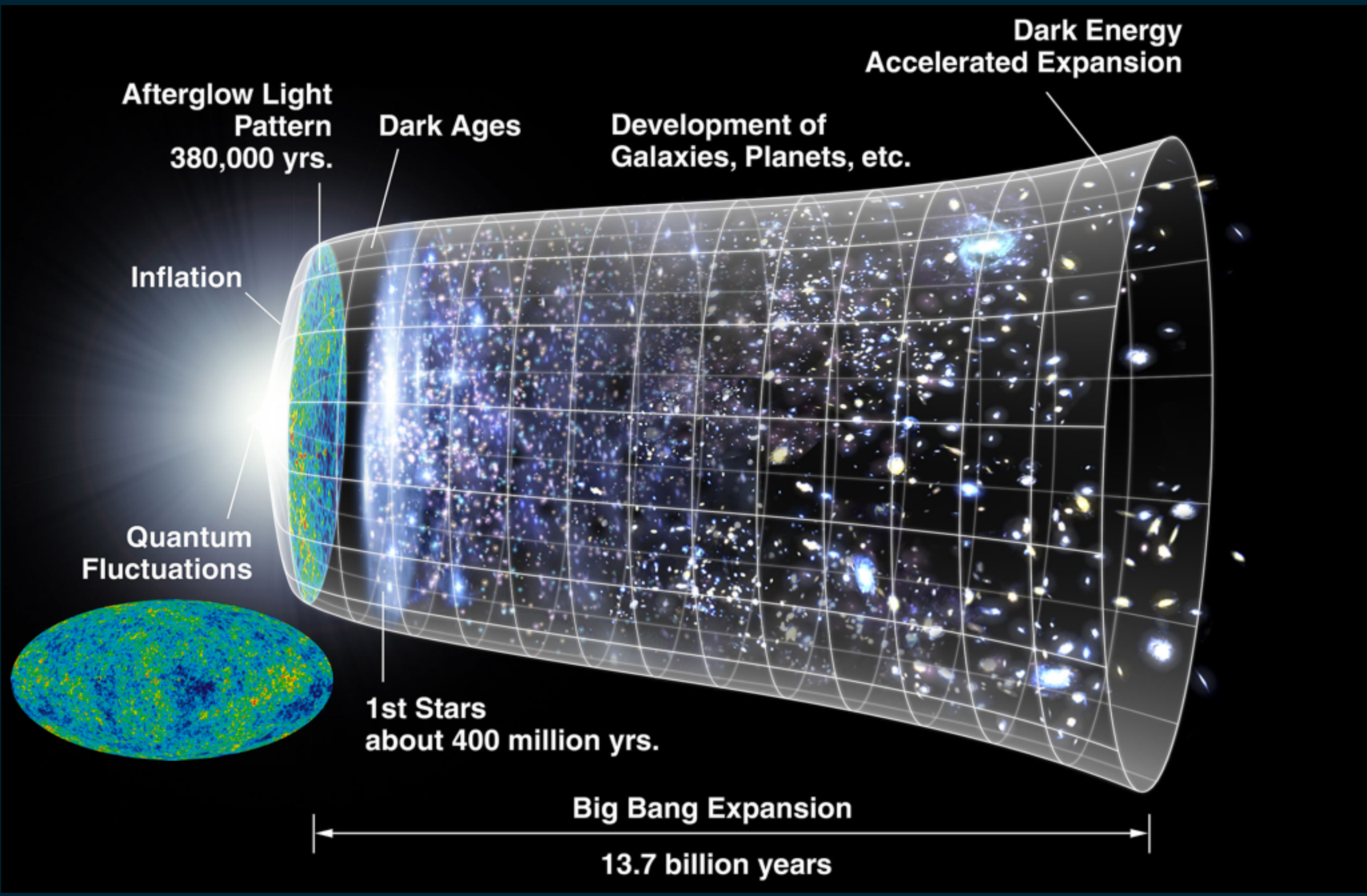
Sunlight  8 minutes old

Light from our closest galaxy (Andromeda):

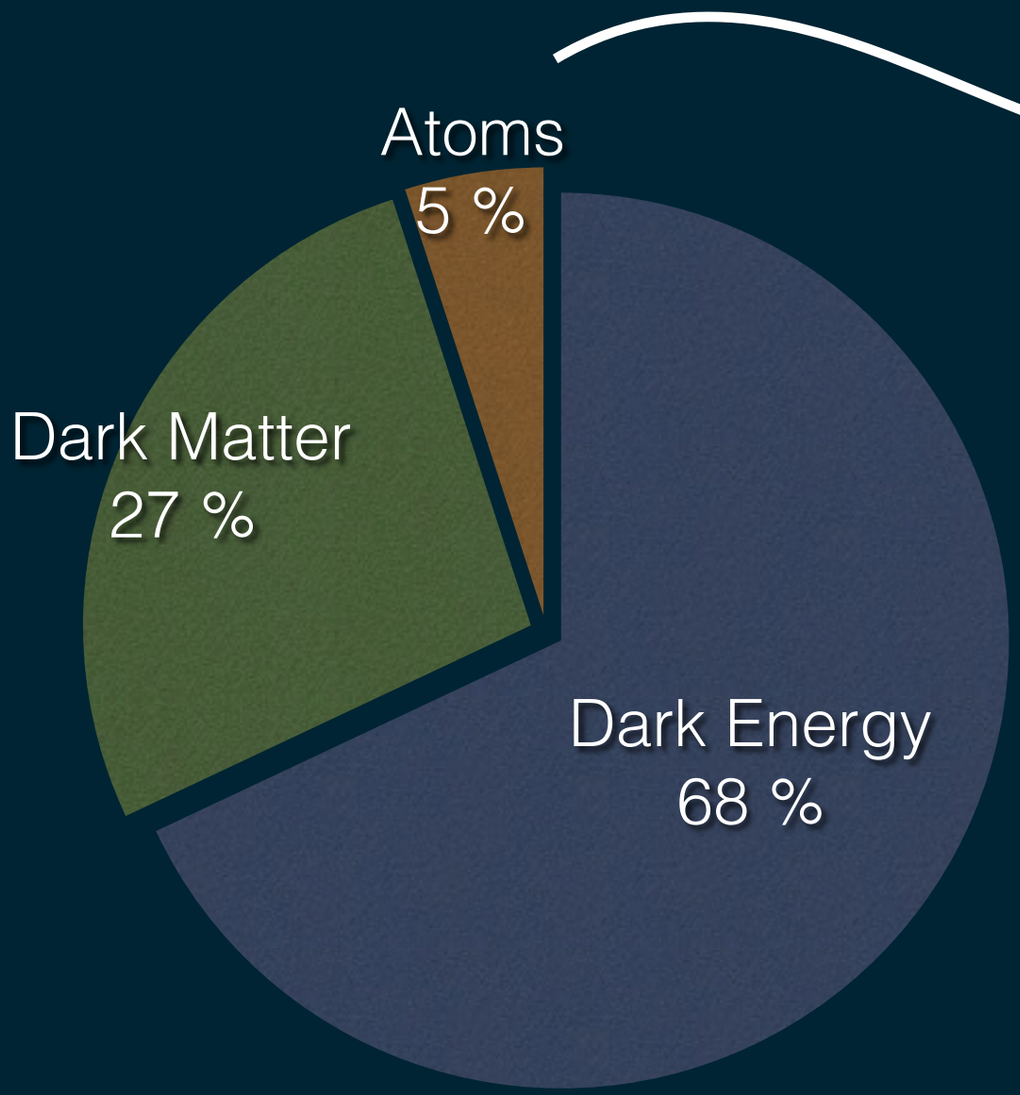
2.5 million years old

Light from very far away galaxies:

more than 10 billion years old

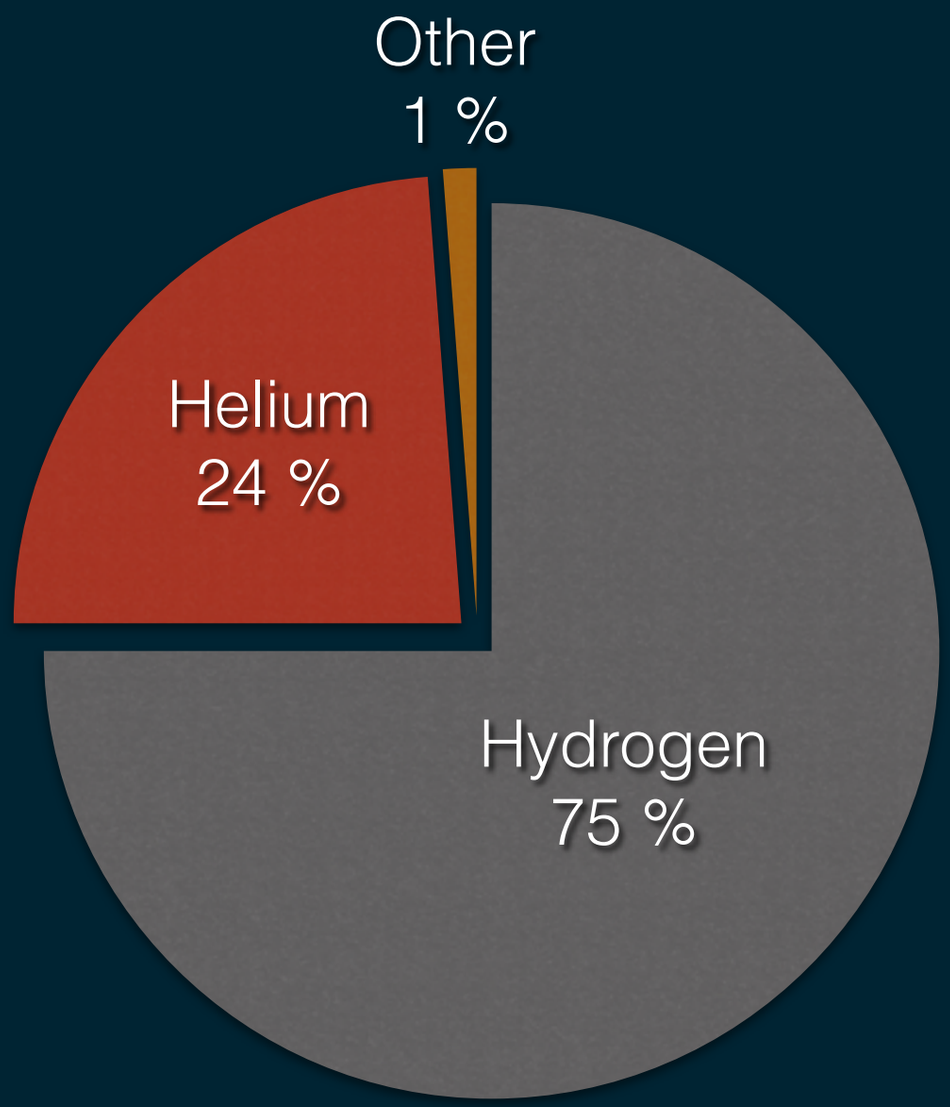

Dark Energy
Accelerated Expansion
Afterglow Light
Pattern
380,000 yrs.
Dark Ages
Development of
Galaxies, Planets, etc.
Inflation
Quantum
Fluctuations
1st Stars
about 400 million yrs.
Big Bang Expansion
13.7 billion years

What we have to work with:
Composition of our Universe

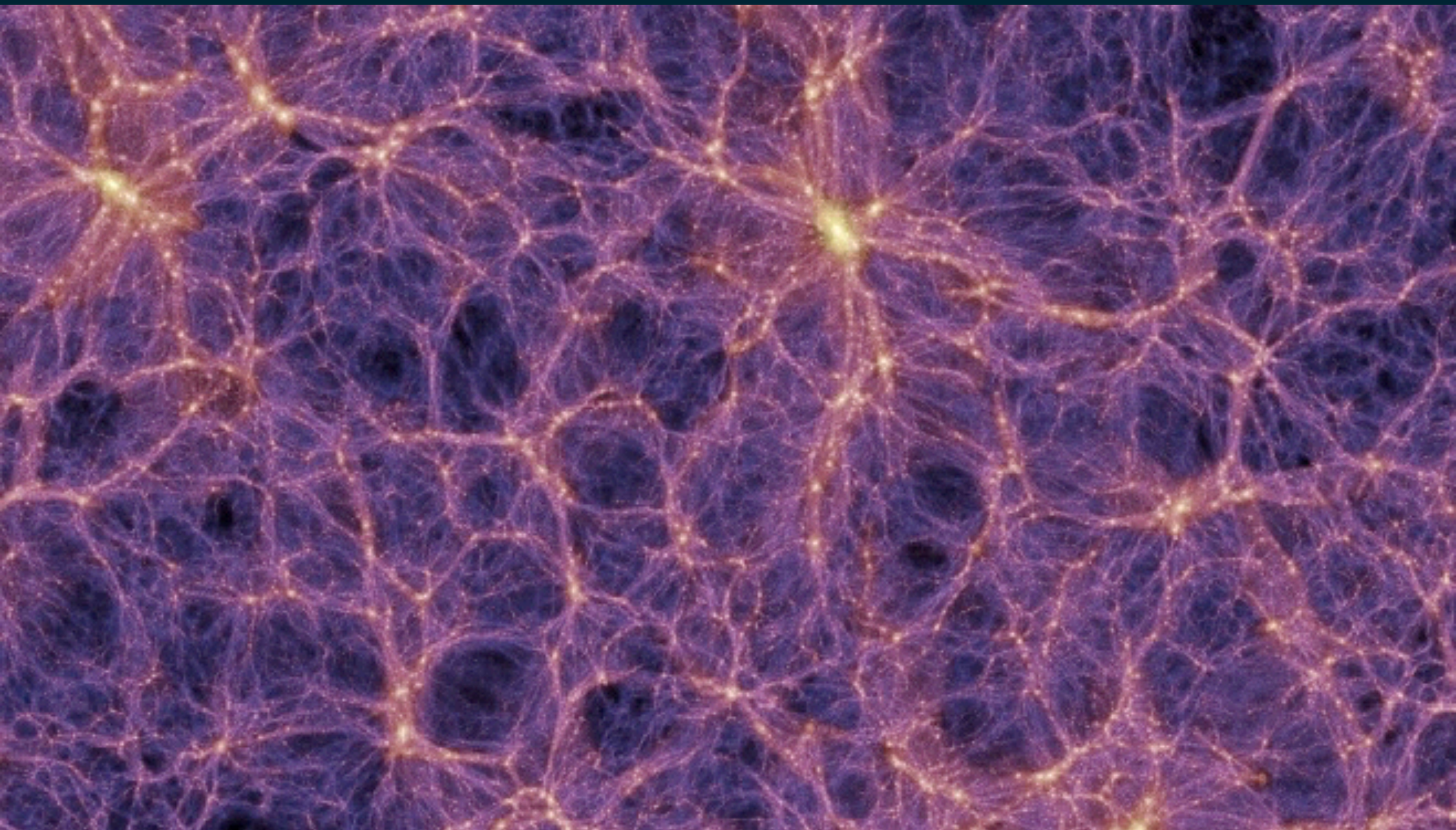


Present day
composition

Distribution of atoms
just after the big bang



Dark matter filaments

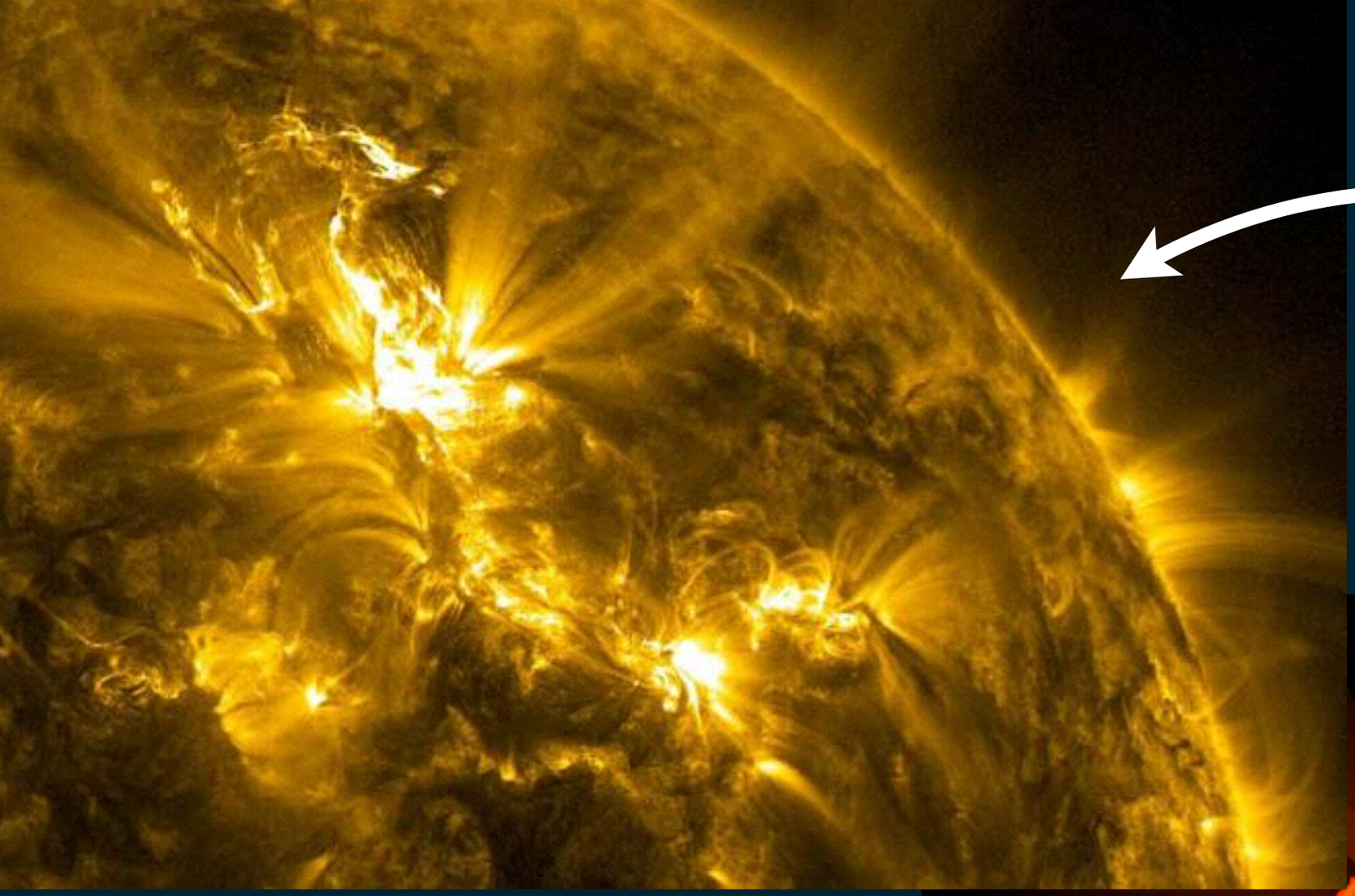


4.5 Gyr

Looking from very far away

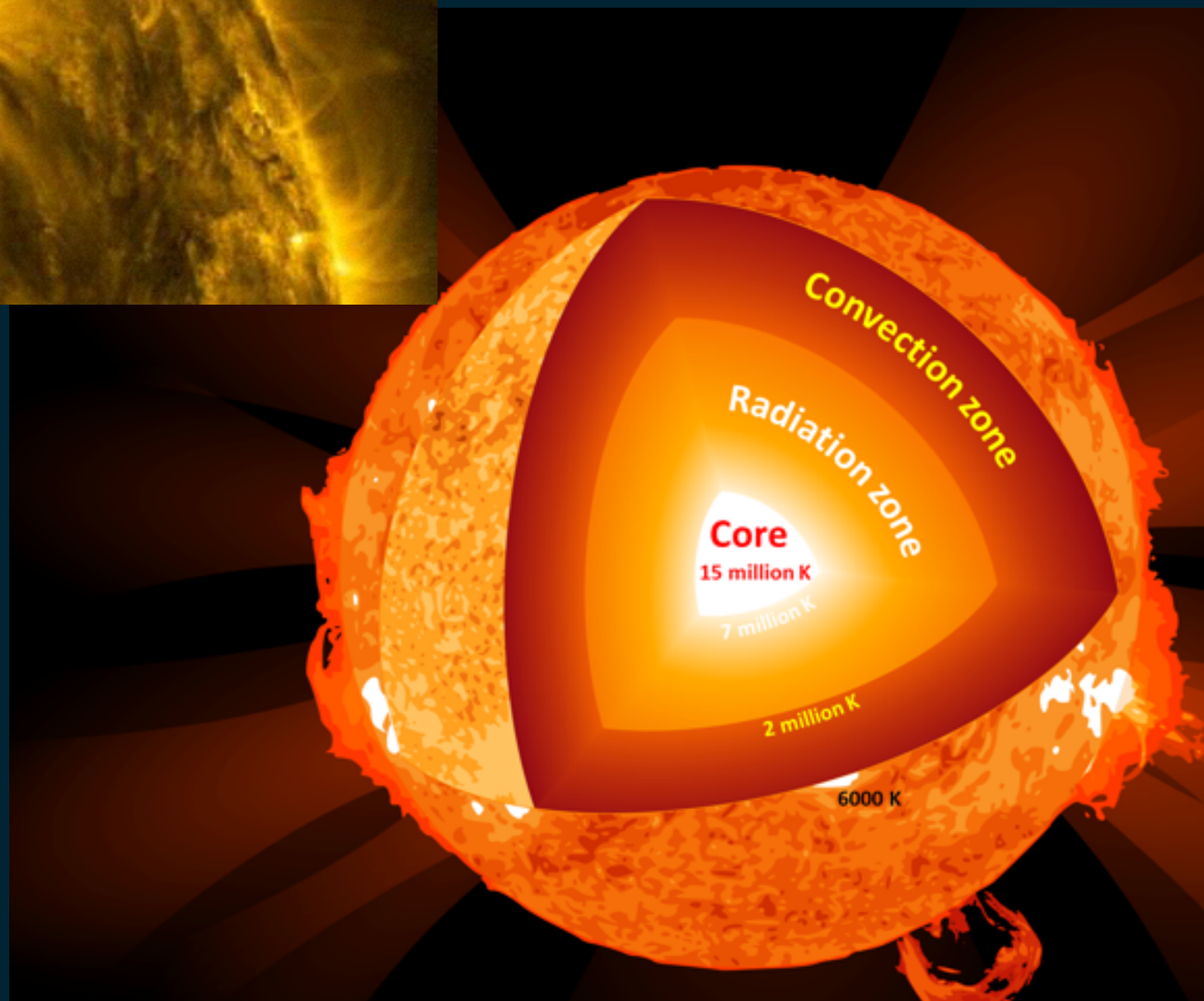
8 million light years

Film credit G. Stinson

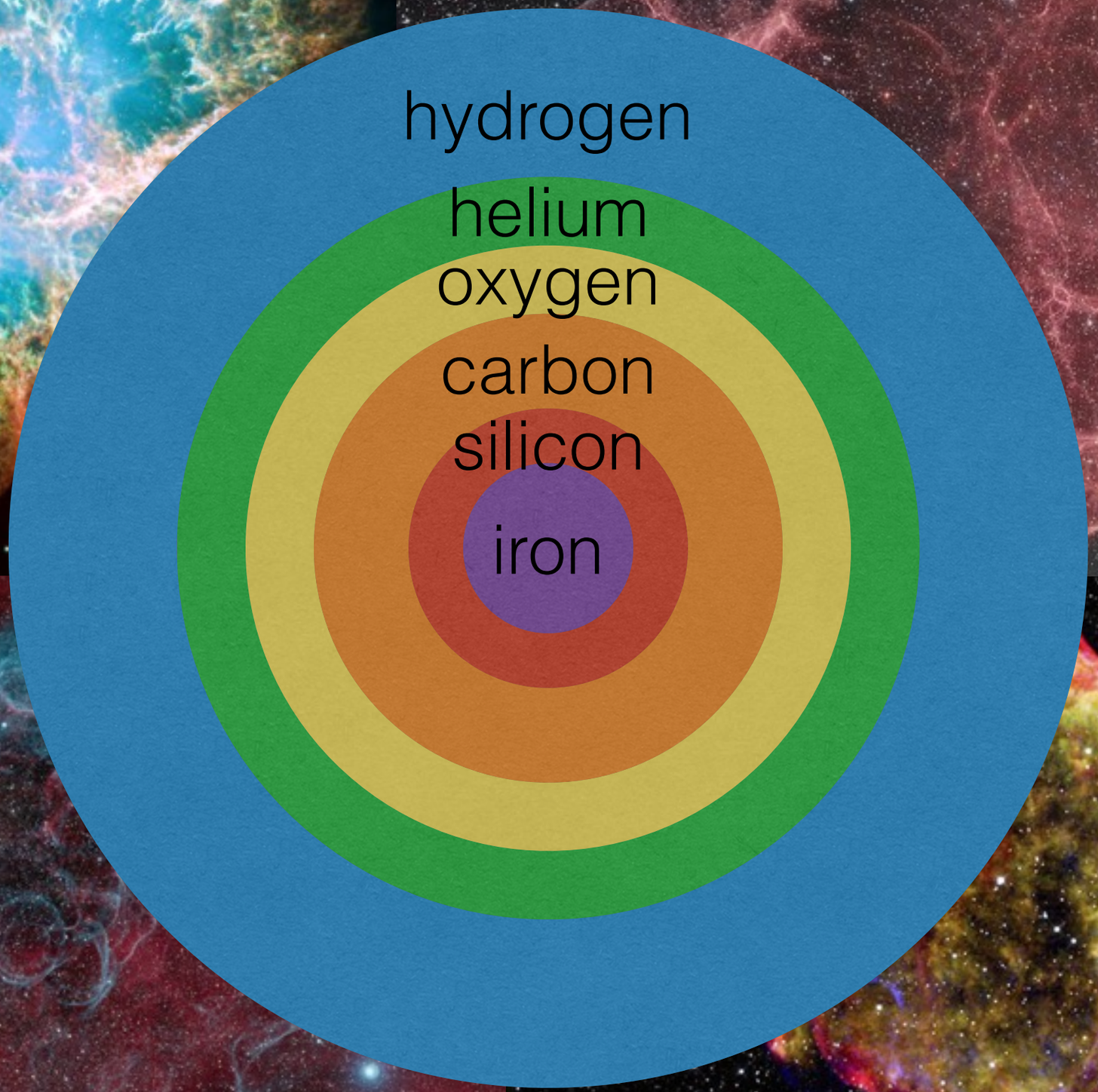


Actual observations of the sun

Our sun:
The closest star to us



Enrichment of the gas



150 light years

Photos credit APOD

6.6 Gyr

Enrichment of the gas

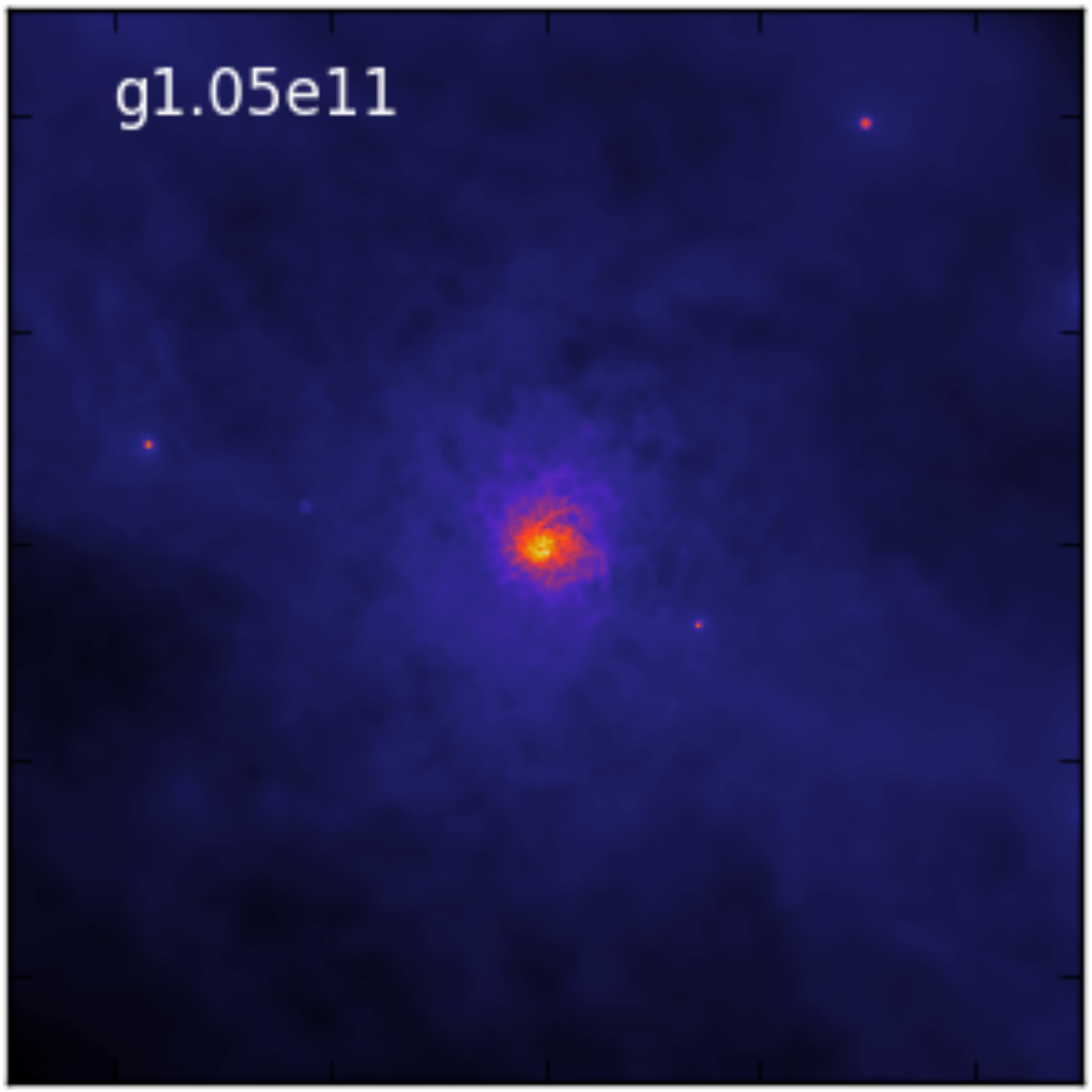
500 000 light years

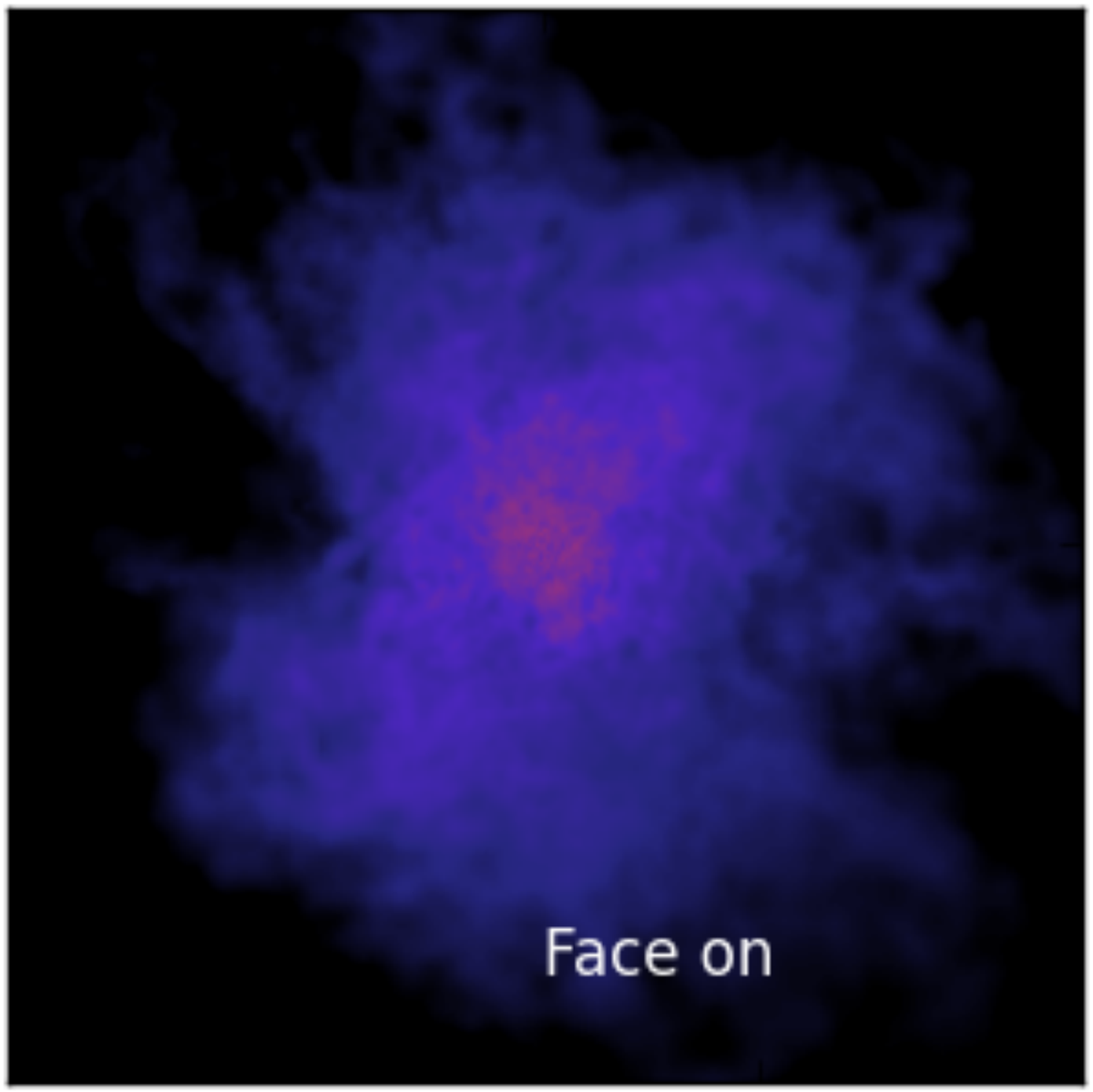
Film credit G. Stinson

Element abundances

Hydrogen

Oxygen



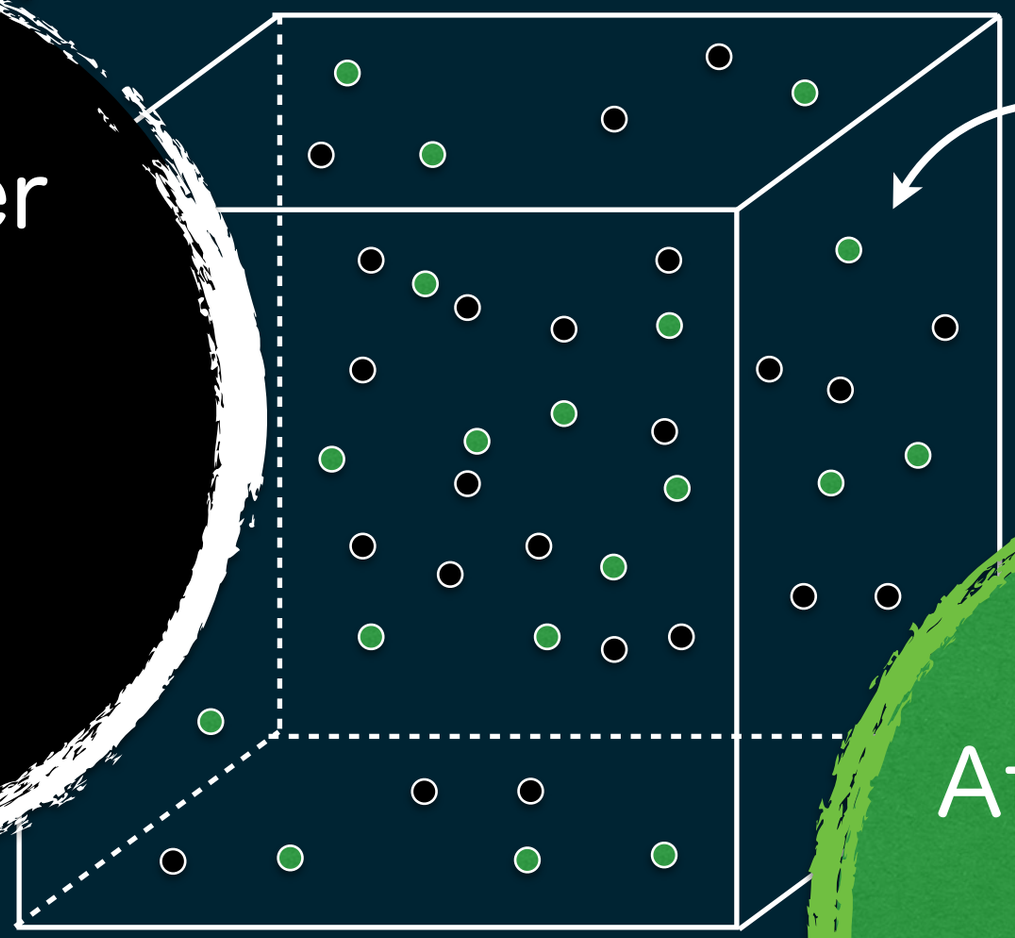


N-body simulation

N : Number of particles

Dark matter particles

20 million solar masses



2 million particles

Atomic particles

1 million solar masses

250 million light years

Star formation region

ensity

Creation of

one star particle

100 000 solar masses

represents a whole

generation of stars

Photo credit L. Fényes

Image credit L. Wang

NIHAO simulations

Numerical **I**nvestigation of a **H**undred **A**strophysical **O**bjects
Simulation of 100 galaxies

From dwarf galaxies to milky way-like galaxies

A statistical sample of galaxies across many orders of magnitude allows a look into the characteristics and evolutionary behavior of galaxies in general

6.1 Gyr

So what are galaxies?

Dark matter

Hydrogen/
Helium

Stars

complex elements:
star dust