

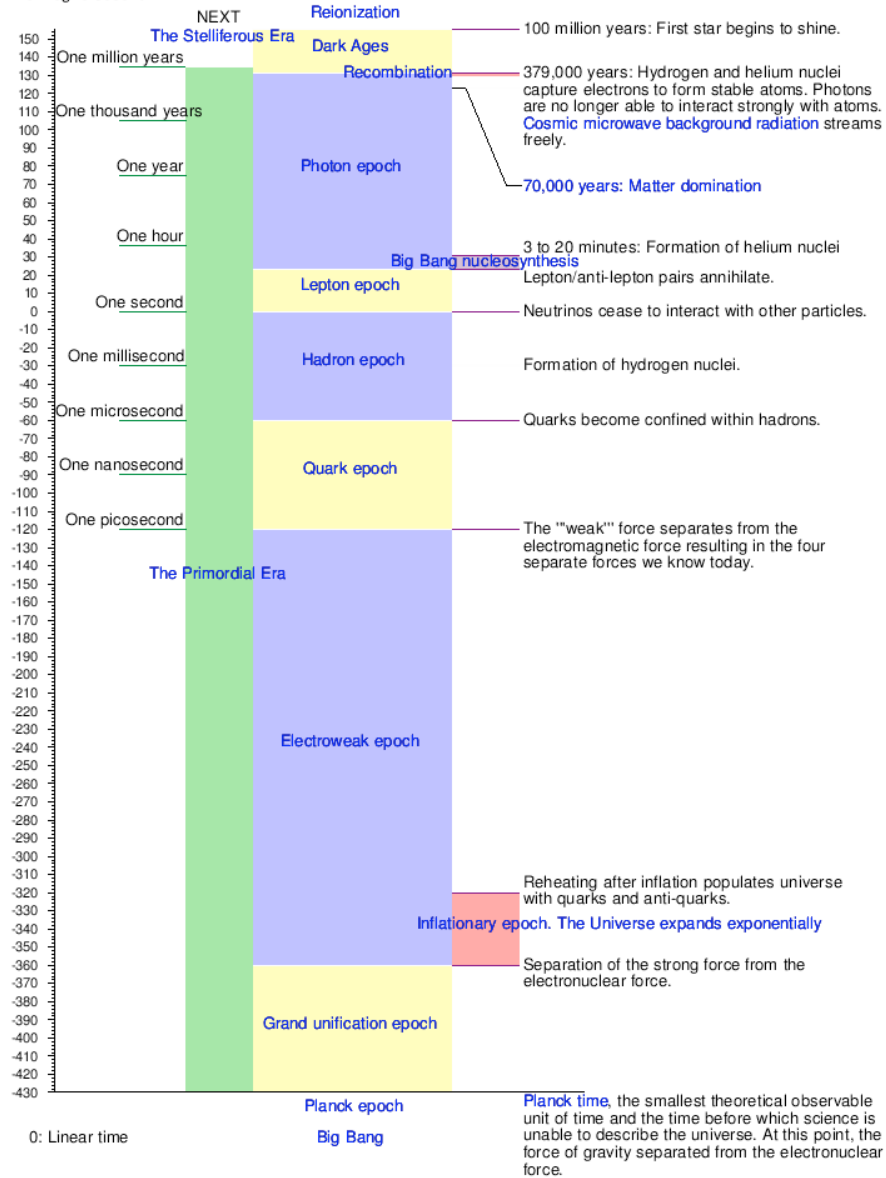


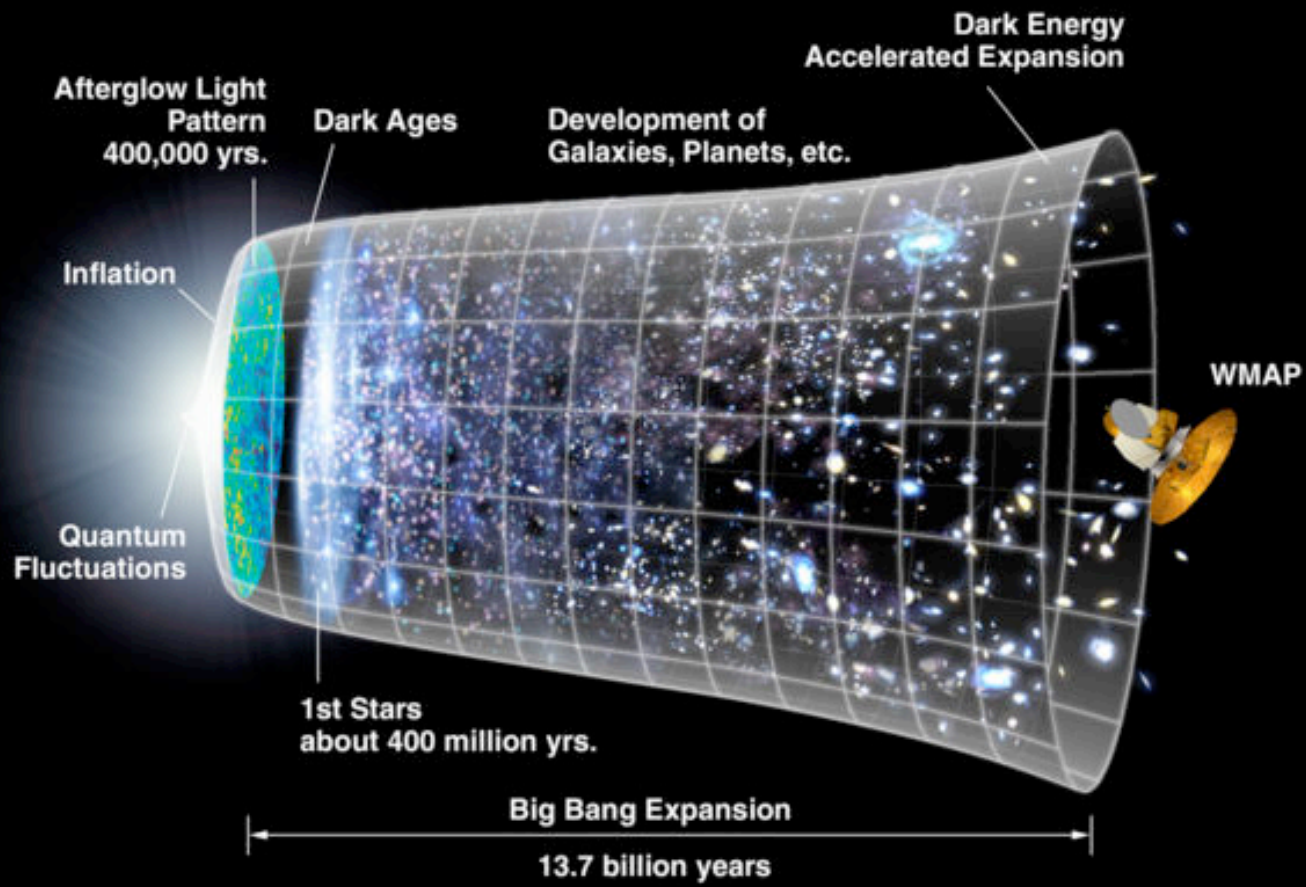
The Cosmic Shopping List

Renée Hlozek

Cosmic Scales

Logarithmic time:
 $10 \cdot \log_{10}$ second

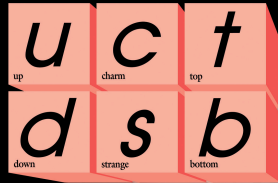




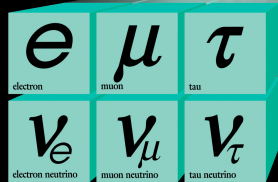
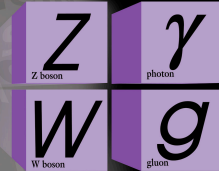
NASA/WMAP

Ingredients

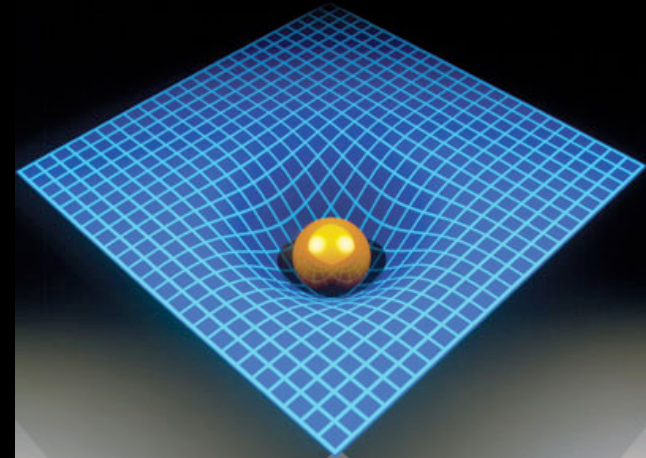
Quarks



Forces

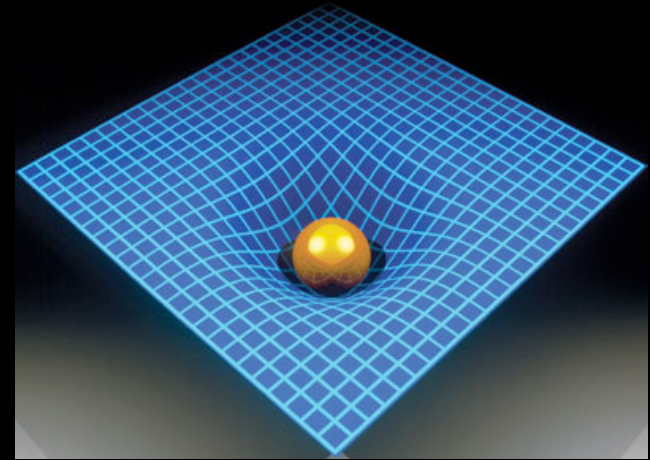


Leptons

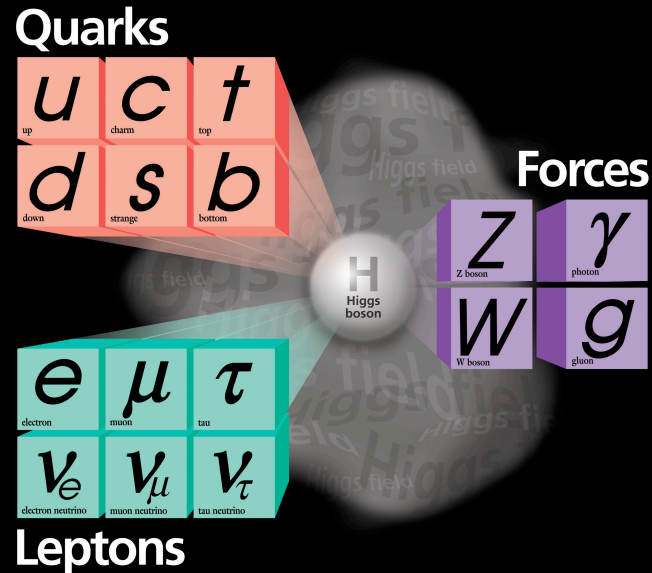


The Forces of Nature

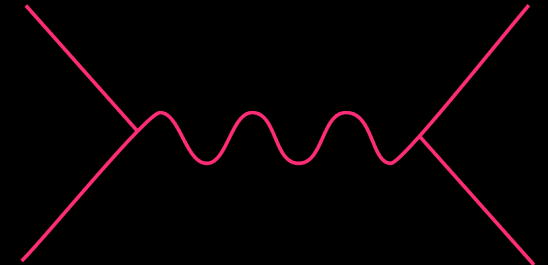
- Gravity is a fundamental force of nature
- Einstein: GR relates gravity to the physics of space itself.
- Space has a SHAPE



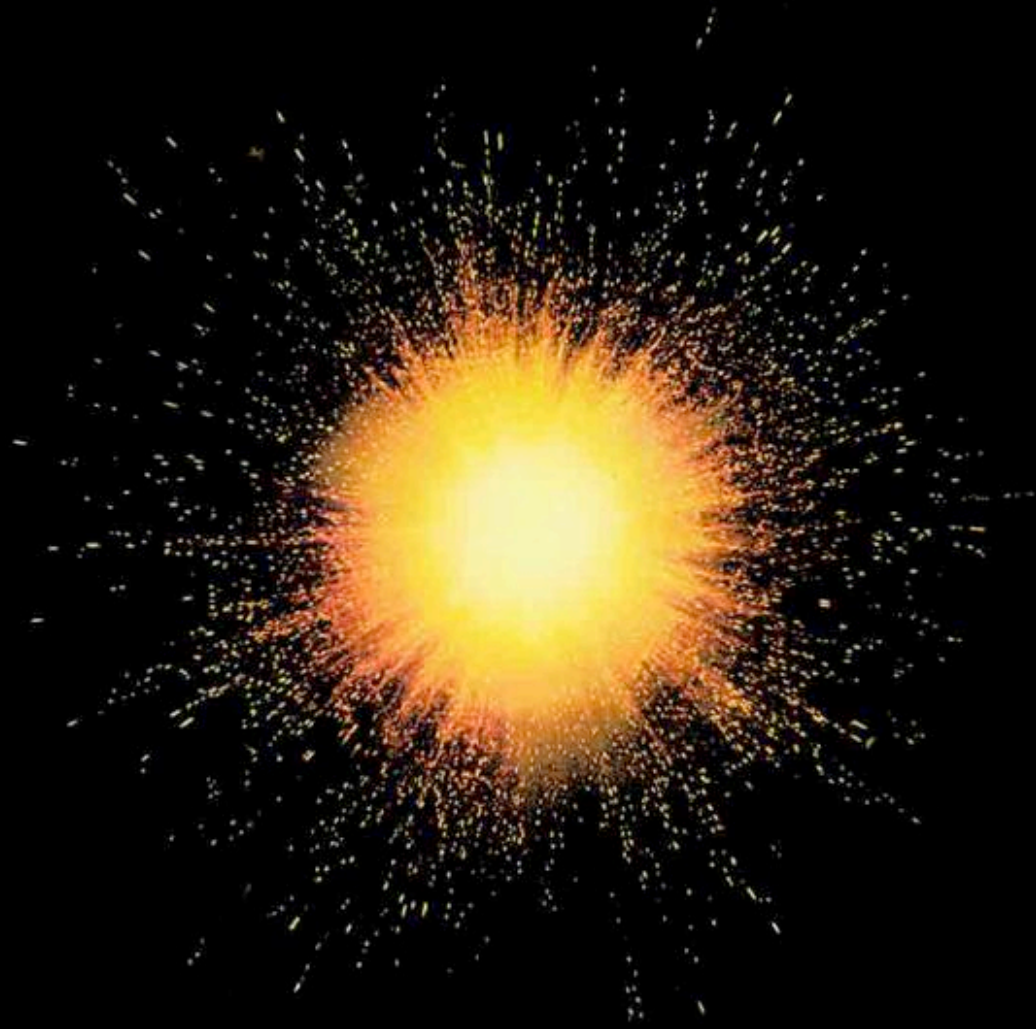
The Standard Model

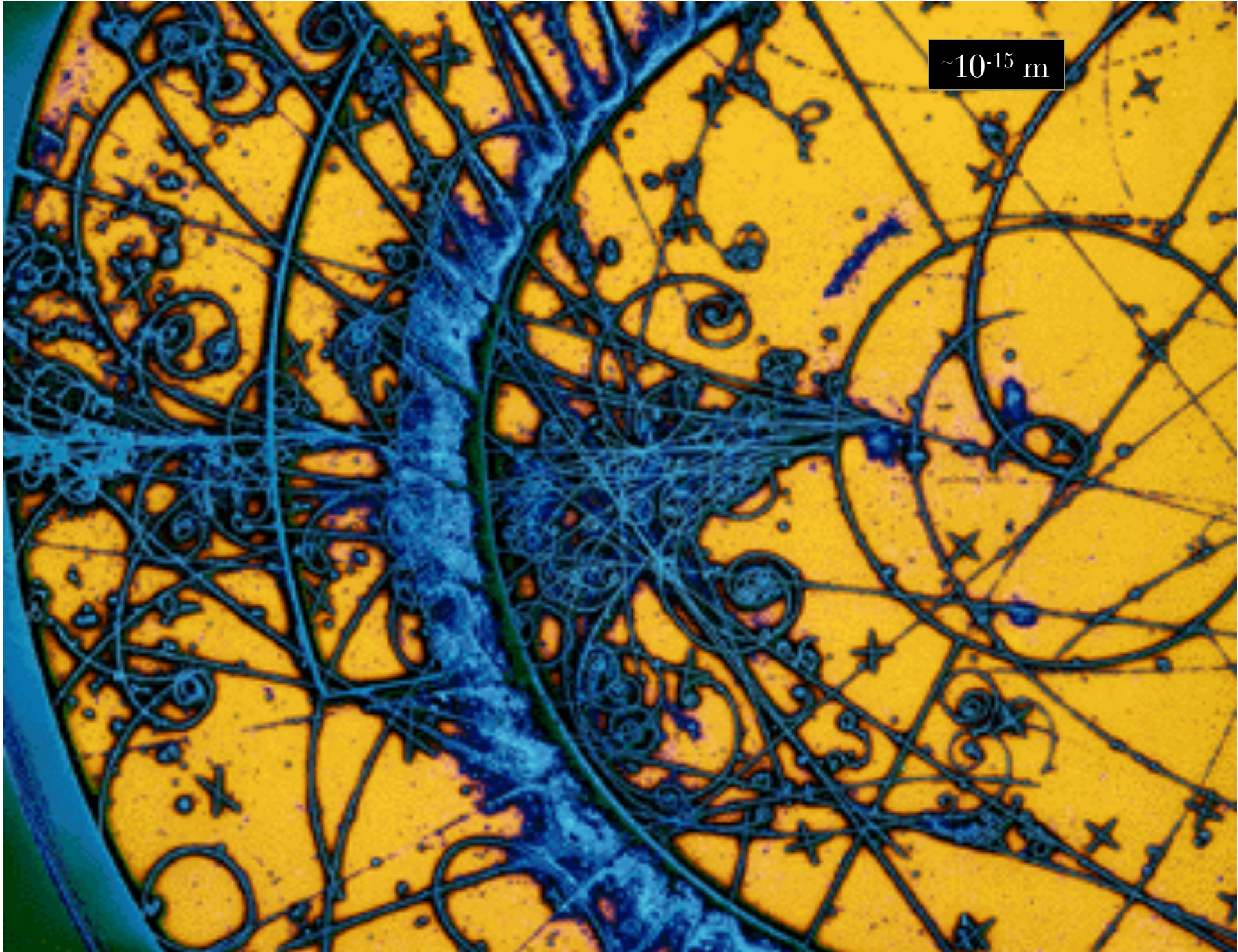


- Particles that make up atoms
- Forces act on specific particles
- Quantum Mechanical

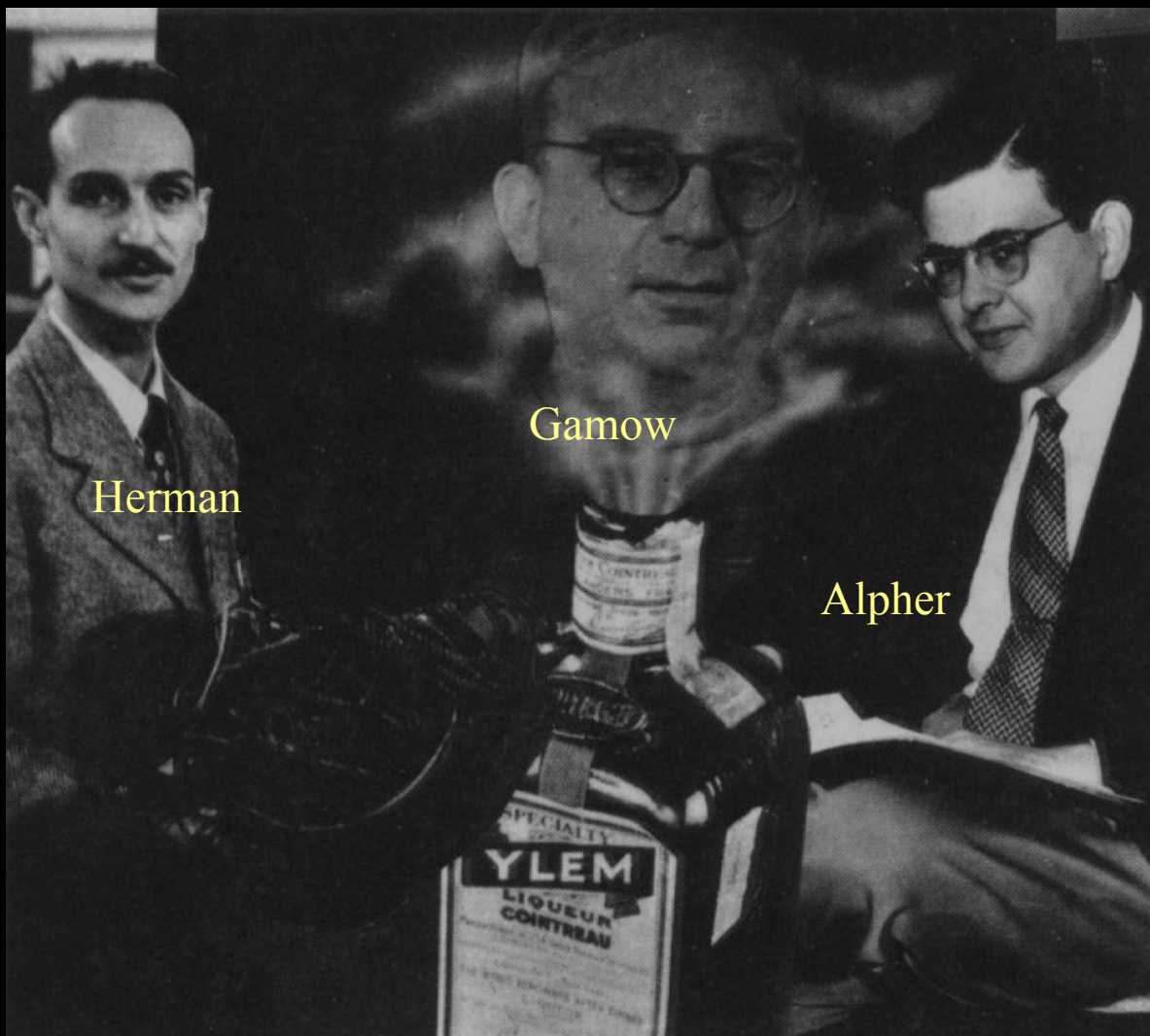


The Cosmic Fireball





Cosmic Cooking



Herman

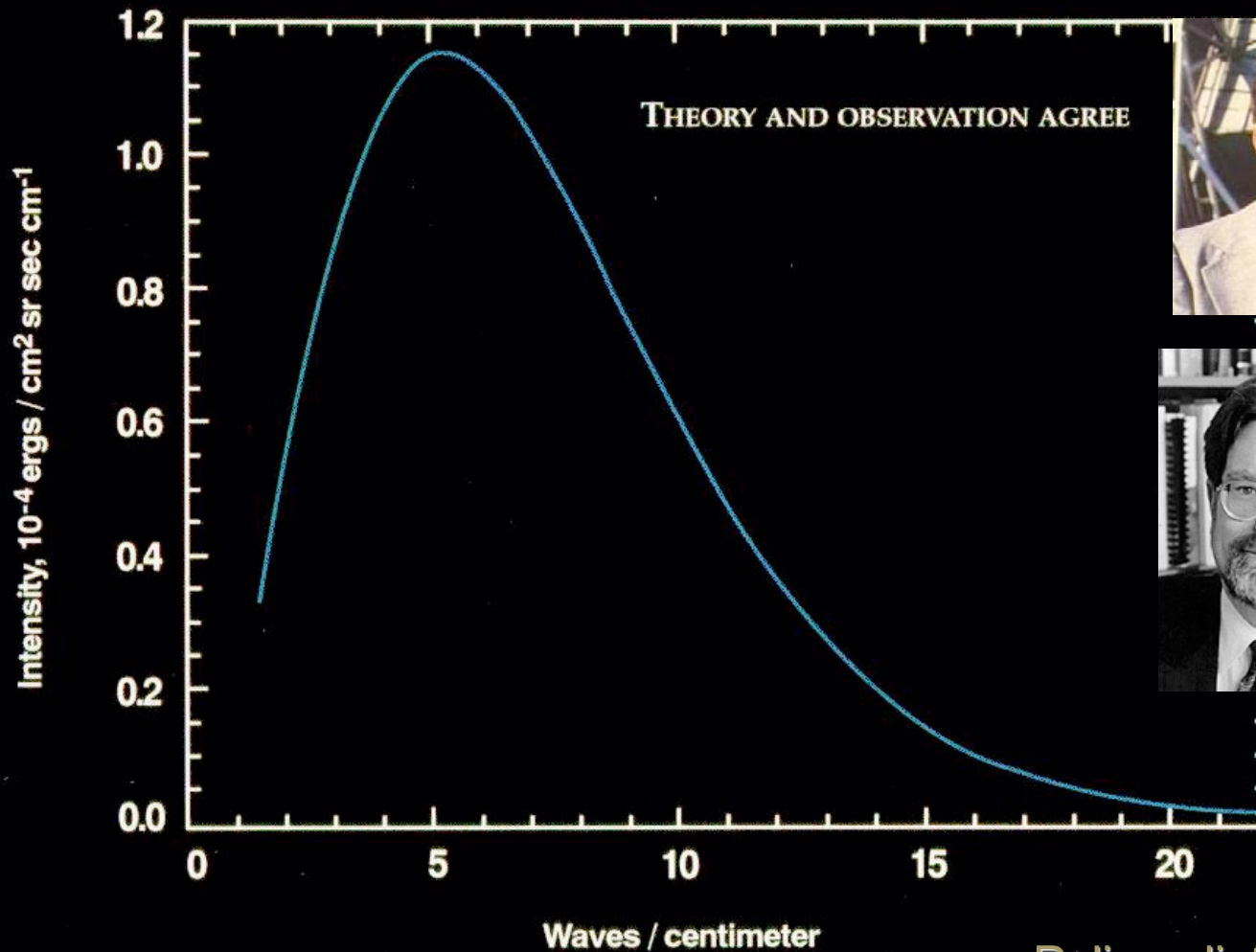
Gamow

Alpher

Evidence for the Big Bang

COSMIC MICROWAVE BACKGROUND SPECTRUM FROM COBE

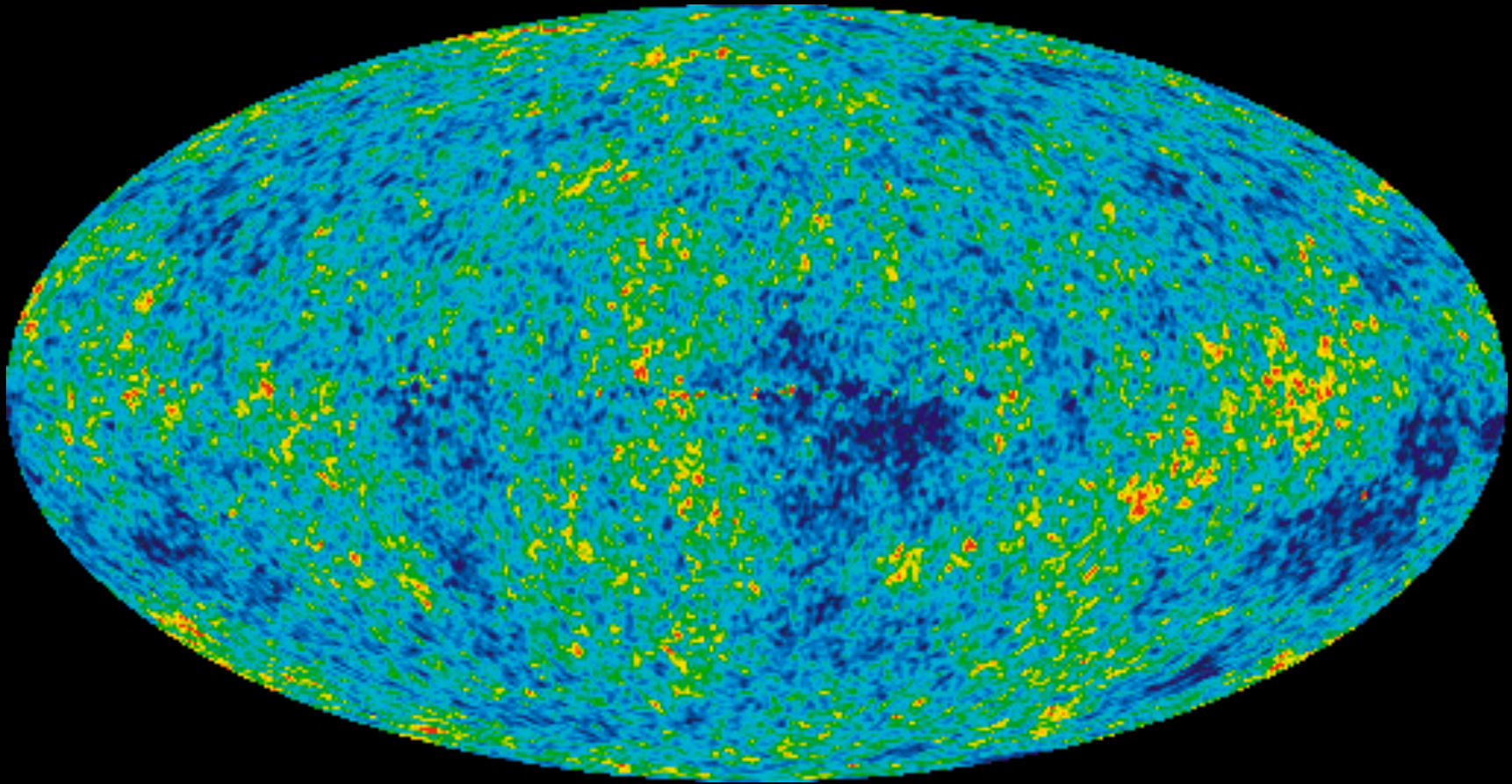
Penzias and Wilson



Smoot and Mather

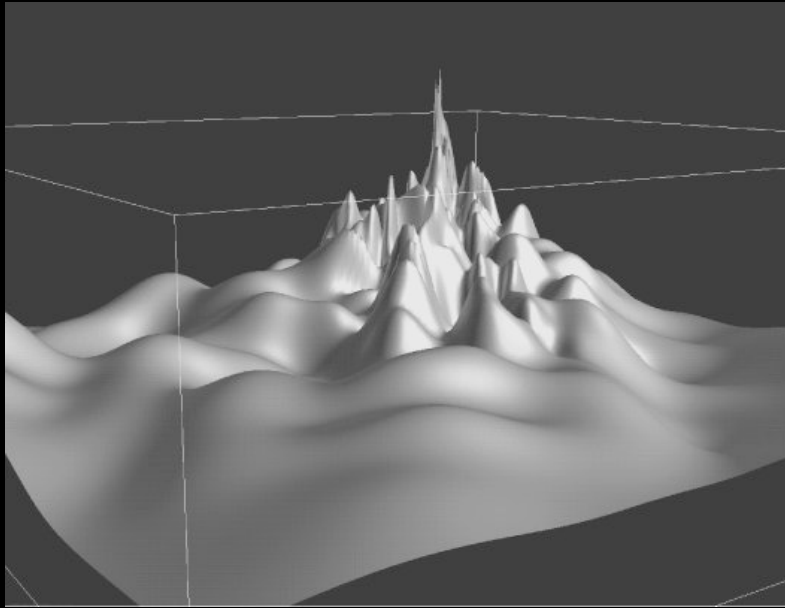
Relic radiation left over from the Big Bang discovered in 1964

Cosmic Ripples in the spectrum...



We need some rapid form of expansion

Inflation

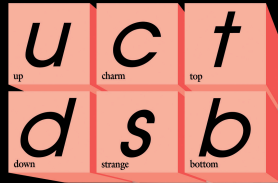


- Inflation makes the universe flat
- Inflation predicts the specific shape of ripples in the CMB

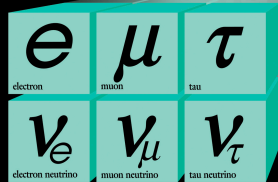
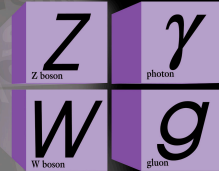


Ingredients

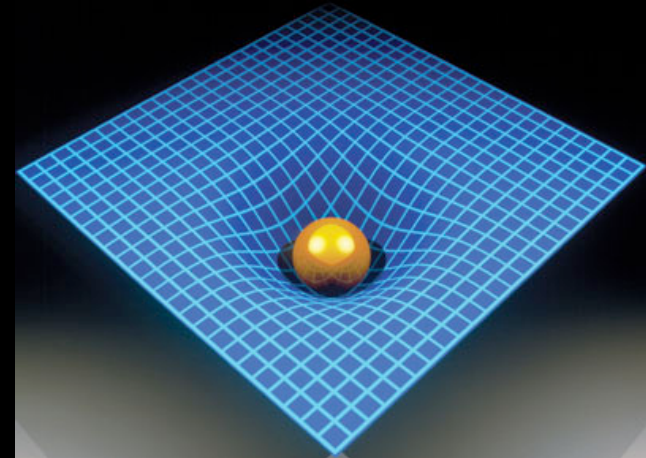
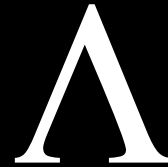
Quarks



Forces



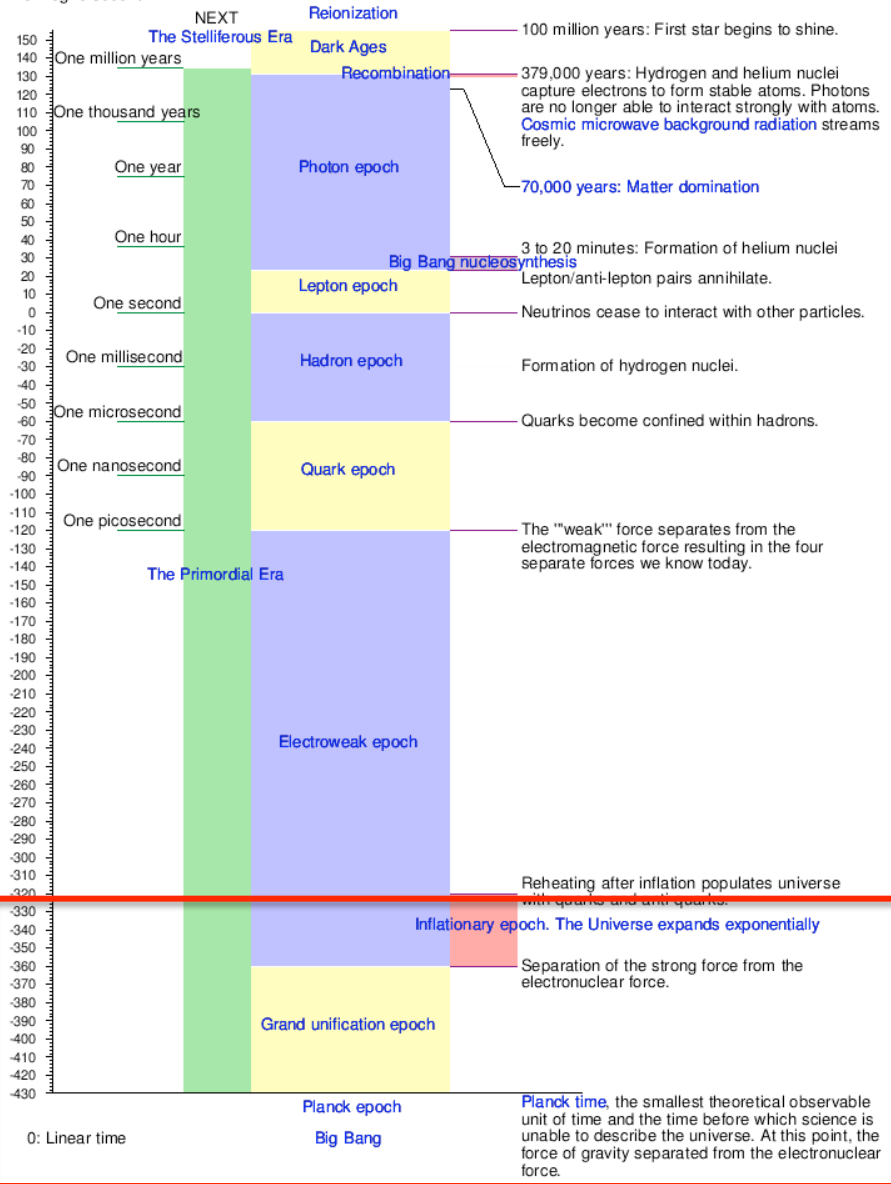
Leptons

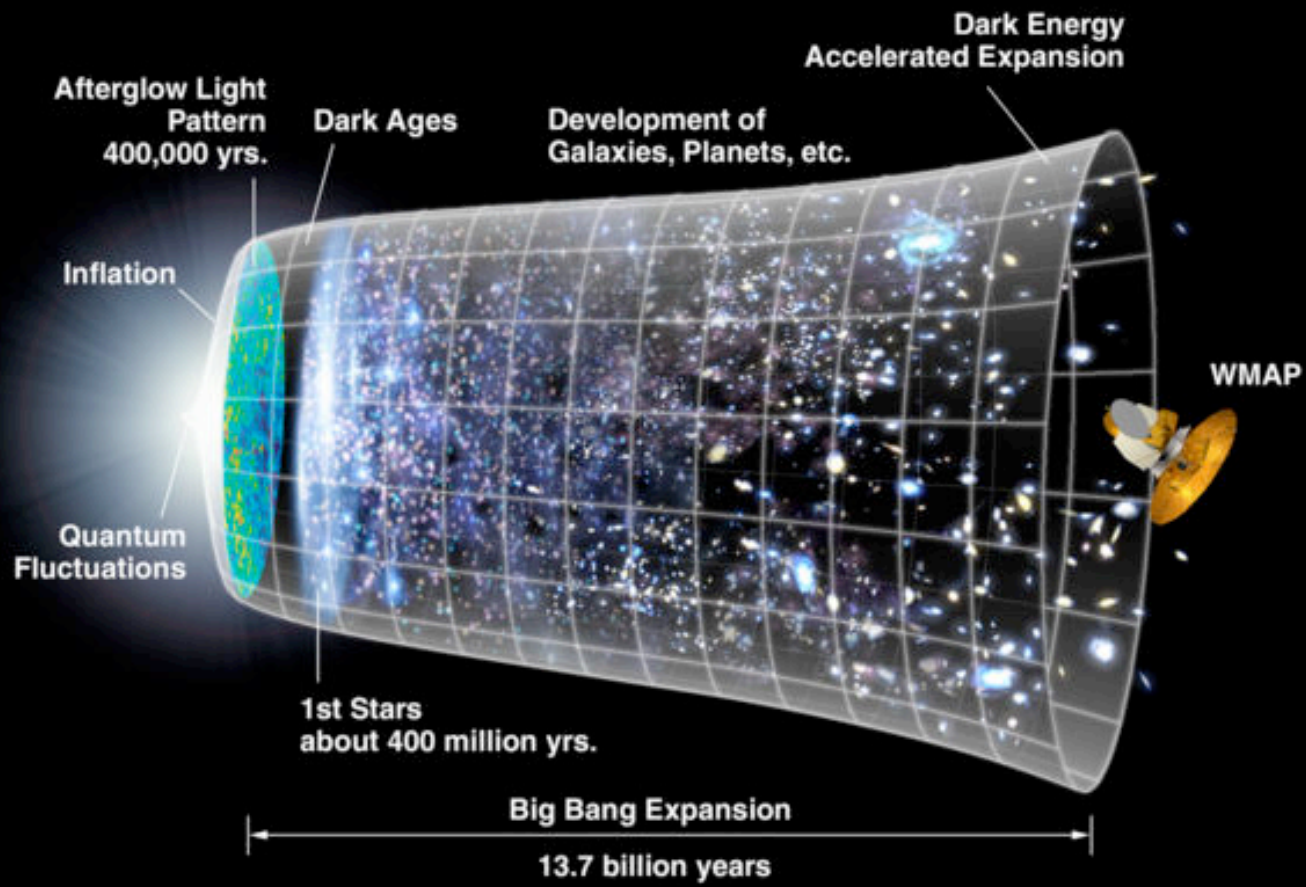


What is the inflaton?

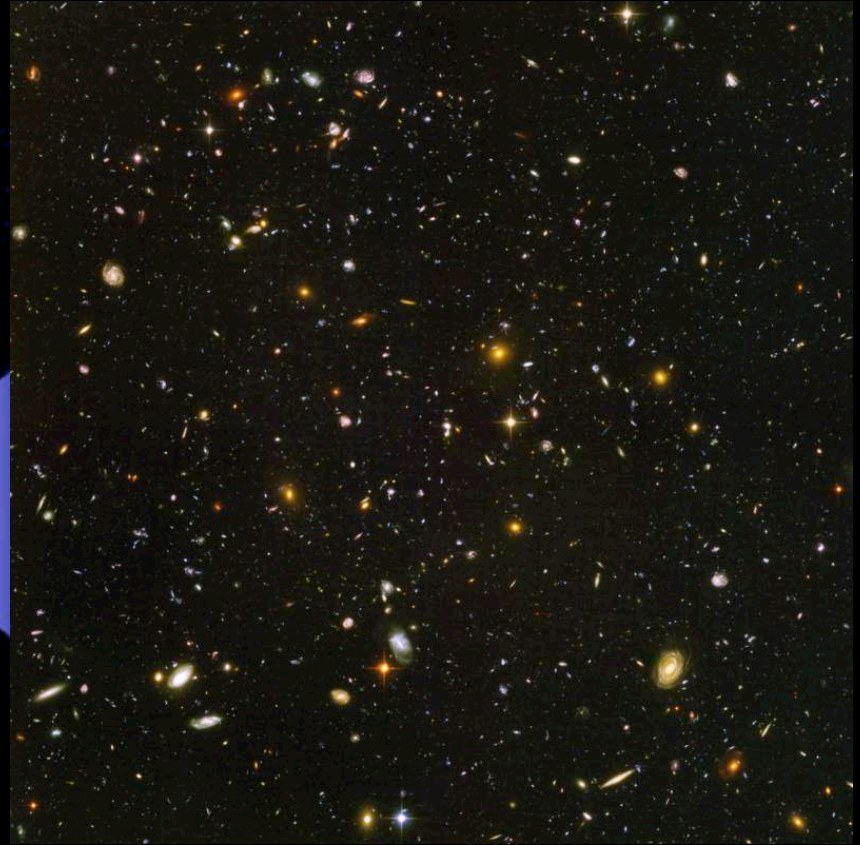
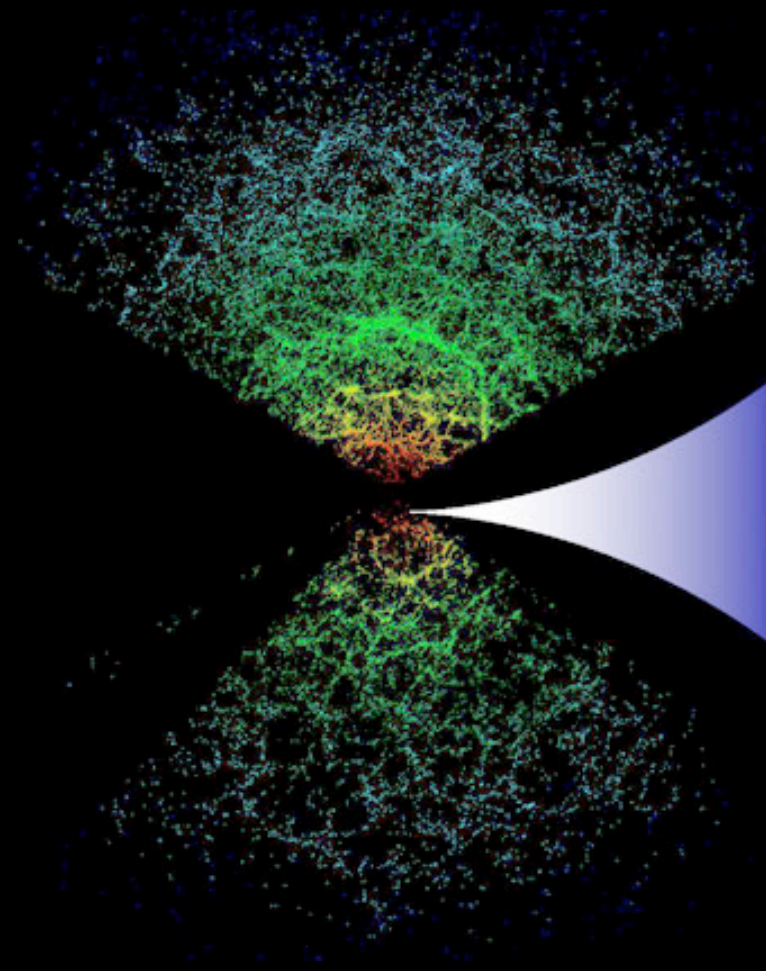
Cosmic Scales

Logarithmic time:
 $10 \cdot \log_{10}$ second



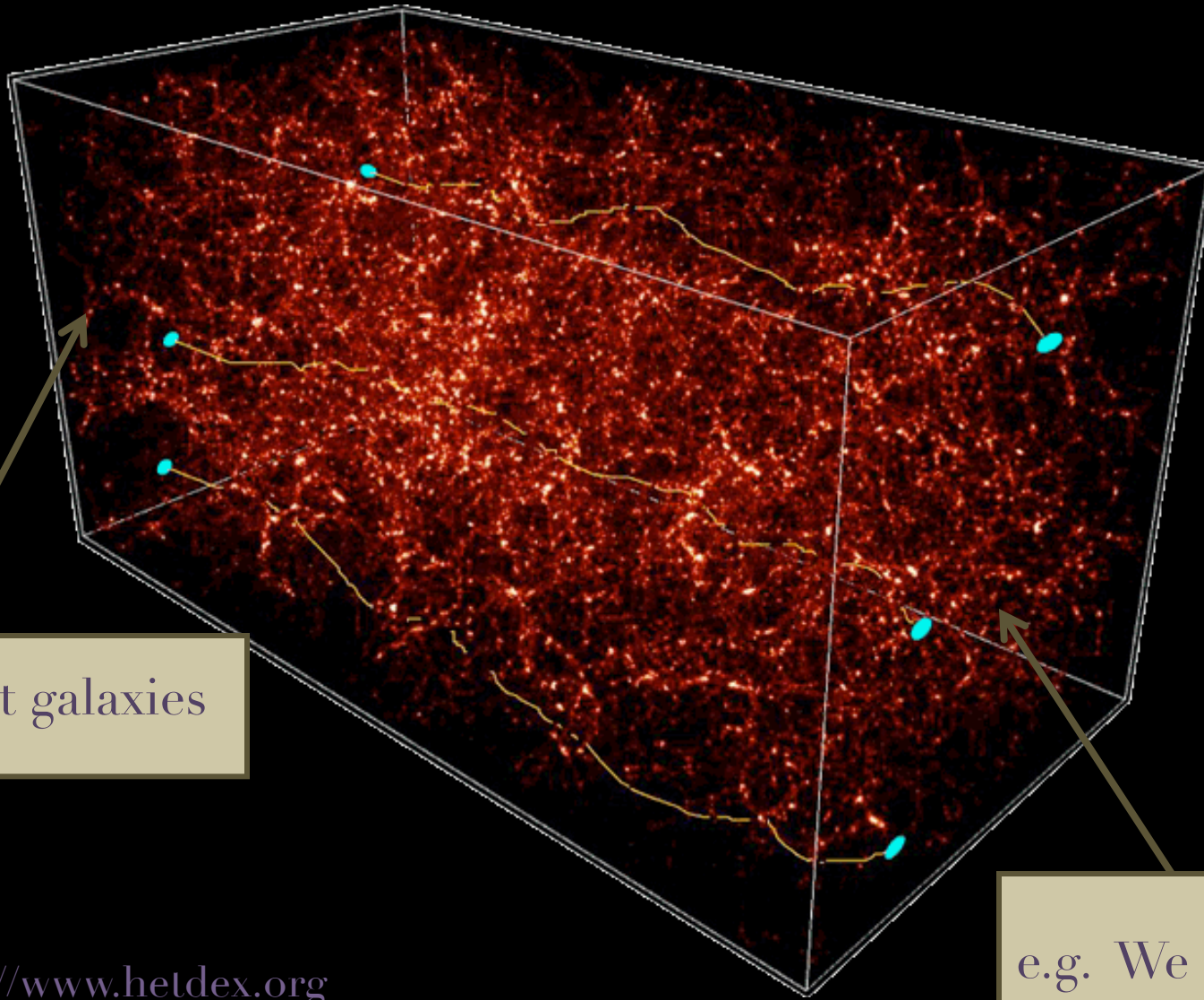


NASA/WMAP



Hubble Ultra
Deep Field

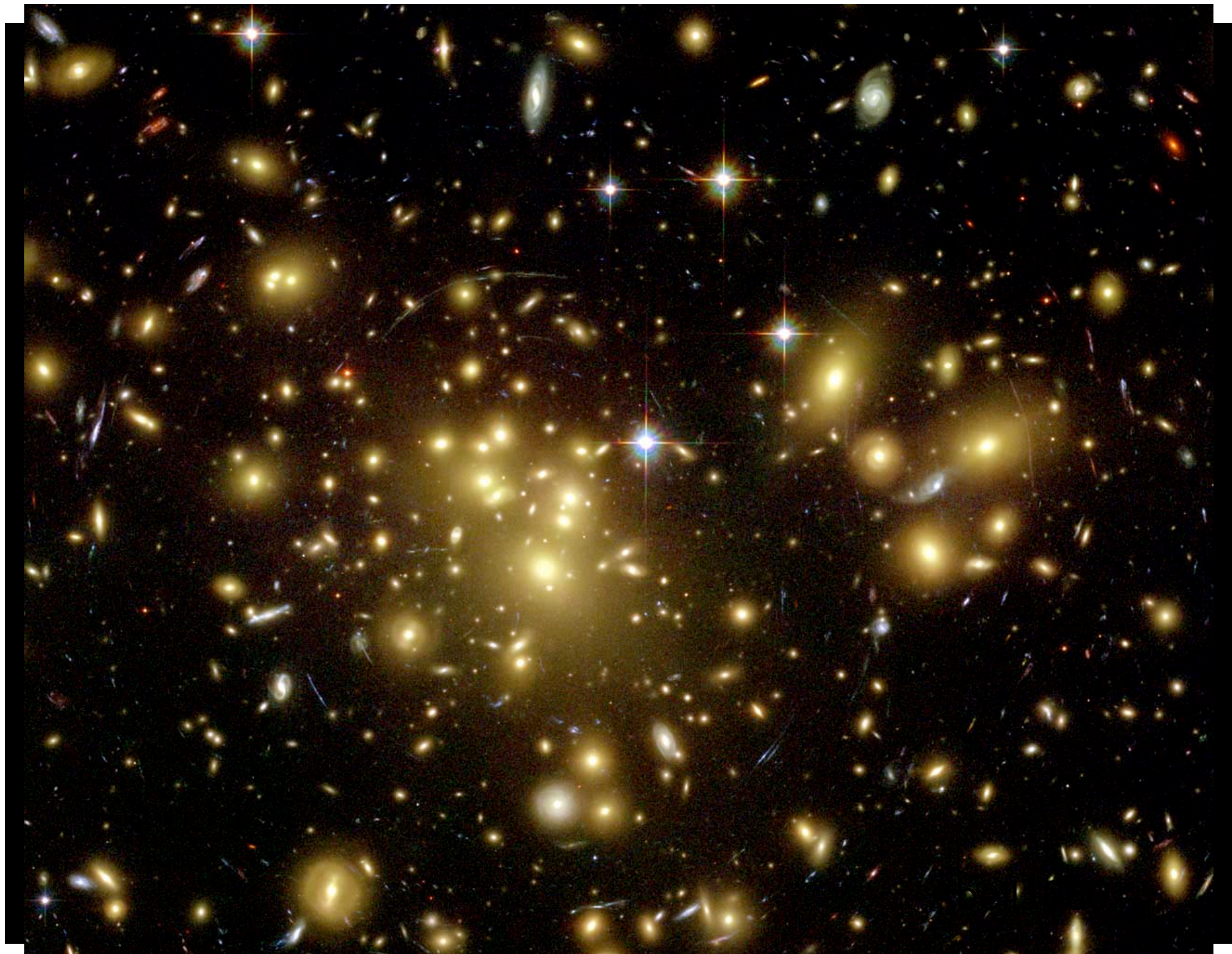
Cosmic Constituents

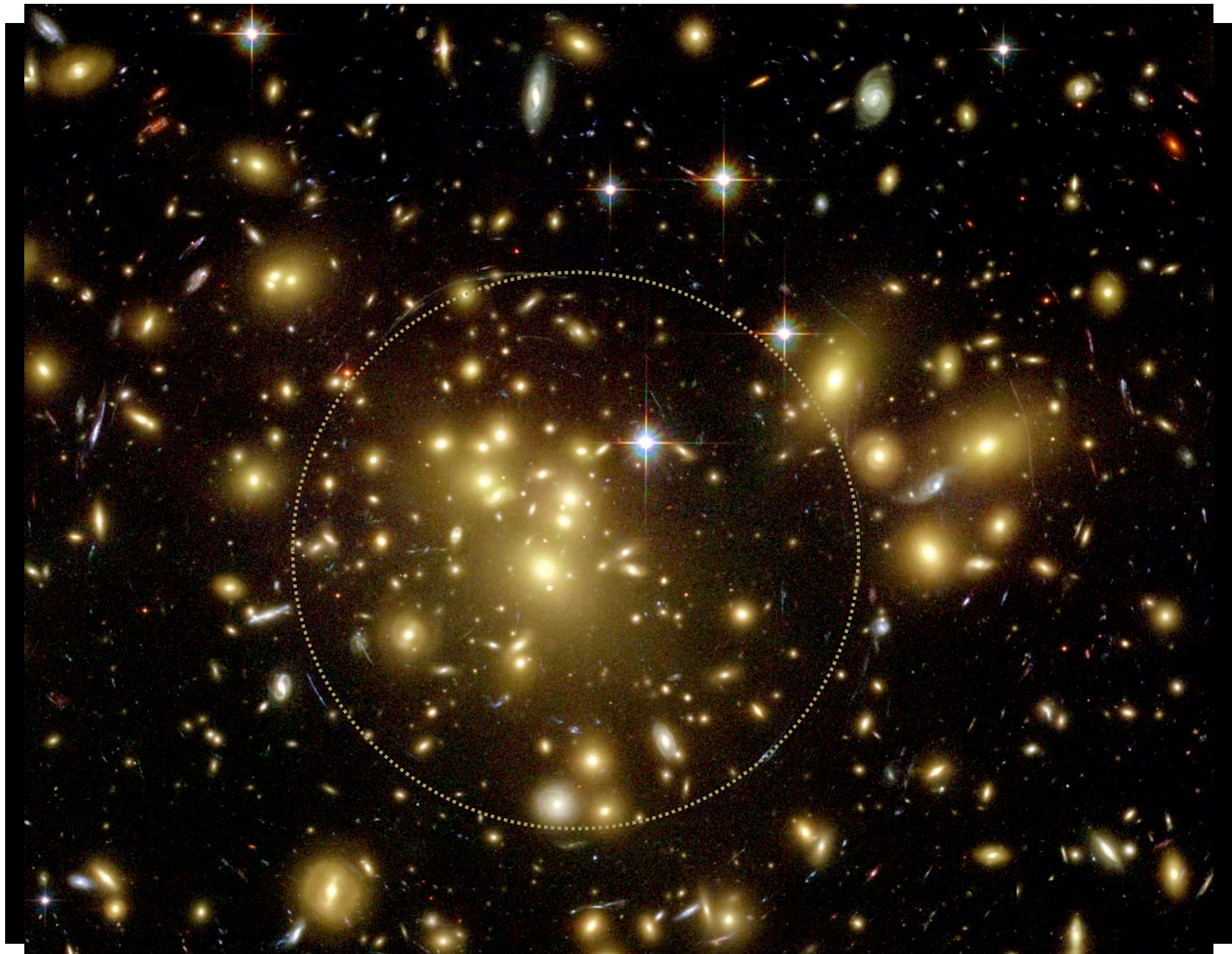


Distant galaxies

e.g. We are here

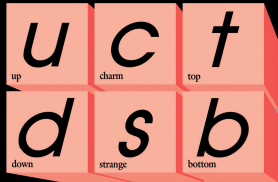
<http://www.hetdex.org>



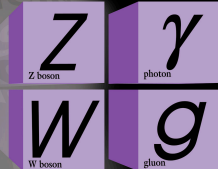


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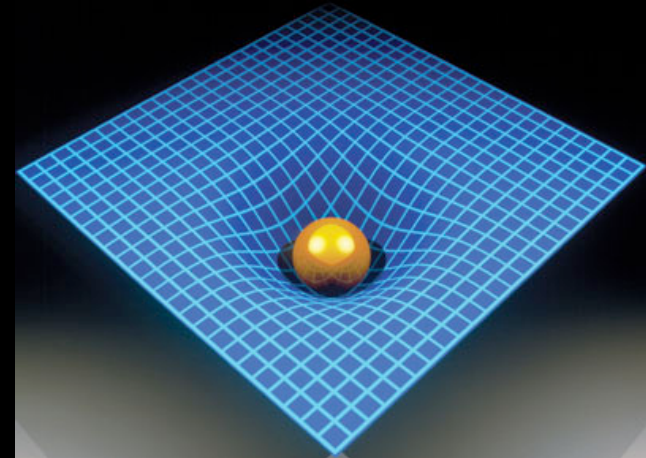
Quarks



Forces

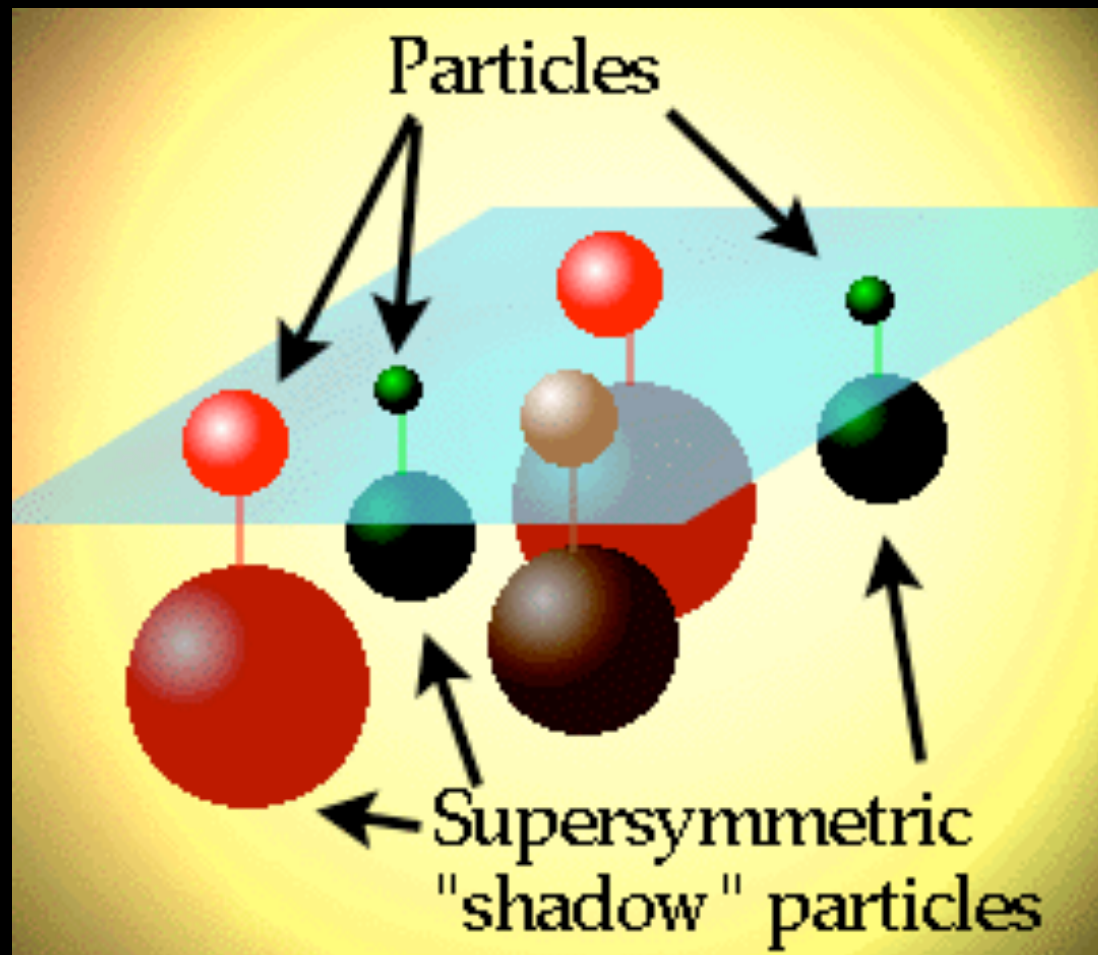


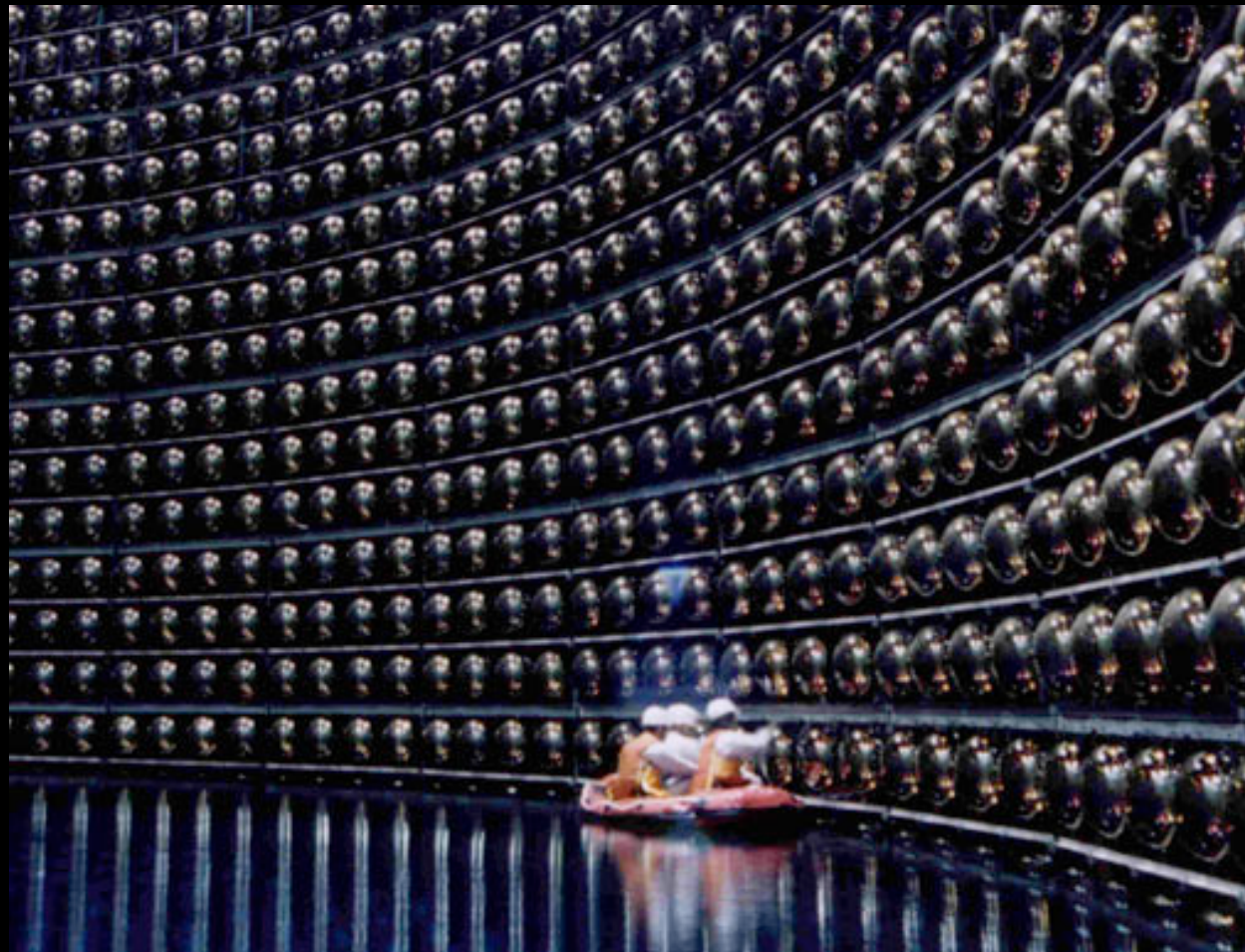
Leptons



What is the inflaton?

What is the dark matter?

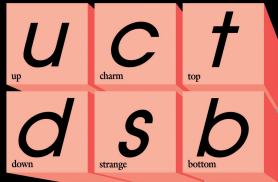




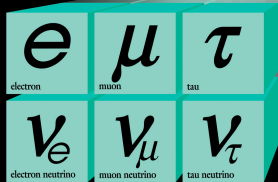
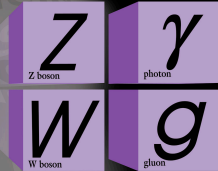


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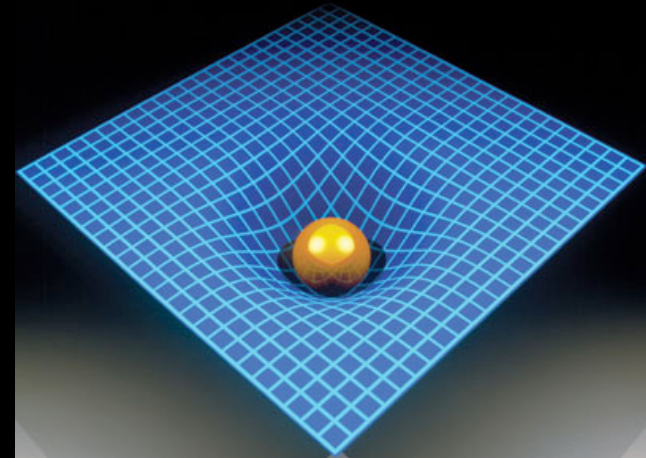
Quarks



Forces



Leptons

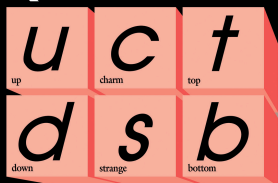


What is the inflaton?

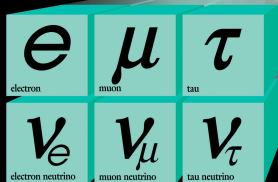
What is the dark matter?

Ingredients

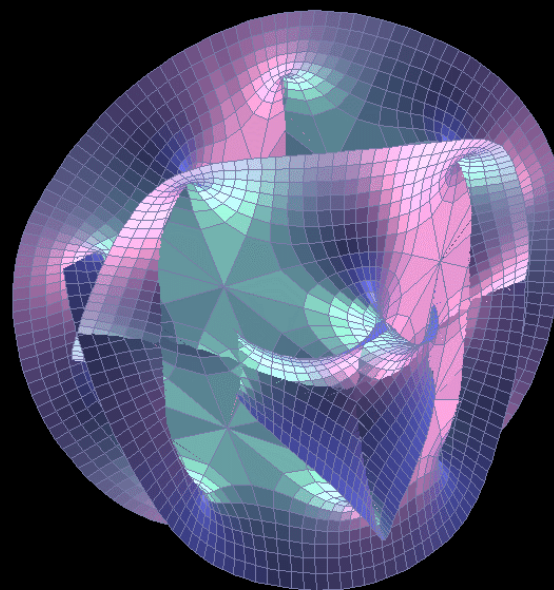
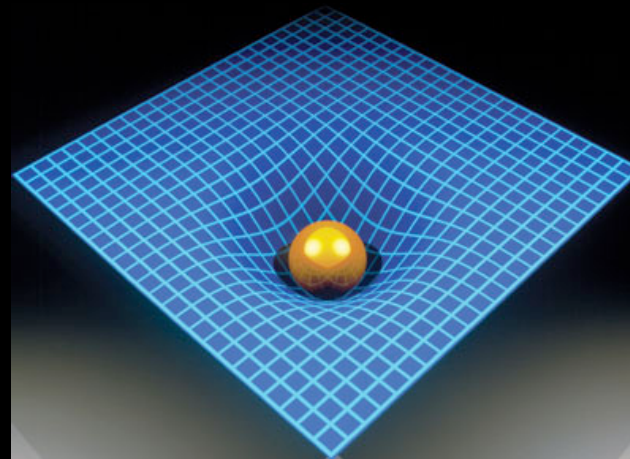
Quarks

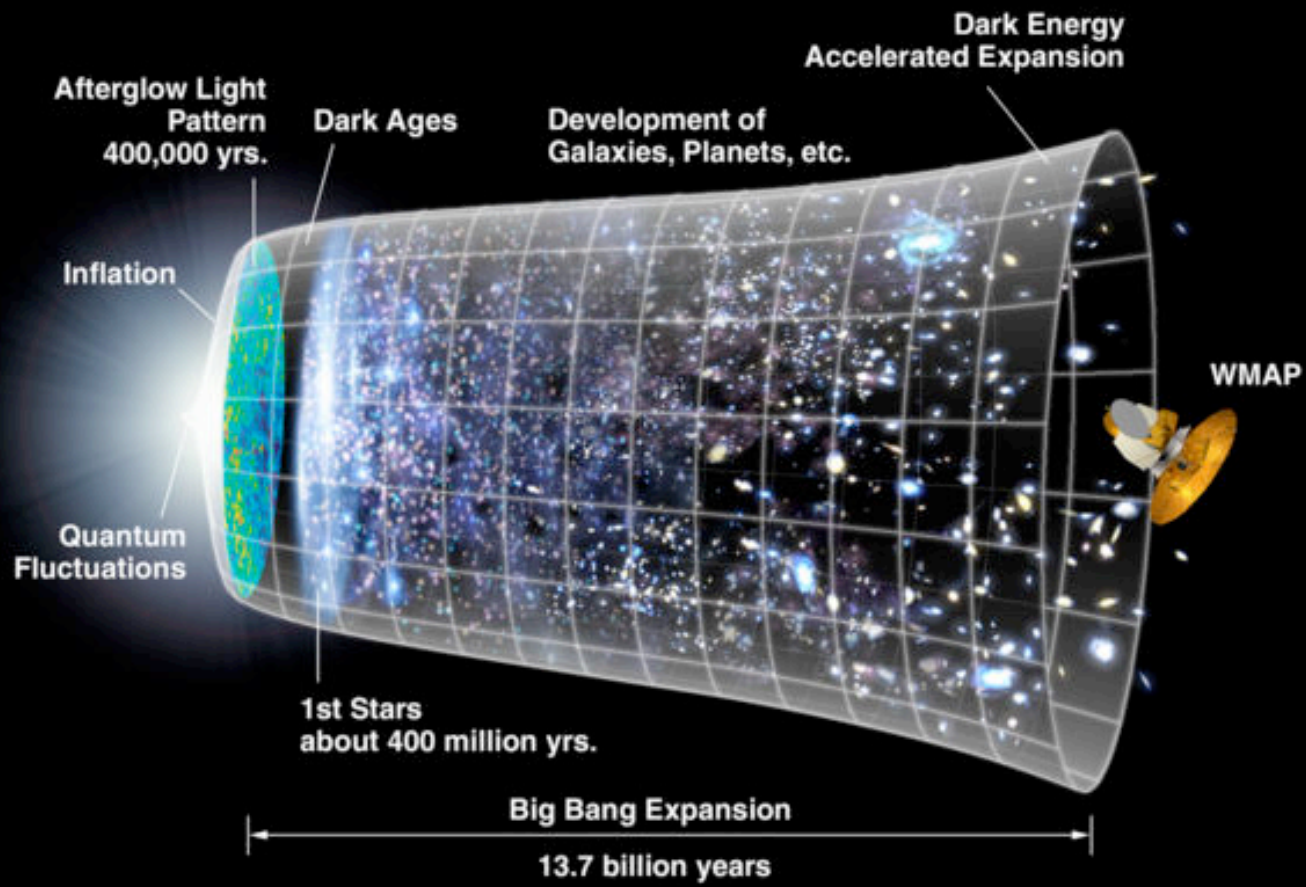


Forces



Leptons





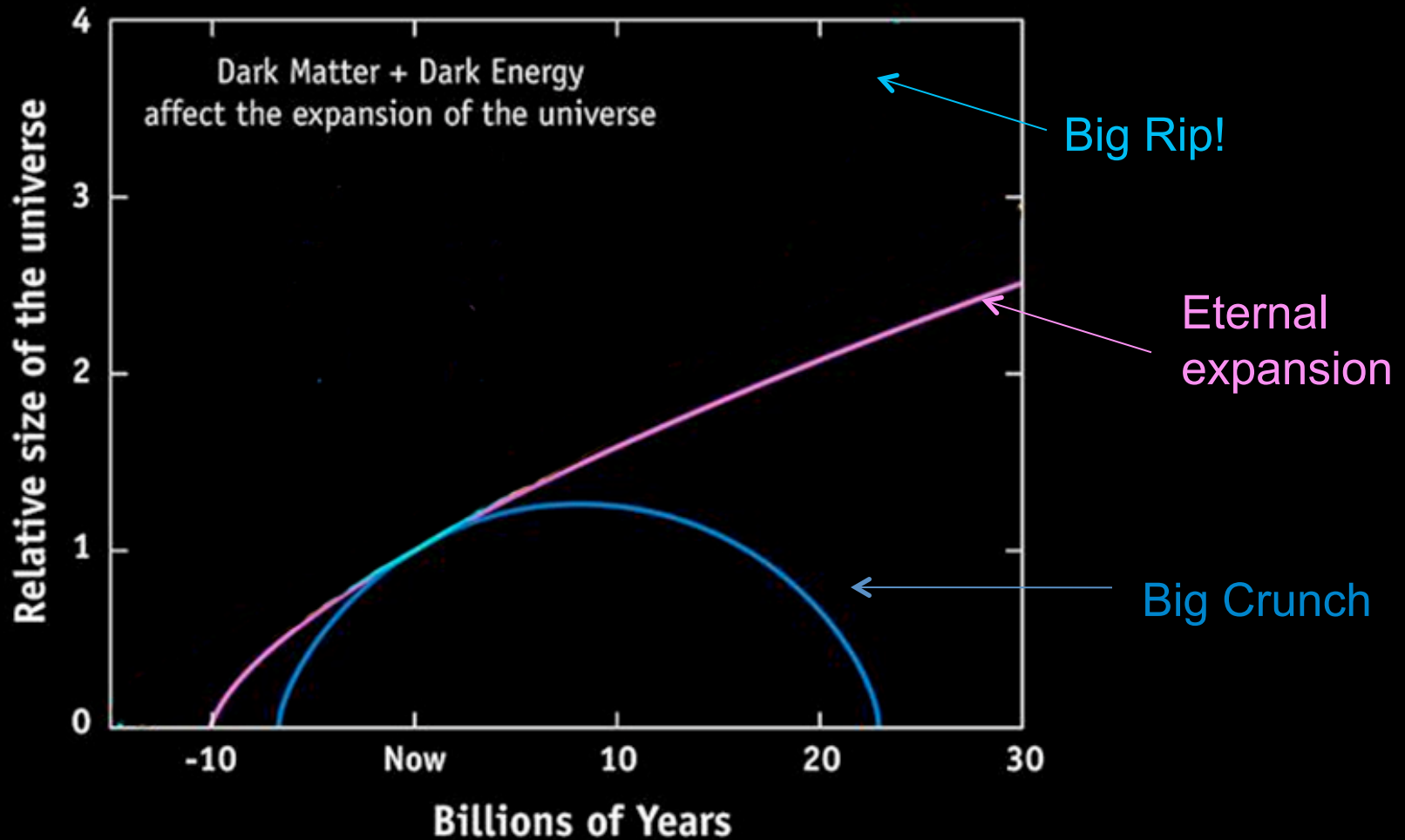
NASA/WMAP

Cosmic Acceleration

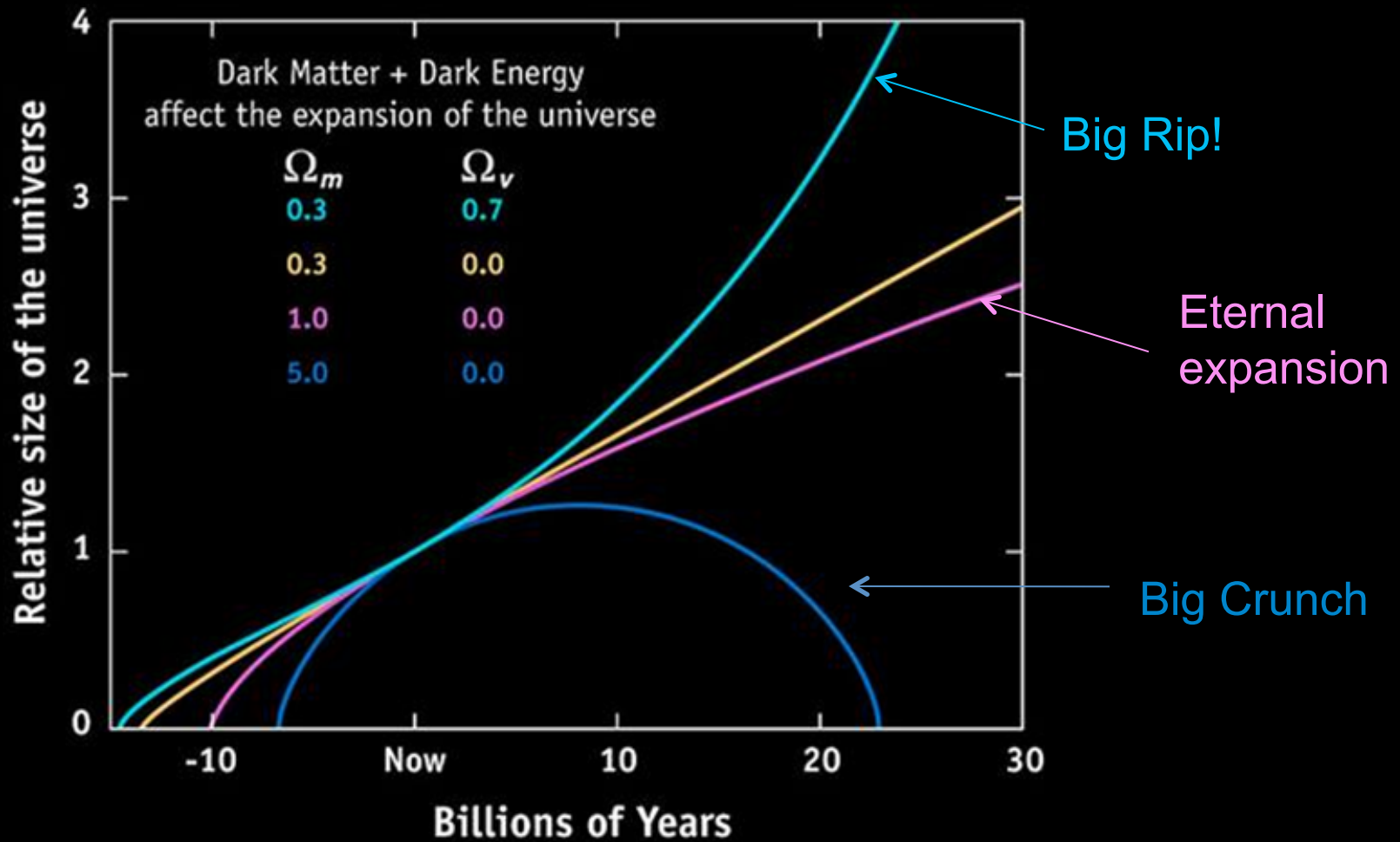


Hubble Space
Telescope
image

EXPANSION OF THE UNIVERSE

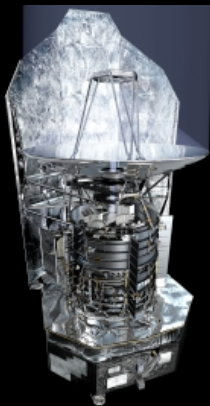
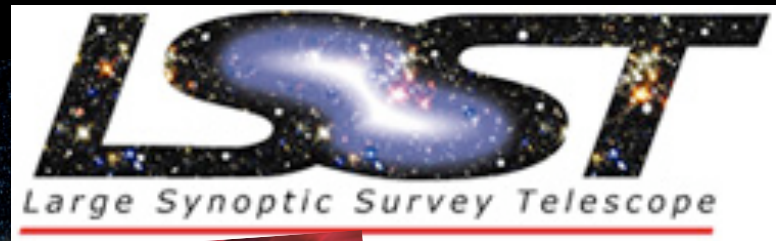


EXPANSION OF THE UNIVERSE





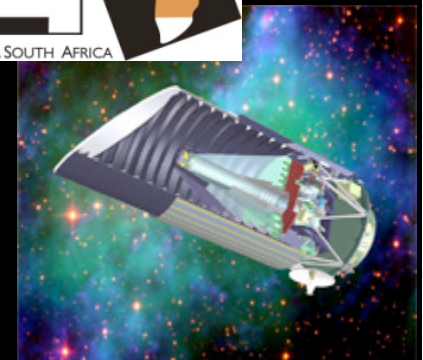
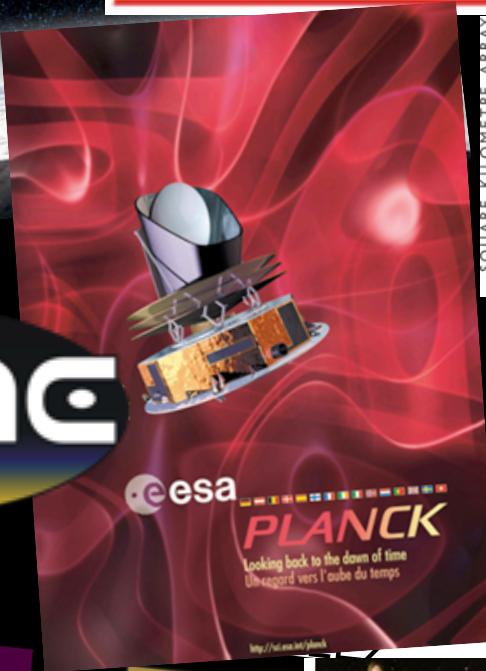
Atacama
Large
Millimeter /
submillimeter
Array



Herschel



LOFAR



SNAP



SWIN
BUR
NE

CENTRE FOR
ASTROPHYSICS AND
SUPERCOMPUTING



Sloan Digital Sky



JWST

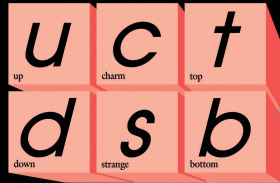


WMAP

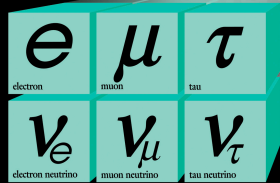
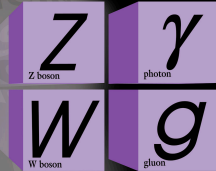


The Cosmic Melting Pot?

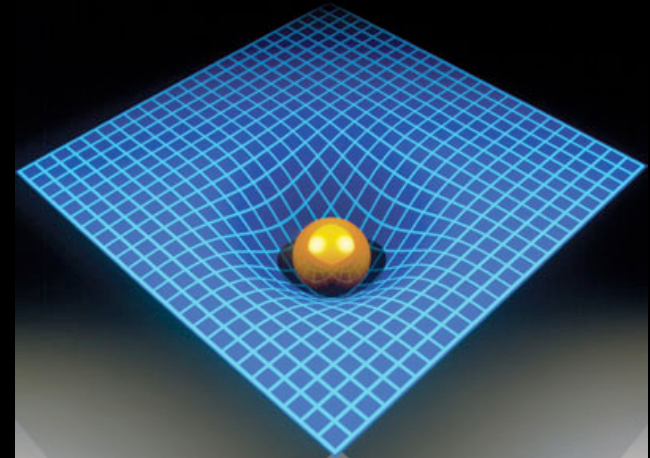
Quarks



Forces



Leptons



What is
Lambda?

