

Why are we here?

Origin of Universe and Ourselves

Katsushi Arisaka

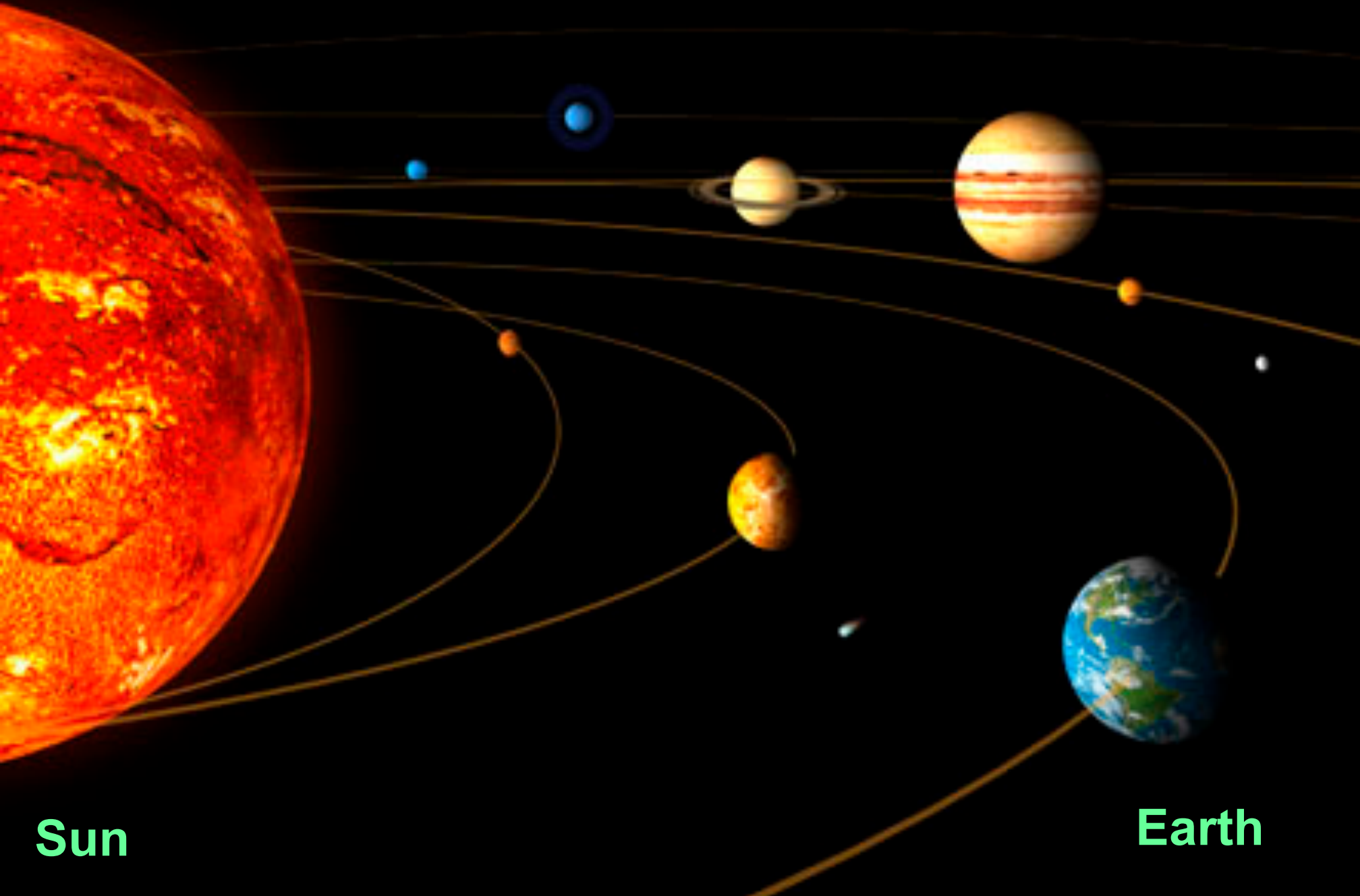
***University of California, Los Angeles
Department of Physics and Astronomy***

arisaka@physics.ucla.edu



Why are we here?

Solar System



Sun

Earth



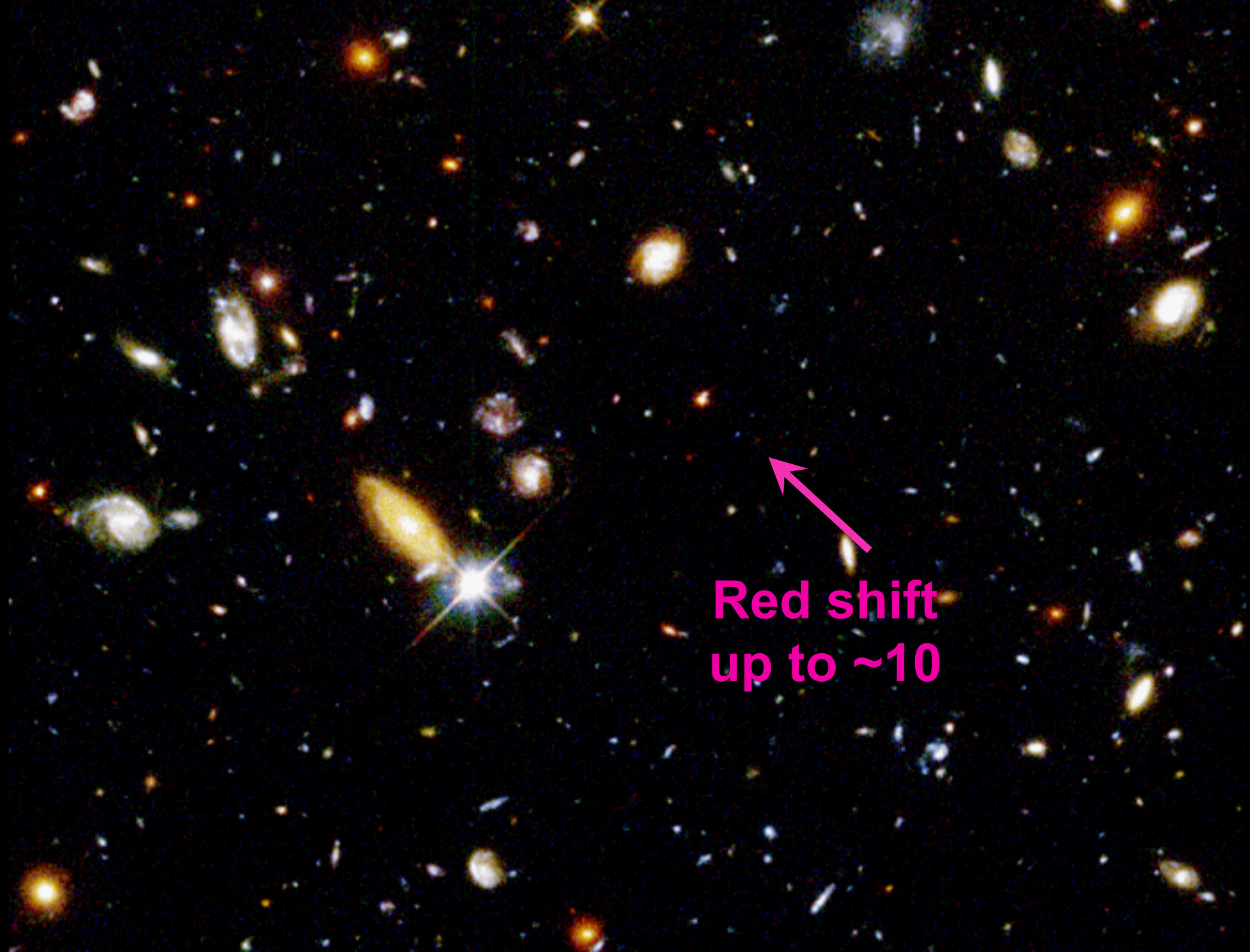
~100 Billions Stars in a Galaxy

ANDROMEDA
GALAXY.

Hubble Deep Field

The image displays a dense field of galaxies, including various types such as spirals, ellipticals, and irregular shapes, scattered across a dark background. The galaxies are concentrated in the central and lower-left regions, with some appearing as bright, distinct points of light and others as faint, diffuse structures. The overall appearance is that of a rich, multi-colored stellar population.

~100 Billion Galaxies

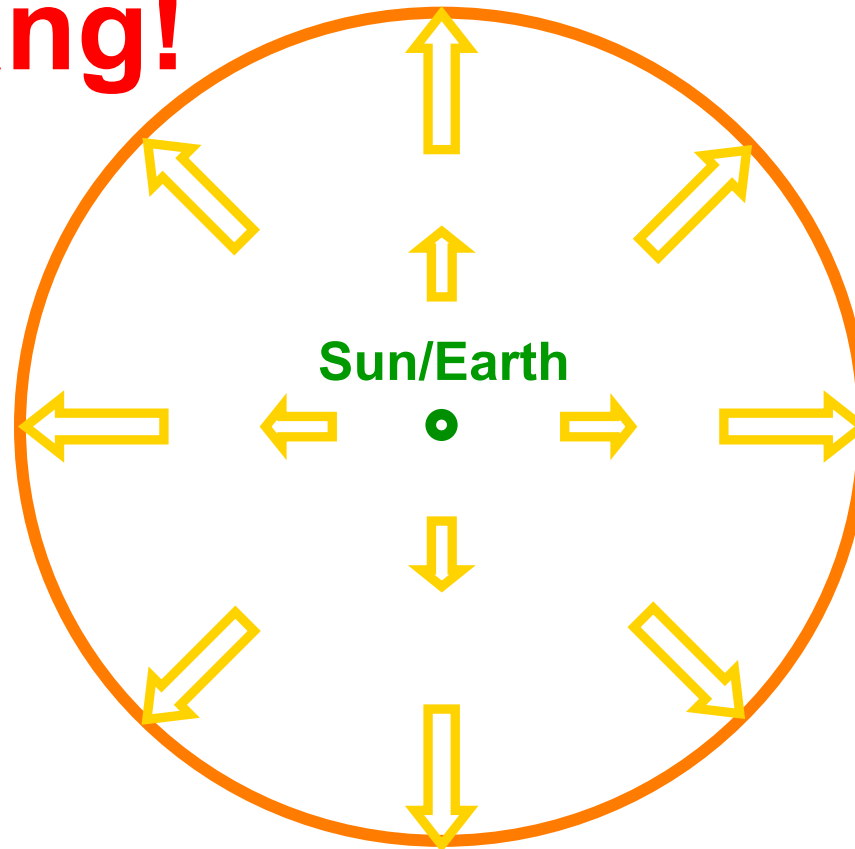


**Red shift
up to ~10**

Hubble's Law: Expansion of the Universe

Big Bang!

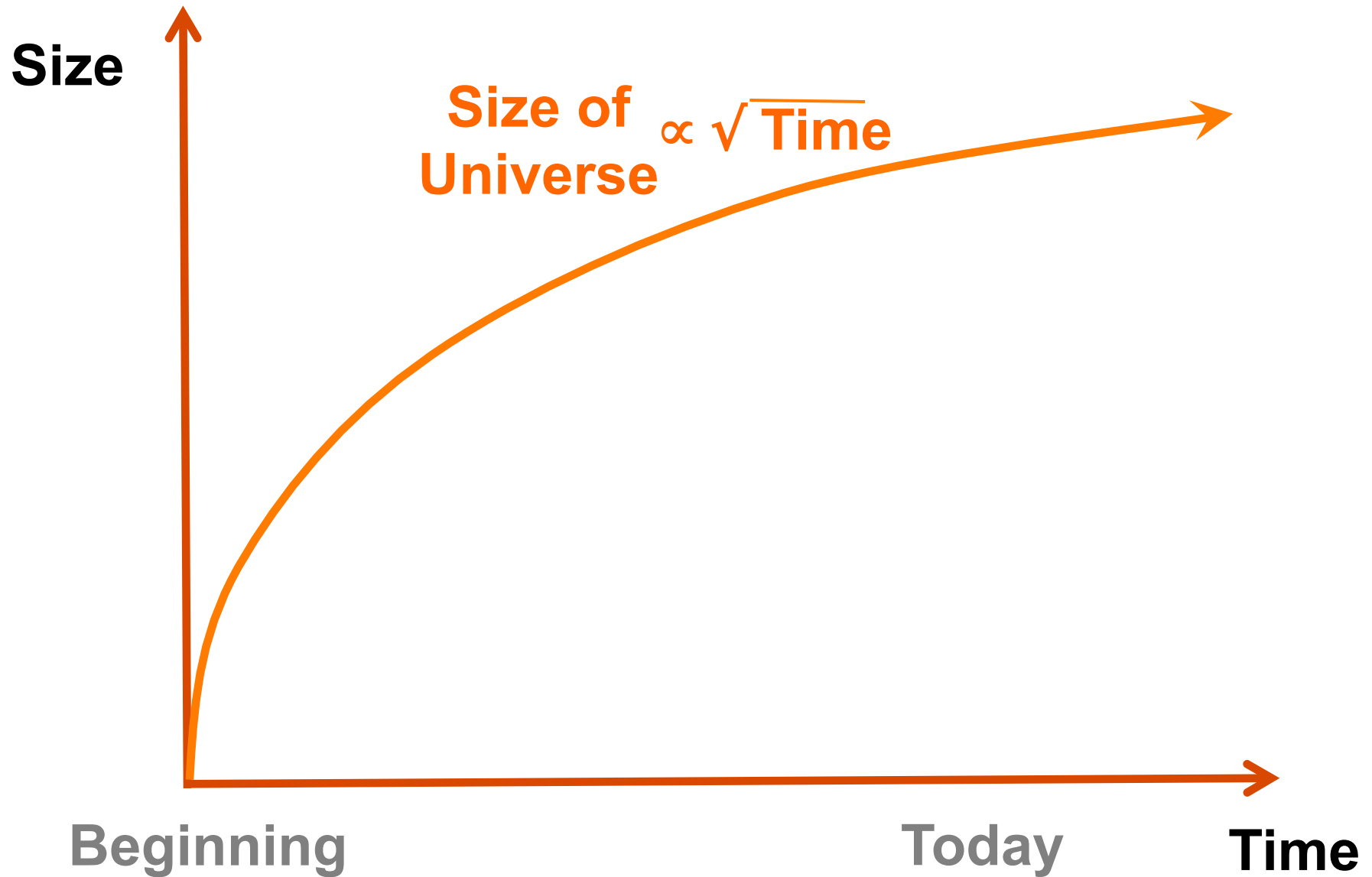
Horizon
of Universe



14 Billion
Light Years

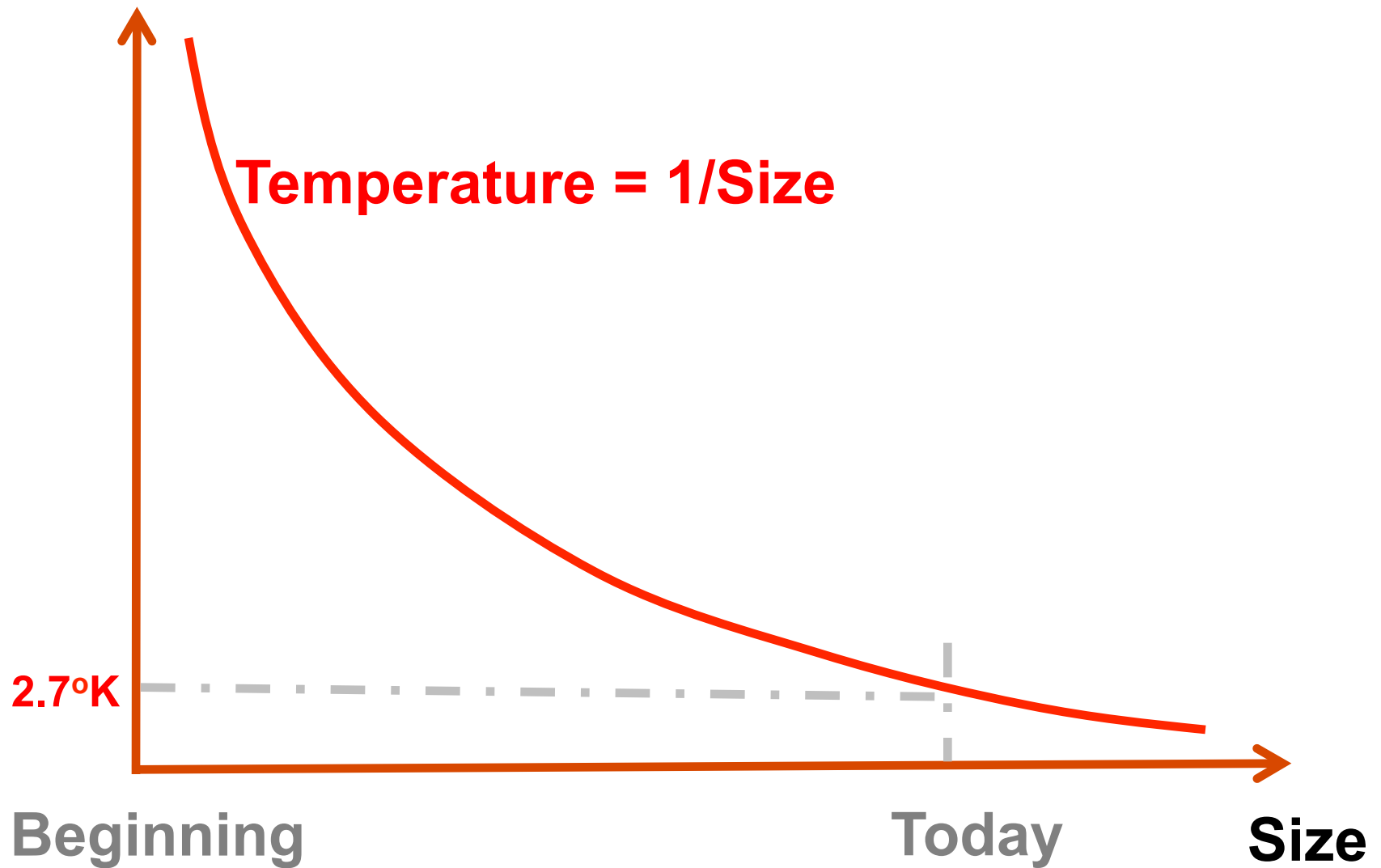
Moving Away
at Speed of Light

Expansion of Universe



Temperature of Universe

Temperature

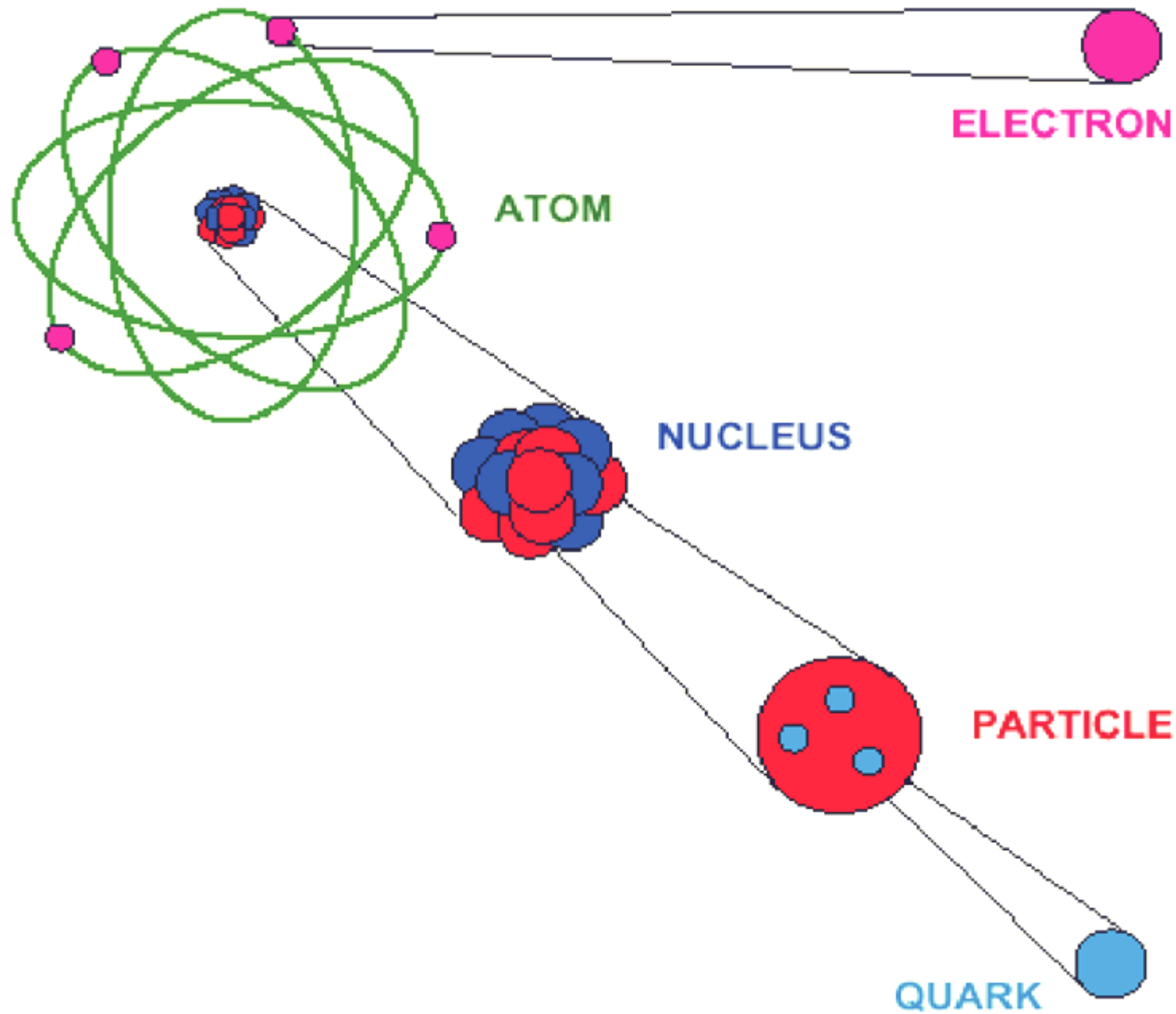


Tevatron at Fermi Lab near Chicago (1980 – 2010)

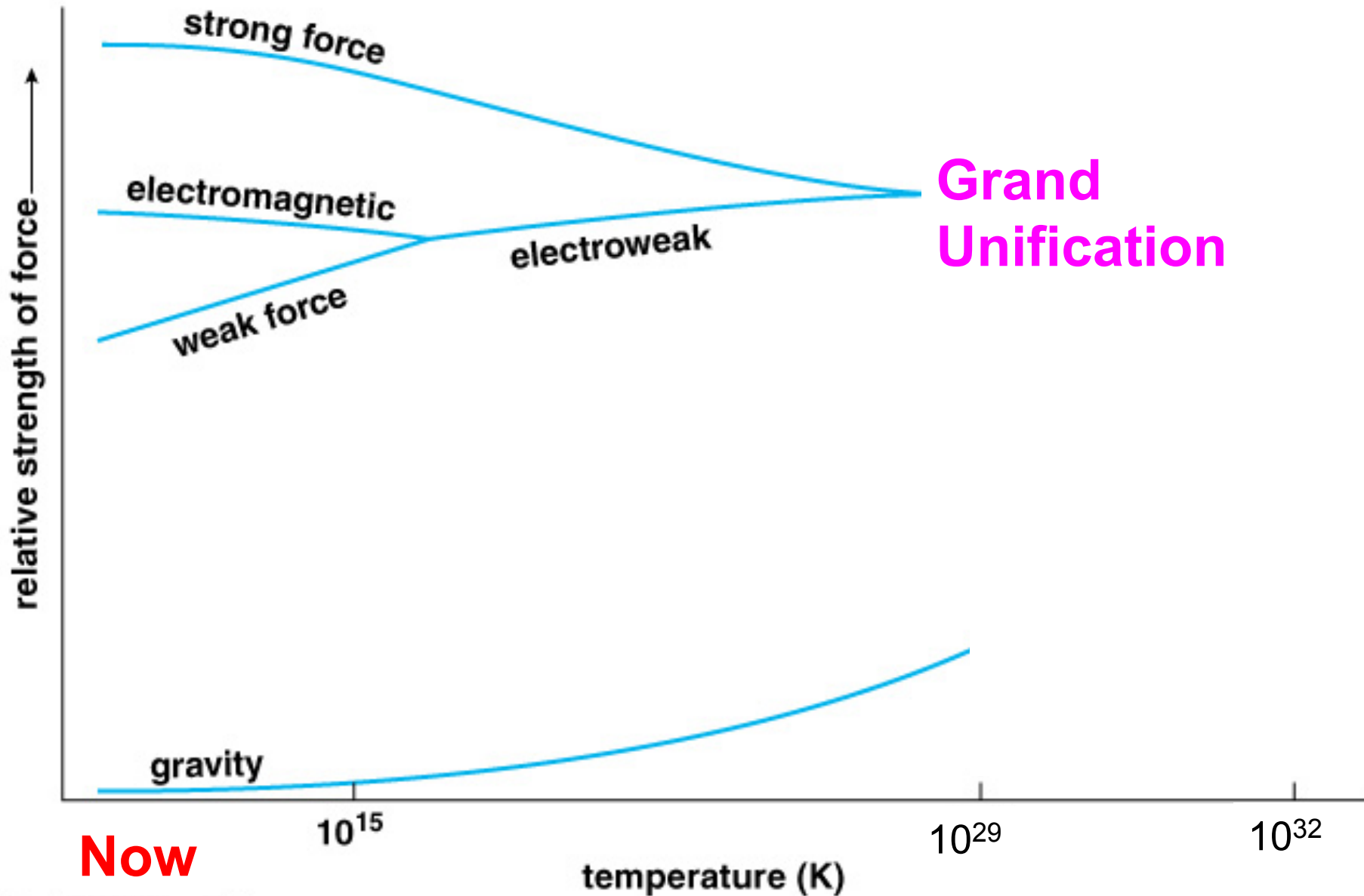


6km Circumference

Elementary Particles



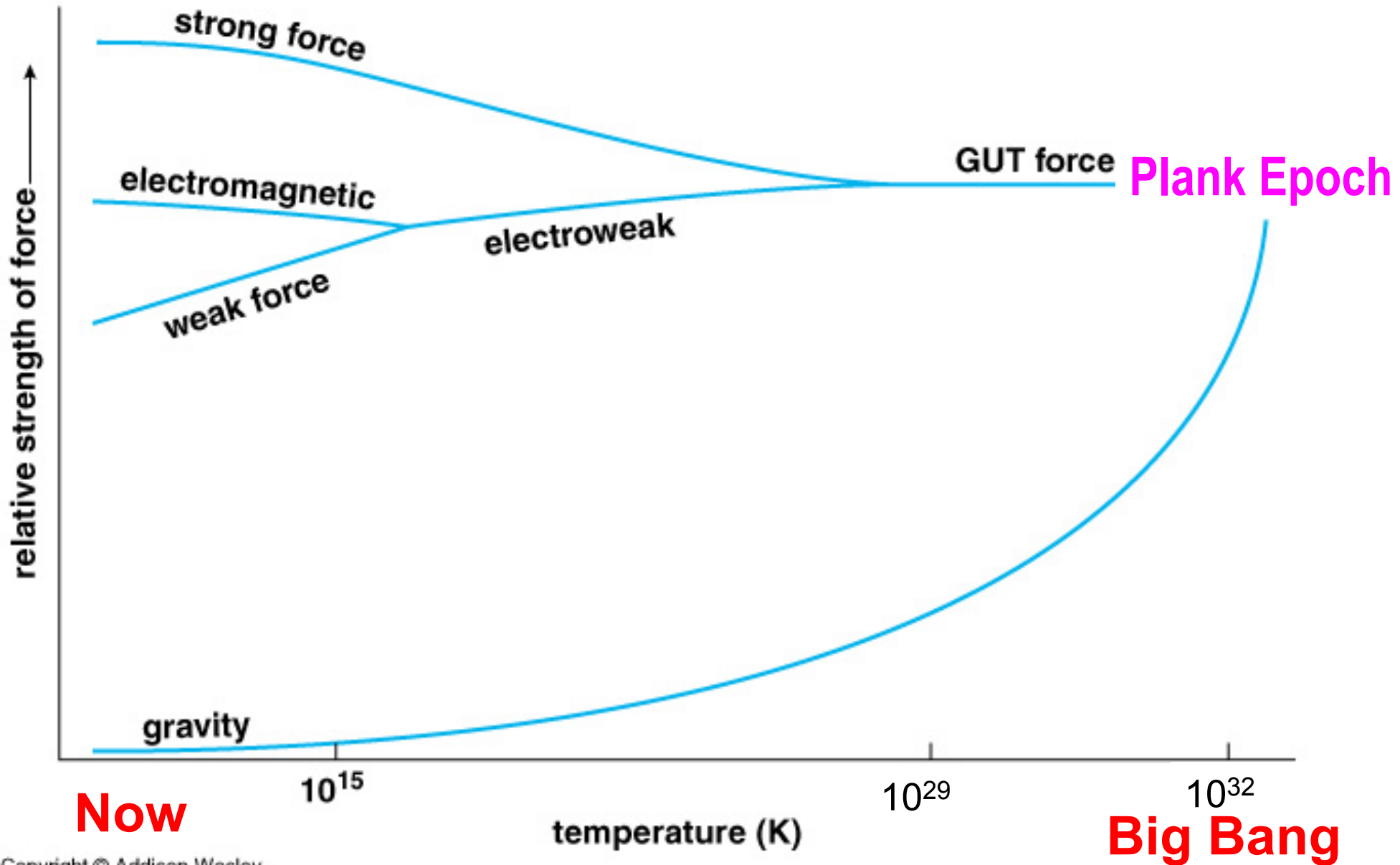
Unification of Four Forces



Now

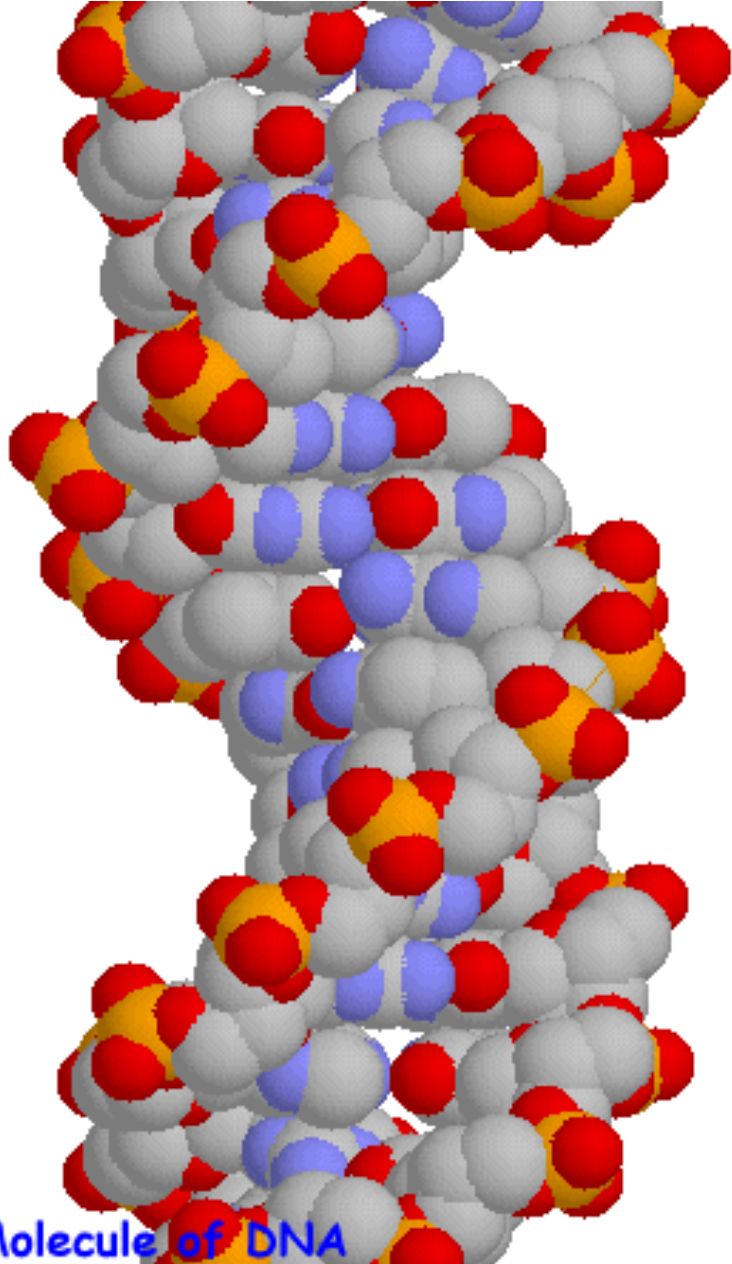
Copyright © Addison Wesley.

Unification of Four Forces

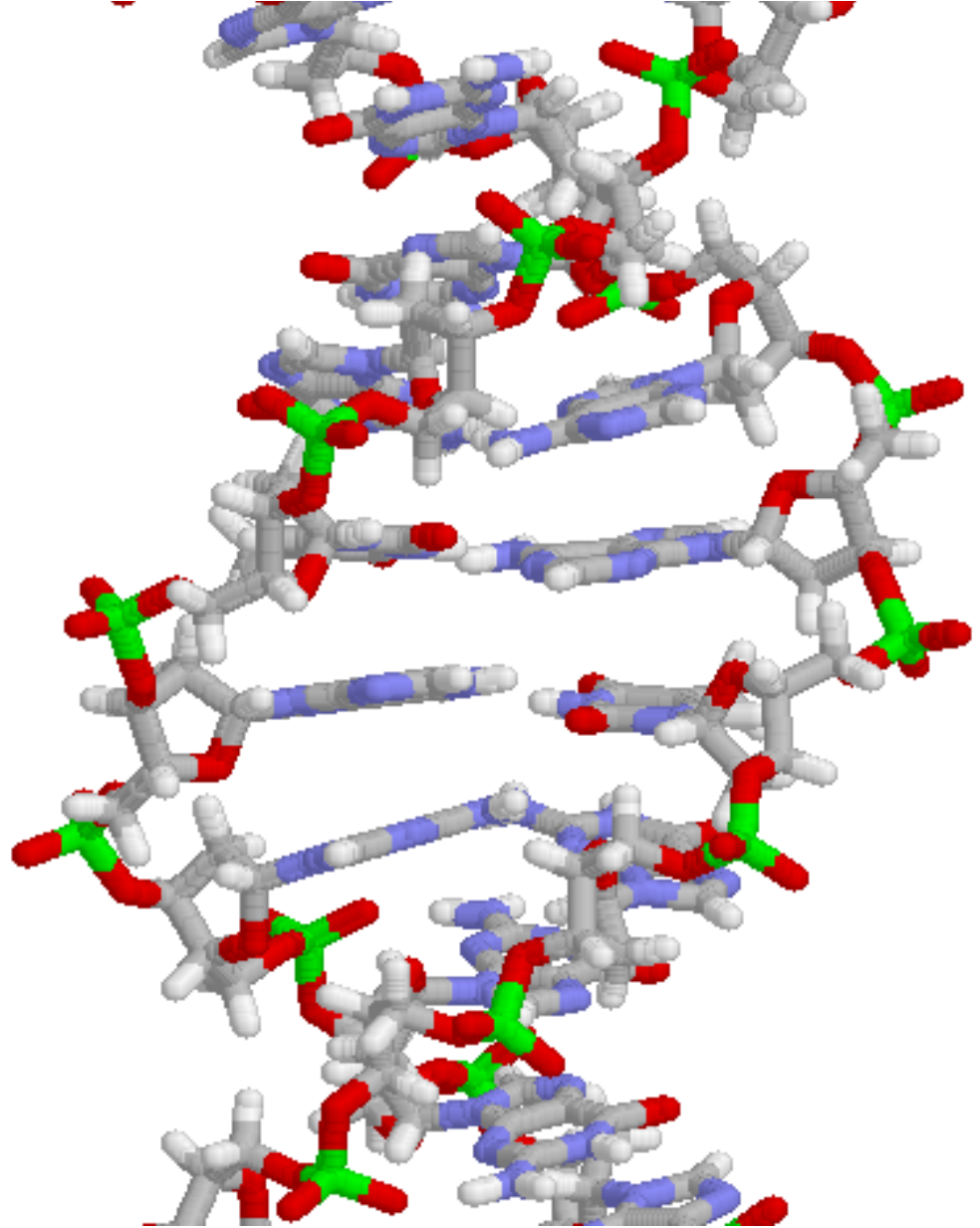


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Structure of DNA

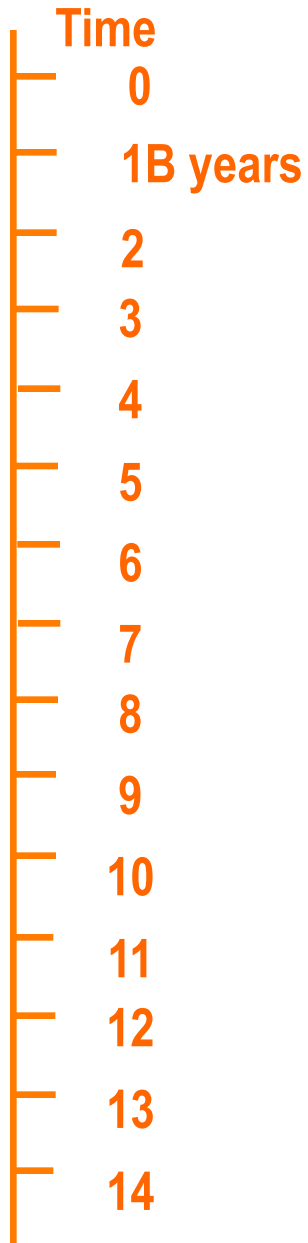


©Rothamsted Experimental Station, 1997, 1998



Molecule of DNA

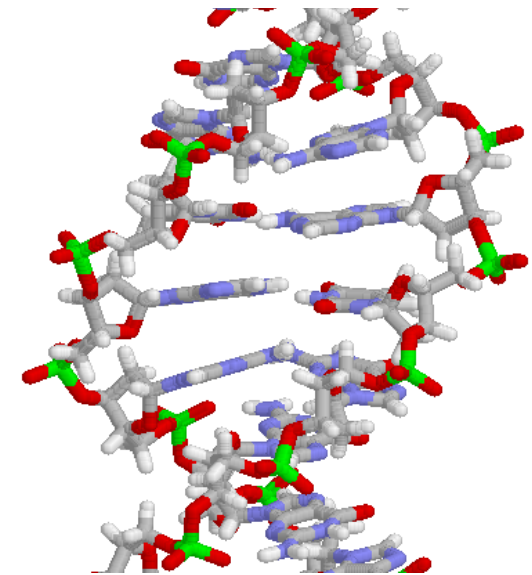
Symmetry Breaking



Simple

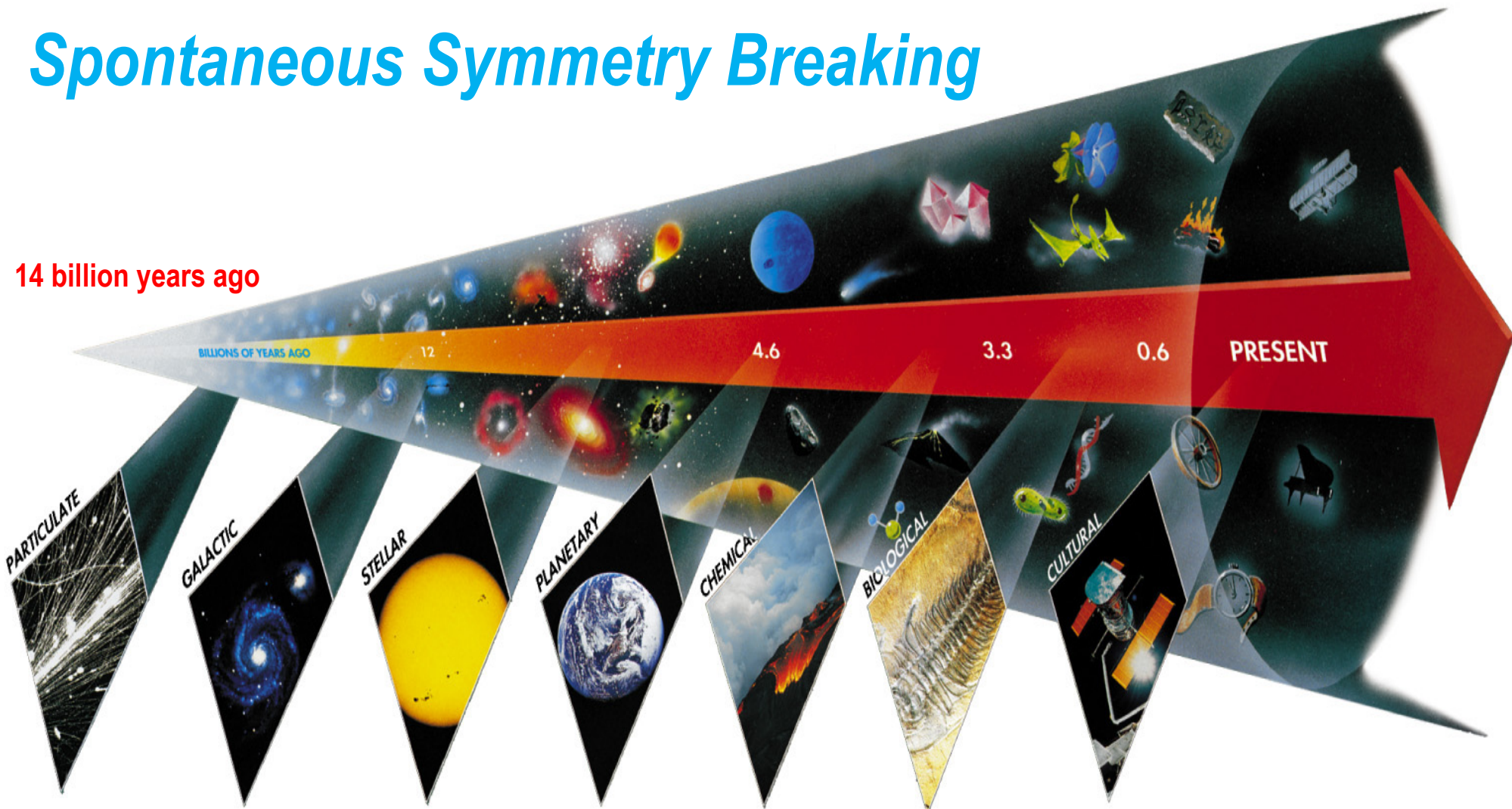
*Symmetry
Break Down*

Complex



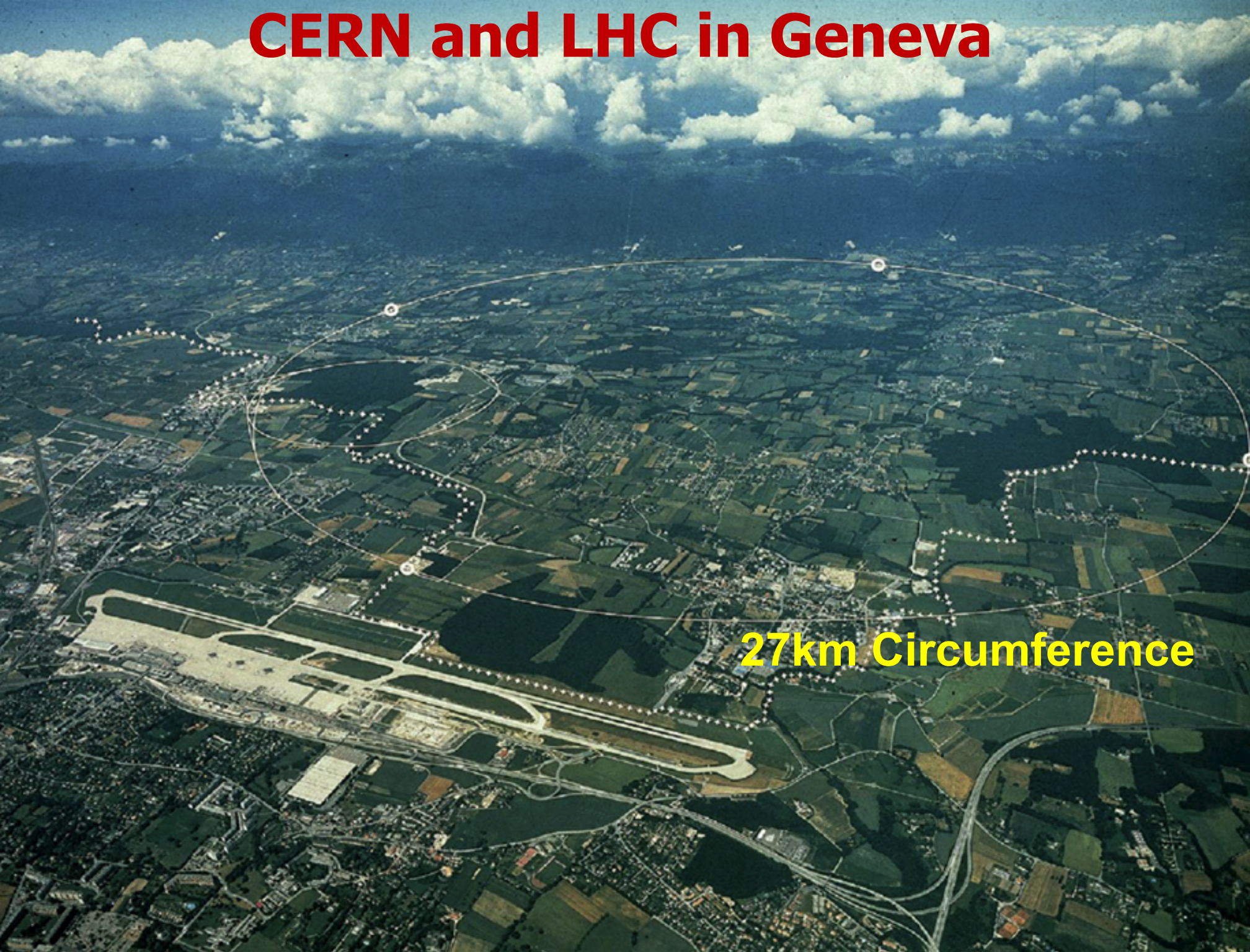
Seven Phases of Cosmic Evolution

Spontaneous Symmetry Breaking



Origin of
Particles

CERN and LHC in Geneva



27km Circumference

LHC Tunnel with Magnets



electromagnetic calorimeter

solenoid

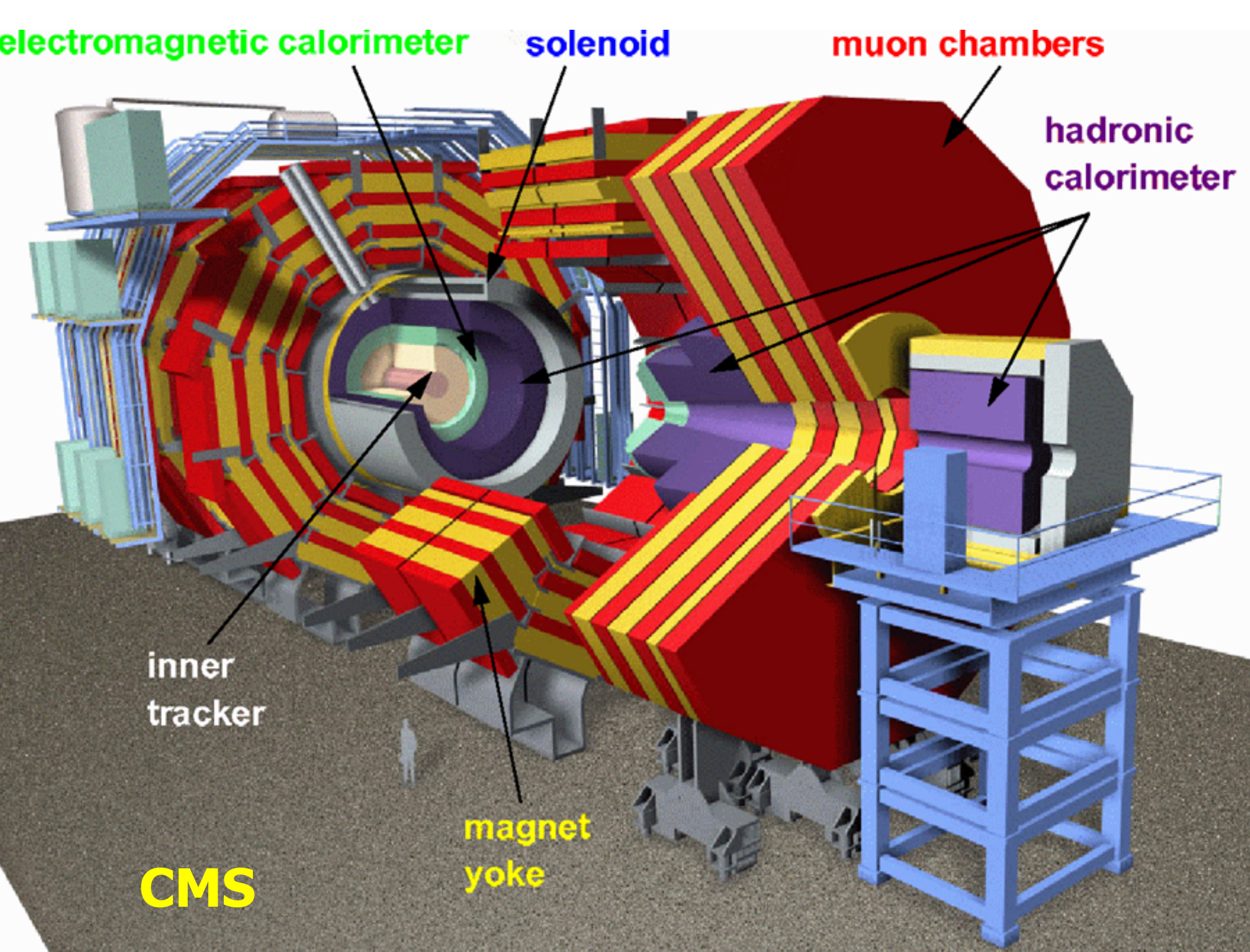
muon chambers

hadronic calorimeter

inner tracker

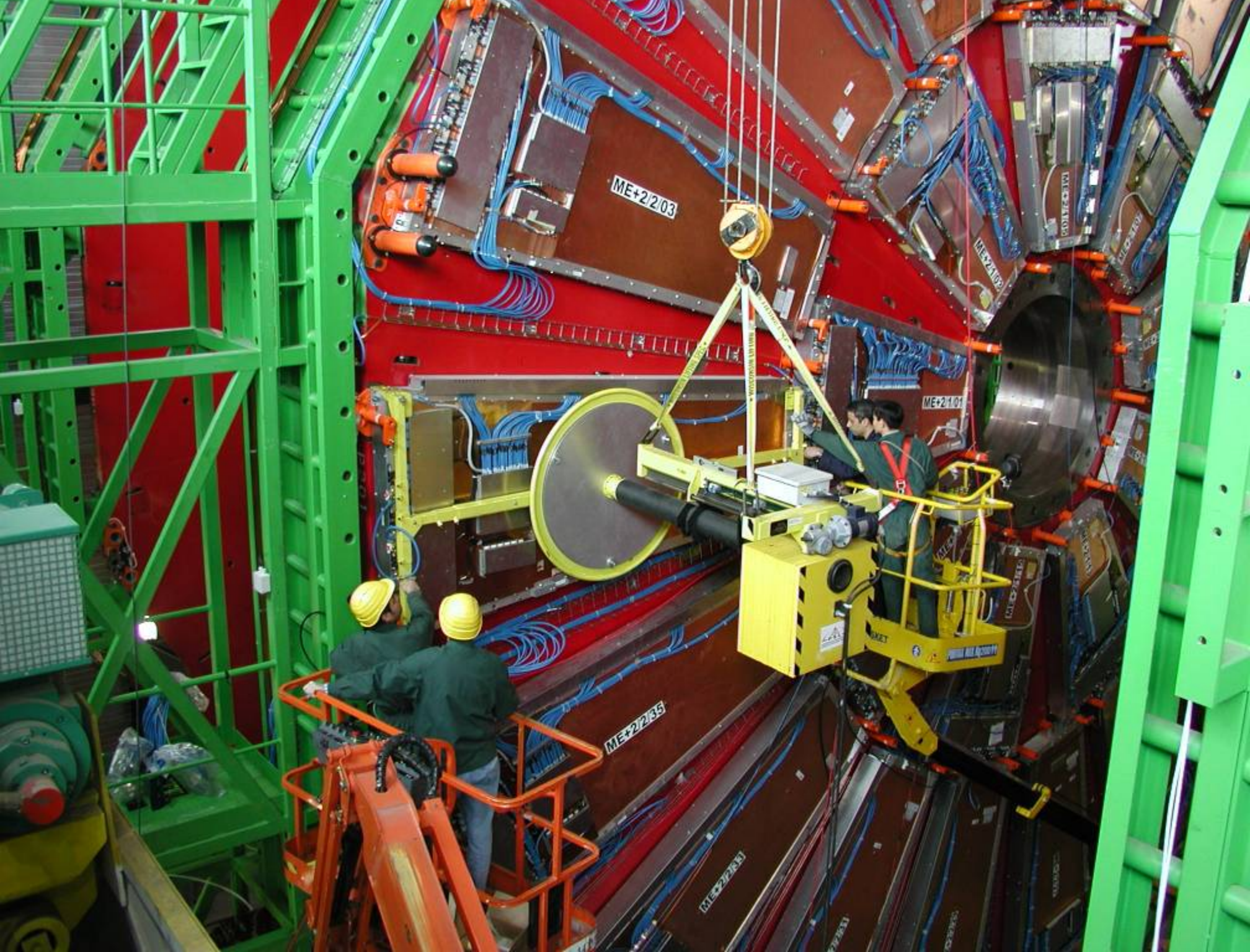
magnet yoke

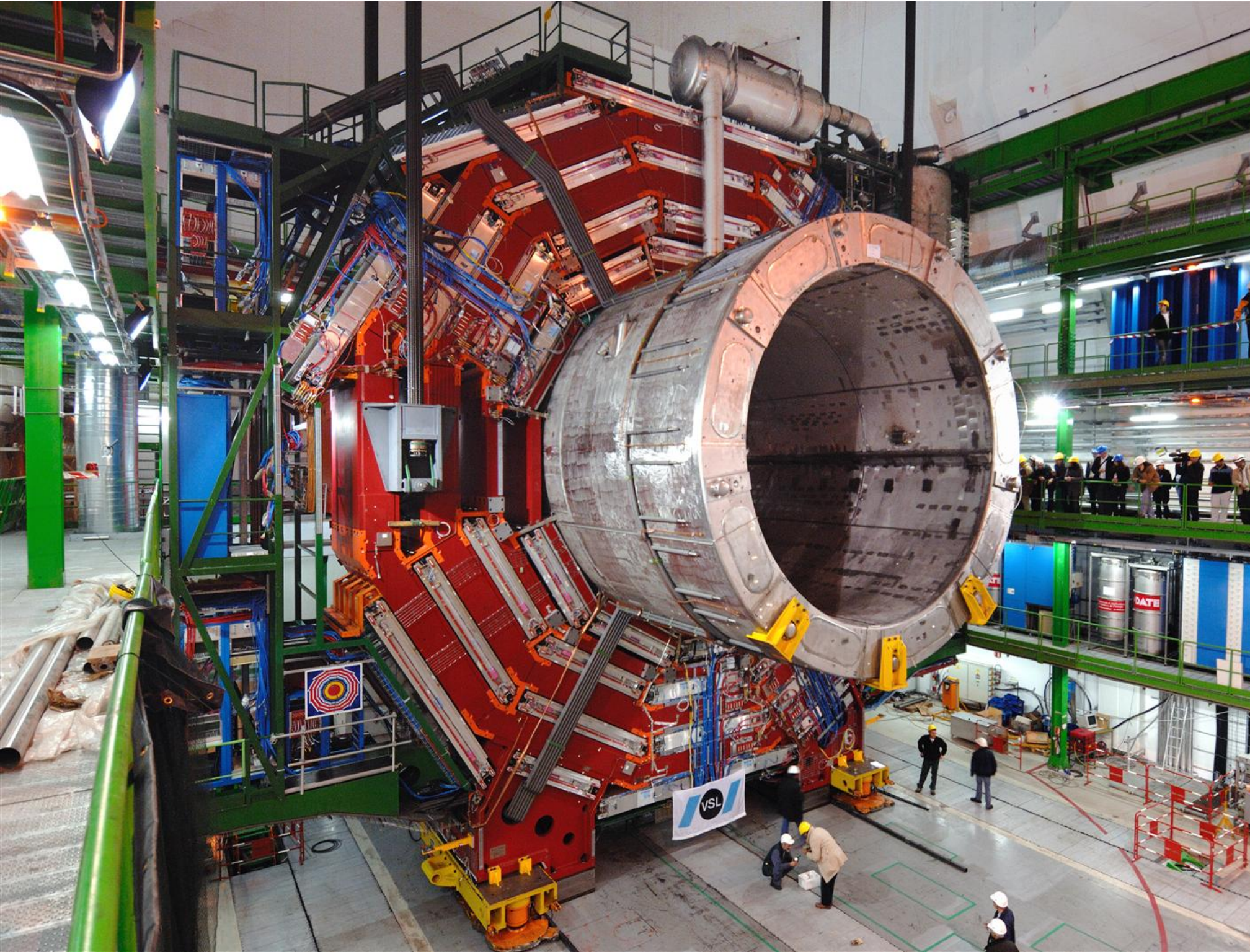
CMS

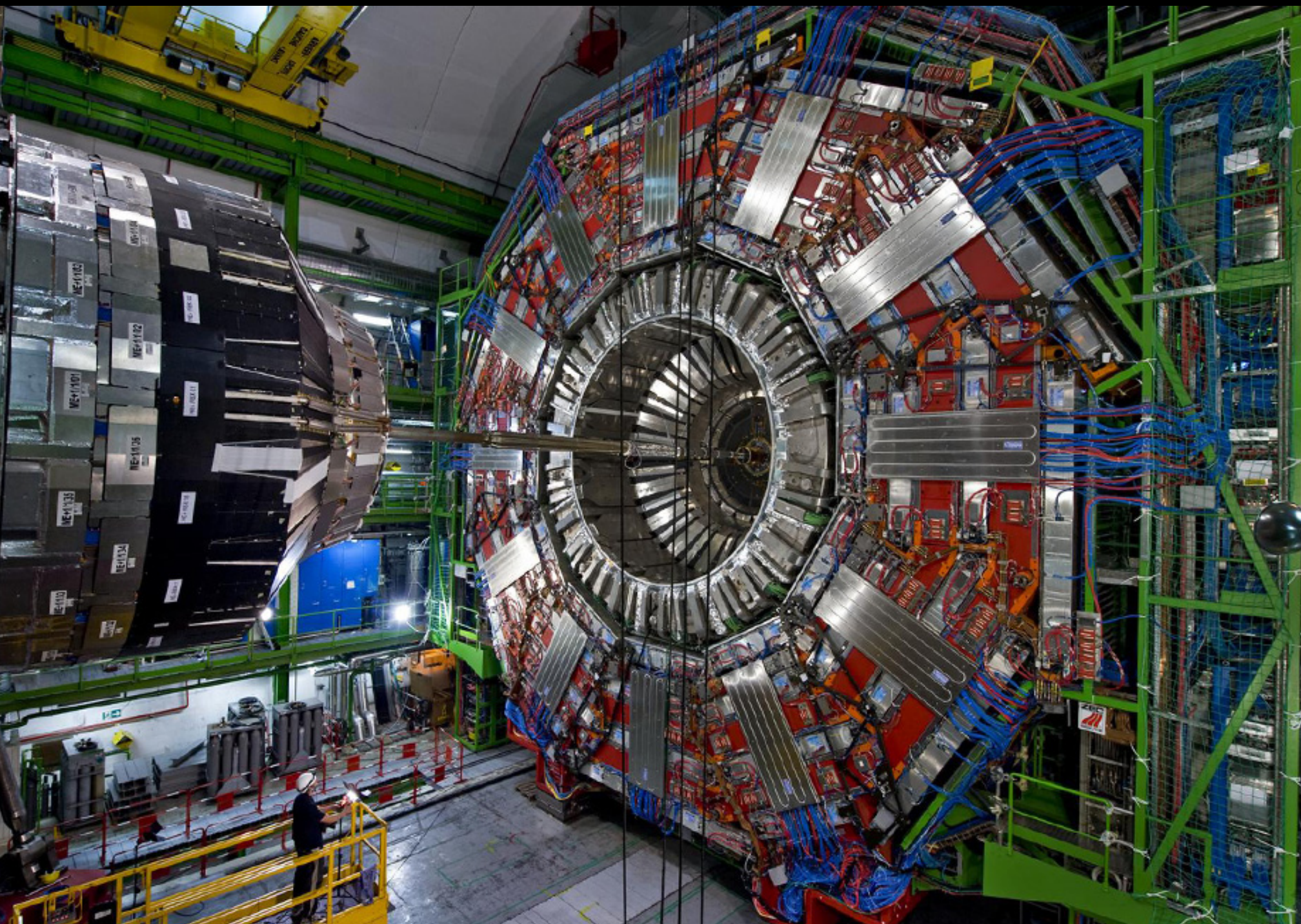


CMS Barrel Yoke









11/7/2012

Katsushi Arisaka, UCLA

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Newsweek

The Biggest Experiment Ever (And It's European)



Particle detectors constructed at Westwood, now at LHC, CERN



NEWSWEEK.COM SEPTEMBER 15, 2008 PHOTOGRAPH BY MARTIAL TREZZINI-AP

The new CERN collider in Geneva

Albania Lek 600	Finland €4.40	Israel NIS 20.00	Netherlands €4.40	Slovenia €3.40
Austria €4.40	France €4.40	Italy €4.40	Norway Kr 41.00	Spain €4.40
Belgium €4.40	Germany €4.40	Kazakhstan \$4.40	Poland (incl tax) \$4.40	Sweden SKr 34.00
Bulgaria BGL 4.50	Gibraltar £2.90	Latvia €4.40	Portugal Cont €4.40	Switzerland SF 7.70
Croatia KN 22.00	Greece €4.40	Lithuania \$4.40	Romania Lei 11.00	Turkey YTL 4.00
Cyprus €2.58/€4.40	Hungary FL 700.00	Luxembourg €4.40	Russia \$4.40	Ukraine \$4.40
Czech Republic CZK 115.00	Iceland IKR 390.00	Malta Lm 1.70/€3.96	Serbia DIN 240	United Kingdom £2.80
Denmark Kr 38.00	Ireland (incl tax) €4.40	Montenegro €4.40	Slovakia SK 120.00/€3.98	U.S. Forces \$3.25

11/7/2012

Sept 15, 2008 Issue

CMS Experiment, CERN

Data_taken 2009-Nov-07 19:12:36.880368 GMT

Run_no 120015

Event_no 8

Lumi_sec 1

Orbit 584946

Crossing 2603

<http://iguana.cern.ch/iss/>

L1 Triggers:

L1_DoubleHEBitCountsRing1_P1N1

L1_DoubleHEBitCountsRing2_P1N1

L1_ETM20

L1_ETM30

L1_MinBias_HTT10

L1_Mu3QE8_Jet6

L1_SingleEG1

L1_SingleEG10

L1_SingleEG12

L1_SingleEG15

L1_SingleEG20

L1_SingleEG25

L1_SingleEG30

L1_SingleEG35

L1_SingleEG40

L1_SingleEG45

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L1_SingleEG1385

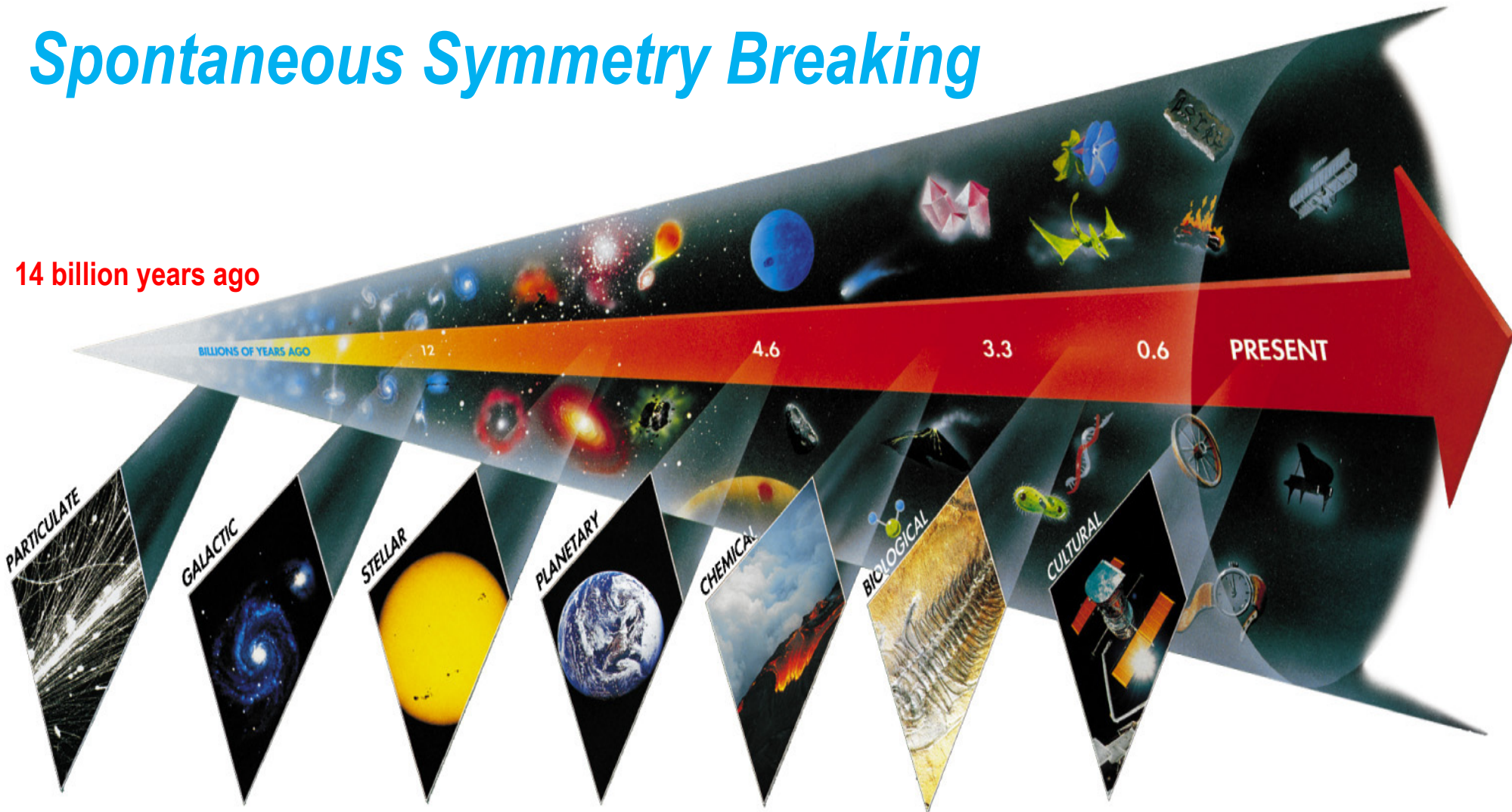
L1_SingleEG1390

L1_SingleEG1395

</

Seven Phases of Cosmic Evolution

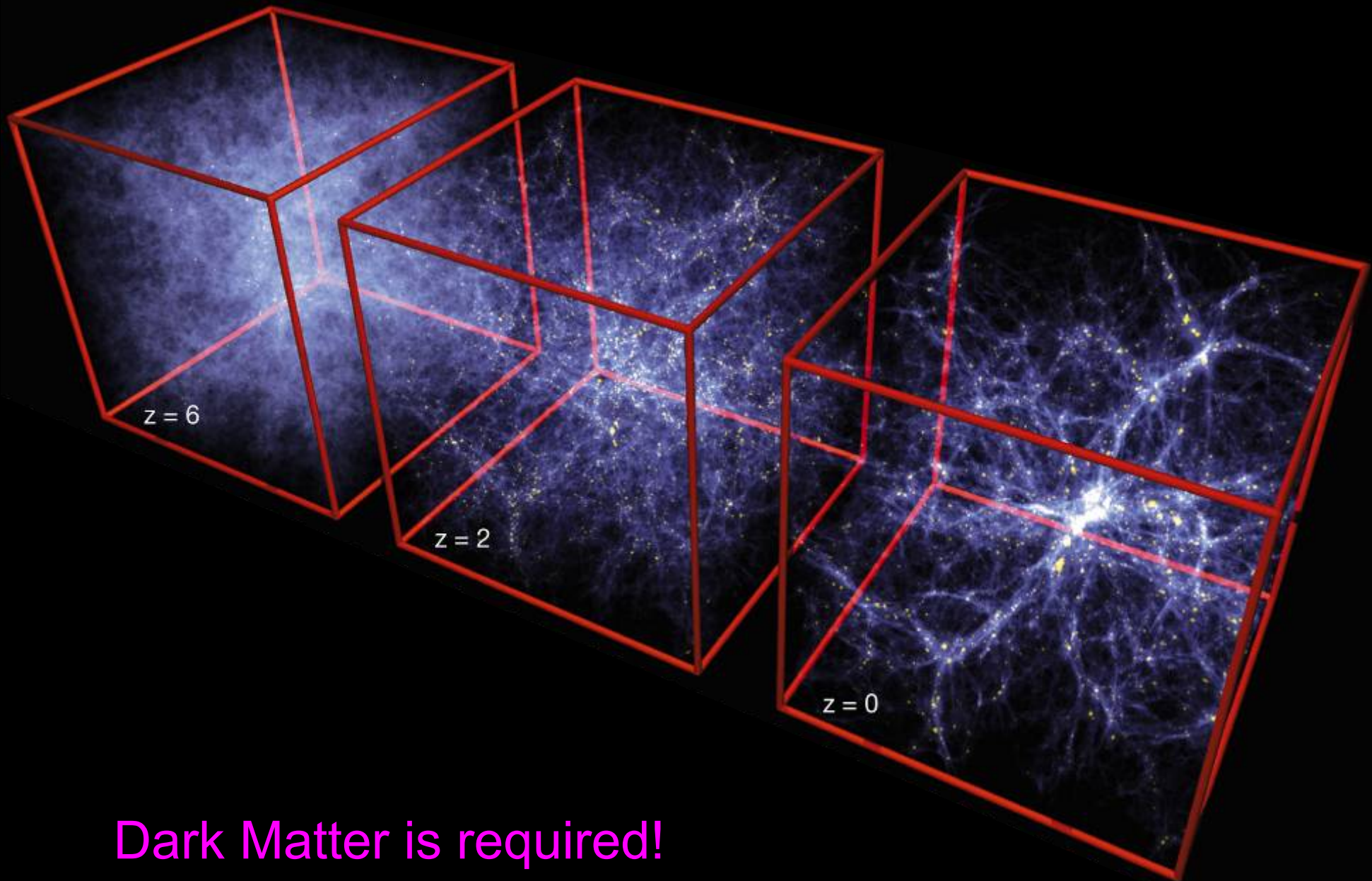
Spontaneous Symmetry Breaking



Origin of
Particles

Origin of
Structure

Formation of Structure in the Universe



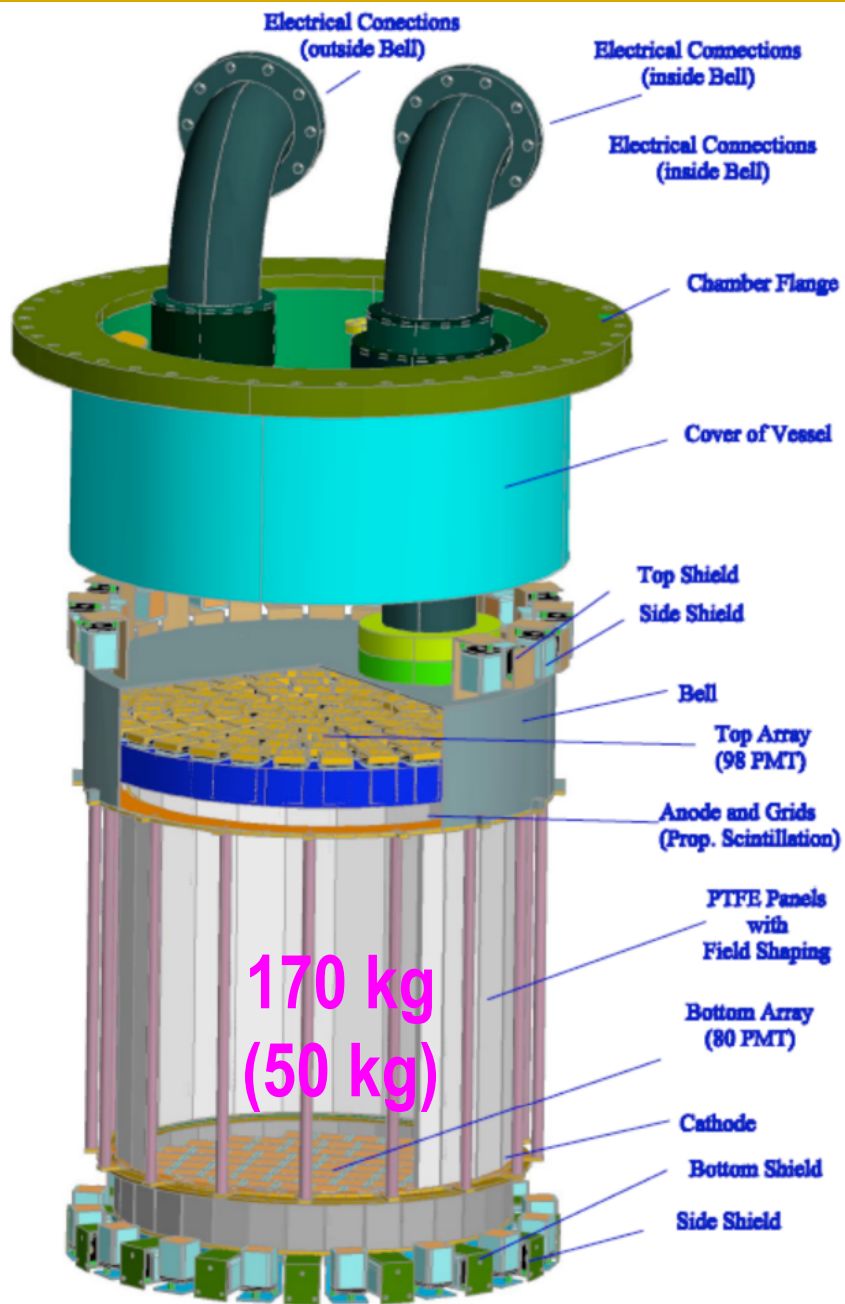
Dark Matter is required!

Laboratori Nazionali del Gran Sasso, Italy

LNGS 1400 m Rock (3100 w.m.e)



XENON100 Detector

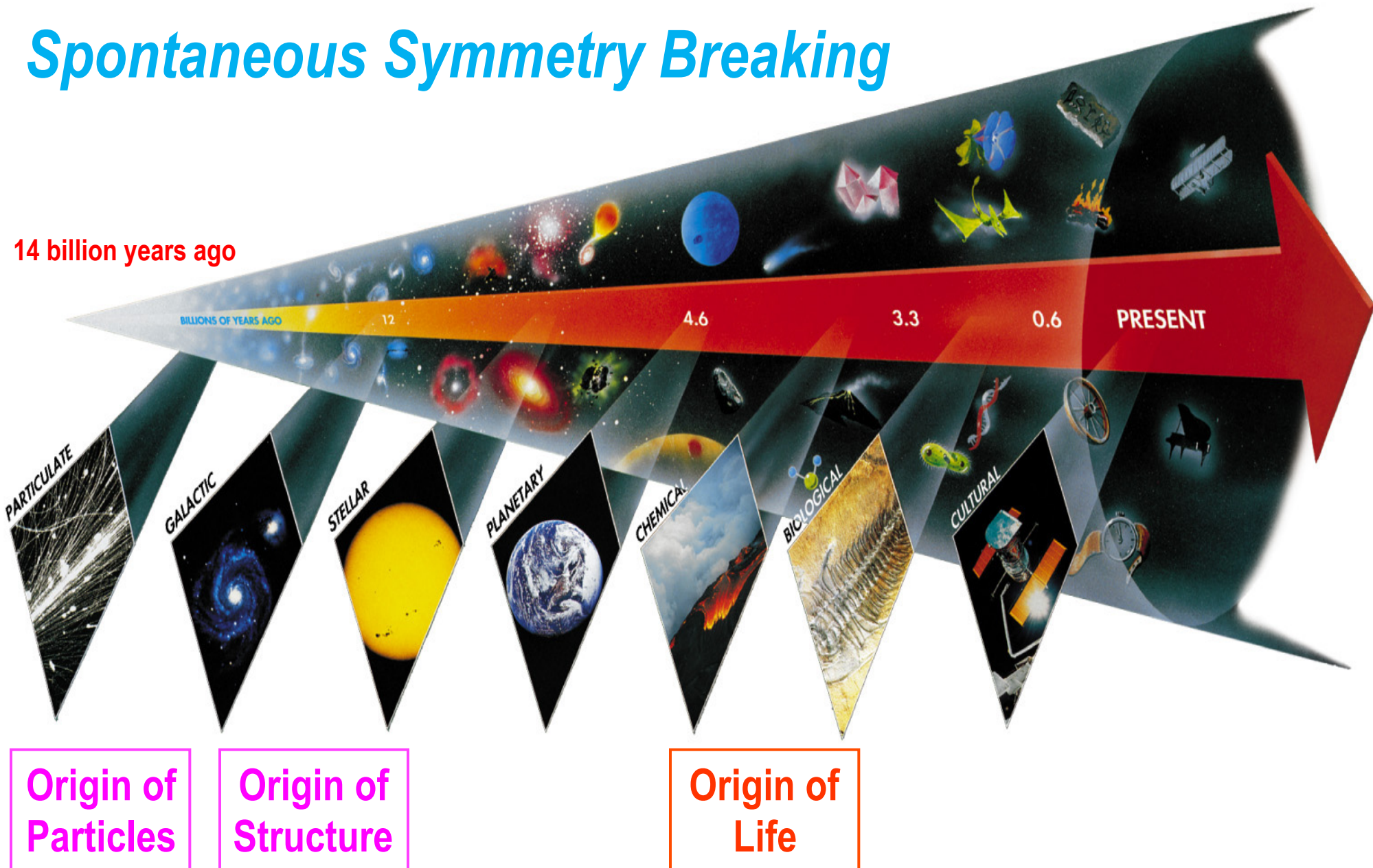


XENON100 Detector (2009)

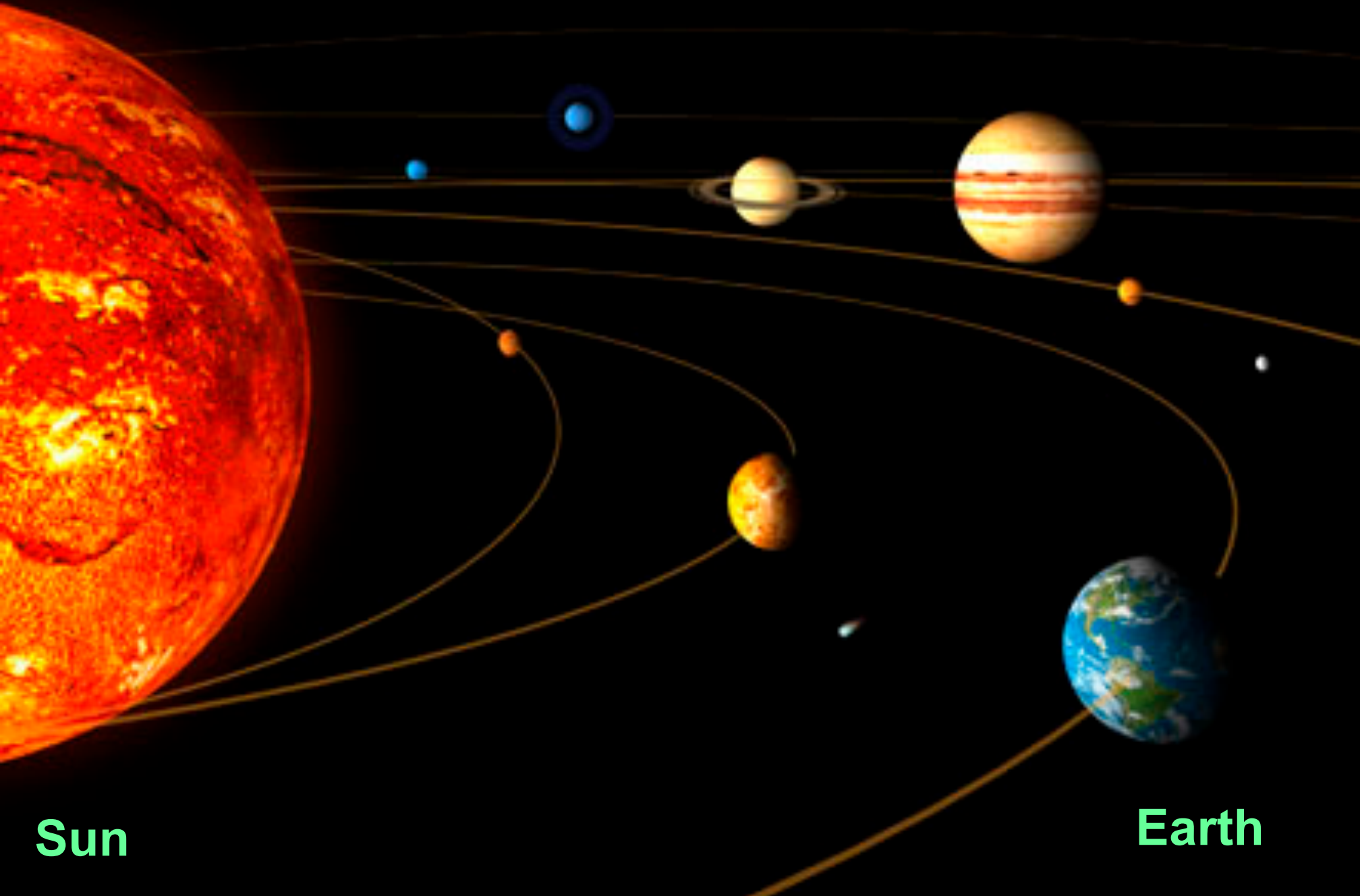


Seven Phases of Cosmic Evolution

Spontaneous Symmetry Breaking



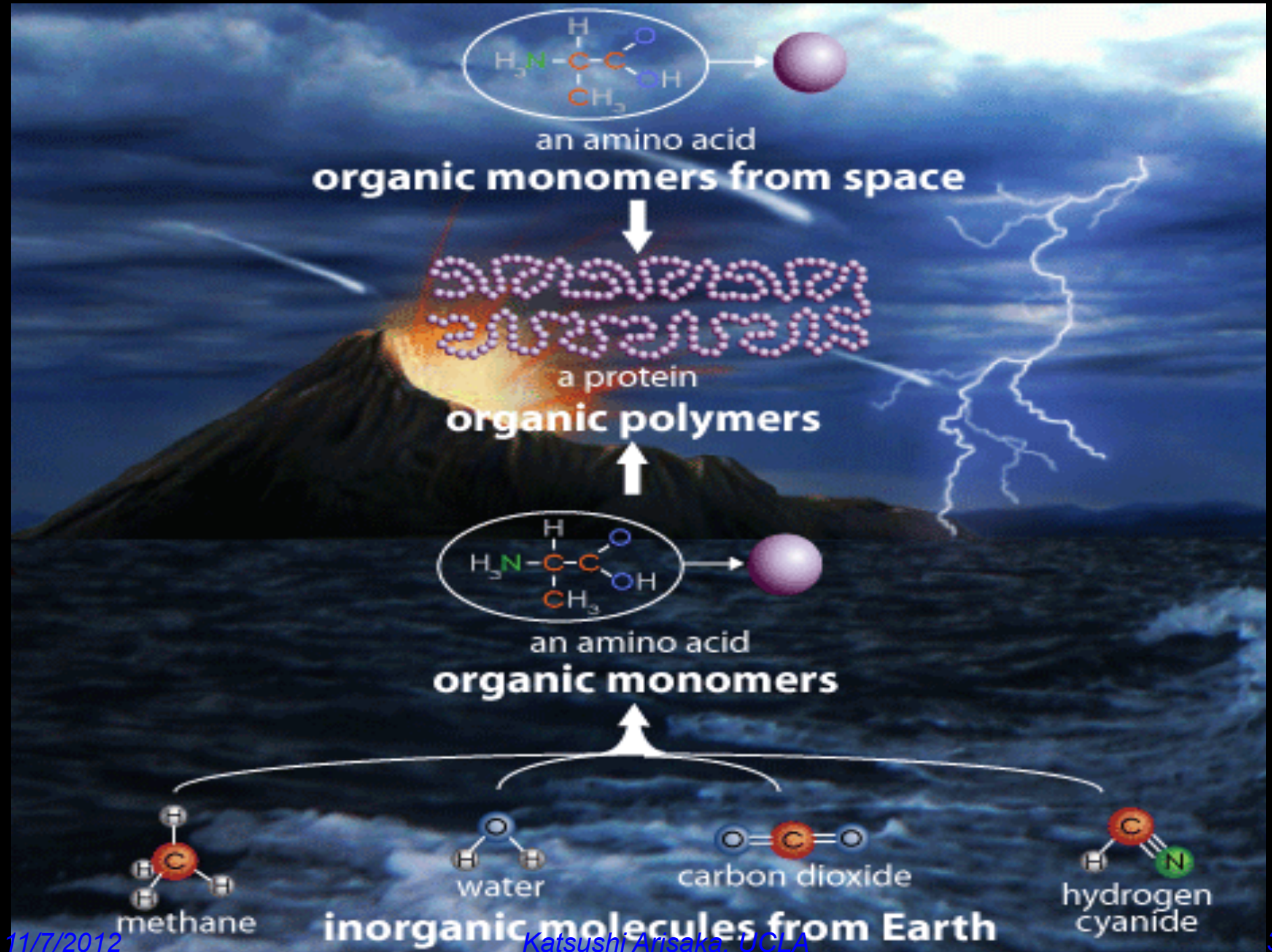
Solar System (4.6 B years ago)



Sun

Earth

Organic Polymers (4.5B → 4B years)



How to observe the “Origin of Life”

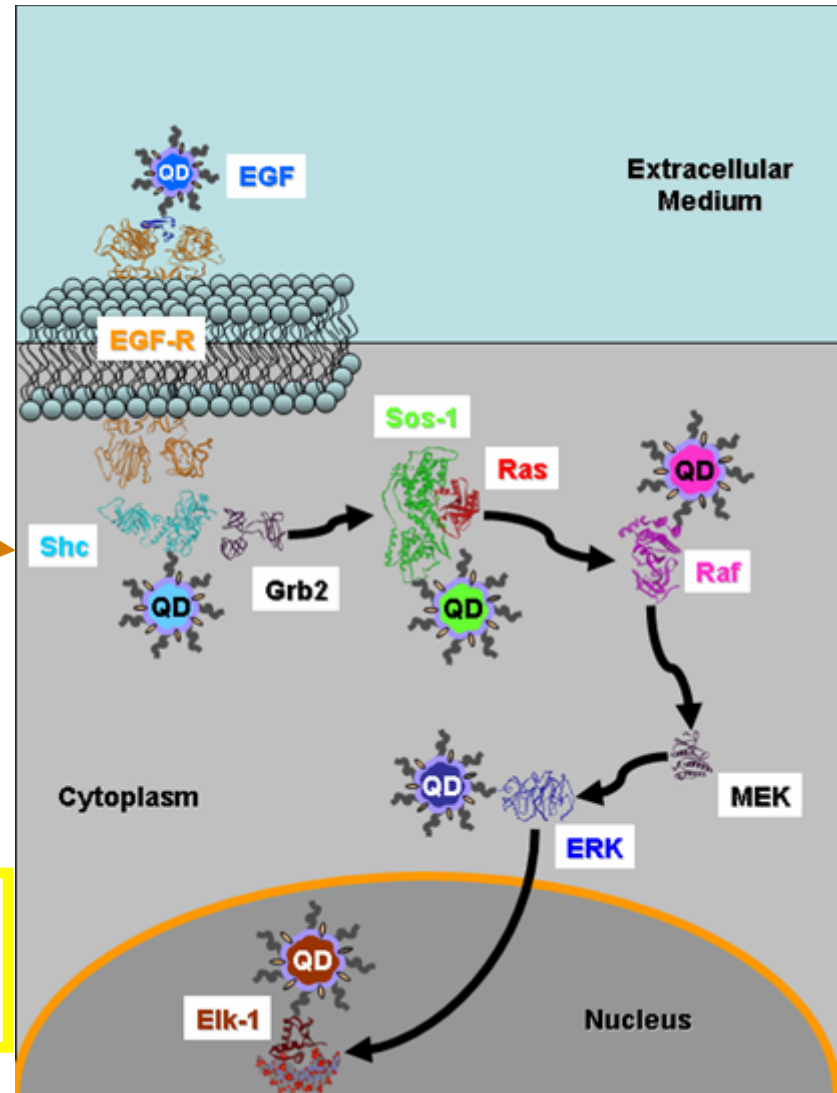
- Exactly the same way as we look for the “Origin of Universe”

Telescope ↔ Microscope

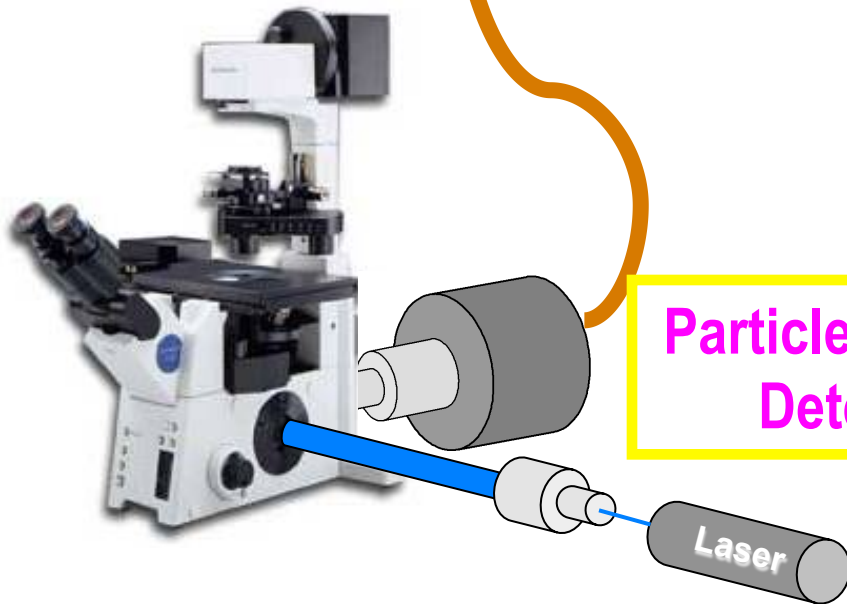
- We must look for “Live Life”
- Take advantages of the state of art “Photon Detectors” in particle physics.

Single Molecule Imaging

Nano Technology

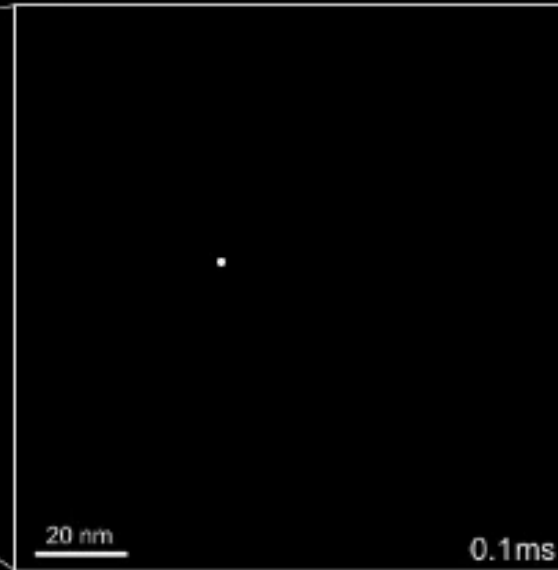
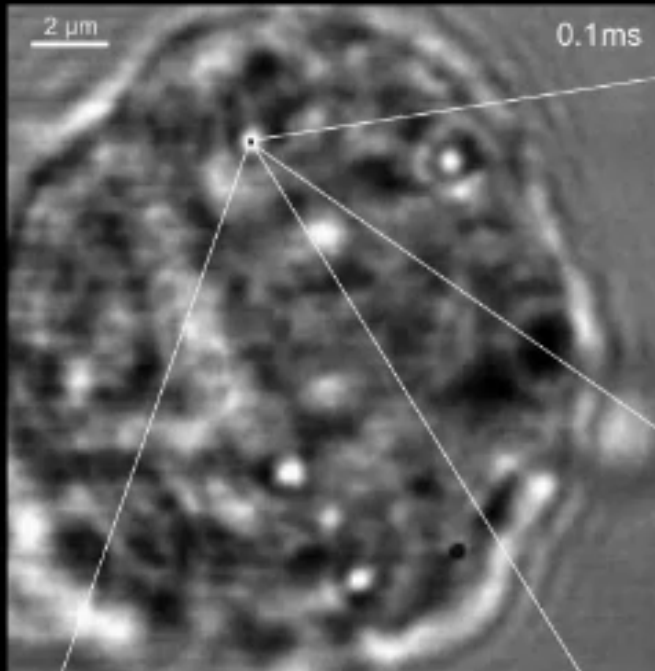


Particle Physics Detector

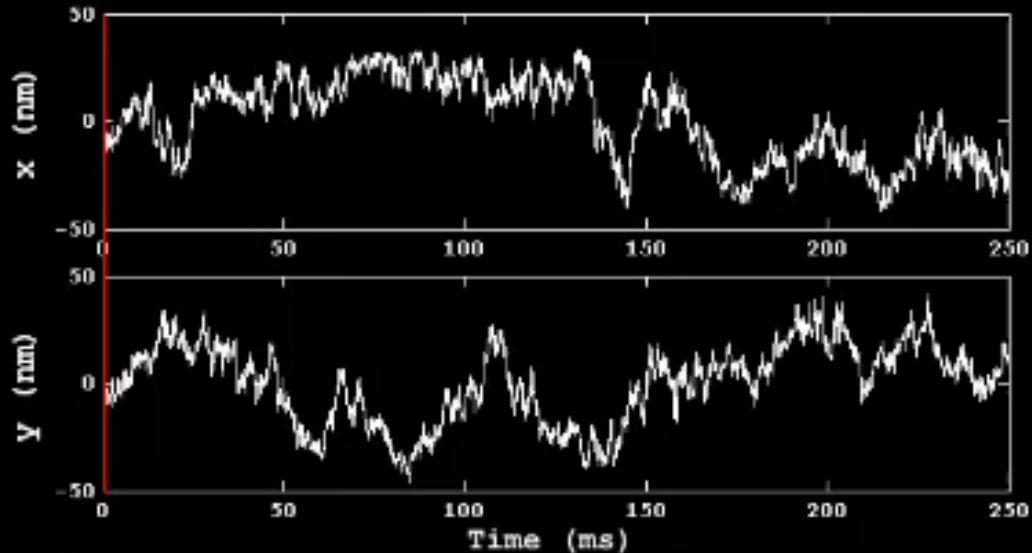
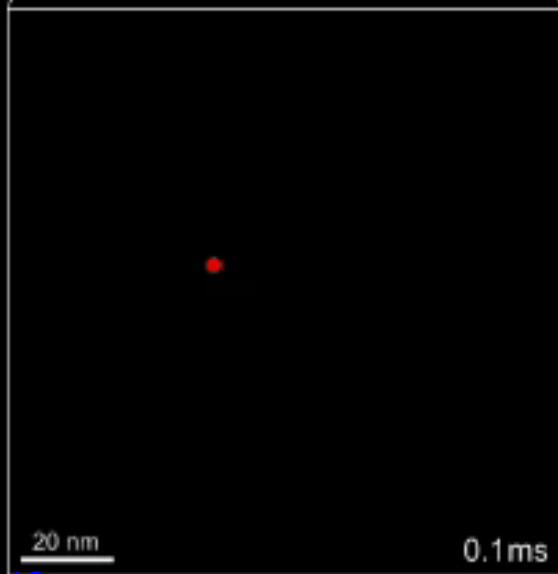


Gold nano particle (40nm) attached to Transferrin Receptor (TfR) on Cancer Cell

Prof. Manuel Penichet (Oncology)



(10,000 frame/sec)

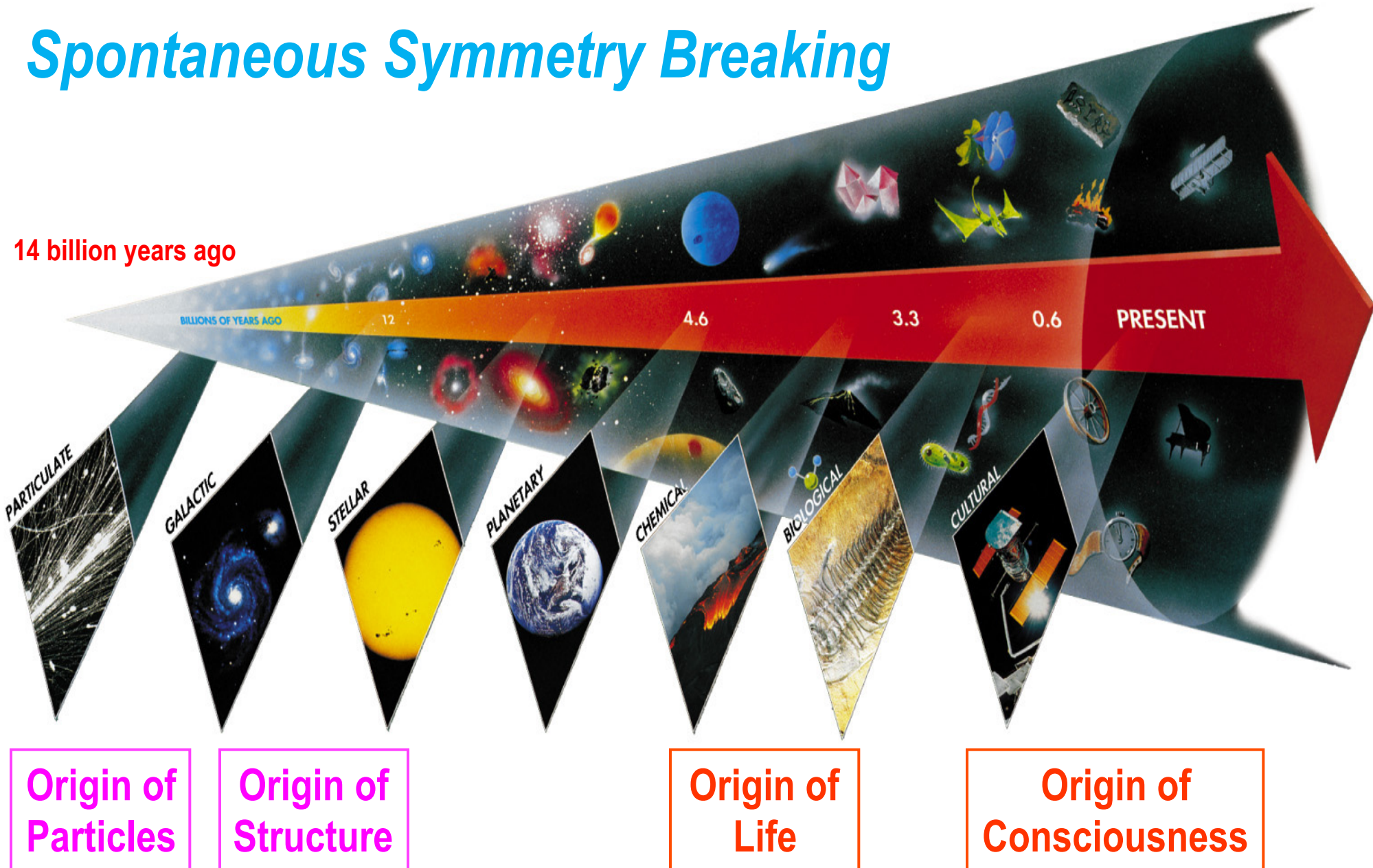


UCLA Fast Bio-Imaging Group

L. Rothblat, H. Rodriguez, C.A. Cheng, K. Jewhurst, J. Miao, K. Arisaka

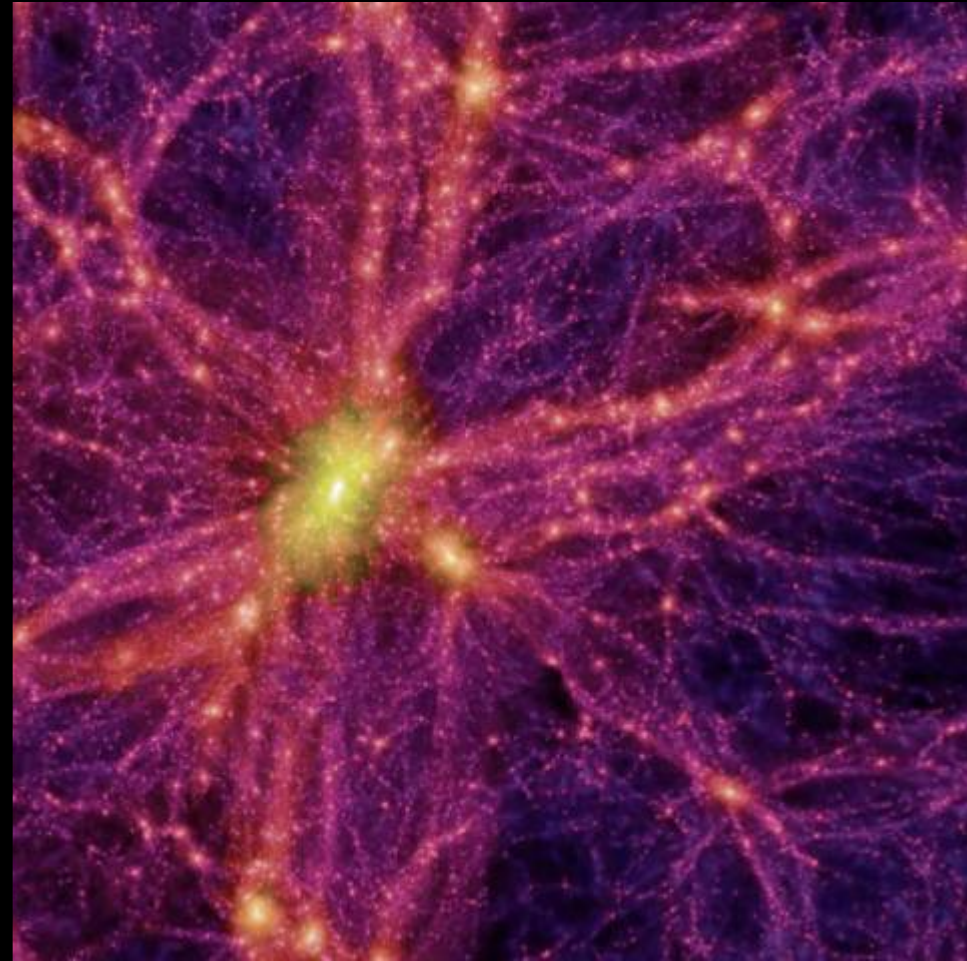
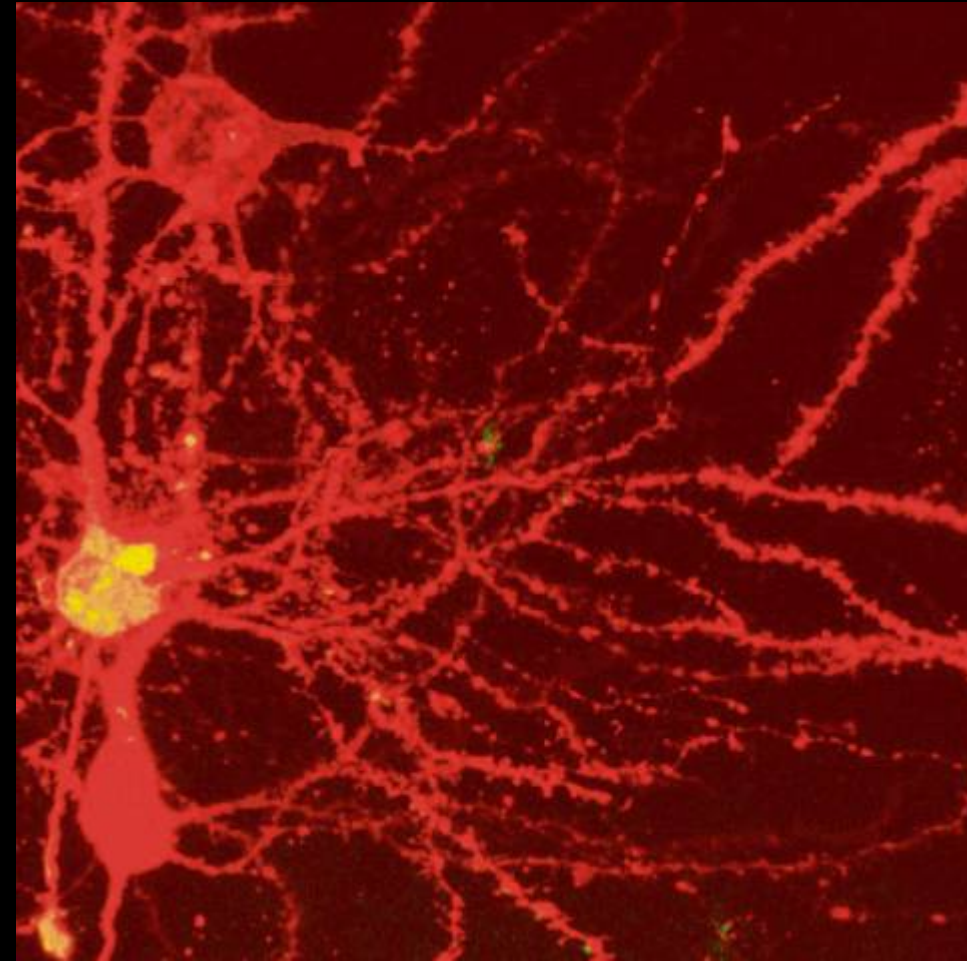
Seven Phases of Cosmic Evolution

Spontaneous Symmetry Breaking



Brain

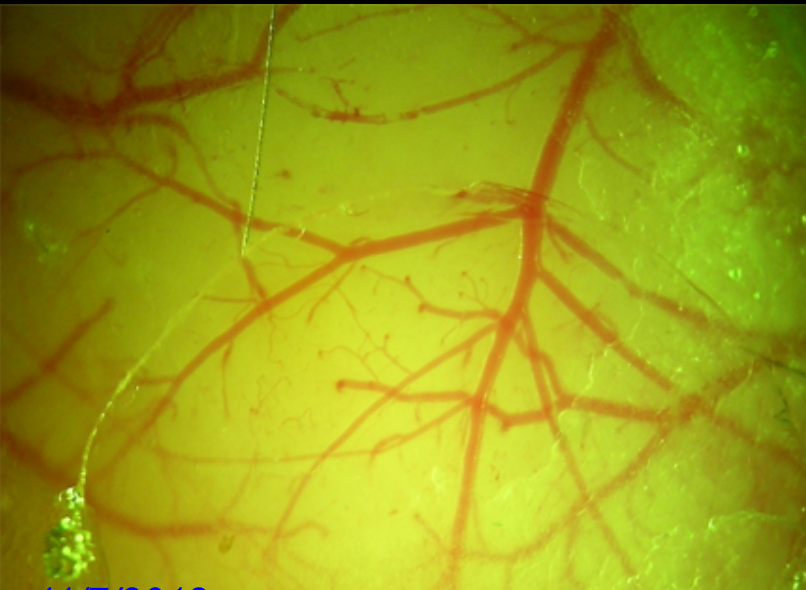
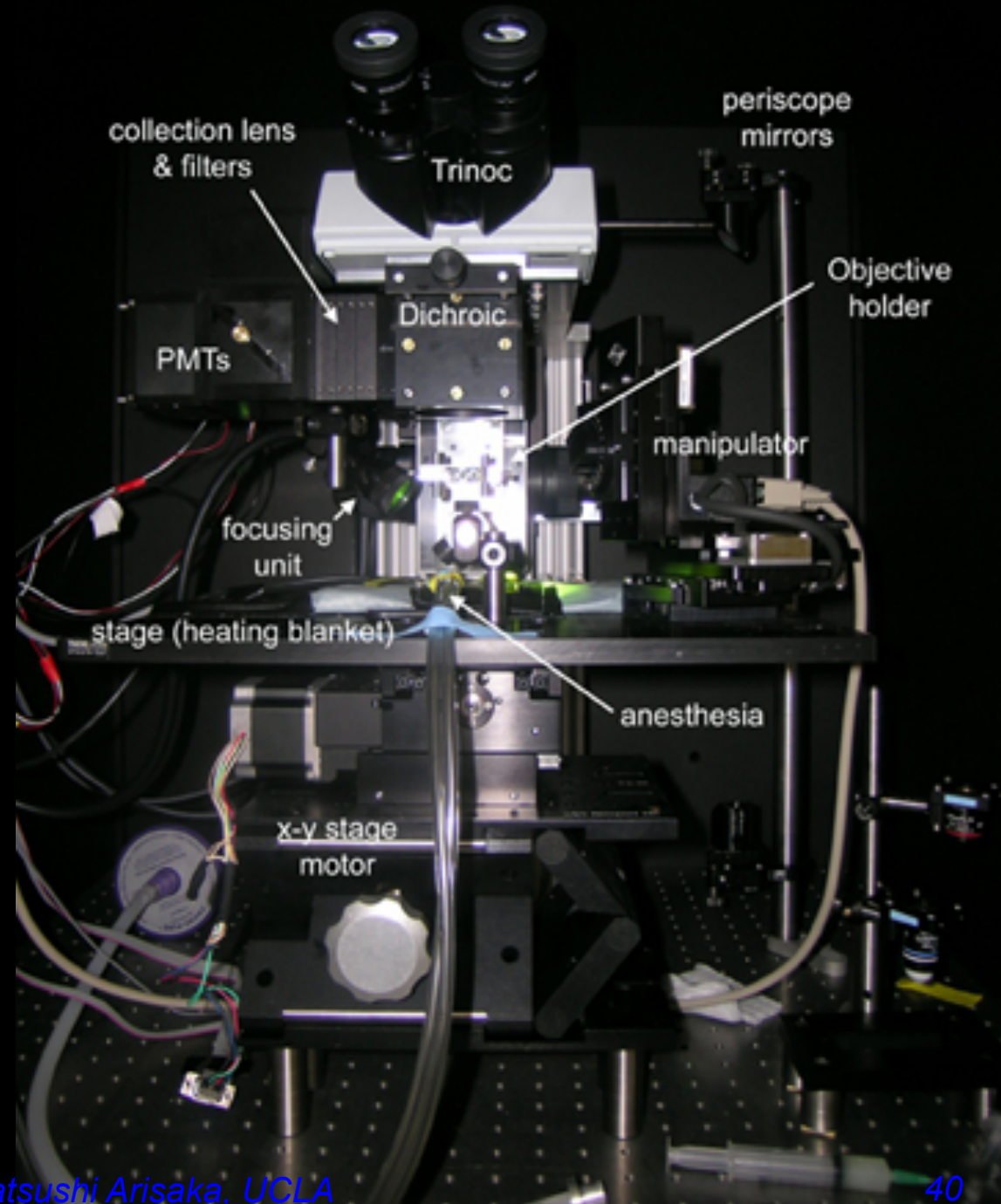
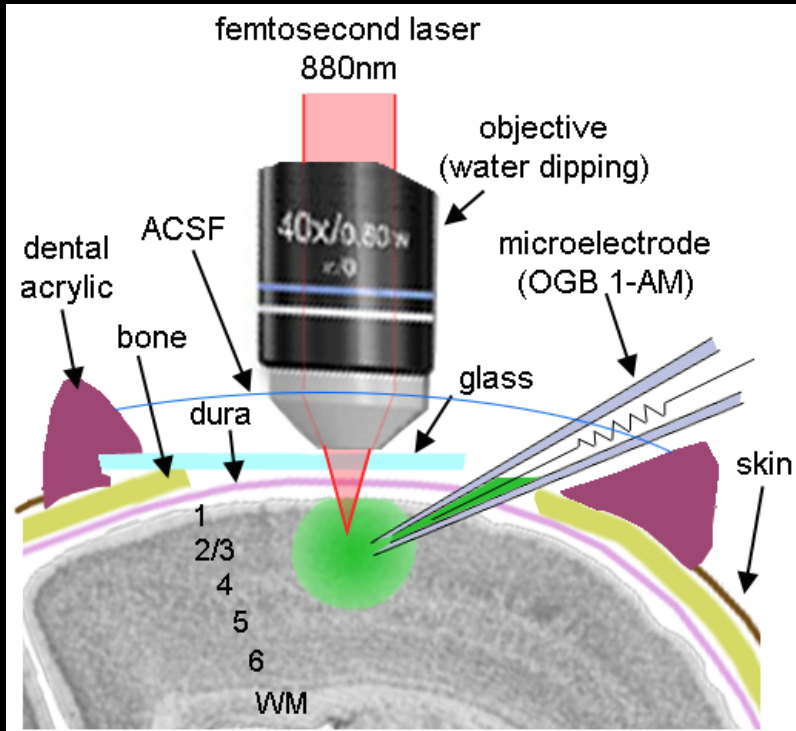
Universe



100 Billions Neurons

100 Billions Galaxies

In vivo calcium imaging of neuronal activity



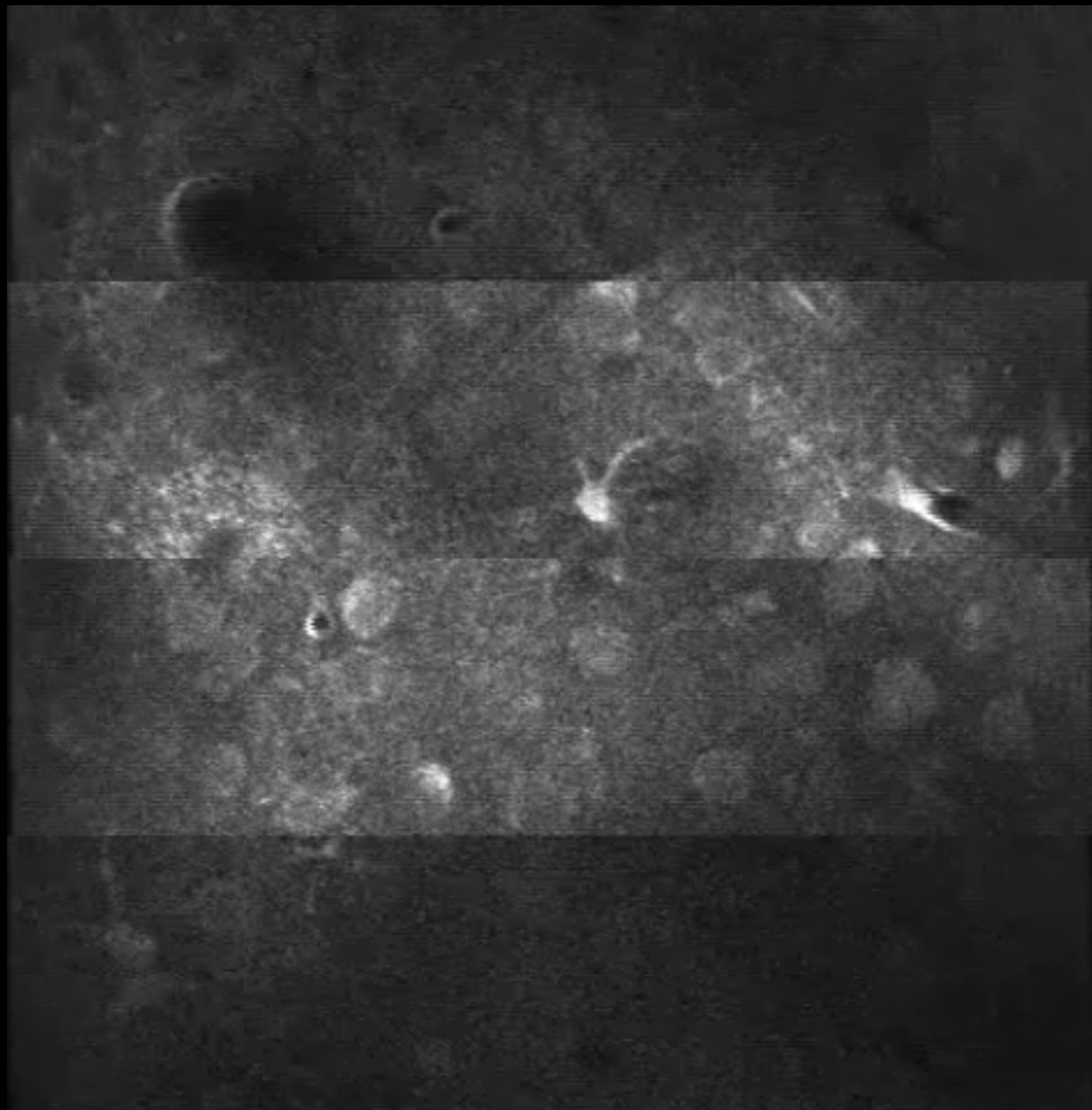
In vivo calcium imaging of Barrel Cortex of Mouse

Barrel Cortex
Layer 2/3

150 μm deep

240 fps
Raw Data

(x3 faster
than real)



Beam 1
(0 ns)

Beam 2
(+3 ns)

Beam 3
(+6 ns)

Beam 4
(+9 ns)

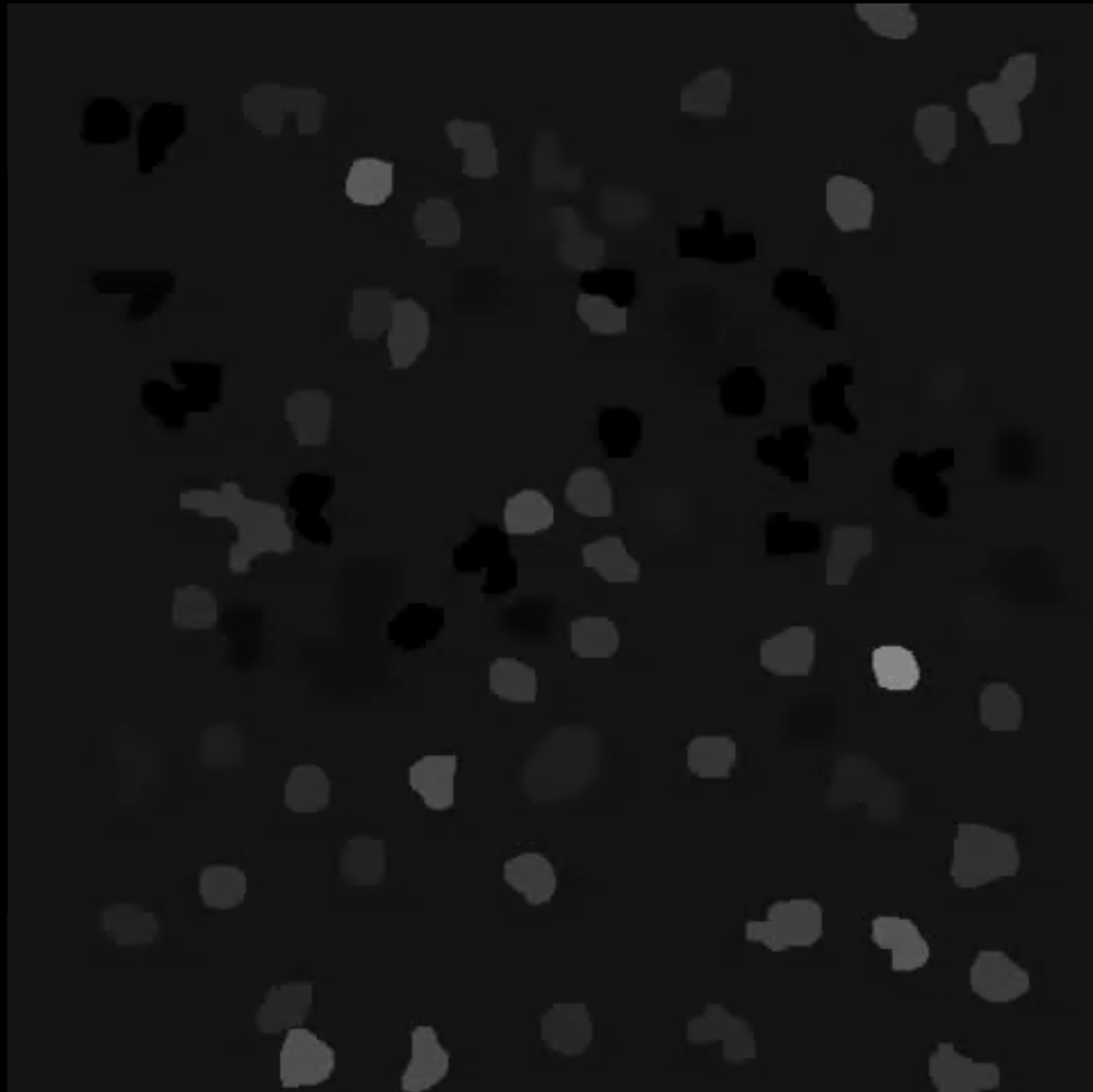
In vivo calcium imaging of Barrel Cortex of Mouse

**Barrel Cortex
Layer 2/3**

150 μm deep

**After
averaging**

**(x3 faster
than real)**

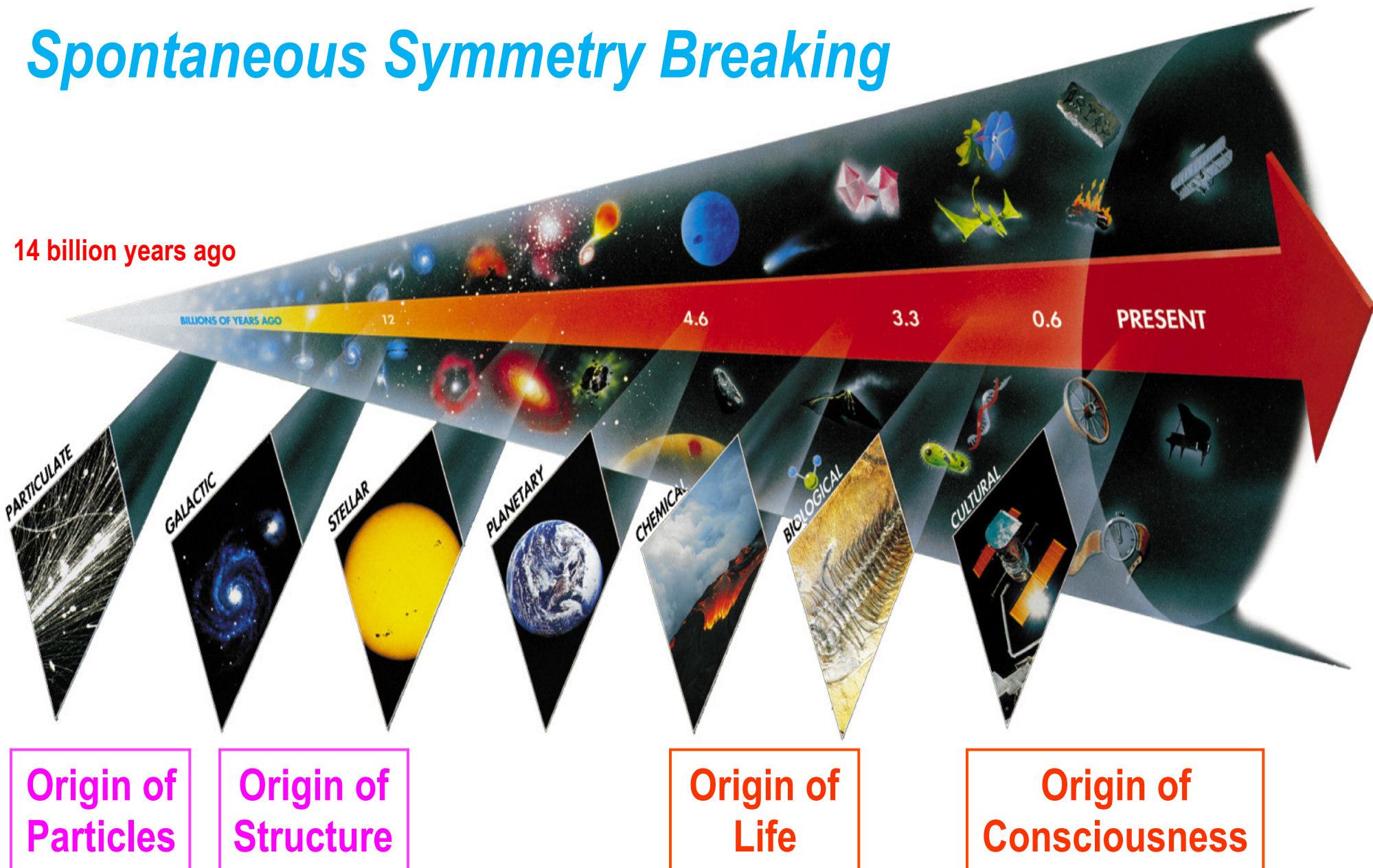


58 neurons

*(~100 billions
neurons
in our brain)*

Seven Phases of Cosmic Evolution

Spontaneous Symmetry Breaking





Why are we here?

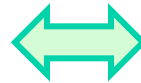


There may be ~100 Billion Universes.

Four Major Science

Origin of Particles
Particle Physics

Origin of Universe
Cosmology



Origin of Life
Molecular Biology

Origin of Consciousness
Neurophysics

