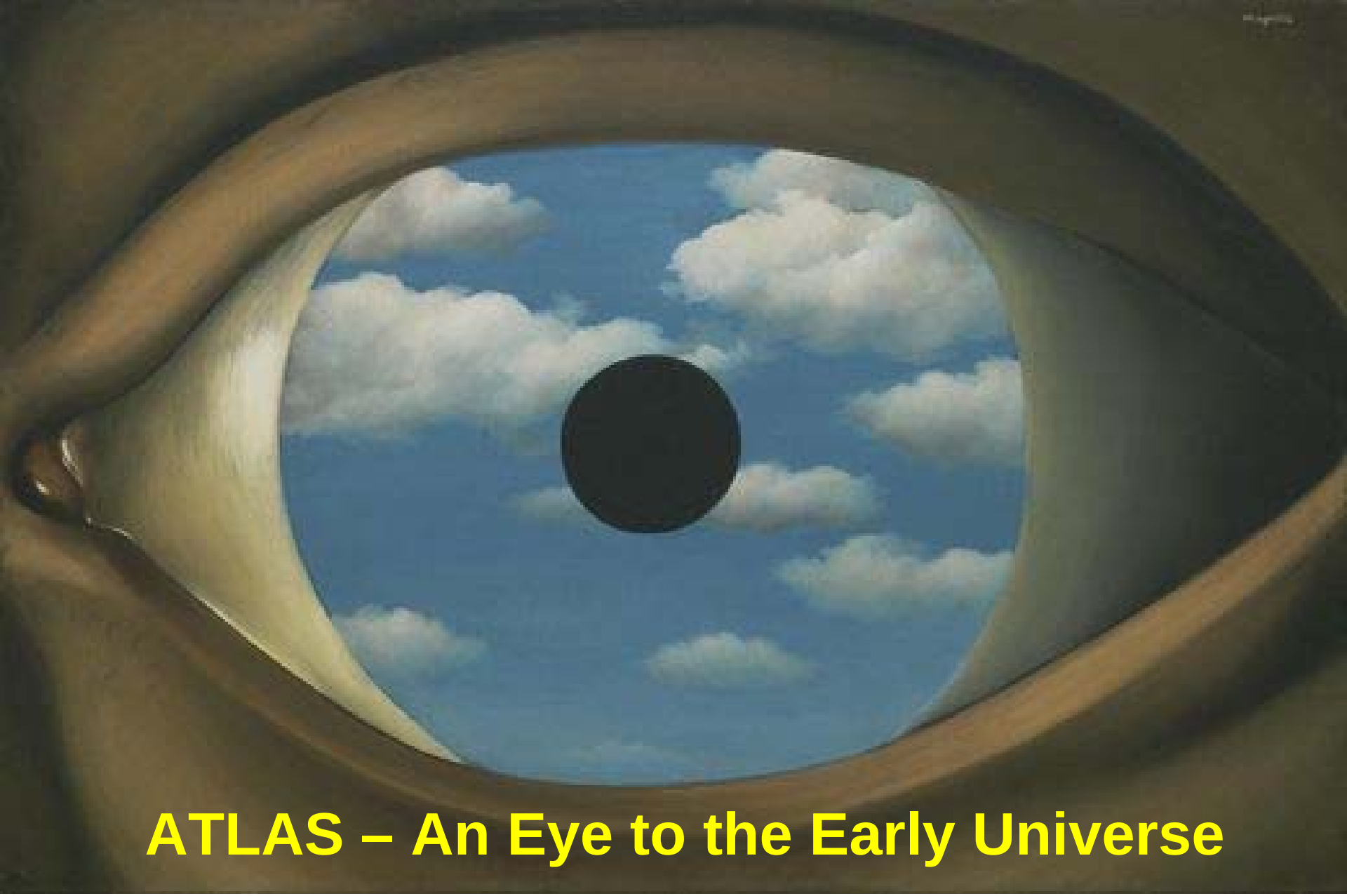
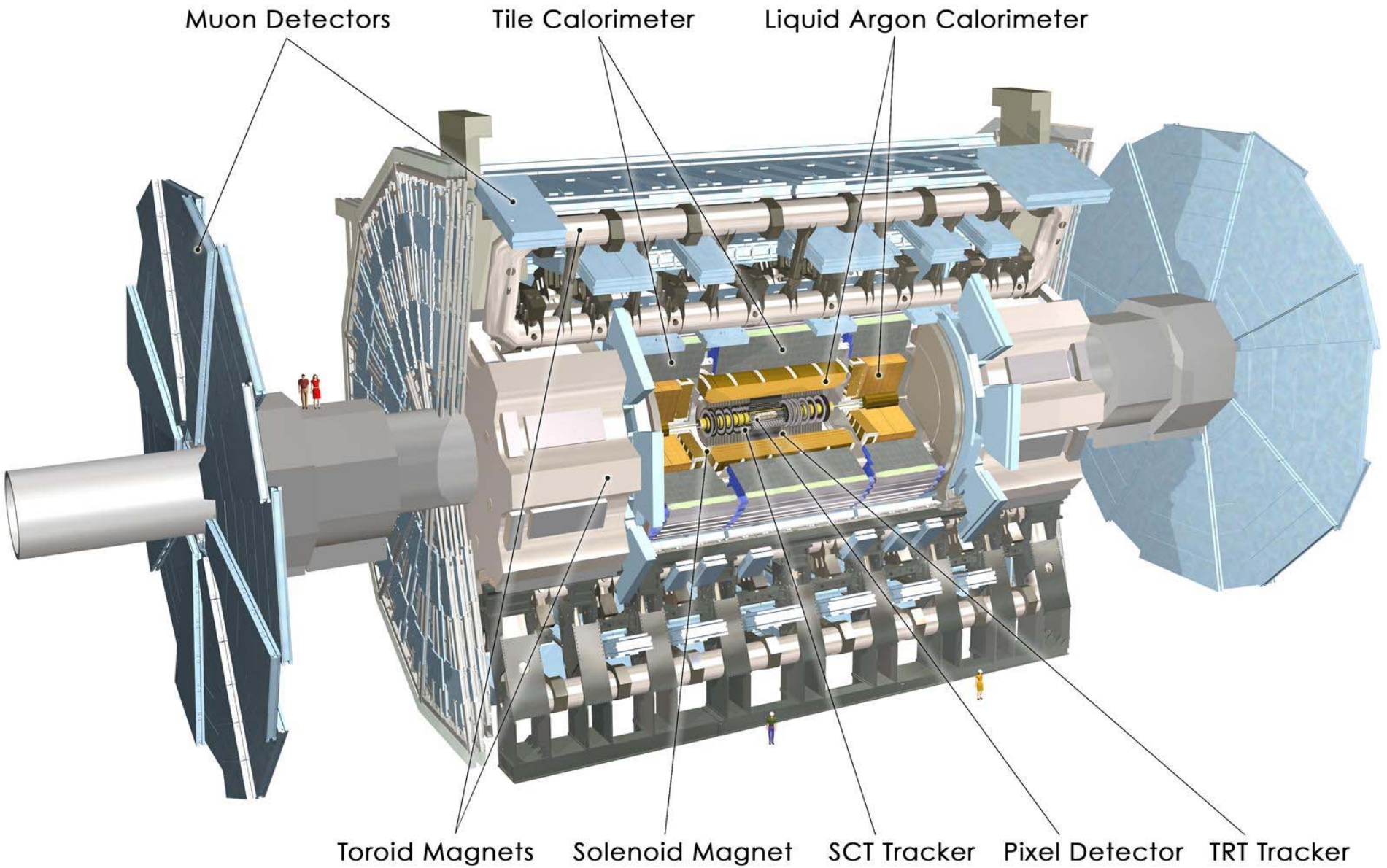


ATLAS – An Eye to the Early Universe

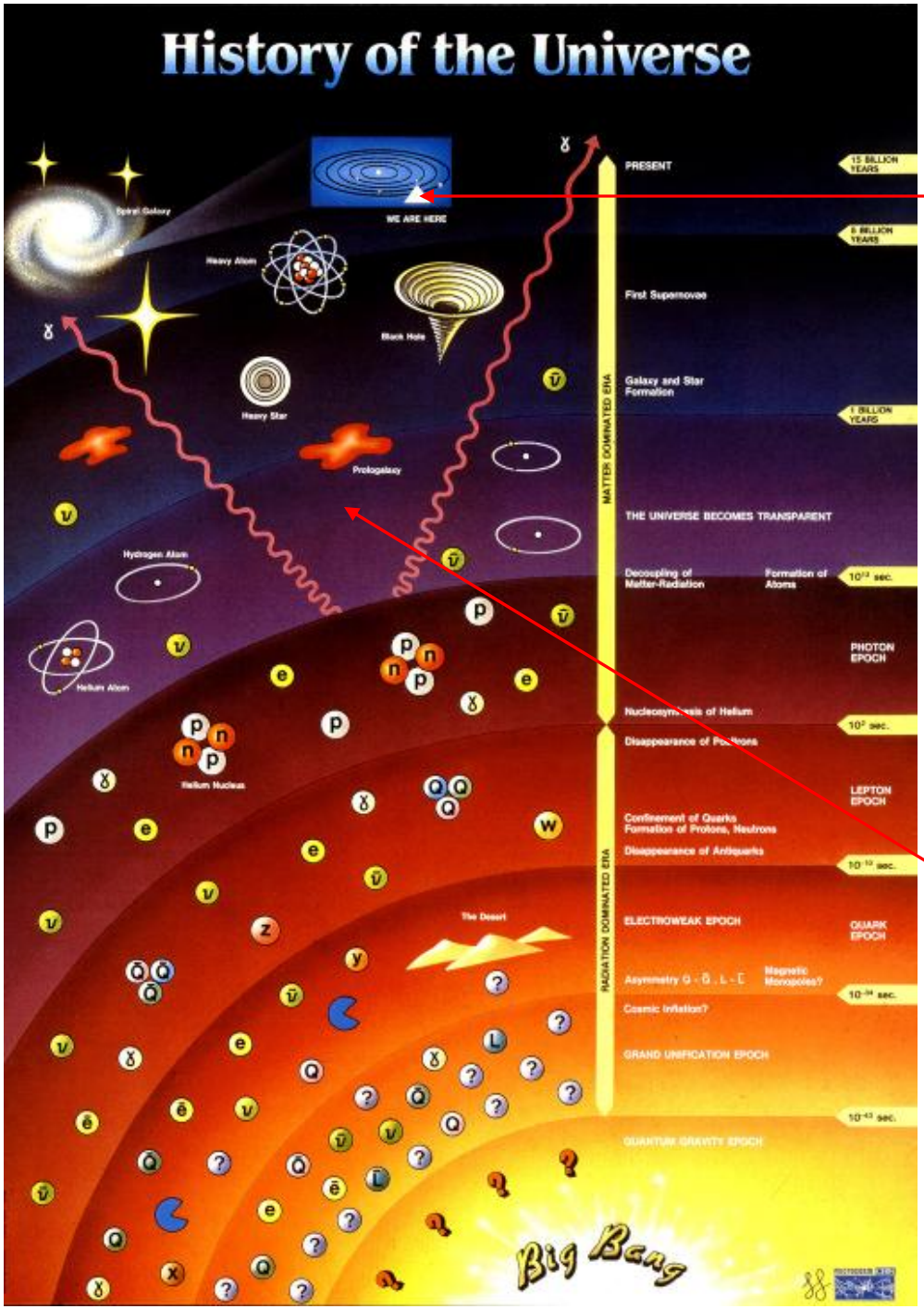
OpenLab Board of Sponsors Meeting 25.04.2008

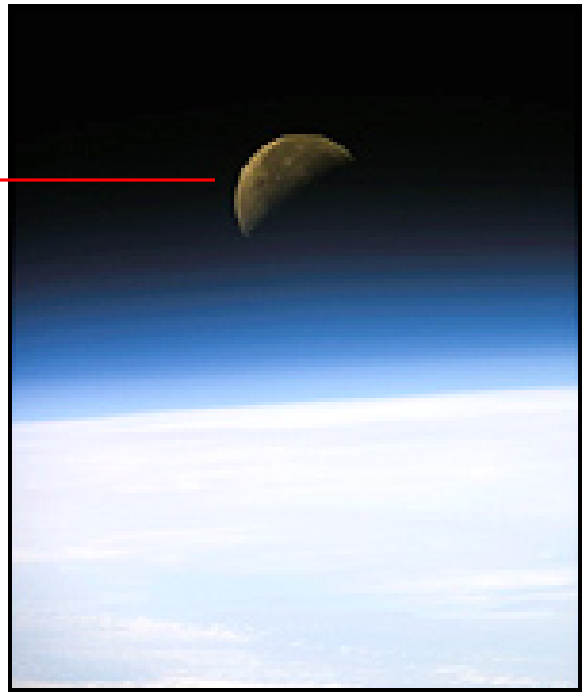
markus.nordberg@cern.ch

The Eyepiece - ATLAS Detector

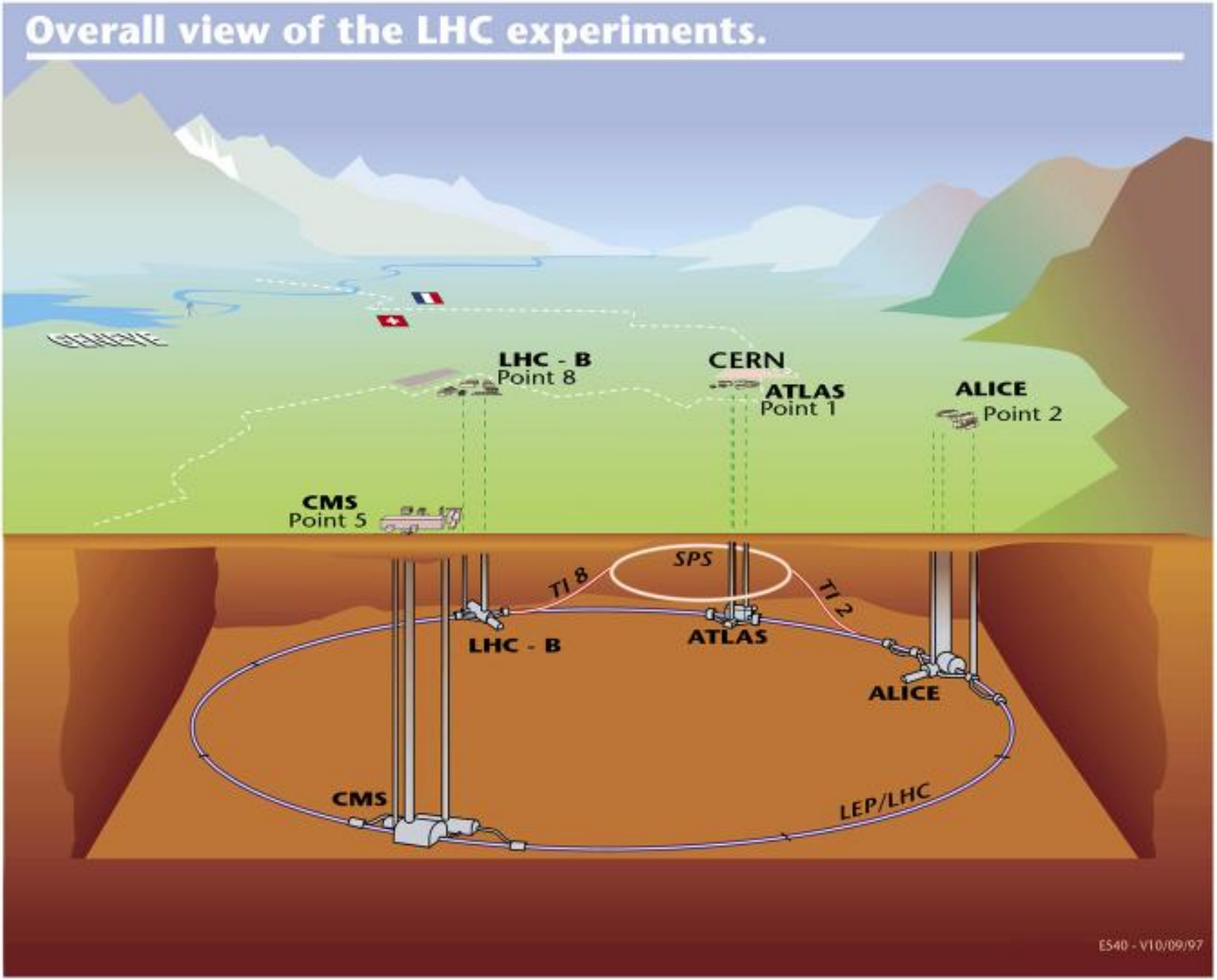



C
D

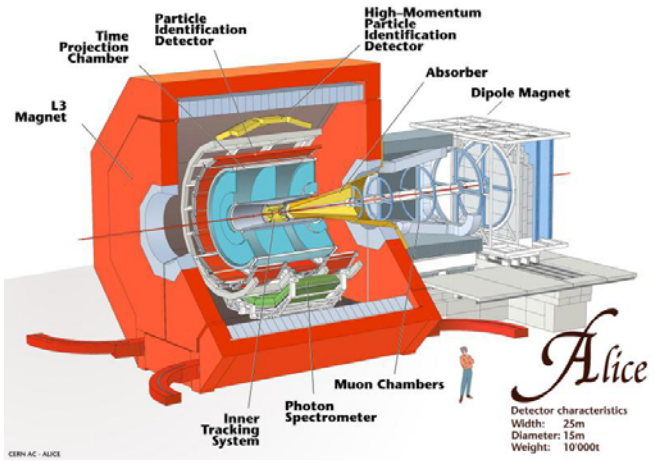

History of the Universe
WE ARE HERE
Spiral Galaxy
Heavy Atom
Black Hole
Heavy Star
Protogalaxy
Hydrogen Atom
Helium Atom
Helium Nucleus
The Desert
PRESENT
15 BILLION YEARS
8 BILLION YEARS
First Supernovae
Galaxy and Star Formation
1 BILLION YEARS
THE UNIVERSE BECOMES TRANSPARENT
Decoupling of Matter-Radiation
Formation of Atoms
PHOTON EPOCH
Nucleosynthesis of Helium
Disappearance of Positrons
LEPTON EPOCH
Confinement of Quarks
Formation of Protons, Neutrons
Disappearance of Antiquarks
ELECTROWEAK EPOCH
QUARK EPOCH
Asymmetry Q - Q̄ , L - L̄
Magnetic Monopoles?
Cosmic Inflation?
GRAND UNIFICATION EPOCH
QUANTUM GRAVITY EPOCH
MATTER DOMINATED ERA
RADIATION DOMINATED ERA
Big Bang

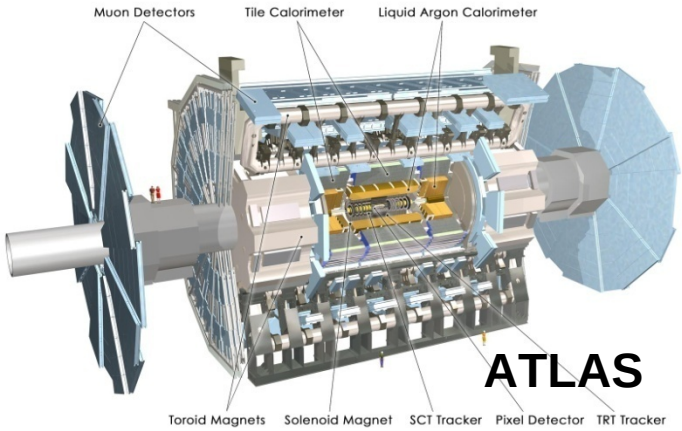


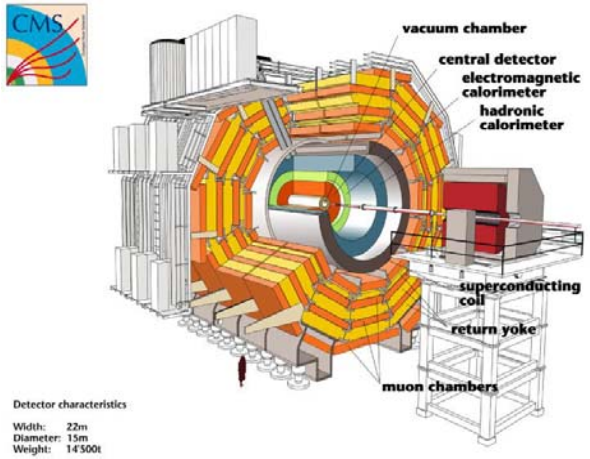
Overall view of the LHC experiments.

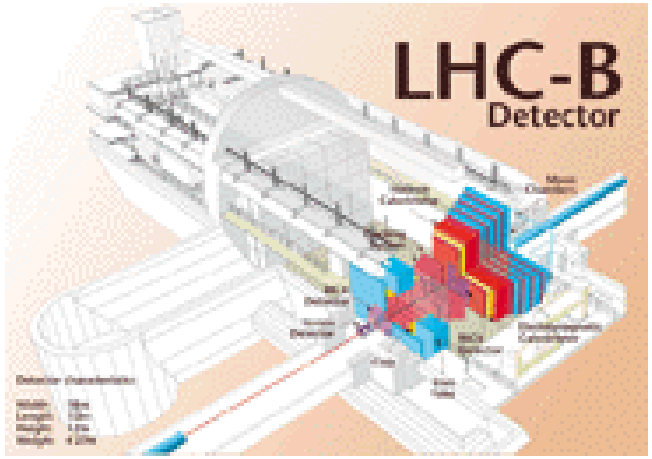


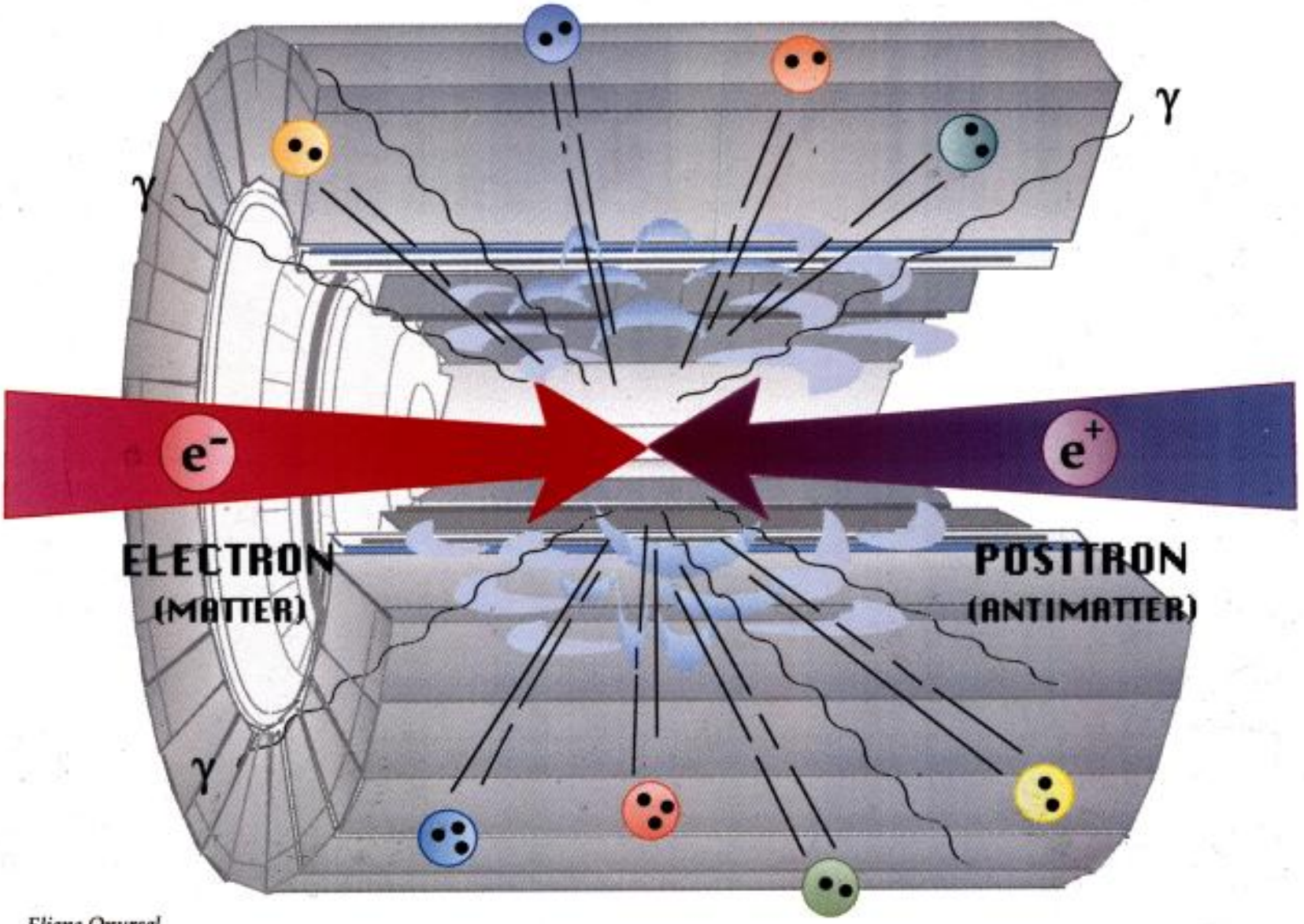
LHC Experiments



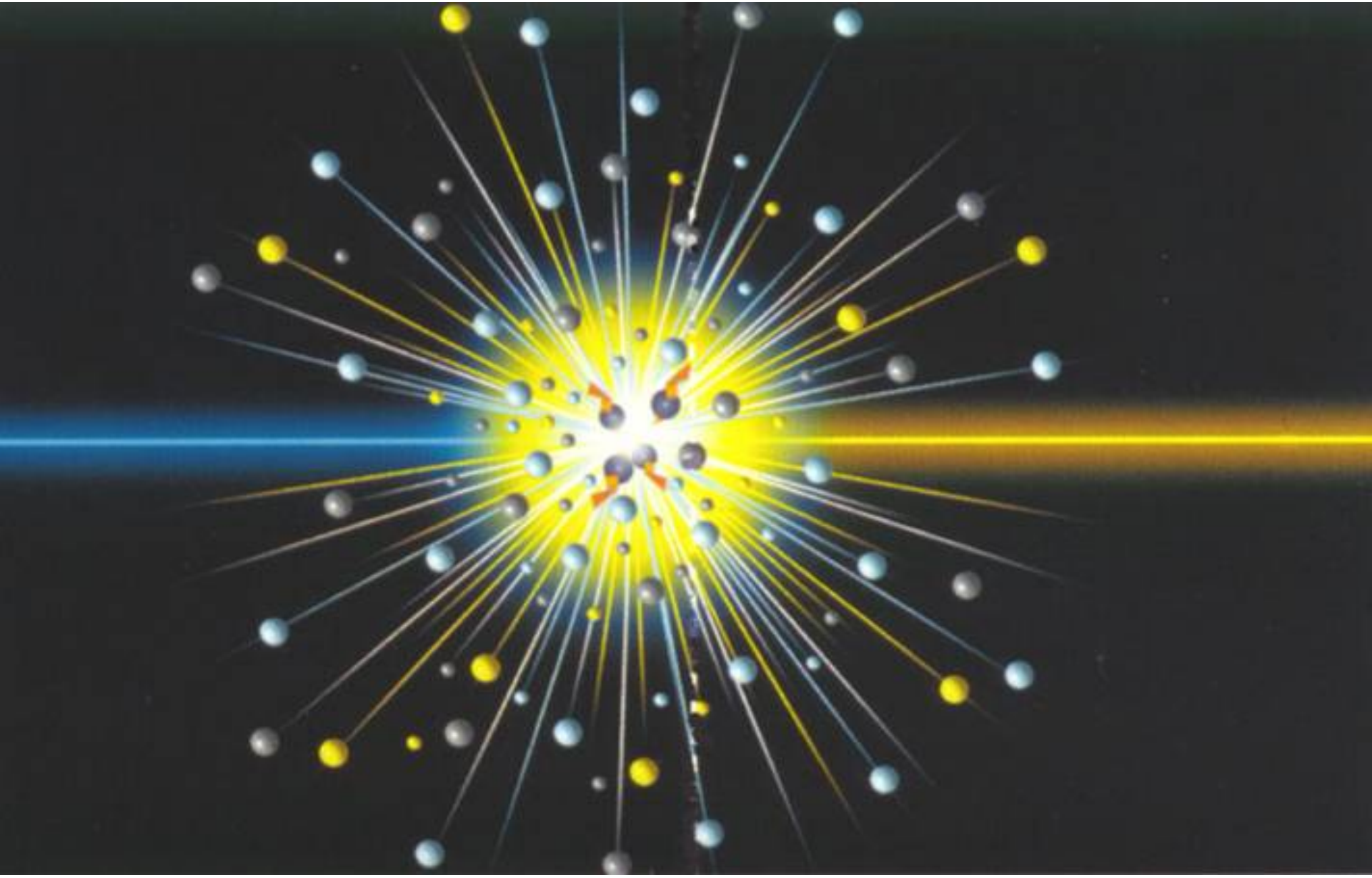


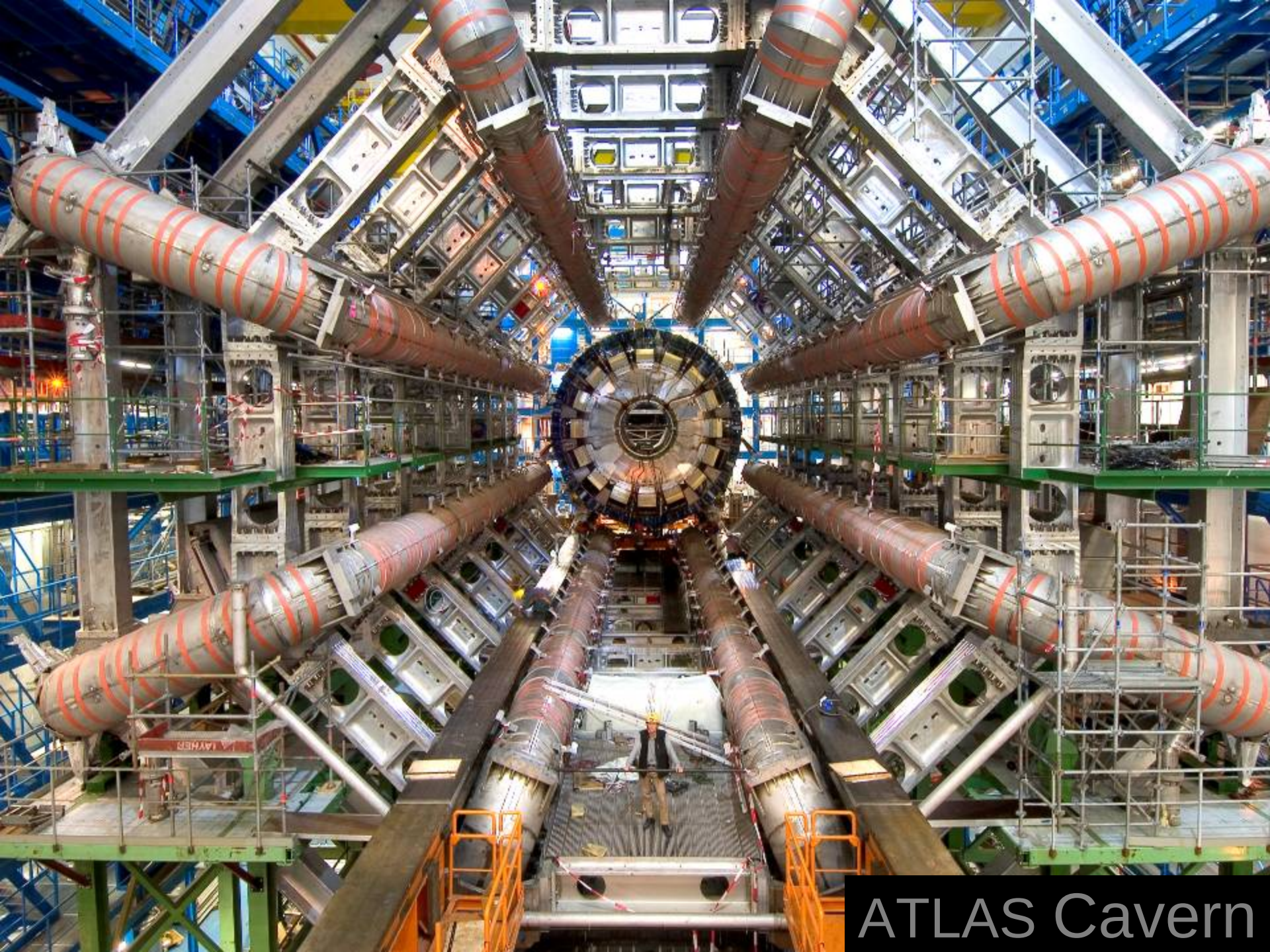






Eliane Onursal

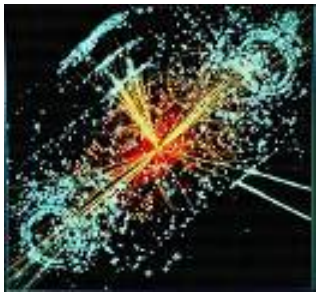




ATLAS Cavern

Computing

The LHC experiments will produce 10-15 PB of data per year 1 PB=10^6 GB
(~ 1 billion events/year recorded, each event has ~ 100 000 signals)
This corresponds to ~ 20 million CD's (a 20 km stack …)



Data analysis requires computing power equivalent to ~100 000 today's fastest PC processors.

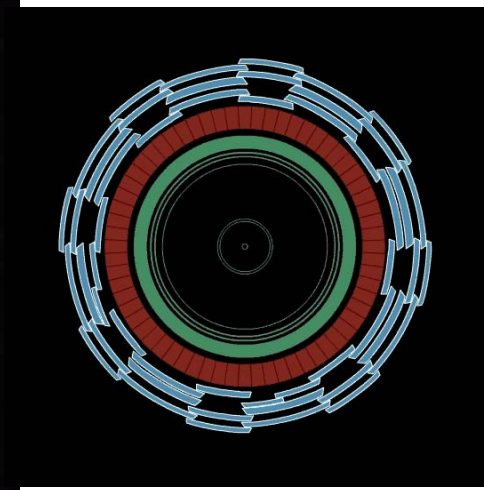
The experiment international Collaborations are spread all over the world → computing resources must be distributed.

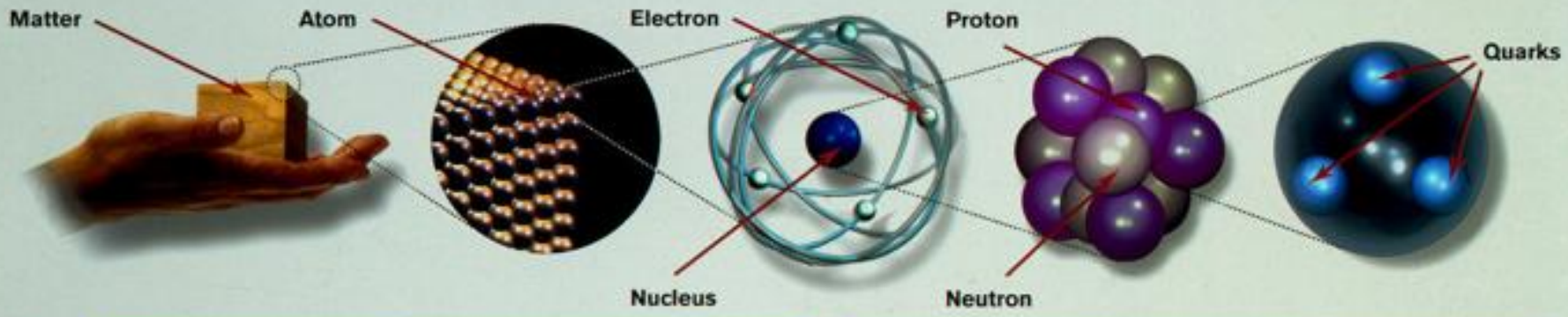
Cooperation of many computer centres all over the world is needed
(CERN provides ~20% of the resources)

Courtesy of F. Gianotti


17
17


DELPHI Interactive Analysis
Beam:45.6 GeV Run:26154 DAS :25-Aug-1991
Prod:1-Oct-1991 Evt:3018 21:47:02
Scan:15-Jan-1992
TD TE TS TK TV ST PH
Hot 92 18 0 38 0 0 0
Count 0 0 0 0 0 0 0
DELPHI
ENDCAPS
BARREL
CENTRAL
Return





Matter particles

All ordinary particles belong to this group

These particles existed just after the Big Bang. Now they are found only in cosmic rays and accelerators

LEPTONS

FIRST FAMILY	**Electron** Responsible for electricity and chemical reactions; it has a charge of -1	**Electron neutrino** Particle with no electric charge, and possibly no mass; billions fly through your body every second
SECOND FAMILY	**Muon** A heavier relative of the electron; it lives for two-millionths of a second	**Muon neutrino** Created along with muons when some particles decay
THIRD FAMILY	**Tau** Heavier still; it is extremely unstable. It was discovered in 1975	**Tau neutrino** not yet discovered but believed to exist

QUARKS

Up Has an electric charge of plus two-thirds; protons contain two, neutrons contain one	**Down** Has an electric charge of minus one-third; protons contain one, neutrons contain two
Charm A heavier relative of the up; found in 1974	**Strange** A heavier relative of the down; found in 1964
Top Heavier still	**Bottom** Heavier still; measuring bottom quarks is an important test of electroweak theory

Force particles

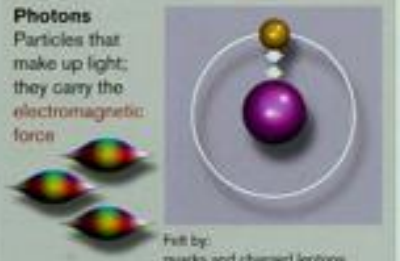
These particles transmit the four fundamental forces of nature although gravitons have so far not been discovered

Gluons
Carriers of the strong force between quarks

Felt by: quarks

The explosive release of nuclear energy is the result of the strong force

Photons
Particles that make up light; they carry the electromagnetic force



Felt by: quarks and charged leptons

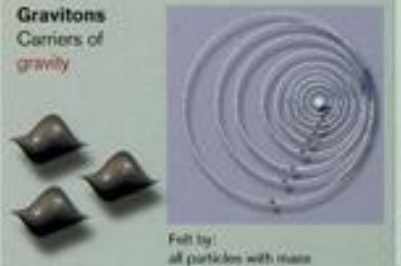
Electricity, magnetism and chemistry are all the results of electro-magnetic force

Intermediate vector bosons
Carriers of the weak force

Felt by: quarks and leptons

Some forms of radio-activity are the result of the weak force

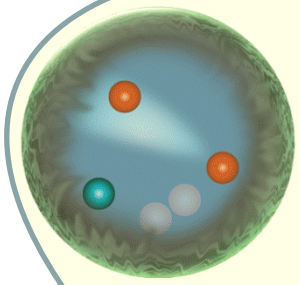
Gravitons
Carriers of gravity



Felt by: all particles with mass

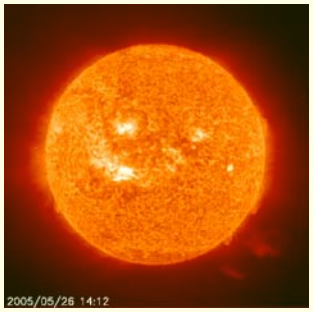
All the weight we experience is the result of the gravitational force

Basic Forces and their Carriers



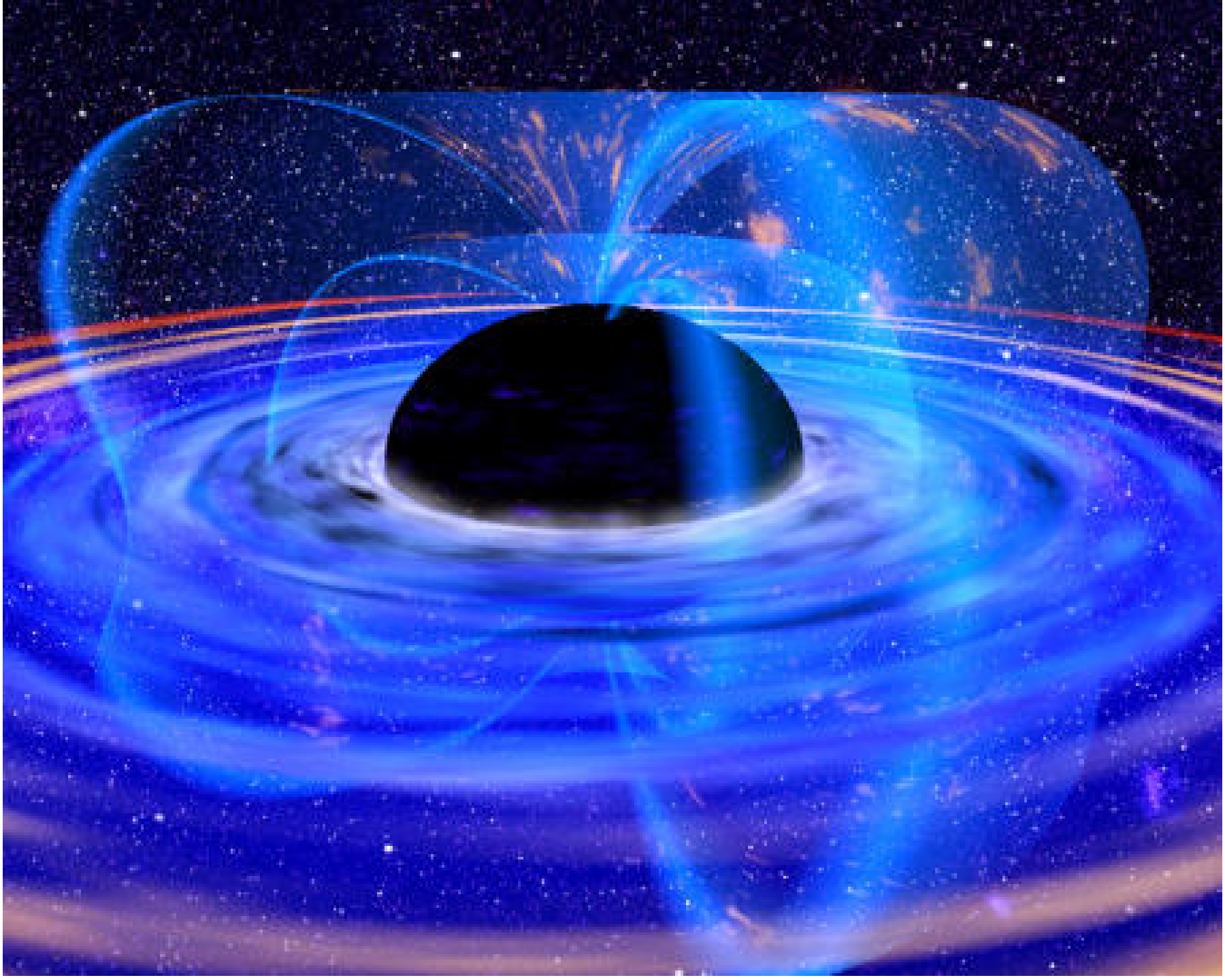
Gluons

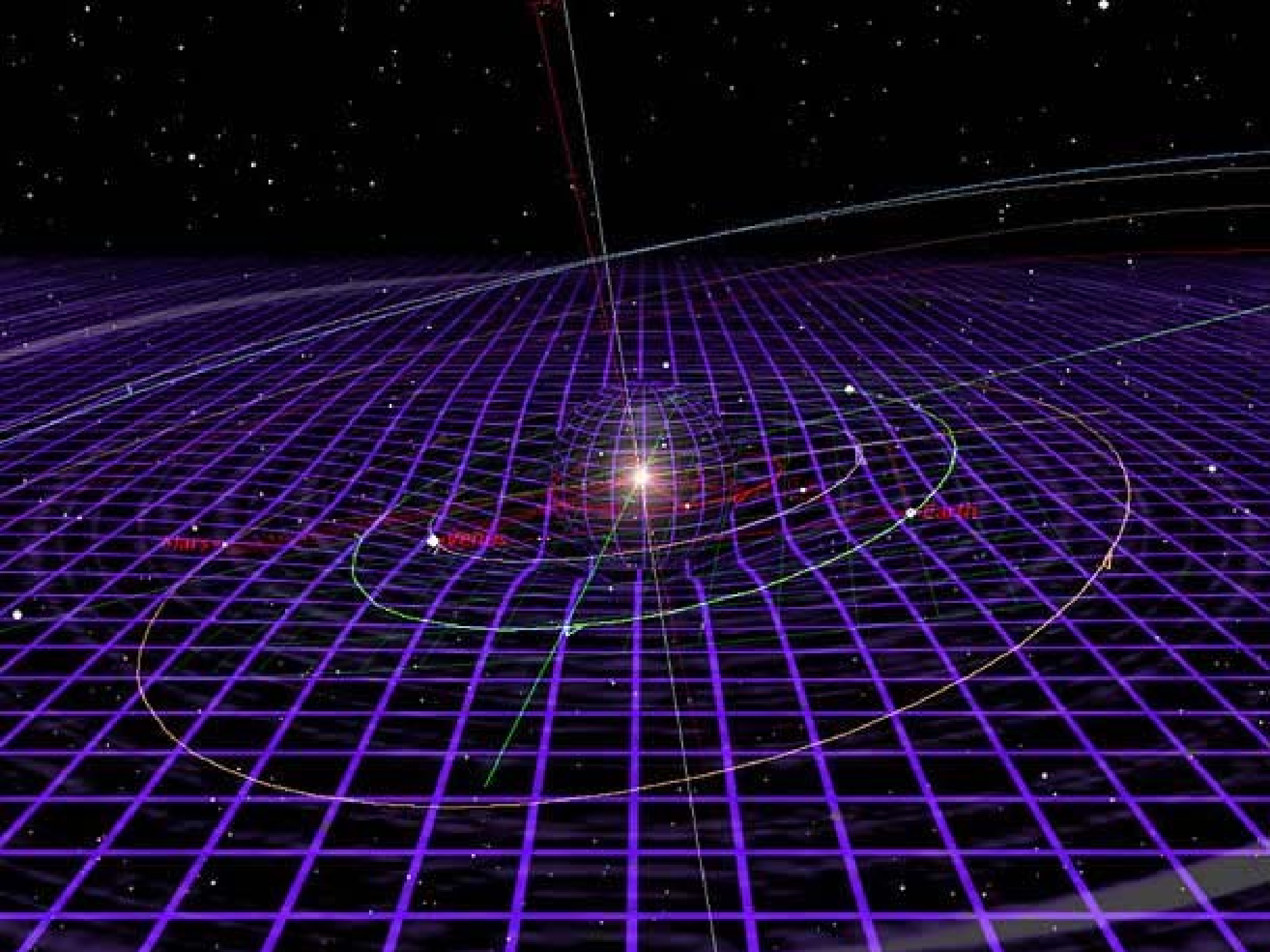
Photons

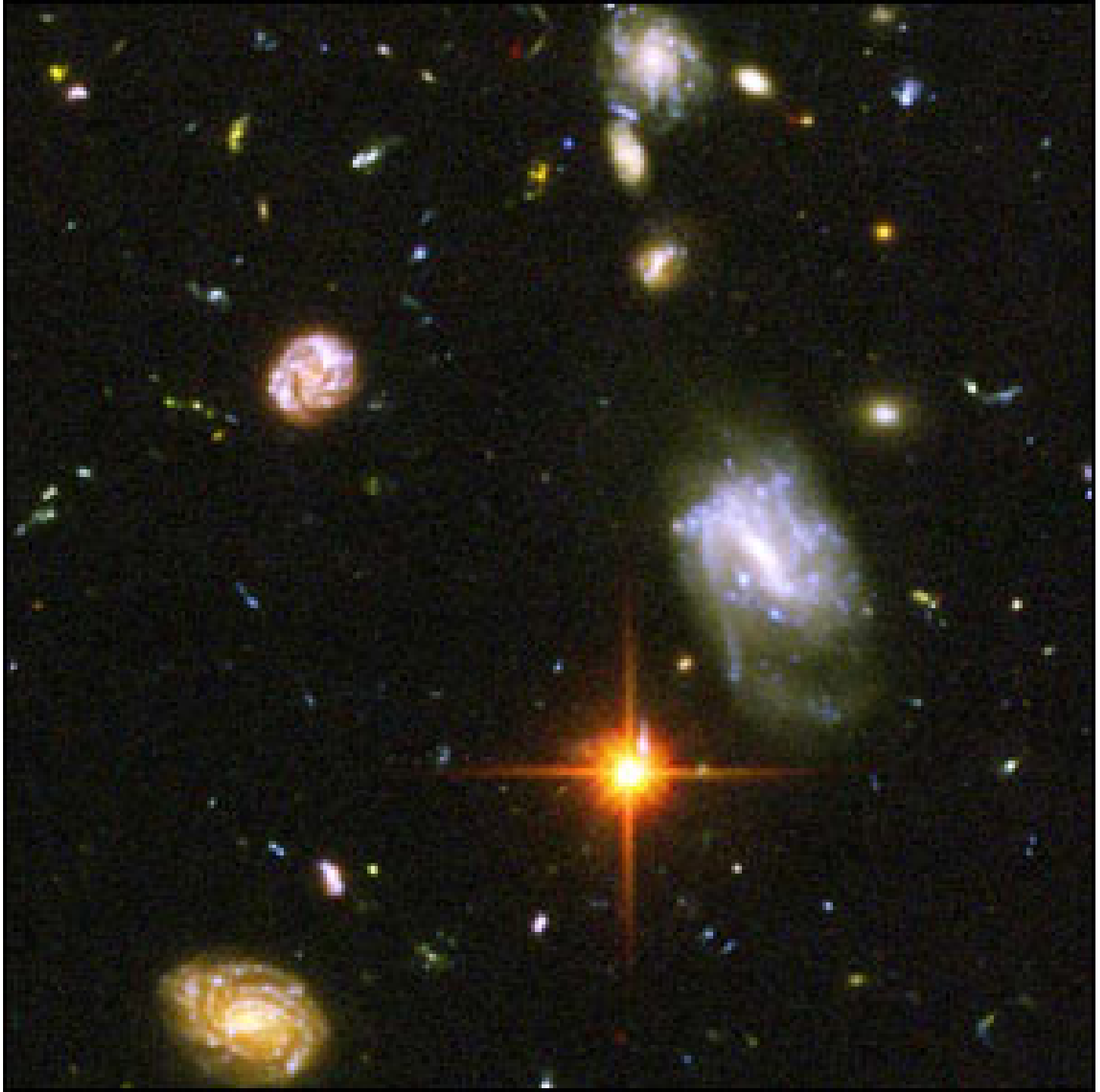


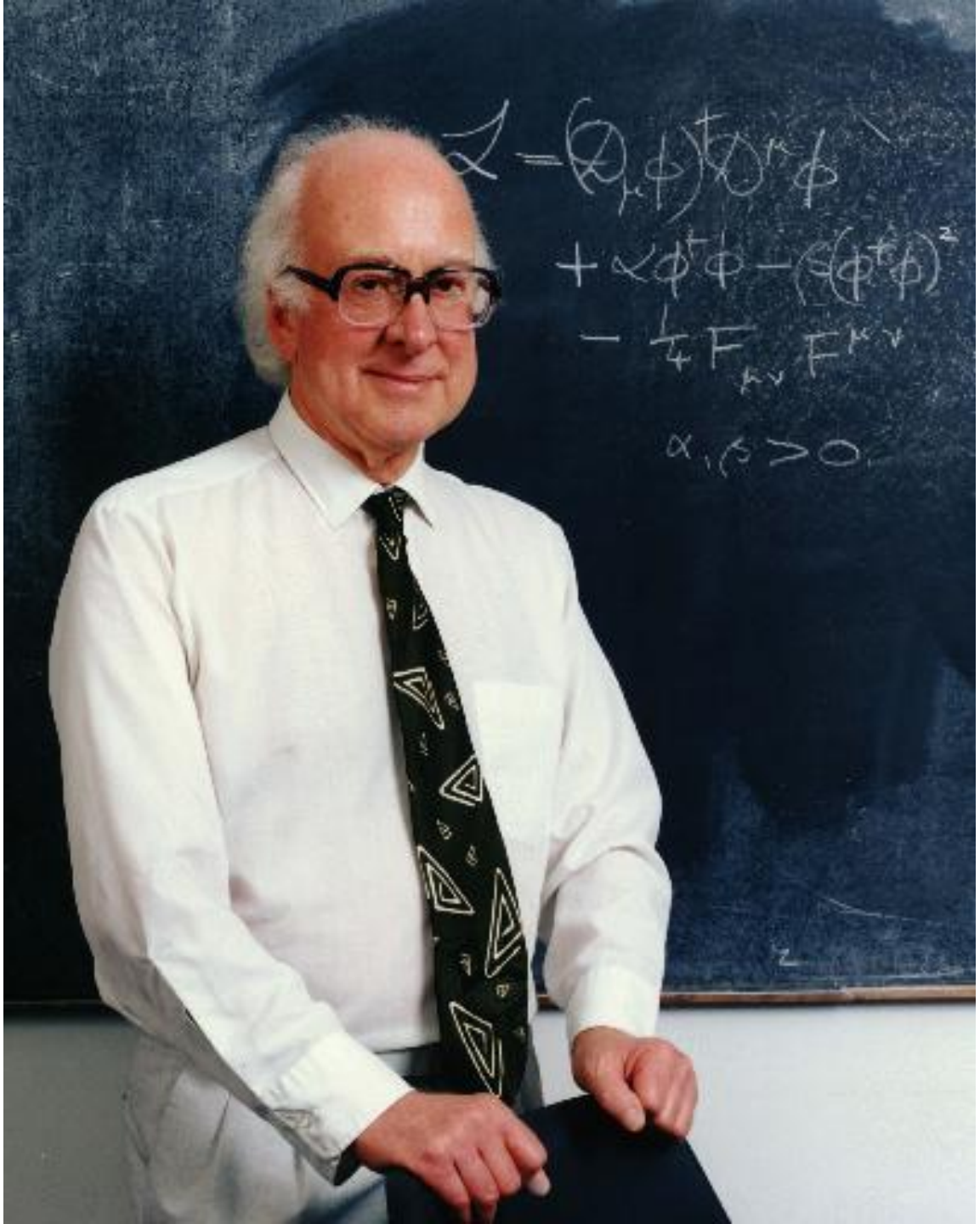
W,Z Bosons

Gravitons








$\mathcal{L} = (\partial_\mu \phi)^\dagger \partial^\mu \phi$
$+ \alpha \phi^\dagger \phi - \beta (\phi^\dagger \phi)^2$
$- \frac{1}{4} F_{\mu\nu} F^{\mu\nu}$
$\alpha, \beta > 0$