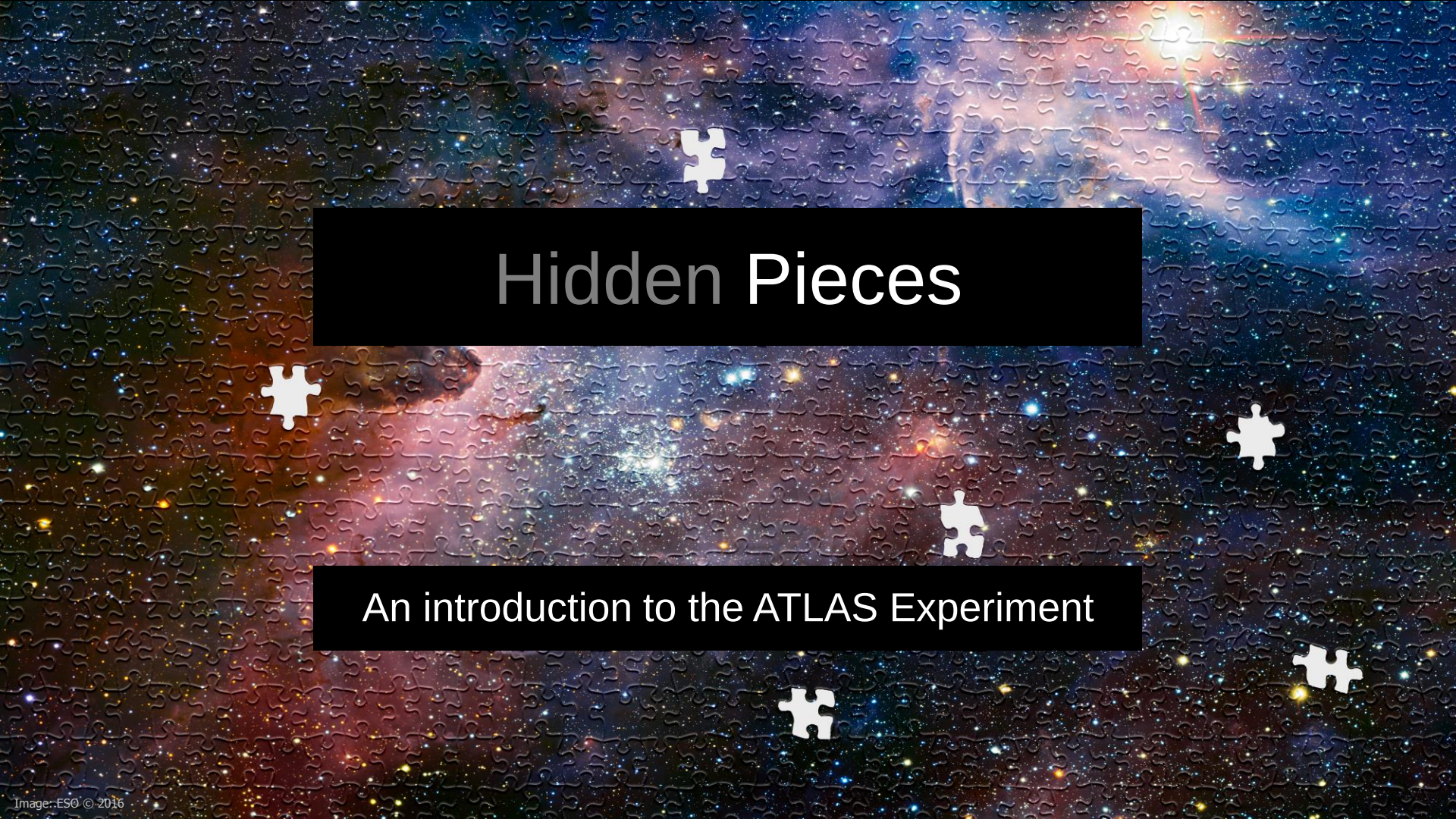
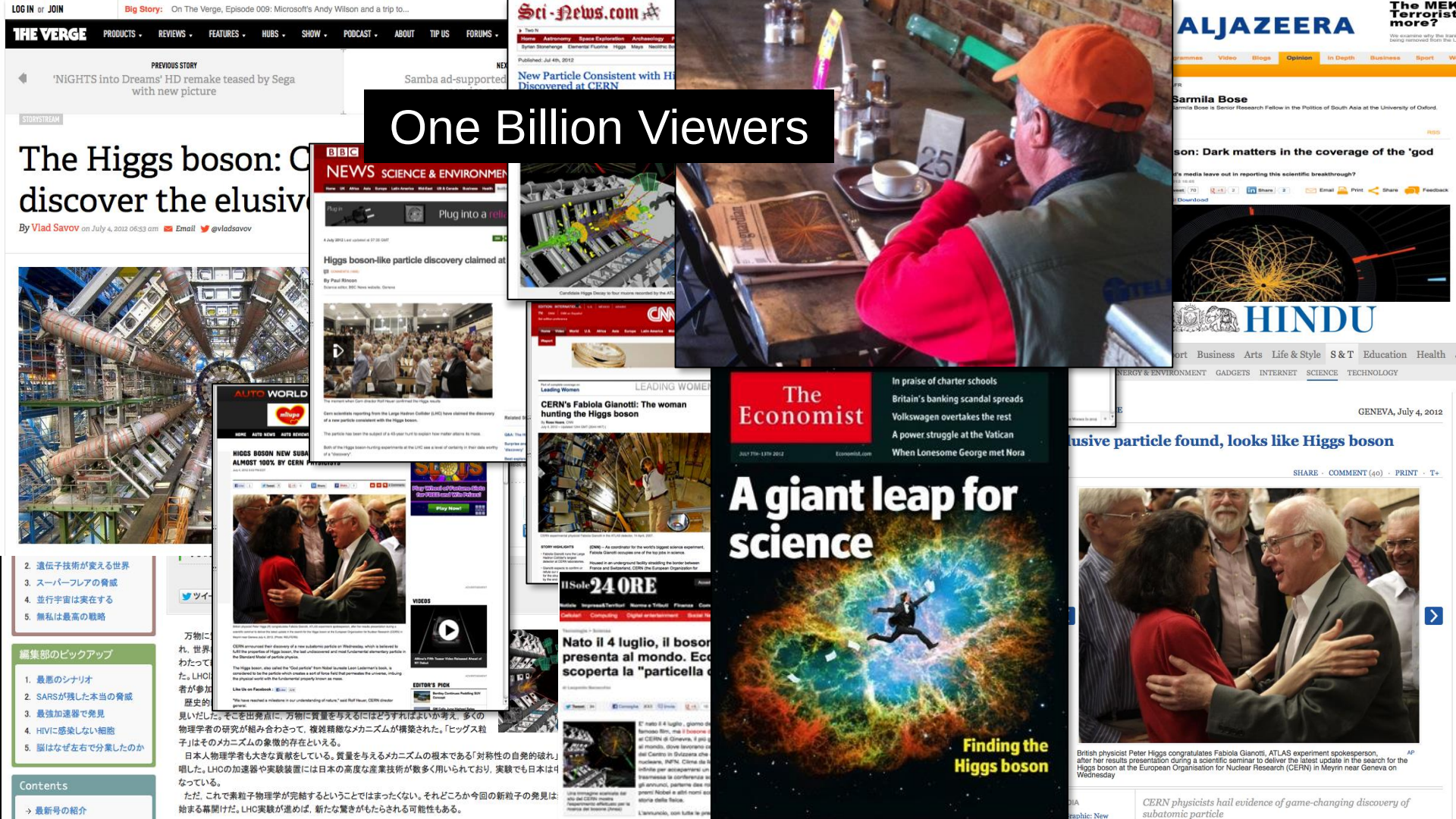

Hidden Pieces
An introduction to the ATLAS Experiment
Image: ESO © 2016

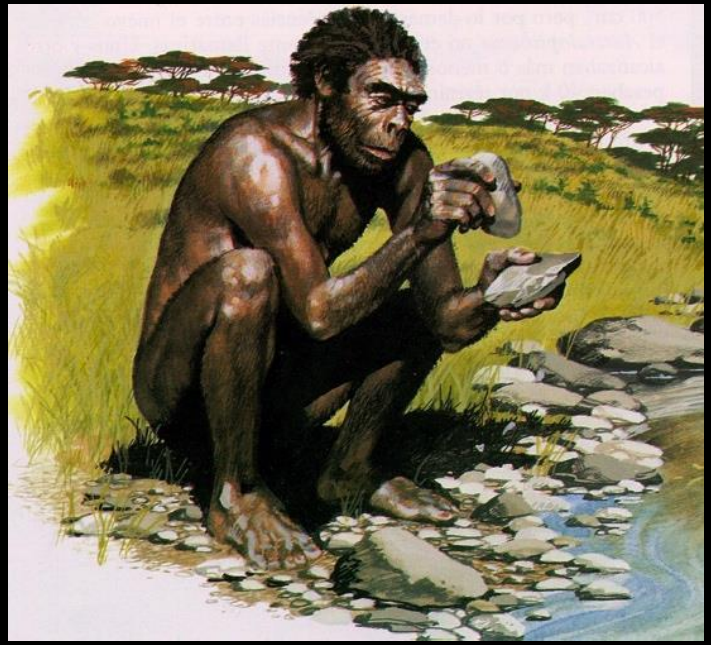

Warning:
This talk contains actual facts. It might not be convenient for audiences who prefer “alternative facts” or outright lies. Follow at your own risk.

Physics Seminar – 4 July 2012

One Billion Viewers

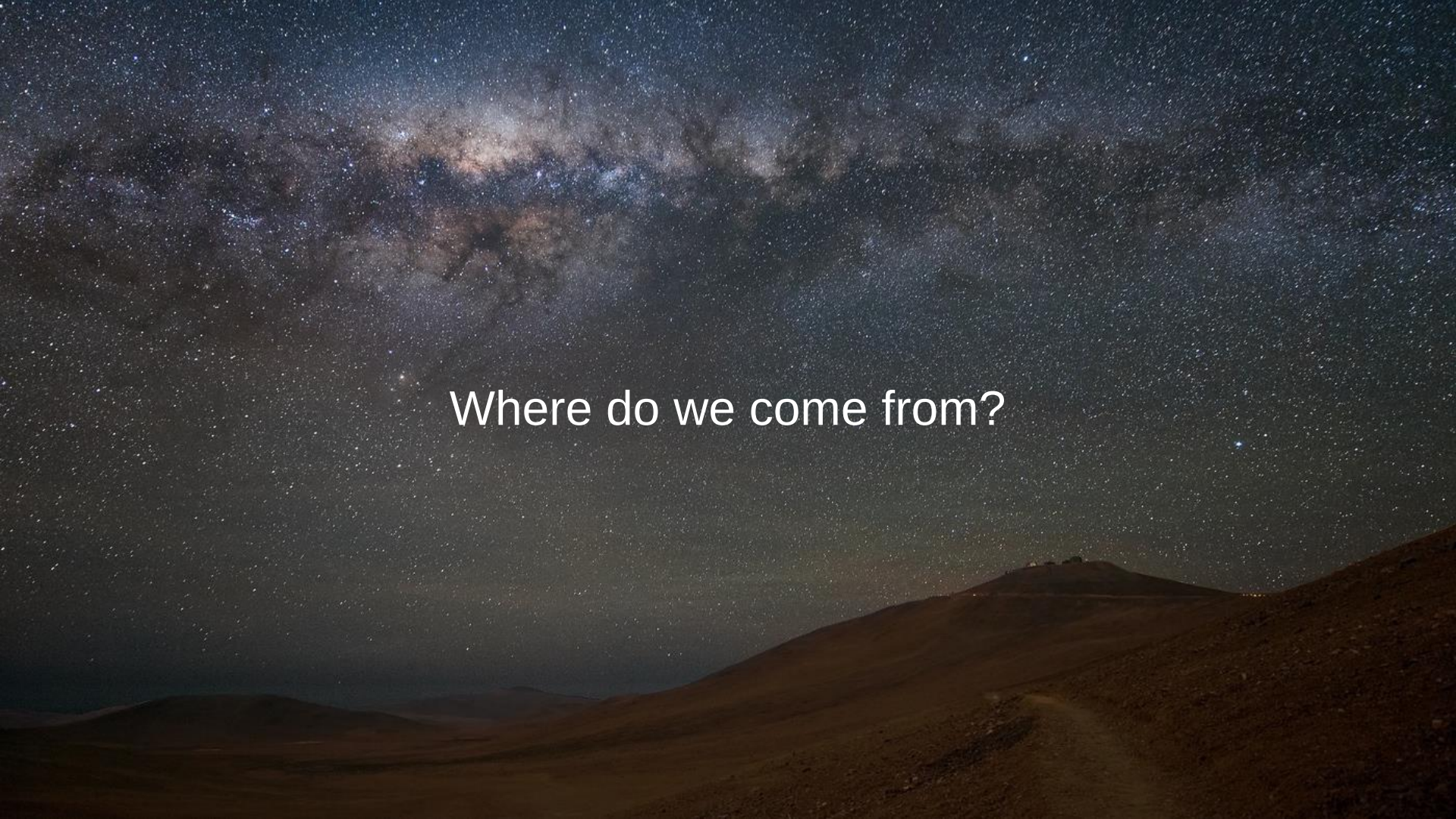



Why?



Physics Seminar – 4 July 2000012 BCE


We have Big Questions…


Where do we come from?


What are we made of ?


What is our destiny?


What are the rules behind all this?


Is there anything else we don’t see?

Photo: Eric Wiessner CC-BY-SA

Human Hair (15cm away)

Andromeda (2.5 million light years away)

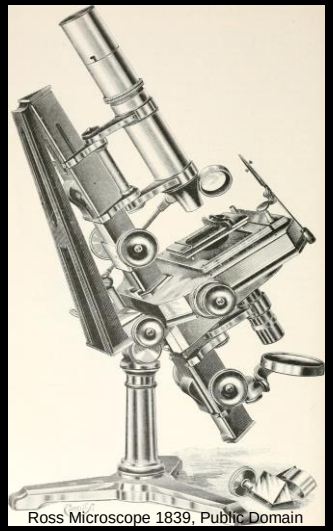
Good enough?

Never!

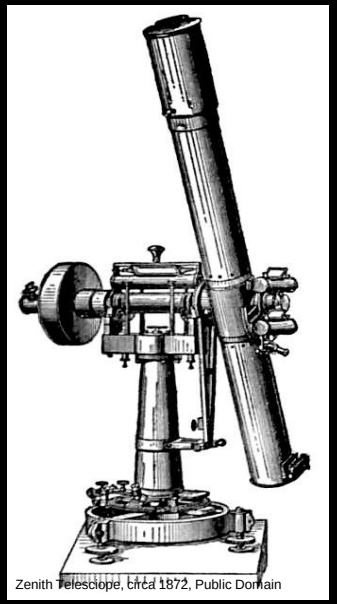
Flammarion Woodcut 1888. Public Domain

How do we measure what we can’t see?

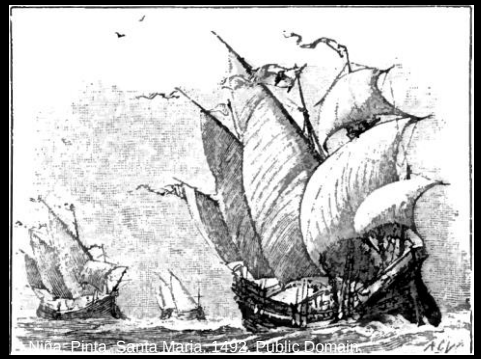
Exploration



Ross Microscope 1839, Public Domain

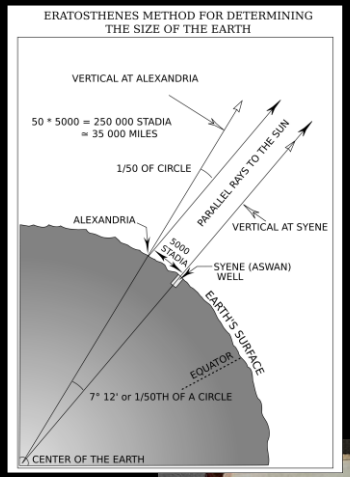


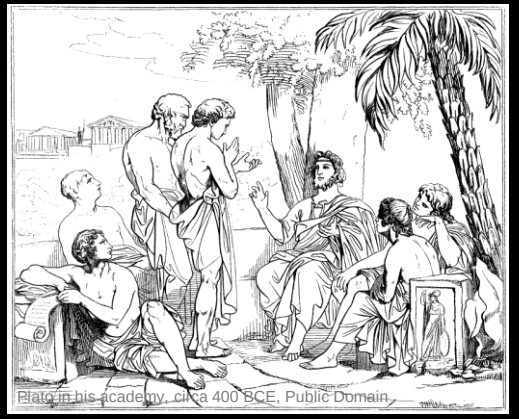
Zenith Telescope, circa 1872, Public Domain



Niña, Pinta, Santa María, 1492., Public Domain

Extrapolation





Plato in his academy, circa 400 BCE, Public Domain

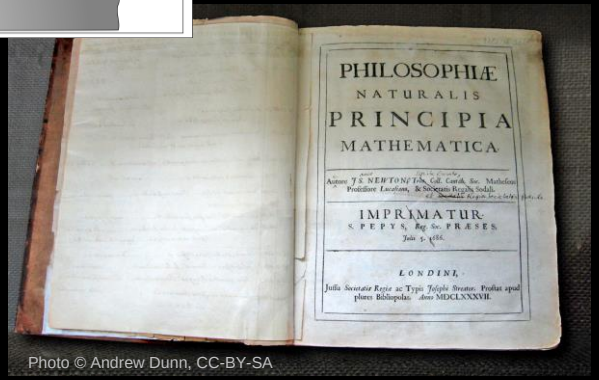
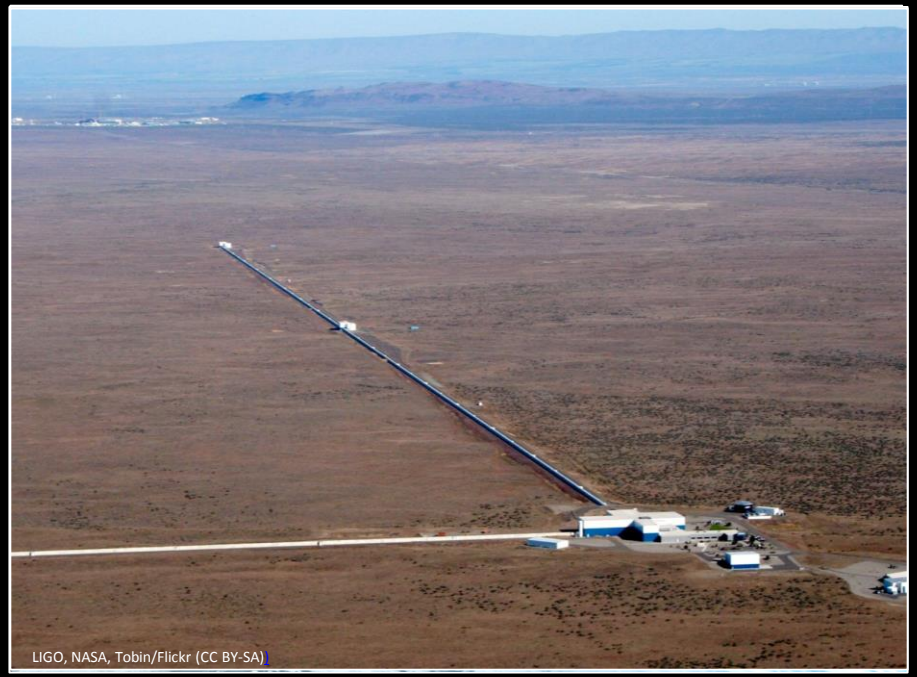


Photo © Andrew Dunn, CC-BY-SA

Looking out



LIGO, NASA, Tobin/Flickr (CC BY-SA)

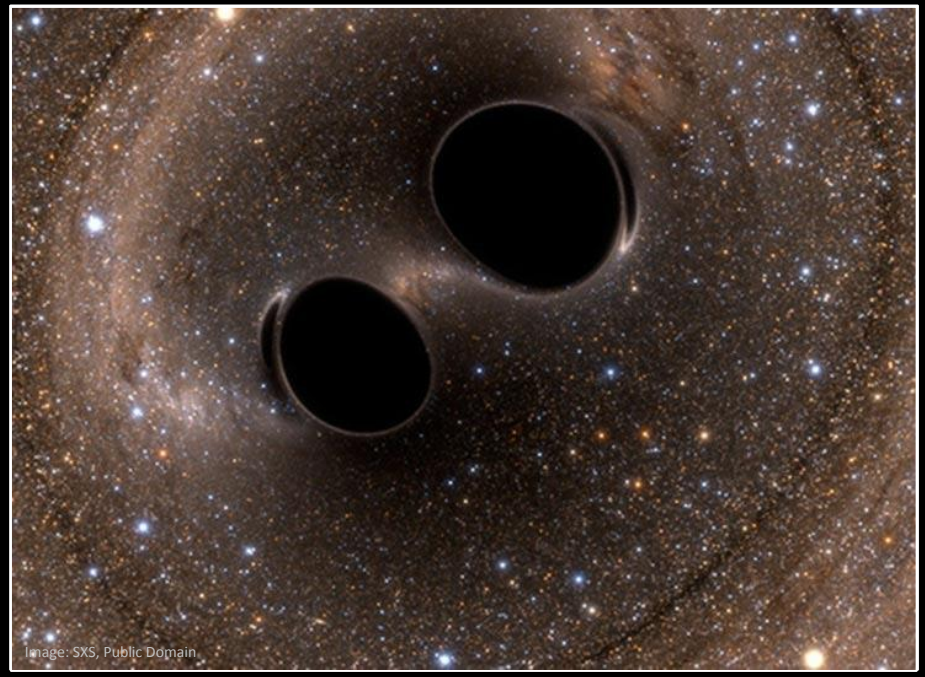
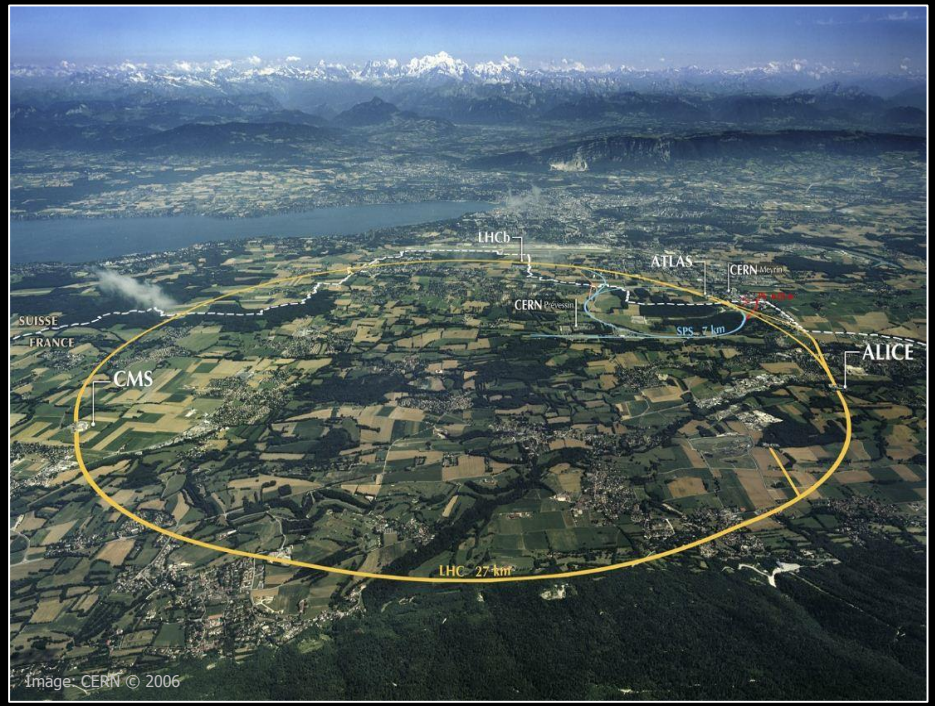
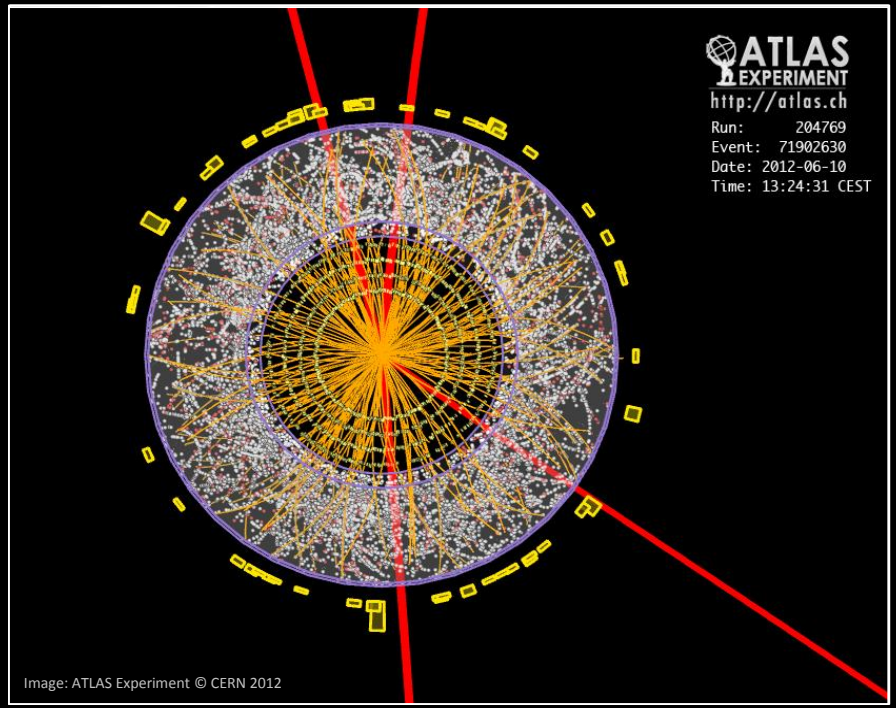


Image: SXS, Public Domain

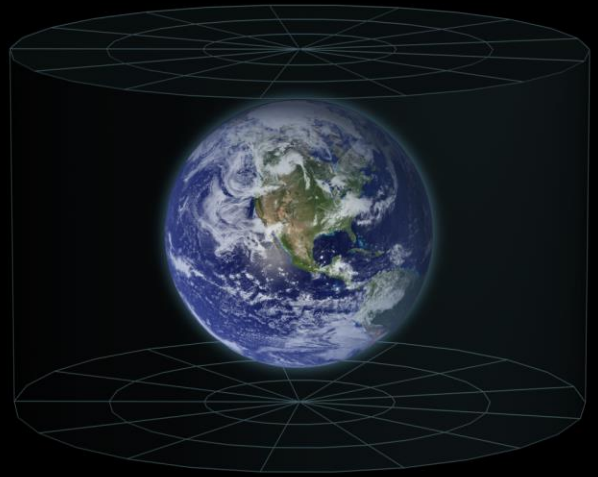
Looking in


LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SPS 7 km
SUISSE
FRANCE
CMS
ALICE
LHC 27 km
Image: CERN © 2006

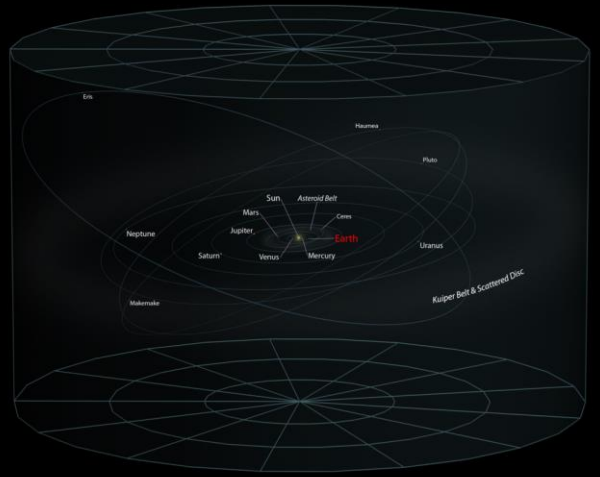

ATLAS
EXPERIMENT
http://atlas.ch
Run: 204769
Event: 71902630
Date: 2012-06-10
Time: 13:24:31 CEST
Image: ATLAS Experiment © CERN 2012


What have we learned?

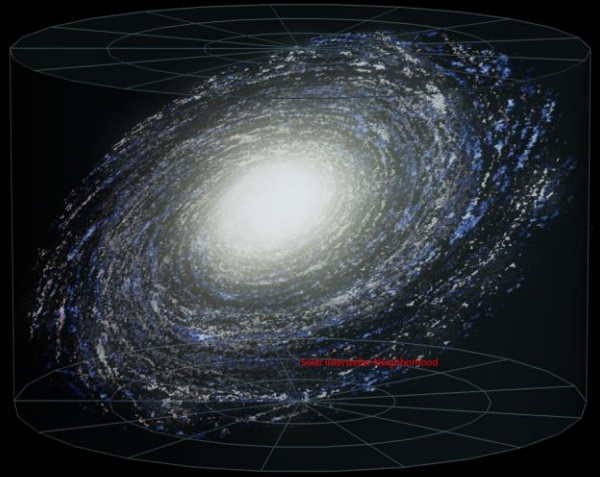
EARTH



SOLAR SYSTEM



MILKY WAY GALAXY



Images: Andrew Z. Colvin, CC-BY-SA

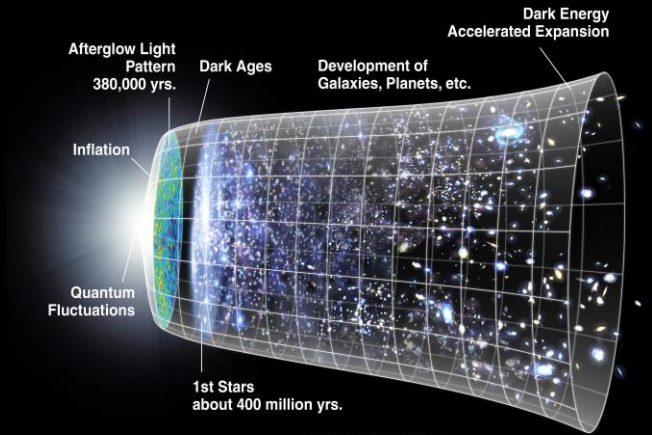


Image: NASA/WMAP, Public Domain

CELL

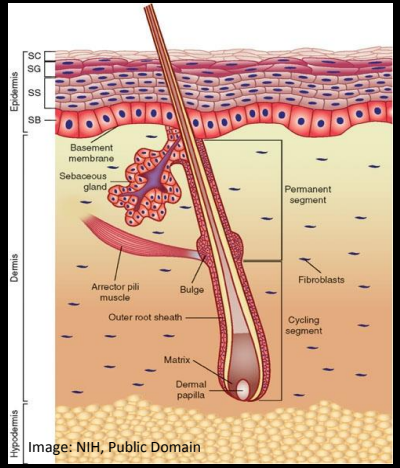


Image: NIH, Public Domain

MOLECULE

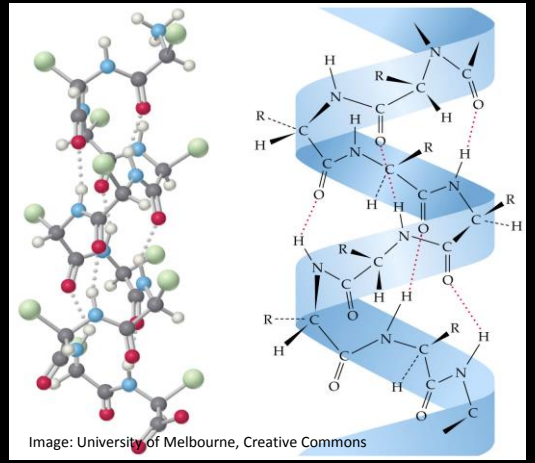


Image: University of Melbourne, Creative Commons

ATOM

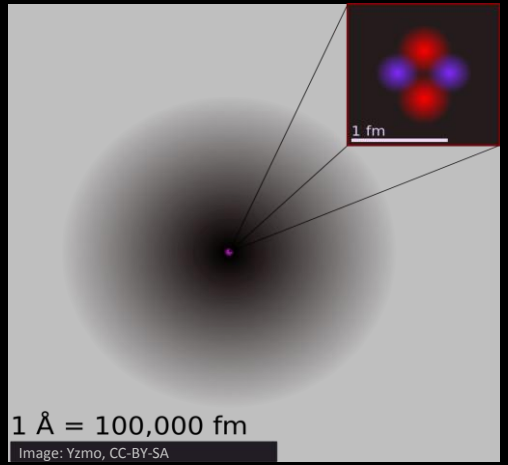


Image: Yzmo, CC-BY-SA

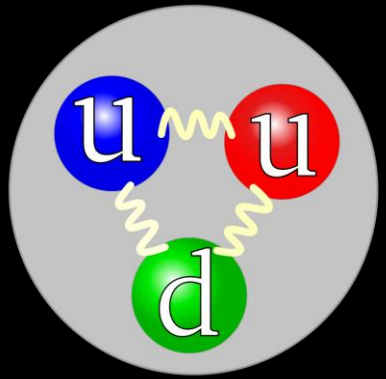
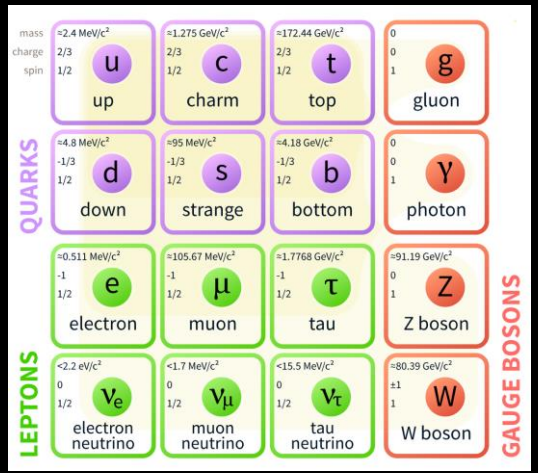
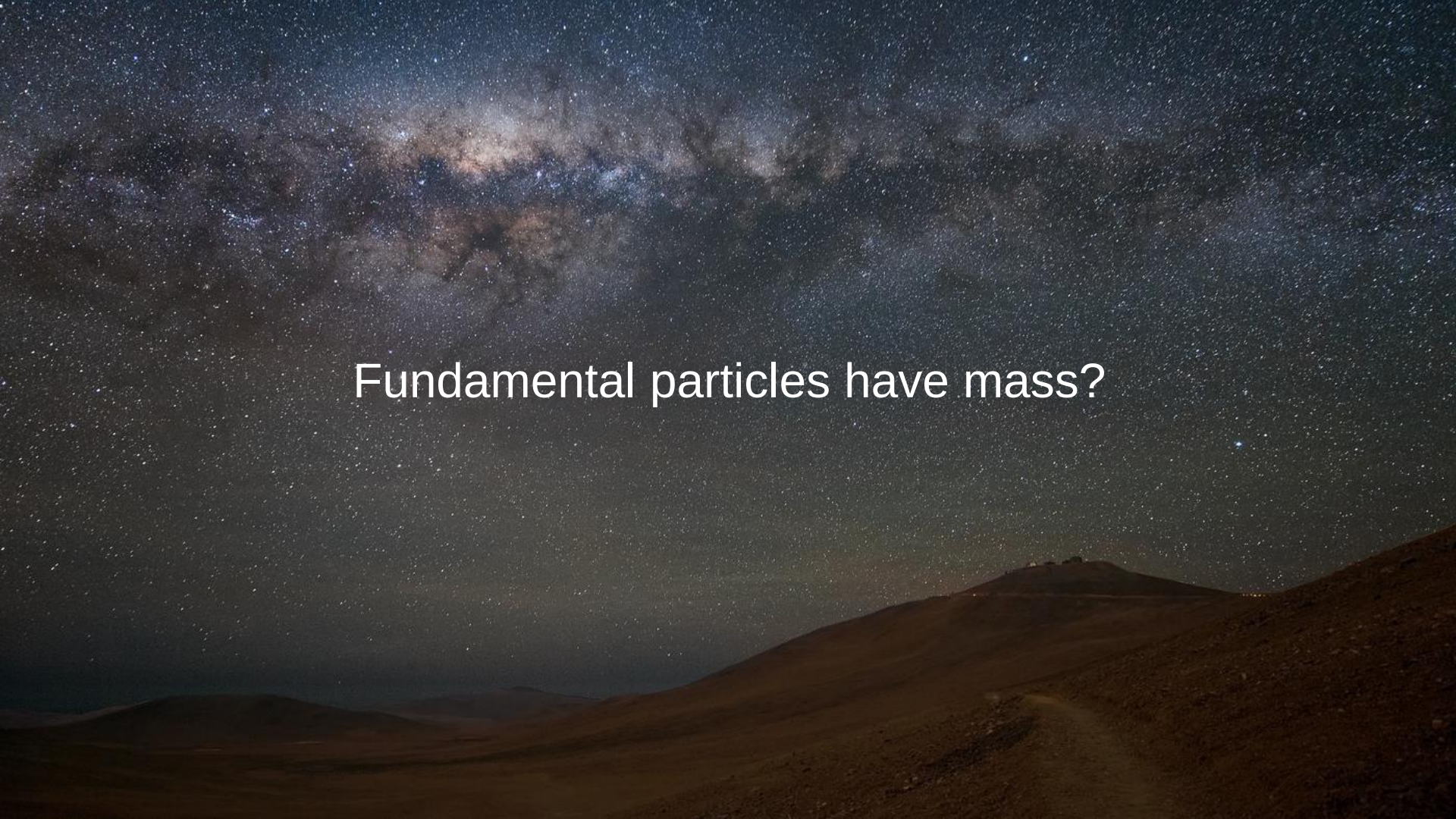
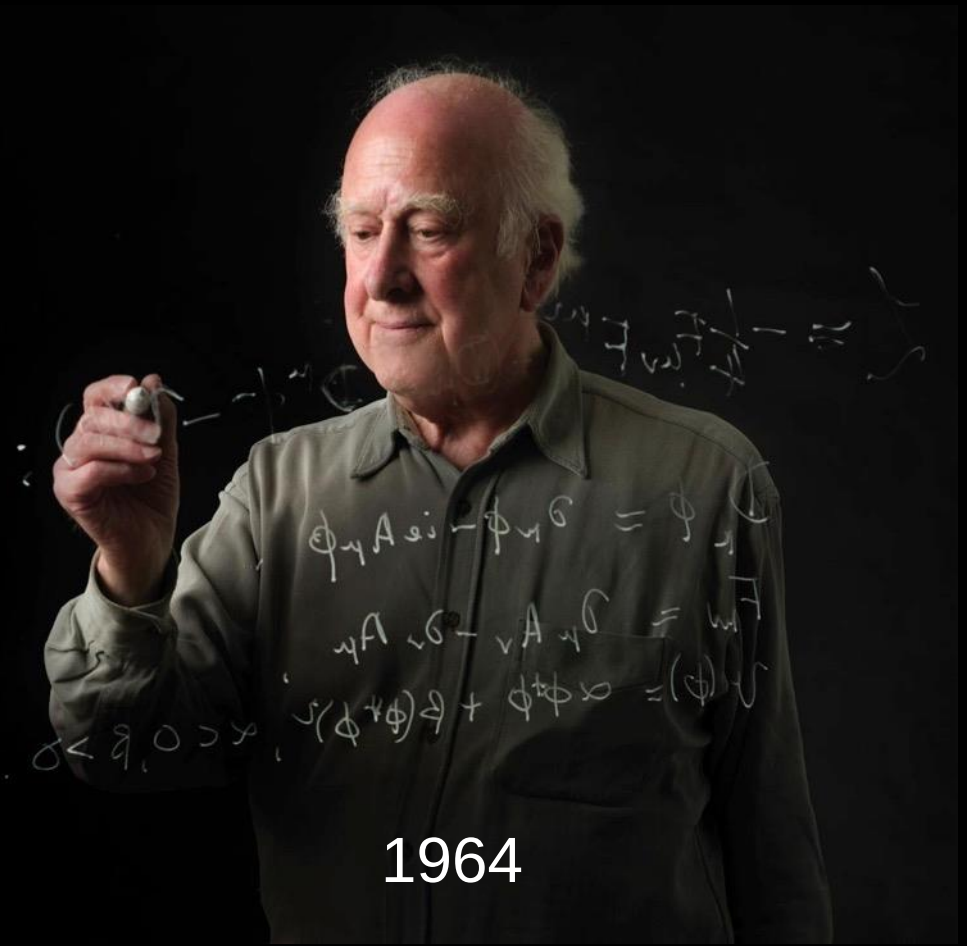


Image: Arpad Horvath, CC-BY-SA

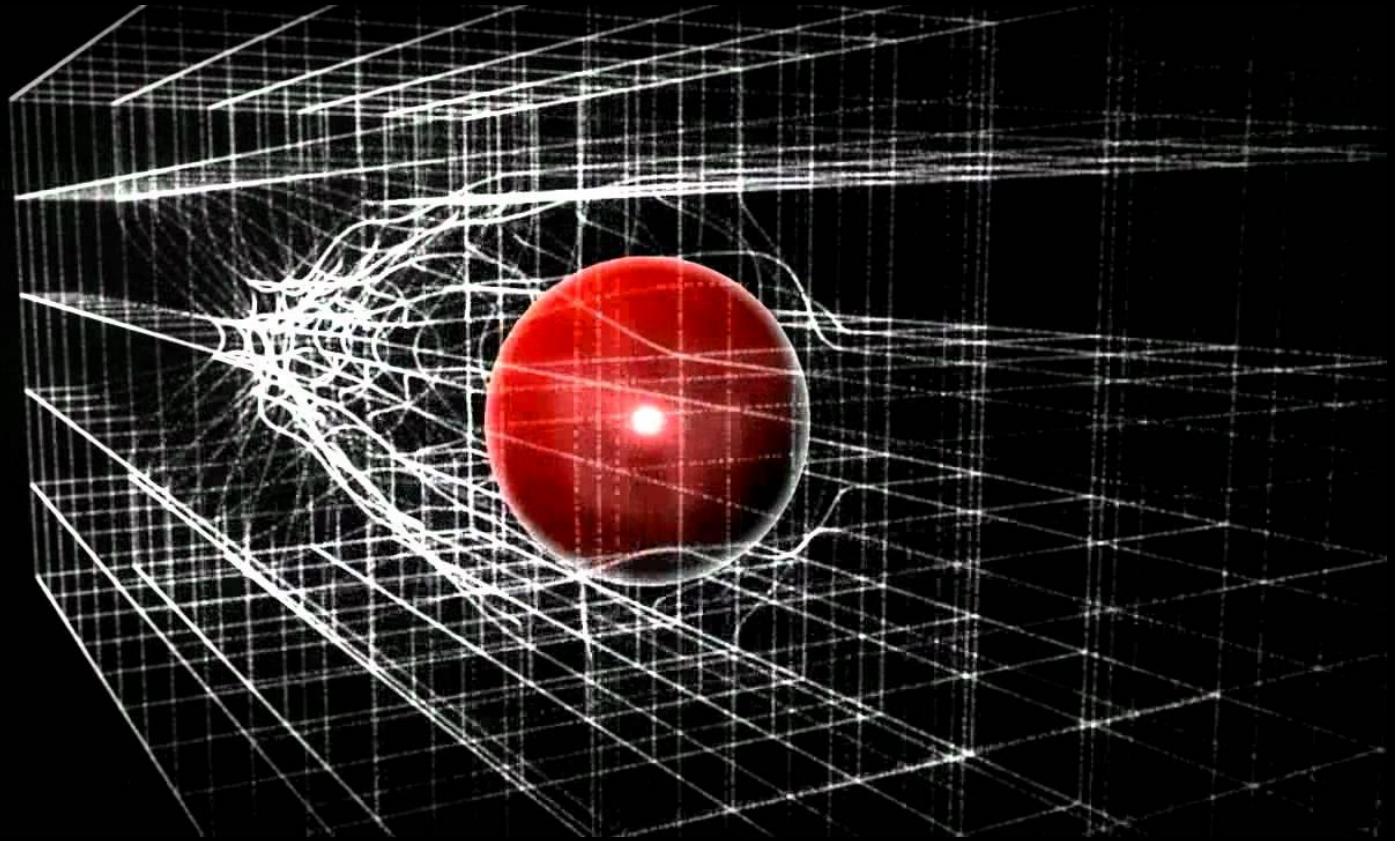



Fundamental particles have mass?

How?

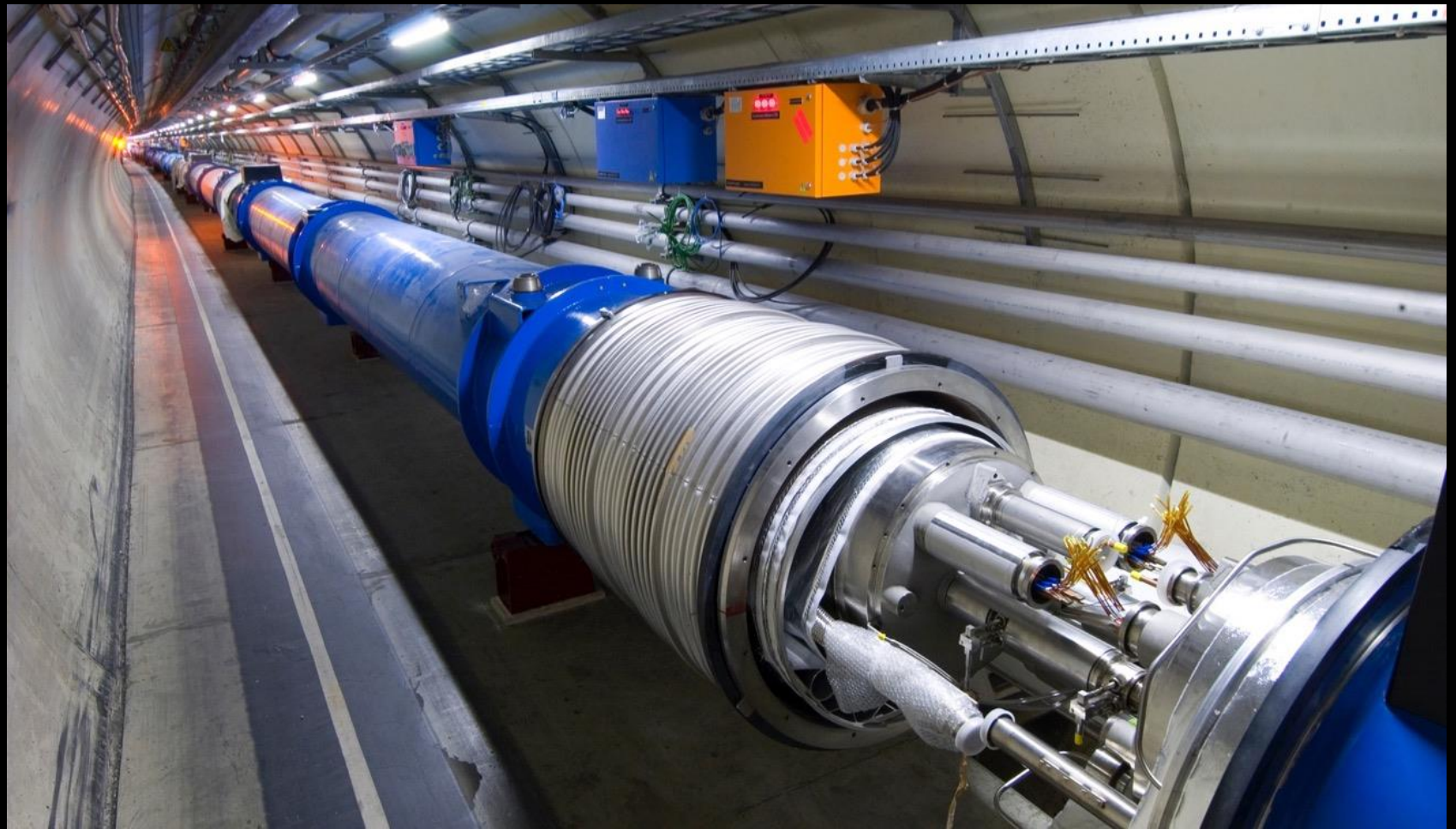


1964

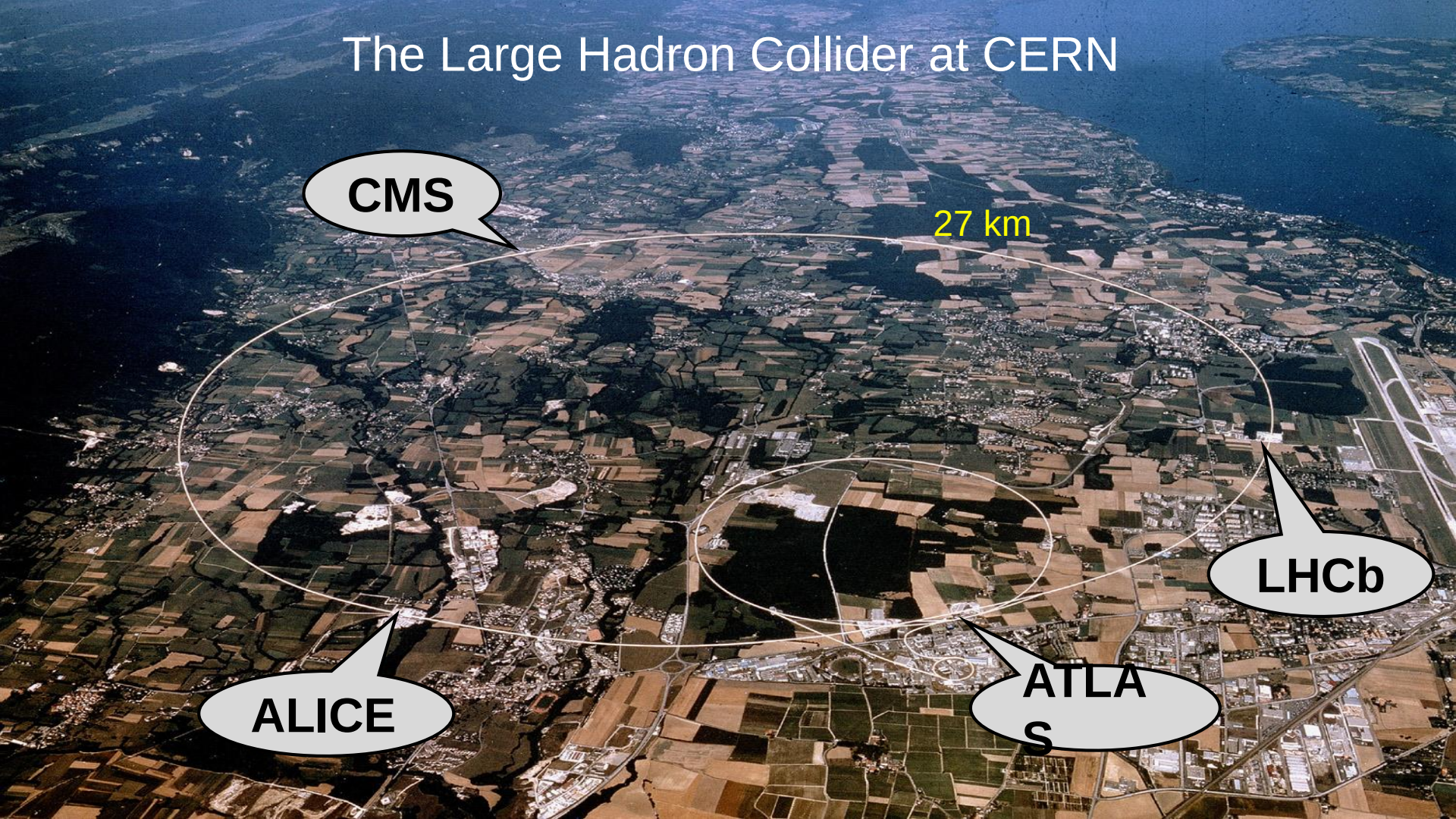


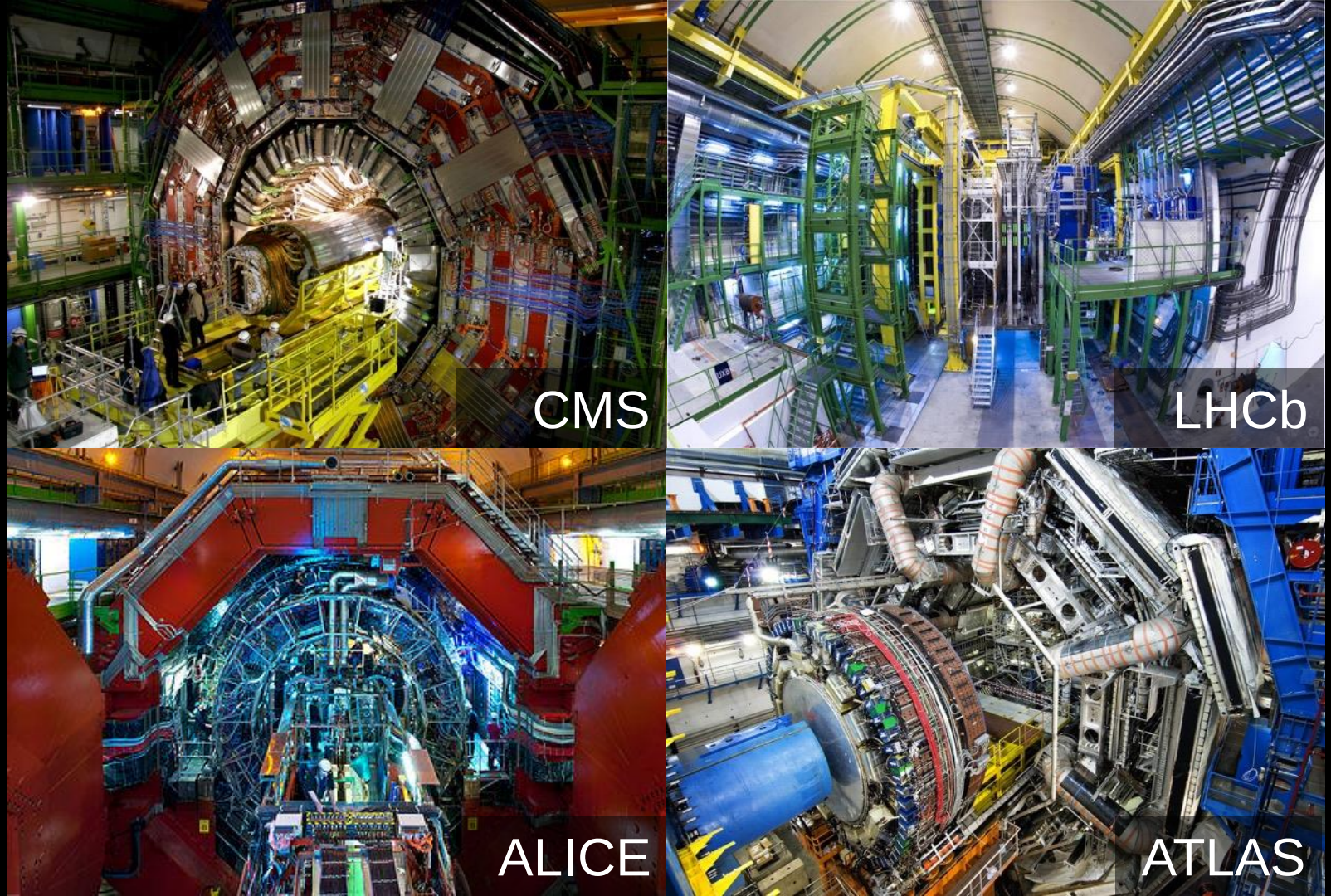
The Brout-Englert-Higgs Mechanism

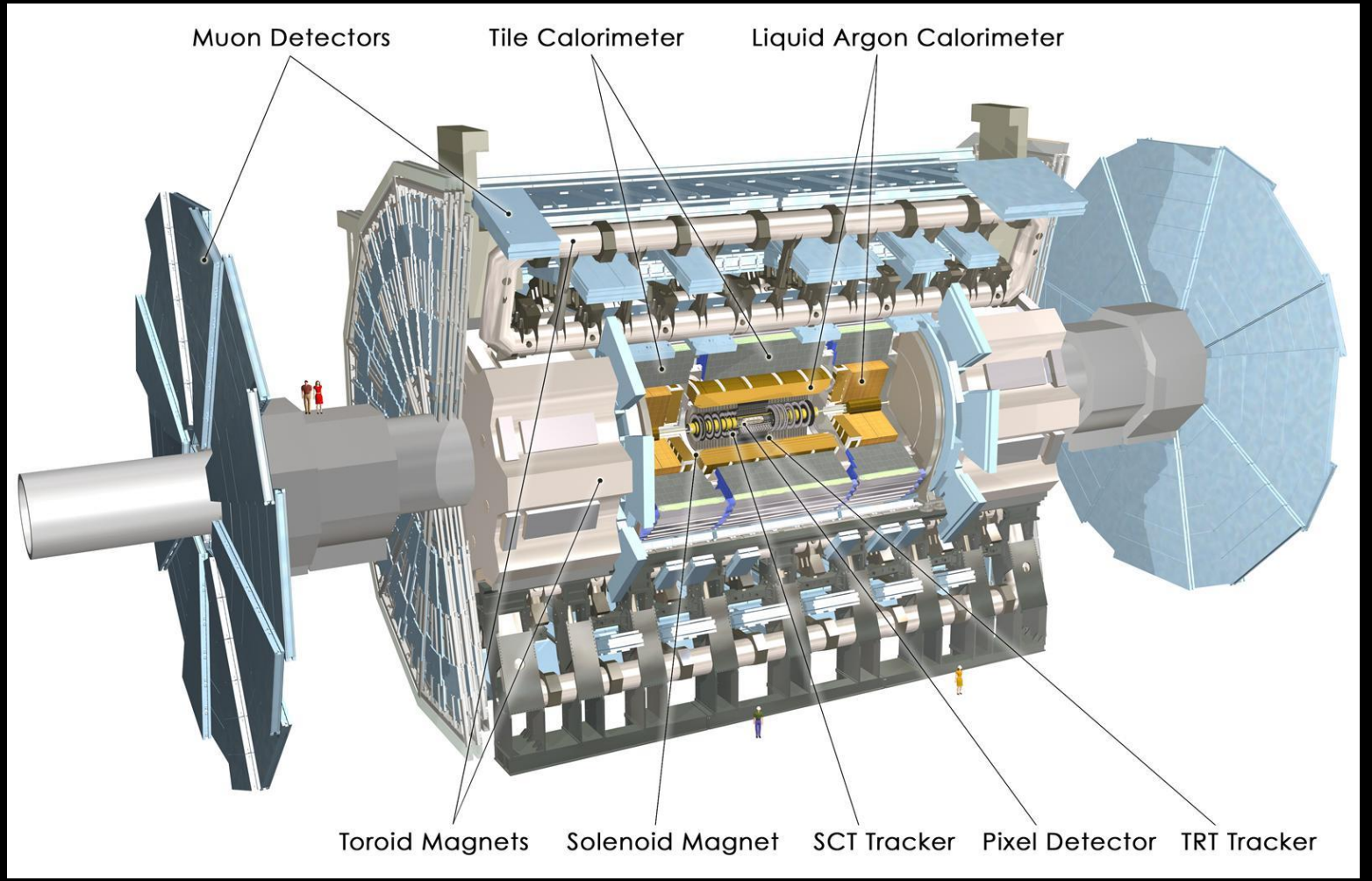
The Large Hadron Collider at CERN

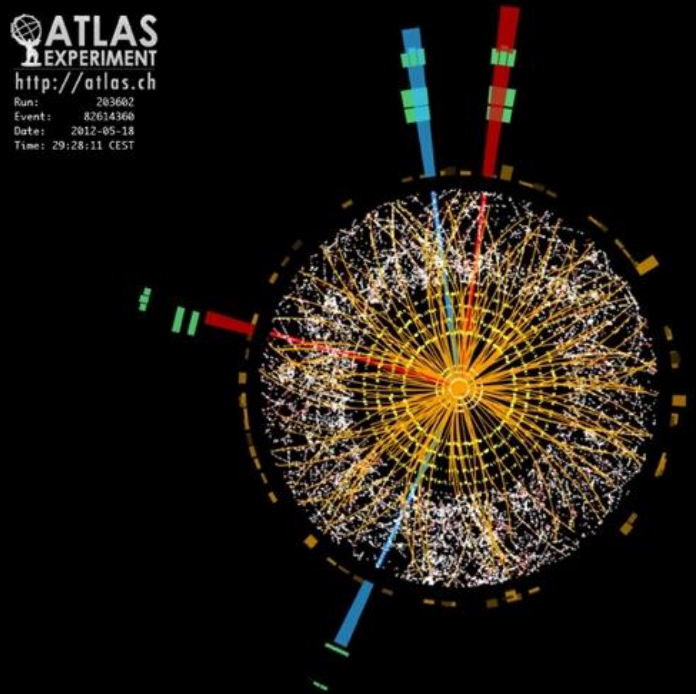


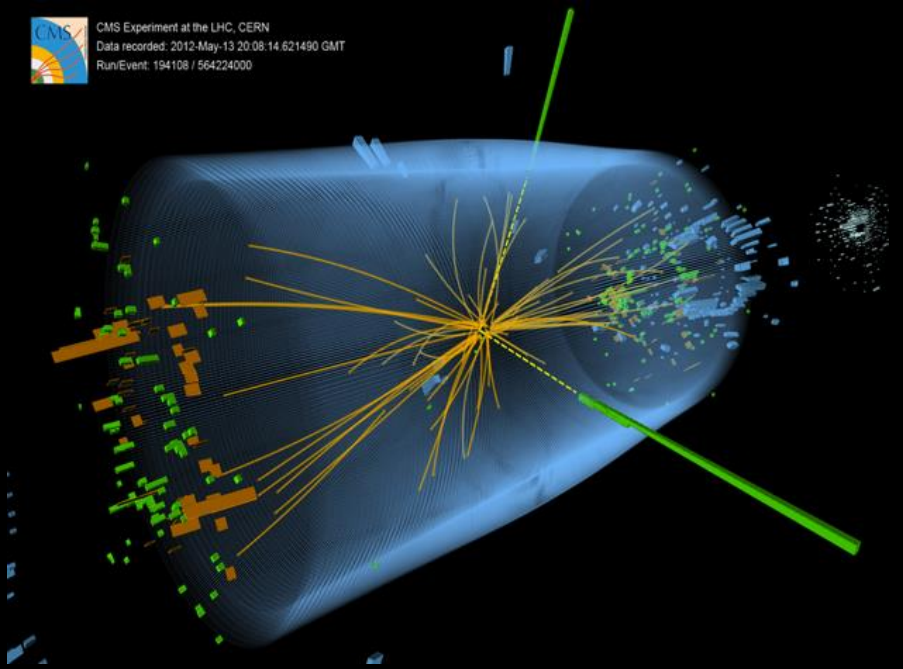
The Large Hadron Collider at CERN



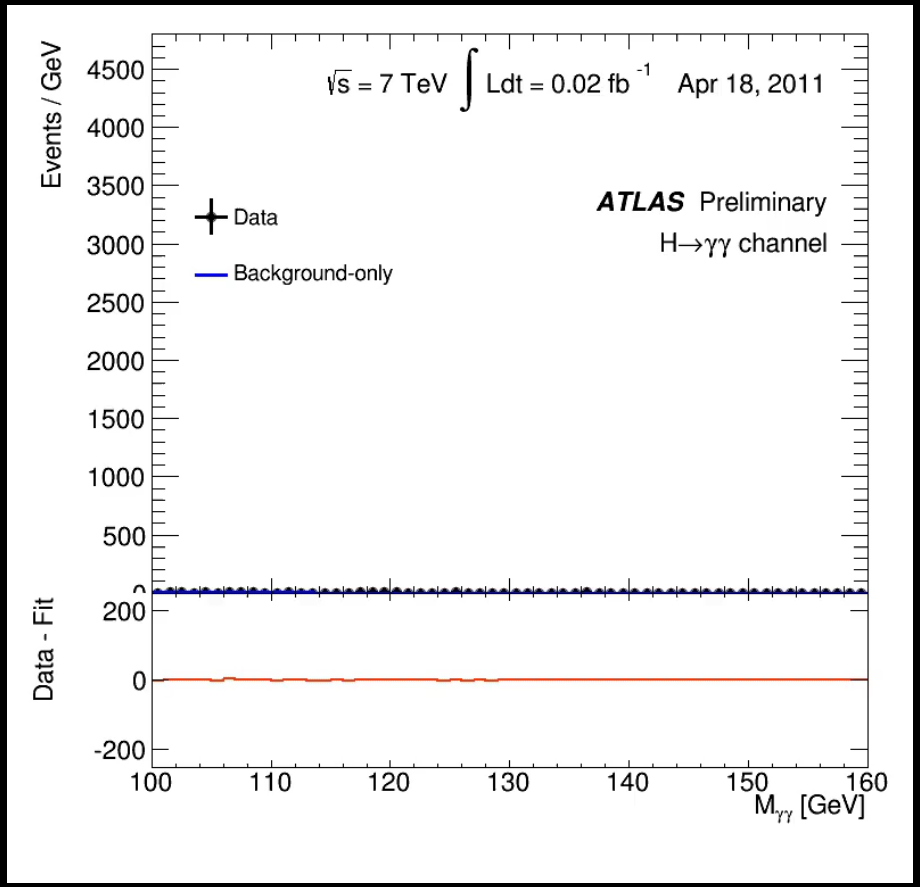

CMS
LHCb
ALICE
ATLAS

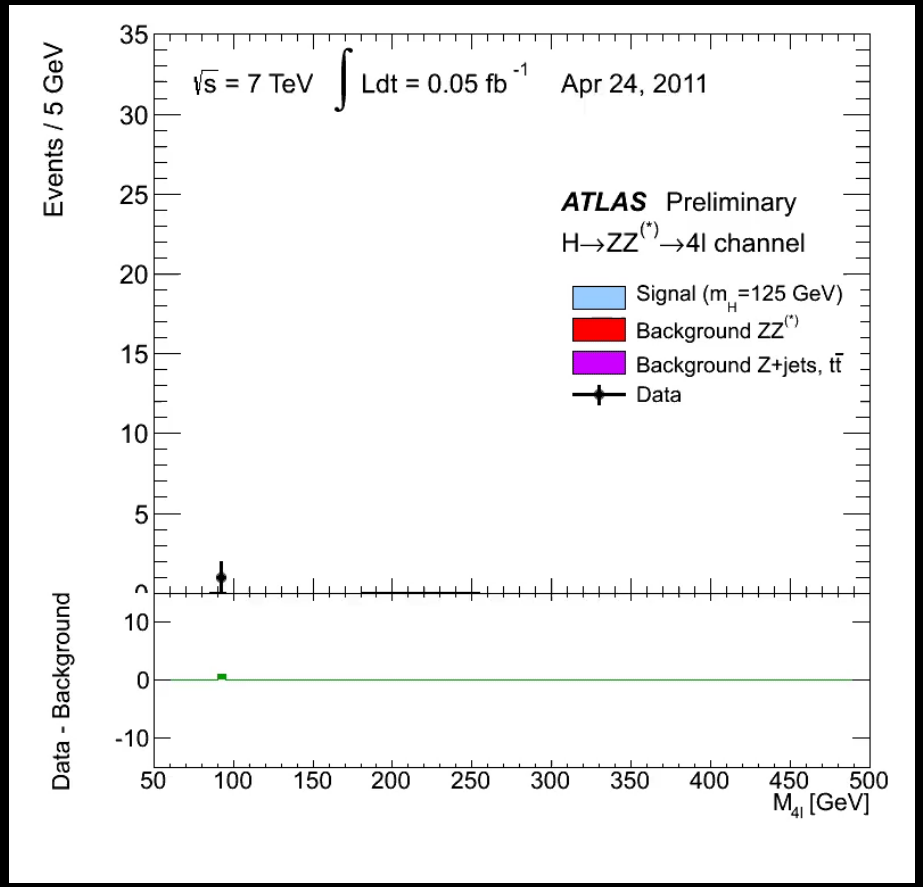

Muon Detectors
Tile Calorimeter
Liquid Argon Calorimeter
Toroid Magnets
Solenoid Magnet
SCT Tracker
Pixel Detector
TRT Tracker

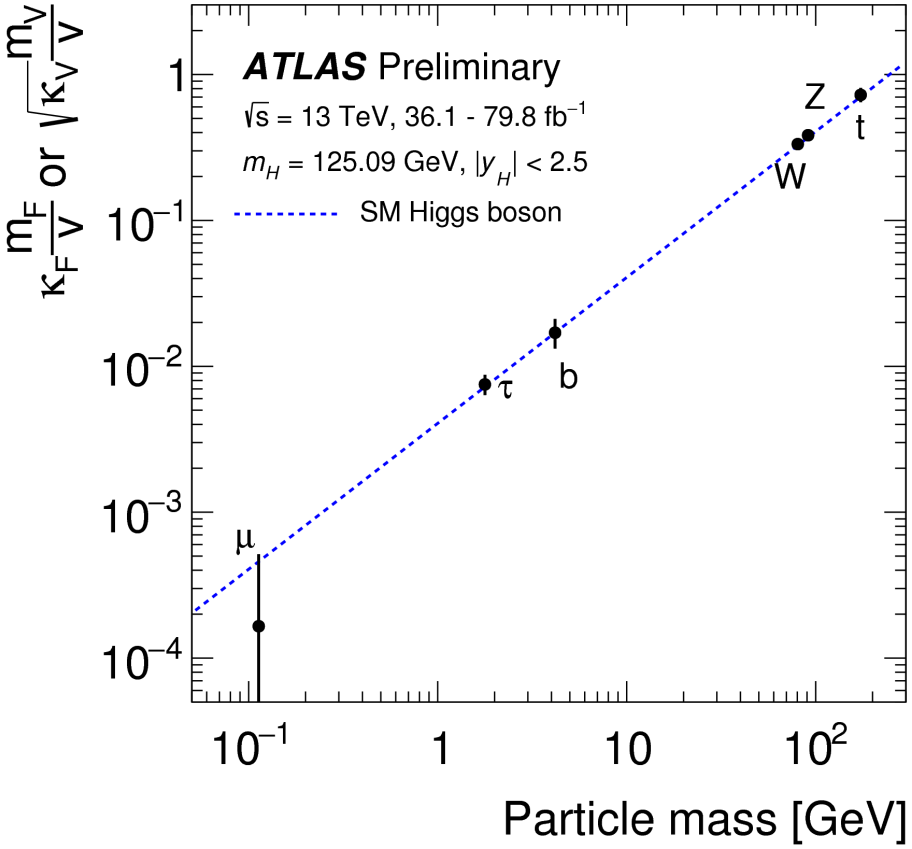

ATLAS
EXPERIMENT
http://atlas.ch
Run: 203602
Event: 82614360
Date: 2012-05-18
Time: 29:28:11 CEST

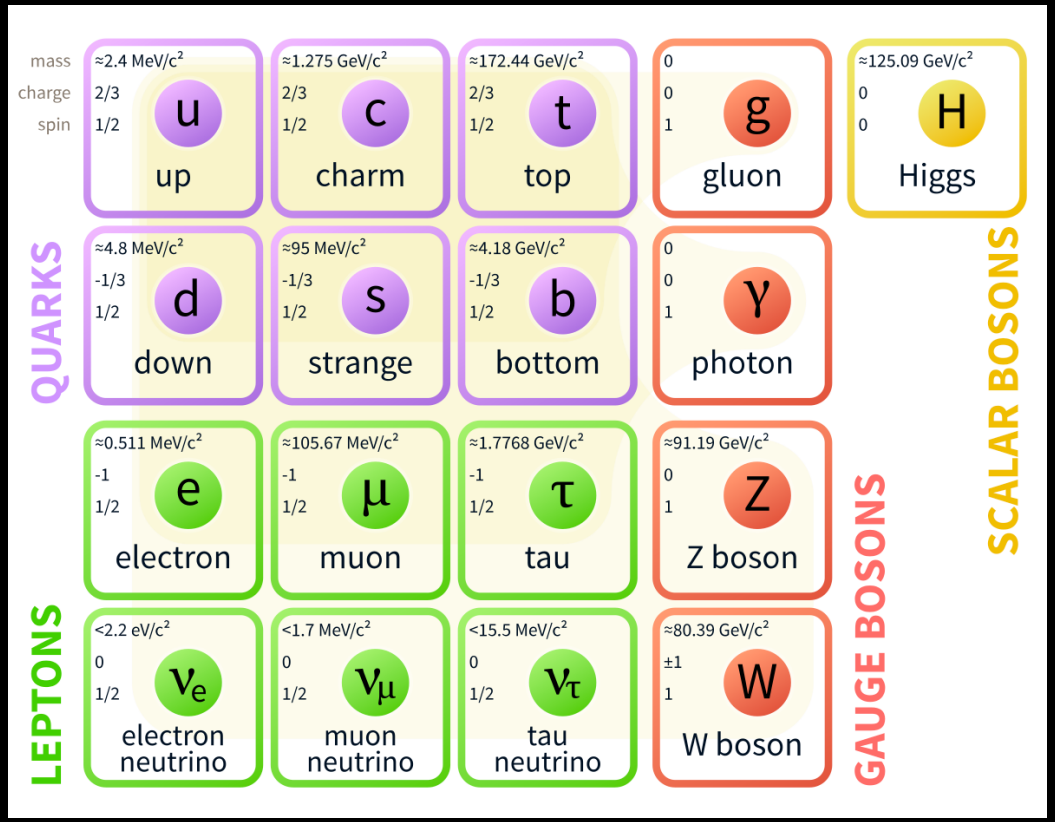

CMS Experiment at the LHC, CERN
Data recorded: 2012-May-13 20:08:14.621490 GMT
Run/Event: 194108 / 564224000

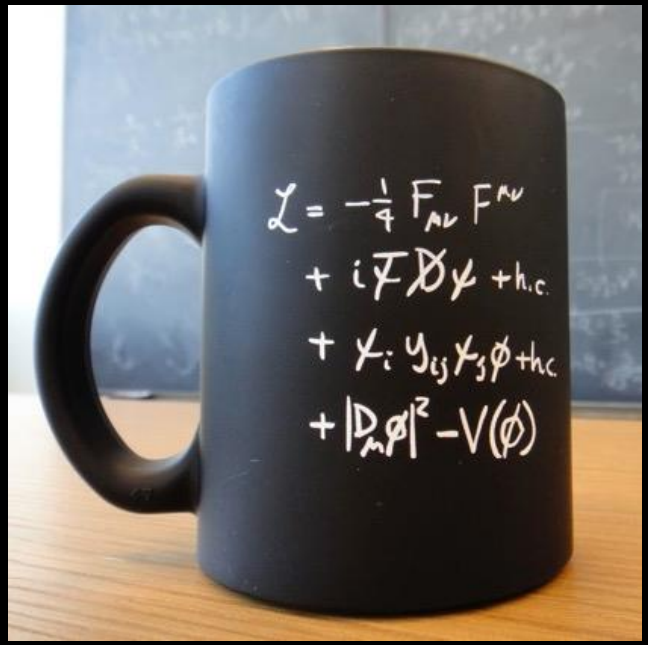
2012


√s = 7 TeV ∫ Ldt = 0.02 fb -1 Apr 18, 2011
ATLAS Preliminary
H→γγ channel
Data
Background-only
Events / GeV
Data - Fit
Mγγ [GeV]


√s = 7 TeV ∫ Ldt = 0.05 fb -1 Apr 24, 2011
ATLAS Preliminary
H→ZZ(*)→4l channel
Signal (mH=125 GeV)
Background ZZ(*)
Background Z+jets, tt̄
Data
Events / 5 GeV
Data - Background
M4l [GeV]


ATLAS Preliminary
√s = 13 TeV, 36.1 - 79.8 fb⁻¹
m_H = 125.09 GeV, |y_H| < 2.5
SM Higgs boson
Z
t
W
τ
b
μ
1
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻¹
1
10
10²
Particle mass [GeV]
m_F / κ_F v or √(κ_V m_V / v)

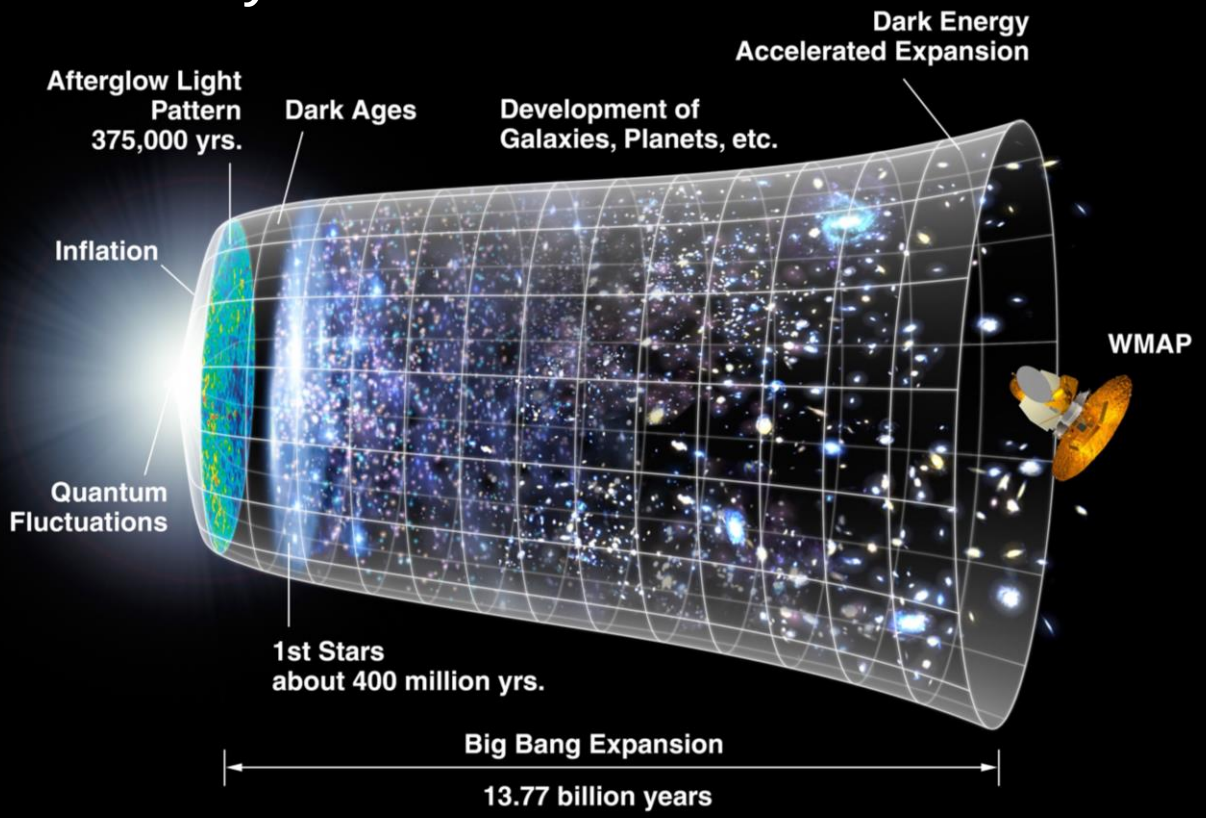




The Standard Model of Particle Physics


What we still don’t know

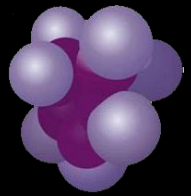
Where do we come from?
What is our destiny?




Why do we exist?

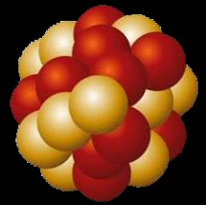
What are we made of ?

10^{-1} m
visible stuff

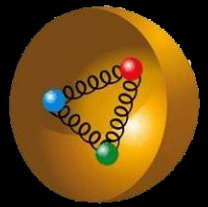


10^{-9} m
molecule

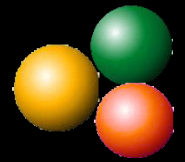
10^{-10} m
atom



10^{-14} m
nucleus

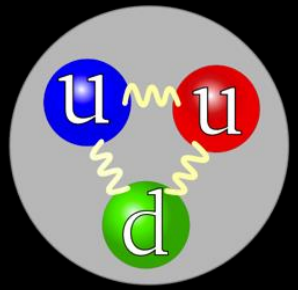


10^{-15} m
proton
neutron

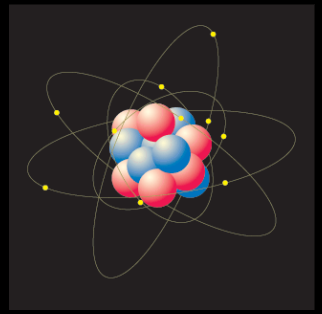


$< 10^{-18}$ m
quark
electron

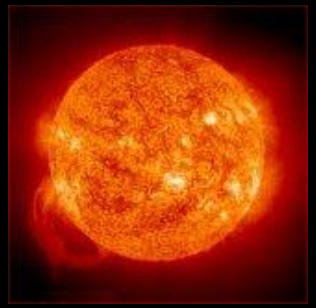
Why is gravity so weak?



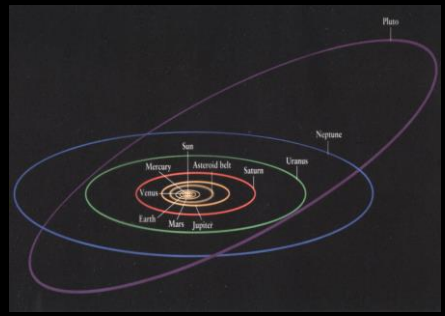
Strong Nuclear
60



Electromagnetism
1



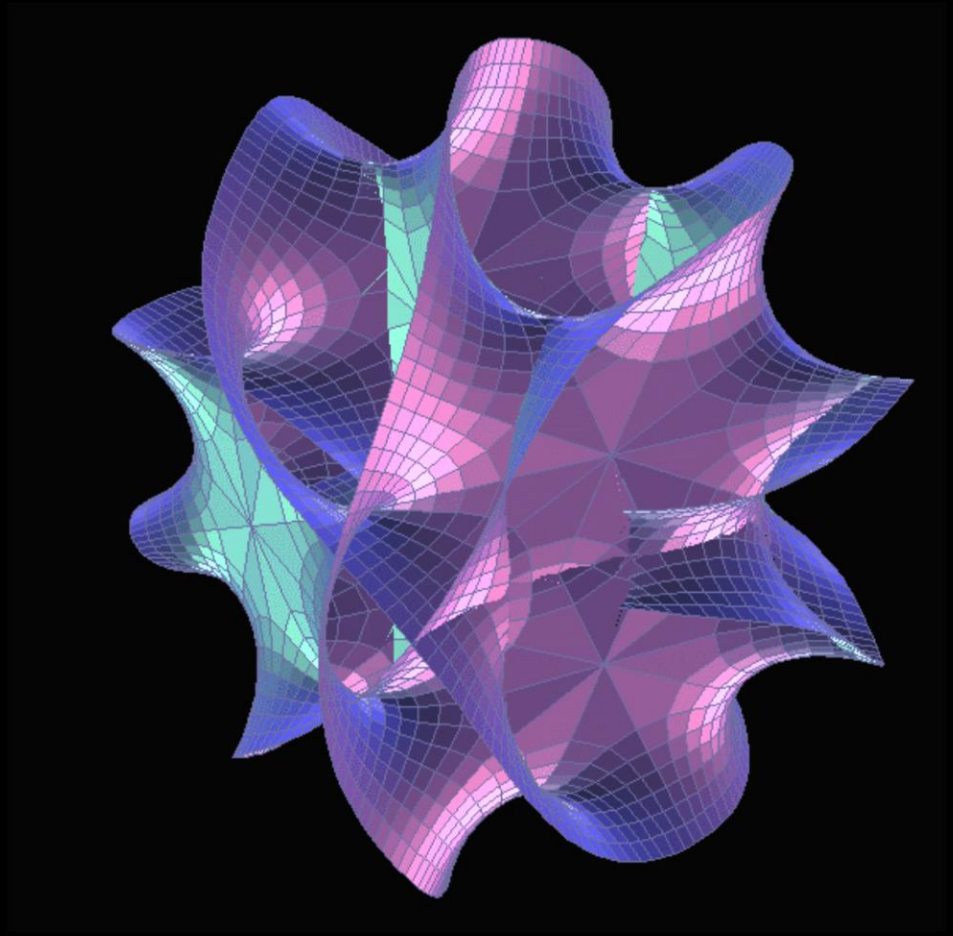
Weak Nuclear
10^{-4}



Gravity
10^{-41}

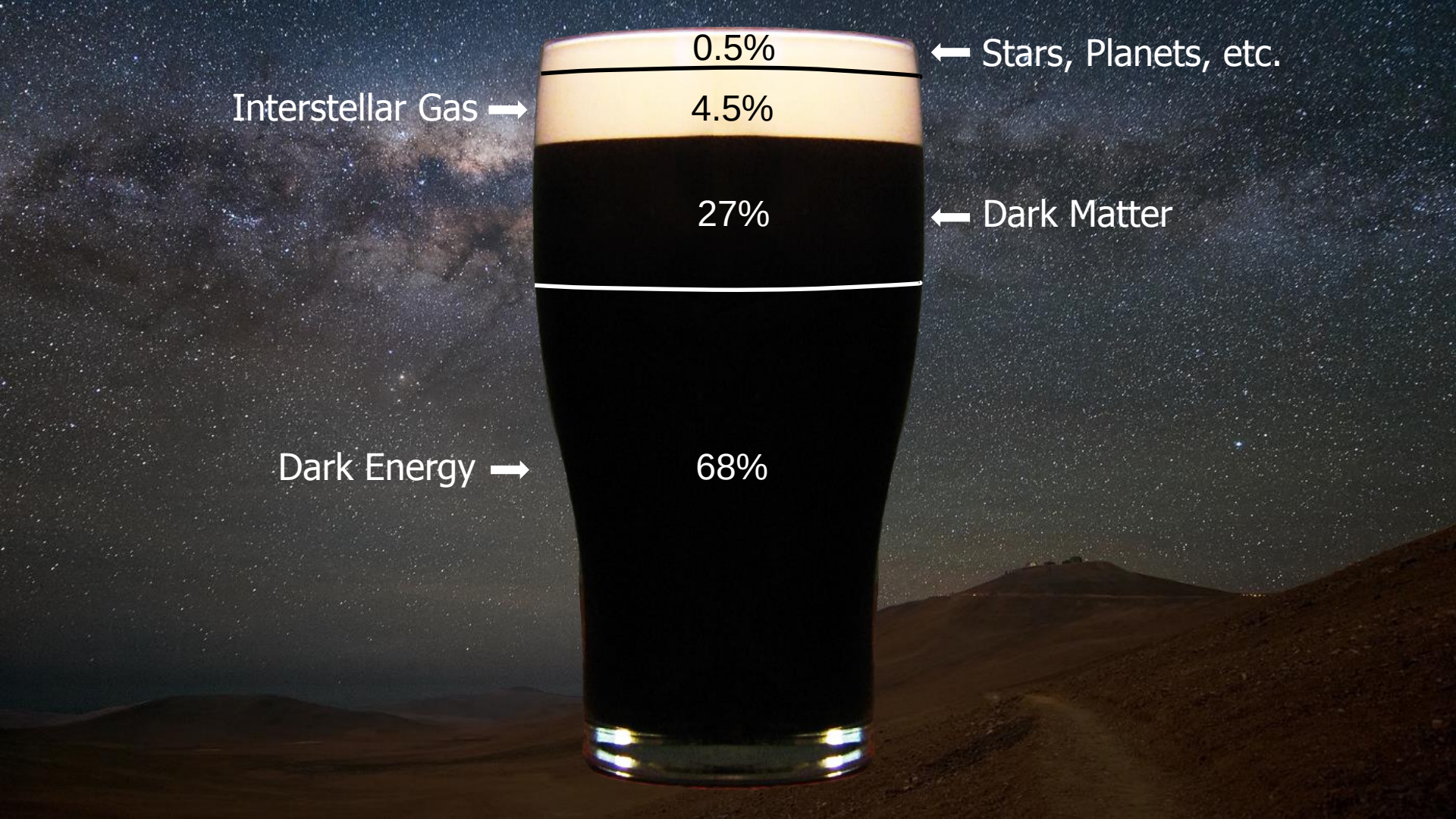
Relative force strengths specified at scale of quarks and gluons

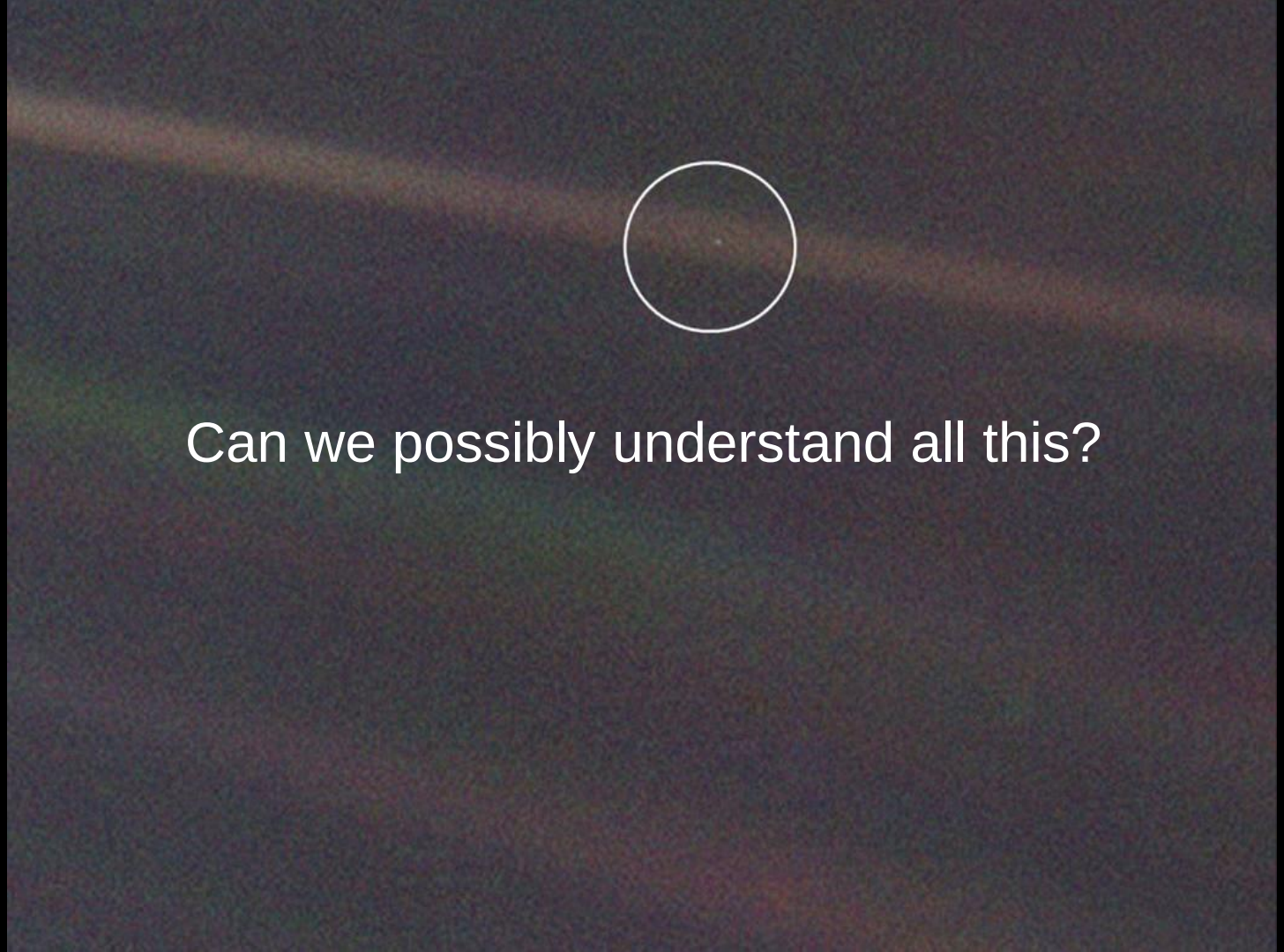
Could there be other dimensions?

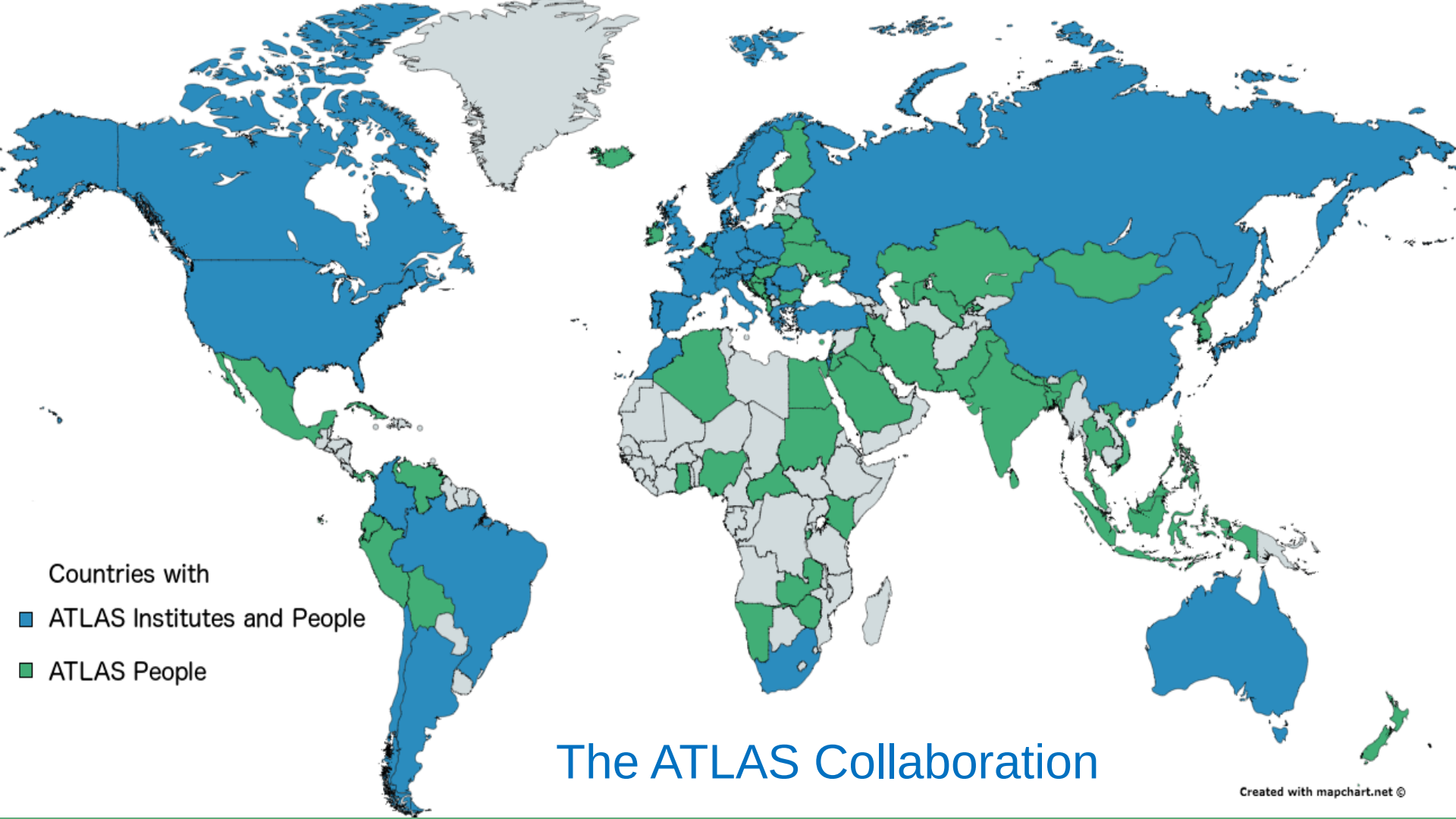


What is holding this together?

Vera Rubin


0.5%
Stars, Planets, etc.
Interstellar Gas
4.5%
27%
Dark Matter
Dark Energy
68%


Can we possibly understand all this?



The ATLAS Collaboration