




Hidden Pieces

The LHC and our Dark Universe

A night sky with the Milky Way galaxy visible over a desert landscape. The sky is dark with numerous stars and the bright, hazy band of the Milky Way stretching across the upper half. The foreground shows dark, rolling sand dunes under a starry sky.

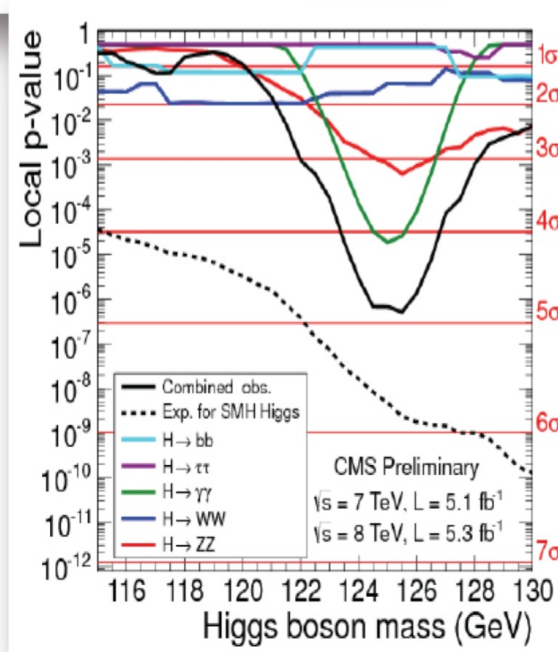
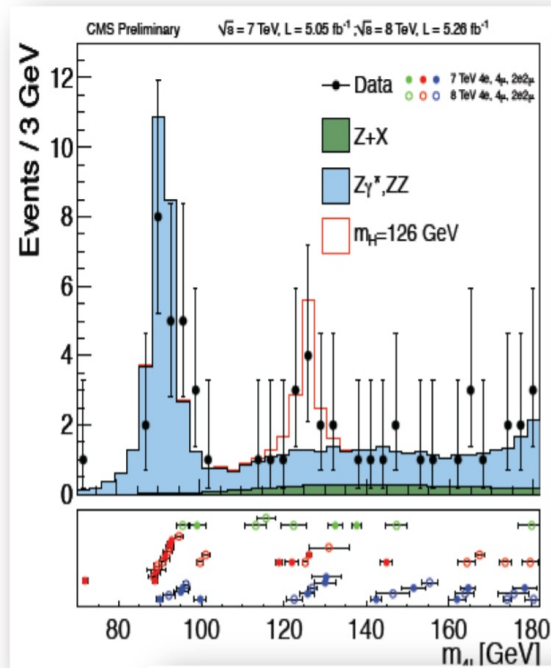
Warning:

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

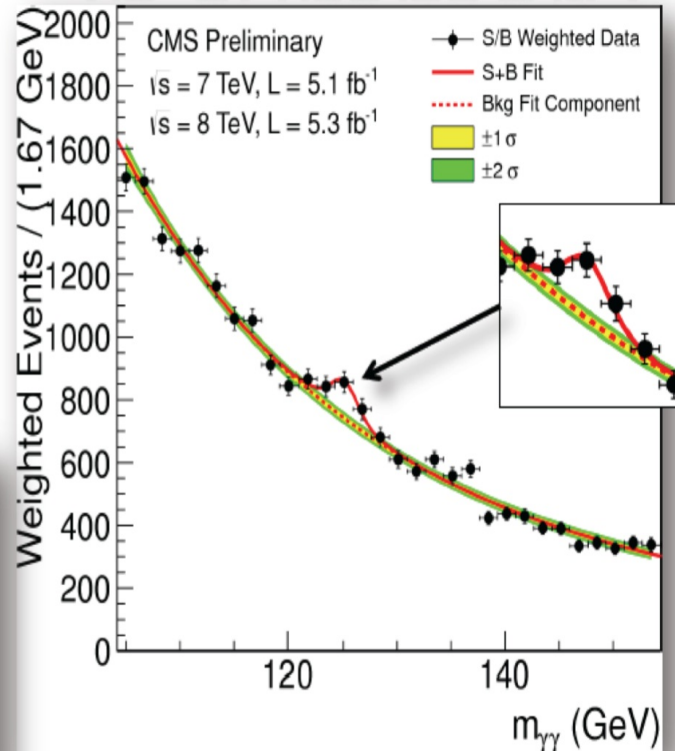


Physics Seminar – 4 July 2012

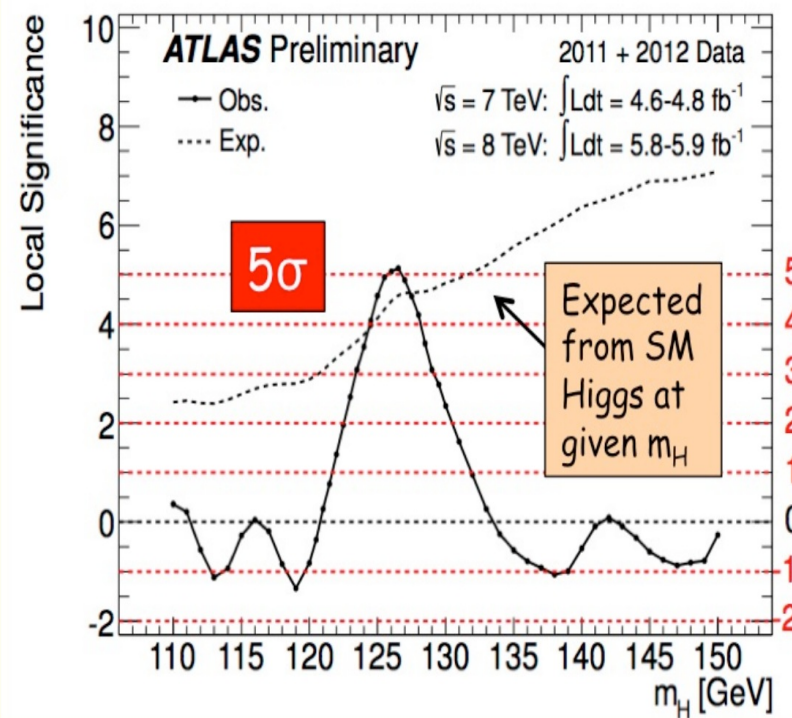
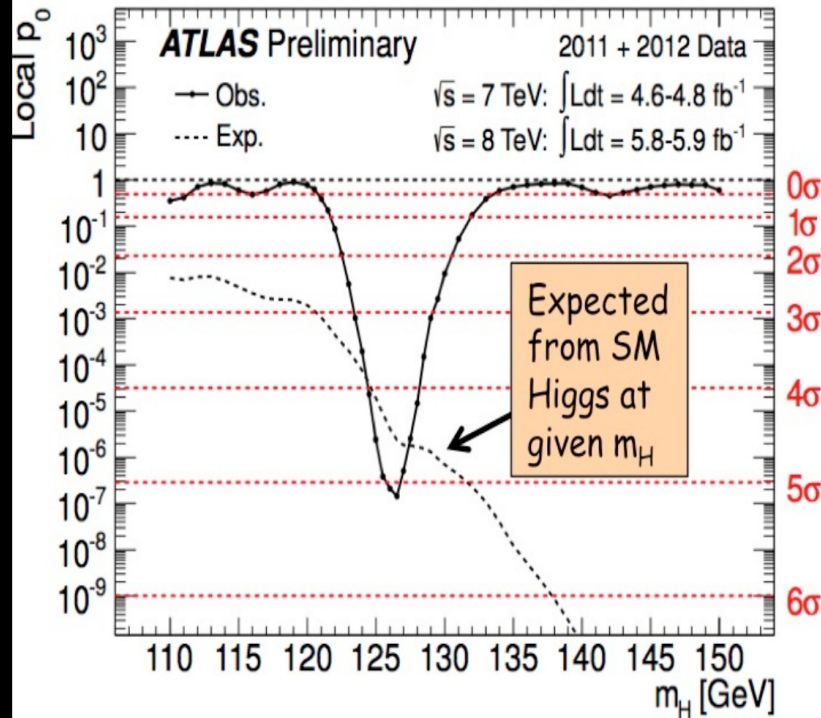
July 4th 2012 The Status of the Higgs Search J. Incandela for the CMS COLLABORATION



In summary



Combined results: the excess



Maximum excess observed at

$m_H = 126.5 \text{ GeV}$

Local significance (including energy-scale systematics)

5.0 σ

Probability of background up-fluctuation

3×10^{-7}

Expected from SM Higgs $m_H=126.5$

4.6 σ

Global significance: 4.1-4.3 σ (for LEE over 110-600 or 110-150 GeV)

PREVIOUS STORY
'NIGHTS into Dreams' HD remake teased by Sega with new picture

STORYSTREAM

The Higgs boson: CERN discovers the elusive particle

By Vlad Savov on July 4, 2012 06:53 am | Email | @vladsavov



- 2. 遺伝子技術が変える世界
- 3. スーパーフレアの脅威
- 4. 並行宇宙は実在する
- 5. 無私最高の戦略

編集部ピックアップ

- 1. 最悪のシナリオ
- 2. SARSが残した本当の脅威
- 3. 最強加速器で発見
- 4. HIVに感染しない細胞
- 5. 脳はなぜ左右で分業したのか

Contents

→ 最新号の紹介

万物に... 世界... わたつて... LHC... 者が参加... 歴史的... 見いだした。そこを出発点に、万物に質量を与えるにはどうすればよいか考え、多くの物理学者の研究が組み合わさって、複雑精緻なメカニズムが構築された。「ヒッグス粒子」はそのメカニズムの象徴的存在といえる。

日本人物理学者も大きな貢献をしている。質量を与えるメカニズムの根本である「対称性の自発的破れ」唱えた。LHCの加速器や実験装置には日本の高度な産業技術が数多く用いられており、実験でも日本は欠かせない。

ただ、これで素粒子物理学が完結するということではまったくなく、それどころか今回の新粒子の発見は、始まる幕開けだ。LHC実験が進めば、新たな驚きをもたらされる可能性もある。

One Billion Viewers

BBC NEWS SCIENCE & ENVIRONMENT

4 July 2012 Last updated at 07:35 GMT

Higgs boson-like particle discovery claimed at CERN

By Paul Rincon

Source: BBC News website, Geneva



The moment when CERN director Rolf Heuer confirmed the Higgs boson discovery.

CERN scientists reporting from the Large Hadron Collider (LHC) have claimed the discovery of a new particle consistent with the Higgs boson.

The particle has been the subject of a 45-year hunt to explain how matter attains its mass.

Both of the Higgs boson-hunting experiments at the LHC saw a level of certainty in their data worthy of a "discovery".

HIGGS BOSON NEW SUBSTANCE ALMOST 100% BY CERN

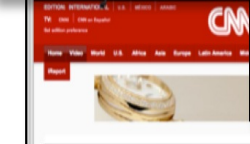
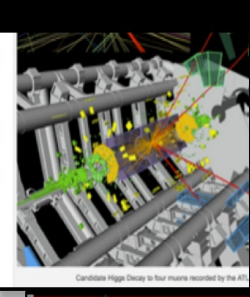
4 July 2012 06:53 GMT



VIDEO: Higgs boson discovery

EDITOR'S PICK

Best of the week



LEADING WOMEN

CERN's Fabiola Gianotti: The woman hunting the Higgs boson

By Rose Hines

July 4, 2012



Il Sole 24 ORE

Nato il 4 luglio, il bosone presenta al mondo. Ecco scoperta la "particella di Dio"



Il 4 luglio, giorno di nascita del bosone di Higgs, il più grande successo del CERN a Ginevra, il più grande successo del mondo, dove lavorano i fisici del Centro in Svizzera che ha scoperto la particella di Dio, il bosone di Higgs, il più grande successo del mondo.



The Economist

July 7th - 13th 2012

In praise of charter schools

Britain's banking scandal spreads

Volkswagen overtakes the rest

A power struggle at the Vatican

When Lonesome George met Nora

A giant leap for science

Finding the Higgs boson

Programmes Video Blogs Opinion In Depth Business Sport

Sarmila Bose

Sarmila Bose is Senior Research Fellow in the Politics of South Asia at the University of Oxford.

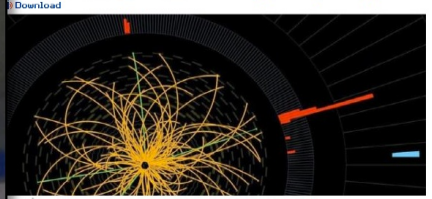
son: Dark matters in the coverage of the 'god particle'

Why do media leave out in reporting this scientific breakthrough?

112 16:05

100% 70

Download



SPORT BUSINESS ARTS LIFE & STYLE S&T EDUCATION HEALTH

GENEVA, July 4, 2012


Disruptive particle found, looks like Higgs boson

SHARE · COMMENT (40) · PRINT · T+

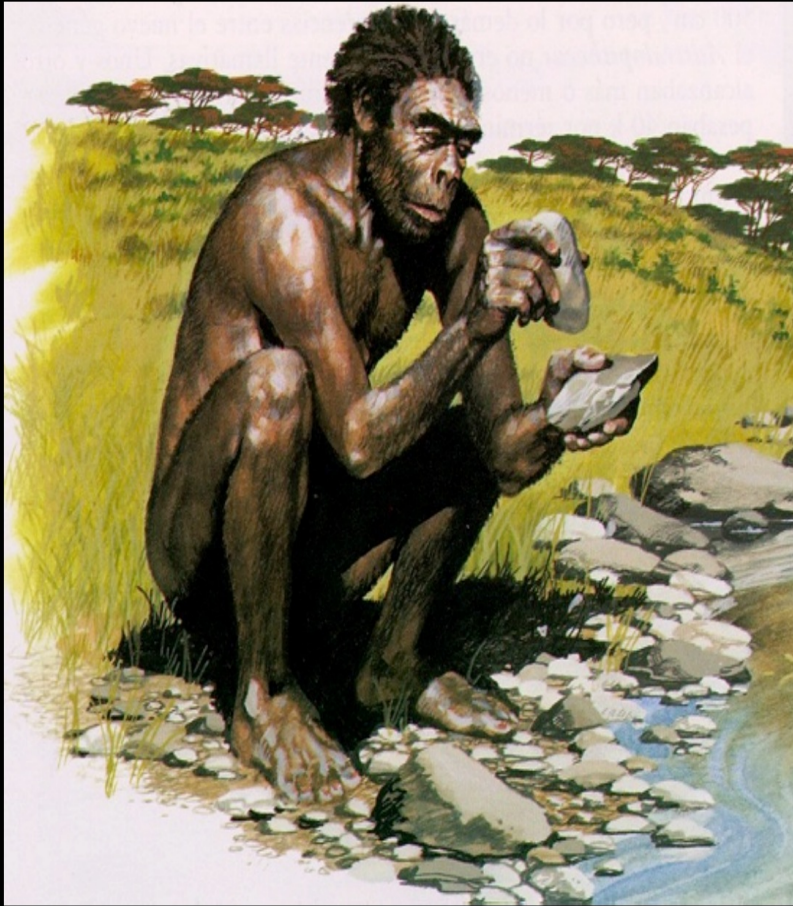


British physicist Peter Higgs congratulates Fabiola Gianotti, ATLAS experiment spokesperson, after her results presentation during a scientific seminar to deliver the latest update in the search for the Higgs boson at the European Organisation for Nuclear Research (CERN) in Meyrin near Geneva on Wednesday

CERN physicists hail evidence of game-changing discovery of subatomic particle

A wide-angle photograph of a clear night sky. The Milky Way galaxy is the central focus, appearing as a dense, glowing band of stars and dust that stretches across the upper two-thirds of the frame. The stars are numerous and vary in brightness, with some appearing as sharp points of light and others as soft, hazy clouds. The sky is a deep, dark blue-black. In the foreground, the dark, undulating silhouettes of sand dunes are visible, their ridges and valleys softly lit by the ambient light of the stars. The overall mood is serene and awe-inspiring.

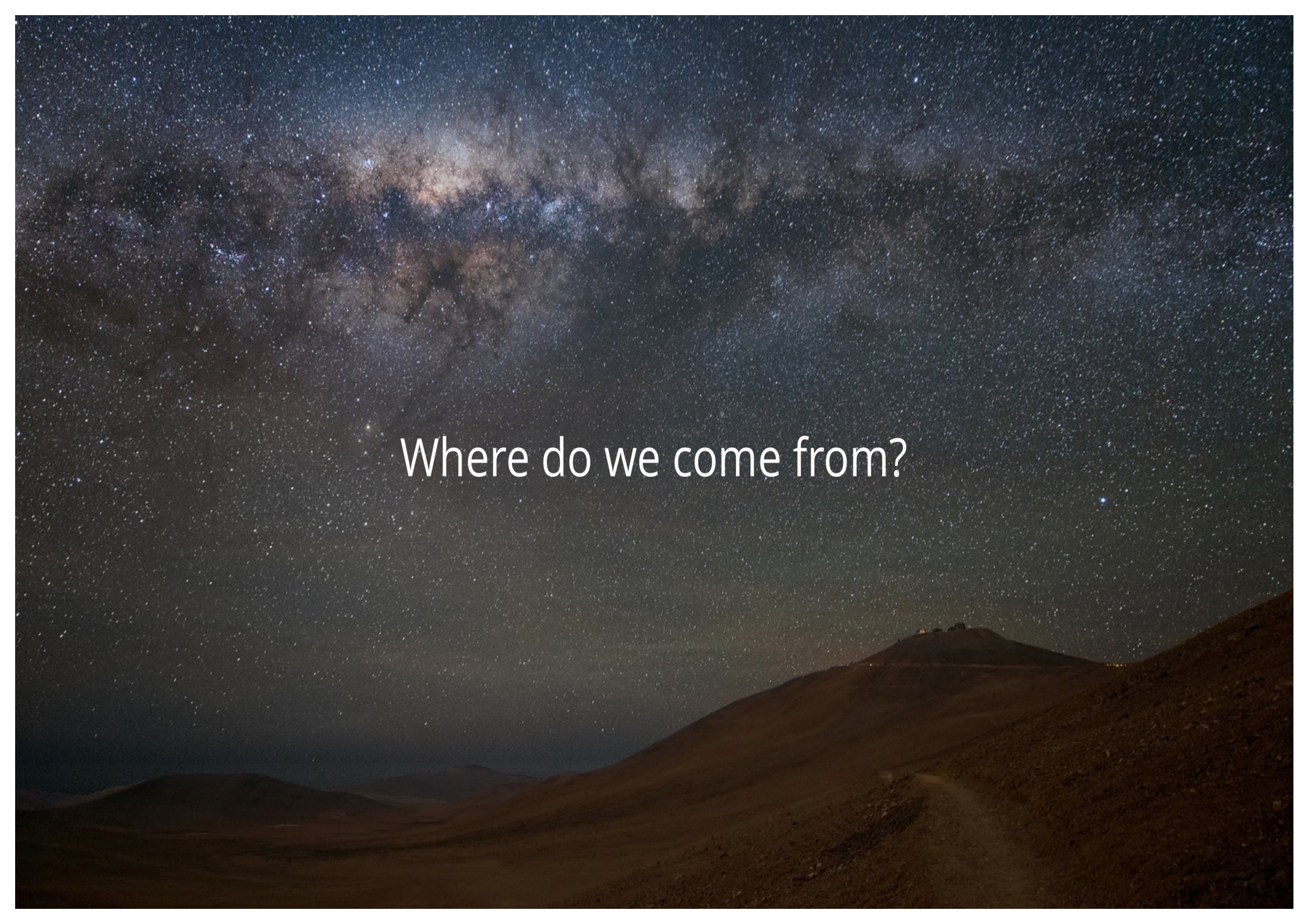
Why?




Physics Seminar – 4 July 2000012 BCE

A night sky photograph showing the Milky Way galaxy arching across the frame, with a dark desert landscape in the foreground. The text "The Big Questions:" is centered in the sky.

The Big Questions:

A night sky photograph showing the Milky Way galaxy stretching across the upper half of the frame. The galaxy's core is visible as a bright, hazy band of light, with numerous individual stars scattered throughout. The foreground consists of dark, rolling sand dunes under a clear, star-filled sky. The overall scene is a vast, open landscape under a starry night sky.

Where do we come from?

A night sky photograph showing the Milky Way galaxy arching across the frame, with a desert landscape in the foreground. The sky is filled with stars, and the Milky Way is visible as a bright, cloudy band of light. The foreground shows dark, rolling sand dunes under a starry sky.

What are we made of?

A night sky photograph showing the Milky Way galaxy stretching across the upper half of the frame. The galaxy's core is visible as a bright, hazy band of light. The foreground consists of dark, rolling sand dunes under a starry sky. The text "What is our destiny?" is centered in the middle of the image.

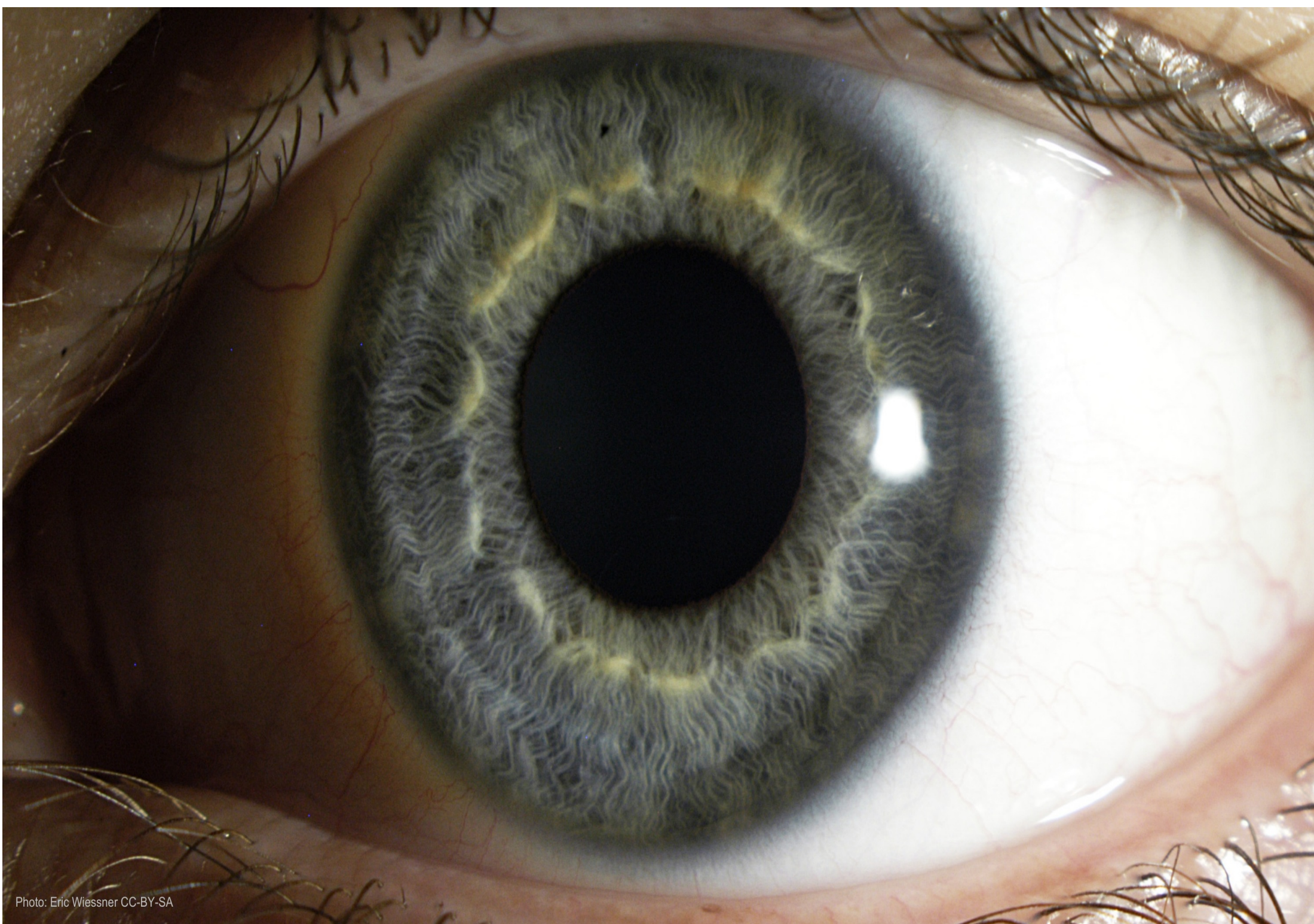
What is our destiny?

A night sky photograph showing the Milky Way galaxy arching across the frame, with a dark desert landscape in the foreground. The sky is filled with stars, and the Milky Way's structure is clearly visible. The foreground shows dark, rolling sand dunes under a starry sky.

What are the rules behind all this?

A wide-angle photograph of a night sky over a desert landscape. The Milky Way galaxy is prominently visible, stretching across the upper half of the frame. The sky is filled with numerous stars, and the foreground shows dark, rolling sand dunes. The text "Is there anything else we don't see?" is overlaid in the center of the image.

Is there anything else we don't see?



Human Hair (15cm away)



Photo: Steven Goldfarb, CC-BY-SA

Andromeda (2.5 million light years away)



Photo: Thomas Bresson, CC-BY-SA

Good enough?

Never!

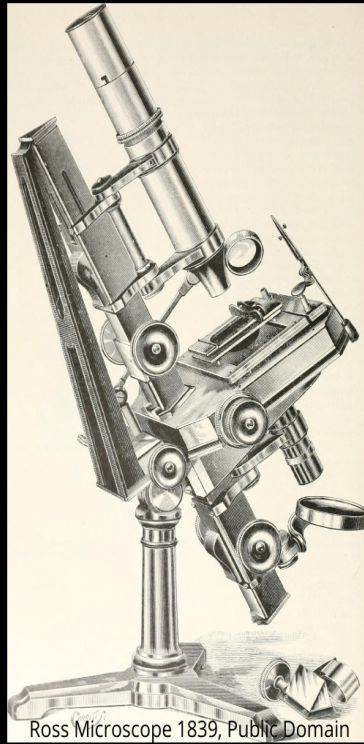


Hammarion Woodcut 1888, Public Domain

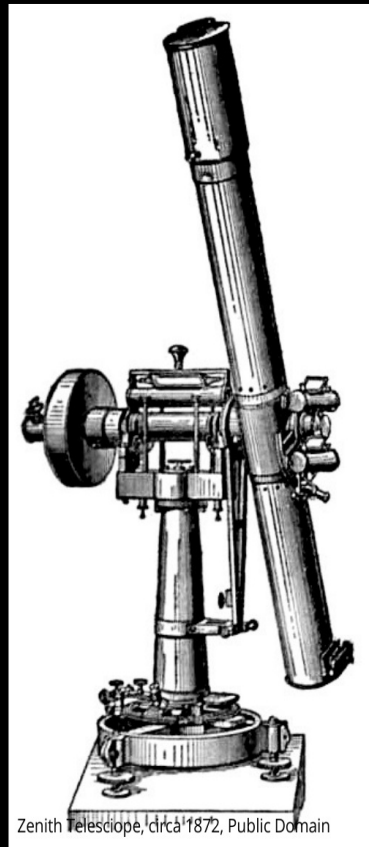


How do we measure what we can't see?

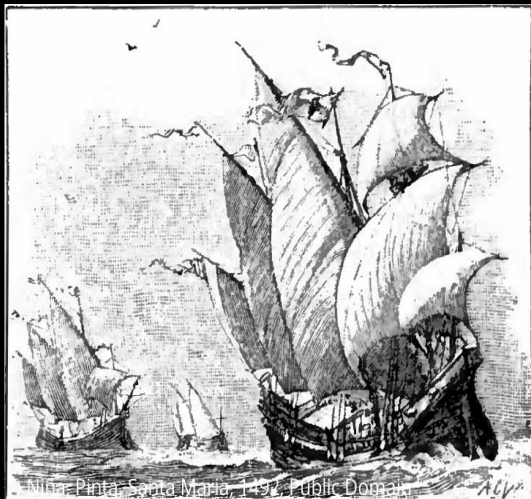
Exploration



Ross Microscope 1839, Public Domain

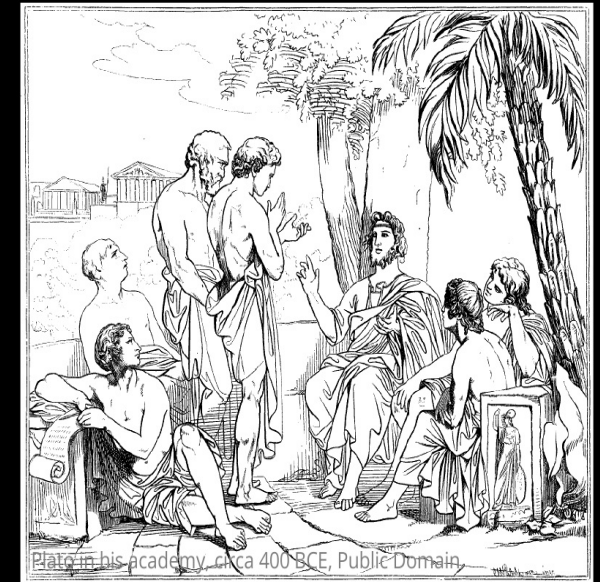
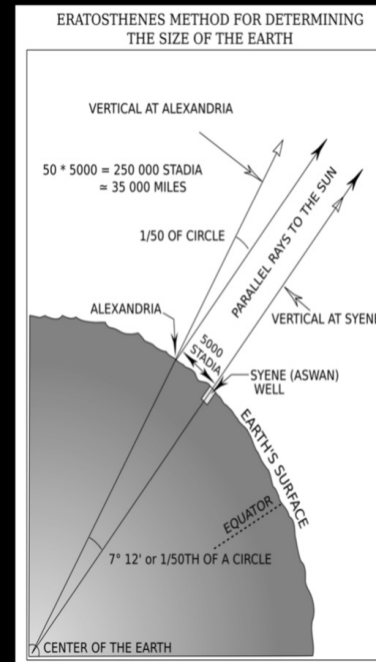


Zenith Telescope, circa 1872, Public Domain



Nina Pinta, Santa Maria, 1492, Public Domain

Extrapolation

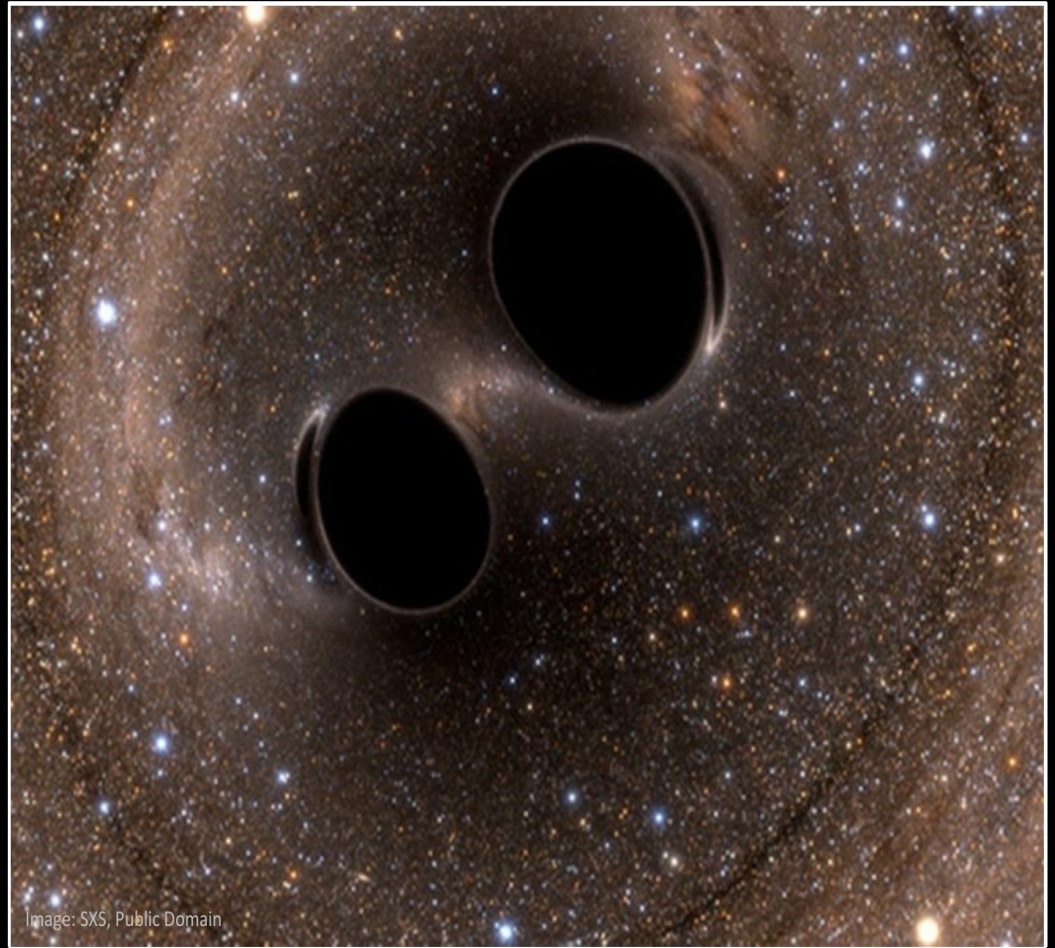
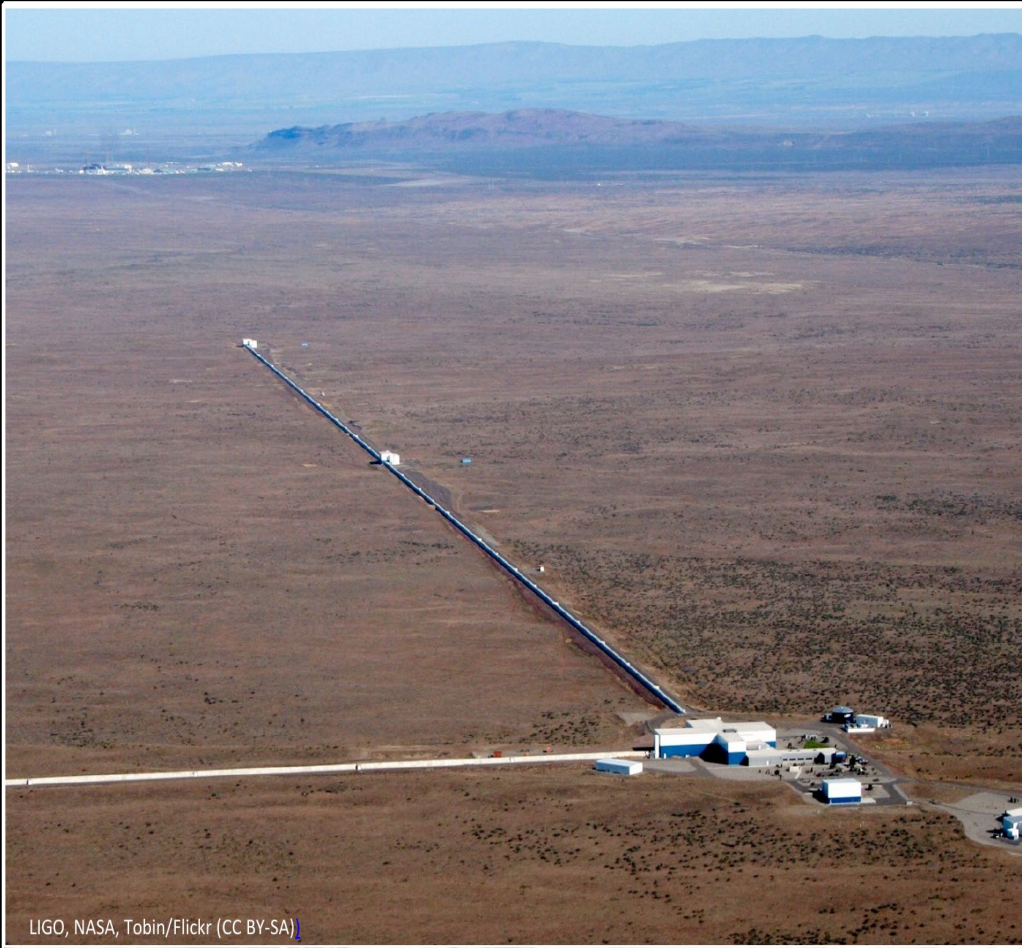


Plato in his academy, circa 400 BCE, Public Domain

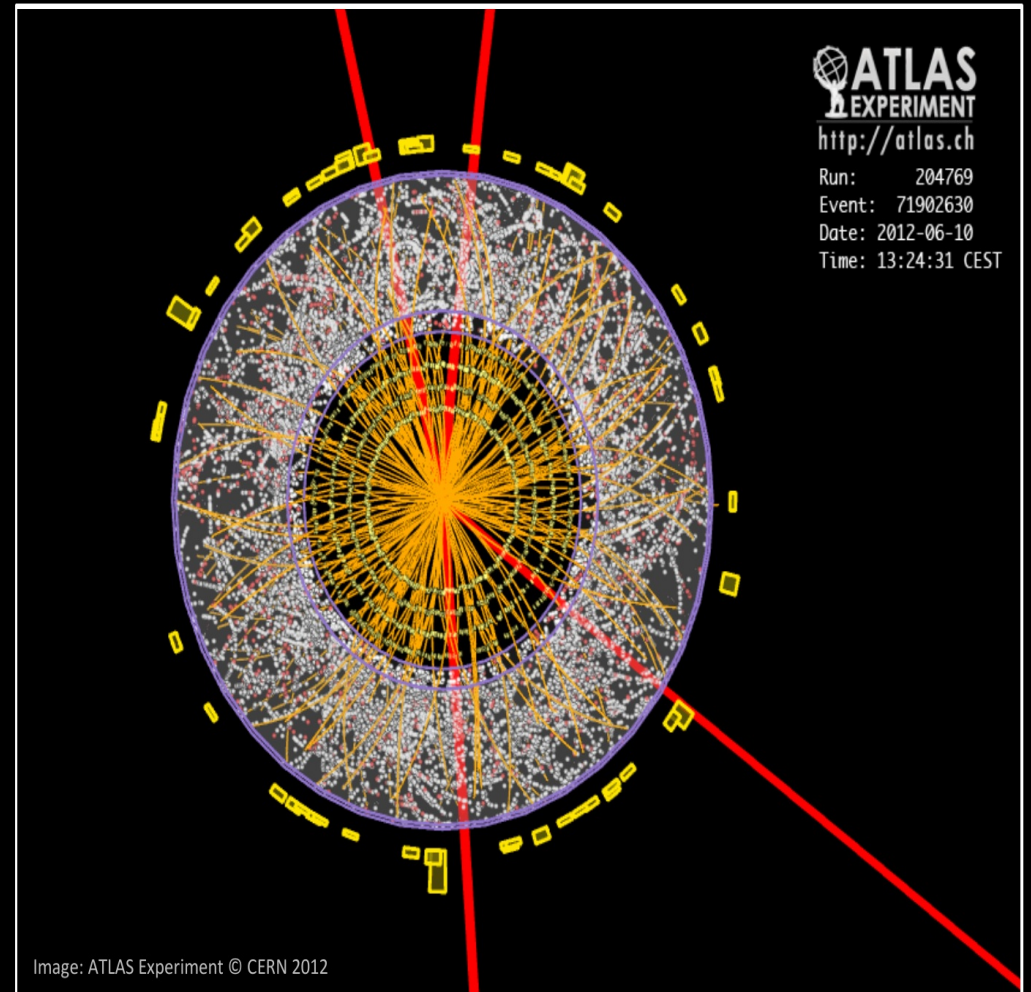
“...the fool on the hill
sees the sun going down,
And the eyes in his head
See the world spinning 'round.”


- George Harrison

Looking out



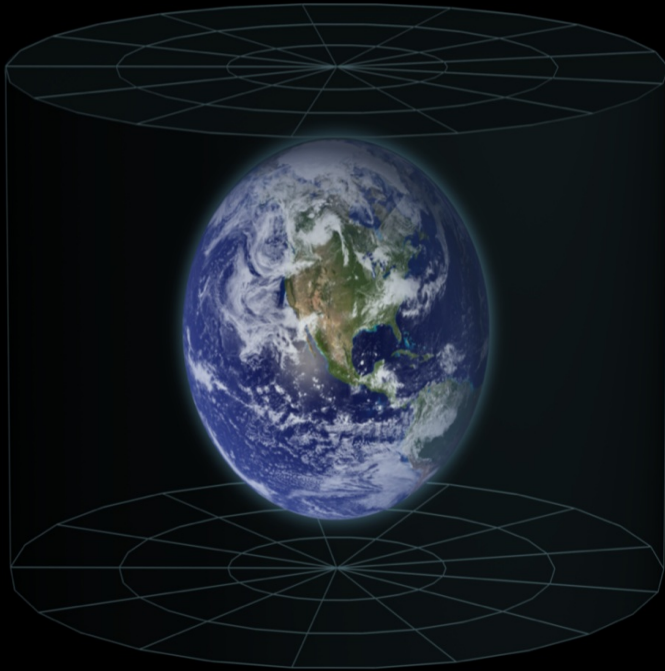
Looking in



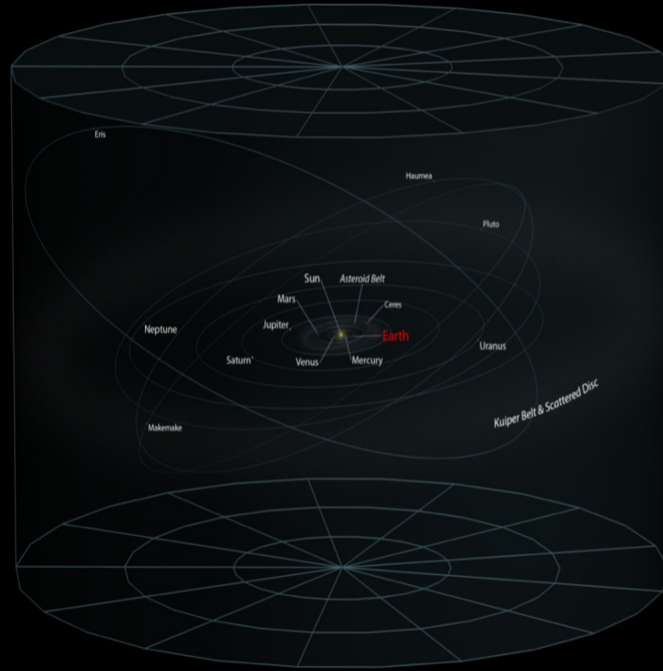
A night sky photograph showing the Milky Way galaxy arching across the frame, with a dark desert landscape in the foreground. The text "What have we learned?" is centered in the image.

What have we learned?

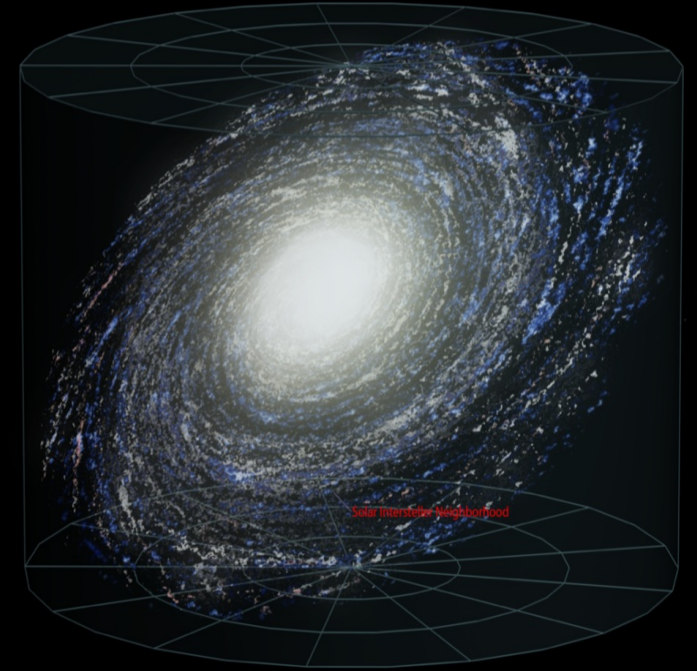
EARTH



SOLAR SYSTEM



MILKY WAY GALAXY



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

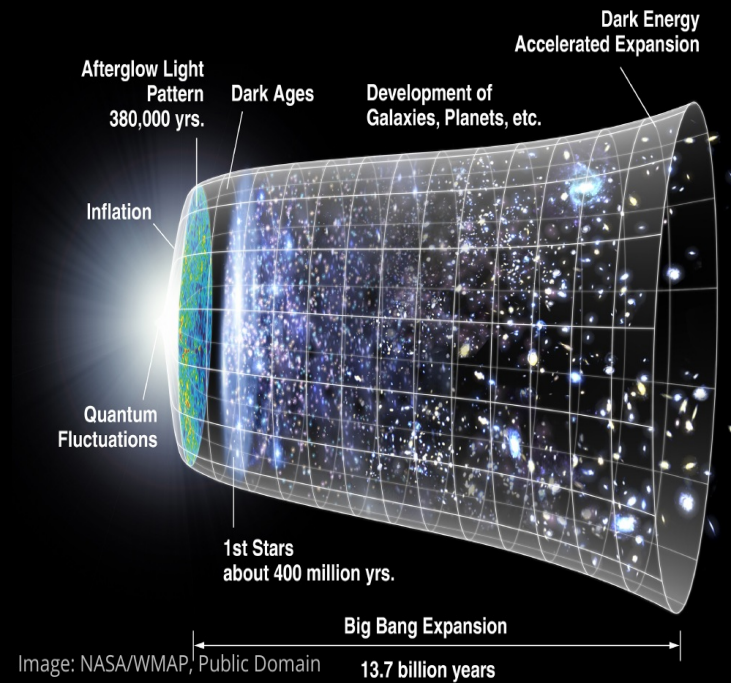
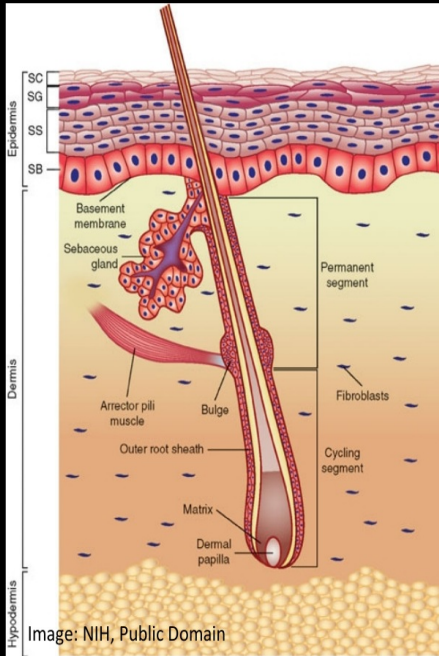
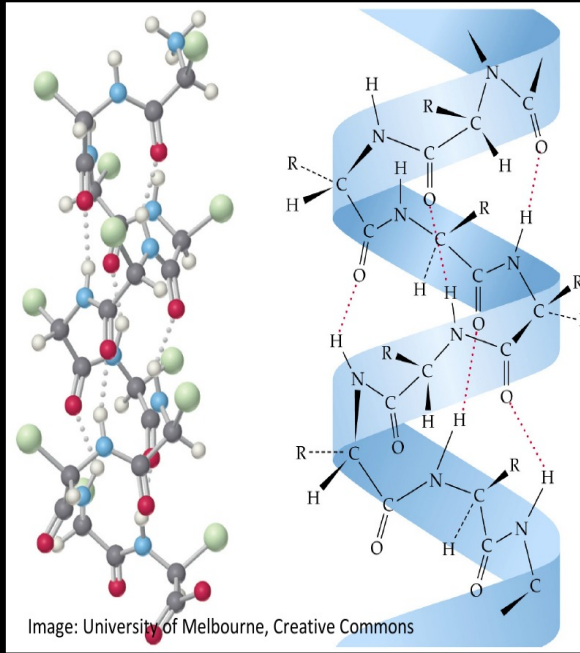


Image: NASA/WMAP, Public Domain

CELL



MOLECULE



ATOM

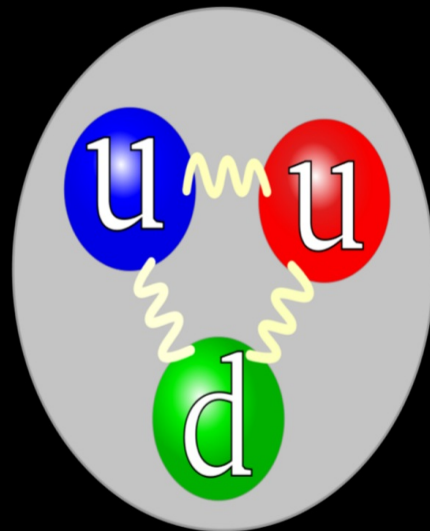
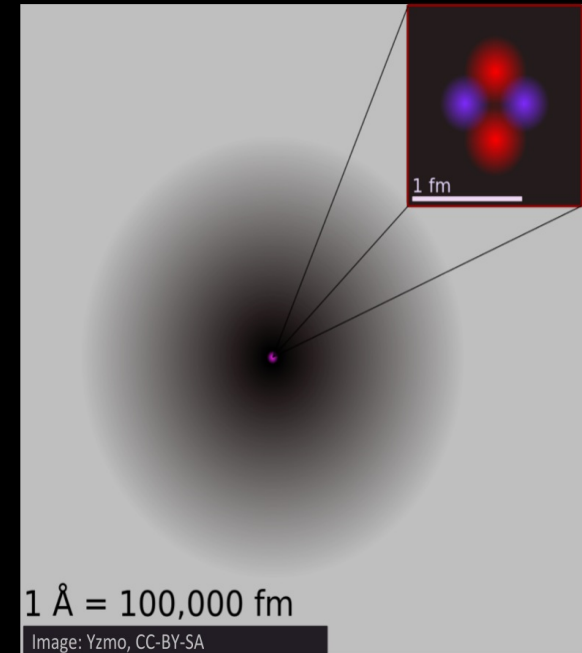


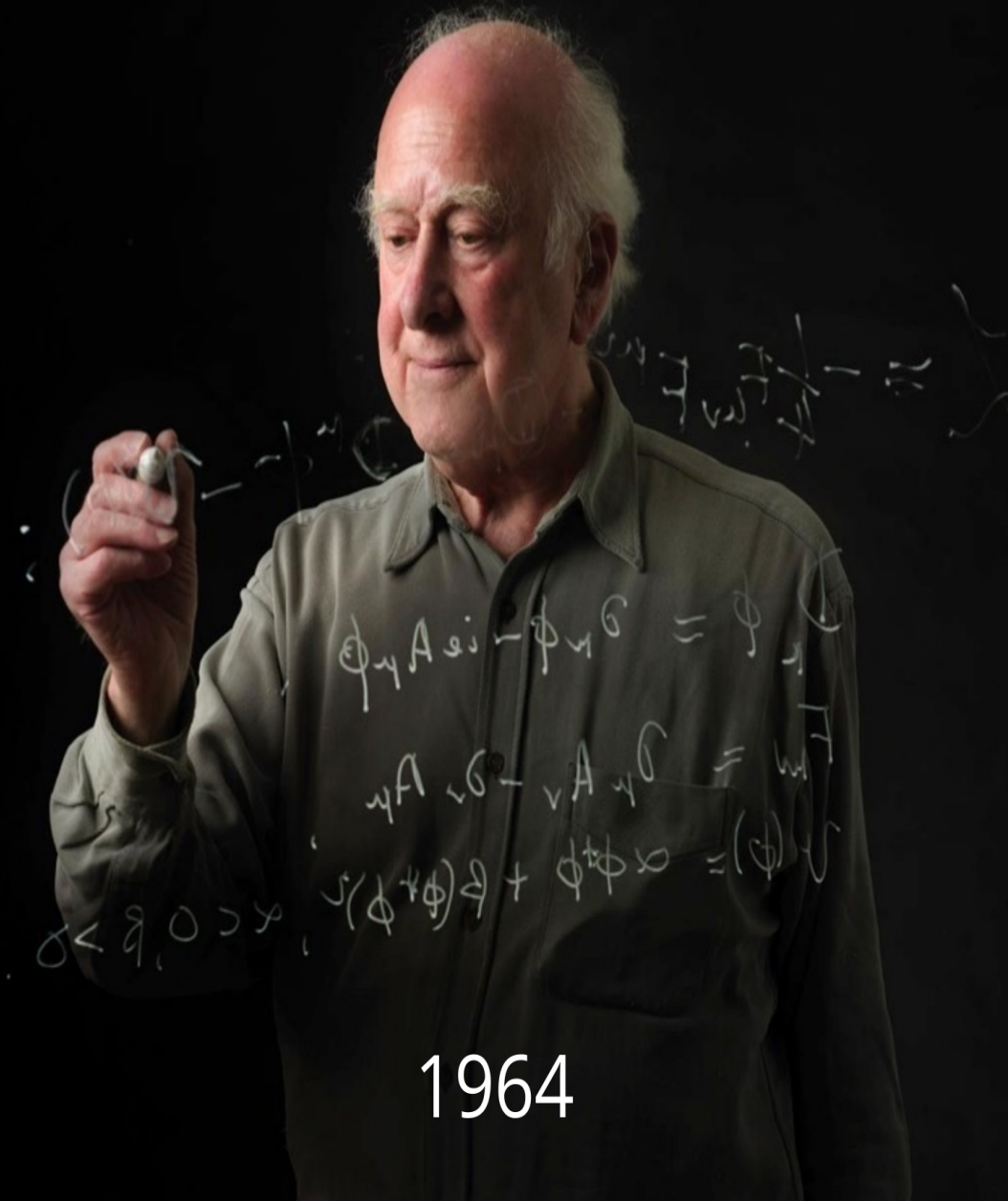
Image: Arpad Horvath, CC-BY-SA

	mass	charge	spin																		
QUARKS	$\approx 2.4 \text{ MeV}/c^2$	$2/3$	$1/2$	u	up	$\approx 1.275 \text{ GeV}/c^2$	$2/3$	$1/2$	c	charm	$\approx 172.44 \text{ GeV}/c^2$	$2/3$	$1/2$	t	top	0	0	1	g	gluon	
	$\approx 4.8 \text{ MeV}/c^2$	$-1/3$	$1/2$	d	down	$\approx 95 \text{ MeV}/c^2$	$-1/3$	$1/2$	s	strange	$\approx 4.18 \text{ GeV}/c^2$	$-1/3$	$1/2$	b	bottom	0	0	1	γ	photon	
	$\approx 0.511 \text{ MeV}/c^2$	-1	$1/2$	e	electron	$\approx 105.67 \text{ MeV}/c^2$	-1	$1/2$	μ	muon	$\approx 1.7768 \text{ GeV}/c^2$	-1	$1/2$	τ	tau	0	0	1	Z	Z boson	
	$< 2.2 \text{ eV}/c^2$	0	$1/2$	ν_e	electron neutrino	$< 1.7 \text{ MeV}/c^2$	0	$1/2$	ν_μ	muon neutrino	$< 15.5 \text{ MeV}/c^2$	0	$1/2$	ν_τ	tau neutrino	$\approx 80.39 \text{ GeV}/c^2$	± 1	1	1	W	W boson
	LEPTONS																				
	GAUGE BOSONS																				

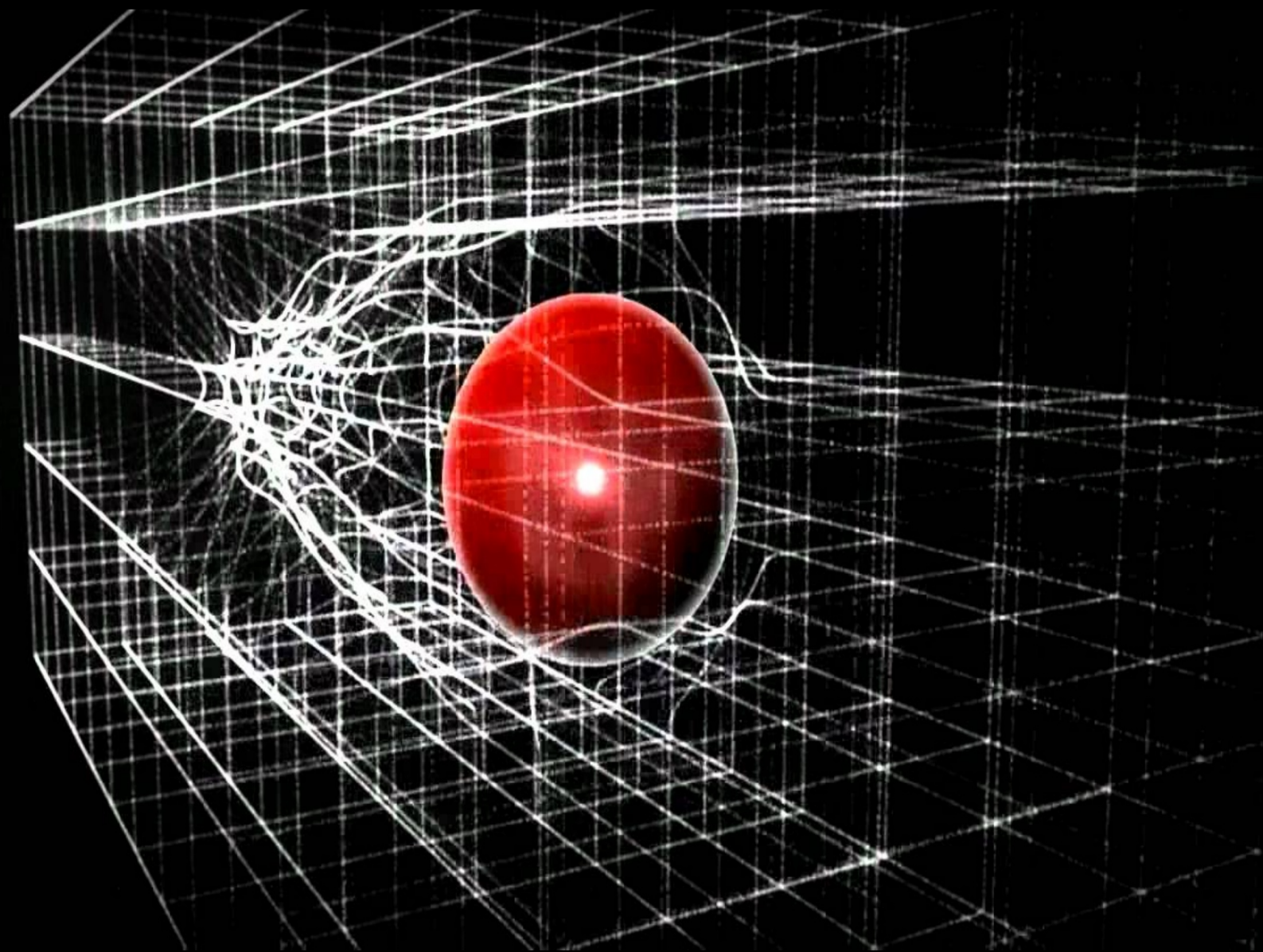
A long-exposure photograph of the Milky Way galaxy, showing its characteristic band of stars and dust stretching across the night sky. The foreground consists of dark, rolling sand dunes under a clear, star-filled sky. The word "Mass?" is overlaid in white text in the center of the image.

Mass?

How do fundamental particles attain mass?

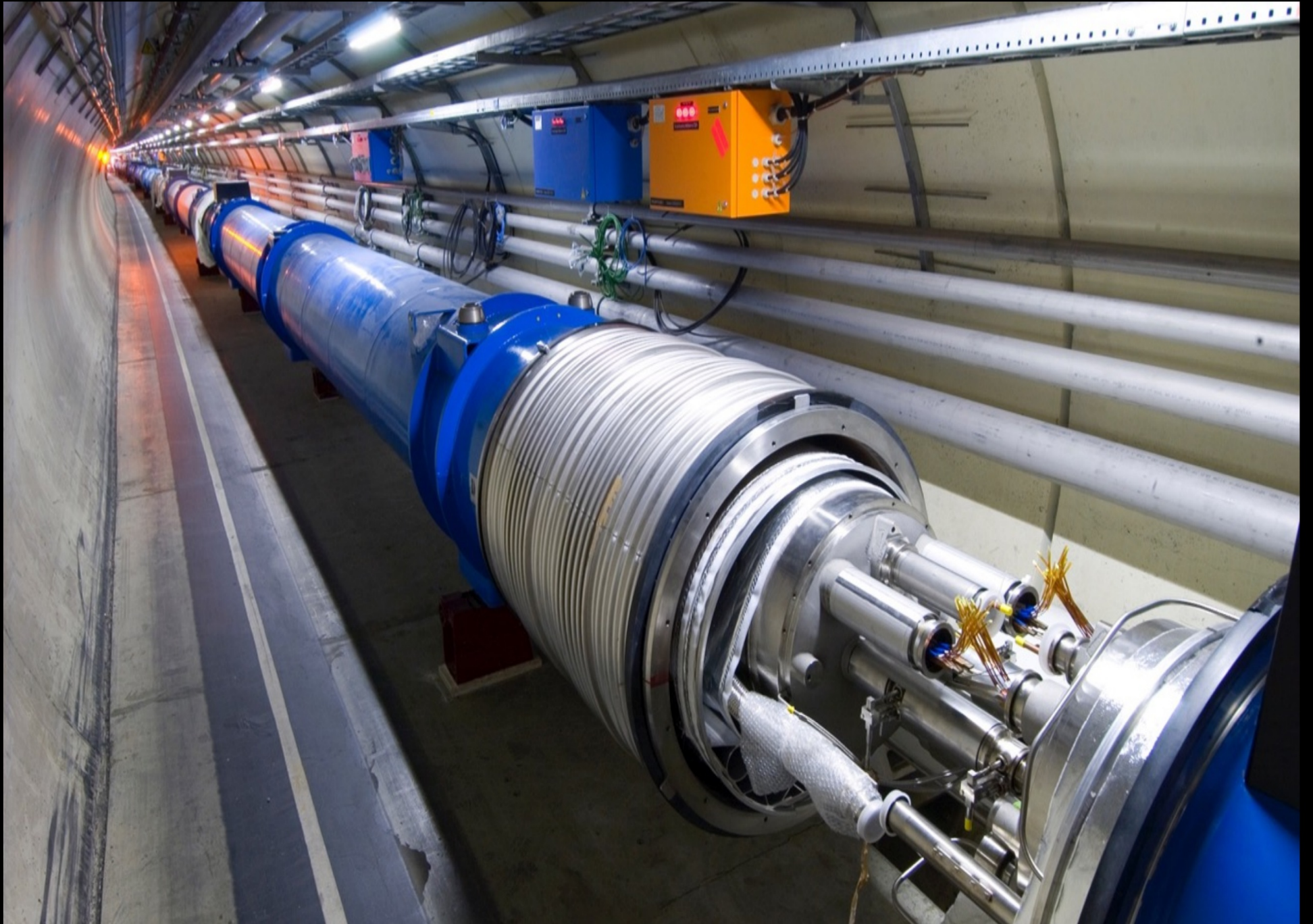


1964



The Brout-Englert-Higgs Mechanism

The Large Hadron Collider at CERN



The Large Hadron Collider at CERN

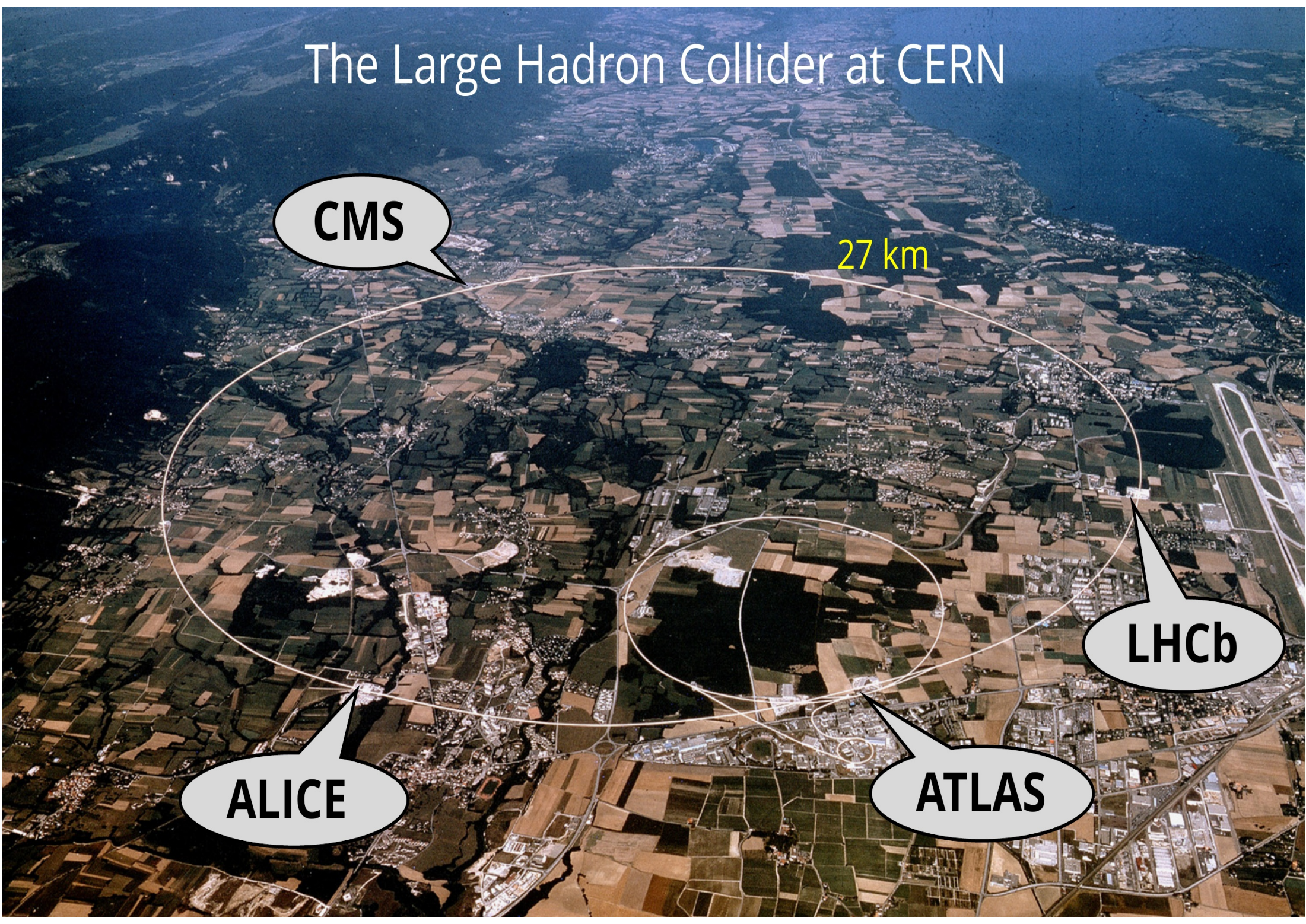
CMS

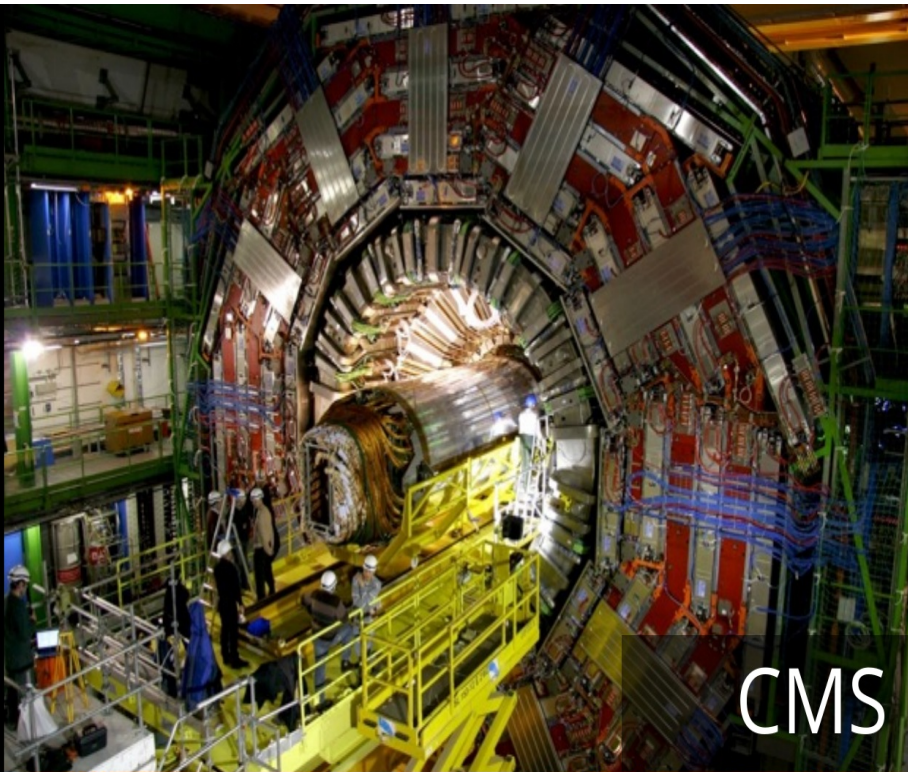
27 km

LHCb

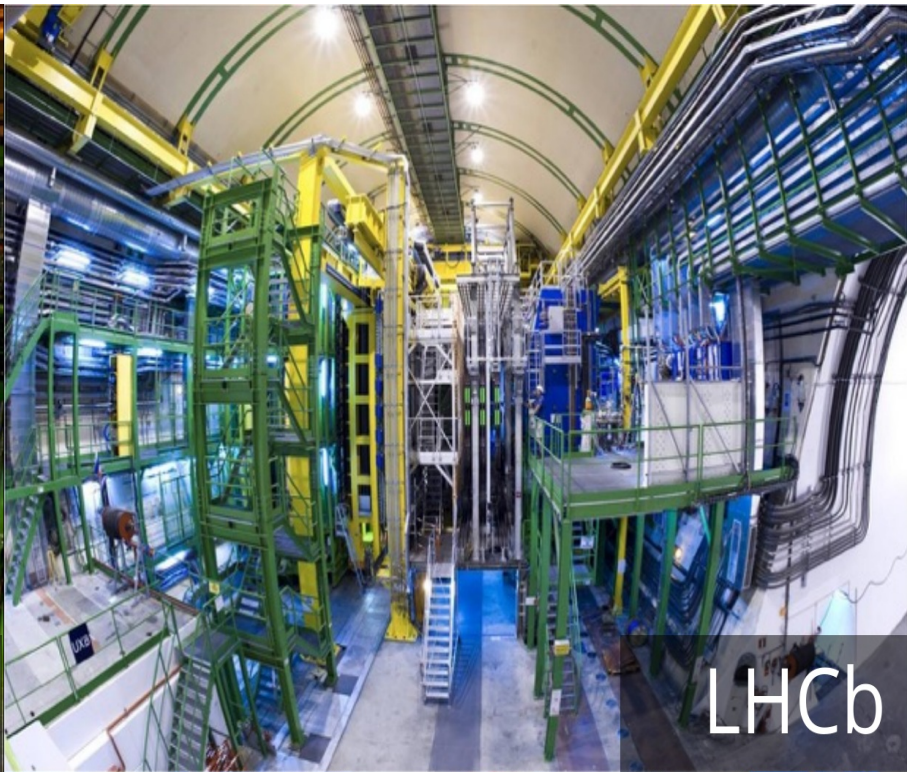
ALICE

ATLAS

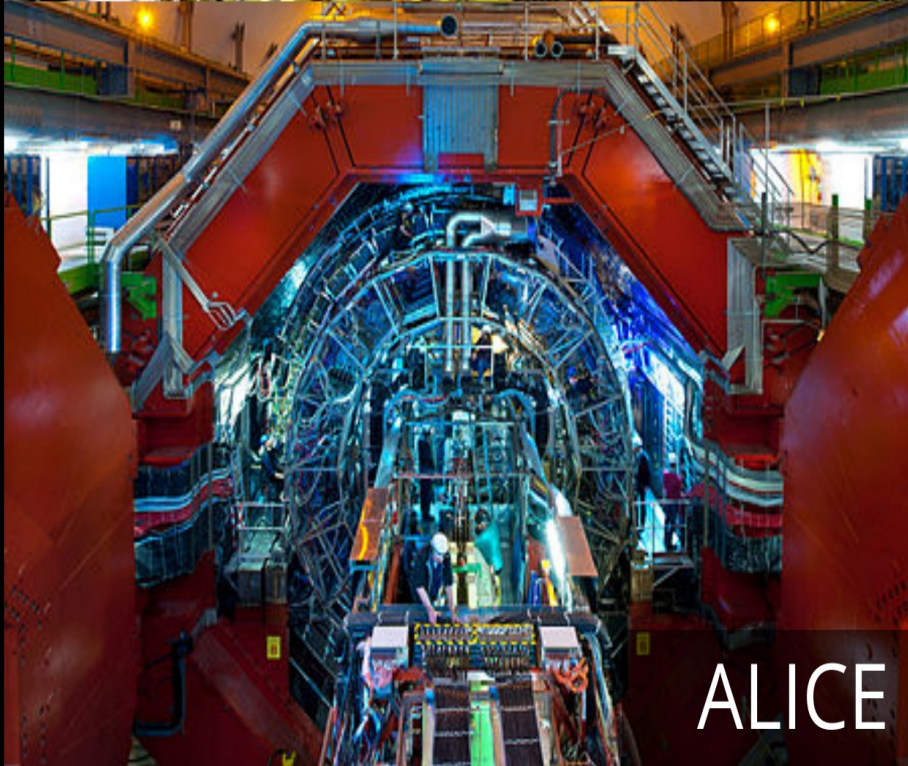




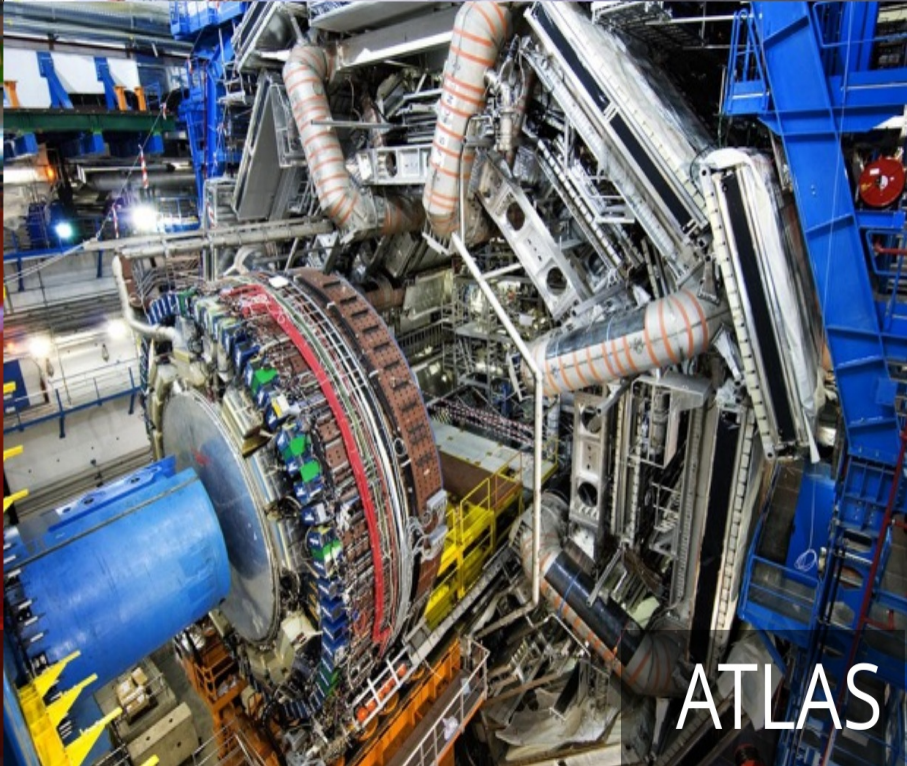
CMS



LHCb



ALICE

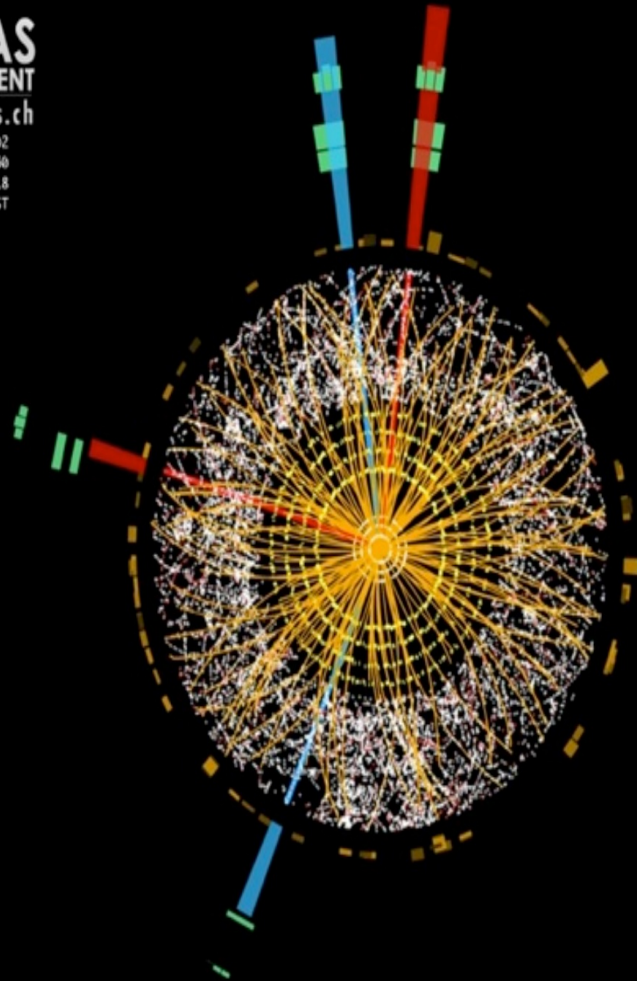


ATLAS

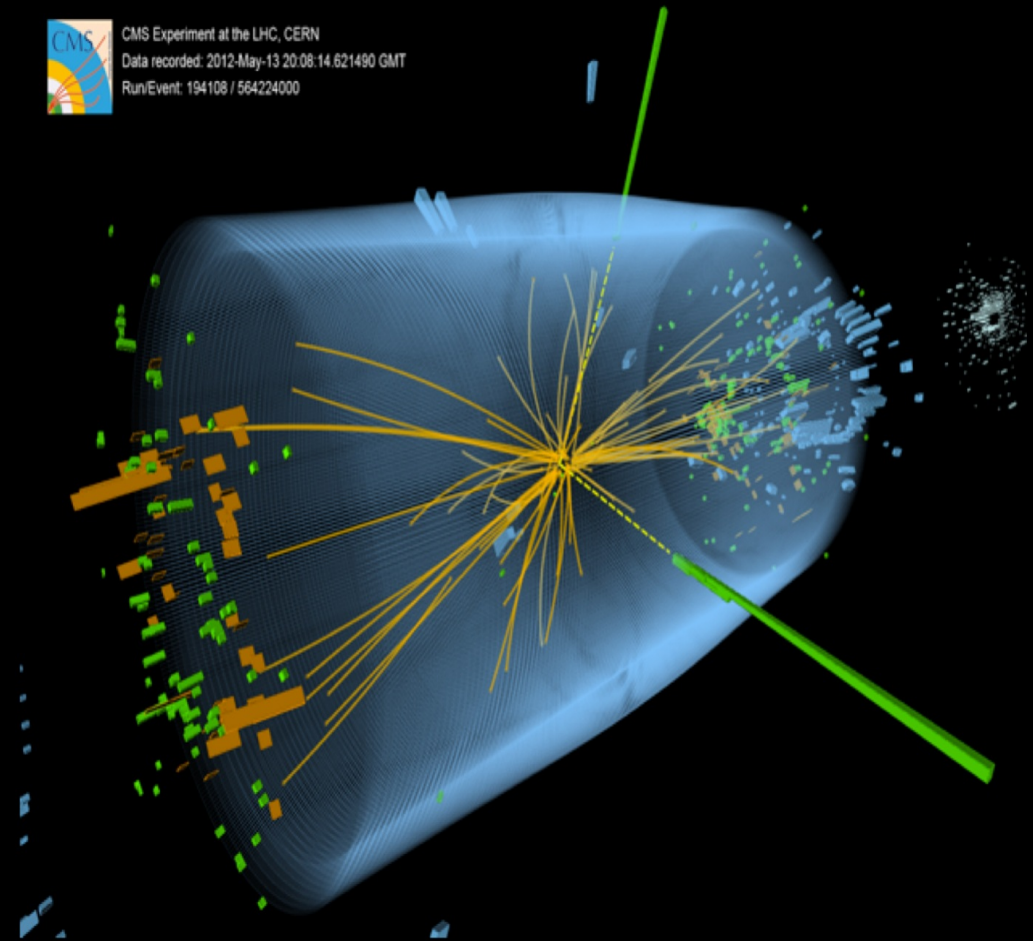
ATLAS
EXPERIMENT

<http://atlas.ch>

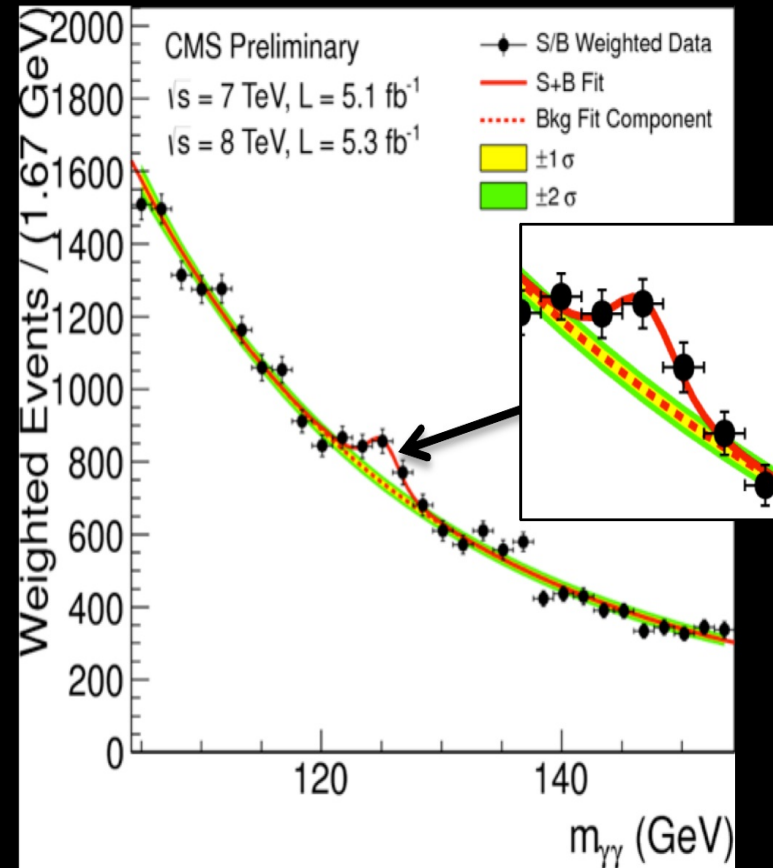
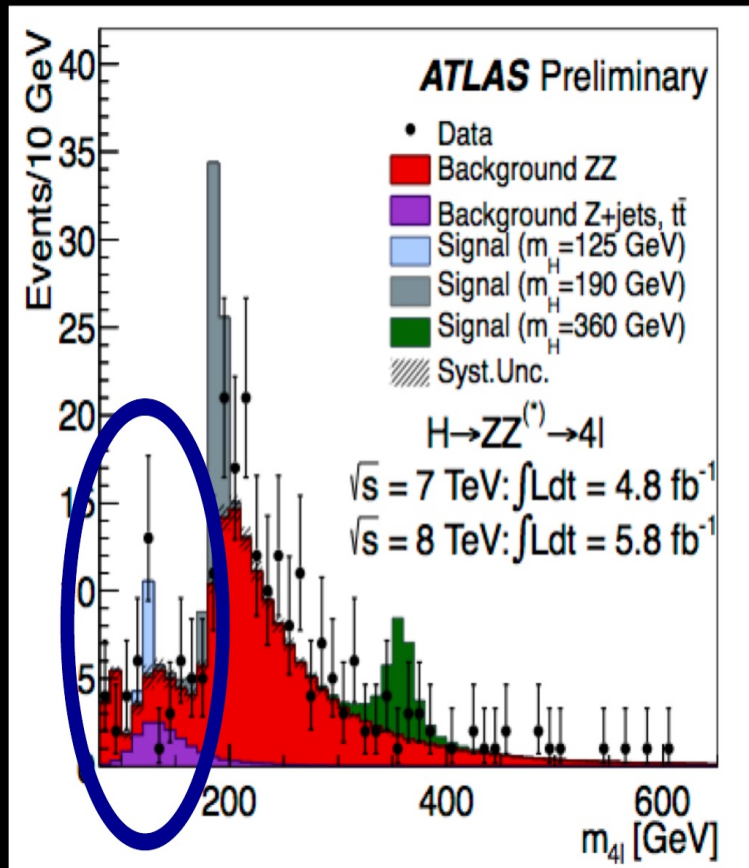
Run: 203602
Event: 82614360
Date: 2012-05-18
Time: 29:28:11 CEST



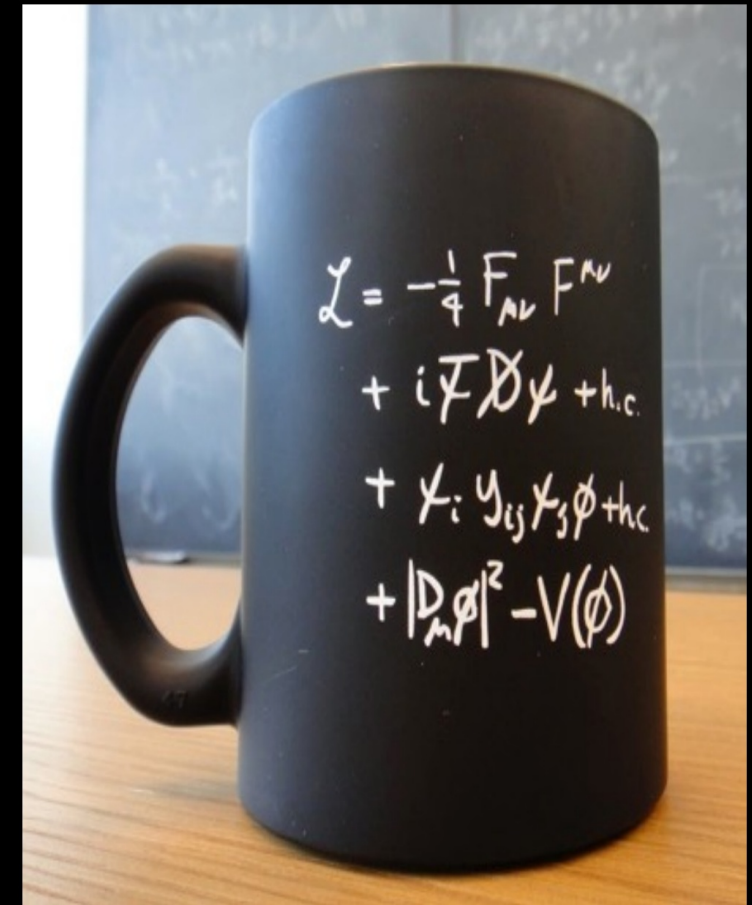
CMS Experiment at the LHC, CERN
Data recorded: 2012-May-13 20:08:14.621490 GMT
Run/Event: 194108 / 564224000



2012



	mass	charge	spin																									
QUARKS	$\approx 2.4 \text{ MeV}/c^2$	$2/3$	$1/2$	u	up	$\approx 1.275 \text{ GeV}/c^2$	$2/3$	$1/2$	c	charm	$\approx 172.44 \text{ GeV}/c^2$	$2/3$	$1/2$	t	top	0	0	1	g	gluon	$\approx 125.09 \text{ GeV}/c^2$	0	0	0	H	Higgs		
	$\approx 4.8 \text{ MeV}/c^2$	$-1/3$	$1/2$	d	down	$\approx 95 \text{ MeV}/c^2$	$-1/3$	$1/2$	s	strange	$\approx 4.18 \text{ GeV}/c^2$	$-1/3$	$1/2$	b	bottom	0	0	1	γ	photon								
	$\approx 0.511 \text{ MeV}/c^2$	-1	$1/2$	e	electron	$\approx 105.67 \text{ MeV}/c^2$	-1	$1/2$	μ	muon	$\approx 1.7768 \text{ GeV}/c^2$	-1	$1/2$	τ	tau	$\approx 91.19 \text{ GeV}/c^2$	0	1	Z	Z boson								
	$< 2.2 \text{ eV}/c^2$	0	$1/2$	ν_e	electron neutrino	$< 1.7 \text{ MeV}/c^2$	0	$1/2$	ν_μ	muon neutrino	$< 15.5 \text{ MeV}/c^2$	0	$1/2$	ν_τ	tau neutrino	$\approx 80.39 \text{ GeV}/c^2$	± 1	1	W	W boson								

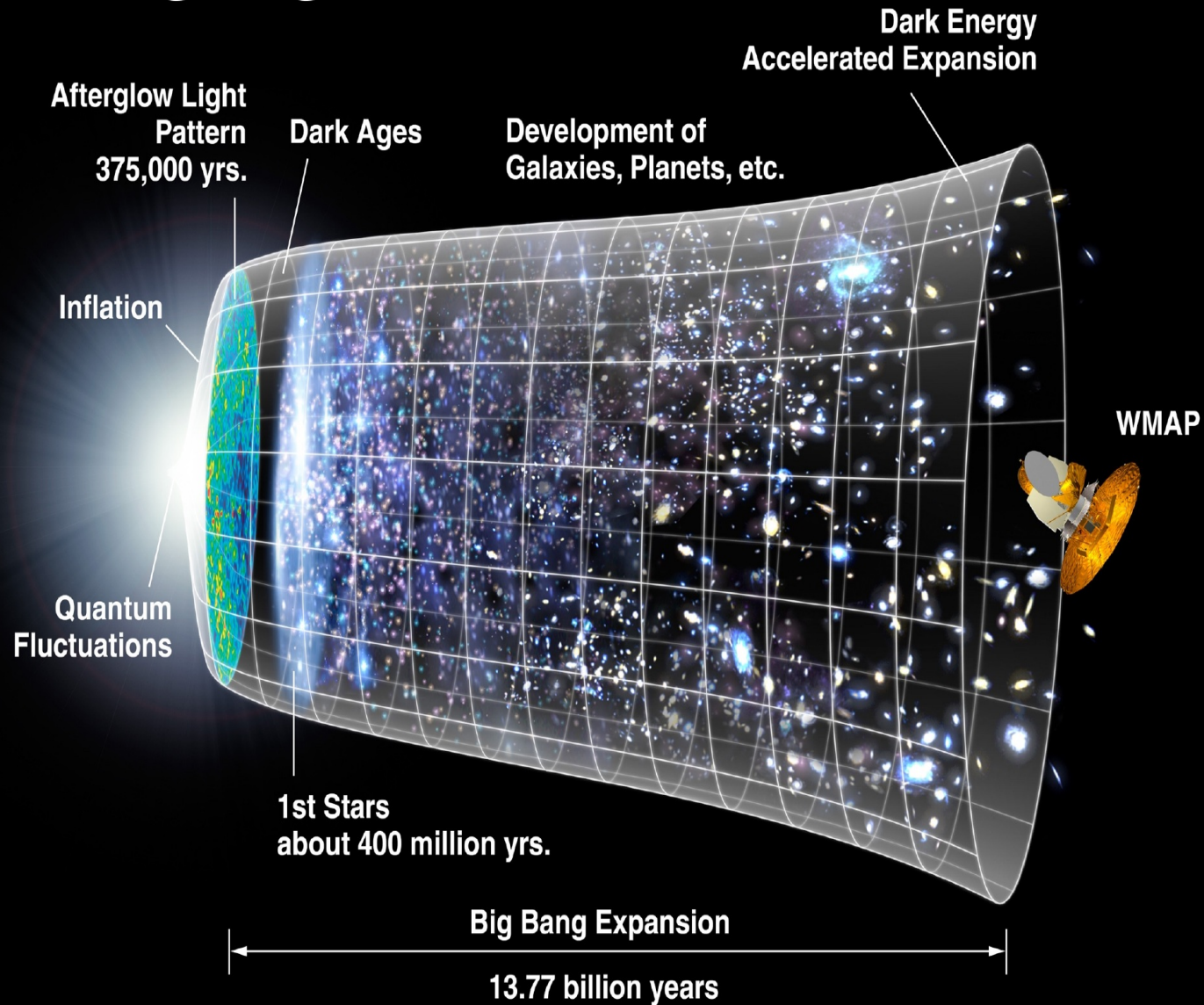


The Standard Model of Particle Physics

A night sky photograph showing the Milky Way galaxy arching across the frame, with a dark desert landscape in the foreground. The text "What we still don't know" is centered in the sky.

What we still don't know

Where do we come from? Where are we going?



Why do we exist at all?



What are we made of?



10^{-1} m
visible stuff



10^{-9} m
molecule



10^{-10} m
atom



10^{-14} m
nucleus

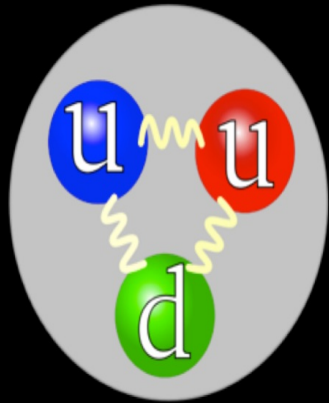


10^{-15} m
proton
neutron

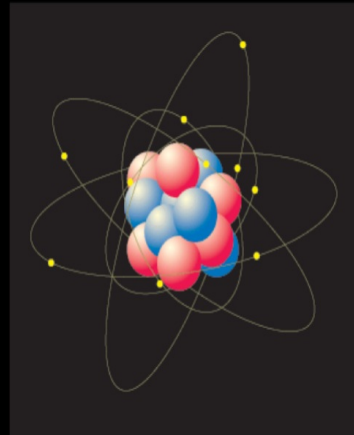


$< 10^{-18}$ m
quark
electron

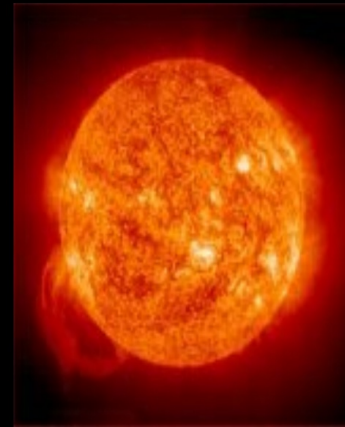
Why is gravity so weak?



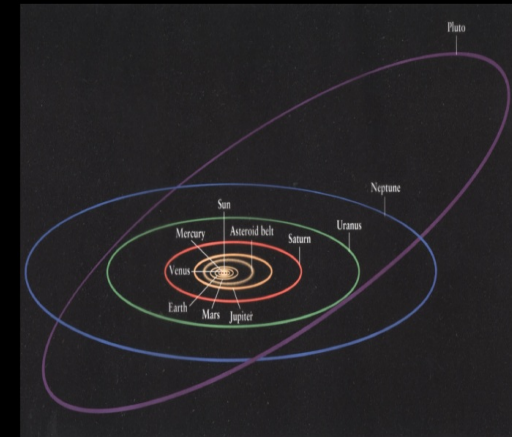
Strong Nuclear
60



Electromagnetism
1



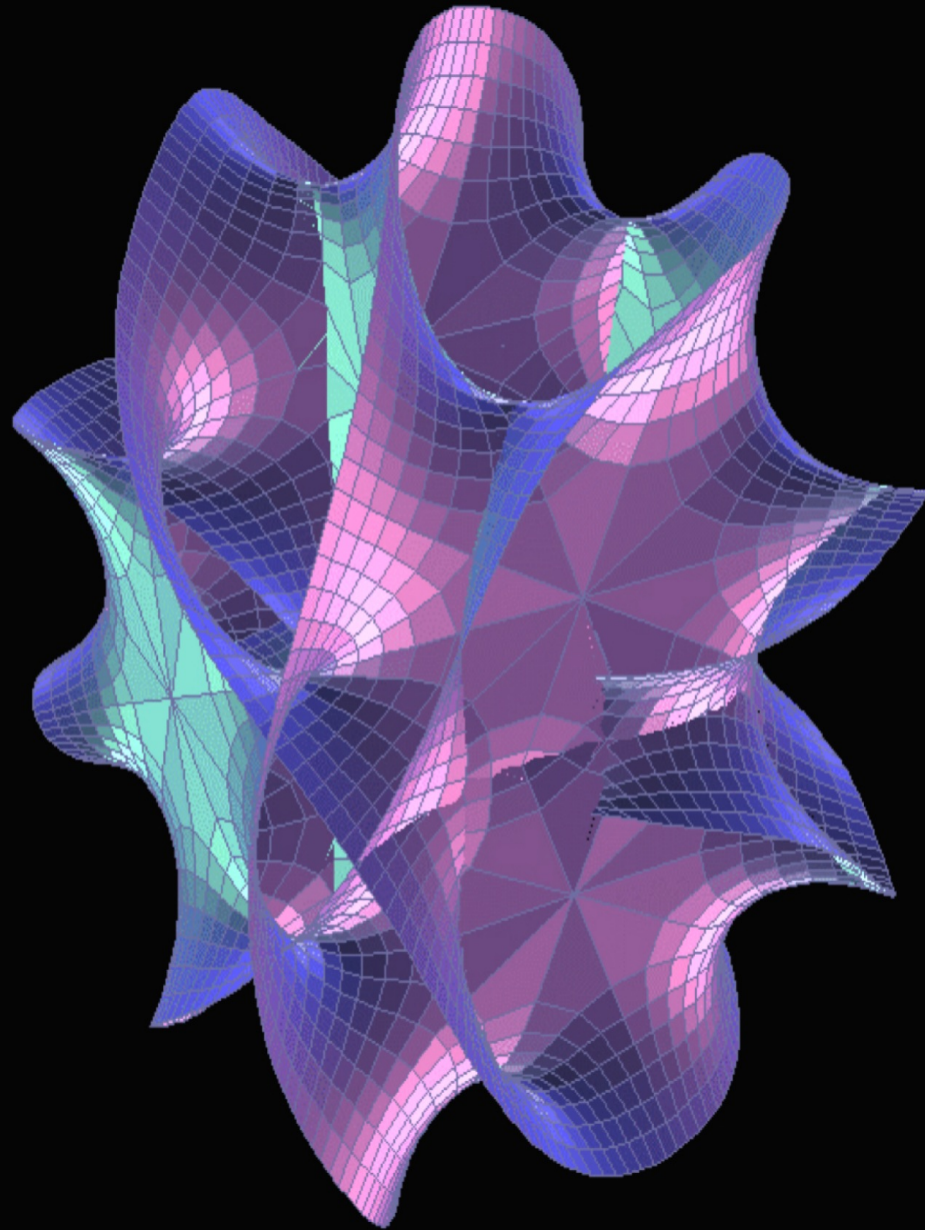
Weak Nuclear
 10^{-4}



Gravity
 10^{-41}

Relative force strengths specified at scale of quarks and gluons

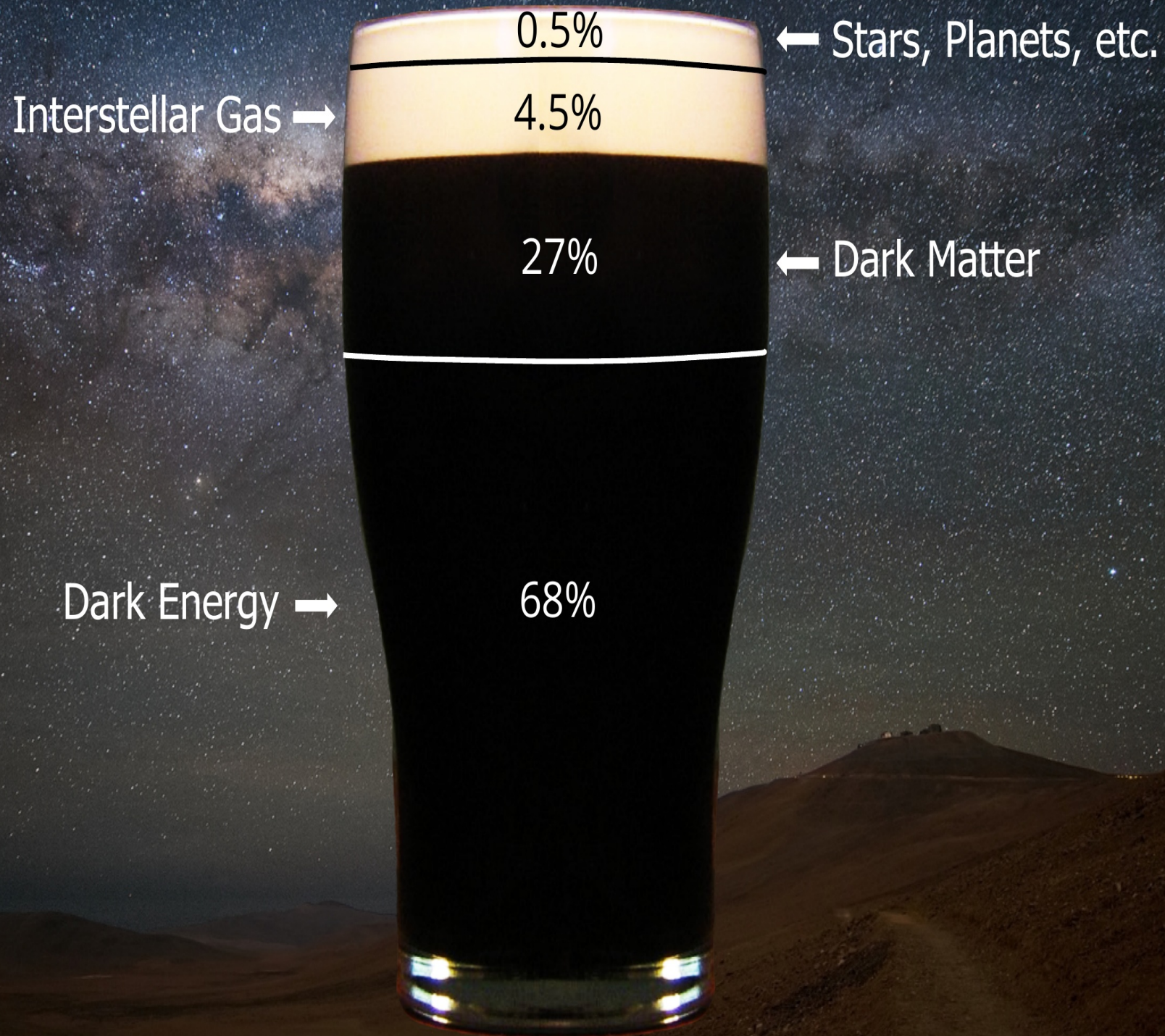
Could there be other dimensions?



What is holding this together?



Vera Rubin



A night sky photograph showing the Milky Way galaxy stretching across the upper half of the frame. The galaxy's core is visible as a bright, hazy band of light, with numerous individual stars scattered throughout. The foreground consists of dark, rolling sand dunes under a clear, star-filled sky. The overall scene is a serene and awe-inspiring view of the universe from a desert location.

Opening paths to solve these problems

Open Window



Open Data

Explore more than **1 petabyte**
of open data from particle physics!

Start typing...

Search

search examples: [collision datasets](#), [keywords:education](#), [energy:7TeV](#)

Explore

- [datasets](#)
- [software](#)
- [environments](#)
- [documentation](#)

Focus on

- [ATLAS](#)
- [ALICE](#)
- [CMS](#)
- [LHCb](#)

▾ Get started ▾

Open Data

Filter by type

- Dataset 101
 - Derived 59
 - Simulated 42
- Documentation 5
 - About 1
 - Activities 3
 - Policy 1
- Environment 4
 - VM 4
 - News 2
- Software 3
 - Analysis 1
 - Framework 1
 - Tool 1

Filter by experiment

- ALICE 26
- ATLAS 115
- CMS 3600
- LHCb 11

Filter by year

- 2011 18
- 2012 87

Filter by file type

- gz 3
- pdf 2

Sort by: Best match ▾ asc. ▾

Display: detailed ▾ 20 results ▾

Found 115 results.

< 1 2 3 4 5 6 >

ATLAS Higgs Machine Learning Challenge

The dataset from the ATLAS Higgs Machine Learning Challenge has been released on CERN Open Data Portal. The Challenge, which ran from May to September 2014, was to develop an algorithm that improved the detection of the Higgs boson signal.

News ATLAS

ATLAS ZPath 2015 Masterclass dataset 1

A dataset of 1000 event display files accessible via HYPATIA as part of the Masterclasses Z-Path. The events were recorded in 2012 by the ATLAS detector....

Dataset Derived ATLAS

ATLAS WPath 2015 Masterclass dataset 5

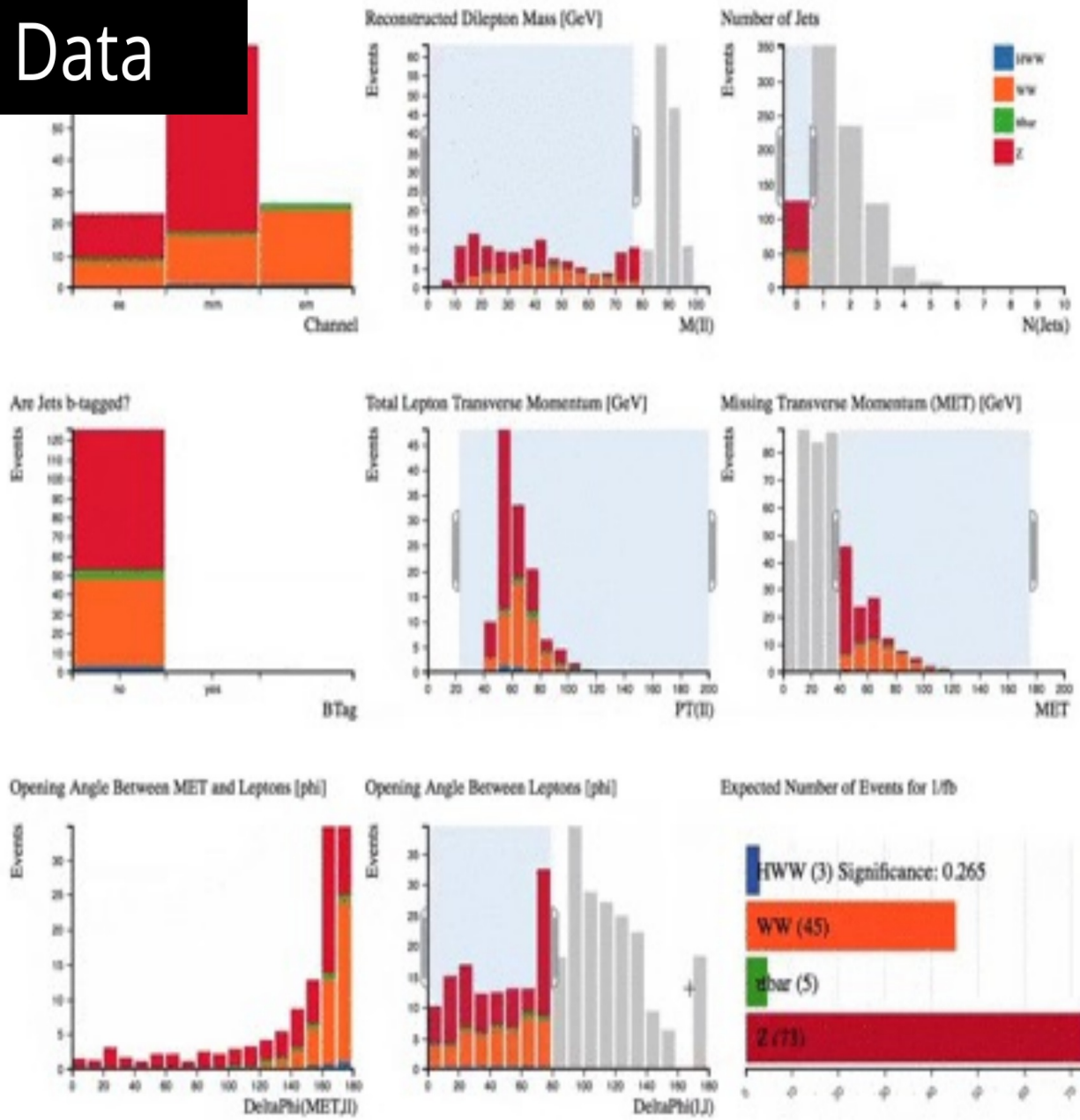
A dataset of 1000 event display files accessible via MINERVA as part of the Masterclasses W-Path. The events were recorded in 2011 by the ATLAS detector....

Dataset Derived ATLAS

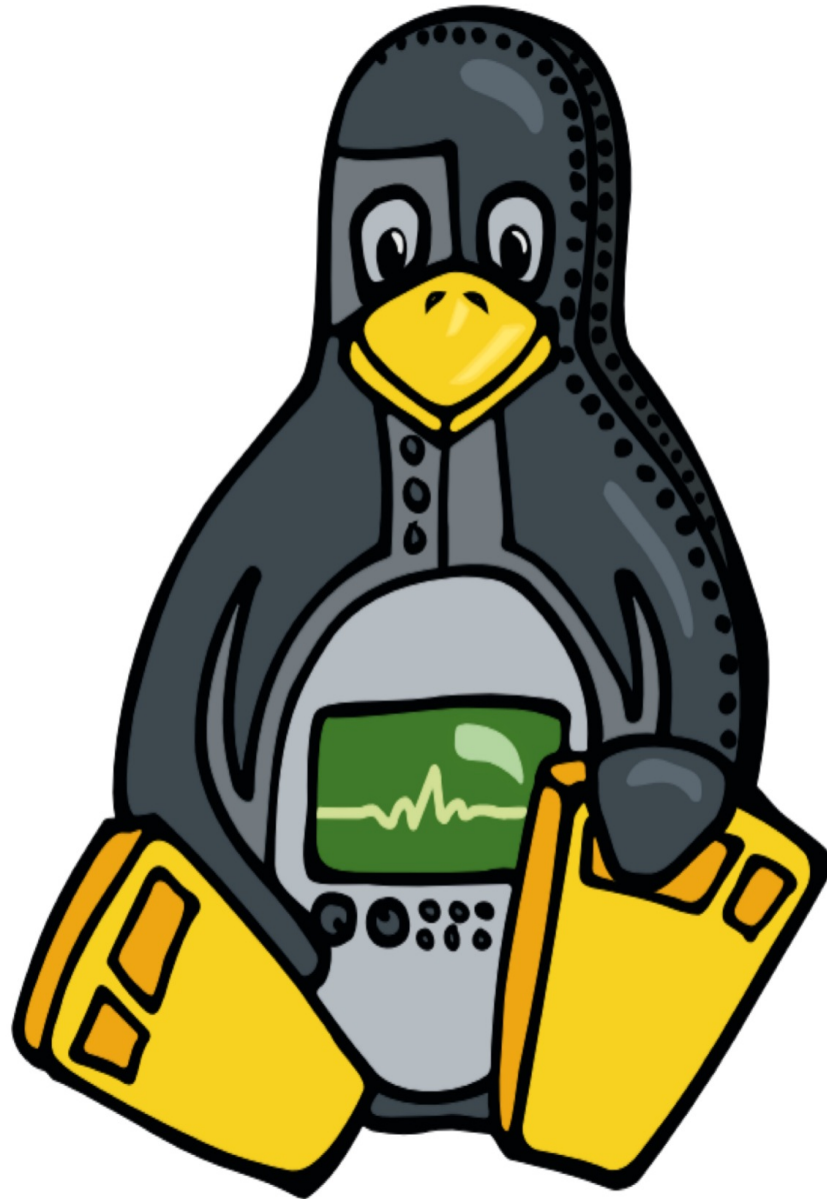
ATLAS WPath 2015 Masterclass dataset 7

A dataset of 1000 event display files accessible via MINERVA as part of the Masterclasses W-Path. The events were recorded in 2011 by the ATLAS detector....

Open Data

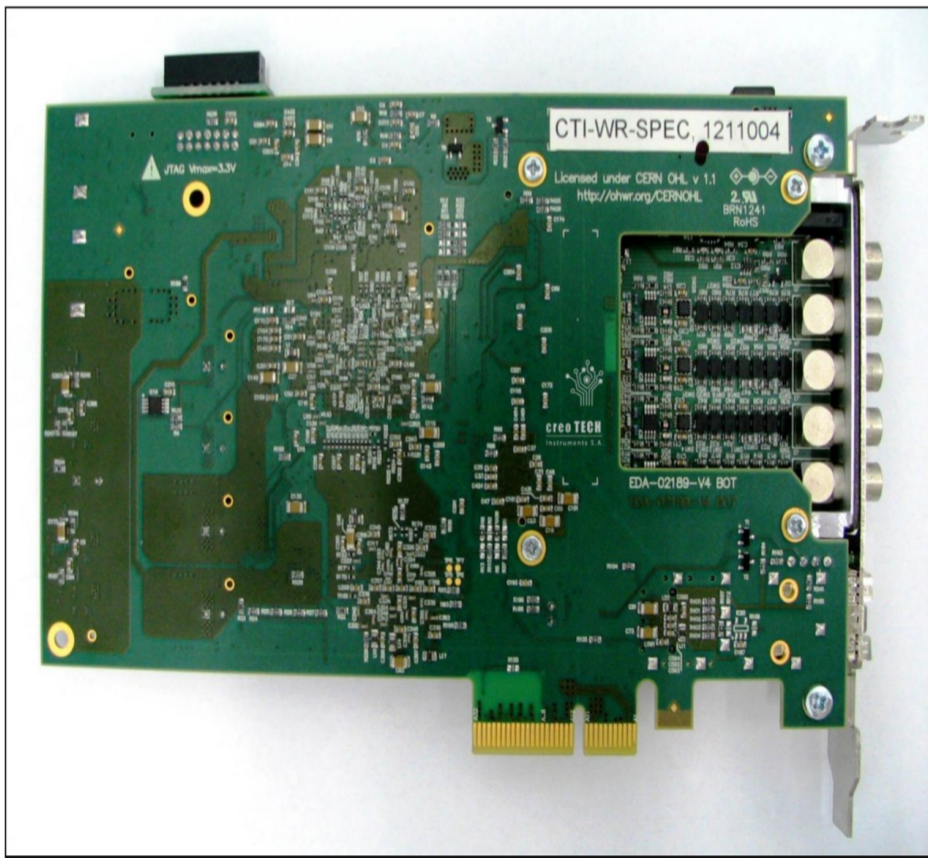


Open Source



CERN releases new version of open hardware licence

by Marina Giampietro



OPEN HARDWARE

Welcome to the Open Hardware Repository, a place on the web for electronics designers at experimental physics facilities to collaborate on open hardware designs, much in the philosophy of the free software movement.

Getting Started

FEATURED PROJECTS

CERN Open Hardware Licence

A project devoted to developing and discussing the CERN Open Hardware Licence.

[More info at the Wiki page](#)

OHR Meta Project

A meta project used to discuss and present information about Open Hardware and related subjects.

[More info at the Wiki page](#)

[More info about the CERN Open Hardware licence](#)

[More info about the OHR.org site support](#)

CERN BE-CO-HT contribution to KiCad

This project hosts documentation and code to be contributed by CERN's BE-CO-HT section to the KiCad PCB design tool.

[More info at the Wiki page](#)

White Rabbit

White Rabbit is a fully deterministic Ethernet-based network for general purpose data transfer and synchronization. It can synchronize over 1000 nodes with sub-ns accuracy over fiber lengths of up to 10 km.

Commercially available.

[More info at the Wiki page](#)

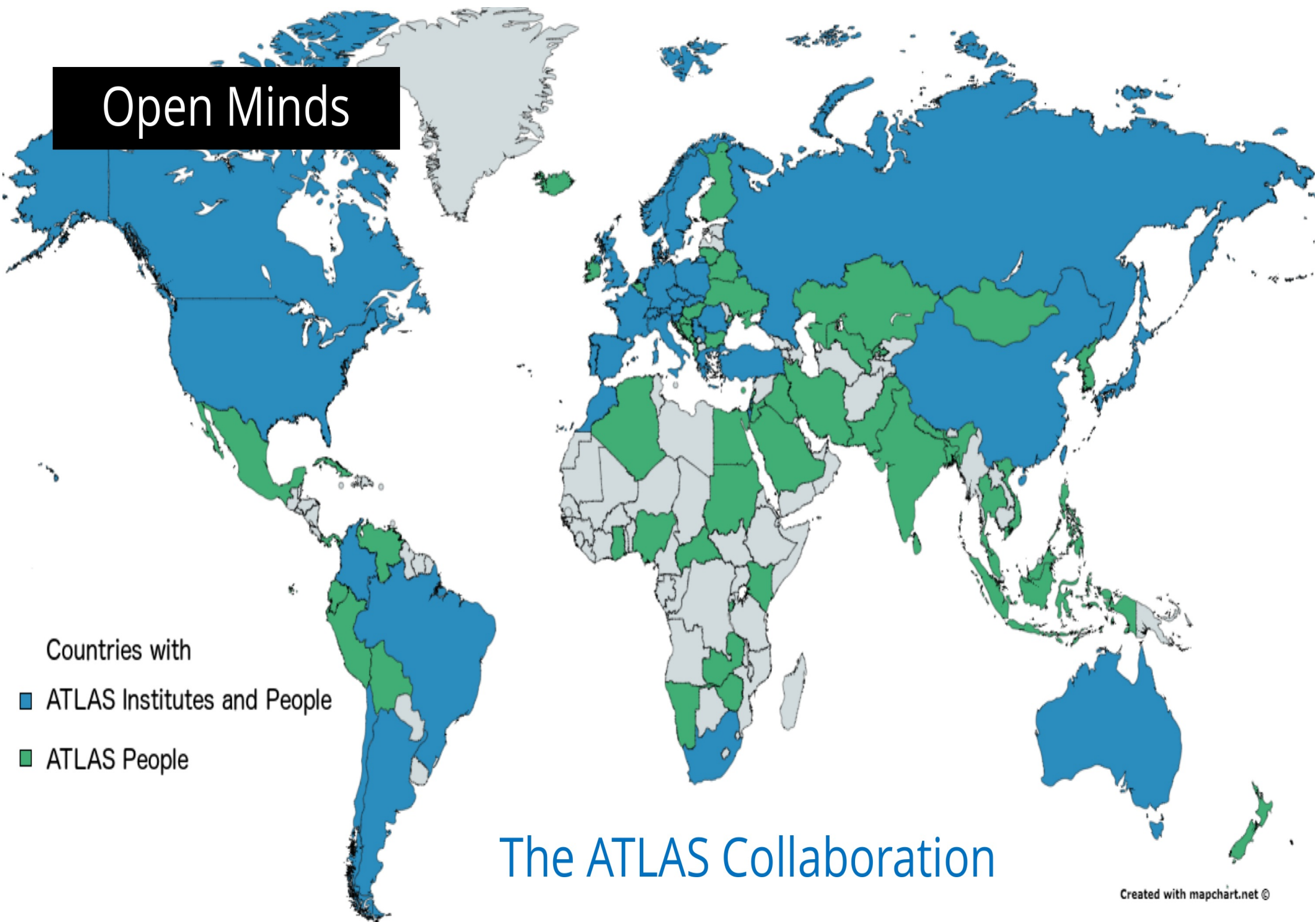
Projects



Overall activity

NAME	PUBLIC	STATUS	EXPAND ALL
Applications of Open Hardware	✓		▼
▶ FMC DEL 1ns 4cha - stand-alone application	✓	Beta	▼
ARMadillo	✓		▼
Beam Position Monitor	✓		▼
▶ Beam Positoning Monitor - Gateware	✓	Alpha	▼
▶ Beam Positoning Monitor - RF Front-End	✓		▼
▶ Beam Positoning Monitor - Software	✓	Alpha	▼
CERN ELMB	✓	Mature	▼
CERN Open Hardware Licence	✓	Release	▼
CernFIP	✓	Release	▼
▶ MasterFIP	✓	Planning	▼
▶ MasterFIP - Gateware	✓	Alpha	▼
▶ MasterFIP - Hardware	✓	Alpha	▼
▶ MasterFIP - Software	✓	Planning	▼
▶ MasterFIP - Testing	✓	Planning	▼
▶ nanoFIP	✓	Release	▼

Open Minds



- Countries with
- ATLAS Institutes and People
 - ATLAS People

The ATLAS Collaboration



Can we possibly do it?

