

Instruments





(Particle beams)
Electron
Microscope
Microscope







Telescope

Radio Telescope

Observables

Big Bang

10-34

10-30

10-26

10-22

10-18

10-14

10-10

10-6

1m

10⁶

1010

1014

10¹⁸

1022

10²⁶

SUSY particle?
Higgs?
Z/W (range of weak force)
Proton (range of Nuclei nuclear force)
Atom





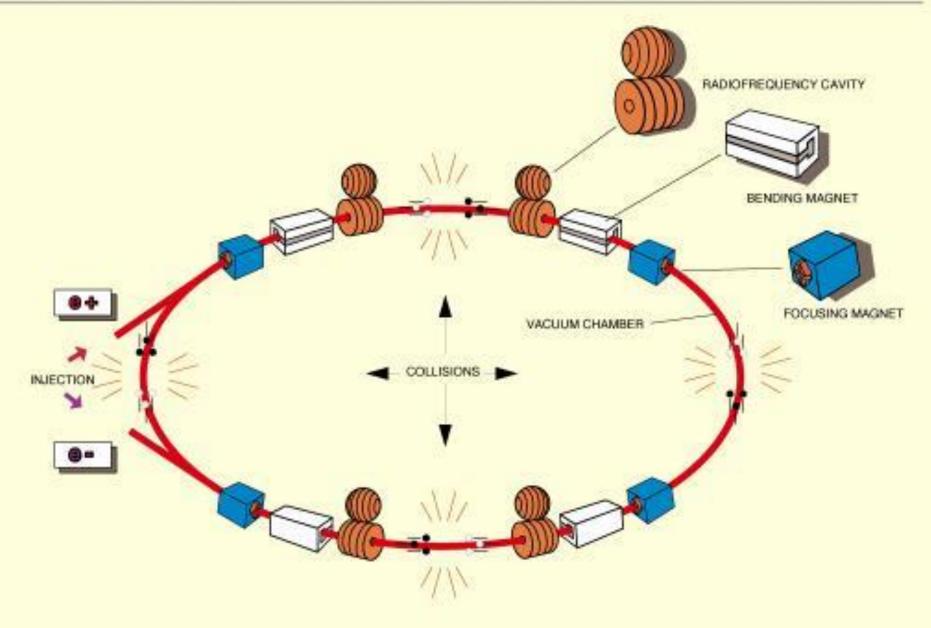
Earth radius Earth to Sun



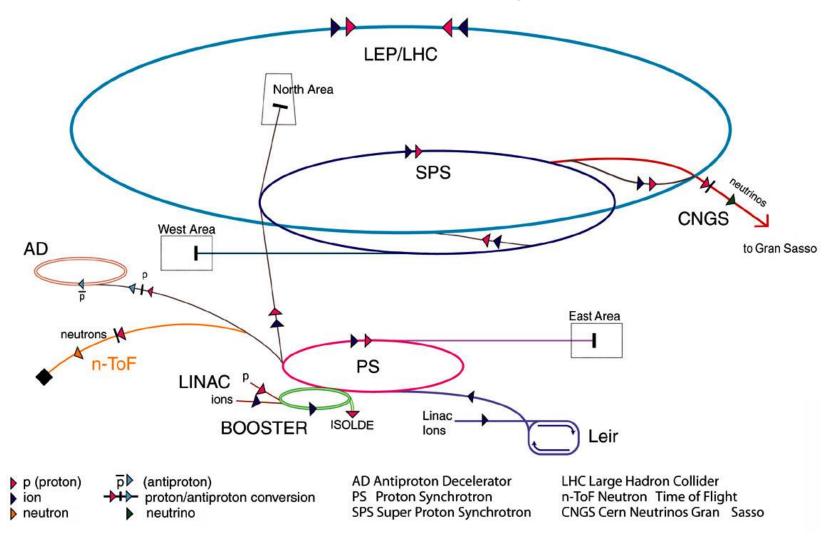
Galaxies Radius of

Radius of observable Universe

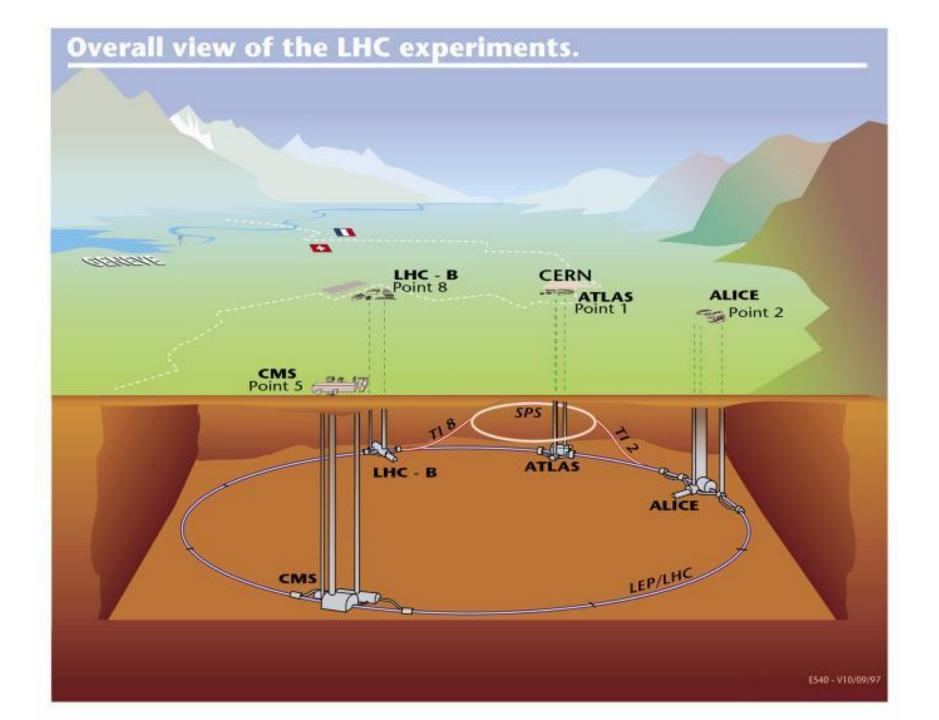
THE PRINCIPAL MACHINE COMPONENTS OF THE LEP ACCELERATOR.



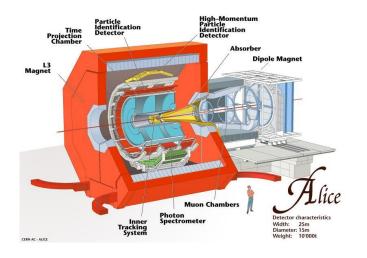
Accelerator chain at CERN, a complex business

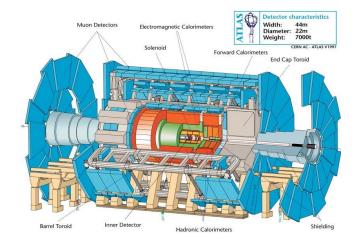


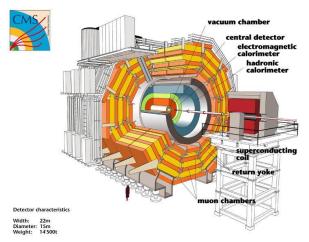


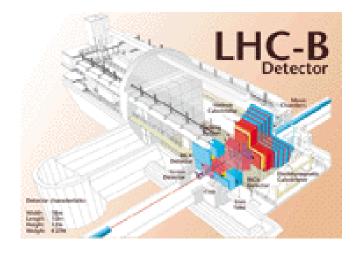


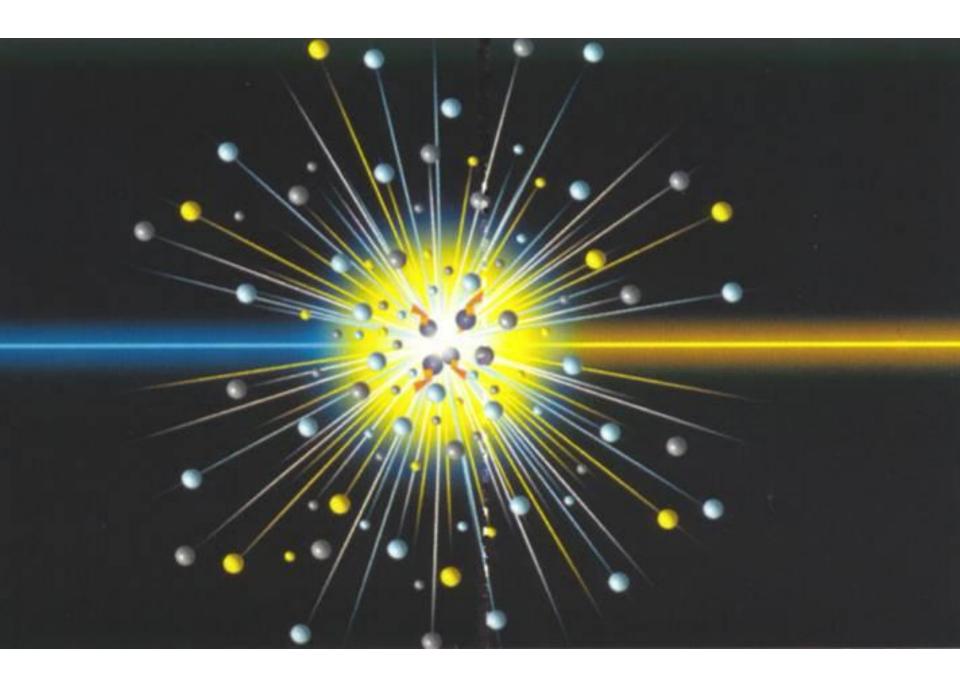
LHC Experiments

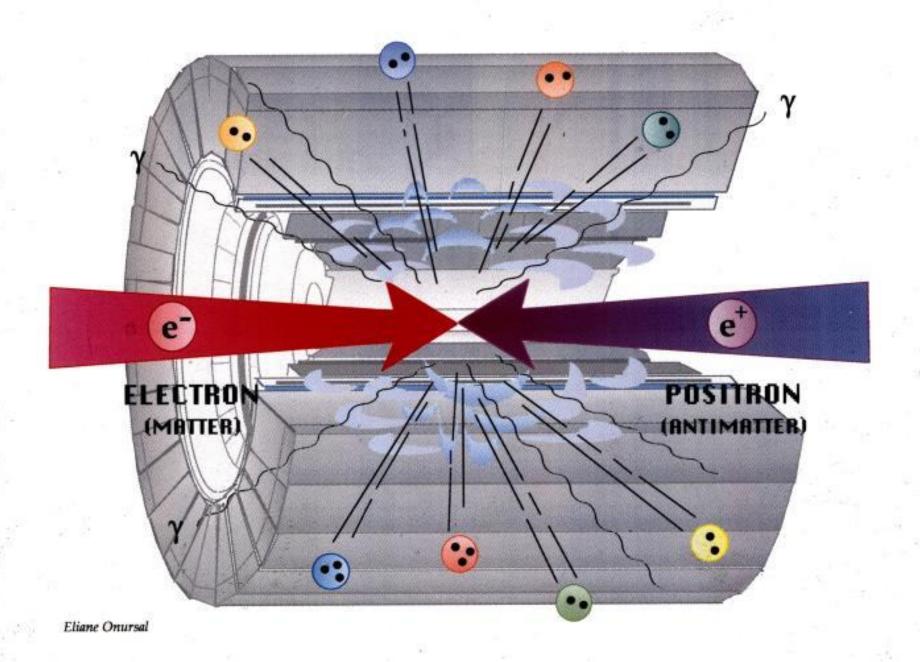


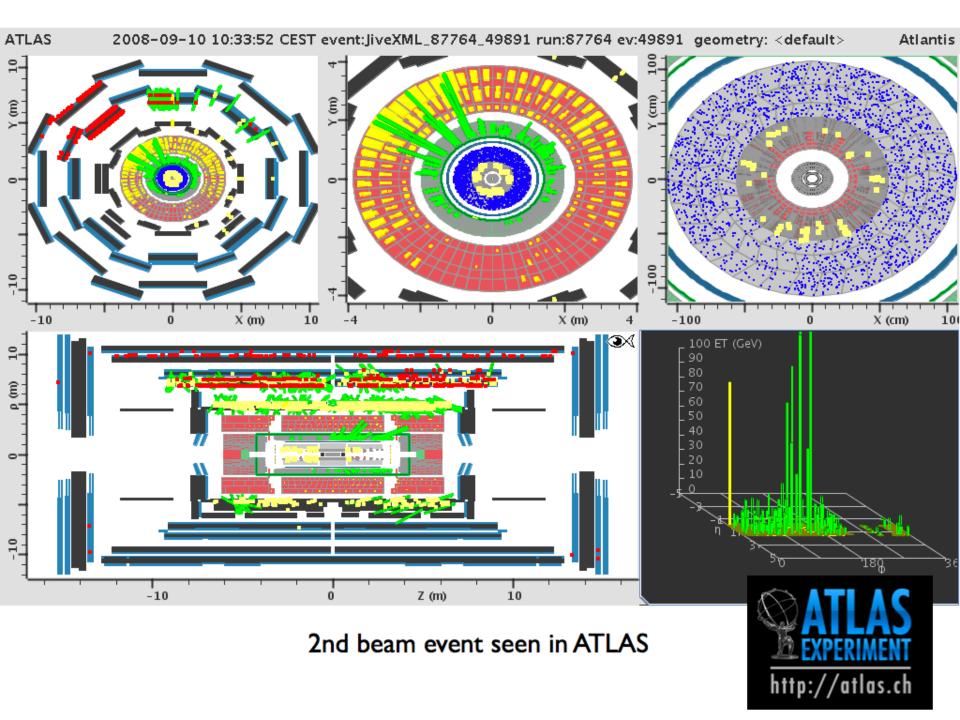


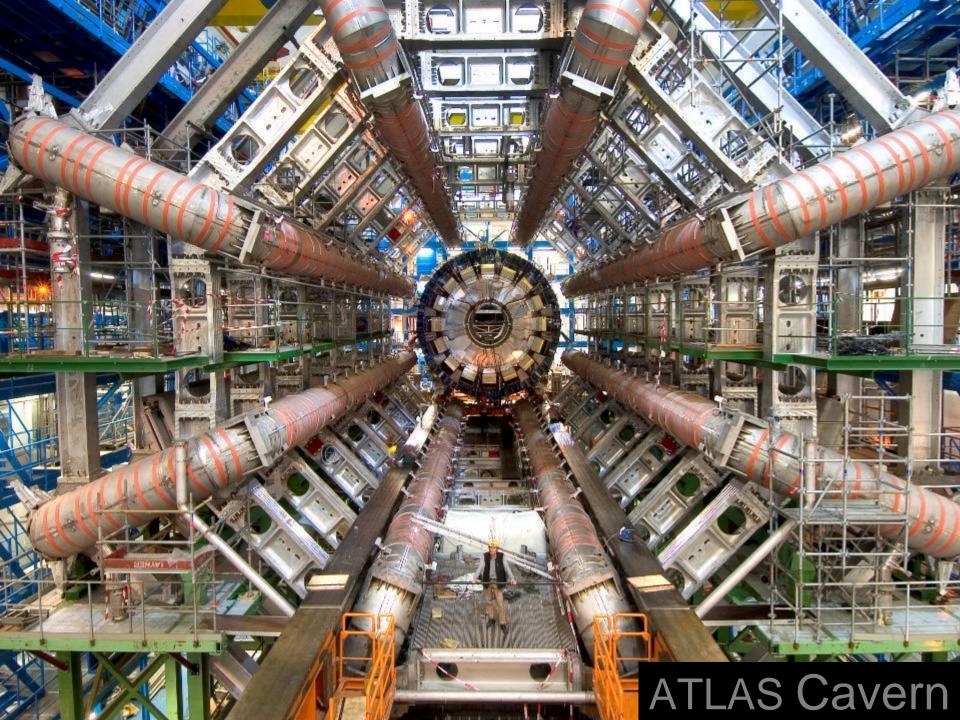




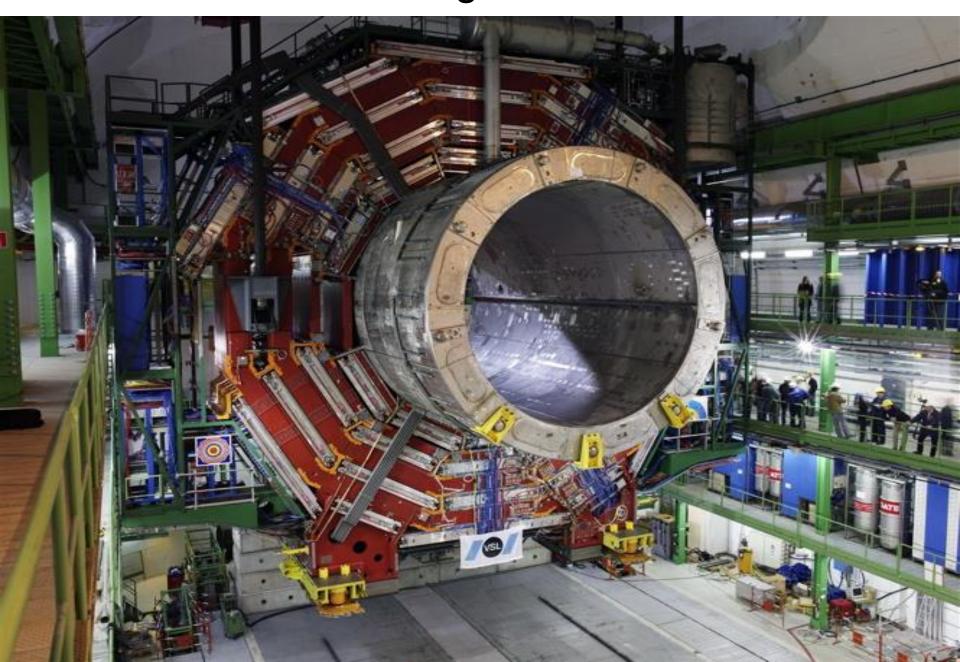








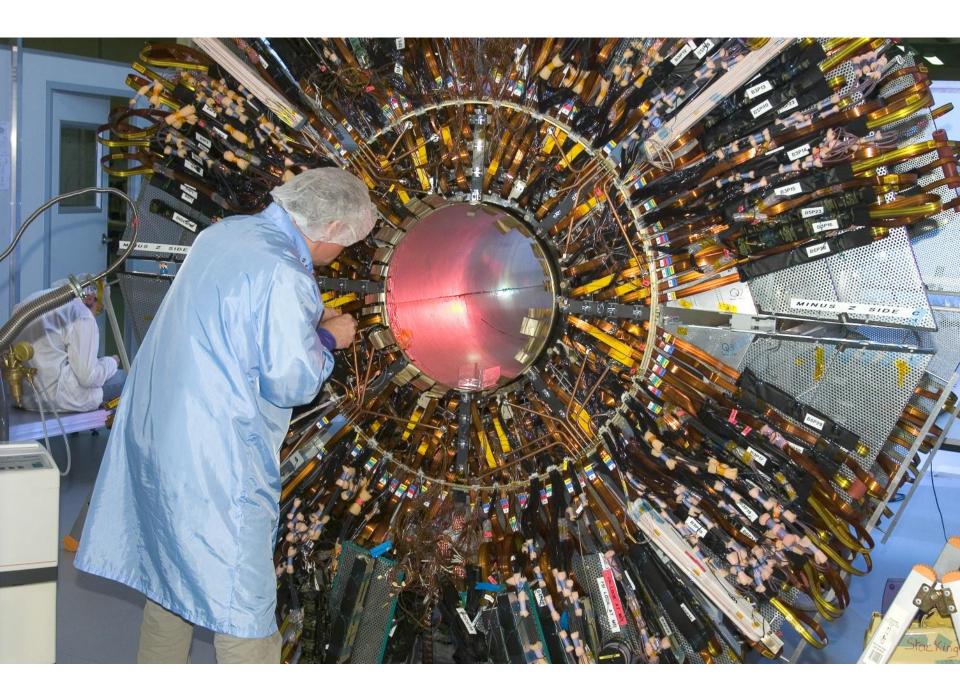
Building CMS

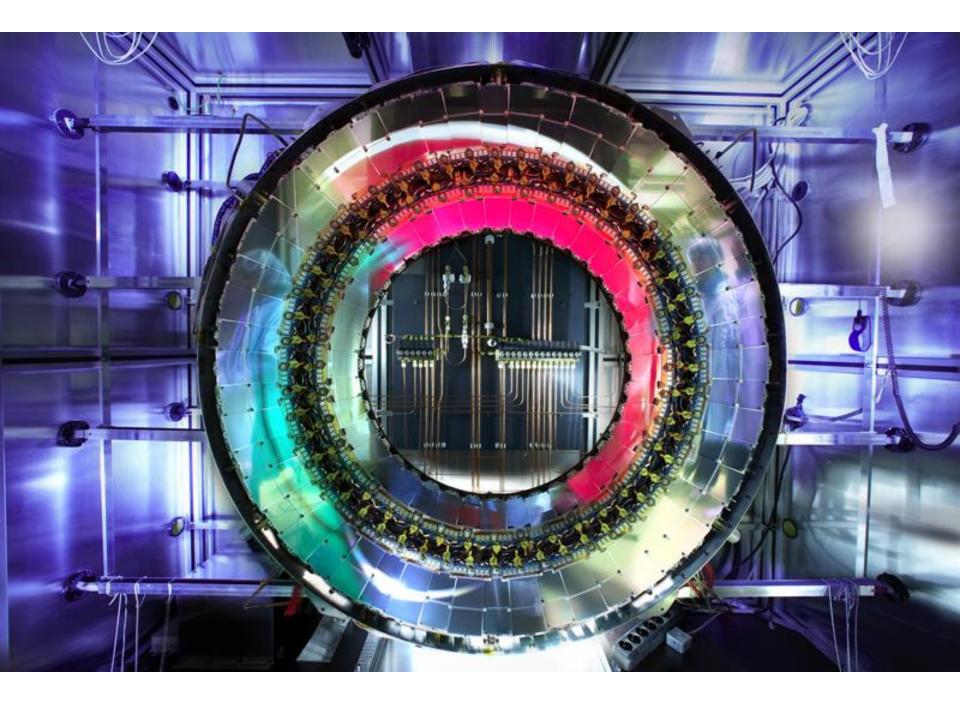


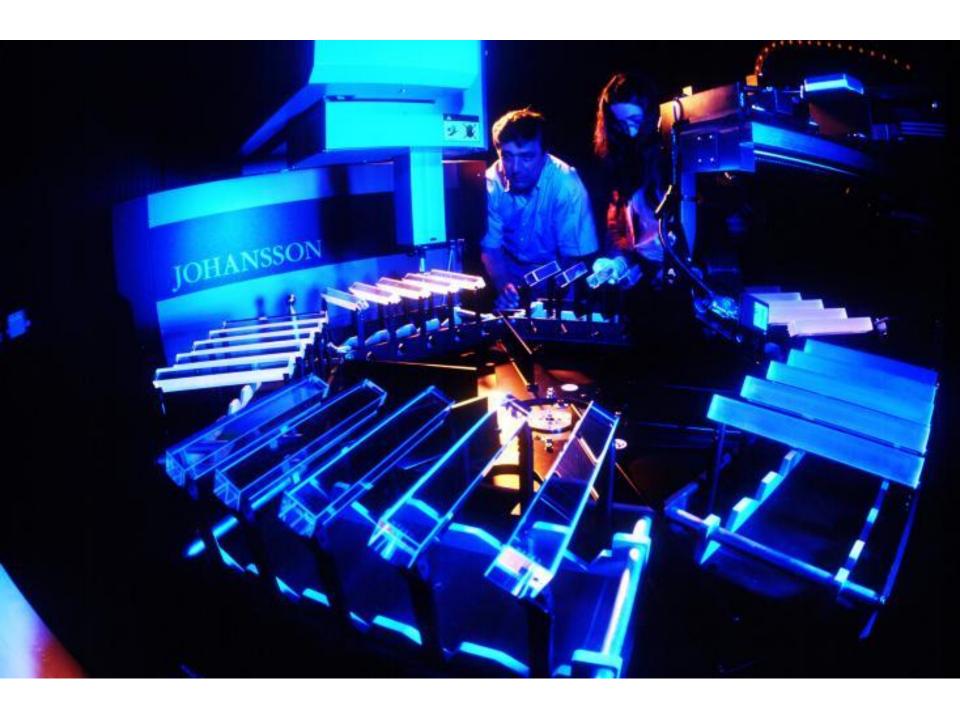














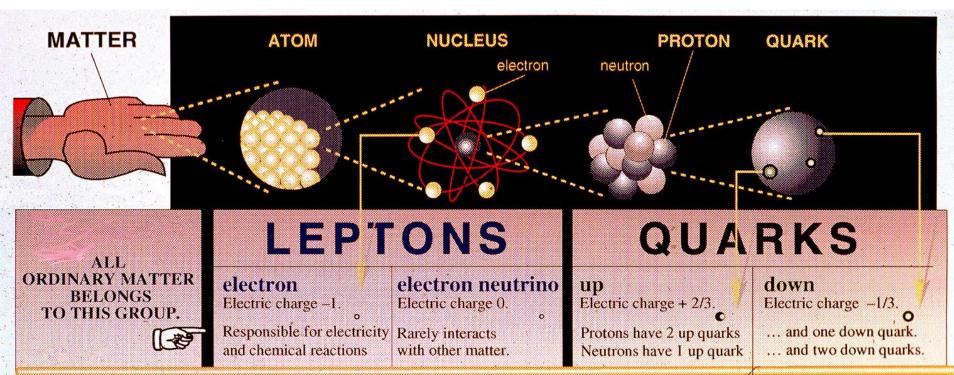












THESE PARTICLES
EXISTED JUST
AFTER THE
BIG BANG.

NOW THEY ARE
FOUND ONLY
IN COSMIC RAYS
AND ACCELERATORS.

muon

tau

still.

Heavier

A heavier relative of the electron.

0

muon neutrino

Created with muons when some particles decay.

tau neutrino

Not yet observed directly.

charm

A heavier relative of the up.

top.

still,

Heavier

recently

observed.



strange

A heavier relative of the down.



bottom

Heavier still.



ANTIMATTER

Each particle also has an antimatter counterpart ... sort of a mirror image.



Mass Ratios of Elementary Particles (MeV)

	Lepton	Neutrino	Quark 1	Quark 2
1st Family	0.5	0	3	6
2nd Family	106	0	1300	100
3rd Family	1800	0	175000	4500

	Lepton	Neutrino	Quark 1	Quark 2
1st Family	1	0	1	1
2nd Family	212	0	433	17
3rd Family	3600	0	58333	750

	Lepton	Q1/Q2	L/(Q1/Q2)
1st Family	1	1	1
2nd Family	212	26	8
3rd Family	3600	78	46

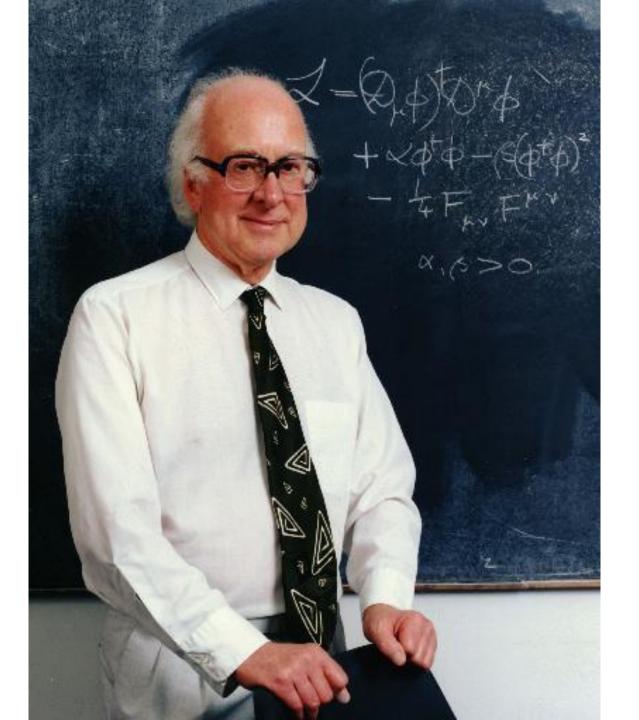
Basic Forces and their Carriers

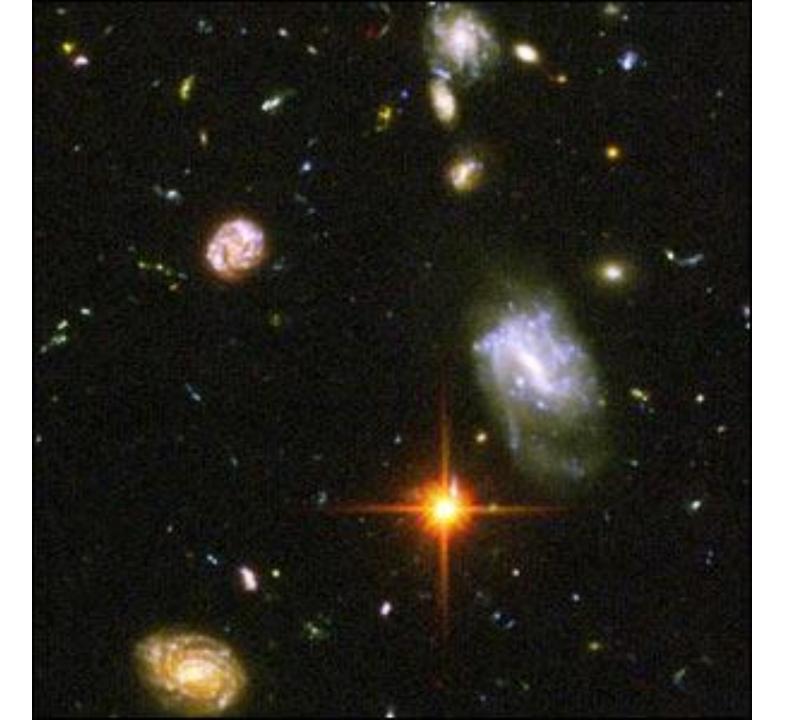
Gluon

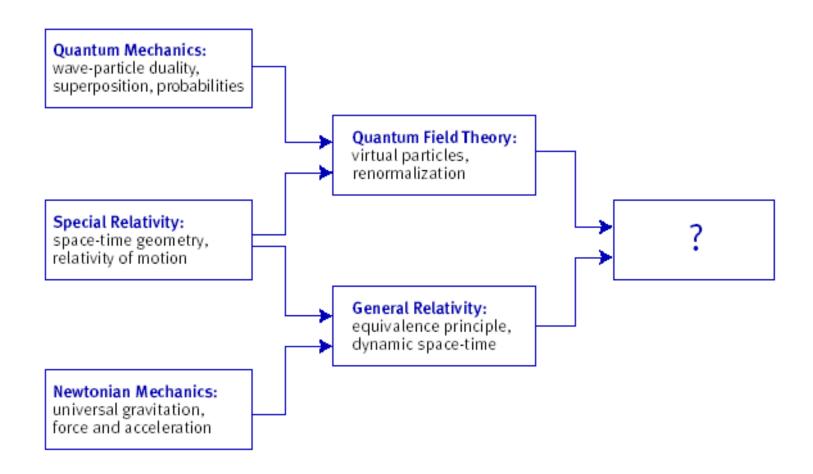
Strong Force:

	Electro-Magnetic Force:	Photon
2505/95/26 14:12	Weak Force:	Bosons (W, Z)
	Gravitation: Falling apples, orbiting Moon	Graviton

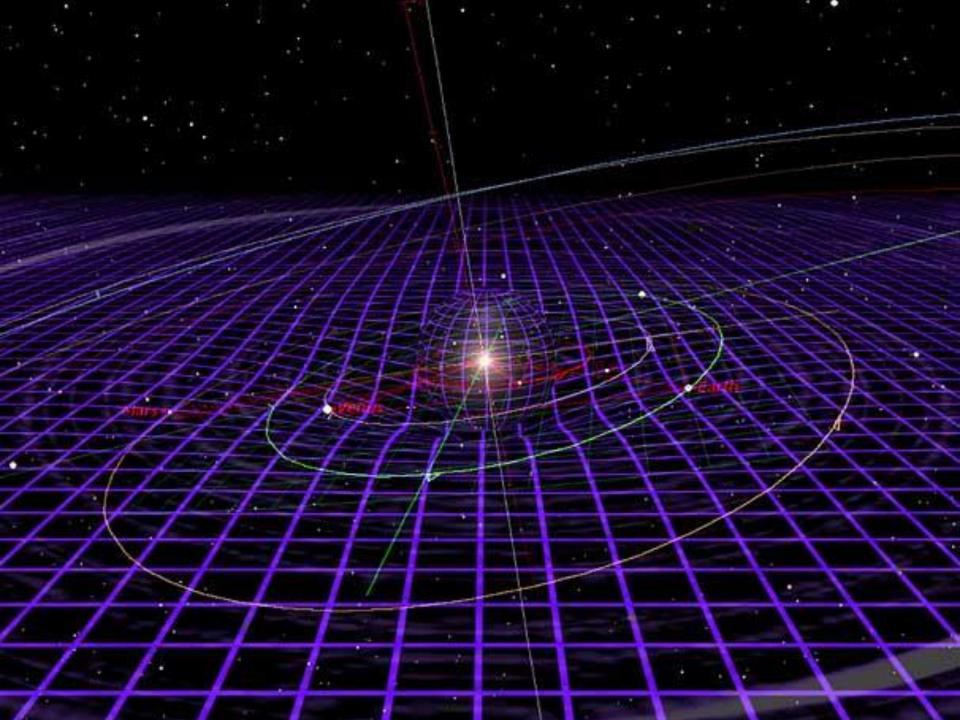
Relative strength $\sim (1/10^{38})$



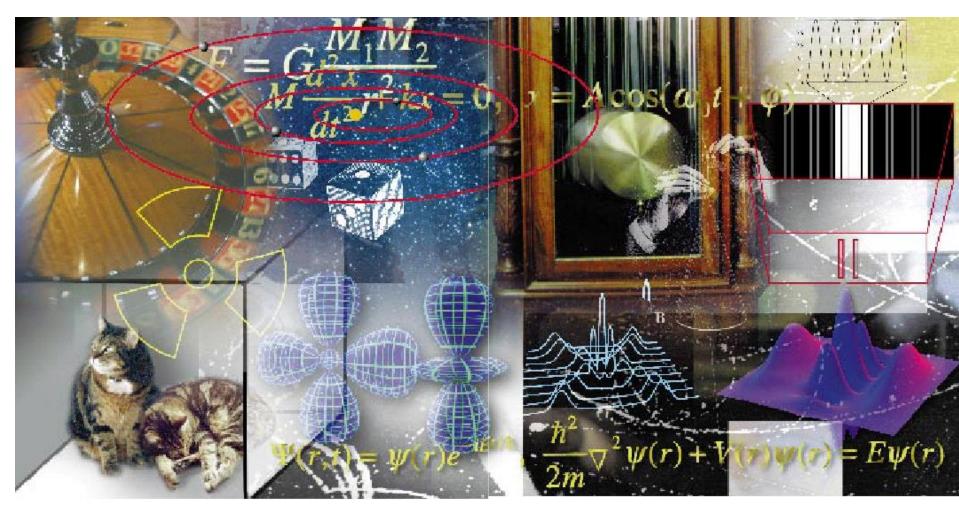






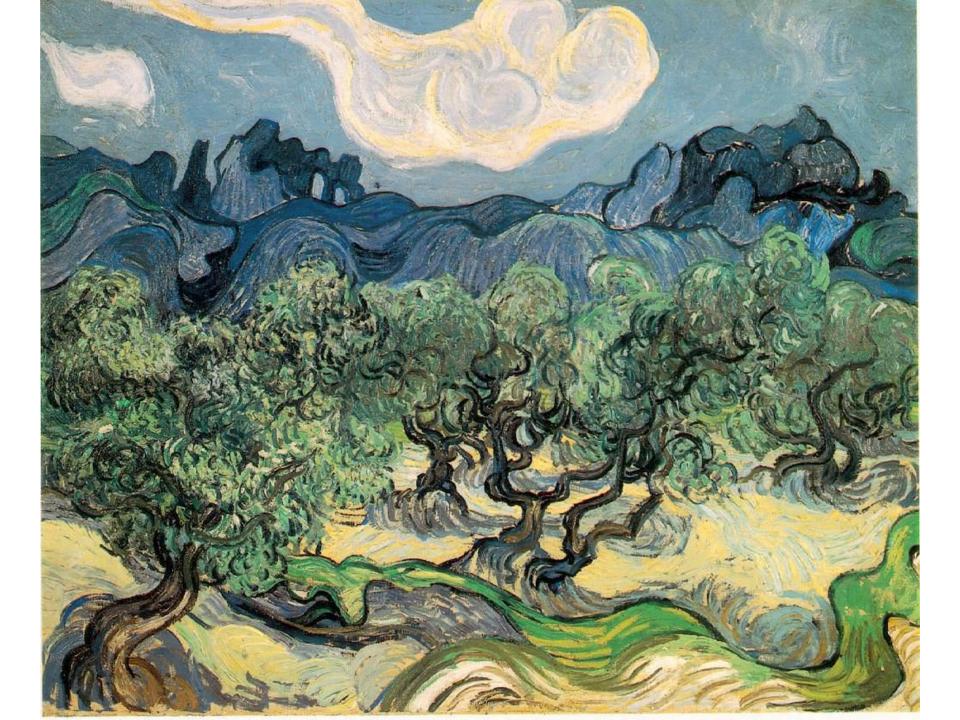






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Bringing Schrödinger's Cat to Life











SEEING INTERFERENCE

- Wrap the tinfoil around the business end of the laser and put a pinhole in it to let through some of the light beam.
- Set up the laser so it shines on the screen from at least six feet away. It should produce a circular spot of light on the screen.
- Position the wire vertically and centered in the light.
 WHAT HAPPENS: As shown, you should see an interference pattern consisting of a row of fringes { bright and dark bands}. The interference pattern arises because light passing on the left of the

wire is combining, or "interfering," with light passing on the righthand side. If you hold a piece of paper just after the wire, you will see a lobe of light on each side of the shadow of the wire. The lobes expand and largely overlap by the time they reach the screen. For each individual photon arriving at the screen in the overlap region, it is impossible to tell whether it went on the left or the right side of the wire, and the combination of the two ways it went causes the fringes. Although you are looking at trillions of photons, each of them is interfering only with itself.



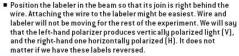


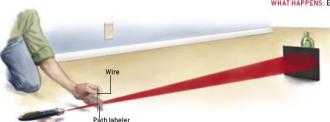
INTERFERENCE seen is captured in this photograph. The size and other features of the patterns depicted in the diagrams are exaggerated.



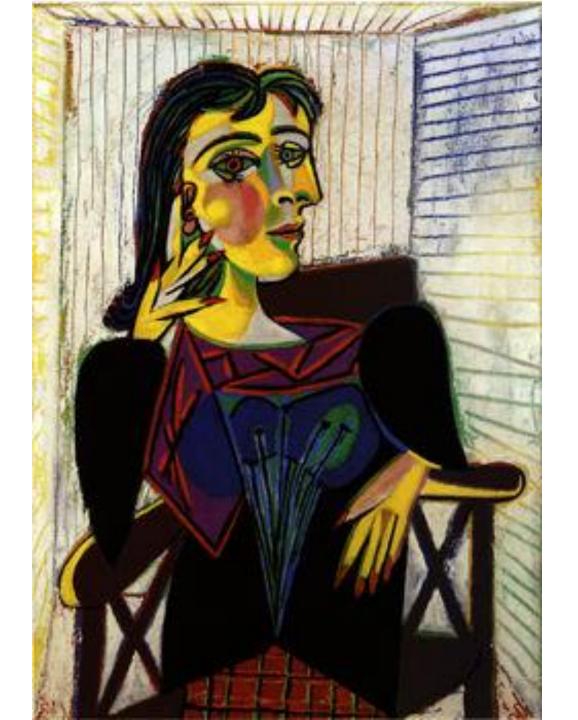
LABELING THE PATH

- Take two polarizers and rotate one of them so that their axes are perpendicular; you have done this correctly if when you overlap the film temporarily, no light goes through the overlap region.
- Tape them together side by side with no gap or overlap. Do the taping along the top and bottom so the tape will not block the light. We will call this the path labeler.

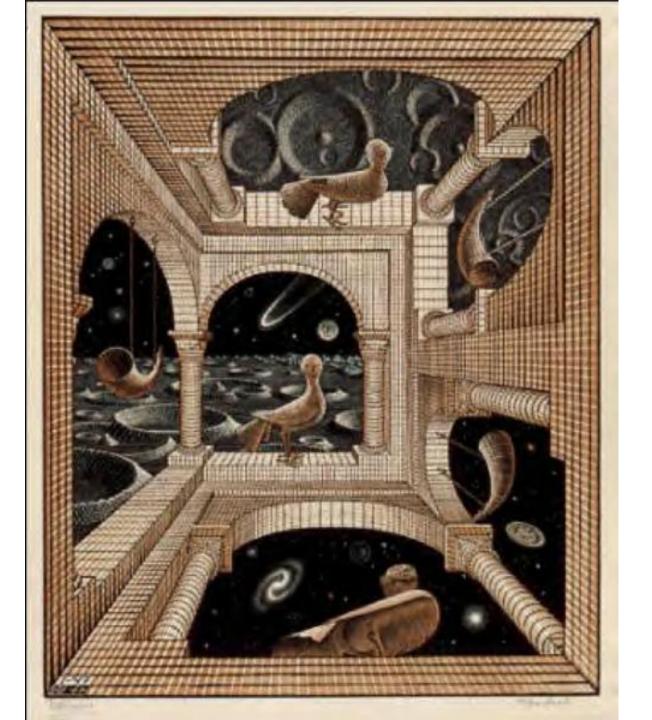


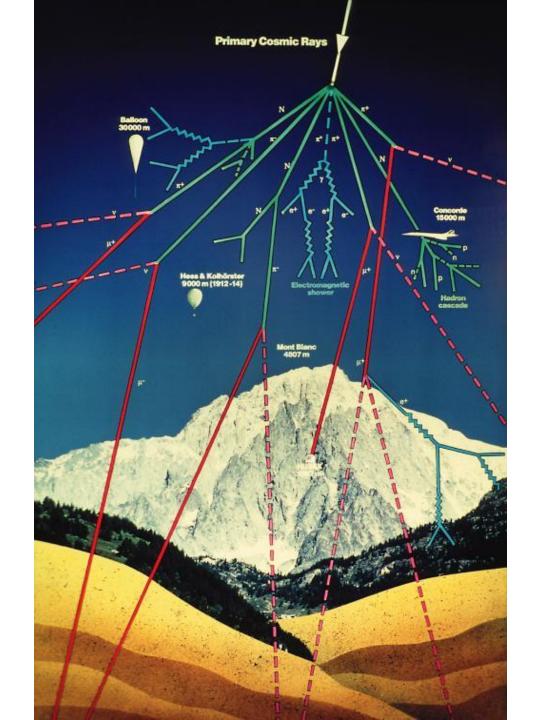


WHAT HAPPENS: Even though the light is again passing on both sides of the wire, the fringes should be gone. If a photon reaches the screen by passing to the left of the wire, it arrives V-polarized; if to the right of the wire, H-polarized. Thus, the labeler has made available the information about which way each photon went, which prevents the interference.

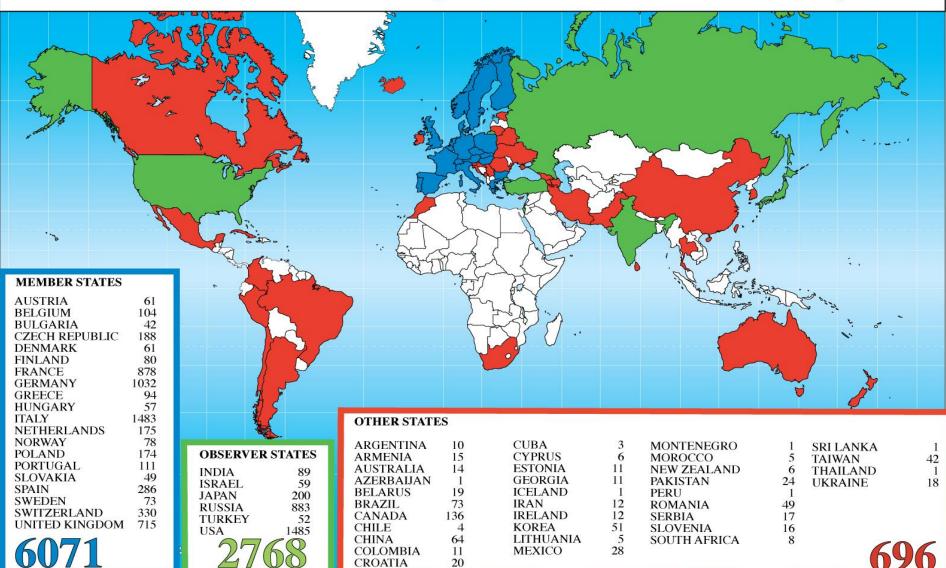








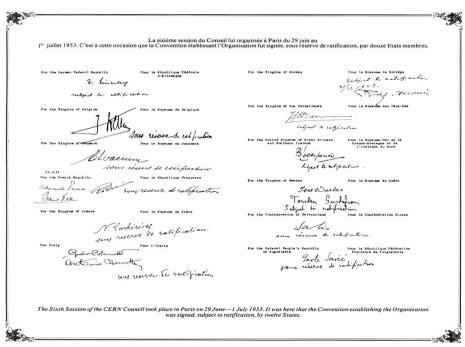
Distribution of All CERN Users by Nation of Institute on 6 January 2009



CERN

European Organization for Nuclear Research

- Founded in 1954 by 12 countries
- Now: 22 member states, 5 + 2 observers (jp, ru, tr, us, EU, Unesco)
- More than 7000 users from all over the world
- ~1000 Meur / Year budget





2007: The 20 member states

1954: Convention establishing the Organization - original signatures

CERN ORGANISATIONAL CHART 07/2001

