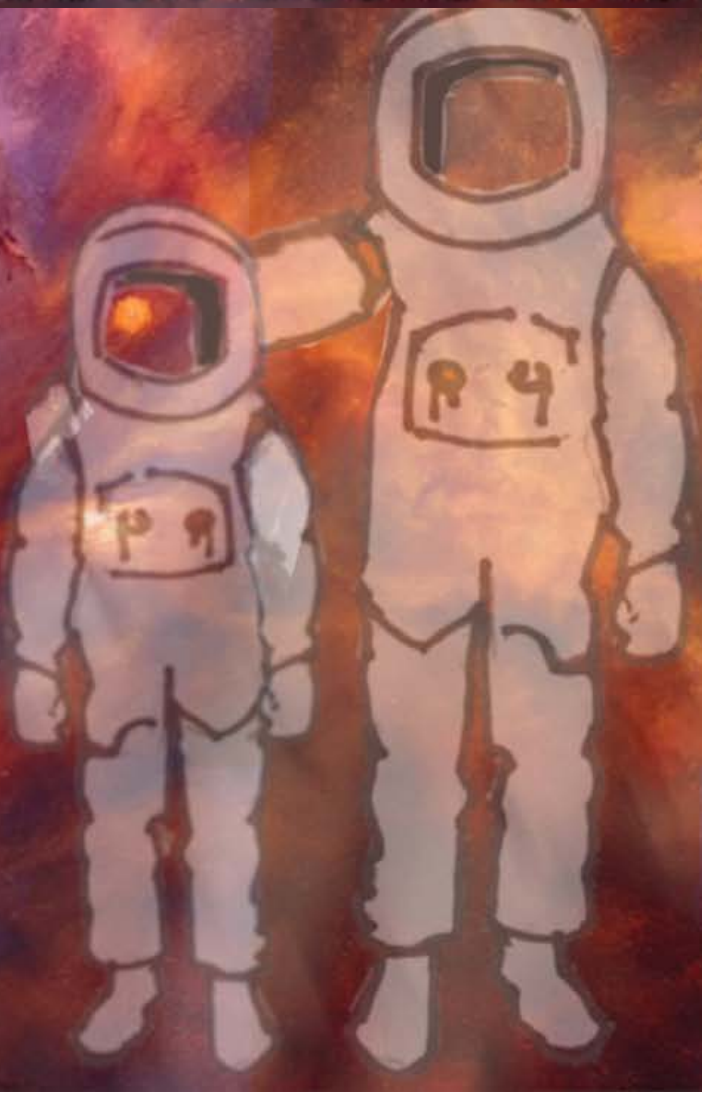
INSPYRE
INternational School on modern PhYsics and REsearch
ONLINE EDITION

Welcome to INSPYRE 2020
Hitchhikers in the Universe!

Catalina Curceanu
LNF-INFN

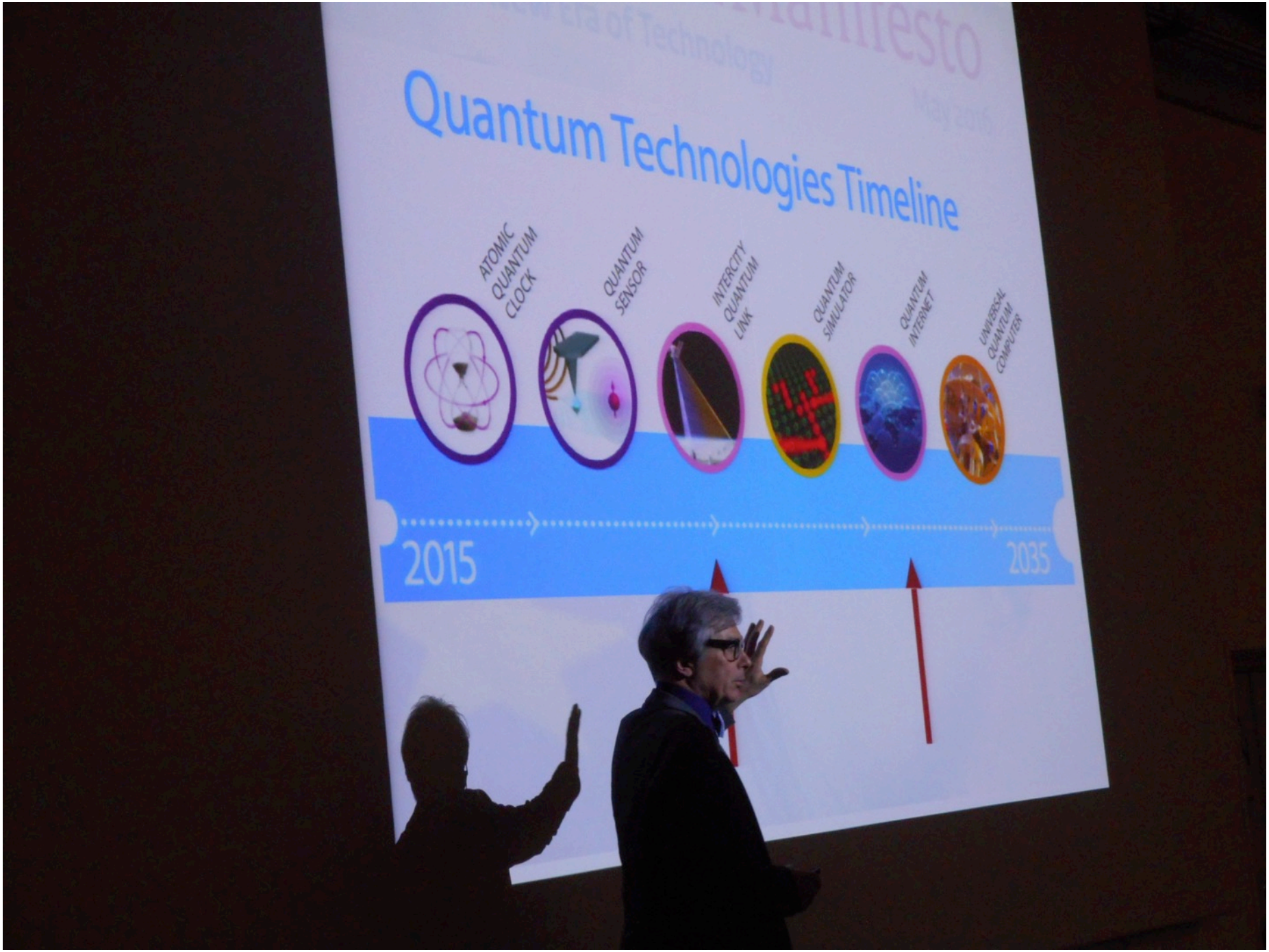



"The Hitchhiker's Guide to the...Universe"
INFN
Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati
INSPYRE
INternational School on modern PhYsics and REsearch
10th Edition, March 30th - April 3rd, 2020
Online edition
Directors
Catalina Curceanu, Rossana Centioni
Organization
Camilla Paola Maglione, Debora Bifaretti, Sara Arnone
In this difficult situation generated by COVID-19, we want to give you some positive message, a hope for the future: INSPYRE 2020 is here for you, to inspire and guide you into the beauty of science.
In 2020 INSPYRE – INternational School on modern PhYsics and Research – celebrates 10 years since its birth. The 2020 INSPYRE edition, "The Hitchhiker's Guide to the… Universe", is dedicated to the hottest topics and challenges in Modern Physics, from particles to cosmology. Through a series of online talks, we'll guide our travellers in a fantastic journey from quarks to black holes, from gravity to quantum physics and technologies, up to the main experimental facilities of LNF and CERN. Get ready to be INSPYRED!
CENTRO FERMI
MUSEO STORICO DELLA FISICA E CENTRO STUDI E RICERCHE ENRICO FERMI
frascati scienza
NuPECC
STRONG 2020
Servizio Informazione e Divulgazione Scientifica
stages@lists.lnf.infn.it

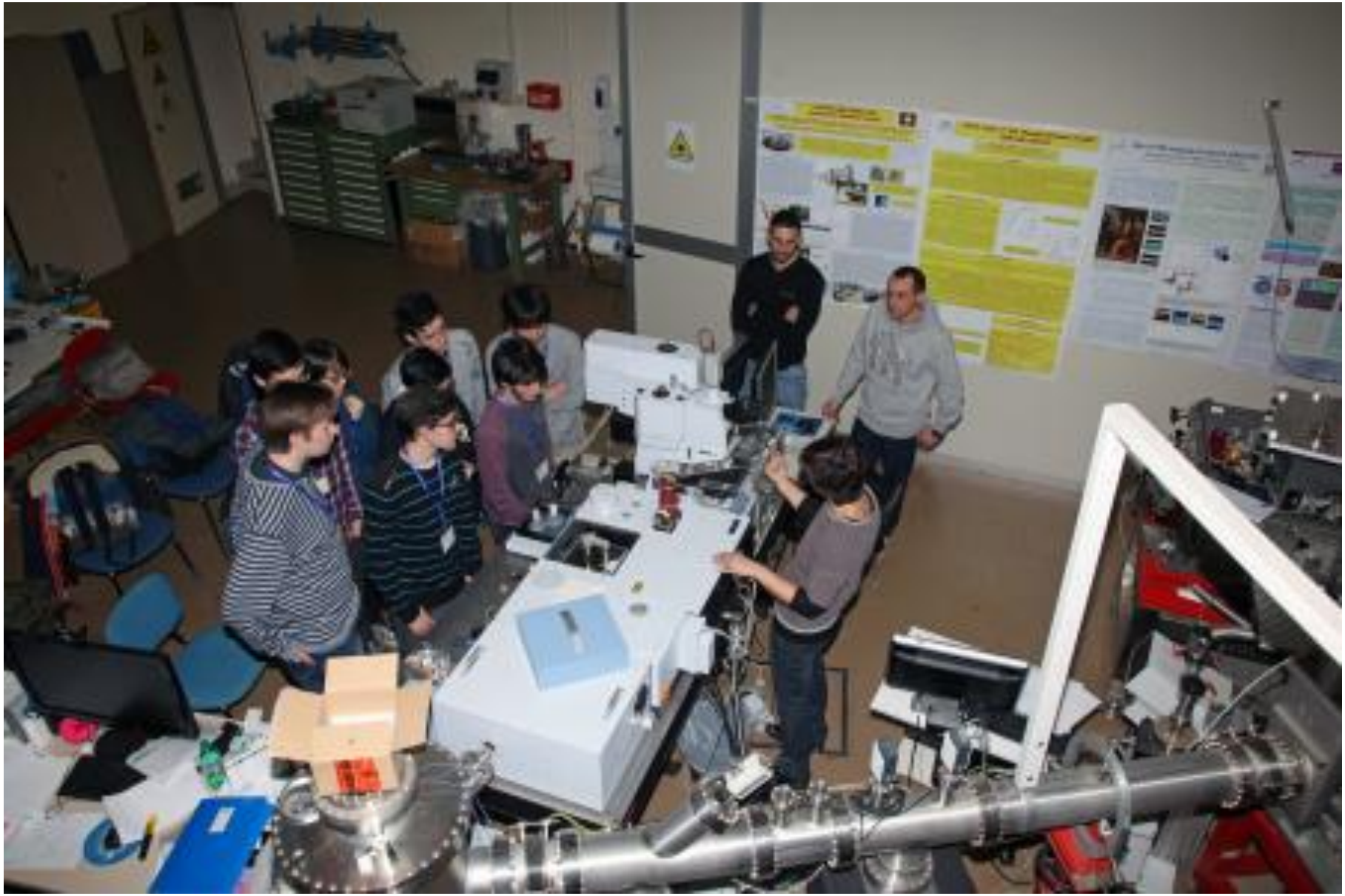
INSPYRE 2019:
About 90 students
of 15 nationalities
from 46 schools
all around the world!

INSPYRE 2020:100 students registered!


INSPYRE 2019
INternational School on modern PhYsics and REsearch
"Challenges in Modern Physics and Quantum Technologies"
INFN
Laboratori Nazionali di Frascati
Auditorium B. Touschek
9th Edition, April 1st - 5th 2019
Directors
Organization
cost
SIDS-Ufficio Educazione e Divulgazione Scientifica
EDU.LNF.INFN.IT
LNF-INFN (Photo by C. Federici 2019)


Quantum Technologies Timeline
ATOMIC QUANTUM CLOCK
QUANTUM SENSOR
INTERCITY QUANTUM LINK
QUANTUM SIMULATOR
QUANTUM INTERNET
UNIVERSAL QUANTUM COMPUTER
2015
2035

Hands-on



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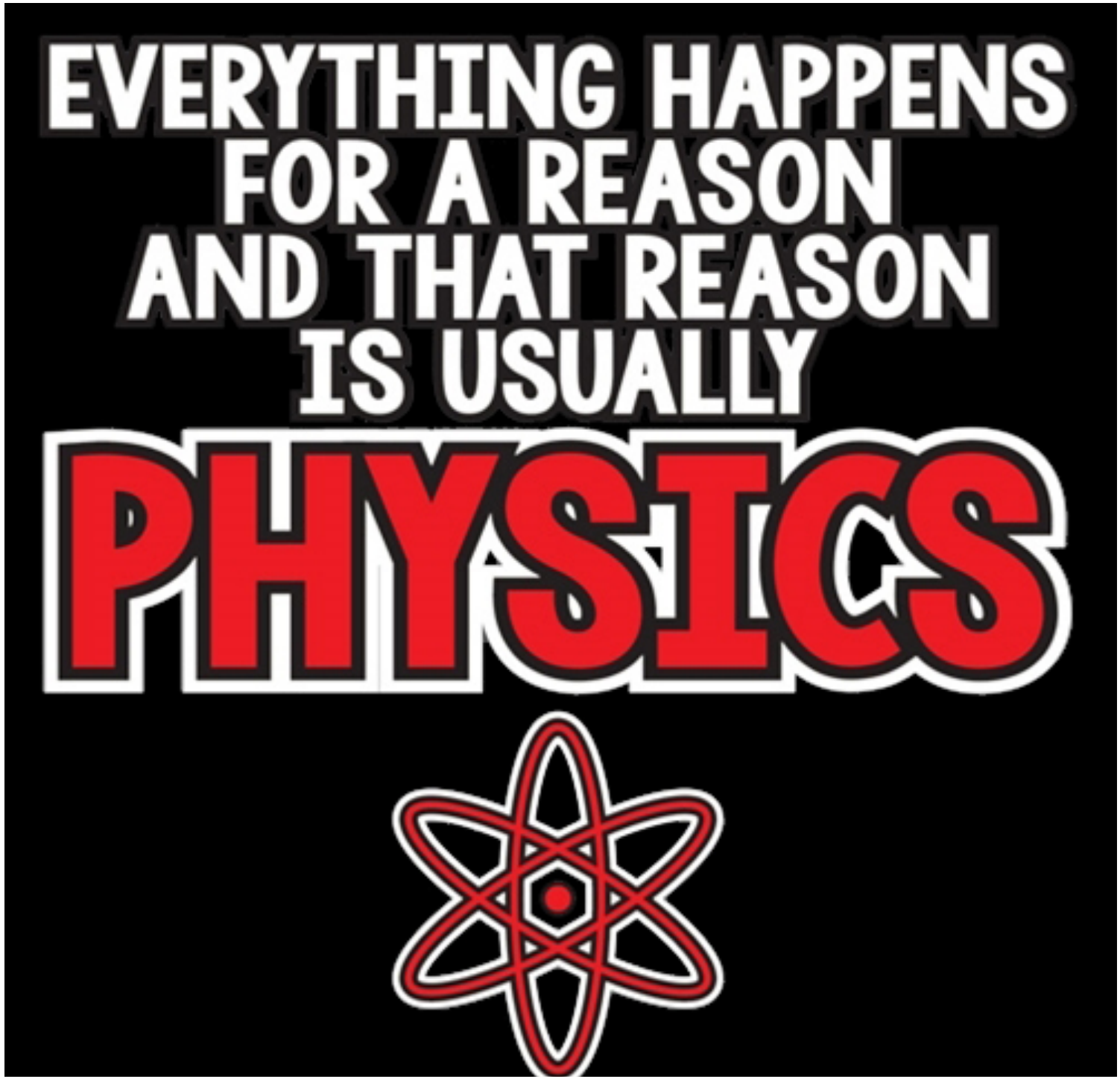
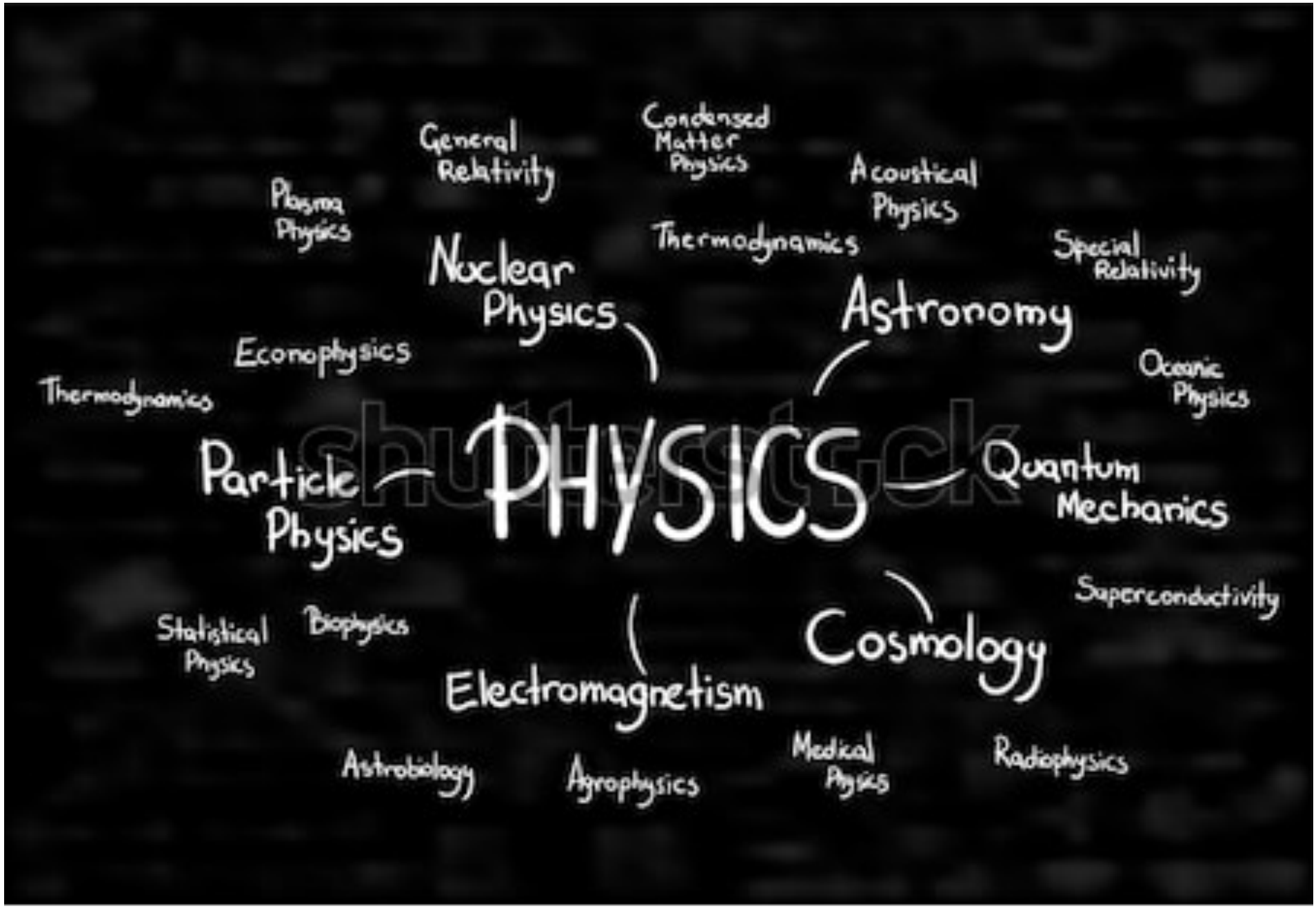
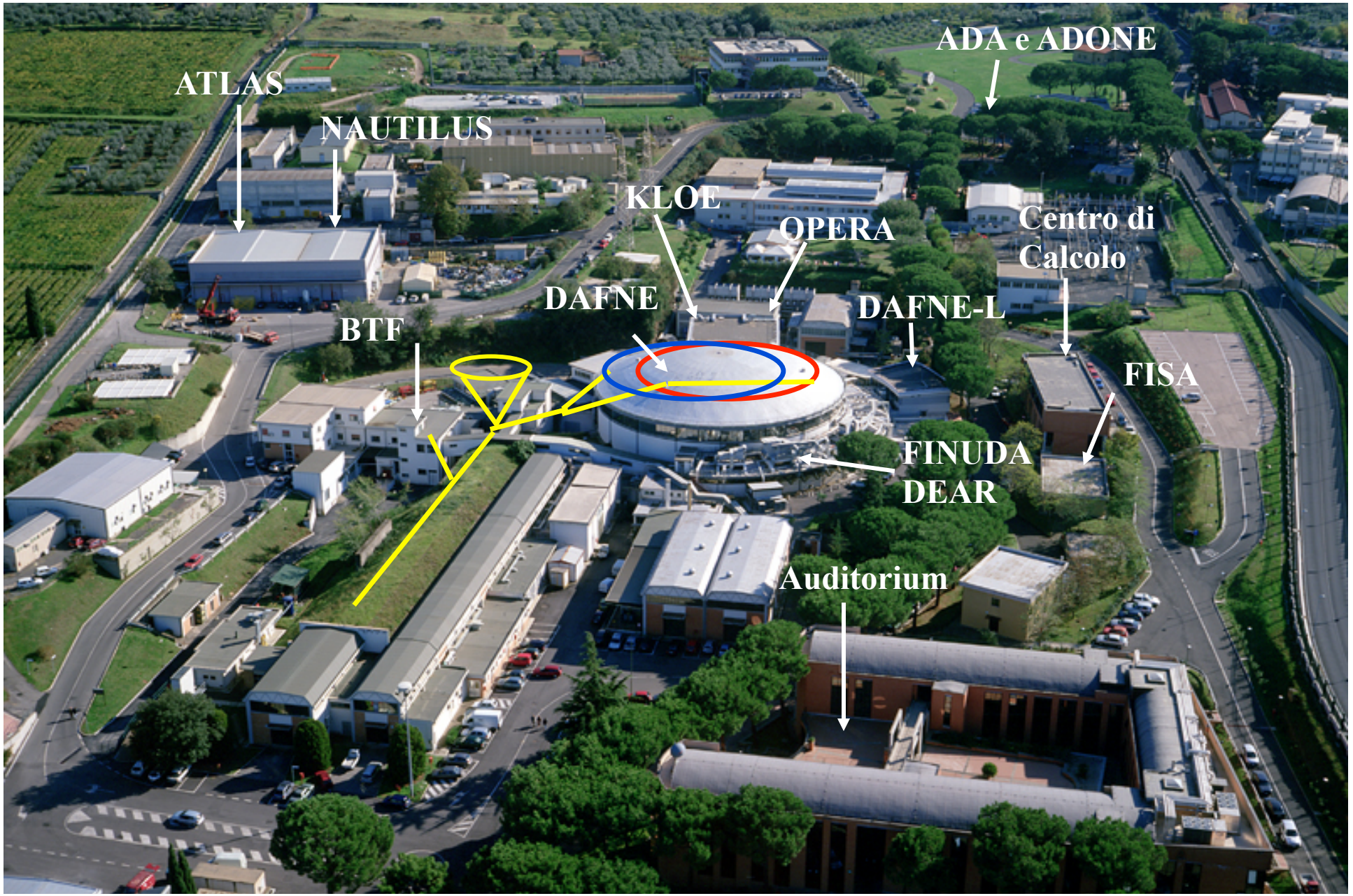
EVERYTHING HAPPENS
FOR A REASON
AND THAT REASON
IS

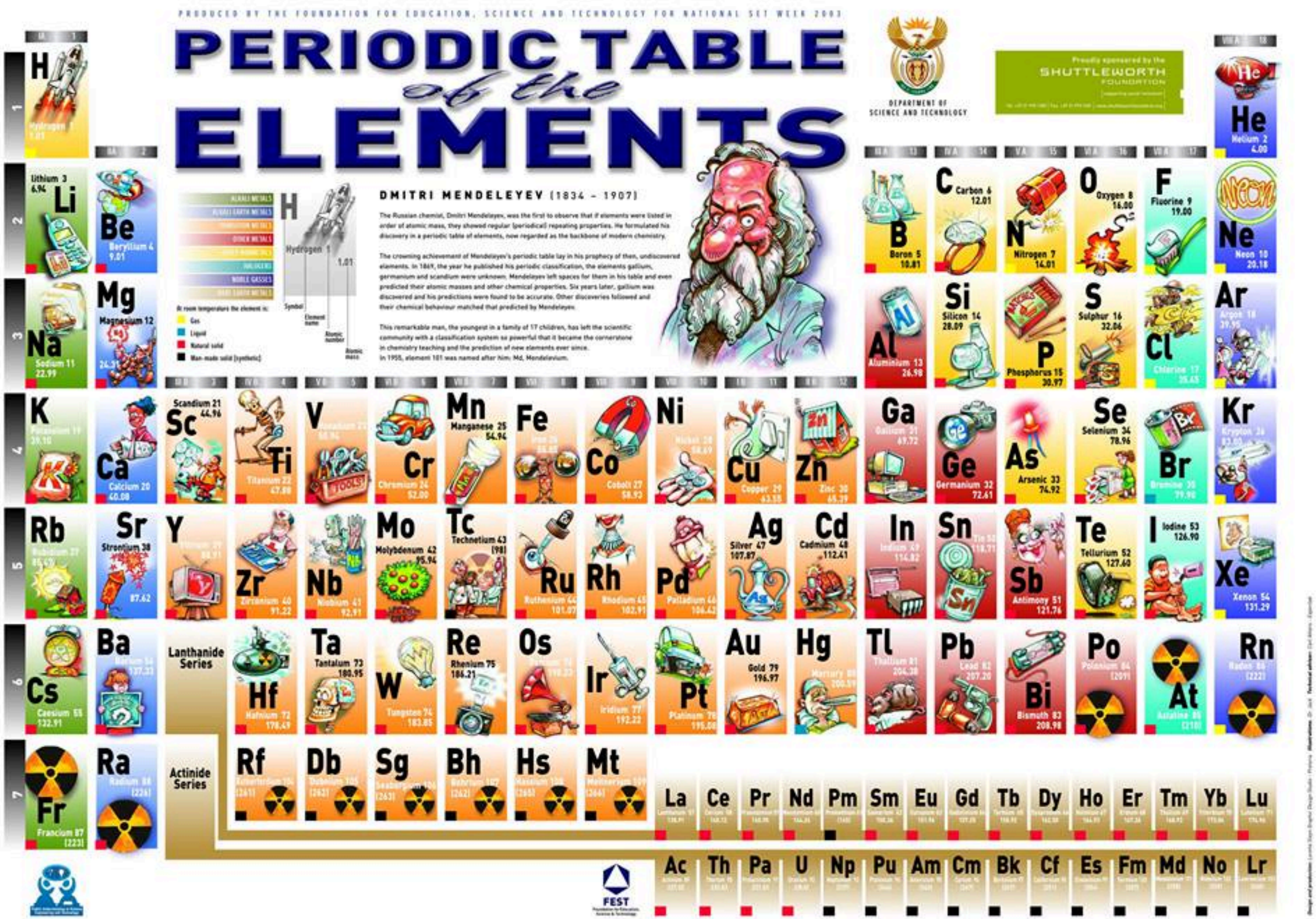

EVERYTHING HAPPENS
FOR A REASON
AND THAT REASON
IS USUALLY
PHYSICS

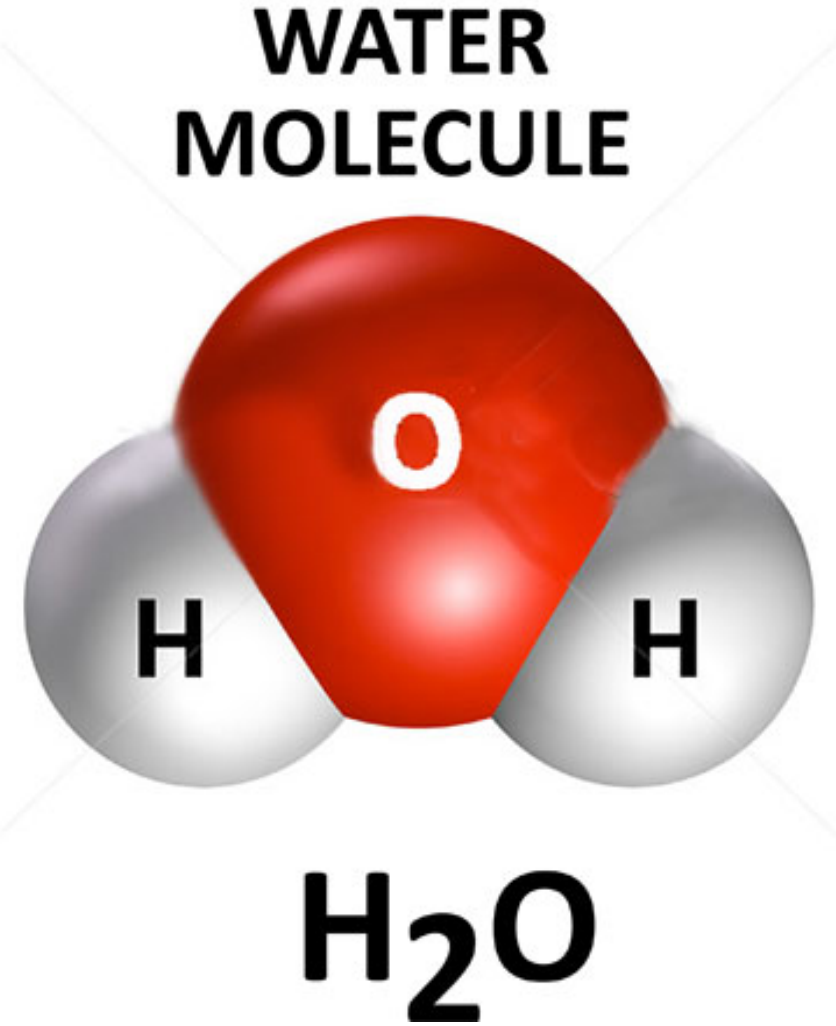


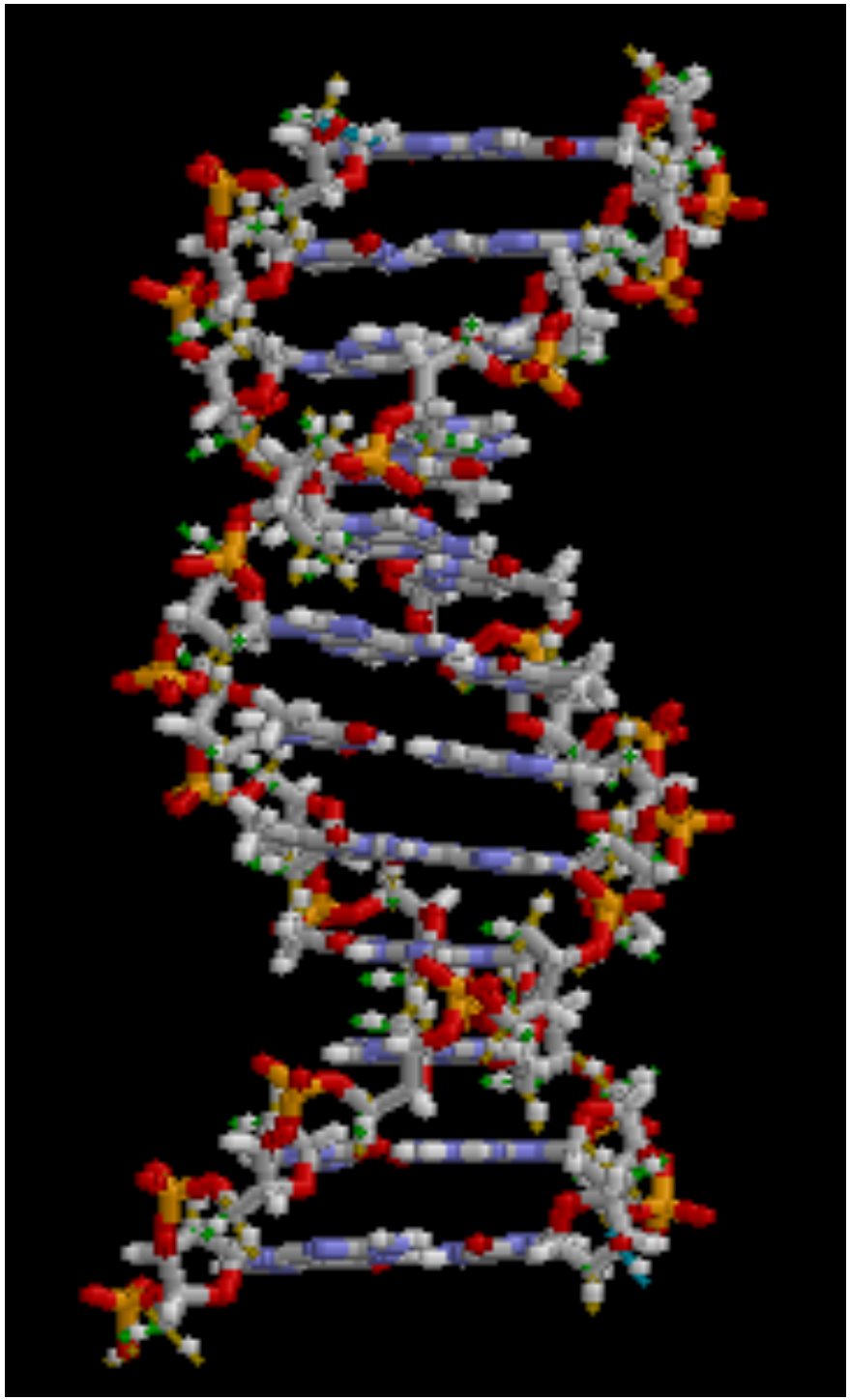
Inside LNF-INFN

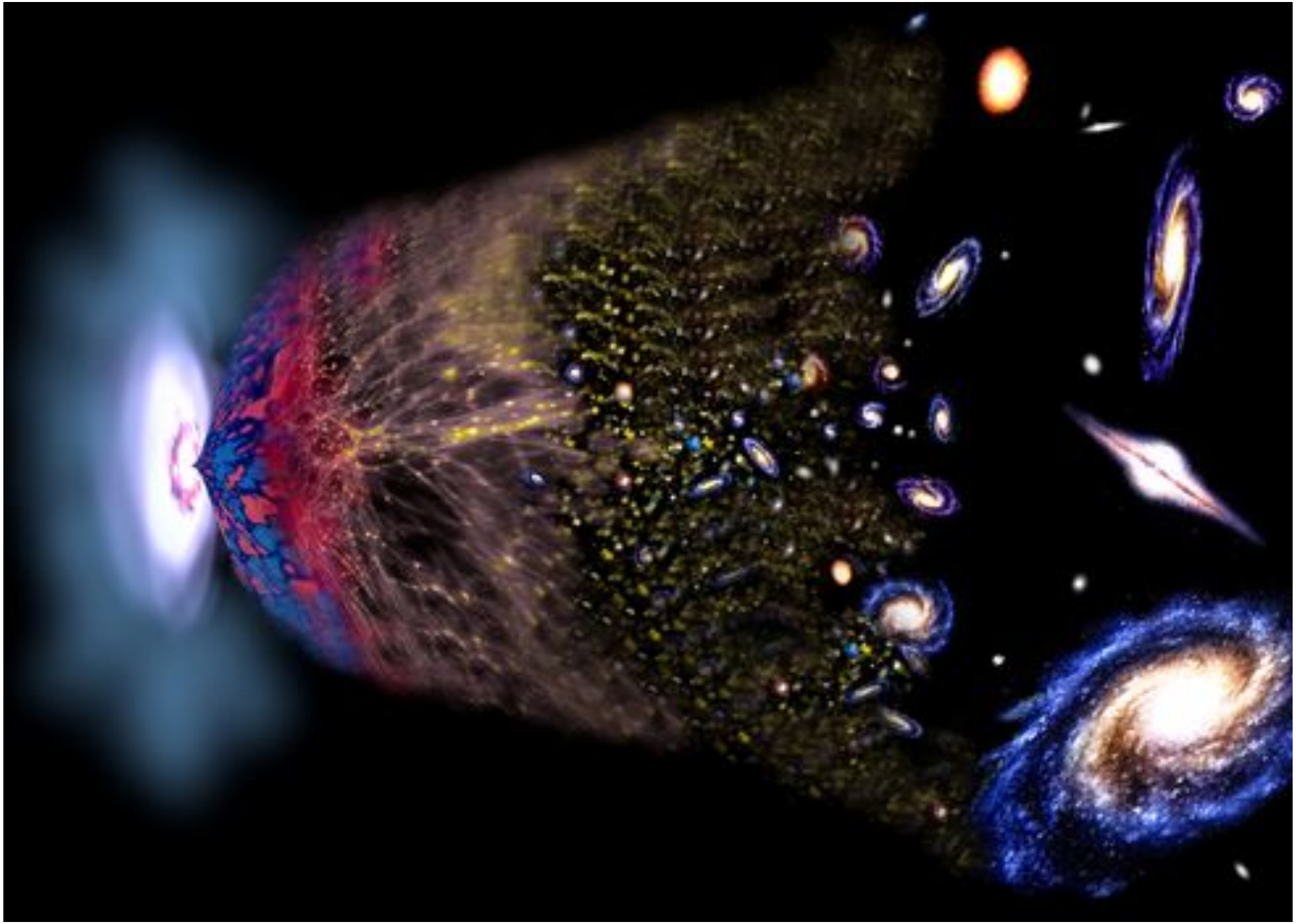
Laboratori Nazionali di Frascati




PRODUCED BY THE FOUNDATION FOR EDUCATION, SCIENCE AND TECHNOLOGY FOR NATIONAL SET WEEK 2003
PERIODIC TABLE of the ELEMENTS
DEPARTMENT OF SCIENCE AND TECHNOLOGY
Proudly sponsored by the SHUTTLEWORTH FOUNDATION
DMITRI MENDELEYEV (1834 – 1907)
The Russian chemist, Dmitri Mendelayev, was the first to observe that if elements were listed in order of atomic mass, they showed regular (periodical) repeating properties. He formulated his discovery in a periodic table of elements, now regarded as the backbone of modern chemistry.
The crowning achievement of Mendelayev's periodic table lay in his prophecy of then, undiscovered elements. In 1869, the year he published his periodic classification, the elements gallium, germanium and scandium were unknown. Mendelayev left spaces for them in his table and even predicted their atomic masses and other chemical properties. Six years later, gallium was discovered and his predictions were found to be accurate. Other discoveries followed and their chemical behaviour matched that predicted by Mendelayev.
This remarkable man, the youngest in a family of 17 children, has left the scientific community with a classification system so powerful that it became the cornerstone in chemistry teaching and the prediction of new elements ever since.
In 1955, element 101 was named after him: Md, Mendelevium.
ALKALI METALS
ALKALI EARTH METALS
TRANSITION METALS
OTHER METALS
HALOGENS
NOBLE GASSES
RARE EARTH METALS
At room temperature the element is:
Gas
Liquid
Natural solid
Man-made solid (synthetic)
H Hydrogen 1 1.01
Symbol
Element name
Atomic number
Atomic mass
H Hydrogen 1 1.01
He Helium 2 4.00
Lithium 3 6.94 Li
Be Beryllium 4 9.01
B Boron 5 10.81
C Carbon 6 12.01
N Nitrogen 7 14.01
O Oxygen 8 16.00
F Fluorine 9 19.00
Ne Neon 10 20.18
Na Sodium 11 22.99
Mg Magnesium 12
Al Aluminium 13 26.98
Si Silicon 14 28.09
P Phosphorus 15 30.97
S Sulphur 16 32.06
Cl
Ar
K
Ca Calcium 20 40.08
Scandium 21 44.96 Sc
Ti Titanium 22 47.88
V
Cr Chromium 24 52.00
Mn Manganese 25 54.94
Fe
Co Cobalt 27 58.93
Ni
Cu Copper 29
Zn Zinc 30
Ga
Ge Germanium 32 72.61
As Arsenic 33 74.92
Se Selenium 34 78.96
Br
Kr
Rb
Sr Strontium 38 87.62
Y
Zr Zirconium 40 91.22
Nb Niobium 41 92.91
Mo Molybdenum 42 95.94
Tc Technetium 43 (98)
Ru Ruthenium 44 101.07
Rh Rhodium 45 102.91
Pd Palladium 46 106.42
Ag Silver 47 107.87
Cd Cadmium 48 112.41
In
Sn
Sb Antimony 51 121.76
Te Tellurium 52 127.60
I Iodine 53 126.90
Xe Xenon 54 131.29
Cs Caesium 55 132.91
Ba
Lanthanide Series
Hf Hafnium 72 178.49
Ta Tantalum 73 180.95
W Tungsten 74 183.85
Re Rhenium 75 186.21
Os
Ir Iridium 77 192.22
Pt Platinum 78 195.08
Au Gold 79 196.97
Hg
Tl
Pb
Bi Bismuth 83 208.98
Po
At
Rn
Fr Francium 87 (223)
Ra
Actinide Series
Rf Db Sg Bh Hs Mt
La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
Ac Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr
FEST


WATER
MOLECULE
O
H
H
H2O





Modern Physics:

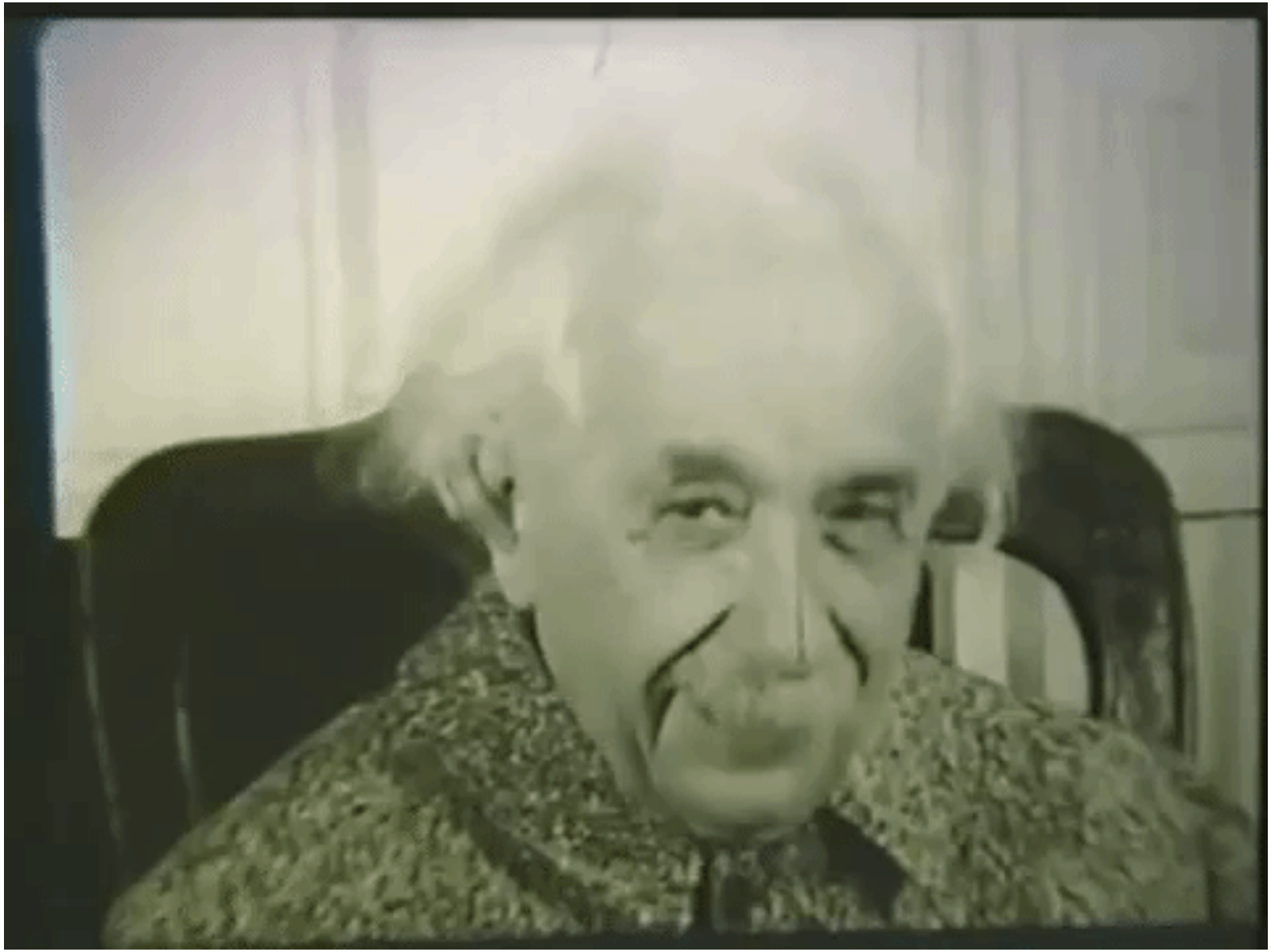
Pillars:

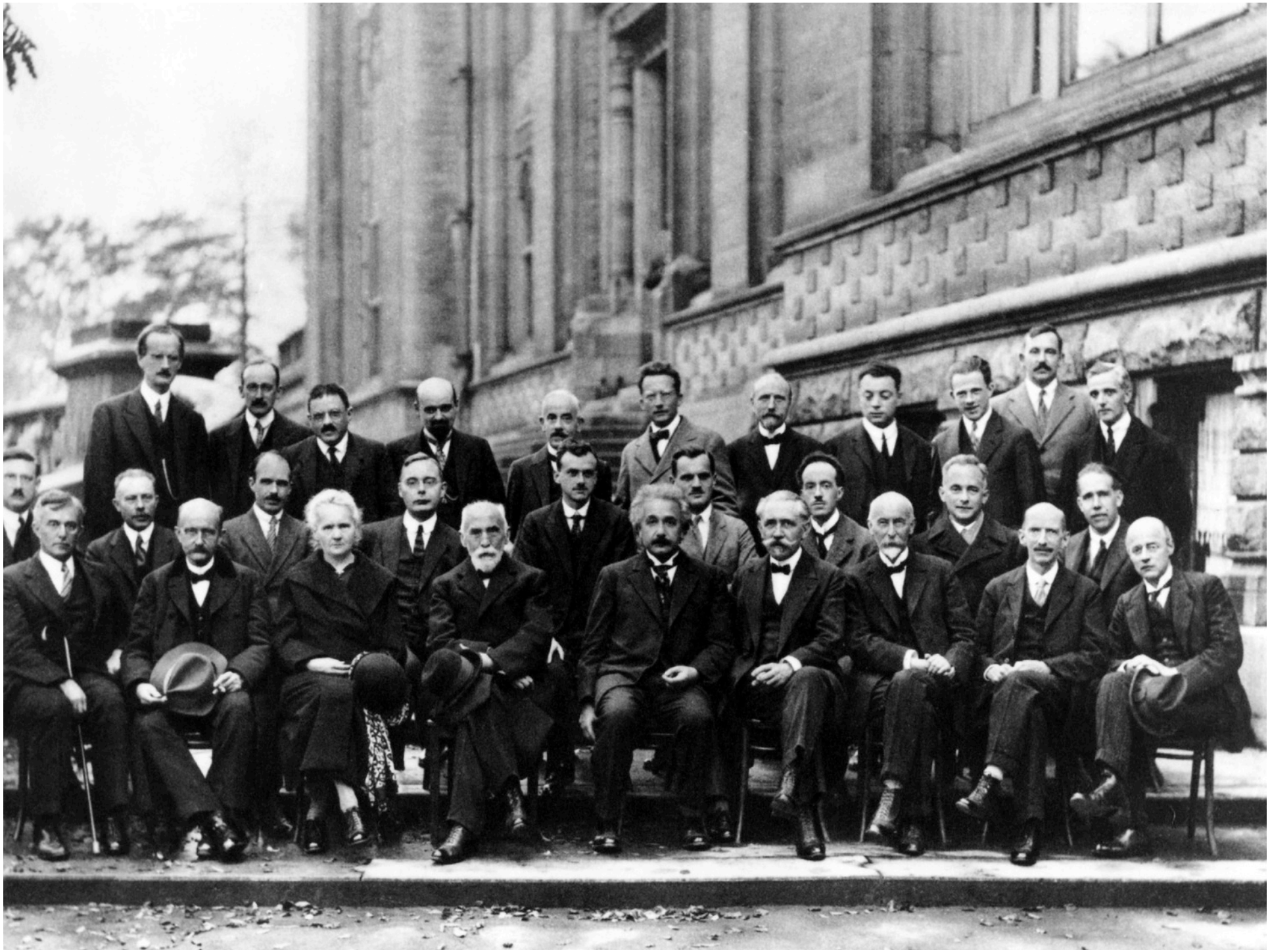
Relativity

Quantum Mechanics

Relativity

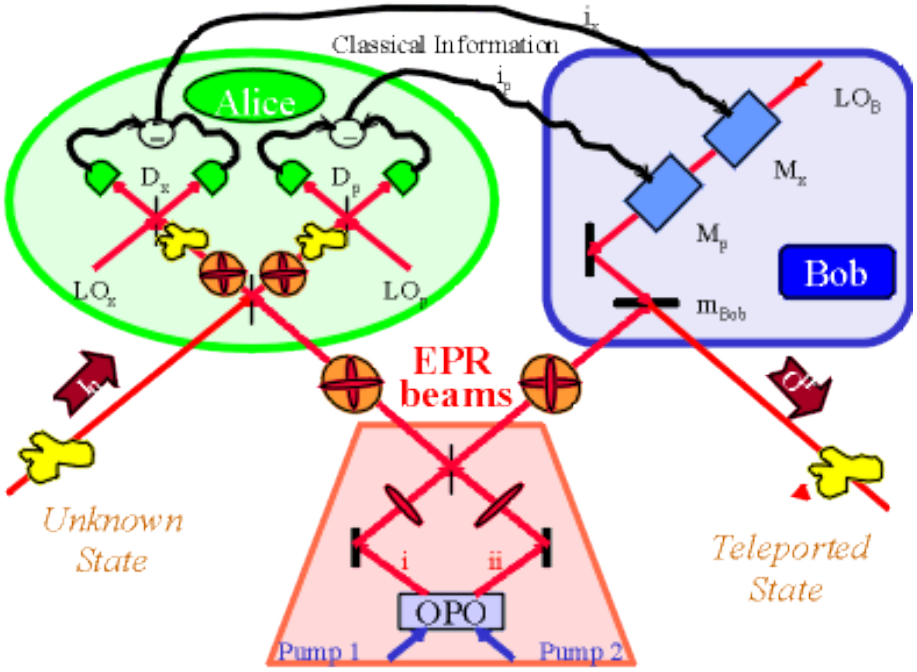

Imagine travelling through space on a beam of light at the speed of light.
Albert Einstein, theory of relativity, gravity, velocity, energy, mass, speed, time, E=mc2 Albert Ein
Bobonart

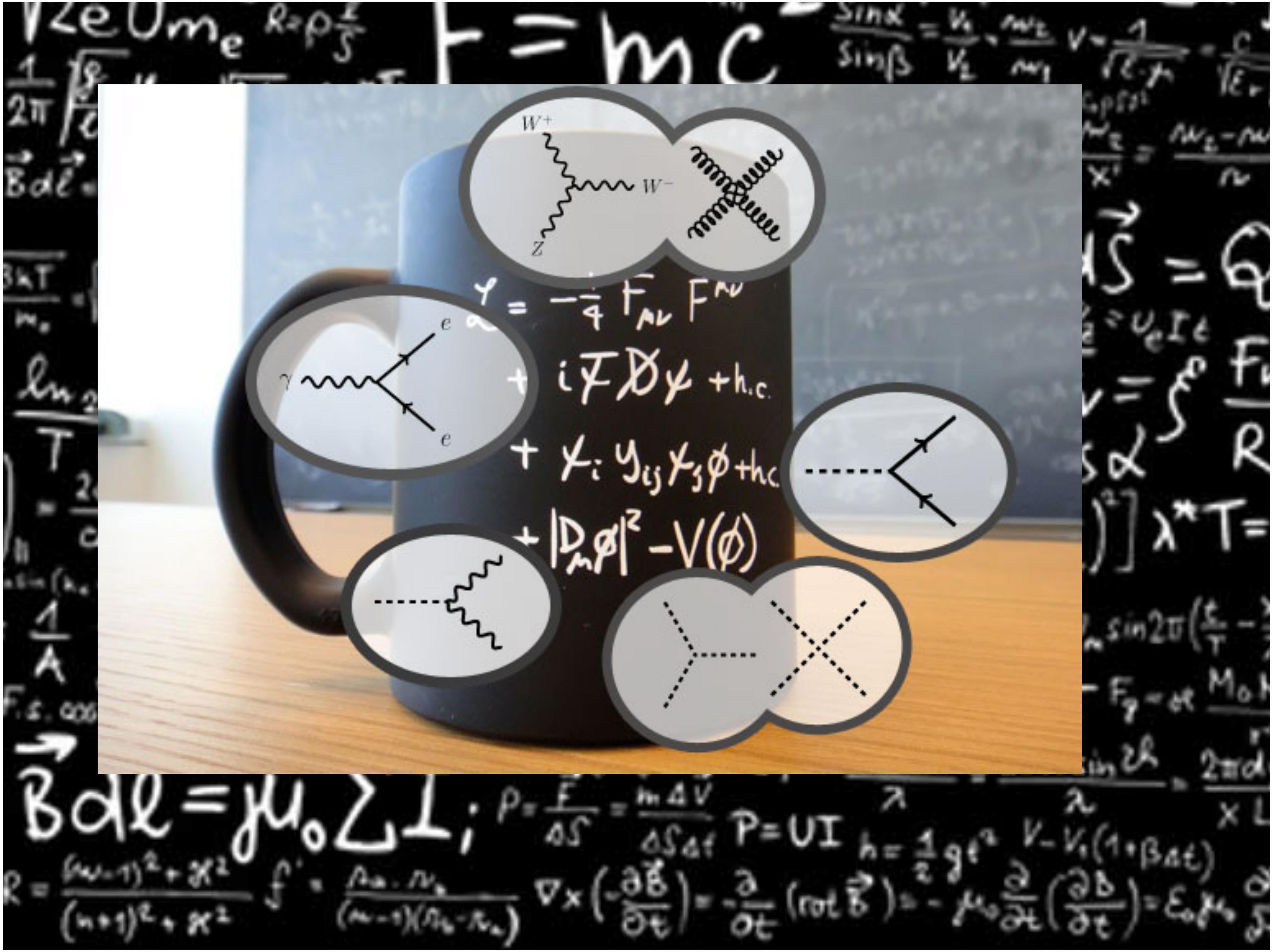




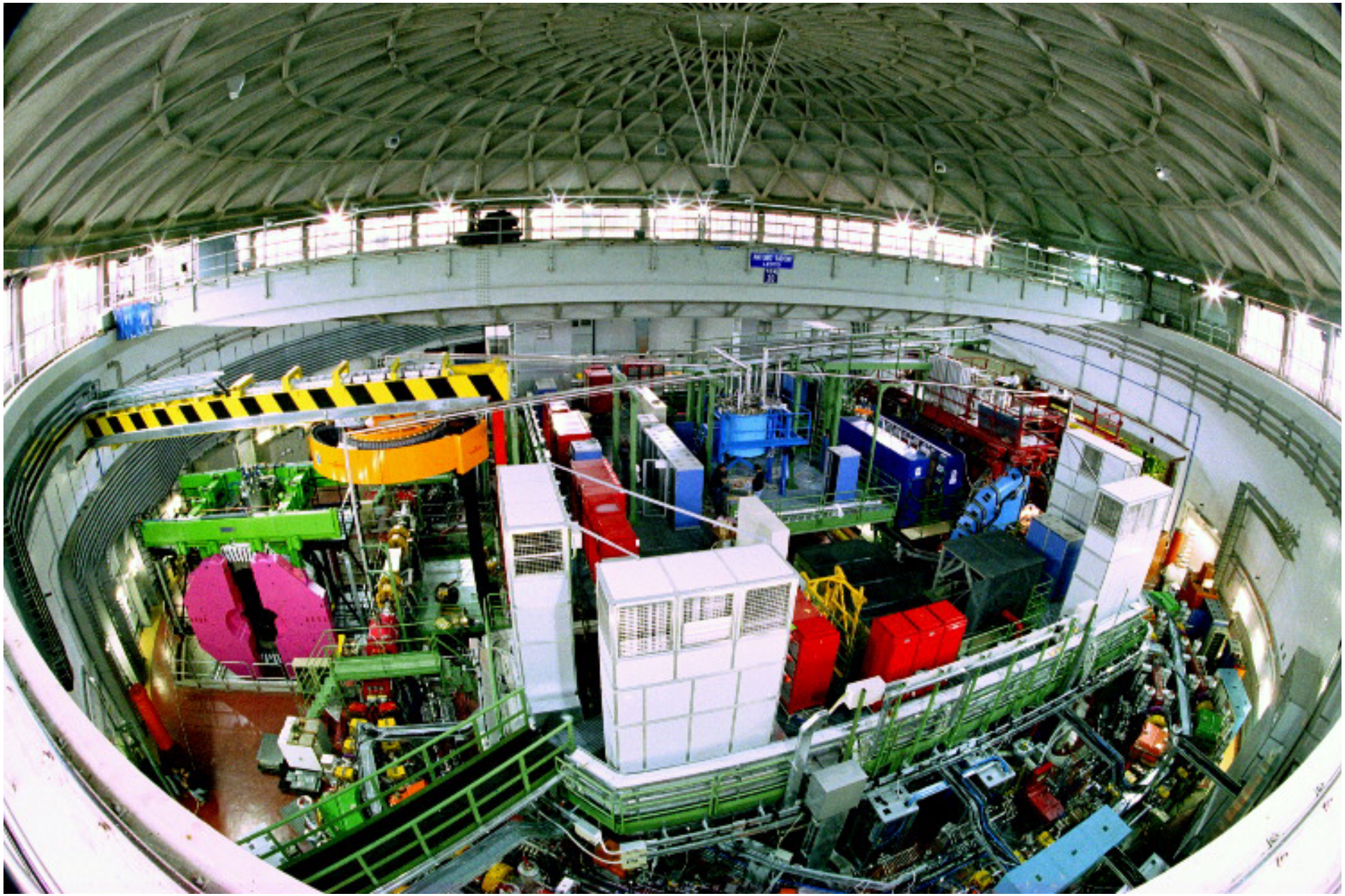

RESULTS
DEAD
ALIVE
BOTH
SCHRÖDINGER'S CAT
Experiment #001

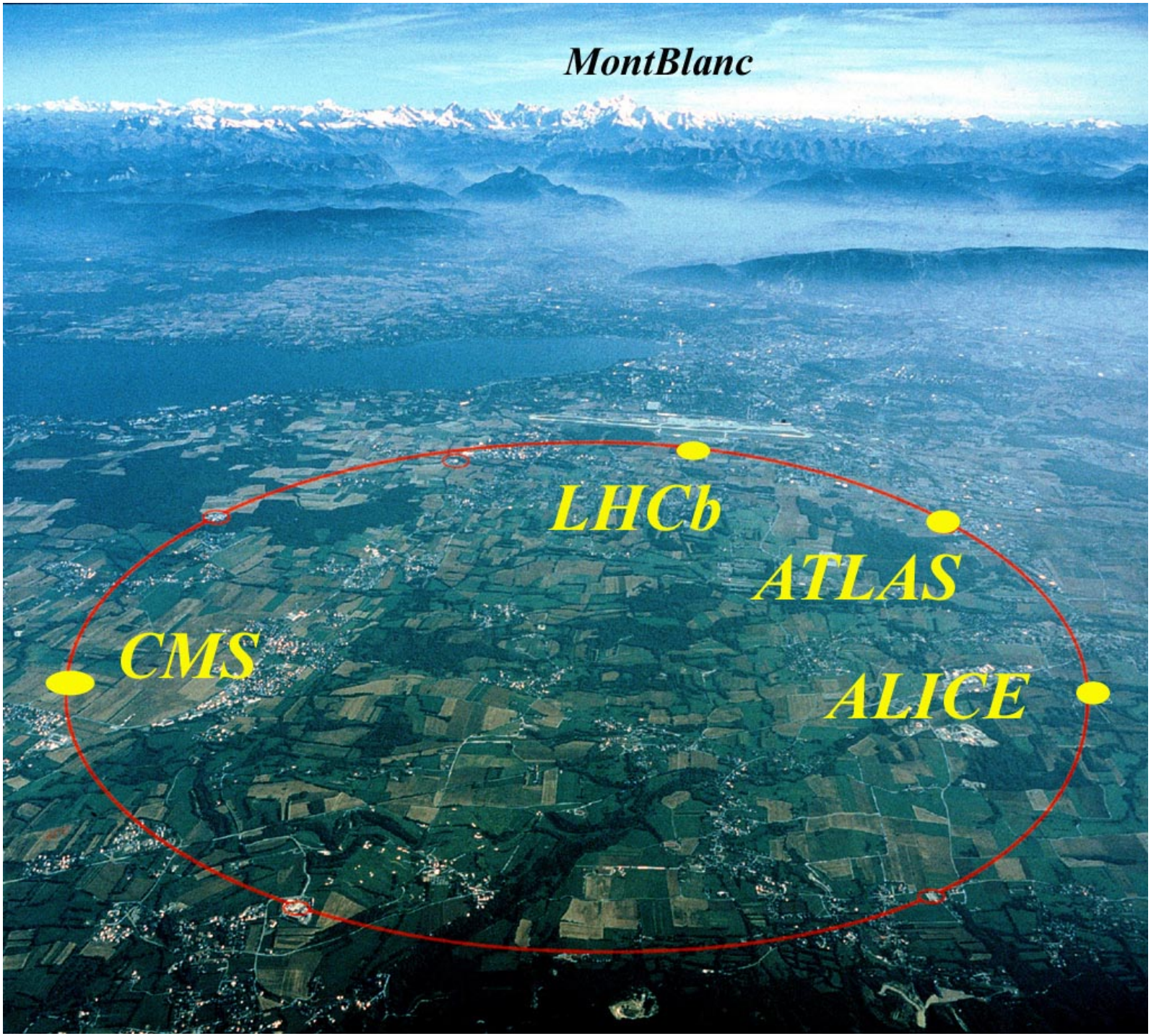
Quantum Teleportation

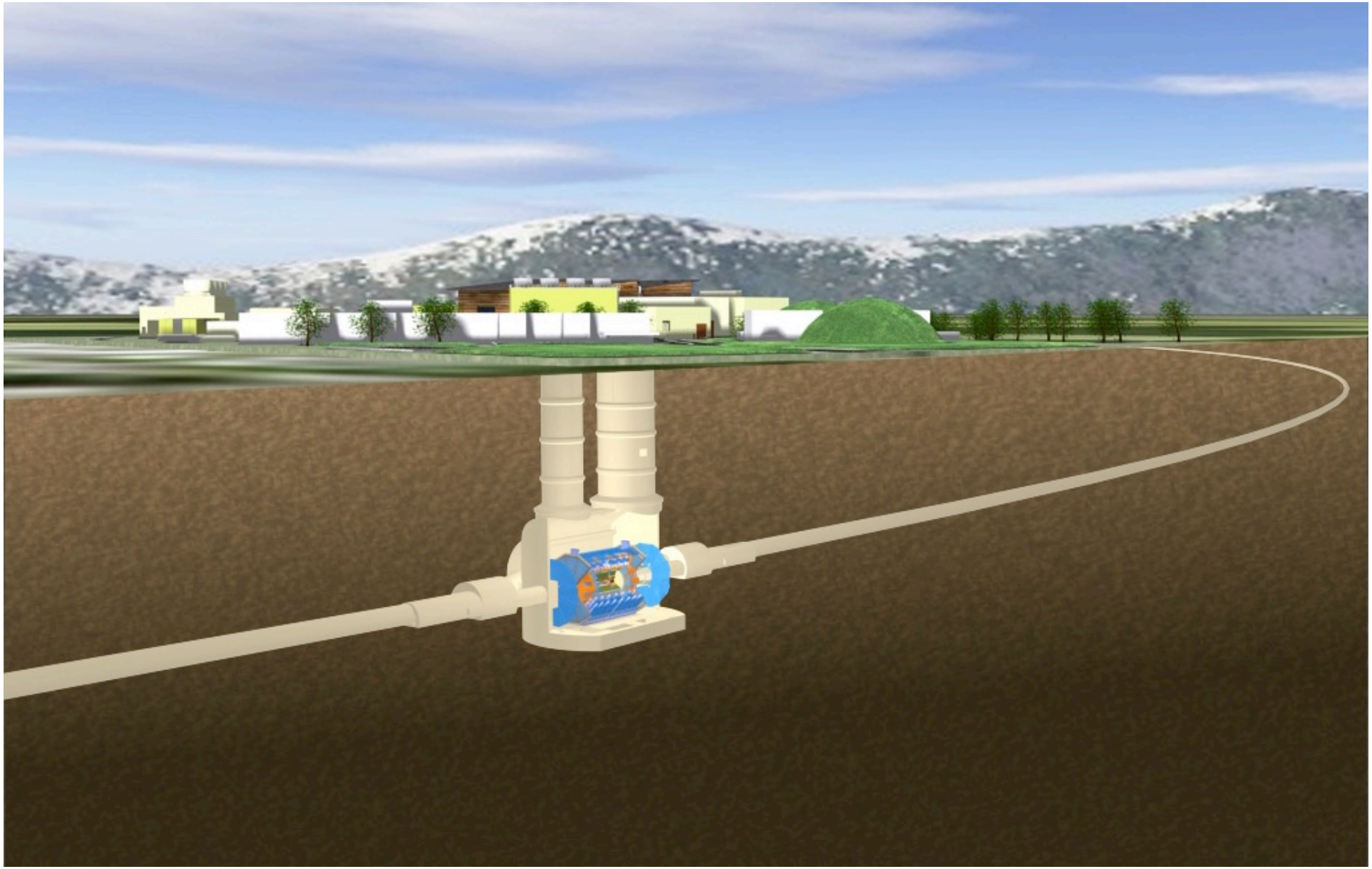


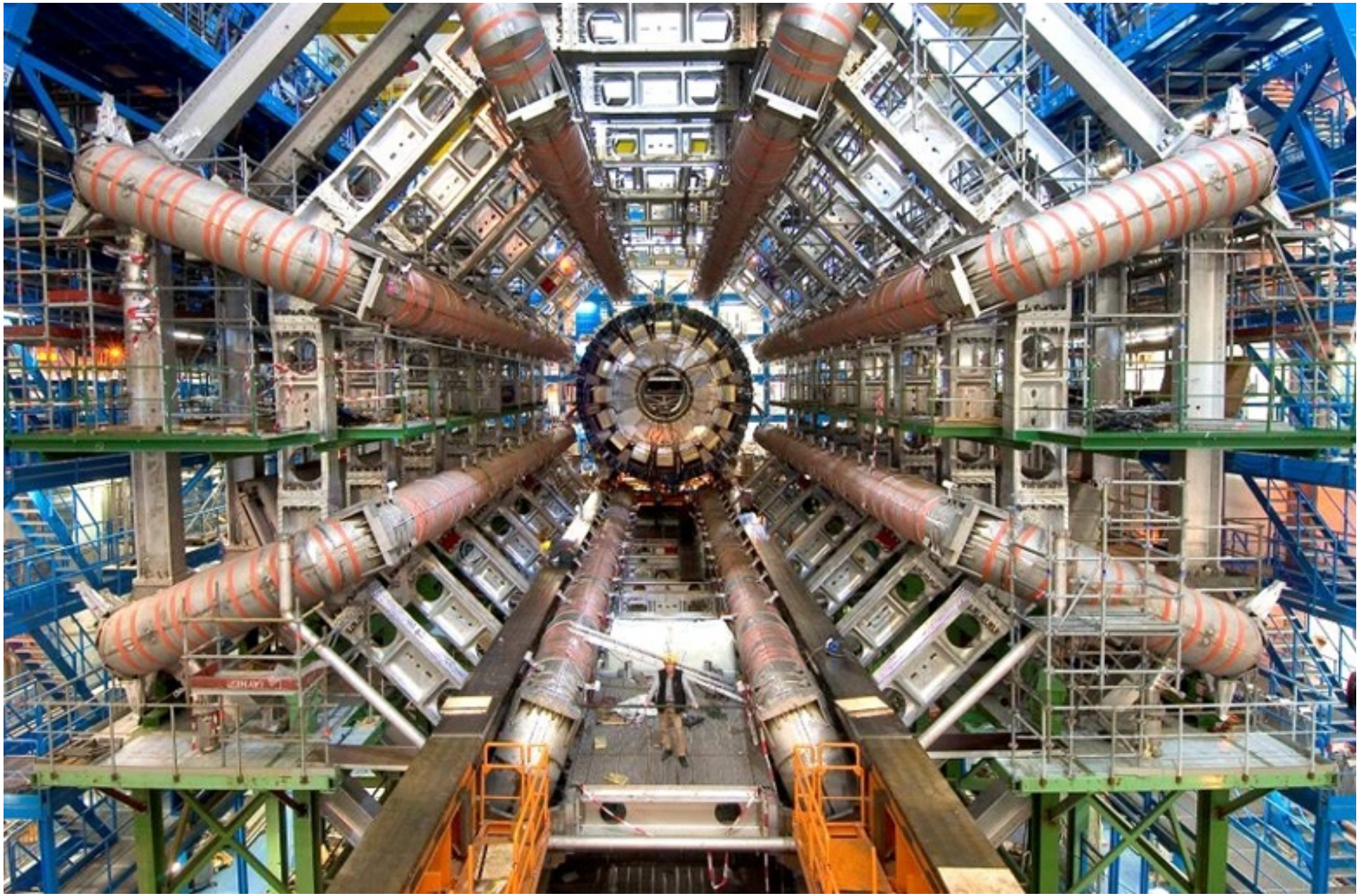


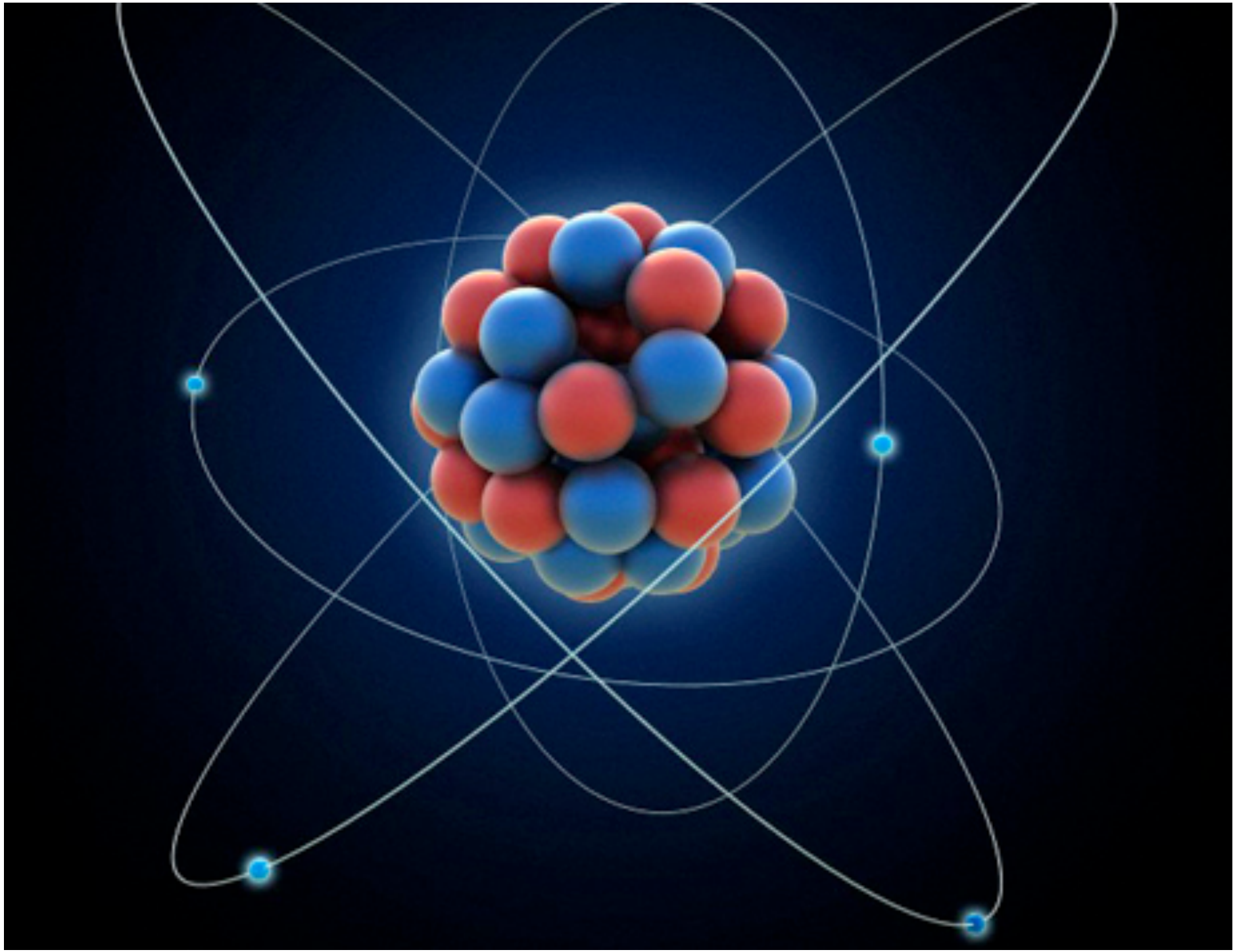
W+
W−
Z
γ
e
e
L = −1/4 Fμν F^μν
+ iψ̄ D̸ ψ + h.c.
+ ψi yij ψj φ + h.c.
+ |Dμφ|² − V(φ)
E = mc
P=UI

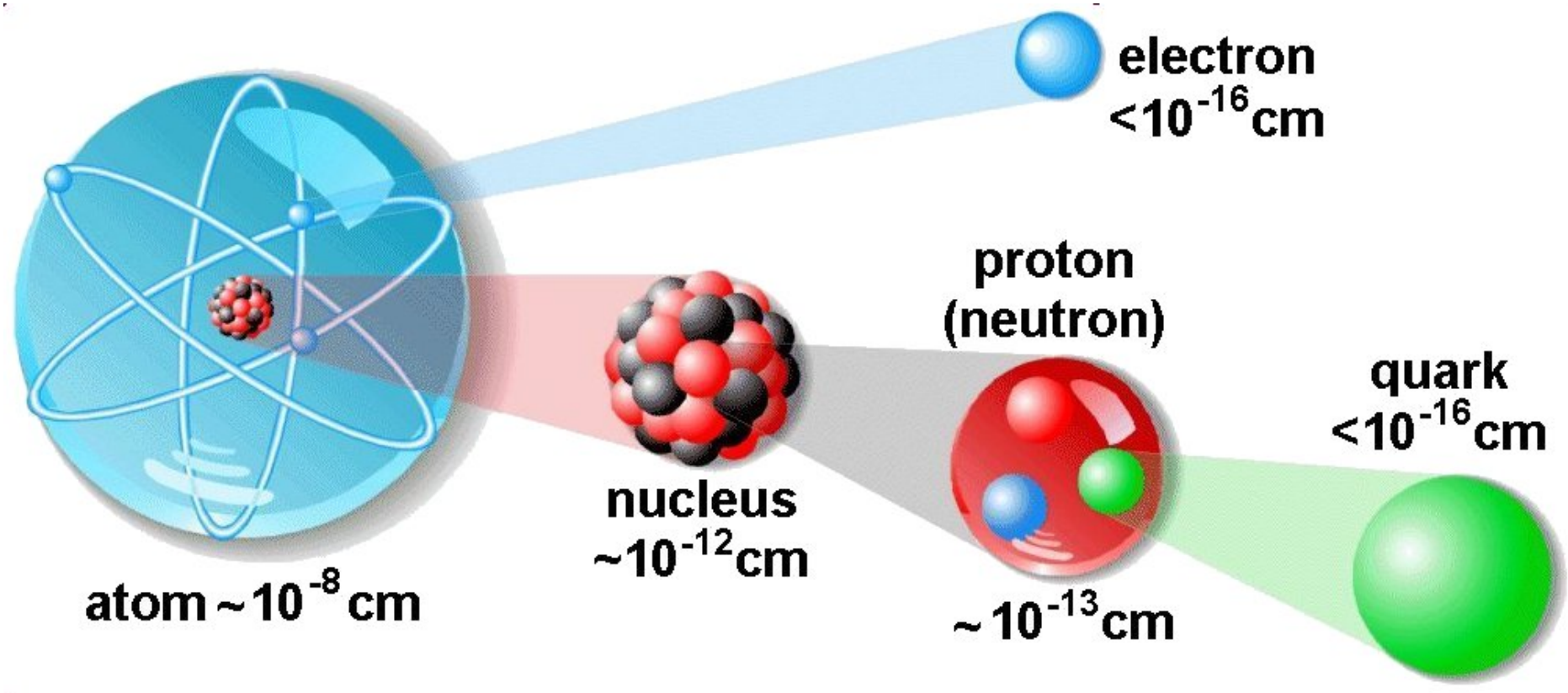


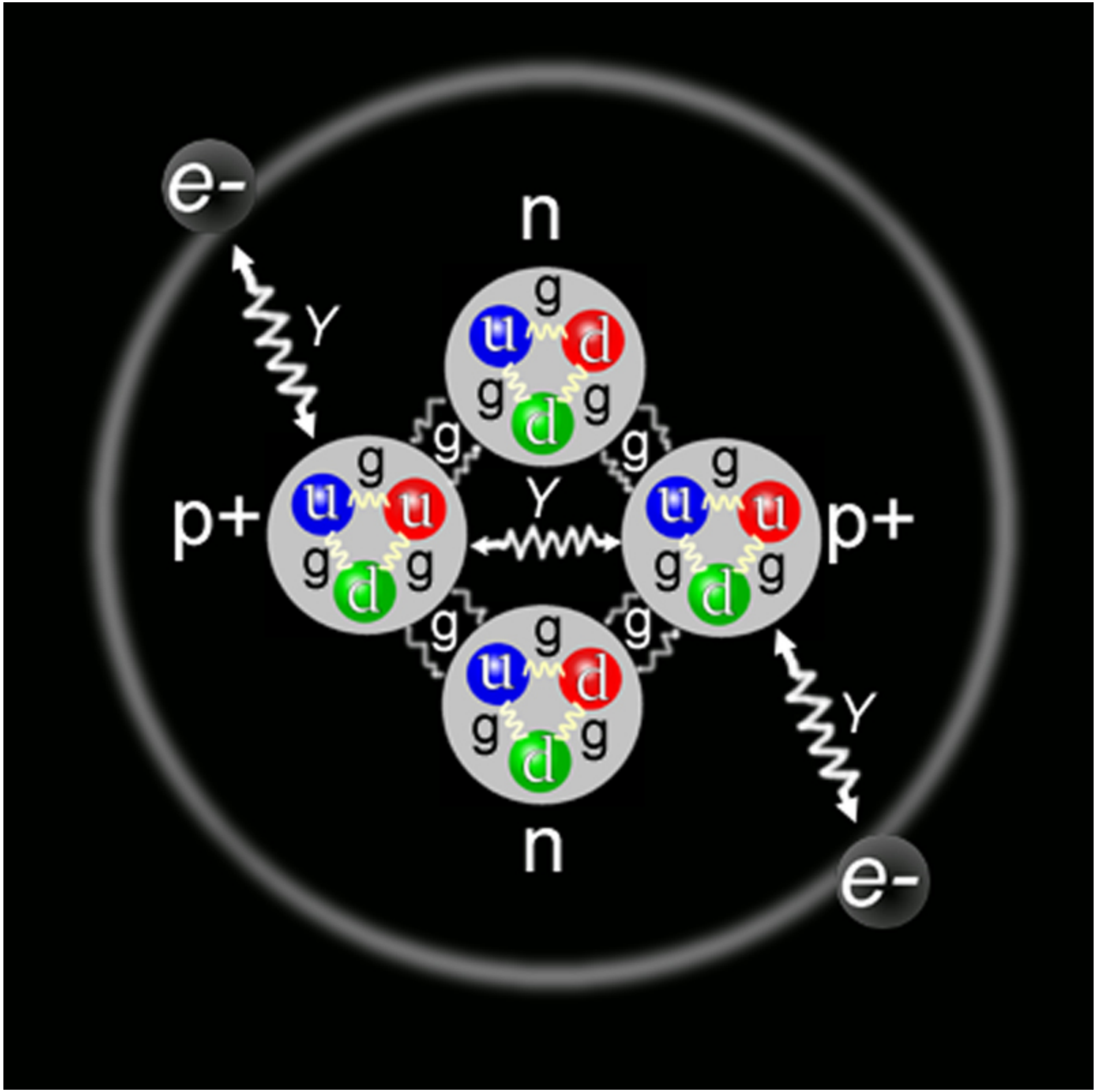

MontBlanc
LHCb
ATLAS
CMS
ALICE



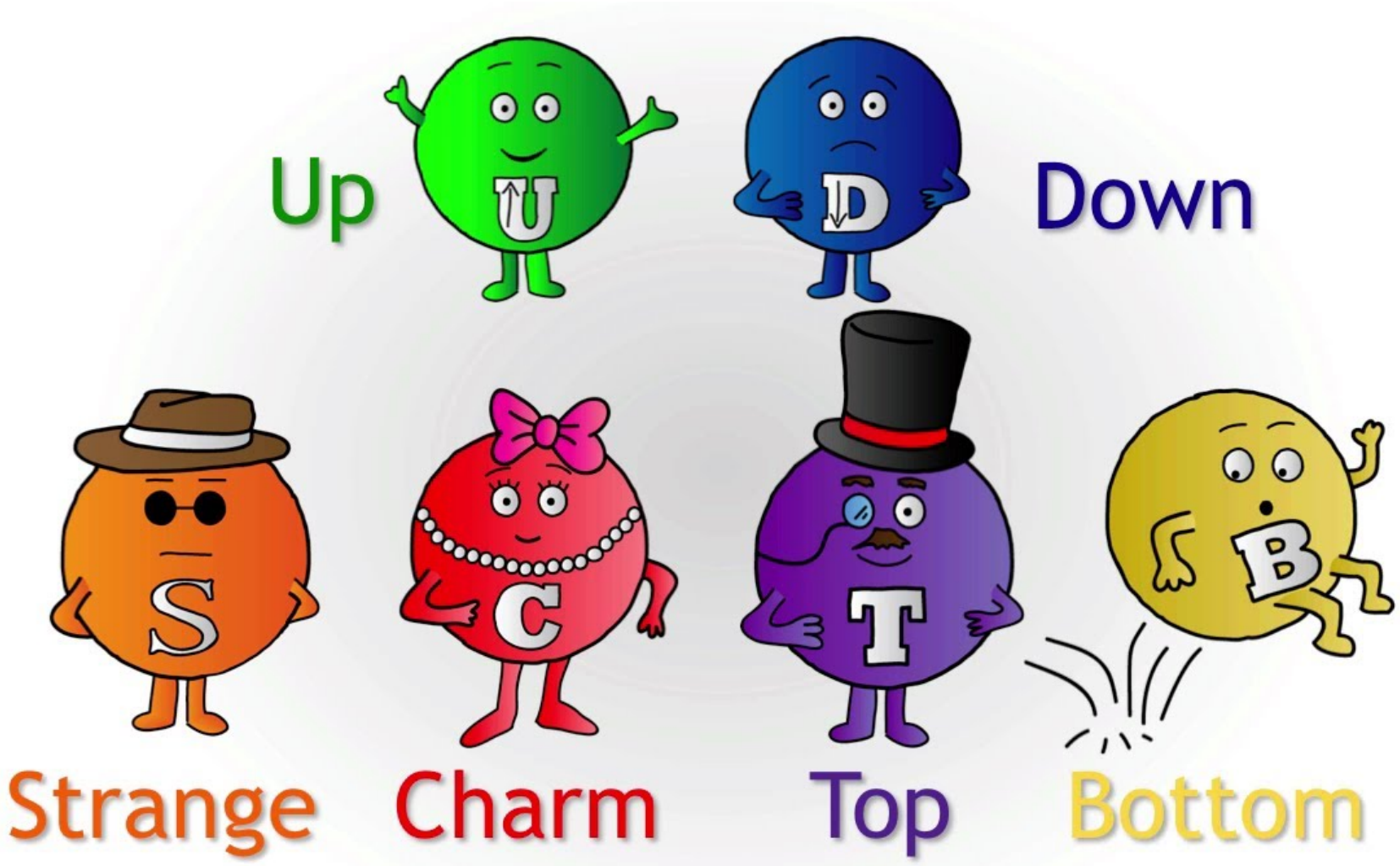


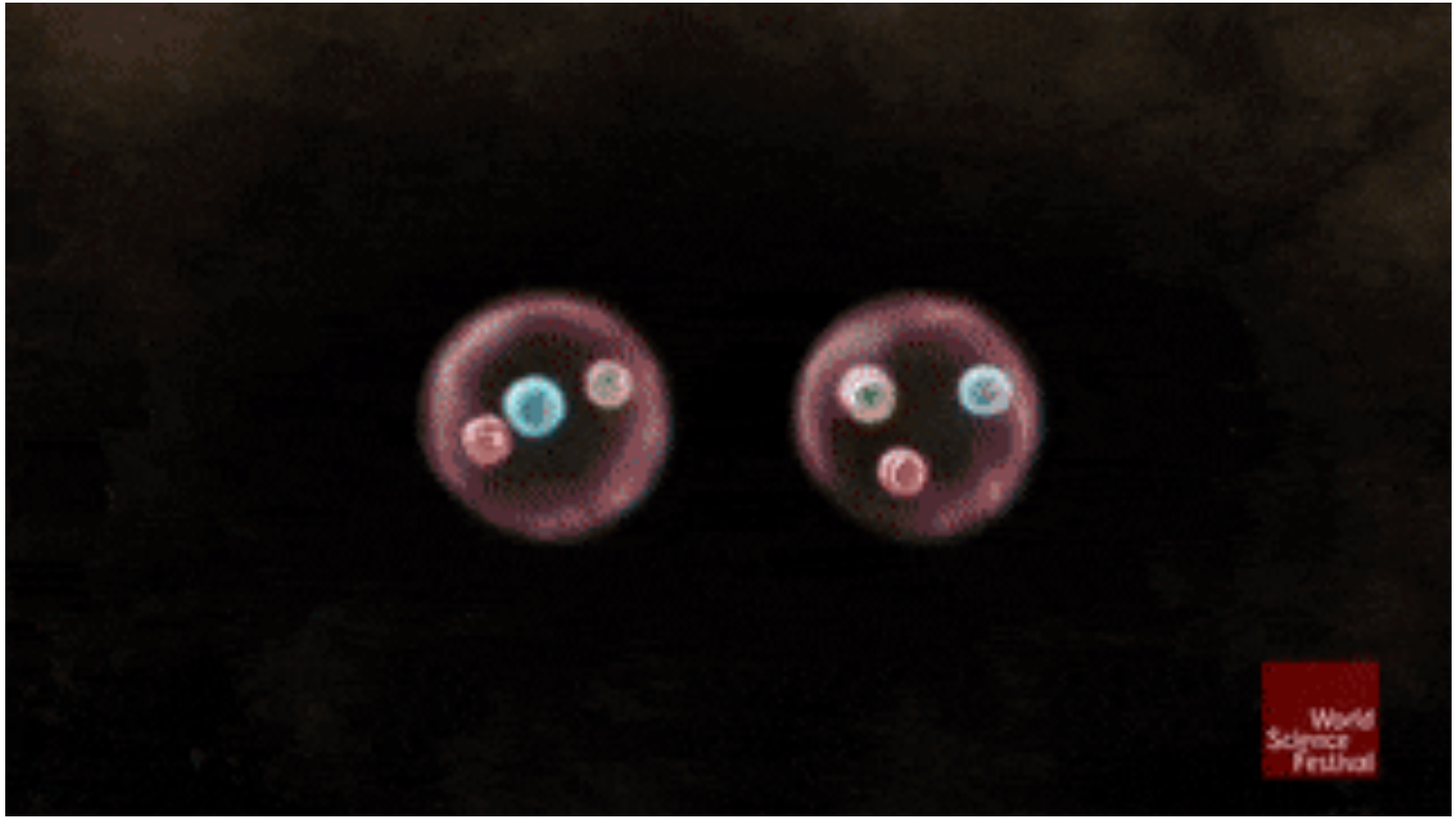



electron
<10^-16 cm
proton
(neutron)
quark
<10^-16 cm
nucleus
~10^-12 cm
atom ~10^-8 cm
~10^-13 cm

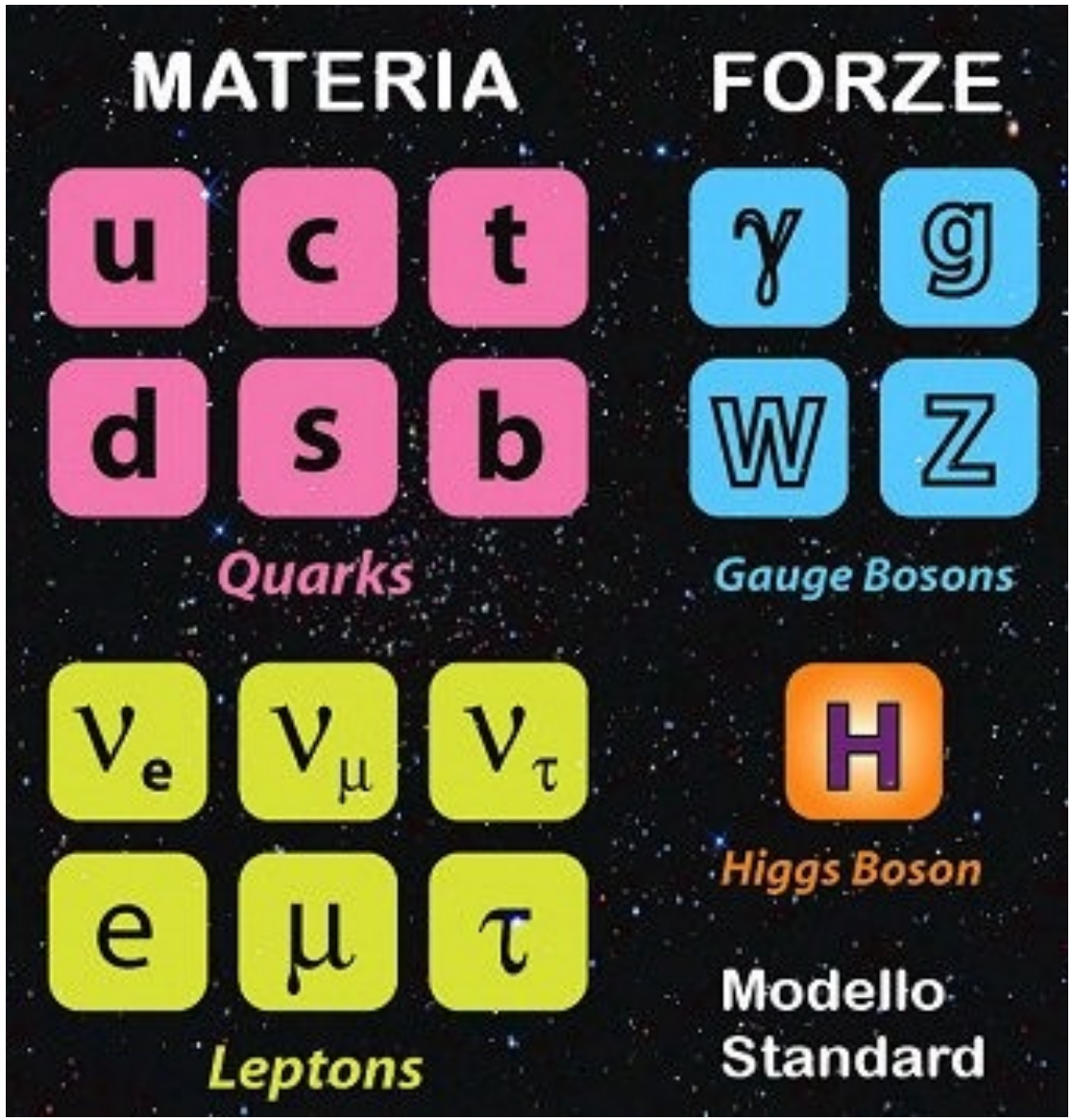


e-
n
g
u
d
g
g
d
Y
g
g
p+
g
u
u
g
g
d
Y
g
u
u
g
g
d
p+
g
g
g
u
d
g
g
d
Y
n
e-

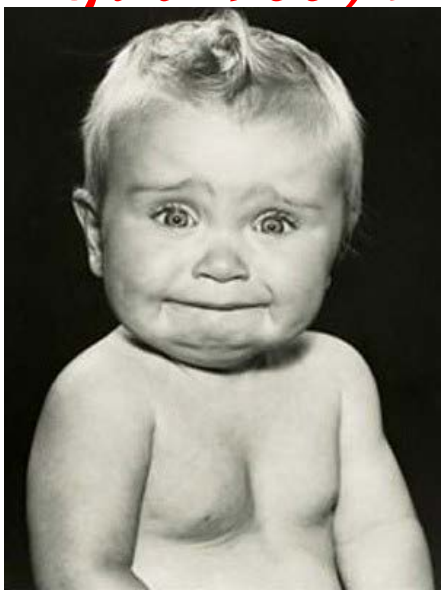

Up
U
D
Down
S
C
T
B
Strange
Charm
Top
Bottom


World
Science
Festival

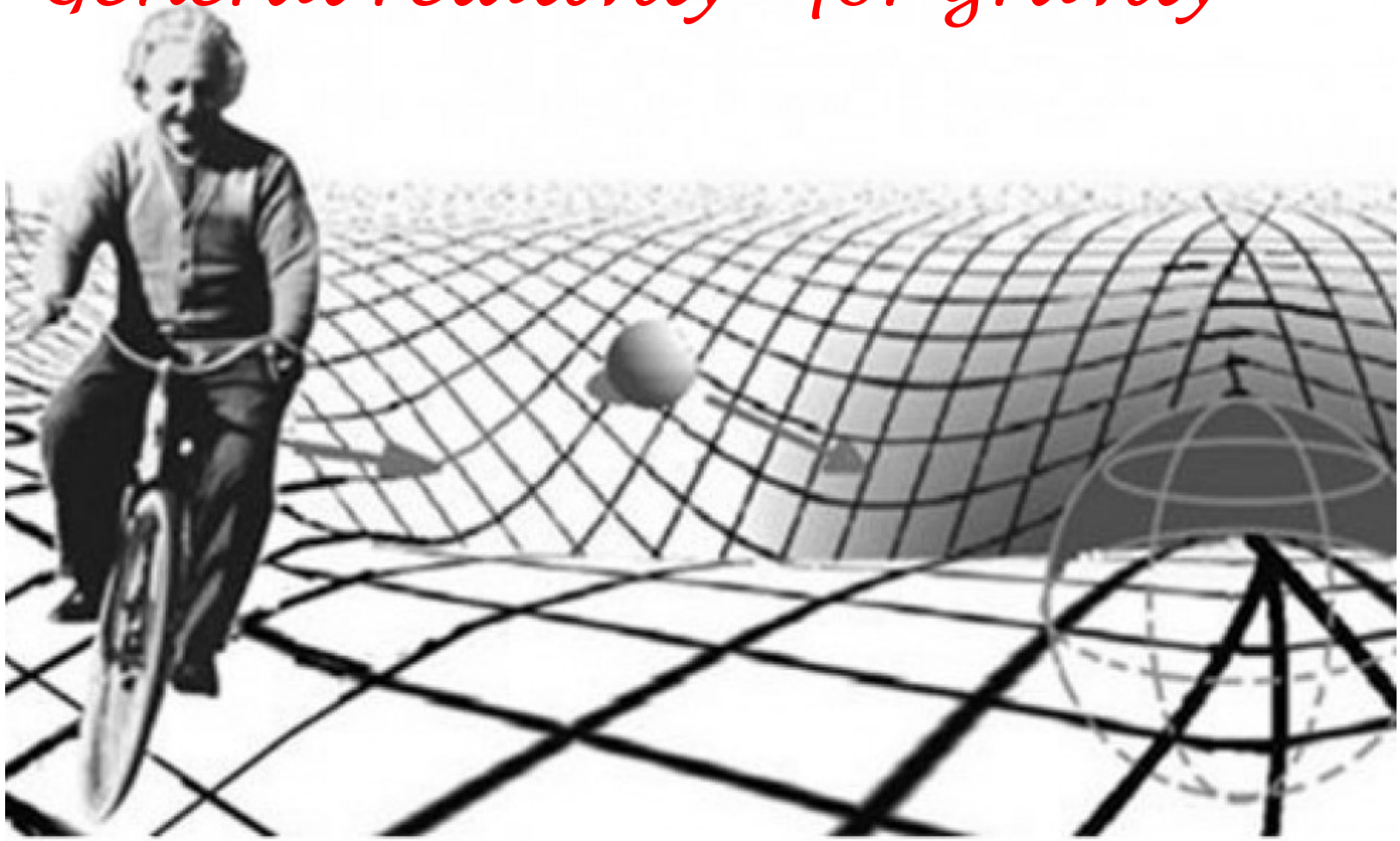
The Standard Model of Particle Physics



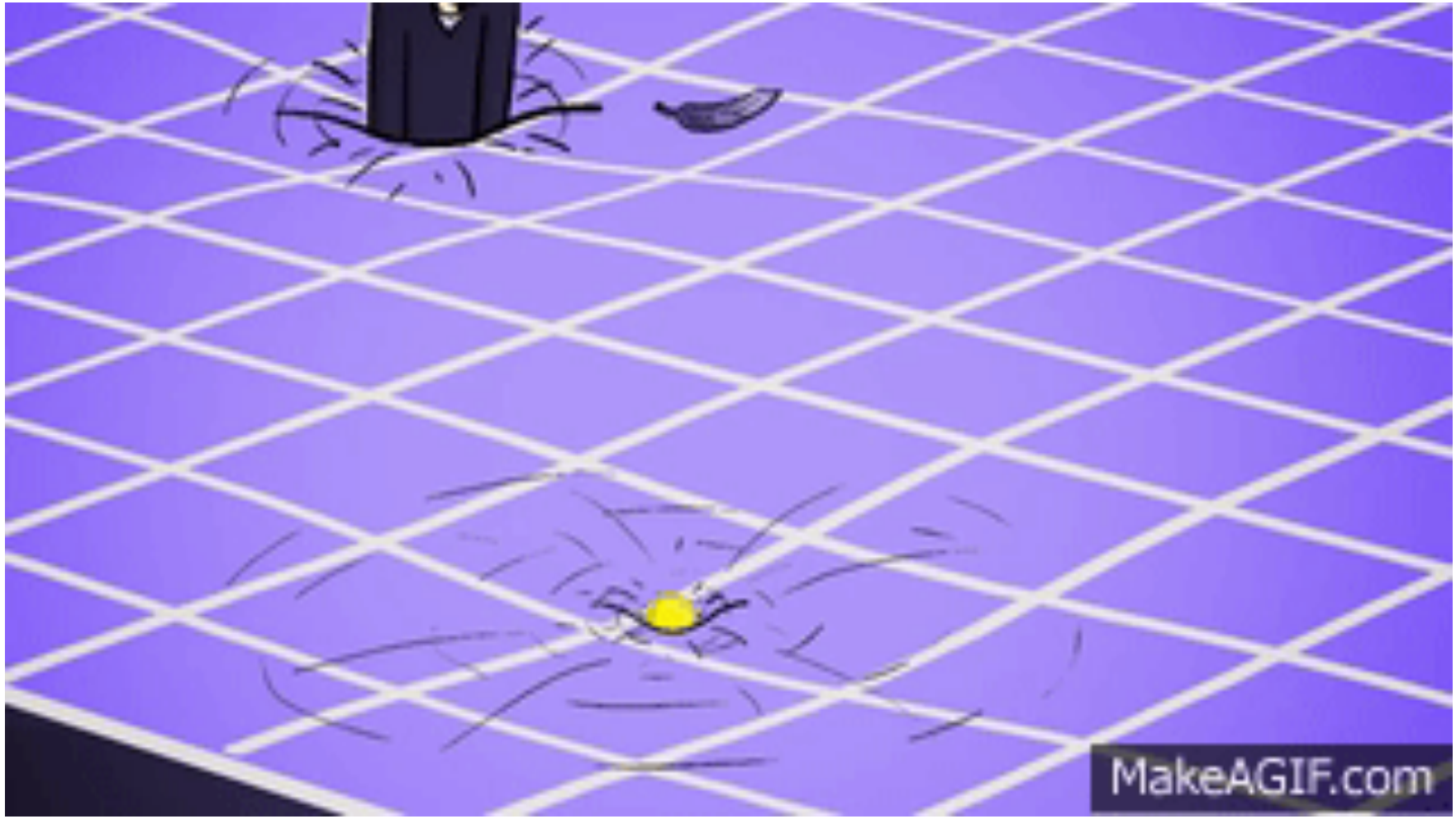
Does not include Gravity!

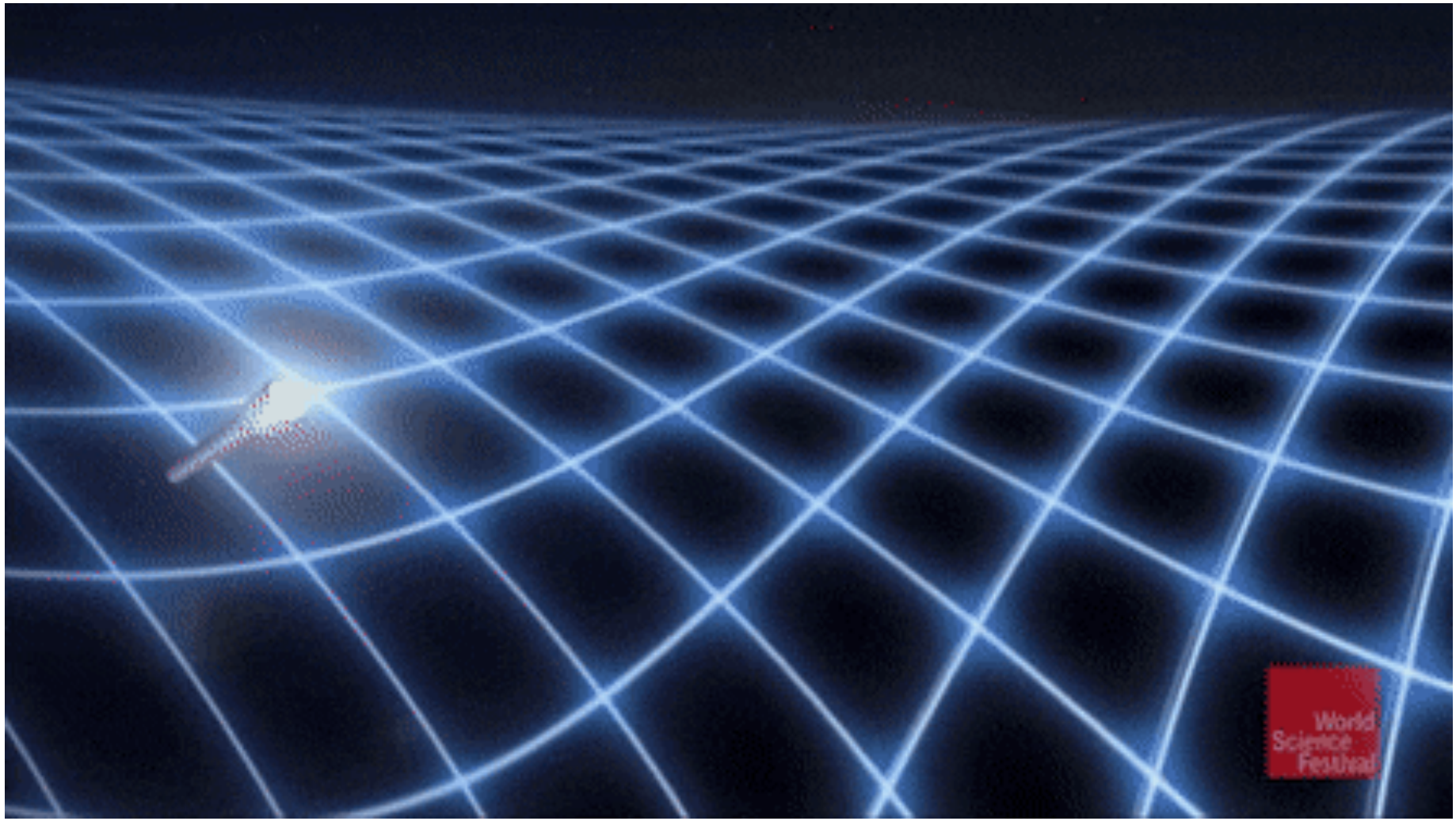


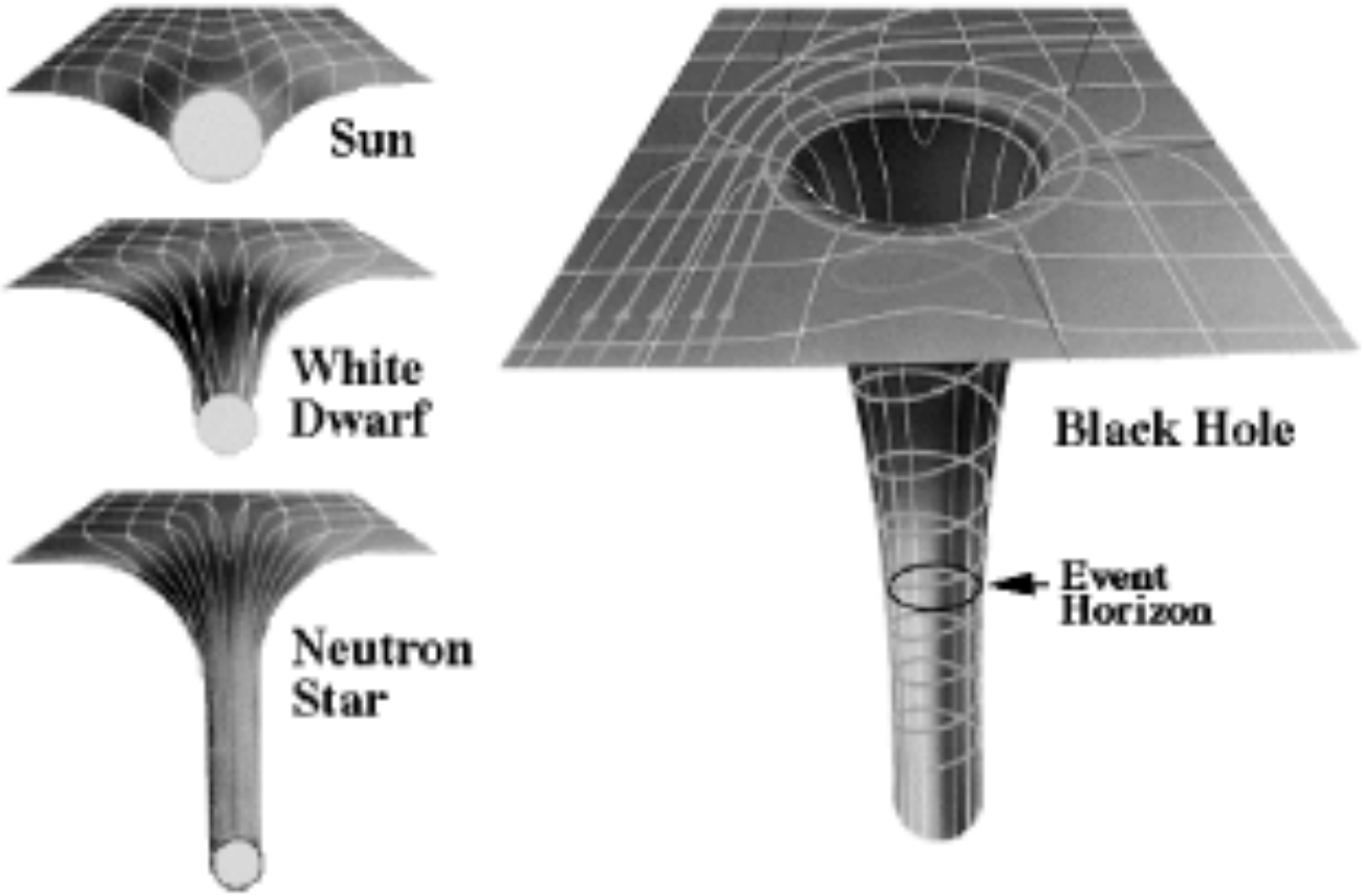
General relativity - for gravity



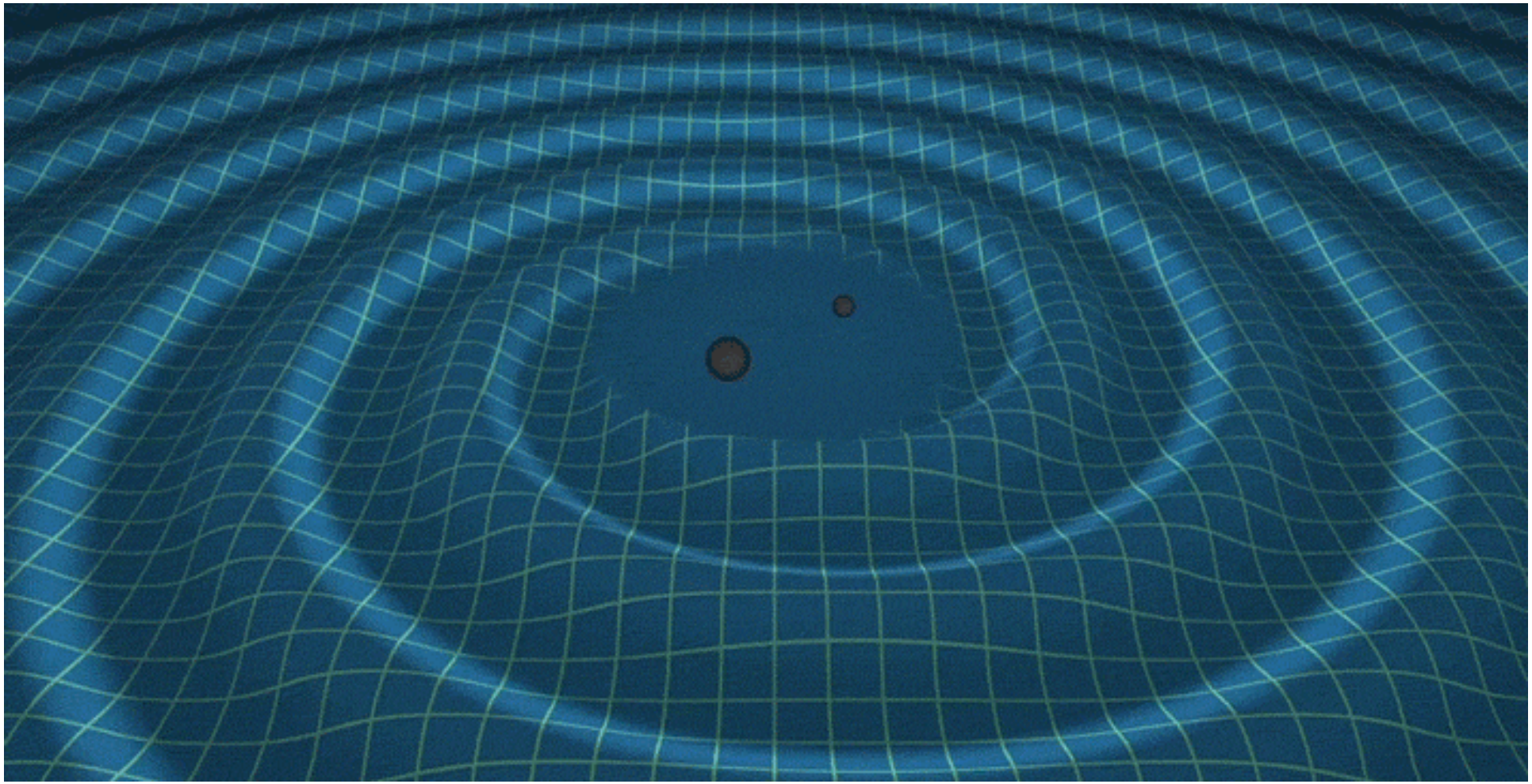

$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = \frac{8\pi G}{c^4} T_{\mu\nu}$
A. EINSTEIN

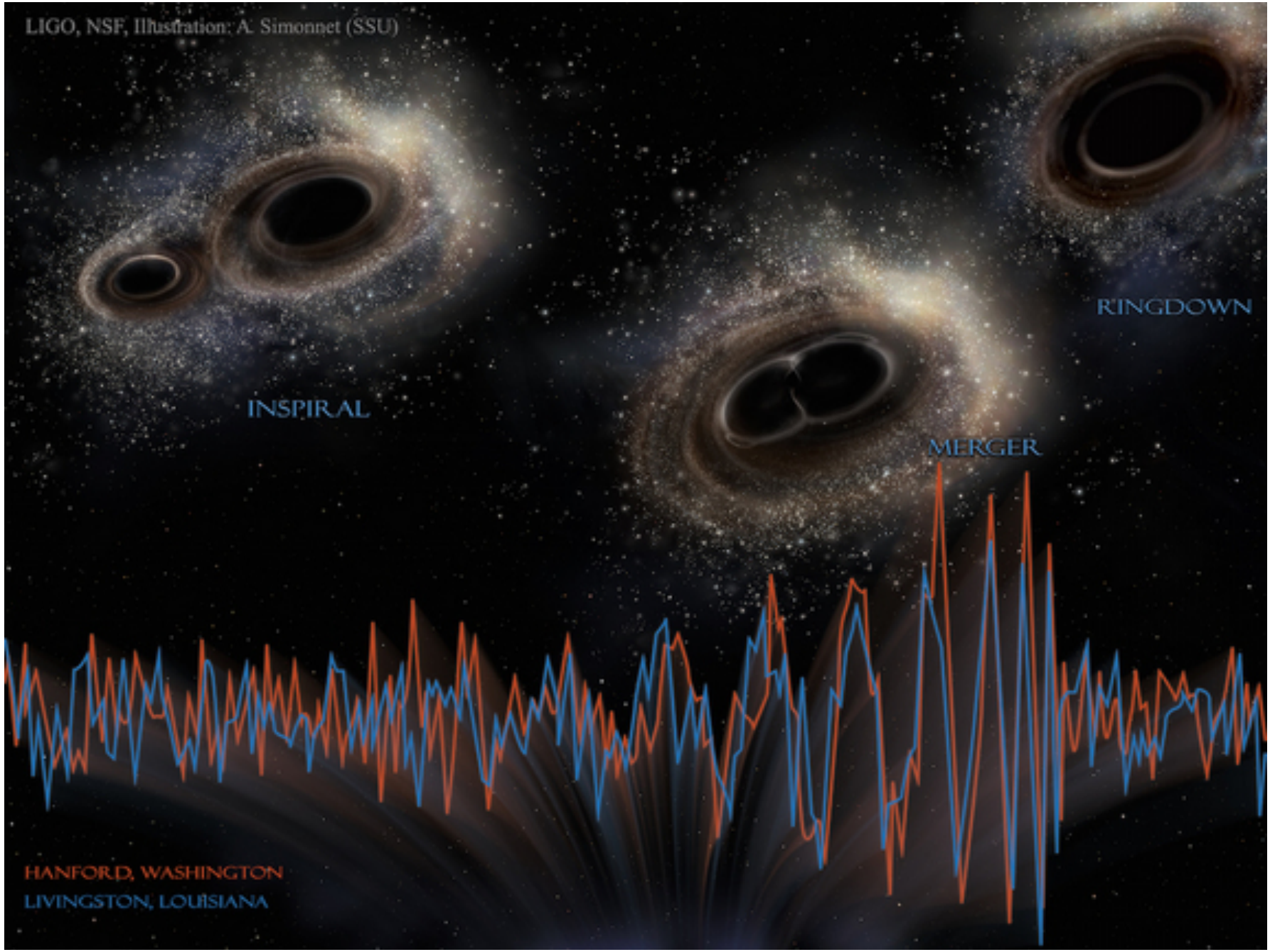

MakeAGIF.com

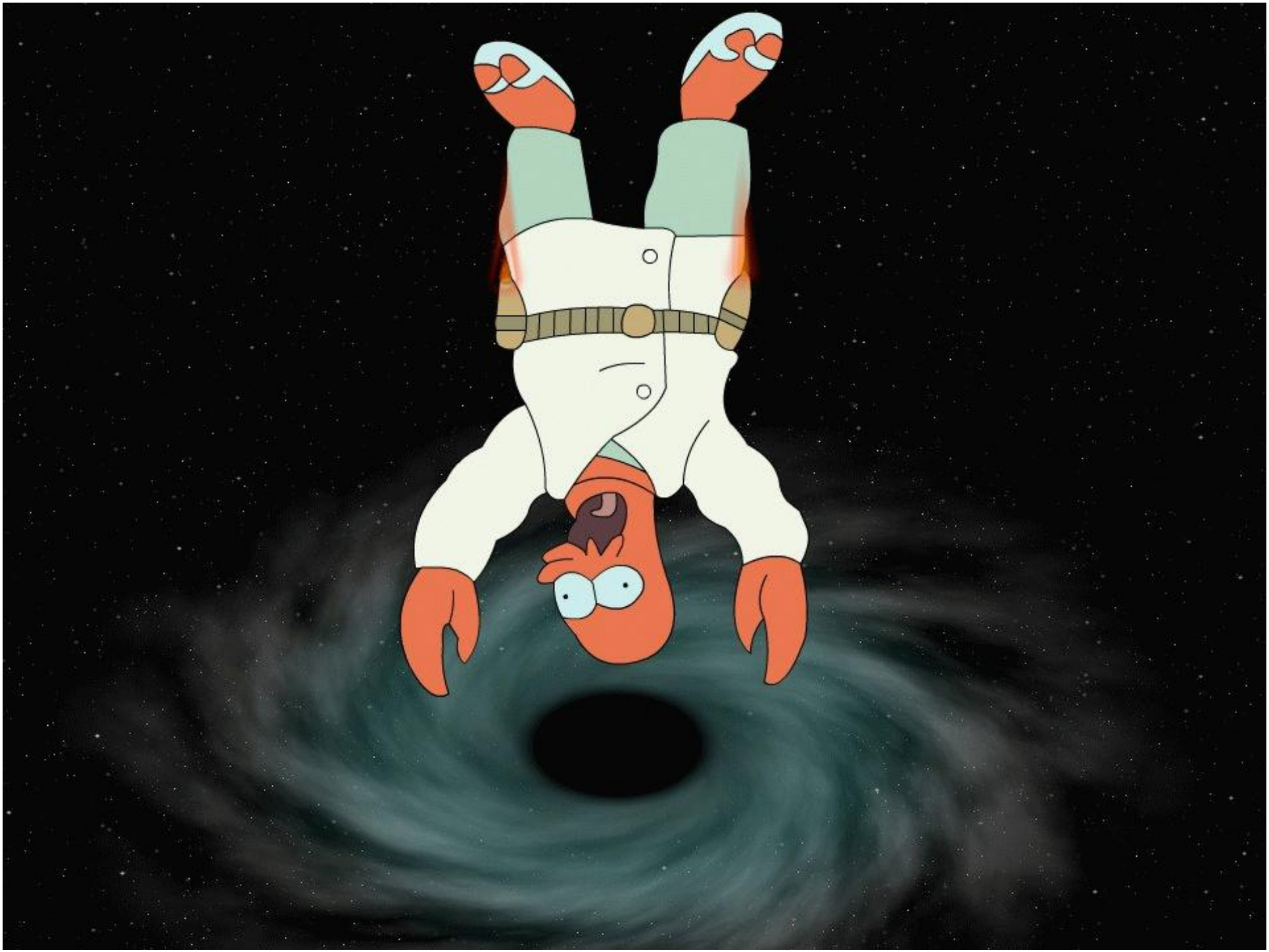

World
Science
Festival



Credit: Adam Apollo

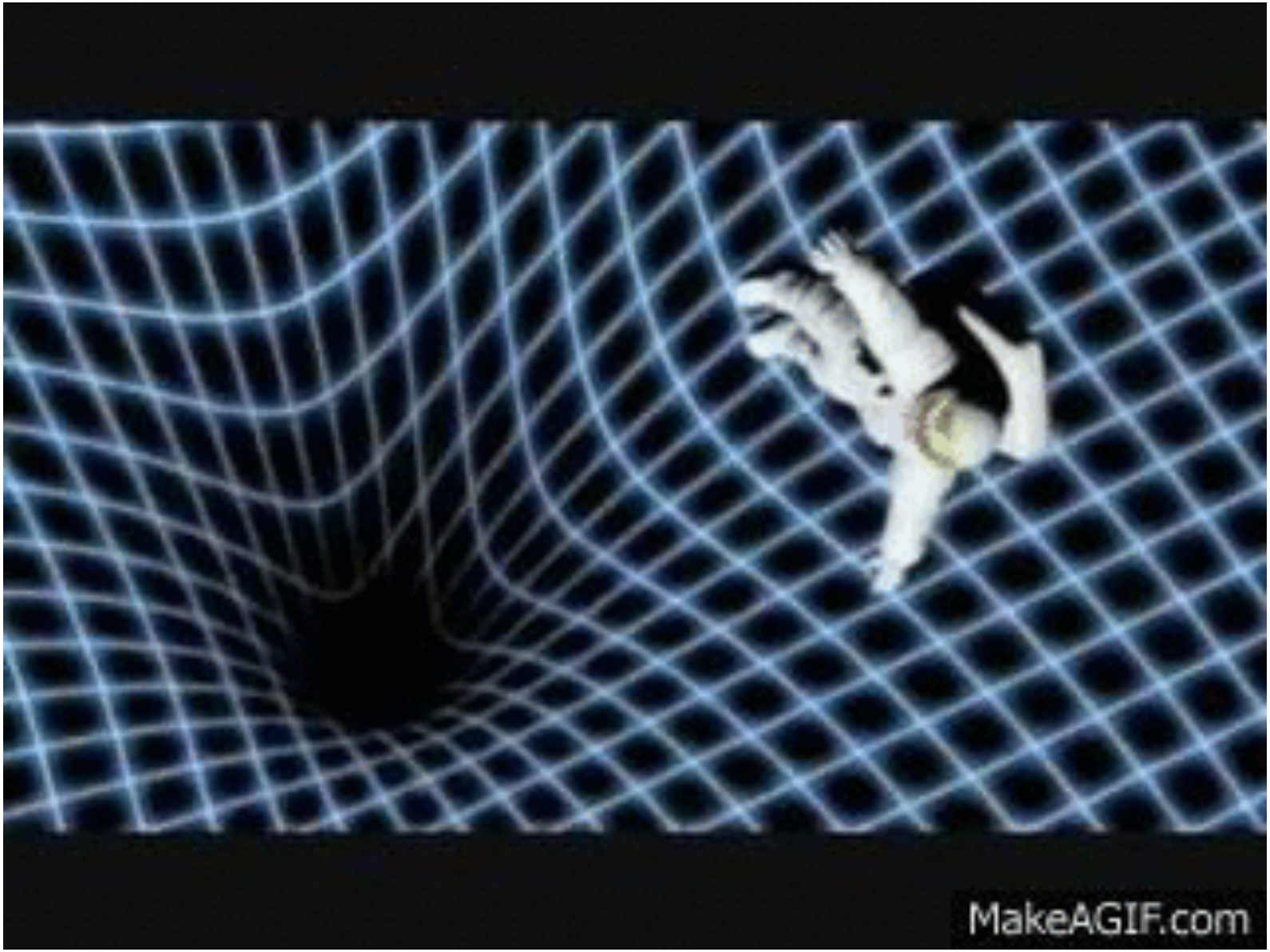



LIGO, NSF, Illustration: A. Simonnet (SSU)
INSPIRAL
MERGER
RINGDOWN
HANFORD, WASHINGTON
LIVINGSTON, LOUISIANA

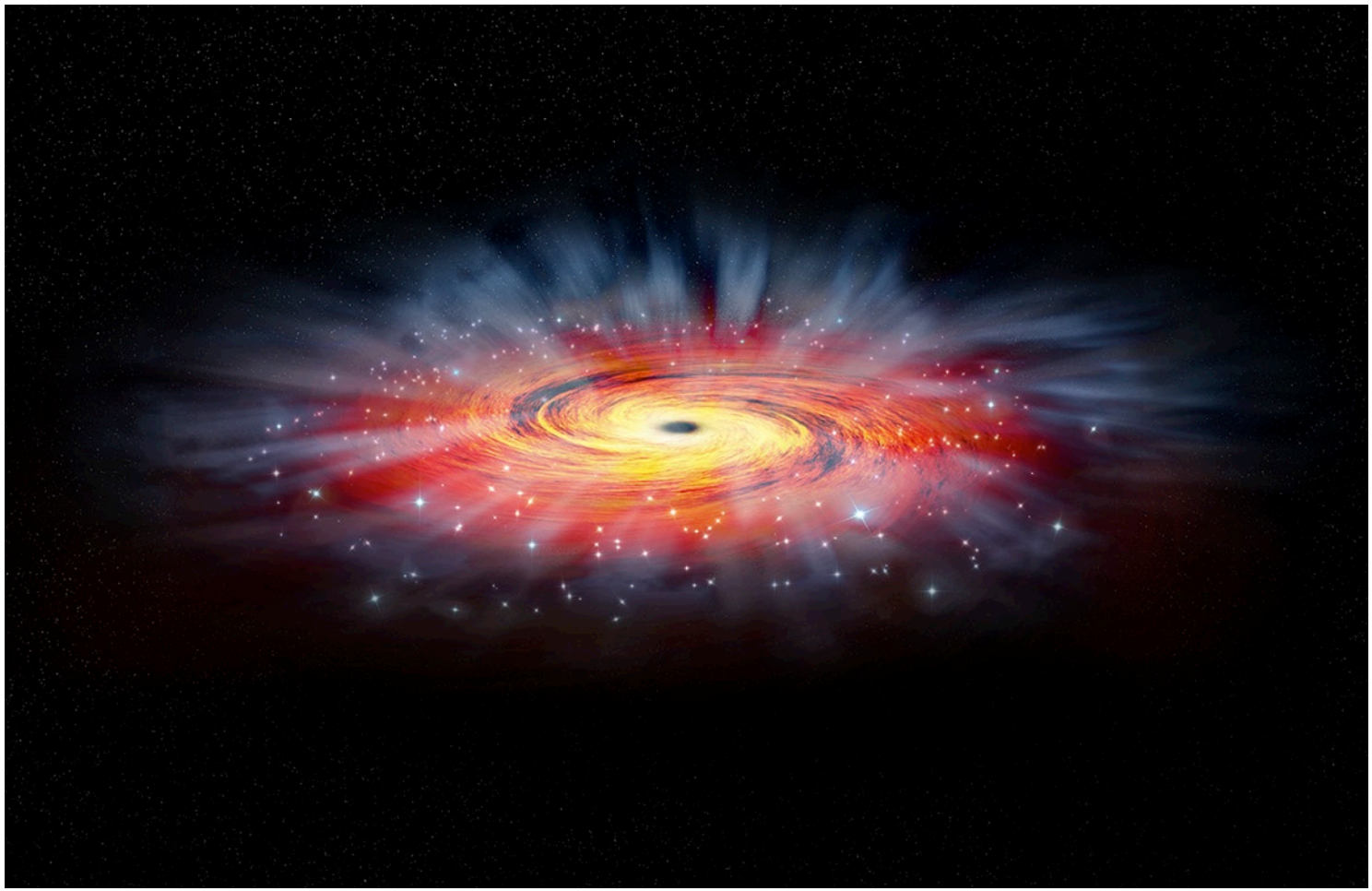


Spaghettification!

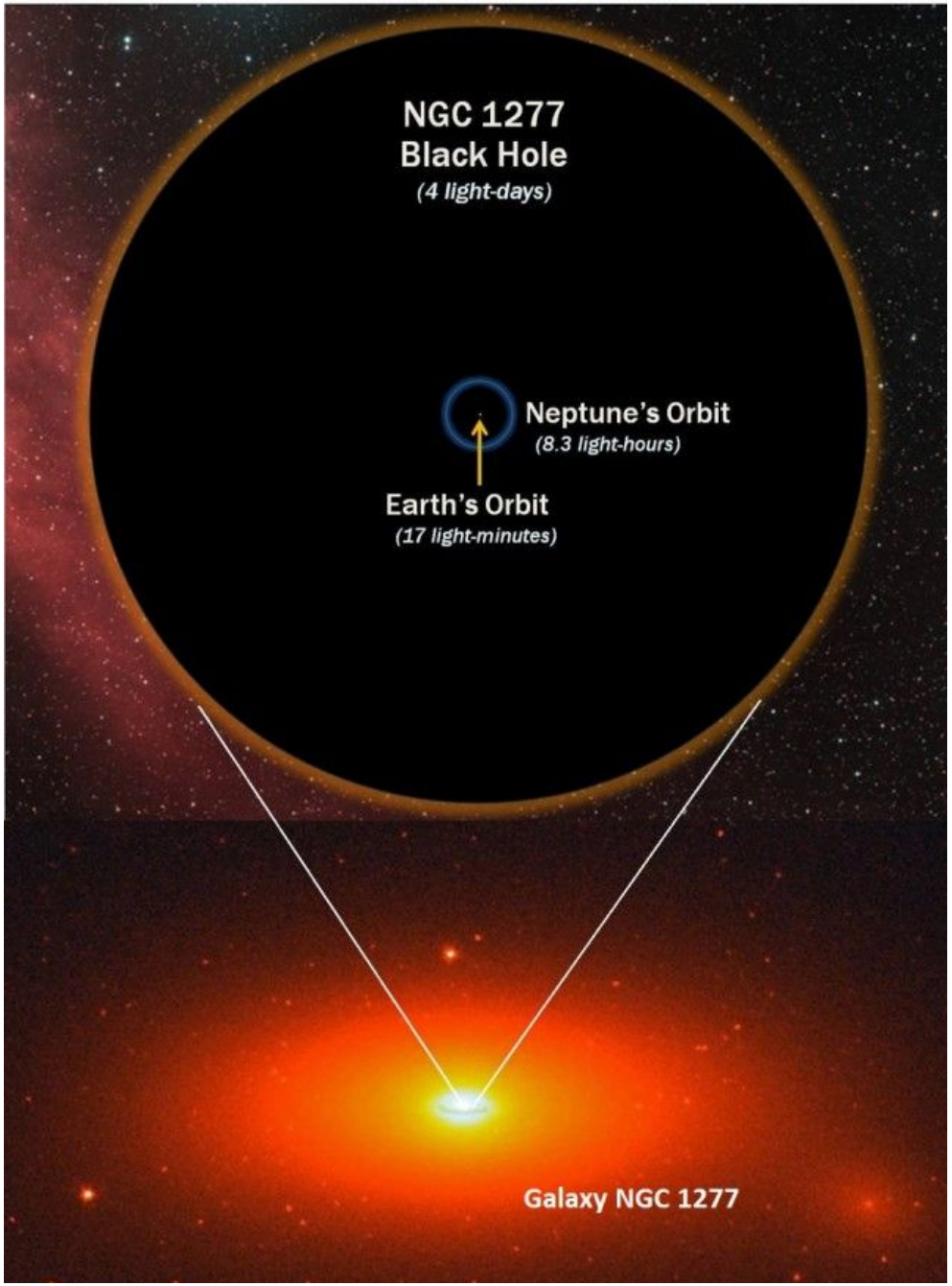
To Black Hole


MakeAGIF.com

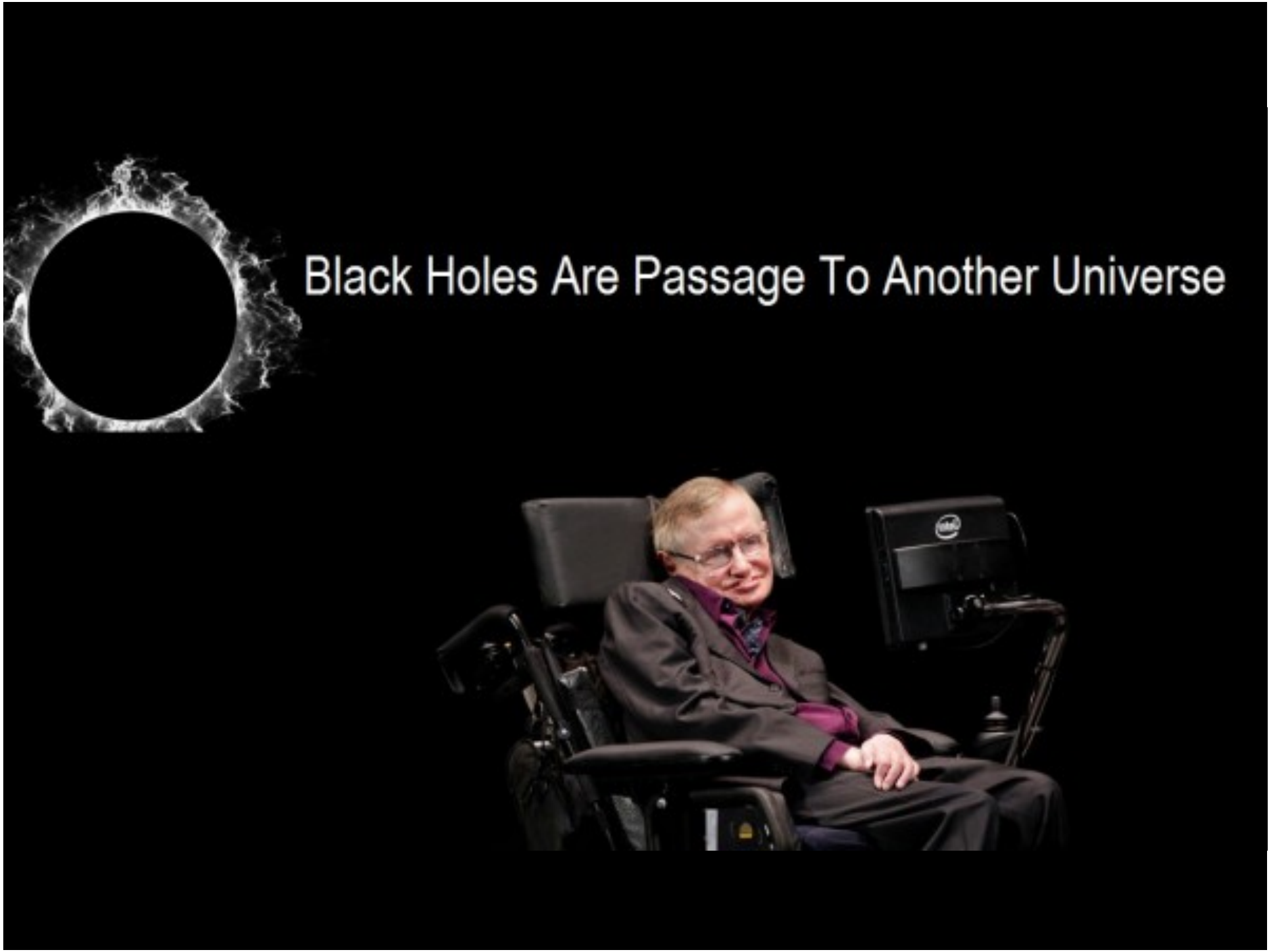
Huge BH
(no spaghetificaton)



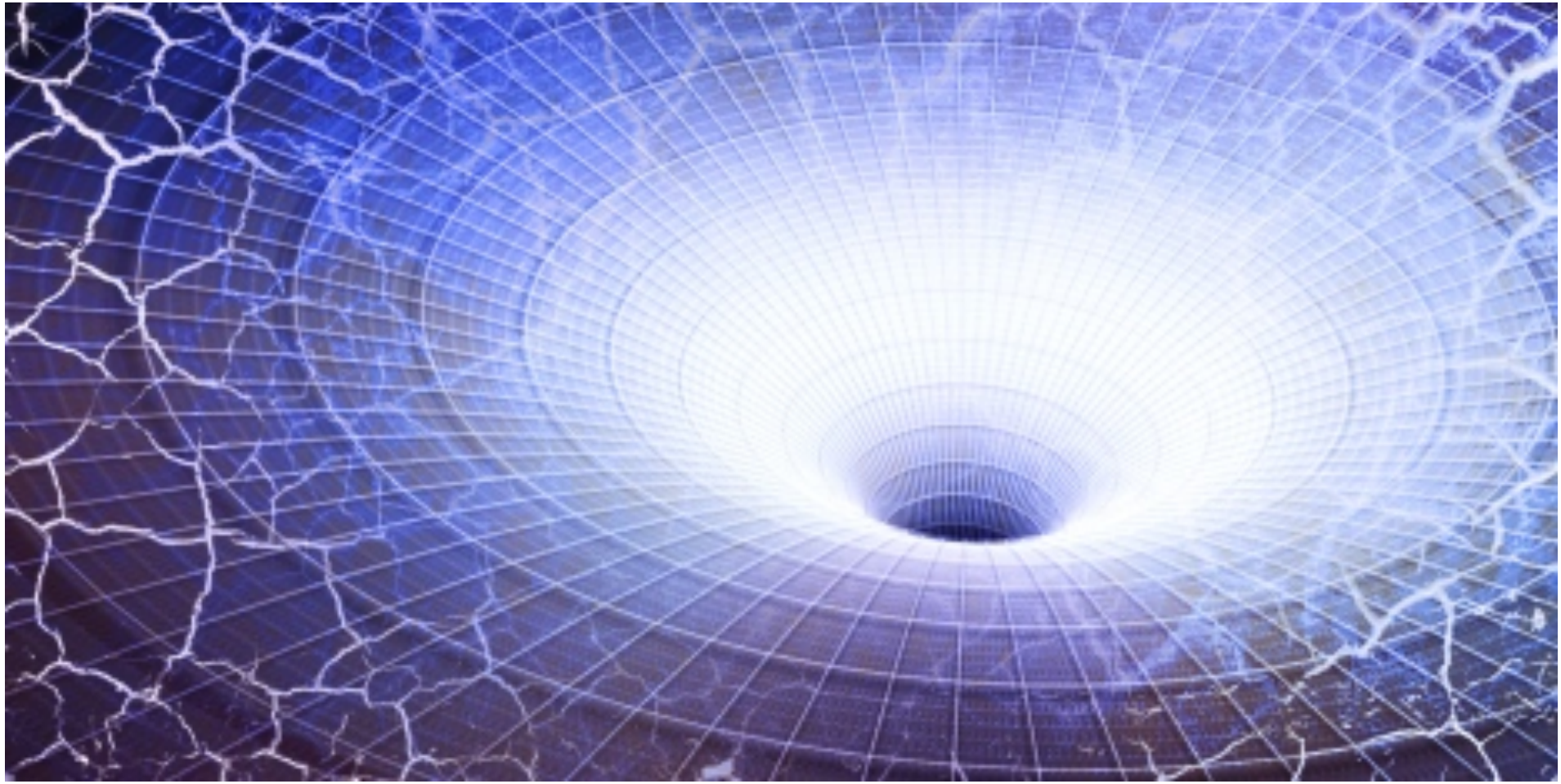
Black Hole – mass about 17 miliarde di volte massa Sole



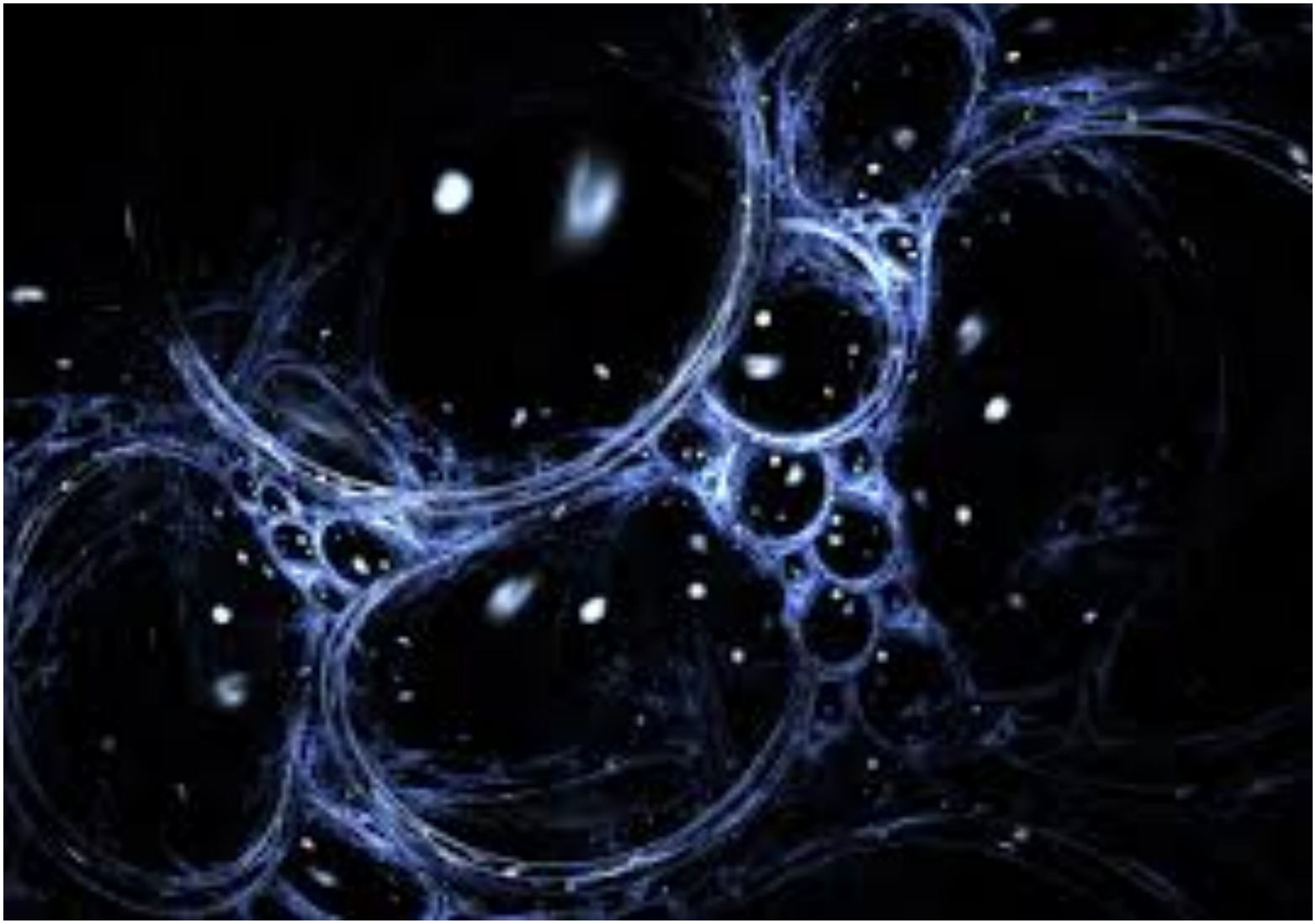

Interstellar?

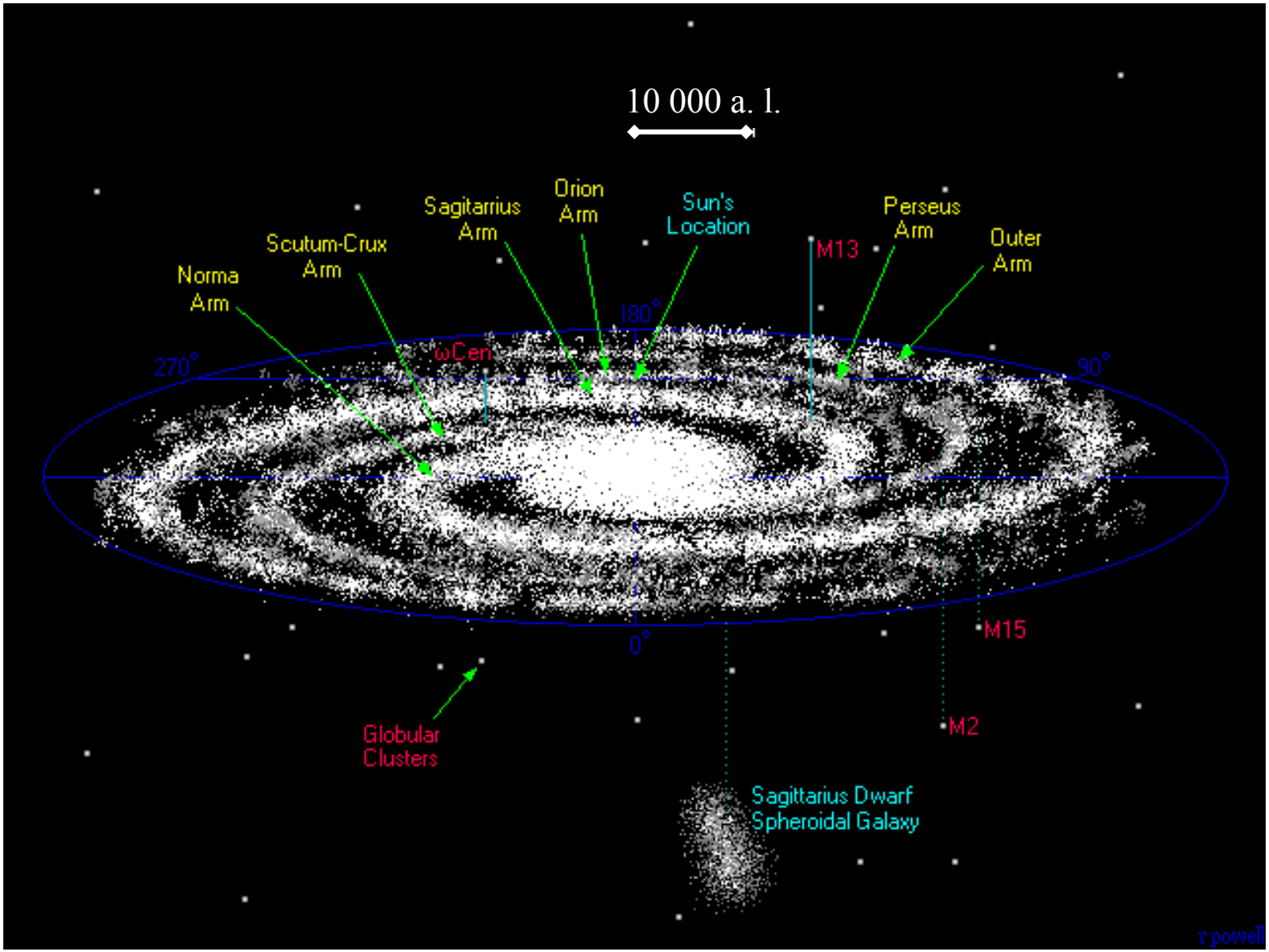

Black Holes Are Passage To Another Universe

To understand BH we need quantum gravity?! A new theory of space and time



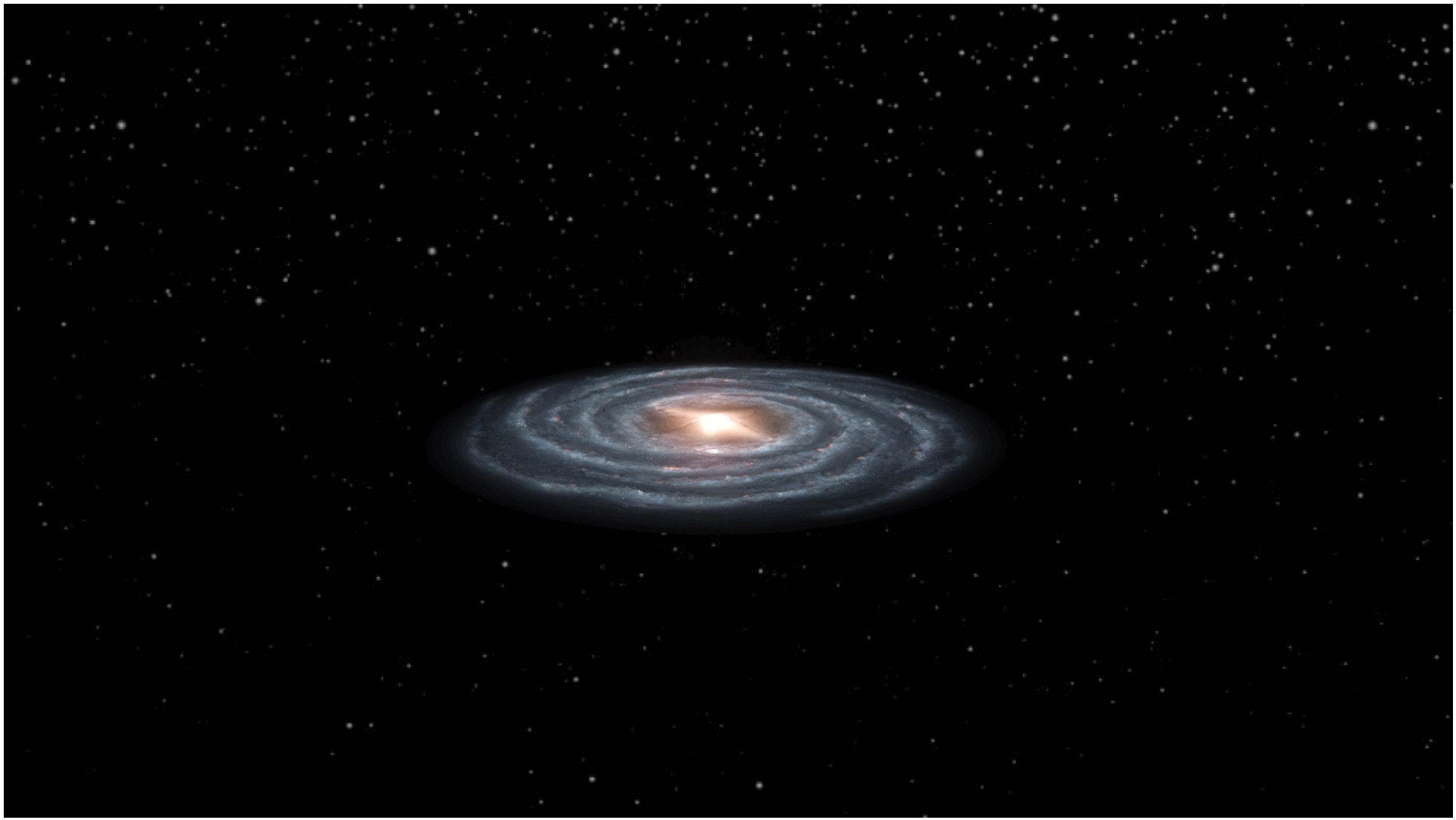
Dark Matter and Energy

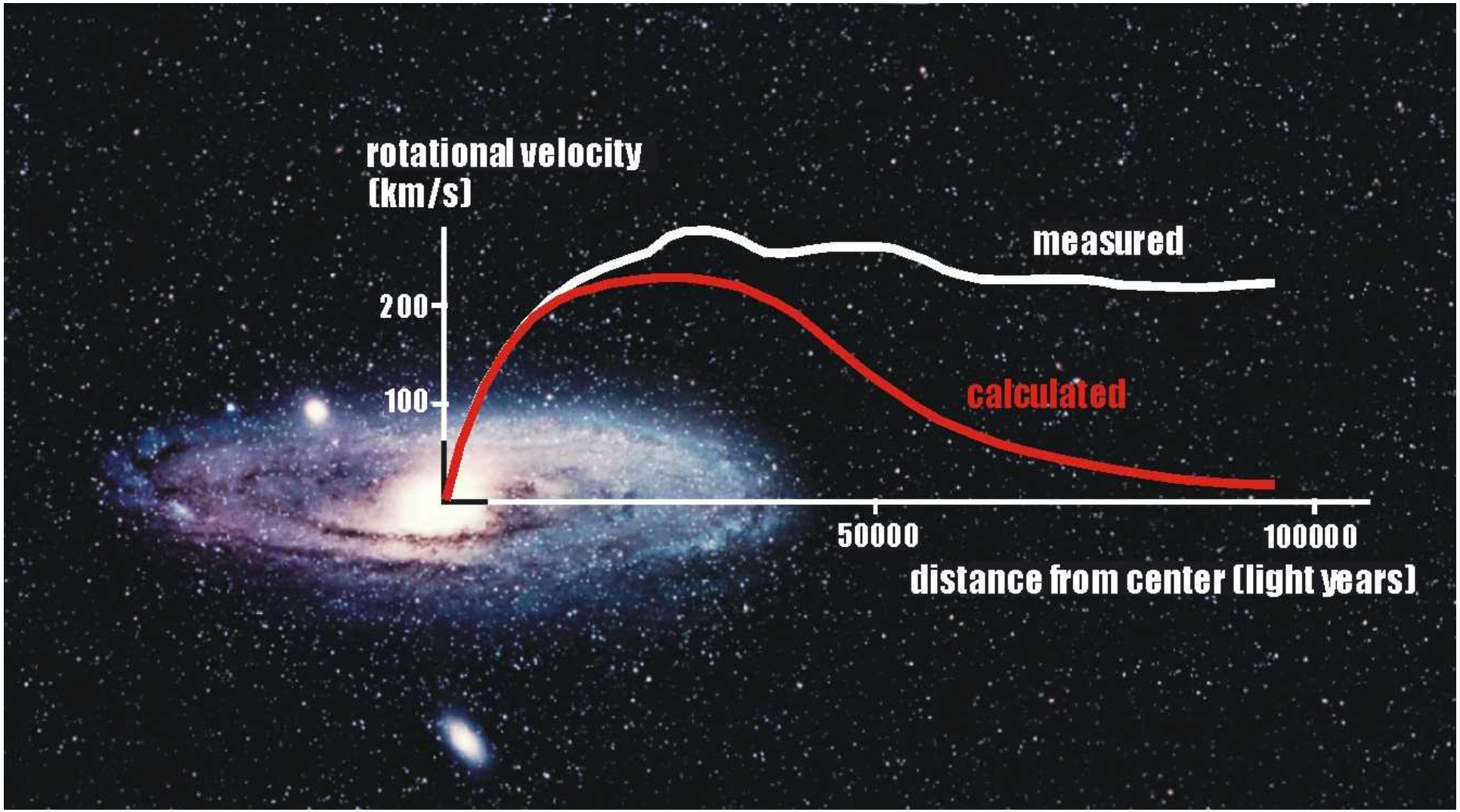


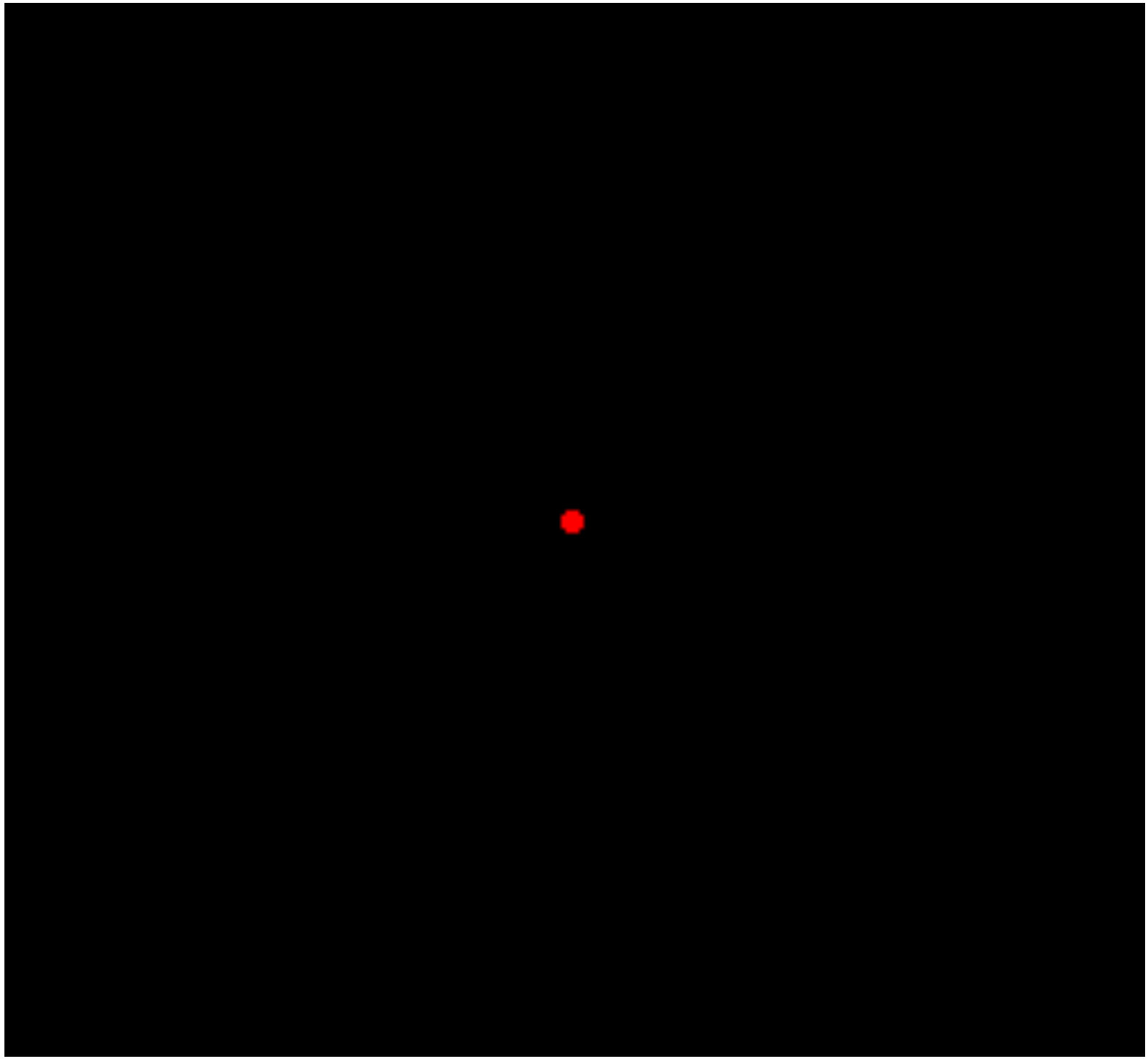


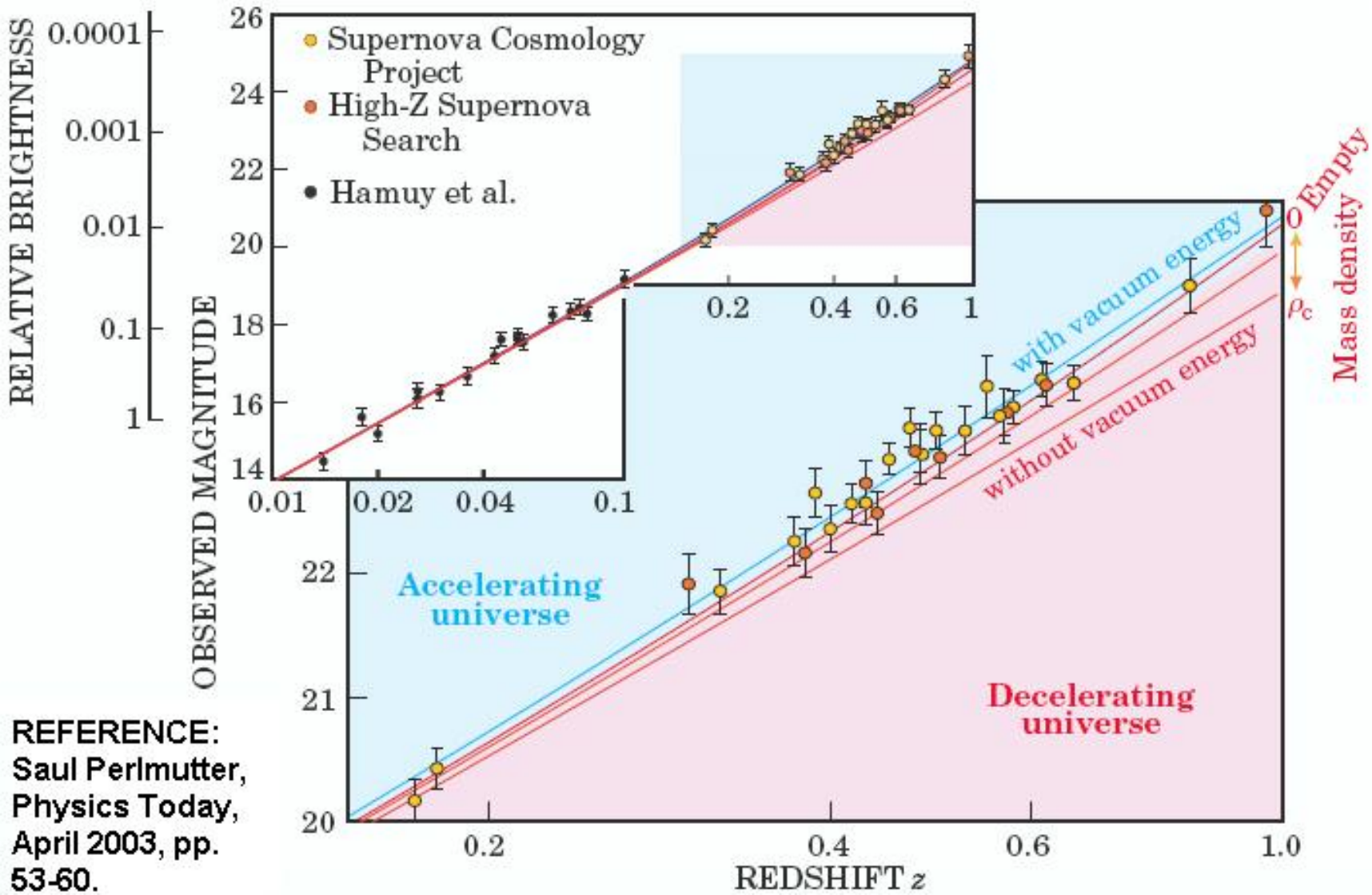
Zoom In x10

Zoom Out x10



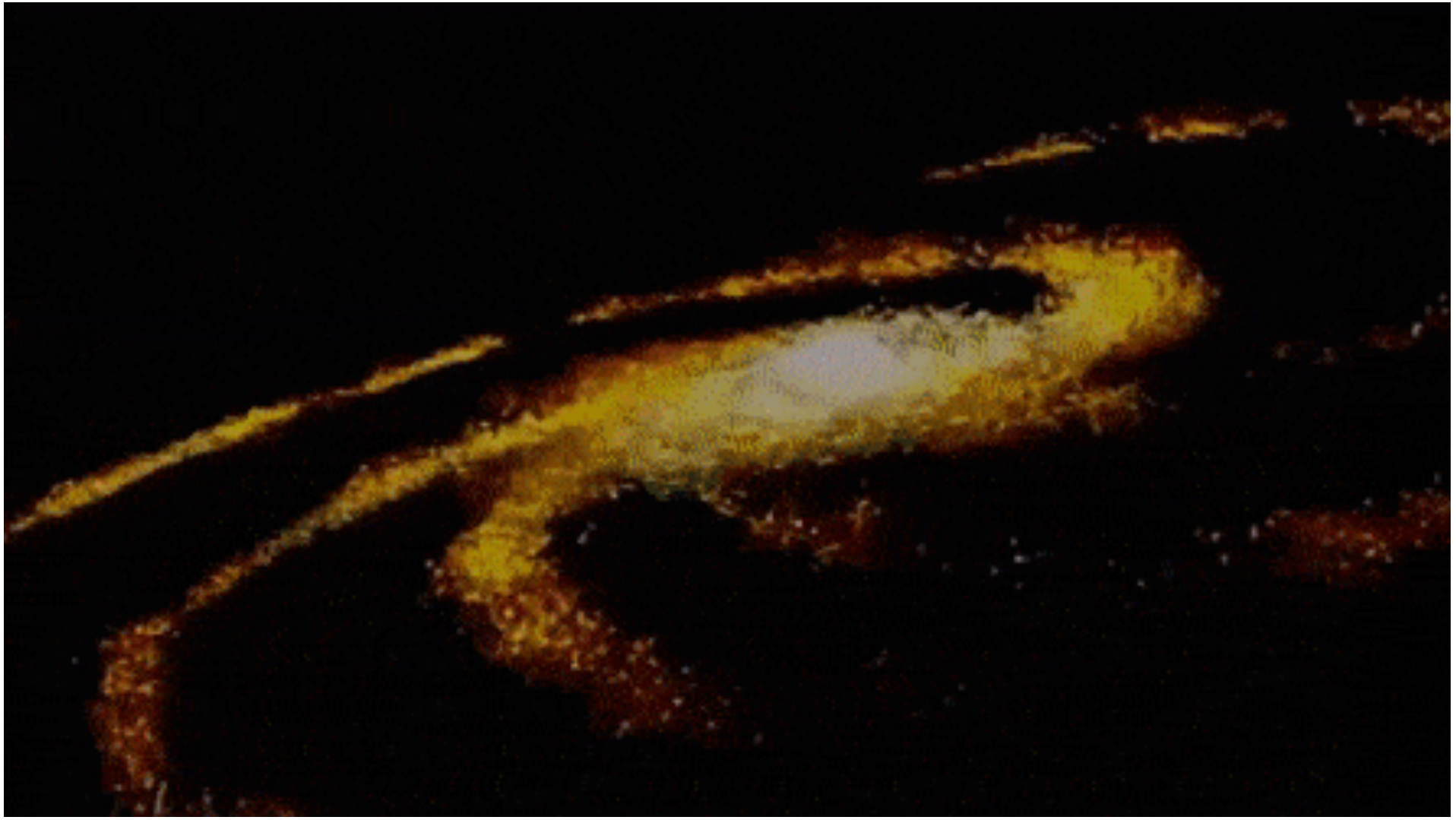

rotational velocity
(km/s)
200
100
measured
calculated
50000
100000
distance from center (light years)

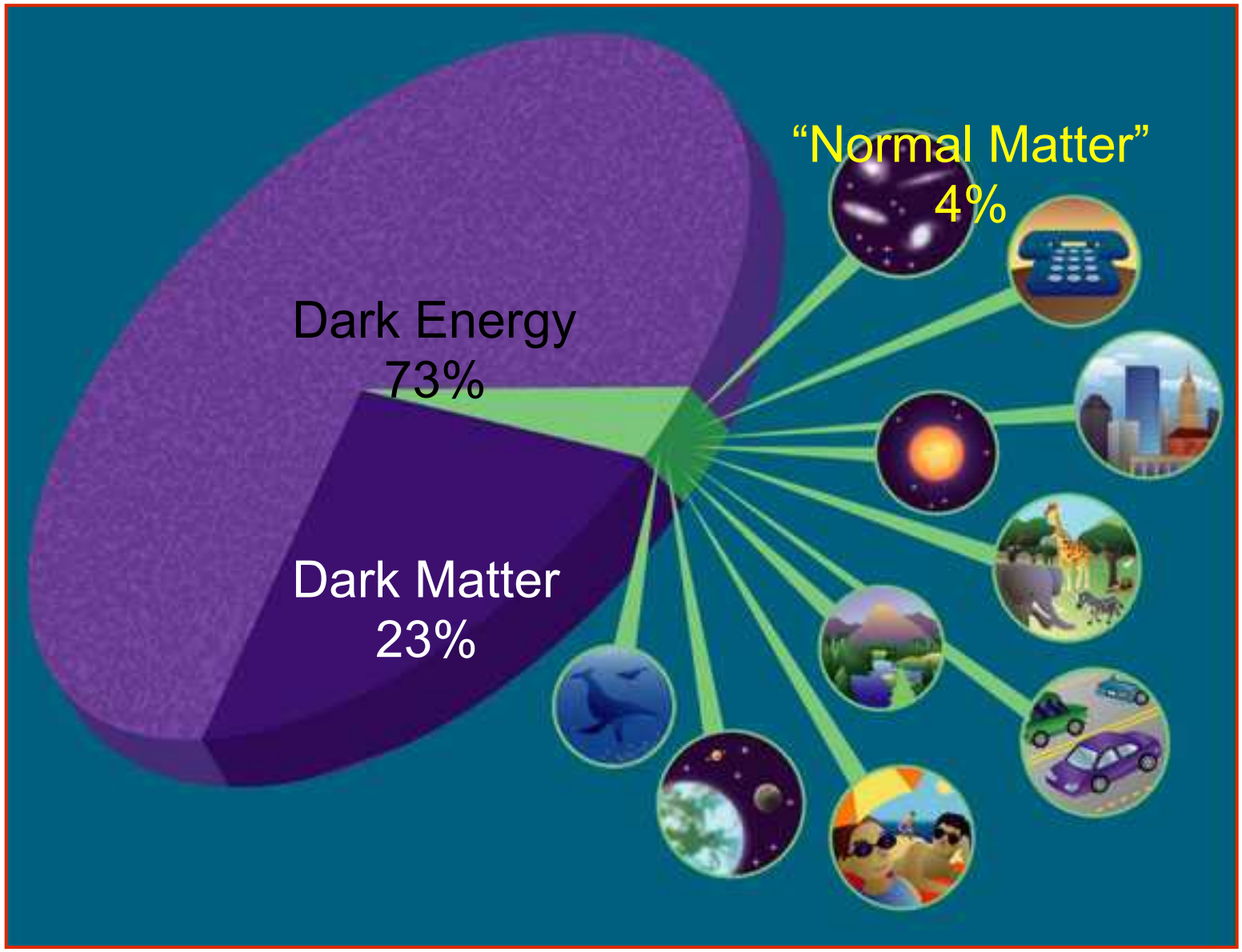




REFERENCE:
Saul Perlmutter, Physics Today, April 2003, pp. 53-60.

Dark Energy




“Normal Matter”
4%
Dark Energy
73%
Dark Matter
23%

1951
4 University Sections
Milano, Torino, Padova, e Roma

1957
Laboratori Nazionali di Frascati

Frascati

INFN
Istituto Nazionale di Fisica Nucleare

Legnaro

VIRGO-EGO

European

Gravitational

Observatory

Laboratori del Sud (Catania)

Gran Sasso

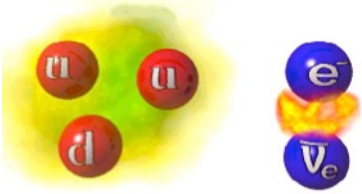
19 Sections

11 Related Groups

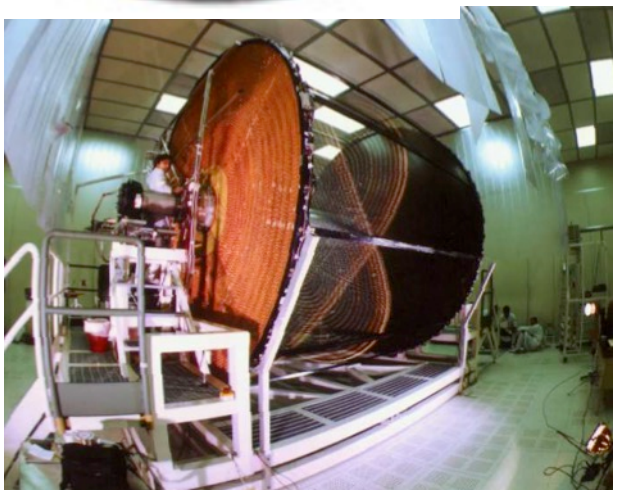
4 National Laboratories

What are the activities performed at Laboratori Nazionali di Frascati?

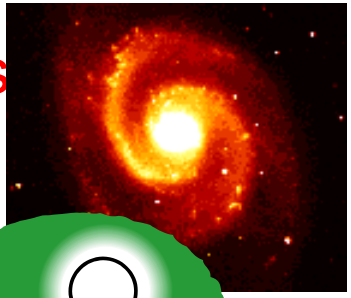
Fundamental research



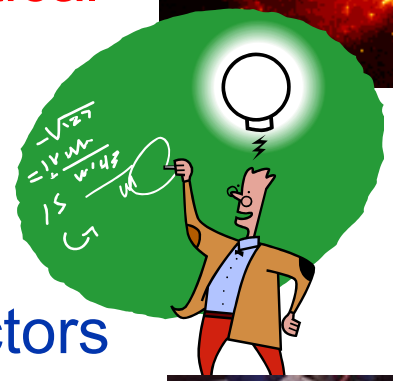
- Studies of the ultimate matter structure



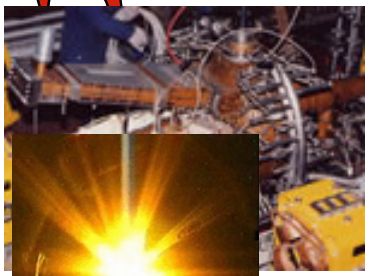
- Search for gravitational waves



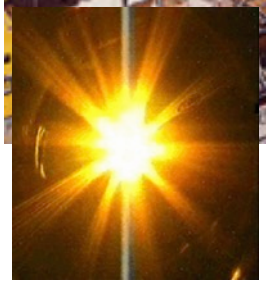
- Developments of theoretical models



- Development and construction of particle detectors

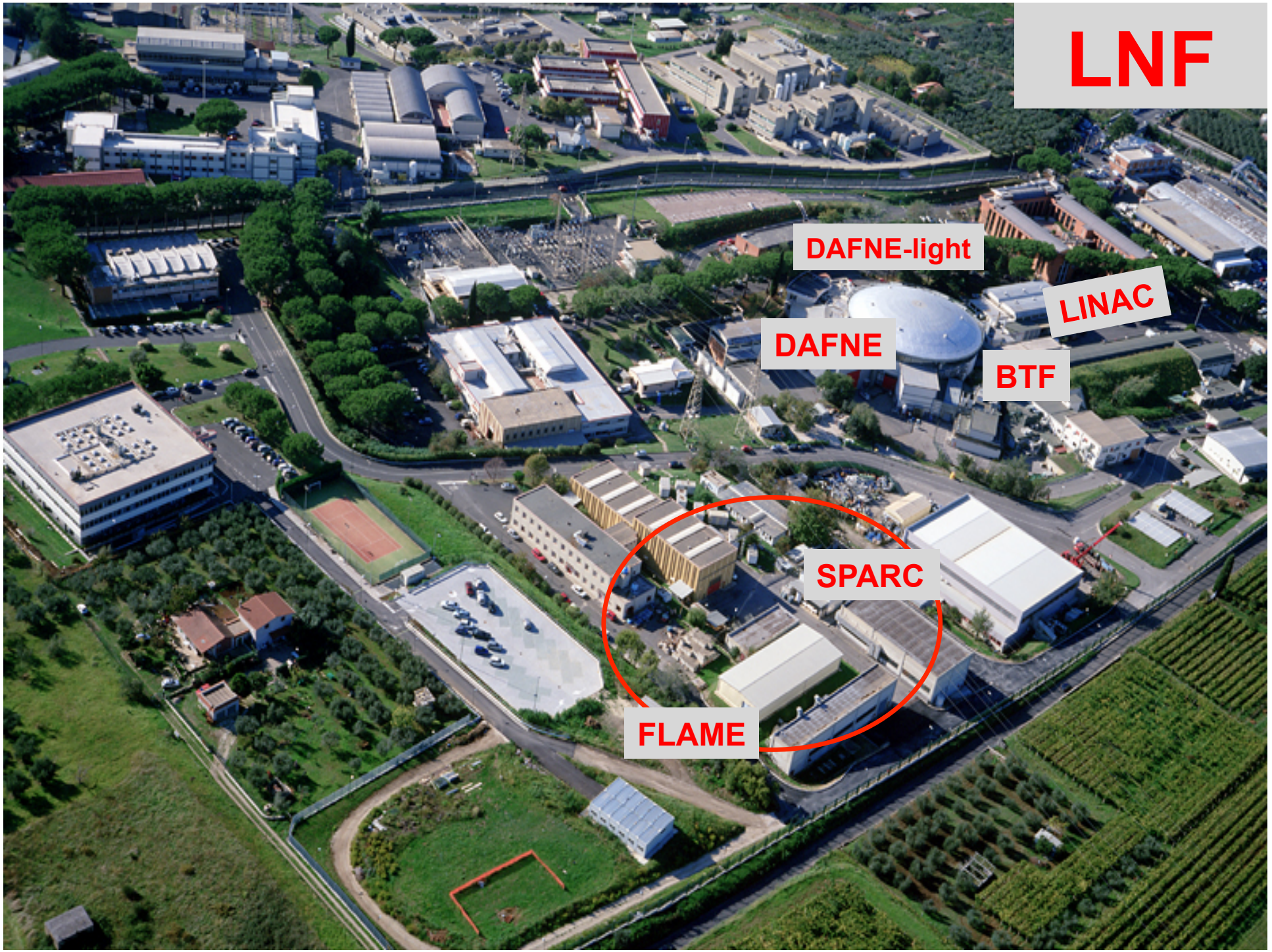


- Studies and development of accelerating techniques



- Material studies and bio-medical research with the synchrotron light

- Development and support for computing systems and nets

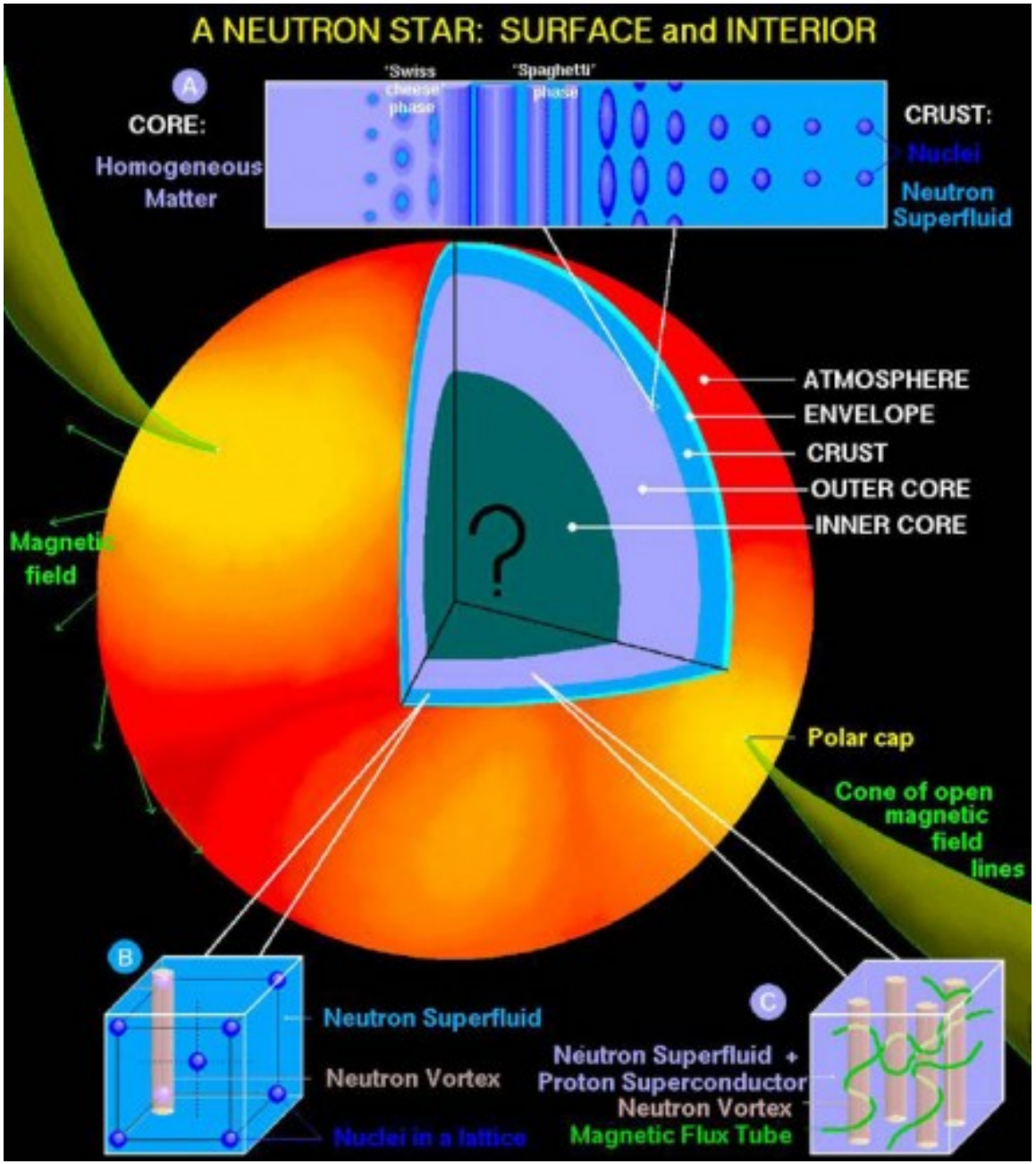

LNF
DAFNE-light
LINAC
DAFNE
BTF
SPARC
FLAME

Matter-antimatter colliders

LHC at Cern (pp)

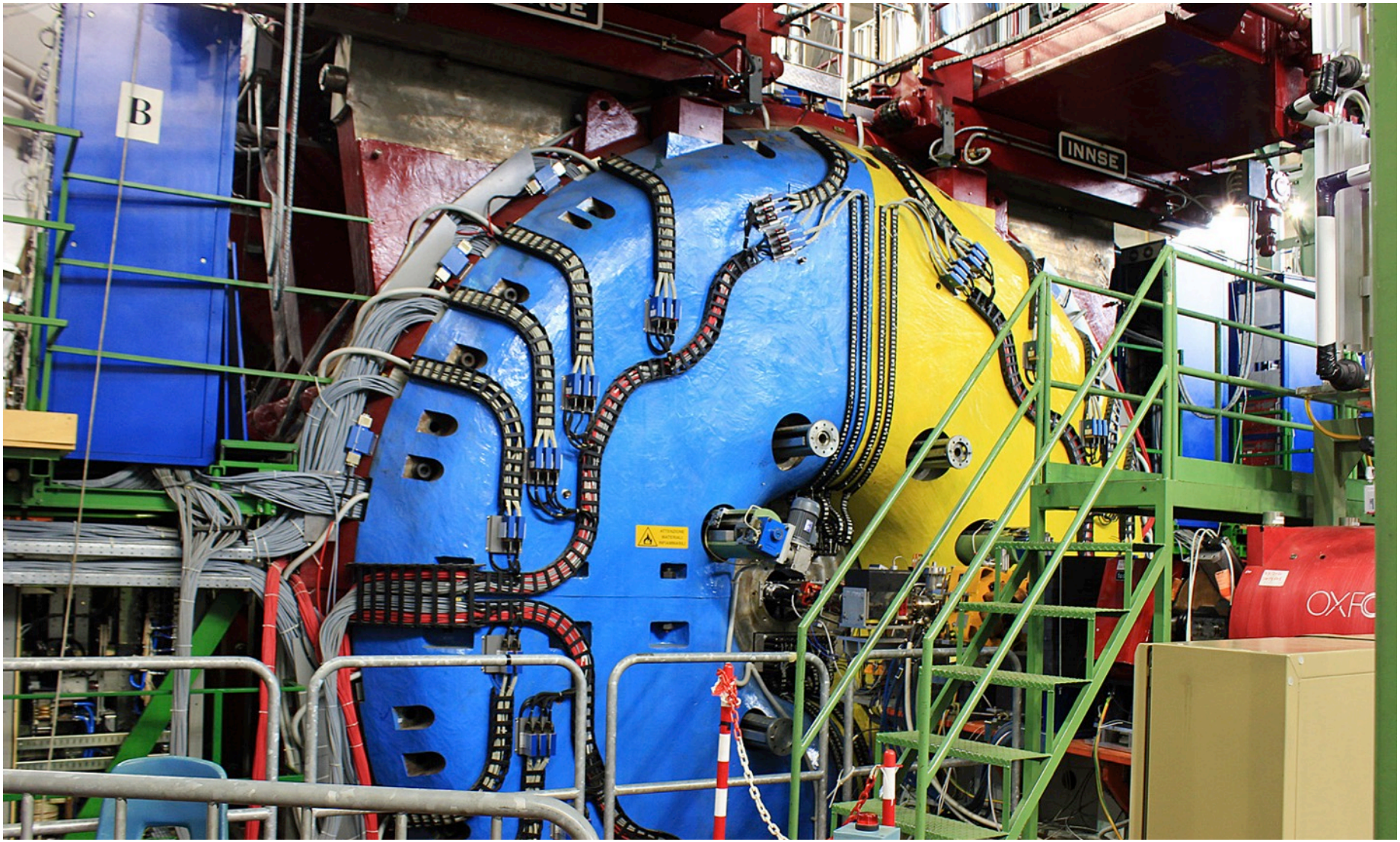
SIDDHARTA Collaboration

Could strangeness play a role in neutron stars?

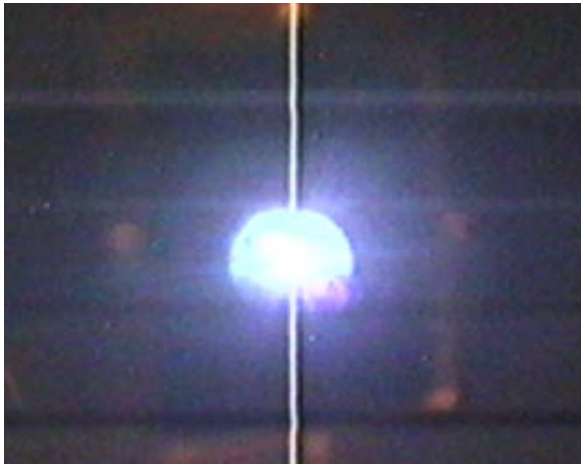


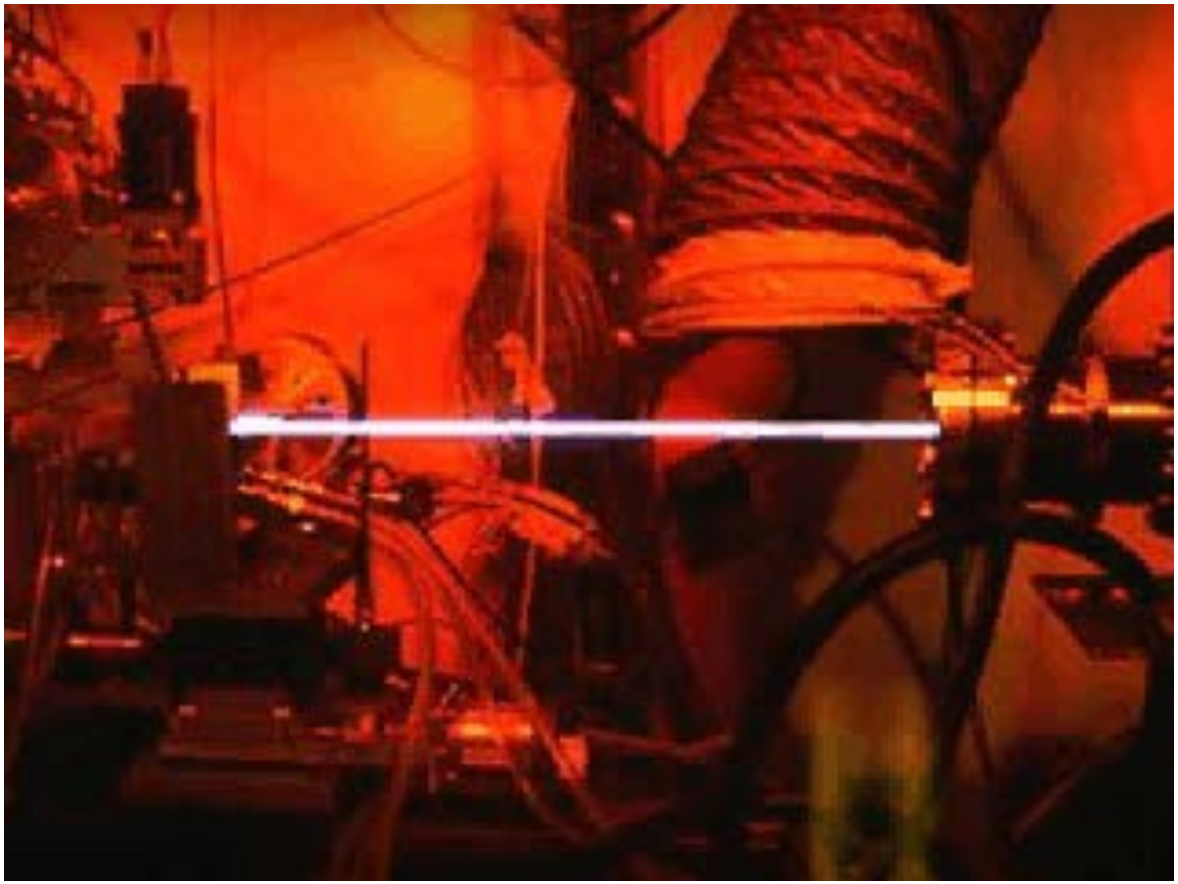
KLOE2 – where antimatter disappeared?

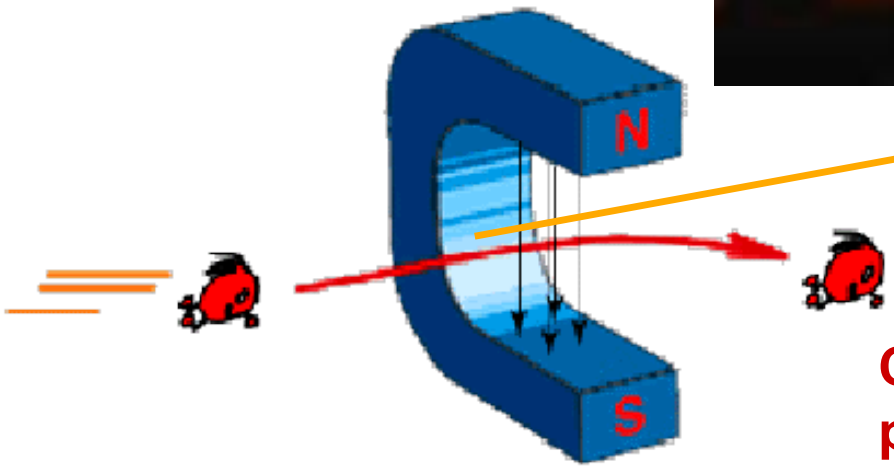
(K LOng Experiment)



Synchrotron light (DAΦNE-luce)







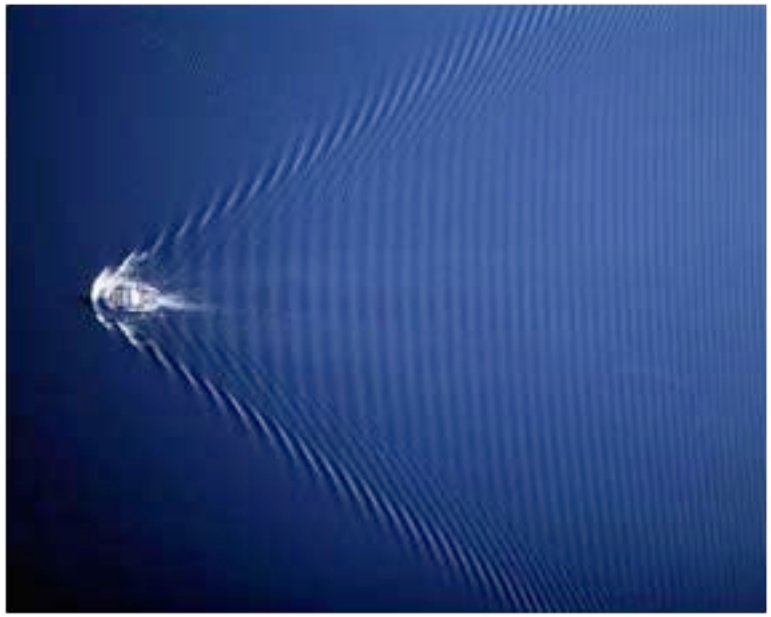
Light (photons)

European Synchrotron Radiation Facility

Charged particle

New acceleration technique

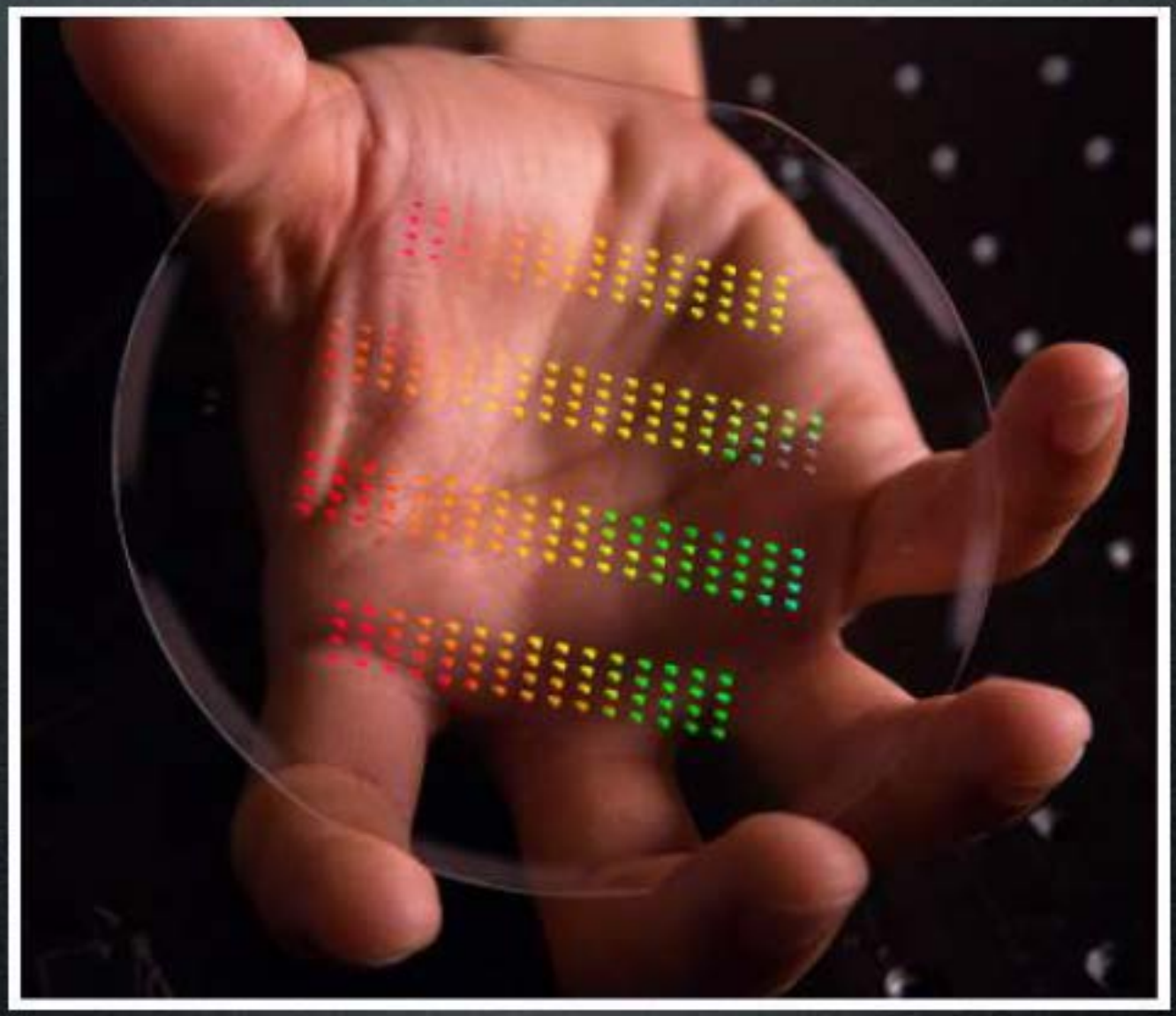
Laser pulse creates a wave



Particles get accelerated

In few cm electrons get accelerations as in present accelerators of hundred meters

Accelerator on a Chip?



Medical diagnosis

Mamography

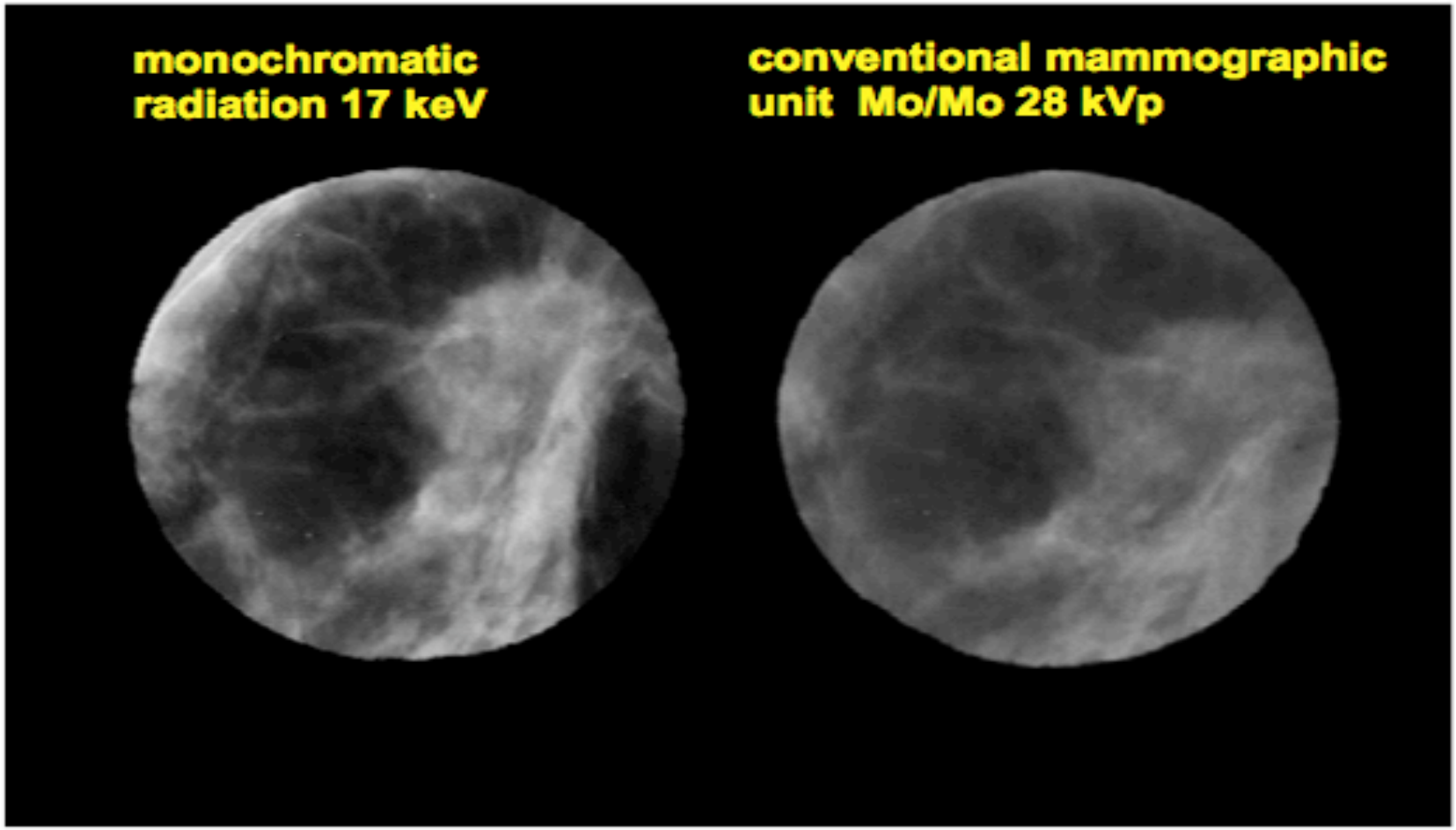
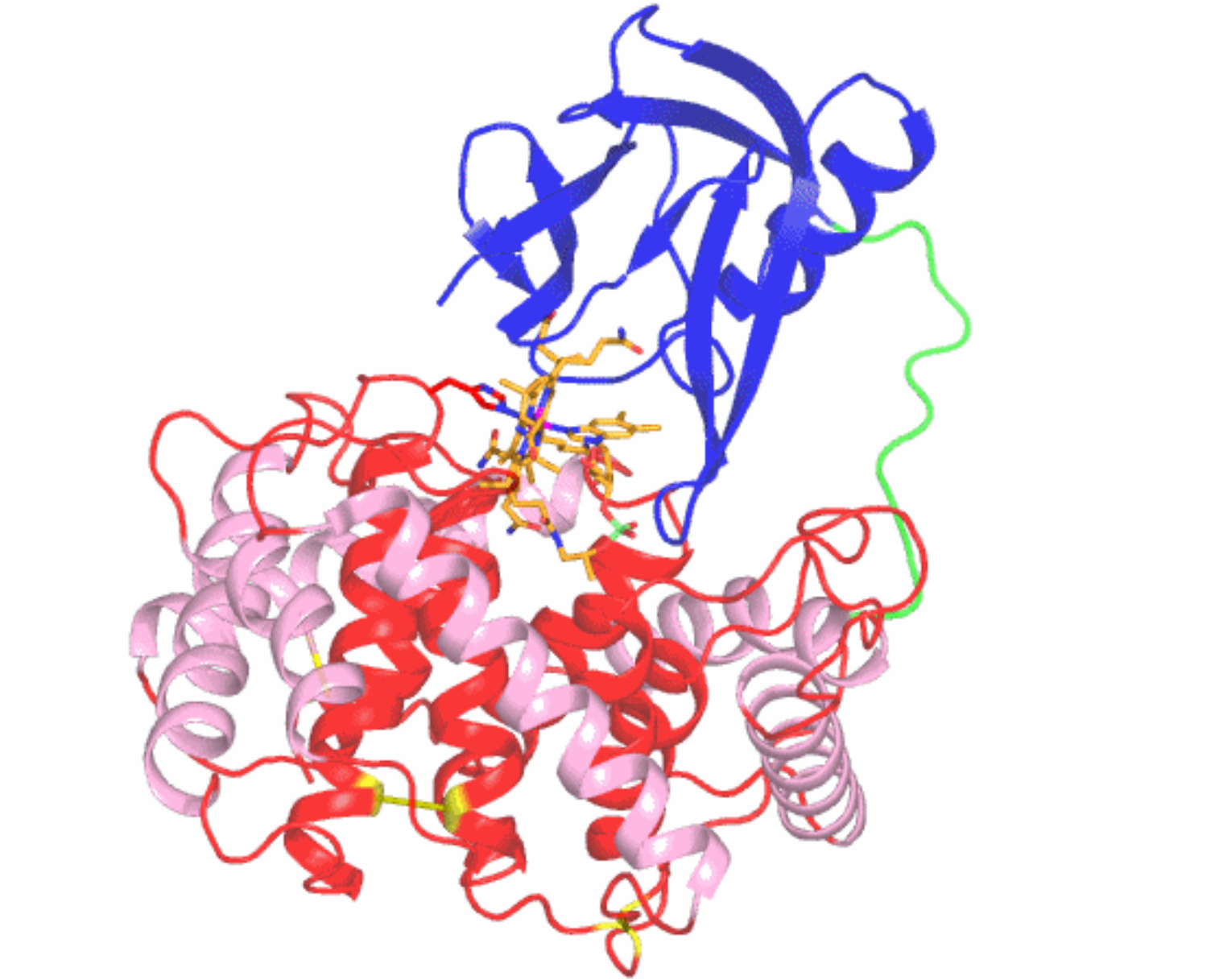


Fig. 3 – Confronto fra una mammografia monocromatica (sinistra) con una tradizionale (destra).

Proteins



INSPYRE 2020 Program

Monday 30 March – Chair Catalina Curceanu

10:30 – 11:45 INSPYRE 2020 – Hitchhiker's Guide to the Universe: Welcome and Introduction (INSPYRE Director: C. Curceanu)

12:00 – 13:15 Where is everybody? Searching for life in the Universe (Amedeo Balbi – Univ. Tor Vergata, Roma)

Tuesday 31 March – Chair Danilo Domenici

10:30 – 11:45 The second Quantum revolution (Fabio Sciarrino – Univ. Sapienza, Roma)

12:00 – 13:15 What is time? Answers from modern physics (Lorenzo Maccone – Univ. di Pavia)

Wednesday 1 April – Chair Paola Gianotti

10:30 – 11:45 Bionanotechnologies (Stefano Bellucci – INFN-LNF)

12:00 – 13:15 Bionanotechnologies and other application: From synthesis to device (Antonino Cataldo – INFN-LNF)

INSPYRE 2020 Program

Thursday 2 April – Chair Pasquale Di Nezza

10:30 – 11:45 Micro and macro-physics with gravitational waves in the next decades
(Viviana Fafone – Univ. and INFN Tor Vergata)

12:00 – 13:15 Strangeness in the Neutron stars investigated at the DAFNE accelerator
(Catalina Curceanu – INFN-LNF)

Friday 3 April – Chair Barbara Sciascia

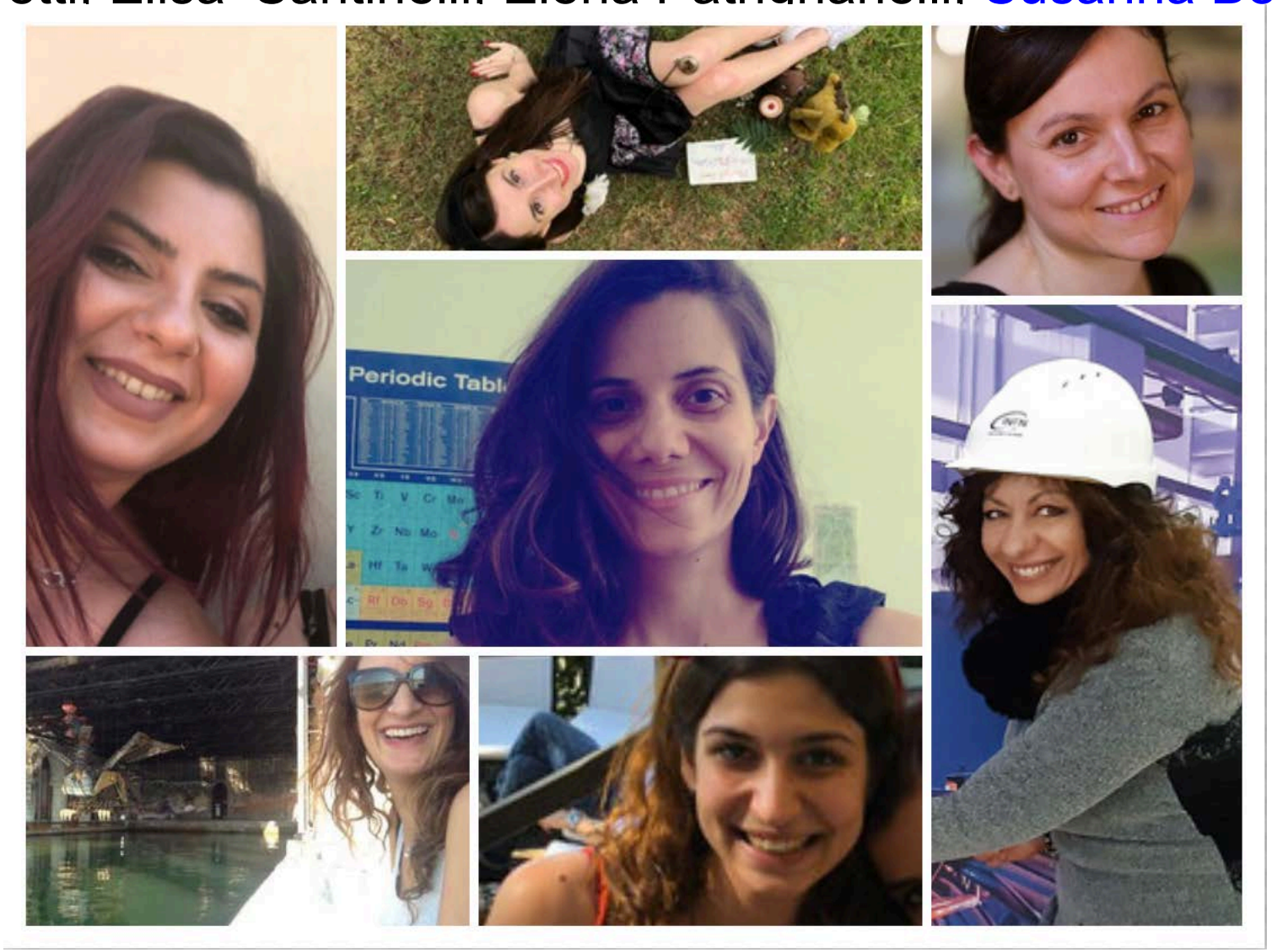
10:30 – 11:45 Big machines, high energies, and tiny particles: Physics at the femtoscale
(Frederik Van Der Veken – CERN)

12:00 – 13:15 The 21st century news jungle: food for thought to survive (Matteo Martini – FrascatiScienza – INFN-LNF – UniMarconi)

INSPYRE 2020 team:

Sara Reda, Camilla Paola Maglione, Sara Arnone, Debora

Bifaretti. Elisa Santinelli. Elena Patrignanelli. Susanna Bertelli



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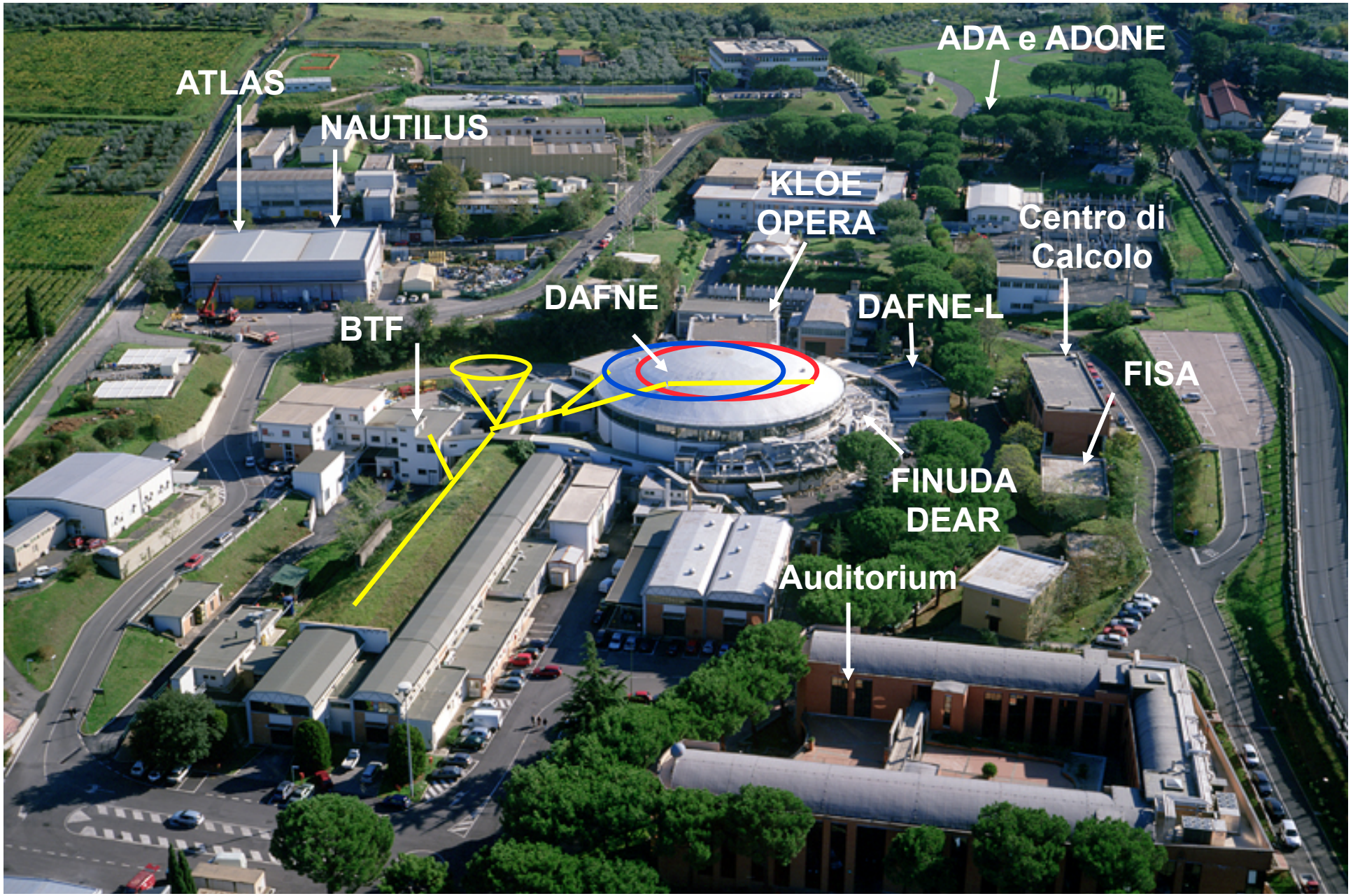
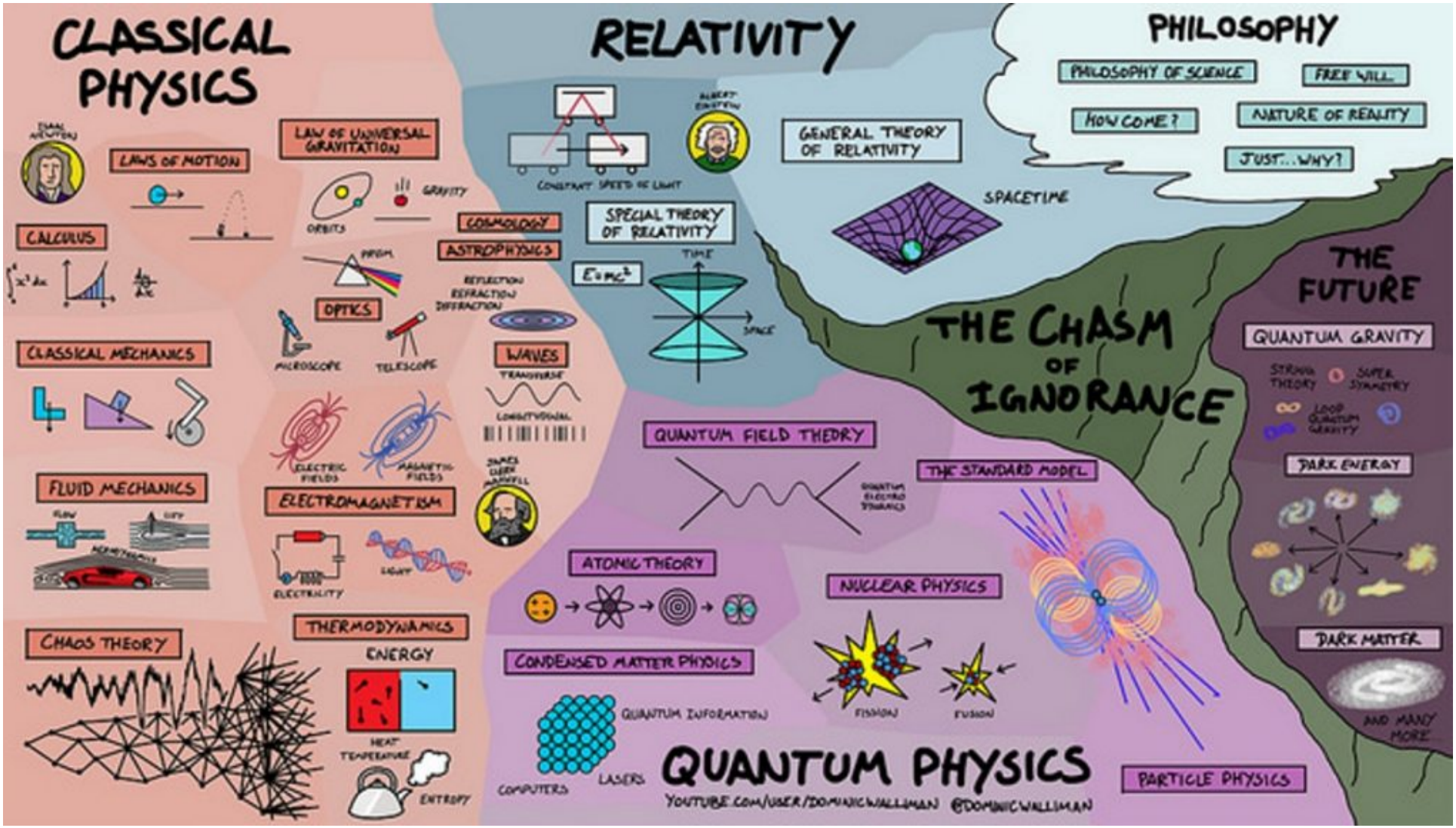
Frascati

Laboratori Nazionali di Frascati

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LAWS OF MOTION
LAW OF UNIVERSAL GRAVITATION
GRAVITY
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RELATIVITY
CONSTANT SPEED OF LIGHT
GENERAL THEORY OF RELATIVITY
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FREE WILL
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NATURE OF REALITY
JUST...WHY?
THE CHASM OF IGNORANCE
THE FUTURE
QUANTUM GRAVITY
STRING THEORY
SUPER SYMMETRY
LOOP QUANTUM GRAVITY
DARK ENERGY
DARK MATTER
AND MANY MORE
QUANTUM FIELD THEORY
QUANTUM ELECTRODYNAMICS
THE STANDARD MODEL
ATOMIC THEORY
NUCLEAR PHYSICS
FISSION
FUSION
CONDENSED MATTER PHYSICS
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The Hitchhikers's Guide to the Universe