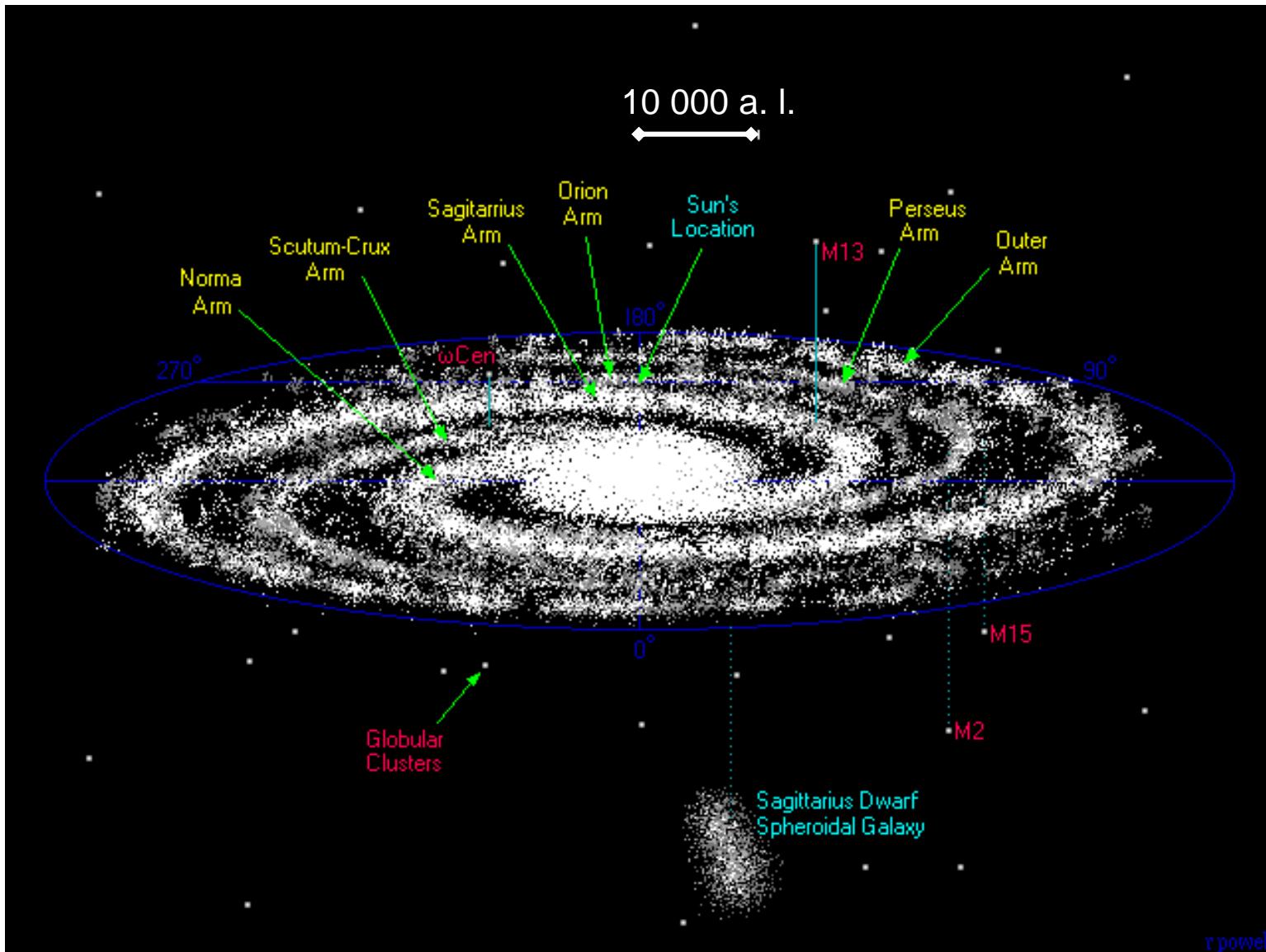


7 big questions IN MODERN PHYSICS

Catalina Curceanu INSPYRE 2016



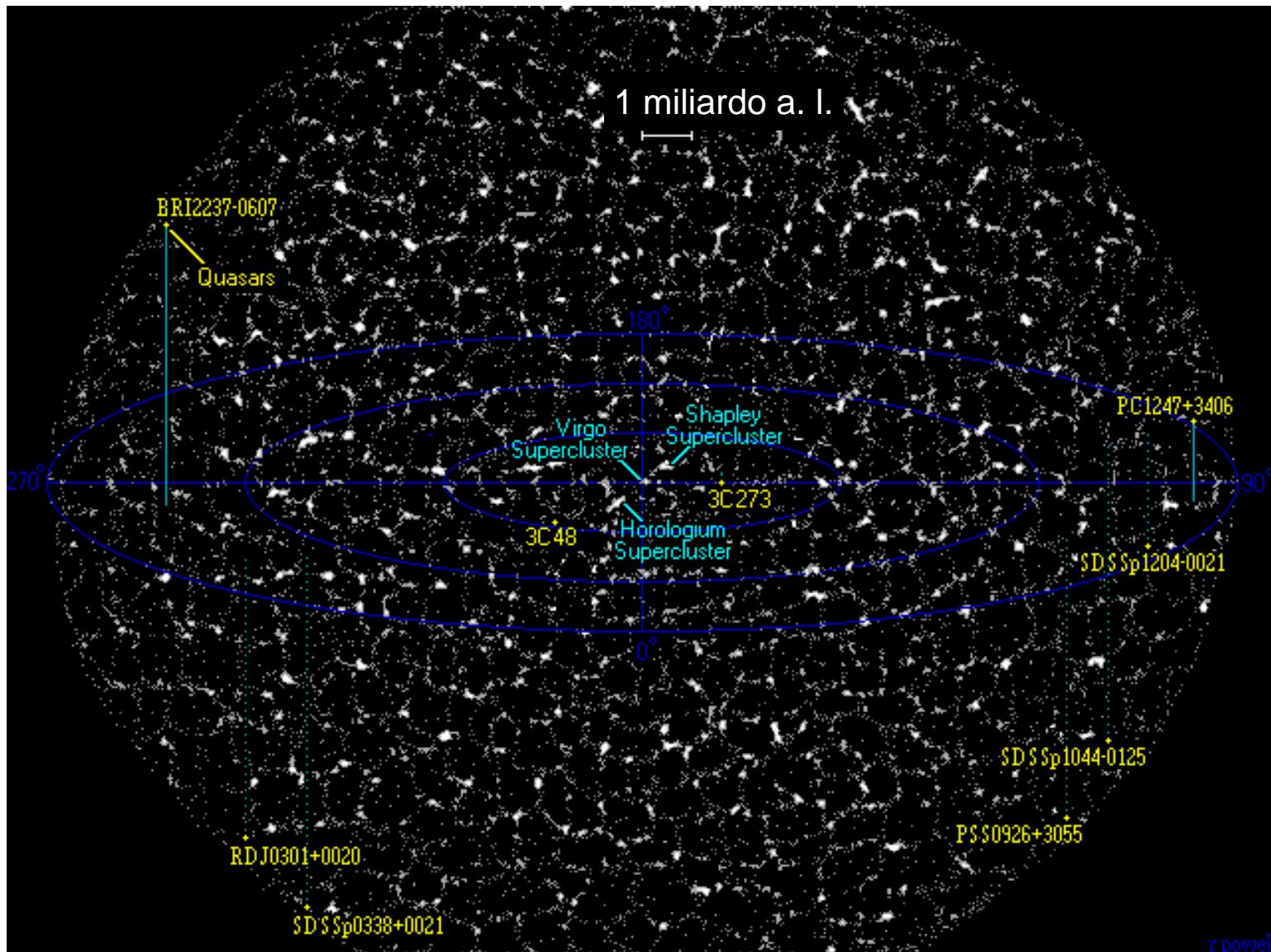




rpowell

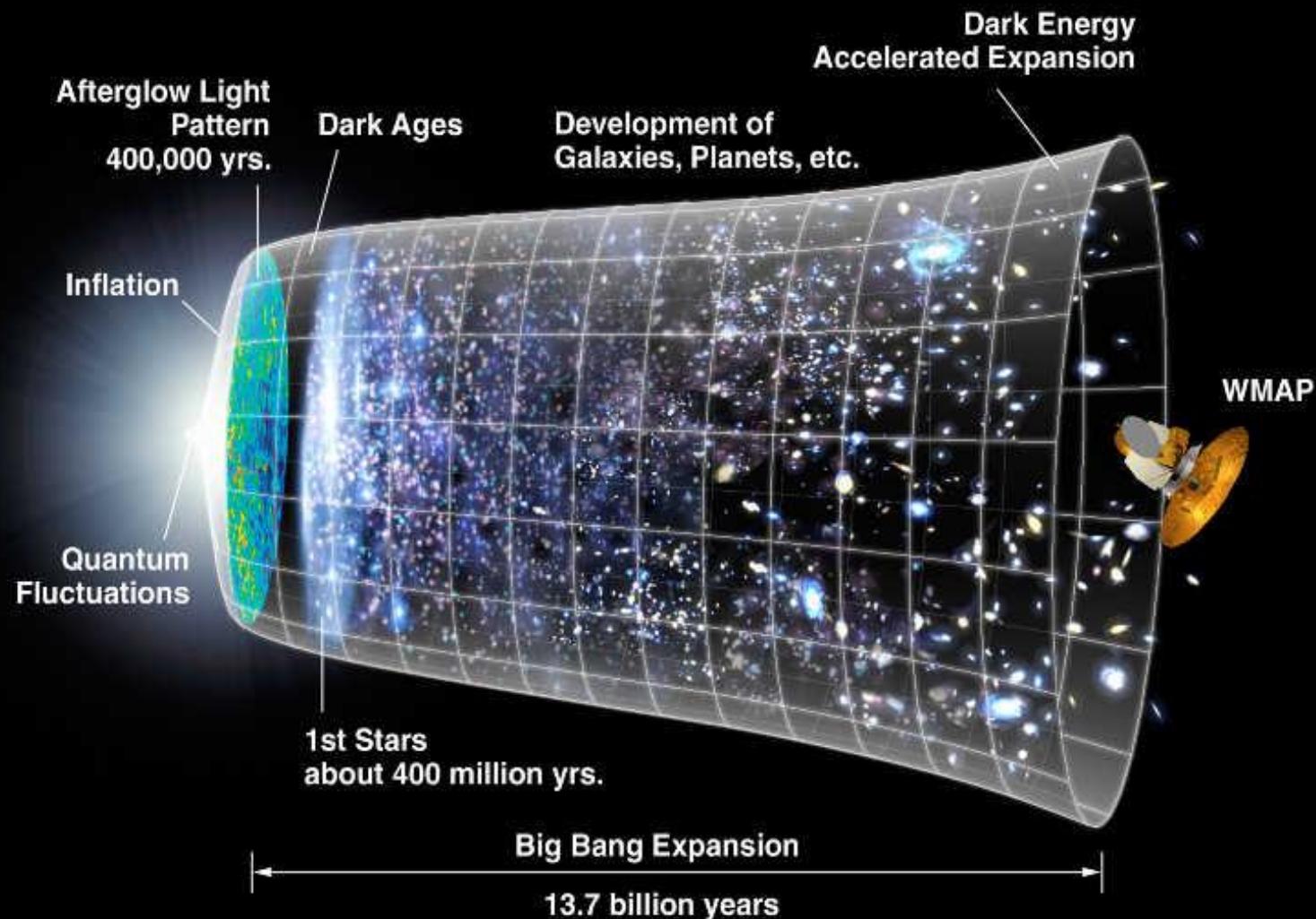
Zoom In x10

Zoom Out x10

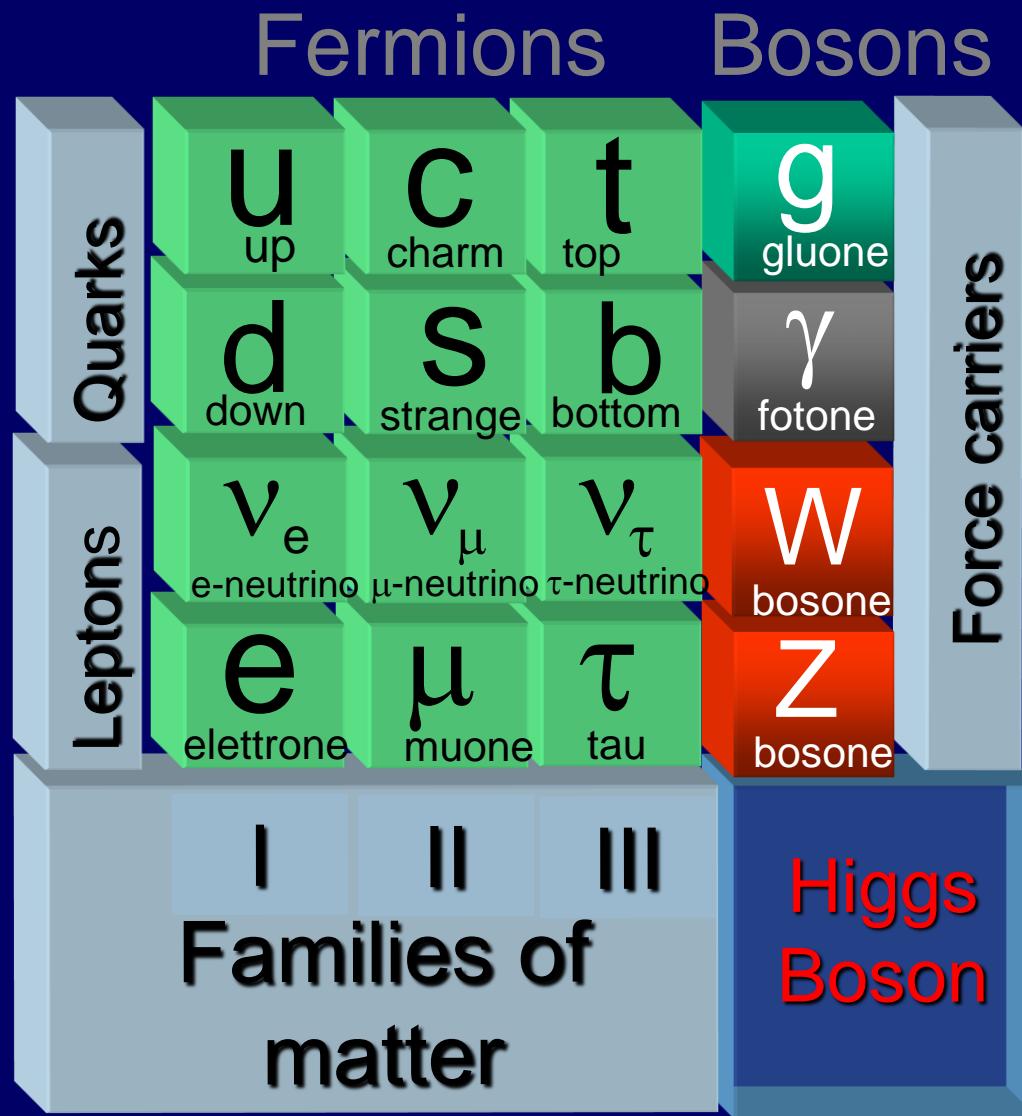


Zoom In x15

The Big Bang Model

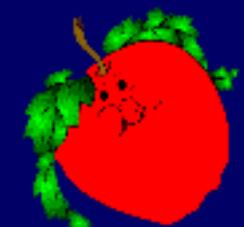


The Standard Model



Gravity

The...
“opera
Ghost”

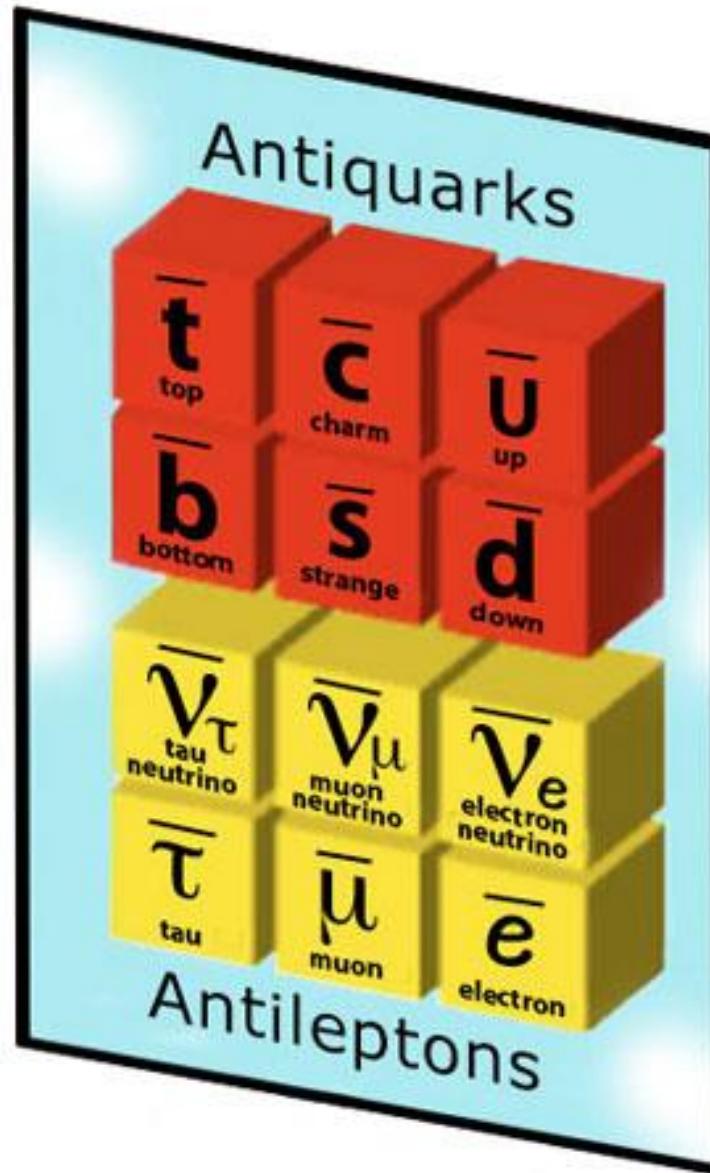
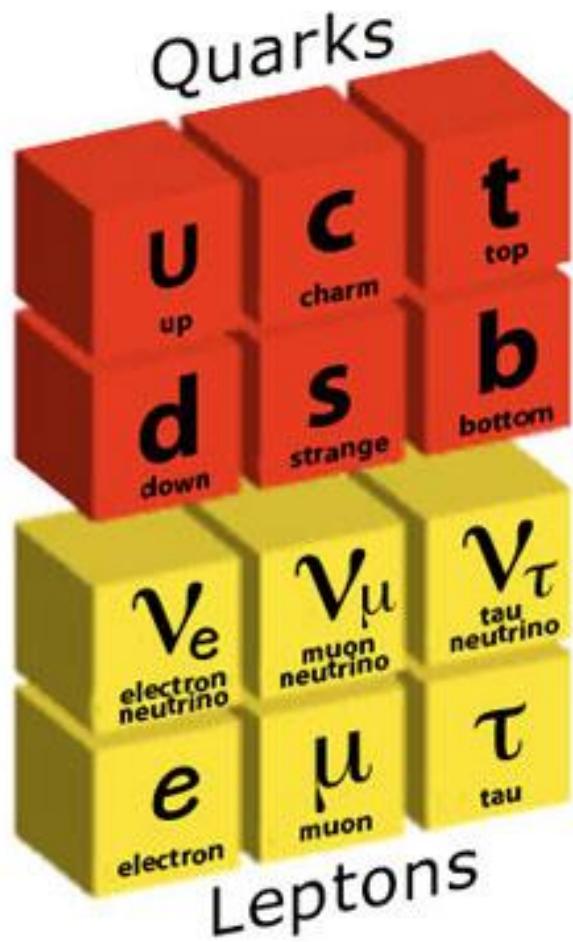


7 big questions in modern physics:

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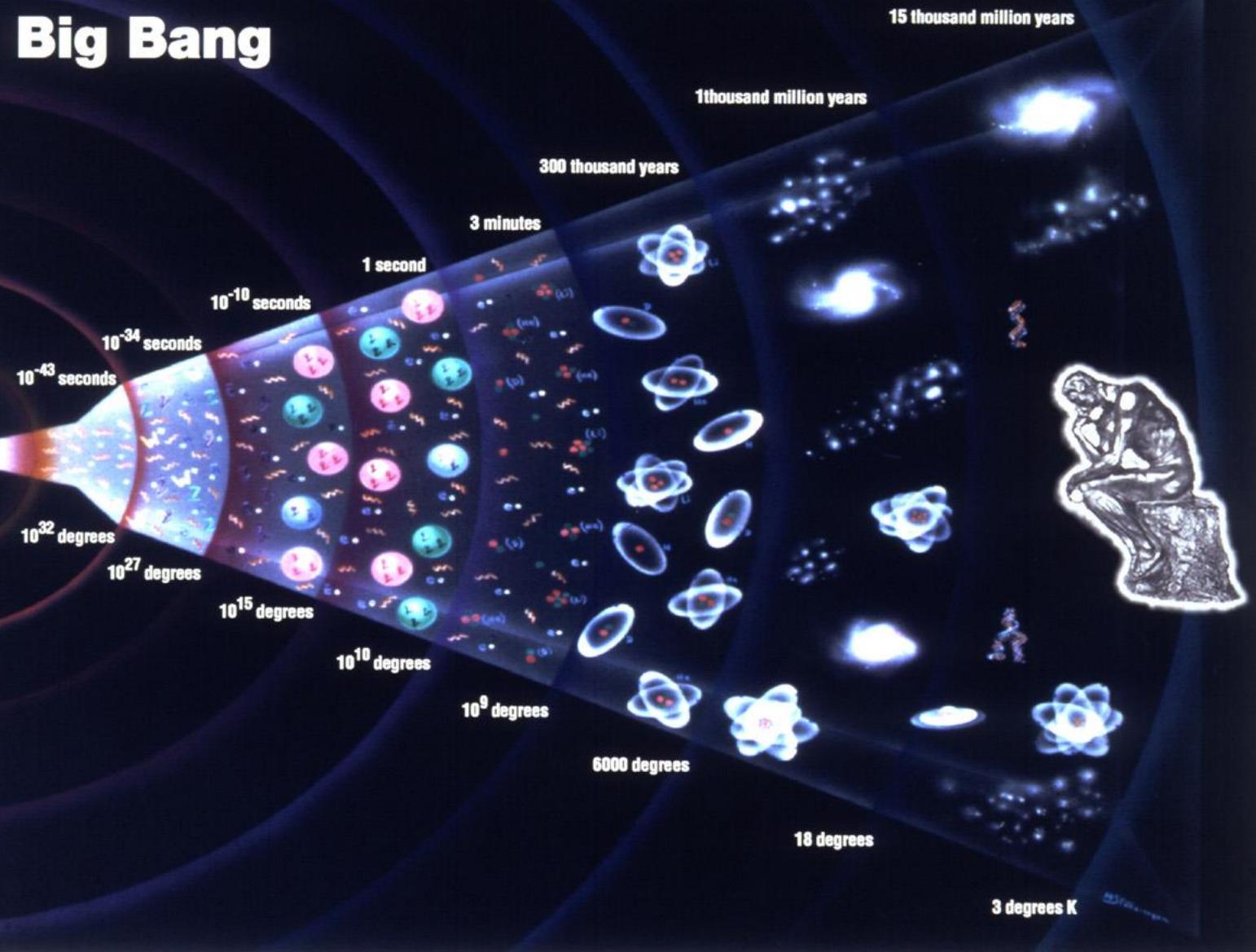
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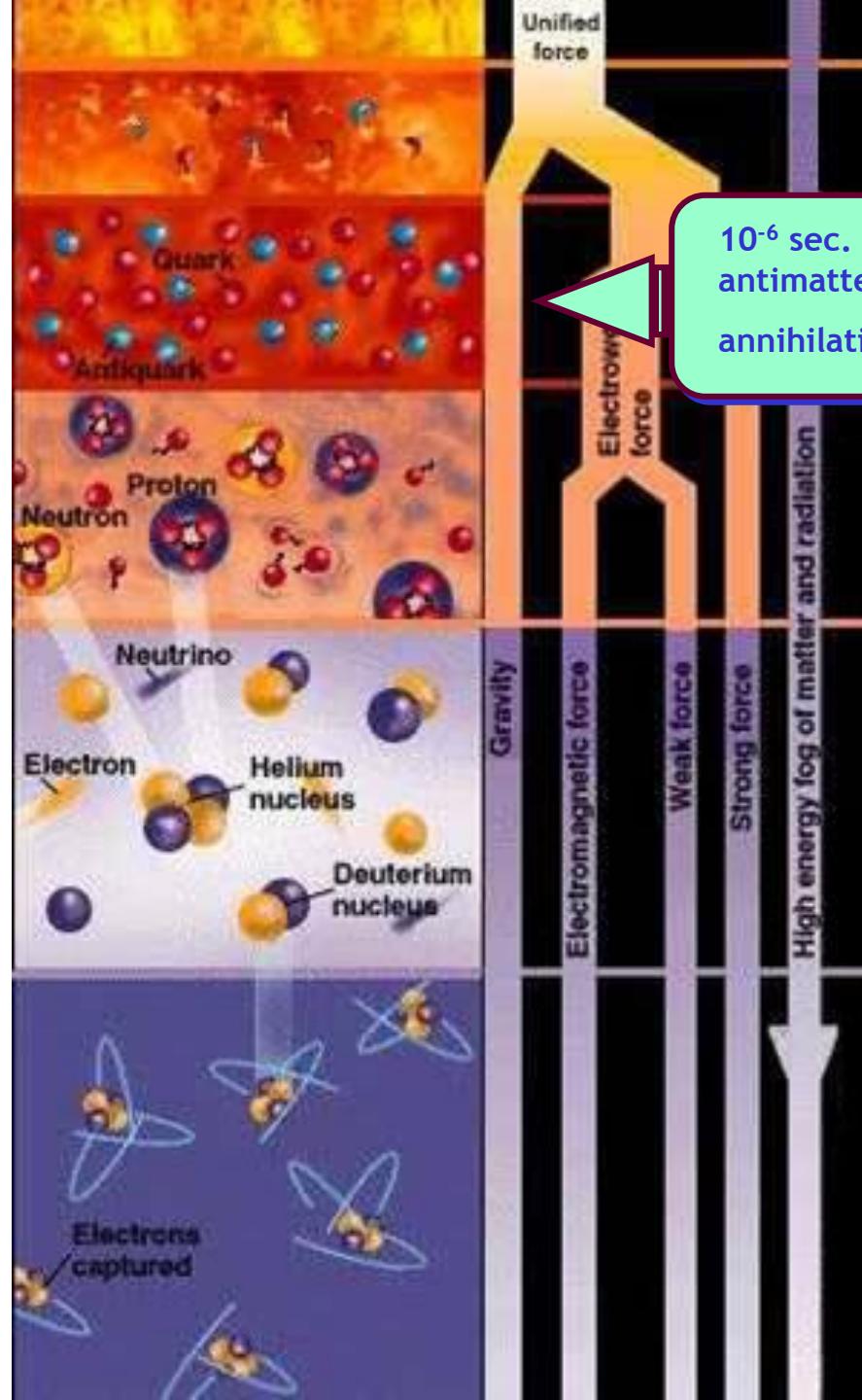
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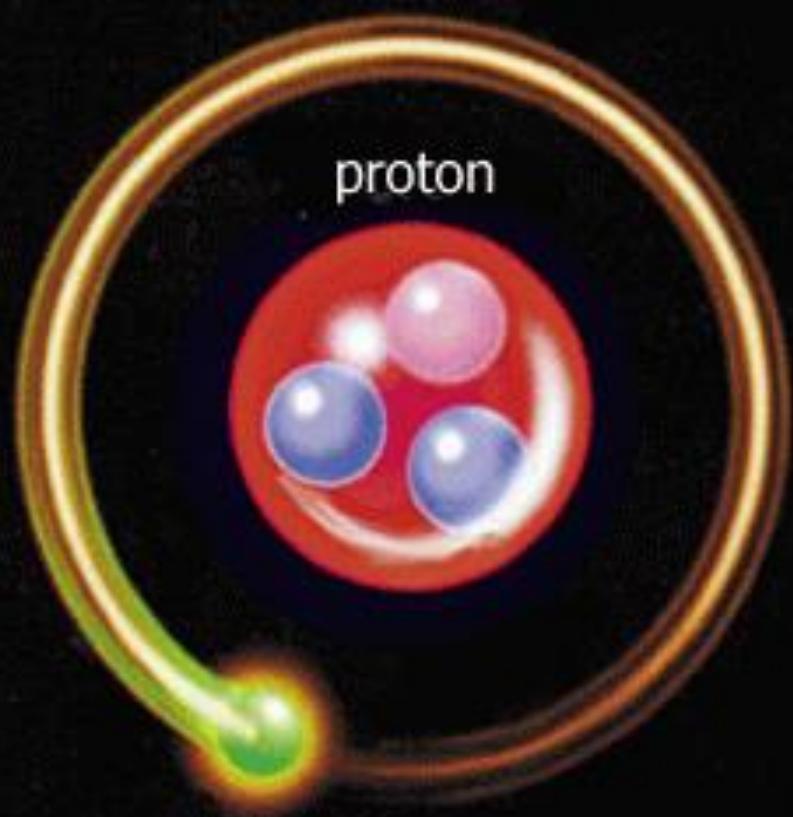


La storia dell'Universo

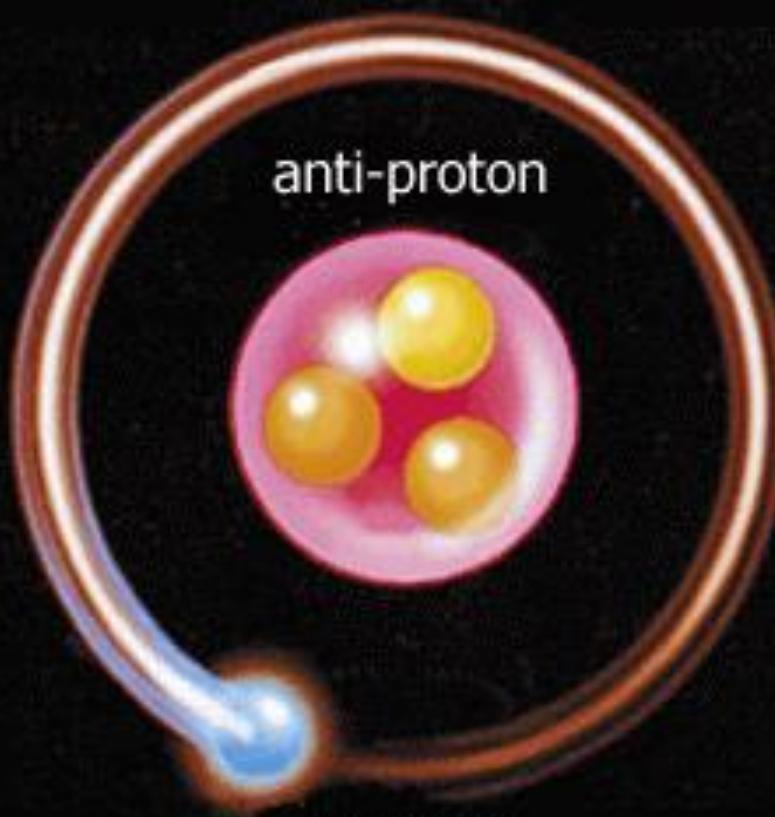
Big Bang







hydrogen



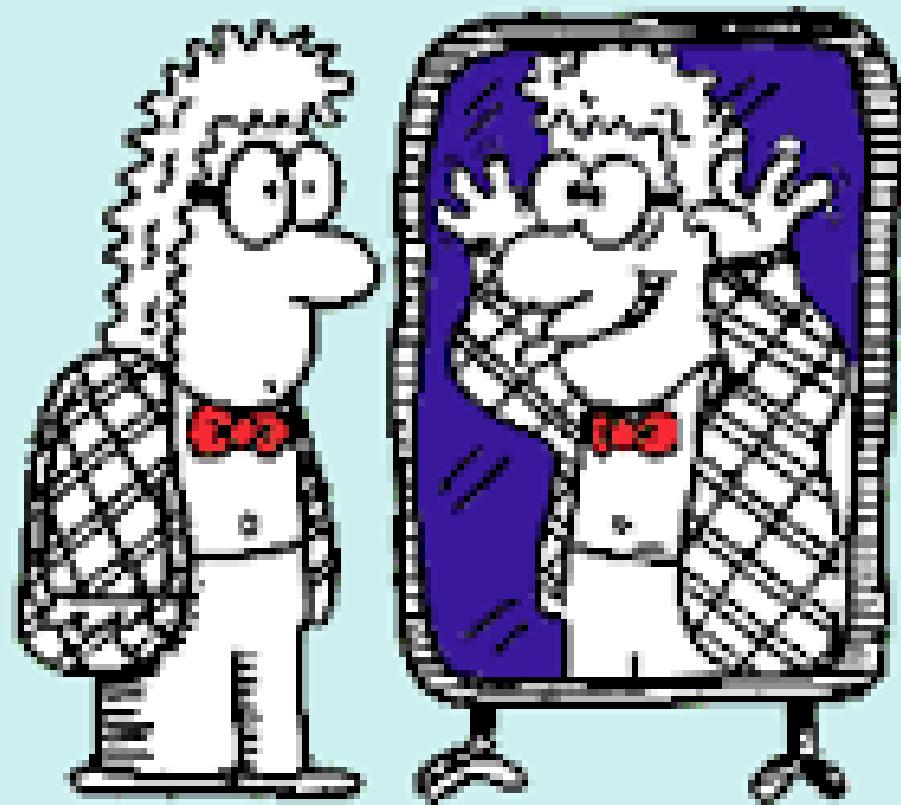
anti-hydrogen

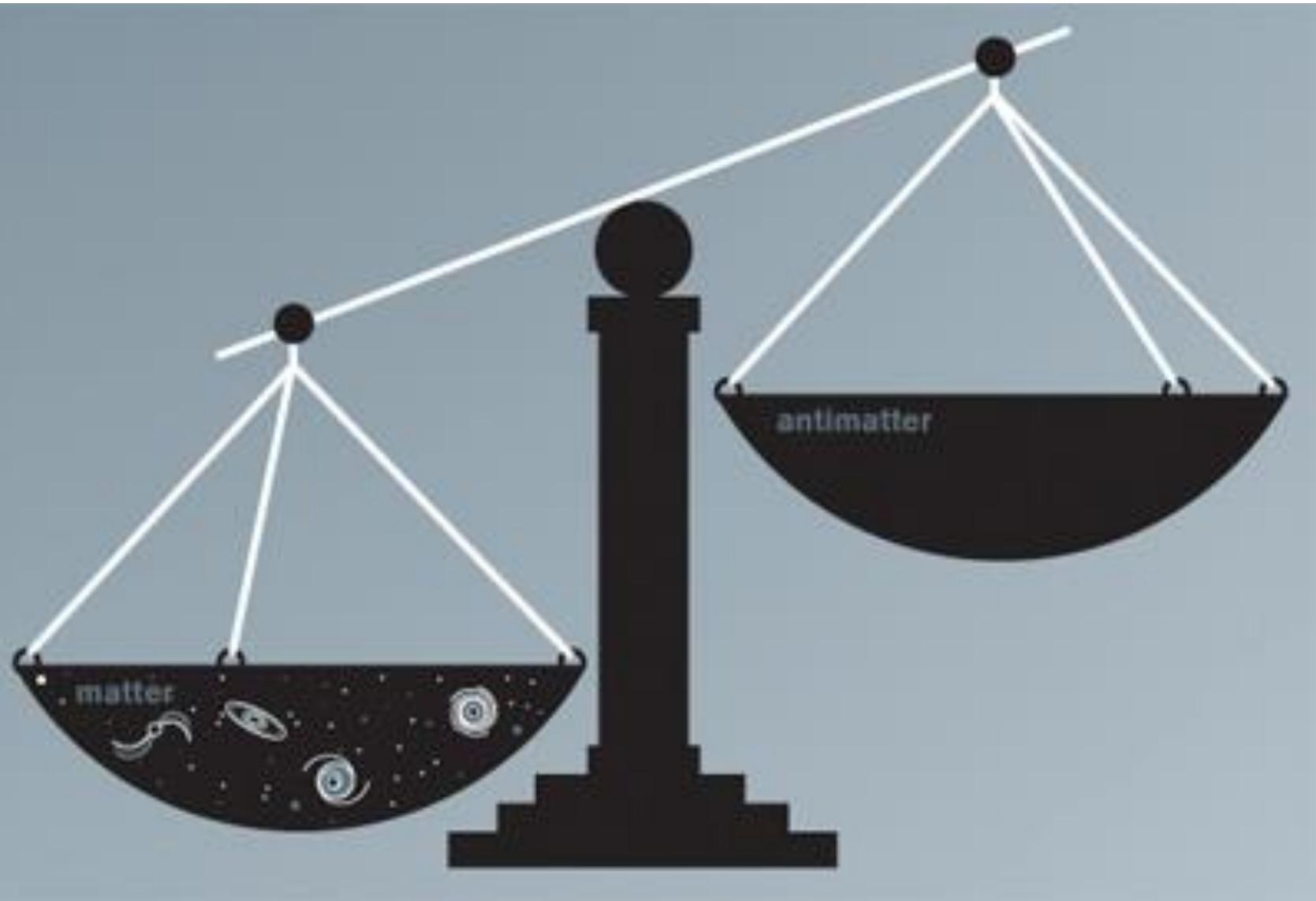
CP violation (CPT)
Assymetry between “laws of matter
and laws of antimatter” e

**KLOE at DAFNE
LHCb at LHC-CERN**

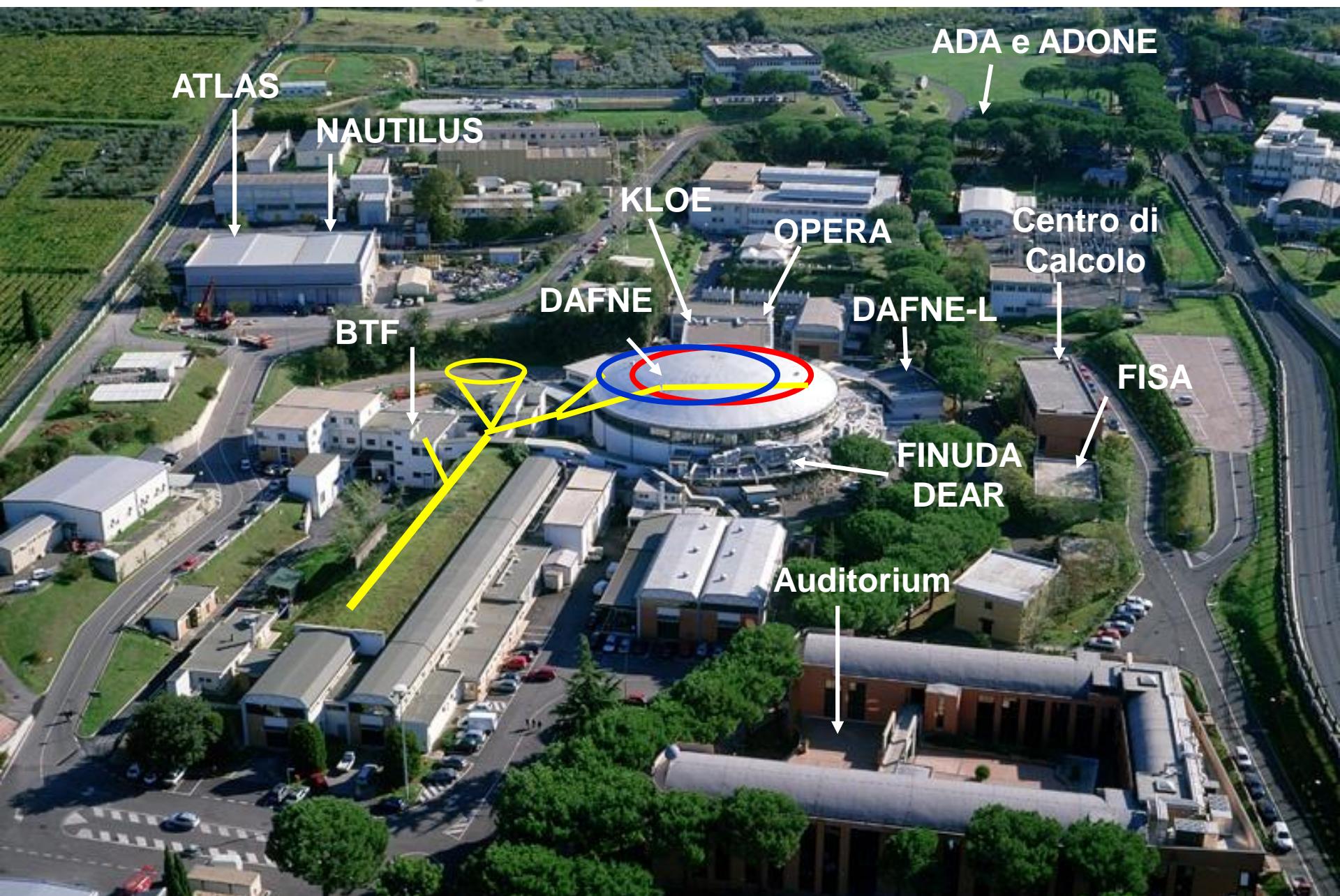
.....

THE MIRROR DID NOT SEEM TO
BE OPERATING PROPERLY.

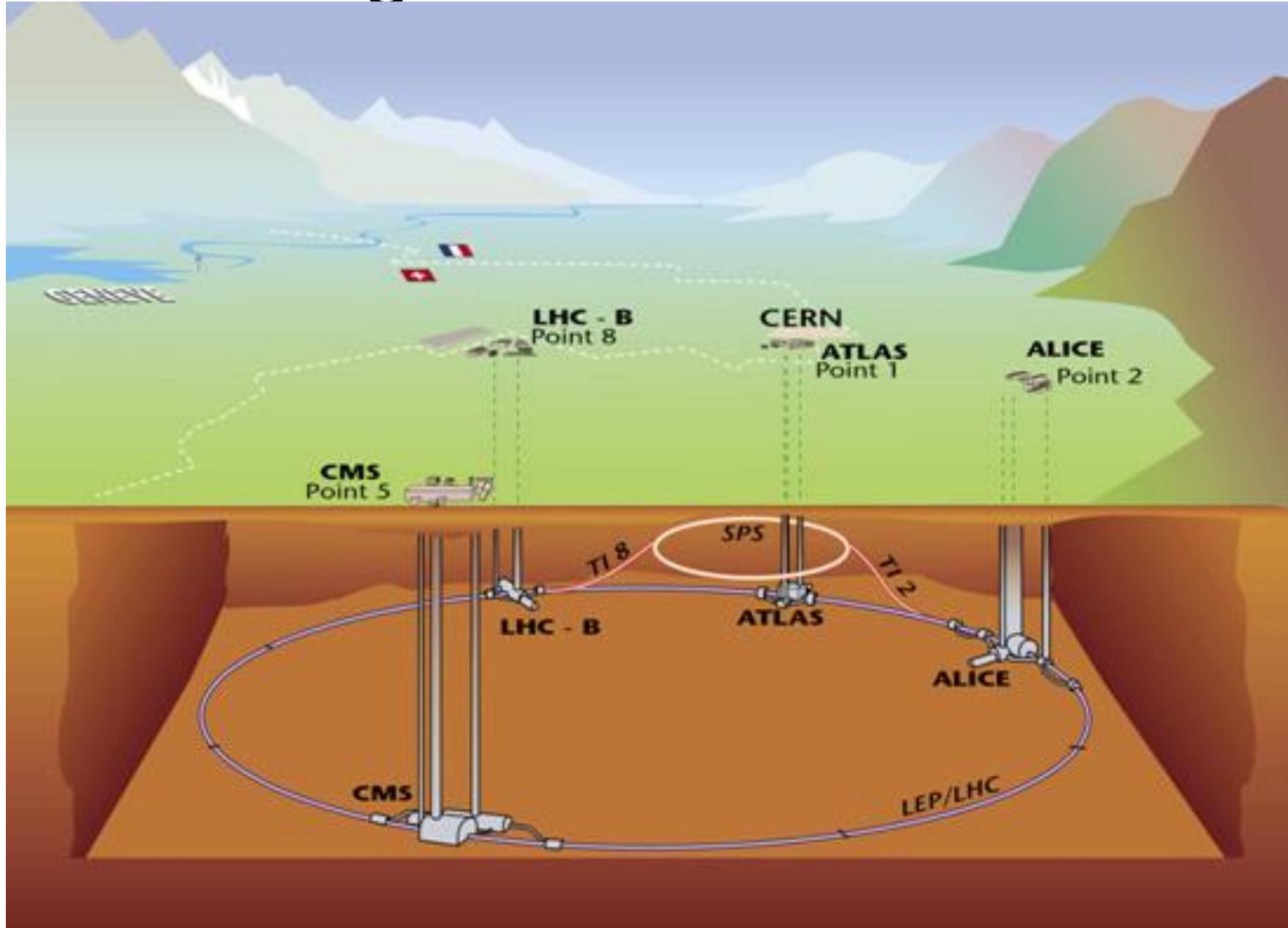




Laboratori Nazionali di Frascati, info:
<http://www.lnf.infn.it/sis/>

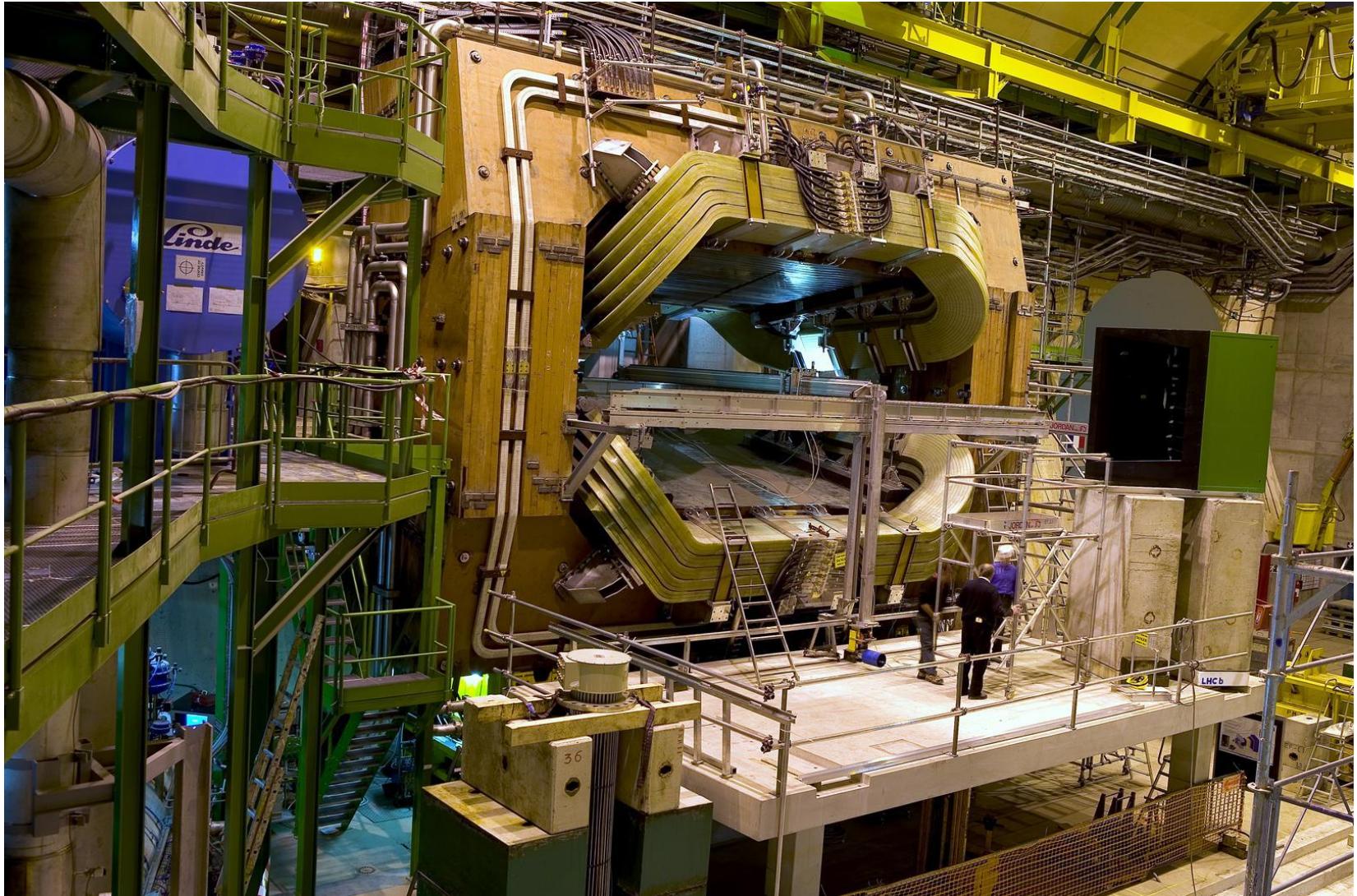


Large Hadron Collider





LHCb

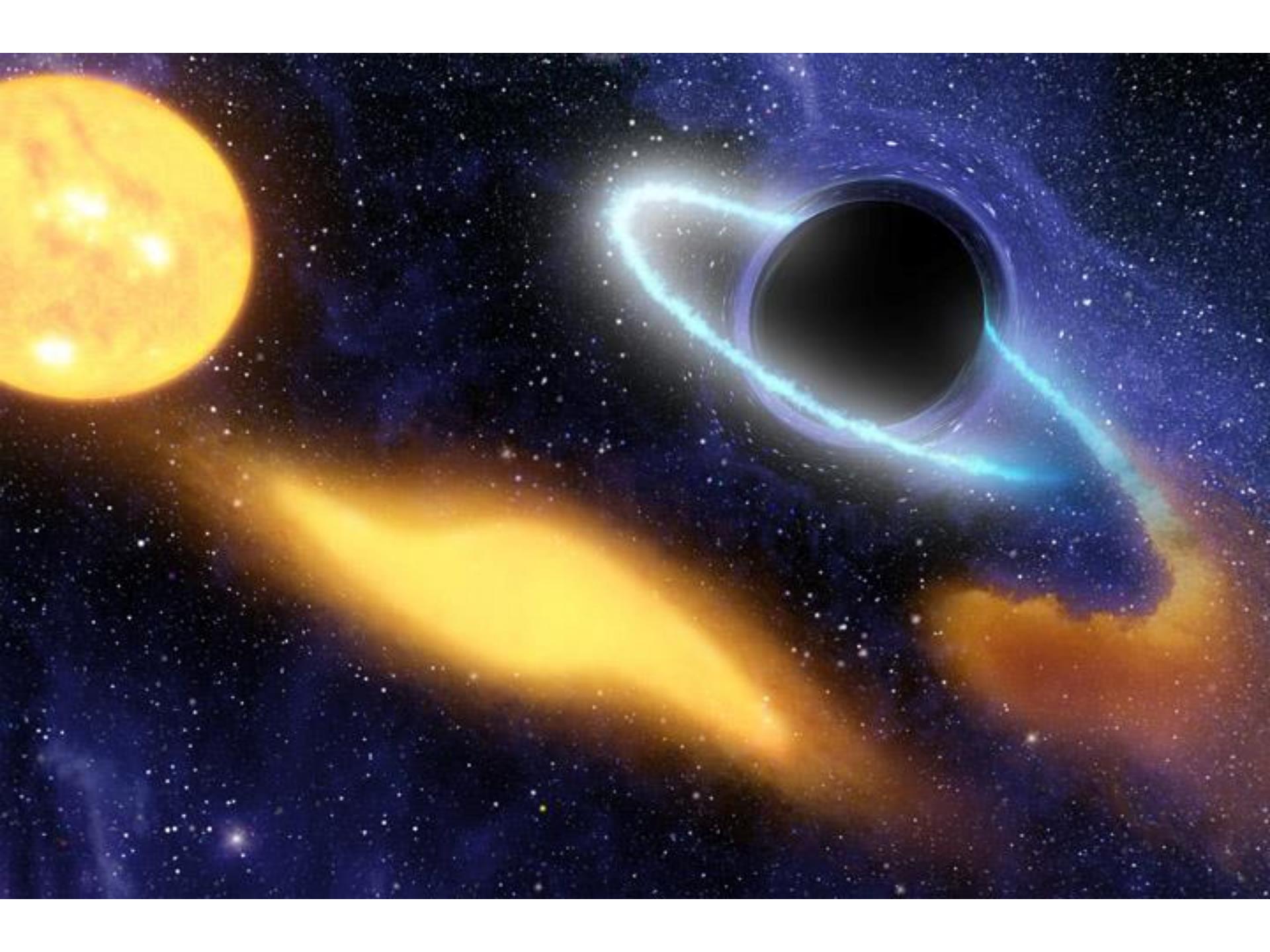


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Imisteriosi buchi neri





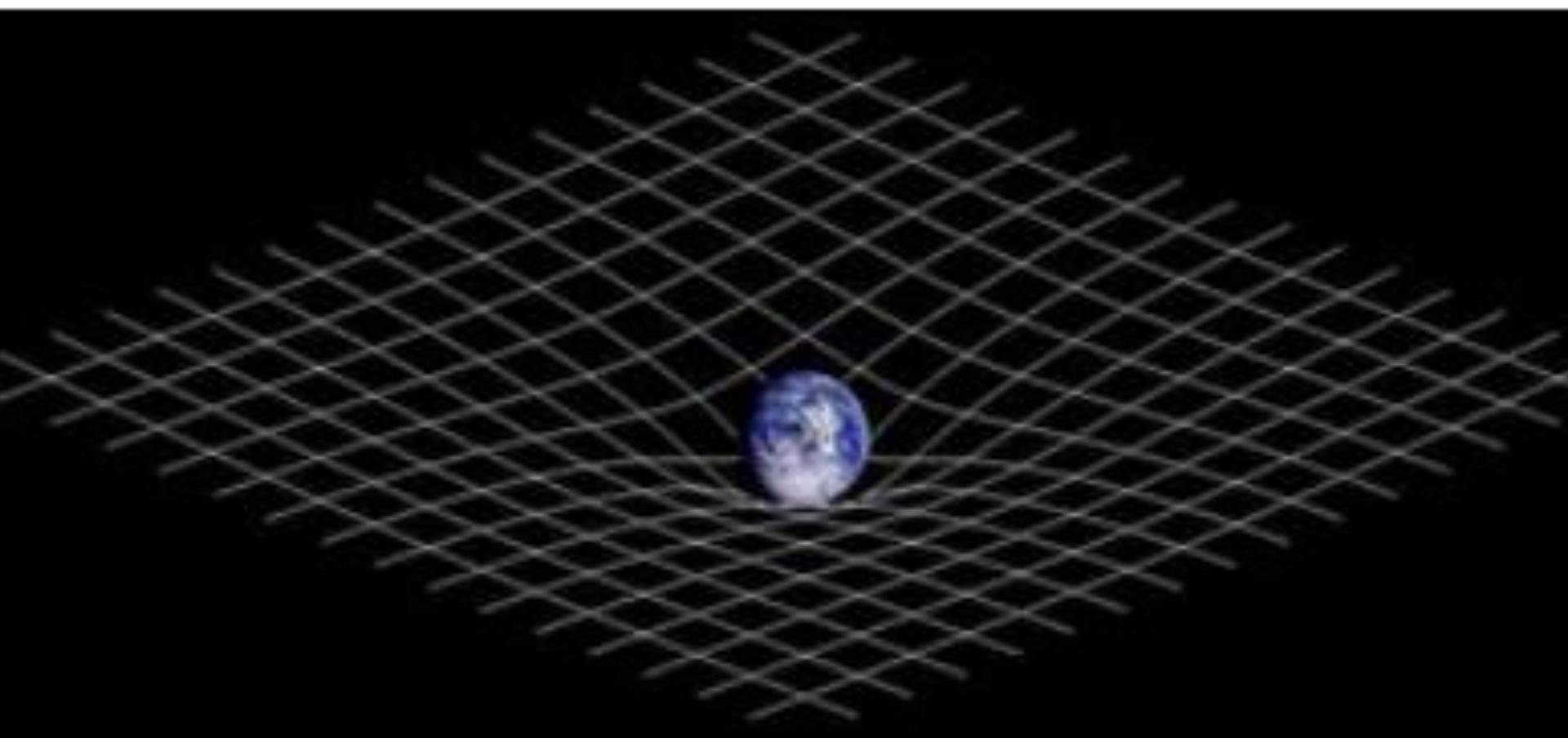
Relativity'

Imagine travelling through space on a beam of light at the speed of light.

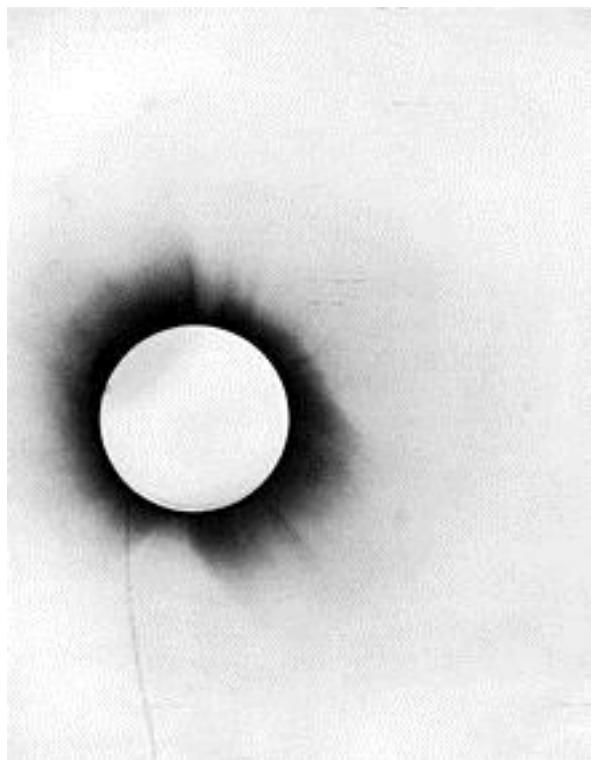
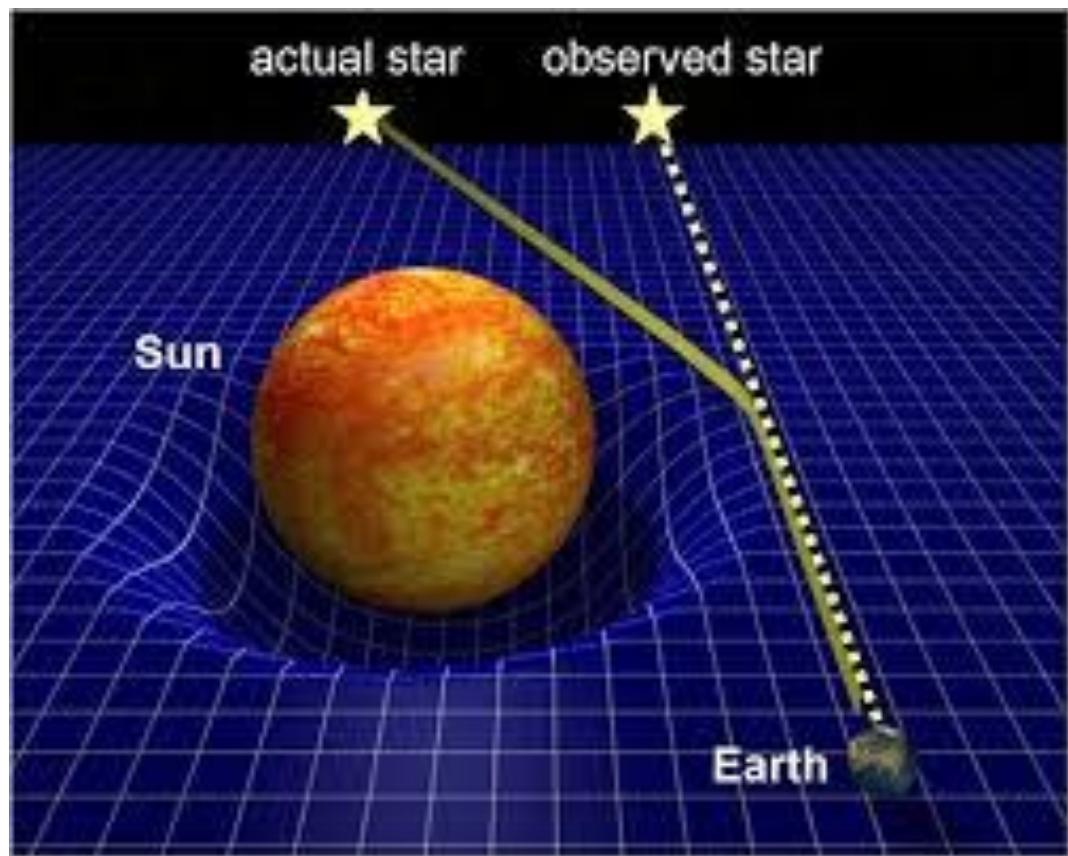


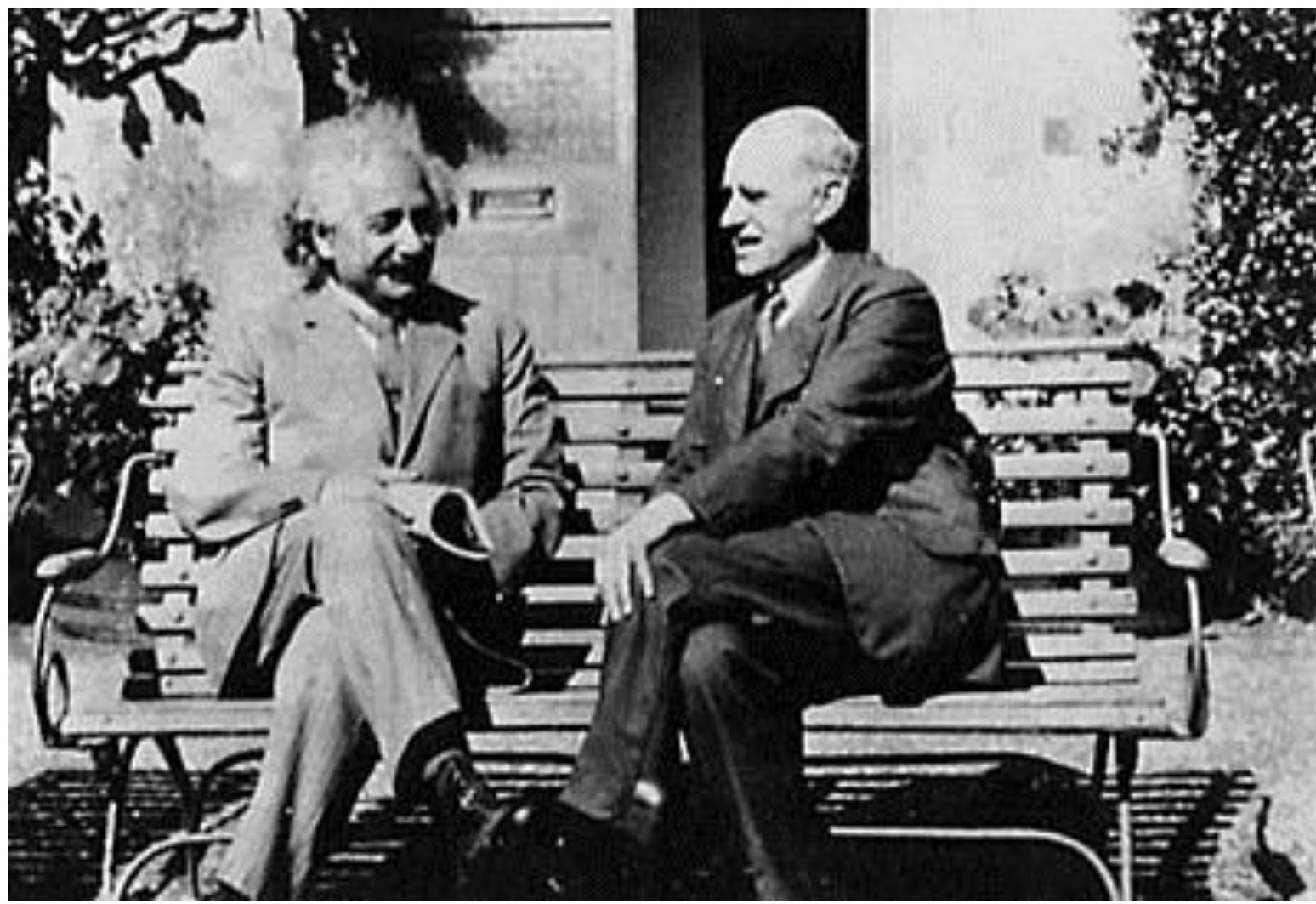
Albert Einstein, theory of relativity, gravity, velocity, energy, mass, speed, time, E=mc²

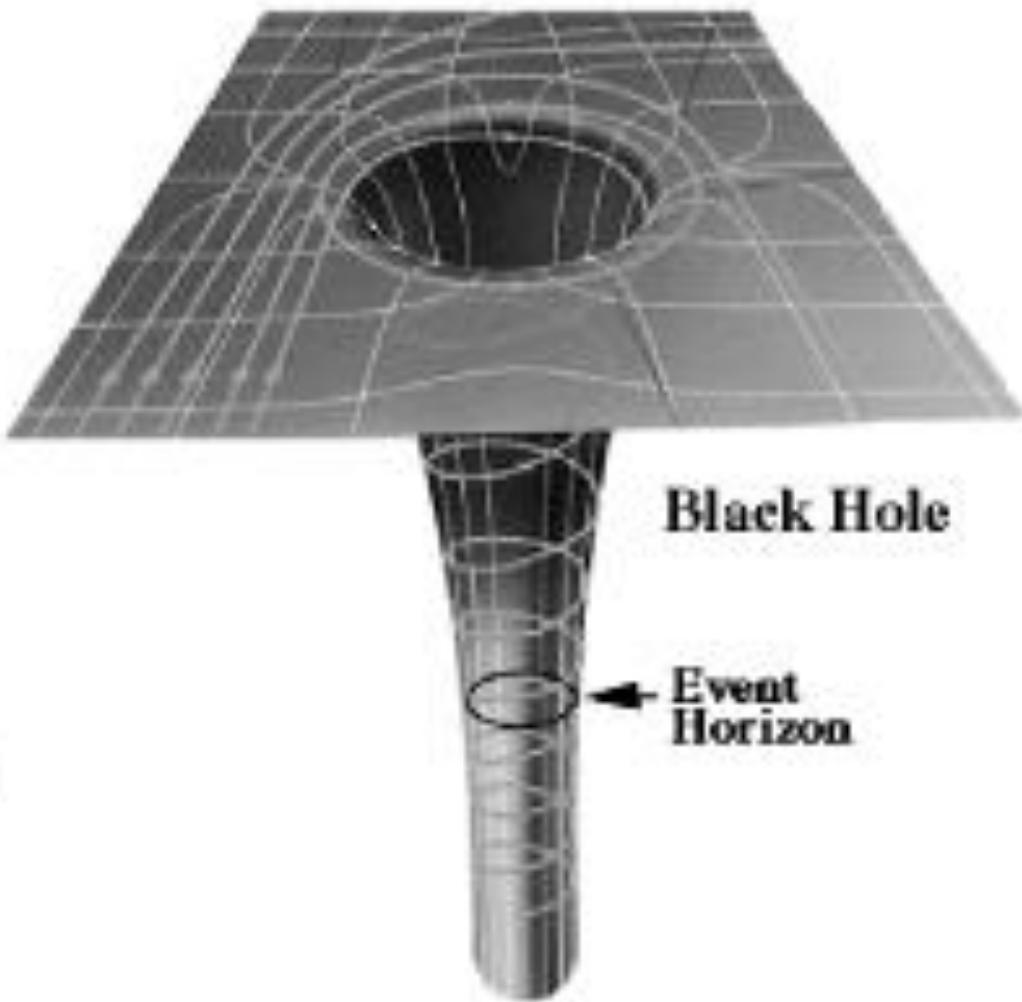
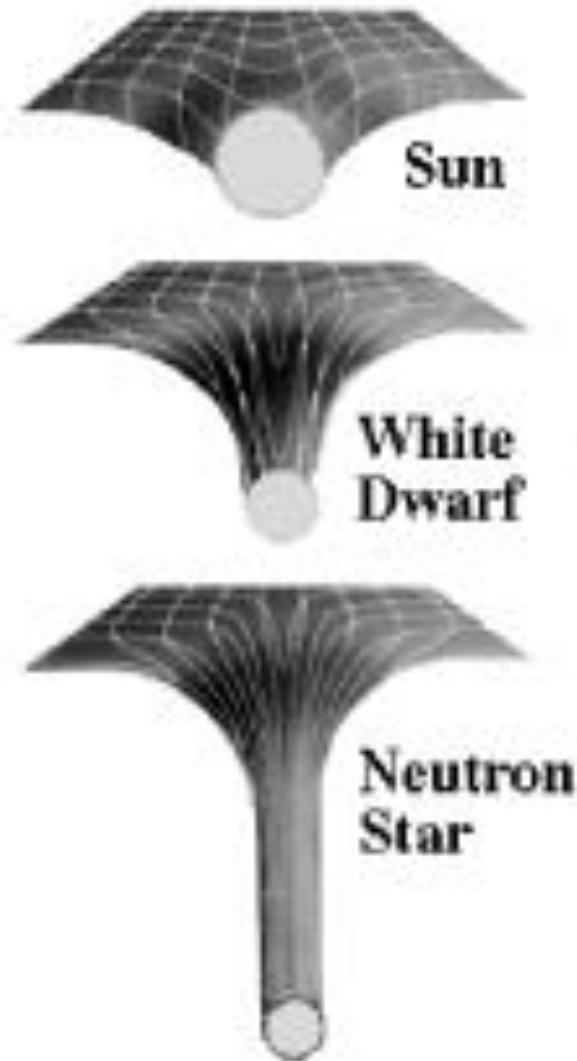
Bobonart



$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} + \underline{\Lambda} g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$







Credit: Adam Apollo



Hawking radiation (quantum effect)



Lanciarsi in un buco nero?



7 big questions in modern physics:

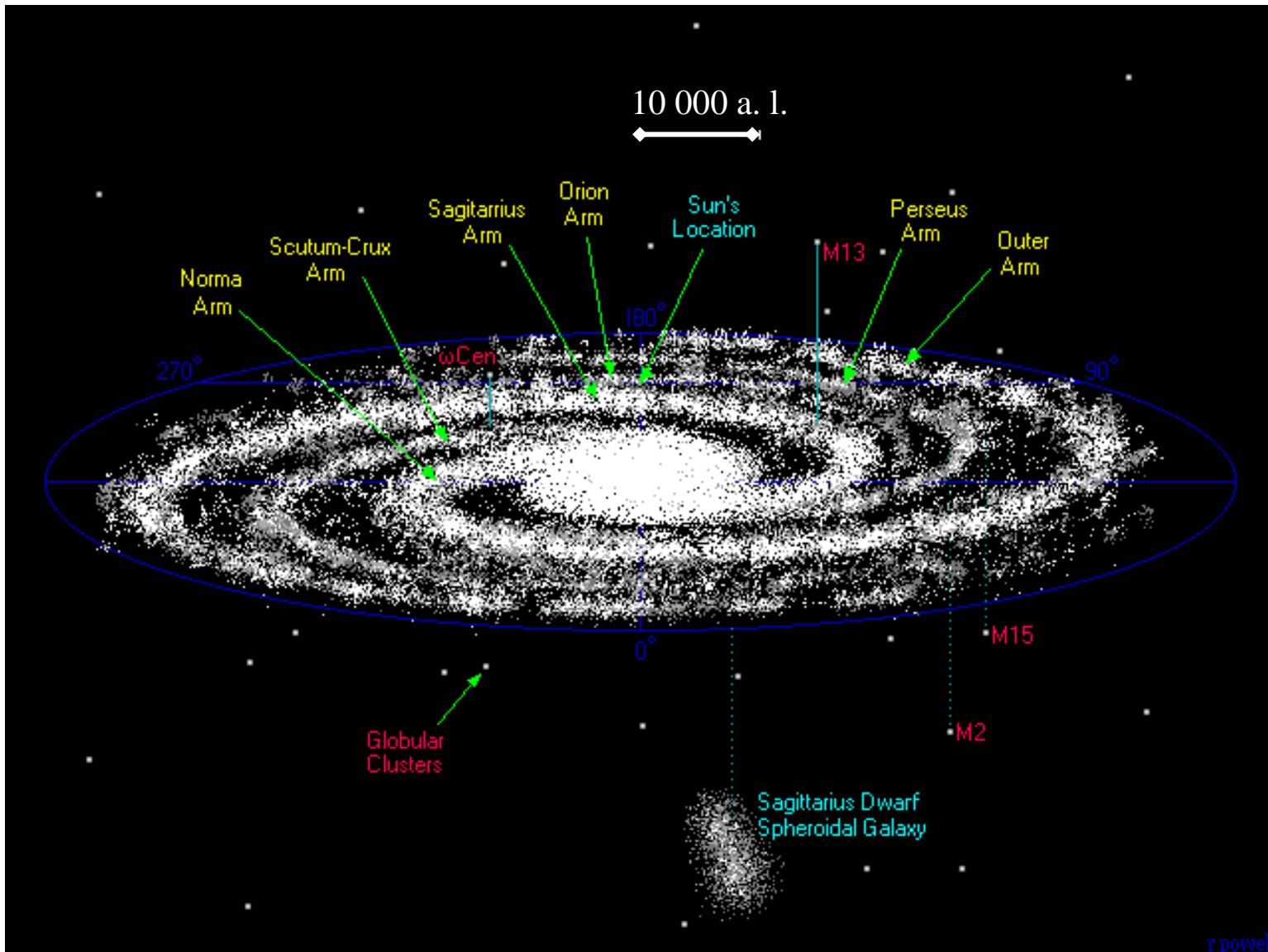
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Dark side of the Universe

Dark matter and

dark energy'

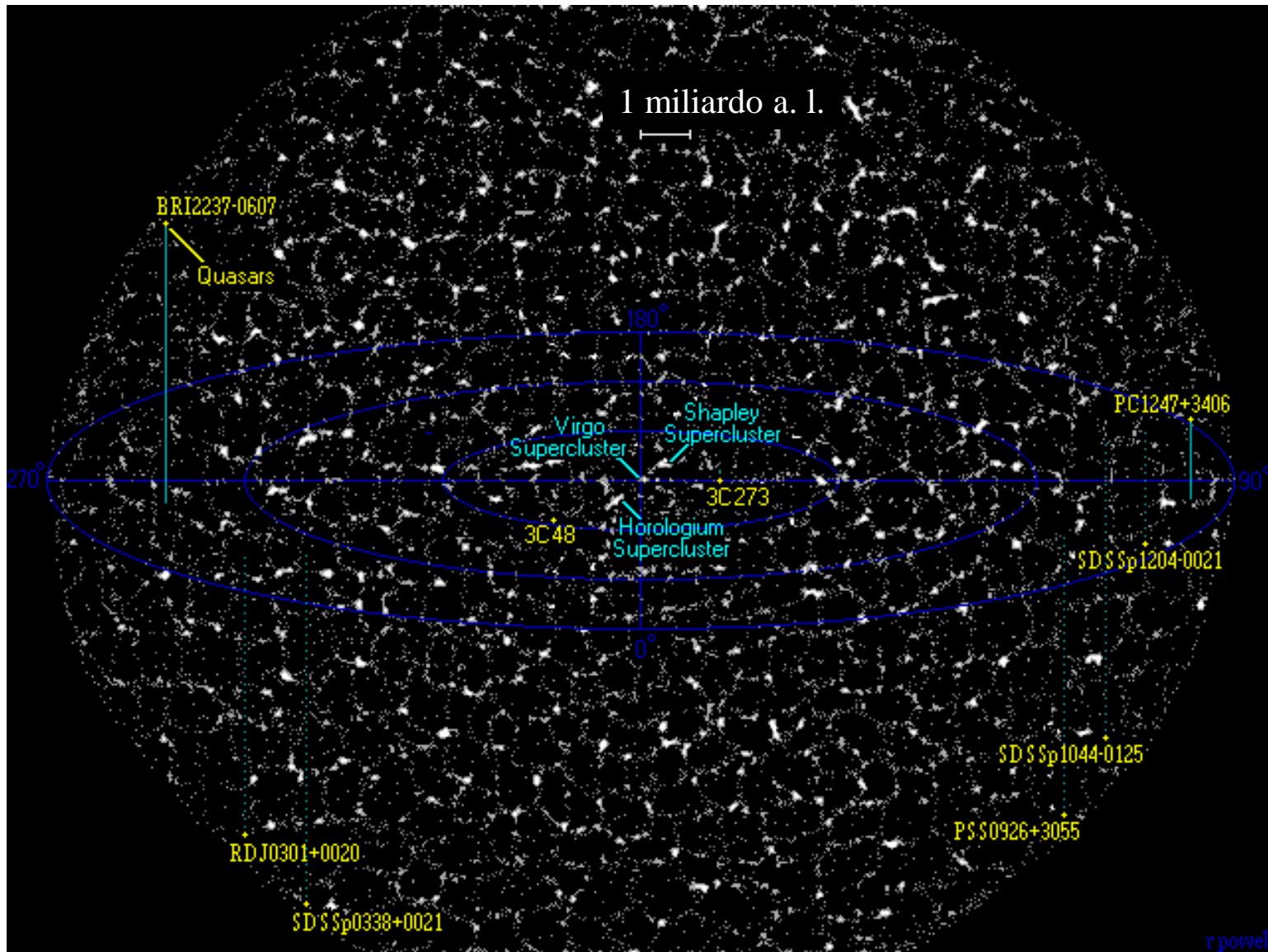




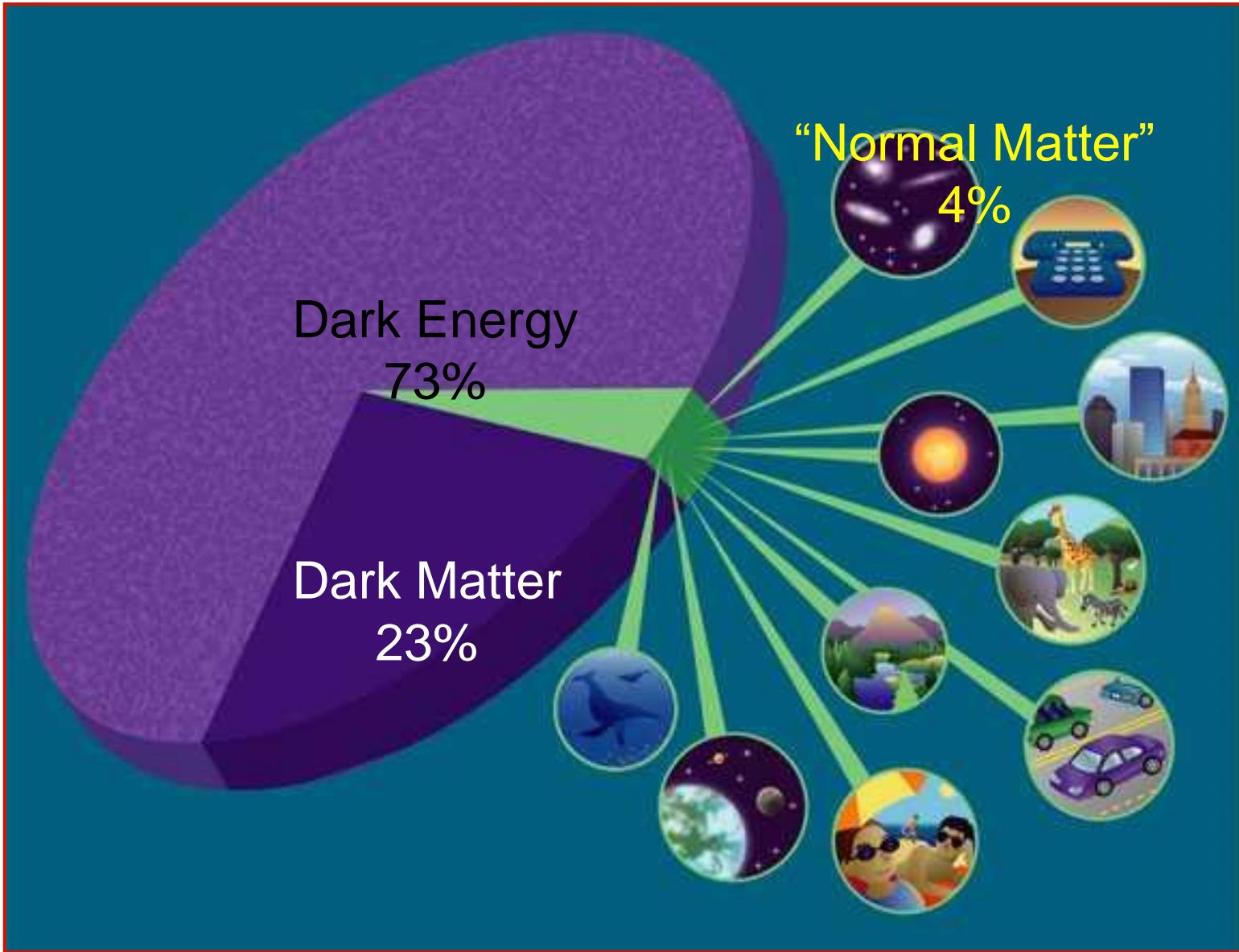
r powell

Zoom In x10

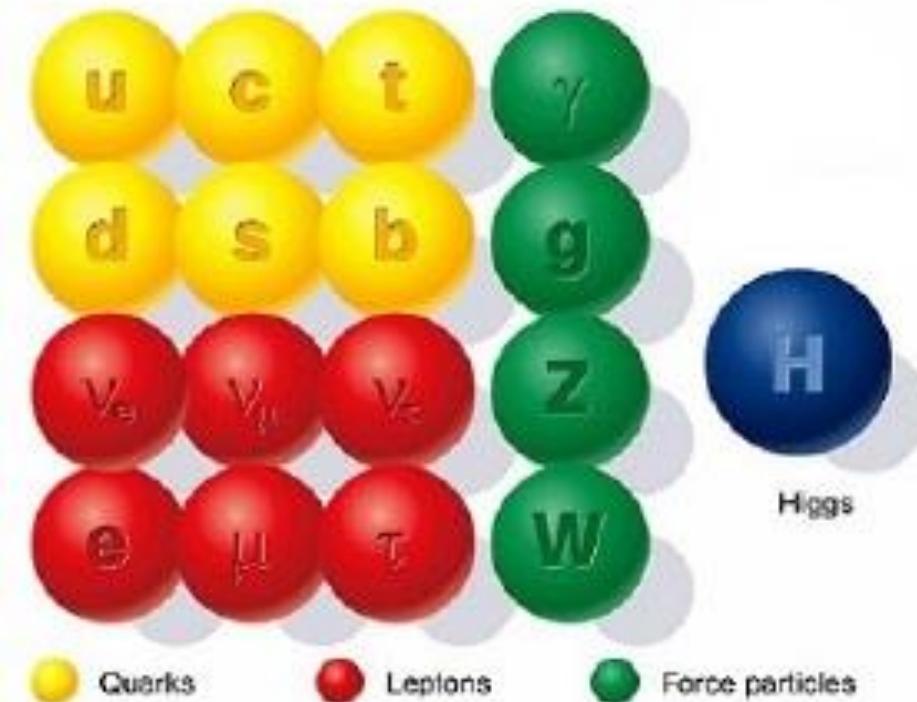
Zoom Out x10



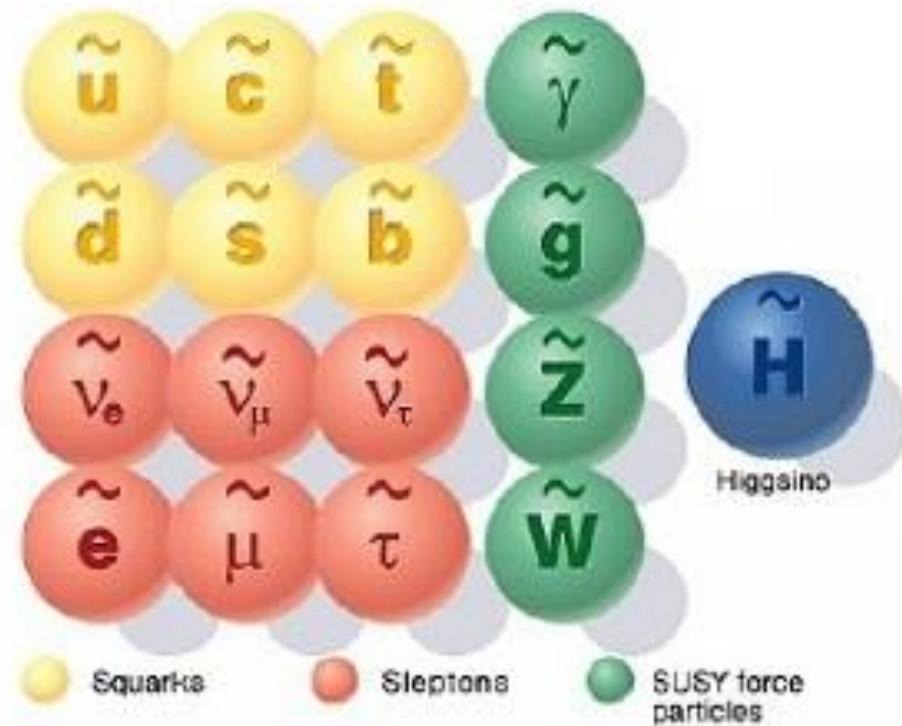
Zoom In x15



SUPERSYMMETRY

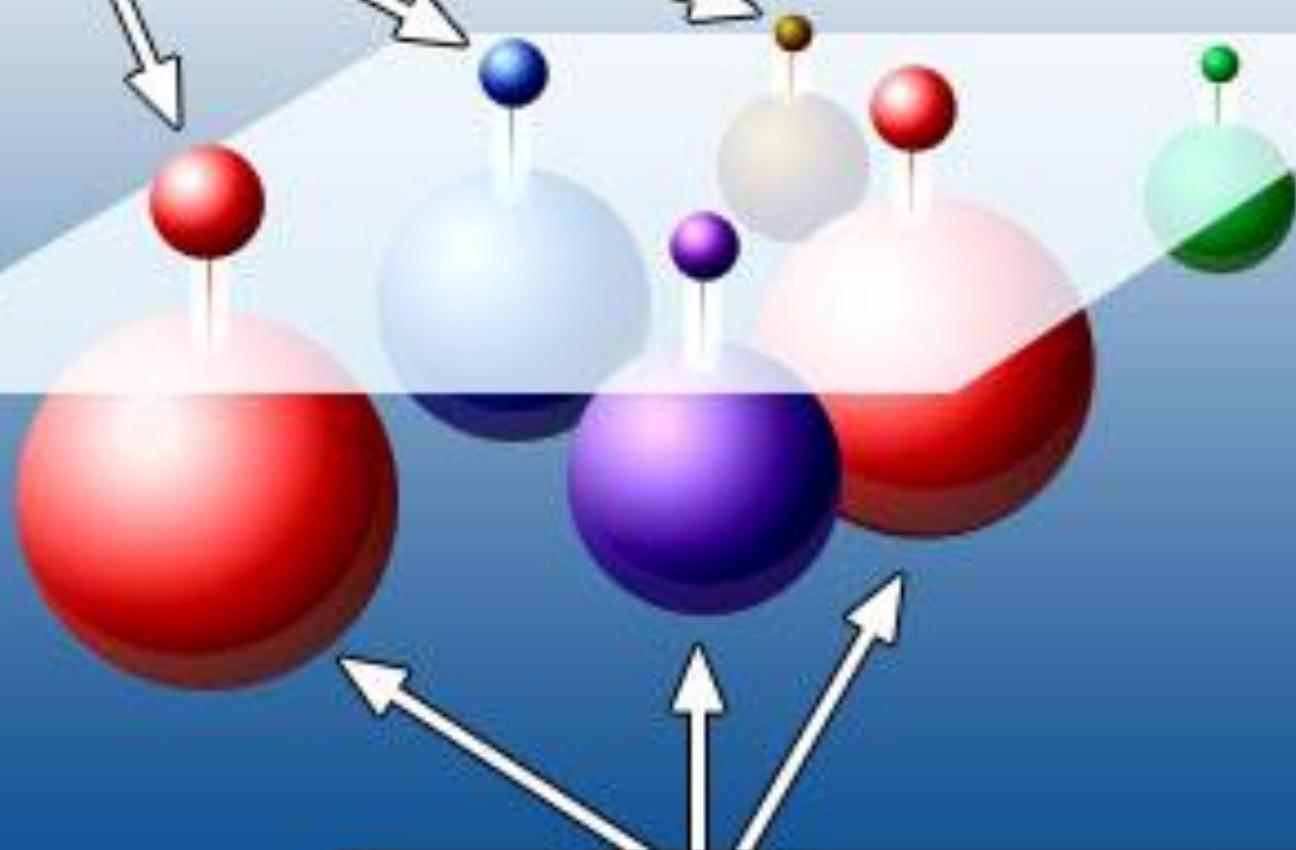


Standard particles



SUSY particles

Particles



Supersymmetric “shadow” particles

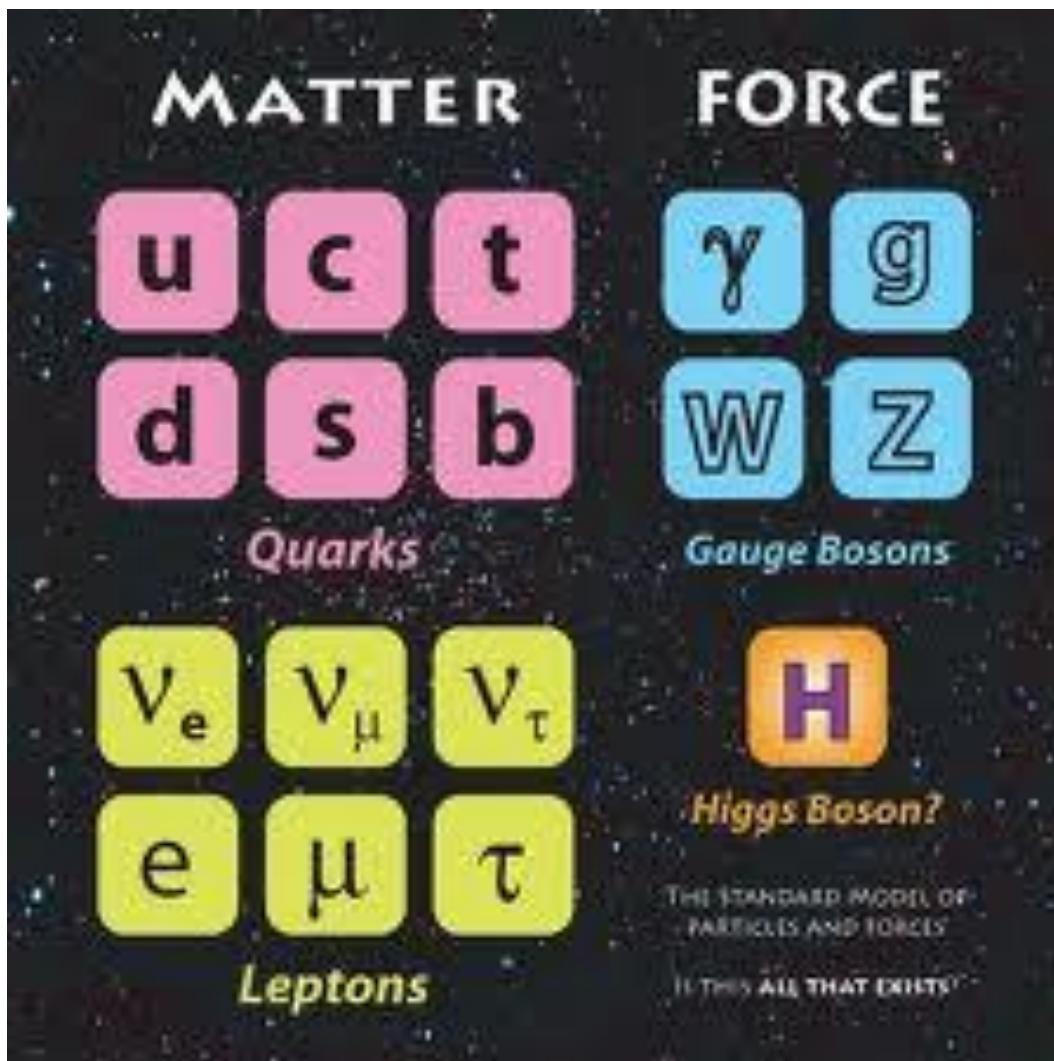


$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} + \underline{\Lambda} g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

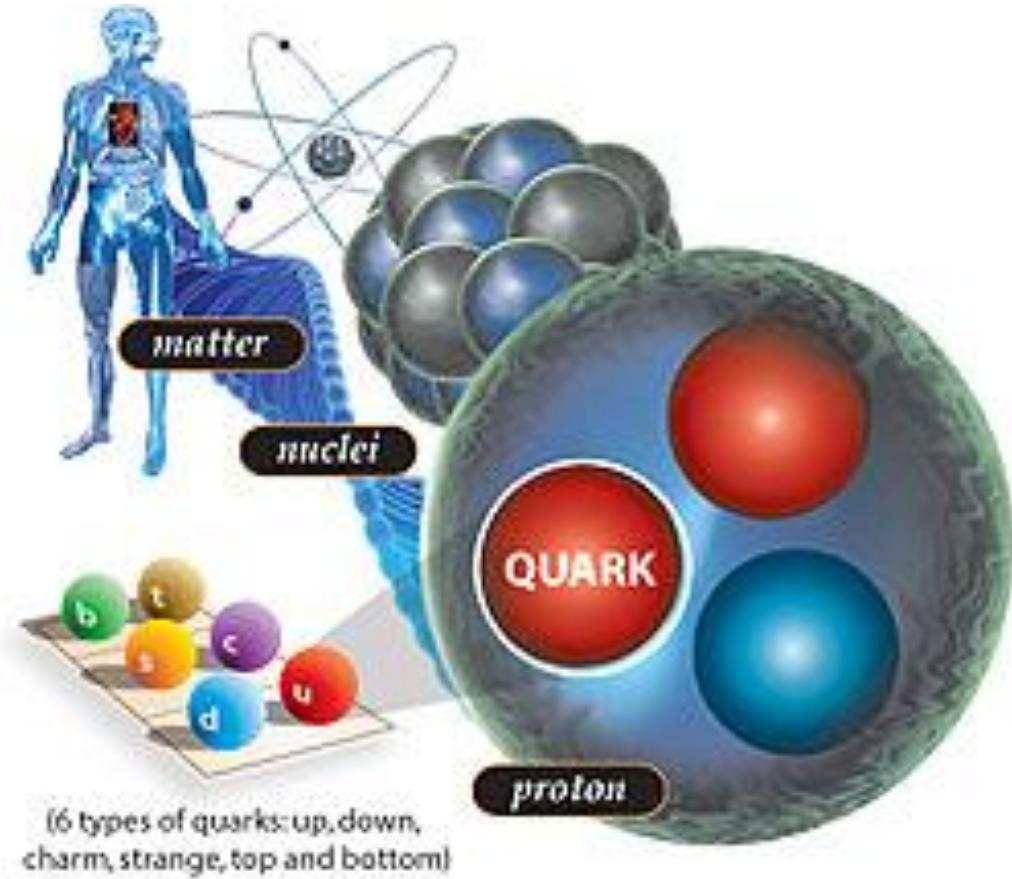
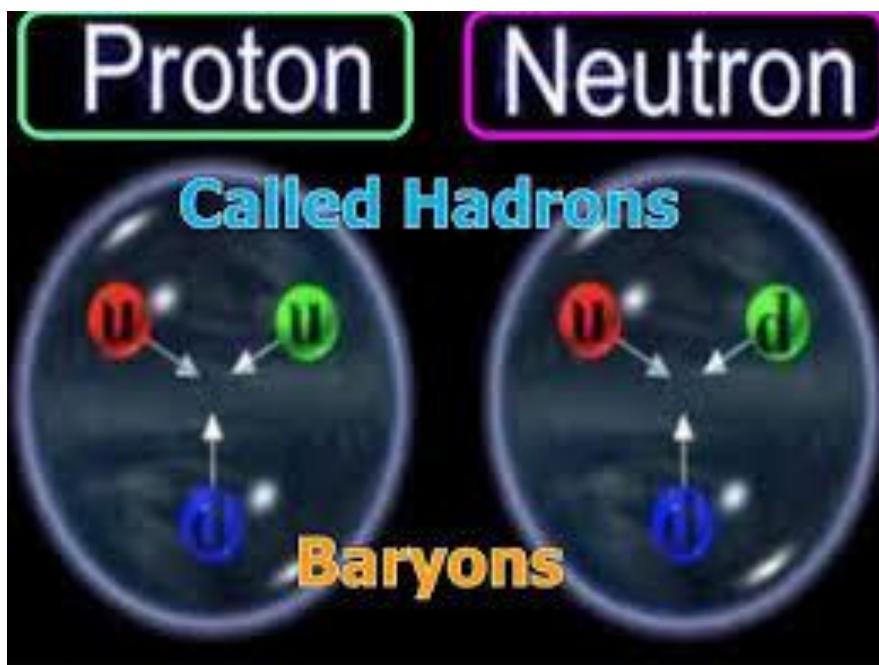
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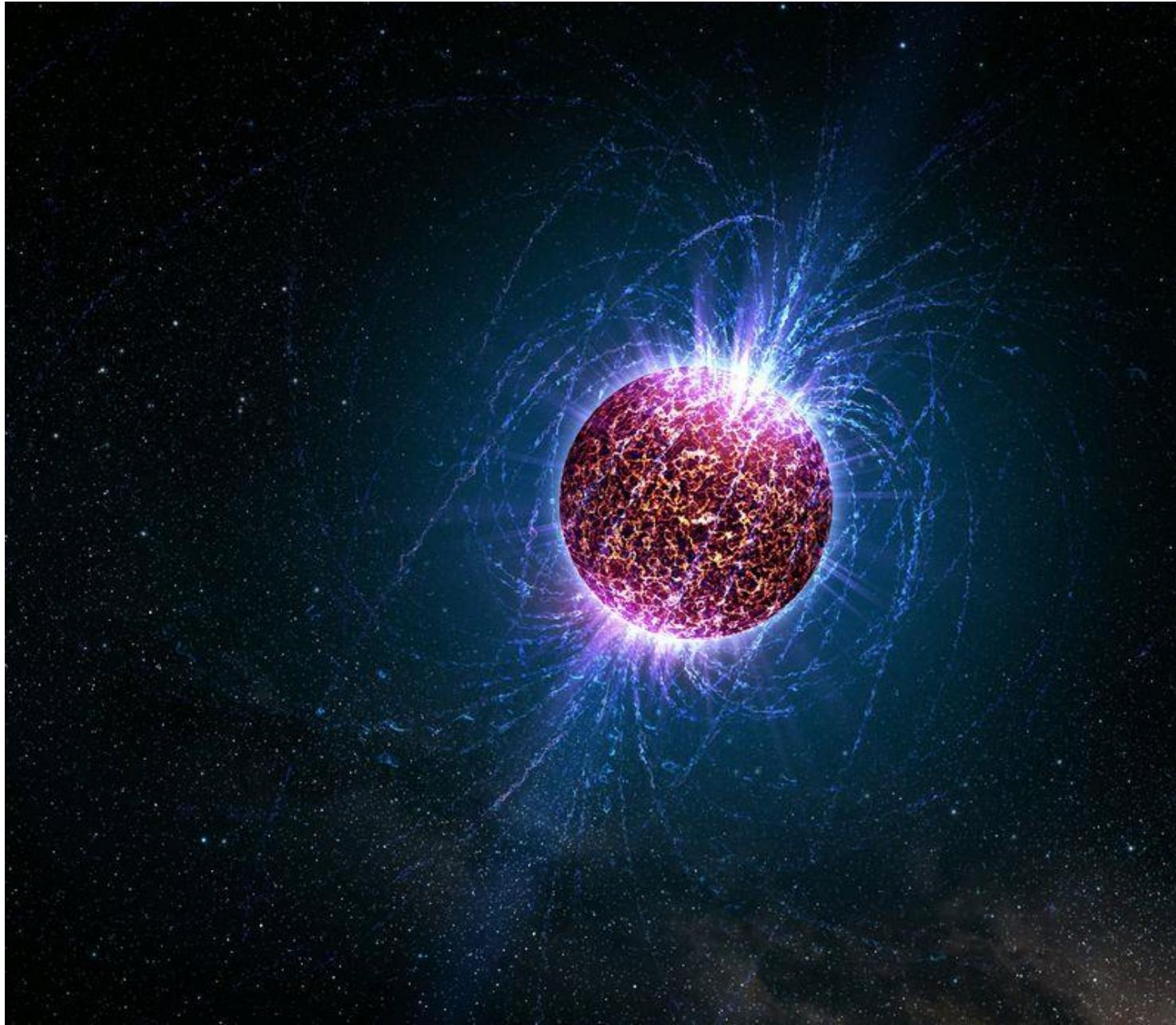
The Standard Model

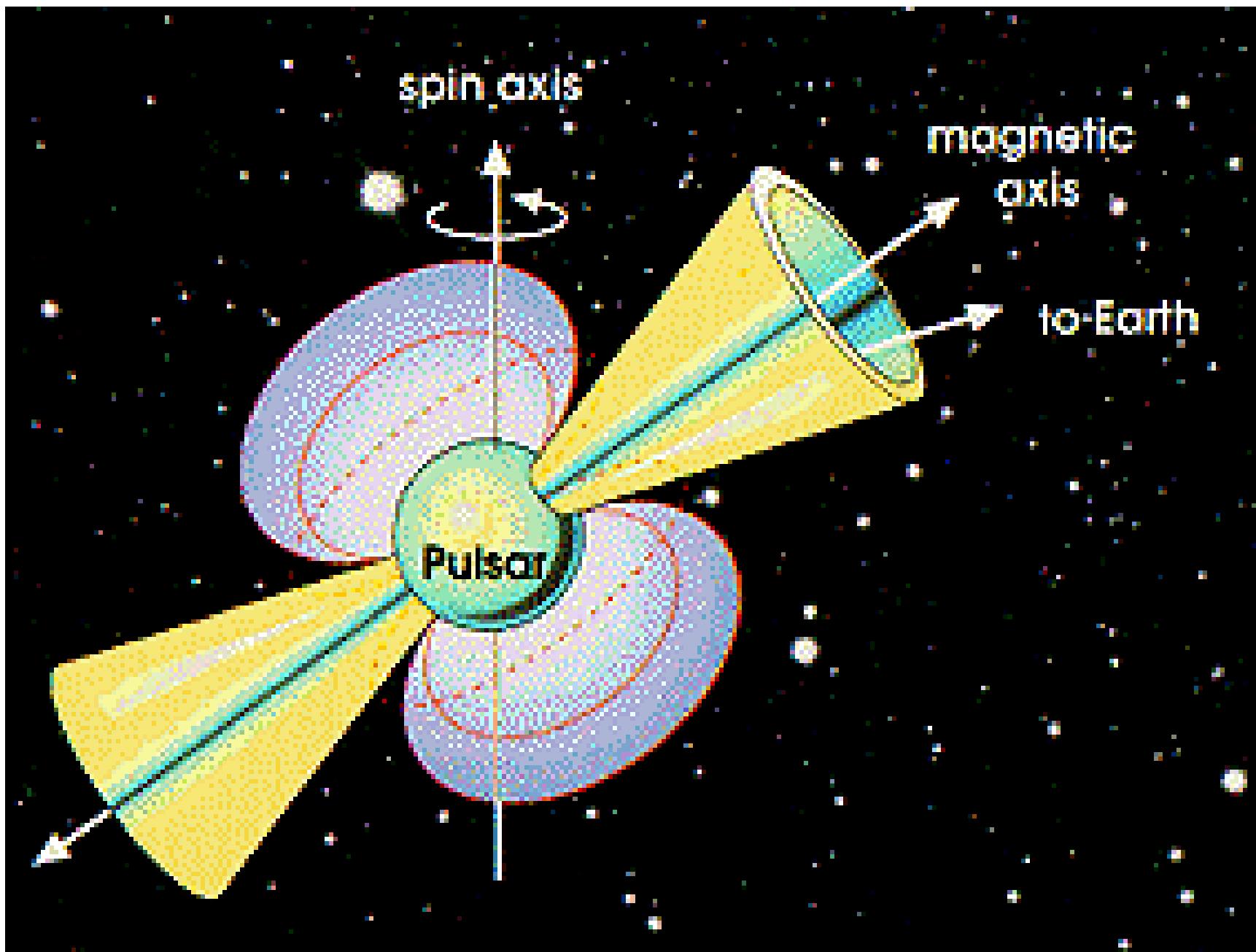


The Standard Model



Neutron stars



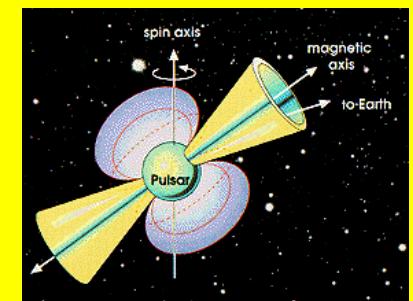


EXERCISE:

How much is the weight of a milk-shake made of collapsed matter?



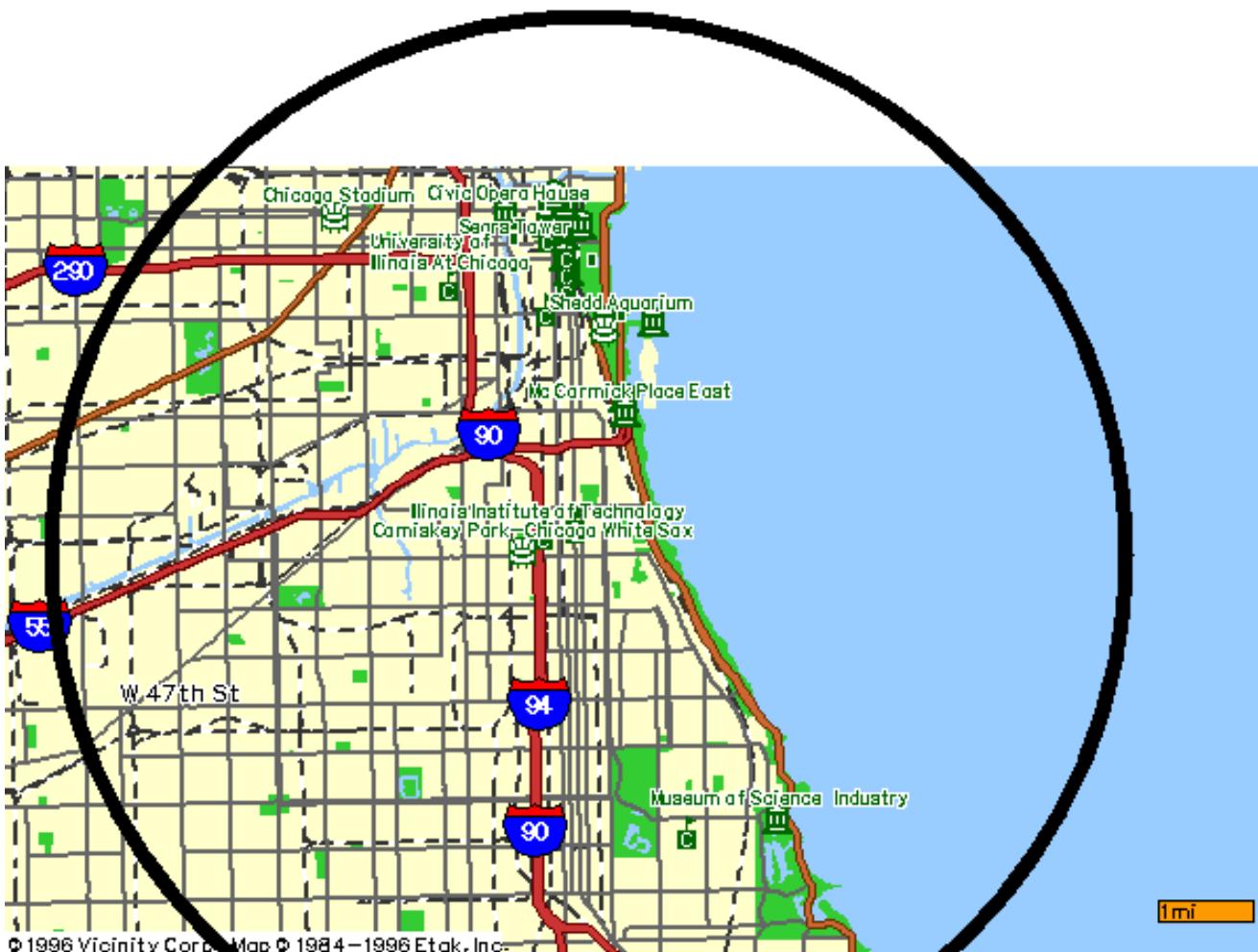
Pesa 100 Miliardi
di Tonnellate !!!



Le pulsar sono oggetti con queste densità con 20 km di raggio
che possono
compiere decine e centinaia di giri al secondo su loro stesse

Anche la velocità è un parametro da cui dipende l'emissione

Neutron star vs. Chicago

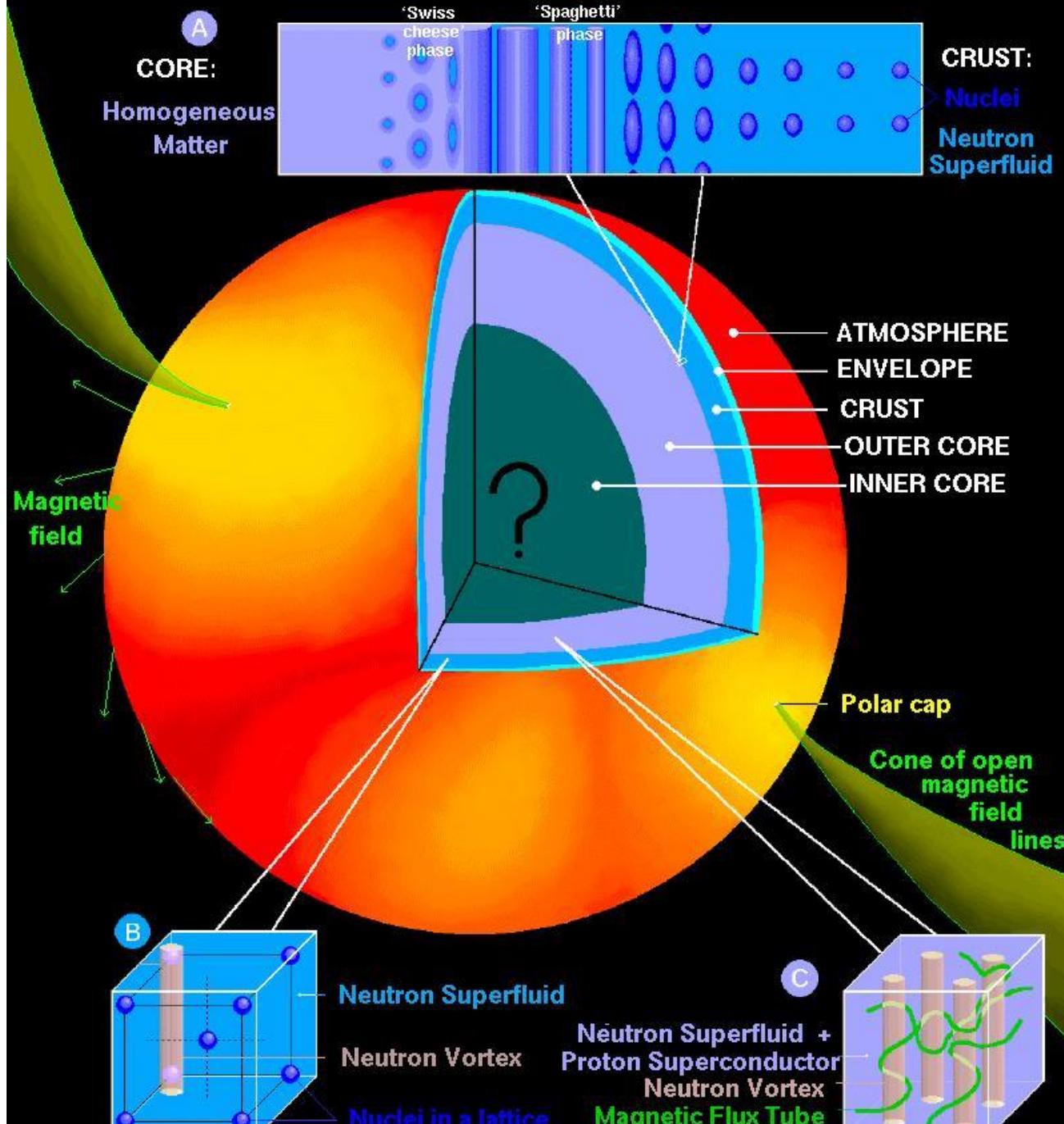


Mass= $1.4 M_{\text{sun}}$, Radius=10 km

Spin rate up to 38,000 rpm

Density $\sim 10^{14}$ g/cc, Magnetic field $\sim 10^{12}$ Gauss

A NEUTRON STAR: SURFACE and INTERIOR





DAΦNE, since 1998





Istituto Nazionale
di Fisica Nucleare
Laboratori Nazionali di Frascati



PN Sensor

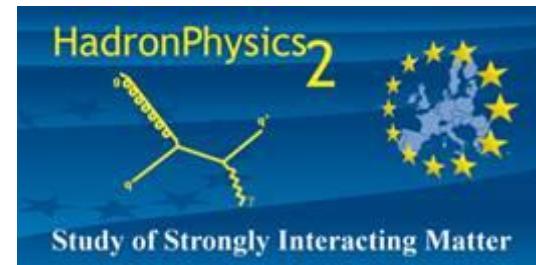
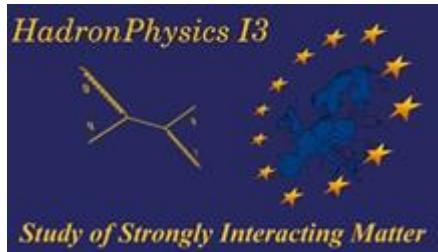


British Columbia
Canada

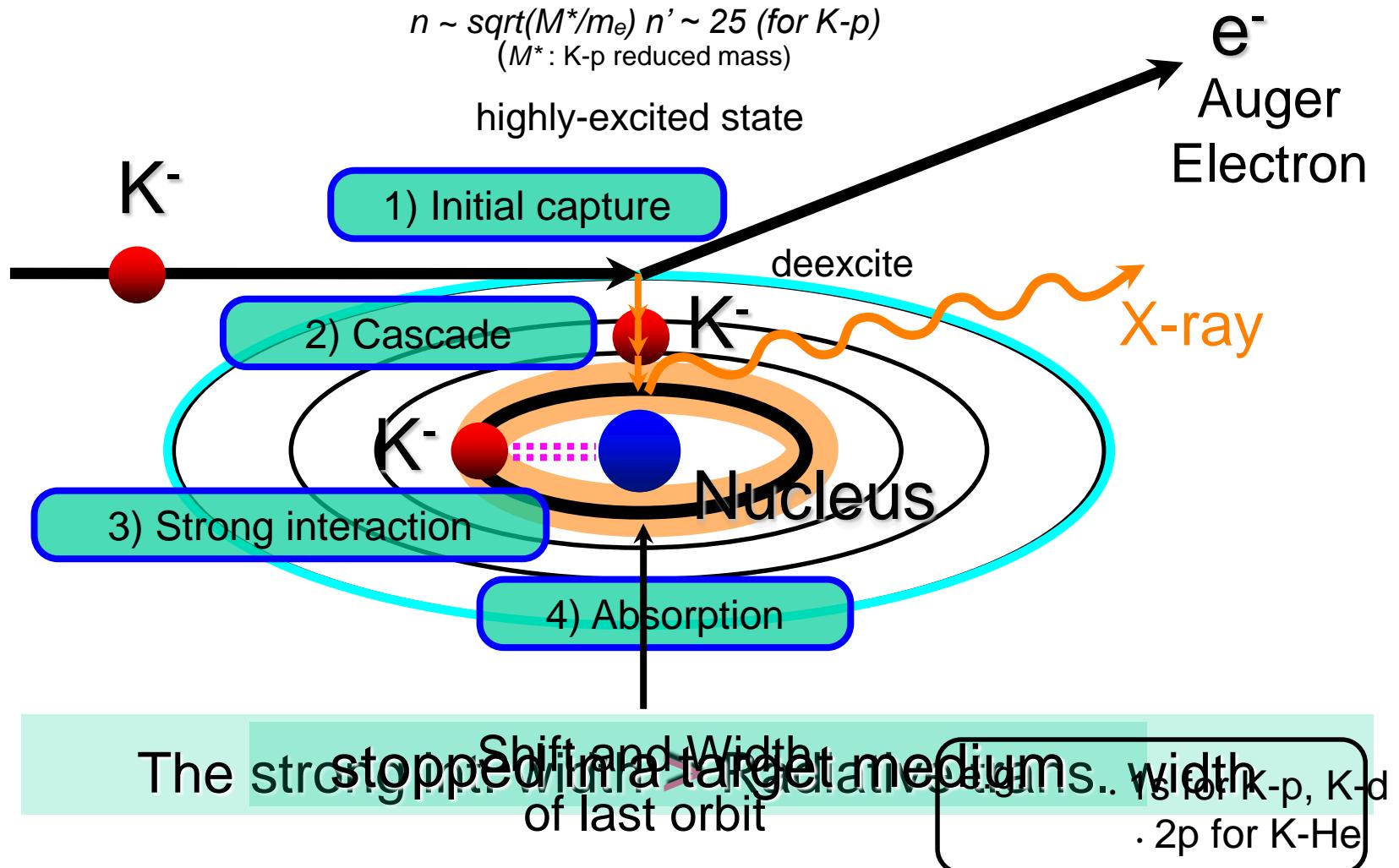


SIDDHARTA

Silicon Drift Detector for Hadronic Atom Research by Timing Applications



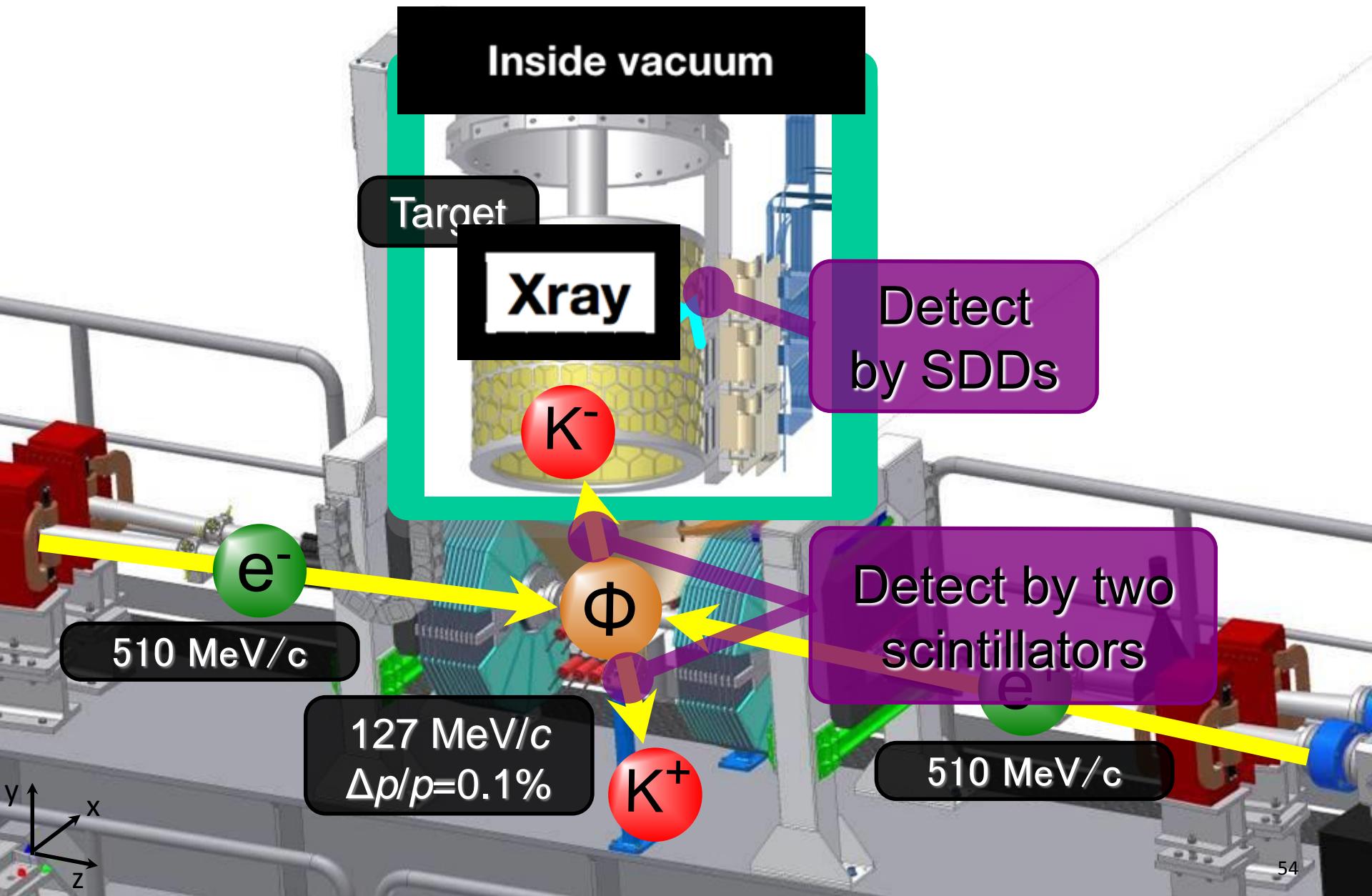
Formazione di un atomo esotico (atomo kaonico)



Silicon Drift Detectors

1 cm² x 144 SDDs

SIDDHARTA overview





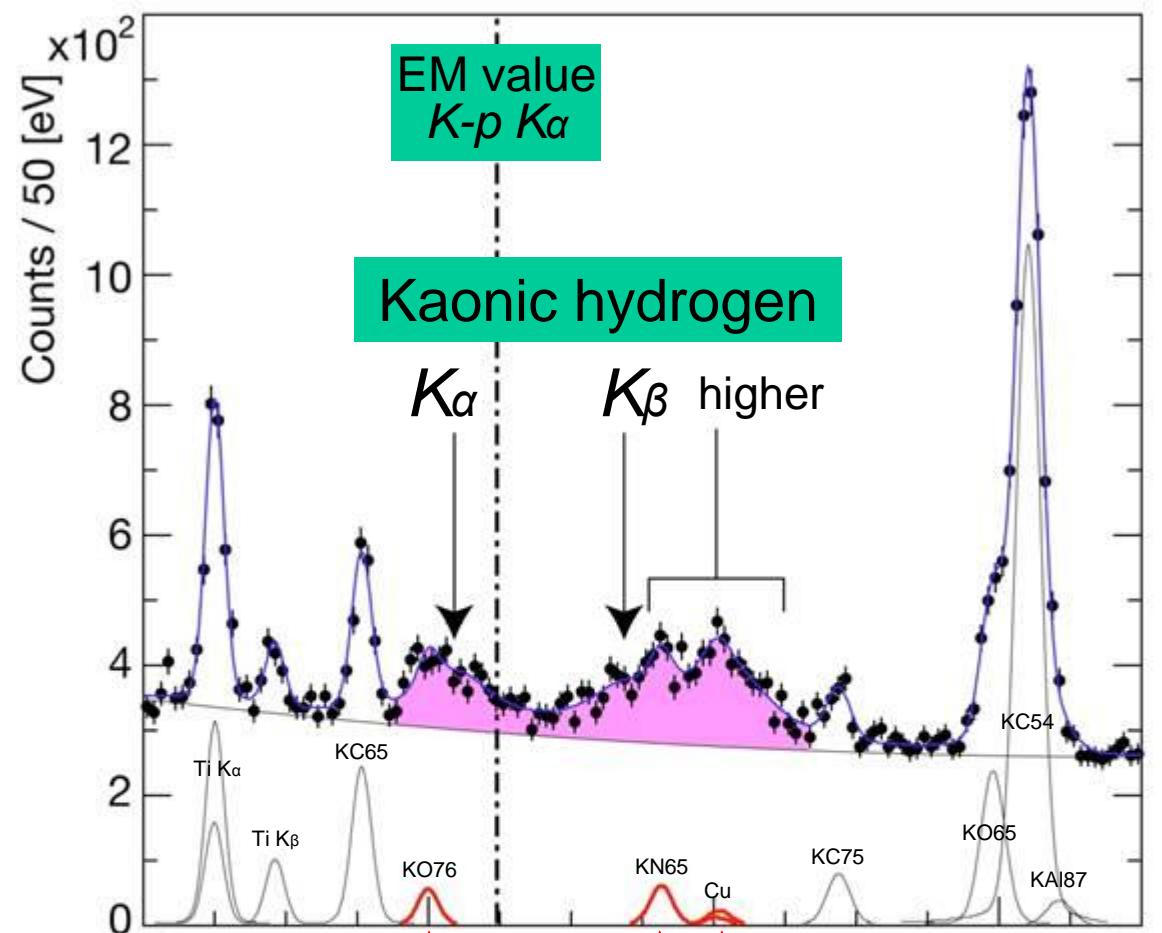
SIDDHARTA setup

SDDs & Target
(inside vacuum)

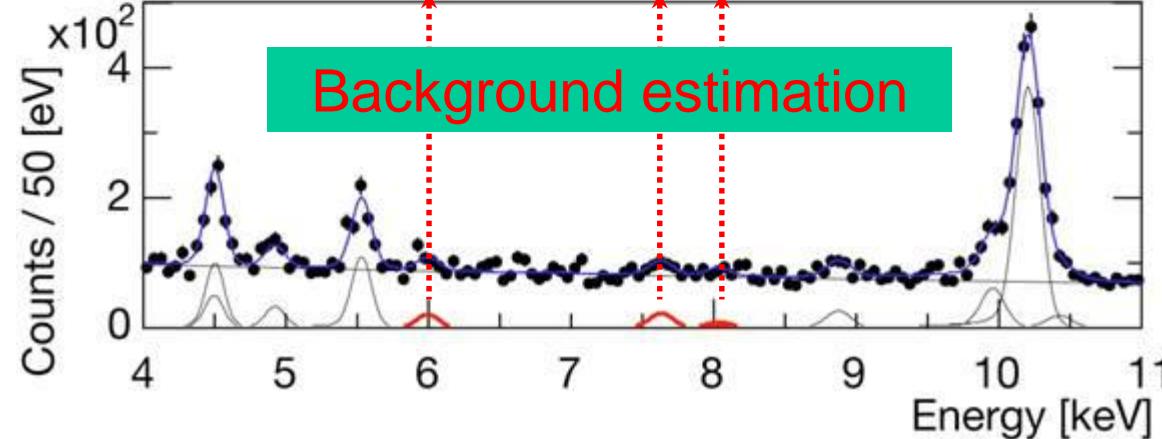
Kaon detector



Hydrogen spectrum

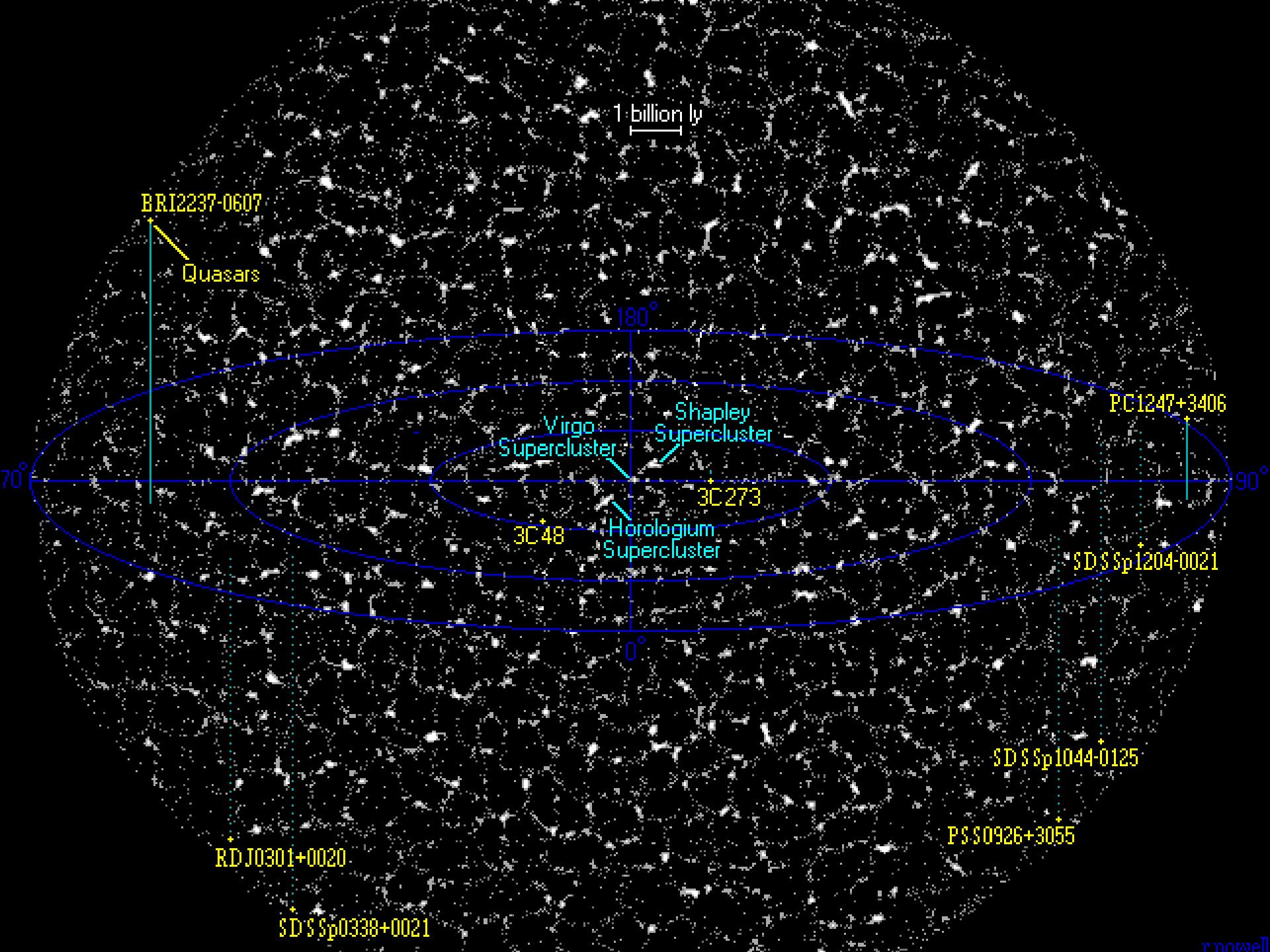


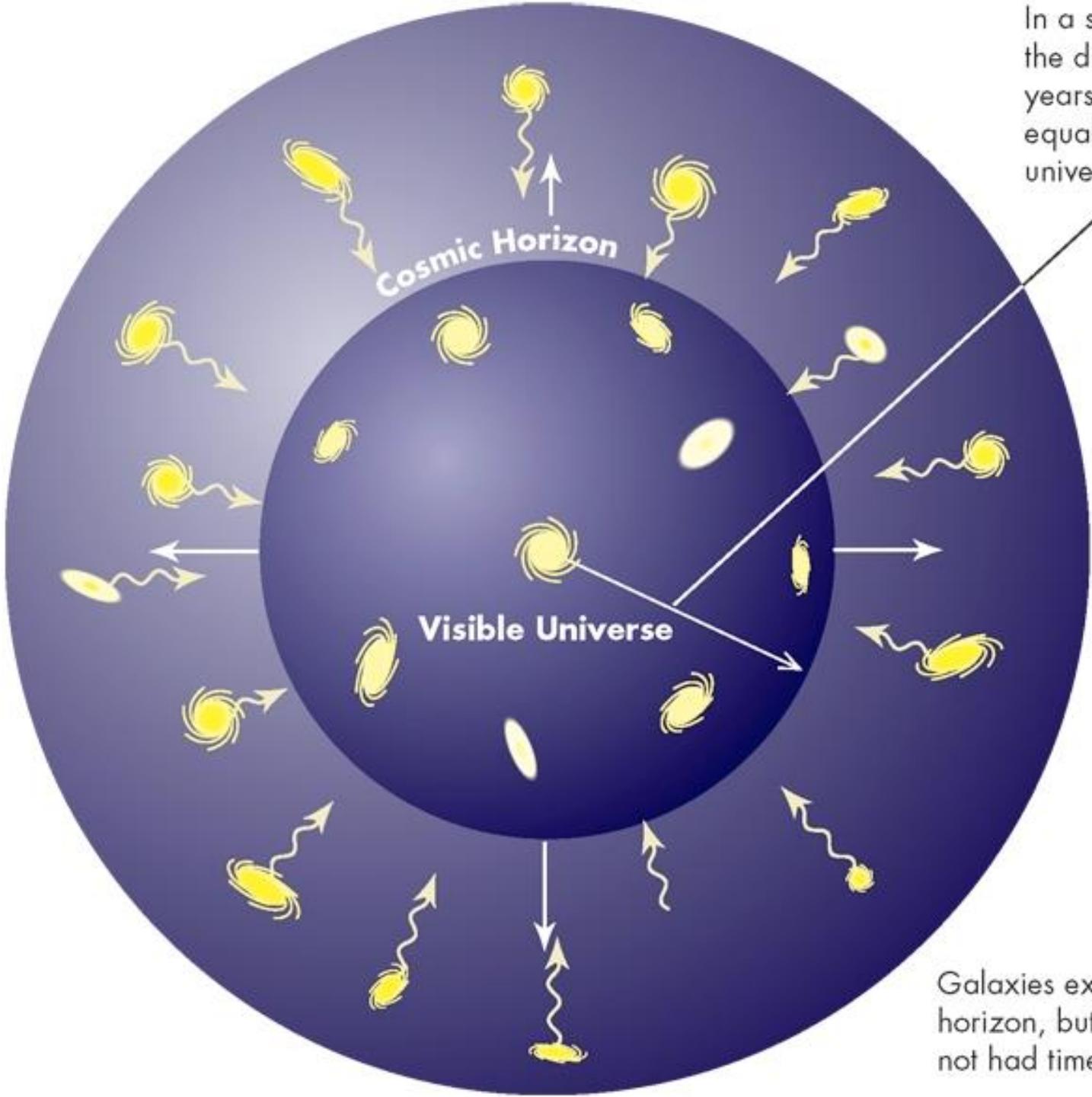
Deuterium spectrum



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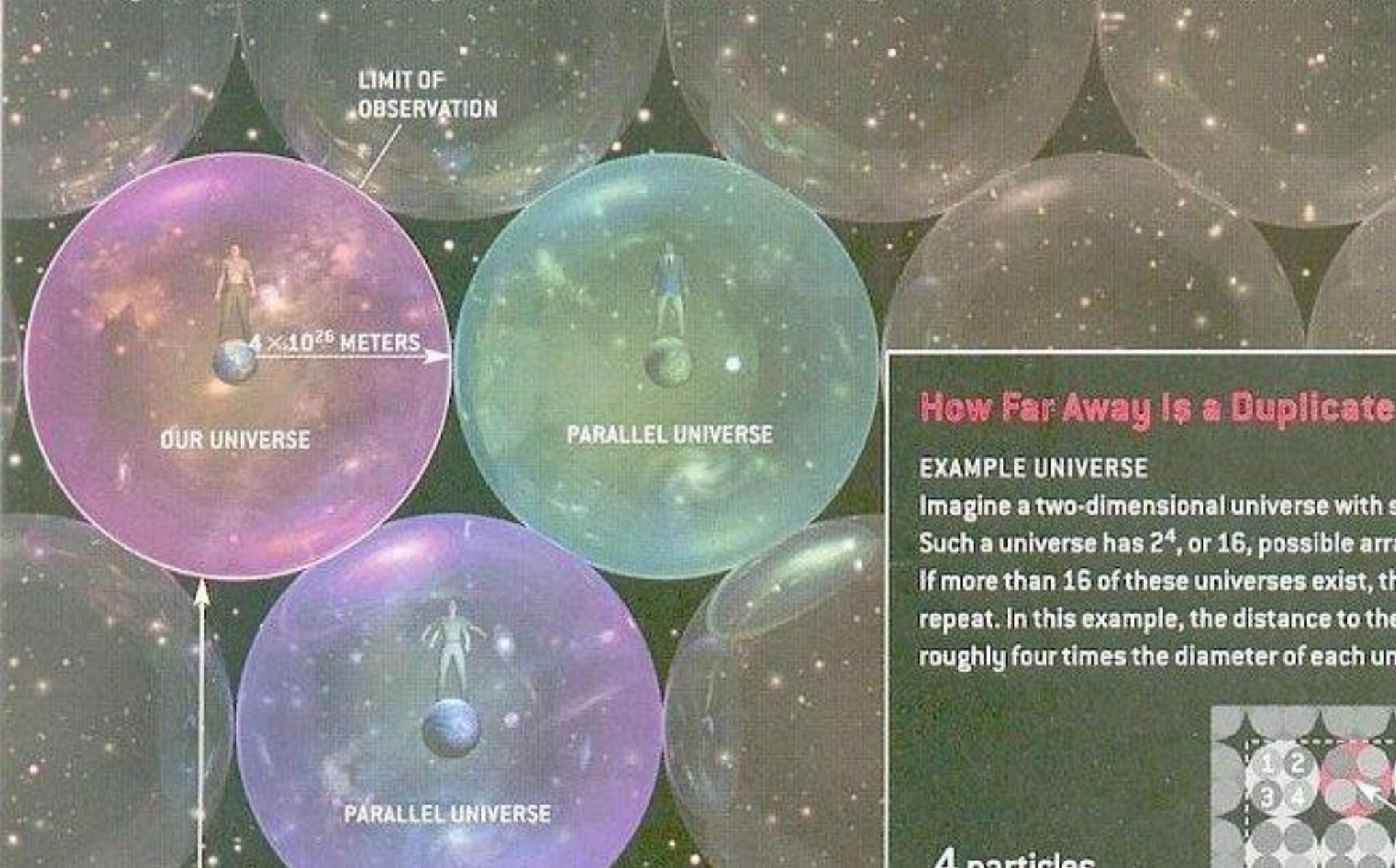


In a static universe,
the distance in light-
years to the horizon
equals age of
universe in years.

Galaxies exist beyond the
horizon, but their light has
not had time to reach us.

THE SIMPLEST TYPE of parallel universe is simply a region of space that is too far away for us to have seen yet. The farthest that we can observe is currently about 4×10^{26} meters, or 42 billion light-years—the distance that light has been able to travel since the big

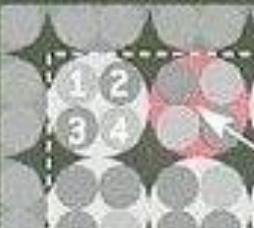
bang began. [The distance is greater than because cosmic expansion has lengthened Level I parallel universes is basically the differences stem from variations in the ini



How Far Away Is a Duplicate?

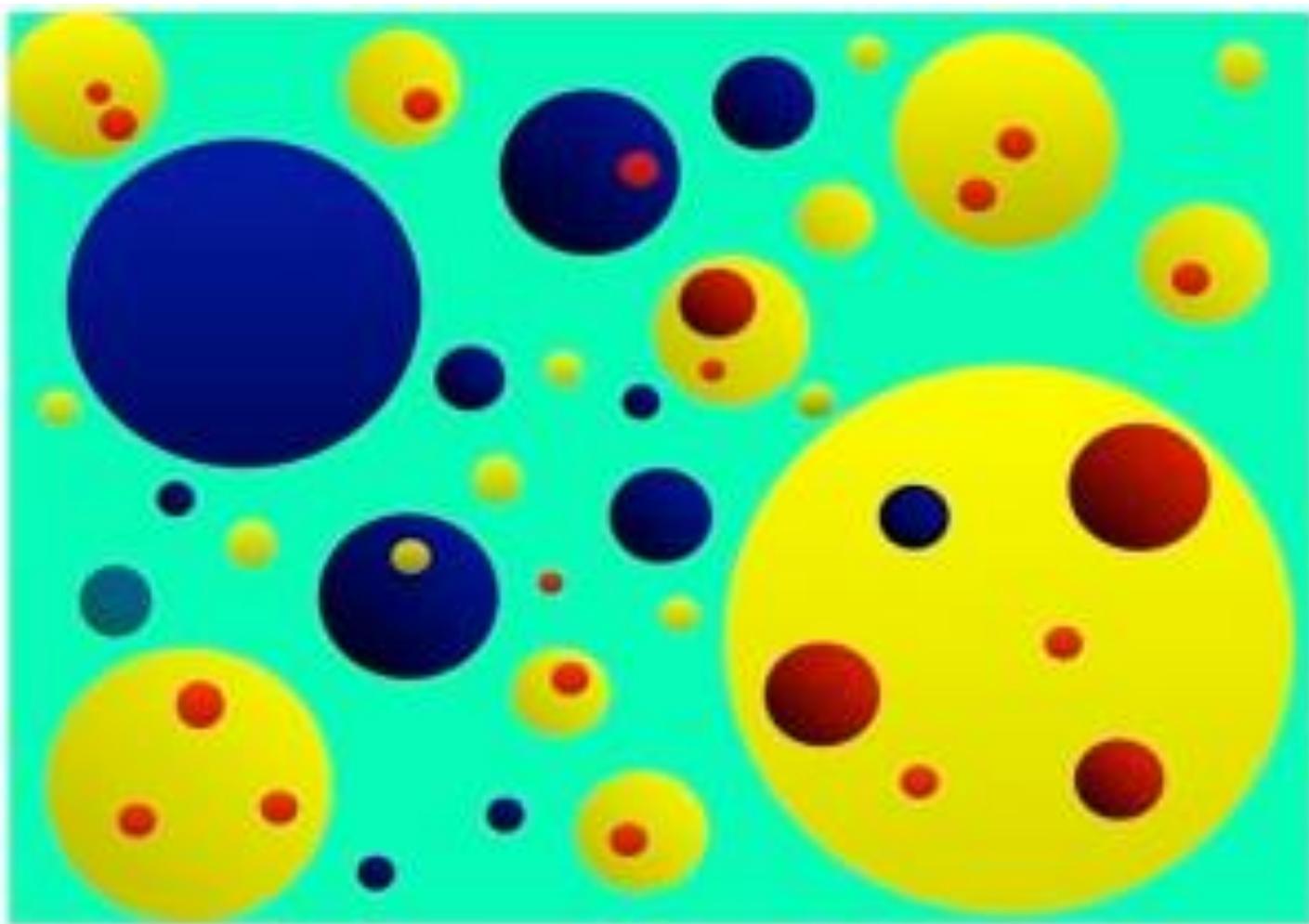
EXAMPLE UNIVERSE

Imagine a two-dimensional universe with 4×10^{26} meters. Such a universe has 2^4 , or 16, possible arrangements of particles. If more than 16 of these universes exist, the pattern repeats. In this example, the distance to the nearest duplicate is roughly four times the diameter of each universe.

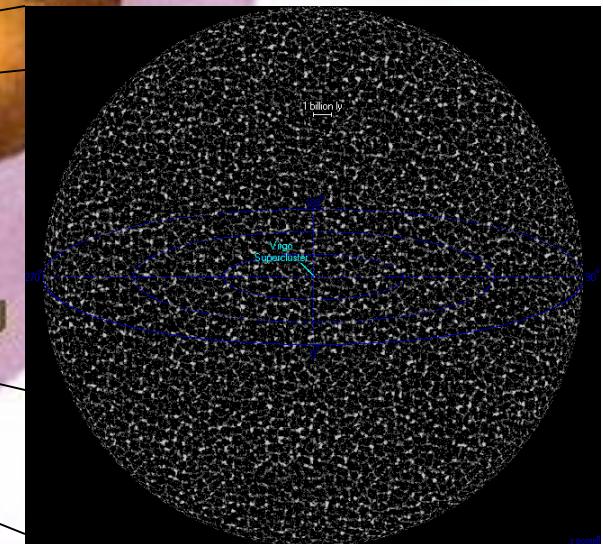
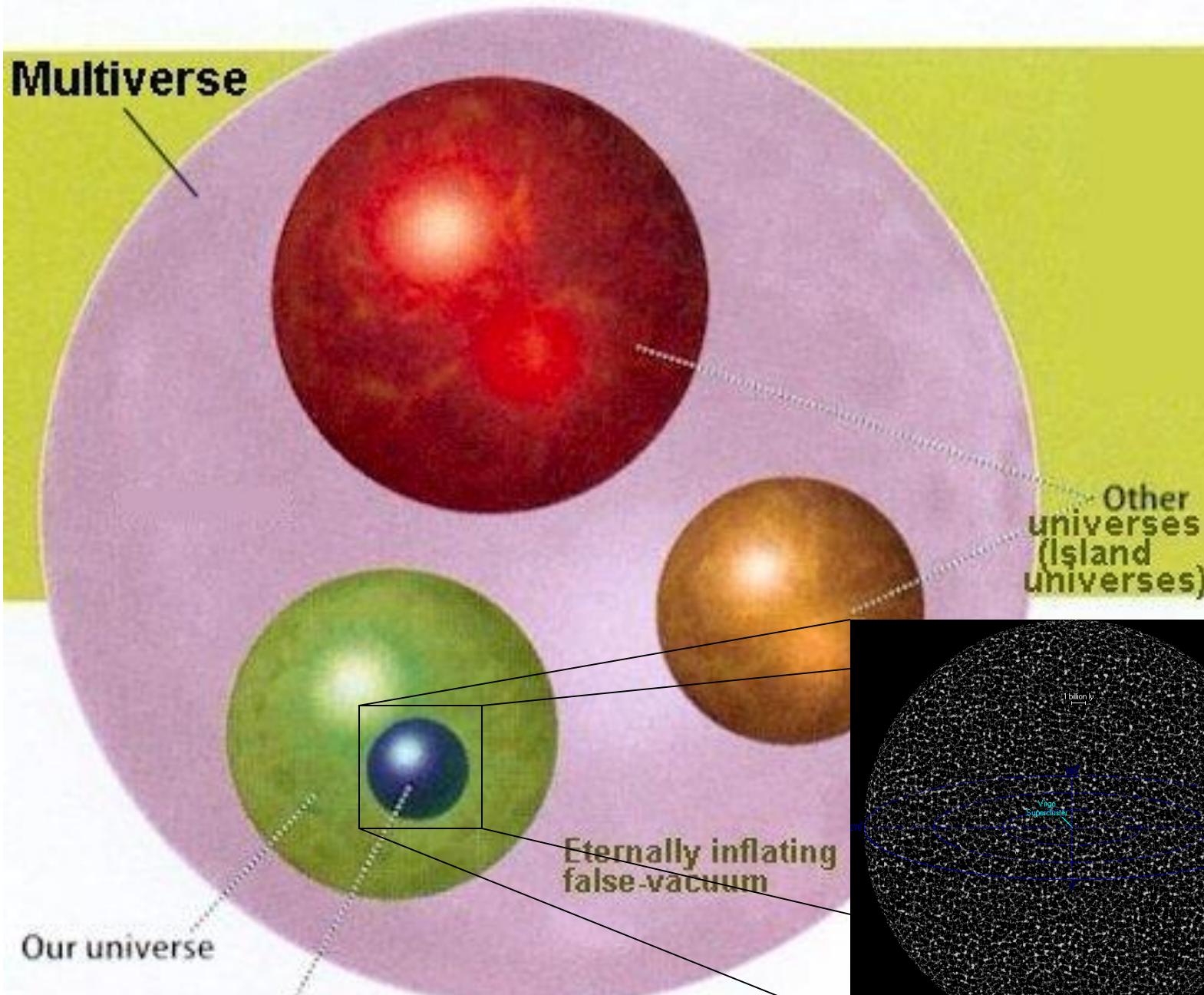


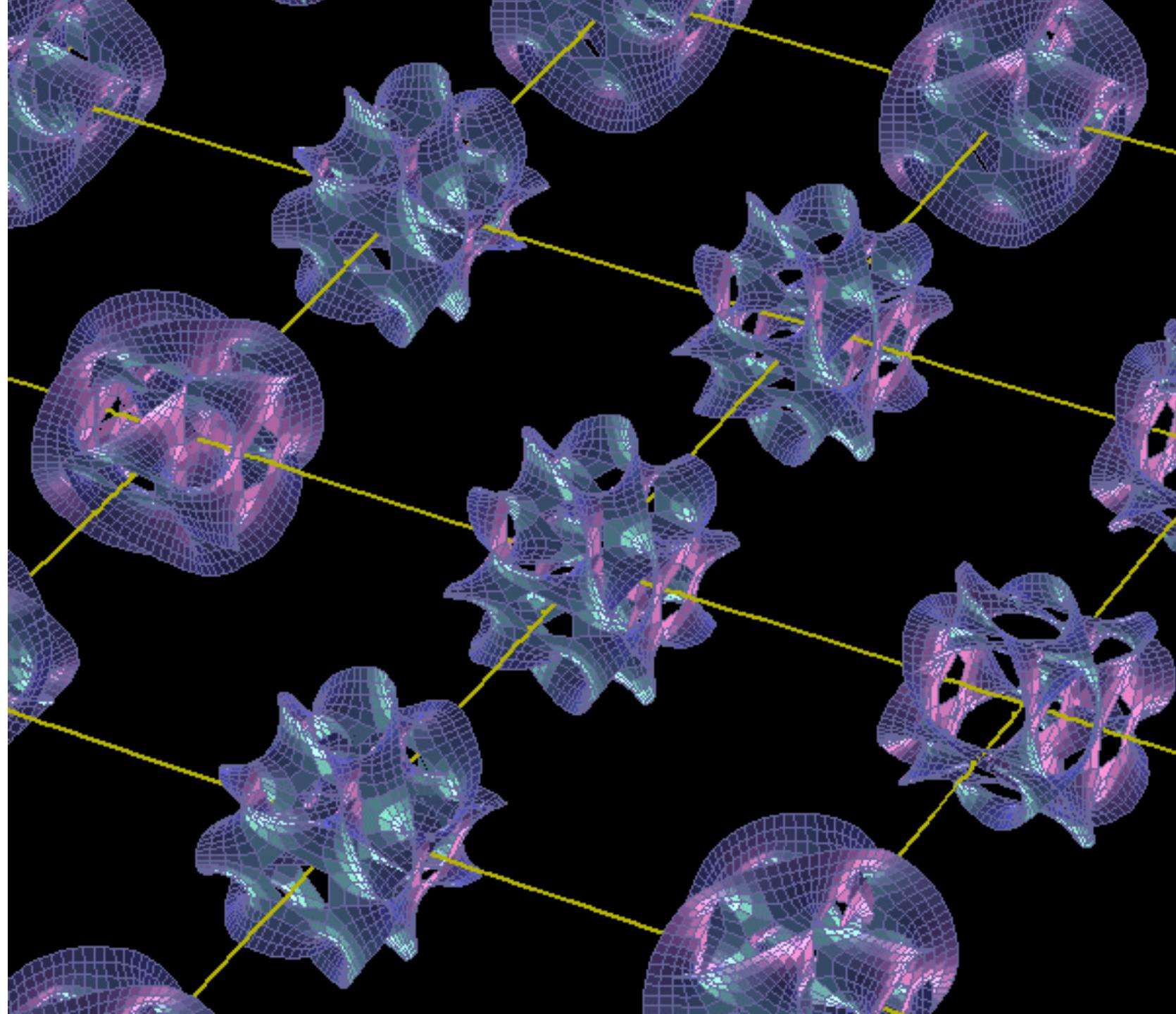
4 particles

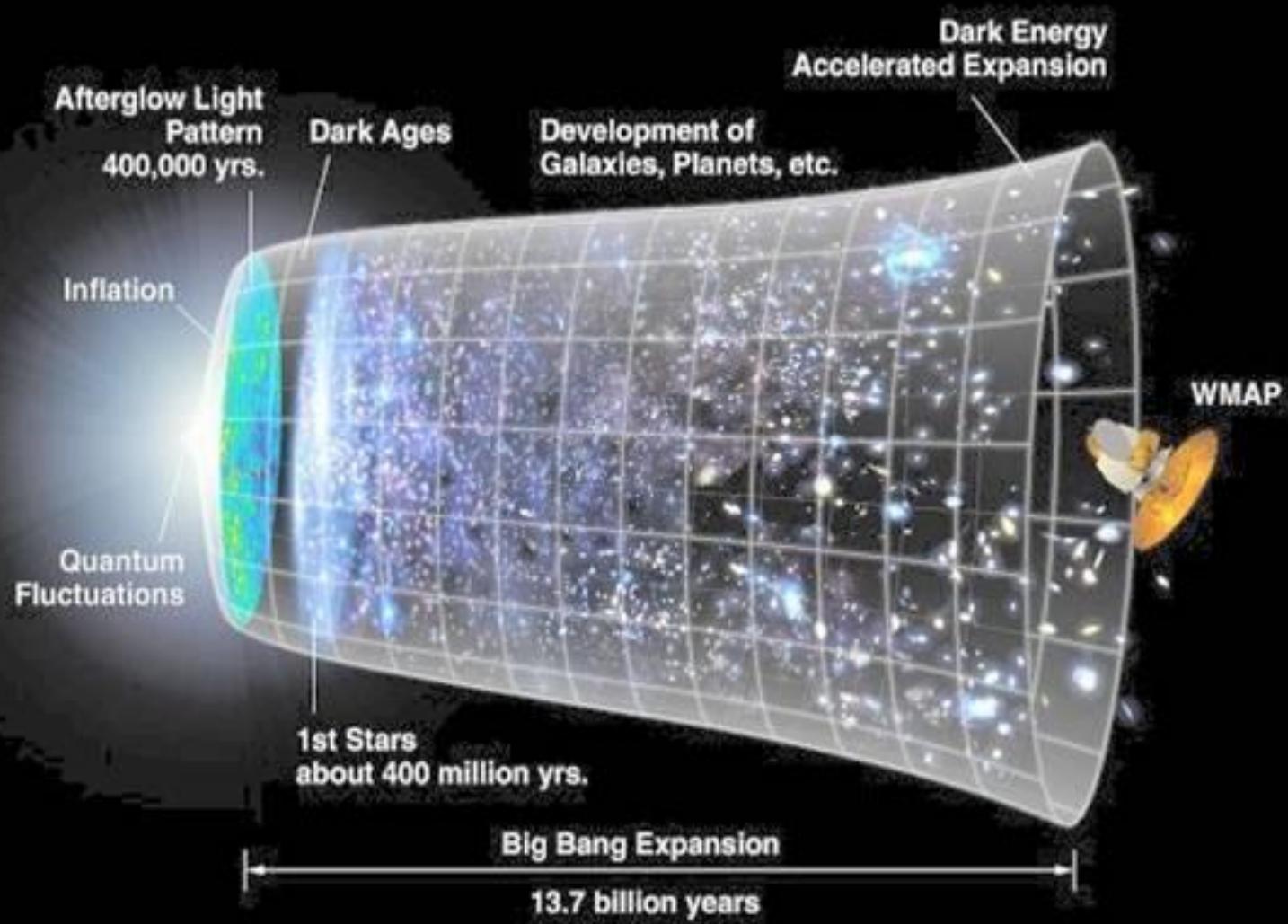
More Universes with different physics



Multiverse







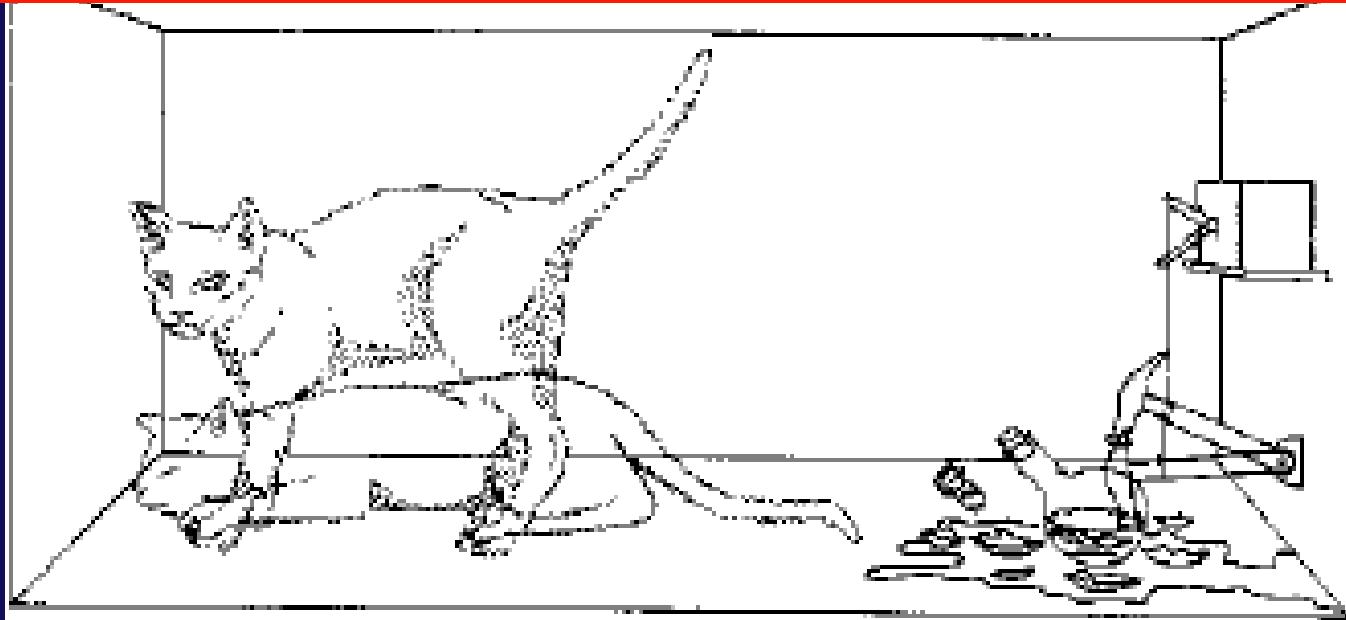
Many-world from QM

Il gatto di Schrodinger

- un paradosso della meccanica quantistica ovvero
- quando il "senso comune" non ci aiuta a risolvere i problemi !



Il gatto di Schrodinger



- Immaginiamo che esista un apparato contenente atomi di ^{13}N ed un rivelatore che rivela quando uno degli atomi è decaduto radiativamente
- Connesso al rivelatore vi è un relè connesso ad un martello che, all'atto del decadimento di un atomo, si attiva facendo cadere il martello che colpisce un'ampolla contenente del gas velenoso.
- Tutto l'apparato è posto in un contenitore insieme ad un gatto, ed aspettiamo 10 minuti
- Allo scadere esatto dei 10 min ci chiediamo: Il gatto è vivo o morto ?

MQ: Il gatto e' 50% vivo e 50% morto!

Il gatto di Schrodinger

Fintantochè non apriamo la scatola non possiamo conoscere quale delle due possibilità si è verificate

In gergo quantistico si dice che il sistema è collassato in uno stato. È l'interazione con l'osservatore (misura) che fa collassare il sistema in uno dei due stati.

Il gatto di Schrodinger – un paradosso

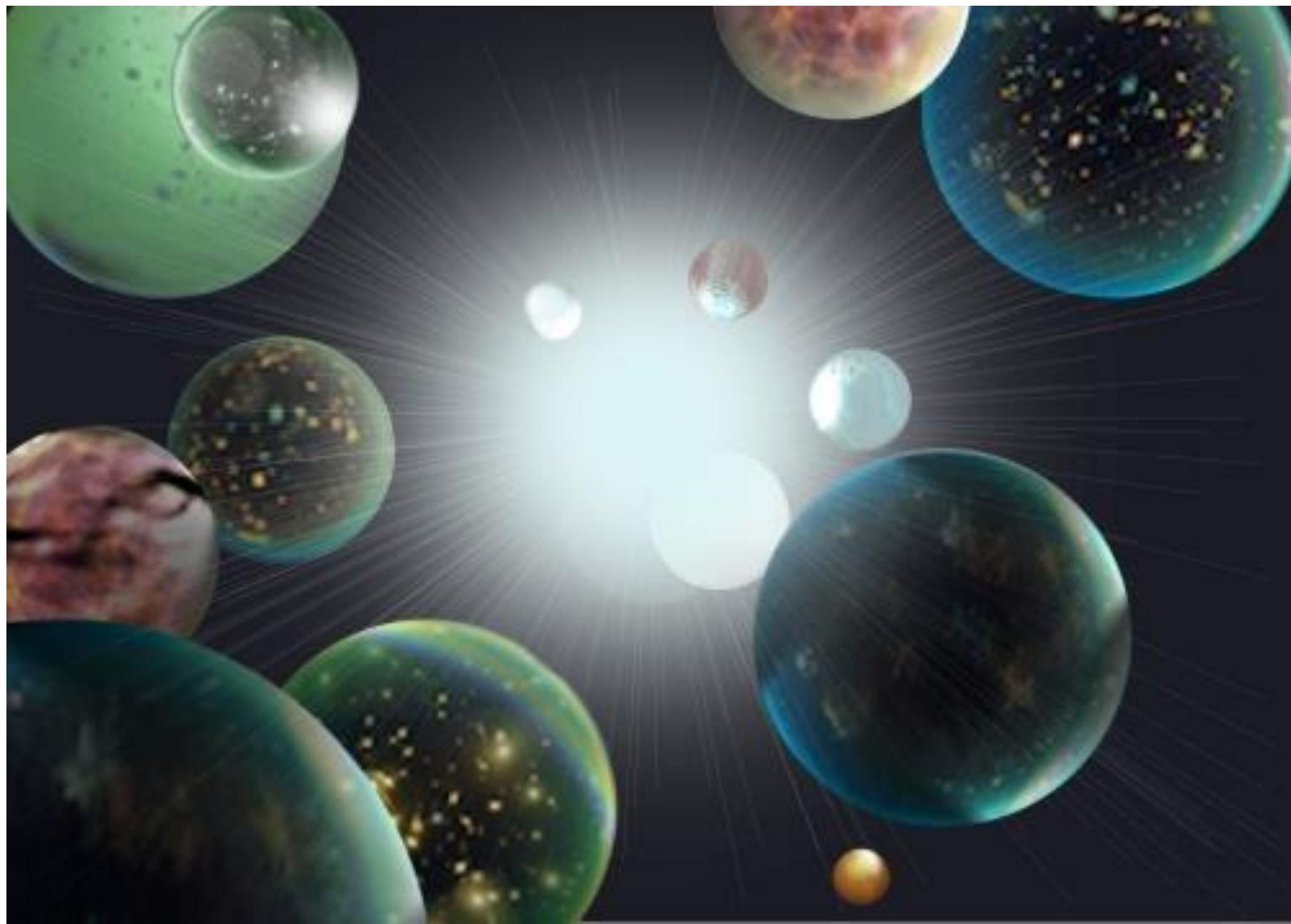


Tutta una serie di interpretazioni
della meccanica quantistica:

- De Broglie - Bohm
- Many-World Interpretations
- Collasso della funzione d'onda

-





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Fermi paradox

Where are they if they exist, why are they not here?



PARADOSSO DI FERMI

"DOVE SONO TUTTI QUANTI?"

**SE NELL'UNIVERSO ESISTE
UN GRAN NUMERO DI CIVILTÀ
ALIENE, PERCHÉ LA LORO
PRESENZA NON SI È MAI
MANIFESTATA?**



Drake's equation:

$$N = R_* f_p n_e f_l f_i f_c L$$

DRAKE EQUATION

The first National Academy of Sciences conference on the detection of extraterrestrial intelligent life was held from October 30 to November 1, 1961. In his opening remarks, Frank Drake proposed the above equation as the agenda for the meeting. The terms have the following meanings:

N = number of communicative civilizations in the Galaxy.	f_l = fraction of such temperate planets on which life begins.
R_* = rate of solar type star formation in the Galaxy.	f_i = fraction of the life-starts that evolve intelligence.
f_p = fraction of such stars having planetary systems.	f_c = fraction of these that attempt interstellar communication.
n_e = average number of planets in the ecosphere of the star.	L = average longevity of the communicative species.

The factors on the right are essentially unknown, so N remains a tantalizing mystery. Nevertheless, the Drake equation served, and still serves, as an excellent way to categorize our ignorance and thereby stimulate productive discussion and research.

Presented here by Carl Sagan, in commemoration of his discovery by the SETI Institute, October 1995.

DRAKE EQUATION

$$N = R \times f_* \times f_p \times n_e \times f_i \times f_c \times L$$

R average rate of star formation

f_{}* fraction of good stars that have planetary systems

n_e number of planets around these stars that could be "ecosystems"

f_i fraction of life forms that develop intelligent life

f_c fraction of intelligent life forms that develop communications

L fraction of intelligent life forms that last long enough to communicate

L lifetime of intelligent life forms





Over 1000 Confirmed Exoplanets



Number of confirmed exoplanets in each category are in red, total 1010.

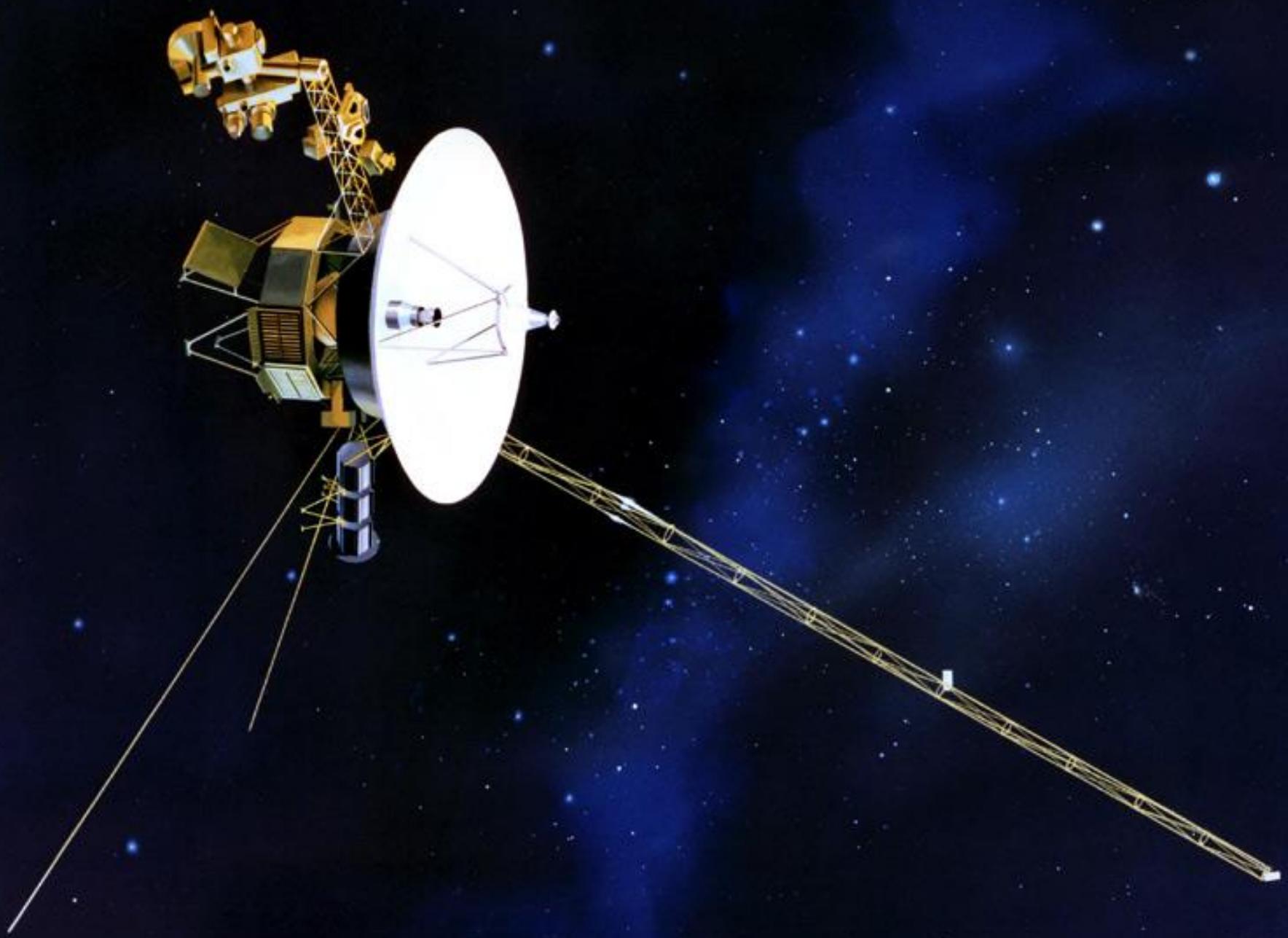
Credit: PHL @ UPR Arecibo, Oct 2013

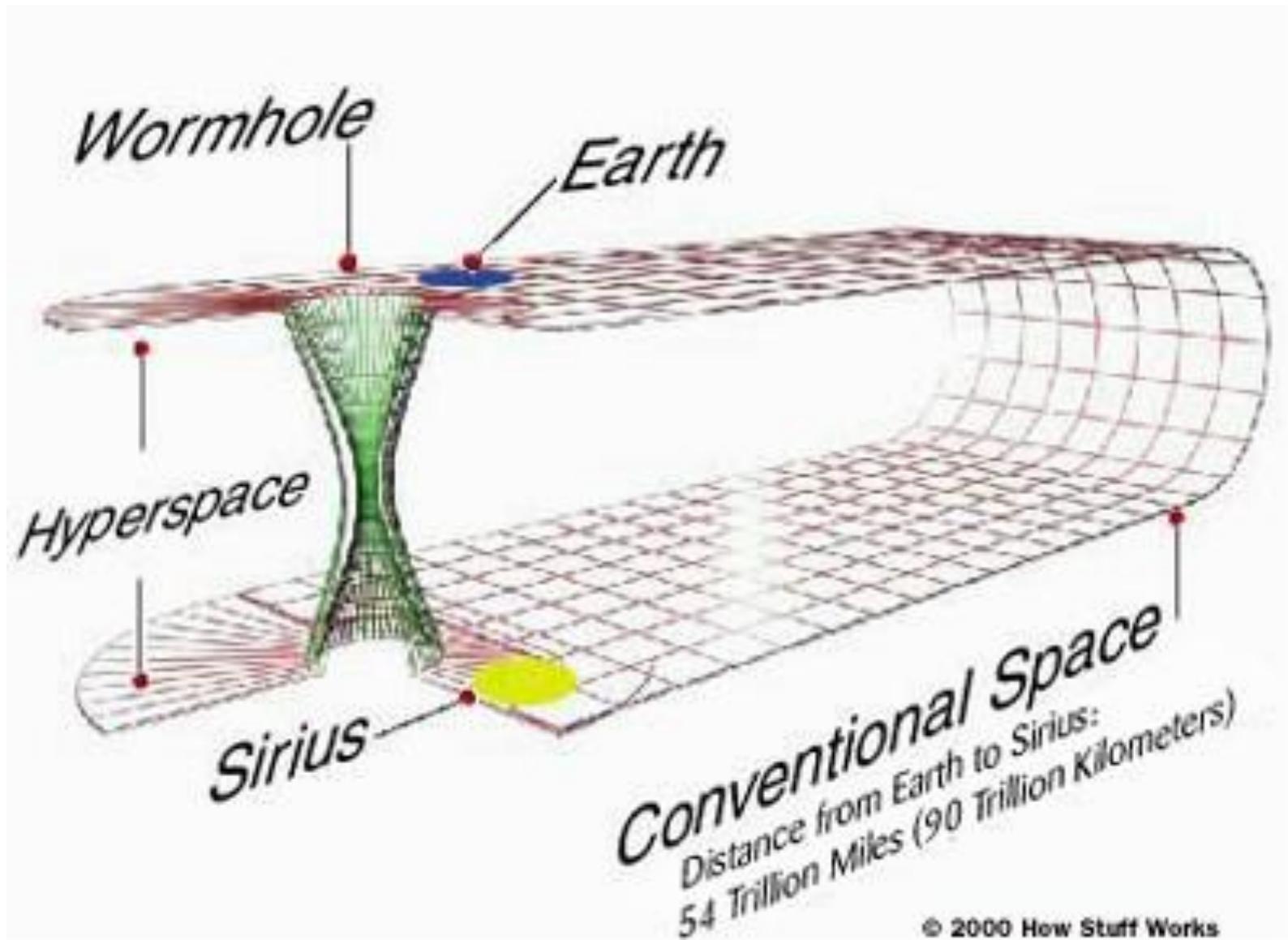
They are here











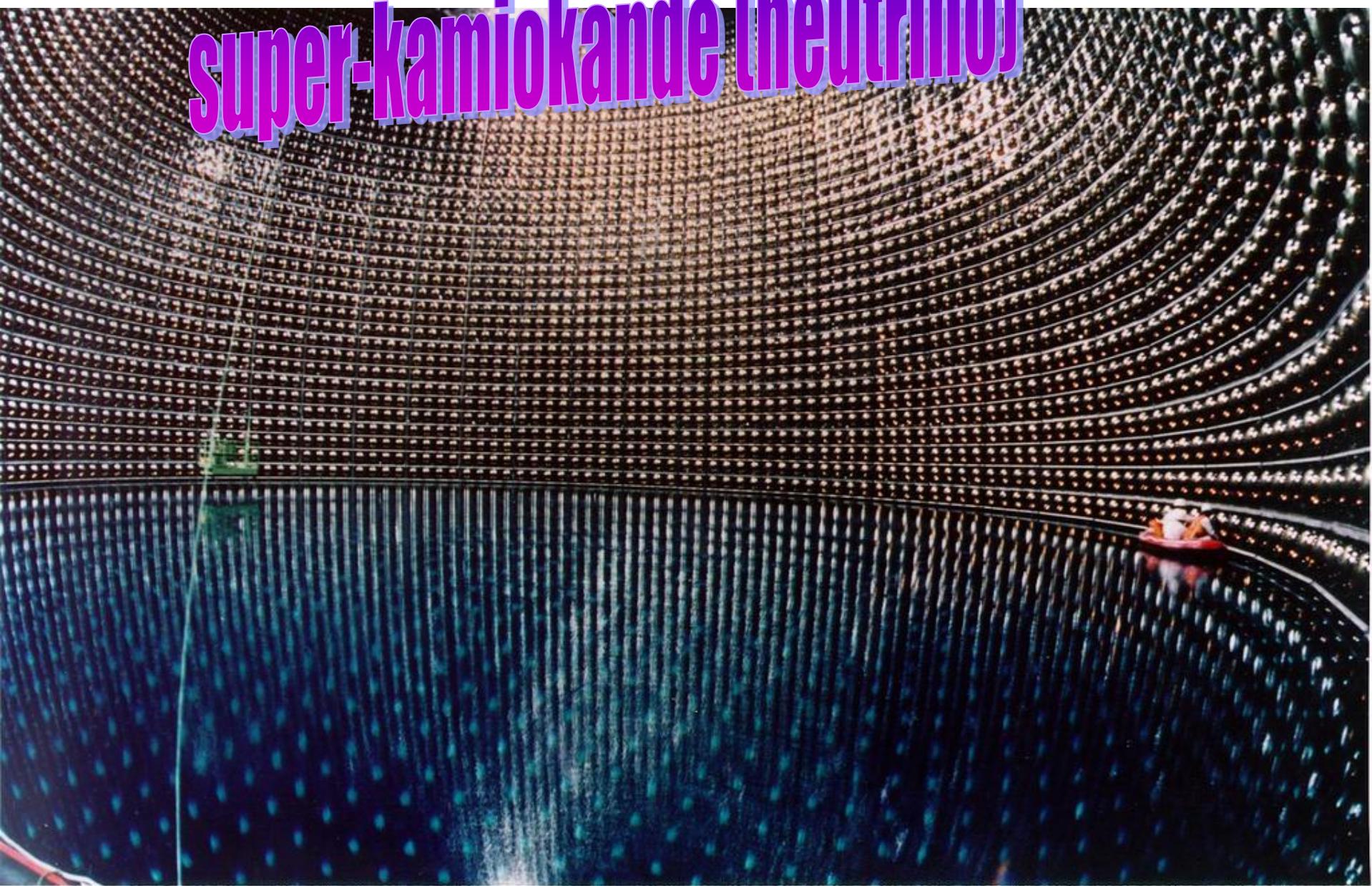
ALATERRY
IN GENESIS CREATIVITY



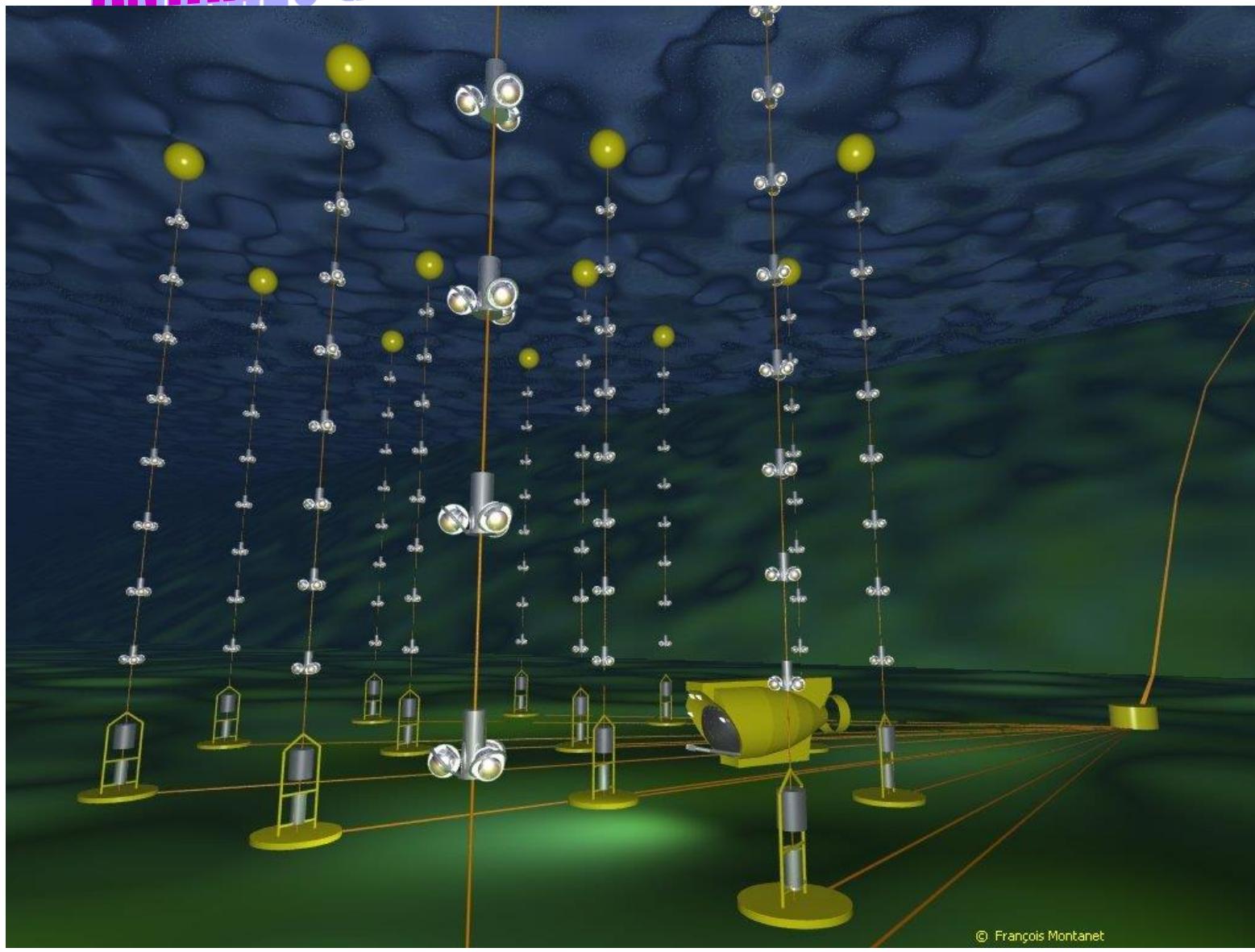
ARECIBO (Puerto Rico)
diam. 305 m, profondita' 51 m

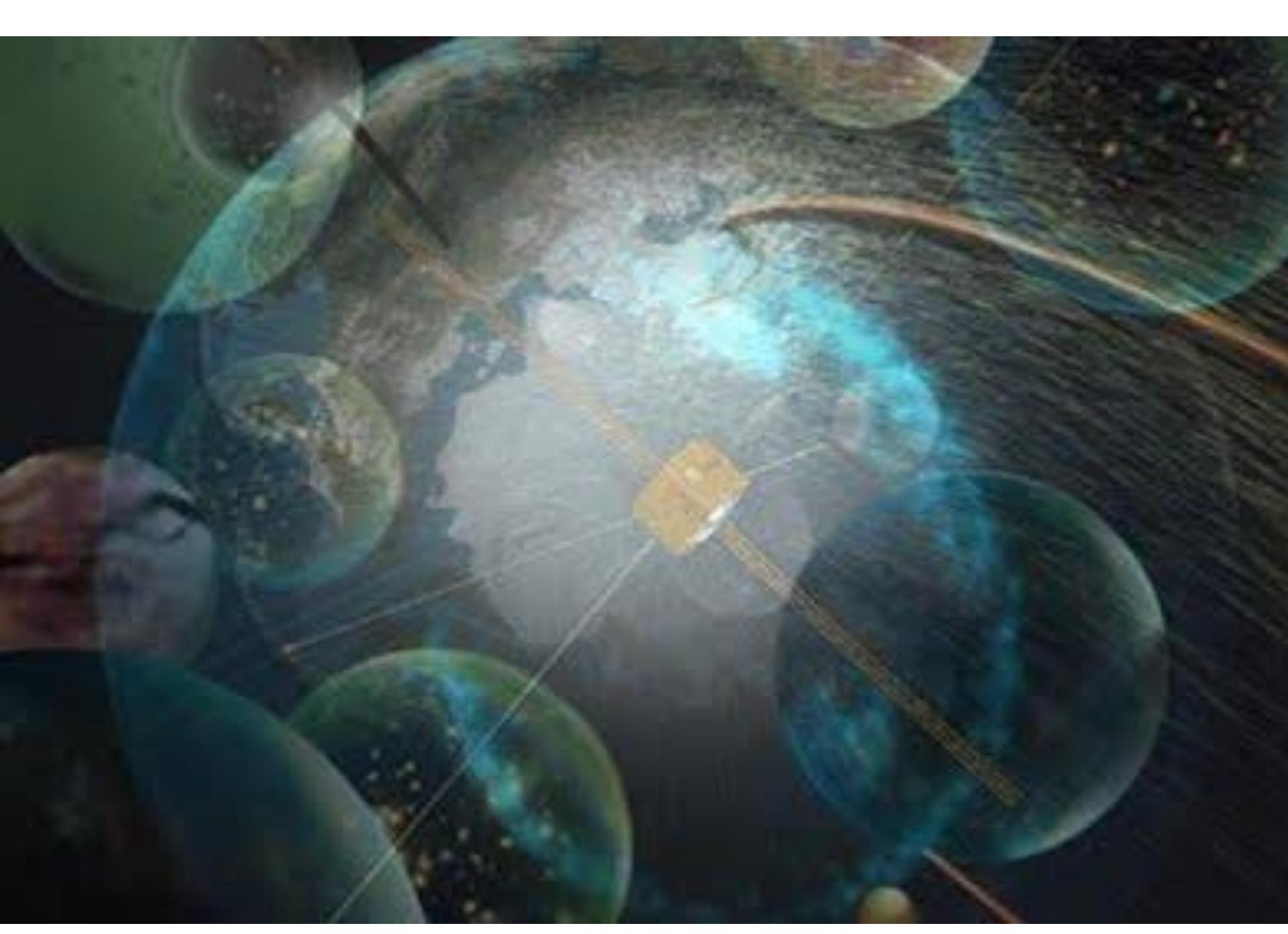


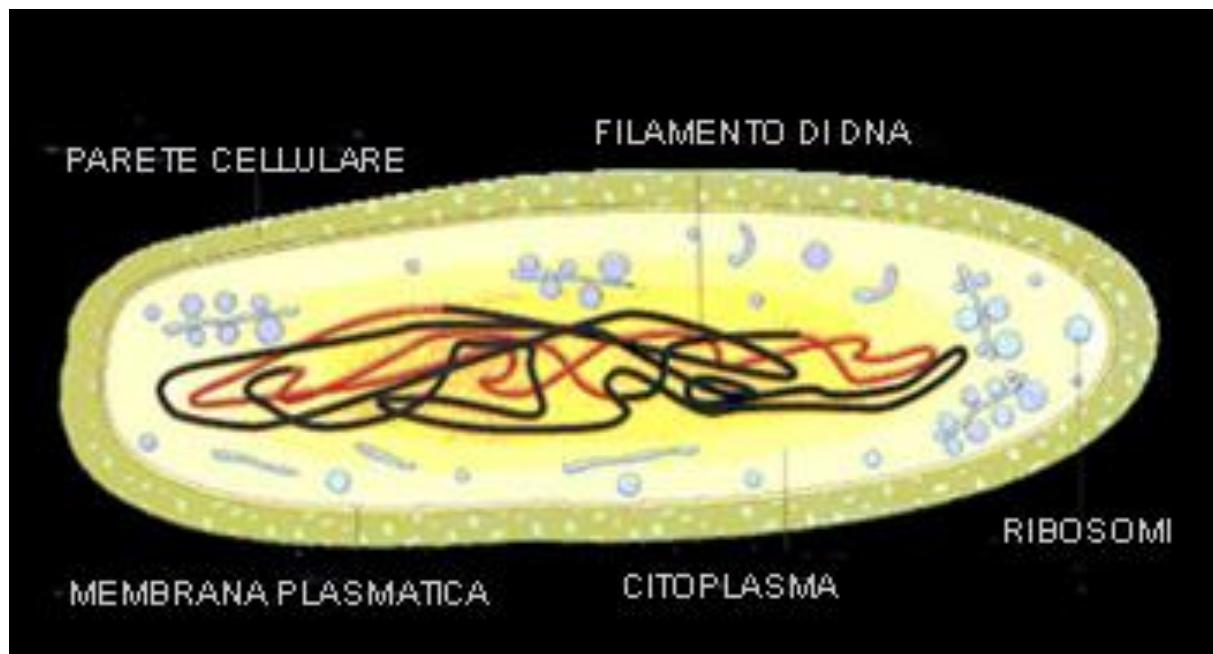
super-kamiokande (neutrino)

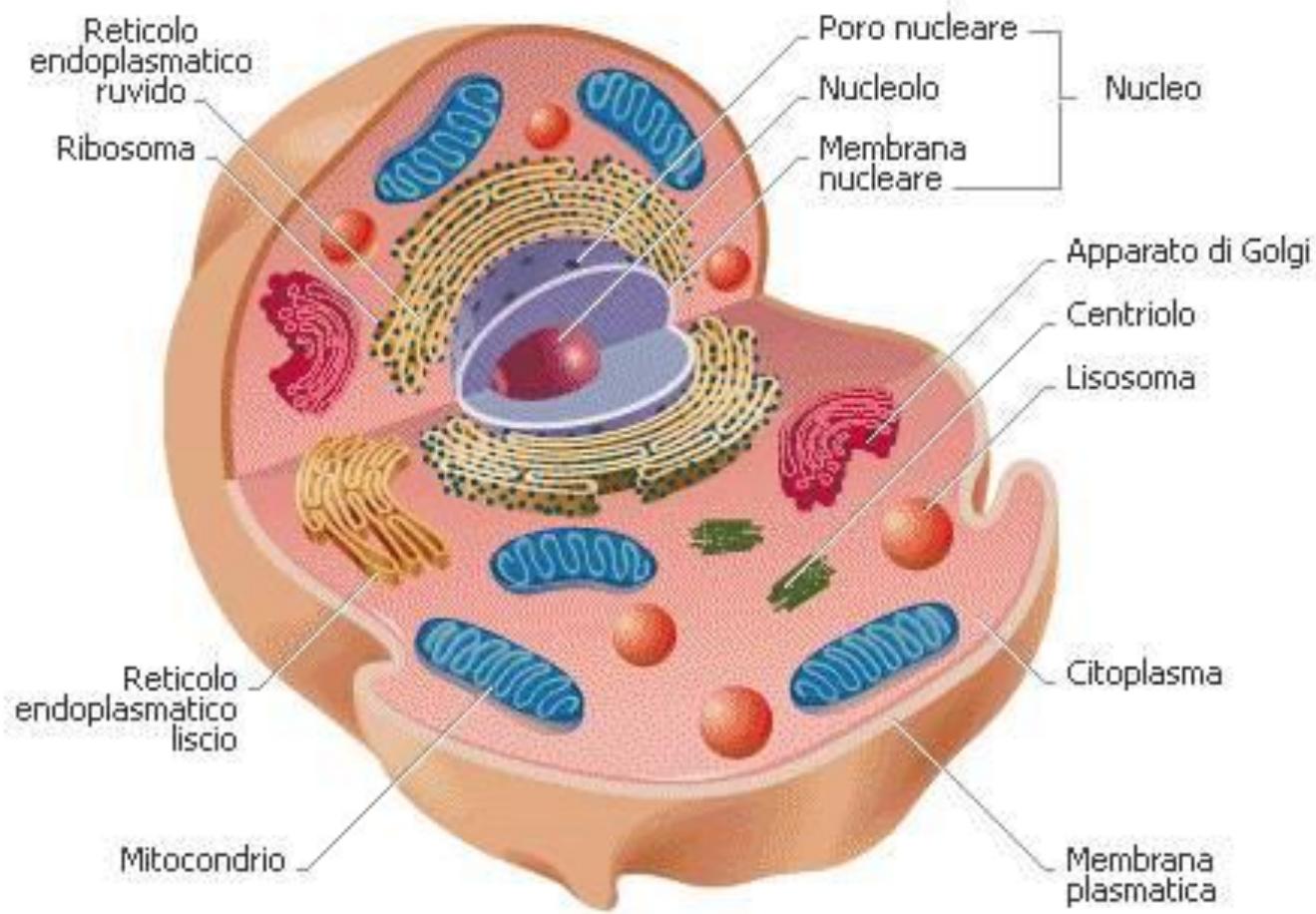


ANTARES (neutrino, materia oscura)



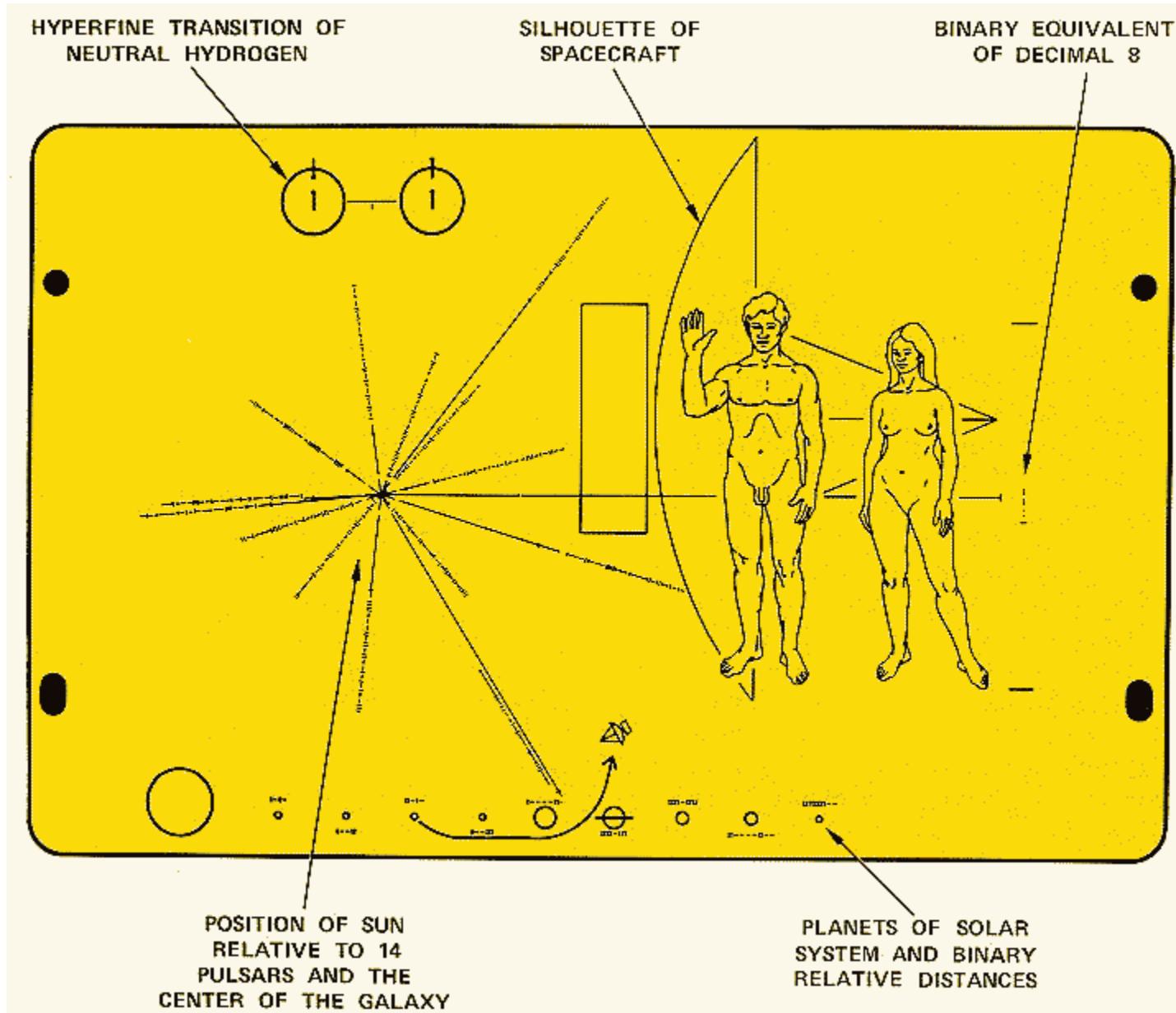






Pioneer 10 (17-10-70) e 11

C.
Sagan &
F. Drake





Catalina Oana Curceanu

Dai buchi neri all'adroterapia

Un viaggio nella fisica moderna



 Springer

 zoku



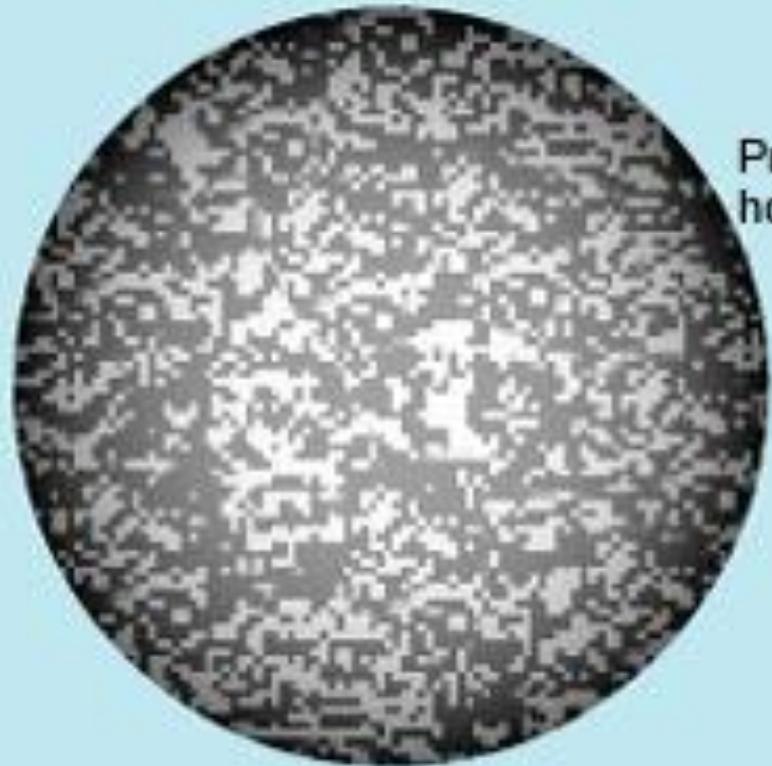
Nata in Transilvania (Bucovina, Romania) Catalina Oana Curceanu è Primo Ricercatore dell'Istituto Nazionale di Fisica Nucleare, Istituzioni Nazionali di Ricerca. Dirige un gruppo di ricercatori che lavorano nel campo della fisica sperimentale adronica e nucleare, conducendo esperimenti sia in Italia sia all'estero, e coordina vari progetti europei. Ha organizzato varie conferenze internazionali ed è autrice di più di 200 pubblicazioni scientifiche in riviste internazionali. Svolge un'intensa attività di formazione e divulgazione scientifica e culturale per vari giornali e riviste italiane e straniere. Ha la passione di spiegare a tutti quanto sia bello e affascinante il mondo della scienza.

What about the information? Hawking & Preskill (the bet)



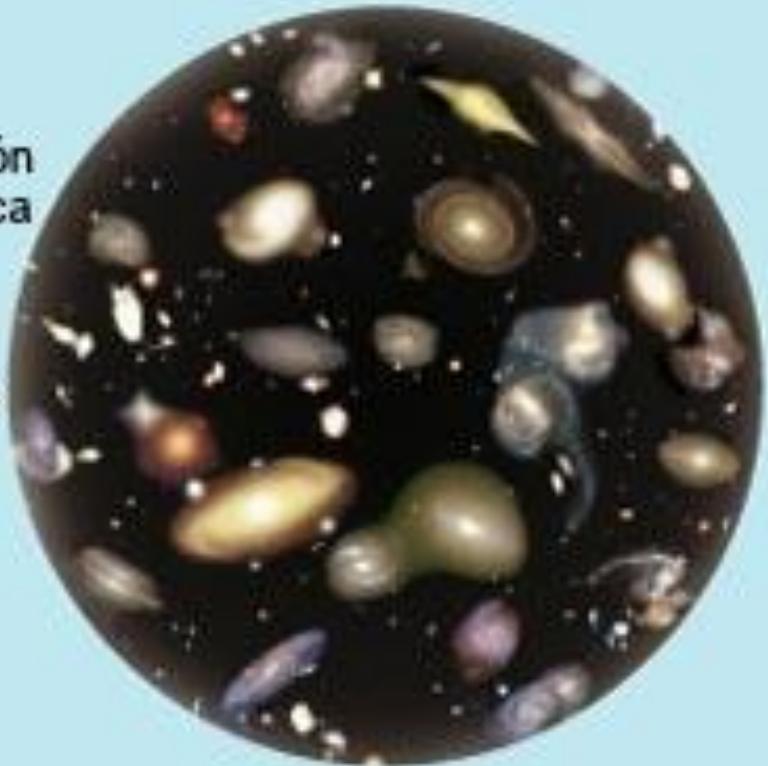
Holographic principle





Superficie bidimensional

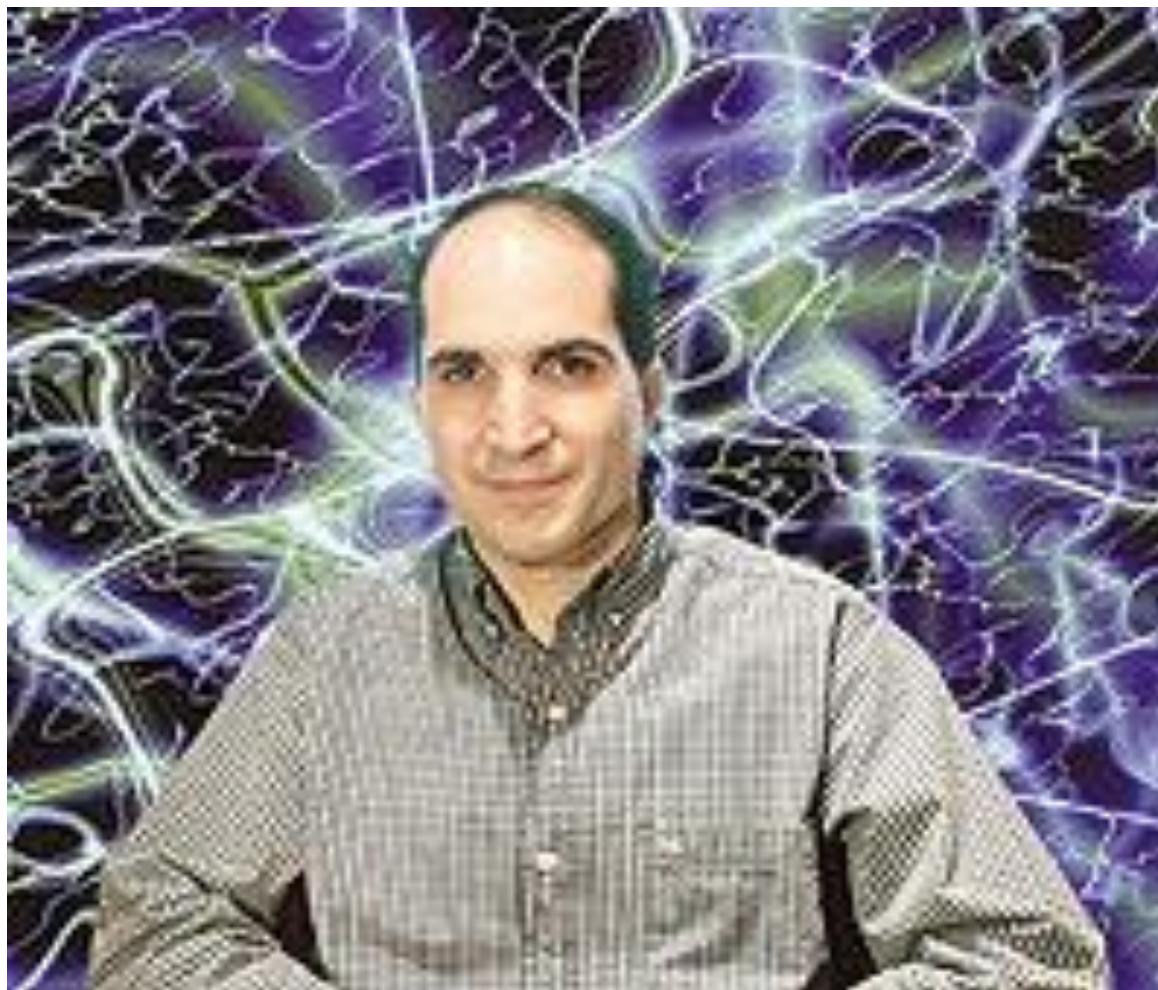
Proyección
holográfica



Universo aparentemente tridimensional

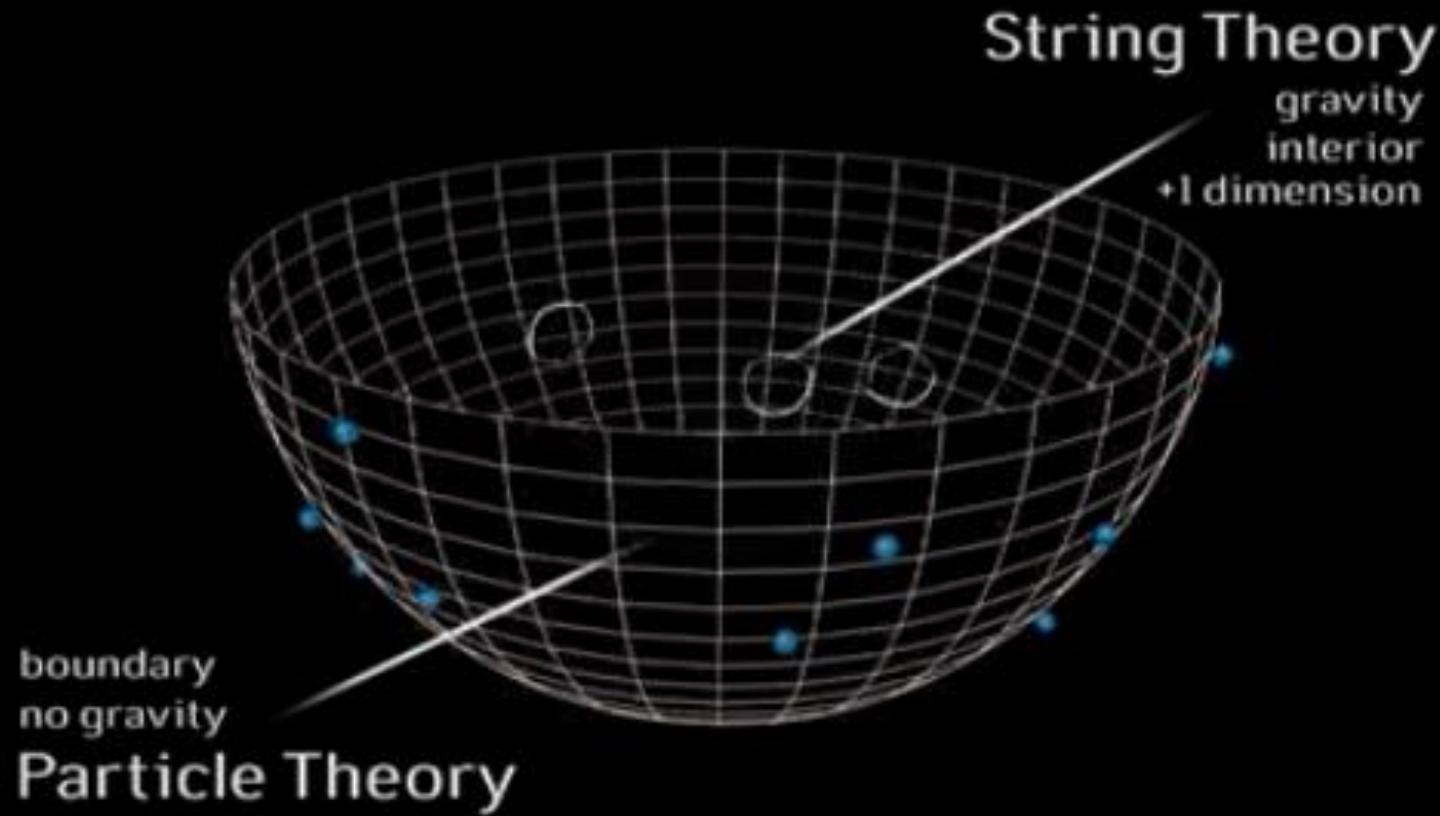
The black holes war

Maldacena



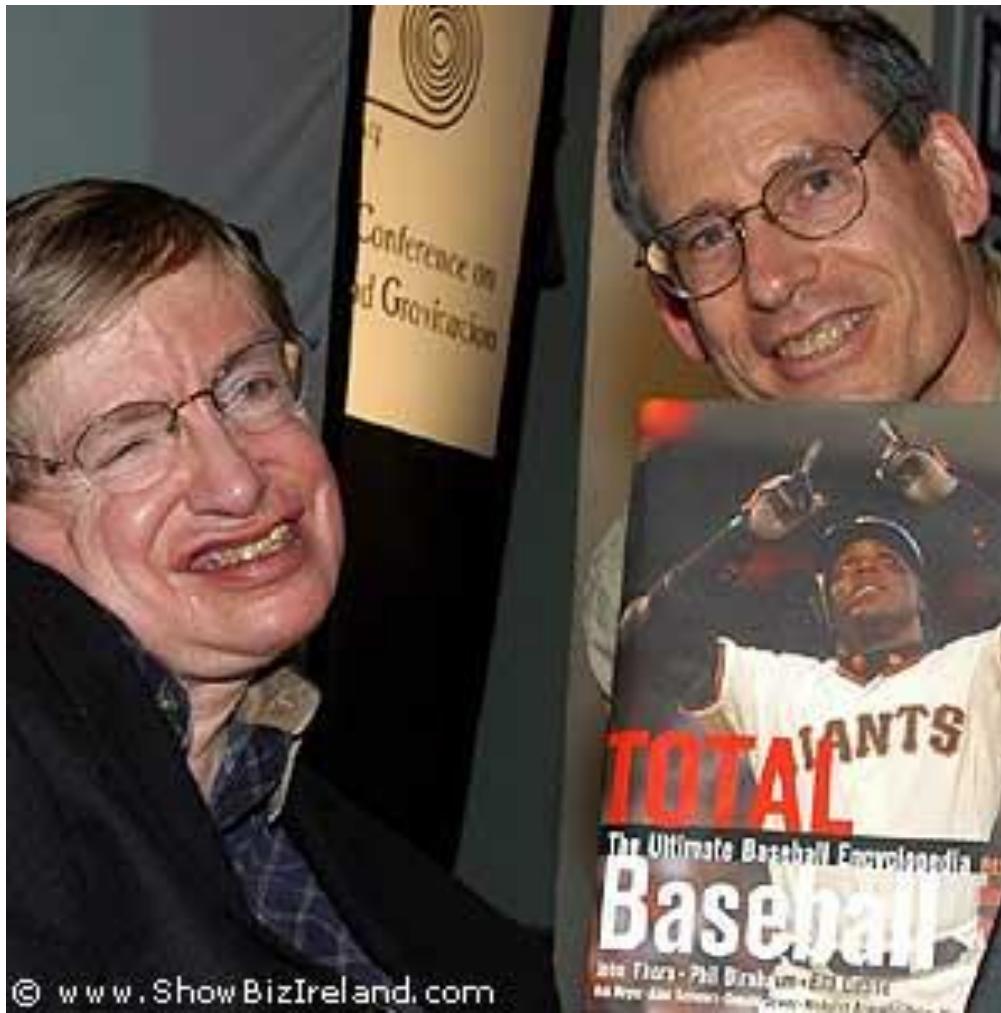
Dual theories

Maldacena



Black hole war

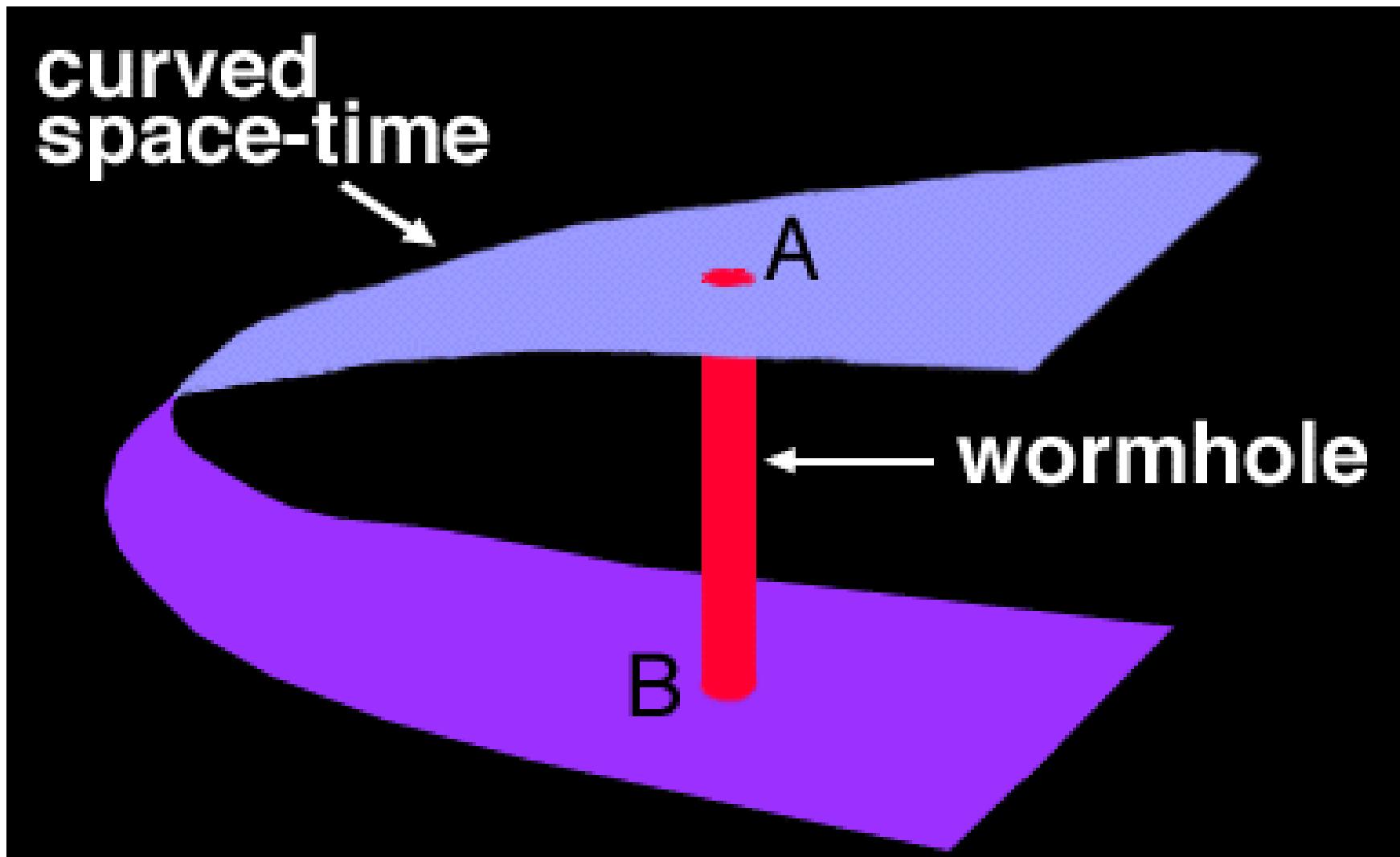
Hawking lost the bet



We need
quantum gravity!



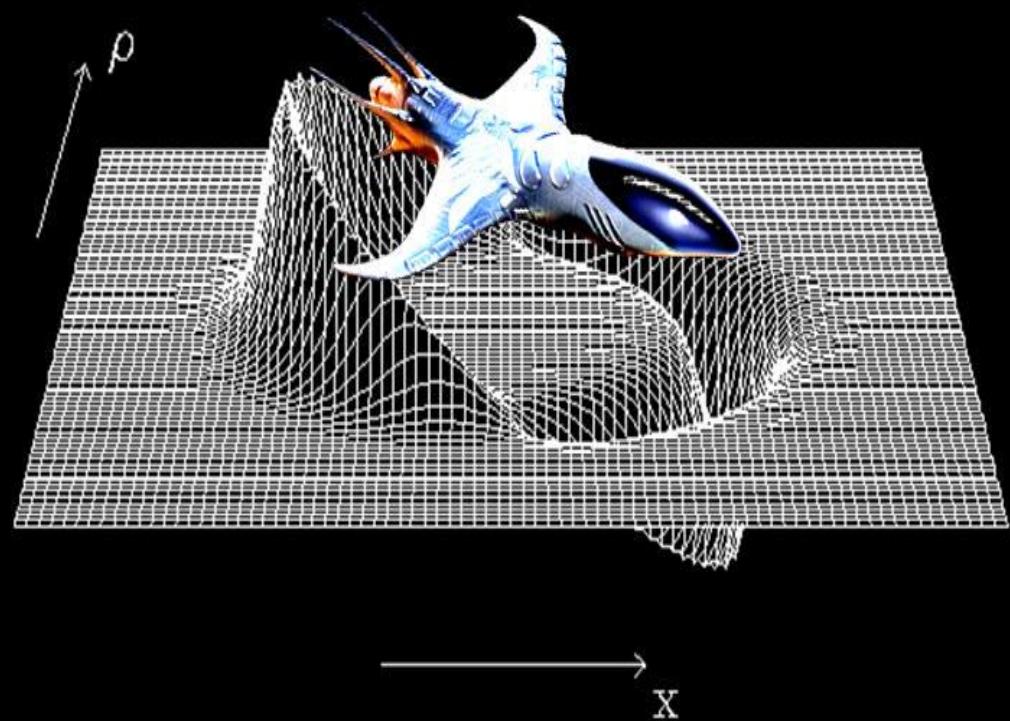
Scorciatoie spazio-temporali





Alcubierre Warp Drive

$$\vartheta = -\alpha \operatorname{Tr}(K)$$



Alcubierre Warp Drive: stretches spacetime in a wave causing the fabric of space ahead of a spacecraft to contract and the space behind it to expand.

The ship can ride the wave to accelerate to high speeds and time travel.