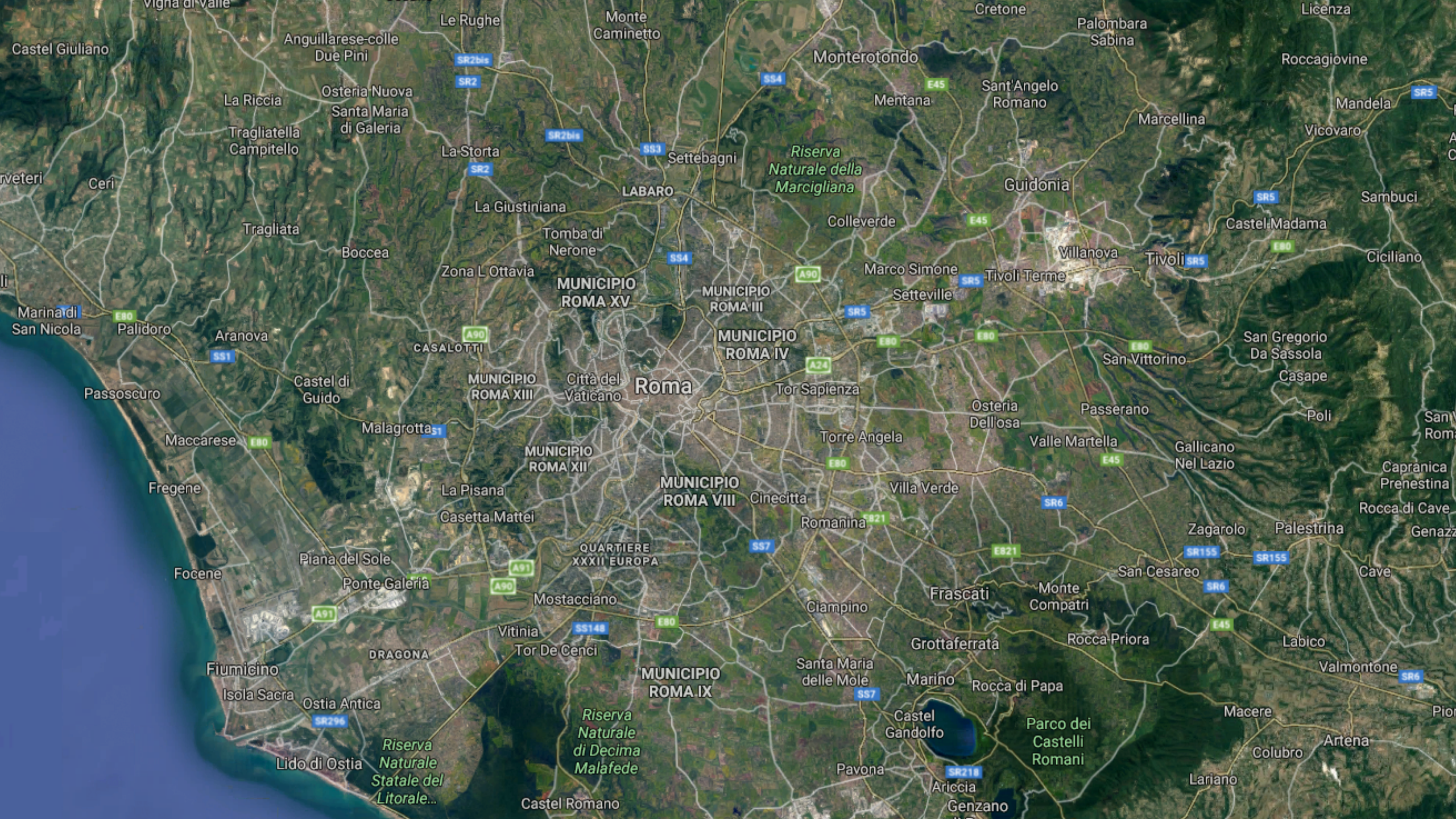


ALLA RICERCA DELLA MATERIA OSCURA

Valerio Ippolito
Damiano Vannicola


Unicredit
SP493
IIS Gaetano De Sanctis - Sede Centrale
Via la Moletta


Roma
MUNICIPIO ROMA XV
MUNICIPIO ROMA III
MUNICIPIO ROMA IV
MUNICIPIO ROMA XIII
MUNICIPIO ROMA XII
MUNICIPIO ROMA VIII
MUNICIPIO ROMA IX
QUARTIERE XXXII EUROPA
CASALOTTI
LABARO
DRAGONA
Città del Vaticano
Tor Sapienza
Torre Angela
Villa Verde
Cinecitta
Romanina
La Pisana
Casetta Mattei
Tomba di Nerone
Zona L Ottavia
La Giustiniana
Settebagni
Riserva Naturale della Marcigliana
Riserva Naturale di Decima Malafede
Riserva Naturale Statale del Litorale...
Parco dei Castelli Romani
Monterotondo
Mentana
Sant'Angelo Romano
Guidonia
Colleverde
Villanova
Marco Simone
Setteville
Tivoli
Tivoli Terme
Castel Madama
Marcellina
Vicovaro
Mandela
Roccagiovine
Palombara Sabina
Cretone
Licenza
Sambuci
Ciciliano
San Gregorio Da Sassola
Casape
San Vittorino
Poli
Passerano
Osteria Dell'osa
Valle Martella
Gallicano Nel Lazio
Capranica Prenestina
Rocca di Cave
Palestrina
Zagarolo
San Cesareo
Cave
Genazz
Frascati
Monte Compatri
Ciampino
Grottaferrata
Rocca Priora
Labico
Valmontone
Marino
Rocca di Papa
Santa Maria delle Mole
Castel Gandolfo
Macere
Artena
Colubro
Lariano
Pavona
Ariccia
Genzano
Castel Romano
Monte Caminetto
Le Rughe
Anguillarese-colle Due Pini
Castel Giuliano
Osteria Nuova
Santa Maria di Galeria
La Riccia
Tragliatella Campitello
La Storta
Ceri
Tragliata
Boccea
Aranova
Palidoro
Marina di San Nicola
Passoscuro
Castel di Guido
Malagrotta
Maccarese
Fregene
Piana del Sole
Focene
Ponte Galeria
Mostacciano
Vitinia
Tor De Cenci
Fiumicino
Isola Sacra
Ostia Antica
Lido di Ostia
Casalbertone
Tiburtino
Prenestino-Centocelle
Appio Latino
Ostiense
Portuense
Gianicolense
Aurelio
Trionfale
Prati
Monte Mario
Flaminio
Parioli
Pinciano
Salario
Nomentano
Tiburtino
Prenestino-Centocelle
Appio Latino
Tuscolano
Ostiense
Portuense
Gianicolense
Aurelio
Trionfale
Prati
Monte Mario
Flaminio
Parioli
Pinciano
Salario
Nomentano
SR2bis
SR2
SS4
SS3
E45
SR5
E80
A90
SS1
A24
SR6
E821
SS7
A91
SS148
SR155
SR218
SR296





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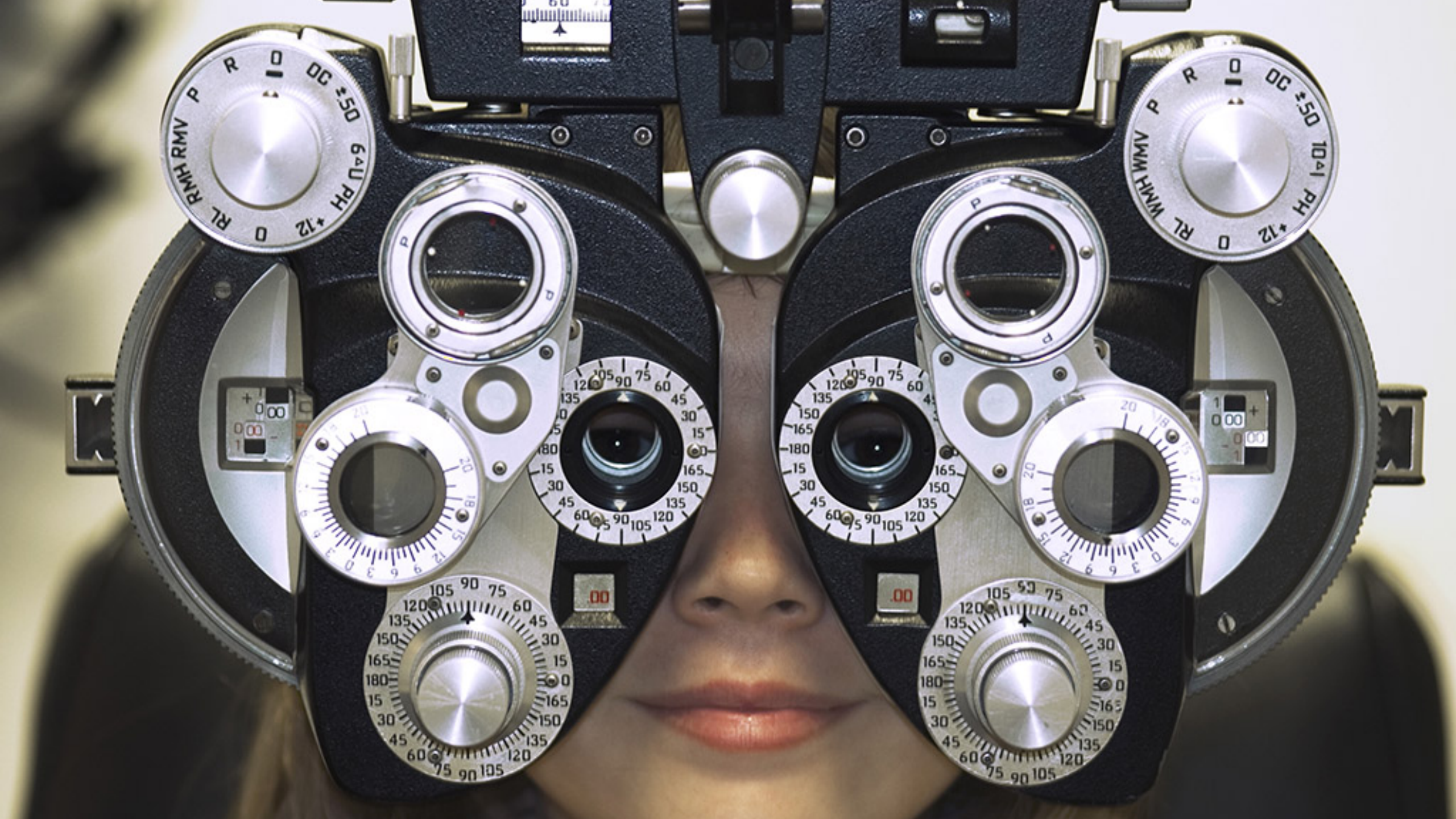
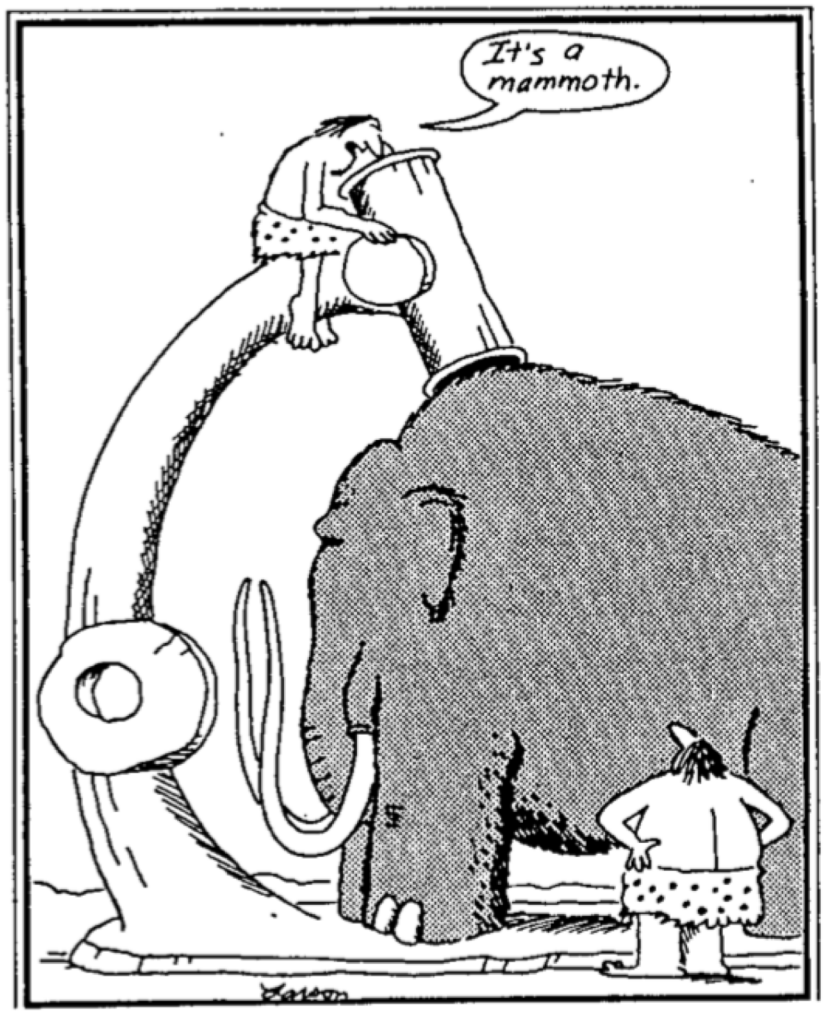




Early microscope

VS





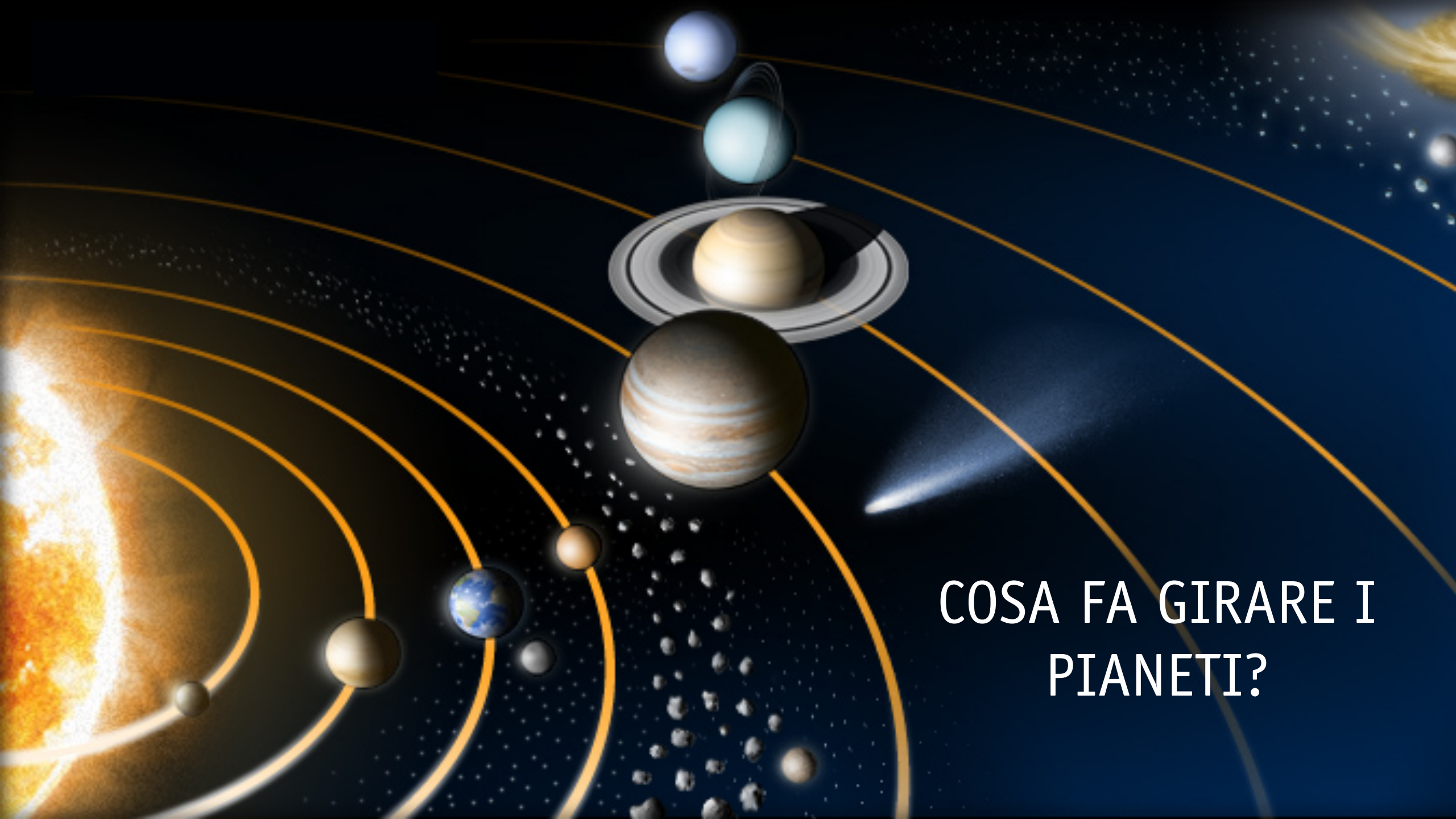

è tutto qui?


è tutto qui?
materia
materia
materia
materia


LUCE = MATERIA
MATERIA = LUCE

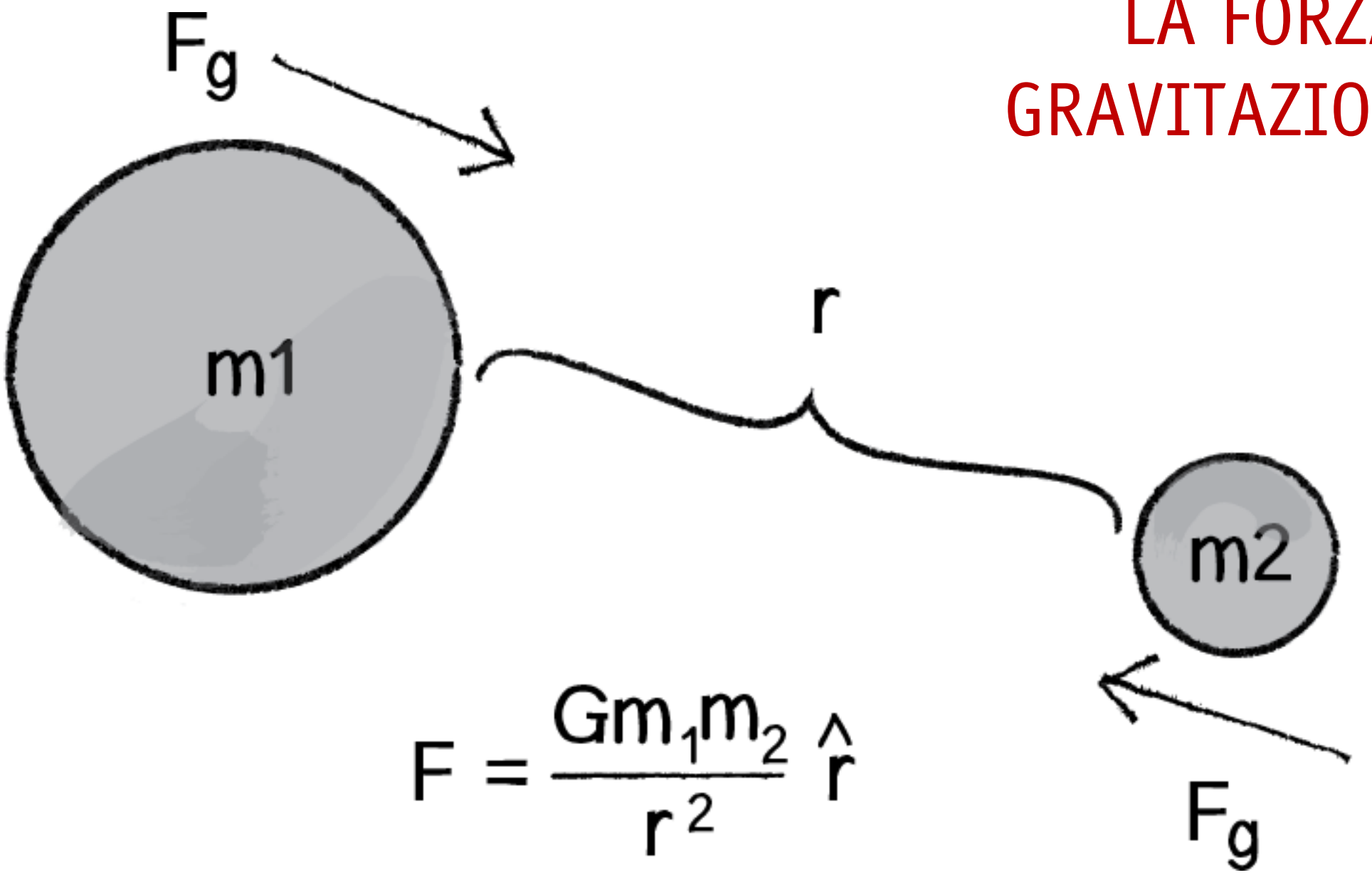






COSA FA GIRARE I PIANETI?

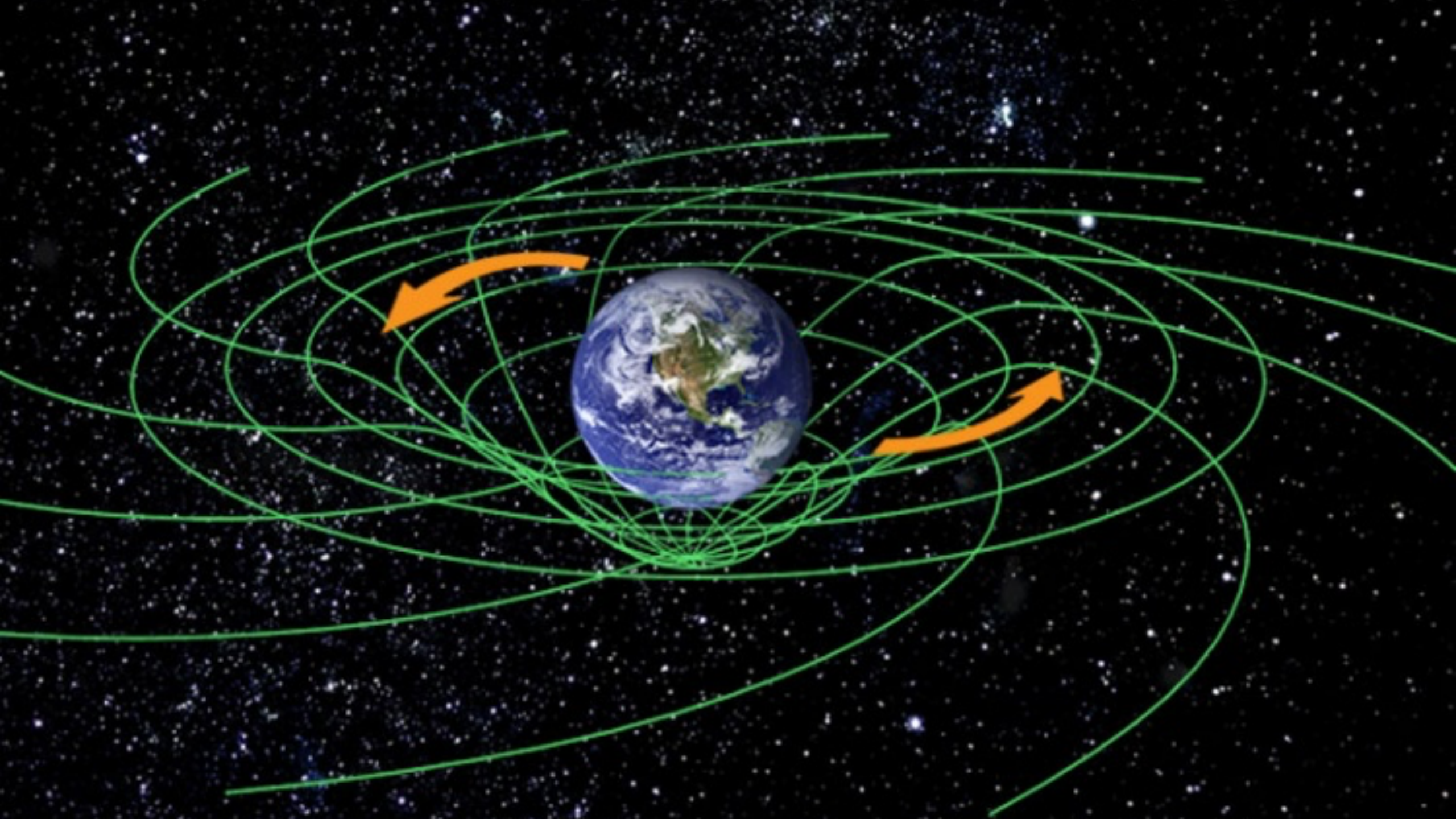
LA FORZA GRAVITAZIONALE

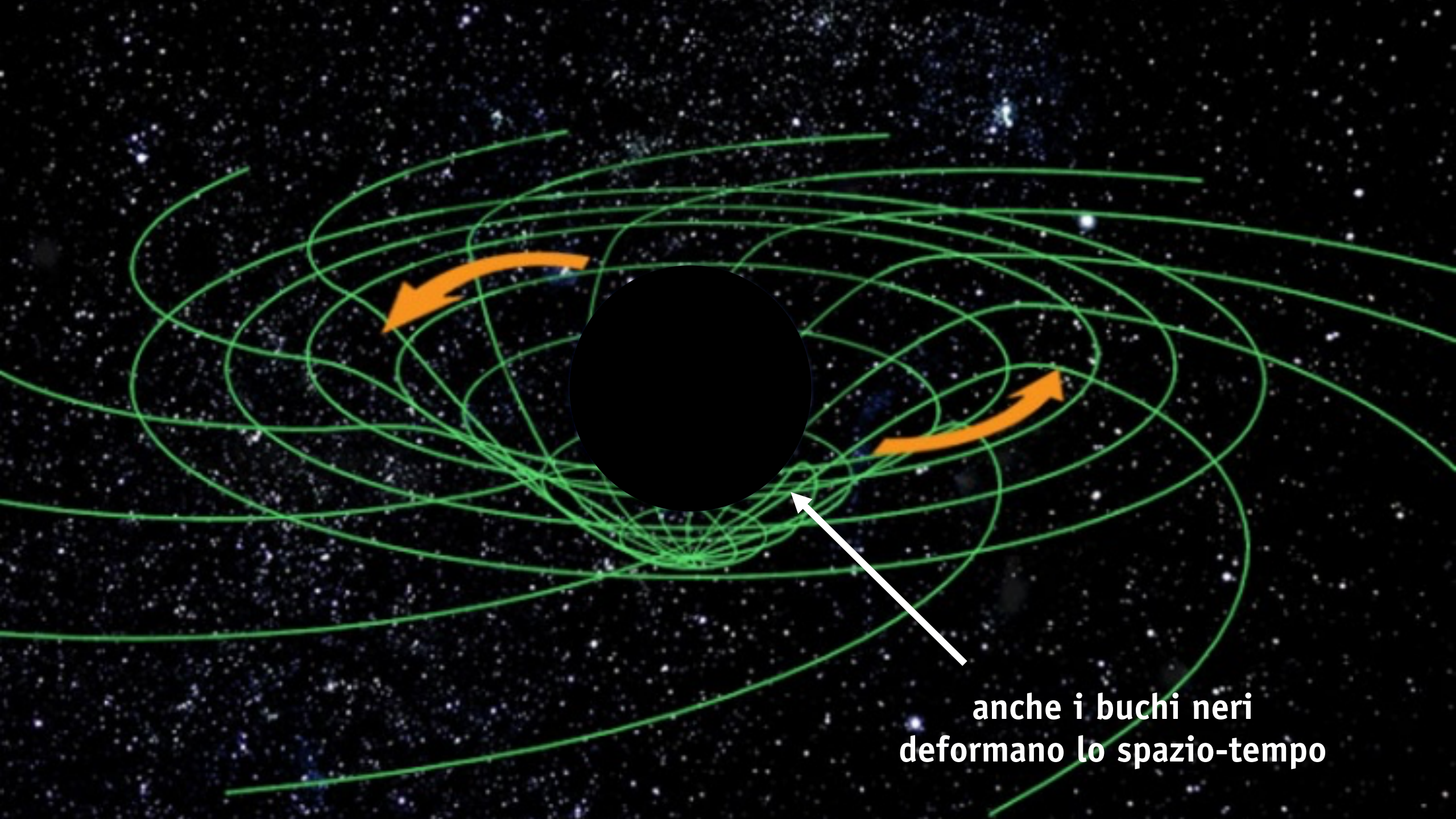


$$F = \frac{Gm_1m_2}{r^2}\hat{r}$$

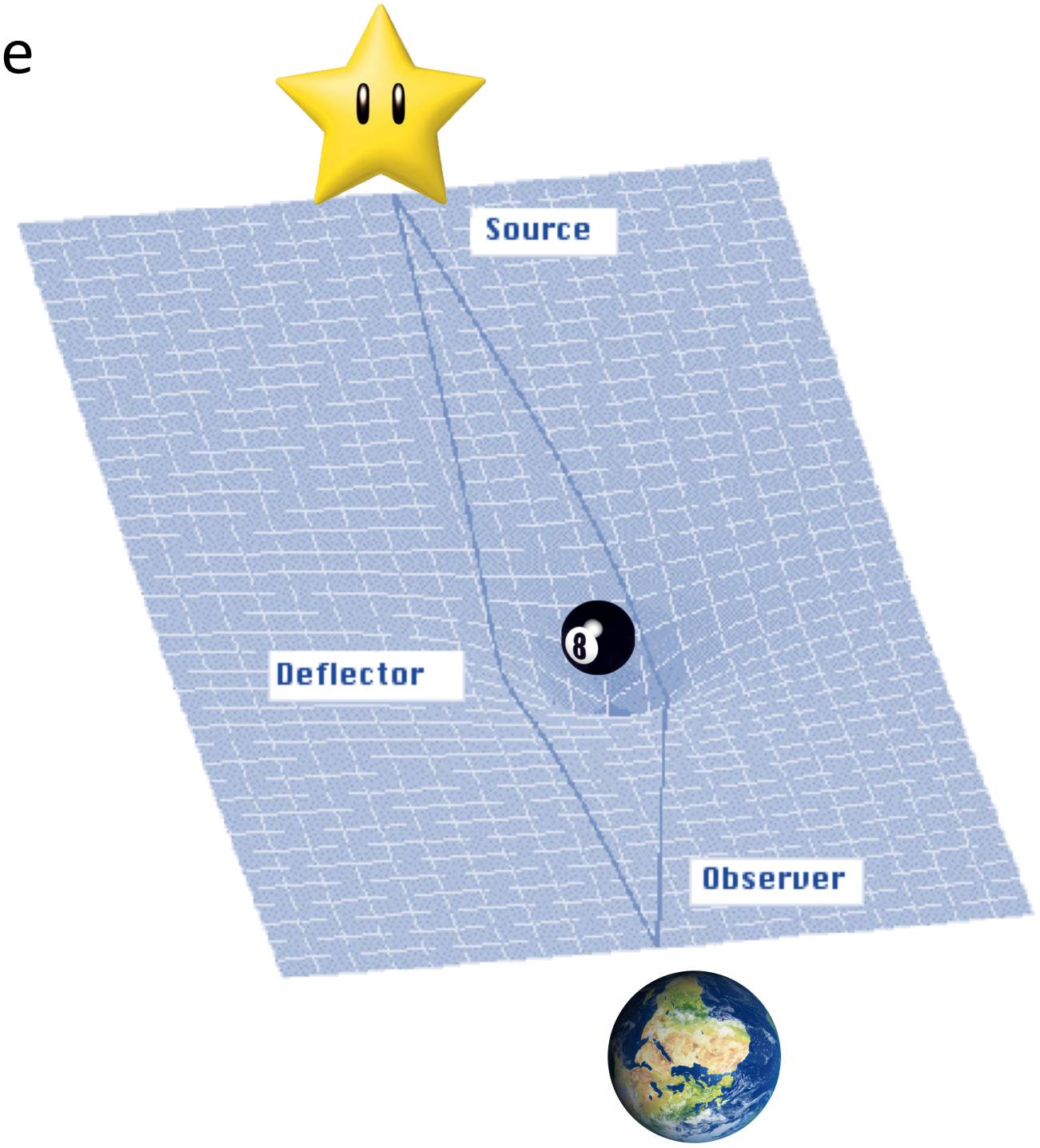
e se guardiamo piú lontano?

Interactive Dark Matter




anche i buchi neri
deformano lo spazio-tempo

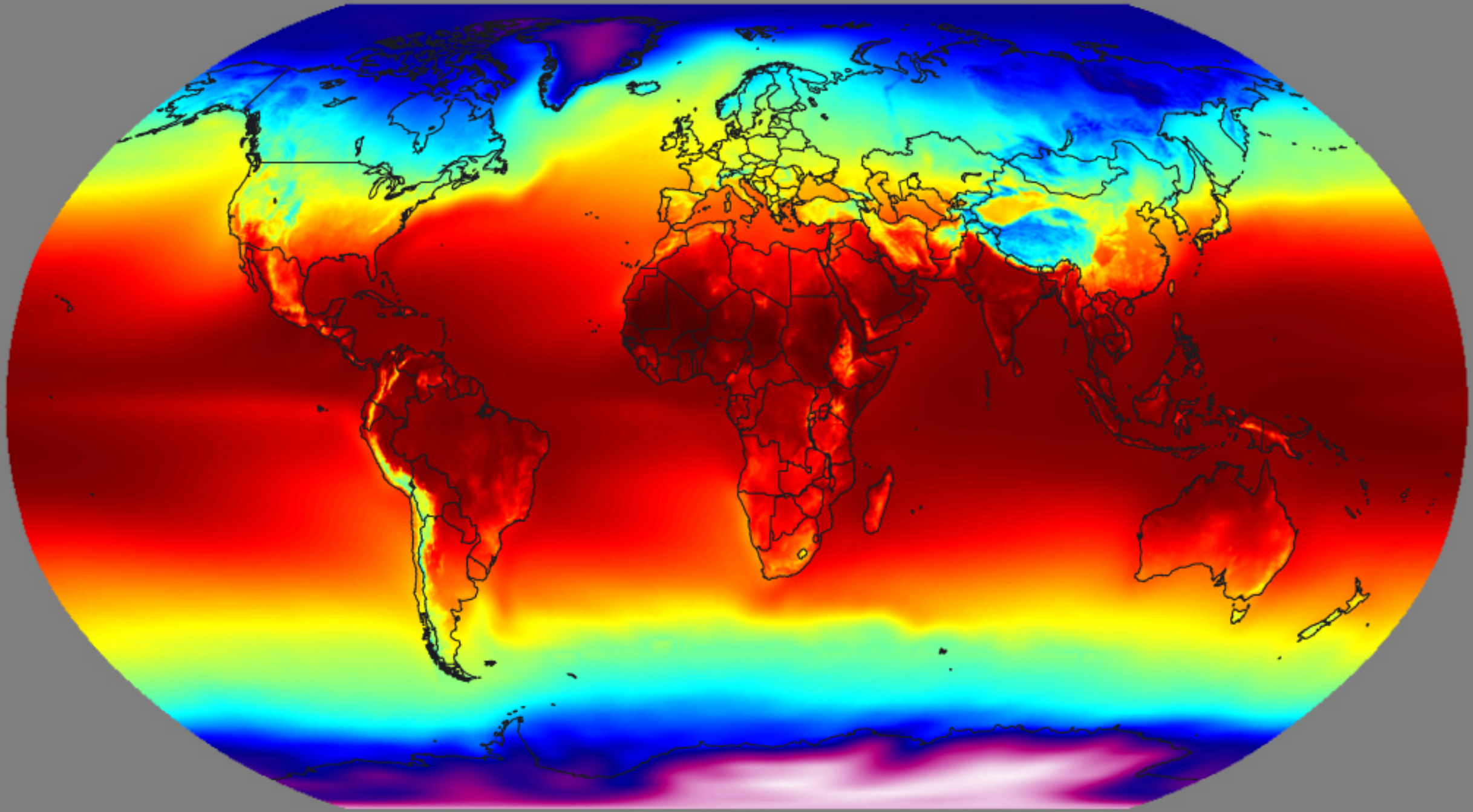
che cosa succede



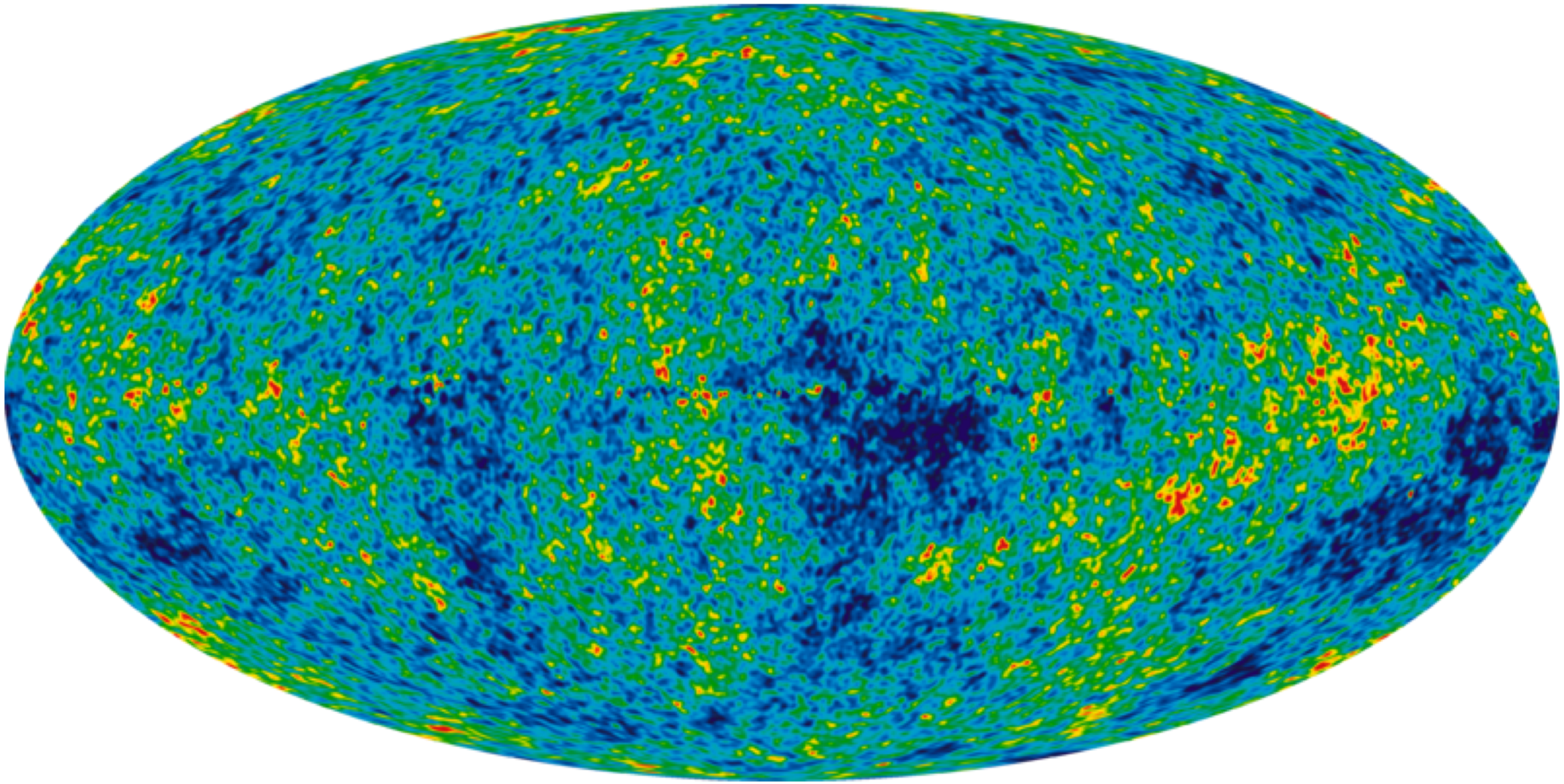
Questa deflessione risente della materia oscura!



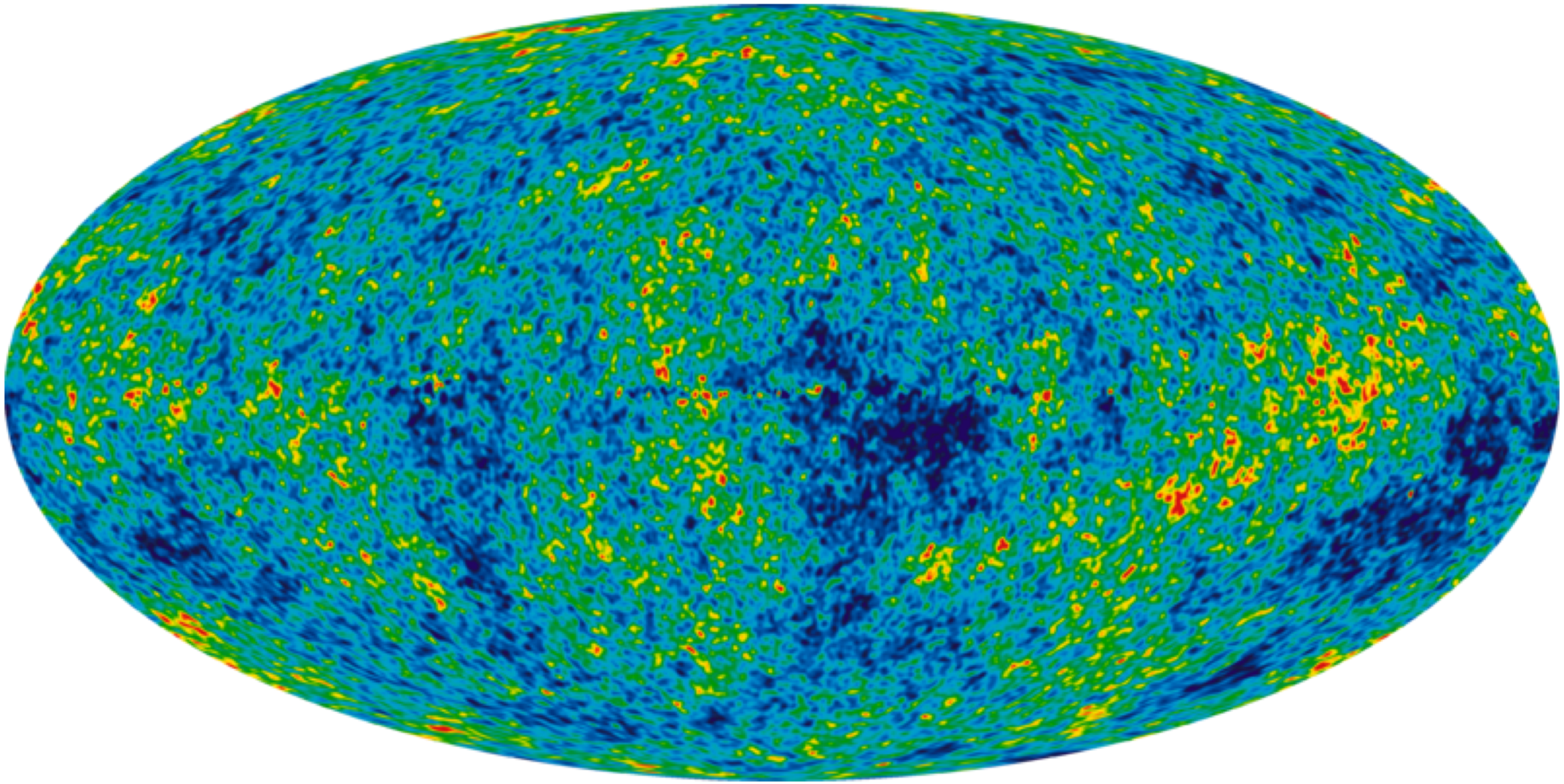
lenti gravitazionali, un’ulteriore prova della materia oscura!



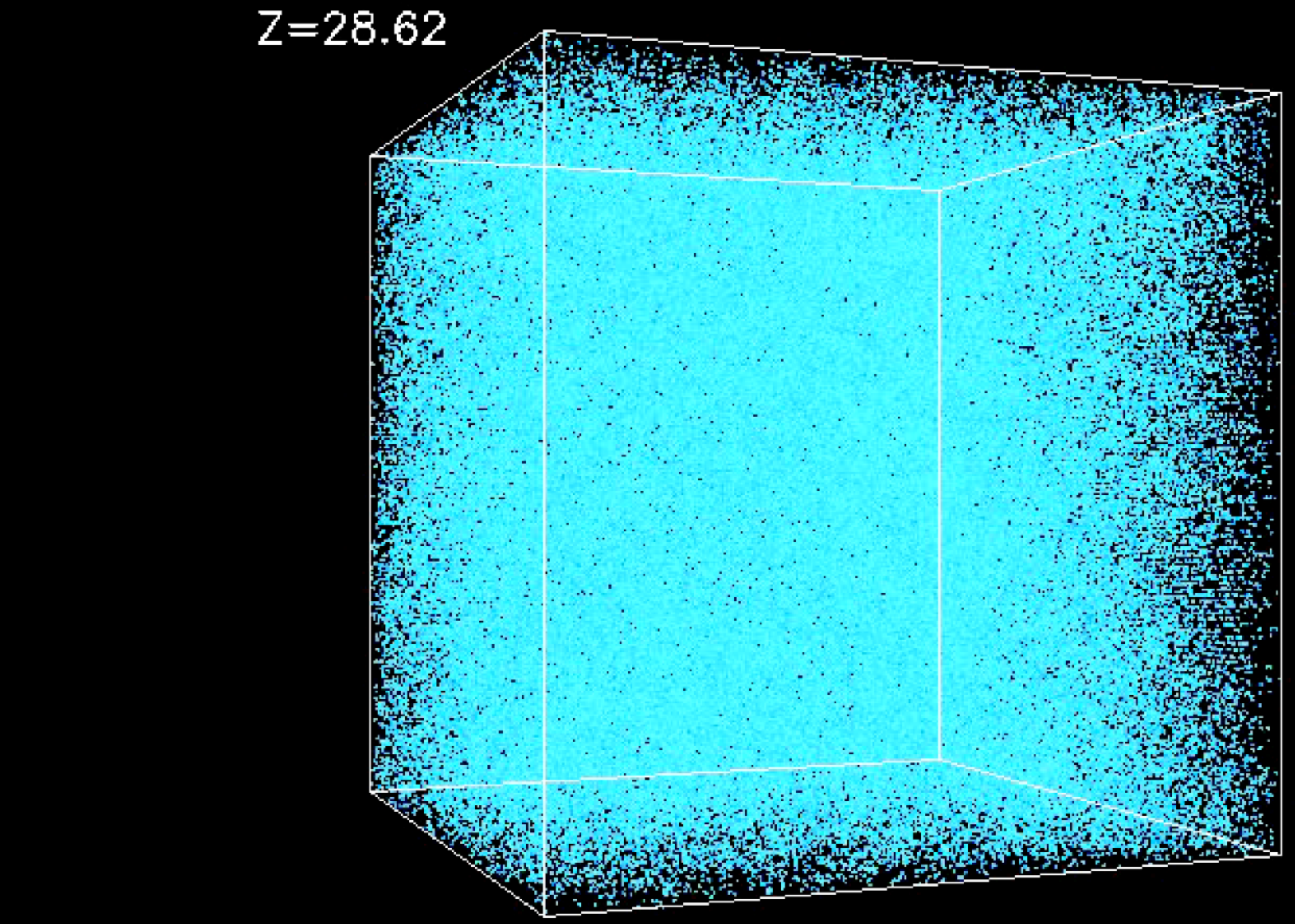
la temperatura dell’universo



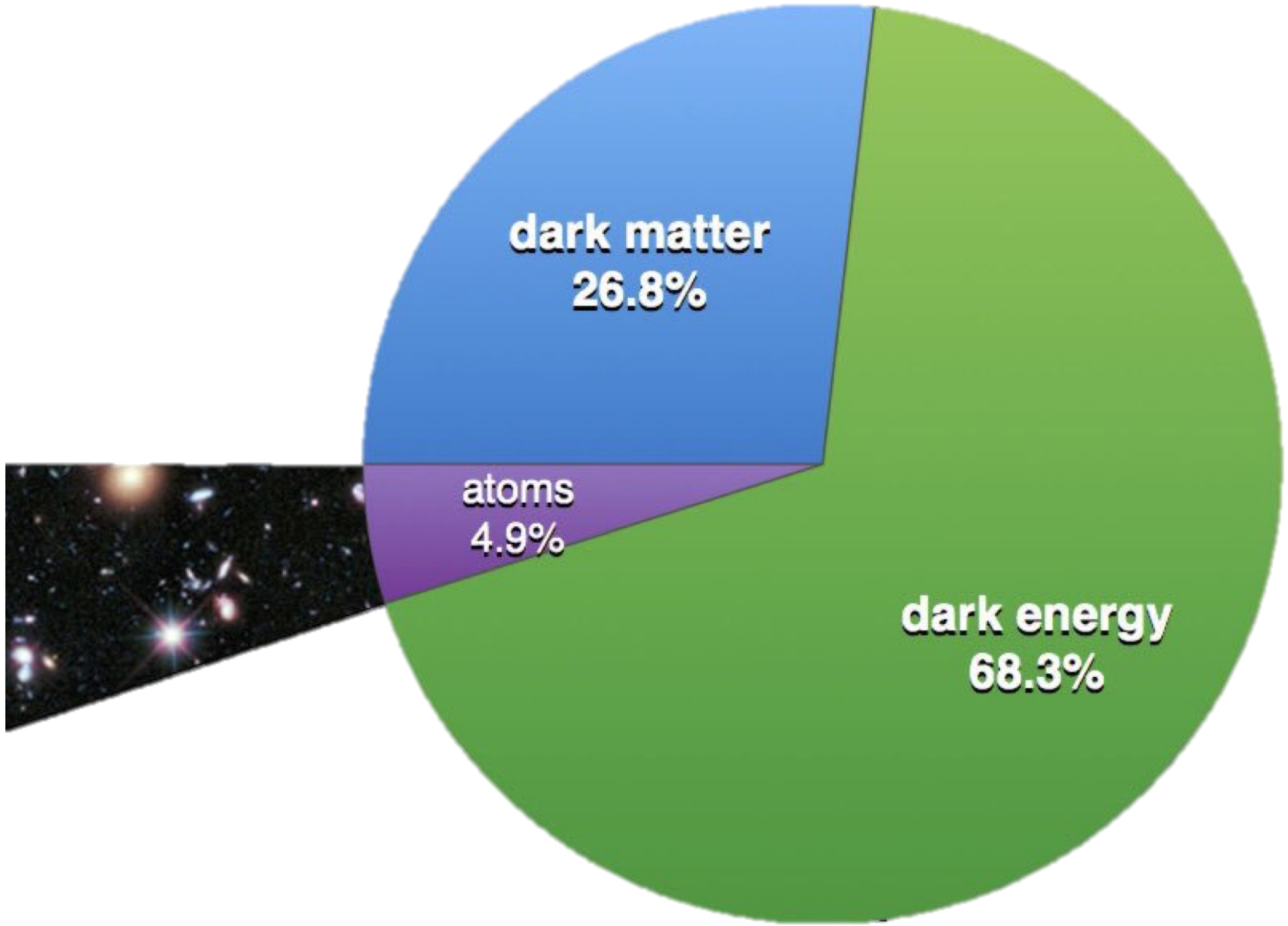
la temperatura dell’universo



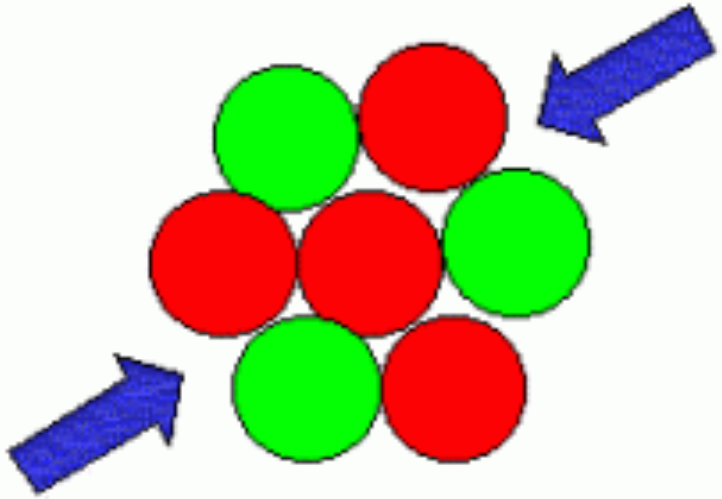
variazioni dello 0.001% dovute alla materia oscura!


Z=28.62

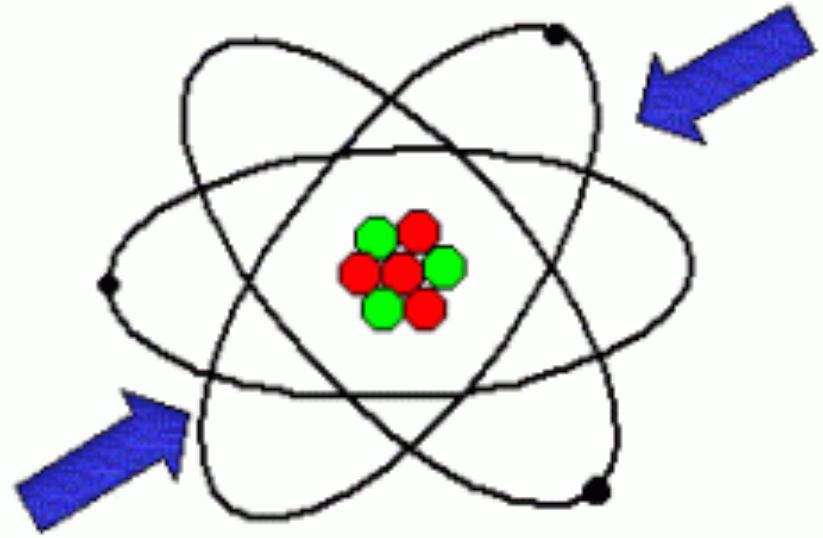
l'universo è quasi invisibile!



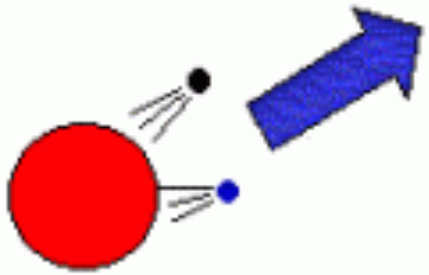

è tanta
è ovunque
ma cos’è?



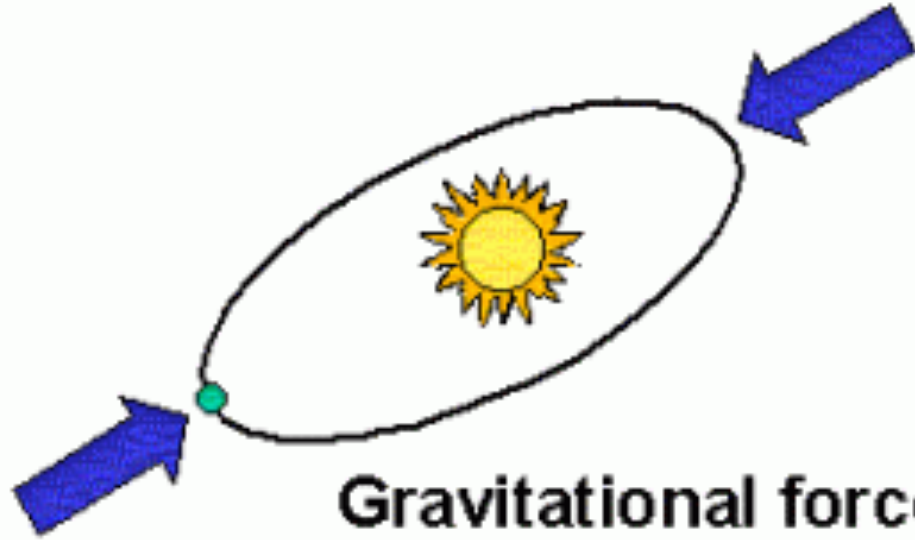
Strong force
binds the nucleus



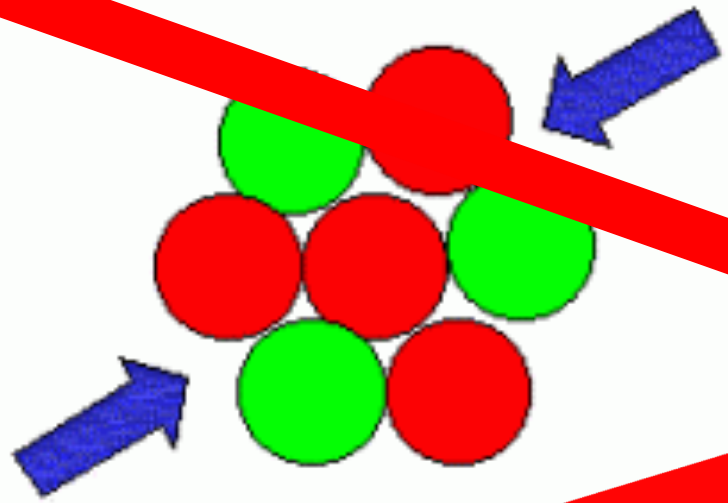
Electromagnetic
force binds atoms



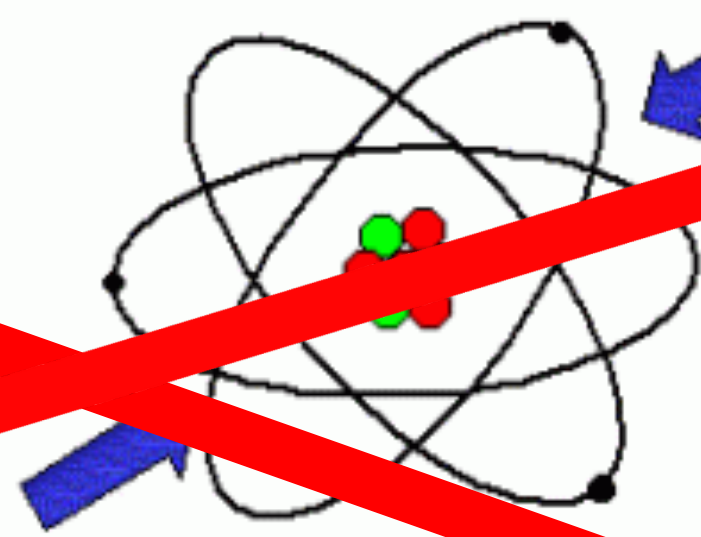
Weak force in
radioactive decay



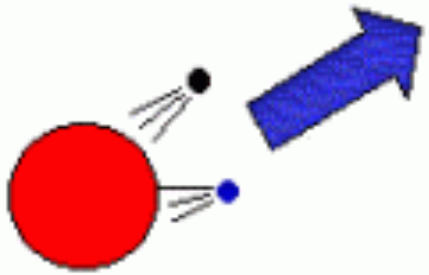
Gravitational force
binds the solar system



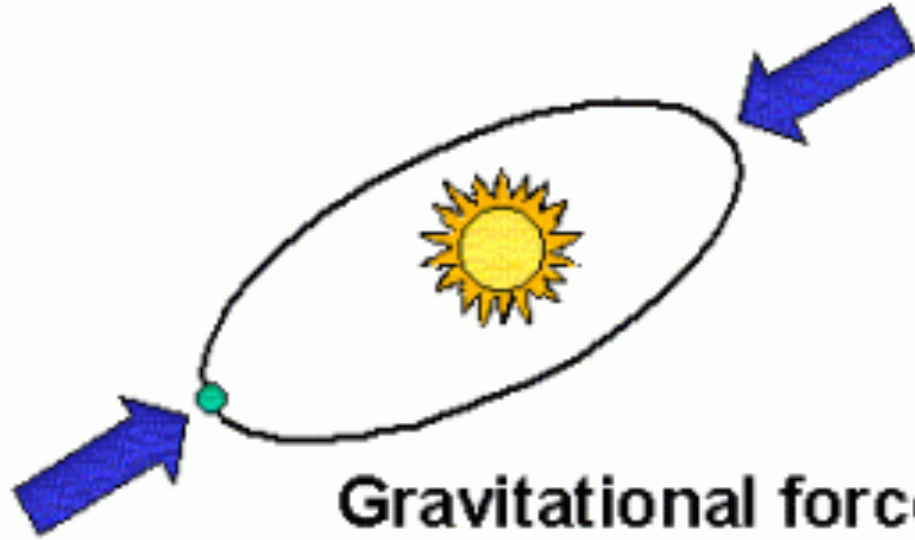
Strong force
binds the nucleus



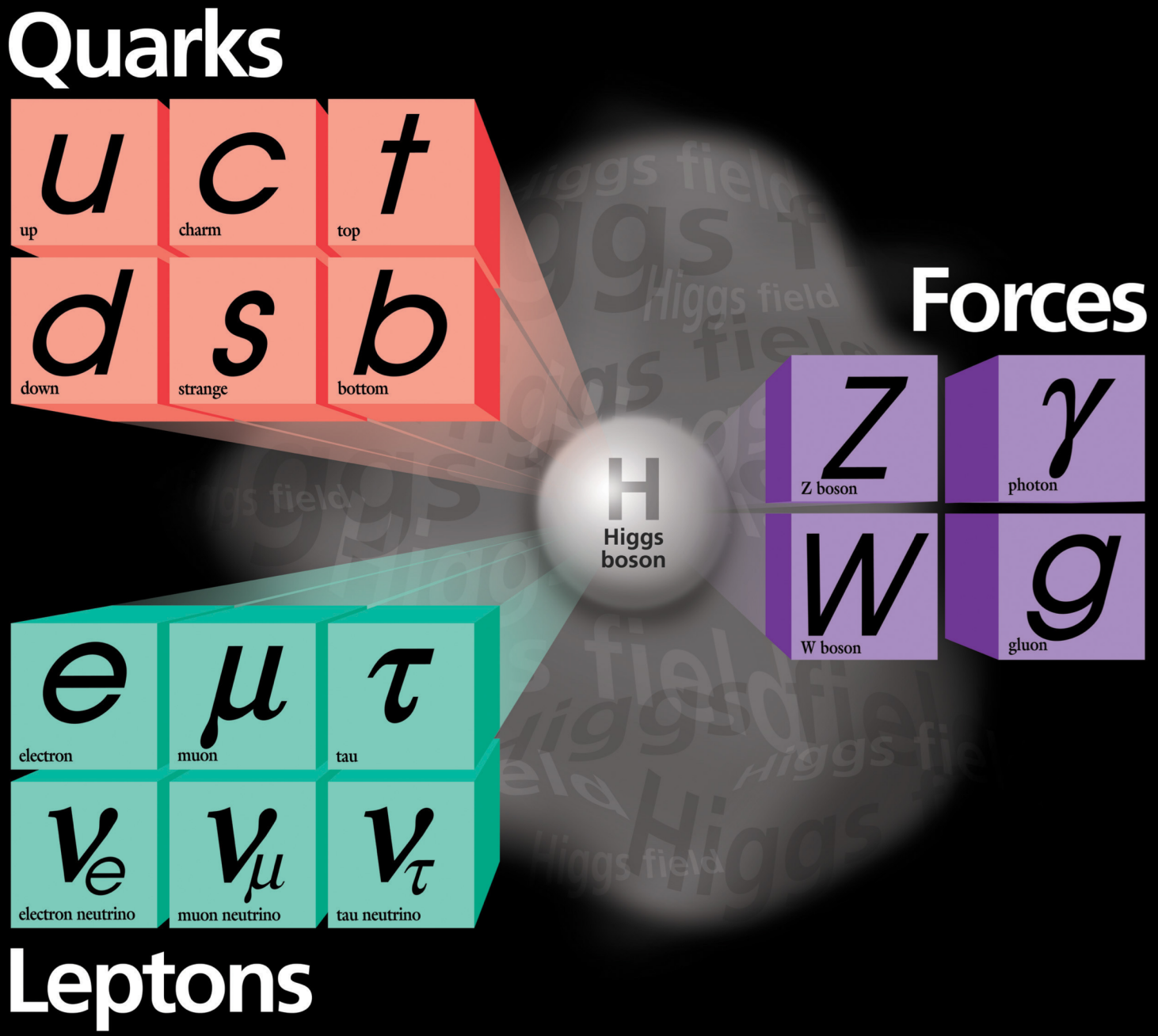
Electromagnetic
force binds atoms

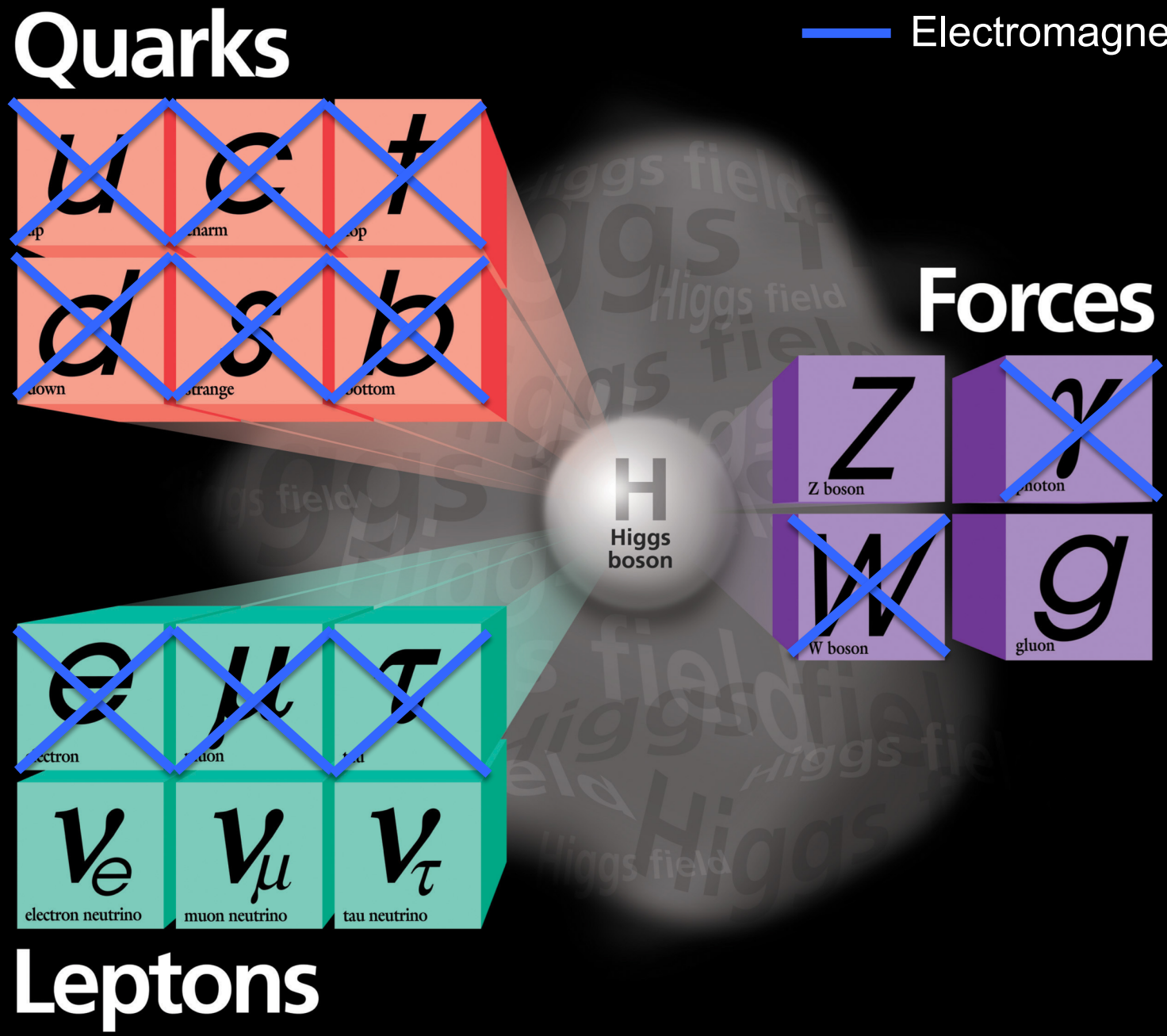


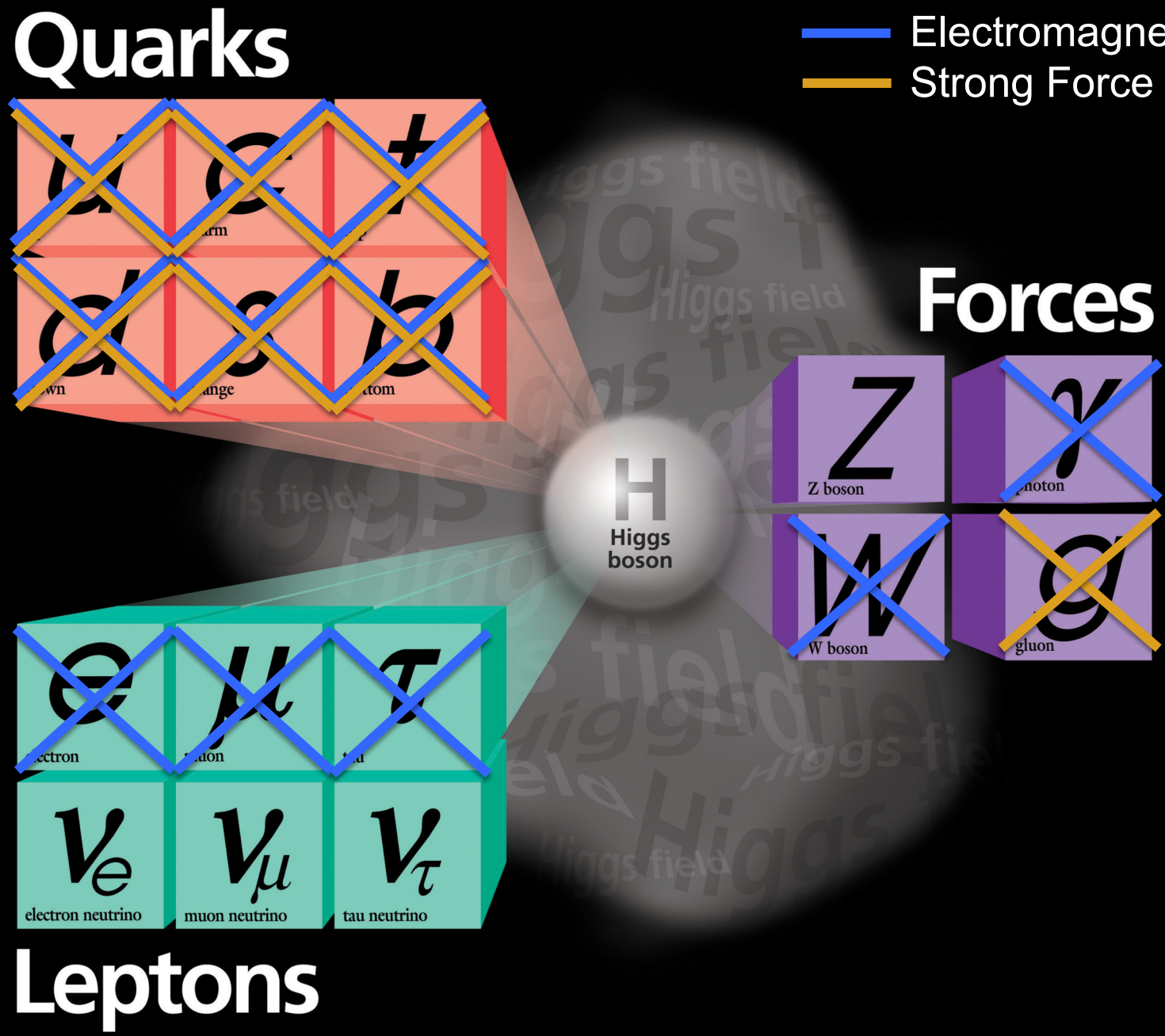
Weak force in
radioactive decay

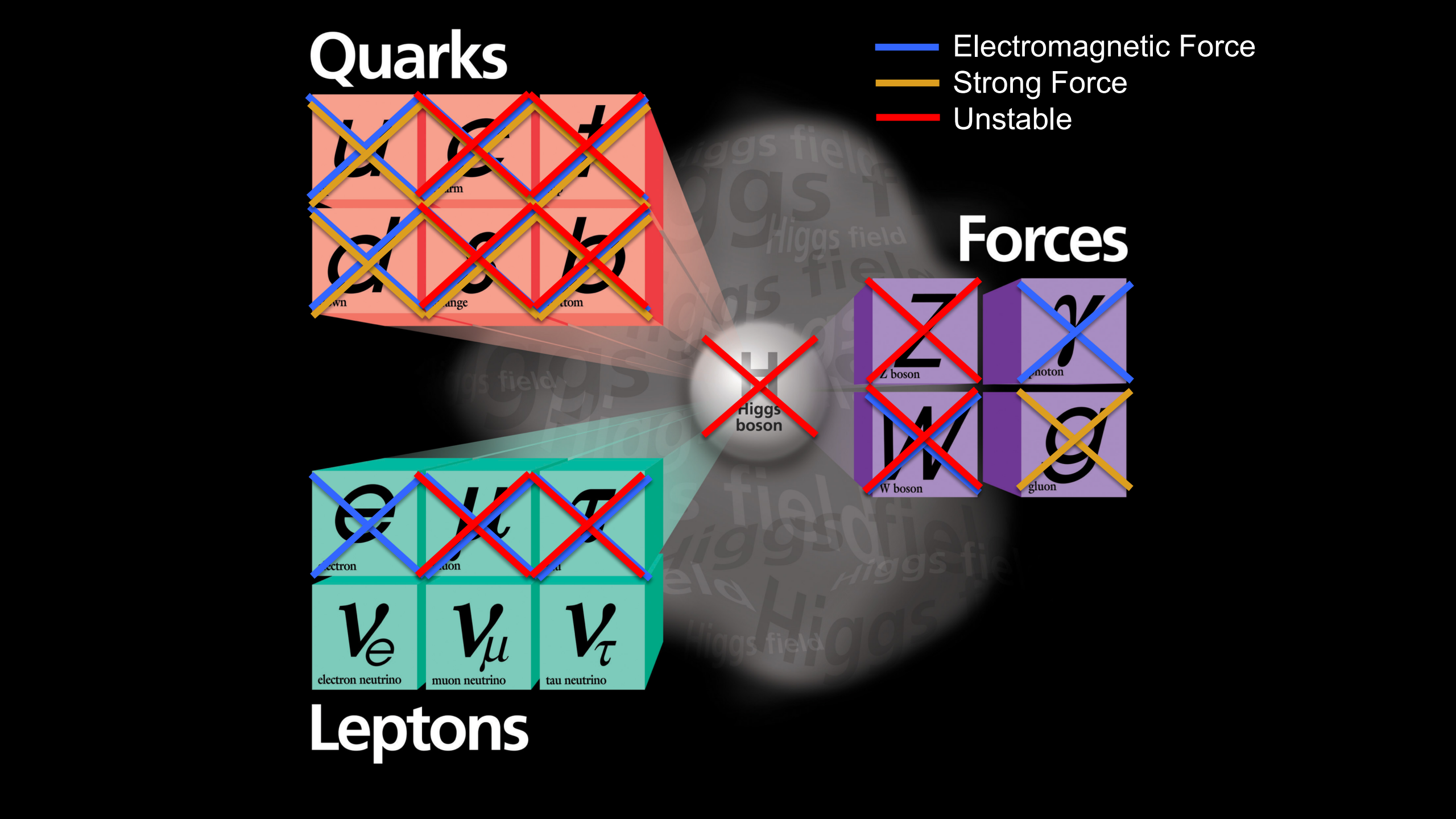


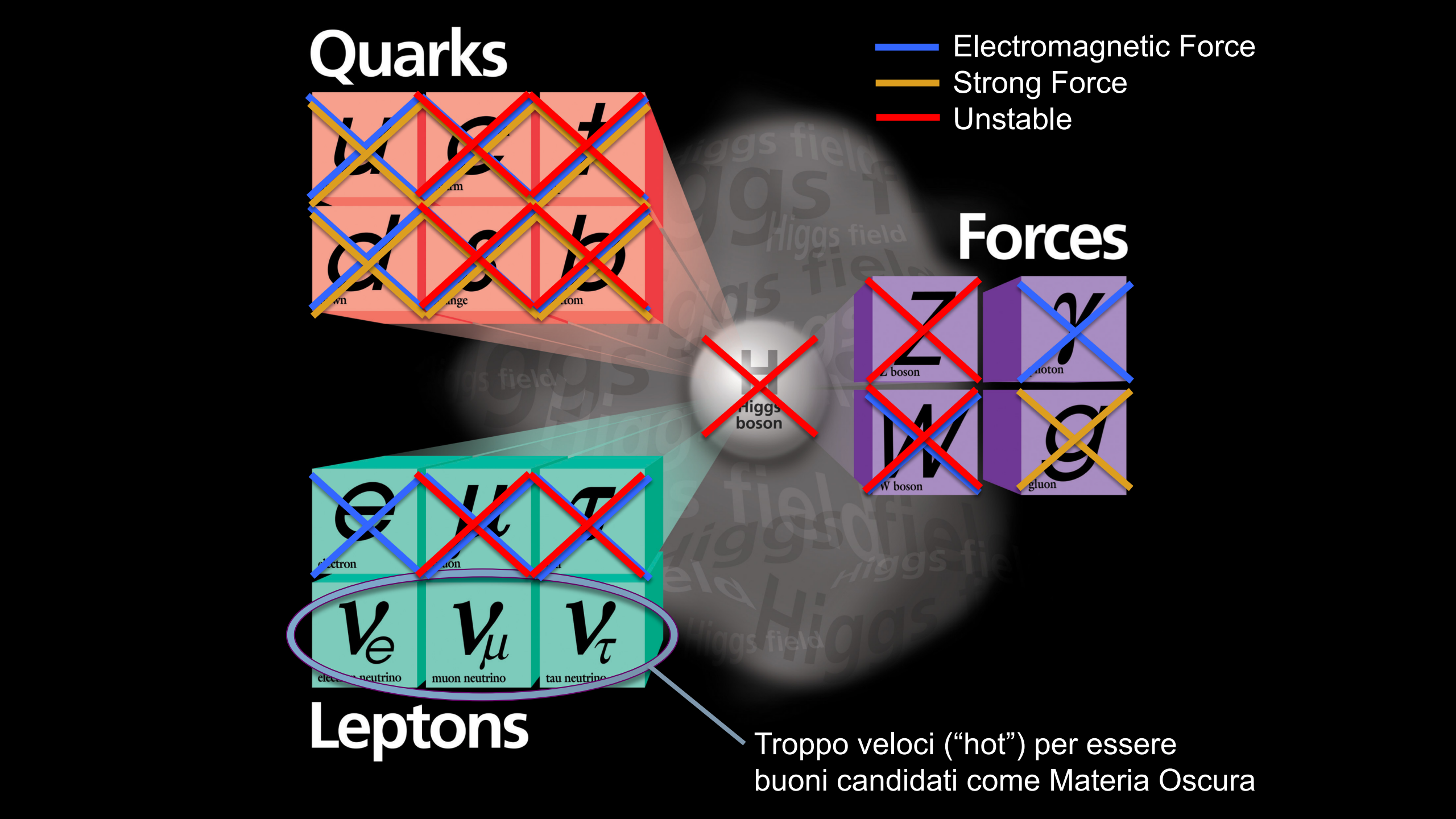
Gravitational force
binds the solar system

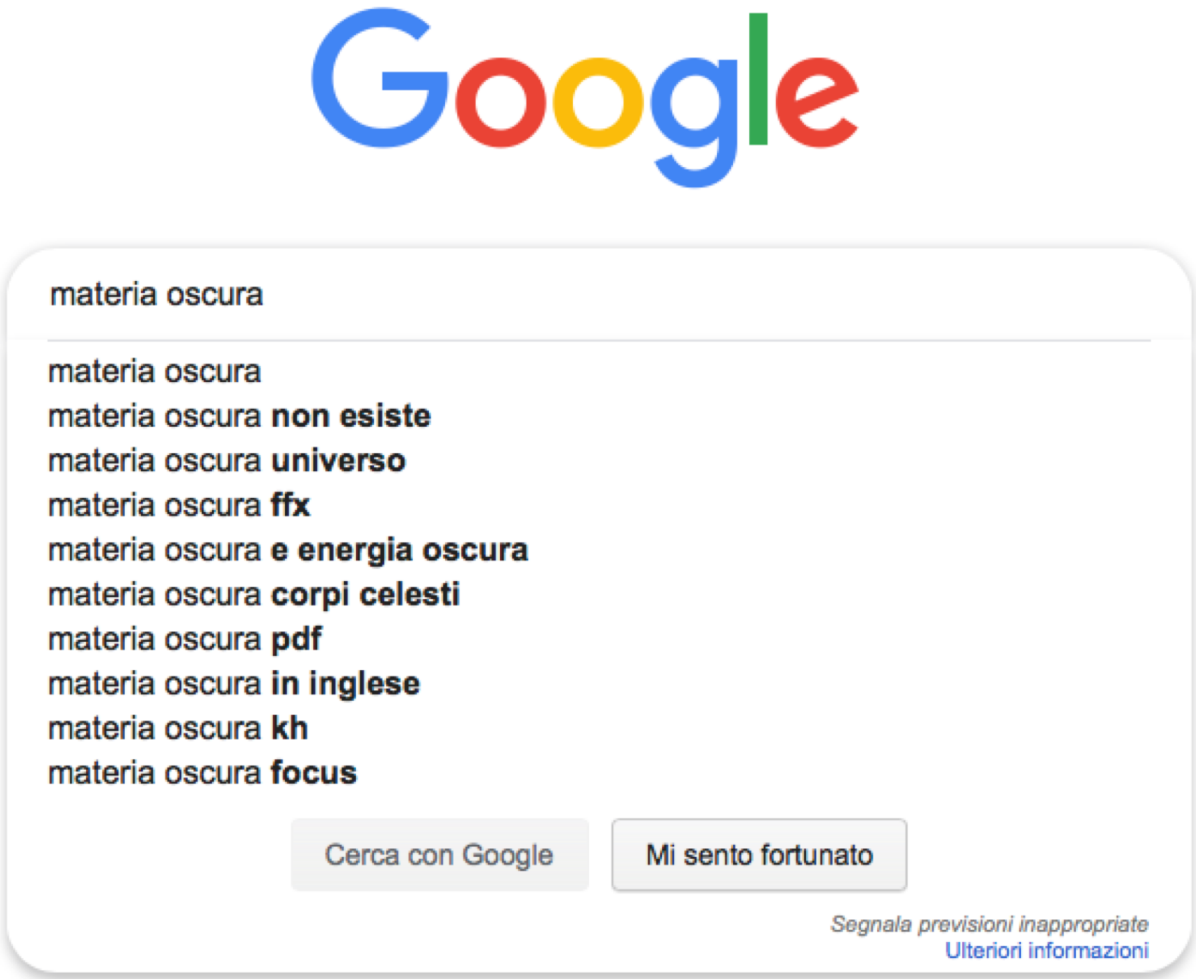

Quarks
u
up
c
charm
t
top
d
down
s
strange
b
bottom
Forces
Z
Z boson
γ
photon
W
W boson
g
gluon
H
Higgs boson
e
electron
μ
muon
τ
tau
νe
electron neutrino
νμ
muon neutrino
ντ
tau neutrino
Leptons
Higgs field


Quarks
Electromagnetic Force
Forces
Higgs boson
Z boson
photon
W boson
gluon
electron neutrino
muon neutrino
tau neutrino
Leptons


Quarks
Electromagnetic Force
Strong Force
Forces
H
Higgs boson
Z boson
W boson
gluon
electron neutrino
muon neutrino
tau neutrino
Leptons


Quarks
Electromagnetic Force
Strong Force
Unstable
Forces
Higgs boson
Z boson
photon
W boson
gluon
electron neutrino
muon neutrino
tau neutrino
Leptons

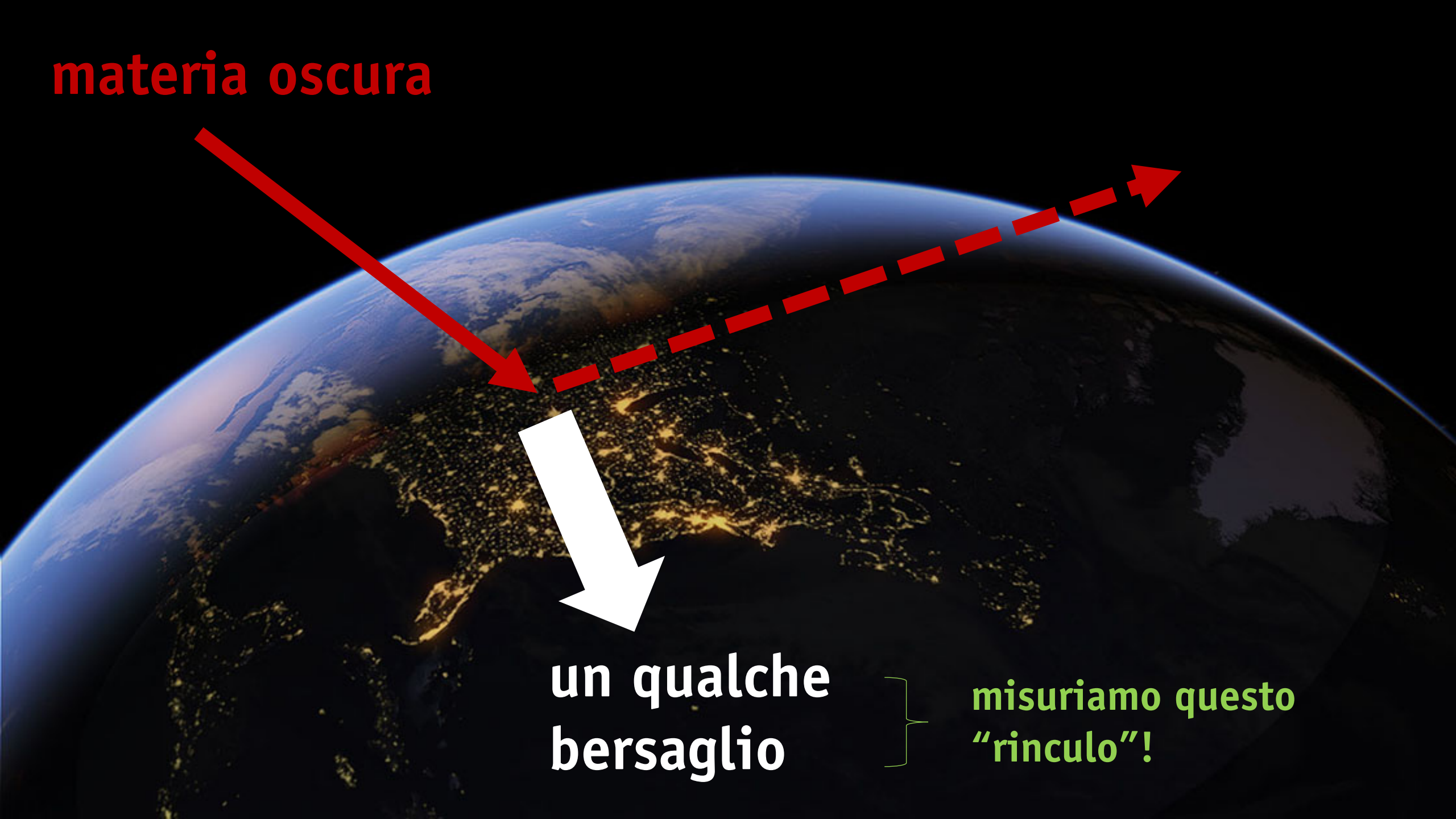

Quarks
Electromagnetic Force
Strong Force
Unstable
Forces
Higgs boson
muon neutrino
tau neutrino
Leptons
Troppo veloci (“hot”) per essere
buoni candidati come Materia Oscura



di certo non con Google!

il vento di materia oscura




materia oscura
un qualche bersaglio
misuriamo questo “rinculo”!

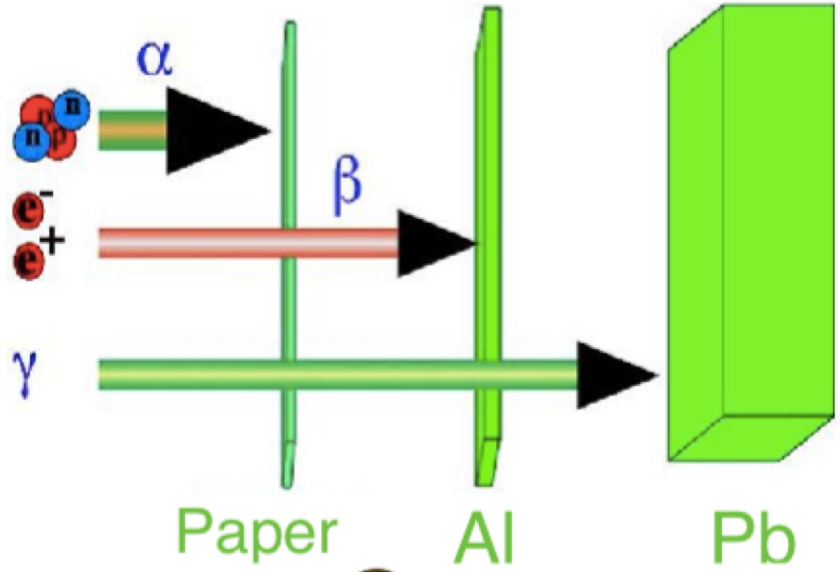

rivelatore
(bersaglio che rincula)
vento di materia oscura
materia oscura


rivelatore
(bersaglio che rincula)
vento di materia oscura
materia oscura

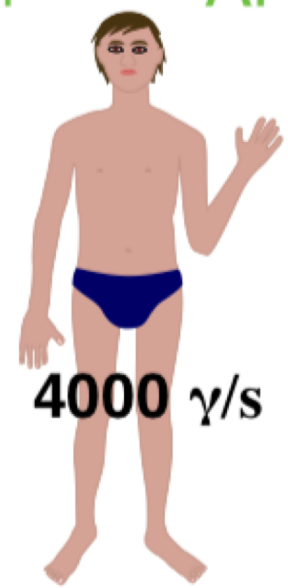

ma il cosmo è
un biliardo
pieno di
particelle!

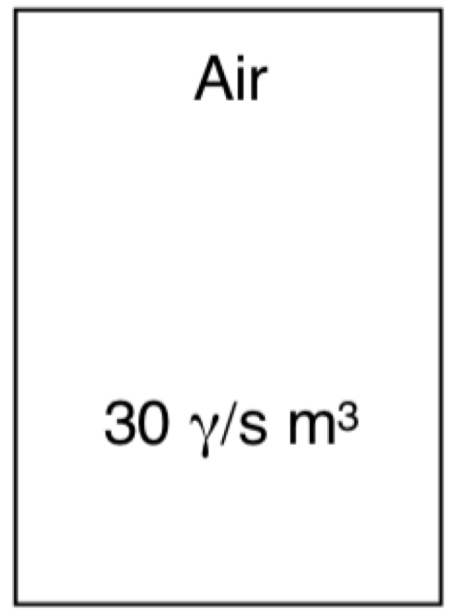

Esperimento DarkSide-50, 1600 m sotto la montagna
Laboratori Nazionali INFN del Gran Sasso

RADIOACTIVITY CONTROL



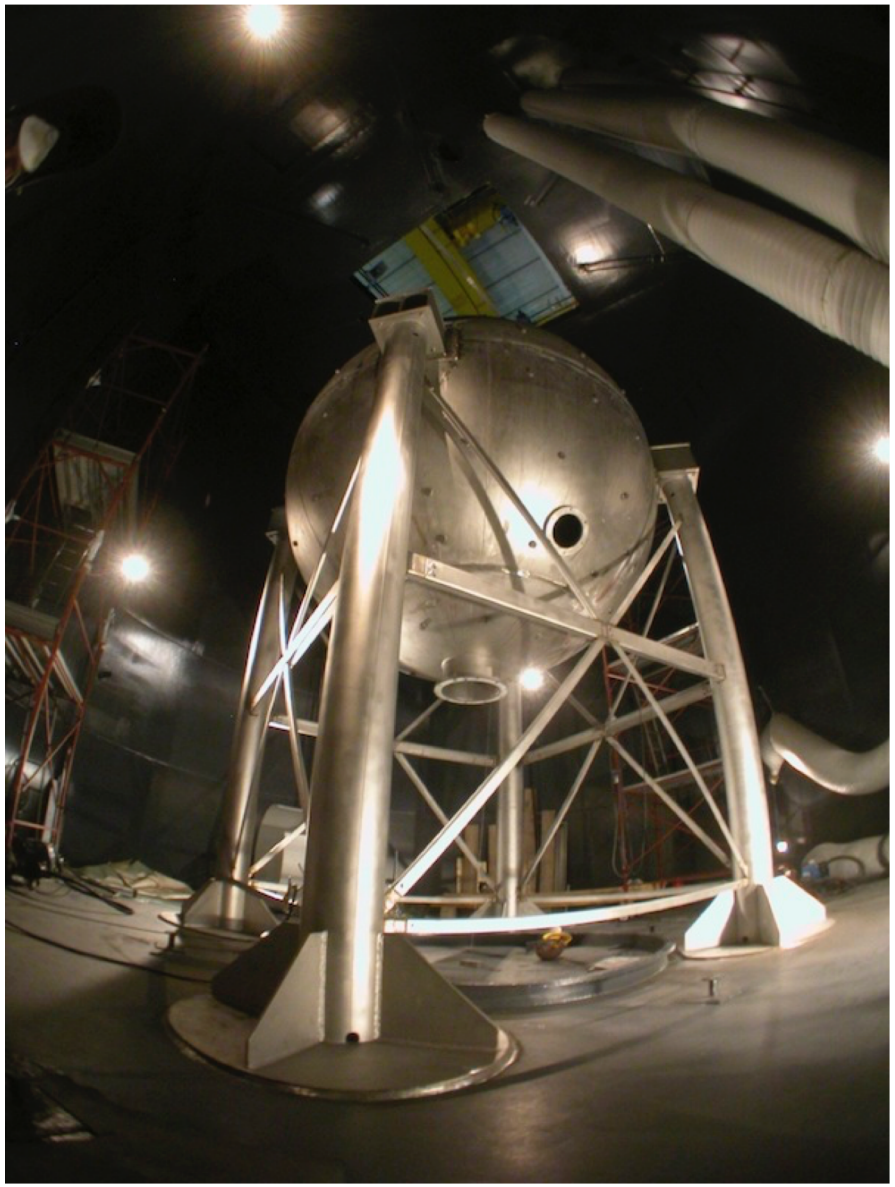


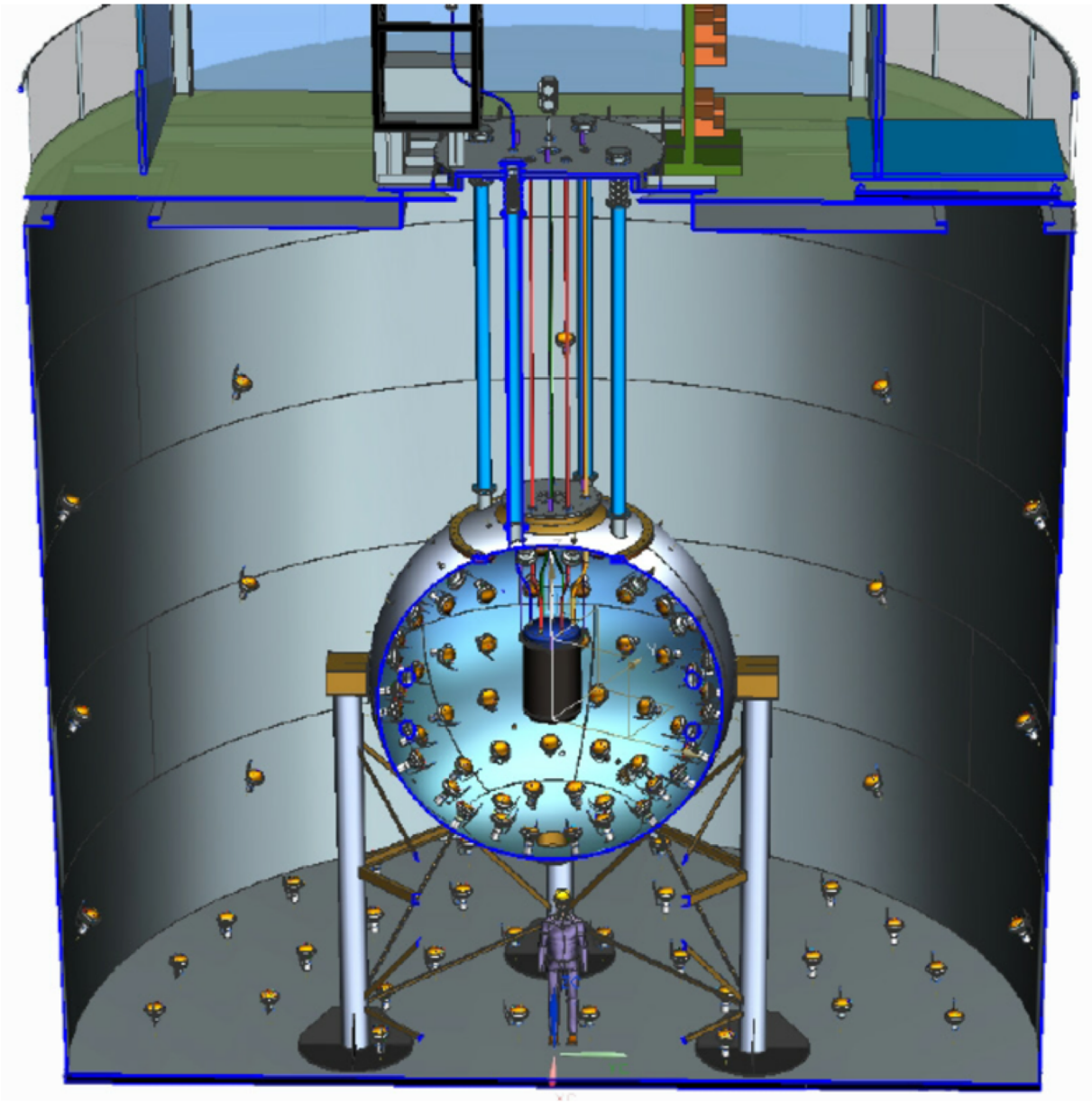


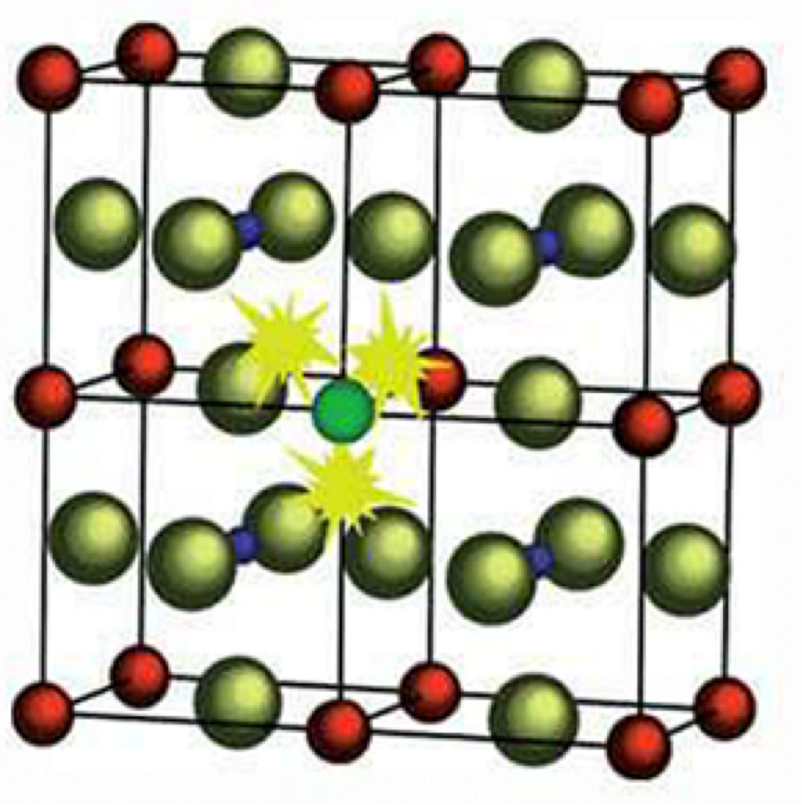


Radiopure materiale in radiopure environments

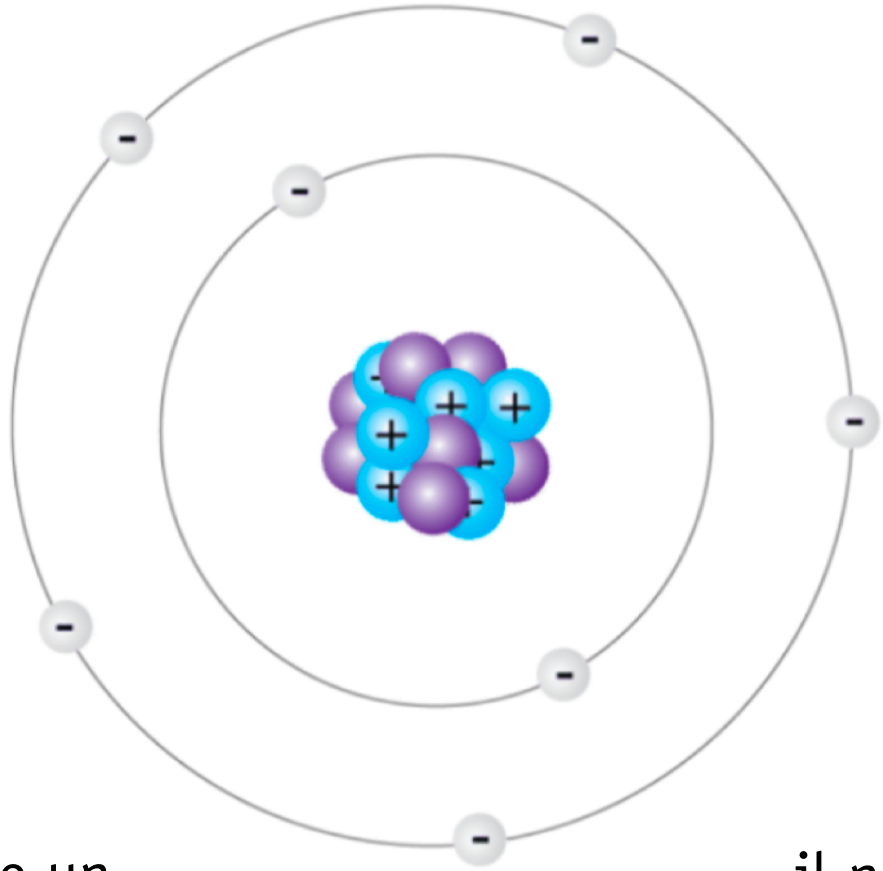
DarkSide-50







- la materia oscura “impatta” un nucleo di un atomo del rivelatore
- è un fenomeno raro, servono rivelatori grandi (1 volta per anno per un rivelatore di 10 kg!)
- come riveliamo il rinculo del nucleo?



IONIZZAZIONE

il nucleo che rincula rimuove un elettrone dagli orbitali degli altri atomi

“accelero” questi elettroni e misuro una corrente

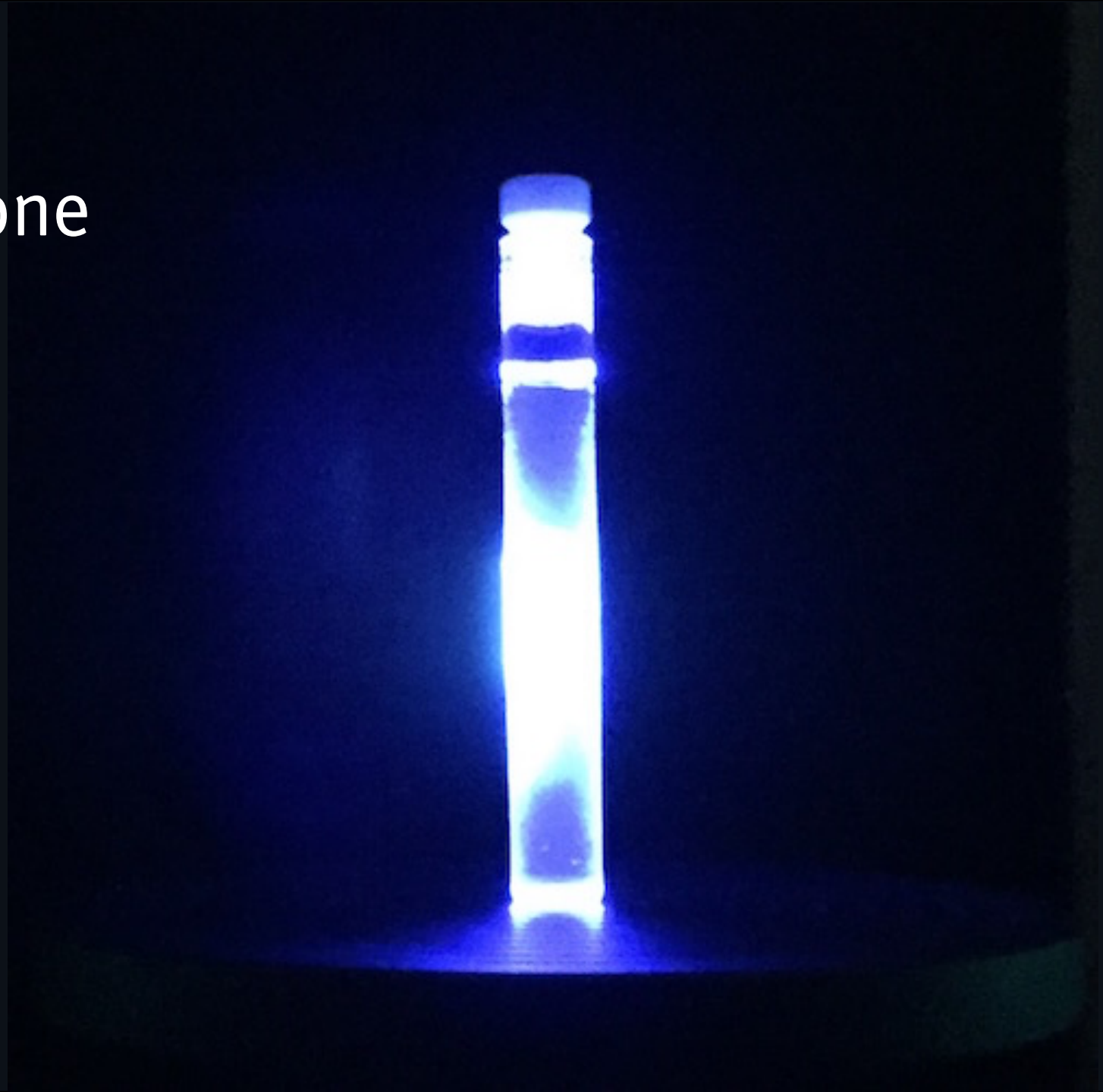
SCINTILLAZIONE

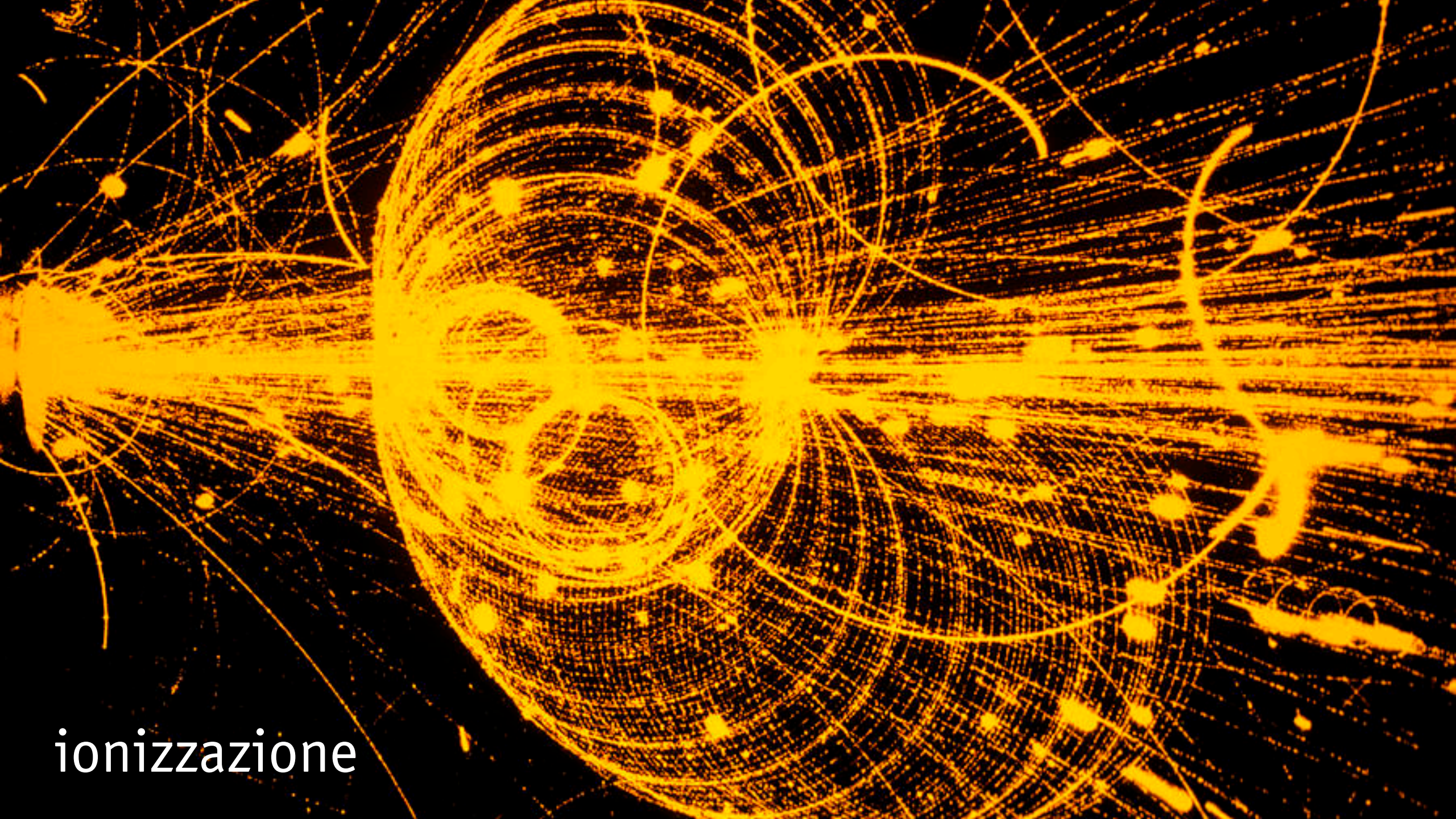
il nucleo che rincula eccita uno dei nuclei degli altri atomi, che si diseccita emettendo luce

misuro un segnale luminoso

(a grandi linee)

luce di scintillazione



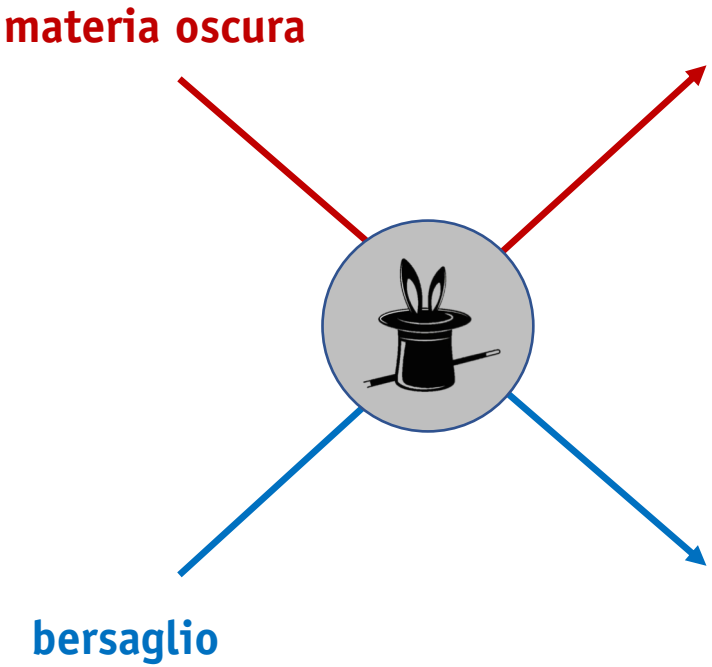


ionizzazione

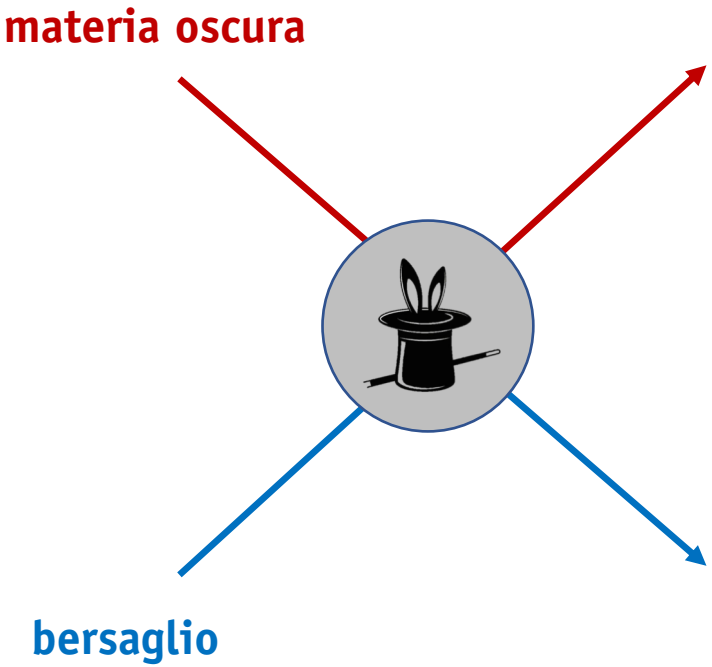

tutto questo in rivelatori giganteschi!

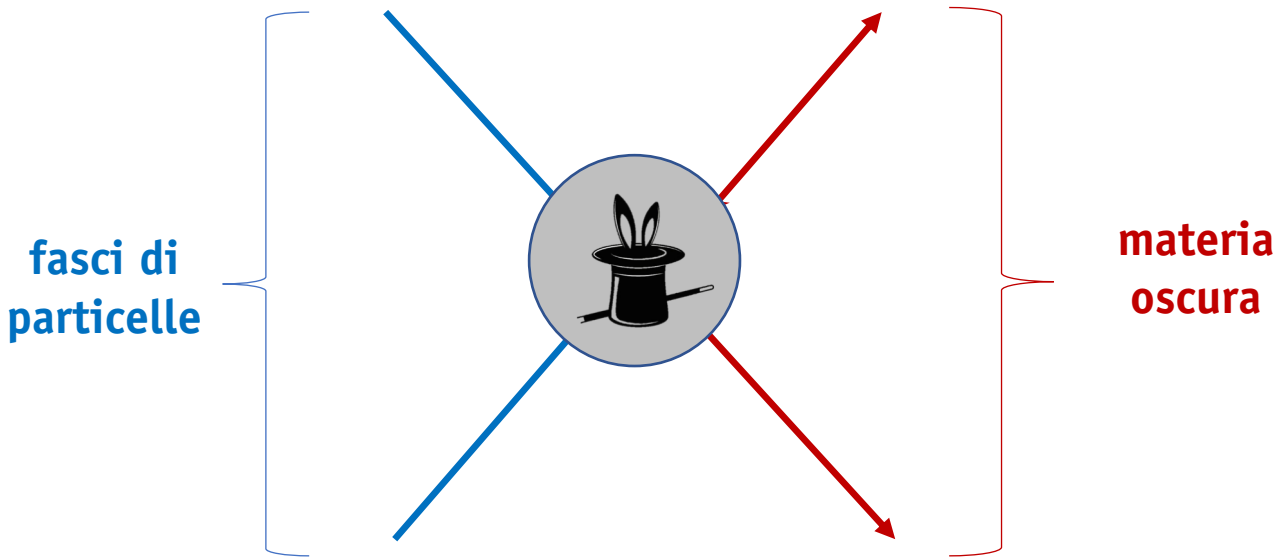
e se la vedessimo in un altro modo?

invece di rivelarla...



invece di rivelarla...



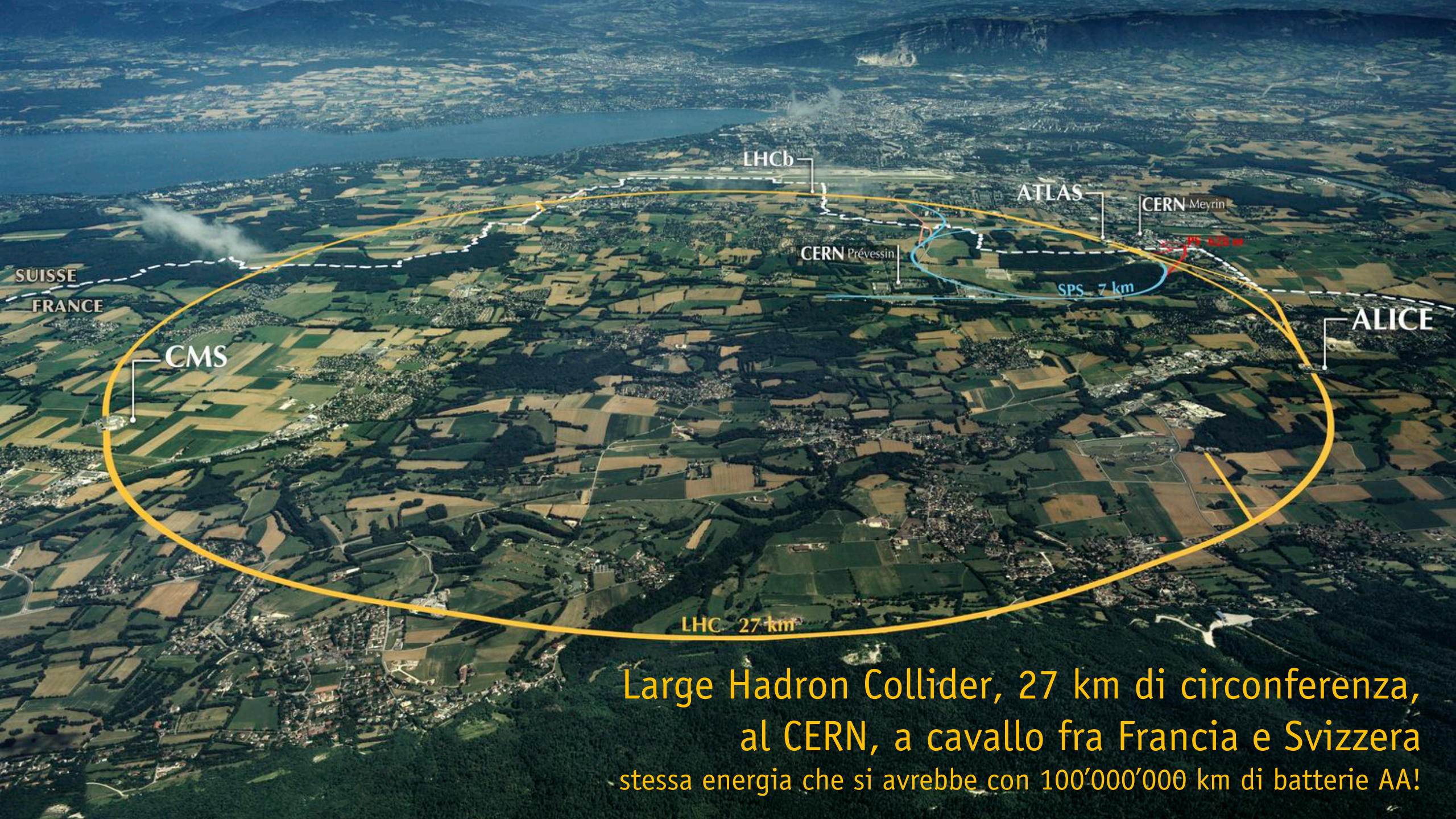


... la creiamo!

(o almeno ci proviamo ;))

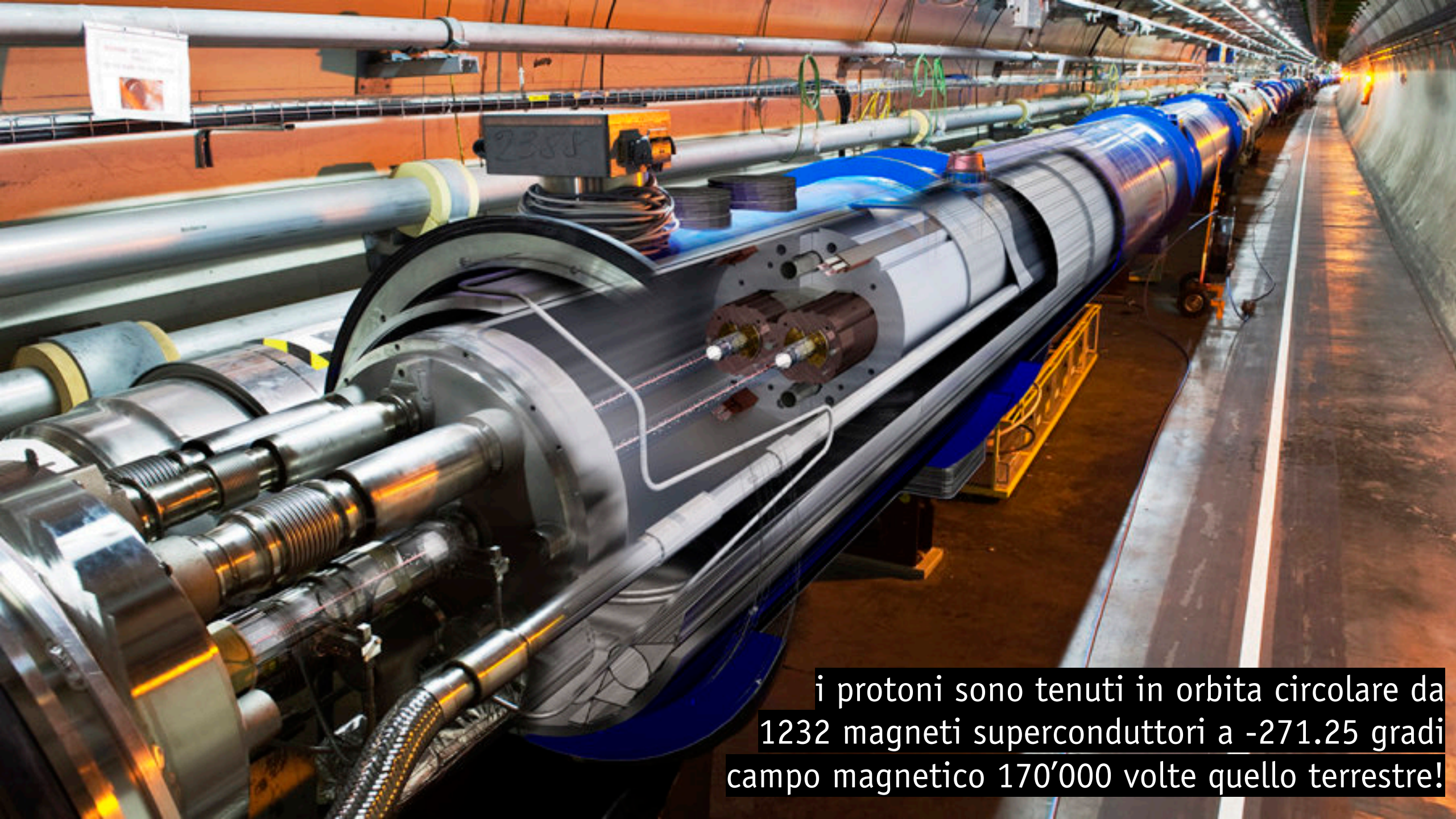
- prendiamo dei **protoni** (una bottiglia di idrogeno basta per alcuni anni!)
- li acceleriamo a **99.999999896%** della velocità della luce
- li facciamo **scontrare** e vediamo cosa succede





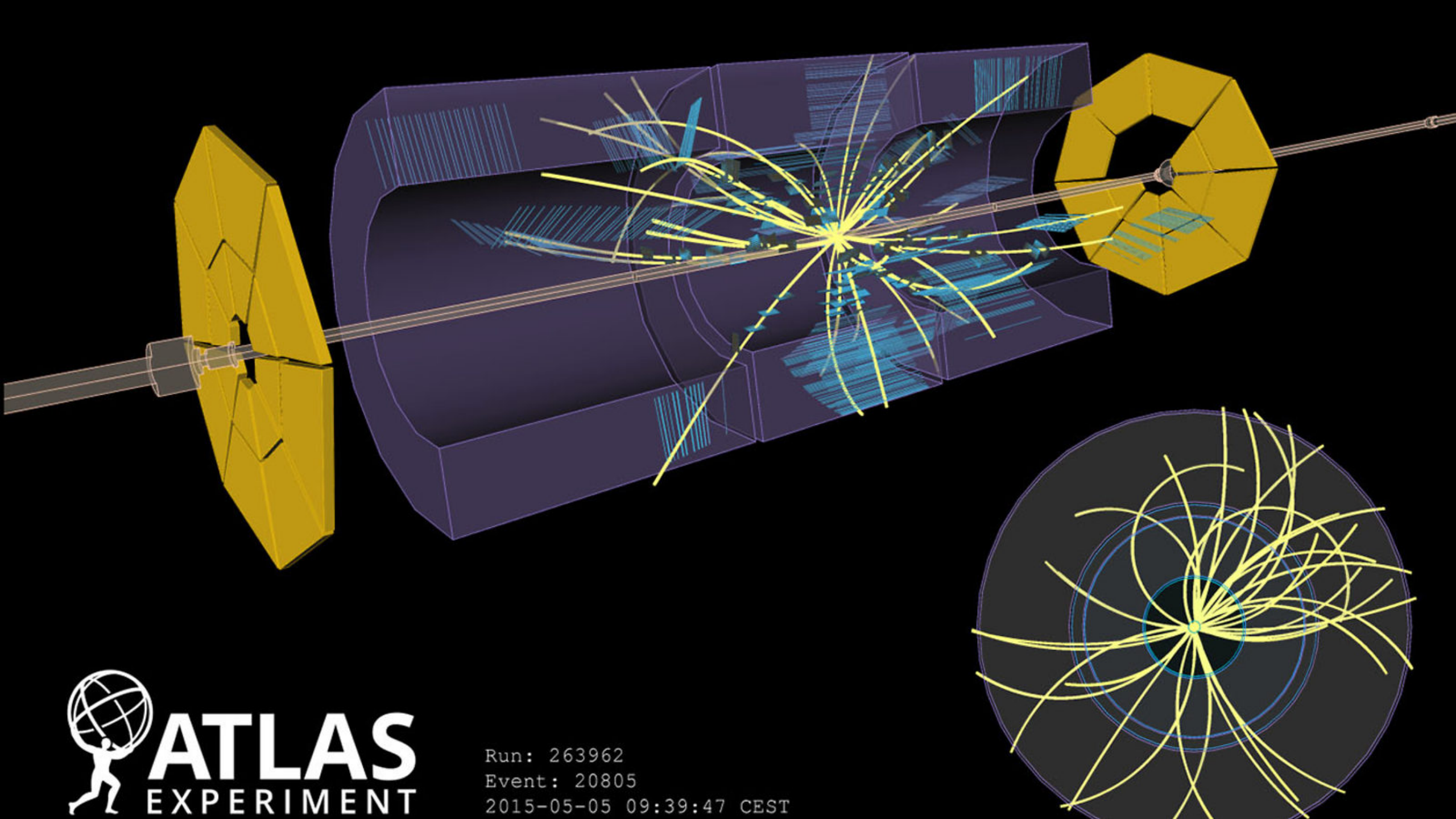
Large Hadron Collider, 27 km di circonferenza, al CERN, a cavallo fra Francia e Svizzera

stessa energia che si avrebbe con 100'000'000 km di batterie AA!



i protoni sono tenuti in orbita circolare da
1232 magneti superconduttori a -271.25 gradi
campo magnetico 170’000 volte quello terrestre!




ATLAS
EXPERIMENT
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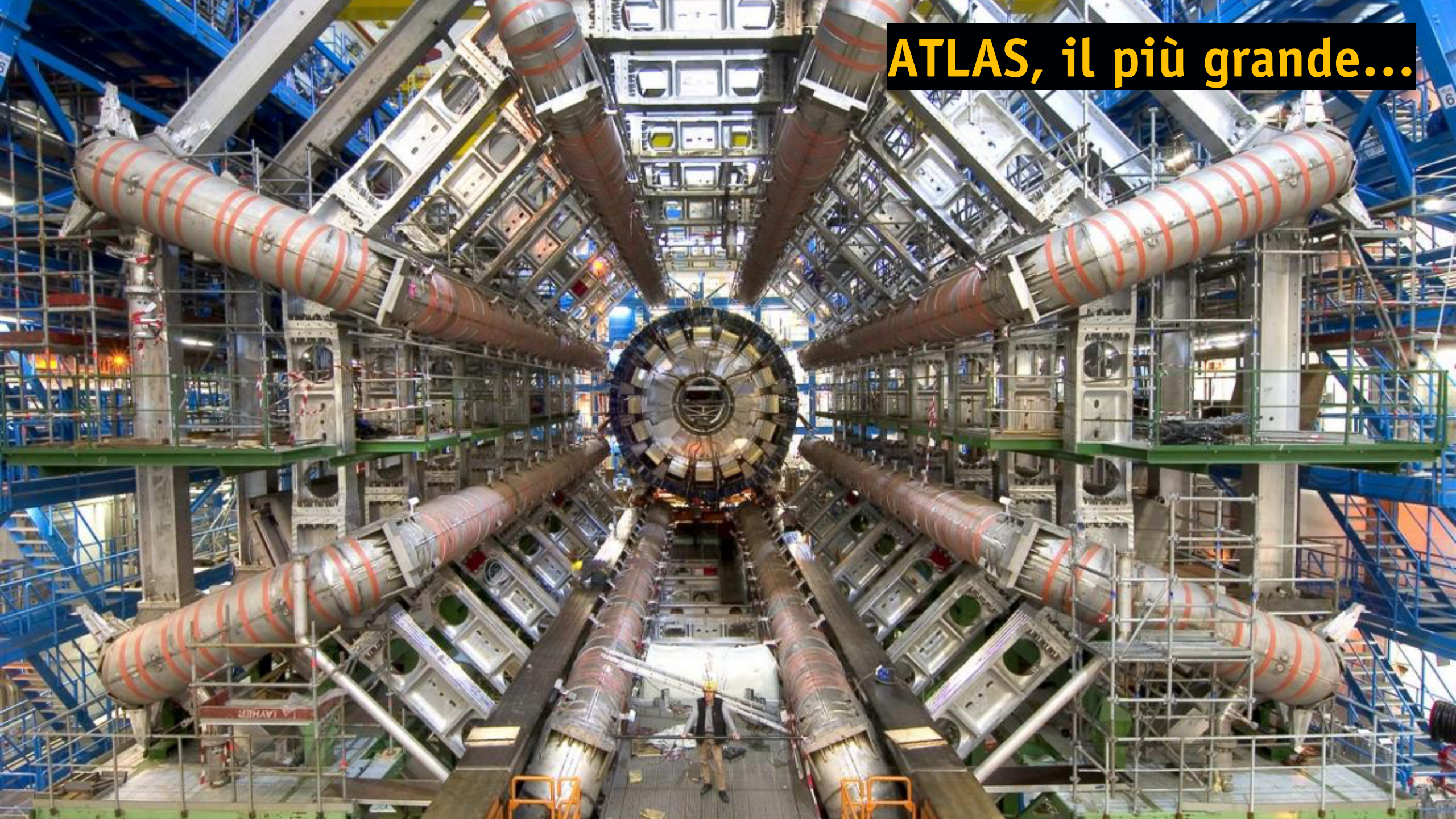
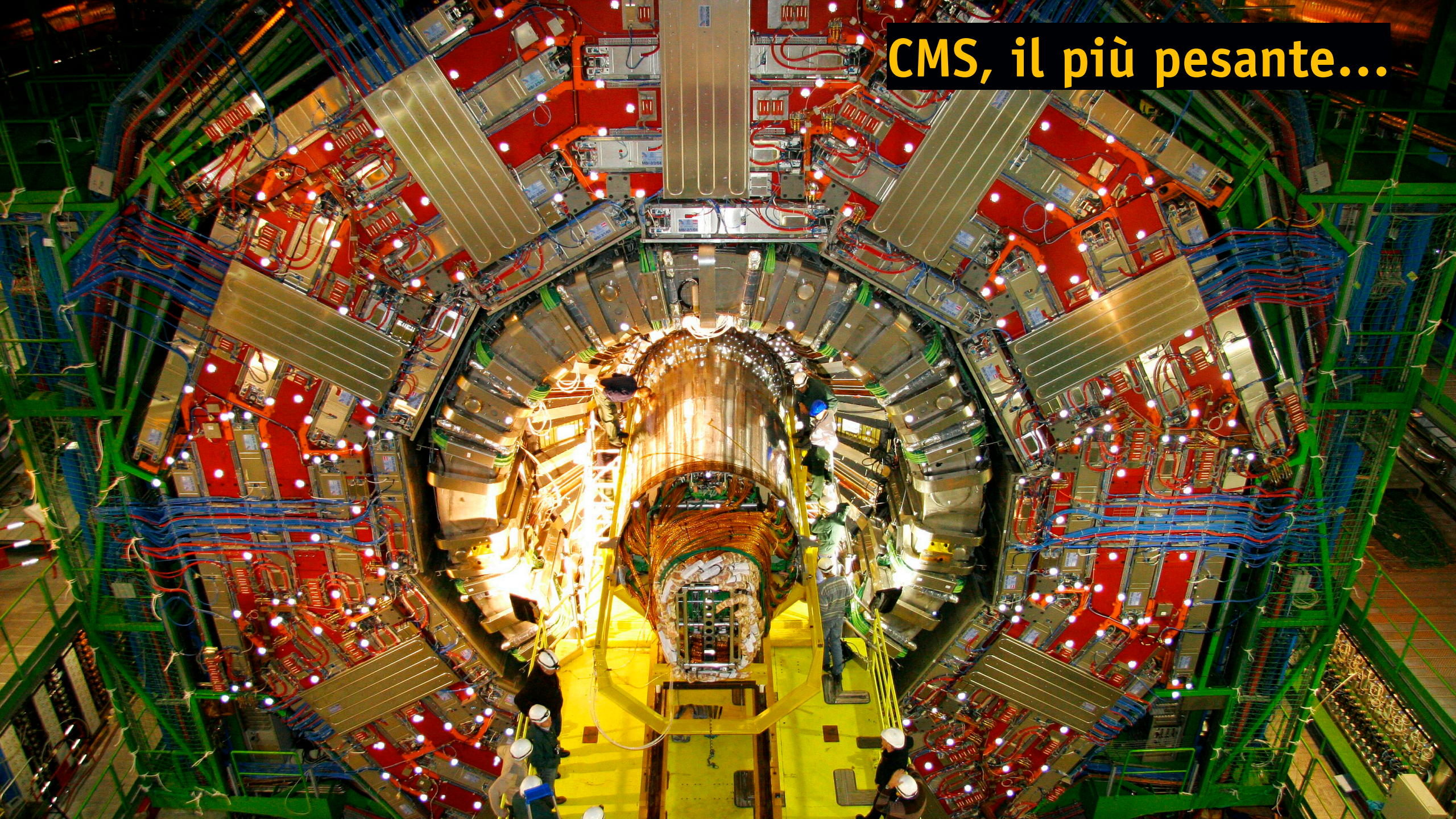
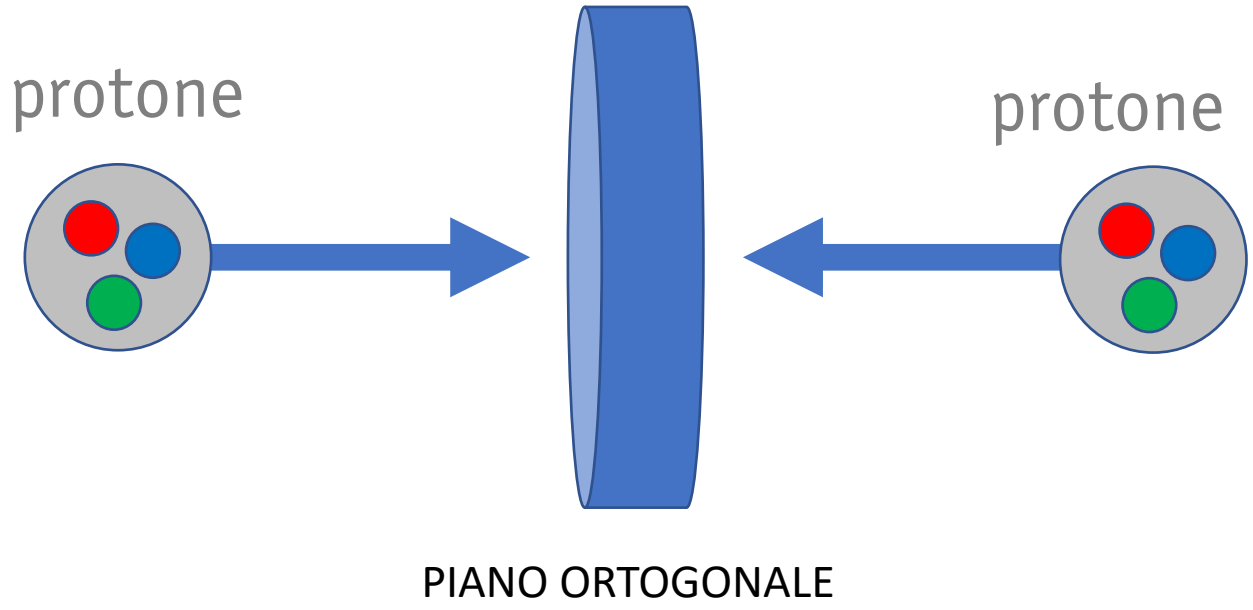
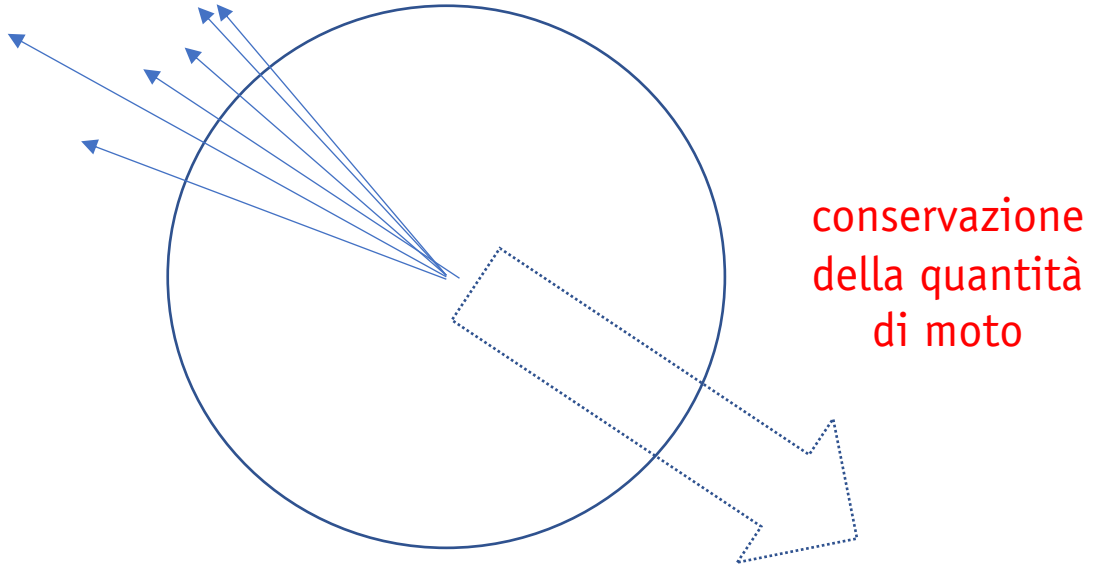
Event: 20805
2015-05-05 09:39:47 CEST


ATLAS, il più grande...

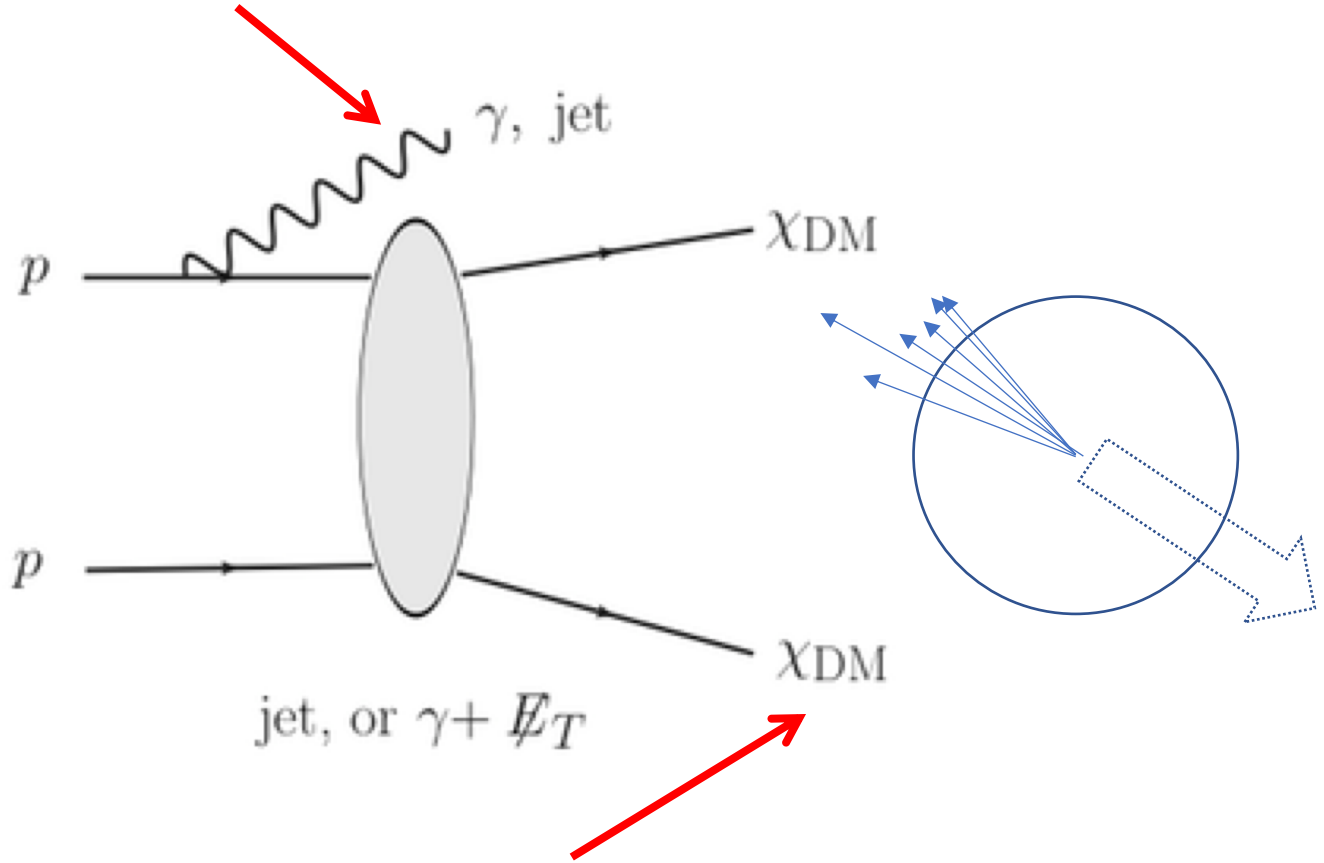

CMS, il più pesante...

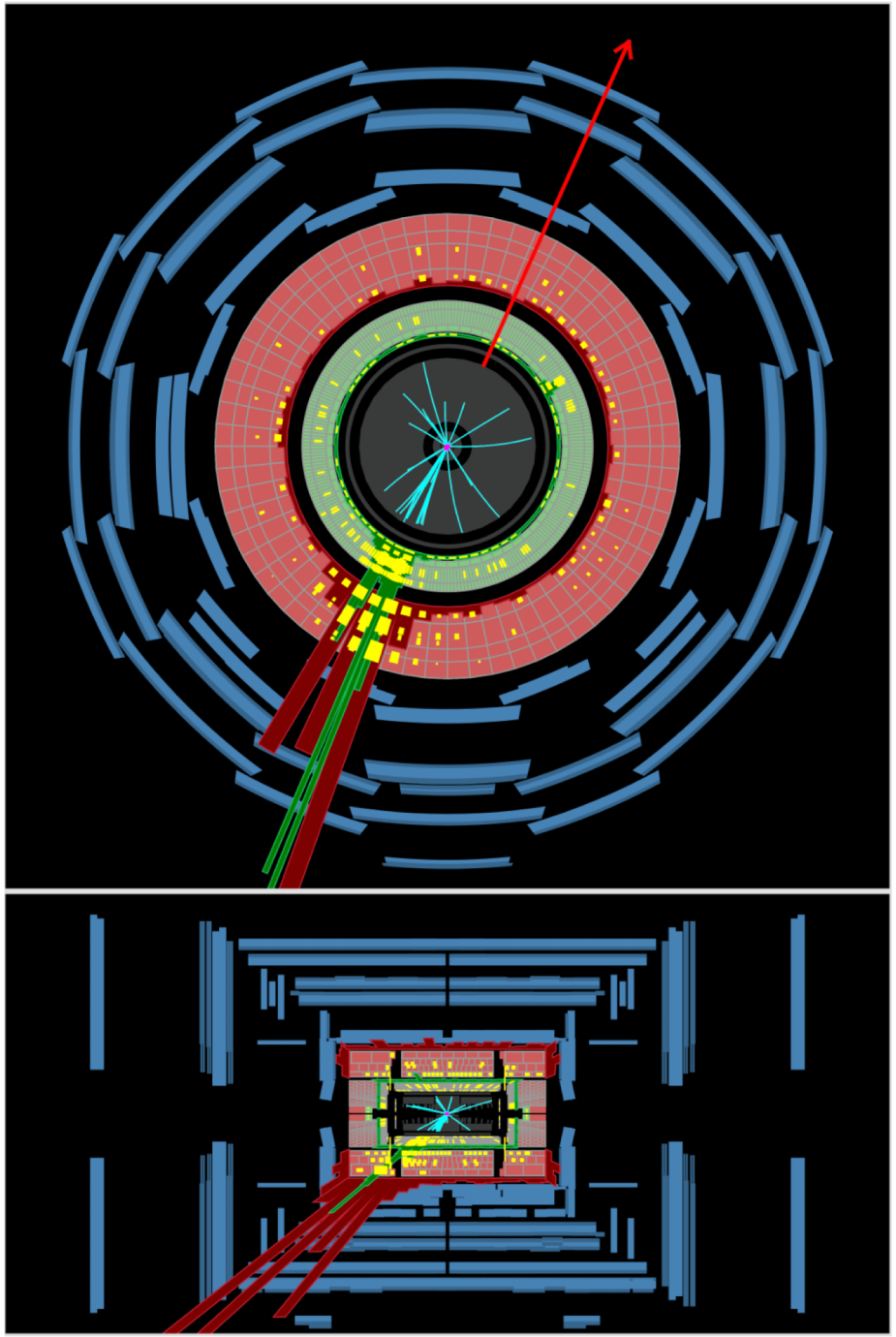
- nelle collisioni la massa non si conserva: LHC **crea** nuove particelle
- i protoni non sono particelle elementari: si conservano **energia** e **quantità di moto** nel **piano ortogonale** alla collisione





Particella Normale: VISIBILE





Particelle di Materia Oscura: INVISIBILI

Evento MONO-JET in ATLAS


non sappiamo ancora cosa sia la
materia oscura...
... ma la stiamo
cercando in tutti i modi!



Un giorno Alice arrivò a un bivio sulla strada e vide lo Stregatto sull'albero."

"Che strada devo prendere?" chiese.
La risposta fu una domanda:
"Dove vuoi andare?"
"Non lo so", rispose Alice.
"Allora, – disse lo Stregatto – non ha importanza."

quello della scienza è un viaggio di scoperta, che porta a fare luce sull'ignoto




quello della scienza è un viaggio di
scoperta, che porta a fare luce sull'ignoto
è un viaggio che durerà decenni,
verso la materia oscura e oltre!