



MERTON  
COLLEGE  
OXFORD



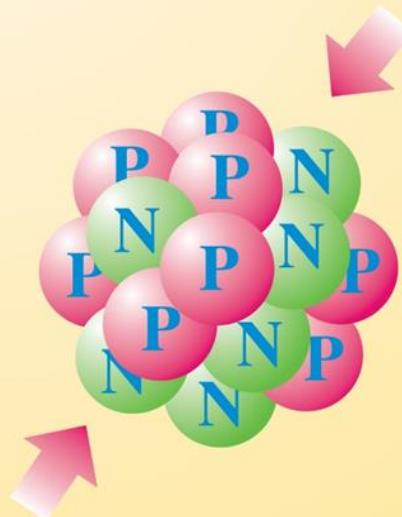
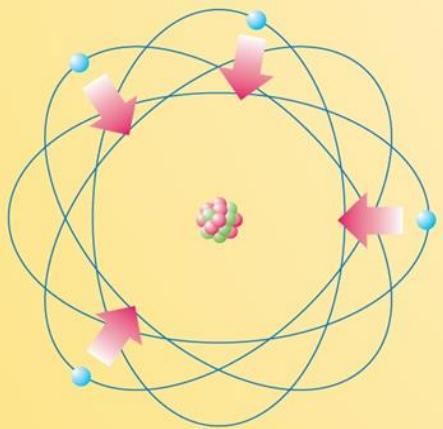
# The Four Fundamental Forces of Nature

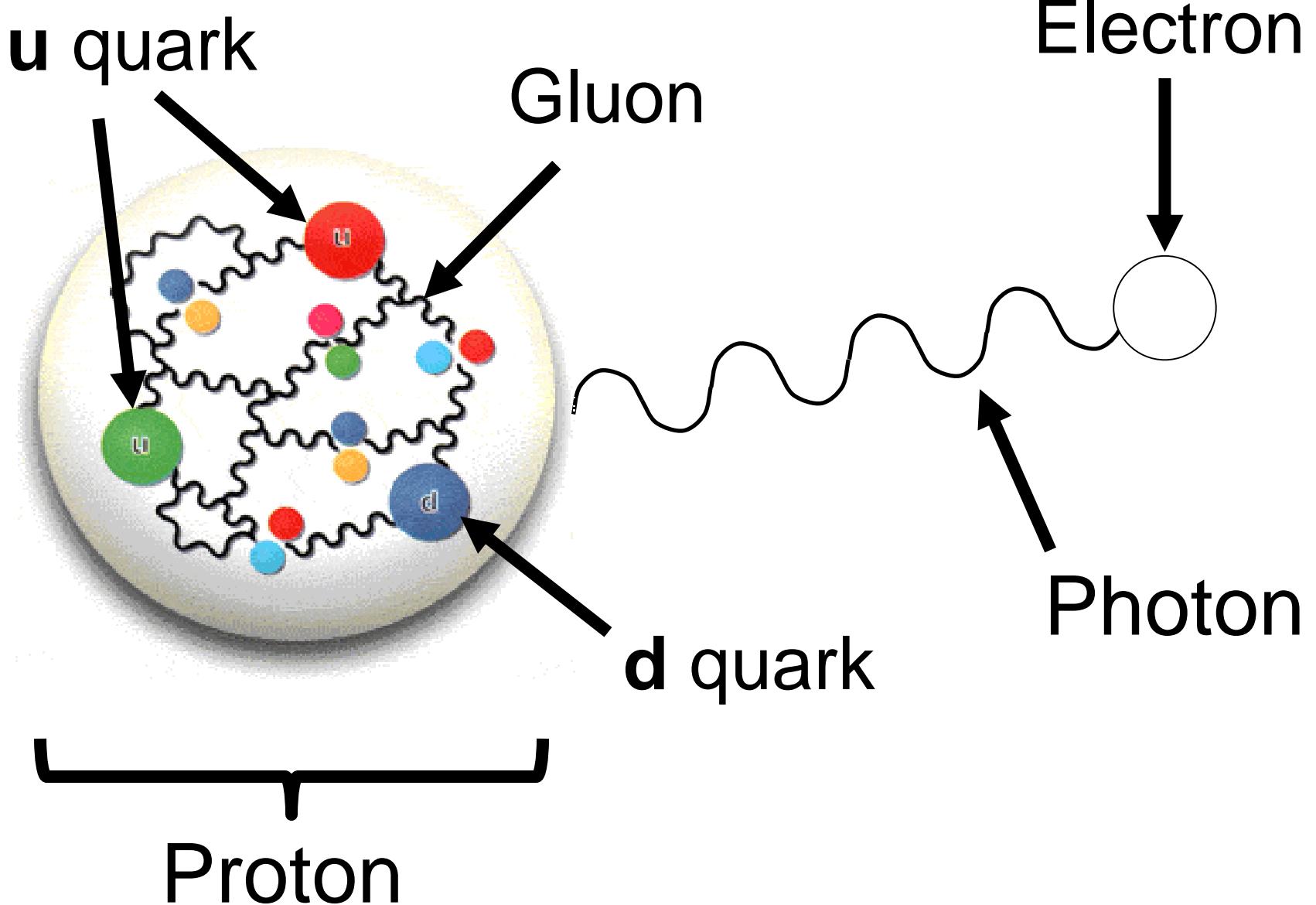
Electro-magnetism

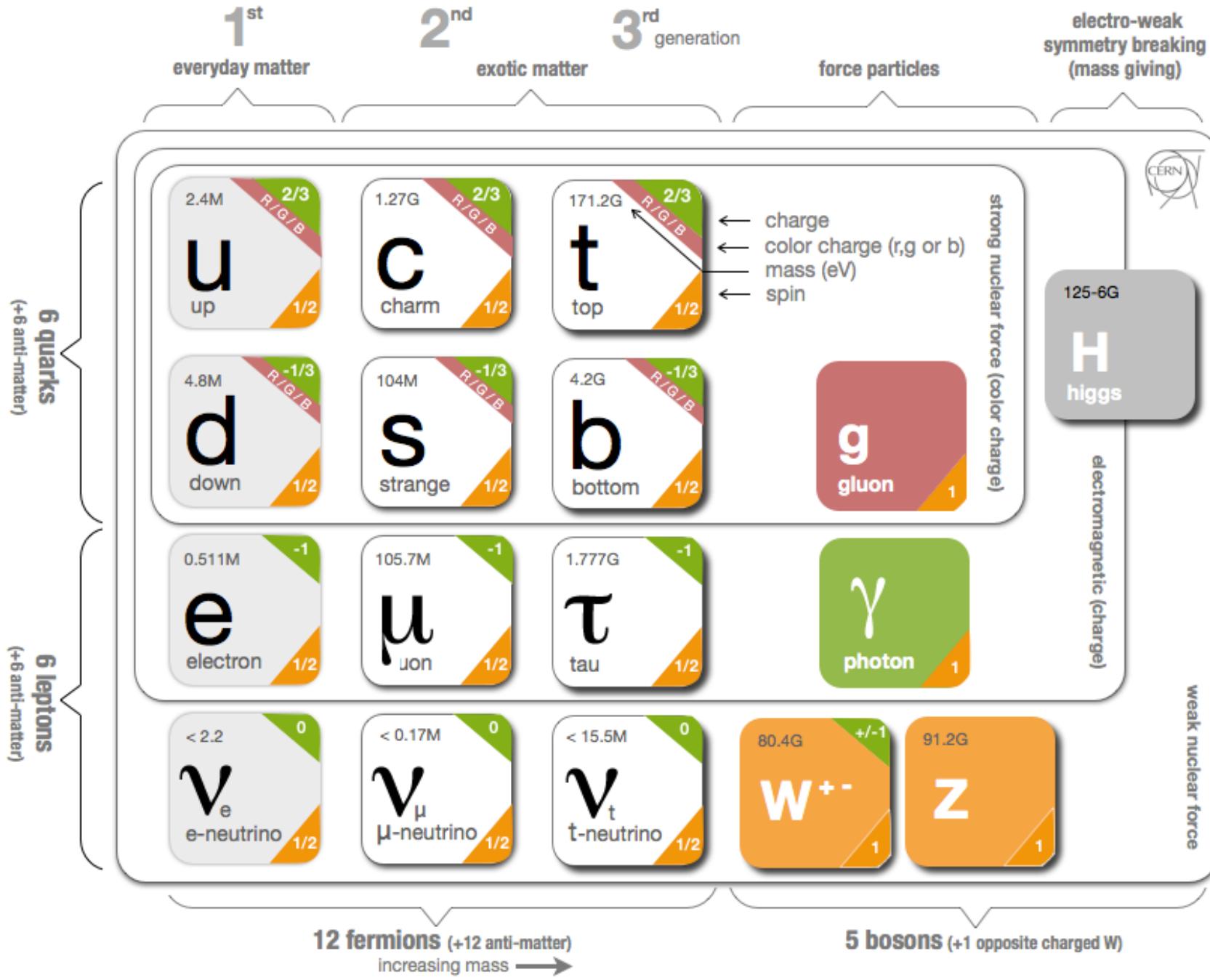
Weak Interaction

Strong Interaction

Gravitation







# A very precise theory



Electrons behave like gyroscopes

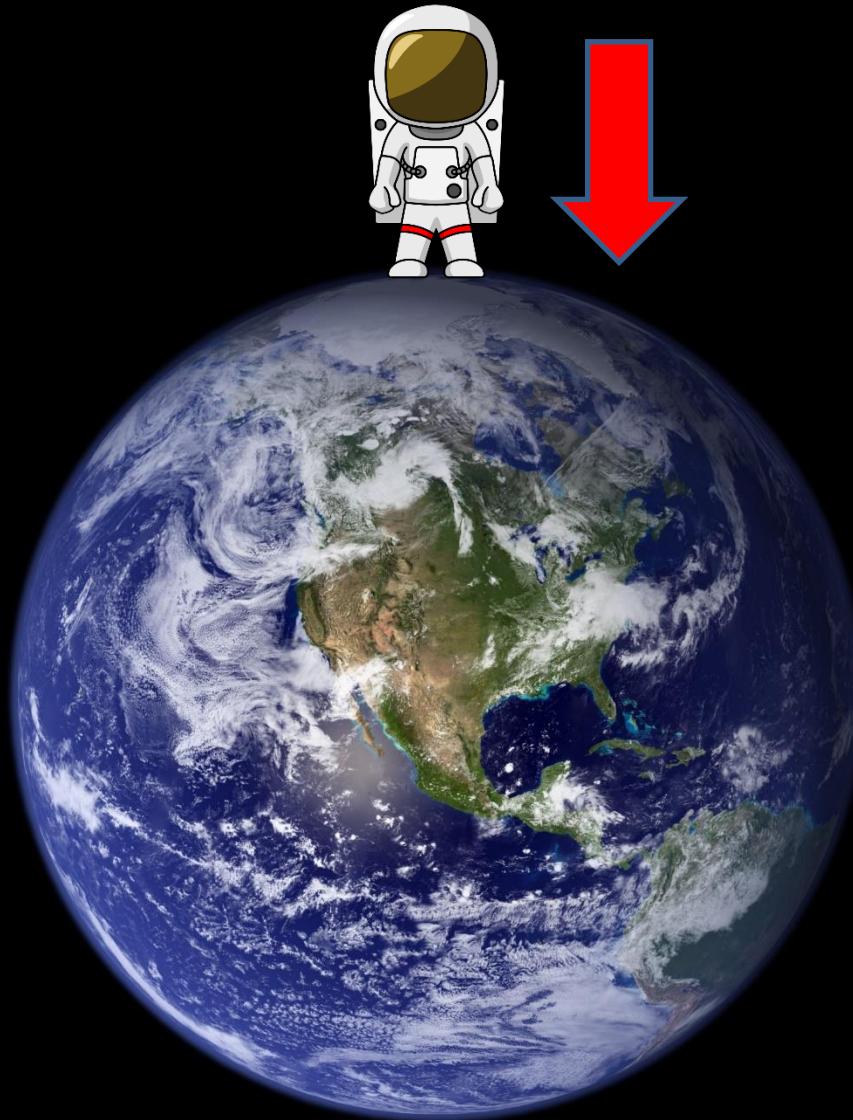
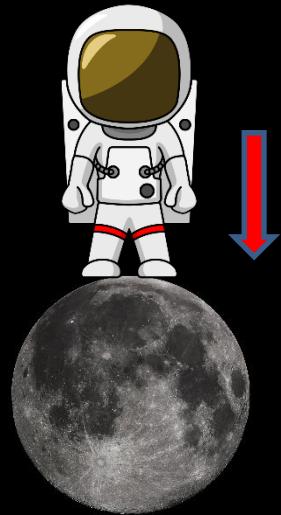
Experiment:

$$g/2 = 1.001\ 159\ 652\ 180\ 7\ (3)$$

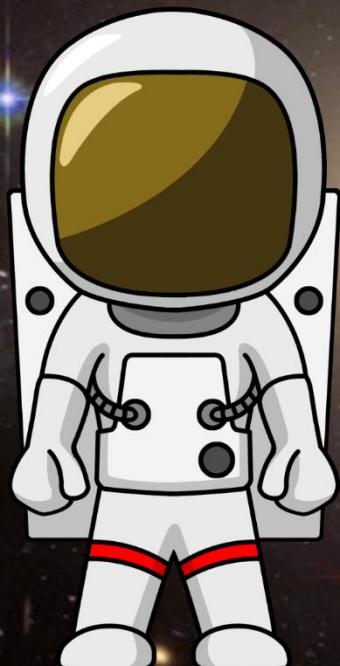
Theory:

$$g/2 = 1.001\ 159\ 652\ 181\ 8\ (8)$$

# Weight



# Mass



$$E = mc^2$$

$V$

$$L = (D_\mu \phi)^* D^\mu \phi - V(\phi) - \frac{1}{4} F_{\mu\nu} F^{\mu\nu}$$

$$D_\mu \phi = \partial_\mu \phi - ie A_\mu \phi$$

$$\omega = \partial_\mu A_\nu - \partial_\nu A_\mu$$

$$V(\phi) = \alpha \phi^* \phi + \beta (\phi^* \phi)^2$$

$$\alpha < 0, \quad \beta > 0$$

# A theory of mass

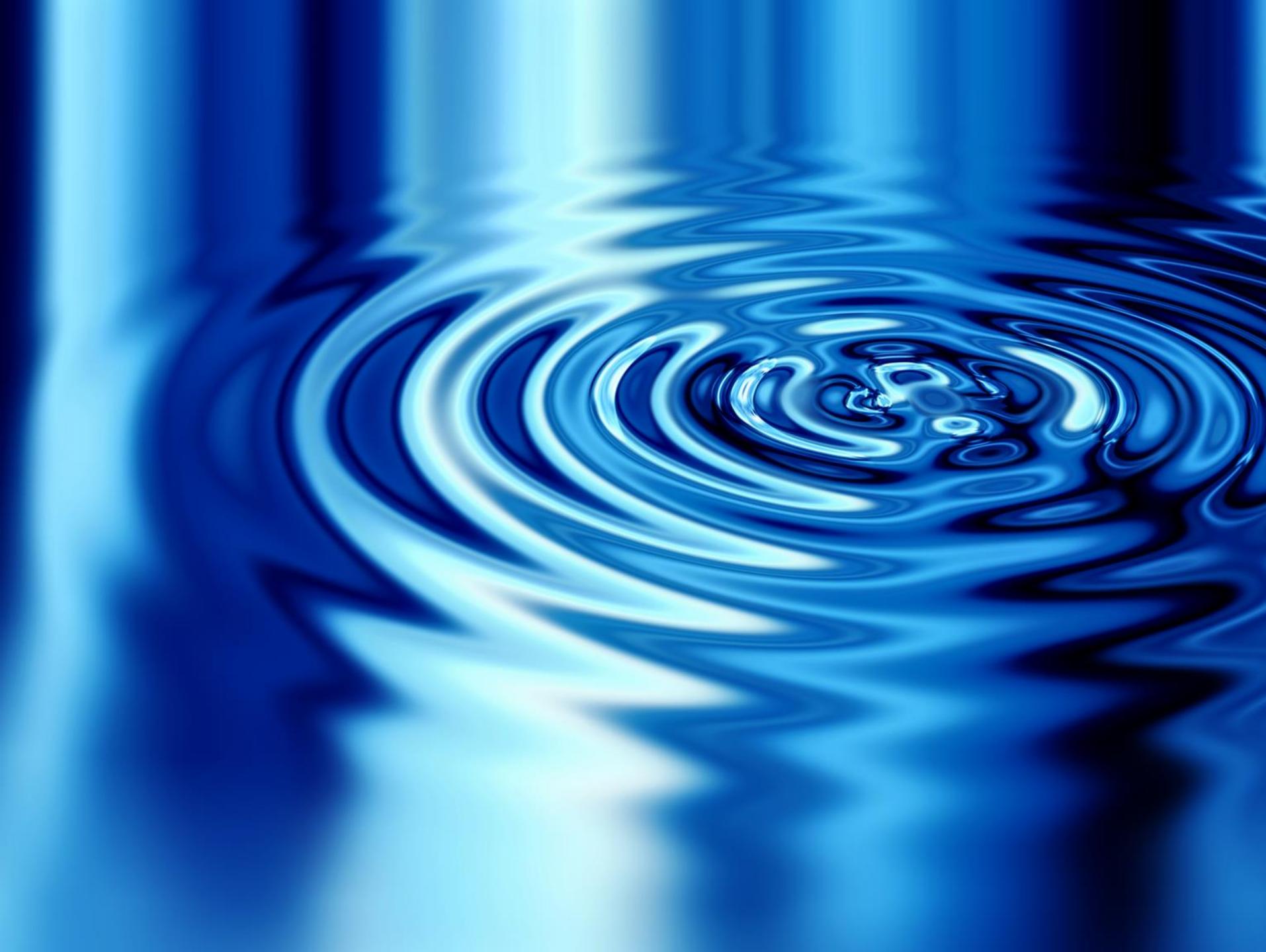
Ingredients:

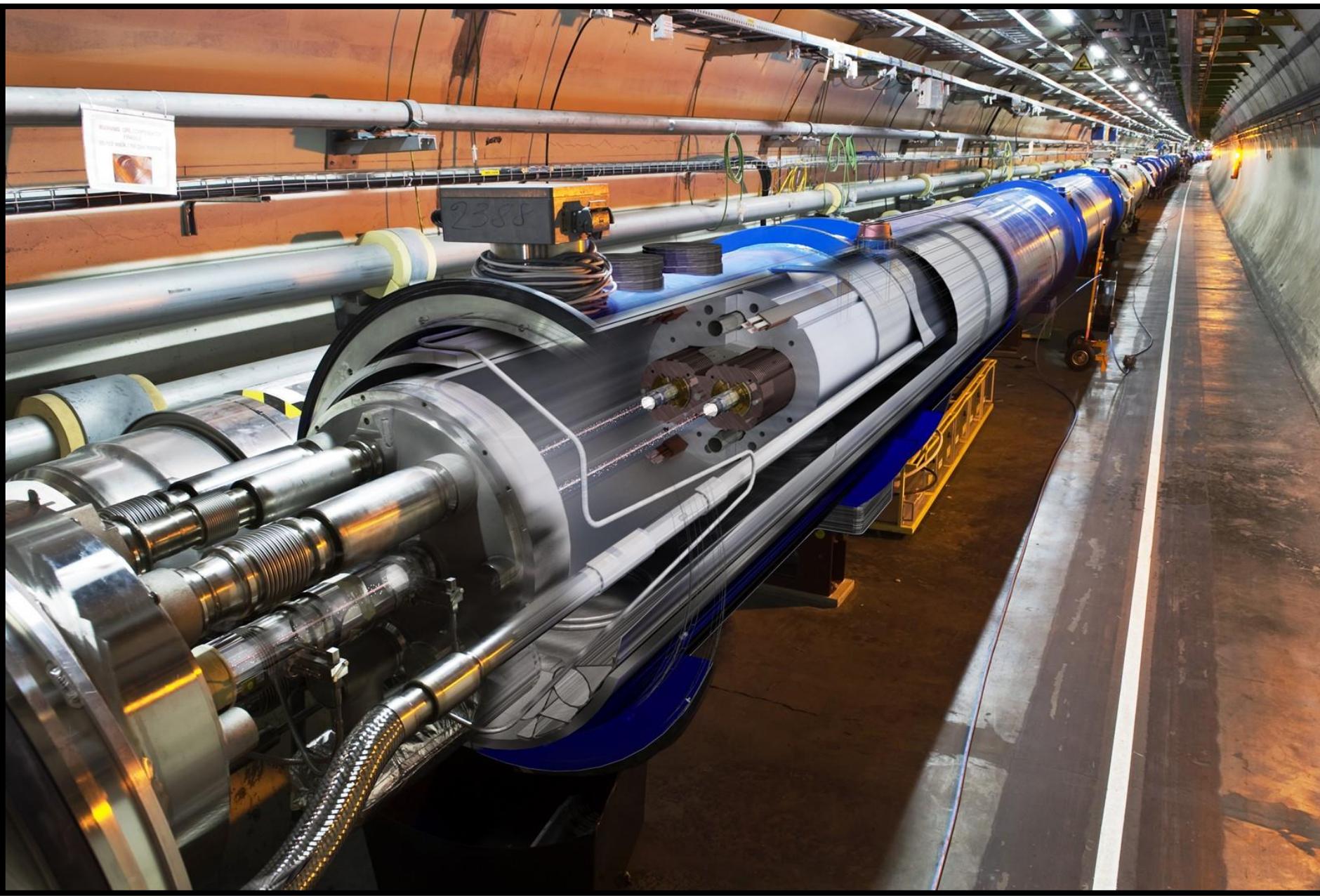
1. Field
2. Interaction
3. Excitation









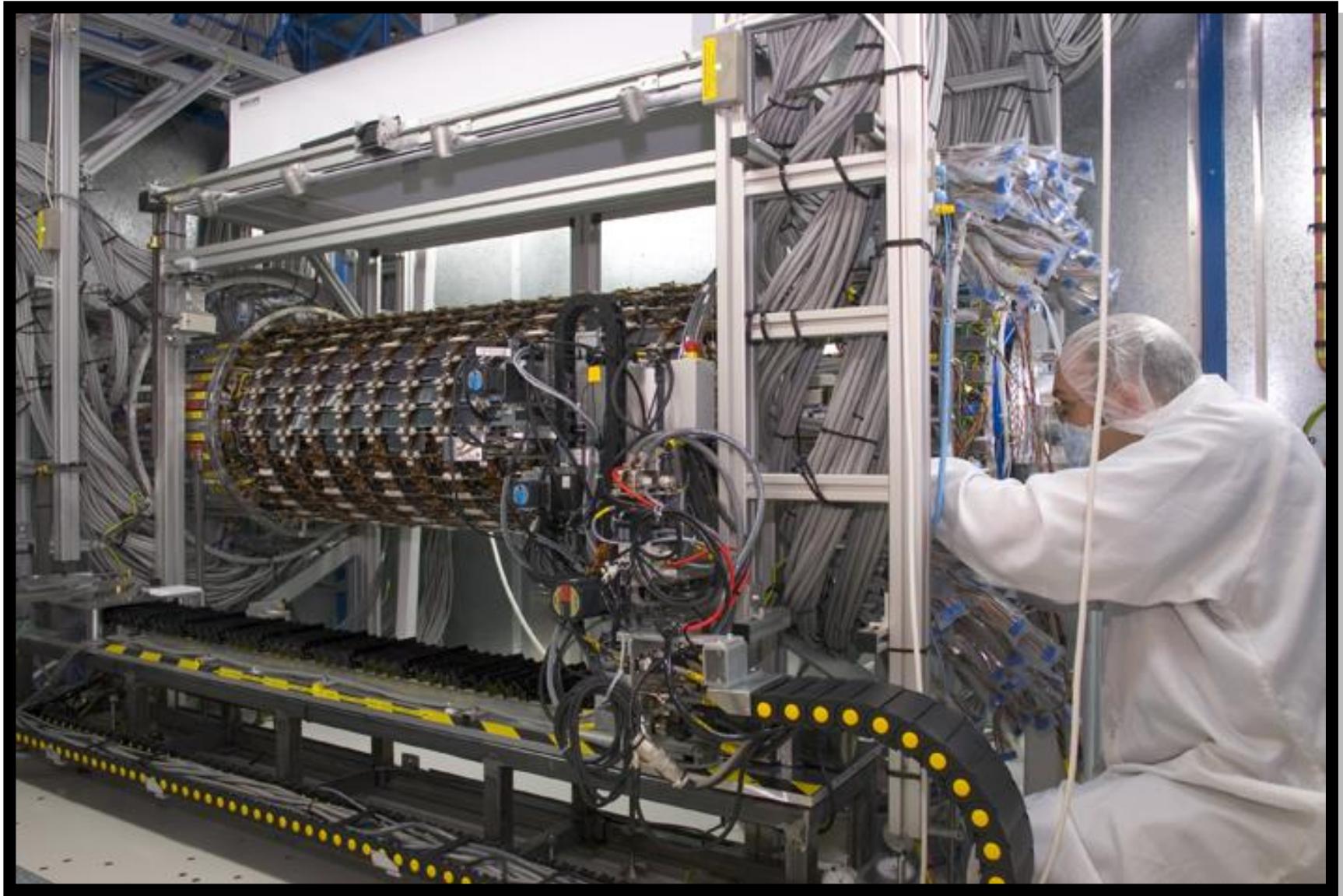


Note concerning “high energy”

FOURTEEN THOUSAND

BILLION VOLTS

Spark could jump 5000 km in air  
(~radius of The Earth)

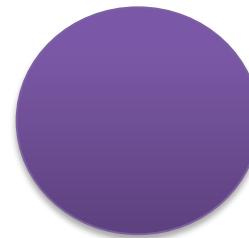


**Proton**

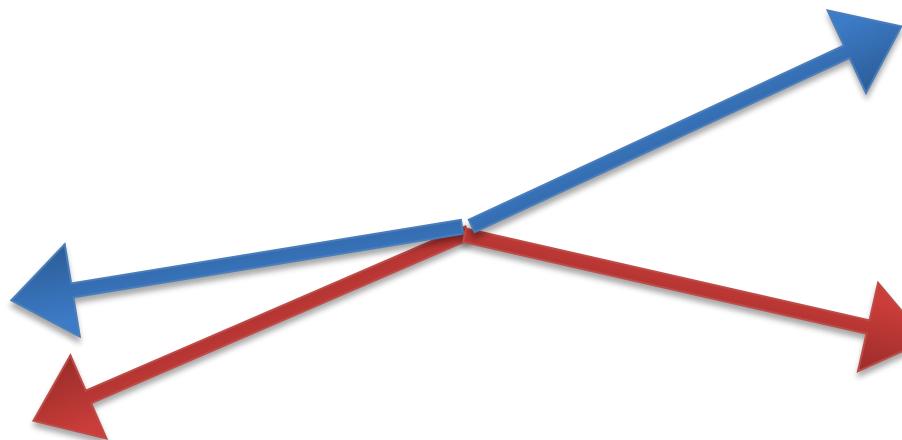


**Proton**

**Higgs boson**



**Decay products**

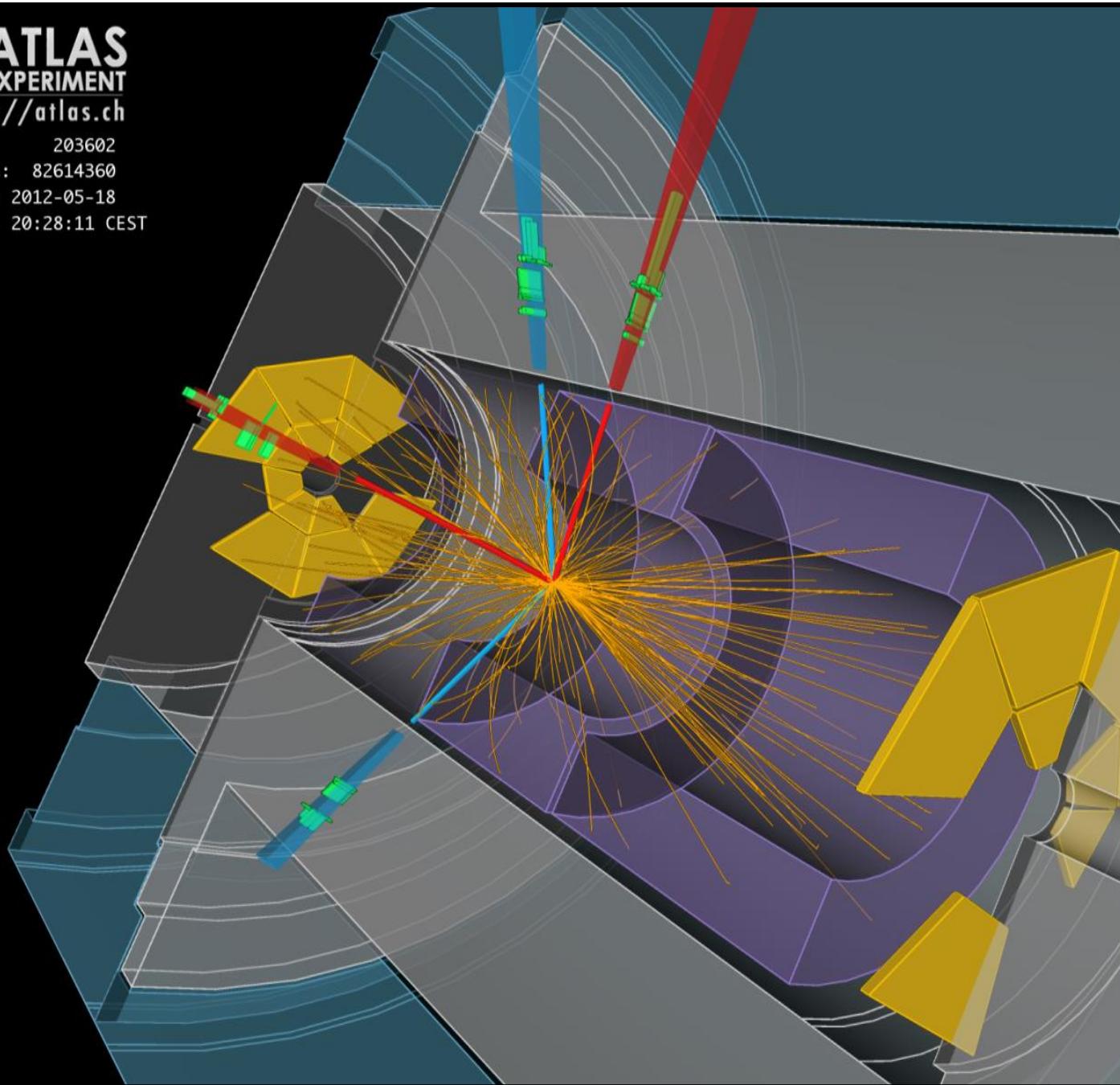


**Decay products**



<http://atlas.ch>

Run: 203602  
Event: 82614360  
Date: 2012-05-18  
Time: 20:28:11 CEST

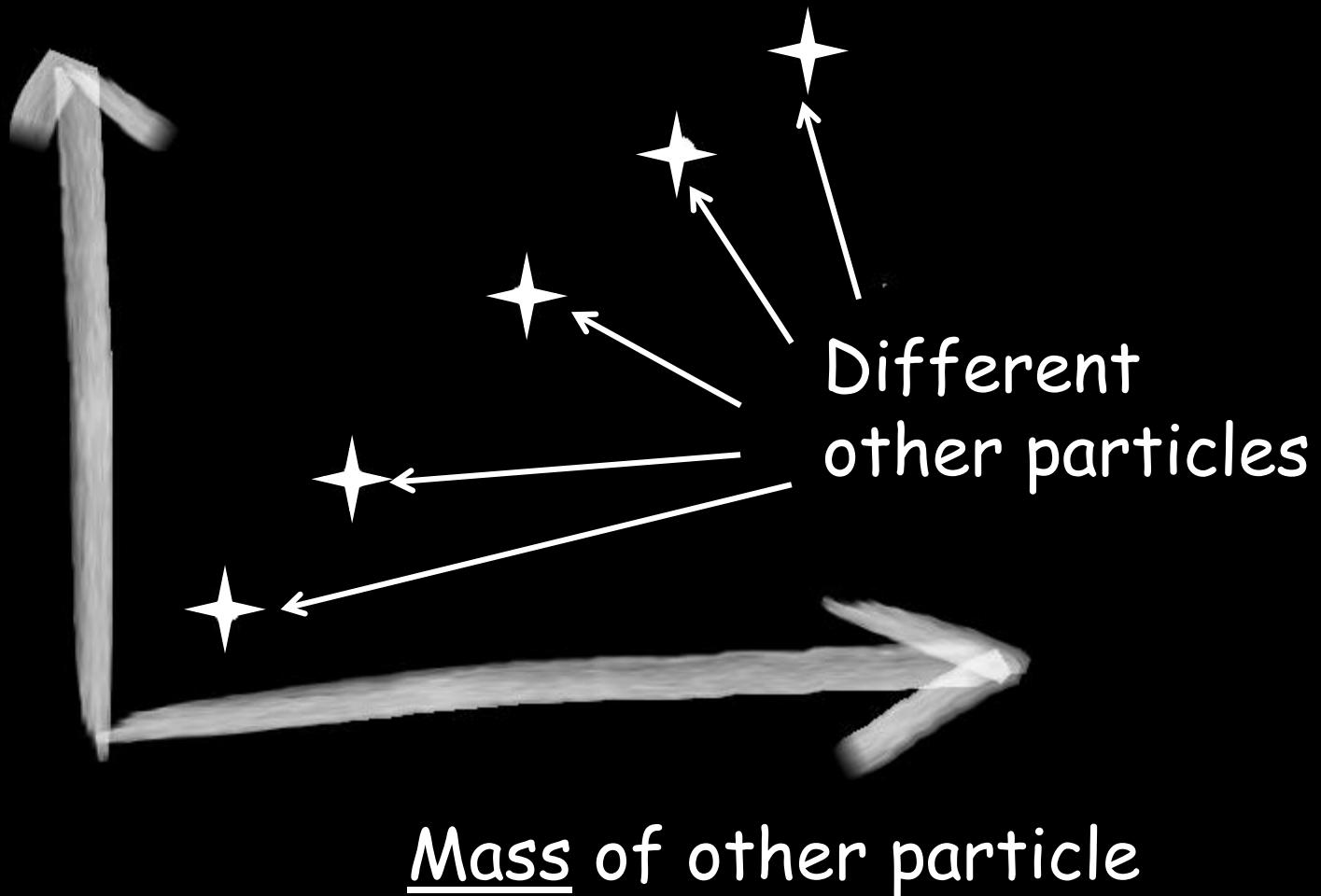


# Discovery!



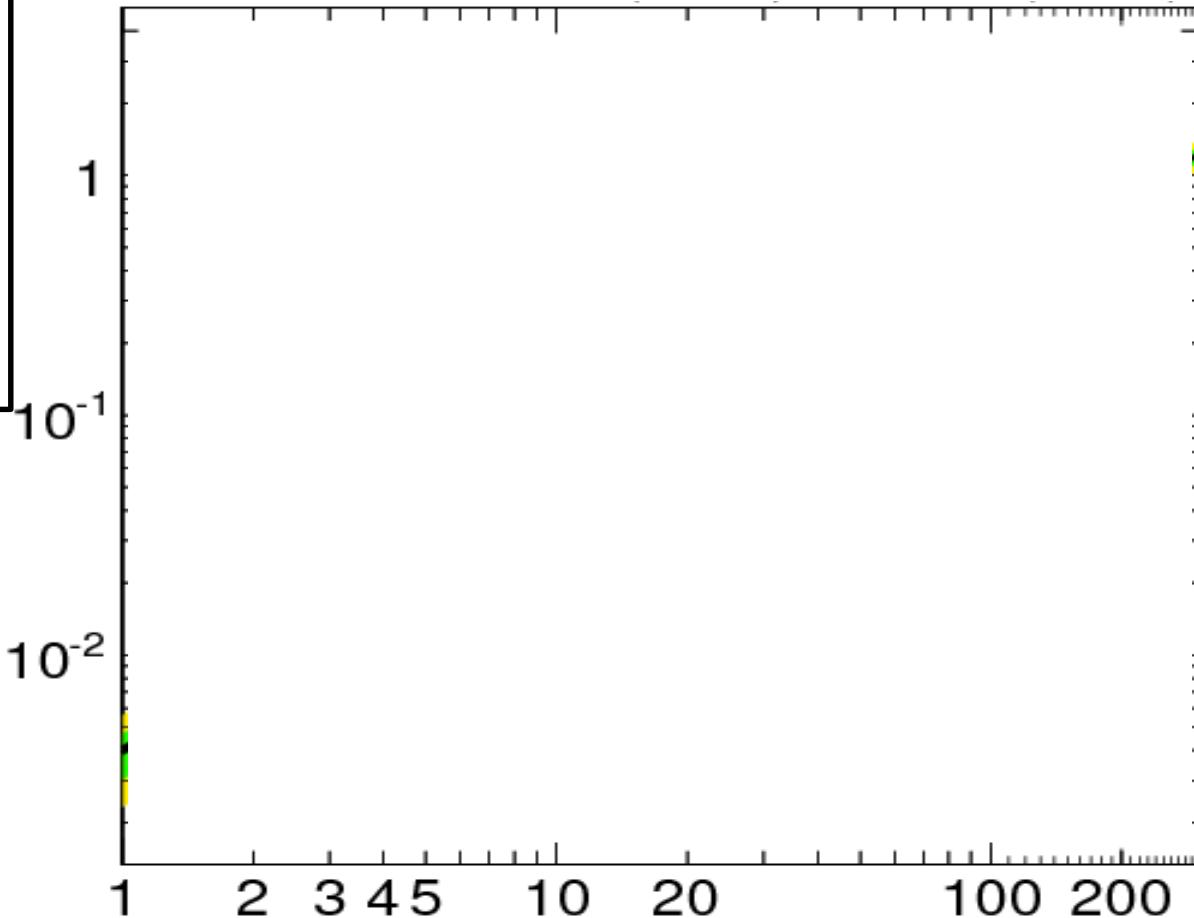
# Fingerprinting the Higgs boson

Interaction with  
other particle



# Fingerprinting the Higgs boson

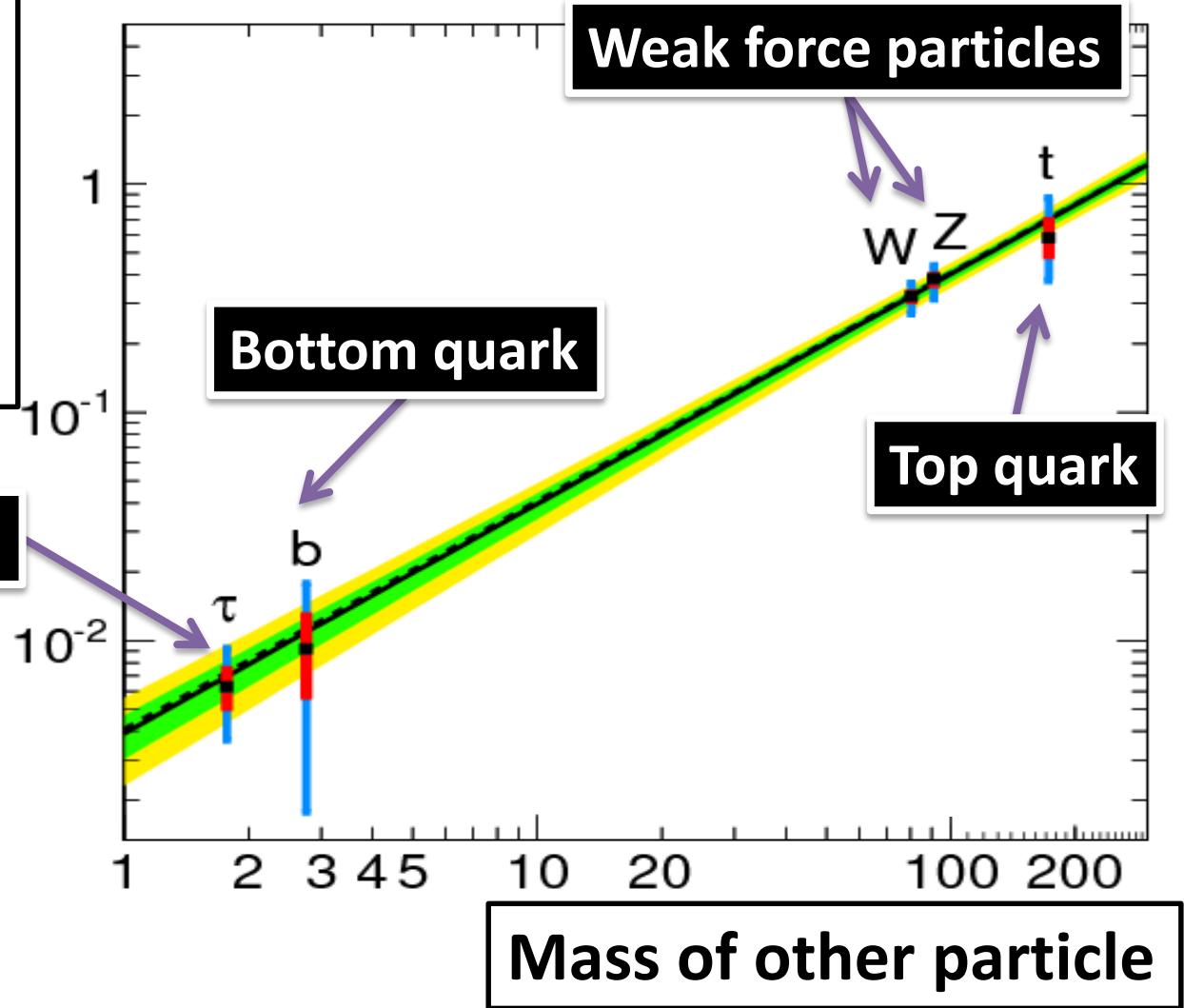
**Interaction  
strength of  
other particle  
with the new  
Higgs boson**



**Mass of other particle**

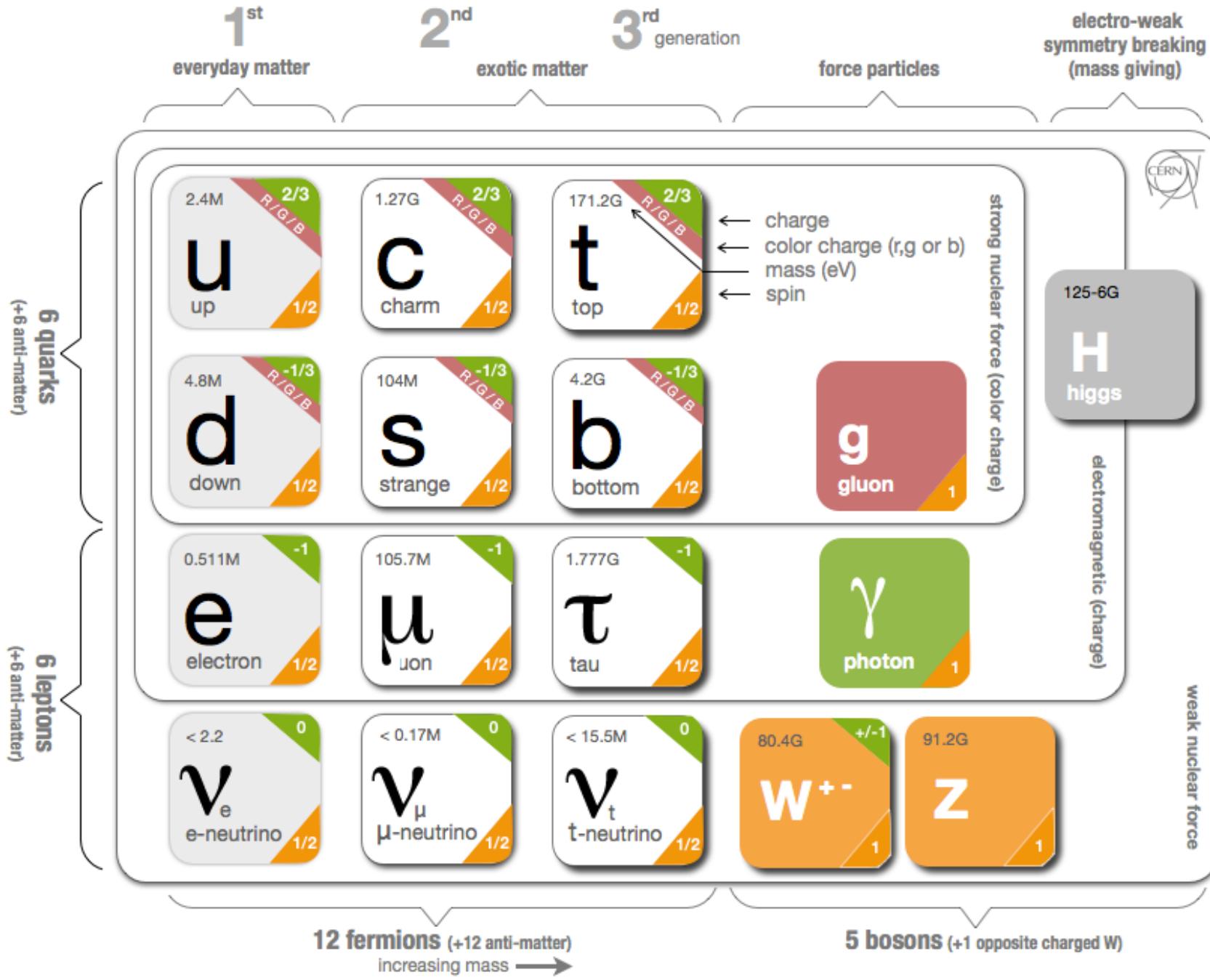
# Fingerprinting the Higgs boson

**Interaction  
strength of  
other particle  
with the new  
Higgs boson**

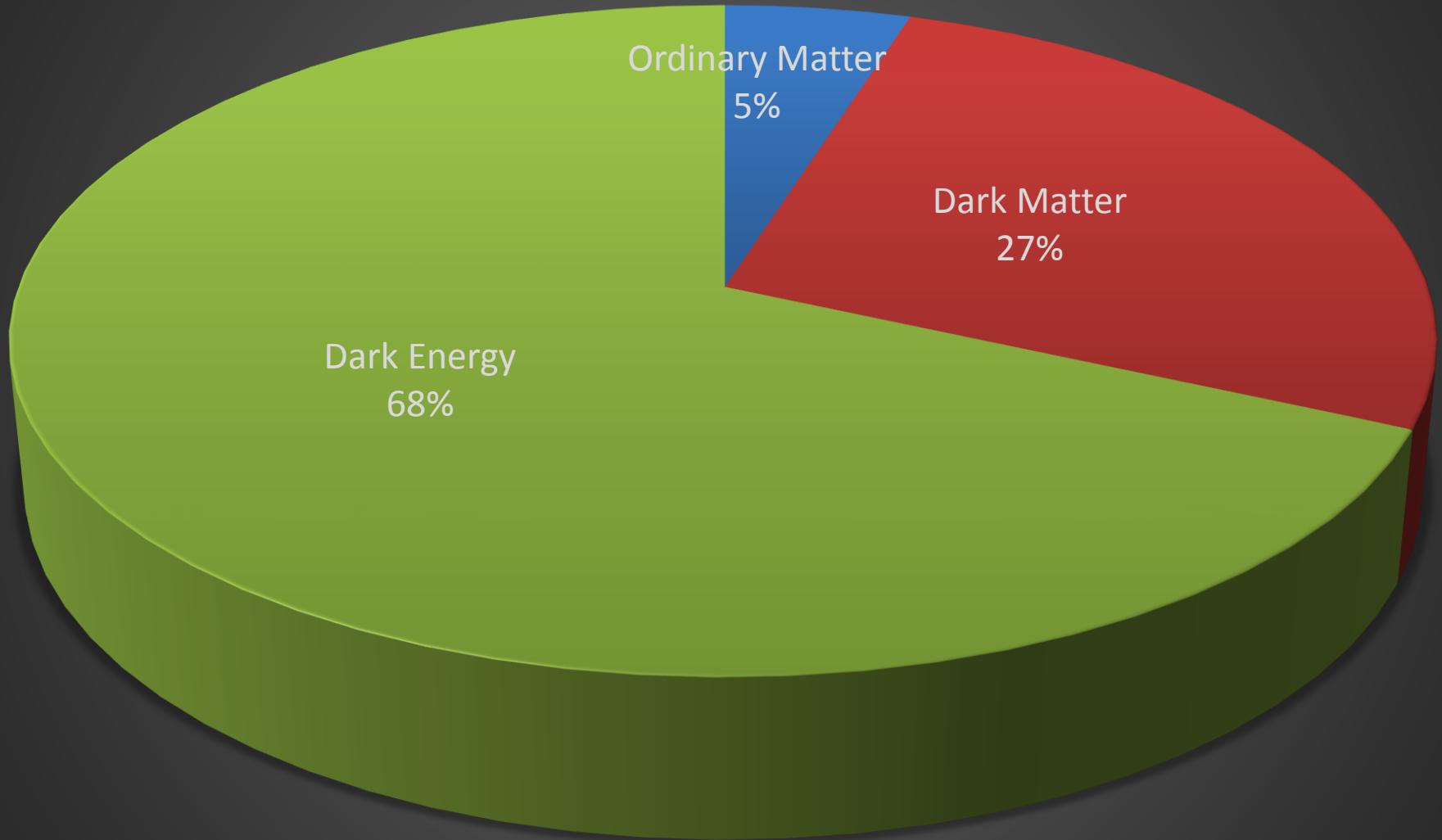


# Now what?

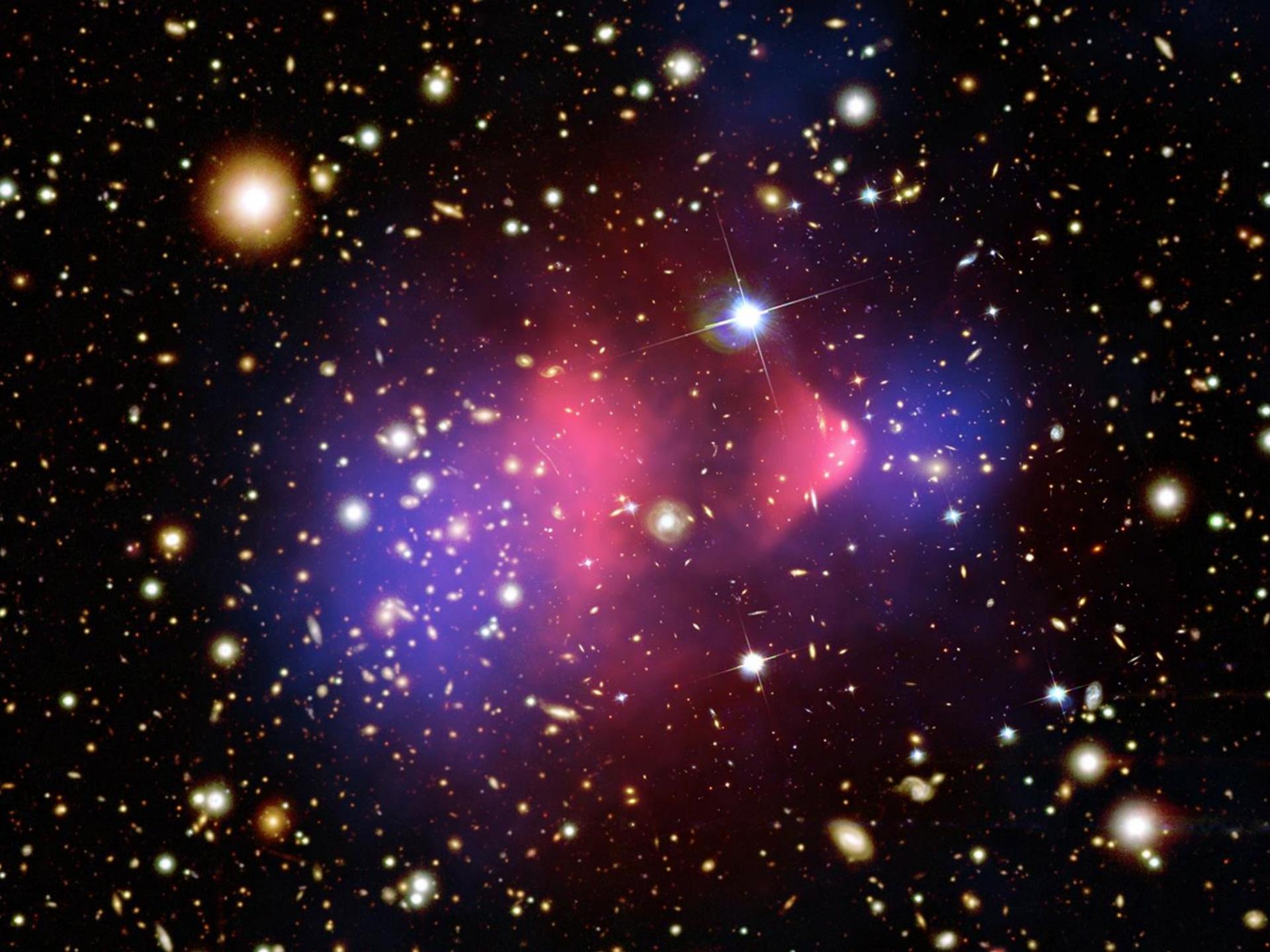
- Higgs properties
  - Is it really the Standard Model Higgs?
- Dark Matter
- Neutrino Masses
- Supersymmetry?
- Dark Energy
- Extra dimensions?
- (Quantum) Gravity



# Far from the full story







# **Spin offs...**

- **World Wide Web**
- **Medical imaging scanners**
- **Airport scanners**
- **Climate change modelling**
- **Drug development**
- **Radiotherapy**

**... and who knows what else?**



Support gratefully acknowledged