

*MasterClasses IPPOG - 11 marzo 2019*

# *Introduzione alle International Masterclass 2019*

[James O'Brien for Quanta Magazine]



Istituto Nazionale di Fisica Nucleare  
LABORATORI NAZIONALI DI FRASCATI

*Barbara Sciascia*

# 6 March 1869, "the" table

*Атомно-весовыя Таблицы.*

47,5  
17,5  
83,0

$Zn = 65,2$   
 $Ca = 40$   
 $Fe = 56$   
 $Al = 27,1$   
 $Si = 28$   
 $N = 14$   
 $O = 16$   
 $F = 19$   
 $Li = 7$   
 $Na = 23$   
 $K = 39$   
 $Rb = 85,4$   
 $Cs = 133$   
 $Ba = 137$   
 $Pb = 207$   
 $Bi = 210?$   
 $Po = 210?$   
 $At = 210?$   
 $Th = 118?$   
 $Pa = 182$   
 $U = 128?$   
 $La = 94$   
 $Ce = 92$   
 $Pr = 94$   
 $Nd = 94$   
 $Pm = 94$   
 $Sm = 94$   
 $Eu = 94$   
 $Gd = 94$   
 $Tb = 94$   
 $Dy = 94$   
 $Ho = 94$   
 $Er = 94$   
 $Tm = 94$   
 $Yb = 94$   
 $Lu = 94$

$H = 1$   
 $Be = 9,1$   
 $B = 11$   
 $C = 12$   
 $N = 14$   
 $O = 16$   
 $F = 19$

$Mg = 24$   
 $Al = 27,1$   
 $Si = 28$   
 $P = 31$   
 $S = 32$   
 $Cl = 35,5$   
 $K = 39$   
 $Ca = 40$   
 $? = 45$   
 $Sc = 45$   
 $Ti = 50$   
 $V = 51$   
 $Cr = 52$   
 $Mn = 55$   
 $Fe = 56$   
 $Co = 59$   
 $Ni = 59$   
 $Cu = 63,4$   
 $Zn = 65,2$   
 $Ga = 70$   
 $Ge = 72$   
 $As = 75$   
 $Se = 79,4$   
 $Br = 80$   
 $Rb = 85,4$   
 $Sr = 87,6$   
 $Y = 89$   
 $Zr = 90$   
 $Nb = 94$   
 $Mo = 96$   
 $Tc = 98$   
 $Rh = 104,4$   
 $Pd = 106,4$   
 $Ag = 108$   
 $Cd = 112$   
 $In = 113$   
 $Sn = 118$   
 $Sb = 122$   
 $Te = 128?$   
 $I = 127$   
 $Cs = 133$   
 $Ba = 137$   
 $Pt = 197,1$   
 $Au = 197?$   
 $Hg = 200$   
 $Tl = 204$   
 $Pb = 207$

*Handwritten notes and corrections:*  
 $Er = 56,3$   
 $Zn = 35,3? Zn = 65$   
 $Al = 94,2$   
 $Ca = 128$   
 $Fe = 74,4$   
 $Si = 115,7$   
 $N = 14,0$   
 $O = 16,0$   
 $F = 19,0$   
 $Li = 7,0$   
 $Na = 23,0$   
 $K = 39,1$   
 $Rb = 85,4$   
 $Cs = 132,9$   
 $Ba = 137,3$   
 $Pb = 207,2$   
 $Bi = 210$   
 $Po = 210$   
 $At = 210$   
 $Th = 118$   
 $Pa = 182$   
 $U = 128$   
 $La = 94$   
 $Ce = 92$   
 $Pr = 94$   
 $Nd = 94$   
 $Pm = 94$   
 $Sm = 94$   
 $Eu = 94$   
 $Gd = 94$   
 $Tb = 94$   
 $Dy = 94$   
 $Ho = 94$   
 $Er = 94$   
 $Tm = 94$   
 $Yb = 94$   
 $Lu = 94$

*Additional notes:*  
 $C = 12,01$   
 $F = 18,998$   
 $O = 15,999$   
 $N = 14,007$   
 $Si = 28,086$   
 $Al = 26,981$   
 $Ca = 40,078$   
 $Fe = 55,845$   
 $Zn = 65,38$   
 $Ag = 107,868$   
 $Cd = 112,411$   
 $Hg = 200,59$   
 $Pb = 207,2$   
 $Bi = 208,980$   
 $Po = 209$   
 $At = 209$   
 $Th = 232,0377$   
 $Pa = 231,036888$   
 $U = 238,02891$   
 $La = 138,90547$   
 $Ce = 140,12$   
 $Pr = 140,90766$   
 $Nd = 144,242$   
 $Pm = 145$   
 $Sm = 150,36$   
 $Eu = 151,964$   
 $Gd = 157,25$   
 $Tb = 158,92535$   
 $Dy = 162,500108$   
 $Ho = 164,930329$   
 $Er = 167,2593$   
 $Tm = 168,9304$   
 $Yb = 173,0547$   
 $Lu = 174,967$

## ОПЫТЪ СИСТЕМЫ ЭЛЕМЕНТОВЪ.

ОСНОВАННОЙ НА ИХЪ АТОМНОМЪ ВѢСѢ И ХИМИЧЕСКОМЪ СХОДСТВѢ.

	Ti = 50	Zr = 90	? = 180.
	V = 51	Nb = 94	Ta = 182.
	Cr = 52	Mo = 96	W = 186.
	Mn = 55	Rh = 104,4	Pt = 197,1.
	Fe = 56	Rn = 104,4	Ir = 198.
	Ni = Co = 59	Pl = 106,5	O = 199.
	Cu = 63,4	Ag = 108	Hg = 200.
H = 1	Be = 9,1	Mg = 24	Zn = 65,2
	Cd = 112		
	B = 11	Al = 27,1	? = 68
	Ur = 116	Au = 197?	
	C = 12	Si = 28	? = 70
	Sn = 118		
	N = 14	P = 31	As = 75
	Sb = 122	Bi = 210?	
	O = 16	S = 32	Se = 79,4
	Te = 128?		
	F = 19	Cl = 35,5	Br = 80
	I = 127		
Li = 7	Na = 23	K = 39	Rb = 85,4
	Cs = 133	Tl = 204.	
	Ca = 40	Sr = 87,6	Ba = 137
	Pb = 207.		
	? = 45	Ce = 92	
	?Er = 56	La = 94	
	?Yt = 60	Di = 95	
	?In = 75,5	Th = 118?	

Д. Менделѣевъ

# *“The” table today*

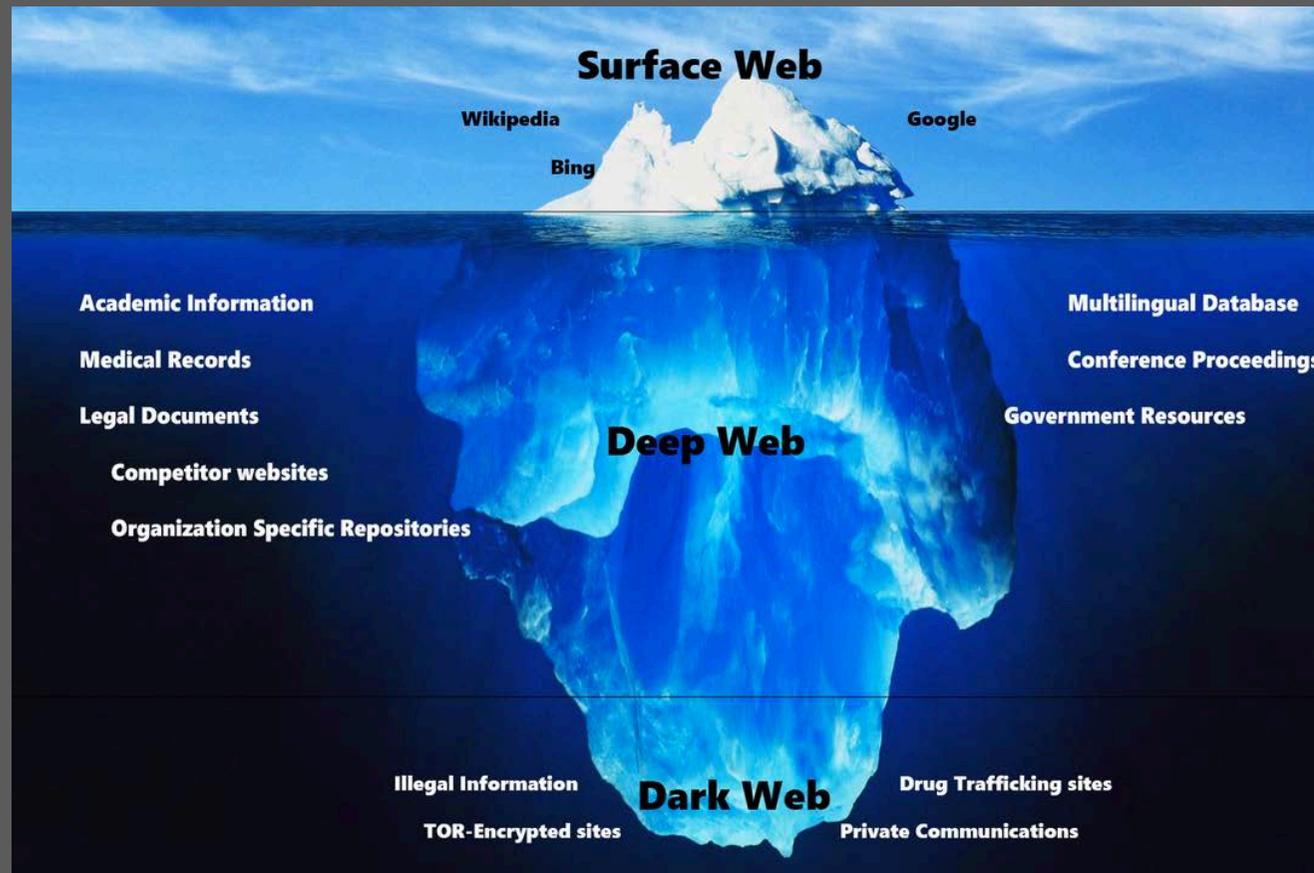
Group →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Period ↓	1																		2
	1 H													5 B	6 C	7 N	8 O	9 F	10 Ne
	2 Li	4 Be												13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
	3 Na	12 Mg																	
	4 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	
	5 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	
	6 Cs	56 Ba	57 La *	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	
	7 Fr	88 Ra	89 Ac *	104 Rf *	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og	
				* 58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu		
				* 90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr		

# 12 March 1989: World Wide Web

## 30th Anniversary of the World Wide Web

*Suppose all the information stored on computers everywhere were linked. Suppose I could program my computer to create a space in which everything could be linked to everything.'*

*Sir Tim Berners-Lee, inventor of the World Wide Web*



# *A full week of lectures and laboratories*

	<b>Lunedì 11</b>	<b>Martedì 12</b>	<b>Mercoledì 13</b>	<b>Giovedì 14</b>	<b>Venerdì 15</b>
10-11.30		Modello Standard	Modello Standard	Acceleratori	“Gravitational coding”
11.45-13.30	Welcome!	Acceleratori	Rivelatori	Rivelatori	
14.30-17	“Gravitational coding”	“Gravitational coding”	LHCb	Visita LNF LHCb link	“Gravitational coding”

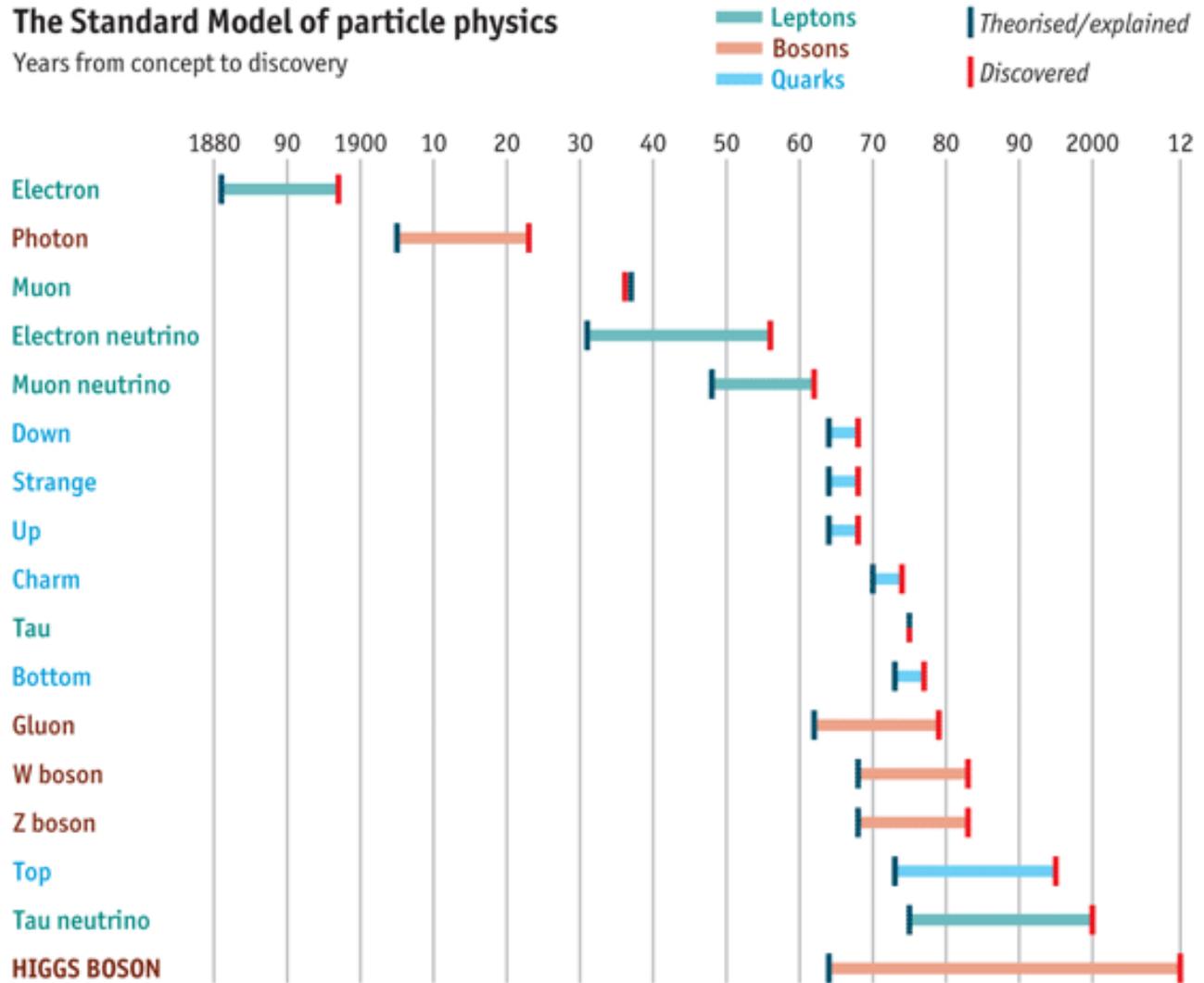
# *A full week of lectures and laboratories*

	<b>Lunedì 11</b>	<b>Martedì 12</b>	<b>Mercoledì 13</b>	<b>Giovedì 14</b>	<b>Venerdì 15</b>
10-11.30		<b>Marco Pruna</b>	<b>Marco Pruna</b>	<b>David Alesini</b>	<b>Marco Giordano e Barbara Sciascia</b>
11.45-13.30	<b>Barbara Sciascia</b>	<b>David Alesini</b>	<b>Danilo Domenici</b>	<b>Danilo Domenici</b>	
14.30-17	<b>Marco Giordano e Barbara Sciascia</b>	<b>Marco Giordano e Barbara Sciascia</b>	<b>Barbara + LHCb staff</b>	<b>Danilo e Barbara</b> <b>LHCb</b>	<b>Marco Giordano e Barbara Sciascia</b>

	11	12	13	14	15

### The Standard Model of particle physics

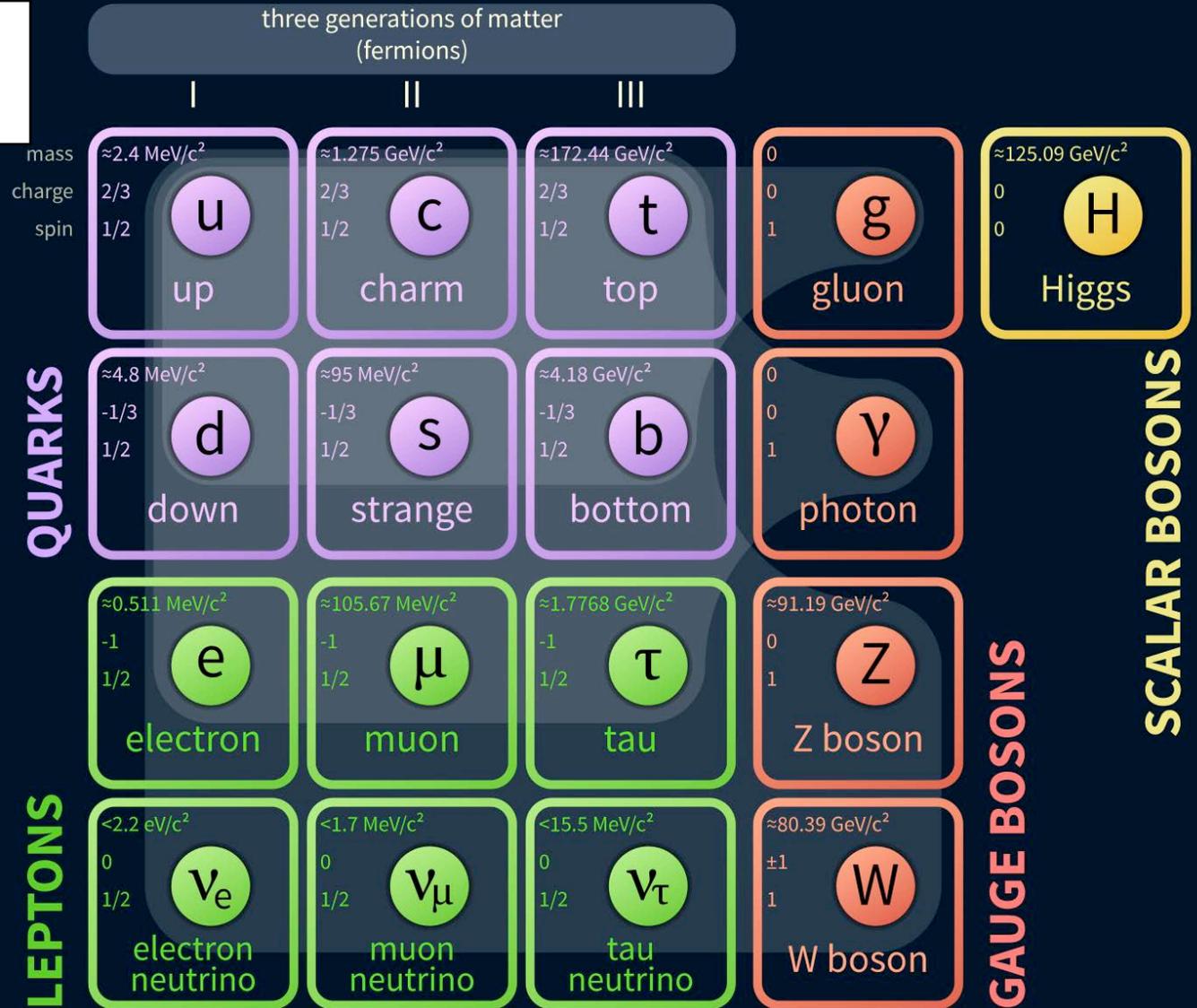
Years from concept to discovery



Source: *The Economist*

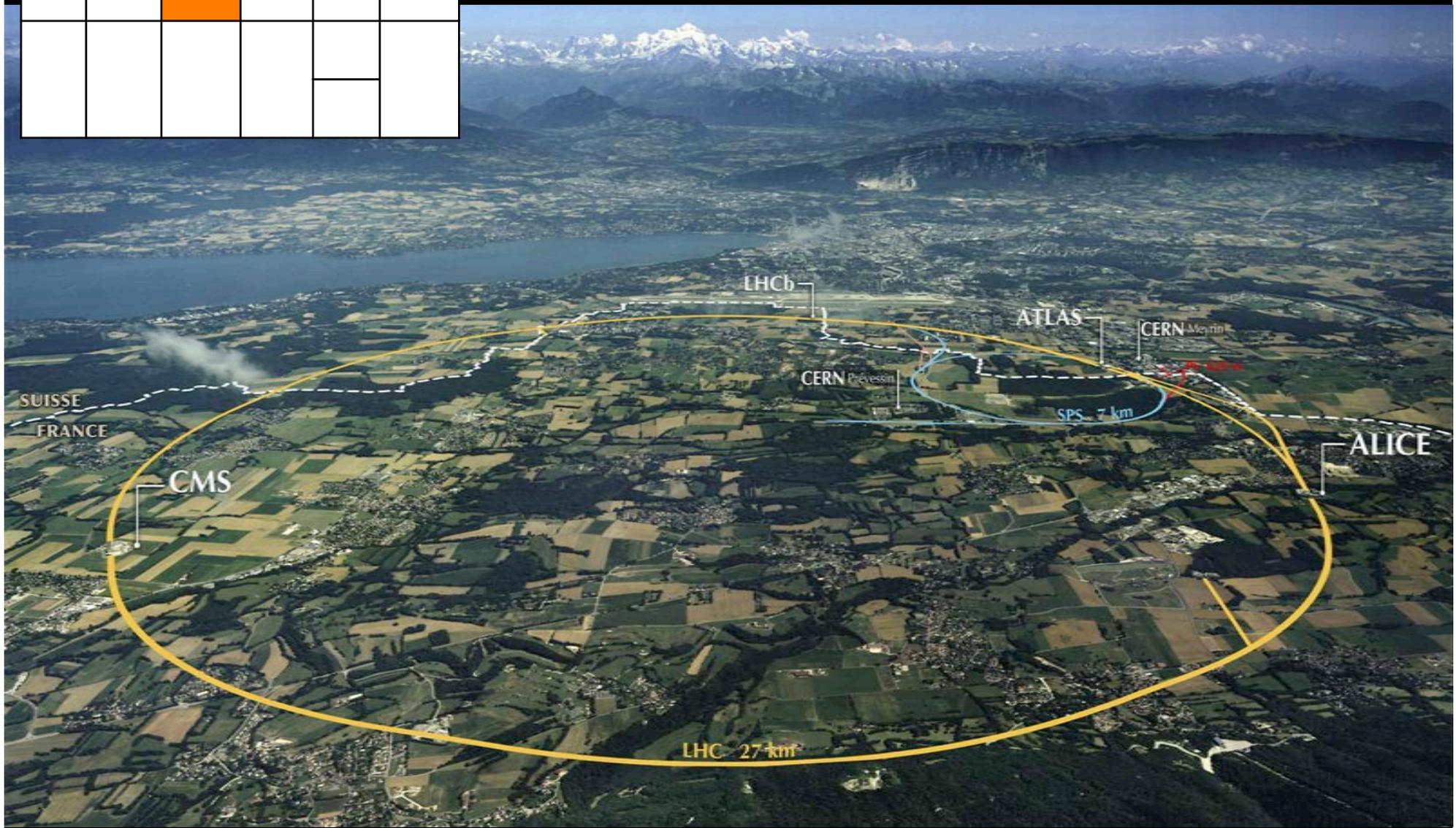
	11	12	13	14	15

# Standard Model of Elementary Particles

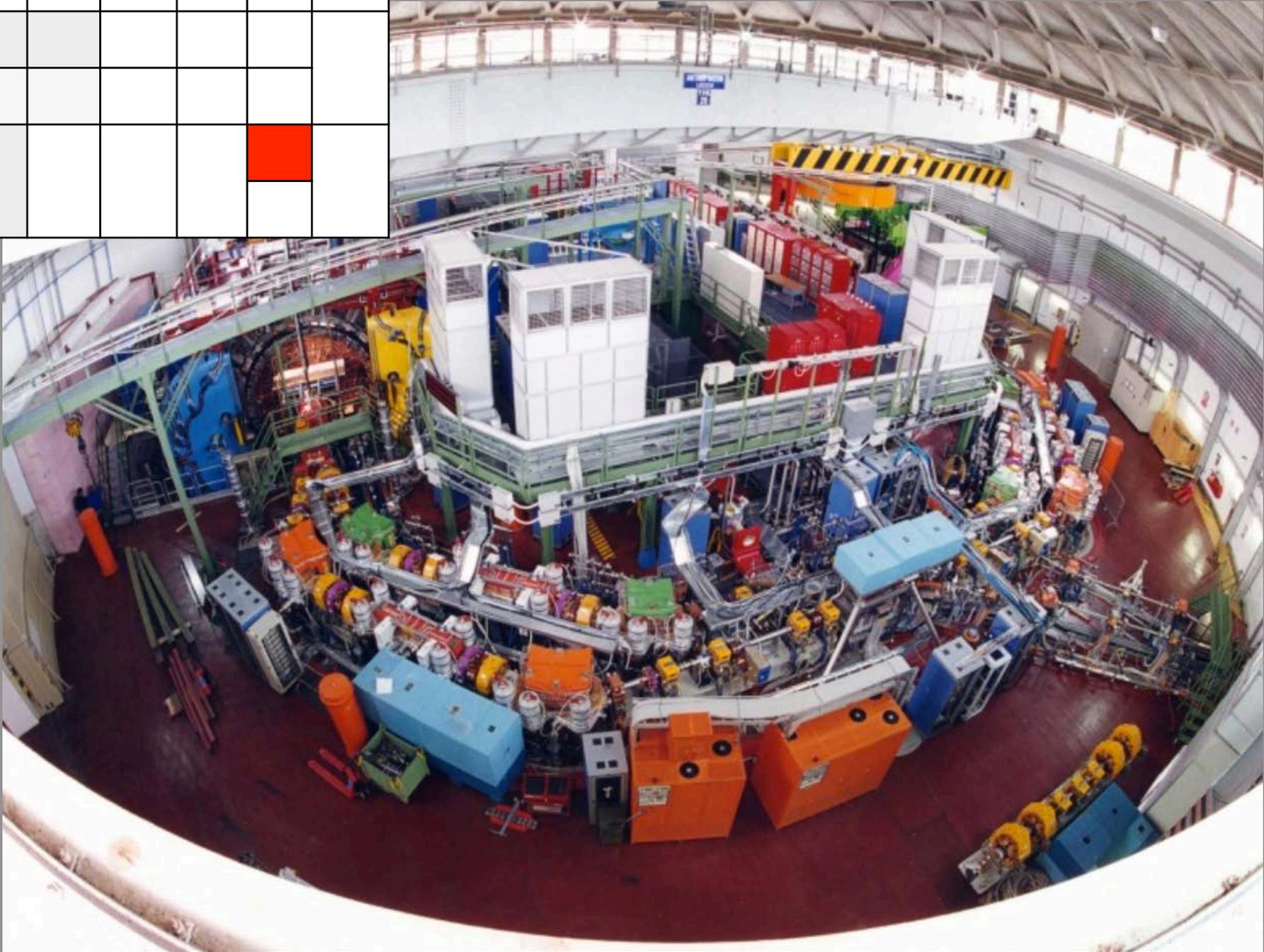


By Cush - Own work - previous version, CC0, <https://commons.wikimedia.org/w/index.php?curid=57404346>

	11	12	13	14	15

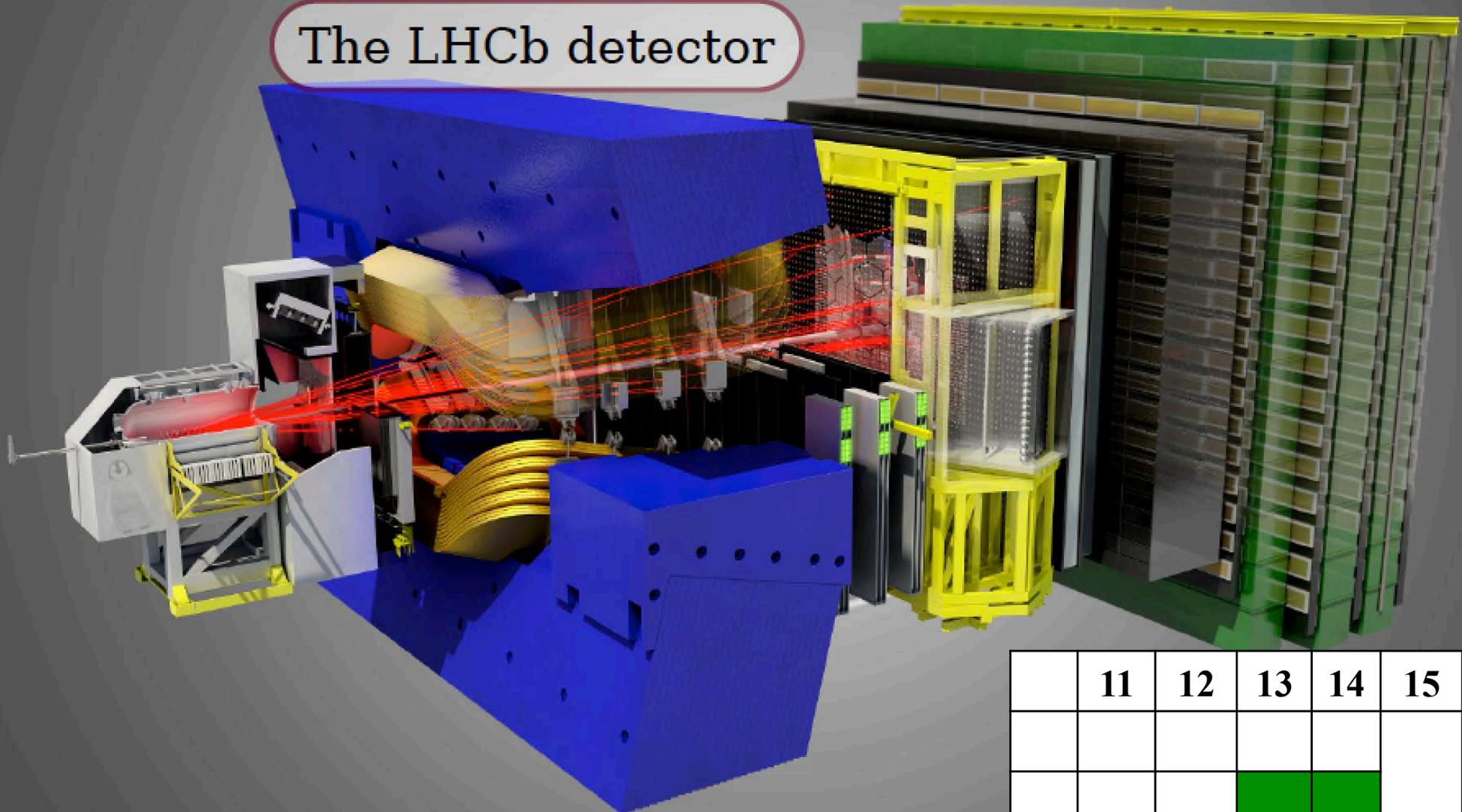


	11	12	13	14	15



- Barbara Sciascia (INFN/LNF) - Introduction IPPOG 2019 -

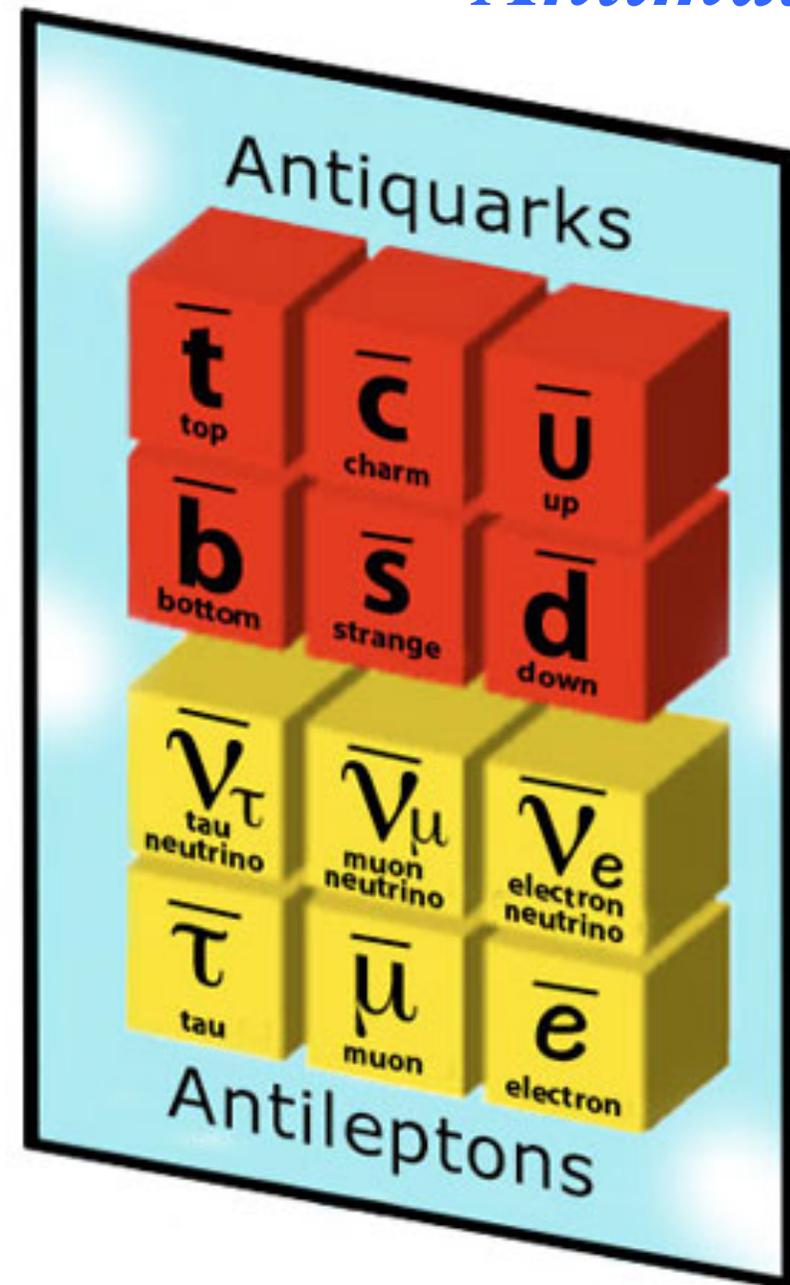
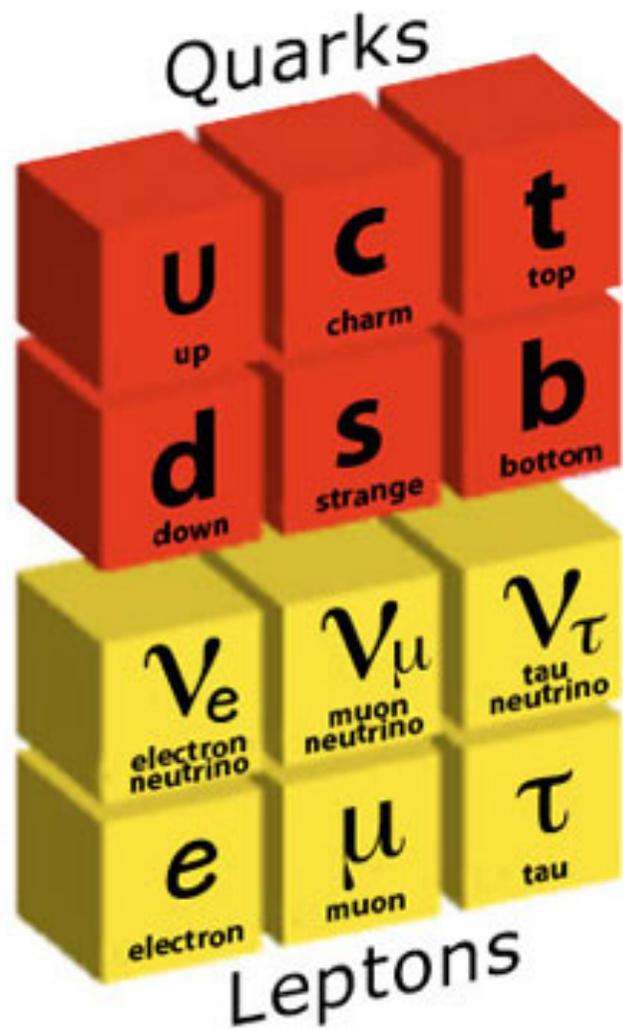
## The LHCb detector

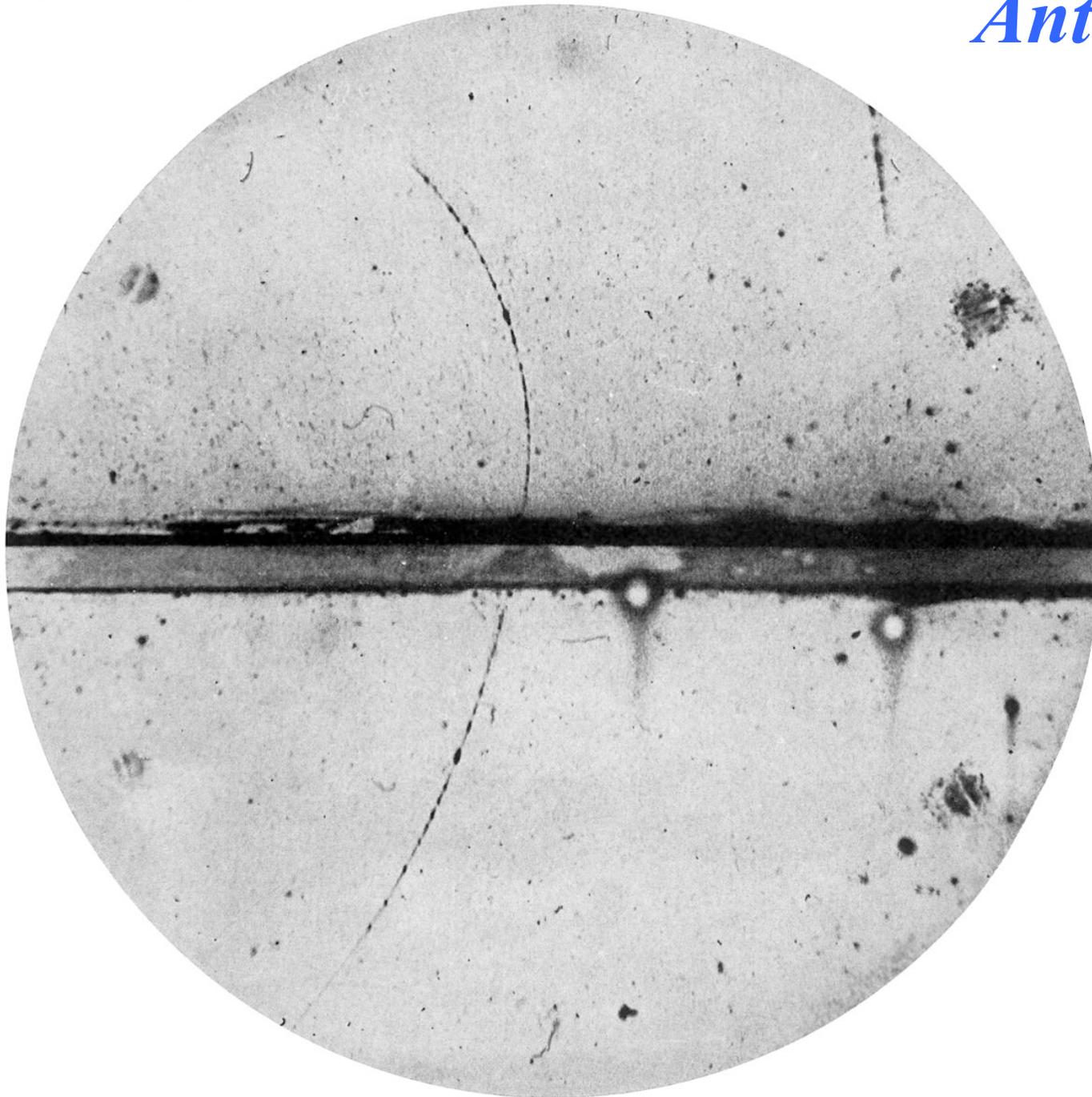


	11	12	13	14	15

[LHCb, A. Alves et al., The LHCb Detector at the LHC, JINST 3 (2008) S08005]

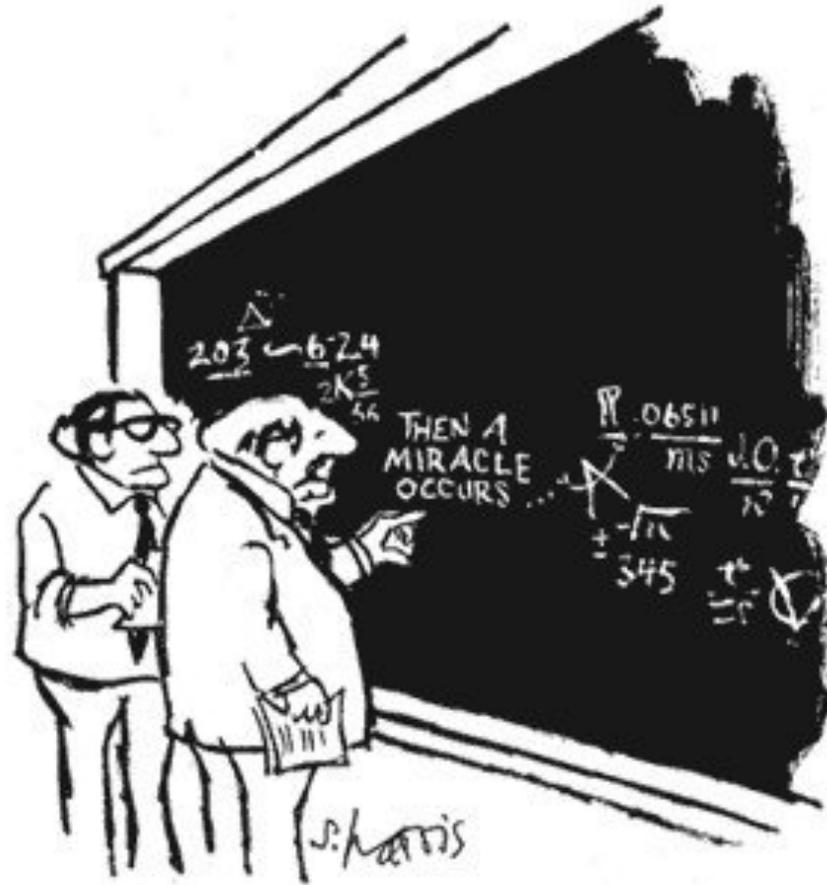
# Antimatter







# Quantitative approach...



"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

# Angeli e demoni

- **Creazione di atomi di anti-materia**: la prima volta 9 atomi in 3 settimane, oggi decine di migliaia al giorno. **10 milioni di miliardi di volte** per riempire un palloncino (cioè molti miliardi di anni)



- **Potere distruttivo**: con 0.5 g di anti-materia stesso effetto di una bomba nucleare da 20 kton, ma ci metteremmo miliardi di anni per produrla... è poco probabile che chiunque voglia aspettare così a lungo.
- **Costi**: l'anti-materia ha solo **1 decimiliardesimo dell'energia** usata per produrla. Tutta l'anti-materia finora prodotta al CERN potrebbe fornire energia per una lampadina per pochi minuti.



# Interstellar



Direct link, Thursday 14 March, 4.30 pm: <https://indico.cern.ch/event/803887/>

Dear colleagues,

Please find details related to the CERN Colloquium on Thursday 14 March in Main Auditorium (500-1-001) at 16h30:

**Art and Science in the Movies: the Visual Effects of Interstellar**

**by Mr Graham Jack (Chief Technology Officer, DNEG), Mr Oliver James (Chief Scientist, DNEG), Mr Paul Franklin (Co-Founder and Senior Visual Effects Supervisor, DNEG)**

<https://indico.cern.ch/event/803887/>

**Abstract:**

Christopher Nolan's science-fiction epic *Interstellar* presented DNEG the opportunity to combine visual storytelling with theoretical physics.

We discuss our Research & Development efforts to visualise the complex physics of black holes and gravitational waves: How did we approach the visual effects for this movie, namely the design of a virtual environment to represent higher spatial dimensions and our collaboration with Kip Thorne (Nobel Prize in Physics, 2017) to develop a new renderer to ray-trace through gravitationally warped space.

This project, in the region where art and science overlap, resulted in the publication of two academic papers, and contributed to the movie winning both the Academy Award and BAFTA for Special Visual Effects.

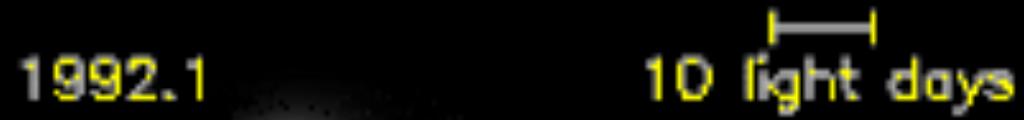
# *Interstellar*



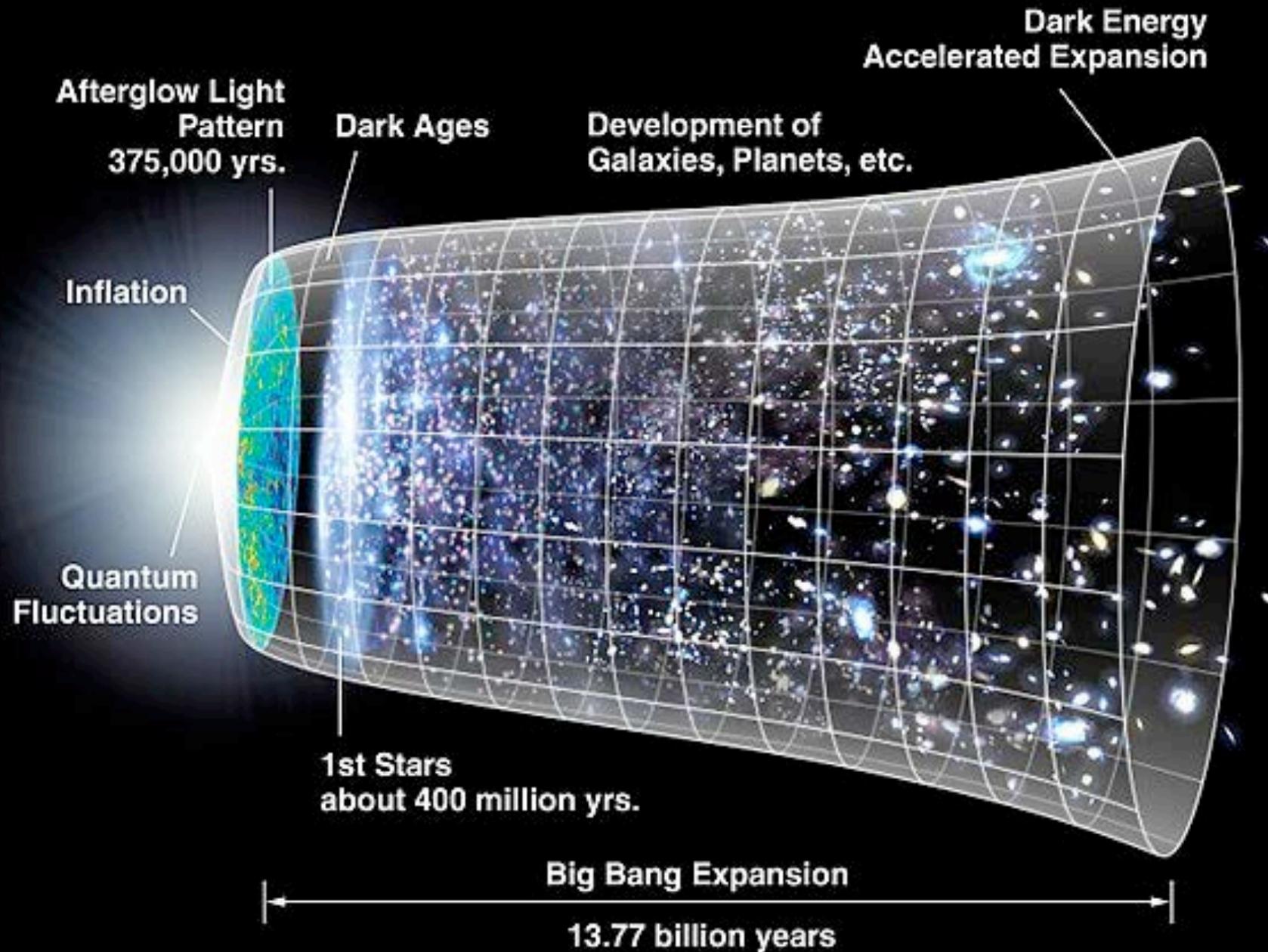
# *Al centro della Galassia*

1992.1

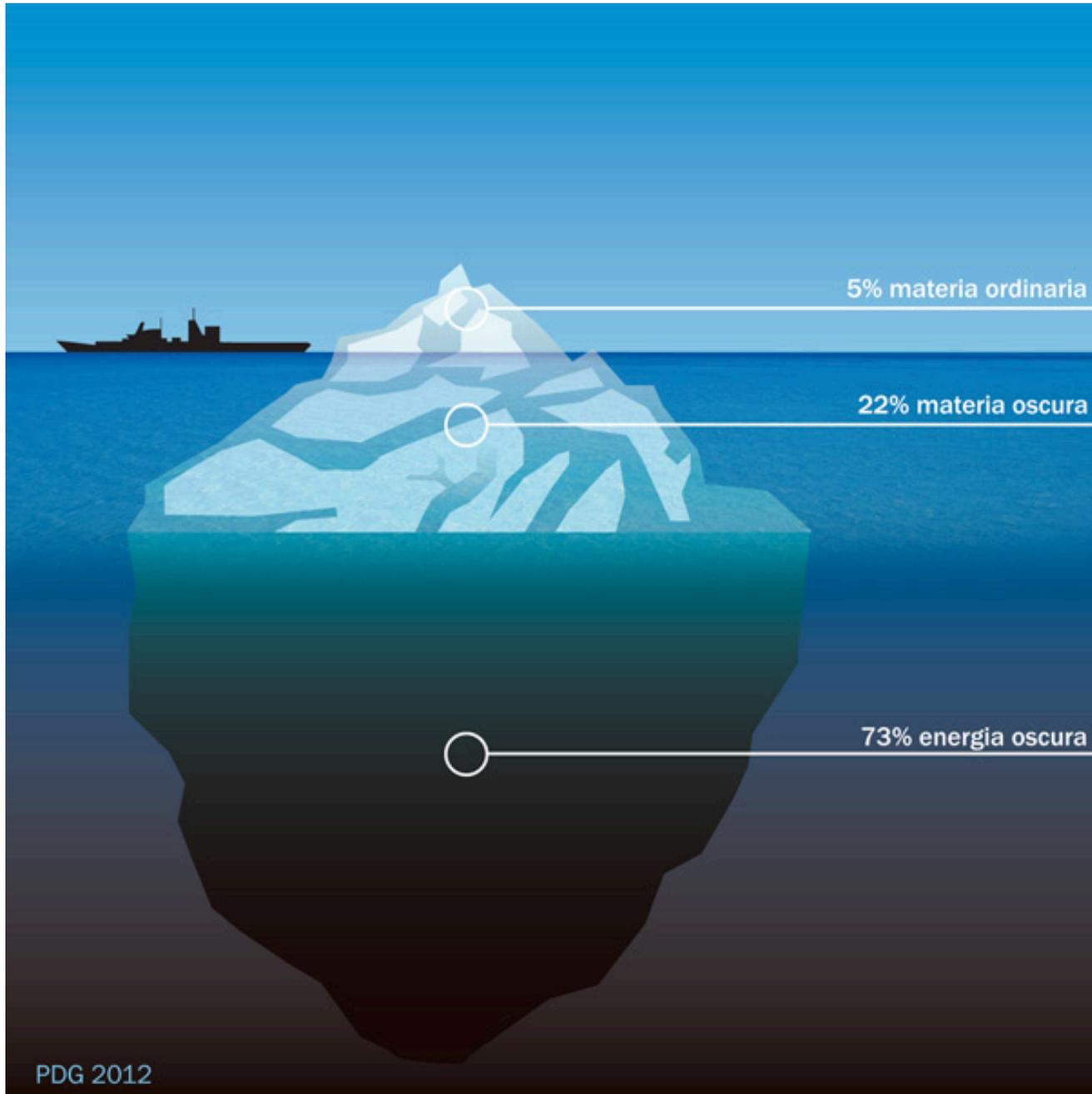
10 light days



# Cosmological Standard Model



Credits: <https://commons.wikimedia.org/w/index.php?curid=11885244>



[PDG 2018:  
Materia ordinaria 4.84%  
Materia oscura 25.8%  
Energia oscura 69.2%]

# *La signora dell'oscurità*



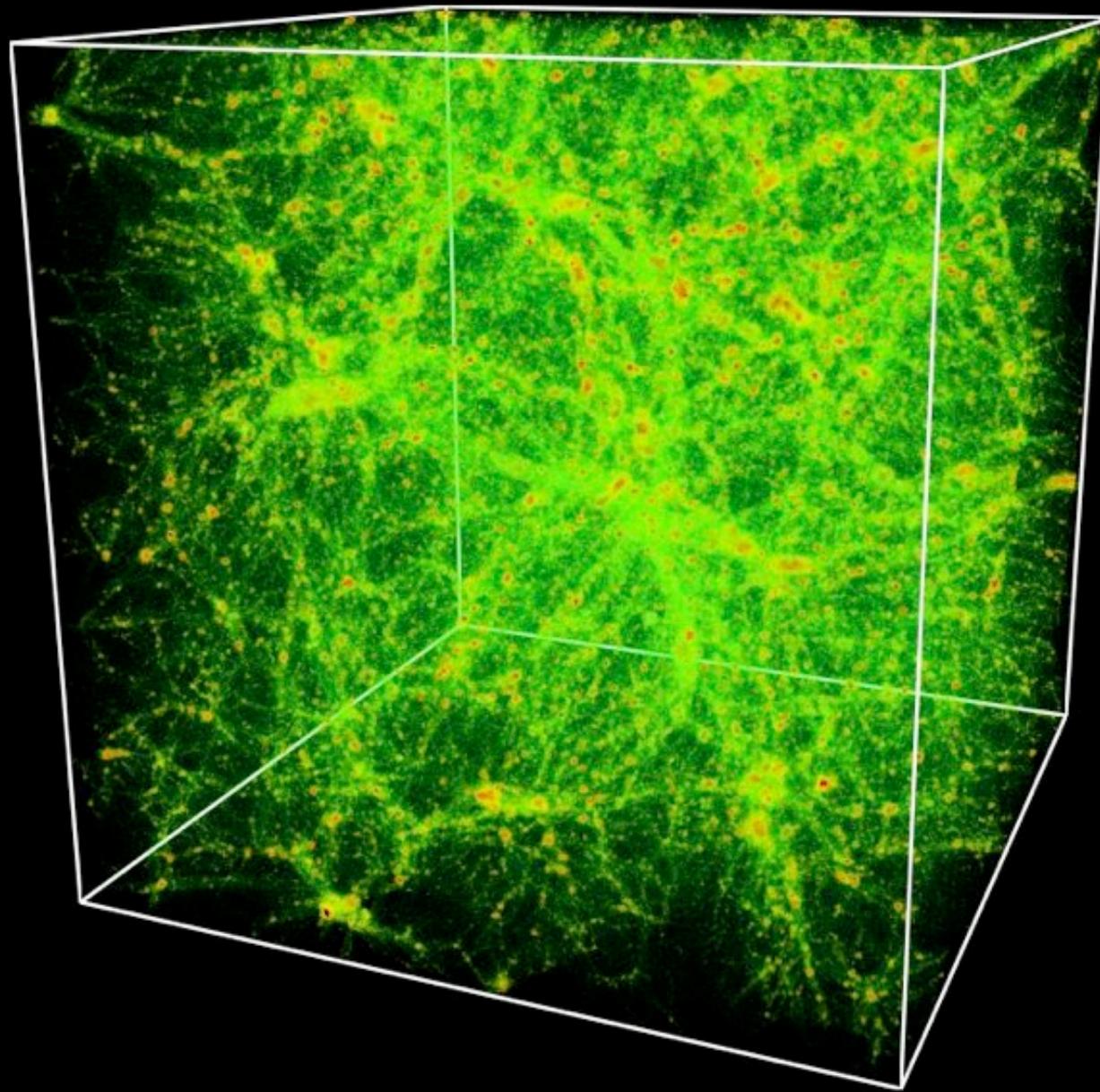
Vera Rubin, 1928 - 2016



# *Materia e Materia Oscura*

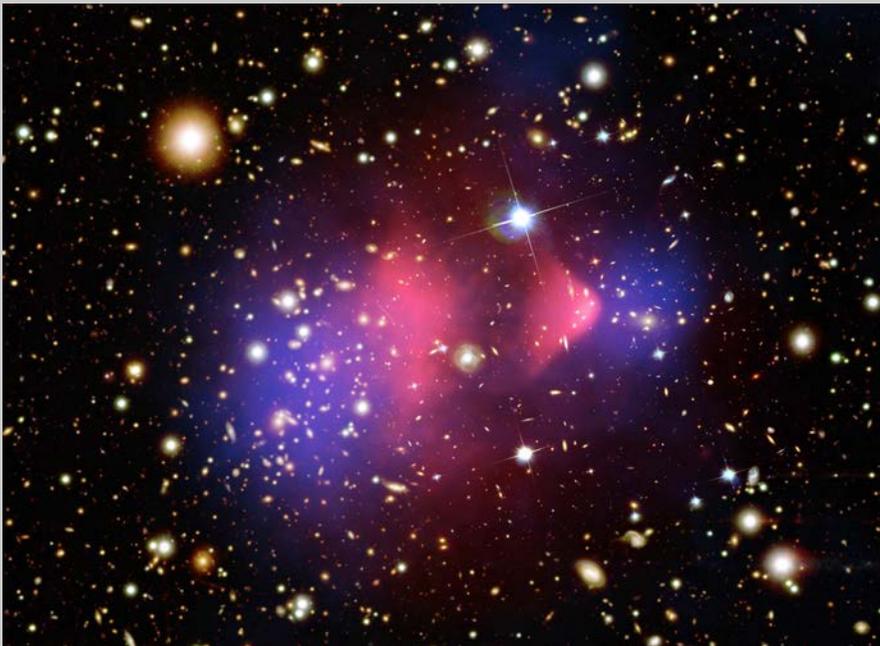
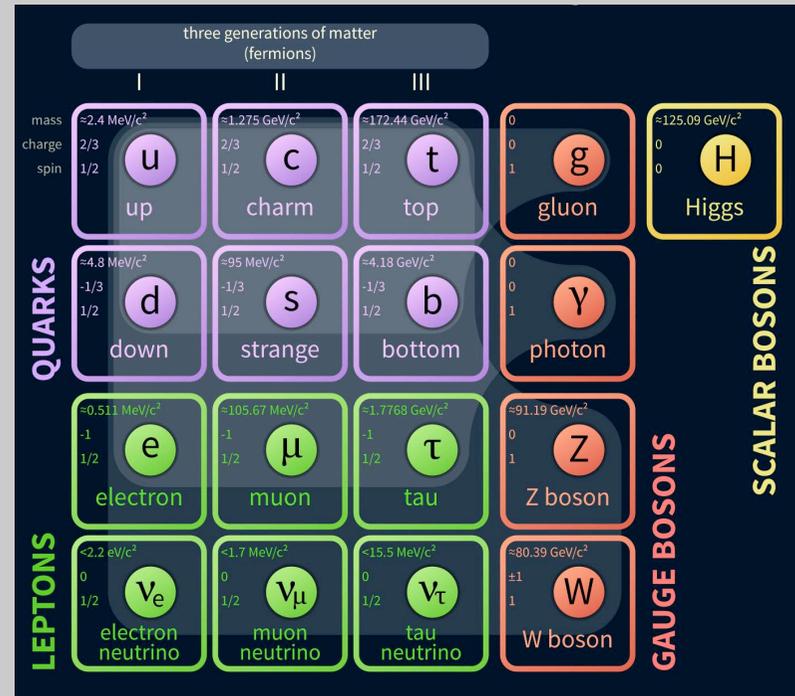


# *Materia e Materia Oscura*

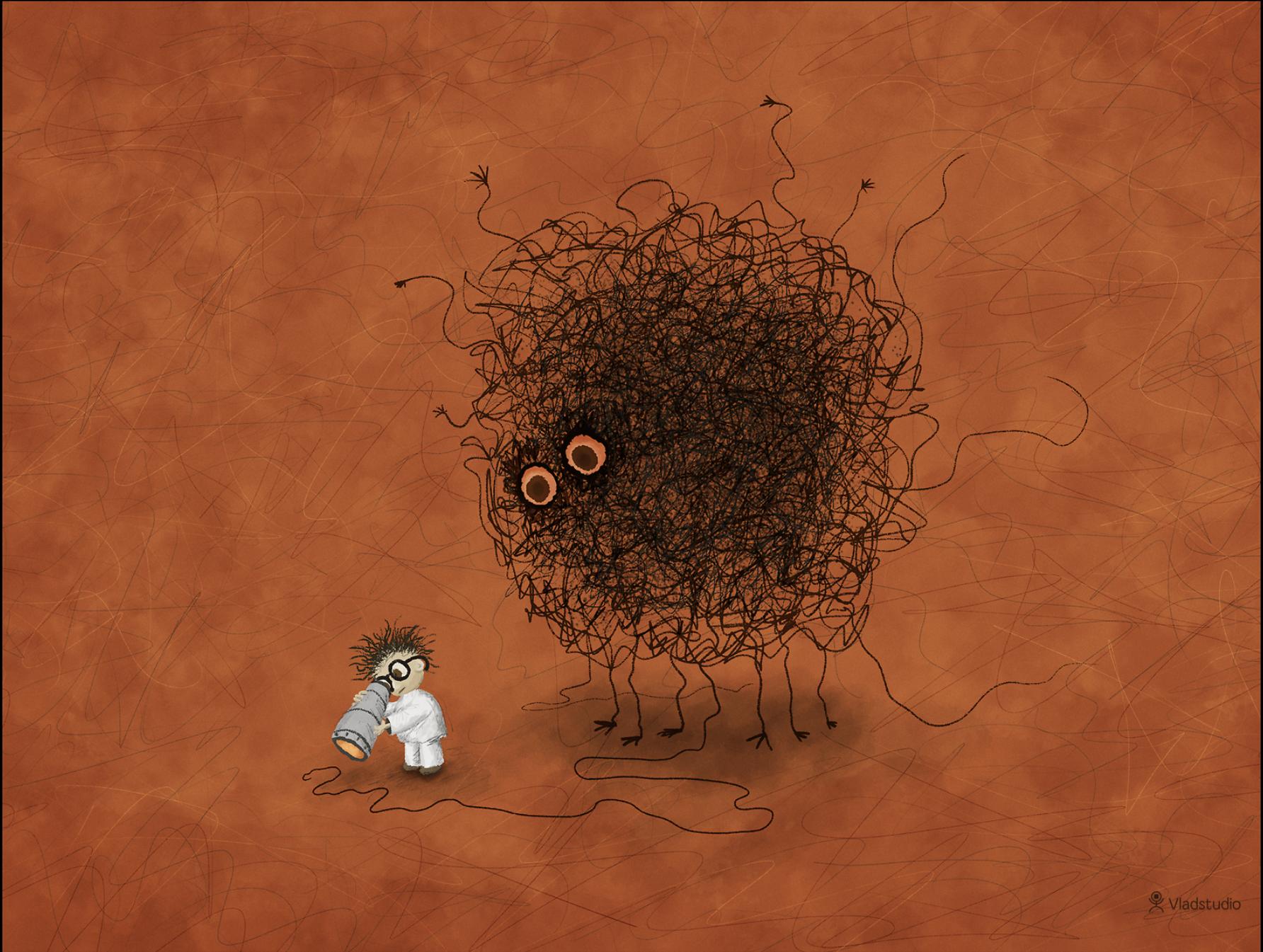


# Open points: SM (and beyond)

- No explanation for the quark hierarchy
- Why are there 3 families/generations?
- No real explanation for CP violation
- Why it is only found in the weak interaction?
- Mass value of the Higgs boson
- EW and strong unification
- ...



- No explanation for baryogenesis
- Dark matter and dark energy
- Neutrino masses
- Gravity
- ...



 Vladstudio