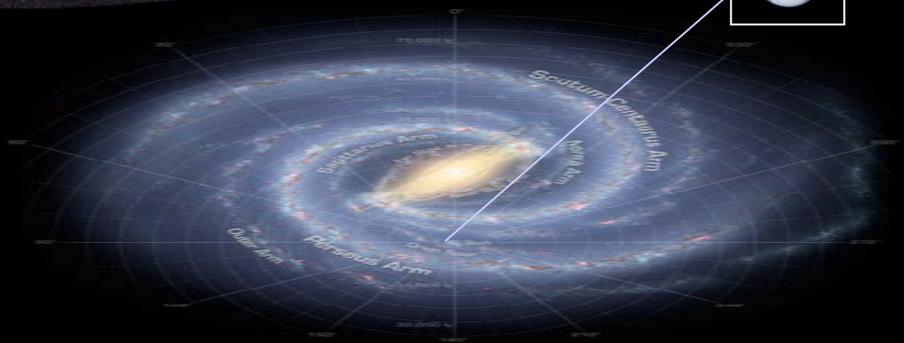
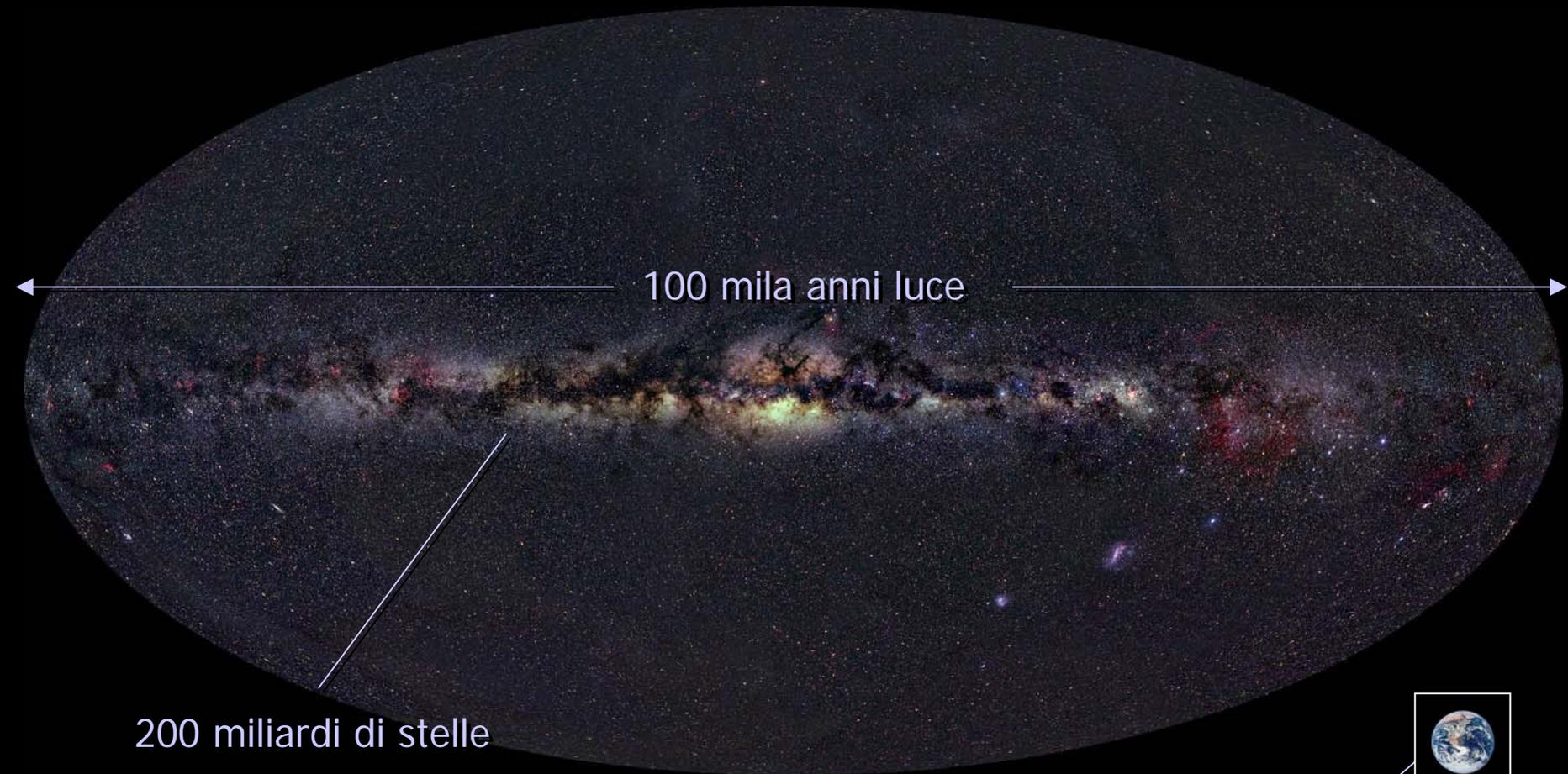


" Se guardo il Tuo cielo ..."

Emilia Regni & Marco Laveder

Padova, Dip. di Astronomia 24 marzo 2011

La Via Lattea





Mappa tridimensionale dell'universo

2dF Galaxy Redshift Survey
Goal: 250,000 galaxies mapped

Sloan Digital Sky Survey
Goal: 1 million galaxies
100,000 QSO



*« Se guardo il tuo cielo, opera delle tue dita,
la luna e le stelle che tu hai fissate,
che cosa è l'uomo perché te ne ricordi
e il figlio dell'uomo perché te ne curi? »*

*« Eppure l'hai fatto poco meno di Te,
di gloria e di onore lo hai coronato. »*

(Sal, 8: 3-6)



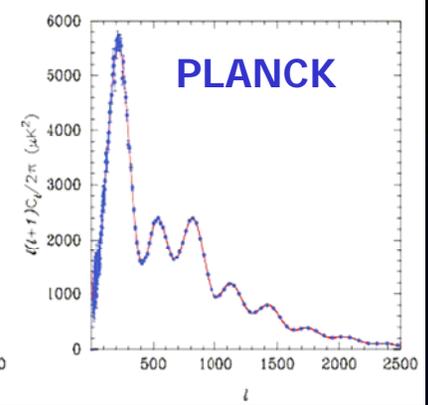
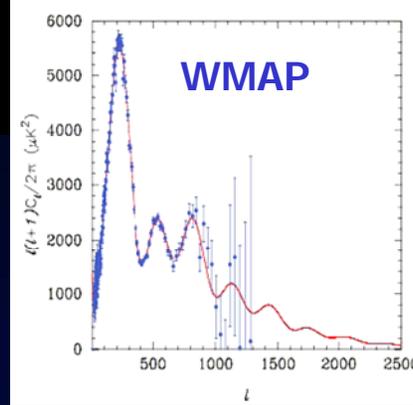
Planck: precision cosmology



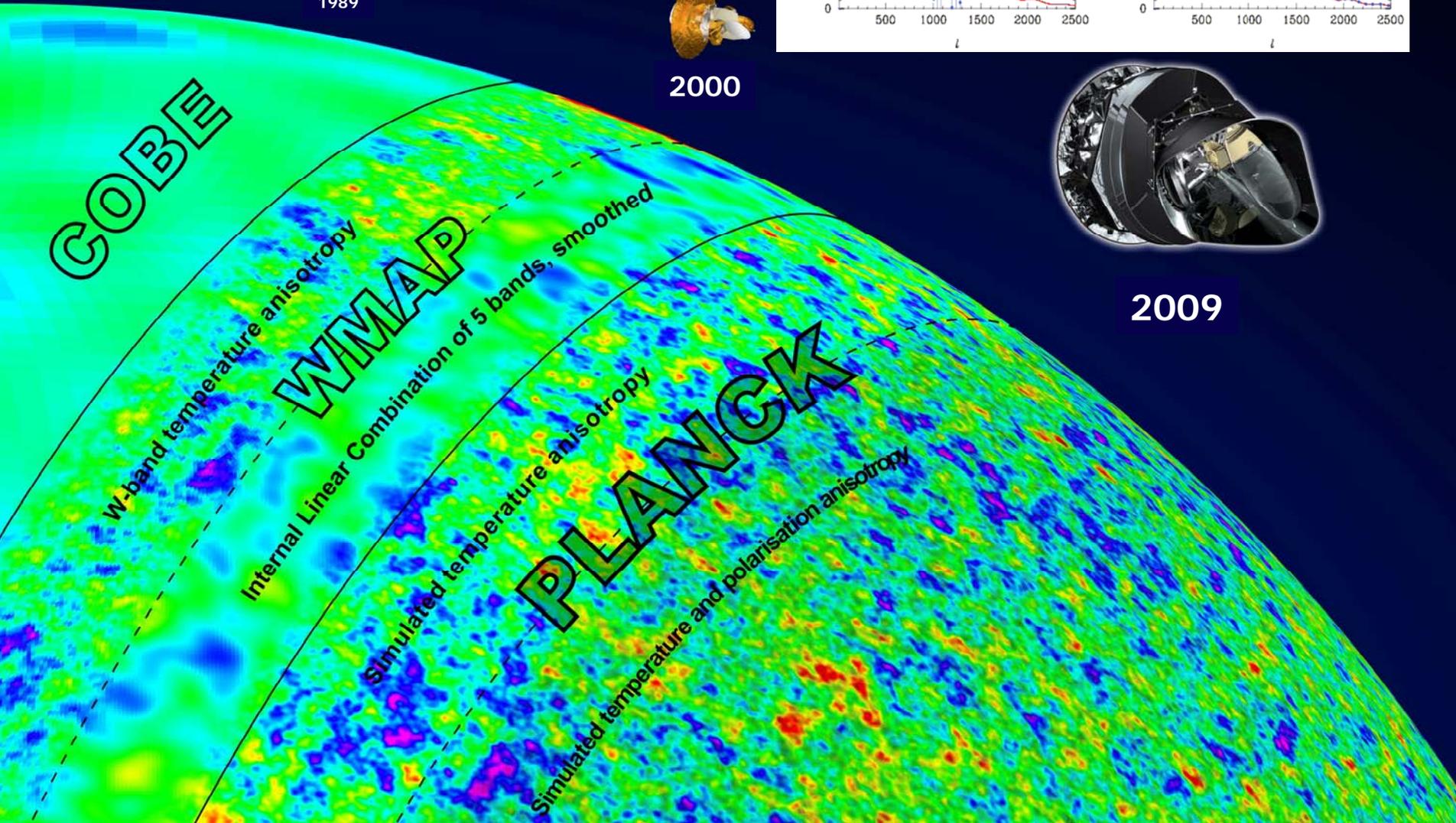
1989



2000

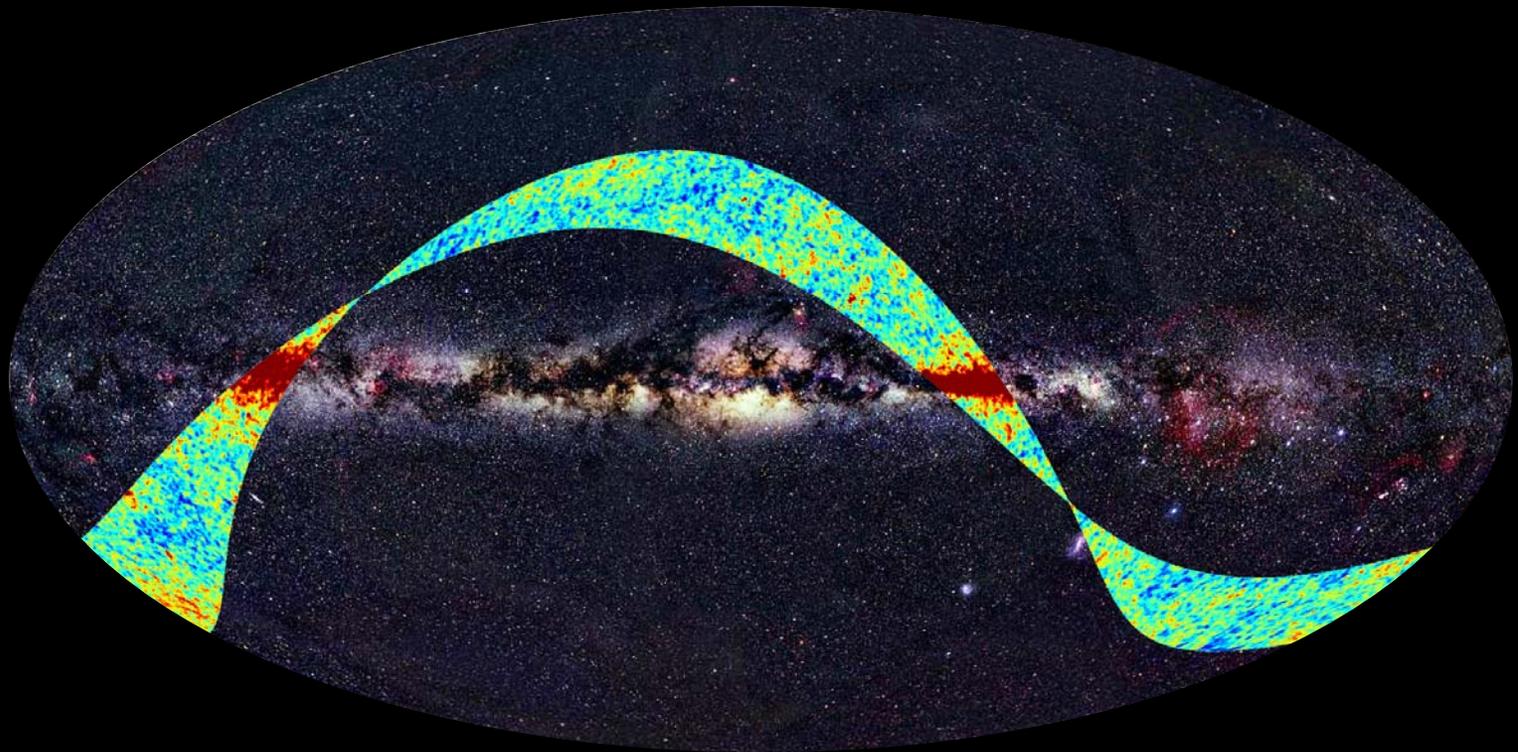


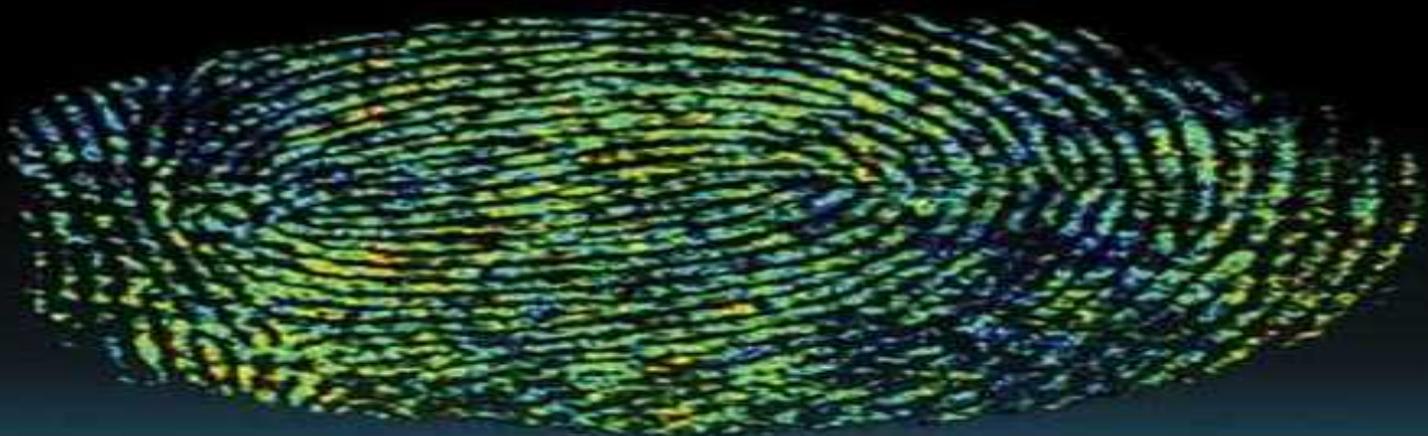
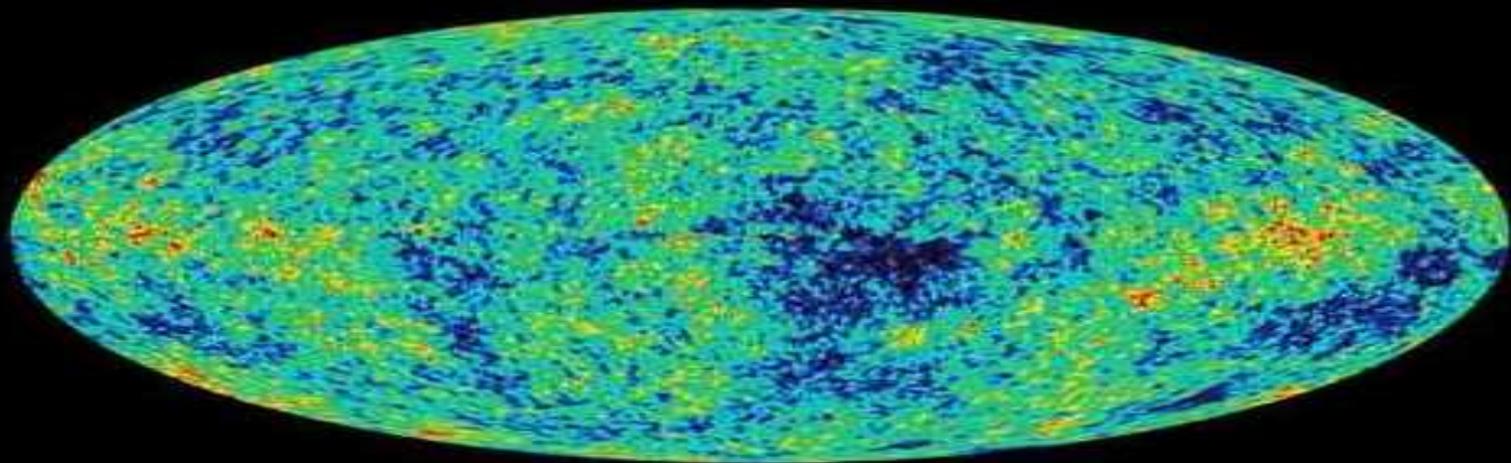
2009



First Planck data

October 2009





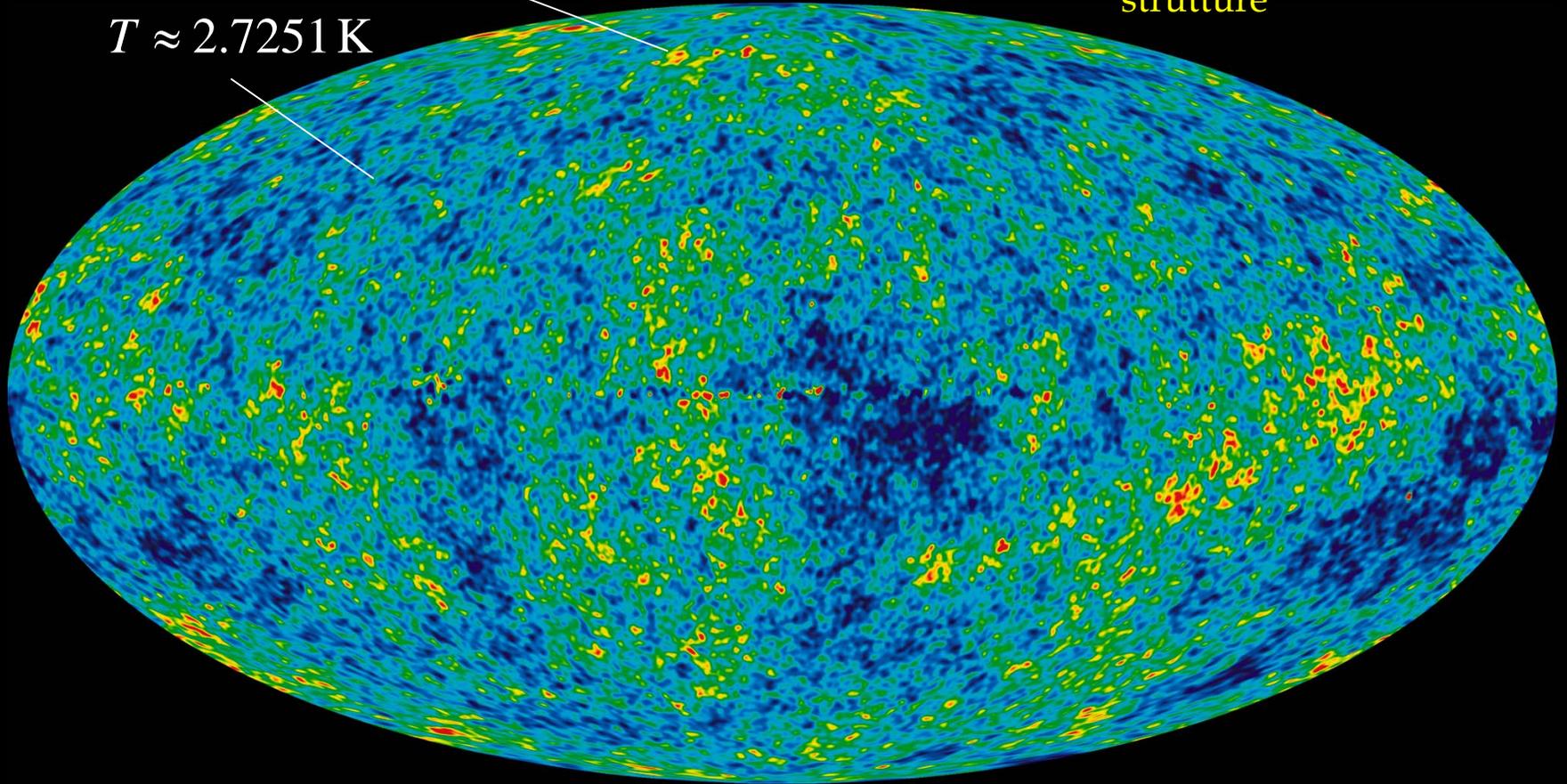
L'universo 13.7 miliardi di anni fa

$$\frac{\Delta T}{T} \approx \frac{\Delta \rho}{\rho} \approx 10^{-5} \longrightarrow$$

Fluttuazioni di diversa intensità incompatibili con evoluzione delle strutture

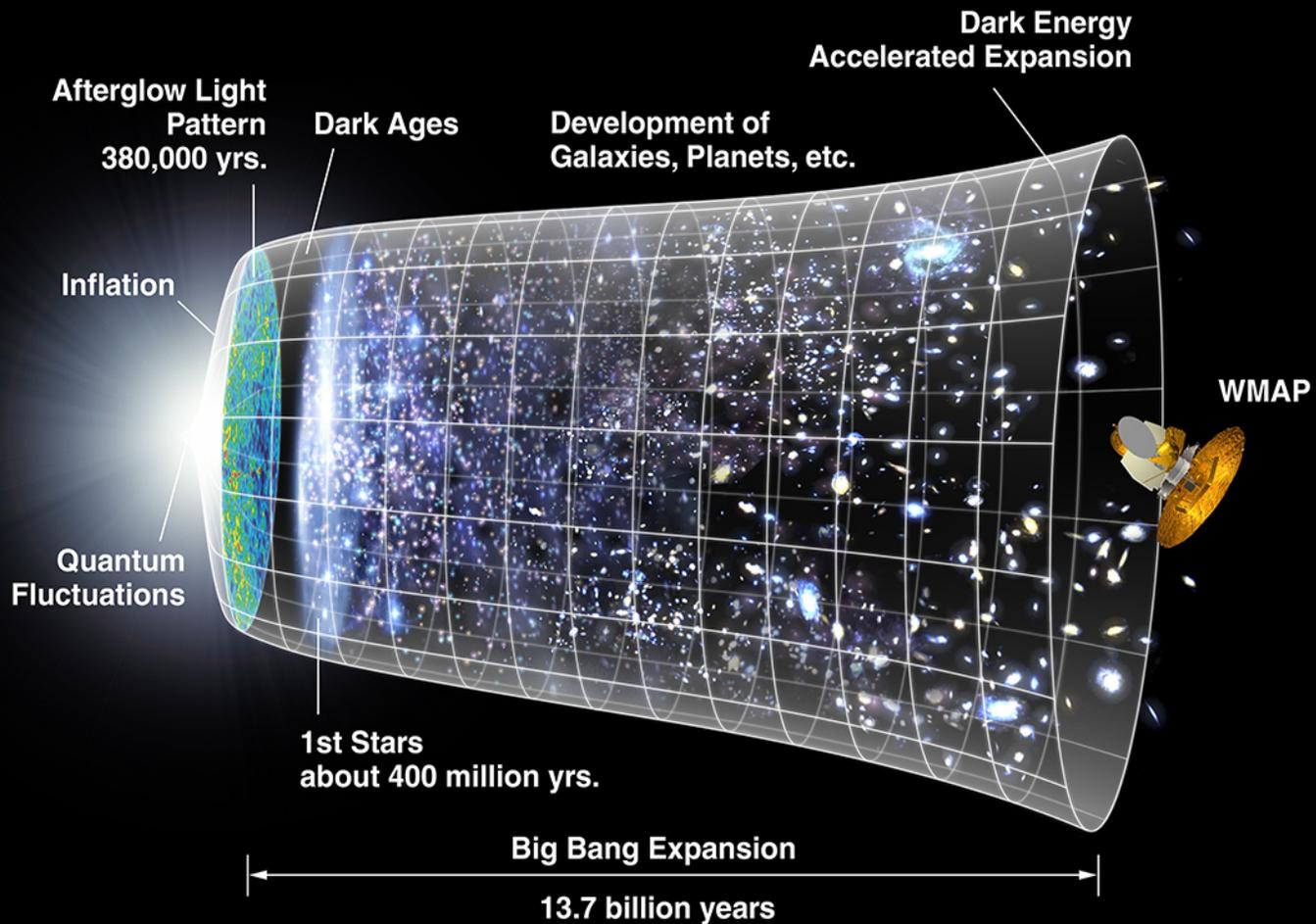
$T \approx 2.7252 \text{ K}$

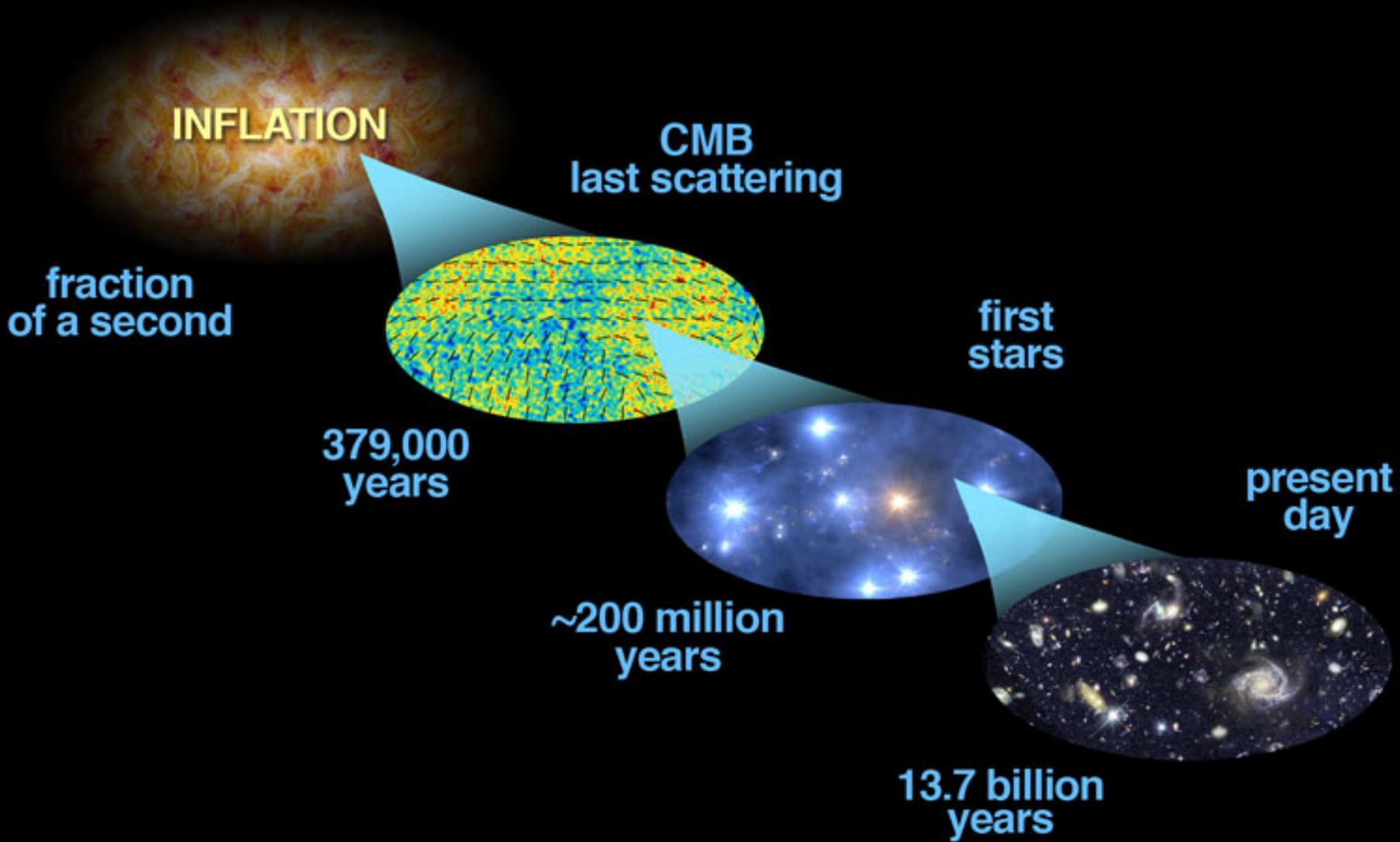
$T \approx 2.7251 \text{ K}$



WMAP, 2001

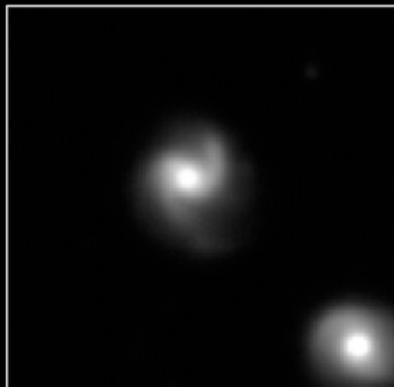
$\longrightarrow H_0, \Omega_M, \Omega_\Lambda, \Omega_R, \Omega_0$



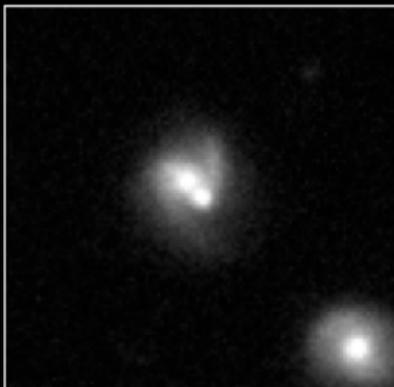


L'imprevisto

Reference image



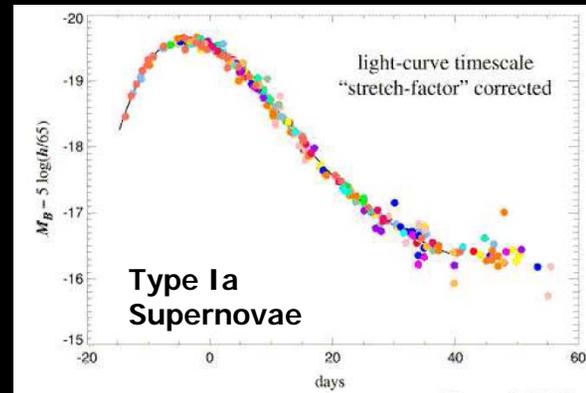
SN event



Subtraction image



Light curve



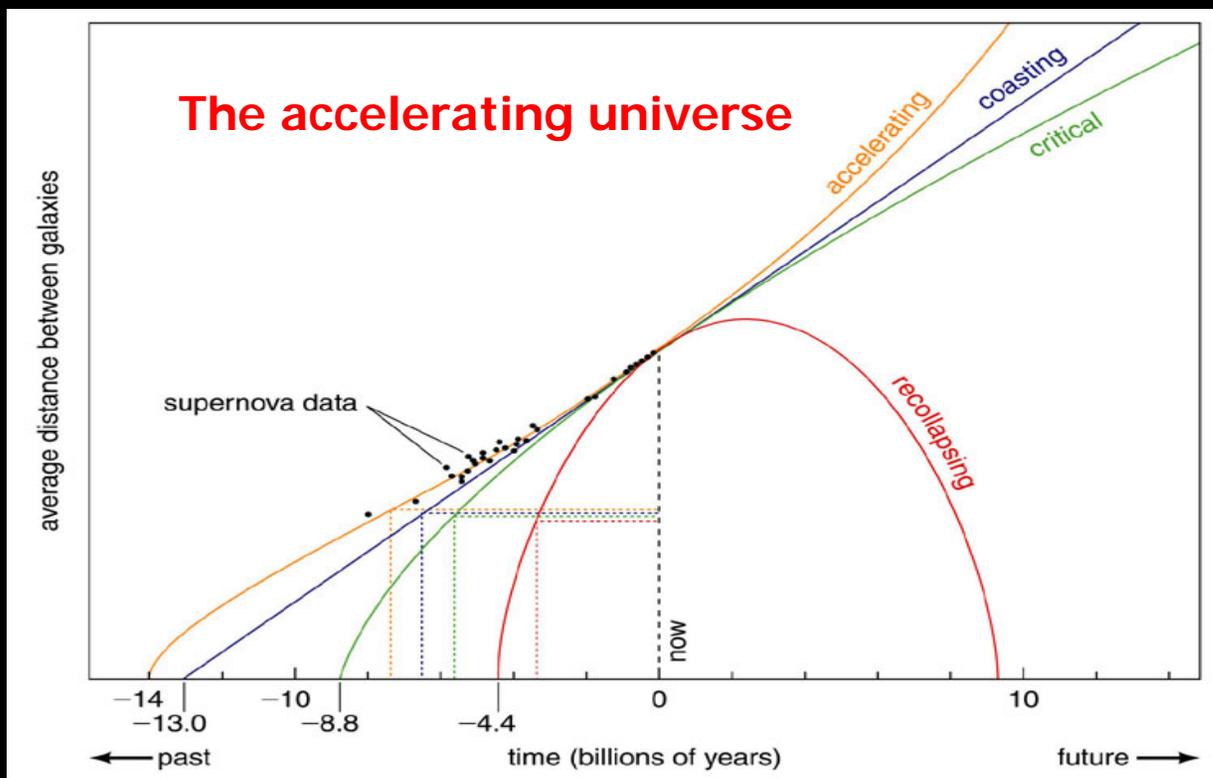
Standard
candels



Distance
indicators



Distance vs
expansion rate



THE STANDARD MODEL OF COSMOLOGY

- Atoms make up only 4% of the Universe

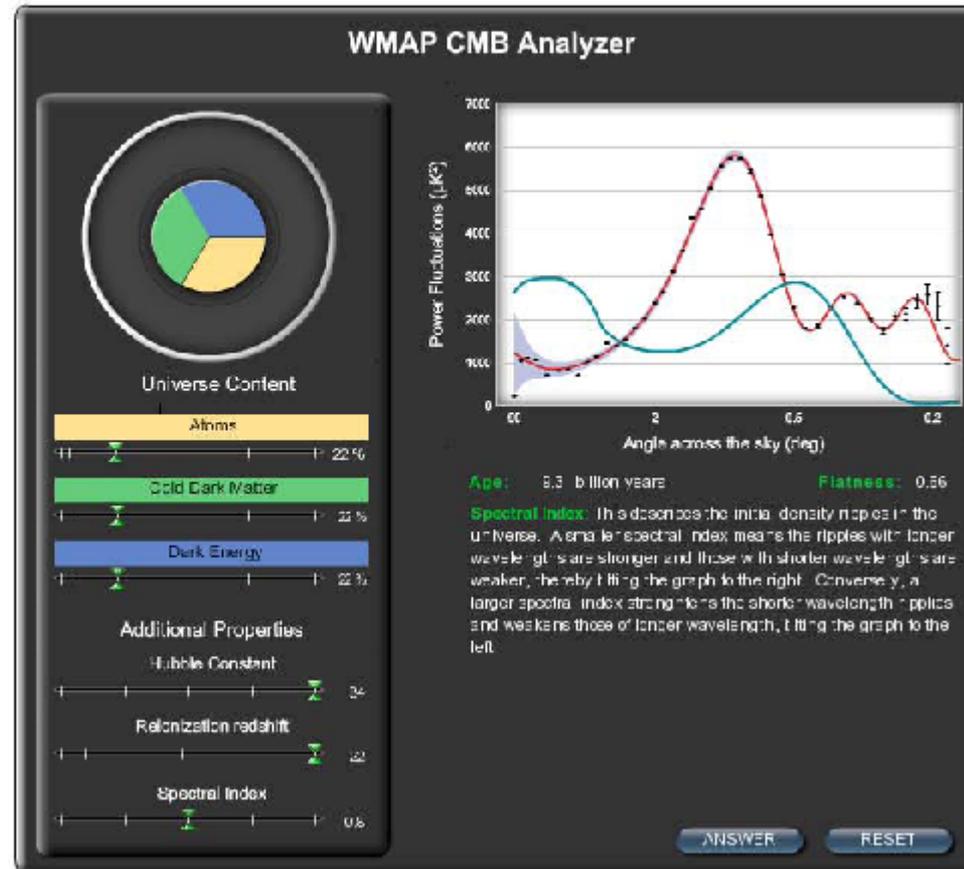


- The rest of the matter is dark matter, which does not shine or reflect light
 - Not atoms
 - Cold
 - Stable
- Also, 73% of the Universe isn't even matter

http://map.gsfc.nasa.gov/resources/camb_tool/index.html

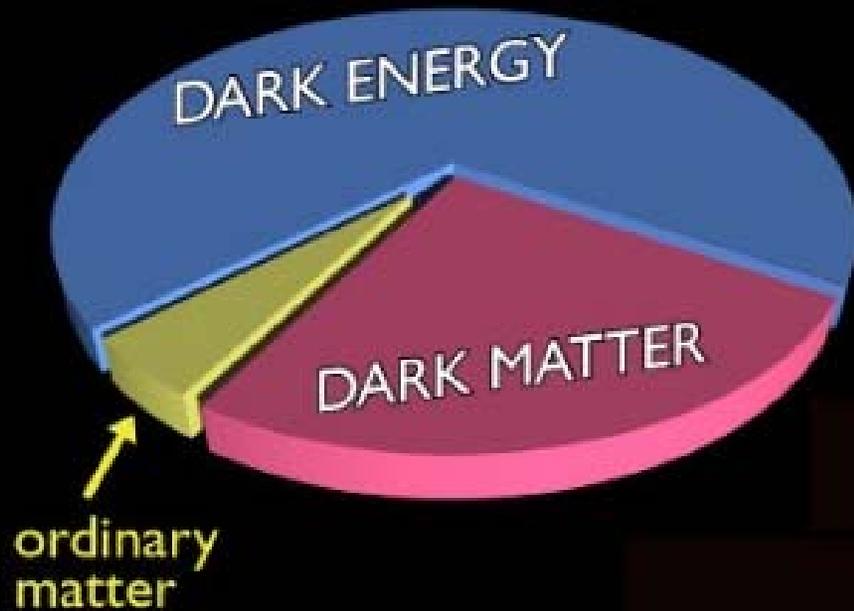
ing
web site.

USE THE SLIDERS TO MATCH THE **BLUE LINE** TO THE **RED LINE**



This tool requires an Adobe Flash player to be installed for your browser. Make full screen in new window

Universo sconosciuto



- Quali sono i costituenti dell'universo?
- Che cosa è accaduto nei primissimi istanti?
- Qual è il destino dell'espansione?

«La sapienza si è costruita una casa» (Pro 9, 1).

La potenza di Dio e Padre, per se stessa sussistente, si è preparata, come propria dimora, l'universo intero, nel quale abita con la sua forza creatrice.



Questo universo, che è stato creato ad immagine e somiglianza di Dio, consta di natura visibile e invisibile.

«Commento sui Proverbi» di san Procopio di Gaza

Key Questions of Particle Physics

origin of mass/matter or
origin of electroweak symmetry breaking

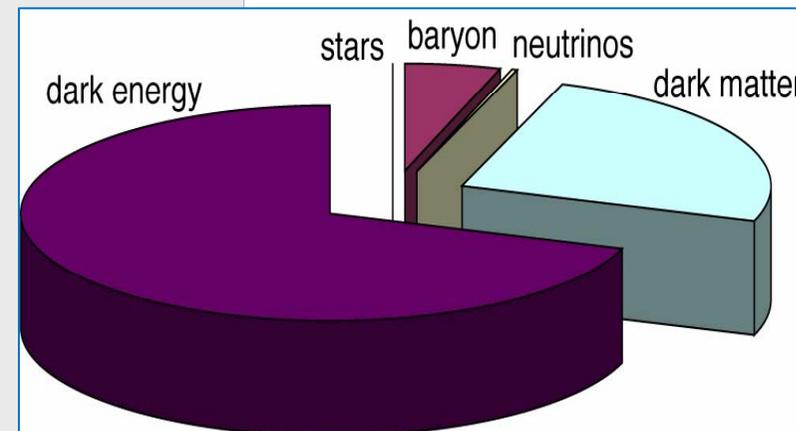
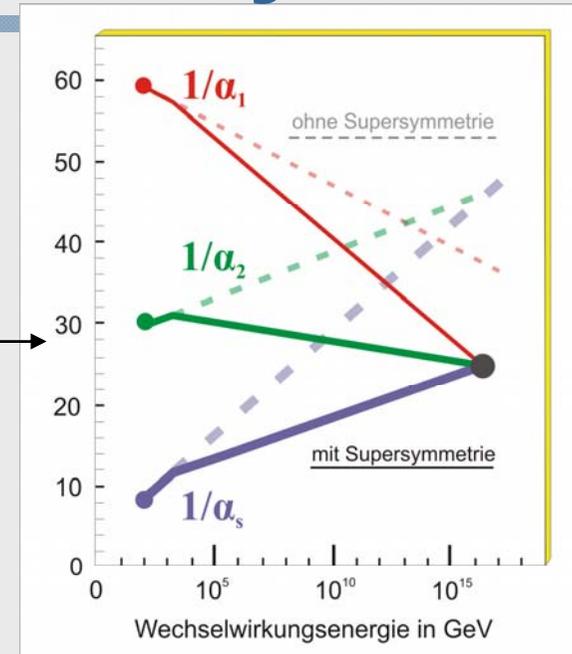
unification of forces

fundamental symmetry of forces and
matter

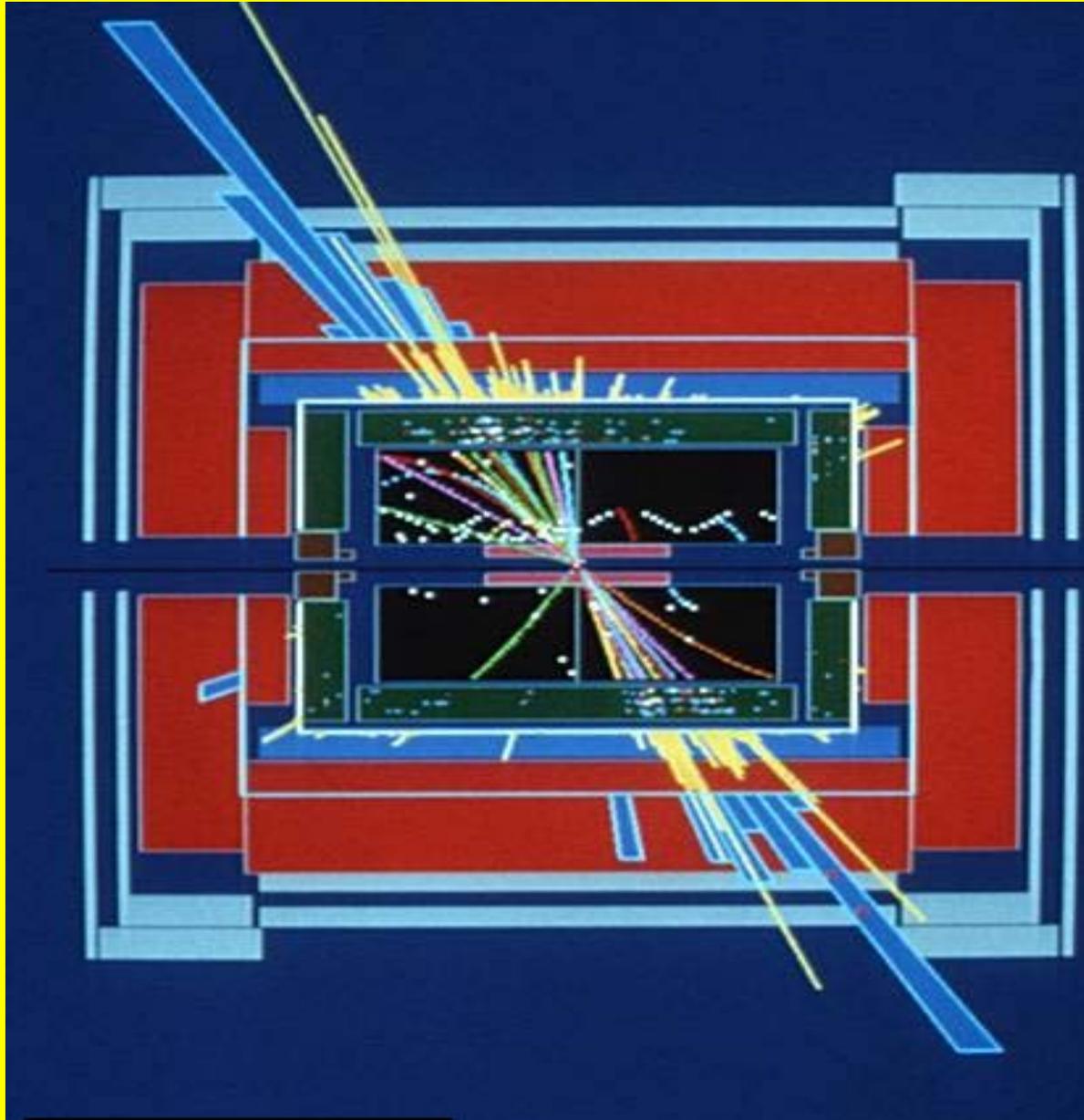
unification of quantum physics and
general relativity

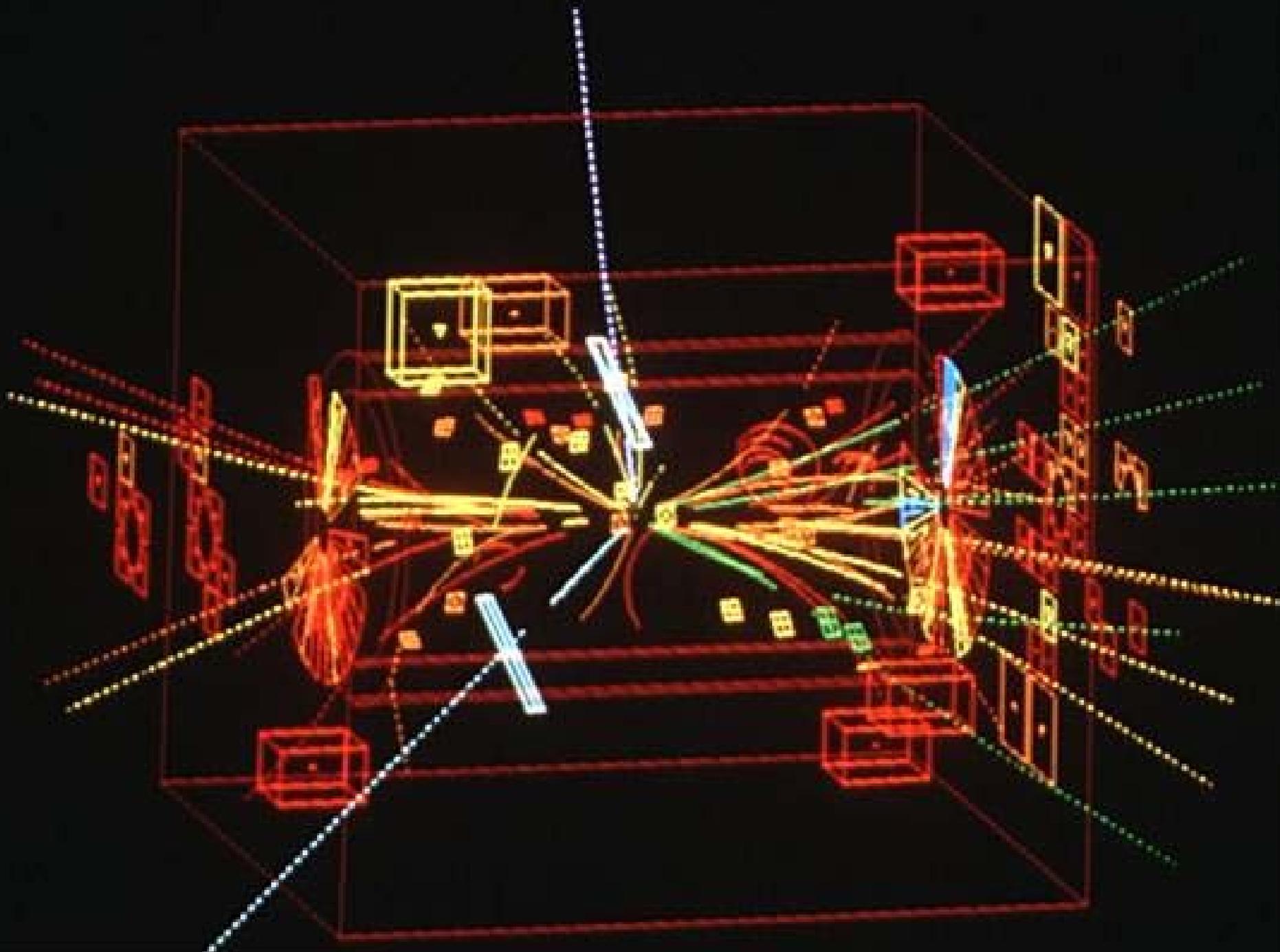
number of space/time dimensions

what is dark matter
what is dark energy



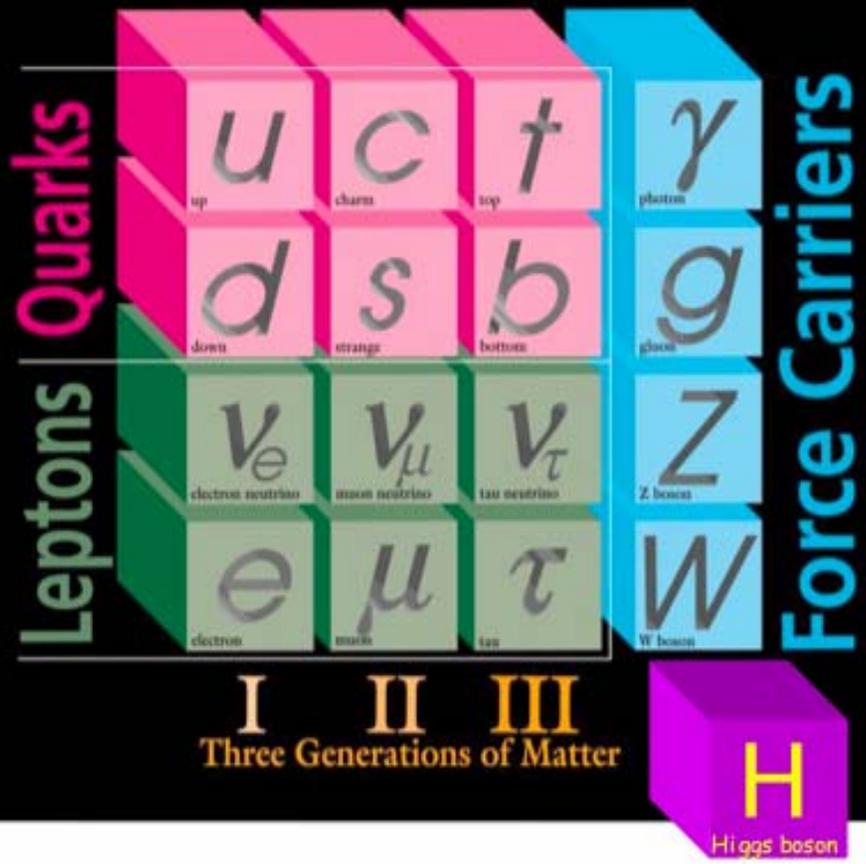
Modello Standard





Gravity
?

The Standard Model



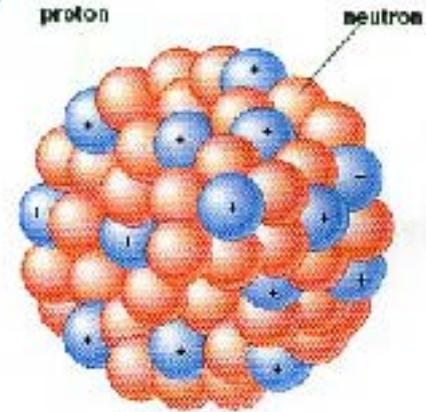
4 FORCES OF NATURE

- Gravity



Gravity ?

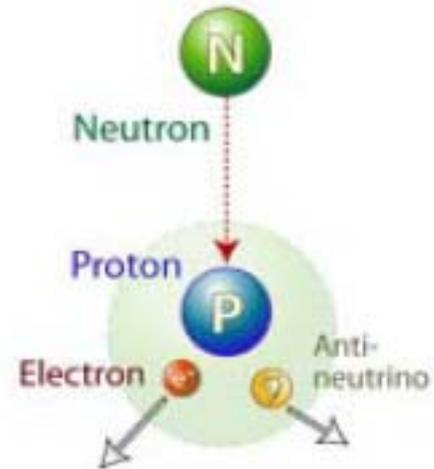
- Strong



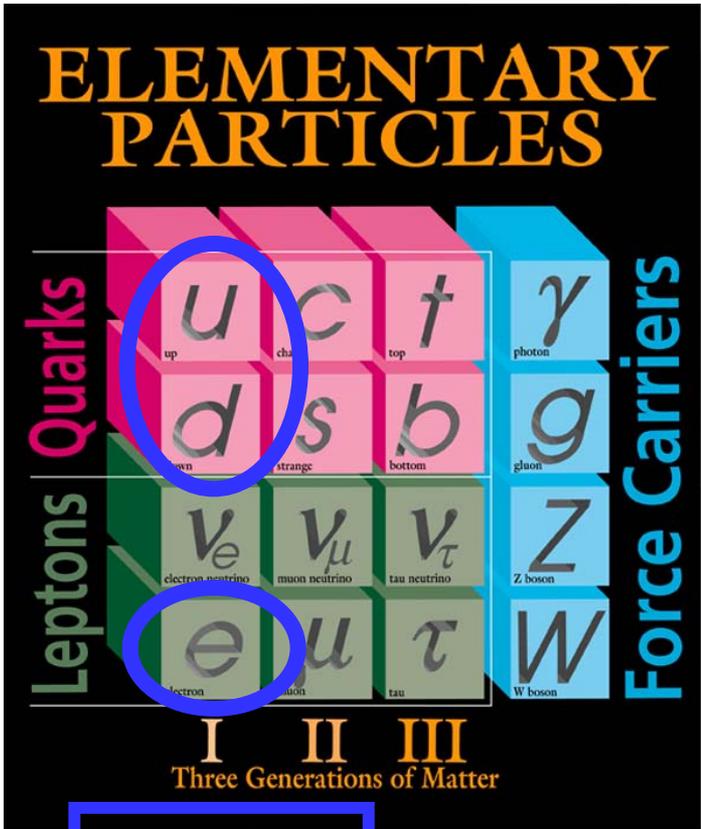
- Electromagnetism



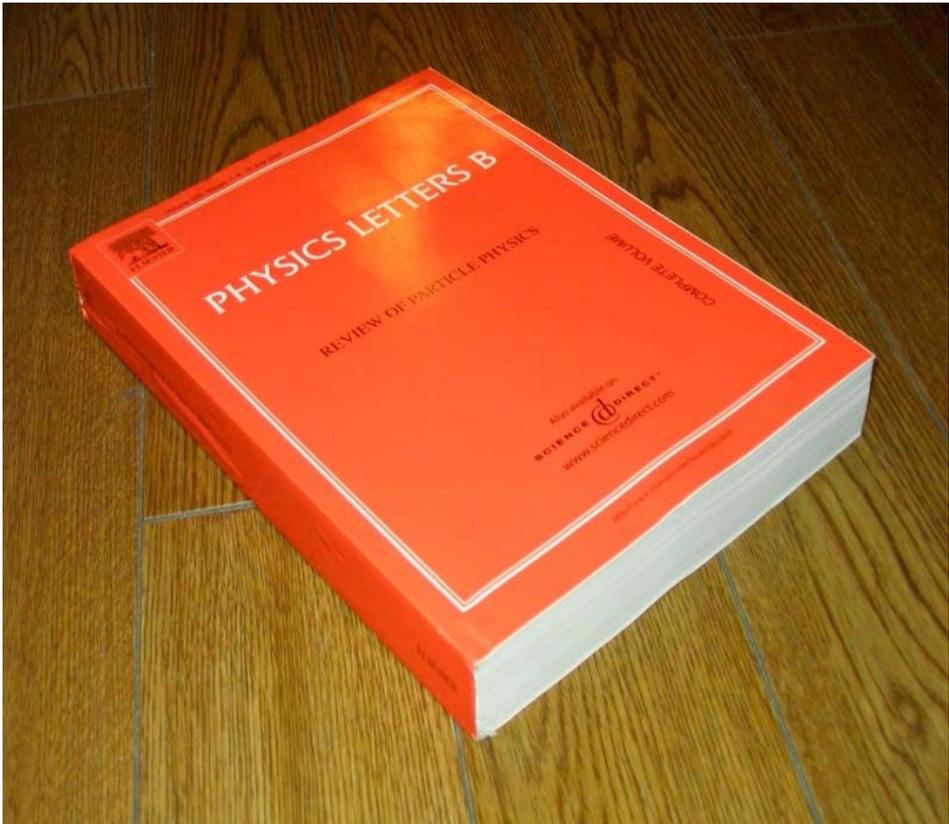
- Weak



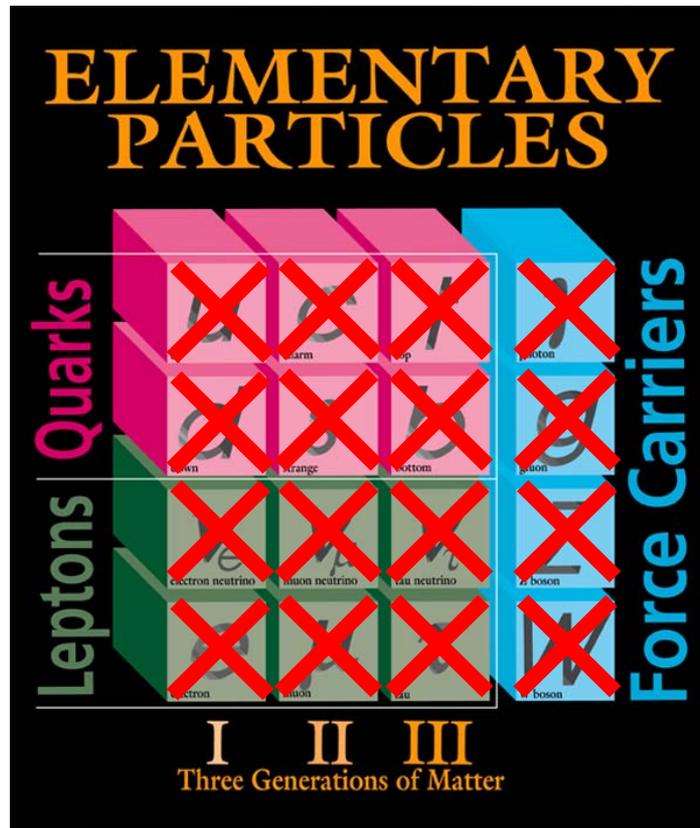
STANDARD MODEL OF PARTICLE PHYSICS



Atoms



WHICH PARTICLE IS DARK MATTER?



Known DM properties

- Not atoms
- Cold
- Stable

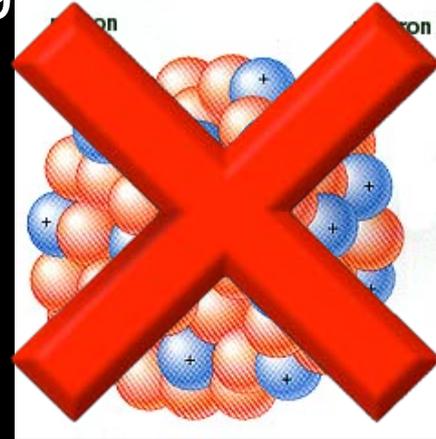
The extraordinarily successful standard models of cosmology and particle physics are inconsistent

WHICH FORCES DOES DARK MATTER FEEL?

- Gravity



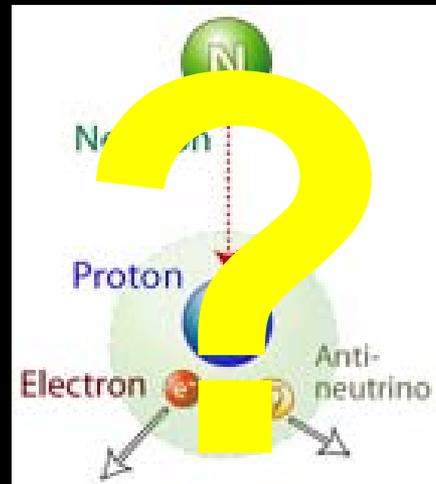
- Strong



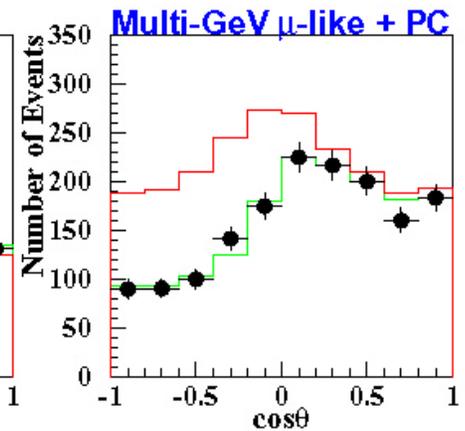
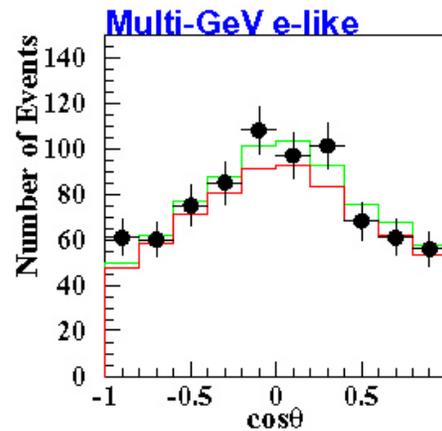
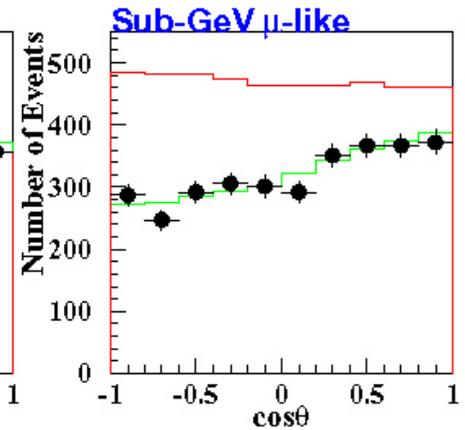
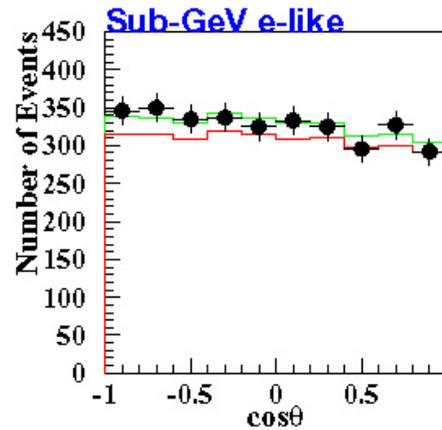
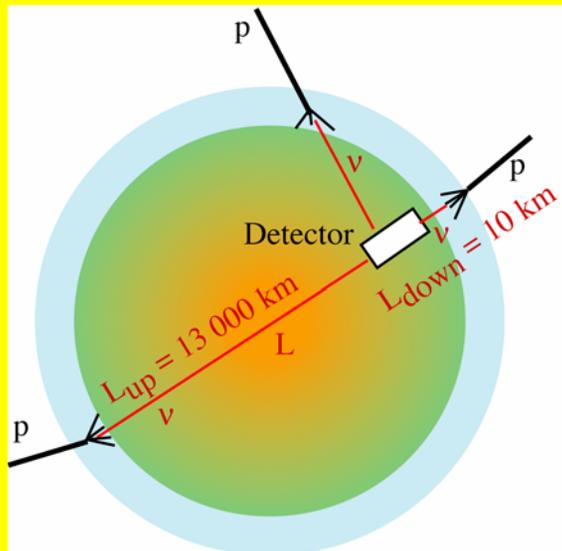
- Electromagnetism



- Weak



oltre il Modello Standard : i neutrini hanno massa

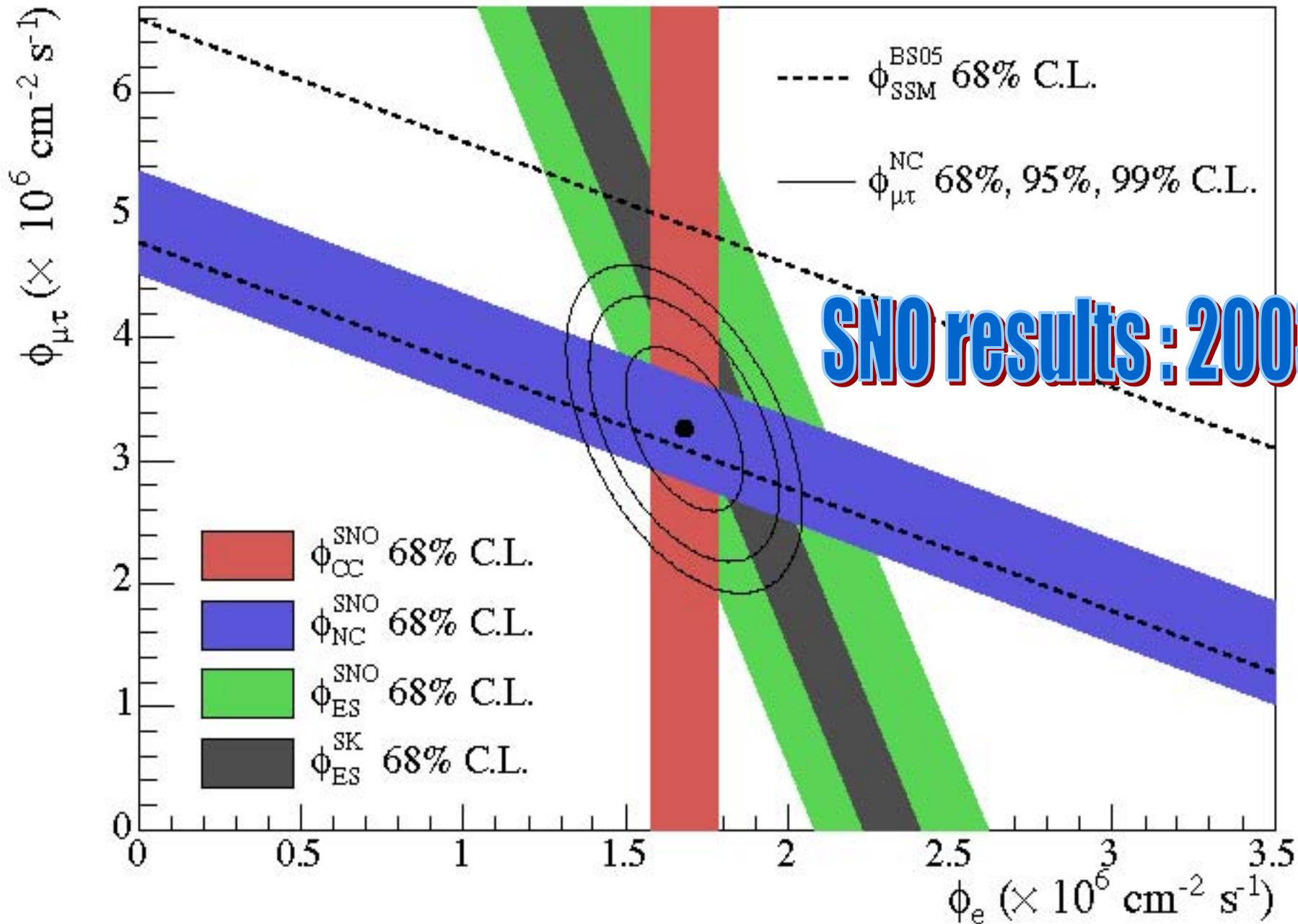


Il SOLE : la sorgente di neutrini più vicina



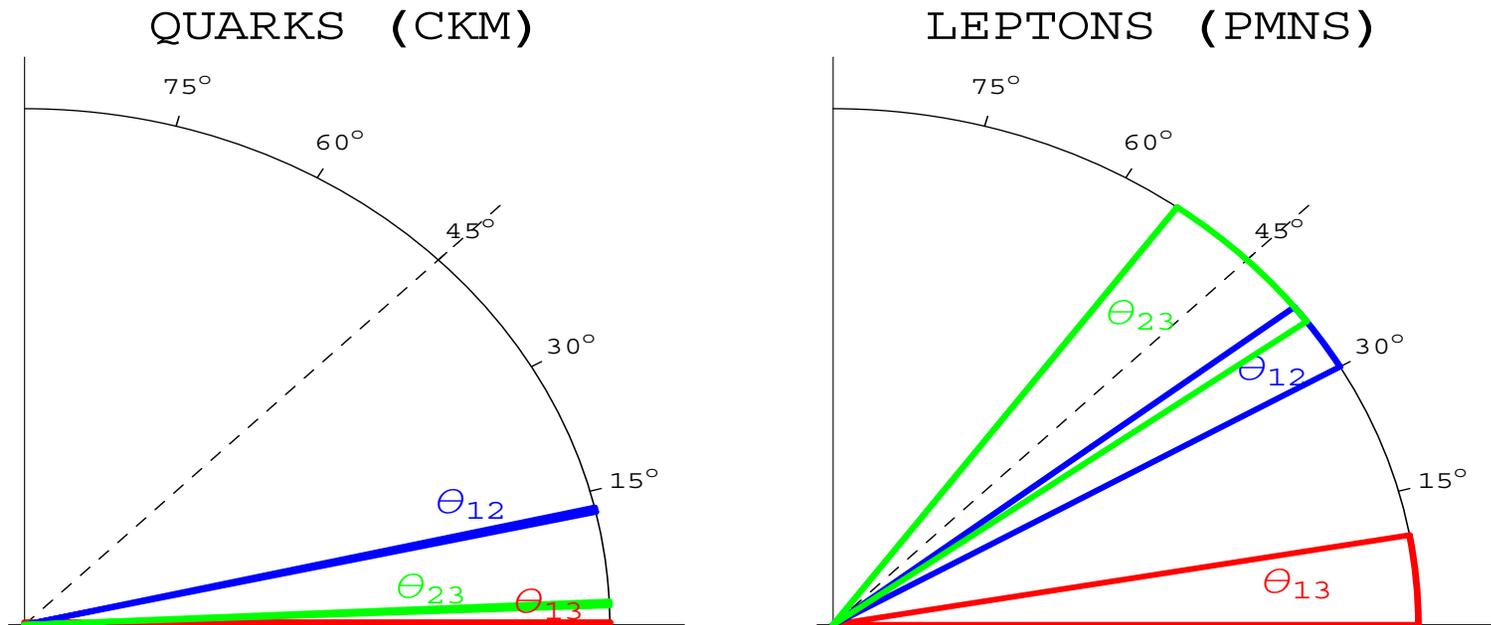
www.nu.to.infn.it

2004/03/16 19:19



SNO results: 2003

WHICH NEUTRINO MIXING ?



Experimental ν mixing angles between active ν are BI-LARGE:

$$\theta_{12} \sim 32^\circ \quad \theta_{23} \sim 45^\circ \quad \theta_{13} \leq 13^\circ$$

Natura del neutrino



Nuovo Cimento 14 (1937) 171-184

TEORIA SIMMETRICA DELL'ELETTRONE E DEL POSITRONE

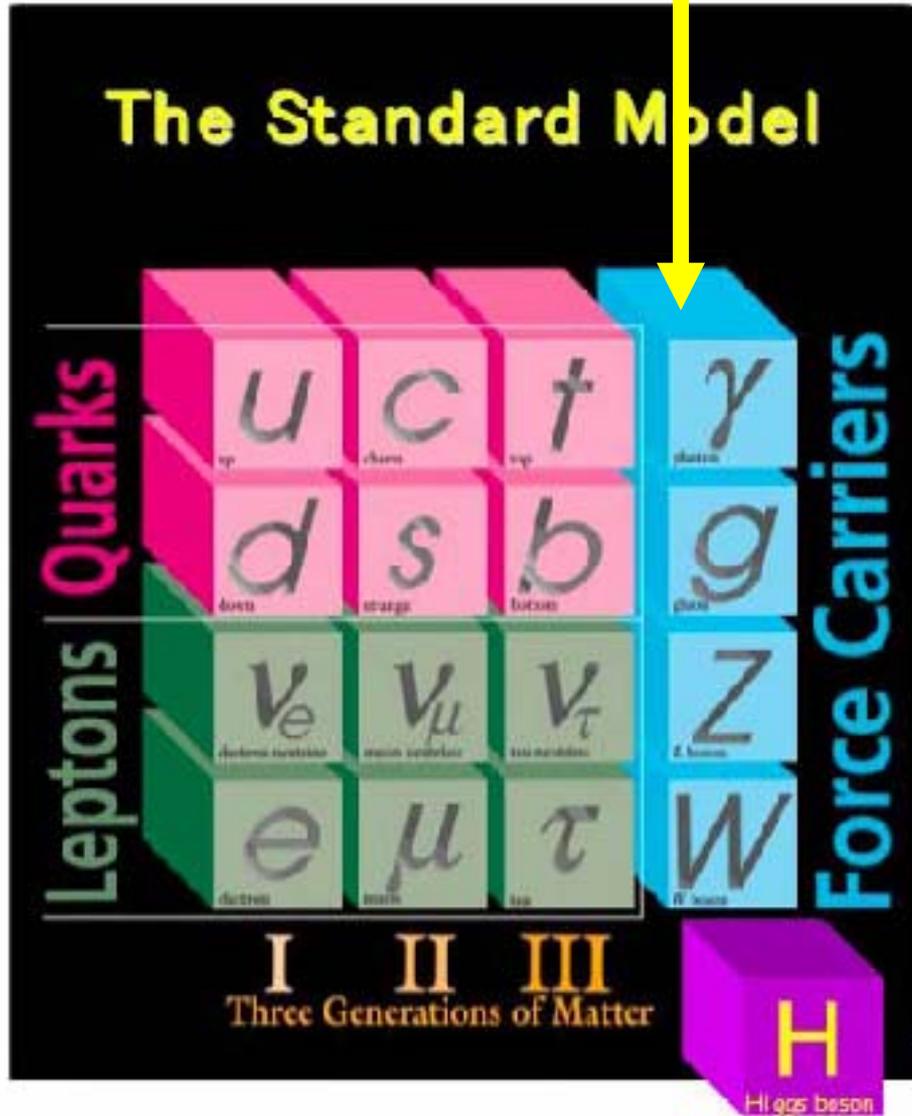
Nota di ETTORE MAJORANA

Sunto. - *Si dimostra la possibilità di pervenire a una piena simmetrizzazione formale della teoria quantistica dell'elettrone e del positrone facendo uso di un nuovo processo di quantizzazione. Il significato delle equazioni di DIRAC ne risulta alquanto modificato e non vi è più luogo a parlare di stati di energia negativa; nè a presumere per ogni altro tipo di particelle, particolarmente neutre, l'esistenza di « antiparticelle » corrispondenti ai « vuoti » di energia negativa.*

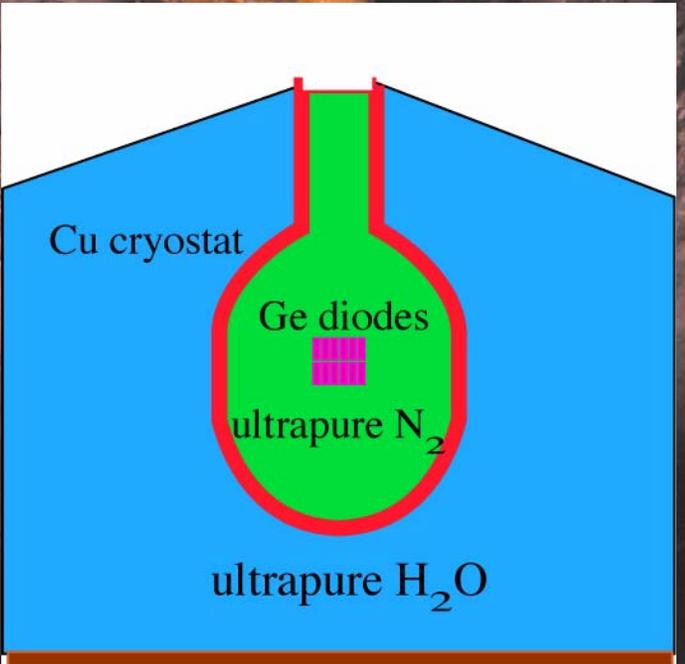
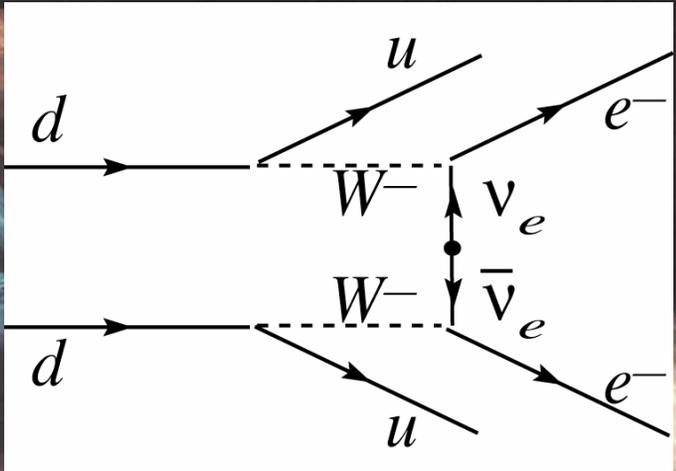
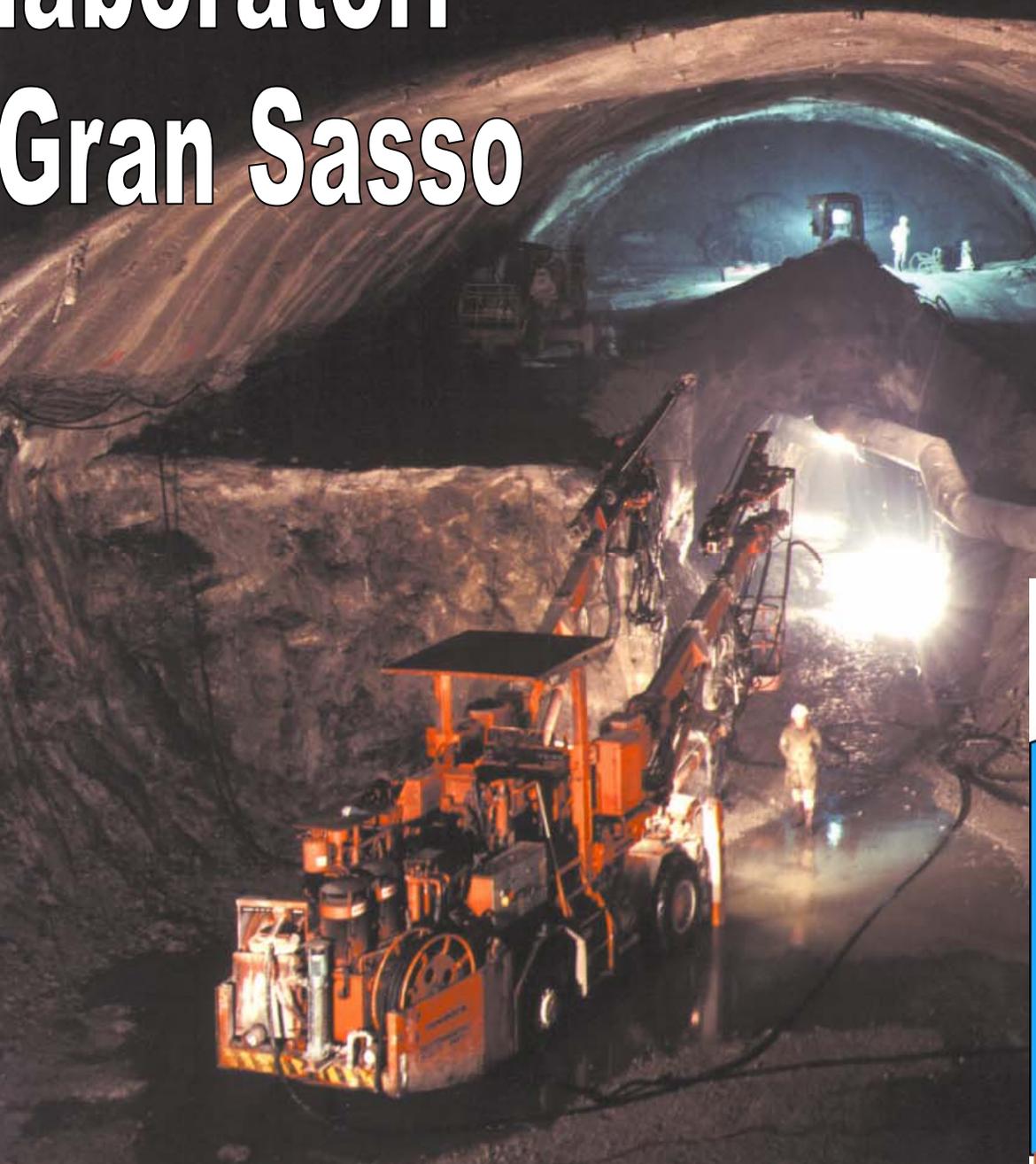
We show that it is possible to achieve complete formal symmetrization in the electron and positron quantum theory by means of a new quantization process. The meaning of Dirac equations is somewhat modified and it is no more necessary to speak of negative-energy states; nor to assume, for any other type of particles, especially neutral ones, the existence of antiparticles, corresponding to the “holes” of negative energy.

Majorana Neutrino

Gravity
?



laboratori Gran Sasso



Evidence from Heidelberg-Moscow @ LNGS

$MT = 71.7 \text{ kg y}$ (86% ^{76}Ge)

$b = 0.11 \text{ ev}/(\text{kg keV yr})$ before PSA

Resolution on 8 years $\Delta E = 3.27 \text{ keV}$

Claimed evidence of $0\nu\beta\beta$ @ 4σ

$T_{1/2} = 2.2_{-0.31}^{+0.44} 10^{25} \text{ y}$

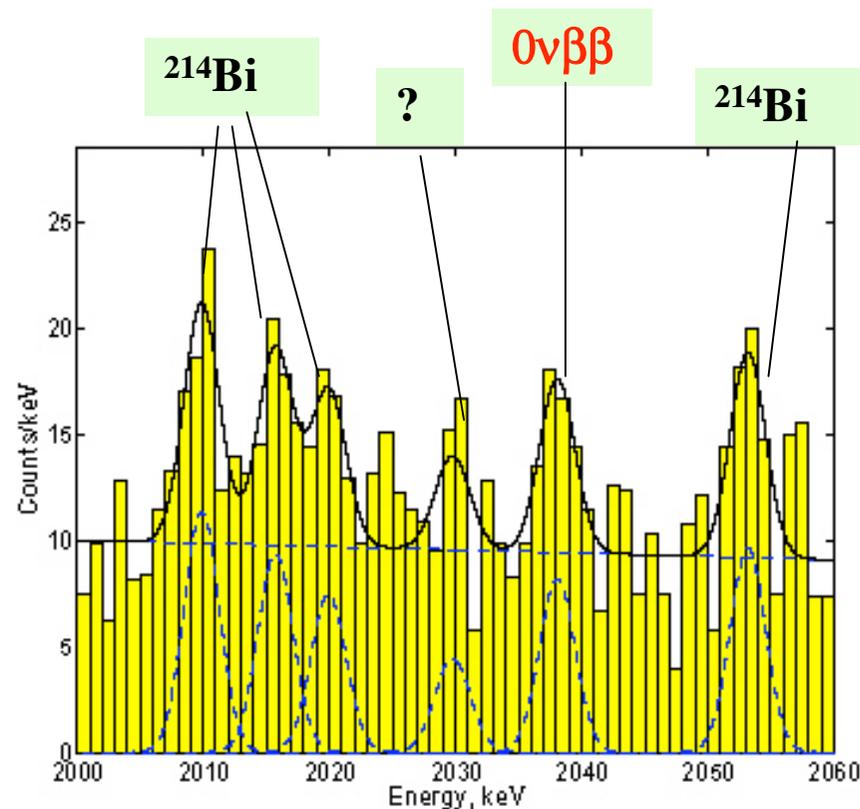
$M_{ee} = 150 - 520 \text{ meV}$

(as quoted by Fogli et al. hep-ph/0805.2517)

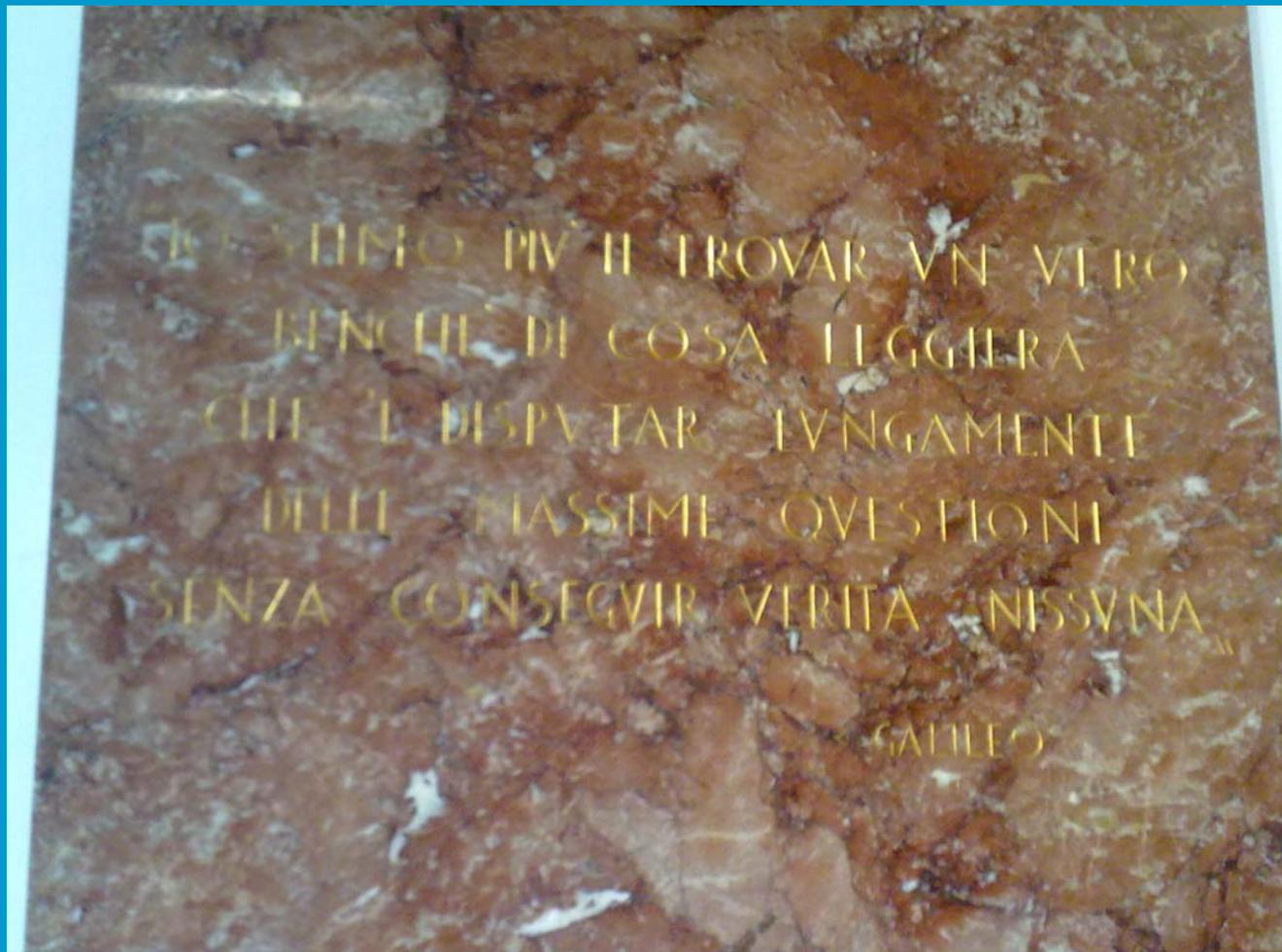
Expected position of $0\nu\beta\beta$ line well known

$Q_{\beta\beta} = 2039.006 \pm 0.05 \text{ keV}$

found @ $Q_{\beta\beta} = 2038.7 \pm 0.44$ (+2.1 σ)



IGEX @ LSC, the other experiment with Ge diodes and similar sensitivity, gives an upper limit $T_{1/2} > 1.6 10^{25} \text{ y}$



Quale relazione tra il Neutrino di Majorana e la Dark Matter ?

VSBL Electron Neutrino Disappearance



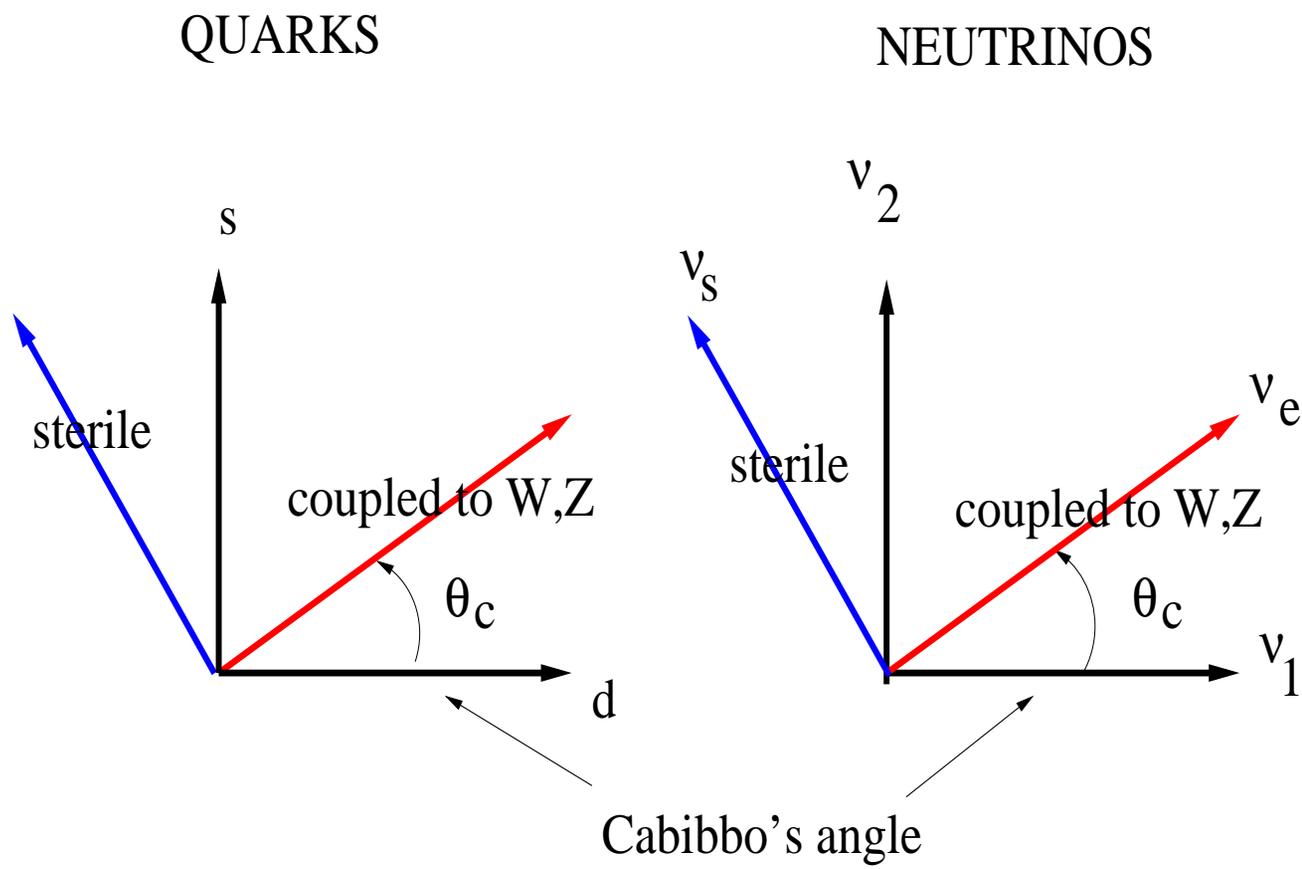
MARCO LAVEDER

Padova University and INFN

Ferrara - 26 March 2010

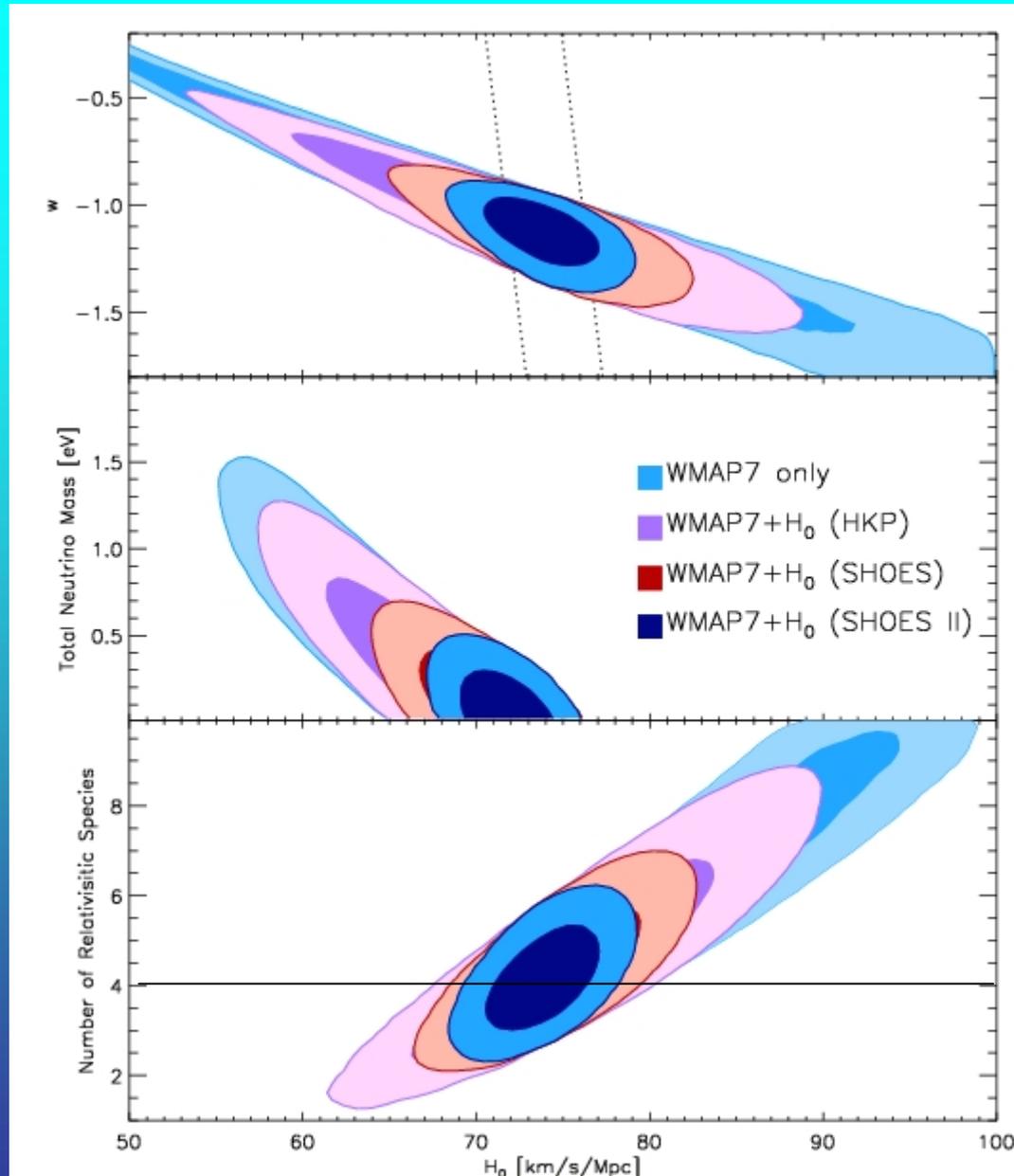
work in collaboration with **Carlo Giunti** [arXiv:0902.1992]

and with **Carlo Giunti & Walter Winter** [arXiv:0907.5487]

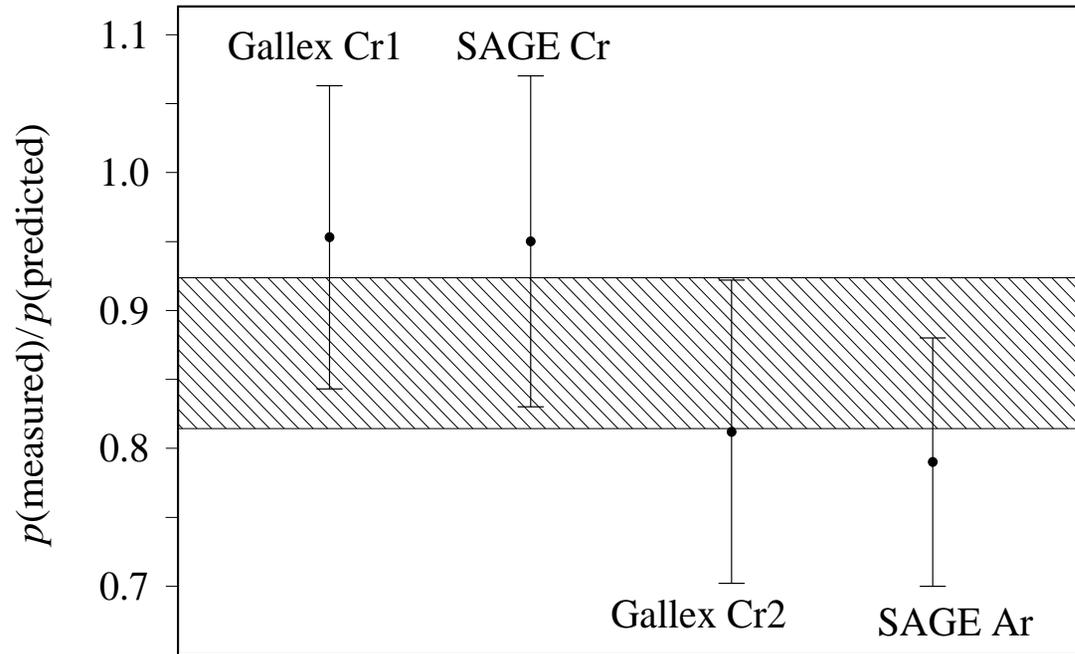


COMPLEMENTARITY relation :

$$\theta_{12} \sim 32^\circ \quad \theta_{es} \sim 13^\circ \quad \theta_{12} + \theta_{es} = 45^\circ$$



ν_e Disappearance in Gallium radioactive source experiments



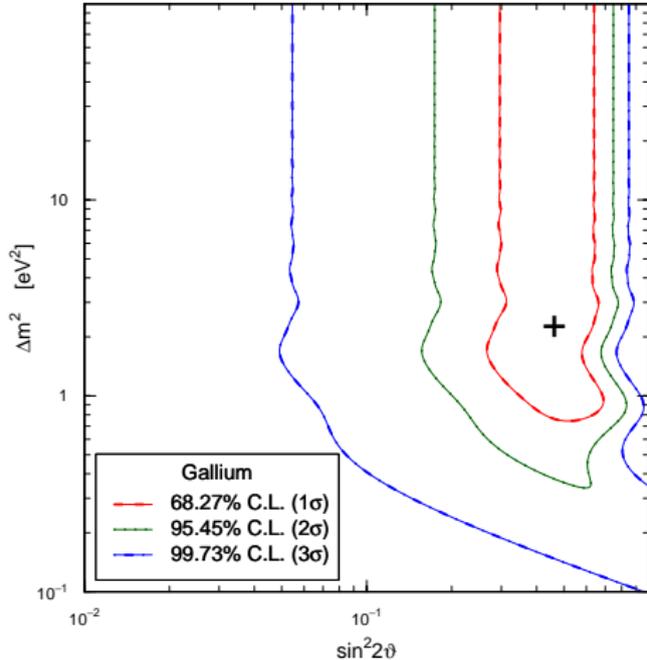
$R \equiv$ wheighted average value of the ratio of measured and predicted ^{71}Ge production rates (p) :

$$R \equiv \frac{p(\text{measured})}{p(\text{predicted})} = 0.87 \pm 0.05$$

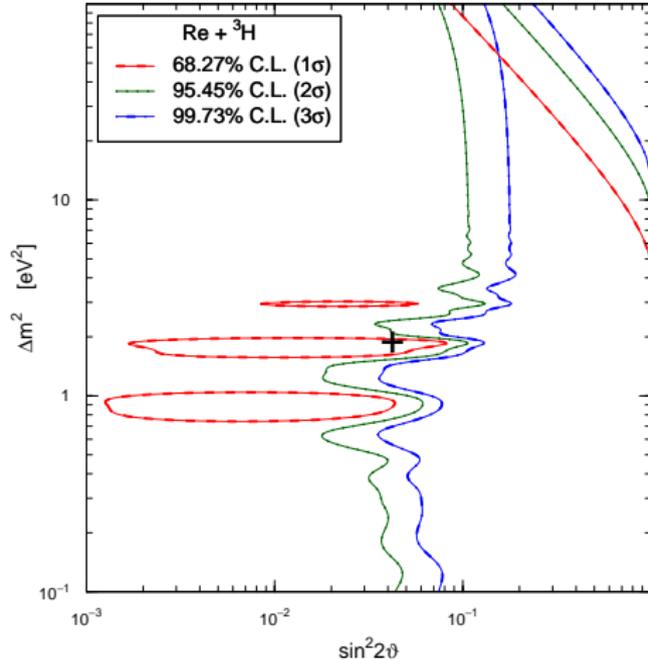
[arXiv:0901.2200\[nucl-ex\]](https://arxiv.org/abs/0901.2200)

Ga radioactive source exp. results may be interpreted as an indication of the disappearance of ν_e due to active-sterile oscillations!

hep-ph/0610352 Carlo Giunti & ML



[Giunti, Laveder, arXiv:1006.3244]



[Giunti, Laveder, PRD 82 (2010) 053005, arXiv:1005.4599]

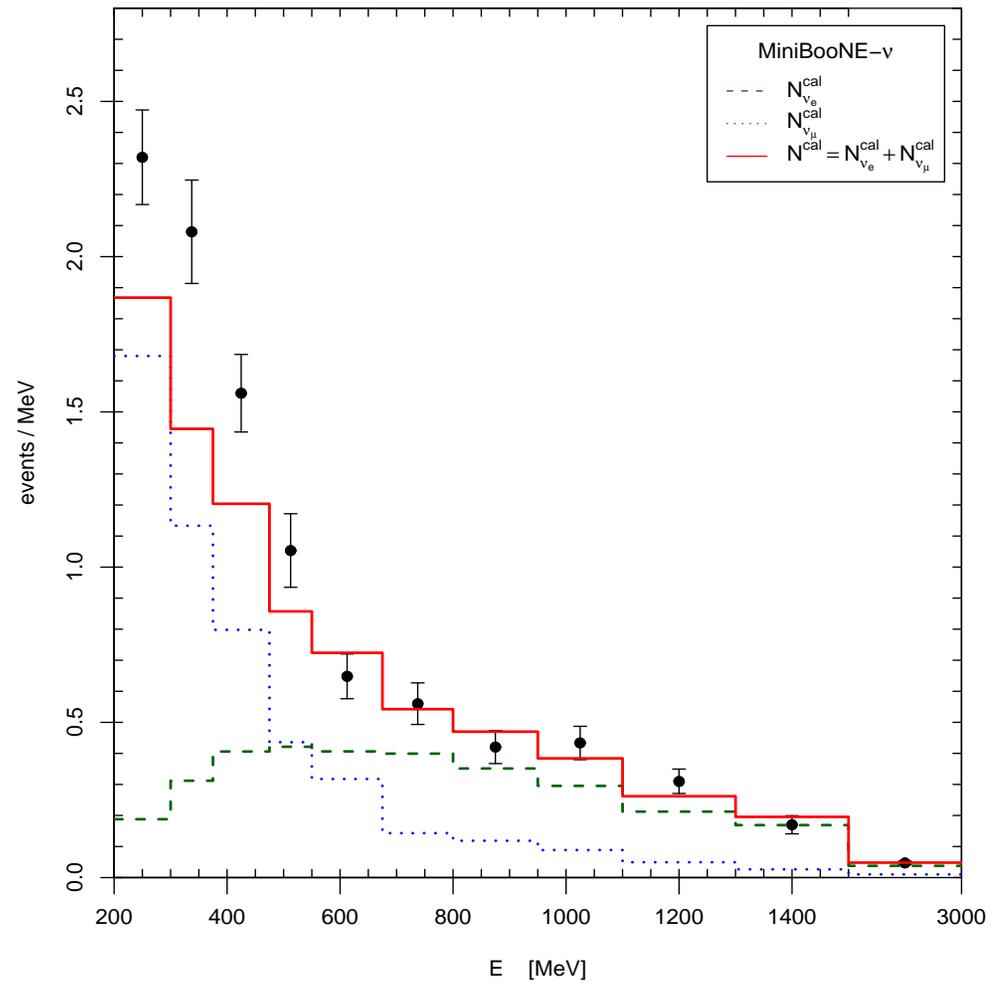
$\Delta m_{\text{SBL}}^2 \gtrsim 1 \text{ eV}^2$ is OK, but $\sin^2 2\vartheta_\nu > \sin^2 2\vartheta_{\bar{\nu}}$

Parameter Goodness of Fit = 0.2%

CPT violation?

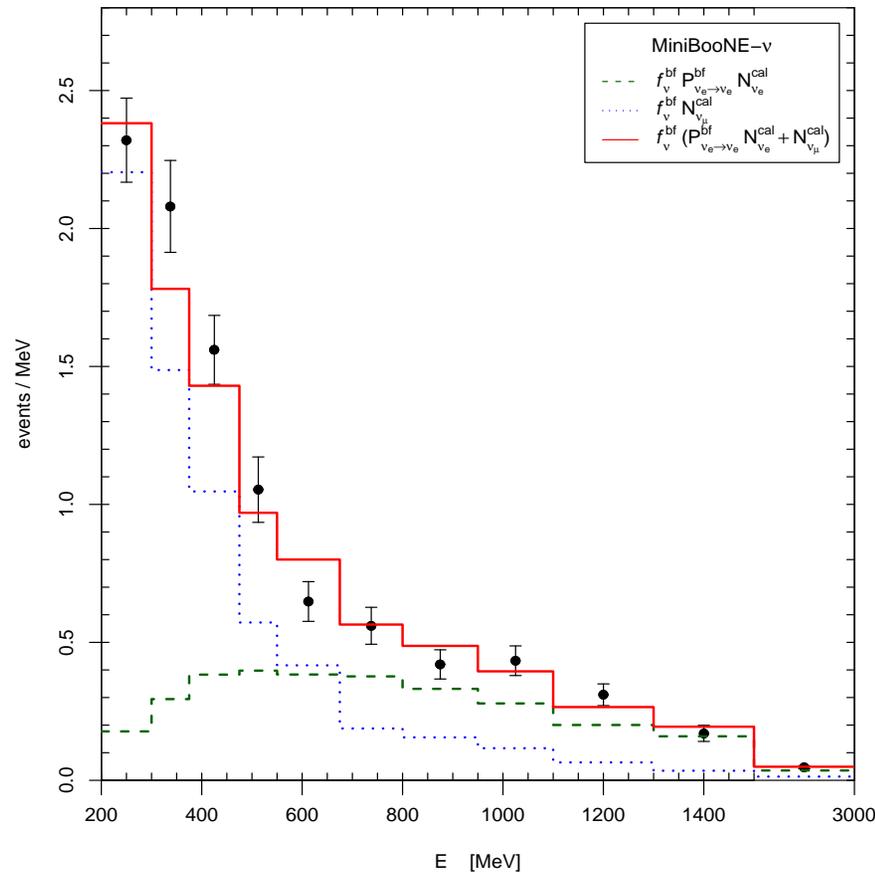
[Giunti, Laveder, PRD 82 (2010) 113009, arXiv:1008.4750]

Miniboone- ν data : Low Energy Excess or ...



arXiv:0812.2243

ν_e Disappearance in Miniboone- ν data



Phys. Rev. D 77, 093002 (2008) C.Giunti & ML

A renormalization of the absolute event rate by a constant factor f_ν ($\Delta f_\nu = 0.15$) with a simultaneous disappearance of the ν_e in the beam .

A constant $P_{\nu_e \rightarrow \nu_e} \leftrightarrow \Delta m^2 \gtrsim 20 \text{ eV}^2$.

Miniboone- ν & Gallium : Osc vs No Osc

		MB- ν	MB- ν +Ga
No Osc.	χ_{\min}^2	27.2	34.0
	NDF	10	11
	GoF	0.2%	0.04%
	f_{ν}^{bf}	1.15	1.15
Osc.	χ_{\min}^2	17.7	20.1
	NDF	9	10
	GoF	3.8%	2.8%
	$P_{\nu_e \rightarrow \nu_e}^{\text{bf}}$	0.72	0.83
	f_{ν}^{bf}	1.31	1.24
PG	$\Delta\chi_{\min}^2$		2.4
	NDF		1
	GoF		12.4%

Active-Sterile ν_e mixing !

- The parameter goodness-of-fit of 12.4% implies that the results of the MiniBooNE neutrino and the Gallium radioactive source experiments are compatible in the framework of the ν_e disappearance hypothesis.
- The goodness of fit of 2.8% is acceptable and much better than the 0.04% obtained without ν_e disappearance.
- $P_{\nu_e \rightarrow \nu_e} = 1$ is disfavored at more than 3σ (the precise value is 99.98% CL).

The large disappearance of ν_e found in Gallium and in Miniboone- ν data, may be due to oscillations into sterile neutrinos $\nu_e \rightarrow \nu_s$ since

- $\nu_e \rightarrow \nu_\mu$ transitions are restricted by the results of CCFR , KARMEN , NOMAD and MINIBOONE ;
- $\nu_e \rightarrow \nu_\tau$ transitions are limited by the results of CHORUS and NOMAD .

Miniboone & Gallium & Reactor : Osc vs No Osc

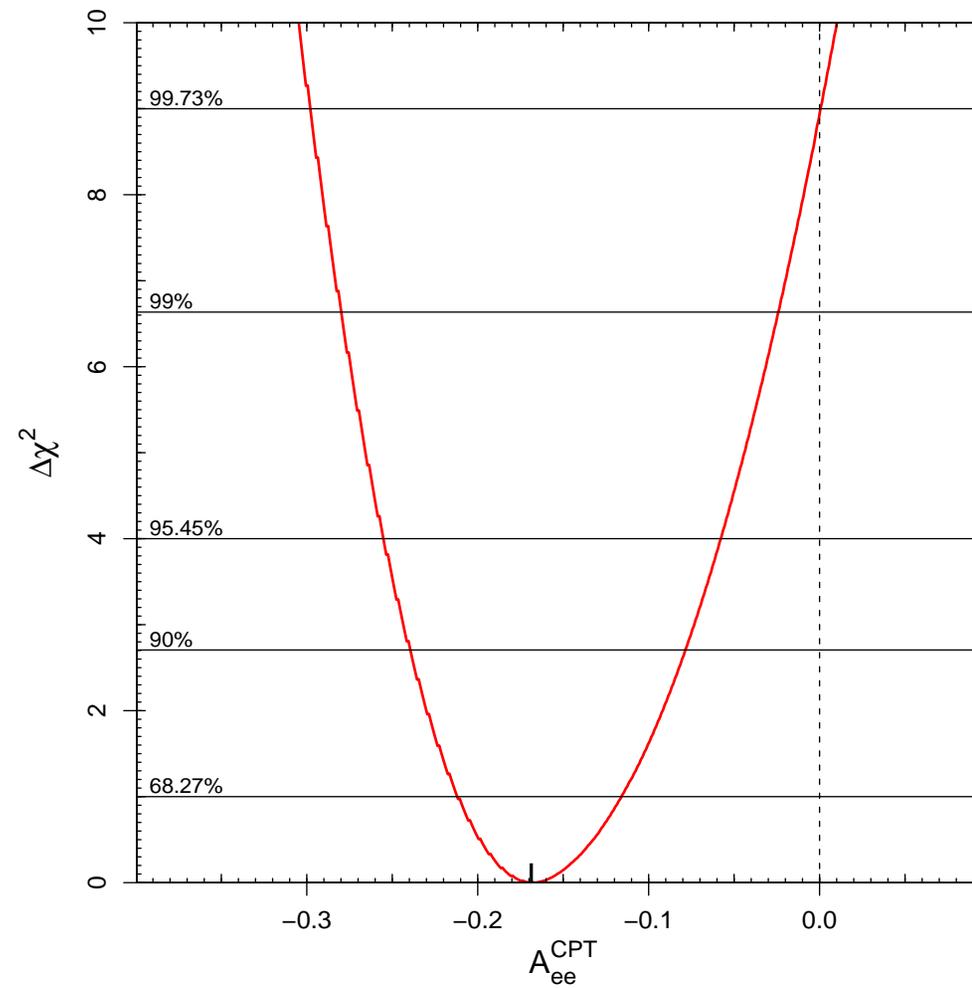
		MB- ν	MB- ν +Ga	MB- ν +Ga+Re	MB+Ga+Re
No Osc.	χ_{\min}^2	27.2	34.0	36.9	53.8
	NDF	10	11	18	29
	GoF	0.2%	0.04%	0.5%	0.3%
	f_{ν}^{bf}	1.15	1.15	1.15	1.15
	$f_{\bar{\nu}}^{\text{bf}}$				1.08
Osc.	χ_{\min}^2	17.7	20.1	31.7	48.9
	NDF	9	10	17	27
	GoF	3.8%	2.8%	1.7%	0.6%
	$P_{\nu_e \rightarrow \nu_e}^{\text{bf}}$	0.72	0.83	0.93	0.93
	f_{ν}^{bf}	1.31	1.24	1.19	1.19
	$f_{\bar{\nu}}^{\text{bf}}$				1.10
PG	$\Delta\chi_{\min}^2$		2.4	11.1	8.3
	NDF		1	2	3
	GoF		12.4%	0.4%	4.1%

Tension between ν_e and $\bar{\nu}_e$ data

- The parameter goodness-of-fit of 4.1% do not allow us to reject the compatibility of the data under the hypothesis of ν_e disappearance. This results indicate that the possibility that the tension between MiniBooNE neutrino and Gallium data on one side and reactor data on the other side is due to statistical fluctuations may be correct.
- The goodness of fit of 0.6% is rather low and it is better than the 0.3% obtained without ν_e disappearance.
- $P_{\nu_e \rightarrow \nu_e} = 1$ is disfavored at more than 2σ (97.04% CL).
- Next we consider a possible violation of the CPT equality $P_{\nu_e \rightarrow \nu_e} = P_{\bar{\nu}_e \rightarrow \bar{\nu}_e}$ as a possible explanation of the tension between MiniBooNE and Gallium neutrino data on one side and reactor antineutrino data on the other side under the hypothesis of ν_e disappearance.
- We quantify the amount of CPT violation through the asymmetry

$$A_{ee}^{\text{CPT}} \equiv P_{\nu_e \rightarrow \nu_e} - P_{\bar{\nu}_e \rightarrow \bar{\nu}_e} .$$

CPTV fit of Miniboone & Gallium & Reactor



$$\chi_{min}^2 = 38.3/(26 \text{ dof}) \quad GoF = 5.7\% \quad A_{ee}^{\text{CPT}} = -0.165_{-0.04}^{+0.05}$$

SBL future experiments at CERN-PS beam

detector mass	0.6 kton	1.0 kton
detector distance	850 m	850 m
references	C.Rubbia et al.	A. Rubbia et al.
ν_μ CC	720000	1200000
ν_e CC	18000	30000
stat error	134	173
syst error	360	600
total error	384	624
expected deficit	2970	4950
n. of sigma	7.73	7.93

Event rates presented at CERN workshop "Neutrino detector studies and possible experiment at CERN PS", 17-18 march 2010 .

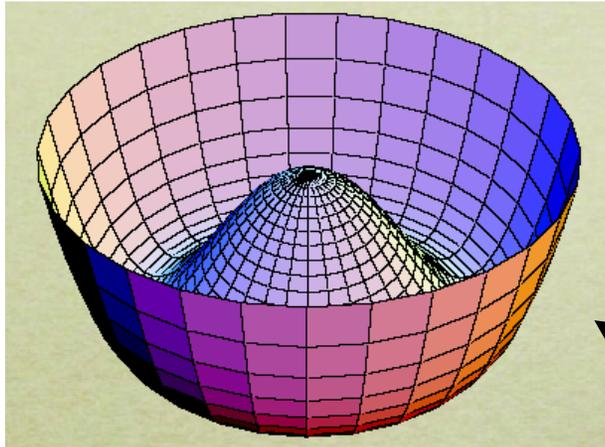
A ν_e contamination of 2.5 % is assumed here (tagged kaons - F.Terranova private communication) with a 2% systematic error on the ν_e flux .

The HIGGS BOSON CONDENSATE

gravity 

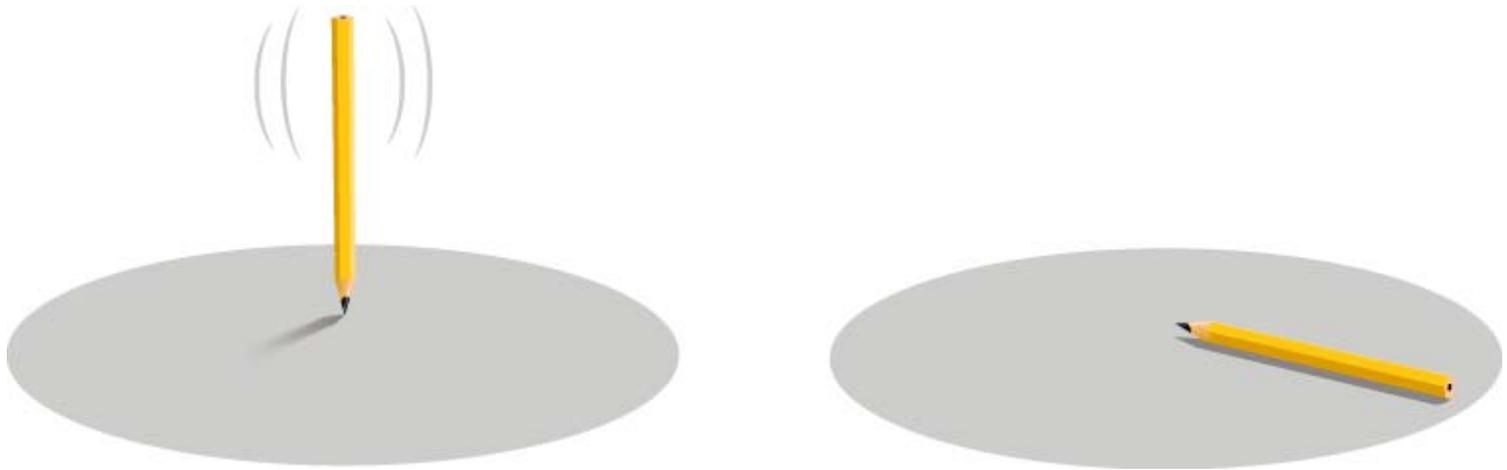
electric force 

weak force



- “**SOMETHING**” fills the Universe: it “**disturbs**” Weak interactions making them **SHORT-RANGED**, while it does **NOT** affect gravity or electromagnetism.
- **WHAT IS IT?**
- Analogy with **SUPERCONDUCTIVITY**: in a superconductor the magnetic field gets repelled (Meissner effect) and penetrates only over the “penetration length”, i.e. **the magnetic field is short-ranged** → **source which disturbs are the boson condensates, Cooper pairs.**
- We are “swimming” in Higgs Boson Condensates → its value at the minimum of its potential determines **the masses of all particles!**

Spontaneous symmetry breaking



Vacuum = state with lowest energy is not symmetric

But the theoretical description of the dynamics is symmetric

TEORIA RELATIVISTICA DI PARTICELLE CON MOMENTO INTRINSECO ARBITRARIO

Nota di ETTORE MAJORANA

(1932)

Sunto. - *L'autore stabilisce equazioni d'onda lineari nell'energia e relativisticamente invarianti per particelle aventi momento angolare intrinseco comunque prefissato.*

Quando si cercano le soluzioni di (16) corrispondenti a onde piane con massa positiva si trovano tutte quelle che derivano per trasformazione relativistica dalle onde di momento nullo. Per queste l'energia è data da

$$(18) \quad W_0 = \frac{mc^2}{j + \frac{1}{2}}$$

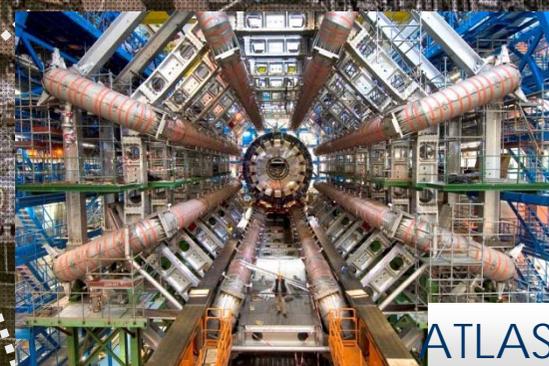
Massa dell' "Higgs" (J=0) = 3 volte la massa del bosone Z(J=1) → 273 GeV !!!

Enter a New Era in Fundamental Science

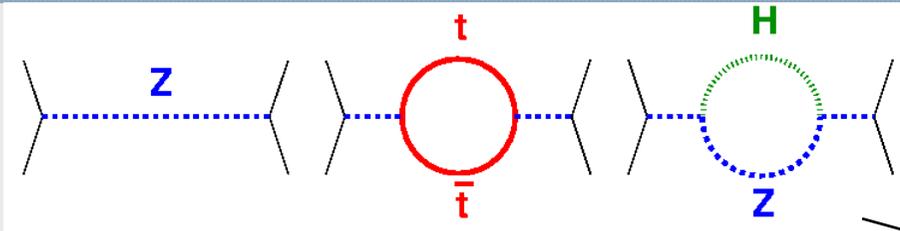
Start-up of the Large Hadron Collider (LHC), one of the largest and truly global scientific projects ever, is the most exciting turning point in particle physics.



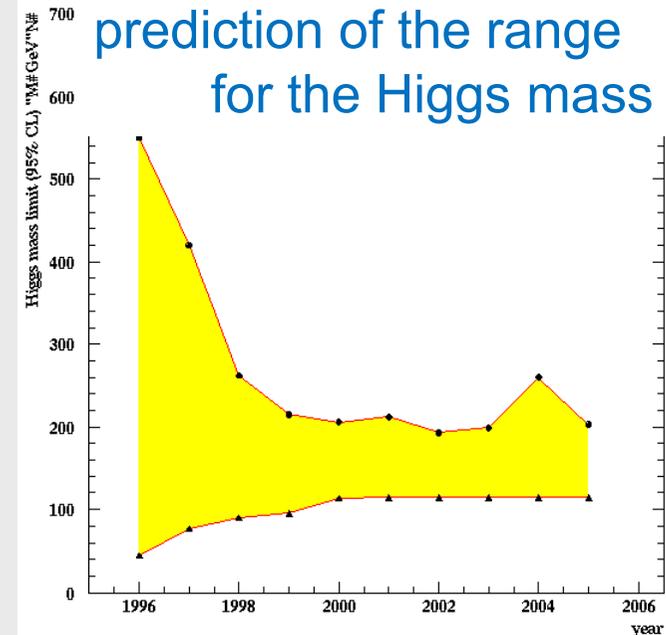
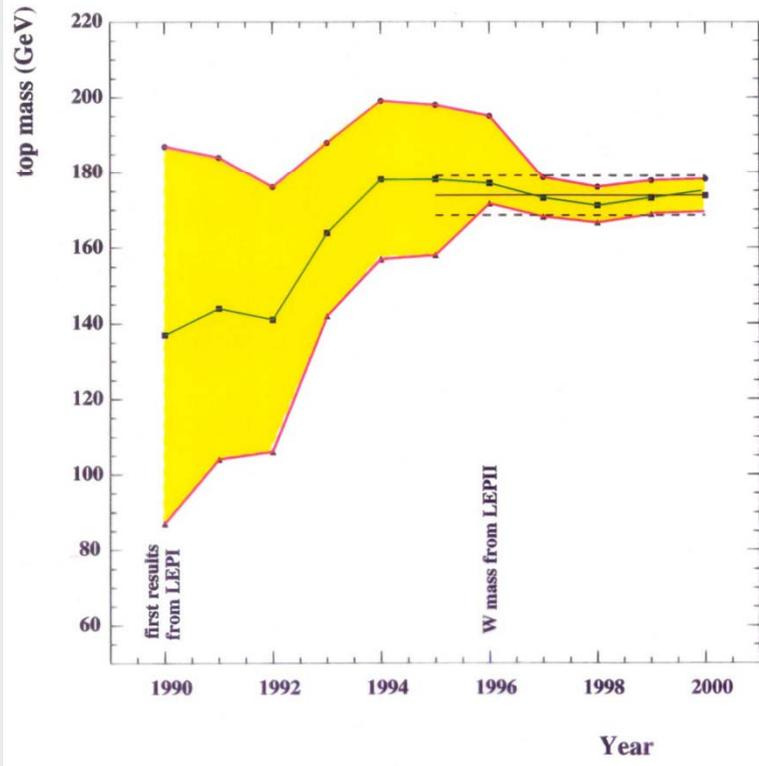
Exploration of a new energy frontier



Test of the SM at the Level of Quantum Fluctuations



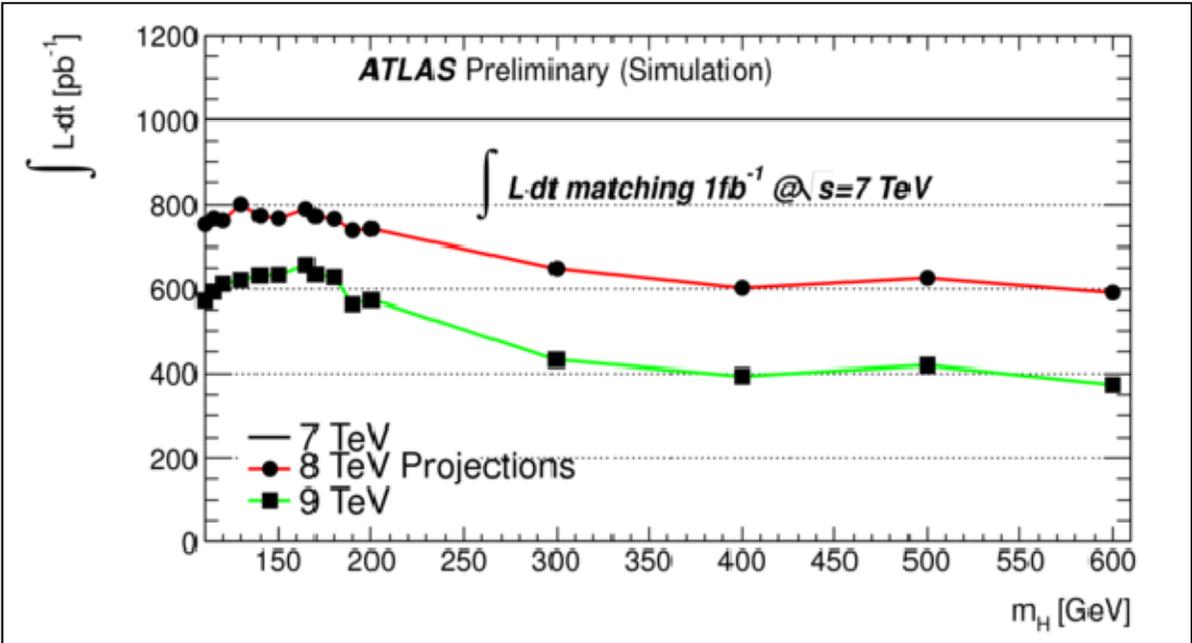
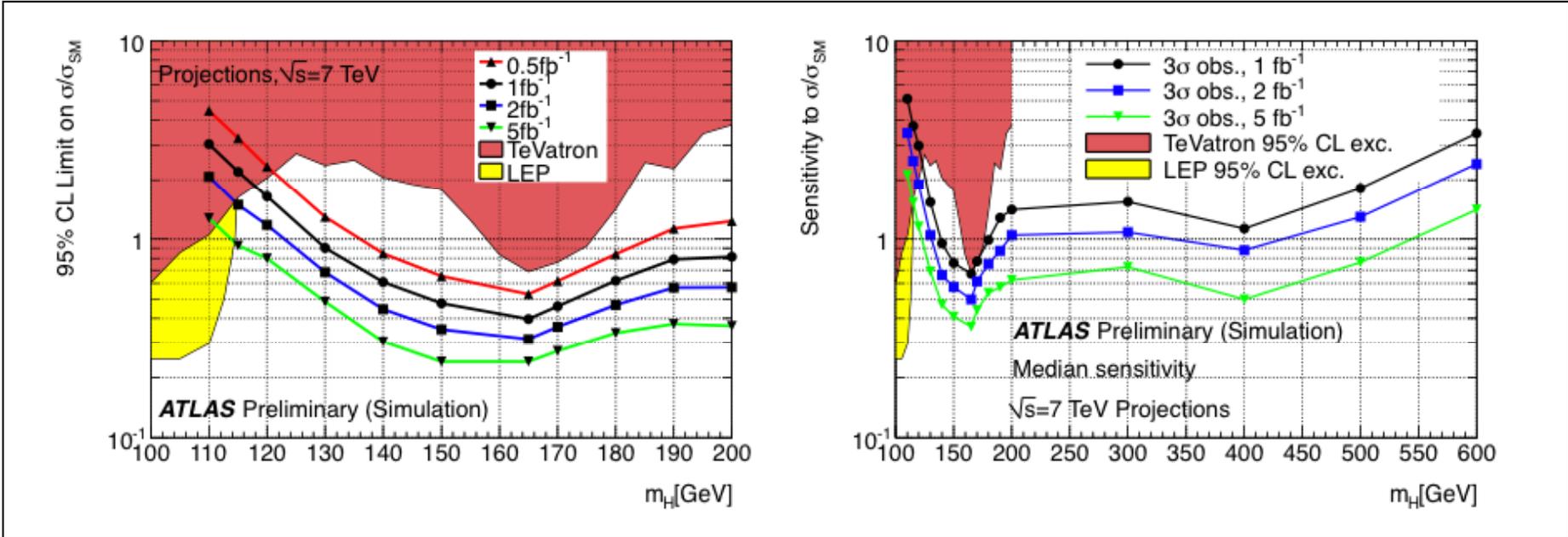
indirect determination of the top mass



- possible due to
- precision measurements
 - **known higher order electroweak corrections**

$$\propto \left(\frac{M_t}{M_W}\right)^2, \ln\left(\frac{M_h}{M_W}\right)$$

Higgs sensitivities



... if they are roses they'll flower...



... A BRIGHT FUTURE for Majorana ν physics !!!

Da Sabato 26 marzo a Domenica 1 maggio 2011 – SALA DEGLI AFFRESCHI

STUPORE DEL SACRO

Icone delle Grandi feste nella tradizione liturgica

omaggio a Paola Zuddas, iconografa

in collaborazione con:

Comune di Corzezzola

Fond'Arte Tono Zancanaro

Associazione sviluppo e crescita dell'Arte



Centro Ecumenico
Vladimir Solov'ev



Scuola di Iconografia San Luca

INAUGURAZIONE

Sabato 26 marzo 2011, ore 18

ORARI DI VISITA:

sabato pomeriggio 15 - 19

domenica mattina 11 - 12

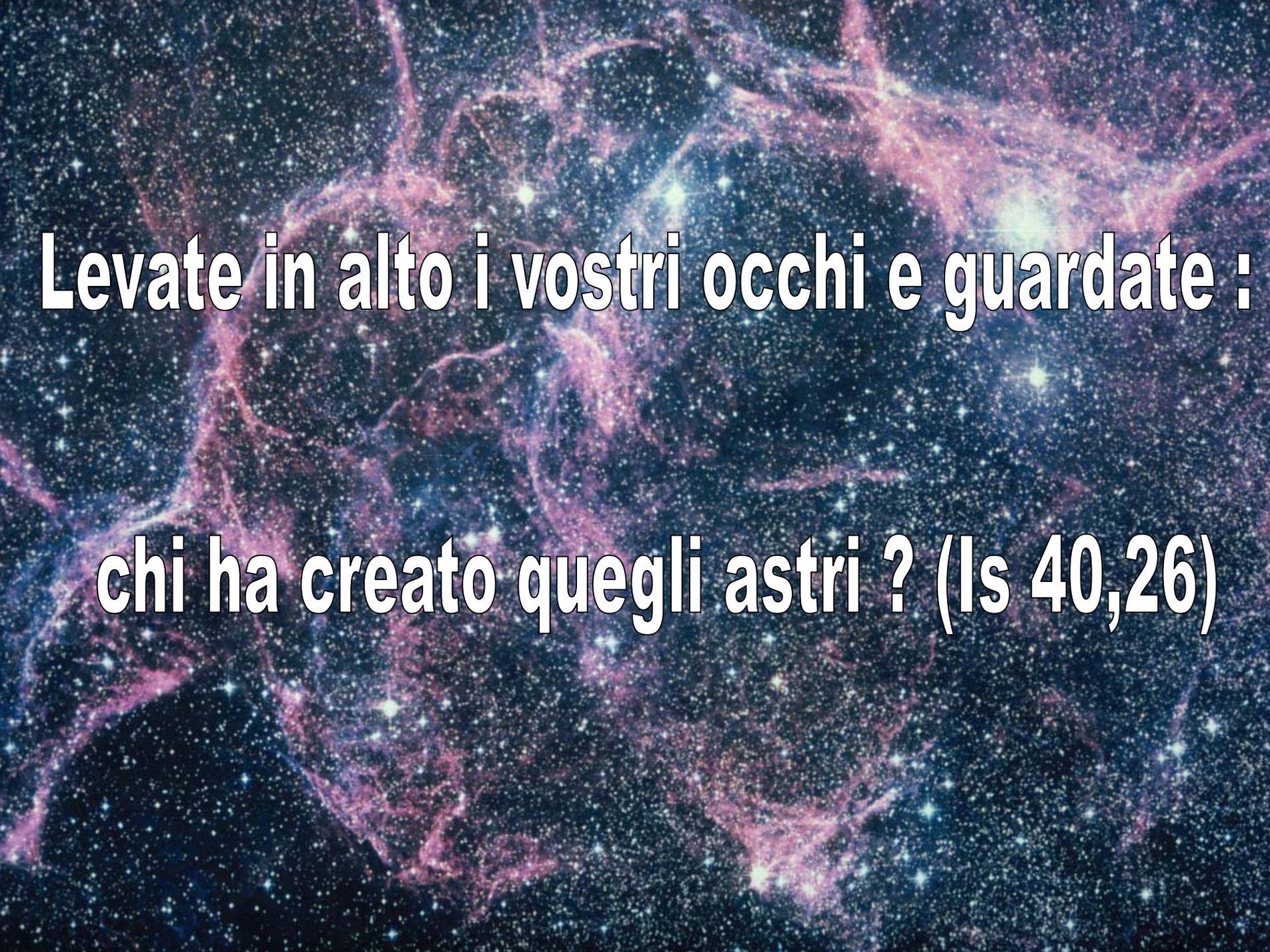
domenica pomeriggio 15 - 19

in altri giorni su prenotazione



Incontro sul tema "L'icona della Santa Trinità" con il professor Vladimir Zelinskij, teologo ortodosso russo, venerdì 26 aprile, ore 20,45

Domenica 1 maggio, ore 17, Santa Liturgia slava cattolica orientale e Panichida per Paola



Levate in alto i vostri occhi e guardate :

chi ha creato quegli astri ? (Is 40,26)

Egli conta il numero delle stelle



e chiama ciascuna per nome (Salmo 147)

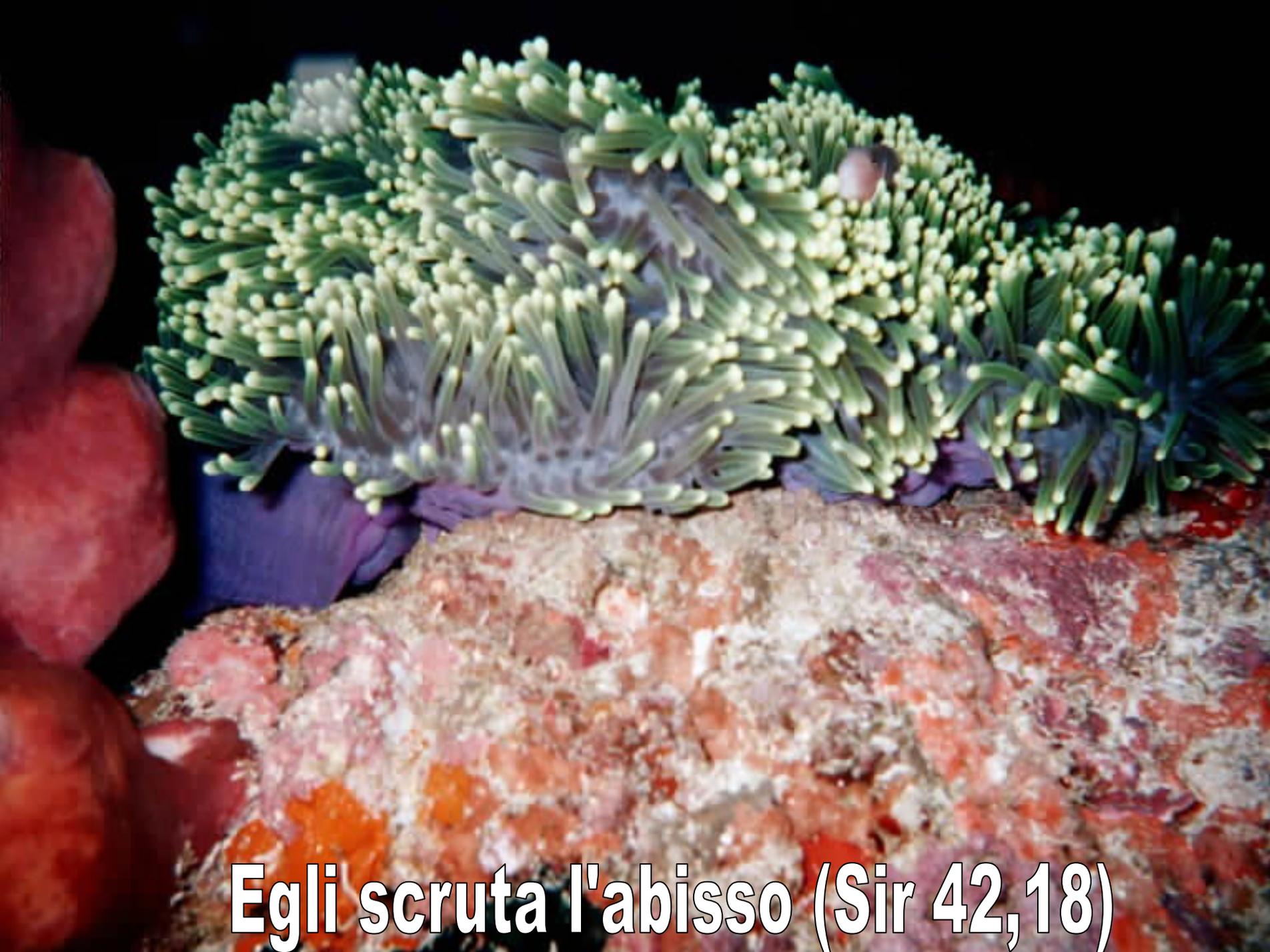
egli copre il cielo di nubi



prepara la pioggia per la terra



fa germogliare l'erba sui monti



Egli scruta l'abisso (Sir 42,18)



**neppure i santi del Signore sono in grado
di narrare tutte le sue meraviglie**

cantate al Signore un canto di grazie



fa scendere la neve come lana



manda una sua parola



ed ecco si scioglie

“Anche l'uomo di scienza è chiamato ad esercitare un suo sacerdozio. Sì, in un certo senso ogni vero scienziato è un sacerdote: quel fine che il Signore Dio ha assegnato al primo uomo al momento della creazione [...] ha una applicazione particolare e privilegiata per l'uomo di scienza. Proprio perché



vede meglio e di più, più stringente è il suo dovere, da una parte, di riconoscere, lodare, ammirare, ringraziare Dio nelle opere della sua creazione e, dall'altra, di fare un uso retto e responsabile del proprio ingegno e delle conquiste piccole e grandi che ne sono il frutto.

All'Università di Pisa, 2 settembre 1981



Grazie.