

Fisica teorica e fenomenologia delle particelle elementari

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**Incontro di orientamento
per la laurea magistrale in scienze fisiche**

Pavia, 23 maggio 2013

Chi siamo

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M. CHIESA (dottorando)

V. PROSPERI (dottorando)

Altri collaboratori

CERN e altri laboratori

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Univ. Silesia, Katowice, Poland

Univ. of Southampton

Univ. Wuppertal, Germany

Collaboratori

M. MORETTI (UNIFE)

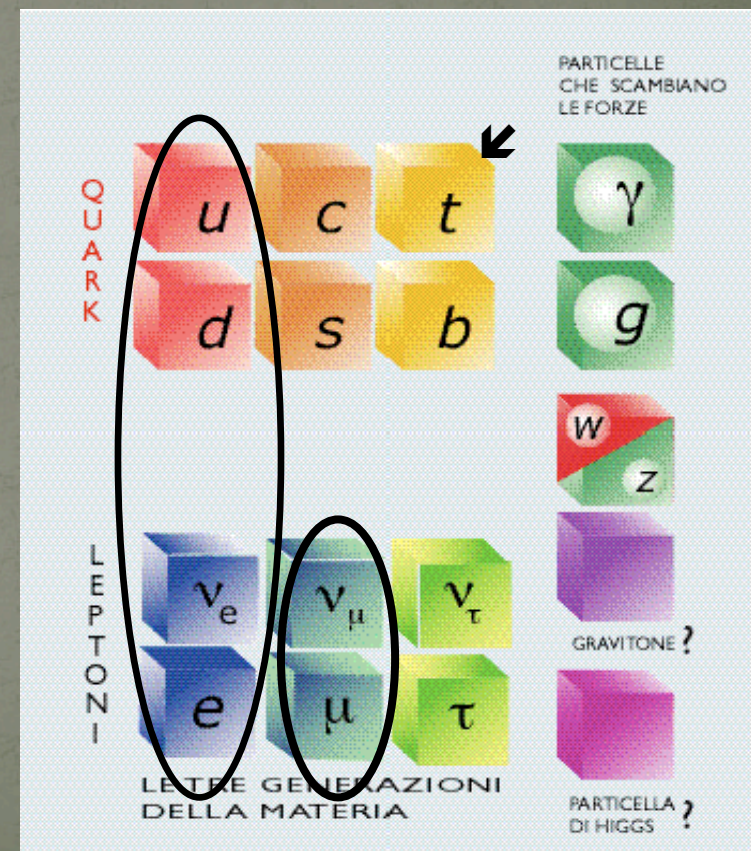
P. NASON (INFN MIB)

A. VICINI (UNIMI)

L. BARZÈ (CERN)

La nostra “tavola periodica” e il Modello Standard (SM) delle interazioni fondamentali

- Simmetria $SU(3)_c \otimes SU(2)_L \otimes U(1)_Y$
- Particelle “materia” e particelle “forza” (+ relative antiparticelle)
- Tre famiglie (?), il nostro mondo fatto della prima (e un po' di seconda)
- Dimensione particelle $< 10^{-19}\text{m}$



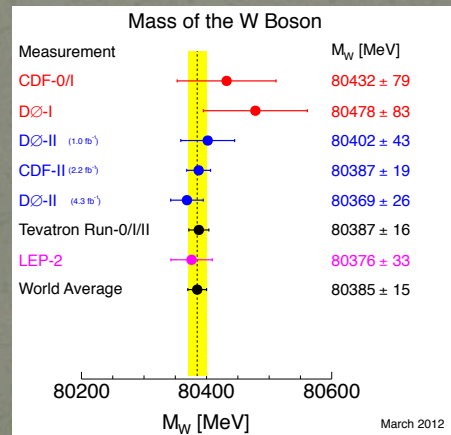
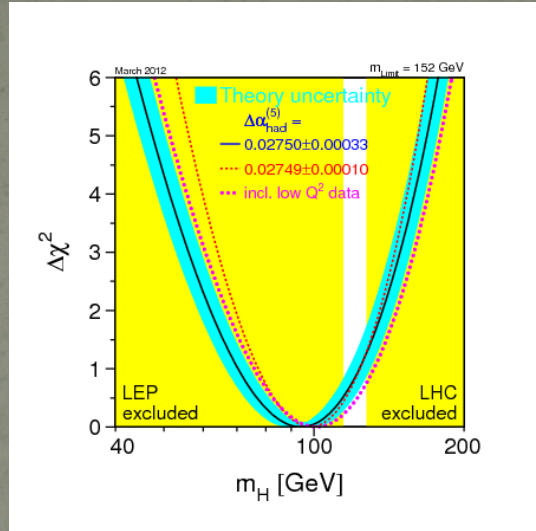
Test di precisione del SM

LEP (CERN): collisioni elettrone-positrone $E_{cm} = 100-200$ GeV

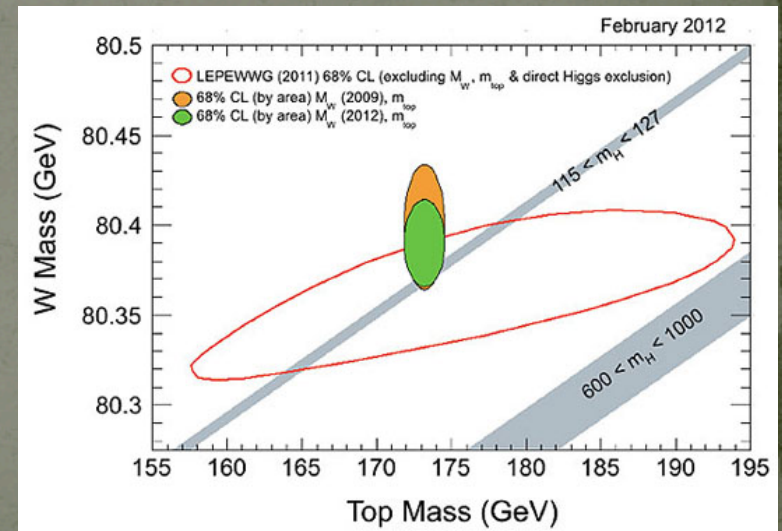
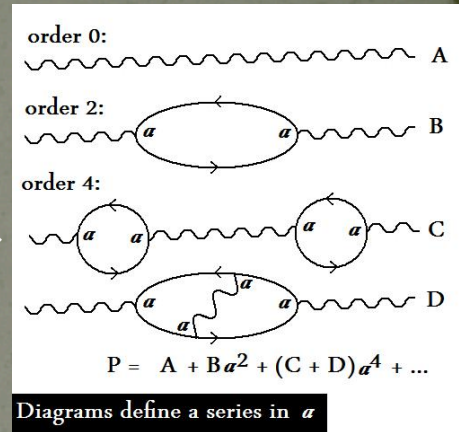
LEP EW
working group →



Measurement	Fit	$ \sigma_{meas} - \sigma_{fit} /\sigma_{meas}$
$\Delta\alpha_{had}^{(5)}(m_Z)$	0.02750 ± 0.00033	0.02759
m_Z [GeV]	91.1875 ± 0.0021	91.1874
Γ_Z [GeV]	2.4952 ± 0.0023	2.4959
σ_{had}^0 [nb]	41.540 ± 0.037	41.478
R_1	20.767 ± 0.025	20.742
$A_{fb}^{0,l}$	0.01714 ± 0.00095	0.01645
$A_{fb}(P_e)$	0.1465 ± 0.0032	0.1481
R_b	0.21629 ± 0.00066	0.21579
R_c	0.1721 ± 0.0030	0.1723
$A_{fb}^{0,b}$	0.0992 ± 0.0016	0.1038
$A_{fb}^{0,c}$	0.0707 ± 0.0035	0.0742
A_b	0.923 ± 0.020	0.935
A_c	0.670 ± 0.027	0.668
$A_{f}(SLD)$	0.1513 ± 0.0021	0.1481
$\sin^2\theta_{eff}^{lep}(Q_{fb})$	0.2324 ± 0.0012	0.2314
m_W [GeV]	80.385 ± 0.015	80.377
Γ_W [GeV]	2.085 ± 0.042	2.092
m_t [GeV]	173.20 ± 0.90	173.26



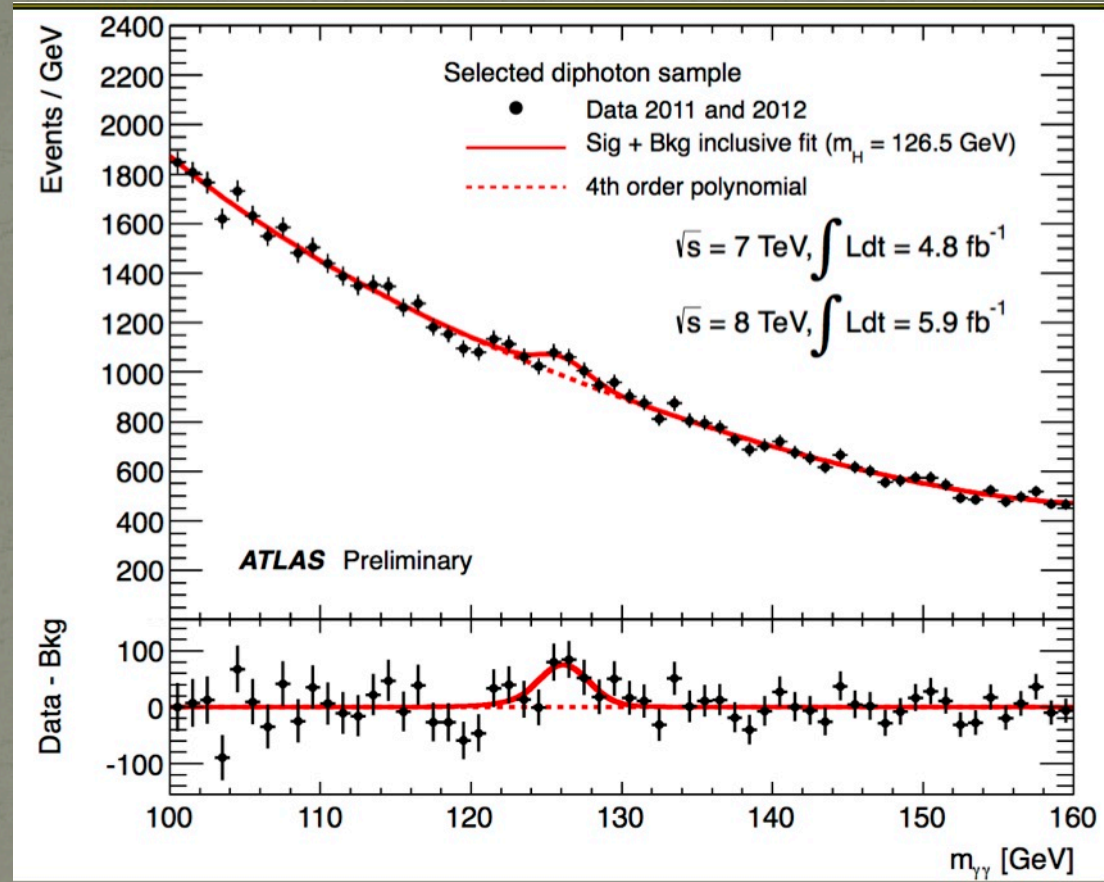
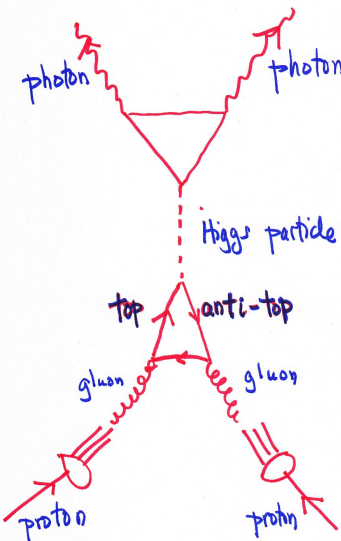
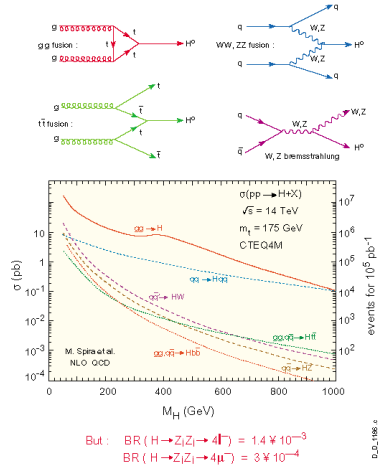
Fluttuazioni
Quantistiche →



$$M_W = M_W(\alpha, G\mu, M_Z, \dots, m_t, M_H) \text{ via MQ}$$

Il bosone di Higgs

H⁰ production at hadron colliders:

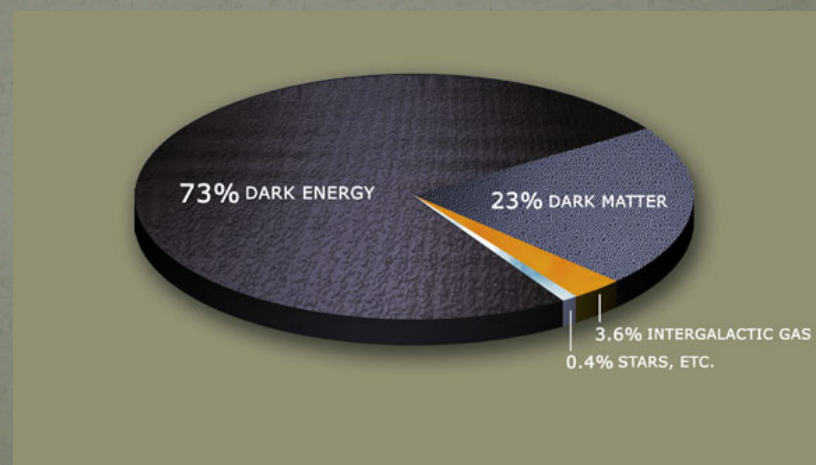
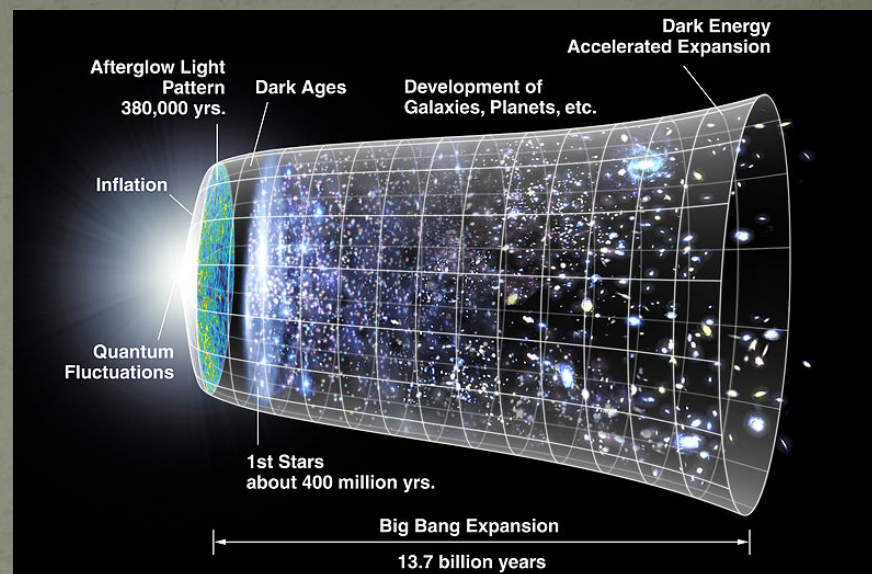


Problemi aperti

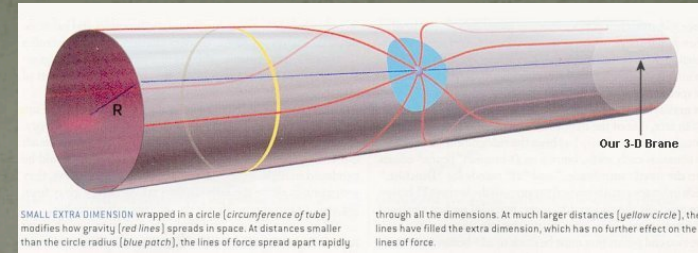
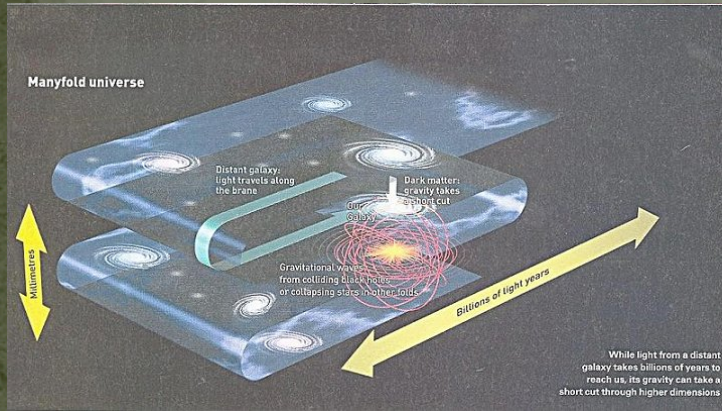
Il Modello Standard

- Non include gravità
- Problema naturalezza/ gerarchia (presenza di scalari elementari)
- Perché tre famiglie?
- Grande unificazione?
- Masse e oscillazioni di neutrini
- ...?

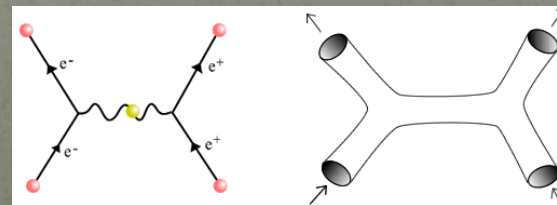
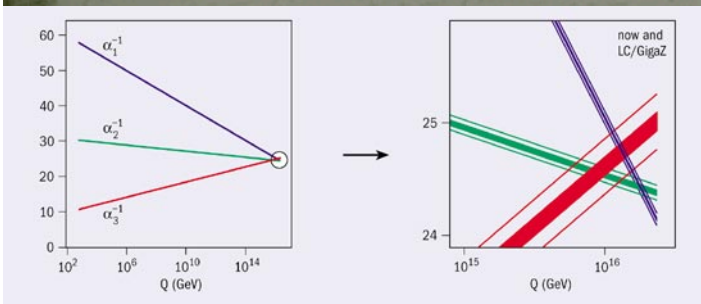
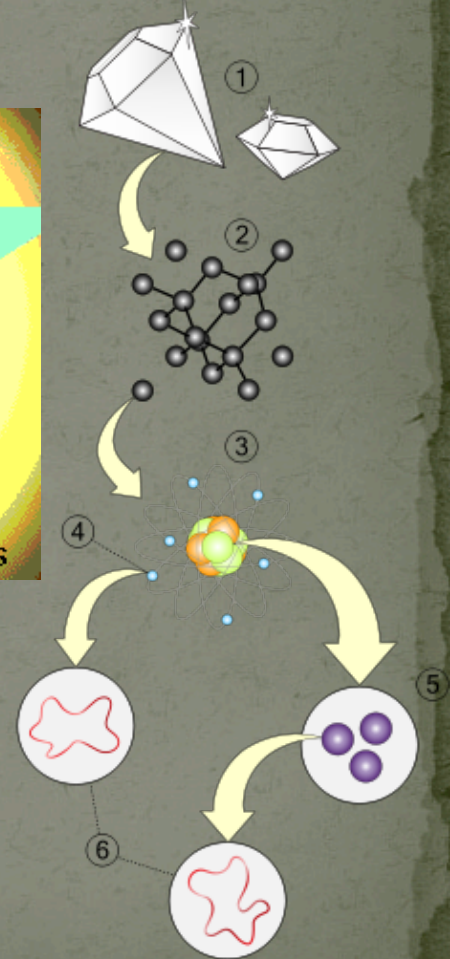
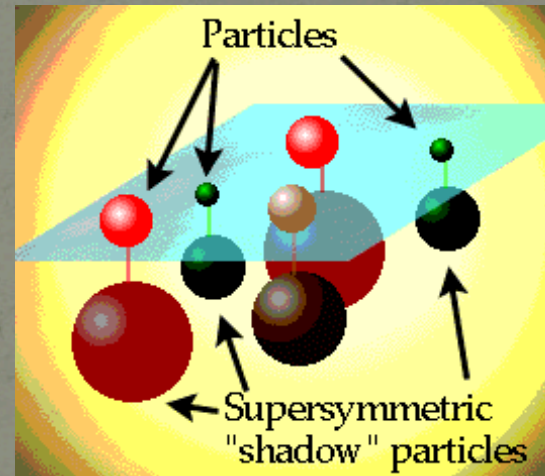
- Materia oscura(!)
- Energia oscura(!!)



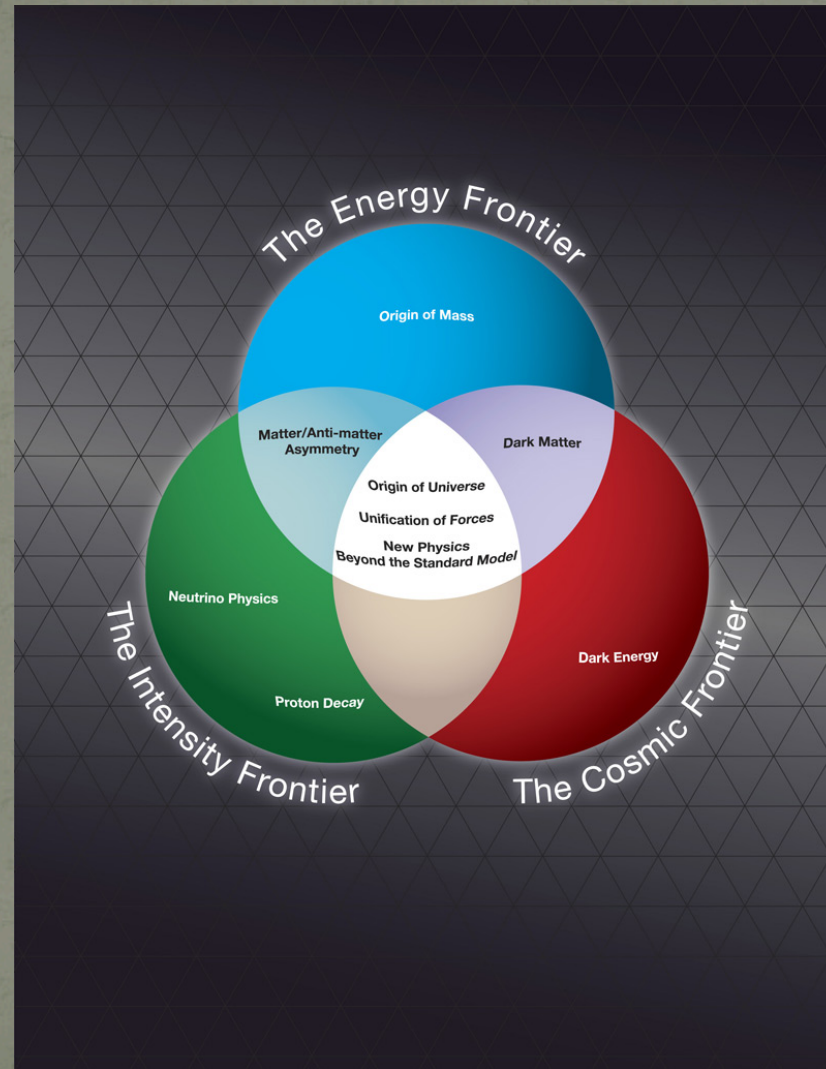
Sviluppi (speculazioni)



- Scalari composti (Technicolor-superconduttività)
- Supersimmetria
- Teorie Grandunificate
- Dimensioni extra
- Teoria di stringa



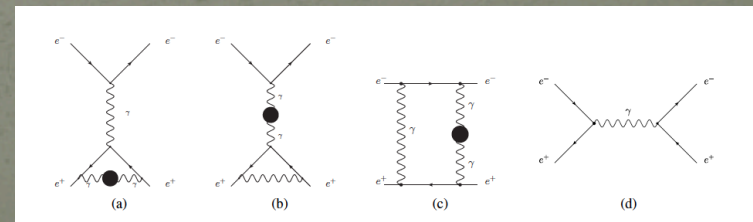
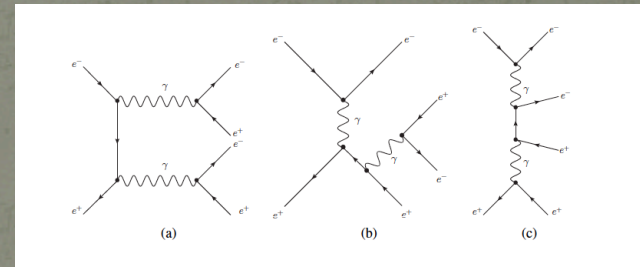
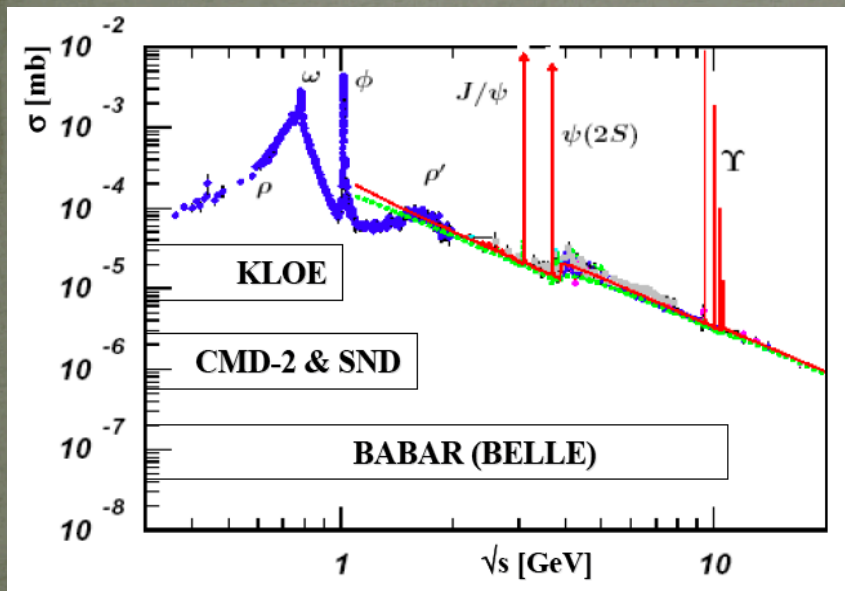
Cosa facciamo?



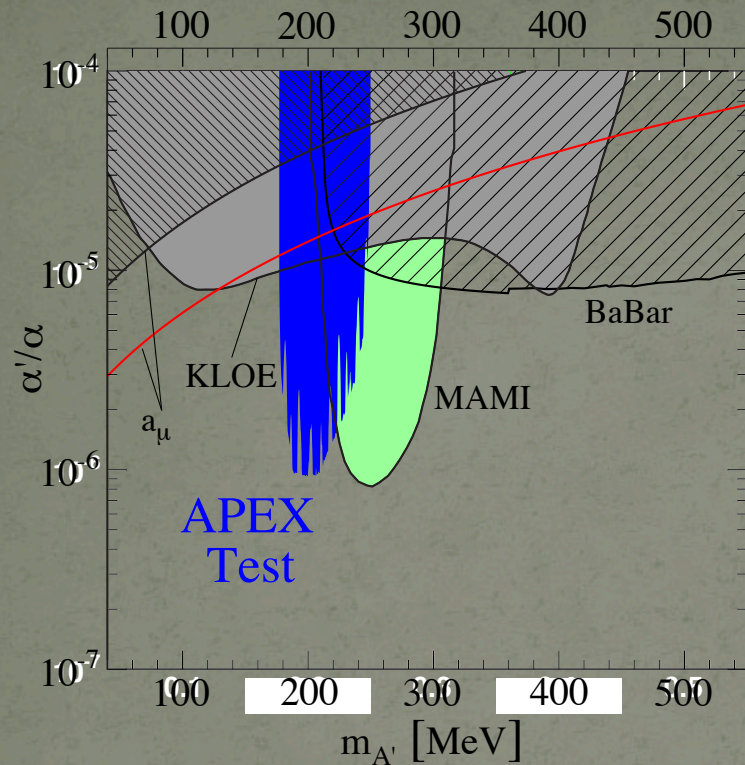
BabaYaga@NLO at flavour factories (BES, DAFNE, SuperB...)

Precision measurements at e^+e^- colliders between 1 GeV - 10 GeV require a knowledge of luminosity at a 0.1% accuracy (QED processes)

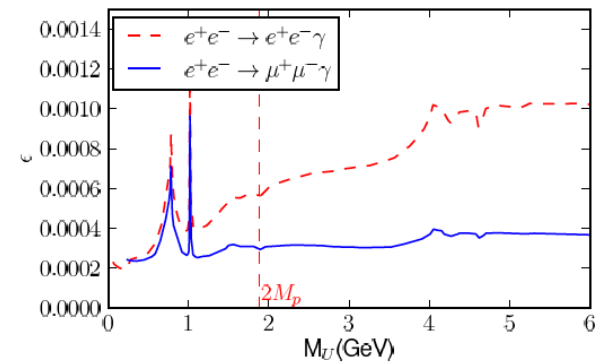
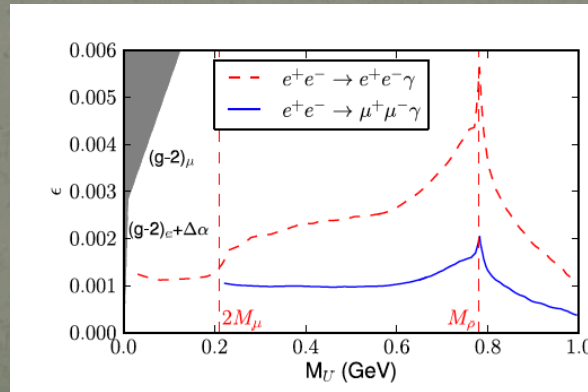
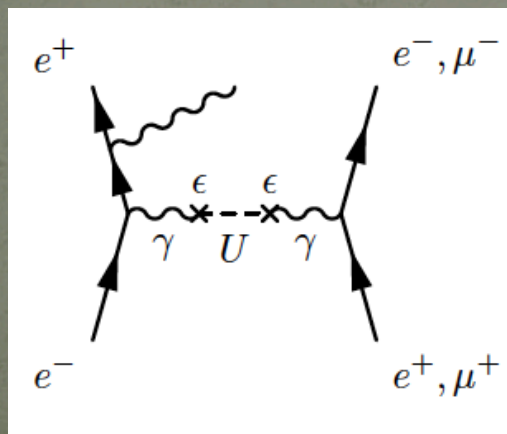
Improved BabaYaga with 0.1% precision used by KLOE, BELLE, BES, CLEO, BABAR... for Bhabha, gamma gamma, $\mu^+ \mu^-$



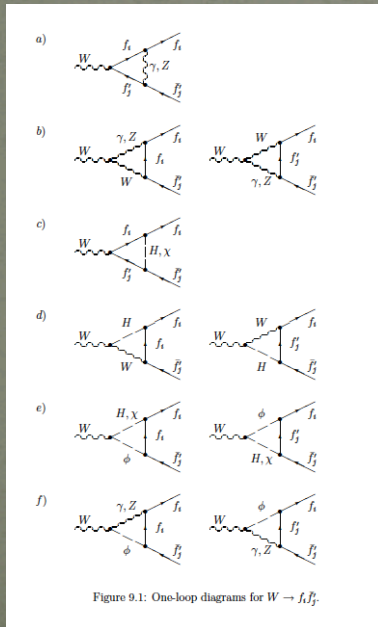
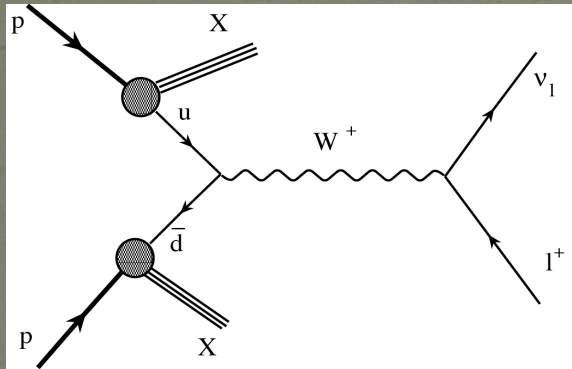
Dark matter from a secluded sector of the SM



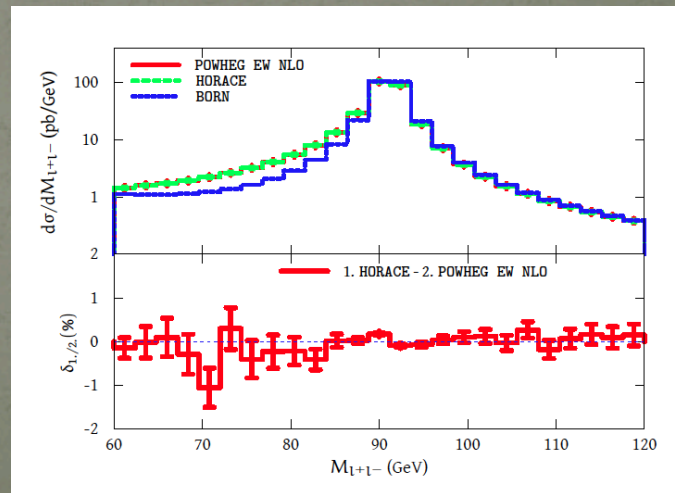
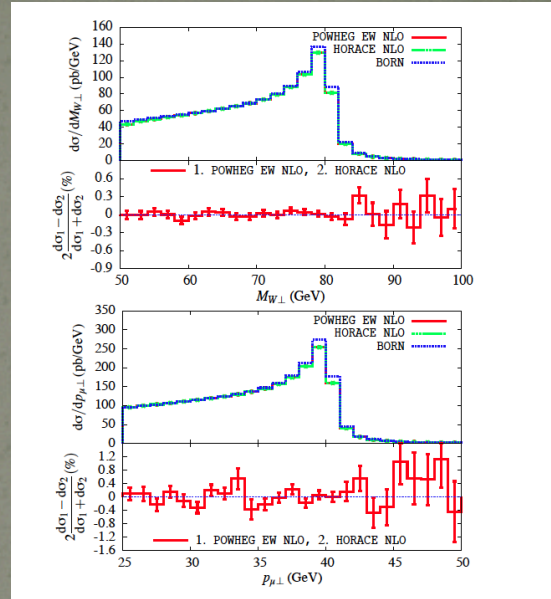
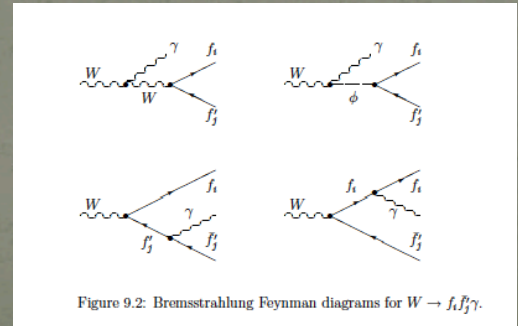
In some BSM models, a secluded DM sector is assumed, DM interacting via a new Z' weakly coupled light boson. Z' could be mixed to standard EW neutral bosons, resulting in possible new signals detectable at high luminosity flavour factories. Possible explanation for 511 KeV line, positron (but not anti-proton) excess...

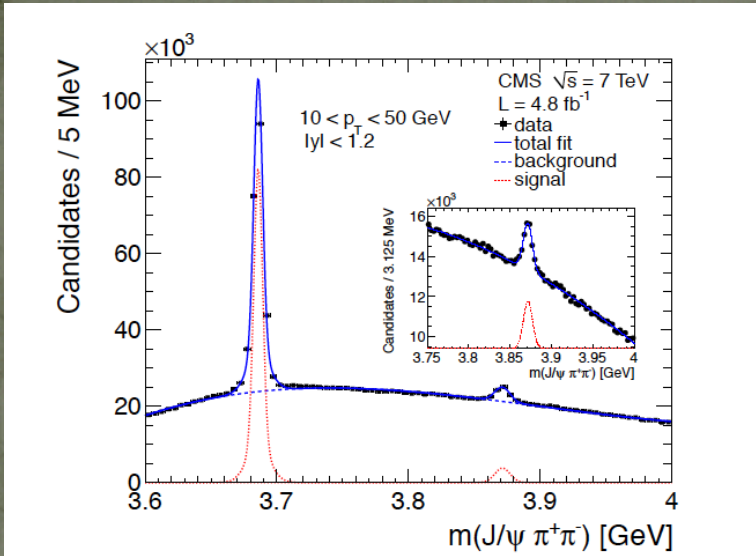


EW&QCD corrections to W/Z production at the Tevatron and LHC

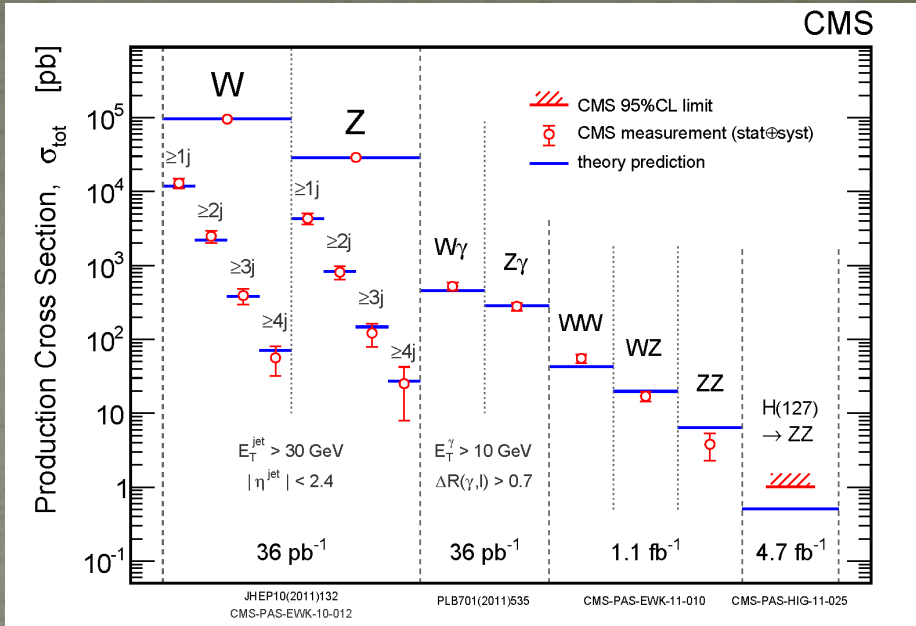


HORACE \leftrightarrow POWHEG

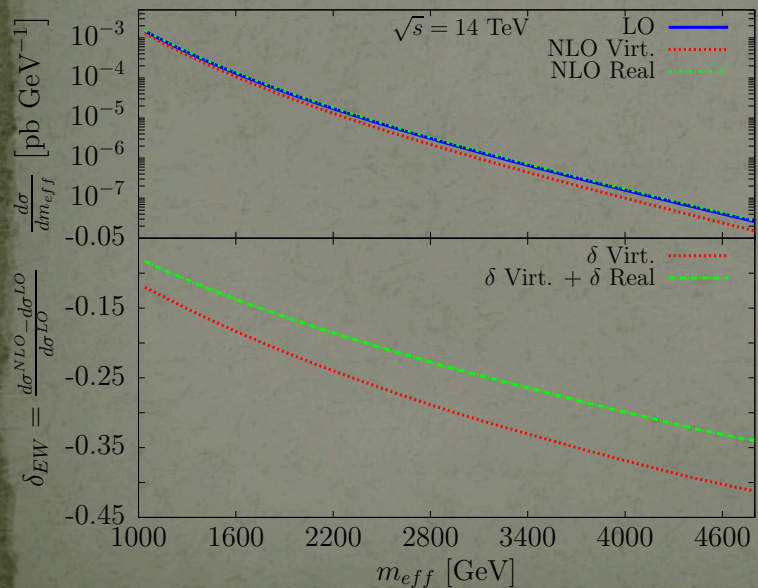




X(3872): tetraquark or hadronic molecule?

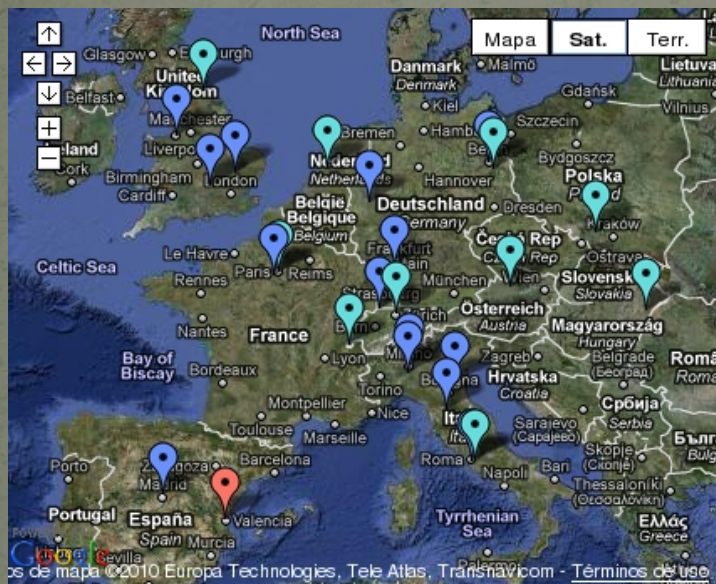


NLO QCD corrections to $W\gamma$ and $Z\gamma$ and implementation in POWHEG (with M. Chiesa and V. Prospero)



The effect of Sudakov logs at high invariant mass (with M. Chiesa)

Finanziamenti



PRIN 2010 - *Simmetrie, masse e misteri: rottura della simmetria elettrodebole, mescolamento dei sapori e violazione di CP e materia oscura nell'era di LHC*

SNS Pisa, Roma “La Sapienza”,
Firenze, Padova, Milano, INFN
LNF, Pavia, Roma 3, SISSA Trieste,
Torino, Genova
(Febbraio 2013 – Gennaio 2016)

LHCPhenonet: network EU in 7th Framework Program
“Advanced Particle Phenomenology in the LHC era”;
48 mesi, started January 2011; tra i nodi INFN e UNIPV;
coordinatore G. Rodrigo (Valencia)

**PR21: Teoria di campo delle interazioni fondamentali
Pavia, Ferrara, Firenze, Parma, Milano B, Cosenza**

Econofisica?



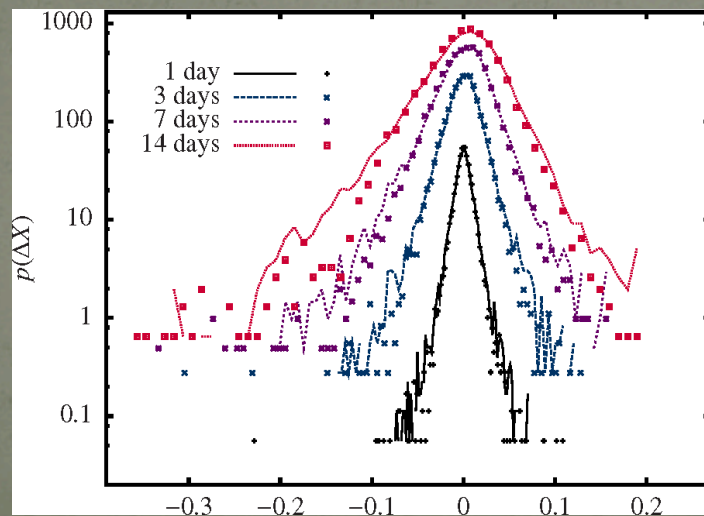
Econofisica: applicazione dei metodi della fisica teorica allo studio dei mercati finanziari considerati come sistemi complessi (H.E. Stanley)

- Modelli stocastici della dinamica dei ritorni finanziari (non gaussiani)
- Valutazione del rischio di strumenti finanziari complessi
- Modelli ad agenti per la modellizzazione microscopica del mercato

Model for log-prices: $S_t = S_0 e^{\mu t + X_t}$

$$dX_t = \sigma_t dW_{1,t}$$

$$d\sigma_t = \alpha(\theta - \sigma_t)dt + k\sigma_t dW_{2,t}$$



G. Livan: Post-doc ICTP
G. Bormetti: RTD SNS Pisa
D. Delpini: RU Sassari, Economia

V. Cazzola: Quantitative Analyst
presso UniCredit
N. Moreni: Quant at Banca IMI
E. Cisana: PricewaterhouseCoopers
Advisory

...

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