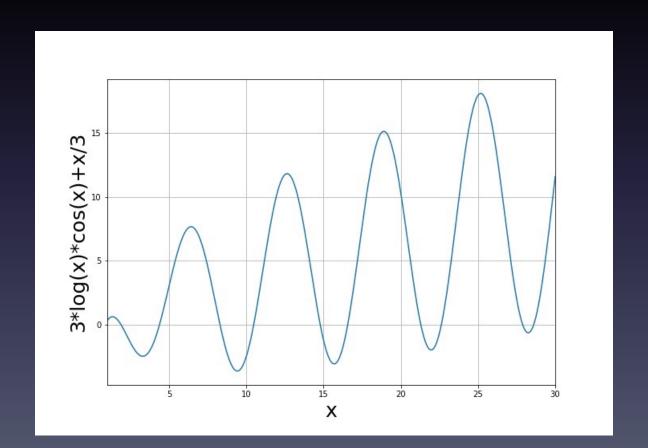
Computazione e Fisica

ovvero:

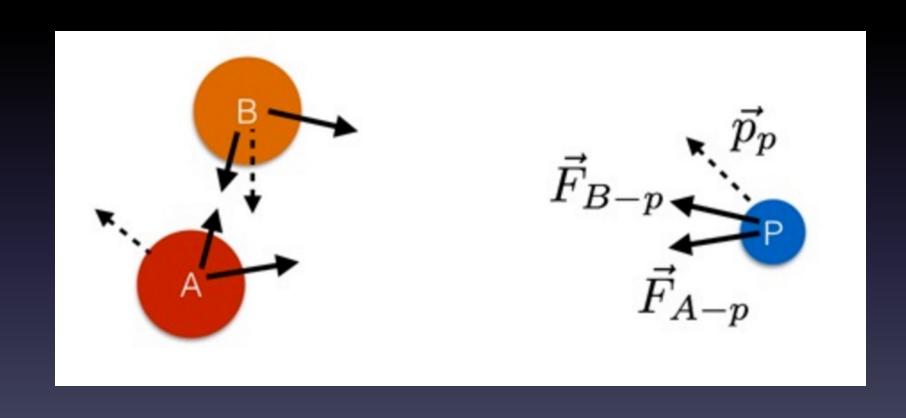
perchè Tecniche Informatiche al primo semestre del primo anno?

Problemi semplici non risolvibili analiticamente

$$a_n x^n + a_{n-1} x^{n-1} + \ldots + a_1 x + a_0 = 0$$

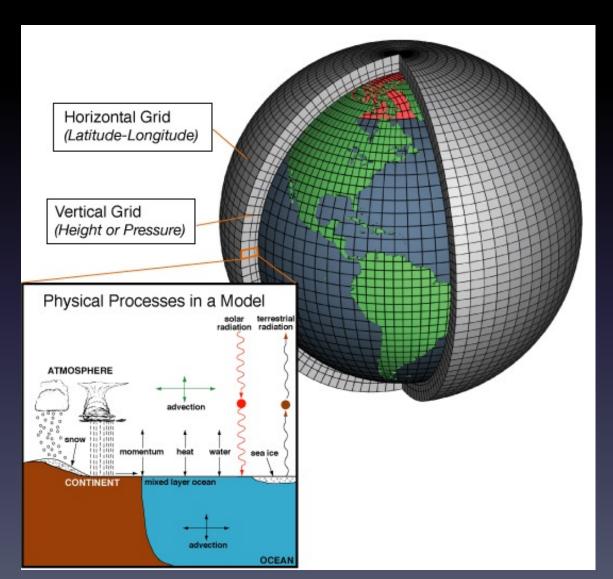


3 masse gravitanti: le forze sono note. Non sappiamo calcolare il moto.



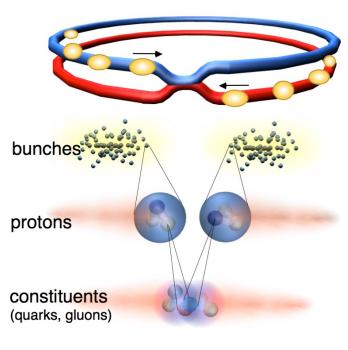
Problemi complessi

Dinamica dell'atmosfera



Un esperimento al CERN

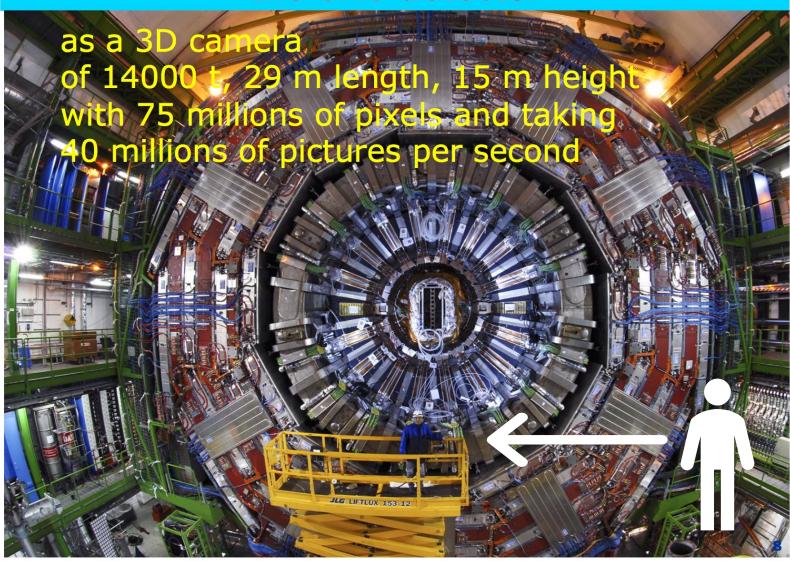
proton collisions at LHC



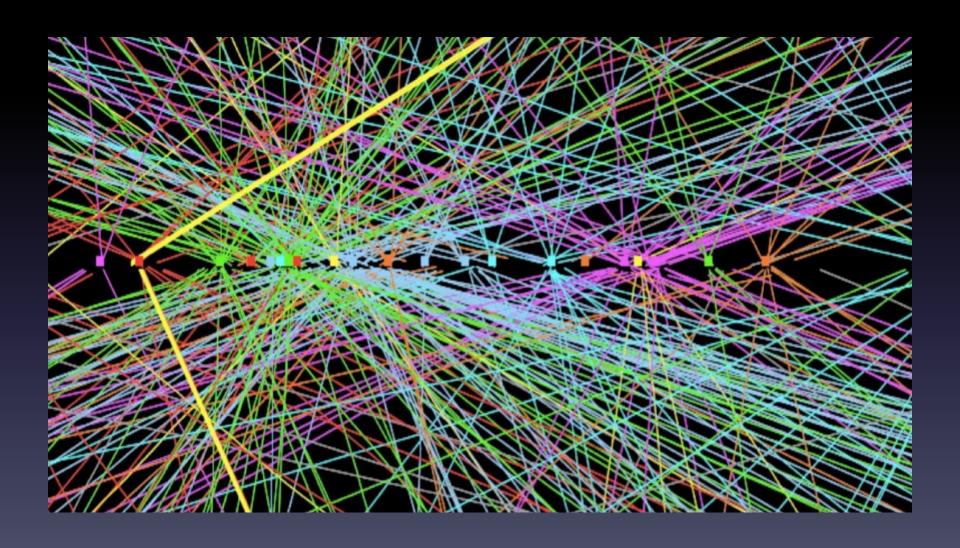
Higgs e Z° e

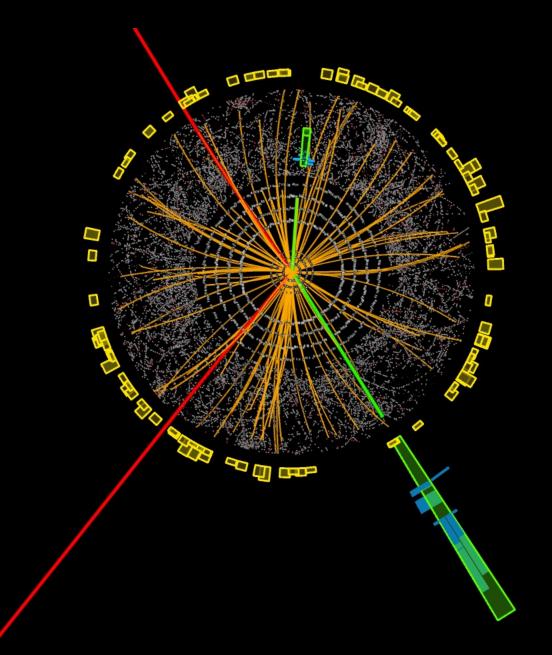
- 2800 bunches of protons
- energy of each proton: 6.5 TeV
- 100 billions protons / bunch
- beam crossing rate: 40 MHz
- in the experiments at each crossing:
 - ~ 20-50 proton-proton collisions
 - ~ 1500 particles produced
- 1 billion interactions / second
- impossible to record everything!
- a Higgs boson to find within 5 billions of collisions...

the CMS detector



Un evento: ~20 urti, ogni traccia una particella

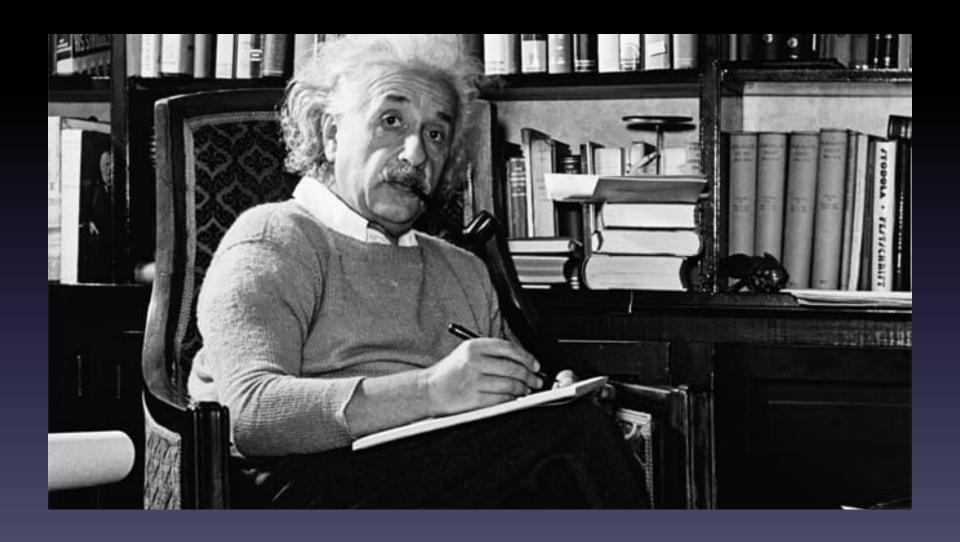






Run: 205113 Event: 12611816 Date: 2012-06-18 Time: 11:07:47 CEST

Farò il teorico, come Einstein...



 $\begin{array}{c} {\rm TTP00-20} \\ {\rm hep\text{-}ph/0008287} \\ {\rm August~2000} \end{array}$

Two-Loop Master Integrals for $\gamma^* \to 3$ Jets: The planar topologies

T. Gehrmann^a and E. Remiddi^b

Agosto 2000

$$p_{123} \longrightarrow p_{2} = \left(\frac{S_{\epsilon}}{16\pi^{2}}\right)^{2} \frac{(-s_{123})^{-2\epsilon}}{s_{12} + s_{13}} \sum_{i=-1}^{3} \frac{f_{5.1,i}\left(\frac{s_{13}}{s_{123}}, \frac{s_{23}}{s_{123}}\right)}{\epsilon^{i}} + \mathcal{O}(\epsilon^{2}), \tag{4.20}$$

with:

$$f_{5.1,3}(y,z) = 0, (4.21)$$

$$f_{5.1,2}(y,z) = -H(0;z),$$
 (4.22)

$$f_{5.1,1}(y,z) = +H(0;y)H(0;z) - 2H(0;z) + 2H(0,0;z) + H(1,0;z) + \frac{\pi^2}{6}, \qquad (4.23)$$

 $f_{5.1,0}(y,z) = +2H(0;y)H(0;z) - 2H(0;y)H(1,0;z) - 4H(0;z) - H(0;z)H(1-z,0;y)$

$$-2H(0,0;y)H(0;z) + 4H(0,0;z) - 2H(0,0;z)H(0;y) - 4H(0,0,0;z) - H(0,1,0;y)$$

$$-2H(0,1,0;z) + 2H(1,0;z) - H(1,0;z)H(1-z;y) - 2H(1,0,0;z) - 2H(1,1,0;z)$$

$$-H(1-z,1,0;y) + \frac{\pi^2}{6} \left[+2 - 2H(0;y) - 3H(0;z) - 2H(1;z) - H(1-z;y) \right] , \qquad (4.24)$$

$$f_{5.1,-1}(y,z) = +4H(0;y)H(0;z) - 4H(0;y)H(1,0;z) + 4H(0;y)H(1,0,0;z) + 4H(0;y)H(1,1,0;z) \\ -8H(0;z) - 2H(0;z)H(1-z,0;y) + 2H(0;z)H(1-z,0,0;y) \\ +H(0;z)H(1-z,1-z,0;y) - 4H(0,0;y)H(0;z) + 4H(0,0;y)H(0,0;z) \\ +4H(0,0;y)H(1,0;z) + 8H(0,0;z) - 4H(0,0;z)H(0;y) + 2H(0,0;z)H(1-z,0;y) \\ +4H(0,0,0;y)H(0;z) - 8H(0,0,0;z) + 4H(0,0,0;z)H(0;y) + 8H(0,0,0,0;z) \\ +2H(0,0,1,0;y) + 4H(0,0,1,0;z) - 2H(0,1,0;y) - 4H(0,1,0;z) \\ +4H(0,1,0;z)H(0;y) + 2H(0,1,0;z)H(1-z;y) + 2H(0,1,0,0;y) + 4H(0,1,0,0;z)$$

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$$-H(0,1,1,0;y) + 4H(0,1,1,0;z) + 2H(0,1-z;y)H(1,0;z) \\ +2H(0,1-z,0;y)H(0;z) + 2H(0,1-z,1,0;y) + 4H(1,0;z) - 2H(1,0;z)H(1-z;y) \\ +2H(1,0;z)H(1-z,0;y) + H(1,0;z)H(1-z,1-z;y) - 4H(1,0,0;z) \\ +2H(1,0,0;z)H(1-z;y) + 4H(1,0,0,0;z) + 4H(1,0,1,0;z) - 4H(1,1,0;z) \\ +2H(1,1,0;z)H(1-z;y) + 4H(1,1,0,0;z) + 4H(1,1,1,0;z) + H(1-z,0,1,0;y) \\ -2H(1-z,1,0;y) + 2H(1-z,1,0,0;y) - H(1-z,1,1,0;y) + H(1-z,1-z,1,0;y) \\ +\frac{7\pi^4}{90} + 5\zeta_3H(0;z) \\ +\frac{\pi^2}{6} \left[+4 - 4H(0;y) + 4H(0;y)H(0;z) + 4H(0;y)H(1;z) - 6H(0;z) \\ +H(0;z)H(1-z;y) + 4H(0,0;y) + 6H(0,0;z) - H(0,1;y) \right] \\ +2H(0,1-z;y) - 4H(1;z) + 2H(1;z)H(1-z;y) + 4H(1,0,z;y) + 4H(1,0,z;y) \\ +2H(1-z;y) + 2H(1-z,0;y) - H(1-z,1;y) + H(1-z;y) \\ +2H(1-z;y) + 2H(1-z;y) + H(1-z;y) + H(1-z;y) \\ +2H(1-z;y) + H(1-z;y) + H(1-z;y) + H(1-z;y) \\ +2H(1-z;y) + H(1-z;y) + H(1-z;y)$$

Ognuno degli H(...) è una funzione da valutare numericamente

$$-2H(1-z,0,1,0;y) + 2H(1-z,1,0;y) - 2H(1-z,1,0,0;y)$$

$$-H(1-z,1-z,1,0;y) + \frac{37\pi^4}{360} + \zeta_3 \left[10 - 6H(0;y) - 5H(0;z) - H(1;z) - H(1-z;y)\right]$$

$$+\frac{\pi^2}{6} \left[+2H(0;y) - H(0;y)H(0;z) - H(0;y)H(1;z) - H(0;z)H(1-z;y) - 2H(0,0;y) - H(0,1;z) - 2H(0,1-z;y) + 2H(1;z) - H(1,0;z) + 2H(1-z;y) - H(1-z,0;y) - H(1-z,1-z;y)\right]. \tag{4.31}$$

Per arrivare a queste formule sono stati necessari mesi di tempo macchina

$$\begin{array}{ccc}
p_{123} & & & & & & & \\
p_{2} & & & & & & \\
p_{3} & & & & & \\
p_{3} & & & & & \\
\end{array} = \left(\frac{S_{\epsilon}}{16\pi^{2}}\right)^{2} \frac{(-s_{123})^{-2\epsilon}}{s_{23}} \sum_{i=-1}^{3} \frac{f_{5.2,i}\left(\frac{s_{13}}{s_{123}}, \frac{s_{23}}{s_{123}}\right)}{\epsilon^{i}} + \mathcal{O}(\epsilon^{2}), \tag{4.26}$$

with:

$$\begin{array}{rcl} f_{5,2,3}(y,z) & = & -1 \; , & (4.27) \\ f_{5,2,2}(y,z) & = & -2 + H(0;y) + H(0;z) \; , & (4.28) \\ f_{5,2,1}(y,z) & = & -4 + 2H(0;y) - H(0;y)H(0;z) + 2H(0;z) - 2H(0,0;y) - H(0,0;z) - H(1,0;y) \; , (4.29) \\ f_{5,2,0}(y,z) & = & -8 + 4H(0;y) - 2H(0;y)H(0;z) + H(0;y)H(1,0;z) + 4H(0;z) + H(0;z)H(1-z,0;y) \\ & -4H(0,0;y) + 2H(0,0;y)H(0;z) - 2H(0,0;z) + H(0,0;z)H(0;y) + 4H(0,0;0;y) \\ & + H(0,0,0;z) + 2H(0,1,0;y) - 2H(1,0;y) + H(1,0;z)H(1-z;y) + 2H(1,0,0;y) \\ & + H(1,1,0;z) + H(1-z,1,0;y) + 5\zeta_3 + \frac{\pi^2}{6} \left[+ H(0;y) + H(1;z) + H(1-z;y) \right] \; , \; \; (4.30) \\ f_{5,2,-1}(y,z) & = & -16 + 8H(0;y) - 4H(0;y)H(0;z) + 2H(0;y)H(1,0;z) - H(0;y)H(1,0,0;z) \\ & - H(0;y)H(1,1,0;z) + 8H(0;z) + 2H(0;z)H(1-z,0;y) - 2H(0;z)H(1-z,0,0;y) \\ & - H(0;z)H(1-z,1-z,0;y) - 8H(0,0;y) + 4H(0,0;y)H(0;z) - 2H(0,0;y)H(0,0;z) \\ & - 2H(0,0;y)H(1,0;z) - 4H(0,0;z) + 2H(0,0;z)H(0;y) - H(0,0;z)H(0;y) \\ & + 8H(0,0,0;y) - 4H(0,0,0;y)H(0;z) + 2H(0,0,0;z) - H(0,0,0;z)H(0;y) \\ & - 8H(0,0,0,0;y) - H(0,0,0,0;z) - 4H(0,0,1,0;y) + 4H(0,1,0;y) \\ & - H(0,1,0;z)H(0;y) - H(0,1,0;z)H(1-z;y) - 4H(0,1,0,0;y) - H(0,1,1,0;z) \\ & - 2H(0,1-z;y)H(1,0;z) - 2H(0,1-z,0;y)H(0;z) - 2H(0,1-z,1,0;y) \\ & - 4H(1,0;y) + 2H(1,0;z)H(1-z;y) - H(1,0;z)H(1-z,0;y) \\ & - H(1,0;z)H(1-z,1-z;y) + 4H(1,0,0;y) - H(1,0,0;z)H(1-z;y) \\ & - 4H(1,0,0,0;y) - H(1,0,1,0;z) + 2H(1,0;z) - H(1,0,0;z)H(1-z;y) \\ \end{array}$$

Risolvere numericamente un problema richiede la capacità di spezzarlo in parti più semplici, di individuare i passi per ottenere la risposta, di controllare la correttezza di ogni passo

Non vi laureerete senza imparare a programmare

Cominciamo subito

http://personalpages.to.infn.it/~maina/