Alcune considerazioni sulle LHC Olympics (LHCO)

- qual'è il loro scopo
- in cosa consistono
- chi vi partecipa
- ricadute e sviluppi futuri

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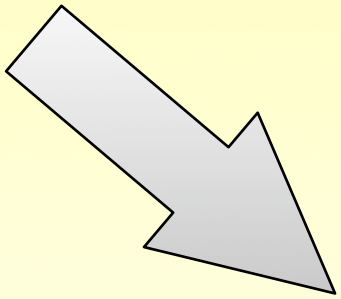
(con contributi di Gian Giudice)

Qual'e` il loro scopo :

- ★ dopo molti anni di preparazione, LHC si appresta a partire
- ★ probabile enorme impatto su tutti i settori della fisica delle particelle (e sul loro futuro ...)
- ★ anche la parte della comunita` tradizionalmente piu' lontana dalle analisi sperimentali dovrebbe acquistare familiarita` con le procedure che connettono i dati prodotti dall'esperimento con la loro interpretazione

Definizione di LHCO

(dalla pagina : http://ph-dep-th.web.cern.ch/ph-dep-th/lhcOlympics/lhcolympicsII.html)



phenomenologists,
model builders,
string theorists

" a forum for *theorists of all stripes* to prepare for the *advent* of LHC data, and to *facilitate* communication with experimentalists "

LHCO : in cosa consistono

3 attivita` collegate

- ✓ web page and links , to provide user-friendly instructions on how to use existing collider event simulation tools (Pythia, ... PGS,....)
- ✓ solution of "black boxes"
- ✓ series of workshop meetings :

LHCO: in cosa consistono (cont.)

Black boxes ➡ "unsophisticated" approach to the

LHC Inverse Problem 

given a new-physics ***signal*** at LHC, how can we use it to determine the ***underlying theory*** (the TeV Lagrangian, the string/M theory vacuum, . . .)?

"black boxes" = data sets

a) generated with specified programs (mostly with Pythia) from new-physics models *(unknown to LHCO participants)*,

b) processed through a simulation of an *LHC-like* detector (PGS);

✓ participants are challenged to look at , interpret the LHC new physics blackbox signals, and find out

what underlying model has generated these data !

inside a black box .....

each event ***consists of a set of rows in the blackbox data file.***

each row ***corresponds to an "object"*** ***[*** $\ell, \gamma, \mathbf{j}, \mathbf{E}_{\mathbf{miss}} \ldots$ ***]***

* 1st column = counter that labels the object *(when the label reverts to "1", the previous event is complete and a new event is being listed)*
* 2nd column = type of object being listed

  [0,1,2,3,4,6 = $\gamma, \mathbf{e}, \mu, \tau \rightarrow \mathbf{h}, \mathbf{j}, \mathbf{E}^{\mathbf{T}}_{\mathbf{miss}}$].
* 3rd, 4th, 5th columns = $\eta, \phi, \mathbf{E}^{\mathbf{T}}$
* 6th column = invariant mass of the object *(if it is a jet)* or its charge *(if the object is not a jet)*
* 7th column = additional information about the object
* 8th column = 0 *(unless the object is a jet that has been "tagged" as probably containing a heavy quark, in which case it is 1)*.

example : a $t\bar{t} \rightarrow \ell\nu$ b j j b event

1 2 -1.419 2.873 24.94 1.00 0.0 0.0 (*an isolated muon, positively charged, with 25 GeV of transverse momentum*)

2 4 -0.804 2.307 130.99 16.14 10.0 1.0 (a heavy-flavor jet (presumably a b quark jet) with 131 GeV of transverse momentum, an invariant mass of 16 GeV, and 10 charged tracks)

3 4 1.046 4.245 82.75 14.11 2.0 0.0 (an ordinary jet with 83 GeV of transverse momentum, an invariant mass of 14 GeV, and 2 charged tracks)

4 4 1.247 5.996 78.72 13.75 14.0 1.0 (a heavy-flavor jet (presumably a b quark jet) with 79 GeV of transverse momentum, an invariant mass of 14 GeV, and 14 charged tracks)

5 4 -2.154 3.884 13.85 5.83 3.0 0.0 (an ordinary jet with 14 GeV of transverse momentum, an invariant mass of 6 GeV, and 3 charged tracks, at a very small angle to the beampipe)

6 6 0.000 6.245 92.14 0.00 0.0 0.0 (the "missing transverse energy" in the event, 92 GeV, from a combination of the muon neutrino in the event and possible mismeasurements)

then . . . plot hystograms of distributions and figure out what NEW PHYSICS model gave rise to the data ....

(no SM bckgrd up to now !)

LHCO: in cosa consistono (cont.)

- **series of workshop meetings** :
  - instructive talks by experts,
  - discussions between theorists and experimenters,
  - ***reports by participants on their progress in deciphering the "black box" data sets***

list of participants includes

- leading experimenters,
- experts on Monte Carlo tools,
- ***theorists with widely varying levels of expertise in collider physics***

"active" partecipants to the Oympics

Organising Comittee

- Ignatios Antoniadis (CERN)
- Nima Arkani-Hamed (Harvard)
- Savas Dimopoulos (Stanford)
- Gian Giudice (CERN)
- Gordy Kane (Michigan)
- Steve Mrenna (Fermilab)
- Matt Strassler (Univ. of Washington)
- Herman Verlinde (Princeton)

1st workshop CERN - 25/26 July 2005
2nd workshop CERN - 9/10 February 2006
3rd workshop KITP, USA - end August 2006

Final Comments

- ★ large participation, but activity in Black Box solving completely driven by US groups, with apparent lack of participation from Europe
- ★ enthusiastic (and active) participation of graduate students (exercise can be useful for physics education !)
- ★ search new ways to confront theoretical models with data ; emphasis given to model-independent approaches and analyses which go beyond the well-known ones
- ★ some research papers directly stimulated by LHCO activity already appeared ☞

Supersymmetry and the LHC Inverse Problem

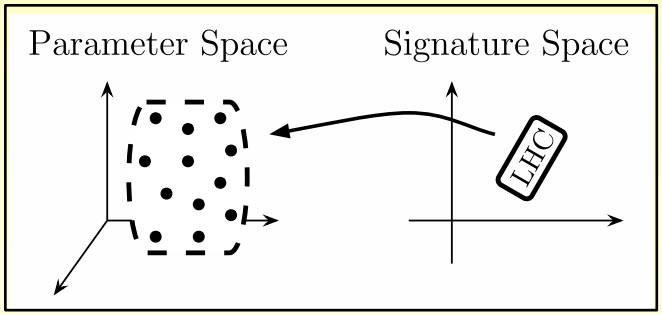
N. Arkani-Hamed, G. L. Kane, J. Thaler, and Lian-Tao Wang

arXiv:hep-ph/0512190 v1 14 Dec 2005

→ study the "inverse map" *from the space of LHC signatures to the parameter space* of theoretical models within MSSM
(using 1808 LHC observables)

→ show that the *inverse map* of a point in signature space consists of *a number of isolated islands* in parameter space

→ existence of **"degeneracies"** = qualitatively different models with the same LHC signatures. (reflecting discrete ambiguities in electroweak-ino spectrum)



Top Partners at the LHC: Spin and Mass Measurement

P. Meade and M. Reece

hep-ph/0601124

→ *model independent analysis* of the phenomenology of the "*top partner*" t′
(odd under a parity which is responsible for the stability of a WIMP)

→ discover opportunities at LHC, *mass* determination, and *spin* determination of t′

proposal by Arkani-Hamed
(with help by Wolfram, creator of Mathematica)

create a single "unified" computational tool
which takes a generic Lagrangian as input
and gives collider events as output ;

modular ➡ it would use existing elements
(matrix-elements calculation,
hadronization and fragmentation,
detector simulation)
and it would allow for their replacements as
the various elements are modified and updated

revolutionary idea, but technical and sociological problems !