L. Rurua
CERN

SUSY 06 ≡ SUSY #12

1st SUSY : 93

⟶ ? discovery ?

transformed in conferences

Beyond the Standard Model

→ difficulty in summary :

- large number of topics
- large " " talks
- no transparencies from home
- no " " speakers
- competition with World-Cup !

Briefly :

Exp. - no signs of new physics

- LHC on schedule

Th. - well prepared for "standard" physics of SM and Beyond in LHC

- Explosion of new ideas and models

⇒ Imagination or Reality ?

OUTLINE

- Statistics
- Brief review of talks in groups
- susy: motivations / history
  advantages, problems
- Naturalness
- Getting ready for / expectations from LHC

Statistics

Talks : 30 plenary

218 parallel

2 discussion sessions

participants : 318 $\Rightarrow$ > 80% talked !

Parallel sessions

- Collidevs : 51
- Cosmology : 50
- Alternative : 38
- Models : 27
- Strings : 26
- Precision : 26

---

total : 218

TOPICS (plenary sessions)

1) Experiments (colliders)

Evans (LHC), Anastassov, Givaz (Tevatron).

Rosenzweig (future), Mrenna (tools).

+ discussion session

2) Higgs + SUSY

Zeppenfeld (Higgs), Nojiri (SUSY), Barger (singlets)

3) Naturalness (landscape)

Vafa, Dine, Giudice + discussion session

4) strings + other

Kachru, Trivedi, Roiden

Nelson, Chacko

5) Non accelerator

Gonzalez-Garcia, Dedes (neutrinos)

Pospelov (EDM), Nakao (B-factories)

6) Dark Matter

Schnee (direct), Baltz (Colliders),

Moroi ($\tilde{\nu}_R$ LSP), Buchmuller (spin-3/2 LSP)

Kamionkowski

7) Cosmology

Steigman, Olinto (UHE Cosmic R), Bean

Grojean (EW phase transition)

Introduction of SUSY :

mathem curiosity → convinced on the way

Advantages :

- Unification of gauge couplings
- Dark Matter candidate
- EW Radiative Breaking
- Naturalness
- Naturally from string theory

Inconveniences : "freedom" of soft terms

- Large nb of parameters
- FCNC
- $\not{B}$, $\not{L}$ $\Rightarrow$ R-parity ?
- μ-problem

Naturalness : became dominant motivation

enhanced after EW precision data (LEP 1)

ruled out conventional Technicolor

Last ~10 years : explosion of different

theoretical ideas / approaches

. absence of exp data

. theoretical development in string theory

- Large extra dimensions / Low scale Q Gravity
- Low string scale
- Warped dimensions ↔ AdS/CFT

composite Higgs ideas back

- TeV^{-1} extra dimensions

- Higgs from higher dim gauge field

- Higgsless models

* LEP 2 "paradox" : ~1% fine-tuning

  ⇒ "little" hierarchy problem

- Little Higgs models

- Singlet extensions revival

- Twin higgses

- Combined models (ED + SUSY, LH + SUSY, ...)

* Dark energy, eternal inflation,

  landscape of string vacua

  ⇒ Live with hierarchies ?

Environmental selection ?

physics or "meta"-physics ?

"relevant" question or not ?

"sad" possibility for EW hierarchy

but worth to explore ⇒ predictivity ?

Concrete proposal : Split susy

scalars heavy , keep fermions light

⇒ unification + DM candidate remain

FCNC , $\not{B}$, $\not{L}$ + ... "solved"

Clear signals of "fine-tuning" :

- long-lived gluinos ⇒ displaced vertices
- unification of 5 couplings at m_{susy}

HWA , H^4

1) LHC

- All key objectives been reached end 05
- Magnet installation should finish end 03.07
- Every effort is made for collisions by end 07

Evans

- LHC phenomenology begins with the SM
- Need complete description of main processes
- Discrepencies will arise in specific final states

Mrenna

EW data fit $\Rightarrow$ $m_H = 89^{+42}_{-30}$ GeV

+ direct search $\Rightarrow$ $114.4 \lesssim m_H \lesssim 207$ GeV

TEVATRON

Anastassov, Grivaz

Higgs discovery potential

SM : $m_H < 180$ GeV

MSSM Higgs for $m_A < 300$ GeV

New physics limits

SUSY (cMSSM):

$m_{\chi^+} \gtrsim 140$ $M_{\tilde{g}} \gtrsim 241$ $M_{\tilde{q}} \gtrsim 325$ GeV

New gauge bosons: $M_{W'} \gtrsim 788$ $M_{Z'} \gtrsim 850$ GeV

EDims : $M_* \gtrsim 1.4$ TeV $M_{RS} \gtrsim 785$ GeV

- Exploring already energies above LEP
- Expect $\sim fb^{-1} \Rightarrow$ frontier physics

2) LHC Higgs production

- dominant modes : gluon + weak-boson fusion
- multiple decay channels observable

  ⇒ great info on Higgs couplings (SM ou MSSM)

- NLO QCD corrections needed for signal

  + important backgrounds Zeppenfeld

SUSY production

- generic signature : new color particles decaying into a stable neutral "LSP"
- first discovery / not data ⇒ discriminate "susy-like" scenarios Nojiri

Singlet extension of MSSM

- solve μ-problem
- soften little hierarchy ...
- light higgs can be "invisible" but still detectable
- 2nd Higgs $\approx$ 1st of MSSM

Barger

3/4) Landscape + Strings

- String landscape may be significantly reduced

  swampland ≡ boundary of it by eff field

  theories mostly inconsistent

  Vafa

- String realizations of mechanisms of gauge mediation

  Kachru

- Attractors : moduli are fixed in terms of charges

  on black-hole horizons

  SUSY and Non-SUSY attractors Trivedi

- Efficient string techniques for tree and 1-loop

  QCD computations improved by twistors

  Roidan

5) Non accelerator

- EDM sensitivity : comparable to LHC reach

  · probe new phys in superpotential → 10^9 GeV

  · 1-loop susy corrections > EDM sensitivity.

  Pospelov

- Neutrinos

  · new data from terrestrial exps ⇒

  start constructing leptonic mixing matrix

  Gonzalez-Garcia

  · MSSM extension with L violation ⇒

  calculable ν-masses by radiative corrections

  Dedes

6/7) Dark Matter + cosmology

problem: energy density of the universe

mostly unknown

baryons: 5 % dark matter: 20 %

dark energy: 75 %

DM solution requires detection in galaxy

+ study of its properties in lab

Complementary approaches: direct / indirect detection

+ accelerators Baltz

Weakly interacting particles in 100 GeV - TeV range

Direct searches: no signs of WIMPS at $\sigma \sim 10^{-7}$ pb

Expected sensitivity in 5 yrs: $\sim 10^{-9}$ pb

Schnee

- SUSY standard scenario : neutralino LSP

- Other viable scenaria :

  . Right sneutrino $m_{\tilde{\nu}_R} \sim 100$ GeV — Moroi

  . Gravitino (1 - 100 GeV) — Buchmuller

  ⇒ interesting collider signatures

. EW phase transition 1st order

enhanced e.g. by $|H|^6$ terms in the higgs potential

⇒ gravitational waves production

in the milli Hertz frequency — Grojean

Getting ready for LHC

Explosion of testable ideas and models

some with spectacular signatures

but only few / simple cases used in standard analysis

need efficient interactions theorists - experimenters

hadronic machines: difficult for unexpected surps

unless something clear and spectacular

→ Main questions to be answered

- Is nature natural or unnatural ?

- Where is the Higgs ?

- Is susy realized in some form at "low energies"?

  if yes any information on mechanism

  of susy + mediation ? → new era

- Find Dark Matter WIMPs ?

- Gauge unification will survive LHC data ?

- Any signal of string theory at "low energies" ?