The Higgs Discovery and Implications for Theoretical Particle Physics

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Minneapolis, July 30, 2013
July 4th, 2012

- Discovery of a new type of particle
- Discovery of a new type of force
- Start of a new era for particle physics at cosmology

1960-1967
- SSB
- The mechanism
- the particle
- the model

The power of Theory:
A 10B dollar machine built to find the Higgs predicted in the SM

- cutting-edge technology in accelerators and detectors
- decades of work on Higgs Phenomenology (70’s – today)

- precise computation of Higgs production and decays-
- as well as all other SM processes (backgrounds) -
- understanding collider signatures
What does a 125 GeV Higgs tell us?

In SUSY:
Multiple Higgs particles necessary: New Higgs bosons at LHC reach or only one SM-like Higgs and the rest heavy
Higgs mass strongly correlated with stops (sbottoms and staus)

In the MSSM: 125 GeV Higgs implies:
Large stop mixing ($A_t/M_Q \sim 1$) but no stringent lower bound on the stop mass
An upper bound on the SUSY scale [$10^3$-$10^4$ GeV if $\tan \beta$ moderate (5-10)]
Scale of SUSY Breaking

The importance of higher order loops computations
What do the Higgs Production and Decays tell us?

Many different pieces of information

$$\bar{t}tH$$

$$VVH$$

Also $$H \rightarrow b\bar{b}, \tau^+\tau^-$$

Different patterns of deviations from SM couplings if:

- New light charged or colored particles in loop-induced processes
- Modification of tree level couplings due to mixing effects
- Decays to new or invisible particles

Crucial info on NP from precision measurements
This is one of the most exciting moments in our field in decades

We expect physics beyond the SM
Where to find it? How to interpret it?

NP can be new particles, new interactions or something else:

- What does the Higgs tells us about Naturalness?
- Is there a Higgs Portal to Dark Matter?
- How does the Higgs interact with neutrinos?
- Is the Higgs triggering baryogenesis?
The funding situation in the US is very challenging and it is becoming difficult to attract and retain young bright minds in the field.

Situation elsewhere (some European countries in particular) are putting much more resources in theoretical research.

US particle theorists have played a leading role in generating novel ideas in the past many decades and are now playing a crucial role in deciphering the mysteries of our universe from experimental data.

Should we try to compete on all areas of theory or concentrate our limited resources on specific ones?