

EoS be.h : Welcome event

WP1 Presentation

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18 October 2018 @ VUB

WP1: Transversal theory approach towards new physics

Motivations:

- hierarchy problem posed by the smallness of EW scale
- search of hidden sectors

Goals:

- build coherent UV completions
- provide phenomenological and experimental signatures

Transversality:

- Links to all other WPs: scalar sector, visible and hidden, portals

From the proposal:

i) What is the symmetry/mechanism stabilizing the EW scale and giving rise to the hierarchy between this and the Unification/Planck scale?

ii) How could this symmetry/mechanism derive from/be implemented in a UV complete model like supersymmetry?

iii) What are the consequences of such a mechanism to address naturalness in terms of observable predictions at the TeV and multi-TeV scales?

Task 1.1: Study of innovative paradigms to address the hierarchy problem

Task 1.2: Unconventional naturalness and LHC signatures

Hierarchy vs Naturalness

There is a very large **hierarchy** between the EW scale and any other UV scale until which the SM is in principle valid, such as GUT or Planck scale.

This hierarchy is implemented in the SM through the smallness of the **mass**² of the scalar sector, which is unprotected by symmetries

This is not **natural** from the point of view of any UV complete theory: new physics effects will change the value of the small parameter...

...Unless there is some **principle** suppressing or canceling them.

Naturalness vs New physics

New principles, based on symmetry, leading to suppressions or cancellations, typically involve **new physics**, i.e. new particles or new sectors.

These can be **visible** UV completions, like in SUSY or 2HDM

Or they can be **hidden**, like in neutral naturalness models, hidden valleys, partial compositeness

Of course, there can be a **mixture** of visible and hidden features!

Visible or hidden alike, new physics has to communicate to the SM typically through **portals**

In practice, what are we going to do?

- Investigate novel approaches to the question of Naturalness
- Provide a unified theoretical framework
- Interpret data from the experimental searches that target the visible and hidden sectors.

We might need a deep revision of the Naturalness concept itself and a critical review of the usual paradigms invoked to solve the hierarchy problem

Study phenomenological implications in the context of the investigations performed in the WP2, WP3, WP4, WP5 and WP6.

Throwing in some ideas...

Neutral Naturalness

Clockwork

Mirror worlds

Relaxion

Task 1.1: Study of innovative paradigms to address the hierarchy problem

- neutral naturalness: **Twin Higgs** and **Folded-SUSY**
- misaligned supersymmetry or other mechanisms inspired from **string theory**

Task 1.2: Unconventional naturalness and LHC signatures

- classify the viable **portal couplings** between the SM and the dark (neutral) Hidden sector
- construct **simplified models** accordingly
- displaced objects and large multiplicity typical of **hidden valley** models

Team:

(co-)PI's:

- Riccardo Argurio (ULB)
- Thomas Hambye (ULB)
- Fabio Maltoni (UCL)
- Alberto Mariotti (VUB)
- Michel Tytgat (ULB)

Expertise:

From string theory to SUSY, from dark matter to neutrinos, from collider phenomenology to SMEFT, to model building.

Postdocs:

- Aqeel Ahmed, funded by EOS:

PD2 (VUB) “New solutions to naturalness and the hierarchy problem”

- Saereh Najjari, funded by HEP@VUB

Journey in Physics

- § Master: Islamabad University
- § PhD: University of Warsaw
“Scalar fields within warped extra dimension”
- § Student researcher:
University of California,
Davis and Riverside (2
years)
- § Postdoc: Johannes Gutenberg
University, Mainz

Research Topics

- § Model building and pheno of warped extra dimensions
- § Dark matter: multi-component DM, warped Higgs DM
- § Neutral Naturalness:
Twin Higgs scalar sector phenomenology
- § Clockwork Mechanism:
4D/5D model building aspects

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- § Model building of New Solutions to Hierarchy Problem:
Neutral Naturalness, Relaxion, Clockwork, etc.
- § Phenomenological implications: LHC, Dark Matter, Baryogenesis, etc.

Education:

- M.Sc. in particle physics,
Tafresh University and IPM, Tehran, Iran.
- Ph.D. in theoretical particle physics,
University of Warsaw on the “Lepton Flavour Violation in the extensions of the Standard Model”

Research Topics: BSM Phenomenology

- Twin Higgs Models,
- Two Higgs Doublet Models,
- Effective Field theories,
- Flavour Physics,
- Collider Physics,
- Dark Matter.

WP1 Past activities

- WP1 Kick-off meeting 5/6/2018

We had our first meeting at ULB. We had a general discussion, with an informal overview of different approaches to the hierarchy problem.

- Seminar by Diego Redigolo 28/9/2018

“The strong CP problem: LHC and flavor physics”

WP1 Future activities

- Journal clubs and seminars
@ ULBTH (weekly), UCL, VUB
- Dedicated WP1 (informal) discussions
Next: 9/11/18, 2pm @ VUB