Topical Group: BSM particle production

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Topics that the BSM group will discuss are

Productions of interesting/important BSM particles
at future lepton colliders (ILC, FCC-ee, CEPC, CLIC, etc.)
with CM energies (250—500GeV, 1TeV, 3TeV and more).

Topics that we will be discussing are on-shell BSM particle productions. Though indirect detections will be covered by other groups, we are also interested in contributing to those via interplays with other groups.

Questions (topics) defining BSM group's scope

- ✓ What is the general landscape of possible BSM particles that are relatively unconstrained by LHC searches but might be accessible to searches at ILC? What are the specific scenarios that deserve intensive study?
- ✓ What scenarios for additional Higgs bosons are open for discovery at ILC? What are the detector requirements (e.g. concerning flavor-tagging) to optimize these searches?
- ✓ What scenarios for supersymmetry are difficult to constrain at LHC but allow discovery at ILC? How would one optimize ILC detectors for these scenarios? For example, what missing-energy performance is required, and what is required from detectors in the very forward region?
- ✓ Among the scenarios for composite Higgs particles are those in which the associated massive particles are color-singlet ("neutral naturalness"). What is the capability of the ILC to discover these massive particles in parameter regions that are difficult for LHC?
- ✓ There are many scenarios in which dark matter particles are produced in e^+e^- annihilation. What are the capabilities of the ILC to discover dark matter in these various possible cases?
- ✓ What is the ILC capability for the discovery of long-lived particles? What opportunities are opened with remote detectors? How can particles whose lifetime is longer than the ILC bunch length be discovered?
- ✓ What BSM particles can be discovered in ILC beam dump or dedicated fixed-target experiments? How does the ILC reach in these modes compare to that of planned fixed-target experiments? Are there implications for the ILC accelerator layout?

Since topics we should cover are broad as seen in the above questions, we are now discussing how we should manage the BSM production group efficiently.

Moreover, our group is one those that are expected to collaborate with the task force of the fixed-target program, it will also affect our management.

One of possible activities we are now considering

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One of efficient ways to handle the questions is, as a first step, to construct

Database of BSM particles.

Then, we can systematically & quantitatively figure out the general landscape of BSM particles, consider detector requirements as well as various options.

Database of BSM particles?

Each component (BSM particle) in the database includes information of

(i) Motivation why the BSM particle (in database) is interesting/important.

(ii) Reason why the BSM particle is difficult to be searched for at the LHC.

(iii) Signals of the BSM particle production at the future lepton colliders.

(iv) Possible interplays with other TGs, task TFs and subgroups in WG3.

Database of BSM particles?

E.g. if the BSM particle in the database is the Higgsino,

(i) Motivation why the BSM particle (in database) is interesting/important.
Higgsino LSP in MSSM, A weak-charged WIMP.

(ii) Reason why the BSM particle is difficult to be searched for at the LHC.
Mass degeneracy among the Higgsino multiplet ($SU(2)_L$ doublet).

(iii) Signals of the BSM particle production at the future lepton colliders.
$e^- e^+ \to \chi^-_1 \chi^+_1 (\gamma), \chi^0_1 \chi^0_2 (\gamma)$ [H. Baer, M. Berggren et. al, PRD101, 2020.]

(iv) Possible interplays with other TGs, task TFs and subgroups in WG3.
$e^- e^+ \to l^- l^+$ via the oblique correction → Electroweak group.
When $m_\chi >> s^{1/2}$, it gives $W^{\mu\nu} D^2 W_{\mu\nu}$, $(W_{\mu\nu})^3$ → Global interpretations group.

Electroweak

Global interpret.

Higgs properties
E.g. Higgs portal DM, etc.

Heavy flavors/QCD
E.g. Comp-H particles, etc.

Database
- ✓ Motivation
- ✓ Signals @ LHC
- ✓ Signals @ FLCs
- ✓ Interplays

Modeling/Precision.

Task forces
E.g. Fixed-target program via long-lived particles.

Other WG3 groups
E.g. Software, R&D groups for signal analysis, and design needs.

Summary

Many other interesting BSM particles that should be in the database!

E.g. Compressed sleptons & a neutralino from SUSY, dark matter, g_μ-2.

Mediators (vector, scalar, etc.) connecting to SM and dark sectors, become LLPs. Interplay with LLP searches @ LHC is also important.

Is there a BSM particle predicting as a slow particle?

Is there a BSM particle that e^+ polarization is crucial?

We are now in phase to consider how the group works efficiently.

We aim to bring together the interests of people working on future e+e- colliders on direct BSM physics.

We have a few thematic questions we'll be trying to address and keep a list of interesting studies updated to facilitate newcomers.

Please contact and join us :-)