Searching for new physics after the first two years of LHC Run II

Monday 26 June 2017 - Thursday 29 June 2017

Cosener's House

Book of Abstracts

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Hunting for Walking Technicolor using Z' Searches at the LHC

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In July 2012, a Higgs boson was discovered at the LHC, however many open questions regarding its nature are yet to be answered. For decades, theories of strong dynamics, such as Technicolor, have been proposed as alternatives to spontaneous electroweak symmetry breaking. Walking Technicolor (WTC) theory is a well motivated BSM theory, offering a solution to the hierarchy problem, a composite Higgs-boson like particle corresponding to observation, an alternative mechanism of mass generation, and a rich phenomenology. We explore WTC within the current limits of the LHC, searching for heavy neutral resonances to produce the strongest current limits on the WTC parameter space, with the ultimate aim of either discovering or disproving WTC.

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Neutrinos from Dark Matter: the IceCube low-energy excess

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The recent study on the the 6-year up-going muon neutrinos by the IceCube Collaboration and the multi-messenger analyses support the hypothesis of a two-component scenario explaining the diffuse TeV-PeV neutrino flux. In particular, a low-energy excess in the IceCube data is shown in the energy range 10-100 TeV. A statistical analysis on the neutrino energy spectrum and on the angular distribution of neutrino arrival directions is performed in order to shed light on the origin of such excess. We characterize a two-component neutrino flux where decaying/annihilating Dark Matter particles provide a contribution to the IceCube observations.

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Naturalness and Dark Matter in the BLSSM

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We study the naturalness properties of the B – L Supersymmetric Standard Model (BLSSM) and compare them to those of the Minimal Supersymmetric Standard Model (MSSM) at both low (i.e.,

Large Hadron Collider) energies and high (i.e., unification) scales. By adopting standard measures of naturalness, we assess that, in presence of full unification of the additional gauge couplings and scalar/fermionic masses of the BLSSM, such a scenario reveals a somewhat higher degree of Fine-Tuning (FT) than the MSSM, when the latter is computed at the unification scale and all available theoretical and experimental constraints, but the Dark Matter (DM) ones, are taken into account. Yet, such a difference, driven primarily by the collider limits requiring a high mass for the gauge boson associated to the breaking of the additional U(1)B–L gauge group of the BLSSM in addition to the SU(3)C × SU(2)L × U(1)Y of the MSSM, should be regarded as a modest price to pay for the former in relation to the latter, if one notices that the non-minimal scenario offers a significant volume of parameter space where numerous DM solutions of different compositions can be found to the relic density constraints, unlike the case of the minimal structure, wherein only one type of solution is accessible over an ever diminishing parameter space. In fact, this different level of tension within the two SUSY models in complying with current data is well revealed when the FT measure is recomputed in terms of the low energy spectra of the two models, over their allowed regions of parameter space now in presence of all DM bounds, as it is shown that the tendency is now opposite, the BLSSM appearing more natural than the MSSM.

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Exploring Higgs in associated production with a top quark in 2HDM at the LHC

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The production of a Higgs Boson with a single top quark is a channel that allows a direct probe of the top Yukawa coupling. While the SM cross-section for pp > thj is small (approx 70fb) due to destructive interference between the W fusion and top emission diagrams as the integrated luminosity of the LHC increases the signal could be extracted from both hh > gamma gamma and h to b bar{b}. We will discuss how this process could be sensitive to the sign of the top Yukawa coupling and the effect of a change in sign of tbar{t}h on the overall cross section. Furthermore exploration of the 2HDM allows the inclusion of an additional associated diagram and the possibility of further BSM physics.

Student's Session / **7**

"Quirks" at the LHC

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Quirks - particles charged under a QCD-like confining force - are an interesting extension to the Standard Model. If the confinement scale is below ˜100 MeV, pair-produced quirks exhibit extremely unusual dynamics. Current track reconstruction algorithms at the LHC are mostly blind to the 'quirky' tracks these particles leave in the detector, so a new search strategy is proposed that offers good prospects for detection across a broad region of the parameter space.

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Vector-like quark production at the LHC, beyond the Narrow Width Approximation

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This paper explores effects of both finite width nad interference (with background) in the production and decay of extra heavy quarks at the Large Hadron Collider (LHC). These dynamics are normally ignored in the standard experimental searches and we assess here in the regions of validity of current approaches. Further, we discuss the configuration of masses, widths and couplings where the latter breaks down.

Student's Session / **9**

Flavour change proofs in the Higgs bosons production at the LHeC

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We analyse the prospects for observing the charged CP-even Higgs boson ($H^{\pm}$) in their decays to flavour violating $b\bar{c}$ channels (including charge conjugation) at the proposed Large Hadron electron Collider (LHeC), with $\sqrt{s} \approx 1.3 TeV$, the framework of a Two Higgs doublet Model Type III (2HDM-III), assuming a four-zero texture in the Yukawa matrices and a General Higgs potential. We consider theoretically consistent scenarios in agreement with current experimental data from flavour and Higgs physics. We investigate the charged current production process $ep \to \nu_e H^{\pm} q$ in presence of flavour violating decays of the charged Higgs boson, that leads to a $3 - jets +$ $slashed E_T$ signature. We demand two jets, one tagged b-jet and one light-flavour jet, all in central rapidity region. The remaining jet (originated by the remnant quark q is tagged forward or backward regions and this together with a central jet veto (not more that one light flavour jet) are essential criteria to enhance the signal-to-background rates. We consider the most relevant standard model (SM) backgrounds, treating $c - jets$ separately from light-flavour and gluon ones.

Contributed Talks / **10**

Starobinsky-like inflation and SUSY at the LHC

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We discuess a recent simple modification of the no-scale supergravity Wess-Zumino model of Starobinsky-like inflation to include a Polonyi term in the superpotential. The purpose of this term is to provide an explicit mechanism for supersymmetry breaking at the end of inflation. We show how successful inflation can be achieved for a gravitino mass satisfying the strict upper bound $m_{3/2} < 10^3 TeV$,

with favoured values $m_{3/2}$ $O(1)TeV$. The model suggests that SUSY may be discovered in collider physics experiments such as the LHC or the FCC.