Supersymmetry: from M-theory to the LHC

Sunday 10 January 2016 - Tuesday 12 January 2016

University of Kent

Book of Abstracts

Contents

8

Searching for Supersymmetry at the Large Hadron Collider

Author: Nicola Louise Abraham[1]

[1] *University of Sussex (GB)*

Corresponding Author: nicola.abraham@cern.ch

The search for supersymmetry (SUSY) is one of the main physics goals of the ATLAS experiment at the Large Hadron Collider (LHC).
At the increased collision energy of 13 TeV, the lighter weakly interacting SUSY particles are expected to be accessible, for example via their leptonic decay debris channels with high missing transverse energy, MET.
Using the new collected data from the second run of the LHC, Run-2, the analysis work presented will focus primarily on trileptonic searches plus missing transverse energy.
In addition, the production cross section on one of this analysis most dominant backgrounds, ttZ, is discussed.

Presentation Type:

Poster

3

Current Status of MSSM Higgs Sector and Future Prospects at the HL-LHC

Authors: Amit Chakraborty[1]; Arghya Choudhury[2]; Biplob Bhattacherjee[3]

[1] *Tata Institute of Fundamental Research, India*

[2] *University of Sheffield*

[3] *Indian Institute of Science, India*

Corresponding Author: a.choudhury@sheffield.ac.uk

In this work, we search for the regions of the phenomenological minimal supersymmetric standard model (pMSSM) parameter space in ‘’alignment without decoupling” scenarios. In such cases one can expect to have moderate Higgs mixing angle (α) with relatively light additional Higgses after satisfying the current LHC data. Using the most updated data (till December 2014) from the LHC and Tevatron experiments, we perform a global fit analysis. We also consider the constraints coming from the precision measurements of the rare b-decays: $B_s \to \mu^+\mu^-$ and $b \to s\gamma$.
We find that low M_A (≤ 350) and high $\tan\beta$ (≥ 25) regions are disfavored by the combined effect of the global analysis and flavour data. However, current data still allow regions with Higgs mixing angle $\alpha \sim$ 0.1 - 0.8.
We then study the existing direct search bounds on the heavy scalar/pseudoscalar (H/A) and charged Higgs boson ($H^{\pm}$) masses and branchings at the LHC. It has been found that regions with low to moderate values of $\tan\beta$ with light additional Higgses (mass $\leq$ 600 GeV) are unconstrained by the data, while the regions with $\tan\beta > 20$ are excluded considering the direct search bounds by the LHC-8 data.
The possibility to probe the region with $\tan\beta \leq 20$ at the high luminosity run of LHC are also discussed, giving special

attention to the $H \to hh$, $H/A \to tt$ and $H/A \to \tau^+\tau^-$ decay modes.

Presentation Type:

Talk

1

M Theory at the LHC

Author: Miguel Crispim Romao[1]

[1] *University of Southampton*

Corresponding Author: m.crispim-romao@soton.ac.uk

String Theory has been proven to be an important guide in constructing (semi-)realistc supersymmetric models of particle physics. While most recognise the results from Heterotic String theories, strongly coupled and non-perturbative (more general) formulations, such as F and M theories, have recently provided an exciting new branch of String Phenomenology. In this communication we will review how and why Supersymmetry arises in String/M theory, providing an introduction to some terminology and concepts for non-string phenomenologists. Afterwards, we will show how M Theory compactified on G_2 manifolds provide all the ingredients for model building and a yet-much-unexplored territory. In doing so we will present the so-called G_2-MSSM, an $SU(5)$ class of models with the MSSM spectrum, before presenting the most recent developments on $SO(10)$ SUSY GUTs arising from M Theory on G_2 manifolds.

Presentation Type:

Talk

9

Supersymmetry and Geometry and Hyperbolic Monopoles

Author: Moustafa Gharamti[1]

[1] *University of Nottingham*

Corresponding Author: moustafa.gharamti@gmail.com

Hyperbolic monopoles are solutions of the Bogomol'nyi equations on three-dimensional hyperbolic space. These equations are natural reduction of the self-duality equations for Yang-Mills fields in four-dimensional euclidean space. I will present the construction of a supersymmetric Yang-Mills theory on hyperbolic space, identify hyperbolic monopoles as supersymmetric configurations and will show how supersymmetry determines the geometry of the moduli space of hyperbolic monopoles.

Presentation Type:

Talk

0

A Zero Temperature Recipe for a Strong First Order Electroweak Phase Transition

Author: Christopher Harman[1]

Co-author: Stephan Huber [2]

[1] *University of Sussex*

[2] *Unknown*

Taking on a new perspective of the electroweak phase transition, we investigate a quantity called the one loop zero temperature vacuum energy difference. This quantity allows us to address all manner of features that are known to give rise to a strong first order electroweak phase transition. We find a strong trend between the one loop zero temperature vacuum energy difference and the strength of the electroweak phase transition, subject to the vanishing of Higgs masses which ill-define the broken vacuum and avoid a strong first order phase transition. We suggest two recipes that guarantee a strong first order electroweak phase transition without the need for any finite temperature calculations. For single field models that do not suffer from a massless Higgs mode developing, we find one loop zero temperature vacuum energy differences greater than -8.85×10^7 GeV^4 guarantee a strong first order electroweak phase transition. For singlet extended models, we can guarantee a strong first order electroweak phase transition for parameter points which have a vacuum energy difference greater than -1.0×10^8 GeV^4 and which satisfy a bound between the Higgs doublet-singlet mixing and the singlet mass.

Presentation Type:

Poster

4

Searches for third generation scalar quarks with the ATLAS detector

Author: Giuseppe Lerner[1]

[1] *University of Sussex (UK)*

Supersymmetric theories offer an elegant solution to the naturalness problem of the Standard Model Higgs, constraining the mass of the superpartners of the third generation quarks, the stop and the sbottom, to be below the TeV scale. This talk presents the status of the ATLAS searches for stop and sbottom production in final states containing bottom quarks and invisible particles. It first presents an overview of the searches that employ the full statistics of 2012 LHC proton-proton collisions at $\sqrt{s} = 8$ TeV collected by the ATLAS detector, including also new results from the $\sqrt{s} = 13$ TeV collisions data collected during 2015.

Presentation Type:

Talk

10

Searches for direct pair production of third generation squarks at ATLAS

Author: Dave Lewis[1]

[1] *University of London (GB)*

Corresponding Author: dave.lewis@cern.ch

Naturalness arguments favour supersymmetric partners of third generation quarks with masses not too dissimilar to their standard model counterparts. Both top and bottom squarks with masses of a few hundred GeV can lead to high direct pair production rates at the LHC. This talk presents a summary of ATLAS results for direct stop and sbottom pair production using 20/fb of 8 TeV pp collision data, then provides an overview of the prospects for the 13 TeV data, focusing in particular on the search for hadronic stop decays.

Presentation Type:

Talk

5

F-Theory GUTs and Discrete Symmetry

Author: Andrew Meadowcroft[1]

[1] *University of Southampton*

Corresponding Author: am17g08@soton.ac.uk

F-Theory provides an interesting platform for motivating both GUT groups and discrete symmetries. In the work presented, we show that in an $SU(5) \times D_4$ model with a geometric R-parity, it is possible to build models that exhibit no proton decay, but baryon number violation in the form of neutron-antineutron oscillations.

Presentation Type:

Talk

2

Quantum gravity using SUSY as a formal device

Author: Anthony Preston[1]

[1] *University of Southampton*

Corresponding Author: awhp1g12@soton.ac.uk

I will present working towards a manifestly diffeomorphism invariant Exact Renormalization Group. Based on a generalization of the Polchinski flow equation, this is a method to study quantum gravity without fixing a gauge. It has both fixed-background and background-independent versions. Supersymmetry enters the formalism as a method of regularization. This is similar to Parisi-Sourlas supersymmetry in statistical field theory, which I will also outline.

Presentation Type:

Talk

11

Interpretations of BSM light Higgs searches.

Author: Aggleton Robin[1]

[1] *Southampton University*

In this talk I will look at recent experimental results searching for light Higgs bosons at the LHC in the context of supersymmetric models (particularly 2HDM and the NMSSM), and their implications on these models.

Presentation Type:

Talk

7

Exploring $(g-2)_\mu$ in the light of a Pati-Salam model with $A_4 \times Z_5$ family symmetry

Authors: Alexander Belyaev[1]; Antonio De Aguiar E Pestana De Morais[2]; David Miller[3]; José Eliel Camargo Molina[4]; Patrick Schaefers[5]; Stephen King[None]

[1] *STFC - Rutherford Appleton Lab. (GB)*

[2] *LIP Laboratorio de Instrumentacao e Fisica Experimental (LIP)-Un*

[3] *University of Glasgow*

[4] *Lund University*

[5] *University of Southampton*

Corresponding Author: pbh1g14@soton.ac.uk

We explore the potential of the supersymmetric version of the Pati-Salam model with $A_4 \times Z_5$ family symmetry to describe present experimental data. We demonstrate that this model, which was initially developed to describe the neutrino sector, has a great potential to explain collider and non-collider measurements, such as the dark matter relic density, the Higgs boson mass and, most importantly, the anomalous magnetic moment of the muon $(g-2)_\mu$. The latter one suffers from a puzzling discrepancy at about 3σ level between the theoretical prediction and the experimental measured value, which the model is able to resolve precisely. Subsequently, the model predicts light smuons and respective di-muon signatures at the LHC arising from smuon pair production. We explore these signatures and suggest the respective benchmarks for further experimental studies.

Presentation Type:

Talk

6

Electroweak SUSY searches in Compressed SUSY Scenarios using the 3-Lepton+ETmiss signature

Author: Yusufu Shehu[1]

[1] *University of Sussex (GB)*

Corresponding Author: ciwake.yusufu.shehu@cern.ch

Final states with three well isolated leptons
and large ETmiss are well motivated in the search for supersymmetry.
Compressed supersymmetric spectra, where the mass difference between
the chargino or second lightest neutralino and the lightest
supersymmetric particle is relatively small (10-50 GeV), is an
ongoing objective at the Large Hadron Collider (LHC). Compressed
scenarios are explored by selecting 3-lepton events with
an additional relatively hard initial-state radiation (ISR) jet and
sizeable missing transverse energy. This permits the use of softer
leptons in the analysis, which is experimentally challenging both for
triggering and the particle reconstruction. The 3-lepton and ISR selection is explored here
using Run-1 data delivered by the Large Hadron Collider and recorded
with the ATLAS detector. No significant excess were found above the
Standard Model expectations. The new search was interpreted in terms
of 95% confidence-level exclusion limits on the masses of the
charginos and neutralinos. Results are summarised in
arXiv:1509.07152.

Presentation Type:

Talk