SUSY 2025

Report of Contributions

https://indico.cern.ch/e/susy2025

Contribution ID: **1** Type: **not specified**

Status of Weak Scale Supersymmetry, 2025

In spite of extensive searches for supersymmetric matter at LHC and SUSY WIMPs at ton-scale noble liquid dark matter search experiments, the status of SUSY is good.
I review why early naturalness estimates overestimated finetuning while the more recent model-independent measure DEW leaves broad swaths of natural SUSY parameter space.
Rather general arguments from the string landscape favor large soft breaking terms subject to the anthropic condition that the derived value of the weak scale lie within the ABDS window of allowed values. Then this stringy naturalness favors natural SUSY models over finetuned models.
Discrete R-symmetries can be used to solve the SUSY mu problem and other problems, but then lead to both PQ and R-parity as accidental, approximate symmetries which then imply that all SUSY dark matter should be DFSZ axions with depressed detection rates.
Prospects for SUSY at high-lumi LHC are also reviewed, especially the soft dilepton plus jets plus MET signature arising from light higgsino pair production.

Author: BAER, Howard (University of Oklahoma)

Presenter: BAER, Howard (University of Oklahoma)

Session Classification: Supersymmetry phenomenology and experiment

Track Classification: SUSY: phenomenology and experiment

Contribution ID: **6** Type: **not specified**

Machine Learning to rescue large pseudoscalar Yukawa couplings in the C3HDM

With LHC Run 3 in progress, the 125GeV Higgs boson couplings are being examined in greater detail, while testing for additional scalars. Multi-Higgs frameworks allow Higgs couplings to significantly deviate from Standard Model values, enabling indirect probes of extra scalars. We consider the possibility of large pseudoscalar Yukawa couplings in the softly-broken three-Higgs doublet model with CP violating coefficients. We present a parameterization of the rotations leading to the mass eigenstates and describe all the current constraints. To explore the parameter space of the model, we employ a Machine Learning algorithm that significantly enhances sampling efficiency. This method leverages an Evolutionary Strategy to improve convergence towards valid regions with an additional Novelty Reward mechanism. We show the potential of the new techniques, applicable to any beyond the Standard Model scenario.

Author: TEIXEIRA BOTO, Rafael Filipe (Instituto Superior Técnico)

Presenter: TEIXEIRA BOTO, Rafael Filipe (Instituto Superior Técnico)

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **7** Type: **not specified**

Testing the lepton content of the proton at HERA and EIC

Although protons are baryons with an overall vanishing lepton number, they possess a non-trivial leptonic content arising from quantum fluctuations which can be described by lepton parton distribution functions (PDFs) of the proton. These PDFs have been recently computed and can be used to define lepton-induced processes at high-energy colliders. In this article, we propose a novel way to test the computation of lepton PDFs of the proton by analyzing both non-resonant di-lepton and resonant Z gauge boson production processes induced by leptons within the proton at proton-electron colliders like HERA and EIC. Despite the fact that lepton PDFs of the proton are known to be small, this work demonstrates that both processes imply a measurable yield of events at HERA and EIC, which could be used to test these PDFs.

Authors: MEDINA, Anibal (The University of Melbourne); WAGNER, Carlos E.M.; DA ROLD, Leandro (Comision Nac. de Energia Atomica Centro Atomico Bariloche (AR)); Dr ROY, Subhojit (Argonne National Laboratory)

Presenter: Dr ROY, Subhojit (Argonne National Laboratory)

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **11** Type: **not specified**

Updating LHC Constraints on the 2HDM with Vector-Like Quarks: T Singlet and T Doublet Scenarios

We present a recomputation of the Large Hadron Collider (LHC) bounds for the Two-Higgs-Doublet Model (2HDM) extended with vector-like quarks (VLQs), building upon the reported limits for the Standard Model (SM) augmented with VLQs. Our analysis focuses on two distinct scenarios: the vector-like T singlet and the vector-like T doublet. By re-evaluating the experimental constraints and incorporating the additional scalar interactions from the 2HDM, we derive updated exclusion limits and sensitivity projections for the parameter space of both VLQ representations. These results provide new insights into the interplay between the 2HDM and VLQ sectors, offering refined guidance for future LHC searches and phenomenological studies.

Authors: SALIME, K.; BOUKIDI, M.; ECH-CHAOUY, Mohamed (Polydisciplinary Faculty, Laboratory of Physics, Energy, Environment, and Applications, Cadi Ayyad University, Sidi Bouzid, B.P. 4162, Safi, Morocco.); BENBRIK, R.

Presenter: ECH-CHAOUY, Mohamed (Polydisciplinary Faculty, Laboratory of Physics, Energy, Environment, and Applications, Cadi Ayyad University, Sidi Bouzid, B.P. 4162, Safi, Morocco.)

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **14** Type: **not specified**

Non-abelian Embeddings of the Standard Model Group and Charge Quantisation

In this talk, I will show a novel minimal non-abelian gauge group to embed the G_{SM}/Z1 quotient with fractionally charged beyond the standard model matter fields and show how we can define a new quantum number n_6 that is written in terms of the generators of G_{SM}. We also comment on interesting aspects of this new number, like how the degree of compositeness can shift n_6. This new quantum number we suggest can give a full spectrum of allowed electric and magnetic charges and has an important connection to the topology of the standard model gauge group.

Authors: Ms DEMAKOU, Desponia (IPPP, Durham); Prof. ALONSO, Rodrigo (IPPP, Durham); Prof. KHOZE, Valentin (IPPP, Durham); HA, Yunji (Institute of Particle Physics Phenomenology)

Presenter: HA, Yunji (Institute of Particle Physics Phenomenology)

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **16** Type: **not specified**

Highlights on Higgs measurements with ATLAS

This talk presents recent precision measurements of key properties of the Higgs boson using the full dataset of proton-proton collisions at $\sqrt{s}$ = 13 TeV and 13.6 teV collected during Run 2 and Run 3, respectively, of the LHC by the ATLAS experiment. Recent projections done for the HL-LHC will also be discussed.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Session Classification: Higgs theory and experiment

Track Classification: Higgs theory and experiment

Contribution ID: **17** Type: **not specified**

HH searches and higgs-self couplings measurements by ATLAS

In the Standard Model, the ground state of the Higgs field is not found at zero but instead corresponds to one of the degenerate solutions minimising the Higgs potential. In turn, this spontaneous electroweak symmetry breaking provides a mechanism for the mass generation of nearly all fundamental particles. Experimentally, the Higgs boson self-couplingm and thereby the shape of the Higgs potential, can be probed through the production of Higgs boson pairs (HH). In this talk, the latest HH searches by the ATLAS experiment using the LHC Run 2 and Run 3 datasets are reported. Non-resonant HH search results are interpreted both in terms of sensitivity to the Standard Model and as limits on the Higgs boson self-coupling and the quartic VVHH coupling. Additionally, extrapolations of recent HH results towards the High Luminosity LHC upgrade are also discussed. Many new physics models predict the existence of resonances decaying into two bosons, including the Higgs boson or new scalar S bosons making these important signatures in the search for new physics. Searches for HH or SH resonances performed in various final states are also presented.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Session Classification: Higgs theory and experiment

Track Classification: Higgs theory and experiment

Contribution ID: **18** Type: **not specified**

Searches for strong production of supersymmetric particles with ATLAS

Supersymmetry (SUSY) provides elegant solutions to several problems in the Standard Model, and searches for SUSY particles are an important component of the LHC physics program. Naturalness arguments favour supersymmetric partners of the gluons and third-generation quarks with masses light enough to be produced at the LHC. This talk will present the latest results of searches conducted by the ATLAS experiment which target gluino and squark production, including stop and sbottom, in a variety of decay modes.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Session Classification: Supersymmetry phenomenology and experiment

Track Classification: SUSY: phenomenology and experiment

Contribution ID: **19** Type: **not specified**

Searches for electroweak production of supersymmetric particles with ATLAS

The direct production of electroweak SUSY particles, including sleptons, charginos, and neutralinos, is a particularly interesting area with connections to dark matter and the naturalness of the Higgs mass. The small production cross-sections and challenging experimental signatures lead to difficult searches. This talk will highlight the most recent results of searches performed by the ATLAS experiment for supersymmetric particles produced via electroweak processes.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Session Classification: Supersymmetry phenomenology and experiment

Track Classification: SUSY: phenomenology and experiment

Contribution ID: **20** Type: **not specified**

Search for supersymmetry with compressed spectra with ATLAS

Supersymmetry (SUSY) models with featuring small mass splittings between one or more particles and the lightest neutralino could solve the hierarchy problem as well as offer a suitable dark matter candidate consistent with the observed thermal-relic dark matter density. However, the detection of SUSY higgsinos at the LHC remains challenging especially if their mass-splitting is O(1 GeV) or lower. Searches are developed using the LHC ATLAS Run 2 dataset to overcome the challenge. Novel techniques are developed exploiting machine-learning techniques, low-momentum tracks with large transverse impact parameters, or topologies consistent with VBF production of the supersymmetric particles. Results are interpreted in terms of SUSY simplified models and, for the first time since the LEP era, several gaps in different ranges of mass-splittings are excluded.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Session Classification: Supersymmetry phenomenology and experiment

Track Classification: SUSY: phenomenology and experiment

Contribution ID: **21** Type: **not specified**

Searches for supersymmetry in non-minimal models with ATLAS

Supersymmetry (SUSY) provides elegant solutions to several problems in the Standard Model, and searches for SUSY particles are an important component of the LHC physics program. With increasing mass bounds on MSSM scenarios other non-minimal variations of supersymmetry become increasingly interesting. This talk will present the latest results of searches conducted by the ATLAS experiment targeting strong and electroweak production in R-parity-violating models, as well as non-minimal-flavour-violating models. Recent results and interpretations in the context of the pMSSM are also presented.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Session Classification: Supersymmetry phenomenology and experiment

Track Classification: SUSY: phenomenology and experiment

Contribution ID: **22** Type: **not specified**

Beyond the Standard Model in the Higgs sector

The discovery of the Higgs boson with the mass of about 125 GeV completed the particle content predicted by the Standard Model. Even though this model is well established and consistent with many measurements, it is not capable to solely explain some observations. Many extensions of the Standard Model addressing such shortcomings introduce additional Higgs bosons, beyond-the-Standard-Model couplings to the Higgs boson, or new particles decaying into Higgs bosons. In this talk, the latest searches in the Higgs sector by the ATLAS experiment are reported, with emphasis on the results obtained with the full LHC Run 2 dataset at 13 TeV.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Session Classification: Higgs theory and experiment

Track Classification: Higgs theory and experiment

Contribution ID: **23** Type: **not specified**

Searches for BSM physics using challenging and long-lived signatures with the ATLAS detector

Various theories beyond the Standard Model predict new, long-lived particles with unique signatures which are difficult to reconstruct and for which estimating the background rates is also a challenge. Signatures from displaced and/or delayed decays anywhere from the inner detector to the muon spectrometer, as well as those of new particles with fractional or multiple values of the charge of the electron or high mass stable charged particles are all examples of experimentally demanding signatures. The talk will focus on the most recent results using 13 TeV pp collision data collected by the ATLAS detector.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **24** Type: **not specified**

Searches for Dark Matter and new phenomena in hadronic final states with ATLAS

Many theories beyond the Standard Model predict new phenomena giving rise to multijet final states. These jets could originate from the decay of a heavy resonance into SM quarks or gluons, or from more complicated decay chains involving additional resonances that decay e.g. into leptons. Also of interest are resonant and non-resonant hadronic final states with jets originating from a dark sector, giving rise to a diverse phenomenology depending on the interactions between the dark sector and SM particles. This talk presents the latest ATLAS results.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **25** Type: **not specified**

Searches for new physics with leptons using the ATLAS detector

Many different theories beyond the Standard Model (SM) predict that new physics will manifest itself by decaying into final states involving leptons. Leptoquarks are predicted by many new physics theories to describe the similarities between the lepton and quark sectors of the SM. Right-handed Ws and heavy-neutrinos are also predicted by many extensions of the SM in the gauge sector, and lepton flavour violation could manifest itself by decays of new gauge bosons into leptons of different flavours. This talk will present the most recent 13 TeV results on the searches for leptoquarks with the ATLAS detector, covering flavour-diagonal and cross-generational final states, as well as the latest searches for lepton-flavour violating Z' and heavy neutrinos arising from left-right symmetric models.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **26** Type: **not specified**

Searches for new phenomena in final states with 3rd generation quarks using the ATLAS detector

Many theories beyond the Standard Model predict new phenomena, such as heavy vectors or scalar, vector-like quarks, and leptoquarks in final states containing bottom or top quarks. Such final states offer great potential to reduce the Standard Model background, although with significant challenges in reconstructing and identifying the decay products and modelling the remaining background. The recent 13 TeV pp results, along with the associated improvements in identification techniques, will be reported.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **27** Type: **not specified**

ATLAS Searches for new scalars & BSM Higgs decays

The discovery of the Higgs boson with the mass of about 125 GeV completed the particle content predicted by the Standard Model. Even though this model is well established and consistent with many measurements, it is not capable to solely explain some observations. Many extensions of the Standard Model addressing such shortcomings introduce additional Higgs bosons, beyond-the-Standard-Model couplings to the Higgs boson, or new particles decaying into Higgs bosons. In this talk, the latest searches in the Higgs sector by the ATLAS experiment are reported.

Author: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Presenter: VIVARELLI, Iacopo (Universita e INFN, Bologna (IT))

Session Classification: Higgs theory and experiment

Track Classification: Higgs theory and experiment

Contribution ID: **28** Type: **not specified**

Vector-Like Quarks at the LHC: A unified perspective from ATLAS and CMS exclusion limits

We present the current exclusion limits for vector-like quarks (VLQs) of bottom (B) and top (T) types, based on combined ATLAS and CMS data from the LHC. For B-type VLQs, pair production excludes masses up to 1.52 TeV in doublet scenarios, while single production limits the mixing parameter κ to values between 0.2 and 0.7. For T-type VLQs, pair production excludes masses up to 1.49 TeV, with single production constraining κ to less than 0.26 at 1.5 TeV and up to 0.42 at 2 TeV. These results, obtained using the VLQBounds tool, highlight the increasing sensitivity of single production at higher masses.

Authors: Dr BOUKIDI, Mohamed (Université Cadi Ayyad, Marrakech); Mr ECH-CHAOUY, Mohamed (Université Cadi Ayyad, Marrakech); Prof. YAN, Qi-Shu (Chinese Academy of Science); Prof. BENBRIK, Rachid (Université Cadi Ayyad, Marrakech); Prof. MORETTI, Stefano (Uppsala University); Ms SALIME, khawla (Université Cadi Ayyad, Marrakech)

Presenter: Ms SALIME, khawla (Université Cadi Ayyad, Marrakech)

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **34** Type: **not specified**

Higgs Boson Production at μ+ μ+ Colliders

Motivated by recent advancements in antimuon cooling, we study Higgs boson production at $\mu^+\mu^+$ colliders at high energy. Since both initial-state particles are positively charged, there is no W boson fusion at the leading order, as it requires a W^+W^- pair. However, we find that the cross section of the higher-order, γ- and Z-mediated W boson fusion process is large at high center-of-mass energies $\sqrt{s}$, growing as $(\log s)^3$. This is in contrast to the $(\log s)$ behavior of the leading-order W boson fusion. Thus, even though it is a higher-order process, the rate of Higgs boson production for 10 TeV energies at $\mu^+\mu^+$ colliders with polarized beams can be as high as about half of the one at $\mu^+\mu^-$ colliders, assuming the same integrated luminosity. To calculate the cross section of this process accurately, we carefully treat the collinear emission of the photon in the intermediate state. The thereby obtained large cross section furthermore shows the significance of Higgs boson production with an extra W boson in the final state also at $\mu^+\mu^-$ and e^+e^- colliders.

Authors: TAKAURA, Hiromasa (Yukawa Inst., Kyoto U.); TREUER, Lukas (Yukawa Inst., Kyoto U. and KEK, SOKENDAI (Japan)); TAKAI, Ryoto (Yukawa Inst., Kyoto U. and KEK, SOKENDAI); KITANO, Ryuichiro (Yukawa Inst., Kyoto U.); MATSUDO, Ryutaro (Yukawa Inst., Kyoto U.); OKAWA, Shohei (Yukawa Inst., Kyoto U.); HAMADA, Yu (DESY, RECNS/Keio U.)

Presenter: TREUER, Lukas (Yukawa Inst., Kyoto U. and KEK, SOKENDAI (Japan))

Session Classification: Higgs theory and experiment

Track Classification: Higgs theory and experiment

Contribution ID: **40** Type: **not specified**

Heavy Twin Higgs Axion

Heavy axions address the strong CP problem in a robust way, less susceptible to high scale corrections to their potential. We outline a framework for producing a GeV scale axion while simultaneously addressing the other naturalness issue of the Standard Model: the electroweak hierarchy problem. This is done by modifying the twin Higgs framework so that the twin sector has a larger color group while preserving its natural aspects. We also comment on the experimental signatures that can be used to probe this construction.

Authors: BATELL, Brian Thomas; VERHAAREN, Christopher (Brigham Young University)

Presenter: VERHAAREN, Christopher (Brigham Young University)

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **42** Type: **not specified**

Soft-lepton excesses in EW SUSY searches: Interpretation in (GUT-based) SUSY scenarios

For the first time ATLAS and CMS report consistently about excesses in the search for EW SUSY particles, seen in two different search channels by each experiment. We interpret these excesses as the production of two light EW MSSM particles, yielding $M_1 \sim M_2$, i.e. not within "natural GUT-based scenarios". We also interpret these excesses in the NMSSM, where the relation $M_1 \sim M_2/2 \sim M_3/6$ can be retained, with the gluino mass beyond the LHC bounds.

Authors: BAGNASCHI, Emanuele Angelo (INFN Laboratori Nazionali di Frascati); SAHA, Ipsita; CHAKRABORTI, Manimala; HEINEMEYER, Sven (CSIC (Madrid, ES))

Presenter: HEINEMEYER, Sven (CSIC (Madrid, ES))

Session Classification: Supersymmetry phenomenology and experiment

Track Classification: SUSY: phenomenology and experiment

Contribution ID: **50** Type: **not specified**

BSM Higgs physics at the Photon collider

High-energy $\gamma\gamma$- and $e\gamma$-collisions offer a rich phenomenological programme, complementary to e^+e^- collisions at a linear collider both in kinematic as well as physics reaches. In particular, $\gamma\gamma$ collisions offer a unique setting to investigate properties of the Higgs boson(s). High polarisation of the photon beams (produced via Compton back-scattering) can be achieved and adjusted by flipping the polarisation of the incident laser. Furthermore, prospects for di-Higgs production at a $\gamma\gamma$ collider are particularly promising, and could open the way to a direct measurement of the trilinear Higgs self-coupling, at lower centre-of-mass energies than at an e^+e^- collider.
In this talk we will present new results about the di-Higgs production process at the $\gamma\gamma$ collider, comparing different running tups. We will discuss the possibility of measuring the trilinear Higgs coupling, also making use of photon polarisations to disentangle different contributions to di-Higgs production.

Author: BERGER, Marten (University Hamburg)

Co-authors: WEIGLEIN, Georg Ralf (Deutsches Elektronen-Synchrotron (DE)); MOORTGAT-PICK, Gudrid; BRAATHEN, Johannes Alf (DESY)

Presenter: BERGER, Marten (University Hamburg)

Session Classification: Higgs theory and experiment

Track Classification: Higgs theory and experiment

Contribution ID: **52** Type: **not specified**

SU(5) Yukawa sectors at NLO

$SU(5)$ grand unified model, which unifies SM quarks and leptons in $\bar{5}$ and 10 dimensional irreducible representations˜(irrep), yields observationally inconsistent tree-level Yukawa relations when only a single $5_{\rm H}$ or $45_{\rm H}$ dimensional irrep having a single Higgs contributes to the Yukawa sector. For instance, only $5_{\rm H}$ dimensional Higgs in the Yukawa sector yields $Y_d = Y_e^T$, while $45_{\rm H}$ gives $3Y_d = Y_e^T$. These inconsistent tree-level Yukawa relations can be rendered viable by switching on one-loop corrections to different Yukawa vertices. The former scenario requires extending the minimal model by $SU(5)$ singlets while the latter one requires splitting of mass of scalars residing in the same multiplet. Other setups are also explored where radiative effects make the inconsistent tree-level frameworks viable. Importantly, the findings highlight the feasibility of the simplest Yukawa sector when accounting for quantum corrections and substantial threshold effects.

Author: SHUKLA, Saurabh K. (Physical Research Laboratory)

Presenter: SHUKLA, Saurabh K. (Physical Research Laboratory)

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **60** Type: **not specified**

Renormalising the Field Space Geometry

We present a systematic study of one-loop quantum corrections in scalar effective field theories from a geometric viewpoint, emphasizing the role of field-space curvature and its renormalisation. By treating the scalar fields as coordinates on a Riemannian manifold, we exploit field redefinition invariance to maintain manifest coordinate independence of physical observables. Focusing on the non-linear sigma model (NLSM) and \(\phi^4\) theory, we demonstrate how loop corrections induce momentum- and scale-dependent shifts in the curvature of the field-space manifold. These corrections can be elegantly captured through the recently proposed geometry-kinematics duality, which generalizes the colour-kinematics duality in gauge theories to curved field-space backgrounds. Our results highlight a universal structure emerging in the contractions of Riemann tensors that contribute to renormalisation of the field-space curvature. In particular, we find explicit expressions and a universal structure for the running curvature and Ricci scalar in simple models, illustrating how quantum effects reshape the underlying geometry. This geometric formulation unifies a broad class of scalar EFTs, providing insight into the interplay of curvature, scattering amplitudes, and renormalisation.

Authors: Prof. WEILER, Andreas (Technical University of Munich); HASLEHNER, Dominik (Max Planck Institute for Physics & Technical University of Munich); Dr GENDY, Emanuele (Technical University of Munich); Dr BELLAFRONTE, Luigi (Florida State University); Mr AIGNER, Patrick (Technical University of Munich)

Presenter: HASLEHNER, Dominik (Max Planck Institute for Physics & Technical University of Munich)

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **61** Type: **not specified**

Electroweak spin-1 resonances in Composite Higgs models

Composite Higgs models offer an elegant solution to the hierarchy problem by assuming that the Higgs boson is not an elementary particle but a composite state. The Higgs emerges as a pseudo-Nambu-Goldstone boson due to spontaneous symmetry breaking within a new strongly interacting sector.
We focus on minimal realizations of such models with fermionic UV completions that preserve custodial symmetry and naturally include fermionic resonances acting as top partners.
These models predict spin-1 resonances which carry electroweak quantum numbers.
We find that three such states mix significantly with the electroweak gauge bosons, allowing their single production in Drell-Yan-like processes at the LHC. We explore the rich LHC phenomenology of these states and find scenarios where their masses could be as low as 1.5 TeV.

Authors: VEROLLET, Christian; HADLIK, Jan (University Würzburg); KUNKEL, Manuel; CALIRI, Rosy; POROD, Werner

Presenter: HADLIK, Jan (University Würzburg)

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **63** Type: **not specified**

TeV-scale scalar leptoquarks solve shortcomings of SO(10) and explain the flavor anomalies

It is common practice to explain deviations between data and Standard-Model predictions by postulating new particles at the TeV scale ad-hoc. This approach becomes much more convincing, if one successfully embeds the postulated particles into a UV completion which addresses other conceptual or phenomenological shortcomings of the SM. I present a study of an SO(10) grand unified theory which contains scalar leptoquark fields employed to explain the "flavor anomalies"in $b \to s$ and $b \to c$ decays. I find that the additional degrees of freedom improve the renormalization group evolution of the SM parameters and may explain some of the observed fermion masses.

Authors: Prof. NIERSTE, Ulrich; GAO, Xiyuan (KIT, Karlsruhe, TTP)

Presenter: GAO, Xiyuan (KIT, Karlsruhe, TTP)

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **65** Type: **not specified**

Cheshire θ terms, Aharonov-Bohm effects, and axions

We discuss unusual θ terms that can appear in field theories that allow global vortices. These "Cheshire θ terms" induce Aharonov-Bohm effects for some particles that move around vortices. For example, a Cheshire θ term can appear in QCD coupled to an axion and induces Aharonov-Bohm effects for baryons and leptons moving around axion strings. We point out a potential experimental signature left on the spectrum of gravitational waves from axion cosmic string network by the Cheshire θ term.

Author: CHOI, Gongjun

Co-authors: CHERMAN, Aleksey (University of Minnesota); NEUZIL, Maria (University of Minnesota); CHEN, Shi (University of Minnesota)

Presenter: CHOI, Gongjun

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **67** Type: **not specified**

Searching for Supersymmetry at FCC-ee

We discuss indirect probes of the MSSM at FCC-ee, with particular emphasis on the complementarity between single Higgs production and electroweak precision tests at the Tera-Z run. In addition to flavor-universal contributions to the STWY oblique parameters, we point out important flavor non-universal effects. An example of the latter is the heavy Higgs doublet, which gives tree-level shifts in Higgs couplings as well as sizeable RGE contributions to the Zbb vertex. Overall, we find that FCC-ee can probe the MSSM in the multi-TeV range, and test the naturalness of the EW scale at the per-mille level.

Authors: GRELJO, Admir (Universitaet Basel (CH)); VALENTI, Alessandro (University of Basel); STEFANEK, Benjamin (IFIC Valencia)

Presenter: STEFANEK, Benjamin (IFIC Valencia)

Session Classification: Supersymmetry phenomenology and experiment

Track Classification: SUSY: phenomenology and experiment

Contribution ID: **72** Type: **not specified**

Probing Inert Scalar Dark Matter via Vector Boson Fusion at a Future Muon Collider

The Inert Doublet Model (IDM) and Inert Triplet Model (ITM) feature a neutral scalar dark matter candidate along with inert charged scalars. In the ITM, the charged scalars exhibit a compressed mass spectrum, while in the IDM, the mass splittings among scalar components arise from electroweak symmetry breaking. Recent constraints from direct and indirect dark matter searches push these models toward the TeV scale, making their production challenging at current and future LHC runs. However, a future Muon Collider provides a promising alternative via Vector Boson Fusion (VBF), which significantly enhances the production cross-section. In the ITM, the compressed mass spectrum leads to disappearing track signatures from long-lived charged scalars, whereas the IDM predominantly exhibits missing transverse momentum. Both models yield energetic forward muons from VBF, a distinctive feature at a Muon Collider. We analyze these signatures and present discovery prospects based on luminosity projections.

Author: SEN, CHANDRIMA

Presenter: SEN, CHANDRIMA

Contribution ID: **75** Type: **not specified**

Searches for Supersymmetry with compressed scenarios

Results from the CMS experiment are presented for supersymmetry searches targeting so-called compressed spectra, with small mass splittings between the different supersymmetric partners. Such a spectrum presents unique experimental challenges. This talk describes the new techniques utilized by CMS to address such difficult scenarios and presents results based on these techniques.

Author: LIAO, Hongbo (Chinese Academy of Sciences (CN))

Presenter: LIAO, Hongbo (Chinese Academy of Sciences (CN))

Contribution ID: **76** Type: **not specified**

Recent searches for strong and electroweak production of SUSY particles with CMS

A wide variety of searches for strong and electroweak productionSupersymmetry have been performed by experiments at the Large Hadron Collider. In this talk, we present recent highlights from these searches.

Author: LIAO, Hongbo (Chinese Academy of Sciences (CN))

Presenter: LIAO, Hongbo (Chinese Academy of Sciences (CN))

Contribution ID: **77** Type: **not specified**

Stealth and RPV SUSY searches with CMS

Since the classic searches for supersymmetry under R-parity conserving scenarios have not given any strong indication for new physics yet, more and more supersymmetry searches are carried out on a wider range of supersymmetric scenarios. This talk focuses on searches looking for signatures of stealth and R-parity-violating supersymmetry.

Author: LIAO, Hongbo (Chinese Academy of Sciences (CN))

Presenter: LIAO, Hongbo (Chinese Academy of Sciences (CN))

Contribution ID: **79** Type: **not specified**

Searches for additional Higgs bosons (high & low mass) at CMS

We present searches for additional Higgs bosons from the CMS experiment. A variety of states are searched for, at masses both above and below 125 GeV.

Author: LIAO, Hongbo (Chinese Academy of Sciences (CN))

Presenter: LIAO, Hongbo (Chinese Academy of Sciences (CN))

Session Classification: Higgs theory and experiment

Track Classification: Higgs theory and experiment

Contribution ID: **80** Type: **not specified**

Phenomenological MSSM interpretation of CMS Run 2 searches

Results are presented for the combination of CMS Run 2 searches for new physics, interpreted in the framework of the phenomenological MSSM (pMSSM) via a scan over its 19-dimensional parameter space, using 138 fb^{-1} of proton-proton collision data collected at 13 TeV. A global Bayesian analysis is performed, using a likelihood-based Markov Chain Monte Carlo (MCMC) approach incorporating data from CMS, as well as constraints from pre-LHC collider searches, the flavor sector, and Higgs mass measurements. In particular, the impact of the CMS search for the supersymmetric partners of tau leptons on the pMSSM parameter space is emphasized.

Author: LIAO, Hongbo (Chinese Academy of Sciences (CN))

Presenter: LIAO, Hongbo (Chinese Academy of Sciences (CN))

Contribution ID: **83** Type: **not specified**

Statistically Learning New Physics from LHC Data

Despite the large amount of data produced by the Large Hadron Collider (LHC), no clear evidence of New Physics (NP) has emerged so far. Most LHC searches target exclusive channels, focusing on specific final states, but NP may appear as a dispersed signal across many channels. This motivates a more global approach to finding out where beyond the Standard Model physics might be hiding. We present a statistical learning algorithm designed to identify such dispersed signals in the slew of published LHC analyses. The algorithm constructs candidate "proto-models", precursors to a possible next Standard Model, from small excesses in the data, while remaining consistent with negative results on NP.

In this talk, I will outline our method and highlight recent algorithmic advancements that goes beyond the initial concept published previously. Furthermore, I will share preliminary results obtained by applying this framework to the latest SModelS database, which aggregates around 110 published experimental analyses.

Authors: LESSA, Andre; REYES-GONZÁLEZ, Humberto; YELLEN, Jamie; ALTAKACH, Mohammad Mahdi (LPSC); KRAML, Sabine; NARASIMHA, Sahana; PASCAL, Timothée; WALTENBERGER, Wolfgang

Presenter: ALTAKACH, Mohammad Mahdi (LPSC)

Session Classification: Supersymmetry phenomenology and experiment

Track Classification: SUSY: phenomenology and experiment

Contribution ID: **89** Type: **not specified**

Using MTN to study multiply-produced semi-invisible resonances at hadron colliders

The stransverse mass variable MT2 was originally proposed for the study of SUSY-like events at hadron colliders in which N=2 parent particles are produced and then decay semi-invisibly. Here we consider the generalization to the case of N≥3 semi-invisibly decaying parent particles. We introduce the corresponding class of kinematic variables MTN and illustrate their mathematical properties. Many of the celebrated features of the MT2 kinematic endpoint are retained in this more general case, including the ability to measure the mass of the invisible daughter particle from the stransverse mass kink.

Authors: DONG, Zhongtian (University of Kansas); KONG, K.C.; MATCHEV, Konstantin (University of Alabama (US)); MATCHEVA, Katia (University of Alabama)

Presenter: MATCHEV, Konstantin (University of Alabama (US))

Contribution ID: **91** Type: **not specified**

CP-violation in the complex singlet extension of 2HDM

We explore the possibility of CP-violation in the complex-singlet extension of 2HDM. The addition of complex singlet paves the way for additional sources of CP-violation compared to 2HDM. If a Z2-symmetry is imposed on the complex-singlet, such a model can accommodate a dark matter candidate as well. We identify the regions of parameter space, that can fit DM observables and at the same time generate sufficient CP-violation. The amount of CP-violation gets severely constrained from electric-dipole moment (EDM) experiments, which we take into account. In addition, we examine the impact of other theoretical and experimental constraints. Finally, we probe the CP-violation in this model at present and future collider experiments.

Authors: Dr LI, Cheng (Sun Yat-Sen University); Prof. MOORTGAT-PICK, Gudrid (University of Hamburg, DESY); Dr LAHIRI, Jayita (University of Hamburg)

Presenter: Dr LAHIRI, Jayita (University of Hamburg)

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **92** Type: **not specified**

Distinguishing between Dirac and Majorana HNL's at FASER2

Heavy Neutral Leptons (HNLs) are promising extensions of the Standard Model that could explain neutrino masses, baryogenesis, and dark matter. A key question is whether HNLs are Dirac or Majorana particles, with the latter allowing lepton number violation. We investigate the potential of the proposed FASER2 detector, alone and in combination with ATLAS, to distinguish between Dirac and Majorana HNLs in the GeV mass range. Using simulations with FORESEE and HNLCalc, we assess sensitivity to HNL mass, mixing, and lifetime differences. We find that there are regions of un-probed HNL parameter space where FASER2 alone can discriminate between Dirac and Majorana scenarios based on their energy spectra. Furthermore, we demonstrate that FASER2 can act as a viable trigger for ATLAS within the allowed timing constraints. This coordination enables the use of charge information from prompt leptons observed in ATLAS, which significantly enhances model discrimination when combined with FASER2 data.

Authors: HEWITT, Alec; LA ROCCO, Daniel; FENG, Jonathan Lee (University of California Irvine (US))

Presenter: HEWITT, Alec

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **94** Type: **not specified**

Anomaly-Mediated SUSY Breaking in QCD-like SU(N) and Sp(N) Gauge Theories

We present an analytical derivation of the chiral symmetry breaking minima in supersymmetric asymptotically-free SU(N) and Sp(N) theories with F flavors of "quarks", perturbed by Anomaly Mediated Supersymmetry Breaking. We are able to show that all such theories, except in the SU(N) case of N = F, possess stable chiral symmetry breaking minima that are plausibly continuously connected to the vacua of QCD-like SU(N) or Sp(N) theories for large SUSY breaking.
In SU(N) QCD, due to the presence of incalculable global minima, we are often able to only derive "locally stable" chiral symmetry breaking minima. In particular, tachyonic two-loop AMSB masses lead to baryonic runaways to incalculable minima at the upper end of the free magnetic phase (1.5N ≥ F ⊠ 1.43N), whereas for the s-confining case (F = N + 1) and most of the free-magnetic phase (F ≤ 1.43N) we find that naive tree-level baryonic runaways are stabilized by loop effects near the origin of moduli space. However, in the Sp(N) counterparts, all the minima that we derive are global because tachyonic dual squark directions are naturally stabilized by quartic tree level SUSY potentials, and there are no tree level runaways as baryons are absent.

Authors: ROY VARIER, Digvijay (University of California, Berkeley); MURAYAMA, Hitoshi (University of California Berkeley (US)); NOETHER, Bea (UC Berkeley); GU, Zijian (Virginia Tech)

Presenter: ROY VARIER, Digvijay (University of California, Berkeley)

Contribution ID: **99** Type: **not specified**

The EDM inverse problem: Disentangling the sources of CP violation and PQ breaking with EDMs

The permanent electric dipole moments (EDMs) of nucleons, atoms, and electrons serve as powerful probes of new physics beyond the TeV scale. Once a non-vanishing EDM is discovered, an important issue may be identification of the underlying CP violating source originated from high energy physics. In this work, we investigate the feasibility of experimentally identifying the ultraviolet (UV) origin of CP violation through future EDM measurements. In particular, we explore whether future EDM data can reveal the UV origin of the QCD axion vacuum expectation value. We find that CP violation dominated by the gluon chromo-electric dipole moment (CEDM) or by quark CEDMs—with or without the QCD axion—can be experimentally distinguished from CP violation dominated by the Standard Model (SM) QCD theta term, based on distinctive nuclear and atomic EDM patterns. Generally, future EDM experiments, together with improved theoretical calculations, may enable us to disentangle (semi-)leptonic and four other hadronic UV CP-violating sources from the SM CP violation dominated by the QCD theta term.

Author: Dr IM, Sang Hui (IBS CTPU)

Co-authors: Prof. CHOI, Kiwoon (IBS CTPU); Dr JODŁOWSKI, Krzysztof (IBS CTPU)

Presenter: Dr IM, Sang Hui (IBS CTPU)

Contribution ID: **100** Type: **not specified**

Quark-universal U(1) breaking scalar at the LHC

If the quarks or leptons are charged under a new $U(1)$ gauge symmetry, then besides a Z' boson there must exist at least one new boson whose decay products include Standard Model particles. In the case of a minimal symmetry breaking sector, that new boson is a scalar ϕ that couples to the Z' boson as well as to the new fermions required to cancel the $U(1)$ gauge anomalies. The scalar may be produced at the Large Hadron Collider (LHC) in association with a Z' boson, or through Z' boson fusion, while its decays are typically into four jets or two photons. We analyze in detail the case where the Z' boson is leptophobic, and all the quarks have the same charge under the new $U(1)$. If ϕ mixes with the Standard Model Higgs boson, then the new scalar can also be produced via gluon fusion, and the discovery mode is likely to be a diphoton resonance.

Authors: DOBRESCU, Bogdan; YU, Felix (Johannes Gutenberg University Mainz); ARMBRUSTER, Lorin

Presenter: ARMBRUSTER, Lorin

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **102** Type: **not specified**

Phenomenology of Holographic Chiral Anomalies

In Randall-Sundrum models, the AdS/CFT correspondence motivates the addition of Chern-Simons terms that flow anomalies such that they are entirely localized on the ultraviolet brane. This has interesting implications both for collider physics and for cosmology. We discuss the implications for holographic composite axion solutions to the strong CP problem, and for inflationary cosmology.

Authors: MORADIPASHA, Hanieh; HUBISZ, Jay

Co-author: SINGH, Prakriti (Syracuse University)

Presenter: MORADIPASHA, Hanieh

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **103** Type: **not specified**

Holographic Chiral Anomalies

The structure of chiral anomalies in braneworlds is subtle. The divergence of a 5D current has long been known to be localized to end-of-the world branes, and to be evenly divided between these branes. However, such branes may be hidden by horizons, or may even be replaced by soft-wall geometries in certain cases. We demonstrate the correct approach, particularly in models motivated by the AdS/CFT correspondence, is to flow the anomaly with appropriate Chern-Simons terms so that only the UV, or "cut-off" brane contains the anomaly.

Author: SINGH, Prakriti (Syracuse University)

Co-authors: MORADIPASHA, Hanieh; HUBISZ, Jay

Presenter: SINGH, Prakriti (Syracuse University)

Session Classification: Non-SUSY extensions of the Standard Model

Track Classification: Non-SUSY extensions of the Standard Model

Contribution ID: **104** Type: **not specified**

Status and Recent Results from the LUX-ZEPLIN Dark Matter Experiment

LUX-ZEPLIN (LZ) is a direct detection dark matter experiment located nearly a mile underground at the Sanford Underground Research Facility in South Dakota, USA, employing 7 tonnes of active liquid xenon in a dual-phase time projection chamber (TPC). It is further surrounded by a veto system that includes a 2-tonne liquid xenon skin, a gadolinium-loaded liquid scintillator, and an ultra-pure water tank. The experiment has been taking data since 2021, and in 2024 released world-leading constraints on WIMP-nucleon cross-sections for WIMP masses > 9 GeV/c2. This talk will discuss the status of the LZ experiment and report on its recent science results with a specific emphasis on the dark matter parameter space being probed.

Author: KODROFF, Daniel (Lawrence Berkeley National Lab)

Presenter: KODROFF, Daniel (Lawrence Berkeley National Lab)

Contribution ID: **110** Type: **not specified**

Maximal Entanglement and Symmetries in the 2HDMs

We consider 2-to-2 scatterings of Higgs bosons in a CP-conserving two-Higgs-doublet model (2HDM) and study the implication of maximizing the entanglement in the flavor space. In the unbroken phase and turning off the gauge interactions, entanglement maximization results in the appearance of an U(2) x U(2) global symmetry. Interestingly, once the Higgs bosons acquire vacuum expectation values, maximal entanglement enforces an exact U(2)xU(2) symmetry, which is spontaneously broken to U(1) x U (1). As a byproduct, this gives rise to Higgs alignment as well as to the existence of 6 massless Nambu-Goldstone bosons. The U(2)xU(2) symmetry can be gauged to lift the massless Goldstones, while maintaining maximal entanglement demands the presence of a discrete Z2 symmetry interchanging the two gauge sectors. The model is custodially invariant in the scalar sector, and the inclusion of fermions requires a mirror dark sector, related to the standard one by the Z2 symmetry.

Author: Prof. WAGNER, Carlos (University of Chicago)

Presenter: Prof. WAGNER, Carlos (University of Chicago)

Session Classification: Higgs theory and experiment

Track Classification: Higgs theory and experiment