

# **XIV NExT PhD Workshop: the shape of new physics to come**

## **Report of Contributions**

Contribution ID: 1

Type: **not specified**

## Listening for ultra-heavy dark matter using underwater acoustic sensors

*Monday, 15 July 2024 16:30 (20 minutes)*

Dark matter with masses beyond the Planck scale pose a direct detection challenge given their very low flux. There have been attempts to constrain macroscopic scale dark matter using large volume terrestrial mediums such as the atmosphere, and long integration time mediums such as ancient mica. In this talk, I show that searches of macroscopic dark matter using  $\mathcal{O}(100 \text{ km}^3)$  arrays of hydrophones which have been proposed for UHE neutrino detection could probe new parameter space.

**Primary author:** CLEAVER, Damon (King's College London)

**Presenter:** CLEAVER, Damon (King's College London)

**Session Classification:** Student talks

Contribution ID: 2

Type: **not specified**

## Non-decoupling scalars at future detectors

*Monday, 15 July 2024 16:50 (20 minutes)*

The nature of the electroweak symmetry breaking remains the last theoretical unknown of the Standard Model (SM). In this work, we extend the SM with a set of simplified scalar models which are classified by their electroweak irreducible representations. We present a no-lose theorem for future experiments by showing that any additional particle to the SM that acquires a significant fraction of their mass from the Higgs mechanism is discoverable at the FCC-ee. In addition, these scalar extensions can also induce a strong first-order phase transition which may be detected by future gravitational wave interferometers such as LISA.

**Primary author:** CRAWFORD, Graeme

**Presenter:** CRAWFORD, Graeme

**Session Classification:** Student talks

Contribution ID: 3

Type: **not specified**

## Search For Boosted Light Higgs Bosons From Supersymmetric Cascade Decays

*Wednesday, 17 July 2024 17:30 (20 minutes)*

Although there is no concrete evidence of physics beyond the Standard Model at the LHC, there is still a great deal of potential to be explored. Taking advantage of the upgraded detectors and the higher integrated luminosity expected in future runs is critical for uncovering novel phenomena at the LHC.

Our research is looking for pairs of light Higgs bosons ( $H_1$ ) through SUSY cascade decays of pair-produced squarks ( $\tilde{q}$ ) and gluinos ( $\tilde{g}$ ). These events have small missing transverse momentum ( $p_T$ ) in the final state, as a result of the mass spectrum between the singlino-like particle in the Next-to-Minimal-Supersymmetric Standard Model (NMSSM) and the Higgs. This leads to cascade decays via the next-to- Lightest SUSY Particle (LSP),  $\tilde{\chi}_2^0$ , to a singlino-like LSP,  $\tilde{\chi}_1^0$ , and a CP-even singlet-like Higgs boson  $H_1$ . This research is based on previously published analysis for Run 2 data.

In the published analysis,  $H_T$  binning was used. However, for Run 3, we are planning to use Squark mass binning to make the analysis more precise. I will discuss in detail, why Squark mass reconstruction is important and outline the best methods to achieve it.

**Primary author:** MOALLEMI, Mehrnoosh (Science and Technology Facilities Council STFC (GB))

**Presenter:** MOALLEMI, Mehrnoosh (Science and Technology Facilities Council STFC (GB))

**Session Classification:** Student talks

Contribution ID: 4

Type: **not specified**

## Underlying Event Tuning for VINCIA

*Thursday, 18 July 2024 11:30 (20 minutes)*

Underlying event (UE) modelling is crucial at the LHC, for both precision Standard Model measurements and understanding of soft QCD phenomenology. In recent years, an emergence of newer, improved parton shower models in Monte Carlo generators were seen. One such model is VINCIA, an antenna-based parton shower model that was developed as a plug-in to Pythia. Incorporating both soft and collinear limits of QCD via the antenna functions, VINCIA is expected to handle colour coherence better. This study is the first attempt to develop an ATLAS dedicated tune for VINCIA, with the specific aim of improving the modelling of UE.

This talk will present the state of the tuning study at the time of the NExT PhD Workshop. At the time of submitting this abstract, an initial tune involving multiple parton interactions and colour reconnection parameters has been done and an improvement in the modelling of UE-sensitive observables has been obtained. The tune will be extended to include more parameters and distributions, while the usage of MiNNLO will be investigated so that QCD calculations at NNLO can be matched to parton showers.

**Primary author:** TUNCAY, Baris (University of Oxford (GB))

**Presenter:** TUNCAY, Baris (University of Oxford (GB))

**Session Classification:** Student talks

Contribution ID: 5

Type: **not specified**

## Low energy electron recoil searches within LZ and using FlameNEST for future work

*Thursday, 18 July 2024 11:50 (20 minutes)*

LUX-ZEPLIN (LZ) is a direct dark matter (DM) detection experiment utilising a 7-tonne active target of liquid xenon, searching primarily for WIMP candidates that produce nuclear recoils (NR) of xenon

nuclei. LZ recently published results from the 60 live-day science run one (SR1), producing new world-leading limits for the upper bound of the spin-independent and neutron spin-dependent WIMP-nucleon cross-sections. In 2023, LZ published results in a search for new physics in low-energy

electron recoils from the first LZ exposure, which looked for signals from exotic physics models that produce electron recoils, such as DM candidates that couple to electrons. The search included solar

axions, axion-like particles, hidden photons, and solar neutrino magnetic moment and millicharge. This talk will discuss the results featured in this paper, the work done to calculate projected limits by

combining SR1 with planned exposures from SR3 to estimate future sensitivity and discuss using FlameNEST, a statistical framework being developed within LZ, to produce improved sensitivity results for these models compared to previous statistical methods used by LZ.

**Primary author:** RIYAT, Harkirat (University of Edinburgh)

**Presenter:** RIYAT, Harkirat (University of Edinburgh)

**Session Classification:** Student talks

Contribution ID: 6

Type: **not specified**

## Primordial Black hole relics as Dark matter candidate

*Wednesday, 17 July 2024 17:50 (20 minutes)*

During the talk, I will delve into the unique candidate of Planck mass Primordial Black Hole (PBH) relics as dark matter. These relics, arising from the evaporation of light PBHs with initial masses ranging from  $1g$  to approximately  $10^6g$ , possess the potential to account for the entirety of dark matter in our universe. My presentation will encompass a thorough review of existing constraints on PBH abundance, incorporating the consideration of Planck mass relics. Additionally, I will provide visual representations, such as plots, illustrating the new perspective on dark matter as PBH relics.

**Primary author:** ALJAZAERI, Amirah Saeed M. (University of Sussex)

**Presenter:** ALJAZAERI, Amirah Saeed M. (University of Sussex)

**Session Classification:** Student talks

Contribution ID: 7

Type: **not specified**

## The Double Copy: A Duality for Particles and Gravity

*Monday, 15 July 2024 17:10 (20 minutes)*

An open problem in theoretical physics is to combine all four of the fundamental forces of nature into one single theory. Problematically, gravity has proven difficult to reconcile with the other forces. Recently, relationships between scattering amplitudes (the quantity related to the probability for an interaction to occur between two or more particles) in non-abelian gauge theories (such as the theory of quarks and gluons) and theories of quantum gravity have led to the discovery of a relation known as the double copy. The double copy relates scattering amplitudes in quantum gravity as the square for those in non-abelian gauge theories. This property has been extended to relate solutions in classical electromagnetism with those in general relativity, via a theory known as the classical double copy.

**Primary author:** ARMSTRONG-WILLIAMS, Kymani (Queen Mary University of London)

**Presenter:** ARMSTRONG-WILLIAMS, Kymani (Queen Mary University of London)

**Session Classification:** Student talks



Contribution ID: 8

Type: **not specified**

## Spherically symmetric Einstein-aether gravity

*Wednesday, 17 July 2024 18:10 (20 minutes)*

In this talk, I will address the Einstein-aether theory (EAE). This theory is an ancestor to the aether-scalar-tensor theory (AEST), which is currently considered the most promising relativistic completion of Modified Newtonian Dynamics (MOND). By studying EAE, we can gain valuable insights into the more complicated AEST. First, I will present a new gauge freedom within the spherically symmetric solutions to EAE theory, which simplifies the analysis of a toy model of stars. Next, I will derive the EAE version of Buchdahl's theorem, revealing an unexpected trend for a larger coupling constant. Following this, I will discuss galaxy rotation curves and galaxy clusters, where we discovered a scaling relation between EAE and Newtonian profiles. This relation could provide new perspectives on the missing baryon problem of MOND. These findings pave the way for future investigations of AEST.

**Presenter:** Mr HSU, Arthur Yi-Hsiung (University of Cambridge)

**Session Classification:** Student talks

Contribution ID: 9

Type: **not specified**

## Experimental challenges for future colliders

*Monday, 15 July 2024 11:30 (1 hour)*

**Presenter:** WILLIAMS, Sarah Louise (University of Cambridge (GB))

**Session Classification:** Prospects and challenges for future colliders

Contribution ID: **10**

Type: **not specified**

## **Motivations for physics beyond the Standard Model**

*Monday, 15 July 2024 14:00 (1 hour)*

**Presenter:** YOU, Tevong (King's College London)

**Session Classification:** Motivations for physics beyond the Standard Model

Contribution ID: 11

Type: **not specified**

## Experimental challenges for future colliders

*Tuesday, 16 July 2024 10:00 (1 hour)*

**Presenter:** WILLIAMS, Sarah Louise (University of Cambridge (GB))

**Session Classification:** Prospects and challenges for future colliders

Contribution ID: 12

Type: **not specified**

## Experimental challenges for future colliders

*Tuesday, 16 July 2024 11:30 (1 hour)*

**Presenter:** WILLIAMS, Sarah Louise (University of Cambridge (GB))

**Session Classification:** Prospects and challenges for future colliders

Contribution ID: 13

Type: **not specified**

## Motivations for physics beyond the Standard Model

*Monday, 15 July 2024 15:00 (1 hour)*

**Presenter:** YOU, Tevong (King's College London)

**Session Classification:** Motivations for physics beyond the Standard Model

Contribution ID: 14

Type: **not specified**

## **Motivations for physics beyond the Standard Model**

*Tuesday, 16 July 2024 14:00 (1 hour)*

**Presenter:** YOU, Tevong (King's College London)

**Session Classification:** Motivations for physics beyond the Standard Model

Contribution ID: 15

Type: **not specified**

## **Theoretical and experimental probes of Axion-like particles**

*Tuesday, 16 July 2024 09:00 (1 hour)*

**Presenter:** Dr CHADHA-DAY, Francesca (IPPP, Durham)

**Session Classification:** Theoretical and experimental probes of Axion-like particles



Contribution ID: 16

Type: **not specified**

## **Theoretical and experimental probes of Axion-like particles**

*Tuesday, 16 July 2024 15:00 (1 hour)*

**Presenter:** Dr CHADHA-DAY, Francesca (IPPP, Durham)

**Session Classification:** Theoretical and experimental probes of Axion-like particles

Contribution ID: 17

Type: **not specified**

## **Theoretical and experimental probes of Axion-like particles**

*Wednesday, 17 July 2024 09:00 (1 hour)*

**Presenter:** Dr CHADHA-DAY, Francesca (IPPP, Durham)

**Session Classification:** Theoretical and experimental probes of Axion-like particles

Contribution ID: **18**

Type: **not specified**

## **Gravitational wave cosmology/astronomy for fundamental physics**

*Wednesday, 17 July 2024 10:00 (1 hour)*

**Presenter:** Dr WHITE, Graham (University of Southampton)

**Session Classification:** Gravitational wave cosmology/astronomy for fundamental physics

Contribution ID: 19

Type: **not specified**

## **Gravitational wave cosmology/astronomy for fundamental physics**

*Wednesday, 17 July 2024 14:00 (1 hour)*

**Presenter:** Dr WHITE, Graham (University of Southampton)

**Session Classification:** Gravitational wave cosmology/astronomy for fundamental physics

Contribution ID: 20

Type: **not specified**

## **Gravitational wave cosmology/astronomy for fundamental physics**

*Thursday, 18 July 2024 09:00 (1 hour)*

**Presenter:** Dr WHITE, Graham (University of Southampton)

**Session Classification:** Gravitational wave cosmology/astronomy for fundamental physics

Contribution ID: 21

Type: **not specified**

## **Machine learning methods for new physics searches**

*Wednesday, 17 July 2024 15:00 (1 hour)*

**Presenter:** WINTERHALDER, Ramon (UCLouvain)

**Session Classification:** Machine learning methods for new physics searches

Contribution ID: 22

Type: **not specified**

## **Machine learning methods for new physics searches**

*Wednesday, 17 July 2024 16:30 (1 hour)*

**Presenter:** WINTERHALDER, Ramon (UCLouvain)

**Session Classification:** Machine learning methods for new physics searches

Contribution ID: 23

Type: **not specified**

## **Machine learning methods for new physics searches**

*Thursday, 18 July 2024 10:00 (1 hour)*

**Presenter:** WINTERHALDER, Ramon (UCLouvain)

**Session Classification:** Machine learning methods for new physics searches



Contribution ID: 24

Type: **not specified**

## Welcome

*Monday, 15 July 2024 11:10 (5 minutes)*

**Presenter:** MIMASU, Ken

**Session Classification:** Overview

Contribution ID: 25

Type: **not specified**

## Using Machine Learning to Identify Carbon-rich and Oxygen-rich AGB Stars in Our Galaxy

*Wednesday, 17 July 2024 18:30 (20 minutes)*

**Presenter:** KUSHWAHAA, Tanya (Cardiff Hub for Astrophysics Research and Technology- School of Physics and Astronomy, Cardiff University)

**Session Classification:** Student talks