PPC 2022: XV International Conference on Interconnections between Particle Physics and Cosmology

Report of Contributions

https://indico.cern.ch/e/1126527

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

Neff constraint on portal interaction with hidden sectors

Wednesday, 8 June 2022 16:00 (15 minutes)

Measurement of the effective number of neutrino species, $N_{\rm eff}$, by future cosmic microwave background (CMB) experiments is expected to be sensitive enough to rule out new relativistic particles that were in equilibrium with the Standard model (SM) plasma, if the measured $N_{\rm eff}$ value is consistent with the SM value of 3.044. Consequently, the interaction between the new relativistic particles and SM particles will then be strongly constrained. For a given confidence interval around the SM $N_{\rm eff}$ value, we show a straightforward way to compute the $N_{\rm eff}$ constraints on renormalizeable portal interactions between the new relativistic particles and the SM particles. These $N_{\rm eff}$ constraints can be orders of magnitude larger than collider constraints for future CMB measurements. We demonstrate our result on a model with gauged $B - L$ symmetry with right-handed neutrinos and a model with millicharged particles and dark photon as examples. We also show that CMB-S4 $N_{\rm eff}$ measurements have the potential to rule out extended millicharged particle models that resolve the EDGES 21 cm anomaly. Finally, we find that $N_{\rm eff}$ constraints on renormalizeable portal couplings remain largely unchanged even if the new relativistic particles are part of a larger hidden sector.

Primary authors: RALEGANKAR, Pranjal; SHELTON, Julia; ADSHEAD, Peter

Presenter: RALEGANKAR, Pranjal

Session Classification: Parallel

Contribution ID: **2** Type: **not specified**

Determining neutrino mass hierarchy from new physics

We derive the lower bound on absolute scale of lightest neutrino mass for normal hierarchy and inverted hierarchy patterns of light neutrinos by studying the new physics contributions to charged lepton flavour violations in a TeV scale left-right symmetric model. The framework allows large light-heavy neutrino mixing where the light neutrino mass formula is governed by natural type-II seesaw mechanism unlike the generic type-II seesaw dominance which assumes suppressed light-heavy neutrino mixing. We demonstrate how sizeable loop-induced contribution to light neutrino mass is kept under control such that light neutrino mass formula is dominantly explained by type-II seesaw mechanism. We examine the heavy neutrino contributions to charged lepton flavour violating processes like $\mu \to e\gamma$, $\mu \to 3e$ and $\mu \to e$ conversion inside a nuclei. We also present a complementary study between neutrinoless double beta decay and charged lepton flavour violation taking into account single beta decay bound, double beta decay bound and cosmology bounds on neutrino mass sum.

Primary authors: Ms DASH, Nitali (DESM (Physics), Regional Institute of Education (NCERT), Bhubaneswar); PRITIMITA, Prativa; Dr PATRA, Sudhanwa (IIT Bhilai); Prof. YAJNIK, Urjit (IIT Bombay)

Presenter: PRITIMITA, Prativa

Session Classification: Parallel

Contribution ID: **3** Type: **not specified**

Charged particle dynamics in the surrounding of Schwarzschild anti-de Sitter black hole with topological defect immersed in an external magnetic field

The geodesic motion of the charged particles in the vicinity of the event horizon of weakly magnetized Schwarzschild anti-de-Sitter black hole (BH) with topological defects has been investigated. The effect of dark energy on the size of the event horizon, the mass of the BH, and the stability of the orbits of the particles have also been explored in detail. We discussed, if the BH mass increases and the future universe is dominated by phantom DE, then the BH-apparent horizon (AH) and the cosmic-AH will eventually coincide, after which both horizons disappear and the singularity becomes naked. It happens in finite co-moving time before the Big Rip occurs, violating the Cosmic Censorship Conjecture. Furthermore, DE is not constant rather growing density and hence stronger over cosmic time.

Primary author: HUSSAIN, Saqib

Co-author: Prof. ADNAN ASLAM , Adnan

Presenters: HUSSAIN, Saqib; Prof. ADNAN ASLAM , Adnan

Session Classification: Parallel

Contribution ID: **4** Type: **not specified**

Search for neutrinoless double-beta decays in Ge-76 in the LEGEND experiment

Wednesday, 8 June 2022 14:15 (15 minutes)

The observation of neutrinoless double-beta ($0\nu\beta\beta$) decay would establish both the violation of lepton number conservation and the Majorana nature of the neutrino. It would also constrain the neutrino mass scale in the picture of light-neutrino exchange.
The best limit on the $0\nu\beta\beta$ half-life of ^{76}Ge, one of the most promising isotopes to search for it, is $1.8 \cdot 10^{26}$ at 90% C.L..
LEGEND follows the GERDA and MAJORANA DEMONSTRATOR collaborations, which have achieved the lowest background and best energy resolution in the signal region of any experiment searching for $0\nu\beta\beta$.
Building on their success, the LEGEND collaboration pursues a tonne-scale ^{76}Ge experiment in a staged approach, properly using existing resources to expedite physics results.
The first stage, LEGEND-200, is currently being installed at the Laboratori Nazionali del Gran Sasso (Italy) in the existing GERDA infrastructure.
The half-life discovery potential of the proposed tonne-scale stage, LEGEND-1000, lies beyond 10^{28} years and will allow exploring the parameter space of the inverted neutrino mass ordering.

Primary author: BIANCACCI, Valentina

Presenter: BIANCACCI, Valentina

Session Classification: Parallel

Contribution ID: **5** Type: **not specified**

Projective Gauge Theory and Thomas-Whitehead Gravity

Wednesday, 8 June 2022 15:30 (15 minutes)

Abstract: In 2D, Einstein's theory of general relativity becomes trivial. Yet when one studies the symmetries of 2D through string theory, a new field, dubbed the diffeomorphism field, rise from the algebra of reparameterization. We show that this field has meaning in higher dimensions through the ubiquitous notion of geodesics and projective connections. By using the Thomas-Whitehead connection, which is a natural connection for projective geometry, we construct an action that gives the diffeomorphism field dynamics in the accompaniment of the Einstein-Hilbert action. From there we are able to describe how this field is related to Polyakov 2D gravity, augments gravitational interactions with fermions in 4D, and how it might be a component of dark energy and dark matter in 4D.

Primary author: RODGERS, Vincent

Presenter: RODGERS, Vincent

Session Classification: Parallel

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

T-RAX: Transversely Resonant Axion eXperiment

Wednesday, 8 June 2022 15:30 (15 minutes)

We propose to use an elongated rectangular waveguide near its cutoff frequency to speed up axionic dark matter searches. The detector's large surface area increases the signal power, while its narrow transverse dimension and tapered-waveguide coupling suppress parasitic modes. The proposed system can fit inside a solenoid magnet and detect the QCD-axion at the axion mass $40 - 400\,\mu$eV. We describe the theoretical principles of the new design, present simulation results, and discuss the implementation.

Primary authors: LEE, Chang (Max Planck Institute for Physics); REIMANN, Olaf (Max Planck Institute for Physics)

Presenter: LEE, Chang (Max Planck Institute for Physics)

Session Classification: Parallel

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

Detecting High-Frequency Gravitational Waves with Microwave Cavities

Wednesday, 8 June 2022 13:30 (15 minutes)

We give a detailed treatment of electromagnetic signals generated by gravitational waves (GWs) in resonant cavities. We show that it is crucial to carry out the signal calculation in a preferred frame for the laboratory, the proper detector frame. The proper detector frame metric is obtained by resumming short-wavelength effects to provide analytic results that are exact for GWs of arbitrary wavelength. This formalism allows us to firmly establish that, contrary to previous claims, cavity experiments designed for the detection of axion dark matter only need to reanalyze existing data to search for high-frequency GWs with strains as small as $h \sim 10^{-22} - 10^{-21}$. We also argue that directional detection is possible in principle using readout of multiple cavity modes.

Primary author: SCHÜTTE-ENGEL, Jan

Co-authors: BERLIN, Asher (NYU); BLAS, Diego (UAB/IFAE); D'AGNOLO, Raffaele; ELLIS, Sebastian (Universite de Geneve (CH)); HARNIK, Roni (Fermilab); KAHN, Yonatan (University of Illinois at Urbana-Champaign)

Presenter: SCHÜTTE-ENGEL, Jan

Session Classification: Parallel

Contribution ID: **10** Type: **not specified**

Impact of neutrino effective NSSI on sterile neutrino dark matter production in the early universe

Wednesday, 8 June 2022 14:15 (15 minutes)

Sterile neutrinos with keV-scale masses are popular candidates for warm dark matter. In the most straightforward case they are produced via oscillations with active neutrinos. We introduce all types of effective self-interactions of active neutrinos and investigate the effect on the parameter space of sterile neutrino mass and mixing. Our focus is on mixing with electron neutrinos, which is subject to constraints from several upcoming or running experiments like TRISTAN, ECHo, BeEST and HUNTER. Depending on the size of the self-interaction, the parameter space moves closer to, or further away from the one testable by those future experiments. In particular, phase 3 of the HUNTER experiment would test a larger region of parameter space in the presence of self-interactions than without them. We report also the effect of the self-interactions on the free-streaming length of the sterile neutrino dark matter, important for structure formation observables.

Primary authors: UJJAYINI RAMACHANDRAN, Aaroodd (RWTH Aachen University); Ms BENSO, Cristina (Max Planck Institute for Nuclear Physics in Heidelberg); SEN, Manibrata (MPIK, Heidelberg); RODEJOHANN, Werner (MPIK, Heidelberg)

Presenter: Ms BENSO, Cristina (Max Planck Institute for Nuclear Physics in Heidelberg)

Session Classification: Parallel

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

Inflation from Dynamical Projective Connections

Wednesday, 8 June 2022 16:00 (15 minutes)

Inflationary models that are capable of matching observational constraints are abundant, but very few have an underlying physical principle guiding the choice of the inflaton potential and dynamics. We show how a recently developed model of gravity which incorporates an extension of general relativity to include projective invariance (TW gravity) naturally gives rise to a field acting as the inflaton with a specific form of the potential. We find a parameter space for the free parameters of this model that fit the experimental constraints of the most recent cosmological data.

Primary authors: Mr CHAFAMO, Biruk (Bates College); Mr BAVOR, Calvin (Colorado Mesa University); WHITING, Catherine (Colorado Mesa University); Dr STIFFLER, Kory (Brown University and University of Iowa); Mr ABDULLAH, Muhammad (Bates College); Mr KALIM, Muhammad Hamza (Bates College); Mr JIANG, Xiaole (CUNY and Bates College)

Presenter: WHITING, Catherine (Colorado Mesa University)

Session Classification: Parallel

Contribution ID: **12** Type: **not specified**

Detecting Dark Matter around Black Holes with Gravitational Waves

Wednesday, 8 June 2022 15:45 (15 minutes)

The advent of gravitational wave astronomy has opened up new possibilities for the detection and measurement of dark matter. One of the most promising avenues is the observation of Intermediate Mass Ratio Inspirals (IMRIs) with future space based observatories such as LISA.
Around intermediate mass black holes in the center of smaller halos, dark matter overdensities - so-called dark matter spikes - are expected. When a stellar-mass compact object inspirals, the presence of the dark matter spike can have significant effects on the dynamics. These can be detectable in the gravitational wave signal which should be observable with LISA. With careful modelling, we can map out the dark matter distribution and extract its properties.
I will explain the motivation, status and outlook on the modeling of these systems and how we can use their gravitational wave signals as a powerful new tool to explore the particle nature of dark matter.

Primary author: BECKER, Niklas

Presenter: BECKER, Niklas

Session Classification: Parallel

Contribution ID: **13** Type: **not specified**

Phenomenology of the Dark Matter sector in the Two Higgs Doublet Model with Complex Scalar Singlet extension

Wednesday, 8 June 2022 13:30 (15 minutes)

Extensions of the Two Higgs Doublet model with a complex scalar singlet (2HDMS) can accommodate all current experimental constraints and are highly motivated candidates for Beyond Standard Model Physics. It can successfully provide a dark matter candidate as well as explain baryogenesis and provides gravitational wave signals. In this work, we focus on the dark matter phenomenology of the 2HDMS with the complex scalar singlet as the dark matter candidate. We study variations of dark matter observables with respect to the model parameters and present representative benchmark points in the light and heavy dark matter mass regions allowed by existing experimental constraints from dark matter, flavour physics and collider searches. We also compare real and complex scalar dark matter in the context of 2HDMS. Further, we discuss the discovery potential of such scenarios at the HL-LHC and at future e+e− colliders.

Primary authors: Prof. MOORTGAT-PICK, Gudrid (University of Hamburg and DESY); DUTTA, Juhi; SCHREIBER, Merle (DESY and University of Hamburg)

Presenter: DUTTA, Juhi

Session Classification: Parallel

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

Finding Evidence for Inflation and the Origin of Galactic Magnetic Fields with CMB Surveys

Tuesday, 7 June 2022 16:45 (15 minutes)

The origin of the microgauss magnetic fields observed in galaxies is unknown. One scenario is that primordial magnetic fields (PMFs) generated during inflation, larger than 0.1 nanogauss on Mpc scales, were compressed to microgauss strengths in galaxies during structure formation. Thus, detecting such a PMF just after recombination would be evidence of this inflationary origin. We find that CMB-HD measurements of anisotropic birefringence would lower the upper bound on scale-invariant PMFs to 0.072 nanogauss at the 95% CL. If inflationary PMFs exist, CMB-HD would be able to detect them with 3-sigma significance or higher, providing evidence for inflation itself.

Primary authors: SEHGAL, Neelima; MANDAL, Sayan; NAMIKAWA, Toshiya

Presenter: MANDAL, Sayan

Session Classification: Parallel

Contribution ID: **15** Type: **not specified**

Dark matter studies with the PADME experiment

Tuesday, 7 June 2022 16:00 (15 minutes)

In recent years the physics of Feebly Interacting Particles (FIPs) saw a growing interest as a possible solution to the Dark Matter issue [1]. FIPs are exotic and relatively light particles, not charged under the SM gauge group, whose interactions with the SM particles are extremely suppressed. They are assumed to be part of a possible secluded sector, called the dark sector, with the lightest stable dark particle(s) playing the role of DM.

In this framework is inserted the Positron Annihilation into Dark Matter Experiment (PADME) ongoing at the Laboratori Nazionali di Frascati of INFN. PADME is searching primarily a Dark Photon signal [2] by studying the missing-mass spectrum of single photon final states resulting from positron annihilations on electrons of a fixed target. This kind of approach allows to look for any new particle produced in e+e− annihilations through a virtual off-shell photon such as long lived Axion-Like-Particles (ALPs), proto-phobic X bosons, Dark Higgs ...
After the detector commissioning and the beam-line optimization, the PADME collaboration collected in 2020 about 5×10^{12} positrons on target at 430 MeV. These data are now under analysis and preliminary results are ready to be shown.
In the talk, it will be given an overview of the scientific program of the experiment and the performance of the detector will be presented showing Standard Model channels study (gamma-gamma events, Bremsstrahlung).

References

[1] P. Agrawal et al., "Feebly-Interacting Particles: FIPs 2020 Workshop Report", arXiv:2102.12143v1.
[2] M. Raggi and V. Kozhuharov, Adv. High Energy Phys. 509, (2014) 959802.

Primary authors: FRANKENTHAL, Andre (Princeton University (US)); Dr GIANOTTI, Paola (INFN Laboratori Nazionali di Frascati (IT))

Presenter: FRANKENTHAL, Andre (Princeton University (US))

Session Classification: Parallel

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

Neutrino mass and the early universe

The long-existing problem of neutrino mass and mixing can be connected to cosmological phenomena, such as leptogenesis and the existence of dark matter (DM). In the extension of the type I seesaw model with two right-handed (RH) neutrinos, the seesaw Yukawa can drive the DM production, even with the competition from gravitational effect and constraints from leptogenesis. However, the DM production driven by the seesaw Yukawa is not compatible with the testability of the traditional type I seesaw model, which motivates us to seek a variation. By considering two Higgs doublets, a new type Ib seesaw model is proposed, which can explain the neutrino mass, dark matter and leptogenesis simultaneously while keeping its testability. Moreover, the type Ib seesaw model allows a different approach to dark matter production and stability through a $U(1)'$ extension.

Primary author: FU, Bowen

Presenter: FU, Bowen

Session Classification: Parallel

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

Welcome Address

Monday, 6 June 2022 08:45 (15 minutes)

Presenter: JOLIFF, Brad (McDonnell Center for the Space Sciences)

Session Classification: Plenary I - Emerson Auditorium

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

CMB Physics

Monday, 6 June 2022 09:00 (30 minutes)

Presenter: STAGGS, Suzanne (Princeton University)

Session Classification: Plenary I - Emerson Auditorium

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

Hubble Tension

Monday, 6 June 2022 09:30 (30 minutes)

Presenter: RIESS, Adam

Session Classification: Plenary I - Emerson Auditorium

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

Cosmological Magnetic Fields

Monday, 6 June 2022 11:30 (30 minutes)

Presenter: VACHASPATI, Tanmay (Arizona State University)

Session Classification: Plenary II - Emerson Auditorium

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

Reconstructing Cosmology

Monday, 6 June 2022 10:00 (30 minutes)

Presenter: SARKAR, Subir (University of Oxford)

Session Classification: Plenary I - Emerson Auditorium

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

Axion Detection Experiments

Monday, 6 June 2022 13:30 (30 minutes)

Presenter: CAROSI, Gianpaolo (Lawrence Livermore National Laboratory)

Session Classification: Plenary III - Emerson Auditorium

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

Emergent Early-universe Cosmology

Monday, 6 June 2022 11:00 (30 minutes)

Presenter: BRANDENBERGER, Robert (McGill University)

Session Classification: Plenary II - Emerson Auditorium

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

Probing Miracle-less WIMP Dark Matter via Gravitational Waves Spectral Shapes

Wednesday, 8 June 2022 15:30 (15 minutes)

We propose a novel probe of weakly interacting massive particle (WIMP) dark matter (DM) candidates of a wide mass range which fall short of the required annihilation rates to satisfy correct thermal relic abundance, dubbed as "Miracle-less WIMP". If the DM interactions are mediated by an Abelian gauge boson like B-L, its annihilation rates typically remain smaller than the WIMP ballpark for very high scale B-L symmetry breaking, leading to overproduction. The thermally overproduced relic is brought within observed limits via late entropy dilution from one of the three right handed neutrinos (RHN) present for keeping the model anomaly free and generating light neutrino masses. Such late entropy injection leads to peculiar spectral shapes of gravitational waves (GW) generated by cosmic strings, formed as a result of B-L symmetry breaking. We find interesting correlation between DM mass and turning frequency of the GW spectrum with the latter being within reach of future experiments. The two other RHNs play major role in generating light neutrino masses and baryon asymmetry of the universe via leptogenesis. Successful leptogenesis with Miracle-less WIMP together restrict the turning frequencies to lie within the sensitivity limits of near future GW experiments.

Primary authors: KUMAR SAHA, Abhijit (Indian Association for the Cultivation of Science); Dr BORAH, Debasish (Indian Institute of Technology Guwahati); SAMANTA, Rome (University of Southampton); JYOTI DAS, Suruj (Indian Institute of Technology Guwahati)

Presenter: Dr BORAH, Debasish (Indian Institute of Technology Guwahati)

Session Classification: Parallel

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

Linking early universe transient CP violation and the electron Electric Dipole Moment

Wednesday, 8 June 2022 15:45 (15 minutes)

Low scale leptogenesis scenarios are difficult to verify due to our inability to relate the parameters involved in the early universe processes with the low energy or collider observables. Here we show that one can in principle relate the parameters giving rise to the transient CP violating phase involved in leptogenesis with those that can be deduced from the observation of electric dipole moment (EDM) of the electron. in the context of the left right symmetric supersymmetric model (LRSUSY) which provides a strong connection between such parameters. In particular, we show that combining EDM bound with baryon asymmetry requirements implies the scale M_B–L of the gauged B–L symmetry breaking to be larger than 10ˆ4.5 GeV.

Primary author: YAJNIK, Urjit (IIT Bombay, Mumbai)

Co-author: Ms BANERJEE, Piyali (IIT Bombay)

Presenter: YAJNIK, Urjit (IIT Bombay, Mumbai)

Session Classification: Parallel

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

Axion Stars

Presenter: HERTZBERG, Mark (Tufts University)

Session Classification: Plenary III - Emerson Auditorium

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

Axions in the Early Universe

Monday, 6 June 2022 14:00 (30 minutes)

Presenter: ROMPINEVE, Fabrizio (CERN)

Session Classification: Plenary III - Emerson Auditorium

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

Thermal Axions: Production Mechanisms and Cosmological Signals

Monday, 6 June 2022 14:30 (30 minutes)

Presenter: D'ERAMO, Francesco (University of Padua)

Session Classification: Plenary III - Emerson Auditorium

Contribution ID: **29** Type: **not specified**

Dark Matter in SUSY: Status and Prospects

Tuesday, 7 June 2022 10:00 (30 minutes)

Presenter: GODBOLE, Rohini (Centre for Theoretical Studies (CTS))

Session Classification: Plenary V - Emerson Auditorium

Contribution ID: **30** Type: **not specified**

SUSY from the String Landscape

Monday, 6 June 2022 16:00 (30 minutes)

Presenter: BAER, Howard

Session Classification: Plenary IV - Emerson Auditorium

Contribution ID: **31** Type: **not specified**

How Looking At Genetics & Networks Led To Solving A Quantum Gravity Problem

Monday, 6 June 2022 16:30 (30 minutes)

Presenter: GATES, Jim

Session Classification: Plenary IV - Emerson Auditorium

Contribution ID: **32** Type: **not specified**

Dark Matter Direct Detection Experiments

Tuesday, 7 June 2022 09:00 (30 minutes)

Presenter: MAHAPATRA, Rupak (Texas A&M University)

Session Classification: Plenary V - Emerson Auditorium

Contribution ID: **33** Type: **not specified**

Dark Matter Anomalies

Tuesday, 7 June 2022 09:30 (30 minutes)

Presenter: HOOPER, Dan

Session Classification: Plenary V - Emerson Auditorium

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

AMS Physics Results

Tuesday, 7 June 2022 08:30 (30 minutes)

Presenter: DURANTI, Matteo (Universita e INFN, Perugia (IT))

Session Classification: Plenary V - Emerson Auditorium

Contribution ID: **35** Type: **not specified**

Closing Window on WIMP Dark Matter

Presenter: FRANCESCHINI, Roberto (Rome 3 U.)

Session Classification: Plenary V - Emerson Auditorium

Contribution ID: **36** Type: **not specified**

Line-intensity Mapping and Dark Matter

Tuesday, 7 June 2022 11:30 (30 minutes)

Presenter: KAMIONKOWSKI, Marc (Johns Hopkins University)

Session Classification: Plenary VI - Emerson Auditorium

Contribution ID: **37** Type: **not specified**

Gamma-ray Astrophysics

Tuesday, 7 June 2022 12:00 (30 minutes)

Presenter: HUENTEMEYER, Petra

Session Classification: Plenary VI - Emerson Auditorium

Contribution ID: **38** Type: **not specified**

Strongly Interacting Dark Matter

Tuesday, 7 June 2022 11:00 (30 minutes)

Presenter: KULKARNI, Suchita (University of Graz)

Session Classification: Plenary VI - Emerson Auditorium

Contribution ID: **39** Type: **not specified**

Neutrinos in Cosmological Environments

Wednesday, 8 June 2022 08:30 (30 minutes)

Presenter: GROHS, Evan

Session Classification: Plenary VIII

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

Neutrinos in Astrophysical Environments

Wednesday, 8 June 2022 09:00 (30 minutes)

Presenter: MCLAUGHLIN, Gail

Session Classification: Plenary VIII

Contribution ID: **41** Type: **not specified**

New Physics with Neutron Star Mergers

Wednesday, 8 June 2022 09:30 (30 minutes)

Presenter: HARRIS, Steven (Washington University in St. Louis)

Session Classification: Plenary VIII

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

TBD

Presenter: TBD

Session Classification: Plenary VIII

Contribution ID: **43** Type: **not specified**

Sterile Neutrinos

Wednesday, 8 June 2022 11:00 (30 minutes)

Presenter: FULLER, George

Session Classification: Plenary IX

Contribution ID: **44** Type: **not specified**

EFT of Neutrinoless Double Beta Decay

Wednesday, 8 June 2022 11:30 (30 minutes)

Presenter: CIRIGLIANO, Vincenzo

Session Classification: Plenary IX

Contribution ID: **45** Type: **not specified**

Neutrinoless Double Beta Decay as Probe of New Physics

Wednesday, 8 June 2022 12:00 (30 minutes)

Presenter: DEPPISCH, Frank

Session Classification: Plenary IX

Contribution ID: **46** Type: **not specified**

IceCube Physics Results

Thursday, 9 June 2022 08:30 (30 minutes)

Presenter: CLARK, Brian (Ohio State University)

Session Classification: Plenary X - Emerson Auditorium

Contribution ID: **47** Type: **not specified**

Fundamental Physics with Highest Energy Neutrinos

Thursday, 9 June 2022 09:00 (30 minutes)

Presenter: VIEREGG, Abigail (University of Chicago)

Session Classification: Plenary X - Emerson Auditorium

Contribution ID: **48** Type: **not specified**

Lab-based Neutrino Experiments

Thursday, 9 June 2022 09:30 (30 minutes)

Presenter: SCHOLBERG, Kate

Session Classification: Plenary X - Emerson Auditorium

Contribution ID: **49** Type: **not specified**

Neutrino Theory

Thursday, 9 June 2022 10:00 (30 minutes)

Presenter: BABU, Kaladi (Oklahoma State University)

Session Classification: Plenary X - Emerson Auditorium

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

Dark Unification

Thursday, 9 June 2022 11:30 (30 minutes)

Presenter: MURGUI, Clara

Session Classification: Plenary XI - Emerson Auditorium

Contribution ID: **51** Type: **not specified**

New Physics at DUNE

Thursday, 9 June 2022 11:00 (30 minutes)

Presenter: KIM, Doojin (Texas A & M University (US))

Session Classification: Plenary XI - Emerson Auditorium

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

Electromagnetic Properties of Neutrinos

Monday, 6 June 2022 15:30 (30 minutes)

Presenter: JANA, Sudip (Max-Planck-Institut für Kernphysik)

Session Classification: Plenary IV - Emerson Auditorium

Contribution ID: **53** Type: **not specified**

Higgs Physics

Presenter: SU, Shufang (University of Arizona)

Session Classification: Plenary XII - Emerson Auditorium

Contribution ID: **54** Type: **not specified**

On the Origin of Baryon and Lepton Number Violation

Thursday, 9 June 2022 12:00 (30 minutes)

Presenter: FILEVIEZ PEREZ, Pavel

Session Classification: Plenary XI - Emerson Auditorium

Contribution ID: **55** Type: **not specified**

Implications of Observable Baryon Number Violation

Thursday, 9 June 2022 13:30 (30 minutes)

Presenter: GARDNER, Susan (University of Kentucky)

Session Classification: Plenary XII - Emerson Auditorium

Contribution ID: **56** Type: **not specified**

LHCb Physics Results

Thursday, 9 June 2022 15:30 (30 minutes)

Presenter: FRANCO SEVILLA, Manuel (University of Maryland (US))

Session Classification: Plenary XIII - Emerson Auditorium

Contribution ID: **57** Type: **not specified**

Muon g-2

Thursday, 9 June 2022 14:30 (30 minutes)

Presenter: HOFERICHTER, Martin

Session Classification: Plenary XII - Emerson Auditorium

Contribution ID: **58** Type: **not specified**

Interpreting the Flavor Anomalies

Thursday, 9 June 2022 16:30 (30 minutes)

Presenter: SONI, Amarjit (BNL)

Session Classification: Plenary XIII - Emerson Auditorium

Contribution ID: **59** Type: **not specified**

LHC Exotica Results

Friday, 10 June 2022 08:30 (30 minutes)

Presenter: ASKEW, Andrew (Florida State University (US))

Session Classification: Plenary XIV - Emerson Auditorium

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

Long-lived Particles and FIMP Dark Matter

Friday, 10 June 2022 09:30 (30 minutes)

Presenter: WESTHOFF, Susanne (Heidelberg University)

Session Classification: Plenary XIV - Emerson Auditorium

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

Forward Physics Facilities

Friday, 10 June 2022 10:00 (30 minutes)

Presenter: FENG, Jonathan (University of California Irvine (US))

Session Classification: Plenary XIV - Emerson Auditorium

Contribution ID: **62** Type: **not specified**

Future Colliders

Friday, 10 June 2022 09:00 (30 minutes)

Presenter: HAN, Tao

Session Classification: Plenary XIV - Emerson Auditorium

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

Supernova Physics

Wednesday, 8 June 2022 10:00 (30 minutes)

Presenter: FRIEDLAND, Alexander

Session Classification: Plenary VIII

Contribution ID: **64** Type: **not specified**

New Physics with Gravitational Waves

Friday, 10 June 2022 11:00 (30 minutes)

Presenter: DENT, James (Sam Houston State University)

Session Classification: Plenary XV - Emerson Auditorium

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

Current Status and Future Directions in Particle Physics and Cosmology

Friday, 10 June 2022 12:00 (40 minutes)

Presenter: DUTTA, Bhaskar (Texas A&M University)

Session Classification: Plenary XV - Emerson Auditorium

Contribution ID: **66** Type: **not specified**

Closing Remarks

Friday, 10 June 2022 12:40 (5 minutes)

Presenter: DEV, Bhupal (Washington University in St. Louis)

Session Classification: Plenary XV - Emerson Auditorium

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

Vector Boson Fusion Topology and Simplified Models for Dark Matter Searches at Colliders

We study the possible searches at colliders using Vector Boson Fusion topology in the context of Simplified Models signatures. We examine the possible physics reach of these searches with regard to monojet-type searches, and determine how these two signatures are complementary. We determine the generic characteristics for dark matter signatures in the LHC if the underlying physics imply Vector Boson Fusion type of production.

Primary author: Mr OCAMPO HENAO, Daniel (Universidad de Antioquia (CO))

Co-author: Dr RUIZ-ALVAREZ, Jose (Universidad de Antioquia)

Presenter: Mr OCAMPO HENAO, Daniel (Universidad de Antioquia (CO))

Session Classification: Parallel

Contribution ID: **68** Type: **not specified**

New production mechanism for keV neutrino dark matter

Wednesday, 8 June 2022 14:30 (15 minutes)

In previous work [2004.12904] we have shown that sterile neutrino dark matter can in principle be produced by thermal freeze-out if the Yukawa coupling is effectively dynamic in the early universe. This is realised (for example) within a Froggatt-Nielsen model, if the flavon vev is shifted during a phase transition, as the scalar potential relaxes to its true minimum in field space, thus implementing effectively dynamic Yukawa couplings during the phase transition. Here we formulate a class of models which simultaneously account for the light neutrino masses, the flavour hierarchy in the lepton sector and provide a viable Dark Matter neutrino with masses in the keV range or higher. The Dark Matter relic abundance is here not produced by oscillations or decays (which are tightly constrained mechanisms) but by thermal freeze-out, much like a typical WIMP.

Primary author: JARAMILLO, Carlos

Co-authors: LINDNER, Manfred (Max-Planck-Institut fuer Kernphysik, Heidelberg, Germany); RODEJOHANN, Werner (MPIK, Heidelberg)

Presenter: JARAMILLO, Carlos

Session Classification: Parallel

Contribution ID: **69** Type: **not specified**

Electroweak Phase Transition in the Z_3-invariant NMSSM Implications of LHC and Dark matter Searches and Prospects of Detecting the Gravitational Waves

We study in detail the viability and the patterns of a strong first-order electroweak phase transition as a prerequisite to electroweak baryogenesis in the framework of Z_3-invariant Next-to-Minimal Supersymmetric Standard Model (NMSSM), in the light of recent experimental results from the Higgs sector, dark matter (DM) searches and those from the searches of the lighter chargino and neutralinos at the Large Hadron Collider (LHC). For the latter, we undertake thorough recasts of the relevant, recent LHC analyses. With the help of a few benchmark scenarios, we demonstrate that while the LHC has started to eliminate regions of the parameter space with relatively small $\mu_{\rm eff}$, that favors the coveted strong first-order phase transition, rather steadily, there remains phenomenologically much involved and compatible regions of the same which are yet not sensitive to the current LHC analyses. It is further noted that such a region could also be compatible with all pertinent theoretical and experimental constraints. We then proceed to analyze the prospects of detecting the stochastic gravitational waves, which are expected to arise from such a phase transition, at various future/proposed experiments, within the mentioned theoretical framework and find them to be somewhat ambitious under the currently projected sensitivities of those experiments.

Primary authors: CHATTERJEE, Arindam; DATTA, AseshKrishna (Harish-Chandra Research Institute, India); ROY, Subhojit (Harish-Chandra Research Institute, INDIA)

Presenter: ROY, Subhojit (Harish-Chandra Research Institute, INDIA)

Session Classification: Parallel

Contribution ID: **70** Type: **not specified**

Tachyon-Dominated Cosmology: Status Update

Wednesday, 8 June 2022 15:30 (15 minutes)

A Friedmann-Robertson-Walker spacetime with contents dominated by a gas of tachyonic particles undergoes expansion with inflection (cosmic jerk) and acceleration similar, but not identical, to that of dark-energy-dominated models. The testing of such a tachyonic model against observation, as an alternative to the standard model, is under way. Fitting the model to redshift and distance data for several thousand Type Ia supernovae yields values for such quantities as the Hubble parameter and the age of the universe again similar, but not identical, to standard-model results. Testing the model via features of the cosmic microwave background, and other observations, is in progress at this time.

Primary author: Prof. REDMOUNT, Ian (Saint Louis University, Department of Physics)

Presenter: Prof. REDMOUNT, Ian (Saint Louis University, Department of Physics)

Session Classification: Parallel

Contribution ID: **71** Type: **not specified**

Muon g-2, Neutralino Dark Matter and Stau NLSP

Tuesday, 7 June 2022 17:00 (15 minutes)

We explore the implications of resolving the muon $g-2$ anomaly in a $SU(4)_c \times SU(2)_L \times SU(2)_R$ model, where the soft supersymmetry breaking scalar and gaugino masses break the left-right (LR) symmetry. A 2 σ resolution of the anomaly requires relatively light sleptons, chargino and LSP neutralino. The stau turns out to be the NLSP of mass $m_{\tilde{\tau}} \lesssim 400$ GeV, and the sleptons from the first two families can be as heavy as about 800 GeV. The chargino is also required to be lighter than about 600 GeV to accommodate the muon $g-2$ solutions consistent with the dark matter relic density constraint. The dominant right-handed nature of the light slepton states suppress the sensitivity of possible signals which can be probed in Run3 experiments at the LHC. We also discuss the impact of accomodating the Higgs boson mass and the vacuum stability of the scalar potential for these solutions. The Higgsinos are heavier than about 4 TeV, and the LSP neutralino has the correct relic density if it is Bino-like. We identify stau-neutralino coannihilation as the dominant mechanism for realizing the desired dark matter relic density, with sneutrino-neutralino coannihiliation playing a minor role. These bino-like dark matter solutions can yield a spin-independent scattering cross-section on the order of 10^{-13}pb which hopefully, can be expected to be tested in the near future.

Primary authors: TIWARI, Amit; SHAFI, Qaisar; GOMEZ, Mario E.; UN, Cem Salih (Bursa Uludag University)

Presenter: TIWARI, Amit

Session Classification: Parallel

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

Explorations of pseudo-Dirac dark matter having keV splittings and interacting via transition electric and magnetic dipole moments

We study a minimal model of pseudo-Dirac dark matter, interacting through transition electric and magnetic dipole moments. Motivated by the fact that xenon experiments can detect electrons down to ~keV recoil energies, we consider O(keV) splittings between the mass eigenstates. We study the production of this dark matter candidate via the freeze-in mechanism. We discuss the direct detection signatures of the model arising from the down-scattering of the heavier state, that are produced in Solar upscattering, finding observable signatures at the current and near-future xenon based direct detection experiments. We also study complementary constraints on the model from fixed target experiments, lepton colliders, supernovae cooling and cosmology. We show that next generation xenon experiments can either discover this well motivated and minimal dark matter candidate, or constrain how strongly inelastic dark matter can interact via the dipole moment operators.

Primary authors: CHATTERJEE, Shiuli; LAHA, Ranjan (Indian Institute of science (IN))

Presenter: CHATTERJEE, Shiuli

Session Classification: Parallel

Contribution ID: **73** Type: **not specified**

Altered Axion Abundance from a Dynamical Peccei-Quinn Scale

Wednesday, 8 June 2022 15:45 (15 minutes)

I will discuss a model in which the relic abundance of axions is altered from the standard misalignment mechanism, either increased or decreased, due to the presence of a new light scalar that couples to the radial part of the Peccei-Quinn (PQ) field. The light scalar makes the effective PQ symmetry-breaking scale dynamical, altering the early-time dynamics for the axion and affecting its late-time dark matter abundance. I will present a semi-analytical analysis and a numerical analysis of this new mechanism, showing that it can accommodate both lighter or heavier axion dark matter, compared to the standard treatments. I will briefly comment on the implications of the model for axion searches and fundamental physics. This talk is based on the work in 2203.15817.

Primary authors: ALLALI, Itamar J.; HERTZBERG, Mark (Tufts University); LYU, Yi (University of California Santa Cruz)

Presenter: ALLALI, Itamar J.

Session Classification: Parallel

Contribution ID: **74** Type: **not specified**

Two-Component Dark Matter (Review)

Wednesday, 8 June 2022 14:45 (15 minutes)

The study of particle dark matter is of a dramatic importance in both fields particle physics and modern cosmology. It plays a profound rule in understanding the deep structure of nature. However, an abundance of multi-component dark matter models have been studied and investigated over the last decade. And since nature seeks simplicity we choose to review the simplest models and present new interactions that are based on these models such as semi-annihilations and other phenomena such as assisted freeze-out. The aim of this talk is to give a taste of how we can study two-component dark matter models and how to compute their relic densities considering the new interactions.

Primary author: ALNAFISAH, Ali (King Saud University)

Presenter: ALNAFISAH, Ali (King Saud University)

Session Classification: Parallel

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

A bound on the unparticle-photon cross section from the CMB temperature

Tuesday, 7 June 2022 17:45 (15 minutes)

Unparticles are the low energy phase of Banks-Zaks fields, potentially capable of explaining late-time universe. The models is described by breaking the conformal symmetry at finite temperature giving rise to a non-radiative term with an unknown sign in energy density. This sign ambiguity makes the corrections around the IR fixed point to be either normal or tachyonic. The contribution of the first in late-time universe is ruled out in a recent study. The second is associated with $T_C \simeq 4T_{CMB}$ at late-times corresponding to $\Omega_{\mathcal{U}} = 1$. Therefore the CMB is exposed to an enormous heat bath. As the age of the Universe is constrained independently by the globular clusters, it puts serious constraints on any heat exchange between unparticles and the CMB in ΛCDM. This leads us to estimate the cross section of unparticles with CMB photons to be $\sigma_{\gamma\mathcal{U}} < 10^{-40}m^2 = 10^{-3}nb$, preserving the consistency between the age of the universe from CMB with that of the globular clusters. This bound puts unparticles in late-time cosmology, if present, at the edge of the standard model.

Primary authors: Prof. VAN PUTTEN, Maurice (Sejong University); AGHAEI ABCHOUYEH, Maryam

Presenter: AGHAEI ABCHOUYEH, Maryam

Session Classification: Parallel

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

Can Thermal Friction Thaw the Hubble Tension?

Tuesday, 7 June 2022 16:00 (15 minutes)

Thermal friction offers a promising solution to the Hubble and the large-scale structure (LSS) tensions. This additional friction acts on a scalar field in the early universe and extracts its energy density into dark radiation, the cumulative effect being similar to that of an early dark energy (EDE)
scenario. The dark radiation automatically redshifts at the minimal necessary rate to improve the Hubble tension. On the other hand, the addition of extra radiation to the Universe can improve the LSS tension. We explore this model in light of cosmic microwave background (CMB), baryon acoustic oscillation and supernova data, including the SH0ES H0 measurement and the Dark Energy
Survey Y1 data release in our analysis. Our results indicate a preference for the regime where the scalar field converts to dark radiation at very high redshifts, asymptoting effectively to an extra self-interacting radiation species rather than an EDE-like injection. In this limit, thermal friction can ease both the Hubble and the LSS tensions, but not resolve them. We find the source of this preference to be the incompatibility of the CMB data with the linear density perturbations of the dark radiation when injected at redshifts close to matter-radiation equality.

Primary author: BERGHAUS, Kim (Johns Hopkins University)

Co-author: KARWAL, Tanvi (Johns Hopkins University)

Presenter: BERGHAUS, Kim (Johns Hopkins University)

Session Classification: Parallel

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

What does cosmology tell us about the mass of thermal-relic dark matter?

Tuesday, 7 June 2022 17:30 (15 minutes)

The presence of light thermally coupled dark matter affects early expansion history and production of light elements during the Big Bang Nucleosynthesis. Specifically, dark matter that annihilates into Standard Model particles can modify the effective number of light species in the universe Neff , as well as the abundance of light elements created buring BBN. These quantities in turn affect the cosmic microwave background (CMB) anisotropy. We present the first joint analysis of small-scale temperature and polarization CMB anisotropy from Atacama Cosmology Telescope (ACT) and South Pole Telescope (SPT), together with Planck data and the recent primordial abundance measurements of helium and deuterium to place comprehensive bounds on the mass of light thermal–relic dark matter. We consider a range of models, including dark matter that couples to photons and Standard-Model neutrinos. We discuss the sensitivity of the inferred mass bounds on measurements of Neff , primordial element abundances and the baryon density, and quantify the sensitivity of our results to a possible existence of additional relativistic species. We find that the combination of ACT, SPT, and Planck generally leads to the most stringent mass constraint for dark matter that couples to neutrinos, improving the lower limit by 40%–80%, with respect to previous Planck analyses. On the other hand, the addition of ACT and SPT leads to a slightly weaker bound on electromagnetically coupled particles, due to a shift in the preferred values of Yp and Neff driven by the ground based experiments. In most scenarios, the combination of CMB data has a higher constraining power than the primordial abundance measurements alone, with the best results achieved when all data are combined. Combining all CMB measurements with primordial abundance measurements, we rule out masses below ~4 MeV at 95% confidence, for all models. We show that allowing for new relativistic species can weaken the mass bounds for dark matter that couples to photons by up to an order of magnitude or more. Finally, we discuss the reach of the next generation of the CMB experiments in terms of probing the mass of the thermal relic dark matter.

Primary authors: AN, Rui (University of Southern California); GLUSCEVIC, Vera (University of Southern California); CALABRESE, Erminia (Cardiff University); HILL, Colin (Columbia University & Flatiron Institute)

Presenter: AN, Rui (University of Southern California)

Session Classification: Parallel

Contribution ID: **78** Type: **not specified**

Searches for new physics in the final state $B - \tau_h - p_T^{miss}$

Tuesday, 7 June 2022 16:45 (15 minutes)

The $R_{D(*)}$ anomaly represents a tension with the lepton flavor universality. With recent data, the anomaly has a statistical significance greater than 3σ between BaBar, LHCb and Belle observatons. Many theoretical models were proposed to solve such difference between the theory and experiments. In the work we have done, we explore the phenomenology of 3 different models that could explain the $R_{D(*)}$ anomally and would manifest as the final state $B{-}\tau_h{-}p_T^{miss}$ in pp colissions in the LHC and the CMS experiment.

Primary authors: FLOREZ BUSTOS, Carlos Andres (Universidad de los Andes (CO)); RUIZ, Jose (Universidad de Antioquia (CO)); ATEHORTUA GARCES, Tomas (Universidad de Antioquia (CO))

Presenter: ATEHORTUA GARCES, Tomas (Universidad de Antioquia (CO))

Session Classification: Parallel

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

Testing the mean field description of scalar field dark matter

The nature of dark matter, one of the major components of the cosmic standard model, remains one of the outstanding problems in physics. One interesting model is scalar field dark matter (SFDM), which fits naturally into observations in both particle physics and cosmology. Simulations and calculations using SFDM often use a classical field approximation (MFT) of the underlying quantum field theory. And while it is suspected that large occupation numbers make this description good in the early universe, it is possible that this approximation fails during nonlinear structure growth and begins to admit important quantum corrections. To investigate this possibility, we compare simulations using the MFT to those that take into account these corrections. By studying their behavior as we scale the total number of particles in the system we can estimate how long the MFT remains an accurate description of the system. We estimate this time scale for a typical halo may be of order ˜1 Gyr, short compared to the age of the universe. In this talk we will explain how these simulations are performed, as well as their results, and their potential implications.

Primary author: EBERHARDT, Andrew (Stanford University)

Presenter: EBERHARDT, Andrew (Stanford University)

Session Classification: Parallel

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

The quantum nature of gravity seen in cosmological observations

In the author's model of low-energy quantum gravity, the cosmological redshift, additional darkening of distant objects and a diffuse cosmic optical background, presumably detected by the New Horizons mission, can be interpreted, without cosmological expansion and dark energy, as a result of the scattering of photons on superstrongly interacting background gravitons. The constancy of the ratio $H(z)/(1+z)$ in this model is consistent with observations of the Hubble parameter $H(z)$. There is a possibility of interpreting dark matter as a gas of virtual massive gravitons.

Primary author: IVANOV, Michael A.

Presenter: IVANOV, Michael A.

Session Classification: Parallel

Contribution ID: **81** Type: **not specified**

Astrometric Gravitational-Wave Detection via Stellar Interferometry

Wednesday, 8 June 2022 13:45 (15 minutes)

In this talk, I will evaluate the potential for gravitational-wave (GW) detection in the frequency band from 10 nHz to 1 μHz using extremely high-precision astrometry of a small number of stars. In particular, I will argue that non-magnetic, photometrically stable hot white dwarfs (WD) located at $\sim$ kpc distances may be optimal targets for this approach. Previous studies of astrometric GW detection have focused on the potential for less precise surveys of large numbers of stars; this work provides an alternative optimization approach to this problem. Interesting GW sources in this band are expected at characteristic strains around $h_c \sim 10^{-17} \times (\mu\text{Hz}/f_{\text{GW}})$. The astrometric angular precision required to see these sources is $\Delta\theta \sim h_c$ after integrating for a time $T \sim 1/f_{\text{GW}}$. I will show that jitter in the photometric center of WD of this type due to starspots is bounded to be small enough to permit this high-precision, small-N approach. I will also discuss possible noise arising from stellar reflex motion induced by orbiting objects and show how it can be mitigated. The only plausible technology able to achieve the requisite astrometric precision is a space-based stellar interferometer. I will outline how such a future mission with few-meter-scale collecting dishes and baselines of $\mathcal{O}(100\text{km})$ is sufficient to achieve the target precision. This collector size is broadly in line with the collectors proposed for some formation-flown, space-based astrometer or optical synthetic-aperature imaging-array concepts proposed for other science reasons. The proposed baseline is however somewhat larger than the km-scale baselines discussed for those concepts, but there is no fundamental technical obstacle to utilizing such baselines. A mission of this type thus also holds the promise of being one of the few ways to access interesting GW sources in this band.

Primary author: Dr FEDDERKE, Michael A. (Johns Hopkins University)

Co-authors: Prof. MACINTOSH, Bruce (Stanford University); Prof. GRAHAM, Peter W. (Stanford University); Prof. RAJENDRAN, Surjeet (Johns Hopkins University)

Presenter: Dr FEDDERKE, Michael A. (Johns Hopkins University)

Session Classification: Parallel

Contribution ID: **82** Type: **not specified**

Experimental signatures of a new dark matter WIMP

Tuesday, 7 June 2022 17:15 (15 minutes)

We propose and describe a dark matter particle which is consistent with current experiment and observation, and which should be detectable within the next 1-5 years [1,2]. This particle is unique in that it has (i) precisely defined couplings and (ii) a well-defined mass of about 72 GeV. It has not yet been detected because it has no interactions other than second-order gauge couplings, to W and Z bosons. However, these weak couplings are still sufficient to enable observation by direct detection experiments which should be fully functional within the next few years, including XENONnT, LZ, and PandaX. The cross-section for collider detection at LHC energies is small (roughly 1 fb) but observation may ultimately be achievable at the high-luminosity LHC, and should certainly be within reach of the even more powerful colliders now being planned. It is possible that the present dark matter candidate has already been observed via indirect detection: Several analyses of gamma rays from the Galactic center, observed by Fermi-LAT, and of antiprotons, observed by AMS-02, have shown consistency with the interpretation that these result from annihilation of dark matter particles having roughly the same mass and annihilation cross-section as the present candidate. Finally, there is consistency with the observations of Planck, which have ruled out many possible candidates with larger masses. The most promising signature for collider detection appears to be missing transverse energy of > 145 GeV accompanied by two jets, following creation through vector boson fusion. The most promising mechanism for direct detection appears to be a one-loop process involving exchange of two vector bosons. The present dark matter particle and the lightest susy neutralino (as well as an axion-like particle) can stably coexist in a multicomponent dark matter scenario, which results from a fundamental picture which predicts both an extended Higgs sector and supersymmetry [3].

[1] Reagan Thornberry, Maxwell Throm, Gabriel Frohaug, John Killough, Dylan Blend, Michael Erickson, Brian Sun, Brett Bays, and Roland E. Allen. "Experimental signatures of a new dark matter WIMP", EPL (Europhysics Letters) 134, 49001 (2021).

[2] Caden LaFontaine, Bailey Tallman, Spencer Ellis, Trevor Croteau, Brandon Torres, Sabrina Hernandez, Diego Cristancho Guerrero, Jessica Jaksik, Drue Lubanski, and Roland E. Allen, "A Dark Matter WIMP That Can Be Detected and Definitively Identified with Currently Planned Experiments", Universe 7, 270 (2021).

[3] Roland E. Allen, "Predictions of a fundamental statistical picture", arXiv:1101.0586v10 [hep-th].

Primary author: ALLEN, Roland

Presenter: ALLEN, Roland

Session Classification: Parallel

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

Polarized solitons in higher-spin dark matter

Tuesday, 7 June 2022 17:45 (15 minutes)

Apart from the Standard Model, our Universe could be host to a diverse set of degrees of freedom (dark sector). The dark sector could comprise of various bosonic fields with possible self interactions alongside gravity, containing macroscopic/astrophysical bound states known as solitons. Depending upon the spin nature of the field, these solitons can even carry huge amounts of intrinsic spin polarization!, leading to interesting phenomenology. In this talk, I will discuss such solitons arising in spin-1 and higher fields, including Yang-Mills theories in the Higgs phase. For masses in the fuzzy dark matter regime, such 'spinning'solitons may form the cores of dark matter halos, with halos in general being distinguishable from their scalar counterparts. Time permitting, I will also present a possible thermal production scenario of spin-1 fields (with or without self interactions) that can constitute all of the observed DM.

Primary author: JAIN, Mudit

Co-author: AMIN, Mustafa (Rice University)

Presenter: JAIN, Mudit

Session Classification: Parallel

Contribution ID: **84** Type: **not specified**

Maximizing Direct Detection with HYPER Dark Matter

Tuesday, 7 June 2022 16:15 (15 minutes)

We estimate the maximum direct detection cross section for sub-GeV dark matter scattering off nucleons. For dark matter masses in the range of 10 keV – 100 MeV, cross sections greater than $10^{-36} - 10^{-30}$ cm^2 seem implausible. We introduce a dark matter candidate which realizes this maximum cross section: HighlY interactive ParticlE Relics (HYPERs). After HYPERs freeze-in, a dark sector phase transition decreases the mass of the mediator which connects HYPERs to the visible sector. This increases the HYPER's direct detection cross section, but in such a way as to leave the HYPER's abundance unaffected and avoid conflict with measurements of Big Bang Nucleosynthesis and the Cosmic Microwave Background. HYPERs present a benchmark for direct detection experiments in a parameter space with few known dark matter models.

Primary author: MCGEHEE, Robert

Presenter: MCGEHEE, Robert

Session Classification: Parallel

Contribution ID: **85** Type: **not specified**

Impact of Sommerfeld Effect and Bound State Formation in Simplified t-Channel Dark Matter Models

Tuesday, 7 June 2022 15:30 (15 minutes)

A non-minimal dark sector could explain why WIMP dark matter has evaded detection so far. Based on the extensively studied example of a simplified t-channel dark matter model involving a colored mediator, we demonstrate that the Sommerfeld effect and bound state formation must be considered for an accurate prediction of the relic density and thus also when inferring the experimental constraints on the model. We find that parameter space thought to be excluded by LHC searches and direct detection experiments remains viable. Moreover, we point out that the search for bound state resonances at the LHC offers a unique opportunity to constrain a wide range of dark matter couplings inaccessible to prompt and long-lived particle searches.

Primary authors: SENGUPTA, Dipan (UC San Diego); COPELLO, Emanuele (TUM); BECKER, Mathias (Technical University of Munich); HARZ, Julia (Technical University of Munich (TUM)); MOHAN, Kirtimaan Ajaykant

Presenter: BECKER, Mathias (Technical University of Munich)

Session Classification: Parallel

Contribution ID: **86** Type: **not specified**

Reconstructing cosmology

The cosmological standard model is founded on the assumption that the universe is isotropic and homogeneous when averaged on large scales. The CMB dipole anisotropy is attributed to our local motion relative to the cosmic rest frame in which it is isotropic. There must then be a corresponding dipole in the distribution of high redshift sources. However the the matter dipole traced by radio sources & quasars significantly exceeds this expectation. This calls into question the assumption of the FLRW metric and the consequent inference that the universe is dominated by dark energy.

Primary author: Prof. SARKAR, Subir (University of Oxford)

Presenter: Prof. SARKAR, Subir (University of Oxford)

Session Classification: Plenary XV - Emerson Auditorium

Contribution ID: **87** Type: **not specified**

Neutrino echoes as a probe of secret neutrino interactions

Wednesday, 8 June 2022 14:30 (15 minutes)

Beyond the Standard Model (BSM) interactions in the neutrino sector have been of much interest in cosmology and astroparticle physics. We developed a Monte Carlo code to investigate the neutrino time delay distribution caused by BSM interactions en route to the observer. While we find excellent agreement for small optical depths, the optically thick limit show features that are not described by simple analytical estimates. The code can be used to probe BSM interactions in current neutrino detectors such as IceCube and Super-Kamiokande, as well as future detectors. As an example, we show how to constrain neutrino interactions with sub-MeV dark matter in Hyper-Kamiokande via the echo approach, covering a parameter space unexplored by dark matter direct detection experiments.

Primary author: CARPIO, Jose (Penn State University)

Co-authors: KHEIRANDISH, Ali (Pennsylvania State University); MURASE, Kohta (Penn State University)

Presenter: CARPIO, Jose (Penn State University)

Session Classification: Parallel

Contribution ID: **88** Type: **not specified**

QCD Equation of State

Thursday, 9 June 2022 14:00 (30 minutes)

Presenter: RATTI, Claudia

Session Classification: Plenary XII - Emerson Auditorium

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

EHT Constraints on Theories of Gravity

Tuesday, 7 June 2022 13:30 (30 minutes)

Presenter: WONDRAK, Michael (Frankfurt Institute for Advanced Studies (FIAS))

Session Classification: Plenary VII - Emerson Auditorium

Contribution ID: **90** Type: **not specified**

Precision Higgs Physics

Tuesday, 7 June 2022 14:00 (30 minutes)

Presenter: SU, Shufang (University of Arizona)

Session Classification: Plenary VII - Emerson Auditorium

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

BSM Higgs Physics

Tuesday, 7 June 2022 14:30 (30 minutes)

Presenter: LEWIS, Ian (The University of Kansas)

Session Classification: Plenary VII - Emerson Auditorium

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

Searching for the fundamental nature of dark matter in the cosmic large-scale structure

The fundamental nature of dark matter so far eludes direct detection experiments, but it has left its imprint in the large-scale structure (LSS) of the Universe. Extracting this information requires accurate modelling of structure formation and careful handling of astrophysical uncertainties. I will present new bounds using the LSS on two compelling dark matter scenarios that are otherwise beyond the reach of direct detection. Ultra-light axion dark matter, particles with very low mass and astrophysically-sized wavelengths, is produced in high-energy models like string theory ("axiverse"). I will rule out axions that are proposed to resolve the so-called cold dark matter "small-scale crisis" (mass ˜ 10ˆ-22 eV) using the Lyman-alpha forest (mass > 2 x 10ˆ-20 eV at 95% c.l.), but demonstrate how a mixed axion dark matter model (as produced in the string axiverse) could resolve the S_8 tension (mass ˜ 10ˆ-25 eV) using Planck, ACT and SPT CMB data and BOSS galaxy multipoles. Further, I will set the strongest limits to-date on the dark matter – proton cross section for dark matter particles lighter than a proton (mass < GeV). The LSS model involves one-loop perturbation theory, a non-cold dark matter halo model and, to capture the smallest scales that drive improvements in bounds, a machine learning model called an "emulator", trained using hydrodynamical simulations and an active learning technique called Bayesian optimisation.

Primary author: ROGERS, Keir

Presenter: ROGERS, Keir

Session Classification: Parallel

Contribution ID: **93** Type: **not specified**

Acausality in Superfluid Dark Matter and MOND-like Theories

Wednesday, 8 June 2022 13:45 (15 minutes)

There has been much interest in novel models of dark matter that exhibit interesting behavior on galactic scales. A primary motivation is the observed Baryonic Tully-Fisher Relation in which the mass of galaxies increases as the quartic power of rotation speed. This scaling is not obviously accounted for by standard cold dark matter. This has prompted the development of dark matter models that exhibit some form of so-called MONDian phenomenology to account for this galactic scaling, while also recovering the success of cold dark matter on large scales. A beautiful example of this are the so-called superfluid dark matter models, in which a complex bosonic field undergoes spontaneous symmetry breaking on galactic scales, entering a superfluid phase with a 3/2 kinetic scaling in the low energy effective theory, that mediates a long-ranged MONDian force. In this work we examine the causality and locality properties of these and other related models. We show that the Lorentz invariant completions of the superfluid models exhibit high energy perturbations that violate global hyperbolicity of the equations of motion in the MOND regime and can be superluminal in other parts of phase space. We also examine a range of alternate models, finding that they also exhibit forms of non-locality.

Primary authors: LITTERER, Jacob; HERTZBERG, Mark (Tufts University); SHAH, Neil

Presenter: SHAH, Neil

Session Classification: Parallel

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

Multi-track Displaced Vertices at B-Factories

Tuesday, 7 June 2022 17:00 (15 minutes)

We propose a program at B-factories of inclusive, multi-track displaced vertex searches, which are expected to be low background and give excellent sensitivity to non-minimal hidden sectors. Multi-particle hidden sectors often include long-lived particles (LLPs) which result from approximate symmetries, and we classify the possible decays of GeV-scale LLPs in an effective field theory framework. Considering several LLP production modes, including dark photons and dark Higgs bosons, we study the sensitivity of LLP searches with different number of displaced vertices per event and track requirements per displaced vertex, showing that inclusive searches can have sensitivity to a large range of hidden sector models that are otherwise unconstrained by current or planned searches.

Primary author: BLACKBURN, Albany (Harvey Mudd College)

Co-author: SHUVE, Brian (Harvey Mudd College)

Presenter: BLACKBURN, Albany (Harvey Mudd College)

Session Classification: Parallel

Contribution ID: **95** Type: **not specified**

Main Results and Current Progress within the Scale Invariant Vacuum Paradigm

A review of the Scale Invariant Vacuum (SIV) idea will be presented as related to Weyl Integrable Geometry [1]. The main results related to SIV and inflation [2], the growth of the density fluctuations [3], and the application of the SIV to scale-invariant dynamics of Galaxies, MOND, Dark Matter, and the Dwarf Spheroidals [4] will be highlighted.

[1] Gueorguiev, V. G., Maeder, A., The Scale Invariant Vacuum Paradigm: Main Results and Current Progress. Universe 2022, 8 (4) 213; DOI:10.3390/universe8040213 [gr-qc/2202.08412].
[2] Maeder, A., Gueorguiev, V. G., Scale invariance, horizons, and inflation. MNRAS 504, 4005 (2021) [gr-qc/2104.09314].
[3] Maeder, A., Gueorguiev, V., G., The growth of the density fluctuations in the scale-invariant vacuum theory. Phys. Dark Univ. 25, 100315 (2019) [astro-ph.CO/1811.03495]
[4] Maeder, A.; Gueorguiev, V.G. Scale-invariant dynamics of galaxies, MOND, dark matter, and the dwarf spheroidals. MNRAS 492, 2698 (2019) [gr-qc/2001.04978]

Primary authors: Prof. MAEDER, Andre (Geneva Observatory); Dr GUEORGUIEV, Vesselin

Presenter: Dr GUEORGUIEV, Vesselin

Session Classification: Parallel

Contribution ID: **96** Type: **not specified**

Hidden-Sector Neutrinos and Freeze-In Leptogenesis

Wednesday, 8 June 2022 14:00 (15 minutes)

Sterile neutrinos at the GeV scale can resolve several outstanding problems of the Standard Model (SM), such as the source of neutrino masses and the origin of the baryon asymmetry through freeze-in leptogenesis, but they can be challenging to detect experimentally due to their small couplings to SM particles. In extensions of the SM with new interactions of the sterile neutrinos, they can be produced copiously at accelerators and colliders. We systematically investigate the impact of such novel interactions on the asymmetry from freeze-in leptogenesis. We find that the interactions tend to bring the sterile neutrinos into equilibrium at early times, leading to a significant reduction in the generated asymmetry. We also show that observable rates of several hidden-sector neutrino signatures, such as SM Higgs decays to pairs of sterile neutrinos, can be inconsistent with the observed baryon asymmetry and provide an opportunity to falsify freeze-in leptogenesis.

Primary author: SHUVE, Brian (Harvey Mudd College)

Presenter: SHUVE, Brian (Harvey Mudd College)

Session Classification: Parallel

Contribution ID: **97** Type: **not specified**

Traces of a Heavy Field in Gravitational Waves

Wednesday, 8 June 2022 14:00 (15 minutes)

I will discuss gravitational waves (GWs) induced by a heavy spectator field that starts to oscillate during inflation. During the oscillation of the spectator field, its effective mass can also oscillate in some potentials. This mass oscillation can resonantly amplify the spectator field fluctuations. I will show that these amplified fluctuations can induce large GWs, which could be investigated by future gravitational wave observations. This kind of induced GWs can be produced even if the spectator field does not have any interaction with other fields except for gravitational interaction. This talk will be based on my paper, arXiv: 2203.04974.

Primary author: Dr INOMATA, Keisuke (University of Chicago, KICP)

Presenter: Dr INOMATA, Keisuke (University of Chicago, KICP)

Session Classification: Parallel

Contribution ID: **98** Type: **not specified**

The SABRE South Experiment at the Stawell Underground Physics Laboratory

Tuesday, 7 June 2022 16:30 (15 minutes)

The SABRE (Sodium iodide with Active Background REjection) experiment aims to detect an annual rate modulation from dark matter interactions in ultra-high purity NaI(Tl) crystals in order to provide a model independent test of the signal observed by DAMA/LIBRA. It is made up of two separate detectors; SABRE South located at the Stawell Underground Physics Laboratory (SUPL), in regional Victoria, Australia, and SABRE North at the Laboratori Nazionali del Gran Sasso (LNGS).

SABRE South is designed to disentangle seasonal or site-related effects from the dark matter-like modulated signal by using an active veto and muon detection system. Ultra-high purity NaI(Tl) crystals are immersed in a linear alkyl benzene (LAB) based liquid scintillator veto, further surrounded by passive steel and polyethylene shielding and a plastic scintillator muon veto. Significant work has been undertaken to understand and mitigate the background processes, that take into account radiation from the detector materials, from both intrinsic and cosmogenic activated processes, and to understand the performance of both the crystal and veto systems.

SUPL is a newly built facility located 1024 m underground (˜2900 m water equivalent) within the Stawell Gold Mine and its construction will be completed by mid-2022. The laboratory will house rare event physics searches, including the upcoming SABRE dark matter experiment, as well as measurement facilities to support low background physics experiments and applications such as radiobiology and quantum computing. The SABRE South detector assembly is planned to start once SUPL is finalised, and its commissioning is expected to occur in 2023.

This talk will report on the design of SUPL design and its current status, as well as the general status of the SABRE South assembly.

Presenter: ZUROWSKI, Madeleine (University of Melbourne)

Session Classification: Parallel

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

Memory-triggered supernova neutrino detection

Wednesday, 8 June 2022 13:45 (15 minutes)

When a burst of neutrinos from a core-collapse supernova (CCSN) passes by the Earth, it causes a permanent change in the local space-time metric, called the gravitational wave (GW) memory. Long considered unobservable, this effect will be detectable in the near future, at deci-Hertz GW interferometers. I will present a novel idea, where observations of the neutrino GW memory from CCSNe will enable time-triggered searches of supernova neutrinos at megaton (Mt) scale detectors. This combination of a deci-Hz GW detector and a Mt neutrino detector will allow the latter to surpass its current sensitivity limits to detect a nearly background-free sample of ˜ 3 - 30 supernova neutrino events per Mt per decade of operation, from large distances (˜ 10 - 100 Mpc), which will open a new avenue to studying supernova neutrinos.

Primary authors: LUNARDINI, Cecilia (Arizona State University); MUKHOPADHYAY, Mainak (Arizona State University); Dr LIN, Zidu ({Department of Physics and Astronomy, University of Tennessee Knoxville)

Presenter: MUKHOPADHYAY, Mainak (Arizona State University)

Session Classification: Parallel

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

The Light Dark Matter eXperiment, LDMX

Tuesday, 7 June 2022 15:45 (15 minutes)

The constituents of dark matter are still unknown, and the viable possibilities span a very large mass range. Specific scenarios for the origin of dark matter sharpen the focus on a narrower range of masses: the natural scenario where dark matter originates from thermal contact with familiar matter in the early Universe requires the DM mass to lie within about an MeV to 100 TeV. Considerable experimental attention has been given to exploring Weakly Interacting Massive Particles in the upper end of this range (few GeV –˜TeV), while the region ˜MeV to ˜GeV is largely unexplored. Most of the stable constituents of known matter have masses in this lower range, tantalizing hints for physics beyond the Standard Model have been found here, and a thermal origin for dark matter works in a simple and predictive manner in this mass range as well. It is therefore a priority to explore. If there is an interaction between light DM and ordinary matter, as there must be in the case of a thermal origin, then there necessarily is a production mechanism in accelerator-based experiments. The most sensitive way, (if the interaction is not electron-phobic) to search for this production is to use a primary electron beam to produce DM in fixed-target collisions. The Light Dark Matter eXperiment (LDMX) is a planned electron-beam fixed-target missing-momentum experiment that has unique sensitivity to light DM in the sub-GeV range. This contribution will give an overview of the theoretical motivation, the main experimental challenges and how they are addressed, as well as projected sensitivities in comparison to other experiments.

Primary author: GROUP, Robert

Presenter: GROUP, Robert

Session Classification: Parallel

Contribution ID: **101** Type: **not specified**

Muon g-2 and the B-physics anomalies in RPV Supersymmetry and the discovery prospect at LHC

Tuesday, 7 June 2022 17:30 (15 minutes)

In R-parity violating supersymmetric scenarios, assuming the third-generation superpartners to be the lightest (calling the scenario RPV3), we show that there are some benchmark scenarios in which $R_{D^{(*)}}$, $R_{K^{(*)}}$ and $(g-2)_\mu$ anomalies can be addressed and also can be detected at 14 TeV HL-LHC or future hadron colliders.

Primary author: XU, Fang

Co-authors: DEV, Bhupal (Washington University in St. Louis); SONI, AMARJIT

Presenter: XU, Fang

Session Classification: Parallel

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

Freeze-in baryogenesis via dark-matter oscillations

Wednesday, 8 June 2022 16:15 (15 minutes)

We discuss the cosmology and phenomenology of freeze-in baryogenesis via dark-matter oscillations, focusing mainly on the case in which the dark matter couples to Standard Model leptons. We investigate viable models both with and without a Z_2 symmetry under which all new fields are charged, highlighting scenarios in which the baryon asymmetry is parametrically distinct from and enhanced relative to leptogenesis from sterile neutrino oscillations. The models we study predict the existence of new, electroweak-charged fields, and can be tested by a combination of collider searches, structure-formation studies, X-ray observations, and terrestrial low-energy experiments.

Primary authors: BERMAN, Justin (Williams College); SHUVE, Brian (Harvey Mudd College); TUCKER-SMITH, David (Williams College)

Presenter: TUCKER-SMITH, David (Williams College)

Session Classification: Parallel

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

Optimal Pair-finding For Flow Mapping in Liquid Xenon Time Projection Chambers

Tuesday, 7 June 2022 16:45 (15 minutes)

Liquid xenon time projection chambers (LXe-TPCs) combine self-shielding, event position reconstruction, particle-type discrimination, and scalability to produce consistently world leading Weakly Interacting Massive Particle (WIMP) sensitivity. LUX-ZEPLIN (LZ) has the furthest physics reach of any xenon TPC built to date, however Rn222 chain Pb214 decays still represent the largest background contribution to any low energy searches. In position-reconstructing solid-state detectors, Pb214 events are easily tagged by the preceding and following decays in the 222Rn chain, separated by O(10)-minute half-lives, but the constant convection-driven flow in a TPC has thus far prevented such tagging in liquid detectors. This talk will discuss robust parent-child decay pairing methods that allow for discrete direct measurement of flow, as well as generalization of discrete flow measurements to a full flow map, which can be used to reject the Pb214 decays much more effectively than particle-type discrimination alone.

Primary author: MCLAUGHLIN, Jacob (Northwestern University)

Presenter: MCLAUGHLIN, Jacob (Northwestern University)

Session Classification: Parallel

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

Probing the ν_R-philic Z' at DUNE near detectors

Tuesday, 7 June 2022 16:00 (15 minutes)

Hidden U(1) symmetries in the right-handed neutrino (νR) sector are theoretically well-motivated and would give rise to an inherently dark gauge boson which we refer to as the νR-philic Z'. An important feature of this Z' is that its couplings to neutrinos are generally much larger than its couplings to charged leptons and quarks, providing a particularly interesting scenario for future neutrino experiments such as DUNE to probe. In this talk, I'll discuss two approaches to probe this Z' at DUNE near detectors via (i) searching for Z' decay signals and (ii) precision measurement of elastic neutrino-electron (ν-e) scattering. I will show that the former will have sensitivity comparable to or better than previous beam dump experiments while the latter will improve current limits substantially for large neutrino couplings.

Primary author: CHAUHAN, Garv (UCLouvain)

Co-authors: DEV, Bhupal (Washington University in St. Louis); XU, Xunjie

Presenter: CHAUHAN, Garv (UCLouvain)

Session Classification: Parallel

Contribution ID: **106** Type: **not specified**

A Hubble parameter estimate H0 = (73.37 ± 0.54) km/s/Mpc from the late-time Universe and the BAO

Tuesday, 7 June 2022 16:15 (15 minutes)

Modern precision measurements of the Hubble parameter H0 increasingly lay bare an accelerated expansion of the Universe beyond what is expected from Planck-LCDM analysis of the Cosmic Microwave Background (CMB). This H0-tension is here modeled by a non-local dark energy Λ=g(1-q)Hˆ2, subject to the age of the Universe and the BAO inferred from globular clusters of the Milky Way and, respectively, the CMB. Bootstrapping from LCDM, we estimate H0 = (73.37 ± 0.54) km/s/Mpc with gravitational coupling constant g=(1-α/2), anticipating Riess' et al. recent measurement H0 = (73.30 ± 1.04) km/s/Mpc. (Based on van Putten PLB 823 136737 (2021).)

Primary author: VAN PUTTEN, Maurice (Sejong University)

Presenter: VAN PUTTEN, Maurice (Sejong University)

Session Classification: Parallel

Contribution ID: **107** Type: **not specified**

The impact of relative baryon-CDM perturbations on the evolution of Large-Scale Structures

Tuesday, 7 June 2022 16:30 (15 minutes)

Different evolution of the two dominant matter components of our Universe baryons and cold dark matter, due to the photon pressure before recombination, causes relative perturbations between the two fluids in the early Universe. These perturbations can be both in the density and peculiar velocity of the two fields and we call them relative baryon-CDM perturbations which are commonly neglected in the studies of structure formation. However, taking them in to account might become very important in the era of high precision cosmology. In this talk first I will explain these types of perturbations theoretically, using linear perturbation theory, then I will go through the fact that how can we assess the impact of these relative perturbations on halo's distributions performing 2-fluid gravity-only N-body simulations. We further measure the cross/auto power spectra and the associated bias term. Then I will move to presenting the impact of such perturbations on cosmic voids and the real-space two-point correlation function, in particular the baryonic acoustic oscillations peak position.

Primary author: KHORAMINEZHAD, Hasti (Missouri University of Science and Technology)

Co-authors: BACCIGALUPI, Carlo; VIEL, Matteo; HAHN, Oliver; VIELZEUF, Pauline; ANGULO, Raul; LAZEYRAS, Titouan

Presenter: KHORAMINEZHAD, Hasti (Missouri University of Science and Technology)

Session Classification: Parallel

Contribution ID: **108** Type: **not specified**

Revisiting gravitational wave background from primordial black holes

Wednesday, 8 June 2022 14:15 (15 minutes)

The Peters formula, which tells how the coalescence time of a binary system emitting gravitational radiation is determined by the initial size and shape of the elliptic orbit, is often used in estimating the merger rate of primordial black holes and the gravitational wave background from the mergers. Valid as it is in some interesting scenarios, such as the analysis of the LIGO-Virgo events, the Peters formula fails to describe the coalescence time if the orbital period of the binary exceeds the value given by the formula. This could underestimate the merger rate of some binaries. As a result, the energy density spectrum of the gravitational wave background could develop a peak, which is from mergers occurring at either $t \sim 10^{13}$ s (for black holes with mass $M > 10^8 M_\odot$) or $t\ 10^{26}(M/M_\odot)^{-5/3}$ s (for $10^5 M_\odot < M < 10^8 M_\odot$). This can be used to constrain the fraction of dark matter in primordial black holes (denoted by f) if potential probes (such as SKA and U-DECIGO) do not discover such a background, with the result $f < 10^{-6} - 10^{-4}$ for the mass range $10 - 10^9 M_\odot$. We then consider the effect of mass accretion onto primordial black holes at redshift $z\ 10$, and find that the merger rate could drop significantly at low redshifts. The spectrum of the gravitational wave background thus gets suppressed at the high-frequency end. This feature might be captured by future detectors such as ET and CE for initial black hole mass $M = \mathcal{O}(10-100)M_\odot$ with $f > 10^{-4}$.
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Primary author: DENG, Heling

Presenter: DENG, Heling

Session Classification: Parallel

Contribution ID: **109** Type: **not specified**

Recent results from Belle II

Tuesday, 7 June 2022 17:15 (15 minutes)

The Belle II experiment at the SuperKEKB energy-asymmetric e+e− collider is a substantial upgrade of the B factory facility at the Japanese KEK laboratory. The design luminosity of the machine is 6×1035 cm−2s−1 and the Belle II experiment aims to ultimately record 50 ab−1 of data, a factor of 50 more than its predecessor. With this data set, Belle II will be able to measure the Cabibbo-Kobayashi-Maskawa (CKM) matrix, the matrix elements and their phases, with unprecedented precision and explore flavor physics with B and charmed mesons, and τ leptons. Belle II has also a unique capability to search for low mass dark matter and low mass mediators. In this presentation, we will review the latest results from Belle II, with emphasis on those related to lepton flavour violation.

Presenter: COCHRAN, Jim (Iowa State Univ.)

Session Classification: Parallel

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

Upper bound on the smuon mass from vacuum stability in the light of muon g–2 anomaly

Tuesday, 7 June 2022 16:45 (15 minutes)

We derive an upper bound on the smuon mass assuming that the muon $g-2$ anomaly is explained by the supersymmetric (SUSY) contribution. In the minimal SUSY standard model, the SUSY contribution to the muon $g-2$ is enhanced when the Higgsino mass parameter is large. Then, the smuon-smuon-Higgs trilinear coupling is enhanced, which may destabilize the electroweak vacuum. We calculate precisely the decay rate of the electroweak vacuum in such a case. We include one-loop effects which are crucial to determine the overall normalization of the decay rate. Requiring that the theoretical prediction of the muon anomalous magnetic moment is consistent with the observed value at the 1 and 2σ levels (equal to the central value of the observed value), we found that the lightest smuon mass should be smaller than 1.38 and 1.68 TeV (1.20 TeV) for $\tan\beta = 10$ (with $\tan\beta$ being the ratio of the vacuum expectation values of the two Higgs bosons), respectively, and the bound is insensitive to the value of $\tan\beta$.

Primary authors: CHIGUSA, So; MOROI, Takeo (The University of Tokyo); SHOJI, Yutaro (KMI, Nagoya University)

Presenter: CHIGUSA, So

Session Classification: Parallel

Contribution ID: **111** Type: **not specified**

On the construction of theories of $Sp(4)$ dark matter

Wednesday, 8 June 2022 14:15 (15 minutes)

We discuss construction principles of strongly interacting theories containing a dark matter candidate, with a particular focus on an $Sp(4)$ gauge symmetry. We give an account of the global symmetries and breaking patterns of these theories. Finally, we discuss simple portals between the DM sector and the standard model, as well as elucidate phenomenological consequences of such couplings.

Primary authors: MAAS, Axel Torsten; ZIERLER, Fabian (University of Graz); PRADLER, Josef (Austrian Academy of Sciences (AT)); NIKOLIC, Marco; MEE, Seán; KULKARNI, Suchita (University of Graz)

Presenter: MEE, Seán

Session Classification: Parallel

Contribution ID: **112** Type: **not specified**

Quarkofobic W' for LHC searches

Tuesday, 7 June 2022 16:30 (15 minutes)

We consider a simplified model where a quarkofobic W' is added to the standar model. This W' is considered to not couple or couple very feable to quarks, but in addition it couples to the standard model electroweak gauge bosons and leptons. We study the implications of such a new particle for the LHC and b-anomalies. We finally set limits from high energy searches that could be performed in experiments as ATLAS or CMS as a function of the W' couplings to gauge bosons and its mass.

Primary authors: GURROLA, Alfredo (Vanderbilt University (US)); RUIZ, Jose (Universidad de Antioquia (CO))

Presenter: RUIZ, Jose (Universidad de Antioquia (CO))

Session Classification: Parallel

Contribution ID: **113** Type: **not specified**

Forecasting detections of gravitational-wave tails from LIGO data

Wednesday, 8 June 2022 14:45 (15 minutes)

The growing collection of gravitational-wave (GW) detections from current ground-based detectors coupled with constant improvements in detector sensitivity provide opportunities to observe as-of-yet undiscovered consequences of General Relativity. The recent prediction of the existence of GW "tails"produced by primary signals scattering off of stellar-density astrophysical objects is a promising candidate for detection and could yield further insight into properties of the astrophysical populations of such perturbers. In this presentation, I present progress made toward forecasting the capacity for detection of such GW tails in LIGO data at modern-day sensitivities over a representative sample of GW tail parameter space. We find promising results that motivate searches for such signals in public GW data.

Primary author: CARNEY, Matthew

Presenter: CARNEY, Matthew

Session Classification: Parallel

Contribution ID: **114** Type: **not specified**

The Modified Archimedes Principle

Abstract

The Modified Archimedes Principle (MAP) is a modified gravity theory, which holds that a massive body, such as the sun, or a mass equivalent vacuum energy body, such as a halo, which is immersed in the vacuum energy of space, displaces a volume of such space that is centered on such body and contains an amount of mass equivalent vacuum energy that is exactly equal to the mass of the displacing body. This displacement generates a force that complements the mass attracting gravitational force, induces and is induced by the gravitational force, and is called gravitodisplacement (my term).

Actual mass/electromagnetic energy and virtual mass/vacuum energy equally comprise a unified mass/energy system that is expressed most strongly at the surface of a displacing body, from where, pursuant to the inverse square law, attenuated vacuum energy is exponentially amplified, repelled to and concentrated within, a distant vacuum energy "halo". Since vacuum energy is dissipated at the surface of the massive earth, the Casimir plate test results became skewed, in that mass equivalent vacuum energy halos do account for observed stellar/galactic movements.

Two years before its telescopic discovery, your author copyrighted a prediction of the existence of the Kuiper cliff (not the name). Confirmation-of-prediction is accepted proof-of-theory. MAP explains what the Kuiper cliff is, and why it is, where it is, which are unknowns, to this day.

MAP also predicts the existence of the scattered disc cliff and other solar and extrasolar cliffs, and offers plausible interpretations of, et al: the flyby anomaly; the composition and structure of halos; the composition and structure of voids; dark matter/energy; the fabric of space-time; the large scale structure of the universe; the variable acceleration/deceleration/acceleration of the universe; and the cosmological constant.

Primary author: Mr LASKY, Arnold (Unaffiliated)

Presenter: Mr LASKY, Arnold (Unaffiliated)

Session Classification: Parallel

Contribution ID: **115** Type: **not specified**

Revisiting an Early Dark Energy model and the Hubble Tension in a non-flat Universe

Tuesday, 7 June 2022 15:45 (15 minutes)

The flat ΛCDM model of the Universe has started to falter due to recent and precise observations. One of the most promising models to resolve these problems is the axion-like Early Dark Energy (EDE) model. Our goal is to clarify how the EDE model and the shape of the Universe are simultaneously constrained with these recent datasets. We find that Early Dark Energy depends on shape only when using CMB data, but when BAO is added, curvature goes to zero which raises the Hubble constant but is still inconsistent with local data. Even when varying curvature, EDE by itself cannot explain theoretical and local measurements at the same time.

Primary author: STEVENS, Jordan (Missouri University of Science and Technology)

Co-authors: KHORAMINEZHAD, Hasti (Missouri University of Science and Technology); SAITO, Shun (Missouri University of Science and Technology)

Presenter: STEVENS, Jordan (Missouri University of Science and Technology)

Session Classification: Parallel

Contribution ID: **116** Type: **not specified**

High-quality axions in solutions to the μ problem

Wednesday, 8 June 2022 16:00 (15 minutes)

Solutions to the μ problem in supersymmetry based on the Kim-Nilles mechanism naturally feature a Dine-Fischler-Srednicki-Zhitnitsky (DFSZ) axion with decay constant of order the geometric mean of the Planck and TeV scales, consistent with astrophysical limits. We investigate minimal models of this type with two gauge-singlet fields that break a Peccei-Quinn symmetry, and extensions with extra vectorlike quark and lepton supermultiplets consistent with gauge coupling unification. We show that there are many anomaly-free discrete symmetries, depending on the vectorlike matter content, that protect the Peccei-Quinn symmetry to sufficiently high order to solve the strong CP problem. We study the axion couplings in this class of models. Models of this type that are automatically free of the domain wall problem require at least one pair of strongly interacting vectorlike multiplets with mass at the intermediate scale, and predict axion couplings that are greatly enhanced compared to the minimal supersymmetric DFSZ models, putting them within reach of proposed axion searches.

Primary author: BHATTIPROLU, Prudhvi (University of Michigan)

Presenter: BHATTIPROLU, Prudhvi (University of Michigan)

Session Classification: Parallel

Contribution ID: **117** Type: **not specified**

Inelastic deexcitation of the Hoyle state

Wednesday, 8 June 2022 13:30 (30 minutes)

A recent experiment has resolved the 55-year old question of the cross section for nucleon induced inelastic deexcitation of the Hoyle state, a path parallel to EM decay. The experiment deployed the TAMU active target time-projection chamber and used quasi mono-energetic neutrons from the Edwards Accelerator Laboratory (EAL) at Ohio University. The experimental logic uses detailed balance, the replacement of (n,n') with (n,"Y") where the detection of "Y"means the decay of the Hoyle state to three alphas through 8Be, and a multichannel R-matrix analysis. Because the inelastic deexcitation cross section increases slowly above threshold, for this mechanism to be relevant for the production of stable 12C, the astrophysical site must have T > 109 K as well as have high alpha and neutron densities.

Primary author: SOBOTKA, Lee

Presenter: SOBOTKA, Lee

Session Classification: Parallel

Contribution ID: **118** Type: **not specified**

Novel Manifestations of Primordial Black Holes

Tuesday, 7 June 2022 17:30 (30 minutes)

Primordial black holes constitute an attractive dark matter candidate. I will discuss several new observational signatures for primordial black holes spanning orders of magnitude in mass, connecting them to gravitational wave and multi-messenger astronomy as well as long-standing astrophysical puzzles such as the origin of heavy elements.

Primary author: TAKHISTOV, Volodymyr

Presenter: TAKHISTOV, Volodymyr

Session Classification: Parallel

Contribution ID: **119** Type: **not specified**

Exploring Fundamental Physics with Atmospheric Collider

Wednesday, 8 June 2022 14:00 (15 minutes)

Cosmic rays colliding with the atmosphere have historically played a central role in exploration of neutrinos, leading to discovery of neutrino oscillations with Super-Kamiokande experiment. As I will show, the ''atmospheric collider" offers unprecedented novel opportunities for exploration of fundamental physics. I will present leading new searches for magnetic monopoles, as well as promising targets for millicharge particles and dark matter.

Primary author: TAKHISTOV, Volodymyr (Kavli IPMU, U. Tokyo)

Presenter: TAKHISTOV, Volodymyr (Kavli IPMU, U. Tokyo)

Session Classification: Parallel

Contribution ID: **120** Type: **not specified**

Observable proton decay in Flipped SU(5)

Tuesday, 7 June 2022 15:45 (15 minutes)

We explore proton decay in a class of realistic supersymmetric flipped $SU(5)$ models supplemented by a $U(1)_R$ symmetry which plays an essential role in implementing hybrid inflation. Two distinct neutrino mass models, based on inverse seesaw and type I seesaw, are identified, with the latter arising from the breaking of $U(1)_R$ by nonrenormalizable superpotential terms. Depending on the neutrino mass model an appropriate set of intermediate scale color triplets from the Higgs superfields play a key role in proton decay channels that include $p^+ \to (e^+, \mu^+)\,\pi^0$, $p^+ \to (e^+, \mu^+)\,K^0$, $p^+ \to \overline{\nu}\,\pi^+$, and $p^+ \to \overline{\nu}\,K^+$. We identify regions of the parameter space that yield proton lifetime estimates which are testable at Hyper-Kamiokande and other next generation experiments. We discuss how gauge coupling unification in the presence of intermediate scale particles is realized, and a Z_4 symmetry is utilized to show how such intermediate scales can arise in flipped SU(5). Finally, we compare our predictions for proton decay with previous work based on SU(5) and flipped SU(5).

Primary author: MEHMOOD, Maria (Quaid-i-Azam University, Islamabad, Pakistan)

Co-authors: Dr UR REHMAN, Mansoor (Quaid i Azam University Islamabad); Prof. SHAFI, Qaiser (University of Delaware)

Presenter: MEHMOOD, Maria (Quaid-i-Azam University, Islamabad, Pakistan)

Session Classification: Parallel

Contribution ID: **121** Type: **not specified**

New Results from the Majorana Demonstrator

Wednesday, 8 June 2022 14:00 (15 minutes)

The MAJORANA DEMONSTRATOR neutrinoless double-beta decay ($0\nu\beta\beta$) search experiment comprises a 44 kg (29.7 kg enriched to 88\% in ^{76}Ge) array of p-type, point-contact germanium detectors. During its main data taking period from 2015 to 2021, MAJORANA reached an exposure of ∼65 kg-y before the removal of the enriched detectors. The MAJORANA DEMONSTRATOR continues to operate with 14.3˜kg of natural germanium detectors in a single module for background studies and other rare-event searches, after the enriched detectors were removed for deployment in the 200 kg phase of the Large Enriched Germanium Experiment for Neutrinoless $\beta\beta$ Decay (LEGEND-200). In this talk, we present new results from the MAJORANA DEMONSTRATOR on its $0\nu\beta\beta$ decay search in addition to various physics topics including solar axions, bosonic dark matter, test of wavefunction collapse, and more physics beyond the Standard Model. We also discuss excellent performance of the MAJORANA detectors enabling these searches, including low energy threshold, unparalleled energy resolution approaching 0.1% FWHM at the $0\nu\beta\beta$ Q-value, and its ultralow background achieved by the use of ultraclean materials in a deep underground laboratory with pulse-shape discrimination capabilities. In addition, we discuss ongoing progresses of background modelling, which is informing the next-generation LEGEND experiment.

Primary author: KIM, In Wook

Presenter: KIM, In Wook

Session Classification: Parallel

Contribution ID: **122** Type: **not specified**

Gravitational Waves from Early Universe Turbulent Sources at the QCD Scale

Wednesday, 8 June 2022 14:30 (15 minutes)

Gravitational waves (GWs) may be sourced by hydrodynamic and hydromagnetic turbulence generated in cosmological phase transitions such as that at the quantum-chromodynamic (QCD) scale. I will discuss the results of numerical simulations of GWs from the QCD scale induced by various models of primordial turbulence and considering new limits on the turbulent energies which properly account for the decaying nature of the turbulent sources. I will show that the efficiency of GW production and the GW energy spectra depend strongly on the nature of the turbulence and that the new BBN bounds allow for stronger GW signals than previously expected. I will address the prospects for detecting these GW signals from the QCD scale through pulsar timing arrays (particularly in regard to the possible detection of a GW background by the NANOGrav Collaboration) and astrometric missions (such as GAIA).

Primary authors: CLARKE, Emma; Dr KAHNIASHVILI, Tina (Carnegie Mellon University); Dr BRANDENBURG, Axel (Nordita)

Co-authors: STEPP, Jonathan (Carnegie Mellon University); HE, Yutong (Nordita, Stockholm University)

Presenter: CLARKE, Emma

Session Classification: Parallel

Contribution ID: **123** Type: **not specified**

Heavy Neutral Lepton Searches at the Electron-Ion Collider

Tuesday, 7 June 2022 16:15 (15 minutes)

We consider the model of heavy neutral leptons (HNLs) as an example to explore the potential of new physics searches at the Electron-Ion Collider (EIC). We propose two broad categories of search strategies depending on the HNL lifetime: direct searches for the prompt decay of HNLs with a short lifetime and displaced vertex searches for long-lived ones. After identifying the most promising signals and the corresponding backgrounds, we perform a detailed simulation to estimate the sensitivity of the EIC to HNLs, accounting for detector thresholds, resolutions, and geometric acceptance. We derive projections for the EIC reach to the HNL squared mixing angle as a function of the HNL mass under the electron flavor mixing dominance hypothesis. Our findings indicate that the EIC can provide comparable sensitivity to the existing constraints for the prompt searches, while the displaced vertex searches can cover substantial new ground for HNLs in the 1-10 GeV mass range. Our proposed strategies are generally applicable to other new physics scenarios as well and motivate additional phenomenological exploration and dedicated future searches at the EIC.

Primary author: XIE, Keping (University of Pittsburgh)

Presenter: XIE, Keping (University of Pittsburgh)

Session Classification: Parallel

Contribution ID: **124** Type: **not specified**

Cosmological collider signatures of massive gauge bosons

Tuesday, 7 June 2022 17:00 (15 minutes)

The inflationary universe could be an interesting testbed of beyond the Standard Model theories at energies far above the reach of terrestrial colliders. In this talk, I will discuss the production of massive $U(1)$ gauge bosons during inflation and show that it leaves characteristic signatures in CMB spectrum and creates gravitational waves detectable at LIGO/LISA interferometers. I will also talk about the prospect of detecting nongaussianity and parity violation in these signals.

Primary author: RAHAT, Moinul

Presenter: RAHAT, Moinul

Session Classification: Parallel

Contribution ID: **126** Type: **not specified**

Effects of a Hidden Sector On the Matter Power Spectrum

Tuesday, 7 June 2022 17:15 (15 minutes)

Effects of A Hidden Sector on the Matter Power Spectrum

The absence of dark matter signals in direct detection experiments and collider searches has prompted interest in models in which dark matter belongs to a hidden sector minimally coupled to the Standard Model. In these scenarios, a long-lived massive particle might come to dominate the energy density of the early universe temporarily, causing an early matter-dominated era (EMDE) prior to the onset of nucleosynthesis. During an EMDE, matter perturbations grow more rapidly than they would in a period of radiation domination, which leads to the formation of microhalos much earlier than they would in standard cosmological scenarios. These microhalos generate detectable dark matter annihilation signatures, but the observational constraints on these signatures are highly sensitive to the small-scale cut-off in the matter power spectrum. We discuss the effects of an EMDE on the matter power spectrum, focusing on cases where the dark matter belongs to a hidden sector. In this scenario, the particle that dominates the Universe during the EMDE was initially relativistic, and the small-scale cut-off in the power spectrum is set by its pressure support. We relate the resulting cut-off scale to the particle mass and discuss how the properties of the hidden sector relate to the dark matter annihilation signal in these cases.

Primary author: GANJOO, Himanish (North Carolina State University)

Co-authors: MACK, Katherine (North Carolina State University); ERICKCEK, Adrienne (University of North Carolina at Chapel Hill); LIN, Weikang (Tsinghua University)

Presenter: GANJOO, Himanish (North Carolina State University)

Session Classification: Parallel

Contribution ID: **127** Type: **not specified**

Machine-Learning quantum entanglement with top quark pair production at the LHC

Tuesday, 7 June 2022 16:00 (15 minutes)

The top quark spin information is highly correlated with the final state lepton polarization, making the dileptonic $t\bar{t}$ events good candidates to study quantum entanglement at the LHC. The $t\bar{t}$ momentum reconstruction is a key ingredient to accurately assessing such measurements. We will be comparing the strengths and weaknesses of different top-quark momentum reconstruction methods. We will then discuss a necessary and sufficient condition to define entanglement for the dileptonic $t\bar{t}$ events, and compare the reconstructed entanglement information.

Primary author: DONG, Zhongtian (University of Kansas)

Co-authors: KONG, K.C.; GONÇALVES, Dorival (Oklahoma State University); NAVARRO SERRATOS, Alberto

Presenter: DONG, Zhongtian (University of Kansas)

Session Classification: Parallel

Contribution ID: **128** Type: **not specified**

Probing dark sectors with proton bremsstrahlung

Tuesday, 7 June 2022 17:45 (15 minutes)

Experiments using proton beams at high luminosity colliders and fixed-target facilities provide impressive sensitivity to new light weakly coupled degrees of freedom. We revisit the production of dark vectors and scalars via proton bremsstrahlung for a range of beam energies, including those relevant for the proposed Forward Physics Facility (FPF) at the High Luminosity LHC, and upgraded beamlines at Fermilab. In addition, we extend the application of proton bremsstrahlung to other long-lived dark sectors such as axion-like particles (ALPs) with gluon coupling and millicharged particles. In another direction, we utilize the significant neutrino flux in the forward direction at the LHC to study the electromagnetic properties of neutrinos, which serve as a probe to new physics beyond the Standard Model. In particular, we set stringent constraints on the magnetic moment, millicharge, and charge radius of tau neutrinos.

Primary author: FOROUGHI-ABARI, Saeid (University of Victoria)

Co-author: RITZ, Adam

Presenter: FOROUGHI-ABARI, Saeid (University of Victoria)

Session Classification: Parallel

Contribution ID: **129** Type: **not specified**

Projective Geometry, Dark Matter Halos, and Supermassive Black Holes

Wednesday, 8 June 2022 16:15 (15 minutes)

The Thomas-Whitehead projective gravity theory has its origins in string theory. There is an identified correspondence between the coadjoint elements of the Virasoro algebra and Sturm-Liouville operators. This identification of the projective structure in one dimension allows for relating the Virasoro algebra and projective geometry in higher dimensions. The coadjoint orbits of Virasoro algebra promote the existence of an associated "gauge" field, the diffeomorphism field D. We've examined how the Thomas Whitehead projective connection can be used to form a curvature tensor, that is then used to build an action for Thomas Whitehead projective gravity. The fields Pi and D of the Thomas-Whitehead connection source gravitation through an associated energy momentum tensor.
The Pi and Diffeomorphism fields may provide a source for the supermassive black hole; additionally they should modify the Schwarzschild and Kerr solutions for their respective symmetries. We propose to investigate this possibility the energy momentum tensor contributions from the emanated Pi and D fields corresponding to supermassive black hole solutions could supply the dark matter contribution to galaxy rotation curves.

Primary author: GROVER, Tyler (The University of Iowa)

Presenter: GROVER, Tyler (The University of Iowa)

Session Classification: Parallel

Contribution ID: **130** Type: **not specified**

Projective Invariance as the Foundational Principle Beneath Dark Energy and Inflation

Wednesday, 8 June 2022 15:45 (15 minutes)

We review the foundational aspects of the newly developed projectively invariant Thomas-Whitehead (TW) model of gravity. This model is an extension of Einstein-Hilbert Gravity, endowed with projective invariance. The importance of projective invariance to gravitation has deep roots in string theory, which we briefly discuss. We demonstrate how dark energy and an inflaton field naturally emerge from TW gravity and explore the possibilities of connections between the two.

Primary author: STIFFLER, Kory

Co-authors: CHAFAMO, Biruk; BAVOR, Calvin; WHITING, Catherine (Colorado Mesa University); HEITRITTER, Kenneth (University of Iowa); ABDULLAH, Muhammad; KALIM, Muhammad Hamza; Dr BRENSINGER, Samuel (University of Dayton); RODGERS, Vincent; JIANG, Xiaole

Presenter: STIFFLER, Kory

Session Classification: Parallel

Contribution ID: **131** Type: **not specified**

Scattering Amplitudes and Unitarity for Gravitationally Mediated Dark Matter in Extra Dimensions

Wednesday, 8 June 2022 16:00 (15 minutes)

Interactions of Dark Matter with the Standard Model may be mediated through gravitons alone. While this coupling is Planck suppressed in 4 dimensions, in extra dimensional models the coupling can be large and dark matter can be wimp like. Calculating amplitudes for the annihilation of Dark Matter to a tower of massive spin-2 particles in such models is challenging. As a first step, we examine the behavior of amplitudes in a warped extra dimensional model, derive sum rules to show how the apparent bad high energy behavior is curbed and discuss implications for unitarity in such models.

Primary author: MOHAN, Kirtimaan

Co-authors: CHIVUKULA, R. Sekhar (UC San Diego); SIMMONS, Elizabeth (University of California, San Diego); SENGUPTA, Dipan (UC San Diego); FOREN, Dennis (Michigan State University)

Presenter: MOHAN, Kirtimaan

Session Classification: Parallel

Contribution ID: **132** Type: **not specified**

Vector Boson Dark Matter From Trinification

Wednesday, 8 June 2022 16:15 (15 minutes)

We show how trinification models based on the gauge group $SU(3)_C \times SU(3)_L \times SU(3)_R$ realized near the TeV scale can provide naturally a variety of dark matter (DM) candidates. These models contain a discrete T parity which may remain unbroken even after spontaneous symmetry breaking. The lightest T-odd particle, which could be a fermion, a scalar, or a gauge boson, can constitute the dark matter of the universe. This framework naturally admits a doublet-singlet fermionic DM, a singlet scalar DM, or a vector boson DM. Here we develop the vector boson DM scenario wherein the DM couples off-diagonally with the usual fermions and vector-like fermions present in the theory. We show consistency of this framework with dark matter relic abundance and direct detection limits as well as LHC constraints. We derive upper limits of 900 GeV on the vector gauge boson DM mass and 4.5 TeV on the vector-like quark masses. We also show the consistency of spontaneous gauge symmetry breaking down to Standard Model times an extra $U(1)$ while preserving the T-parity.

Primary authors: THAPA, Anil (University of Virginia); BABU, Kaladi; JANA, Sudip (Max-Planck--Institut für Kernphysik)

Presenter: THAPA, Anil (University of Virginia)

Session Classification: Parallel

Contribution ID: **133** Type: **not specified**

Fermion masses and mixings in 3HDM with S_3 flavor symmetry

Tuesday, 7 June 2022 17:15 (15 minutes)

We investigate the Yukawa and the scalar sectors of a general S_3-symmetric three-Higgs doublet model.Assuming that the quarks and leptons belong to 2+1 dimensional representations of S3, we obtain consistent fits to quark and lepton masses and mixings, including neutrino oscillations. We analyze the stability of the Higgs potential as well as perturbative unitarity constraints on the couplings. We explore the lowest allowed heavy Higgs boson mass in this framework, consistent with FCNC and neutron EDM constraints and find it to be in the few TeV range.

Primary authors: BABU, Kaladi; XU, Shiyuan; WU, Yongcheng (Oklahoma State University)

Presenter: XU, Shiyuan

Session Classification: Parallel

Contribution ID: **134** Type: **not specified**

W boson mass, dark matter and $(g-2)_\ell$ in the ScotoZee neutrino mass model

Tuesday, 7 June 2022 16:15 (15 minutes)

In the light of recent experimental results confirming a 4.2σ discrepancy in the measurement of $(g-2)_\mu$ and a possible 7σ excess in the W boson mass, we propose a simple charged singlet extension of the Scotogenic model, the ScotoZee model, to investigate these anomalies while establishing a direct correlation with the neutrino oscillation data as well as the observed relic abundance. The singlet scalar not only gives corrections to the anomalous magnetic moment of muon (and electron) but also serves as a portal to provide the correct relic density from the fermionic dark matter (DM) candidate naturally admitted by the model. We also study the aforementioned anomalies in the context of scalar dark matter and show that although the CDF measurement of W boson mass shift disfavors the scalar DM candidates in the simple Scotogenic model/IDM, the mixing of the charged singlet scalar evades this complication in our model. We show the consistency of this framework involving both scalar and fermionic dark matter candidates while satisfying constraints from charged lepton flavor violation, direct detection as well as existing collider constraints. Furthermore, the model gives predictions for the lepton flavor violating processes, $\tau \to \ell\gamma$, testable in upcoming experiments.

Primary authors: THAPA, Anil (University of Virginia); DCRUZ, Ritu (Oklahoma State University)

Presenter: DCRUZ, Ritu (Oklahoma State University)

Session Classification: Parallel

Contribution ID: **135** Type: **not specified**

The dark side of neutrinos

Wednesday, 8 June 2022 14:45 (15 minutes)

We carry out a systematic investigation for minimal Scotogenic models based on a dark $U(1)_D$ gauge symmetry, in which the neutrino masses are induced at the one-loop level and include a chiral dark matter (DM) candidate. Assuming this $U(1)_D$ gauge symmetry is broken by only one Higgs singlet scalar that also generates masses to all dark fermions, we analyze the stability of the DM candidate which is ensured by a residual symmetry of U(1)_D gauge symmetry.
There can be different DM scenarios explored in this framework and we investigate the associated scalar and fermonic DM phenomenology of one of the minimal models.

Primary authors: BABU, Kaladi; CHAKDAR, Shreyashi; PADMANABHAN KOVILAKAM, vishnupk

Presenter: CHAKDAR, Shreyashi

Session Classification: Parallel

Contribution ID: **136** Type: **not specified**

Searching for Ultra-light Bosons with Stellar Tidal Disruption Events

Wednesday, 8 June 2022 16:15 (15 minutes)

Stars that pass close to the supermassive black holes located in the center of galaxies can be violently disrupted by tidal forces, leading to flares that are observed as bright transient events in sky surveys. The rate for these events to occur depends on the black hole spins, which in turn can be affected by ultra-light bosons due to superradiance. In this talk, I will show that searches for stellar tidal disruptions have a significant potential to uncover the existence of ultra-light bosons. In particular, we find that upcoming stellar tidal disruption rate measurements by LSST can be used to either discover or rule out bosons with masses ranging from 10^{-20} to 10^{-18} eV.

Primary authors: EGANA-UGRINOVIC, Daniel (Perimeter Institute); FRAGIONE, Giacomo (Northwestern University); DU, Peizhi (Stony Brook University); PERNA, Rosalba (U); ESSIG, Rouven

Presenter: DU, Peizhi (Stony Brook University)

Session Classification: Parallel

Contribution ID: **137** Type: **not specified**

Baryon Number Violation in Neutron Stars

Tuesday, 7 June 2022 15:30 (15 minutes)

Baryon number violation (BNV) has been motivated by and studied in various extensions to the Standard Model. Observation of BNV in experiments would be a clear indication of new physics, which has not occurred so far. The high baryon density in neutron stars may enhance the rates of baryon number violating processes beyond those possible in terrestrial settings. Therefore, it is important to analyze the generic consequences of such processes in neutron stars. I will discuss the BNV effects on neutron stars and their observational signatures, noting, e.g., how binary pulsar period measurements can be used to constrain BNV rates.

Primary authors: BERRYMAN, Jeffrey (University of California, Berkeley); ZAKERI, Mohammadreza (University of Kentucky); GARDNER, Susan (University of Kentucky)

Presenter: ZAKERI, Mohammadreza (University of Kentucky)

Session Classification: Parallel

Contribution ID: **138** Type: **not specified**

Gravitational Wave Pathway for Testable Leptogenesis

Wednesday, 8 June 2022 16:30 (15 minutes)

In this article, we have reanalysed the classically scale-invariant $B - L$ model in the context of Leptogenesis using the {\it Mass-Gain} mechanism coined by Blades {\it et. al.}. We have found a very close intimate correlation between the scale of breaking and the Mass of Right Handed Neutrinos (RHNs) and have found for the first time probing high scale leptogenesis scale via near future Gravitational-Wave experiments.

Primary authors: DASGUPTA, Arnab (PITT-PACC); DEV, Bhupal (Washington University in St. Louis); GHOSHAL, Anish (University of Warsaw, Poland); MAZUMDAR, Anupam (Groningen University)

Presenter: DASGUPTA, Arnab (PITT-PACC)

Session Classification: Parallel

Contribution ID: **139** Type: **not specified**

Overview of nEXO neutrinoless double beta decay experiment

Wednesday, 8 June 2022 14:30 (15 minutes)

nEXO is a next-generation 5 tonne homogeneous liquid xenon time projection chamber(TPC) which seeks to detect neutrinoless double beta decay($0\nu\beta\beta$) decay in ^{136}Xe. The experiment will use the combination of scintillation and ionization signals to reconstruct events with an energy resolution of $<1\%$ σ/E at the $0\nu\beta\beta$ Q-value of 2.5MeV. It is projected to reach $0\nu\beta\beta$ half life sensitivity of 1.35×10^{28}yr in 10 years of data taking which will provide a search for lepton number violating processes with 2 orders of magnitude higher sensitivity than existing experiments.Active R&D is ongoing to optimize the design of nEXO, minimize its residual radioactivity budget and optimize novel ionization charge and scintillation light readout techniques. In this talk I will give an overview of the experiment and cover about recent R&D work by nEXO-Collaboration for nEXO design.

Primary author: GAUTAM, Prakash

Presenter: GAUTAM, Prakash

Session Classification: Parallel

Contribution ID: **140** Type: **not specified**

Correlating W-Boson Mass Shift with Muon $g-2$ Anomaly in the 2HDM

Tuesday, 7 June 2022 16:30 (15 minutes)

In this talk, I shall describe how the recent high precision measurement of the W-boson mass by the CDF collaboration and the muon $(g-2)$ anomaly are correlated in the context of the two Higgs doublet model. The charged and neutral scalars of the model cannot be heavier than about 600 GeV for a simultaneous explanation of the two anomalies. The entire parameter space of the model can be tested at the LHC by a combination of same sign dimuon signals in $pp \to (\mu^+\mu^+jj + \not{E}_T)$ and $pp \to (\mu^+\mu^-\tau^+\tau^- + X)$ signals.

Primary authors: Prof. BABU, Kaladi (Oklahoma State University); Dr JANA, Sudip (Max--Planck-Institut für Kernphysik); PADMANABHAN KOVILAKAM, Vishnu (Oklahoma State University)

Presenter: PADMANABHAN KOVILAKAM, Vishnu (Oklahoma State University)

Session Classification: Parallel

Contribution ID: **141** Type: **not specified**

The Radio Neutrino Observatory - Greenland (RNO-G) Experiment

Wednesday, 8 June 2022 13:30 (15 minutes)

The Radio Neutrino Observatory - Greenland (RNO-G) seeks to detect the Askaryan radio emission from energetic neutrinos (> 10 PeV) interacting in the Greenland ice sheet. Initial deployment began last summer, and, at completion, RNO-G will be the largest and most sensitive in-ice Askaryan radio neutrino detector so far, providing access to new parameter space in astrophysical and cosmogenic neutrino fluxes.

This talk will discuss the science motivation, design and current status of RNO-G, as well as describe the initial performance of the first stations.

Primary author: DEACONU, Cosmin

Presenter: DEACONU, Cosmin

Session Classification: Parallel

Contribution ID: **142** Type: **not specified**

Toponium at the LHC

Tuesday, 7 June 2022 15:30 (15 minutes)

Measurements of the dileptonic $t\bar{t}$ events at the LHC found excesses over the SM simulations at small azimuthal angle separation and small invariant mass region. We examine the possibility of those excesses as consequences of non-perturbative enhancement of the $t\bar{t}$ production cross section near the threshold. While sub-dominant in terms of total rates, so-far neglected toponium effects yield additional $t\bar{t}$ pairs in color and spin singlet, giving rise to dileptons with small invariant mass and small azimuthal angle separation. This could contribute to the above-mentioned deviations from the present event simulation that accounts only for perturbative corrections. We propose a method to discover toponium in present and future data, which should improve the precision measurement of the top quark mass at the LHC.

Primary authors: FUKS, Benjamin; MA, Kai; HAGIWARA, Kaoru; ZHENG, Ya-Juan

Presenter: ZHENG, Ya-Juan

Session Classification: Parallel

Contribution ID: **143** Type: **not specified**

The Neutron Electric Dipole Moment Experiment at Oak Ridge National

Wednesday, 8 June 2022 14:45 (15 minutes)

The search for additional CP-violating interactions generated by BSM physics motivates a strong experimental effort to measure the neutron electric dipole moment (nEDM). The nEDM@SNS experiment planned at the Spallation Neutron Source at Oak Ridge National Laboratory aims to achieve a sensitivity of $2—3\times10^{-28}$ e-cm, an improvement upon the current limit of $1x10^{-26}$ e-cm. This is accomplished through a novel combination of ultracold neutrons (UCNs) and a controlled, dilute mixture of superfluid ^{4}He with spin polarized ^{3}He. This talk will give a summary of the experiment and planned measurements of the ^{3}He diffusion constant inside the superfluid – useful for the design of nEDM@SNS as well as other UCN experiments.

Primary authors: ERICKSON, Cameron Blake (University of Illinois at Urbana Champaign); NEDM@SNS COLLABORATION

Presenter: ERICKSON, Cameron Blake (University of Illinois at Urbana Champaign)

Session Classification: Parallel

Contribution ID: **144** Type: **not specified**

Cp Violating Top Yukawa at the Multi TeV Muon Collider

Tuesday, 7 June 2022 15:45 (15 minutes)

The project proposes a search for a new source of CP Violation by studying a CP Violating Top Yukawa. The study is conducted through muon collisions at the proposed muon collider. Signal processes include tth, $tth\nu\nu$, and $tbh\mu\nu$ decaying semi-leptonically. Cross section dependence of signal processes with $\sqrt{s}$ and cross section dependence with varying CP-phase, α, at benchmark $\sqrt{s}$ are presented. Luminosity required for 5σ discovery and 2σ exclusion for different α are shown. Projected bounds on α at 95% CL are presented given the Standard Model case, α = 0, at benchmark $\sqrt{s}$ for a muon collider.

Primary author: CASSIDY, Morgan (University of Washington (US))

Co-authors: LEWIS, Ian; DONG, Zhongtian; KONG, Kyoungchul; ZHANG, Yanzhe; ZHENG, Yajuan

Presenter: CASSIDY, Morgan (University of Washington (US))

Session Classification: Parallel

Contribution ID: **145** Type: **not specified**

Analytic Approximations for the Velocity Suppression of Dark Matter Capture

Tuesday, 7 June 2022 17:00 (15 minutes)

Dark matter (DM) characteristics can be explored via indirect detection through the observations of astrophysical objects which have captured DM. In this paper we analyze the role of stellar velocity on multiscatter DM capture rates. The addition of the stellar velocity with respect to its surrounding DM halo induces a suppression of this capture rate. We develop and validate an analytical representation of this suppression factor. It can be used to easily and directly re-scale previously-obtained bounds on the DM-nucleon cross section provided only with a stellar velocity. We demonstrate this using Population III (Pop III) stars, which are interesting candidates to study DM, as they would form and exist in high DM density environments and at high redshifts. We find that previous constraints for the DM-nucleon cross section using Pop III stars are essentially unchanged when accounting for the possibility of stellar velocities.

Primary authors: ILIE, Cosmin (Colgate University); PAULIN, Jillian (Colgate University)

Presenter: PAULIN, Jillian (Colgate University)

Session Classification: Parallel

Contribution ID: **146** Type: **not specified**

Kaluza-Klein Portal Matter

Tuesday, 7 June 2022 17:30 (15 minutes)

In models of thermal dark matter with MeV-GeV masses, a common simplified construction relies on a U(1) dark sector (and corresponding dark photon of MeV-GeV mass) which kinetically mixes with the Standard Model (SM) hypercharge to serve as a mediator to achieve the observed relic abundance. This kinetic mixing will arise at one-loop order if the theory includes so-called "portal matter"– heavy particles charged under both the dark gauge group and the SM hypercharge. It has been previously argued that if the portal matter is assumed to be fermionic, then phenomenological and theoretical concerns suggest that these portal matter fields will be vector-like copies of SM particles, albeit with additional charge under the dark gauge group, and should have a delicate cancellation of charges such that the resulting kinetic mixing is both finite and calculable. In this talk, we shall argue that extra dimensions present a natural framework in which to realize phenomenologically and theoretically satisfactory fermionic portal matter– if the dark U(1) gauge group is embedded in a larger Lie group that is broken by boundary conditions on the branes, then portal matter will naturally arise as massive Kaluza-Klein states if SM fermions are embedded in dark multiplets in the bulk. To demonstrate, we present a semi-realistic toy model with a single TeV-scale flat extra dimension, discussing the collider phenomenology of this setup and how the inclusion of a portal matter sector would alter the familiar phenomenological constraints on such 5D theories.

Primary author: WOJCIK, GEORGE

Presenter: WOJCIK, GEORGE

Session Classification: Parallel

Contribution ID: **147** Type: **not specified**

Stasis in an Expanding Universe: A Recipe for Stable Mixed-Component Cosmological Eras

Wednesday, 8 June 2022 16:30 (15 minutes)

One signature of an expanding universe is the time-variation of the cosmological abundances of its different components. For example, a radiation-dominated universe inevitably gives way to a matter-dominated universe, and critical moments such as matter-radiation equality are fleeting. In this talk, I shall demonstrate that this lore is not always correct. In particular, I shall show how a form of "stasis" can arise wherein the relative cosmological abundances of the different components remain unchanged over extended cosmological epochs, even as the universe expands. Moreover, I shall also demonstrate that such situations are not fine-tuned, but are in fact global attractors within certain cosmological frameworks, with the universe naturally evolving towards such long-lasting periods of stasis for a wide variety of initial conditions. I shall also discuss some of the implications of a stasis epoch for the evolution of primordial density perturbations and the growth of structure, for dark-matter production, and even for the age of the universe.

Primary author: THOMAS, Brooks

Co-authors: DIENES, Keith (University of Arizona); HEURTIER, Lucien (IPPP, Durham, England); HUANG, Fei (ITP CAS and UC Irvine); KIM, Doojin (Texas A & M University (US)); TAIT, Tim M.P. (University of California, Irvine)

Presenter: THOMAS, Brooks

Session Classification: Parallel

Contribution ID: **148** Type: **not specified**

Generative Adversarial Networks for Approximating the Chameleon Scalar Field

Wednesday, 8 June 2022 16:30 (15 minutes)

One of the main challenges in numerical cosmology is the difficulty of producing large scale, high resolution simulation data, especially when exploring novel cosmological models. Producing physical simulations on cosmological scales with enough detail to resolve galaxy-formation scale physics is very computationally expensive. In this work, I train a generative adversarial network (GAN) to quickly approximate the scalar field potential predicted by the theory of chameleon gravity, a possible dark energy candidate. The chameleon is a hypothetical scalar particle which has an effective mass that depends strongly on the local energy density, meaning that a fifth force mediated by such a particle would be small on Earth and large in low-density intergalactic regions. The dependence of the chameleon on the local density means it could be coupled to mass with a strength on the order of that of gravity, while remaining unseen so far in tests of the equivalence principle on Earth. A fast and accurate solver for this fifth force potential will allow the incorporation of the chameleon field into both large N-body simulations, as well as simulations of table-top fifth force experiments. After training a GAN on 2-dimensional chameleon field data produced using iterative matrix inversion, I find that the generative network is able to calculate the chameleon field from new initial mass distributions significantly faster than other computational methods, with a pixel to pixel error on the order of a few percent. With some tweaks, these results show a promising method for speeding up cosmological simulations including fifth force potentials, and possibly for directing future terrestrial experiments searching for evidence of the chameleon particle.

Primary author: CHARLES, William (Washington University in St. Louis)

Co-author: Dr MERTENS, James (Washington University in St. Louis)

Presenter: CHARLES, William (Washington University in St. Louis)

Session Classification: Parallel

Contribution ID: **149** Type: **not specified**

Cosmological Measurements of Light but Massive Relics

Cosmological data provide a powerful tool in the search for physics beyond the Standard Model (SM). An interesting target are light relics, new degrees of freedom which decoupled from the Standard Model while relativistic. Nearly massless relics contribute to the radiation energy budget, and are commonly searched through variations in the effective number $N_{\rm eff}$ of neutrino species. Additionally, relics with masses on the eV scale (meV-10 eV) become non-relativistic before today, and thus behave as matter instead of radiation. This leaves an imprint in the clustering of the large-scale structure of the universe, as light relics have important streaming motions, mirroring the case of massive neutrinos. Here we forecast how well current and upcoming cosmological surveys can probe light massive relics (LiMRs). We consider minimal extensions to the SM by both fermionic and bosonic relic degrees of freedom. By combining current and upcoming cosmic-microwave-background and large-scale-structure surveys, we forecast the significance at which each LiMR, with different masses and temperatures, can be detected.

Primary author: DEPORZIO, Nicholas

Presenter: DEPORZIO, Nicholas

Session Classification: Parallel

Contribution ID: **150** Type: **not specified**

Beyond Fisher Forecasting for Cosmology

Tuesday, 7 June 2022 15:30 (15 minutes)

As the quantity of cosmological data grows, it becomes increasingly important to be able to accurately forecast the constraints those data can place on cosmological models, so that instrumental and computational time and resources can be used most effectively. Fisher forecasting, which uses the Fisher Information Matrix (FIM) to approximate the (negative) log-likelihood of a given model, is a common approach. The advantage of Fisher forecasting is its speed and simplicity, but it carries the risk, in some cases, of producing over-simplified forecasts. In this talk, I will summarize some recent work that my colleagues and I have done to explore what kinds of forecasts would benefit from an approach that goes beyond the FIM by accounting for non-Gaussian correlations between cosmological model parameters. Additionally, I will describe a simple test that we have devised to determine when it is necessary to go beyond the FIM.

Primary author: RYAN, Joseph (Southern Methodist University)

Co-authors: Dr MEYERS, Joel (Southern Methodist University); Mr STEVENSON, Brandon (Southern Methodist University); Dr TRENDAFILOVA, Cynthia (Southern Methodist University)

Presenter: RYAN, Joseph (Southern Methodist University)

Session Classification: Parallel

Contribution ID: **151** Type: **not specified**

Gegenschein signal from an inhomogeneous axion dark matter distribution

Wednesday, 8 June 2022 16:30 (15 minutes)

Photons with a frequency equivalent to one-half of the axion mass can induce its decay into two photons. Half of the produced photons generate a potentially detectable 'gegenschein' radio signal traveling in the opposite direction. We take into account that, in addition to a smooth halo distribution, a fraction of the axionic dark matter might be in the form of compact objects known as axion stars. We discuss how, as a result, the gegenschein signal might be enhanced.

Presenter: OKAWA, Takuya

Session Classification: Parallel

Contribution ID: **152** Type: **not specified**

Theory Overview of Rare B-decays

Thursday, 9 June 2022 16:00 (30 minutes)

Presenter: MAHMOUDI, Nazila (CERN and Lyon University (FR))

Session Classification: Plenary XIII - Emerson Auditorium

Contribution ID: **153** Type: **not specified**

TBD

Session Classification: Plenary IV - Emerson Auditorium

Contribution ID: **154** Type: **not specified**

Weighing Neutrinos using Cosmology

Monday, 6 June 2022 12:00 (30 minutes)

Presenter: SAITO, Shun (Missouri University of Science and Technology)

Session Classification: Plenary II - Emerson Auditorium

Contribution ID: **155** Type: **not specified**

Gravitational Wave Probes of Dark Matter and Leptogenesis

Friday, 10 June 2022 11:30 (30 minutes)

Presenter: BORAH, Debasish (Indian Institute of Technology Guwahati)

Session Classification: Plenary XV - Emerson Auditorium