The Second International Conference on Axion Physics and Experiment (Axion 2023)

Report of Contributions

https://indico.itp.ac.cn/e/152

Contribution ID : **1** Type : **Online**

Lighting Electroweak-Violating ALP-Lepton Interactions at CEPC

A new type of four-point interaction, W-ℓ-ν-a, in an electroweak-violating scenario of axion-like particle (ALP) and lepton interactions plays a critical role in searching for ALPs from charged mesons and W boson decays because of the novel energy enhancements. Inspired by this interesting finding, we first proposed new t-channel processes for electrophilic ALPs (eALPs) which also involve W-ℓ-ν-a four-point interaction and have obvious energy enhancement behaviors in their cross sections when the collision energy is increasing. On the other hand, heavier eALPs mainly decay to a photon pair induced by the chiral anomaly instead of an electron-positron pair. Therefore, studies of these t-channel processes with a photon pair plus missing energy at CEPC open a new door to search for eALPs at high energy colliders. The proposed search strategies are not only aiming to generate a larger production rate of ALPs, but also trying to distinguish electroweak-violating ALP-lepton interactions from electroweak-preserving ones.

Primary author(s) : LU, Chih-Ting (Nanjing Normal University)

Presenter(s) : LU, Chih-Ting (Nanjing Normal University)

Contribution ID : **2** Type : **Online**

The Realistic Scattering of Puffy Dark Matter

If dark matter has a finite size, the intrinsic interaction responsible for the structure formation is inevitable from the perspective of dark matter self-scattering. To describe the circumstance in which the binding force realizes the finite size dark protons, we first use the Eikonal approximation to simplify the convoluted scattering between dark protons into the case at the $t = 0$ limit. The Chou-Yang model is then introduced to reduce the number of input parameters to one based on the simplicity and analyticity principle.
A new definition of velocity dependence and the corresponding implications on the small cosmological structures from Chou-Yang dark protons are shown clearly. Even though the parameter space is not fully covered, the numerical findings show that the amplitude coefficient can alter the self-scattering cross-section, allowing us to recover the excluded parameter space without using binding force. Finally, we demonstrate that the correct relic density from thermal freeze-out production prefers super heavy dark protons.
When the dark strong interaction is ignored, we present a comprehensive study on the self-interaction cross-section of puffy dark matter (DM) particles, which have a significant intrinsic size compared to their Compton wavelength.
For such puffy DM self-interaction cross-section in the resonant and classical regimes, our study demonstrates the significance of the Yukawa potential and the necessity of partial wave analysis:
(i) Due to the finite-size effect of puffy DM particles, the new Yukawa potential of puffy DM is found to enlarge the Born-effective regime for the self-interaction cross-section, compared with the point-like DM;
(ii) Our partial wave analysis shows that depending on the value of the ratio between R_χ (radius of a puffy DM particle) and $1/m_\phi$ (force range), the three regimes (Born-effective, resonant and classical) for puffy DM self-interaction cross-section can be very different from the point-like DM;
(iii) We find that to solve the small-scale anomalies via self-interacting puffy DM, the Born-effective and the resonant regimes exist for dwarf galaxies, while for the cluster and Milky Way galaxy the non-Born regime is necessary.

Primary author(s) : XU, Wu-Long (Beijing University of Technology)

Presenter(s) : XU, Wu-Long (Beijing University of Technology)

Contribution ID : **3** Type : **In person**

Investigation of the concurrent effects of ALP-photon and ALP-electron couplings in Collider and Beam Dump Searches

Axion-like particles (ALPs) have been studied in numerous experiments to search for their interactions, but most studies have focused on deriving bounds for the single coupling. However, in ultraviolet (UV) models, these couplings can appear simultaneously, and their interplay could have important implications for collider and beam dump searches. In this study, we investigate the concurrent effects of the ALP-photon and ALP-electron couplings in a simplified model and examine how their simultaneous presence modifies existing bounds. We find that modifications to production cross-sections, decaying branching ratios, and the lifetime of the ALP are the major effects. Our results show that low-energy electron-positron colliders such as Belle-II and BaBar are primarily affected by the first two factors, while beam dump experiments such as E137 and NA64 are affected by the cross sections and lifetime. We also consider two UV models - the KSVZ model and a lepton-specific version of the DFSZ model - which have only one of the two couplings at tree-level. However, the other coupling can be generated at loops, and our analysis reveals that the simultaneous presence of the two couplings can significantly modify existing bounds on these models for $10^{-3} < m_a < 10$ GeV, especially for beam dump experiments. Overall, our study highlights the importance of considering the concurrent effects of the ALP-photon and ALP-electron couplings in future collider and beam dump analyses.

Primary author(s) : LIU, Jia (Peking University); Mr LUO, Yan (Peking University); SONG, Muyuan (Peking University, CHEP)

Presenter(s) : SONG, Muyuan (Peking University, CHEP)

Contribution ID : **4** Type : **Online**

Astrophysical heating signals of axion and axion-like dark matter

I will show that axion and axion-like dark matter can inject heat to astrophysical environments. In particular, cold interstellar gas systems can lead to strong constraints on the photon and electron coupling of axion dark matter. In addition, ultralight axion-like dark matter can form granular structures that can also heat up interstellar gas.

Primary author(s) : WANG, Zihui

Presenter(s) : WANG, Zihui

Contribution ID : **5** Type : **In person**

Probing new physics at the FASER detector

In terms of quirk model and inelastic dark matter model, I will discuss the sensitivities of the FASER and FASER2 detectors.

Primary author(s) : Prof. LI, Jinmian (Sichuan University)

Presenter(s) : Prof. LI, Jinmian (Sichuan University)

Contribution ID : **6** Type : **In person**

Identifying axion conversion in compact star magnetospheres with radio-wave polarization signatures

Axion is well-motivated in physics. It solves the strong CP problem in fundamental physics and the dark matter problem in astronomy. Its interaction with electromagnetic field has been expected but never detected experimentally. Such particles may convert to radio waves in the environment with strong magnetic field. Inspired by the idea, various research groups have been working on theoretical modeling and radio data analysis to search for the signature of radio signal generated by the axion conversion in the magnetosphere of compact stars, where the surface magnetic field as strong as 1e13 to 1e14 G is expected. In this work we calculate the observational properties of the axion-induced radio signals (AIRSs) in the neutron star magnetosphere, where both the total intensity and polarization properties of radio emission are derived. Based on the ray tracing method, assuming 100% linear polarization of radio wave generated in each conversion, we compute the polarization emission profile concerning different viewing angles. We note that plasma and general relativistic effects are important for the polarization properties of AIRS. Our work suggests that AIRS can be identified by the narrow bandwidth and distinct polarization features.

Primary author(s) : XUE, Zihan (Peking University)

Co-author(s) : Prof. LEE, K. J. (Peking University); Prof. GAO, X. D. (Beijing University of Technology); Prof. XU, R. X. (Peking University)

Presenter(s) : XUE, Zihan (Peking University)

Contribution ID : **7** Type : **In person**

Dark SHINE——a new initiative to search for light dark matter at SHINE facility

Dark SHINE is a newly proposed fixed-target experiment at SHINE (Shanghai high repetition rate XFEL and extreme light facility, being the 1st hard X-ray FEL in China) under construction targeting completion in 2026. Dark SHINE aims to search for the new mediator, Dark Photon, bridging the Dark sector and the ordinary matter. In this work and presentation, we present the idea of this new project and 1st prospective study in search for Dark Photon decaying into light dark matter. It also provides the opportunity to incorporate broader scope of BSM search ideas such as ALP, utilizing the fixed-target experiment of this type.

Primary author(s) : LI, Shu (Tsung-Dao Lee Institute & Shanghai Jiao Tong University)

Presenter(s) : LI, Shu (Tsung-Dao Lee Institute & Shanghai Jiao Tong University)

Contribution ID : **9** Type : **In person**

Imprints of ultralight axions on the gravitational wave and pulsar timing measurement

We study the new observational effects of ultralight axion-like particles by the space-borne gravitational wave detector and the radio telescope. Taking the neutron star-black hole binary as an example, we demonstrate that the gravitational waveform could be obviously modified by the slow depletion of the axion cloud around the black hole formed through the superradiance process. We compare these new effects on the binary with the well-studied effects from dynamical friction with dark matter and dipole radiation in model-independent ways. Finally, we discuss the constraints from LIGO/Virgo and study the detectability of the ultralight axion particles at LISA and TianQin.

Primary author(s) : HUANG, Fa Peng (Sun Yat-sen University)

Presenter(s) : HUANG, Fa Peng (Sun Yat-sen University)

Contribution ID : **10** Type : **In person**

Electromagnetic responses of the axions in a high magnetic field with high-frequency modulations

It is believed that axion is one of the natural candidates of the cold dark matters and will play the key role to solve the strong CP problem in standard model. However, the existence of the axion has not been verified, until now, although a series of experiments have been developed to probe its possible response. Focusing on the possible electromagnetic response of the axion in a laboratory high stationary magnetic field, basing on the Sikivie effect [1], here we propose an approach to amplify such a response by introducing a high-frequency modulated magnetic field. For the simplicity, we first consider here a toy model [2], i.e., the electromagnetic responses of the axions passing vertically through a one-dimensional high stationary magnetic field superposed by an alternating magnetic field along the same direction, and show that the intensity of the resonant electromagnetic response of the axions could be amplified by at least 2 orders of magnitude, compared with that in the usual stationary high magnetic field. Additionally, the non-resonant response signals could also be generated. The possibility of such a toy model being applied to the experimentally demonstrated three-dimensional cavity setups with only the high stationary magnetic field [3] is also discussed.

[1] P. Sikivie, Experimental Tests of the "Invisible" Axion, Phys. Rev. Lett. 51, 1415 (1983)
[2] Hao Zhang, et al., Electromagnetic responses of the axions in a high magnetic field with high-frequency modulation, to be
published.
[3] T. Braine et al. (ADMX Collaboration), Extended Search for the Invisible Axion with the Axion Dark Matter Experiment, Phys. Rev.
Lett. 124, 101303.

Primary author(s) : ZHANG, Hao; ZHAO, LingBo; ZHONG, ZhiJiang; HE, Wei; JIANG, Qingquan; LI, Jin; LI, Fangyu; WEI, L. F. (Southwest Jiaotong University)

Presenter(s) : WEI, L. F. (Southwest Jiaotong University)

Contribution ID : **11** Type : **In person**

Fractal Path Integrals and its Degeneration to Dimensional Regularization

In this work we study particles propagate in fractal paths and use fractal derivatives to extend the dynamic dimension of Quantum Field Theory. We construct the Lagrangian of fractal scalar, vector and spinor fields to obtain their propagators by path integral. Then we compute the typical tree level and one loop diagrams which correspond to QED cases. The calculations show the dimension dependence of amplitudes. Additionally, in one loop calculation we obtain results which are consistent with dimensional regularization as the dimension approaches to the Standard Model value. Therefore, the fractal path integrals can be regarded as an equivalent theoretical description for regularizing the divergence in the normal Quantum Field Theory. We also derive the equation of motion for scalar, vector and spinor particles propagate in fractal paths and discuss the corresponding local gauge symmetries.

Primary author(s) : WANG, Youkai (Shaanxi Normal University)

Presenter(s) : WANG, Youkai (Shaanxi Normal University)

Contribution ID : **12** Type : **Online**

Light mediator models

Light mediator models have recently garnered significant attention due to their testability in a range of current and upcoming low-energy experiments. These models offer explanations for anomalous experimental results, such as the muon's anomalous magnetic moments and the excess events observed in MiniBooNE. Additionally, certain light mediator models make compelling predictions for reactor neutrino experiments and dark matter direct detection experiments. In this talk, we will focus on a few specific models involving light scalar and vector mediator fields.

Primary author(s) : GHOSH, Sumit

Presenter(s) : GHOSH, Sumit

Contribution ID : **13** Type : **In person**

Phase Transition and Gravitational Wave in Strongly Coupled Dark Matter

We go beyond the state-of-the-art by combining first principal lattice results and effective field theory approaches as Polyakov Loop model to explore the non-perturbative dark deconfinement-confinement phase transition and the generation of gravitational-waves in a dark Yang-Mills theory. We further include fermions with different representations in the dark sector. Employing the Polyakov-Nambu-Jona-Lasinio (PNJL) model, we discover that the relevant gravitational wave signatures are highly dependent on the various representations. We also find a remarkable interplay between the deconfinement-confinement and chiral phase transitions. In both scenarios, the future Big Bang Observer and DECIGO experiment have a higher chance to detect the gravitational wave signals. In addition, we find that this effective field theory approach can be implemented to study the glueball dark matter production mechanism and for the first time provide a solid prediction of glueball dark matter abundance. Our prediction is an order of magnitude smaller than the existing glueball abundance results in the literature.

Primary author(s) : WANG, Zhiwei (UESTC)

Presenter(s) : WANG, Zhiwei (UESTC)

Contribution ID : **14** Type : **In person**

Axion potential-a solution to Higgs mass and gravitational wave signals

The axion potential is characterized by a slowly decaying potential with multiple periodic barriers due to non-perturbative effect. By controlling the motion of the axion(-like) field it could provide a natural solution to the Higgs mass. In this talk I will discuss the dynamics of vacuum annihilation and gravitational waves produced from the axion potential, providing a new test of the relaxion mechanism.

Primary author(s) : JIANG, Yun (Sun Yat-sen University)

Co-author(s) : Mr WEI, Dongdong (Sun Yat-sen University); Mr FAN, Qiqi (Sun Yat-sen University)

Presenter(s) : JIANG, Yun (Sun Yat-sen University)

Contribution ID : **16** Type : **In person**

Spin-based quantum sensing and its applications

Quantum sensing has greatly improved the measurement accuracy of physical quantities such as electromagnetic fields, rotation, time, and gravity, which has brought revolutionary means to many frontier sciences such as verifying basic physical laws. My talk first introduces our developed spin-based metrology for ultra-sensitive weak magnetic field measurement. The quantum sensing system is based on alkali metal and noble gas atoms, and both atomic systems achieve sensitivity at the fT level. In addition, I will also describe how to apply the developed magnetic-field measurement technology to zero-field nuclear magnetic resonance and dark matter searches. The developed zero-field nuclear magnetic resonance technology does not require any superconducting magnets and achieves high-resolution zero-field signals for dozens of chemicals, providing new means for material structure measurement. The direct evidence of dark matter existence can give us a better understanding of the composition and origin of cosmic matter, and may lead to a series of major breakthroughs in basic science. We have achieved the search for ultra-light dark matter particles (including axions and dark photons) with a mass range of 1-1000 feV, surpassing the currently recognized most stringent limit in astrophysics.

Primary author(s) : JIANG, Min (University of Science and Technology of China)

Presenter(s) : JIANG, Min (University of Science and Technology of China)

Contribution ID : **17** Type : **In person**

Axion Cavity at Quantum Level

We show that at the quantum level the single axion-photon conversion rate is enhanced by the cavity quality factor Q, and quantitatively larger than the classical result by a factor $\pi/2$. Thus, the axion cavity can be considered as a quantum device emitting single-photons with temporal separations. This differs from the classical picture in which axions transition in batches and the converted energy accumulates in the electromagnetic field inside the cavity.

Primary author(s) : YANG, Qiaoli (Jinan University)

Presenter(s) : YANG, Qiaoli (Jinan University)

Contribution ID : **18** Type : **In person**

Challenge in realizing de-Sitter space in large scale of Calabi-Yau compactifications

In this talk, I will discuss recent advances in string landscape and swampland. First, I will clarify various corrections in string compactifications and their implications in 4D N=1 SUGRA language. Next, I will focus on warping correction and parameter control issues in achieving de-Sitter space in both KKLT and Large Volume Scenarios. Finally, I will examine the feasibility of these constraints in large scale of Calabi-Yau compactifications, including construction of orientifold Calabi-Yau database and the use of Machine Learning techniques to create new geometries and find orientifold string vacua.

Primary author(s) : GAO, Xin (Sichuan University)

Presenter(s) : GAO, Xin (Sichuan University)

Contribution ID : **20** Type : **In person**

Gaugino masses from misaligned supersymmetry breaking and R-symmetry breaking spurions

In gauge mediation models with multiple spurion fields breaking SUSY and the R-symmetry separately, we show that it is possible to generate gaugino masses at one loop if the R-charge arrangement satisfies a certain condition. The resulting gaugino masses are calculated and suppressed by some power of the messenger mass scale. We present two simple examples to demonstrate this possibility, and discuss possible phenomenology implications.

Primary author(s) : RAN, Longjiang (Sichuan University)

Presenter(s) : RAN, Longjiang (Sichuan University)

Contribution ID : **21** Type : **In person**

Investigating the collinear splitting effects of boosted dark matter at neutrino detectors

We study the probing prospects of cosmic ray boosted dark matter (DM) in the framework of simplified electron-philic dark photon model. Focusing on the dark matter and dark photon masses around keV ~ MeV scale, we consider the bounds obtained from the XENON1T and Super-K experiments. The electron bound state effects are treated carefully in calculating the XENON1T constraint. As for the detection at neutrino detector where the energy threshold is relatively higher, the large logarithmic effects induced by the scale hierarchy between the masses and momentum transfer are considered by introducing the DM parton distribution function (PDF). The logarithmic effects will reduce the electron recoil rate for DM scattering in neutrino detectors. Moreover, we find the DUNE and JUNO experiments provide high sensitivities for probing the dark photon component in the DM PDF through the dark Compton process. We also check the Bullet Cluster constraint on the DM self-scattering cross section.

Primary author(s) : LI, Jinmian; PEI, Junle (Institute of High Energy Physics, CAS); ZHANG, Cong

Presenter(s) : PEI, Junle (Institute of High Energy Physics, CAS)

Contribution ID : **22** Type : **Online**

New Understanding of Coherence in Bragg-Primakoff Detection of Solar Axions

Axions and axion-like pseudoscalar particles with dimension-5 couplings to photons exhibit coherent Primakoff scattering with ordered crystals at keV energy scales, making for a natural detection technique in searches for solar axions. We find that there are large suppressive corrections, potentially greater than a factor of 10^3, to the coherent enhancement when taking into account absorption of the final state photon. This effect has already been accounted for in light-shining-through-wall experiments through the language of Darwin classical diffraction, but is missing from the literature in the context of solar axion searches that use a matrix element approach. We extend the treatment of the event rate with a heuristic description of absorption effects to bridge the gap between these two languages. Furthermore, we explore the Borrmann effect of anomalous absorption in lifting some of the event rate suppression by increasing the coherence length of the conversion. We study this phenomenon in Ge, NaI, and CsI crystal experiments and its impact on the the projected sensitivities of SuperCDMS, LEGEND, and SABRE to the solar axion parameter space. Lastly, we comment on the reach of multi-tonne scale crystal detectors and strategies to maximize the discovery potential of experimental efforts in this vein.

Primary author(s) : Dr THOMPSON, Adrian (TAMU)

Presenter(s) : Dr THOMPSON, Adrian (TAMU)

Contribution ID : **23** Type : **In person**

Searching New Physics from Recent LHAASO Observations of High Energy Cosmic Photons

High energy particles from astrophysical sources have the potential to reveal new features of our Universe. I show that the recent observations of LHAASO on the highest-energy cosmic photon can put strong costraints on the superluminal Lorentz violation (LV) of photons while allowing the parameter space for subluminal LV. The direct observation of the 1.2 PeV photon from Crab Nebela indicates the existence of 2.4 PeV electron by LHAASO, and this puts strong constraints on the LV parameter of electrons. More over, the recent observation of over 10 TeV photons from GRB221009a by LHAASO can hardly be explained by the standard model due to the annihilation of the high energy photon with background EBL photons, I show that photon Lorenzt violation or axion-like particles provide possibilities to explain such novel observation.

Primary author(s) : MA, Bo-Qiang (Peking University)

Presenter(s) : MA, Bo-Qiang (Peking University)

Contribution ID : **24** Type : **Online**

Axion-photon conversion of GRB221009A

The newly observed gamma ray burst GRB221009A exhibits the existence of 10~TeV-scale photons, and the axion-photon conversion has been suggested as a candidate to explain such energetic features of GRB221009A. In this work we adopt a model to calculate the conversion probability of the energetic photons from GRB221009A to the Earth. The result shows that the penetration probability of photons with energy above 10^1~TeV can be up to 10^{-2} to 10^{-4} depending on the coupling constant $g_{a\gamma}$ and the axion mass m_a, together on the magnetic field parameters of the source galaxy of GRB221009A. We show that the parameters of the source galaxy, with the magnetic field handled by a cellular model, contribute a lot of uncertainties to the penetration probability, so we have more freedom to reconcile a variety of axionlike particle parameters from other observations with the Large High Altitude Air Shower Observatory observation. By comparing the results in this article with the data from Large High Altitude Air Shower Observatory, we can obtain more precise constraints on the ranges of these parameters.

Primary author(s) : WANG, Luohan

Presenter(s) : WANG, Luohan

Contribution ID : **25** Type : **In person**

Recent Dark Matter combination summary from ATLAS

Ref: https://arxiv.org/abs/2306.00641

Results from a wide range of searches targeting different experimental signatures with and without missing transverse momentum (E_T^{miss}) are used to constrain a Two-Higgs-Doublet Model (2HDM) with an additional pseudo-scalar mediating the interaction between ordinary and dark matter (2HDM+a). The analyses use up to 139 fb^{-1} of proton-proton collision data at a centre-of-mass energy √s = 13 TeV recorded with the ATLAS detector at the Large Hadron Collider between 2015-2018. The results from three of the most sensitive searches are combined statistically. These searches target signatures with large E_T^{miss} and a leptonically decaying Z boson; large E_T^{miss} and a Higgs boson decaying to bottom quarks; and production of charged Higgs bosons in final states with top and bottom quarks, respectively. Constraints are derived for several common as well as new benchmark scenarios within the 2HDM+a.

Primary author(s) : LI, Shu (Tsung-Dao Lee Institute & Shanghai Jiao Tong University); Dr VU, Ngoc Khanh (Tsung-Dao Lee Institute, Shanghai Jiao Tong University)

Presenter(s) : Dr VU, Ngoc Khanh (Tsung-Dao Lee Institute, Shanghai Jiao Tong University)

Contribution ID : **26** Type : **Online**

Lorentz violations of cosmic particles from string theory model of space-time foam

High-energy cosmic particles are excellent portals to the possible violation of Lorentz (LV) and/or CPT symmetry from underlying (still elusive) quantum gravity (QG). Given that recent studies of energetic photon (or neutrino) events emitted from (or, associated with) gamma-ray bursts suggest possibilities of LV speed variations that increase linearly with energy, with subluminal propagation of photons but (plausibly-)CPT-violating propagation of neutrinos in cosmic space, I propose string/D-brane theory inspired space-time foam as a viable framework to account for these indications, in a way consistent with various astrophysical data available today. Constraints from recent measurements of LHAASO on the PeV gamma-rays in the (direction of) Cygnus and that arriving from the Crab Nebula to (superluminal) LVs in the electromagnetic and electron/positron sectors, respectively, are highlighted. All of these results lend support to the space-time foam models within brane theories.

Primary author(s) : Dr LI, Chengyi (Peking University)

Presenter(s) : Dr LI, Chengyi (Peking University)

Contribution ID : **27** Type : **In person**

Non-thermally produced Axino searches at the LHC

The axino, the supersymmetric partner of axion, is a well-motivated warm/hot dark/cold matter candidate, and provides a natural solution to the relic density problem for the bino-like neutralino if it is the lightest supersymmetric particle (LSP). With the Generalized Minimal Supergravity, we study such kind of the viable parameter space where the bino-like neutralino is the next-to-LSP (NLSP) and the axino is the LSP. In addition, we consider a scenario where the bino is a long-lived NLSP with the lifetime varying from 10^{-6}s to 10^{-4}s, and then propose a new signal searching scheme involving one displaced photon together with the large missing transverse momentum at the HL-LHC. The bino-like lightest neutralino lies under or around 100 GeV and is produced as a decay product of the right-handed sleptons. The relevant axion coupling f_a can be probed up to $\mathcal{O}(10^9)$ GeV at 2σ level for the right-handed slepton mass under 300 GeV and the lightest neutralino mass under 100 GeV.

Primary author(s) : ZHANG, Wenxing (SJTU)

Presenter(s) : ZHANG, Wenxing (SJTU)

Contribution ID : **28** Type : **In person**

No-scale inflation inspired from string theory compactifications

We propose the generic no-scale inflation inspired from string theory compactifications. We consider the renormalizable superpotential of inflaton field φ in general and the Kähler potentials with φ, as well as one, two, and three Kähler moduli. We study the spectral index and tensor-to-scalar ratio in details, and find the viable parameter spaces which are consistent with the Planck and BICEP/Keck experimental data on the cosmic microwave background (CMB). Also, we study the formation of primordial black hole (PBH) dark matter and the generation of scalar induced secondary gravitational waves (SIGWs) in the two-moduli no-scale inflation models by adding an exponential term into the Kähler potential.

Primary author(s) : WU, Lina (Xi'an Technological University)

Presenter(s) : WU, Lina (Xi'an Technological University)

Contribution ID : **29** Type : **In person**

Majoron Dark Matter from Type II Seesaw

The Type II seesaw mechanism is among the simplest extensions of the Standard Model accounting for neutrino masses. These are naturally induced by the vacuum expectation value (vev) of a scalar triplet coupling to the Standard Model Higgs and lepton doublets. In this talk, I will show that the "type-II majoron" - the pseudo Nambu-Goldstone boson that arises in this context if the lepton number is spontaneously broken by the vev of an additional scalar singlet - can naturally account for the dark matter (DM) observed in the universe. I will discuss majoron production in the early universe through both the freeze-in and misalignment mechanism and its signatures and constraints at direct and indirect DM searches.

Primary author(s) : CALIBBI, Lorenzo (Nankai University)

Presenter(s) : CALIBBI, Lorenzo (Nankai University)

Contribution ID : **30** Type : **In person**

Uncovering the microscopic features of axion with low energy observables

I discuss the possibility of uncovering certain microscopic features of axions, for instance the UV origin of the axion field variable and the quality of PQ symmetry, through low energy observables such as the low energy axion couplings and the nucleon and atomic EDMs.

Primary author(s) : Prof. CHOI, Kiwoon (Korea Advanced Institute of Science and Technology)

Presenter(s) : Prof. CHOI, Kiwoon (Korea Advanced Institute of Science and Technology)

Contribution ID : **31** Type : **In person**

On Higgs decay to a photon and a massless dark photon

Many attempts have been made to observe the decay of the Higgs boson to a photon and an invisible massless dark photon. For this decay to be potentially observable at the LHC, new mediators that communicate between the standard model and the dark photon must exist. In this Letter, we study bounds on such mediators coming from the Higgs signal strengths, oblique parameters, electric dipole moment of the electron, and unitarity. We find that the branching ratio of the Higgs boson to a photon and a dark photon is constrained to be far smaller than the sensitivity of current collider searches except for more contrived models, thus calling for a reconsideration of current experimental efforts.

Primary author(s) : CHIANG, Cheng-Wei (National Taiwan University)

Presenter(s) : CHIANG, Cheng-Wei (National Taiwan University)

Contribution ID : **32** Type : **Online**

D-branes, Dark Energy and Pulsar Timing Arrays

In this talk I will discuss modifications of the post-inflationary evolution due to an epoch of DBI-kinetic domination, where longitudinal fluctuations of a D-brane (matter) couple disformaly to its transverse fluctuations. For suitable initial conditions, such epoch can rise the primordial gravitational wave spectrum at frequencies accessible to pulsar timing array (PTA) experiments, contributing to the recent observed signal. For a brane moving along a single angular direction, the scalar potential can trigger an early epoch of dark energy (EDE) around the recombination epoch, which may help relaxing the Hubble parameter H0-tension today. More speculative, if a subsequent potential contribution arises from non-perturbative effects, the same field can act as late time quintessence to explain today's acceleration.

Primary author(s) : ZAVALA, Ivonne

Presenter(s) : ZAVALA, Ivonne

Contribution ID : **33** Type : **In person**

TBA

Primary author(s) : , ( )

Presenter(s) : , ( )

Contribution ID : **34** Type : **In person**

[redacted]

[redacted]PQ[redacted]
Hz[redacted]clockwork[redacted]

Primary author(s) : [redacted]

Presenter(s) : [redacted]

Contribution ID : **35** Type : **In person**

Searching for Exotic Spin-Dependent Interactions by Spin Quantum Sensors

Searching for new particles beyond the standard model is crucial for understanding several fundamental conundrums in physics and astrophysics. Several hypothetical particles can mediate exotic spin-dependent interactions between ordinary fermions, which enable laboratory searches via the detection of the interactions. We present a platform based on diamond quantum sensors for investigating exotic spin-dependent interactions at micrometer scales. Recently, we conducted experimental searches for exotic spin-dependent interactions with an ensemble-NV-diamond magnetometer. Our work shows that NV ensembles are highly capable of probing exotic spin-spin interactions beyond the Standard Model.

Primary author(s) : Prof. RONG, Xing (USTC)

Presenter(s) : Prof. RONG, Xing (USTC)

Contribution ID : **36** Type : **In person**

Axion Dark Radiation from the Primordial Thermal Bath

Scattering and decay processes of thermal bath particles in the early universe can dump relativistic axions in the primordial plasma. If produced with a significant abundance, their presence can leave observable signatures in cosmological observables probing both the early and the late universe. In this talk, I will focus on the QCD axion and I will present recent and significant improvements for the calculation of the axion production rate across the different energy scales during the expansion of the universe. I will apply these rates to predict the abundance of produced axions, and I will present the latest cosmological bounds on the axion mass and couplings. Finally, I will present a phase-space approach to improve the predictions for the dark radiation abundance.

Primary author(s) : Prof. D'ERAMO, Francesco (University of Padua)

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

Contribution ID : **37** Type : **Online**

Axion Searches

The axion provides a solution to the Strong CP Problem of particle physics and is a candidate for the cold dark matter of the Universe I'll briefly review the constraints on the axion from particle physics, stellar evolution and cosmology. The constraints imply that its interactions are extremely weak, so much so that the axion was once thought "invisible". Nonetheless a number of methods have been proposed to detect so-called "invisible" axions and a world-wide campaign is under way to look for them. I'll describe these techniques, the experiments that implement them, and the results that have been obtained so far.

Primary author(s) : SIKIVIE, Pierre

Presenter(s) : SIKIVIE, Pierre

Contribution ID : **38** Type : **In person**

Searching for Axions and Axion-Like Particles via Spin-Dependent Interactions

The solutions to several important problems in modern physics may lead to new spin-dependent interactions mediated by axions or axion-like particles beyond the Standard Model. Experimental methods based on precision measurements are suitable for detecting these new interactions. We review various studies on detecting spin-dependent exotic interactions using polarized 3He, 129Xe+131Xe, polarized neutrons, and other particles. We also report recent experimental results for spin-velocity-dependent new interactions using rotating modulation mass sources and SERF magnetometer arrays. Additionally, we discuss the latest progress in constraining these exotic interactions on astronomical scales, using celestial bodies such as the sun and the moon as sources.

Primary author(s) : YAN, Haiyang

Presenter(s) : YAN, Haiyang

Contribution ID : **39** Type : **Online**

Dark Energy with a Little Help from its Friends

It has proven surprising difficult to obtain a microscopic understanding of Dark Energy within string theory. The two main paradigms, a landscape of de Sitter vacua or slow-roll quintessence (including axion quintessence), seem to require various fine-tunings and/or working at the boundaries of control, which has led to much fruitful debate. I will discuss alternative scenarios for Dark Energy motivated by string theory, in which interacting Dark Sectors – including Dark Radiation, Dark Matter or mutual-aid' Dark Energy – can source a late-time, transitory accelerated expansion. These scenarios require no fine-tuning of initial conditions, no fine-tuning between potential parameters, no large-field displacements, have potentially observable consequences, and are consistent with recent string theoryswampland conjectures'.

Primary author(s) : PARAMESWARAN, Susha

Presenter(s) : PARAMESWARAN, Susha

Contribution ID : **40** Type : **Online**

Observing invisible axions with gravitational waves

If the Peccei-Quinn symmetry associated to an axion has ever been restored after inflation, axion strings inevitably produce a contribution to the stochastic gravitational wave background. Combining effective field theory analysis with numerical simulations, we show that the resulting gravitational wave spectrum has logarithmic deviations from a scale invariant form with an amplitude that is significantly enhanced at low frequencies. As a result, a single ultralight axion-like particle with a decay constant larger than 1014 GeV and any mass between 10-18 eV and 10-28 eV leads to an observable gravitational wave spectrum and is compatible with constraints on the post-inflationary scenario from dark matter overproduction, isocurvature and dark radiation. Since the spectrum extends over a wide range of frequencies, the resulting signal could be detected by multiple experiments. We describe straightforward ways in which the Peccei-Quinn symmetry can be restored after inflation for such decay constants. We also comment on the recent possible NANOgrav signal in light of our results.

Primary author(s) : HARDY, Edward

Presenter(s) : HARDY, Edward

Contribution ID : **42** Type : **In person**

Novel high-frequency gravitational waves detection with split cavity

Gravitational waves can generate electromagnetic effects inside a strong electric or magnetic field within the Standard Model and general relativity. Here we propose using a quarterly split cavity and LC-resonance circuit to detect a high-frequency gravitational wave from 0.1 MHz to GHz. We perform a full 3D simulation of the cavity's signal for sensitivity estimate. Our sensitivity depends on the coherence time scale of the high-frequency gravitational wave sources and the volume size of the split cavity. We discuss the resonant measurement schemes for narrow-band gravitational wave sources and also a non-resonance scheme for broadband signals. For a meter-sized split cavity under a 14 Tesla magnetic field, the LC resonance enhanced sensitivity to the gravitational wave strain is expected to reach h ~ 10−20 around 10 MHz.

Primary author(s) : LIU, Yiming

Presenter(s) : LIU, Yiming

Contribution ID : **43** Type : **Online**

The Fate of Axion Domain Walls

Theories in which the Peccei-Quinn phase transition occurs after inflation tend to suffer from problematic domain walls. One possible solution involves a small, explicit breaking to the symmetry. But this raises other potential issues. In this talk, we review some aspects of axion domain walls, focussing especially on this proposed solution. We argue, in disagreement with some recent literature, that most of the domain wall energy emerges as high momentum axions. We then note that, if one accepts a remarkable coincidence, this solution can be acceptable. We consider a possible explanation of the required coincidence.

Primary author(s) : DINE, Michael

Presenter(s) : DINE, Michael

Contribution ID : **44** Type : **In person**

Nuclear decay anomalies as a signature of axion dark matter

A number of nuclear decay anomalies have been reported in the literature, which purport to show periodic variations in the decay rates of certain radioisotopes. If these reports reflect reality, they would necessitate a seismic shift in our understanding of fundamental physics. We provide the first mechanism to explain these findings, via the misalignment mechanism of QCD axion dark matter, wherein oscillations of the effective theta angle induce periodic variation in nuclear binding energies and hence decay rates. Expecting this effect to be most pronounced in low-Q systems, we analyse 12 years of tritium decay data (Q ⊠ 18.6 keV) taken at the European Commission's Joint Research Centre. Finding no statistically significant excess, we then place novel constraints on the corresponding axion parameter space.

Primary author(s) : ZHANG, Xin

Presenter(s) : ZHANG, Xin

Contribution ID : **45** Type : **Online**

The (in-)visible Axiverse

In this talk, I will review the construction of an ensemble of axion models arising from type IIB string theory on toric hypersurface Calabi-Yau threefold orientifolds. I'll explain some of the observational constraints on these string theory axions, coming from dark matter bounds as well as axion-photon coupling experiments. Finally, I'll explain a mechanism that suppresses axion-photon couplings compared to naive estimates, and present some preliminary data on these couplings.

Primary author(s) : GENDLER, Naomi (Cornell)

Presenter(s) : GENDLER, Naomi (Cornell)

Contribution ID : **46** Type : **In person**

Cosmic acceleration on the axion-saxion moduli spaces and the Swampland

Cosmic acceleration on the axion-saxion moduli spaces and the Swampland

Primary author(s) : GUOEN, Nian (Utrecht University)

Presenter(s) : GUOEN, Nian (Utrecht University)

Contribution ID : **47** Type : **In person**

ALP from $U(1)_L$ and its phenomenology

ALP from $U(1)_L$ and its phenomenology

Primary author(s) : CHAO, Wei (Beijing Normal University)

Presenter(s) : CHAO, Wei (Beijing Normal University)

Contribution ID : **48** Type : **In person**

Experimental Progress of APEX

Experimental Progress of APEX

Primary author(s) : Prof. ZHENG, Dongning (Institute of Physics, Chinese Academy of Sciences)

Presenter(s) : Prof. ZHENG, Dongning (Institute of Physics, Chinese Academy of Sciences)