The Axion Quest 2024 conference - 20th Rencontres du Vietnam

Rapport sur les contributions

https://indico.in2p3.fr/e/VietnamAxion2024

ID de Contribution: **1** Type: **Non spécifié**

Registration at the Seagull Hotel

ID de Contribution: **2** Type: **Non spécifié**

Welcome cocktail & dinner at the Seagull Hotel

ID de Contribution: **4** Type: **Non spécifié**

Departure

ID de Contribution: **5** Type: **Non spécifié**

Introduction

Orateur: RIPP-BAUDOT, Isabelle (IPHC, CNRS/IN2P3)

ID de Contribution: **6** Type: **Non spécifié**

Introductory review on Axion physics

lundi 5 août 2024 10:00 (45 minutes)

Orateur: SEMERTZIDIS, Yannis (IBS-CAPP)

ID de Contribution: **7** Type: **Non spécifié**

Search for the QCD Axion with ADMX

lundi 5 août 2024 11:00 (20 minutes)

Axion dark matter is a compelling particle that could solve both the Strong CP problem and account for all the dark matter in our Universe. Axion haloscopes search for axion dark matter through its conversion into microwave photons in the presence of a strong static magnetic field. The Axion Dark Matter eXperiment (ADMX) is one such axion haloscope and has achieved sensitivity to both benchmark models for the QCD axion through its use of a Josephson Parametric amplifier and low temperature dilution refrigerator. In this talk, I will provide an update on recent results from ADMX as well as updates on plans for higher frequency axion searches. IM No.:LLNL-ABS-865634

Orateur: DU, Nick (Lawrence Livermore National Laboratory)

ID de Contribution: **8** Type: **Non spécifié**

MADMAX A Dielectric Haloscope Experiment

lundi 5 août 2024 11:25 (20 minutes)

The MAgnetized Disc and Mirror Axion eXperiment, MADMAX, is based on a dielectric haloscope aimed at μeV axion masses. This haloscope significantly boosts the weak axion signal by controlling the interference conditions via a mirror and dielectric discs (booster) that can be reconfigured to scan a broad mass range. During the latest dark matter search of MADMAX, measurements were taken with a new booster system with a diameter of 200 mm inside the CERN's Morpurgo magnet. We successfully tuned and reconfigured the experiment to stably operate across a frequency range of roughly 100 MHz. Using a newly developed glass-fiber-based cryostat and a 100 mm version of our booster detector, MADMAX performed a dark matter search in a 1.6 T magnetic field under cryogenic conditions for the first time. Here, we present preliminary results from these measurements.

Orateur: IVANOV, Anton (Max-Planck-Institut für Physik, Garching)

ID de Contribution: **9** Type: **Non spécifié**

IAXO - The next generation axion helioscope

lundi 5 août 2024 11:50 (20 minutes)

IAXO aims to detect solar axions, as they are converted into X-rays along a strong magnet pointing towards the sun. This detection could resolve the strong CP problem or represent the observation of a dark matter candidate in the laboratory. IAXO combines a large-volume magnet, X-ray focusing optics and ultra-low background X-ray detectors. BabyIAXO, the first experimental stage of the IAXO program, is currently under construction at DESY. In my talk will present the status of the IAXO project.

Orateur: WIESINGER, Christoph (Technical University of Munich)

ID de Contribution: **10** Type: **Non spécifié**

Signatures of astrophobic QCD axion

vendredi 9 août 2024 11:20 (30 minutes)

In minimal models of the QCD axion that aim to solve the strong CP problem the axion decay constant is constrained to be above O(10^9) GeV due to astrophysical constraints from the observation of the neutrino burst in SN1987A and the cooling of neutron stars. Such large values of the axion decay constant exclude a possibility to discover axions in near-future helioscopes such as IAXO and do not allow to explain the observed baryon asymmetry via minimal axiogenesis. I will present models of so-called astrophobic QCD axion in which astrophysical constraints are relaxed and allow for the axion decay constant as small as O(10^7) GeV. I will discuss implications of such models for axion dark matter and axiogenesis and possible cosmological and experimental probes of astrophobic axions.

Orateur: BADZIAK, Marcin (University of Warsaw)

ID de Contribution: **11** Type: **Non spécifié**

ALP searches at MEG II

lundi 5 août 2024 14:35 (20 minutes)

Orateur: MORI, Toshinori (The University of Tokyo)

ID de Contribution: **12** Type: **Non spécifié**

The COMET experiment at J-PARC and lepton flavor violating ALPs

lundi 5 août 2024 15:00 (20 minutes)

Charged Lepton Flavor Violating (LVF) processes are among the most sensitive probes of physics Beyond the Standard Model (BSM). One such process is the conversion of a muon to an electron in a muonic atom, which is being investigating with Aluminum atoms by the upcoming COMET experiment at J-PARC, Japan. Carried out in a two-staged approach, COMET ultimately aims to reach a sensitivity on the muon to electron conversion ratio four orders of magnitude above the previous experiments. This presentation introduces the COMET apparatus and outlines the recent progress of the experiment, before discussing COMET's sensitivity to couplings between leptons and LFV Axion-Like Particles (ALPs).

Orateur: BOUILLAUD, Thomas (Kyushu University)

ID de Contribution: **13** Type: **Non spécifié**

Spontaneously Broken (−1)-Form U(1) Symmetries

mercredi 7 août 2024 09:20 (30 minutes)

Spontaneous breaking of symmetries leads to universal phenomena. We extend this notion to (−1)-form U(1) symmetries. The spontaneous breaking is diagnosed by a dependence of the vacuum energy on a constant background field θ, which can be probed by the topological susceptibility. This leads to a reinterpretation of the Strong CP problem as arising from a spontaneously broken instantonic symmetry in QCD. We discuss how known solutions to the problem are unified in this framework and explore some, so far unsuccessful, attempts to find new solutions. I will also discuss the explicit breaking by monopoles.

Orateur: SUZUKI, Motoo (Harvard University)

ID de Contribution: **14** Type: **Non spécifié**

High-temperature superconducting cavities for dark matter axion search at CAPP

mercredi 7 août 2024 08:30 (20 minutes)

Superconducting radiofrequency technology has boosted scientific productivity by enhancing the quality (Q) factor of resonant cavities in various particle physics applications. A high Q factor is also essential for increasing the scanning speed of cavity haloscope experiments. The Center for Axion and Precision Physics Research (CAPP) has been leading in developing high-temperature superconducting (HTS) cavities, achieving Q values up to 10^7 in multi-tesla magnetic fields, which is two orders of magnitude higher than traditional copper cavities. This significant advancement has been widely utilized in axion searches at CAPP. CAPP is developing new cavities, including a 36-liter HTS cavity for the CAPP-MAX experiment with DFSZ sensitivity and multi-cell HTS cavities for high-mass axion searches. This presentation will detail these notable developments.

Orateur: AHN, Danho (IBS-CAPP)

ID de Contribution: **15** Type: **Non spécifié**

Cavity haloscopes for high-frequency axion search at IBS-CAPP

mercredi 7 août 2024 08:55 (20 minutes)

Cavity haloscopes are the most efficient method for searching for axion dark matter in the microwave (μeV) region. Current searches are primarily focused on the relatively low frequency (mass) region due to significant losses in detection volume and gradual decreases in the quality factor with increasing frequency. The IBS Center for Axion and Precision Physics Research (IBS-CAPP) has developed several innovative cavity designs to effectively search for axions in the high-mass region. These designs include multiple cells within a conventional cavity, a double-layer tuning mechanism for exploiting higher-resonant modes, and photonic crystal structure of dielectric arrays. In this talk, we present the details of these designs and share experimental search results using various cavities.

Orateur: YOUN, SungWoo (IBS CAPP)

ID de Contribution: **16** Type: **Non spécifié**

Search for permanent and oscillating EDM of the neutron

lundi 5 août 2024 16:35 (35 minutes)

On behalf of the nEDM collaboration, we will discuss the measurement that established the best upper limit on the electric dipole moment of the neutron, dn < 1.8x10^(-26) e cm (90% CL) [1]. This result was obtained using the nEDM apparatus connected to the ultracold neutron source at the Paul Scherrer Institute (PSI). We will also present n2EDM, the next-generation experiment currently in the commissioning phase at PSI.

The absence of a neutron electric dipole moment (nEDM) at this sensitivity level constrains the CP-violating phase of QCD to an extremely small value, constituting the strong CP problem and motivating the existence of the Axion. Additionally, the neutron EDM is a highly sensitive probe of CP violation beyond the Standard Model.

Moreover, we performed a search in the nEDM data for an oscillating signal potentially due to an oscillating axion-like particles (ALPs) field. This search set upper limits on the axion couplings to gluons and neutrons in the mass range from 10^(-24) eV to 10^(-18) eV [2], and another limit in the mass range from 10^(-16) eV to 10^(-13) eV [3].

[1] C. Abel et al., Phys. Rev. Lett. 124, 081803 (2020)
[2] C. Abel et al., Phys. Rev. X 7, 041034 (2017)
[3] C. Abel et al., SciPost Phys. 15, 058 (2023)

Orateurs: BAN, Gilles (Laboratoire de Physique Corpusculaire de Caen, LPC Caen); PIGNOL, Guillaume (LPSC)

ID de Contribution: **18** Type: **Non spécifié**

Experimental review of ALP searches at accelerators

mardi 6 août 2024 09:10 (30 minutes)

The current status and future prospects of searches for axion-like particles (ALPs) at accelerators will be summarized. I will first discuss beam-dump and fixed-target results, where the ALPs are produced via the Primakoff effect and decay into a pair of photons, covering the mass range m_a \approx 10^-3 – 0.1 GeV. Constraints on ALPs with masses above a few hundred MeV that couple to photons have been set at e+e- colliders (BES-III, B factories) and at the LHC (up to a few TeV) through searches for new a->gamma gamma resonances. The LHC has extended those searches to include rare Z or Higgs bosons decays in tri-, and four-photon final states. Factors of 10–100 improvements in the current sensitivity are expected in the next decade, and orders-of-magnitude further at future colliders such as the FCC.

Orateur: D'ENTERRIA, David (CERN)

ID de Contribution: **19** Type: **Non spécifié**

ALP searches at LHCb

mardi 6 août 2024 13:55 (20 minutes)

Orateur: HENRY, Louis (LPNHE)

ID de Contribution: **20** Type: **Non spécifié**

Two-dimensional Core-collapse Supernova Models with Heavy Axion-like Particles

mardi 6 août 2024 10:45 (30 minutes)

Axion-like particles (ALPs) are a class of hypothetical pseudoscalar particles which feebly interact with ordinary matter. The hot plasma in core-collapse supernovae is a possible laboratory to explore physics beyond the standard model including ALPs. Once produced in a supernova, a part of the ALPs can be absorbed by the supernova matter and affect energy transfer. We recently developed two-dimensional supernova models including the effects of the production and the absorption of ALPs that couple with photons. It is found that the additional heating induced by ALPs can enhance the explosion energy; for moderate ALP-photon coupling, we find explosion energies ~0.6*10^51 erg compared to our reference model without ALPs of ~0.4*10^51 erg. Our findings also indicate that when the coupling constant is sufficiently high, the neutrino luminosities and mean energies are decreased because of the additional cooling of the proto-neutron star. The gravitational wave strain is also reduced becau se the mass accretion on the proto-neutron star is suppressed.

Orateur: MORI, Kanji (National Astronomical Observatory of Japan)

ID de Contribution: **21** Type: **Non spécifié**

Storage ring as an ALP antenna - an experimental proof of principle

mardi 6 août 2024 14:20 (20 minutes)

Axions, or axionlike particles (ALPs), can couple to the spin of nucleons and nuclei, either directly through the axion-wind effect, or indirectly, inducing an oscillating electric dipole moment in nucleons in the process. If ALPs are a part of the cold dark matter in our Galaxy, they can be treated as a classical field. A beam of in-plane polarized hadrons circulating in a storage ring can therefore be used as an ALP antenna. At the resonance between the frequency of an ALP field and the spin-precession frequency of the beam, a buildup of the vertical polarization component should appear as a signal of the ALP presence. As the ALP mass and frequency are unknown, the beam momentum, which is directly related to its spin-precession frequency, needs to be ramped in a search for the resonance crossing. The JEDI collaboration conducted a proof-of-principle experiment demonstrating this new method using the polarized deuteron beam of the COSY synchrotron. An ALP mass range of 0.495-0.502 neV/c2 was scanned. No ALP signal was observed, but a 90% confidence upper limit on the deuteron oscillating electric dipole moment of 6.4 x 10-23 ecm was obtained. The experimental method was successfully tested through injection into the ring of a fake ALP signal generated using a radio-frequency Wien filter. In my talk, I will discuss the method, necessary preparatory work and developments, the experiment and its subtleties, and the results.

Orateur: WRONSKA, Aleksandra (Jagiellonian University)

ID de Contribution: **22** Type: **Non spécifié**

The CAPP-MAX axion haloscope: status and prospects

lundi 5 août 2024 13:30 (20 minutes)

The axion is a solution to the strong CP problem in quantum chromodynamics. Also, in a particular mass range, axion can be a compelling candidate of the dark matter constituent. CAPP-MAX, a flagship experiment of IBS/CAPP at KAIST, is designed for direct detection of axion dark matter with DFSZ sensitivity. The experiment utilizes a 12 T superconducting magnet and a dilution refrigerator operating at approximately 20 mK. The system also adapts innovative approaches, such as optimizing the volume and weight of the cavity by utilizing the copper foils, and extending the bandwidth of the JPA by bundling them up. The system achieves the total system noise temperature of approximately 200 mK. In this presentation, I will talk about the achievement of the experiment so far in the frequency range of 1.02-1.18 GHz, and the future plan utilizing a configuration of 6 JPAs and a superconducting cavity.

Orateur: AHN, Saebyeok (IBS-CAPP)

ID de Contribution: **23** Type: **Non spécifié**

Search for Axion-Like Dark Matter using Cold Neutrons

mardi 6 août 2024 13:30 (20 minutes)

The current best estimate for the universe's matter content consists of 84% dark matter, and the search for its composition remains of great interest. One possible candidate is a so-far undetected ultra-low-mass axion. In this talk, I report on a search for dark matter made of axion-like particles (ALPs) using a Ramsey-type apparatus for cold neutrons. A hypothetical ALP-gluon-coupling would manifest in a neutron electric dipole moment signal oscillating in time. Twenty-four hours of data have been analyzed in a frequency range from 23 Hz to 1 kHz, and no significant oscillating signal has been found. Present dark-matter models allow for constraining the coupling of ALPs to gluons. Details of the analysis and results will be presented.

Orateur: SCHULTHESS, Ivo (DESY)

ID de Contribution: **24** Type: **Non spécifié**

Lattice calculation of neutron electric dipole moment

jeudi 8 août 2024 16:30 (30 minutes)

Orateur: OKI, Hiroshi (Nara Women's University)

ID de Contribution: **25** Type: **Non spécifié**

Searching dark matter with a 1000 km-baseline exotic-field interferometer

mardi 6 août 2024 14:45 (20 minutes)

Orateur: GAVILAN MARTIN, Daniel (Helmholtz Institute Mainz)

ID de Contribution: **26** Type: **Non spécifié**

The echo method for axion dark matter searches

lundi 5 août 2024 13:55 (30 minutes)

The axion dark matter decay rate can be enhanced by several order of magnitude if an electromagnetic environment with frequency equal to half of the axion mass is present. In this talk I will show how this effect can produce an echo of electromagnetic radiation and how we can detect it with radio astronomy and radar technology. I will show sensitivity prospect with current radio astronomy equipment.

Orateur: ARZA, Ariel (Nanjing Normal University)

ID de Contribution: **27** Type: **Non spécifié**

The ORGAN Experiment: Phase 1 results

mardi 6 août 2024 16:20 (20 minutes)

The ORGAN (Oscillating Resonant Group AxioN) experiment in Perth, Australia is a microwave cavity axion haloscope that aims to search for axion dark matter particles within the mass range of 50 to 200 μeV predicted by the standard model axion seesaw Higgs portal inflation (SMASH) model. The experiment's initial phase 1a scan sets an upper limit on the coupling of the axion to two photons of gaγγ ≥ 3 × 10−12 GeV−1 over the mass range between 63.2 – 67.1 μeV with a 95% confidence interval. This highly sensitive result is sufficient to exclude the well-motivated axion-like particle (ALP) cogenesis model for dark matter in the searched region. We also present the most recent results from the phase 1b search, which excludes the ALP cogenesis model between 107.4 – 111.9 μeV.

Orateur: QUISKAMP, Aaron (The University of Western Australia)

ID de Contribution: **28** Type: **Non spécifié**

Probing the PQ (axion) quality with electric dipole moments

mardi 6 août 2024 16:45 (30 minutes)

Orateur: CHOI, Kiwoon (IBS)

ID de Contribution: **29** Type: **Non spécifié**

Time-varying electric dipole moments, spin-precession effects and variations of fundamental constants induced by ultralight axion and scalar dark matter

lundi 5 août 2024 15:55 (30 minutes)

Axion or axionlike dark matter can couple to gluons and fermions, leading to time-varying electric dipole moments and spin-precession effects. Additionally, ultralight axion or scalar dark matter can induce variations of the fundamental constants of nature, such as the particle masses and strengths of fundamental interactions. I discuss the mechanisms involved in generating these effects and associated phenomenological consequences.

References:
[1] Y. V. Stadnik and V. V. Flambaum, Physical Review D 89, 043522 (2014).
[2] C. Abel et al., Physical Review X 7, 041034 (2017).
[3] C. Smorra, Y. V. Stadnik et al., Nature 575, 310 (2019).
[4] V. V. Flambaum, M. Pospelov, A. Ritz and Y. V. Stadnik, Physical Review D 102, 035001 (2020).
[5] Y. V. Stadnik and V. V. Flambaum, Physical Review Letters 114, 161301 (2015).
[6] Y. V. Stadnik and V. V. Flambaum, Physical Review Letters 115, 201301 (2015).

Orateur: STADNIK, Yevgeny (The University of Sydney)

ID de Contribution: **30** Type: **Non spécifié**

Atomic and Molecular searches for Oscillating Fundamental Constants

mardi 6 août 2024 08:30 (30 minutes)

Orateur: BUDKER, Dmitry (Helmholtz Institute JGU Mainz and UC Berkeley)

ID de Contribution: **31** Type: **Non spécifié**

Recent Progress in ARIADNE

mercredi 7 août 2024 10:30 (20 minutes)

Axion is CP-odd scalar particle that remains the most prominent solution of the strong CP problem many decades after its first prediction and is a very well-motivated dark matter candidate as well. Axions could also be linked with new macroscopic P-odd and T-odd spin-dependent interactions which can be probed in sensitive laboratory experiments. ARIADNE (Axion Resonant InterAction DetecioN Experiment) is a novel experiment designed to test the exotic spin-dependent long-range interaction mediated by axion. We report recent progress and future plan in ARIADNE including the design of SQUID gradiometer.

Orateur: SHIN, Yun Chang (Institute for Basic Science)

ID de Contribution: **32** Type: **Non spécifié**

Search for an interaction mediated by axion-like particles with ultracold neutrons at PSI

mercredi 7 août 2024 10:55 (20 minutes)

The "Peccei-Quinn symmetry" first proposed to solve the strong CP problem, spontaneously breaks at some high energies where axion emerges. Subsequently, a new, short-range, spin-dependent interaction, which could be mediated by very light, weakly coupled bosons, such as the axion and other hypothetical axion-like particles (ALPs), was proposed. The monopole-dipole interaction involving the scalar and the pseudoscalar couplings has been extensively searched for worldwide as it violates the combined CP symmetry, which would give an evidence to one of the three criteria to explain the matter-antimatter asymmetry problem. Using the nEDM spectrometer at the Paul Scherrer Institute, we have searched for this ALPs-mediated interaction between unpolarized nucleons close to the material surfaces of the apparatus and polarized ultracold neutrons (UCN) stored in vacuum. The dominant systematic uncertainty resulting from magnetic-field gradients was controlled to an unprecedented level. No signature of a theoretically predicted new interaction was found, and we set a new limit on the product of the scalar and the pseudoscalar couplings for the monopole-dipole interaction. This new result confirms and improves our previous limit by a factor of 2.7 and provides the current tightest limit obtained with free neutrons. In this talk, I will describe the measurement technique of the search for this new interaction, explain the analysis method to achieve an unprecedented level of control of the systematic uncertainties, and show the results published in New Journal of Physics last year.

Orateur: CHIU, Pin-Jung (University of Zurich)

ID de Contribution: **33** Type: **Non spécifié**

Exploring New Physics with the Optical Dump at LUXE

mercredi 7 août 2024 11:20 (20 minutes)

The LUXE experiment at DESY stands at the forefront of the investigation of strong-field quantum electrodynamics with high precision. The interaction between electrons or photons and a high-intensity laser generates new electrons, positrons, and photons. The phenomena under examination include the non-linear Compton scattering. In this talk, I will explain how the photons produced in this process offer an avenue for exploring new physics through a beam-dump-type experiment.

Orateur: SCHULTHESS, Ivo (DESY)

ID de Contribution: **34** Type: **Non spécifié**

How viable is a 10 MeV QCD axion?

vendredi 9 août 2024 13:00 (20 minutes)

It is well-known that a heavy QCD axion is readily excluded by experiments. However, recent studies have suggested that the visible QCD axion at the 10 MeV scale remains viable on the assumption that it exclusively couples to the first-generation quarks and the electron. In this talk, we deal with the cosmological domain wall problem, the quality issue, and constraints arising from the electron electric dipole moment in the 10 MeV QCD axion model. It is also pointed out that the gluon loop-generated axion-top coupling can provide a large contribution to rare B-meson decays, such that the present LHCb data for $B^0 \to K^{*0} e^+ e^-$ rule out the model for the axion mass larger than 30 MeV.

Orateur: NAKAGAWA, Shota (TD Lee Institute Shanghai Jiao Tong University)

ID de Contribution: **35** Type: **Non spécifié**

Axion Relic Pockets —A New Theory of Dark Matter

jeudi 8 août 2024 08:30 (30 minutes)

I will present a new theory of dark matter based on axion physics and cosmological phase transitions.
A first-order phase transition of a so-called dilaton'field that controls the coupling of a hidden-sector gauge theory leads to an exponential change in the mass of the corresponding axion. Following such a transition, cosmologically ambient axions naturally become trapped intoaxion relic pockets': regions of relic false vacua stabilised by the pressure from a kinematically trapped, hot axion gas. Axion relic pockets provide a viable and highly economical theory of dark matter: the macroscopic properties of the pockets depend only on a single parameter (the phase transition temperature). Their sizes range from point-like to astronomical, and their masses from intermediate particle-physics scales to asteroid-like. I will describe the formation, evolution and present-day properties of axion relic pockets, and outline how their phenomenology is distinct from existing dark matter paradigms. I will briefly outline how laboratory experiments and astronomical observations can be used to test the theory. Gamma-ray observations of magnetised, dark-matter-dense environments appear particularly promising.

Orateur: MARSH, David (Stockholm University)

ID de Contribution: **36** Type: **Non spécifié**

Contributions of CP violating interactions to the neutron EDM from lattice QCD

jeudi 8 août 2024 09:10 (30 minutes)

One of the profound mysteries of nature is the lack of matter-antimatter symmetry in the universe, i.e., the almost total absence of antibaryons. One of the conditions necessary to generate this asymmetry is the violation of charge-conjugation-parity (CP) symmetry. Every interaction that violates CP in the SM (Theta-term) and in theories beyond the standard model (BSM) also contributes to the neutron electric dipole moment (nEDM). Thus, a value (or bound) on the nEDM provides constraints on possible BSM theories. I will describe the status of the calculations of the contributions of novel CP violating interactions (the theta term, quark EDM, quark chromo EDM) to the nEDM being done at Los Alamos.

Orateur: GUPTA, Rajan (Los Alamos National Lab)

ID de Contribution: **37** Type: **Non spécifié**

ALP searches at the High Energy Frontier

jeudi 8 août 2024 10:45 (30 minutes)

Orateur: NIEDZIELA, Jeremi (DESY)

ID de Contribution: **38** Type: **Non spécifié**

Discovery potential for ALPs on FASER and FASER 2.

mardi 6 août 2024 09:50 (20 minutes)

The FASER (ForwArd Search ExpeRiment) is a very forward detector on LHC, which locates 480 meters downstream of the ATLAS detector along the beam line. It accepts particles in the geometry range of $\theta < 10^{-3}$ from the ATLAS Interacting Point (IP). Due to the curvature of the LHC tunnel, the FASER detector is placed outside the main tunnel. So there's about 100 meters rock in thickness for all the particles to traverse from the ATLAS IP before they reach the FASER detector. This elegant design depresses the huge background from p-p collisions for axion-like particle research, while sufficiently utilizing the high center of mass energy on LHC. As simulated by MC, the number of light particles with θ less than mrad is still considerable in p-p collision with 13 TeV. So there will be enough statistics during LHC Run 3 and HL-LHC for FASER to be sensitive for searching ALPs with masses up to 300 MeV and couplings around $10^{-4}GeV^{-1}$. This report will briefly introduce the detector structure of FASER, then focus on introducing the discovery potential for ALPs with all types of couplings (photon, fermion, gluon).

Orateur: ZHANG, Shunliang (Tsinghua University)

ID de Contribution: **39** Type: **Non spécifié**

ALP searches at e+e- colliders

jeudi 8 août 2024 11:25 (30 minutes)

Low-energy, high-luminosity electron-positron (e+e−) colliders are ideally suited for probing light particles predicted by theories beyond the Standard Model, thanks to their large datasets and precise resonance reconstruction capabilities. This talk will present the latest results from searches for Axion-Like Particles (ALPs) at e+e− colliders, for masses up to approximately 10 GeV/c^2. The review will include results from the Belle, Belle II, BaBar, and BESIII experiments.

Orateur: CAMPAJOLA, Marcello (INFN Napoli)

ID de Contribution: **40** Type: **Non spécifié**

Search for Solar Axions and ALP Dark Matter with XENONnT

jeudi 8 août 2024 09:50 (20 minutes)

The XENONnT experiment, located at Laboratori Nazionali del Gran Sasso (LNGS), is a dark matter direct detection experiment using a dual-phase time projection chamber with 8.5 tonnes of xenon. In its first science run (SR0), XENONnT achieved an electronic recoil background of 15.8 events/(tonne-year-keV) below 30 keVee, establishing a new benchmark as the lowest background recorded in a dark matter detector. This achievement was made possible by reducing the amounts of radioactive Kr-85 and Rn-222 to an unprecedented low level. With the SR0 data, XENONnT has excluded new physics interpretations of the XENON1T excess and provided stringent constraints on solar axions and axion-like particle (ALP) dark matter. After SR0, the amount of Rn-222 was further reduced by a factor of ~2. In this talk, I will present the results of solar axions and ALP dark matter from XENONnT and its outlook.

Orateur: YE, Jingqiang (The Chinese University of Hong Kong)

ID de Contribution: **41** Type: **Non spécifié**

Artificial Intelligence in the Heavens and on Earth

jeudi 8 août 2024 13:30 (45 minutes)

Machine learning is a branch of data science, aiming at building generic algorithms that can learn a specific task. Machine learning, sometime in disguise, has since long played a role in high energy physics and science. For a decade, trailing the rapid development of deep learning techniques and technology, numerous applications of deep learning in science have been developed and gradually integrated in experimental workflows. Artificial intelligence goes beyond deep learning, with imitating some human functions as a goal. From inception of deep learning in science, to the "automated researcher", we will review how deep learning entered the scientist toolbox and what one could expect from future developments.

Orateur: Dr VLIMANT, Jean-Roch (California Institute of Technology)

ID de Contribution: **42** Type: **Non spécifié**

ALP searches with fixed target experiments

mardi 6 août 2024 11:25 (30 minutes)

In this talk, we will give an overview of searches for axion-like particles at electron and proton fixed target experiments. We will comment on the complementarity with other experiments, like meson factories.

Orateur: GORI, Stefania (University of California Santa Cruz)

ID de Contribution: **43** Type: **Non spécifié**

Search for the Dark Sector particles with molecules

jeudi 8 août 2024 14:30 (20 minutes)

Experiments with molecules are a successful platform for searching for the P,T-violating processes - the interaction of known particles with cosmic fields of the Dark Sector, such as pseudoscalar fields of axions and vector fields of Dark photons. The report will be devoted to studying the influence of these new interactions on the spectra of “symmetric top” type molecules.

Orateur: ZAKHAROVA, Anna (Saint-Petersburg State University)

ID de Contribution: **44** Type: **Non spécifié**

The axion quality problem and possible solutions

jeudi 8 août 2024 15:50 (30 minutes)

The QCD axion is the most interesting solution for the strong CP problem. The QCD axion is the Nambu-Goldstone boson which is associated with spontaneous breaking of Peccei-Quinn symmetry and can absorb theta-term at its potential minimum. However, an explicit breaking of Peccei-Quinn symmetry easily jeopardizes the QCD axion as a solution to the strong CP problem. Thus, the quality of Peccei-Quinn symmetry must be extremely high and this is so-called the axion quality problem. In this talk, we review the axion quality problem and discuss possible solutions.

Orateur: SATO, Ryosuke (Osaka University)

ID de Contribution: **45** Type: **Non spécifié**

High Magnetic Fields to Probe the sub-eV range of Particle/Astroparticle Physics : From OSQAR experiments up to new projects & perspectives at CERN & CNRS-Grenoble with GrAHal

jeudi 8 août 2024 14:55 (20 minutes)

Particle physics is not limited to the high energy range. There are unexplored territories at ultra-low energies, i.e. sub-eV to eV, that offer promising opportunities to go beyond the Standard Model and explain the dark matter (DM) of our Universe. The emblematic particle of this physics is the axion, a pseudo-scalar particle predicted independently by Weinberg and Wilczek, to solve the fundamental problem of the apparent non-violation of the CP symmetry by the strong interaction (QCD) through Peccei-Quinn symmetry breaking. Standard axion at the electroweak scale with a mass around 100 keV has been ruled out after extensive experimental searches. This has led the scientific community to consider the case of almost invisible axion, i.e. with a mass and coupling to other particles extremely weak. If the axion mass is in the range 1-1000 micro-eV, this particle could also be responsible for the DM of our universe and constitutes one of the leading non-supersymmetric candidates. On the other hand, various ultra-light and weakly interacting scalar and pseudo-scalar particles are naturally present in string theory without the need of solving the strong CP problem. This new family of particles has coined the name of WISPs for Weakly Interacting Slim Particles in complement to the WIMPs standing for Weakly Interacting Massive Particles. P. Sikivie demonstrated in 1983 that the invisible axion as well as axion like particles (ALPs), a subfamily of WISPs, could be detected via a chiral anomaly that modifies Maxwell's equations. In this context, one of the objectives of the OSQAR experiment at CERN was to detect ALPs from the light shining through wall scheme and the interaction of 20 W CW laser beam with magnetic field lines produced by two spare 9 T LHC dipoles. It will be presented together with last results obtained, which are the most sensitive to date for this type of experiment for axion mass below 0.2 meV, waiting new limits that will be settle soon by ALPS-II at DESY. OSQAR has been extended for the search of Chameleons, a special type of particle with a mass depending on the density of the surrounding medium and which could be responsible for the dark energy. Ongoing developments at CNRS-Grenoble will also be presented to probe axion/ALPs DM particle with GrAHal (Grenoble Axion Haloscopes) that will be housed in the modular hybrid magnet platform soon in operation at LNCMI-Grenoble and producing static magnetic fields ranging from 9 T in 800 mm diameter up to 43 T in 34 mm diameter. The unique opportunities offered by this modular magnet will be highlighted, in particular to probe the 1-3 micro-eV range with unprecedented sensitivity (GrAHal-CAPP, https://doi.org/10.3389/fphy.2024.1358810).

Orateur: PUGNAT, Pierre (CNRS/LNCMI-Grenoble)

ID de Contribution: **46** Type: **Non spécifié**

Searches for ALP production and decays at kaon factories

vendredi 9 août 2024 08:30 (20 minutes)

The status of the NA62 experiment at CERN is presented. Recent NA62 results on searches for ALP production in kaon decays, and searches for ALP decays with dedicated beam-dump datasets, are reviewed. Future prospects for ALP searches at kaon factories are discussed.

Orateur: GOUDZOVSKI, Evgueni (University of Birmingham)

ID de Contribution: **47** Type: **Non spécifié**

Search for Axion-like Particles in Photonic Final States with FASER

vendredi 9 août 2024 08:55 (20 minutes)

Axions are hypothetical particles that may solve the strong CP problem and act as a dark matter candidate. FASER is able to search for axion-like-particles (ALPs) that couple to both photons and weak gauge bosons in more general models. These ALPs are produced at pp collisions in ATLAS through b-hadron decays, and their decay products are identified as high energy photons in the electromagnetic calorimeter of FASER, located at about 480 m far apart from ATLAS. ALPs mass between 50 and 500 MeV and ALP-W-W coupling between 10-5 and 10-3 GeV-1 can be probed, reaching a previously unexplored region of parameter space. The search result based on 57.7 fb−1 of initial LHC Run-3 data will be presented in this talk.

Orateur: CHEN, Xin (Tsinghua University)

ID de Contribution: **48** Type: **Non spécifié**

Exploring CP Violation beyond the Standard Model and the PQ Quality with Electric Dipole Moments

vendredi 9 août 2024 09:20 (30 minutes)

In some models of physics beyond the Standard Model (SM), one of the leading low energy consequences of the model appears in the form of the chromo-electric dipole moments (CEDMs) of the gluons and light quarks. We examine if these CEDMs can be distinguished from the QCD θ-term through the experimentally measurable nuclear and atomic electric dipole moments (EDMs) in both cases with and without the Peccei-Quinn (PQ) mechanism solving the strong CP problem. We find that the nucleon EDMs show a distinctive pattern when the EDMs are dominantly induced by the light quark CEDMs without the PQ mechanism. In the presence of the PQ mechanism, the QCD θ-parameter corresponds to the vacuum value of the axion field, which might be induced either by CEDMs or by UV-originated PQ breaking other than the QCD anomaly, for instance the PQ breaking by quantum gravity effects. We find that in case with the PQ mechanism the nucleon EDMs have a similar pattern regardless of what is the dominant source of EDMs among the CEDMs and θ-term, unless there is a significant cancellation between the contributions from different sources. In contrast, some nuclei or atomic EDMs can have characteristic patterns significantly depending on the dominant source of EDMs, which may allow identifying the dominant source among the CEDMs and θ-term. Yet, discriminating the gluon CEDM from the QCD θ-parameter necessitates additional knowledge of low energy parameters induced by the gluon CEDM, which is not available at the moment. Our results imply that EDMs can reveal unambiguous sign of CEDMs while identifying the origin of the axion vacuum value, however it requires further knowledge of low energy parameters induced by the gluon CEDM.

Orateur: IM, Sang Hui (IBS-CTPU-PTC)

ID de Contribution: **49** Type: **Non spécifié**

Axion-like particle production from □ meson annihilation decay

vendredi 9 août 2024 10:30 (20 minutes)

Orateur: MARCANTONIO, Daniel (University of Melbourne)

ID de Contribution: **50** Type: **Non spécifié**

Interplay of ALP couplings at a future muon collider

mercredi 7 août 2024 11:45 (20 minutes)

A future muon collider with TeV scale center of mass energy can provide a clean high-energy environment with advantages in searches for TeV-scale axion like particles (ALPs). Although the ALP couplings with the electroweak vector bosons have been considered in the literature at depth, its direct couplings with fermions remain unexplored. Further, the interplay of ALP-gluon and ALP-fermion couplings dictate the ALP decay channels. It is found that a large parameter space of TeV-scale ALPs with TeV-scale decay constants can be probed by utilizing the ALP-top quark and gluon coupling.

Orateur: GIRMOHANTA, Sudhakantha (Tsung-Dao Lee Institute)

ID de Contribution: **51** Type: **Non spécifié**

ALP anarchy

mardi 6 août 2024 15:40 (30 minutes)

String theory models generically predict the existence of multiple axion-like particle (ALP) fields, which can act as both dark matter and dark energy as well as solving the strong CP problem. I will motivate and discuss the phenomenology of systems with multiple ALPs which can undergo oscillations akin to neutrino oscillations. I will explore this phenomenology in some of the leading ALP search strategies, including the CERN Axion Solar Telescope and the gamma-ray spectra of distant blazars. We find that ALP anarchy models can predict drastically different results than single ALP models.

Orateur: CHADHA-DAY, Francesca (IPPP Durham University)

ID de Contribution: **52** Type: **Non spécifié**

Small Instanton-induced Flavor Invariants and the Axion Potential

vendredi 9 août 2024 13:25 (20 minutes)

Small instantons which increase the axion mass due to an appropriate modification of QCD at a high energy scale, can also enhance the effect of CP-violating operators to shift the axion potential minimum by an amount induced-theta, which is severely constrained by neutron electric dipole moment experiments. In this talk, focusing on the dimension-six CP-odd operators in the Standard Model Effective Field Theory (SMEFT), we will introduce a new set of determinant-like flavor invariants that naturally arise in the instanton computation of the quantity induced-theta. We will show that these flavor invariants are useful for anticipating how CP-violating SMEFT operators participate in the instanton computations and for classifying the leading effects from the Wilson coefficients. More generally, the flavor invariants, together with an instanton Naive Dimensional Analysis, can be used to more accurately estimate small instanton effects in the axion potential that arise from any SMEFT ope rator and to conveniently probe the impact of different flavor assumptions on the bounds obtained from induced-theta. Eventually, we will present our recent development on the shift-breaking interactions between axions and SM particles generated by small instanton dynamics. Reference: arXiv: 2402.09361 (https://arxiv.org/abs/2402.09361)

Orateur: VUONG, Pham Ngoc Hoa (DESY)

ID de Contribution: **53** Type: **Non spécifié**

State of the art RF electronics readout for axion dark matter experiments

vendredi 9 août 2024 13:50 (20 minutes)

Axion haloscopes are the most promising method to search for dark matter, requiring with a wide coverage from hundreds of MHz up to hundreds of GHz. The detection principle proposed by Sikivie utilizes high quality resonators under a strong magnetic field and its sensitivity is significantly improved using cryogenic low-noise amplifiers. The Center for Axion and Precision Physics Research (CAPP) of the Institute for Basic Science (IBS) has designed readout systems based on Josephson parametric amplifiers (JPAs). These readout systems feature noise levels slightly exceeding the standard quantum noise limit. One limitation of a single JPA readout is the scanning frequency range of a single chip. At CAPP, we developed a new technique to extend the scanning range by effectively connecting several JPA chips in parallel. We present the operational principle and main parameters of this design, demonstrating that the noise temperature remains unaffected by the parallel connection. Furthermore, single photon counters can increase the sensitivity and scanning rate in axion experiments. We investigate the possibility of the use of the latest types of microwave photon counters based on biased Josephson junctions and zeptojoule nanobolometers. The detector concept can be applied to the signal variance method developed at CAPP to enhance experimental sensitivity. In this talk, we demonstrate the potential of using both readouts in axion haloscope search experiments and discuss the perspectives of the variance method approach.

Orateur: IVANOV, Boris (IBS-CAPP)

ID de Contribution: **54** Type: **Non spécifié**

Multiple QCD axions

vendredi 9 août 2024 14:15 (30 minutes)

How many QCD axions can there be? Can the standard ma-fa relation be modified without extra sources of PQ breaking? We will study in detail the possible masses and couplings to the nEDM of a multiple axion system. A novel sum rule linking multiple axion signals will be obtained and rigorously proved solely as a consequence of the PQ symmetry.
Based on: 2305.15465 [hep-ph] in collaboration with Belen Gavela and Maria Ramos.

Orateur: QUILEZ, Pablo (University of California San Diego)

ID de Contribution: **55** Type: **Non spécifié**

Search for new physics using a 129Xe-131Xe-Rb comagnetometer

vendredi 9 août 2024 10:55 (20 minutes)

In a compact 129Xe-131Xe-Rb comagnetometer, polarized Rb atoms are used both to hyperpolarize Xe atoms and to serve as an in-situ magnetometer to sense the nuclear spin signals of Xe atoms. We have used this comagnetometer to search for monopole-dipole interactions at the sub-millimeter range and at the Earth range. In both searches, we measure the ratio of nuclear spin-precession frequencies between 129Xe and 131Xe, and search for a correlated change of this ratio with either the movement of an external mass or the sensor orientation in the Earth gravitational field. The null results of both experiments set new upper limits on the coupling strength of aforementioned exotic interactions.

Orateur: SHENG, Dong (USTC)

ID de Contribution: **56** Type: **Non spécifié**

Theoretical conclusion

vendredi 9 août 2024 15:15 (20 minutes)

Orateur: CHOI, Kiwoon (IBS)

ID de Contribution: **57** Type: **Non spécifié**

Experimental conclusion

vendredi 9 août 2024 15:40 (20 minutes)

Orateur: YOUN, SungWoo (IBS-CAPP)

ID de Contribution: **58** Type: **Non spécifié**

Farewell

vendredi 9 août 2024 16:05 (10 minutes)

Orateur: PIGNOL, Guillaume (LPSC)

ID de Contribution: **59** Type: **Non spécifié**

Excursion

ID de Contribution: **60** Type: **Non spécifié**

Welcome address

lundi 5 août 2024 08:30 (1 heure)

Orateurs: RIPP-BAUDOT, Isabelle (IPHC, CNRS/IN2P3); TRAN THANH VAN, Jean