Zooming in on Axions in the Early Universe

Report of Contributions

https://indico.cern.ch/e/923834

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

Welcome & Introduction

Monday 22 June 2020 09:45 (15 minutes)

Welcome and introduction to the workshop. I explain our motivation for organizing a virtual workshop, outline the workshop program, introduce our Virtual Axion Institute on Mattermost, and explain our poster sessions.

Presenter: SCHMITZ, Kai (CERN)

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

1. QCD axion dark matter and PBH, 2. Anomaly-free ALP DM and XENON1T

Monday 22 June 2020 10:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Fuminobu's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/fuminobu-takahashi

Abstract: In the first part, I will present a scenario in which PBHs are formed from the QCD axion. If I have time, I will touch on anomaly-free ALP DM (2006.10035, 1403.7390) as well.

Presenter: TAKAHASHI, Fuminobu (Tohoku University)

Session Classification: Dark matter

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

Morning coffee in the Virtual Axion Institute

Monday 22 June 2020 11:00 (1 hour)

(*) Stay in the main Zoom room and have a face-to-face chat with the other participants.
https://cern.zoom.us/j/7930190483 (password: see email)

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(*) Start your own Zoom meeting, announce it in the Virtual Axion Institute, and invite other participants.

Session Classification: Dark matter

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

Afternoon coffee in the Virtual Axion Institute

Monday 22 June 2020 14:00 (1 hour)

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Session Classification: Dark matter

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

Fragmentation of axion-like particle dark matter and observational signatures

Monday 22 June 2020 13:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Aleksandr's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/aleksandr-chatrchyan

Abstract: Light scalar fields, such as axion-like particles, are appealing candidates for dark matter, if produced via the vacuum misalignment mechanism. Due to their small mass, they usually feature large field values, which can give rise to nonperturbative dynamics and fragmentation of the field soon after the onset of oscillations. We investigate this process on the example of monodromy axions, where the discrete shift symmetry is explicitly broken. We confirm the viability of such fields as dark matter for a wide range of masses. Fragmentation imprints strong overdensities in the spatial distribution of the field and we demonstrate that the small size of these fluctuations prevents their collapse into miniclusters. We also calculate the stochastic gravitational wave background that is produced from this process. In some cases the resulting signal may be within reach of future detectors, allowing a complementary probe of this type of dark matter.

Presenter: CHATRCHYAN, Aleksandr (ITP Heidelberg)

Session Classification: Dark matter

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

Phenomenology of the meV QCD axion

Monday 22 June 2020 15:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in David's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/david-j-e-marsh

Abstract: If the Peccei-Quinn symmetry is broken after inflation, then the preferred axion mass required for the DM relic density is of order 1 meV. In this scenario, "axion miniclusters" form in the early Universe, and have potentially observable effects in microlensing. I will describe a new method to compute the mass function and radial distribution function of miniclusters based on the excursion set. The meV axion is particularly challenging for direct detection. I will outline progress on the "TOORAD"proposal to detect meV axions with topological insulators.

Presenter: MARSH, David J. E. (University of Goettingen)

Session Classification: Dark matter

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

Posters: Fernando Arias Aragón, Mario Reig, Raymond Co, Michael Fedderke

Monday 22 June 2020 17:00 (1 hour)

We will have the following poster presentations in the main Zoom room:
https://cern.zoom.us/j/7930190483 (password: see email)

(1) Fernando Arias Aragón
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/fernando-arias-aragon

(2) Mario Reig
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/mario-reig

(3) Raymond Co
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/raymond-co

(4) Michael Fedderke (moved to Friday)
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/michael-fedderke

The discussion on the individual posters can be continued in the respective virtual guest offices.

Presenters: ARIAS ARAGÓN, Fernando (Universidad Autónoma de Madrid); REIG, Mario (Instituto de Física Corpuscular (IFIC)); Dr CO, Raymond (University of Michigan); Dr FEDDERKE, Michael (Stanford University)

Session Classification: Posters

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

Axion kinetic misalignment and baryogenesis

Monday 22 June 2020 16:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Keisuke's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/keisuke-harigaya

Abstract: We will introduce a new cosmological evolution of the QCD axion and an axion-like particle, where the axion field circulates in the potential. Axion dark matter is produced by kinetic misalignment, which allows for a decay constant much below the prediction of the conventional evolutions. The new axion dynamics creates the baryon asymmetry of the universe. In the minimal scenario, which we call axiogenesis, the coupling strength of the axion to standard model particles is predicted as a function of the axion mass. The predicted range is within reach of future experimental axion searches. The lepton number violation by Majorana neutrino masses may aid the baryogenesis scheme. In this scenario, which we call lepto-axiogenesis, we instead obtain a prediction on the mass of the Peccei-Quinn symmetry breaking field, which, in supersymmetric theories, is tied with the masses of super partners.

Presenter: HARIGAYA, Keisuke (Institute for Advaned Study)

Session Classification: Dark matter

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

Lattice formulation of axion inflation: application to preheating

Tuesday 23 June 2020 10:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Daniel's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/daniel-figueroa

Abstract: I will present a lattice formulation of an interaction $\phi F\tilde{F}$ between an axion and a $U(1)$ gauge sector, with the following properties: it reproduces the continuum theory up to $\mathcal{O}(dx_\mu^2)$, it preserves exact gauge invariance and shift symmetry on the lattice, and it is suitable for self-consistent expansion of the Universe. I will discuss an implicit method to solve the lattice equations of motion, which preserves the relevant system constraints down to arbitrary (tunable) precision. We then apply our formalism to study the last efolds of axion-inflation with quadratic potential, and the preheating stage following afterwards. We fully account for the inhomogeneity and non-linearity of the system, including the gauge field contribution to the expansion rate of the Universe and its backreaction into the axion dynamics. We characterize in detail, as a function of the coupling, the energy transfer from the axion to the gauge field, identifying two coupling regimes: sub- and super-critical, depending on whether the final energy fraction stored in the gauge field is below or above $\sim 50\%$ of the total energy. The Universe is very efficiently reheated for super-critical couplings, reassuring previous results with less advanced lattice techniques.

Presenter: FIGUEROA, Daniel G. (IFIC, Valencia)

Session Classification: Gauge fields

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

Morning coffee in the Virtual Axion Institute

Tuesday 23 June 2020 11:00 (1 hour)

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Session Classification: Gauge fields

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

Afternoon coffee in the Virtual Axion Institute

Tuesday 23 June 2020 14:00 (1 hour)

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Session Classification: Gauge fields

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

Equilibration of the chiral asymmetry due to finite electron mass

Tuesday 23 June 2020 13:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Oleksandr's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/oleksandr-sobol

Abstract: One of the possible ways to generate the comological magnetic fields is based on the chiral magnetic effect. In plasma with chiral imbalance, it drives the instability which leads to the enhancement of some long-range magnetic modes of one helicity. In this respect, a very important question for magnetogenesis is how does this chiral imbalance evolve in time. In particular, how fast does it decay due to the chirality flipping processes in plasma? We calculate this rate due to nonzero electron mass in hot electron-positron plasma at temperatures well below the electroweak crossover. We consider the electron mass as a perturbation and apply the linear response formalism in order to extract the leading (quadratic in mass) contribution to the chirality-flipping rate. We show that this rate appears already in the first order in EM coupling constant and the numerical result is three orders of magnitude greater than the previous naive estimates.

Presenter: SOBOL, Oleksandr (EPFL)

Session Classification: Gauge fields

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

Two talks on axion-SU(2) inflation (Ira Wolfson, Leila Mirzagholi)

Tuesday 23 June 2020 15:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 20 minutes talk + 10 min discussion + 20 minutes talk + 10 min discussion

Virtual Axion Institute: The discussion on both talks can be continued in Ira's and Leila's virtual guest offices.
https://mattermost.web.cern.ch/axions/channels/ira-wolfson
https://mattermost.web.cern.ch/axions/channels/leila-mirzagholi

Ira Wolfson: "Here be dragons": no-go areas in the axion-SU(2) chromo-natural model, and the spectator model solution
Abstract: The axion-SU(2) chromo-natural model, proposed in [1,2] presents an attractive phenomenological inflationary model. Unlike other such models it is more stable due to the SU(2)˜SO(3) homomorphism, that in some cases allows the generation of 60 efolds or more. These models are interesting since they produce a distinct chiral tensor radiation signature, while also possibly explaining the matter-antimatter disparity in the early universe. Previous works [3,4] have probed part of its initial condition phase space, and shown a significant basin of attraction to an attractor solution. This brings up the question: How attractive is the isotropic attractor solution of axion-SU(2) inflation? We probe a previously unexplored part of the initial condition phase space and reveal regions where the system fails to converge on the attractor solution. We call this area the "no-go" area, and we study its characteristics. We continue to study a version of the axion-SU(2) model in which the axion and gauge sectors are demoted to spectator status. We show that while the basin of attraction to the attractor solution becomes larger with further dominance of the inflaton sector over the axion's and gauge fields', the "no-go" area persists albeit in a more contained fashion. The talk is based on I.W., Azadeh Maleknejad, and Eiichiro Komatsu, 2003.01617.

Leila Mirzagholi: Effects of gravitational Chern-Simons term during axion-SU(2) inflation
Abstract: I discuss the effect of the gravitational Chern-Simons term coupled to the axion field on the production and propagation of gravitational waves during inflation with the spectator axion-SU(2) sector. Both parity-violating terms RR-tilde and FF-tilde exist simultaneously and should be effectively considered on the same level in the theory. Using the existing bounds on the parameters of the spectator axion-SU(2) gauge field sector and choosing reasonable cut-off scales, we put constraints on the new free parameter in our model to remain in the ghost-free regime.

[1] A. Maleknejad and M. M. Sheikh-Jabbari, Phys. Lett. B 723 (2013) 224 [1102.1513].
[2] A. Maleknejad and M. M. Sheikh-Jabbari, Phys. Rev. D 84 (2011) 043515 [1102.1932].
[3] E. Dimastrogiovanni and M. Peloso, Phys. Rev. D 87 (2013) 103501 [1212.5184].
[4] P. Adshead, E. Martinec and M. Wyman, Phys. Rev. D 88 (2013) 021302 [1301.2598].

Presenters: WOLFSON, Ira (Max-Planck-Institute for Astrophysics, Garching); MIRZAGHOLI, Leila (Max Planck Institute for Astrophysics, Garching)

Session Classification: Gauge fields

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

Posters: Tanmay Poddar, Yuta Hamada, Pablo Quílez, Alexandros Papageorgiou

Tuesday 23 June 2020 17:00 (1 hour)

We will have the following poster presentations in the main Zoom room:
https://cern.zoom.us/j/7930190483 (password: see email)

(1) Tanmay Poddar
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/tanmay-poddar

(2) Yuta Hamada
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/yuta-hamada

(3) Pablo Quílez
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/pablo-quilez

(4) Alexandros Papageorgiou
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/alexandros-papageorgiou

The discussion on the individual posters can be continued in the respective virtual guest offices.

Presenters: PODDAR, Tanmay (Physical Research Laboratory); HAMADA, Yuta (APC Paris); Dr QUILEZ LASANTA, Pablo (DESY); PAPAGEORGIOU, Alexandros (University of Minnesota)

Session Classification: Posters

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

Thermal friction in early cosmology

Tuesday 23 June 2020 16:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Kim's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/kim-berghaus

Abstract: Rolling scalar fields play an important role in understanding cosmology within a particle physics framework. Coupling a rolling scalar field to light degrees of freedom gives rise to a thermal friction which, if large enough, induces a thermal bath. In the context of inflation the presence of such a thermal bath has compelling consequences as it significantly alters the usual observables, leading to a suppression of the tensor-to-scalar ratio r and a unique prediction for non-gaussianities. In my talk, I will illuminate why the axion of a non-Abelian gauge group is the ideal candidate for generating the thermal friction and how it sets the stage for a minimal setup of warm inflation, as well as a potential solution to the Hubble tension.

Presenter: BERGHAUS, Kim (Johns Hopkins University)

Session Classification: Gauge fields

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

Big bounce baryogenesis

Wednesday 24 June 2020 10:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Neil's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/neil-barrie

Abstract: We explore the possibility of an Ekpyrotic contraction phase harbouring a mechanism for Baryogenesis. A Chern-Simons coupling between the fast-rolling Ekpyrotic scalar and the Standard Model Hypercharge gauge field enables the generation of a non-zero helicity during the contraction phase. The baryon number subsequently produced at the Electroweak Phase Transition is consistent with observation for a range of couplings and bounce scales. Simultaneously, the gauge field production during the contraction provides the seeds for galactic magnetic fields and sources gravitational waves, which may provide additional avenues for observational confirmation.

Presenter: BARRIE, Neil (Kavli IPMU)

Session Classification: Baryogenesis

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

Morning coffee in the Virtual Axion Institute

Wednesday 24 June 2020 11:00 (1 hour)

(*) Stay in the main Zoom room and have a face-to-face chat with the other participants.
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Session Classification: Baryogenesis

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

Towards a robust estimate for gravitational leptogenesis

Wednesday 24 June 2020 13:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Kohei's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/kohei-kamada

Abstract: In axion inflation, we can consider the anomalous coupling between the axion and gravity through the Chern-Simons term, which can generate chiral gravitational waves. Lepton asymmetry is also produced via the gravitational chiral anomaly at the same time, with which we can expect for the explanation of the present matter-anti matter asymmetry of the Universe. However, there still remain unclear issues in this model, such as the ghost-like degree of freedom and the UV divergences. In this talk, I will explain these issues in depth and determine with which conditions the present baryon asymmetry is explained.

Presenter: KAMADA, Kohei (Research Center for the Early Universe, University of Tokyo)

Session Classification: Baryogenesis

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

Afternoon coffee in the Virtual Axion Institute (Tanmay Poddar, Raymond Co)

Wednesday 24 June 2020 15:00 (1 hour)

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Presentations in virtual guest offices (in parallel):

(*) Tanmay Poddar
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/tanmay-poddar
Zoom meeting: https://us04web.zoom.us/j/71066215138 (details: see guest office)

(*) Raymond Co
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/raymond-co
Zoom meeting: https://umich.zoom.us/j/98155673494 (details: see guest office)

Presenters: PODDAR, Tanmay (Physical Research Laboratory); CO, Raymond (University of Michigan)

Session Classification: Baryogenesis

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

A unfied model of dark energy, dark matter and baryogenesis (TH Colloquium)

Wednesday 24 June 2020 14:00 (1 hour)

TH Colloquium: https://indico.cern.ch/event/925915/

Zoom meeting: https://cern.zoom.us/j/97792556765?pwd=TVRXTkpQKytibGN4RkxKYzJKUHhWZz09

Virtual Axion Institute: The discussion on this talk can be continued in Robert's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/robert-brandenberger

Abstract: I discuss a model involving a self-interacting complex axion field whose imaginary part, a pseudo-scalar axion, couples to the instanton density of gauge fields including the hypermagnetic field. This coupling may give rise to baryogenesis in the early universe. After tracing out the gauge and matter degrees of freedom, a non-trivial effective potential for the imaginary part of the axion field is obtained. It is proposed that oscillations of this component around a minimum of its effective potential can be interpreted as Dark Matter. The absolute value of the axion field rolls slowly towards infinity. At late times, it can give rise to Dark Energy.

Presenter: BRANDENBERGER, Robert (McGill University)

Session Classification: Seminar

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

Baryogenesis from axion inflation

Wednesday 24 June 2020 16:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Benedict's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/benedict-von-harling

Abstract: The coupling of an axion-like particle driving inflation to the Standard Model particle content through a Chern-Simons term generically sources a dual production of massless helical gauge fields and chiral fermions. We demonstrate that the interplay of these two components results in a highly predictive baryogenesis model, which requires no further ingredients beyond the Standard Model. If the helicity stored in the hyper magnetic field and the effective chemical potential induced by the chiral fermion production are large enough to avoid magnetic diffusion from the thermal plasma but small enough to sufficiently delay the chiral plasma instability, then the non-vanishing helicity survives until the electroweak phase transition and sources a net baryon asymmetry which is in excellent agreement with the observed value. If any of these two conditions is violated, the final baryon asymmetry vanishes. The observed baryon asymmetry can be reproduced if the energy scale of inflation is around H_inf ~ 10ˆ10 - 10ˆ12 GeV with a moderate dependence on inflation model parameters.

Presenter: VON HARLING, Benedict (IFAE)

Session Classification: Baryogenesis

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

Posters: Sang Hui Im, Jacob Leedom, Thomas Schwetz, Yuki Watanabe

Wednesday 24 June 2020 17:00 (1 hour)

We will have the following poster presentations in the main Zoom room:
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(1) Sang Hui Im
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/sang-hui-im

(2) Jacob Leedom
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/jacob-leedom

(3) Thomas Schwetz
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/thomas-schwetz

(4) Yuki Watanabe
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/yuki-watanabe

The discussion on the individual posters can be continued in the respective virtual guest offices.

Presenters: Dr IM, Sang Hui (IBS-CTPU); LEEDOM, Jacob (University of California, Berkeley); SCHWETZ, Thomas (Karlsruhe Institute of Technology); WATANABE, Yuki (Max Planck Institute for Astrophysics)

Session Classification: Posters

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

Probing the relaxed relaxion with luminosity & S1 and S2

Thursday 25 June 2020 10:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Gilad's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/gilad-perez

Abstract: Cosmological relaxation of the electroweak scale is an attractive scenario addressing the gauge hierarchy problem. Its main actor, the relaxion, is a light spin-zero field which dynamically relaxes the Higgs mass with respect to its natural large value. We show that the relaxion is generically stabilized at a special position in the field space, which leads to suppression of its mass and potentially unnatural values for the model's effective low-energy couplings. In particular, we find that the relaxion mixing with the Higgs can be several orders of magnitude above its naive naturalness bound. Low energy observers may thus find the relaxion theory being fine-tuned although the relaxion scenario itself is constructed in a technically natural way. More generally, we identify the lower and upper bounds on the mixing angle. We examine the experimental implications of the above observations at the luminosity and solar-direct-detection frontiers.

Presenter: Prof. PEREZ, Gilad (Weizmann)

Session Classification: Naturalness

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

Morning coffee in the Virtual Axion Institute (Thomas Schwetz)

Thursday 25 June 2020 11:00 (1 hour)

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Presentations in virtual guest offices:

(*) Thomas Schwetz
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/thomas-schwetz
Zoom meeting: https://zoom.us/j/92414190410 (password: see guest office)

Presenter: SCHWETZ, Thomas (Karlsruhe Institute of Technology)

Session Classification: Naturalness

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

Afternoon coffee in the Virtual Axion Institute (Alexandros Papageorgiou)

Thursday 25 June 2020 15:00 (1 hour)

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(*) Alexandros Papageorgiou (Office hours / Q&A session)
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/alexandros-papageorgiou
Zoom meeting ID: 927 1806 9143 (details: see guest office)

Presenter: PAPAGEORGIOU, Alexandros (University of Minnesota)

Session Classification: Naturalness

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

Revisiting the relaxion mechanism

Thursday 25 June 2020 13:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Geraldine's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/geraldine-servant

Abstract: Five years ago, a new mechanism was proposed to address the Higgs mass hierarchy problem through the cosmological evolution of an axion particle, the "relaxion". I will discuss several stopping mechanisms for the relaxion, in particular the effect of axion fragmentation that was omitted in the former literature. I will present the implications for the relaxion parameter space and which new opportunities for model building are opened.

Presenter: SERVANT, Geraldine (DESY and U. Hamburg)

Session Classification: Naturalness

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

A CMB Millikan experiment with cosmic axiverse strings

Thursday 25 June 2020 16:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Anson's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/anson-hook

Abstract: We study axion strings of hyperlight axions coupled to photons. These axions strings produce a distinct quantized polarization rotation of CMB photons which is O(1%). As the CMB light passes many strings, this polarization rotation converts E-modes to B-modes and adds up like a random walk. Using numerical simulations we show that the expected size of the final result is well within the reach of current and future CMB experiments through the measurement of correlations of CMB B-modes with E- and T-modes. The quantized polarization rotation angle is topological in nature and its value depends only on the anomaly coefficient, independent of other details such as the axion decay constant. Measurement of the anomaly coefficient provides information about the UV theory, such as the quantization of electric charge and the value of the fundamental unit of charge. The presence of axion strings in the universe relies only on a phase transition in the early universe after inflation, after which the string network rapidly approaches an attractor scaling solution. The existence of these strings could also be probed by measuring the relative polarization rotation angle between different images in gravitationally lensed quasar systems.

Presenter: HOOK, Anson (University of Maryland)

Session Classification: Naturalness

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

Posters: Enrico Morgante, James Alvey, Alexis Plascencia, Ogan Ozsoy

Thursday 25 June 2020 18:00 (1 hour)

We will have the following poster presentations in the main Zoom room:
https://cern.zoom.us/j/7930190483 (password: see email)

(1) Enrico Morgante
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/enrico-morgante

(2) James Alvey
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/james-alvey

(3) Alexis Plascencia
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/alexis-plascencia

(4) Ogan Ozsoy
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/ogan-ozsoy

The discussion on the individual posters can be continued in the respective virtual guest offices.

Presenters: MORGANTE, Enrico (JGU Mainz); ALVEY, James (King's College London); PLASCENCIA, Alexis (Case Western Reserve University); OZSOY, Ogan (University of Warsaw)

Session Classification: Posters

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

The axidental Universe

Thursday 25 June 2020 17:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Matthew's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/matthew-kleban

Abstract: Theories of N axion fields with random potentials have a number of distinct meta-stable minima that scales super-exponentially with N. This makes large N axion theories extremely complex "landscapes"that are could provide a solution to the cosmological constant problem. Despite this extraordinary complexity, novel techniques exist that make these theories analytically and computationally tractable. For N˜100s and with Planckian or GUT/string energy scales and random parameters, there are many minima with vacuum energy consistent with observed dark energy (as well as very many more with larger positive or negative values). These minima are long-lived, and decay via thin-wall Coleman de Luccia phase transitions only to ˜N nearby neighbors. This landscape supports a variety of types of slow-roll inflation, and tunneling can be followed by inflation of roughly quadratic type, with density perturbations that have amplitude ˜10ˆ{-5} in this same random parameter regime. They naturally contain one or more light fields that can solve the strong CP problem and serve as fuzzy or QCD axion dark matter. The minimal anthropic requirement that structure forms somewhere/sometime singles out cosmological histories that tunnel and then undergo ˜60 efolds of inflation post-tunneling. Hence, a theory of ˜100s axions, without model building and with only GUT-scale random parameters, naturally produces large universes with histories very much like that of our own, including a big bang (tunneling), slow-roll inflation, dark matter, and dark energy.

Presenter: KLEBAN, Matthew (New York University)

Session Classification: Naturalness

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

Primordial GWs from the axion-SU(2) gauge fields during inflation

Friday 26 June 2020 13:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Tomohiro's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/tomohiro-fujita

Abstract: Having on-going and upcoming experiments to detect them, we hope primordial gravitational waves (PGW) will be observed in the near future. PGWs produced during inflation are the unique probe for very high energy physics beyond the reach of particle accelerators, and now is the time to study what we can learn from PGWs. In this talk, I will demonstrate that much more information than the energy scale of inflation can be extracted from PGWs by using a model as an example. In the model, SU(2) gauge fields coupled to a rolling axion during inflation generate detectable PGWs, which are non-gaussian, maximally chiral, and may have non-trivial spectral shape depending on the axion potential.

Presenter: FUJITA, Tomohiro (ICRR, Tokyo University)

Session Classification: Gravitational waves

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

1. Spontaneous Lepto/Baryogenesis & 2. Schwinger effect and Chiral anomaly

Friday 26 June 2020 10:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Kyohei's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/kyohei-mukaida

Presenter: MUKAIDA, Kyohei (DESY)

Session Classification: Gravitational waves

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

Afternoon coffee in the Virtual Axion Institute (Sang Hui Im, Alexis Plascencia, Ogan Ozsoy)

Friday 26 June 2020 15:00 (1 hour)

(*) Stay in the main Zoom room and have a face-to-face chat with the other participants.
https://cern.zoom.us/j/7930190483 (password: see email)

(*) Visit our Virtual Axion Institute and have a chat with the other participants in the coffee room:
https://mattermost.web.cern.ch/axions/

(*) Have a look at the posters on our pinboard:
https://mattermost.web.cern.ch/axions/channels/pinboard

(*) Visit the speakers and poster presenters in their virtual guest offices and continue the discussion on their presentations.

(*) Start your own Zoom meeting, announce it in the Virtual Axion Institute, and invite other participants.

Presentations in virtual guest offices (in parallel):

(*) Sang Hui Im
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/sang-hui-im
Zoom meeting: https://us04web.zoom.us/j/6220520198 (password: see guest office)

(*) Alexis Plascencia
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/alexis-plascencia
Zoom meeting: https://cwru.zoom.us/j/93939002270 (password: see guest office)

(*) Ogan Ozsoy
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/ogan-ozsoy
Zoom meeting: https://us04web.zoom.us/j/2406288112 (password: see guest office)

Presenters: IM, Sang Hui (IBS-CTPU); PLASCENCIA, Alexis (Case Western Reserve University); OZSOY, Ogan (University of Warsaw)

Session Classification: Gravitational waves

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

GWs from axion preheating and SGWB reconstruction at LISA

Friday 26 June 2020 14:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Mauro's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/mauro-pieroni

Abstract: The talk is divided in two independent parts. I will first discuss models in which a pseudoscalar (axion) inflaton is non-minimally coupled with some (Abelian) gauge fields. In particular, I will show that the efficiency of gravitational wave production during preheating can be used to set stringent constraints on the axion/gauge field coupling. In the second part of the talk I will discuss model independent reconstruction of stochastic gravitational wave backgrounds (SGWB) at LISA. After a brief introduction of the topic, I will discuss a recently proposed approach based on principal components analysis.

Presenter: PIERONI, Mauro (Imperial College London)

Session Classification: Gravitational waves

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

Gravitational wave probes of axion-like particles

Friday 26 June 2020 16:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Format: 40 minutes talk + 20 min discussion

Virtual Axion Institute: The discussion on this talk can be continued in Benjamin's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/benjamin-stefanek

Abstract: Conventional approaches to probing axions and axion-like particles (ALPs) typically rely on a coupling to photons. However, if this coupling is extremely weak, ALPs become invisible and are effectively decoupled from the Standard Model. Such particles, which are viable candidates for dark matter, can also produce a stochastic gravitational wave (GW) background in the early universe. This occurs if the axion couples to a dark gauge boson that experiences a tachyonic instability when the axion begins to oscillate. This instability exponentially amplifies vacuum fluctuations of a single dark photon helicity, resulting in a rapidly time-varying, anisotropic energy distribution that sources chiral GWs. We identify the regions of ALP parameter space which may be probed by future GW detectors, including ground- and space-based interferometers and pulsar timing arrays. Interestingly, these experiments have the ability to probe axions from the bottom up, i.e. in the very weakly coupled regime which is otherwise unconstrained. A smoking gun for the model is the completely chiral nature of the GW peak, which could be detected by LISA or Einstein Telescope if the signal amplitude is large. (40 minutes talk + 20 min discussion)

Presenter: STEFANEK, Benjamin A. (JGU Mainz)

Session Classification: Gravitational waves

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

Posters: Caner Ünal, Ashu Kushwaha, Michael Fedderke

Friday 26 June 2020 17:00 (1 hour)

We will have the following poster presentations in the main Zoom room:
https://cern.zoom.us/j/7930190483 (password: see email)

(1) Caner Ünal
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/caner-unal

(2) Ashu Kushwaha
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/ashu-kushwaha

(3) Michael Fedderke
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/michael-fedderke

The discussion on the individual posters can be continued in the respective virtual guest offices.

Presenters: ÜNAL, Caner (Czech Academy of Sciences); KUSHWAHA, Ashu (Indian Institute of Technology Bombay); FEDDERKE, Michael (Stanford University)

Session Classification: Posters

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

Morning coffee in the Virtual Axion Institute (Enrico Morgante)

Friday 26 June 2020 11:00 (1 hour)

(*) Stay in the main Zoom room and have a face-to-face chat with the other participants.
https://cern.zoom.us/j/7930190483 (password: see email)

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(*) Start your own Zoom meeting, announce it in the Virtual Axion Institute, and invite other participants.

Presentations in virtual guest offices:

(*) Enrico Morgante
Virtual guest office: https://mattermost.web.cern.ch/axions/channels/enrico-morgante

Presenter: MORGANTE, Enrico (JGU Mainz)

Session Classification: Gravitational waves

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

Happy Hour

Friday 26 June 2020 19:00 (2 hours)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Informal Happy Hour for everyone who wants to stick around. We won't provide any specific program; the idea simply is to chat a bit and have a drink together. However, if you wish to contribute to this Happy Hour in a particular way, e.g., by playing something on your guitar, teaching us your favorite cocktail recipe, or organizing a little pub quiz, please feel free to do so.

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

Pati-Salam axion (BSM Forum)

Thursday 25 June 2020 14:00 (1 hour)

BSM Forum: https://indico.cern.ch/event/917072

Zoom meeting: https://cern.zoom.us/j/99113688676

Virtual Axion Institute: The discussion on this talk can be continued in Luca's virtual guest office.
https://mattermost.web.cern.ch/axions/channels/luca-di-luzio

Abstract: I discuss the physics case for the GUT axion, motivated by the fact that the GUT axion window could be completely explored by the late phases of the axion Dark Matter experiments CASPEr-Electric and ABRACADABRA. This connection is exemplified for the case of the Pati-Salam partial unification scheme, in which the axion mass is predicted as a function of a sliding Left-Right symmetry breaking scale.

Presenter: DI LUZIO, Luca (DESY)

Session Classification: Seminar

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

Search for axions and axion-like particles with XENON1T

Friday 26 June 2020 18:00 (1 hour)

Zoom meeting: https://cern.zoom.us/j/7930190483 (password: see email)

Speaker: Michelle Galloway on behalf of the XENON1T Collaboration

Abstract: We present the latest results from a search for QCD axions from the Sun as well as axion-like particles of solar and dark matter origins. With an unprecedented low background of 76 ± 2 stat events/(tonne × year × keV) between 1–30 keV, XENON1T is uniquely poised to explore new parameter space for these electronic-recoil channels via the axio-electric effect. Our search revealed an excess of events in the (1 - 7) keV region, favoring these channels over background with significances of 3.5 sigma for solar axions/ALPs and 3.0 sigma global (4.0 local) for ALP dark matter with a peak at 2.3 +- 0.2 keV (68% C.L.). We review the detection principles, cross checks of our results, discrepancy with stellar constraints, and present a hypothesis of a new background from a previously undetected tritium component.

Presenter: GALLOWAY, Michelle (University of Zurich)

Session Classification: Seminar