Unraveling the Particle World and the Cosmos at Berkeley—Workshop in Honor of Lawrence Hall and Hitoshi Murayama

Report of Contributions

https://indico.physics.lbl.gov/e/2873

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

Welcome

Thursday, 26 September 2024 09:00 (5 minutes)

Presenter: KAHN, Steven

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

Atomic effects relevant in the scattering of high energy leptons (e.g., neutrinos or muons) off atomic electrons

Thursday, 26 September 2024 09:10 (40 minutes)

I discuss the scattering of high energy leptons off atomic electrons. The focus of the talk is on how the cross section for this process differs from the scattering off free electrons. This involves, atomic binding corrections, Coulomb exchanges between the outgoing energetic struck electron with the remaining atomic debris and other effects. This is not beyond the standard model (BSM) physics, but the results may be relevant for experiments that constrain possible BSM physics.

Title

Abstract

Presenter: WISE, Mark

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

Baryogenesis with only the Standard Model CP violation

Thursday, 26 September 2024 09:50 (40 minutes)

Mesogenesis with a Morphing Mediator (3M) is a new proposal for baryogenesis and dark matter production in which, contrary to common lore, the Standard Model CP violation is sufficient to generate the entire primordial asymmetry of matter over antimatter. Furthermore, the dark sector dynamics of this mechanism produce gravitational waves that can be probed with current and future Pulsar Timing Arrays. 3M-baryogenesis is based on Mesogenesis mechanisms which leverage the CP violation in charged or neutral Standard Model meson systems. I will first give an overview of existing mechanisms of Mesogenesis (their respective signals and features), and discuss general ongoing and proposed search strategies (at colliders, neutrino detectors and more), before introducing the new 3M mechanism.

Title

Abstract

Presenter: ELOR, Gilly

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

Quantum Devices for Model Builders

Thursday, 26 September 2024 11:50 (40 minutes)

Presenter: HARNIK, Roni

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

Remote session

Opportunity for remote participants to give their best wishes to Hitoshi and Lawrence

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

New Materials for Dark Matter Detection

Thursday, 26 September 2024 14:00 (40 minutes)

Title

Abstract

Presenter: HOCHBERG, Yonit

Contribution ID: **8** Type: **not specified**

Majorana versus Dirac, Beyond Neutrinoless Double-Beta Decay

Thursday, 26 September 2024 14:40 (40 minutes)

Presenter: DE GOUVEA, Andre

Contribution ID: **9** Type: **not specified**

Nu Physics in the LCDM Desert

Thursday, 26 September 2024 16:00 (40 minutes)

Presenter: WEINER, Neal

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

Dark matter detection using superconducting qubits

Thursday, 26 September 2024 16:40 (40 minutes)

Detection of wave-like dark matter using superconducting qubits is proposed. Due to their capacitive coupling with external electric fields, superconducting qubits are well-suited for detecting dark matter candidates such as hidden photons or axions, which induce effective electric fields. I will discuss the expected sensitivity in the search of these dark matter candidates using superconducting qubits as quantum sensors. I will also explore a possibility to enhance the signal rate with the help of the quantum coherence in qubits.

Presenter: MOROI, Takeo (U. Tokyo)

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

Exploring QCD-like dynamics with AMSB

Friday, 27 September 2024 09:00 (40 minutes)

Presenter: CSAKI, Csaba

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

Will we see light dark matter?

Friday, 27 September 2024 09:40 (40 minutes)

Presenter: PIERCE, Aaron

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

LOOKING FOR NEW PHYSICS IN THE MUD

Friday, 27 September 2024 10:50 (40 minutes)

Title

Abstract

Presenter: SCHUTZ, Katelin

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

Going Beyond the Standard Model

Friday, 27 September 2024 14:50 (40 minutes)

Presenter: RANDALL (REMOTE), Lisa

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

TBA

Friday, 27 September 2024 14:00 (10 minutes)

Presenter: Prof. WITHERELL, Mike (LBNL)

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

TBA

Friday, 27 September 2024 14:10 (40 minutes)

Presenter: DIMOPOULOS, Savas

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

Higgs and Z2 symmetry

Friday, 27 September 2024 16:10 (40 minutes)

Presenter: HARIGAYA, Keisuke

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

Spontaneous symmetry breaking and low-energy excitations in gapless frustration free systems.

Friday, 27 September 2024 11:30 (40 minutes)

Presenter: WATANABE, Haruki

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

TBA

Friday, 27 September 2024 16:50 (40 minutes)

Presenter: ARKANI-HAMED (REMOTE), Nima

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

How to Unitarize the Sommerfeld Enhancement

Saturday, 28 September 2024 09:00 (40 minutes)

Presenter: SLATYER, Tracy

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

New era in dark matter searches the dawn of the nuclear clocks

Saturday, 28 September 2024 09:40 (40 minutes)

Presenter: PEREZ, Gilad

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

TBA

Saturday, 28 September 2024 10:50 (40 minutes)

Presenter: RUDERMAN, Joshua

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

Impacts and Imprints of Axion Dynamics

Saturday, 28 September 2024 11:30 (40 minutes)

We discovered that the (QCD) axion's novel evolution, an oscillation or a rotation in field space, can address cosmological mysteries of the Universe. Oscillations can give rise to a new origin of dark matter via parametric resonance. Rotation dynamics may naturally arise as a result of quantum gravity effects and cosmic inflation. This talk will explore the example where axion rotations contribute to axion dark matter through kinetic misalignment and can generate the observed baryon asymmetry of the Universe via axiogenesis. Remarkably, rich phenomenology automatically arises with sharp, distinct, and correlated predictions, including stronger interactions, unique gravitational wave signals, correlated mass scales of supersymmetry and neutrinos, and dark matter gravitational lensing. Thus far, novel axion dynamics have added fuel to experimental efforts and paved new theory research avenues.

Title

Abstract

Presenter: CO, Raymond

Contribution ID: **24** Type: **poster**

Understanding Strongly Coupled Theories via AMSB

Historically, supersymmetry has been a fruitful tool in understanding the dynamics of strongly coupled gauge theories. But as SUSY breaking is introduced, one often loses the theoretical advantages that make such understanding possible, hindering the application of this progress to more general gauge theories. A particularly well-behaved kind of SUSY-breaking was developed by Professor Murayama (coincidentally, published the year I was born). This Anomaly-mediated SUSY Breaking (AMSB) enjoys UV-insensitivity, such that SUSY breaking effects are under control at all energy scales and in any description of the degrees of freedom. In recent years, Professor Murayama has initiated the use of AMSB as a tool for approximating non-SUSY gauge theories. It is proposed that there is some class of SUSY theories that can be continuously deformed into their non-SUSY counterparts without encountering a phase transition. I review my work with Professor Murayama in this pursuit, showing non-trivial consistency checks, first-principles derivations of known and new results in QCD-like theories, as well as early investigations into what kinds of theories for which the method fails.

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Primary author: NOETHER, Bea (UC Berkeley)

Presenter: NOETHER, Bea (UC Berkeley)

Contribution ID: **25** Type: **poster**

Strong CP and Flavor in Multi-Higgs Theories

The most well-known solutions to the Strong CP problem are arguably axion and Nelson-Barr models. A much lesser known class of solutions involves a simple extension of scalar sector of the Standard Model by at least one additional Higgs doublet. I review my recent work with Professor Hall, in which we develop a mechanism by which a combination of CP and flavor symmetry can simultaneously reproduce the masses, mixings, and CP-violating phase of the CKM matrix while giving sufficiently small contributions to $\bar{\theta}$ that are stable to radiative corrections.

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Primary author: NOETHER, Bea (UC Berkeley)

Presenter: NOETHER, Bea (UC Berkeley)

Contribution ID: **26** Type: **poster**

Probing High Energy Particle Physics with the Cosmic Gravitational Microwave Background

The thermal plasma in the early universe produced a guaranteed stochastic gravitational wave (GW) background, which peaks today in the microwave regime and was dubbed the cosmic gravitational microwave background (CGMB). The CGMB spectrum encodes fundamental information about particle physics and cosmology at ultra high energies. In particular, one can determine from the CGMB spectrum the maximum temperature of the universe and the effective degrees of freedom at the maximum temperature. This allows us to investigate particle physics models at these ultra-high energy scales. Additionally, quantum gravity effects are manifest in the CGMB spectrum as small corrections to the leading order result.

Title

Abstract

Primary author: SCHUETTE-ENGEL, Jan (UC Berkeley)

Presenter: SCHUETTE-ENGEL, Jan (UC Berkeley)

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

Welcome

Thursday, 26 September 2024 09:05 (5 minutes)

Presenter: ROE, Natalie

Contribution ID: **28** Type: **poster**

Constraining the Higgs Potential with Neural Simulation-based Inference for Di-Higgs Production

Determining the form of the Higgs potential is one of the most exciting challenges of modern particle physics. Higgs pair production directly probes the Higgs self-coupling and should be observed in the near future at the High-Luminosity LHC. We explore how to improve the sensitivity to physics beyond the Standard Model through per-event kinematics for di-Higgs events. In particular, we employ machine learning through simulation-based inference to estimate per-event likelihood ratios and gauge potential sensitivity gains from including this kinematic information. In terms of the Standard Model Effective Field Theory, we find that adding a limited number of observables can help to remove degeneracies in Wilson coefficient likelihoods and significantly improve the experimental sensitivity.

Title

Abstract

Primary authors: NACHMAN, Benjamin; MASTANDREA, Radha; PLEHN, Tilman

Presenter: MASTANDREA, Radha

Contribution ID: **29** Type: **poster**

Axion-Photon Sensitivity with NuSTAR Observations of M82 and M87

Ultra-light axions with weak couplings to photons are motivated extensions of the Standard Model. We perform one of the most sensitive searches to-date for the existence of these particles with the NuSTAR telescope by searching for axion production in stars in the M82 starburst galaxy and the M87 central galaxy of the Virgo cluster. This involves a sum over the full stellar populations in these galaxies when computing the axion luminosity, as well as accounting for the conversion of axions to hard X-rays via magnetic field profiles from simulated IllustrisTNG analogue galaxies. We find no evidence for axions, and instead set robust constraints on the axion-photon coupling at the level of $|g_{a\gamma\gamma}|$
$lesssim 6.4 \times 10^{-13}$ GeV^{-1} for m_a
$lesssim 10^{-10}$ eV at 95% confidence.

Title

Abstract

Primary authors: SAFDI, Benjamin (University of California, Berkeley); NING, Orion (University of California, Berkeley)

Presenter: NING, Orion (University of California, Berkeley)

Contribution ID: **30** Type: **poster**

String theory axion strings and QCD axion mass prediction

The QCD axion may solve the strong CP problem and constitute the dark matter (DM) abundance in our Universe. I discuss how the cosmology of string theory axions is fundamentally different from that of Peccei-Quinn (PQ) field theory axions. In particular, while field theory axions may form axion strings if the PQ phase transition occurs after inflation, string theory axions do not generically form strings. However, they may form in special inflationary paradigms such as brane inflation –in such cases I discuss what to expect for the QCD axion DM abundance and gravitational wave signals. Lastly, I discuss ongoing work to refine the computation of the QCD axion mass from the most precise and accurate lattice simulations to-date of axion-string networks.

Title

Abstract

Primary authors: Mr BENABOU, joshua; BUSCHMANN, Malte; BONNEFOY, Quentin; KUMAR, Soubhik; SAFDI, Benjamin

Presenter: Mr BENABOU, joshua

Contribution ID: **31** Type: **poster**

QCD Axion-Mediated Dark Matter

A QCD axion with a decay constant below 10^{11} GeV is a strongly-motivated extension to the Standard Model, though its relic abundance from the misalignment mechanism or decay of cosmic defects is insufficient to explain the origin of dark matter. Nevertheless, such an axion may still play an important role in setting the dark matter density if it mediates a force between the SM and the dark sector. In this work, we explore QCD axion-mediated freeze-out and freeze-in scenarios, finding that the axion can play a critical role for setting the dark matter density. Assuming the axion solves the strong CP problem makes this framework highly predictive, and we comment on experimental targets.

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Primary authors: Prof. DROR, Jeff; Mr MUNBODH, Pankaj; Prof. GORI, Stefania

Presenter: Mr MUNBODH, Pankaj

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

Gamma rays from supernova axions converting in stellar magnetic fields

Proto-neutron stars, formed in the center of Type-II supernovae, represent promising science targets for probing axions. The hypothetical particles are emitted via e.g. the Primakoff process and can modify the cooling rate of the proto-neutron stars and also convert to observable gamma rays while propagating through astrophysical magnetic field. Observations of Supernova 1987 (SN 1987A) from the Solar Maximum Mission (SMM) gamma-ray telescope have previously been used to set bounds on the axion-photon coupling. In this work, we present updated limits with SMM data by including nucleon-nucleon bremsstrahlung as an additional mechanism of axion production. We also consider a novel axion conversion mechanism in the progenitor magnetic field of SN 1987A. This allows constraining larger axion masses and smaller axion-photon couplings due to the stronger magnetic field of the progenitor star compared to the magnetic field of the Milky Way. We use these results to project the sensitivity of gamma-ray searches towards a future Galactic supernova with a proposed full-sky gamma-ray telescope network.

Title

Abstract

Primary authors: MANZARI, Claudio Andrea (LBNL); SAVORAY, Inbar (University of California, Berkeley); SAFDI, Benjamin (University of California, Berkeley); PARK, Yujin (University of California, Berkeley)

Presenter: PARK, Yujin (University of California, Berkeley)

Contribution ID: **33** Type: **poster**

Anomaly Mediated SUSY breaking in Sp(N) Gauge Theories

We present a careful study of the chiral symmetry breaking minima and other potential minima in supersymmetric symplectic QCD (Sp(N) with F flavors) perturbed by Anomaly Mediated Supersymmetry Breaking (AMSB). This is an application of "UV insensitive" AMSB as a tool for approximating non-SUSY gauge theories — an idea initiated by Professor Hitoshi Murayama. Although the case of F = N+1 requires particular care due to the inherently strongly coupled nature of the quantum modified moduli space, we are able to show that all Sp(N) theories to which AMSB can be applied (F < 3(N+1)) possess stable chiral symmetry breaking minima, which are plausibly continuously connected to the vacua of QCD-like Sp(N) theories for large SUSY breaking, and are protected from runaways to incalculable minima. Unlike SU(N) theories, here the runaway induced by 2-loop AMSB in the dual squark direction is naturally lifted by the tree level SUSY potential at the upper end of the free magnetic phase [1.43(N+1)
$lesssim$ F $\leq$ 1.5(N+1)] and the lower edge of the conformal window.

Title

Abstract

Primary authors: Mr ROY VARIER, Digvijay (University of California, Berkeley); Prof. MURAYAMA, Hitoshi (University of California, Berkeley)

Presenter: Mr ROY VARIER, Digvijay (University of California, Berkeley)

Contribution ID: **34** Type: **poster**

Loop-String-Hadron on Maximal Trees

We explain how to extend the Loop-String-Hadron formalism for hamiltonian lattice SU(2) gauge theory to general graphs. We apply this formalism to provide a loop interpretation to the maximal tree gauge-fixing procedure, providing a fully gauge fixed version of the theory. This has potential applications for quantum simulations of the theory.

Title

Abstract

Primary authors: BAUER, Christian (Lawrence Berkeley National Lab); BURBANO, Ivan (University of California, Berkeley)

Presenter: BURBANO, Ivan (University of California, Berkeley)

Contribution ID: **35** Type: **poster**

Search for dark matter annihilation in dwarf galaxies using Fermi gamma-ray data with simulation-based J-factors

Weakly interacting massive particles (WIMPs) produced through thermal freeze-out are a highly motivated dark matter (DM) candidate. Since WIMP DM acquired its relic abundance through self-annihilations, such particles must continue to annihilate to Standard Model final states and would produce observable signatures in astrophysical gamma-ray searches. In this work, we perform a search for WIMP annihilation in Milky Way dwarf galaxies with gamma-ray data from the Fermi Large Area Telescope. In particular, we improve upon previous searches by inferring astrophysical J-factors for dwarf galaxies using the SatGen semi-analytic satellite galaxy generator.

Title

Abstract

Primary authors: SAFDI, Benjamin (University of California - Berkeley); FOLSOM, Dylan (Princeton University); RAMAN, Kailash (University of California - Berkeley); KAPLINGHAT, Manoj (University of California - Irvine); LISANTI, Mariangela (Princeton University); PARK, Yujin (University of California - Berkeley)

Presenter: RAMAN, Kailash (University of California - Berkeley)

Contribution ID: **36** Type: **poster**

Wrinkles in the Froggatt-Nielsen Mechanism and Flavorful New Physics

In this poster we discuss using flavor to probe physics beyond the Standard Model. We discuss the use of Froggatt-Nielsen (FN) models for explaining the Standard Model flavor hierarchy and define wrinkles, extra suppression or enhancement factors which modify the expected scaling of coupling sizes from FN models. We show how wrinkles can change the expected size of couplings to new physics in FN models, and how they naturally appear in UV models, as well as discuss the example of the recent B->K\nu\nu measurement. We also briefly mention recent work illustrating the complementarity between future muon colliders and precision experiments for probing lepton flavor violation.

Title

Abstract

Primary author: FRASER, Katherine (UC Berkeley)

Presenter: FRASER, Katherine (UC Berkeley)

Contribution ID: **37** Type: **poster**

Multiphonon Processes in Spin-Dependent Dark-Matter Scattering

As nuclear recoil direct detection experiments carve out more and more dark matter parameter space in the WIMP mass range, the need for searches probing lower masses has become evident. Since lower dark matter masses lead to smaller momentum transfers, we can look to the low momentum limit of nuclear recoils: phonon excitations in crystals. Single phonon experiments promise to eventually probe dark matter masses lower than 1 MeV. However the slightly higher mass range of 10-100 MeV can be probed via multiphonon interactions and importantly, do not require as low of experimental thresholds to make a detection. In this work, we analyze spin dependent dark matter scattering in crystals via multiphonon excitations. We consider several likely EFT operators and describe the future prospects of experimentation for finding dark matter via this method. Our results are implemented in the python package DarkELF and can be straightforwardly generalized to other spin dependent EFT operators.

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Primary author: SUTER, Bethany (UC Berkeley)

Co-authors: MUNBODH, Pankaj (University of California Santa Cruz); KNAPEN, Simon; GORI, Stefania; LIN, Tongyan

Presenter: SUTER, Bethany (UC Berkeley)

Contribution ID: **38** Type: **poster**

Fiat Lux: A Physics Survey Course Focusing on Light

I use the common phenomenon of light (electromagnetic radiation) to present a survey of modern physics. Five chapters are high-school level (how far is the moon, color perception, polarization), six are college level (Maxwell's equations, relativity, quantum, thermodynamics), and six are graduate level (Yang-Mills, cosmology, field theory, Feynman diagrams). The book covers only solidly established mainstream physics (except for chapter 17). It is available as a free PDF download, with embedded hyperlinks to Wikipedia.

Title

Abstract

Primary author: Dr BRAHM, David (UCB Alum)

Presenter: Dr BRAHM, David (UCB Alum)

Contribution ID: **39** Type: **poster**

The Geometric Universal One-Loop Effective Action

The field space geometry of two-derivative scalar effective field theories presents a universal structure and introduces geometric covariance through non-derivative field redefinitions. This geometric covariance enables the calculation of the effective action in a covariant manner. In this paper, we extend the geometric covariance to the EFT functional matching problem. While the entire covariance is broken during the matching calculation, we develop a geometric covariant derivative expansion method to evaluate the effective Lagrangian while preserving subcovariance. A universal result is obtained using the geometrized method, which is subsequently applied to the sigma models and singlet extended Standard Model. The results obtained are consistent with conventional matching calculations, and the geometrized method provides a novel perspective on the EFT matching problem.

Title

Abstract

Primary author: LI, Xu-Xiang

Co-authors: ZHANG, Zhengkang; LU, Xiaochuan

Presenter: LI, Xu-Xiang